Conservation of Iranian Wetlands Project

A Concise Baseline Report

Lake Uromiyeh

Compiled and written by: A. Lotfi
Edited by : Dr. M. Moser
November 2012

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Abbriviations

CHTHO	Cultural Heritage, Tourism and Handicraft Organization of IRI
CIWP	Conservation of Iranian Wetlands Project
DOE	Department of Environment of IRI
EAECO	East Azerbaijan Environmental Conservation Office
EAJAO	East Azerbaijan Jihad Agriculture Organization
EAWA	East Azerbaijan Water Authority
EHC	Environmental Higher Council
En	Endangered
GEF	Global Environmental Facility
IUCN	World Conservation Union
IWRM	Integrated Water Resources Management
LR	Lower Risk
MECO	Mahabad Environmental Conservation Office
MOE	Ministry of Energy of IRI
MOJA	Ministry of Jihad Agriculture of IRI
NECO	Naghadeh Environmental Conservation Office
NGO	Non Governmental Organizations
PCDC	Provincial Council for Development Planning
UNEP	United Nations Environmental Program
Vu	Vulnerable
WAECO	West Azerbaijan Environmental Conservation Office
WAJAO	West Azerbaijan Jihad Agriculture Organization
WAWA	West Azerbaijan Water Authority
WI	Wetlands International
WRI	Water Research Institute
WWF	World Wide Fund for Nature

1. INTRODUCTION

Lake Uromiyeh (5000 km2) is a vast hypersaline lake in NW Iran, shared between the provinces of East and West Azerbaijan. It lies at the lowest point within a closed drainage basin of about 52000 km2, a smaller part of which lies in the Kordistan province. The Lake is a National Park, is the largest inland lake in Iran, is one of the largest Iranian Ramsar Sites, and in 1976 was recognized by UNESCO as a Biosphere Reserve. The Lake is surrounded by a number of important freshwater-brackish satellite wetlands, several of which are also of global significance for their biodiversity

1.1. Purpose of the report

This report compiles existing information on Lake Uromiyeh Wetland to describe in brief the ecological attributes of the Lake and some of its satellite wetlands, and to present an overview of the general conditions of its vast watershed area. The report provides a concise baseline of the environmental status of the Lake at the time of the UNDP/ GEF/ DOE Conservation of Iranian Wetlands Project, although in few cases access to the latest information was not possible.

1.2. Existing information

The Uromiyeh Lake and Basin has been subject to numerous different studies during the last 3-4 decades. Major parts of these studies are related to the land and water resources development of different parts of its vast watershed area. Only minor parts of these studies have been undertaken to implicitly describe the ecological characteristics of the Lake or include a considerable amount of information of its Wetlands' attributes. Therefore quite a lot of information is available on the regional climate, geology, soils, hydrology, human population, land-use, etc and development potentials of different plains within the catchment area, while reports on ecology of the Lake and its satellite wetlands including their biotic and abiotic features are rather few. Indeed the latter information is mainly produced by DOE or Environment Conservation Offices in the East and West Azerbijan provinces through periodic or casual surveys. The main periodic survey which has been initiated in 1975 and has been regularly continued is

the annual program for winter count of the migratory water birds. There are very few casual studies on limnology of some of the wetlands which has been conducted by the provincial DOEs.

Shilat Organization through its Artemia Research Center in West Azerbijan and collaboration of the University of Uromiyeh has conducted several studies and evaluations on the Artemia production potentials of the Lake.

There are several sets of reports on the studies conducted to evaluate the environmental status of LU and its satellite wetlands and the potentialities for their conservation as below:

1- The studies conducted in 2002 by Yekom Consulting Engineering Company within the framework of the joint MOJA-World Bank Irrigation Improvement Project and tried to compile available information for the purpose of developing an ecosystem based management plan for the Lake.

2- The studies carried out in 2005 by Pandam Consulting Engineers within the framework of the joint WAWA-Dutch MOA Project for developing an integrated management plan for LU Basin water resources. As a component of the project, this study focused on environmental studies of seven satellite wetlands in the southwest of the Lake and aimed to provide information to help estimating the environmental water requirement of the wetlands to be included in the IWRM planning. This study tried to collect some basic ecology, sociology and hydrology information in relation to the studied satellite wetlands.

3- The studies on the evaluation of the impacts on the Lake from construction of different land and water development projects within the basin. The set of 9 volumes of report was prepared in 2006 by Yekom Consultant Engineering Company for the WARWA.

4- The review made of the reports on the hydro-climatology of the LU Basin. With the support of CIWP, the report was compiled in 2008 by Dr. Hashemi.

5- The studies supported by CIWP and conducted by Tarbiat Modarres University to develop a Drought Risk Management Plan for the LU basin.

6- An evaluation of ecological changes in Lake Uromiyeh during the last 40 years. A research supported by CIWP and conducted by University of Uromiyeh, 2012

The first two reports have tried to compile as much ecological and

environmental information as available through previous studies by other organizations including those of central and provincial DOEs.

Other references dealing with ecology, hydrology and environment of LU and its watershed area are displayed in Table 1.

Table1 Key references on LU ecology and environment

	Subject	Author/ Organization	Year
1	A directory of Wetlands in the Middle East	Scott, D.A.	1995
2	Limnological studies of the wetlands in the West Azerbaijan.	WAECO	1997
3	Resources Assessment of Artemia in LU	Agh, the N. Artemia and Aquatic fauna, Research Institute	2006
4	A methodological framework, guidelines and DSS model to estimate the minimal ecosystem water requirement for wetlands. LU as case study.	Nazaridoust, A. Ph.D. dissertation.	2006
5	Master plan for agricultural development and rehabilitation of natural resources of LU catchment area, volumes 5 and 6.	Jam-e-Iran Consulting Eng.	1995

1.3. Methodology for preparing the present report

The first steps taken for preparing the present report were to collect existing documents dealing with LU and its satellite wetlands including reports stated above.

The content of the above reports which in some cases included contradicting information were then reviewed, compared and the key attributes of the Lake and its satellite wetlands were abstracted and compiled into this concise report to describe the baseline physical, ecological and sociological attributes of the Lake.

1.4. Constraints

The main constraints faced in preparing this report were lack of information on:

- several of the satellite wetlands;
- ecological attributes of the main rivers discharging into the Lake;
- Updated information particularly on agricultural land and water resources
- Updated information on different water uses within the basin.

2. LOCATION AND GEO-PHYSICAL CHARACTERISTICS

2.1. Location

Lake Uromiyeh is formed in a natural depression within the LU basin on the boundary between the West and East Azerbaijan provinces in NW of Iran. The geographic coordinates of the Lake is between 37° 06' 15'' and 38° 15' 15'' North and 45° 00' 13'' and 45° 55' 20'' East. It covers an average area of ca. 5000 km^2 with a maximum extent of 140 km x 50 km. It is a closed internal drainage basin, where all rainfall drains towards a central hypersaline lake.

The vast basin of LU, 51,876 km^2, covers areas in three provinces of East and West Azerbaijan as well as in Kurdistan in the south. The geographic coordinates of this vast area are: 38° 30' and 35° 30' N and 48° 00' and 44° 15'E. Table 2.1 displays the portions in each province of the watershed areas.

Provincial distribution of LU watershed areas

	Province	Watershed area %
1	East Azerbaijan	39
2	West Azerbaijan	51
3	Kurdistan	10

In this report the following geographical levels have been defined (Map 2.1):

1. The Lake Uromiyeh Basin, encompassing the entire hydrological basin of the Lake which has been further sub-divided into sub-basins. Discussions presented at this level are very general and reviews the main attributes of the LU catchment area.

2. The Ecological Zone of the LU, which encompasses the entire Lake and its surrounding satellite wetlands and other habitats which have a strong ecological connectivity with the Lake.

3. The Critical Sites, within the Ecological Zone of LU which include 17 individually important sites (mainly wetlands) including LU itself. Many of these wetlands are located in the southern part of the Lake (Map 2.1).

2.2. Topography

The LU basin is a generally mountainous territory containing two of the famous Iranian volcanic peaks (Sahand, 3707 m. and Sabalan, 4810 m.), and with several vast productive plains in the valleys and around the Lake.

Most parts of the Basin are located at altitudes above 1280 m. and upto 4886 m. above mean sea level. The elevation of Lake's water surface is varying between above 1270 and below 1280 m.

2.3. Landscape

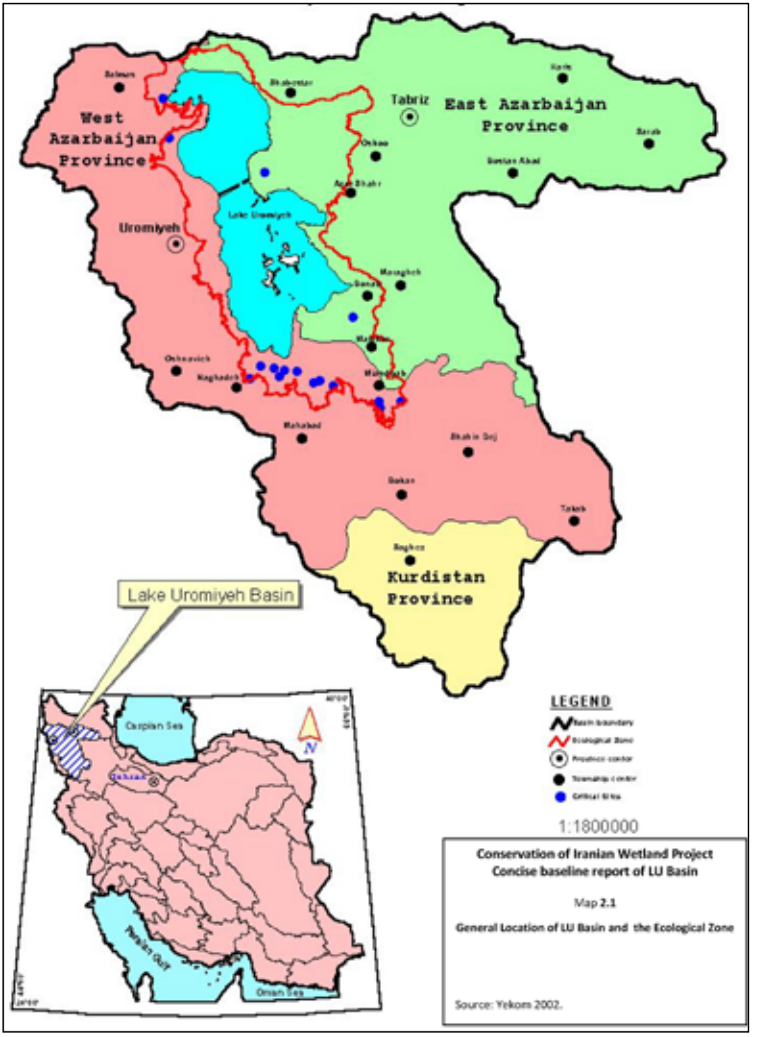
The area within the LU basin in west Azerbaijan is benefiting from a generally green landscape. Considerable areas under fruit gardens, cropped lands and pasturelands all together provide very pleasant and peaceful scenery. Particularly large parts of hillsides covered by rain-fed cultivation create pleasant perspective during spring season. Very similar landscapes prevail in the Kurdistan Province. In East Azerbaijan, however, while discrete pieces of significant landscapes could be found here and there, but larger parts of the basin is covered by natural pasturelands that because of lower precipitation have comparatively lower vegetation density. The vast water area of the lake itself with a few islands creates an attractive and iconic landscape.

2.4. Geology

Due to several tectonic events during different geological era, the geology of the basin is rather complicated. Major parts of folded sedimentary deposits were metamorphed under volcanic events and magmatic activities. Numerous thermal springs all over the basin demonstrates the extent of these volcanic activities.

From a geological point of view the entire basin is categorized in 4 broad tectonic zones, one of which is exceptionally smaller in extent than other three (Map 2.2). A very brief description of these categories is presented below:

1) Colored mélange zone; a very small area in the far western border of the basin consisting of ultra basic, gabro and diorite-radiolarite and limestone rocks.


West Azarbaijan Province
East Azarbaijan Province
Tabriz
Uromiyeh
Lake Uromiyeh
Kurdistan Province
Lake Uromiyeh Basin
Caspian Sea
Persian Gulf
Oman Sea
LEGEND
1:1800000
Conservation of Iranian Wetland Project
Concise baseline report of LU Basin
Map 2.1
General Location of LU Basin and the Ecological Zone
Source: Yekom 2002.

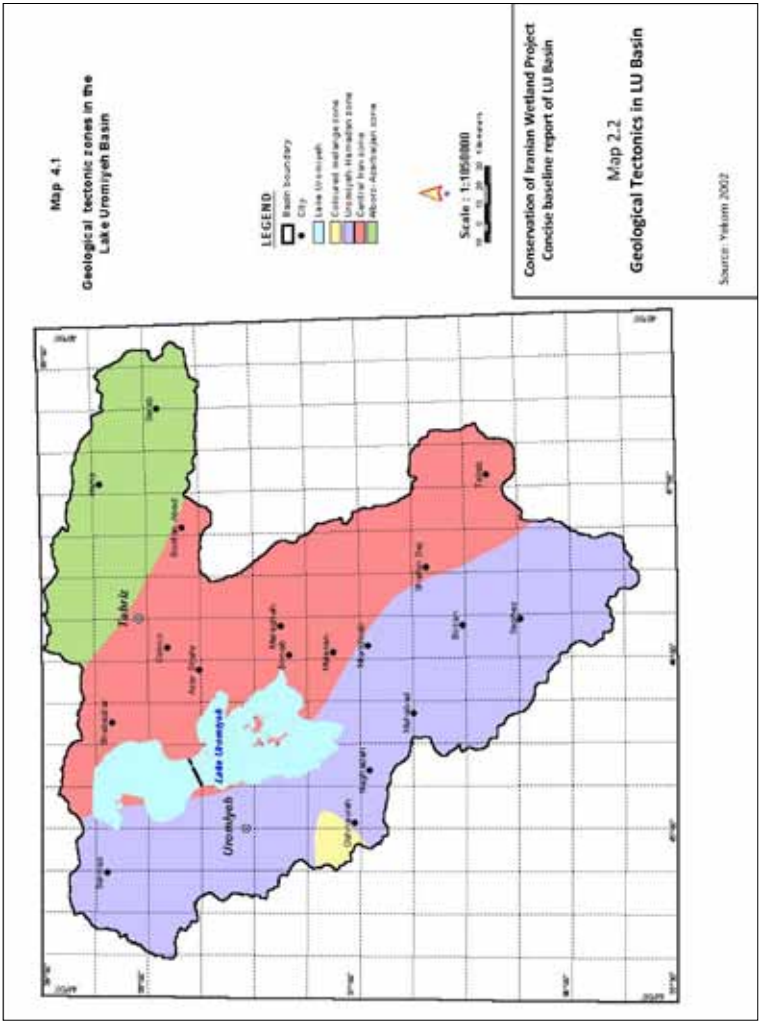
2) Uromiyeh-Hamadan zone; this zone is situated west of the basin and contains a collection of colored mélange and metamorphic rocks and Paleozoic platform sediments of generally Permian age. This collection is attached by the intrusive masses of granite and diorite and is covered by Paleocene flysch and limestone and destructive sediments of Eocene-Oligocene.

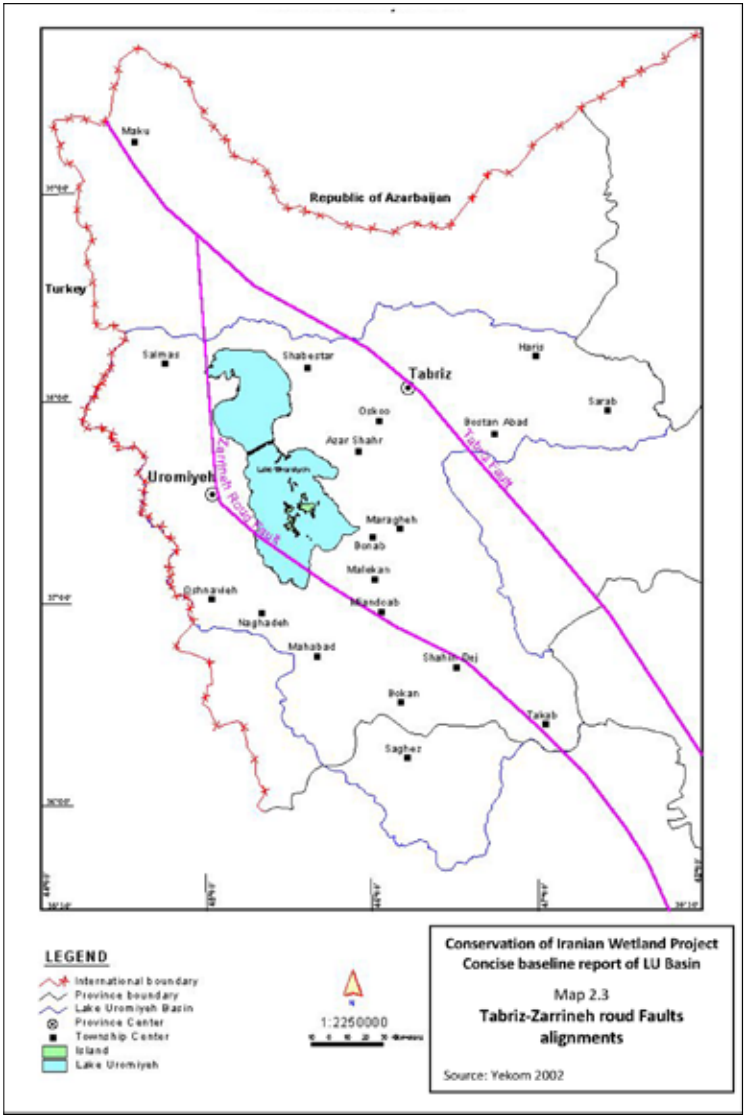
3) Central Iran zone; this zone contains metamorphic rocks and platform Paleozoic sediments. This zone continues to the north of Lake Uromiyeh and is limited, from north and east by the fault of Tabriz-Sofian-Bostanabad. The Zarrineh-Roud valley is the boundary between the Central Iran Zone and Uromiyeh-Hamadan Zone. Sahand volcano (3707) and Lake Uromiyeh are two major geological features of this zone.

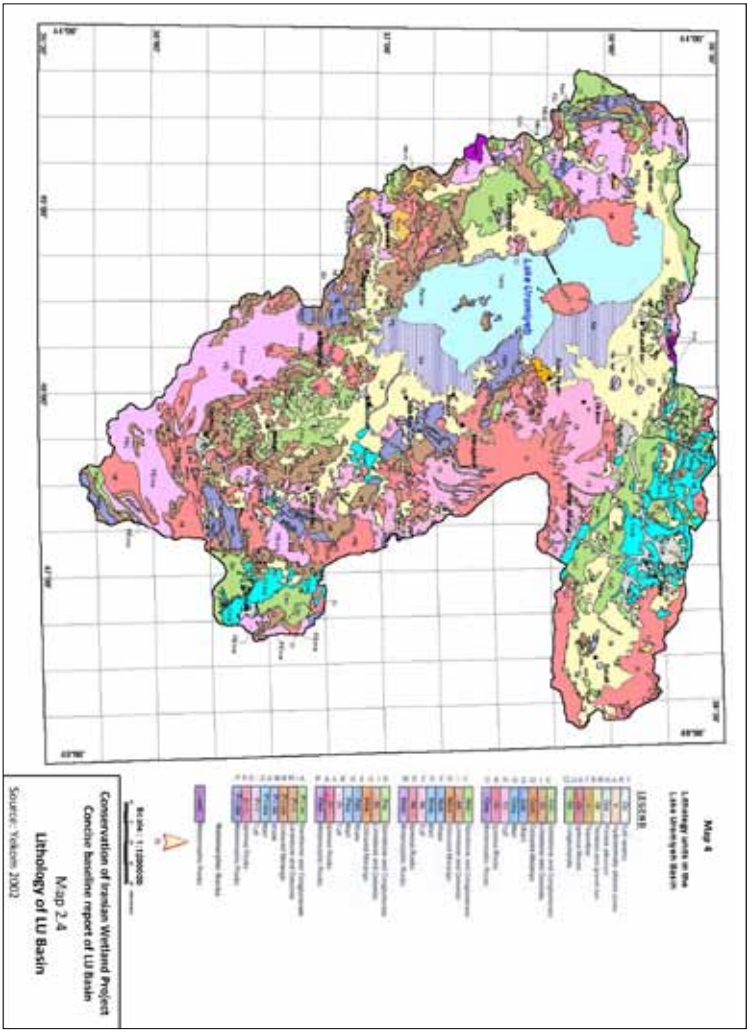
4) Alborz-Azerbaijan zone; this zone is comprised of areas in the north-eastern Azerbaijan, northeast of the Tabriz fault. Sabalan Volcano (4810 m), the vast extension of volcanic ash rocks, and salt domes in Aji Chai sub-basin are major geological features in this zone. Particularly the salt domes in Aji Chai sub-basin are the formation mainly responsible for the high salt concentration of the Lake. Paleocene and Eocene volcanic and granitic rocks are also part of the geological features in this zone.

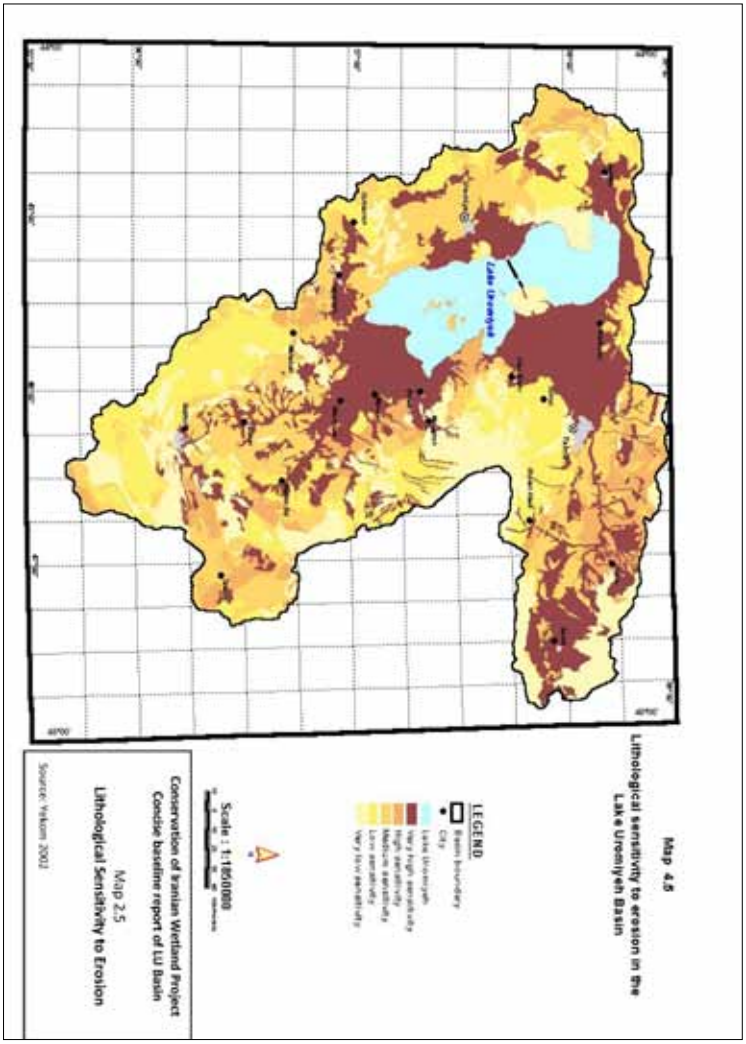
Maps 2.3 and 2.4 respectively display the two indicative geological faults and the complications in the geological formations within the basin.

Another geological feature of significance to mention is the erodibility of the formations. Map 2.5 depicts the extensive coverage of these formations which include tuff, marlstone, shale, etc. These have an important role in sediment load in the river flows, particularly during flood seasons. Part of these sediments carry considerable burden of pollutant minerals, i.e. Sodium Chloride which contributes to the salinity of water resources.


Map 4.1
Geological tectonic zones in the Lake Uromiyeh Basin
LEGEND
Basin boundary
City
Lake Uromiyeh
Cultivated wetlands zone
Urmiyeh-Hamedan zone
Central Iran zone
Alborz-Azarbayjan zone
Scale : 1:1050000
Conservation of Iranian Wetland Project
Concise baseline report of LU Basin
Map 2.2
Geological Tectonics in LU Basin
Source: Yekom 2002
Tabriz
Uromiyeh
Lake Uromiyeh


Maku
Republic of Azarbaijan
Turkey
Salmas
Shabestar
Tabriz
Harir
Sarab
Oskoo
Bostan Abad
Azar Shahr
Uromiyeh
Zarrineh Roud Fault
Tabriz Fault
Maragheh
Bonab
Malekan
Miandoab
Oshnaviyeh
Naghadeh
Mahabad
Shahin-Dej
Bokan
Takab
Sagher
LEGEND
International boundary
Province boundary
Lake Uromiyeh Basin
Province Center
Township Center
Island
Lake Uromiyeh
1:2250000
Conservation of Iranian Wetland Project
Concise baseline report of LU Basin
Map 2.3
Tabriz-Zarrineh roud Faults alignments
Source: Yekom 2002


Lake Uromiyeh
Conservation of Iranian Wetland Project
Concise baseline report of LU Basin
Map 2.4
Lithology of LU Basin
Source: Yekom 2002


Map 4.5
Lithological sensitivity to erosion in the Lake Uromiyeh Basin
LEGEND
Basin boundary
City
Lake Uromiyeh
Very high sensitivity
High sensitivity
Medium sensitivity
Low sensitivity
Very low sensitivity
Lake Uromiyeh
Scale : 1:1950000
Conservation of Iranian Wetland Project
Concise baseline report of LU Basin
Map 2.5
Lithological Sensitivity to Erosion
Source: Yekom 2002

2.5. Soils

Most of the plains in the basin area have been surveyed for the soil and land classification for irrigation and agricultural uses. This chapter presents a very brief description and a broad classification of the soils in the basin. For this purpose three groups of the soils are defined:

• Soils of the plains and valleys; these generally include fine textured alluvial soils, saline alluvial soils (solonchack and solonetz soil), and salt-Marsh soils. The soils in this category are generally formed by soil particles which are brought by water and /or in minor cases by wind. Predominantly among these are alluvial soils, which are composed of recent water-deposited sediments of the flat or gently sloping flood plains. Drainage condition is varying from well drained productive lands to water logged pasture lands or otherwise saline soils (halomorphic) in waste lands. The latter may, according to the hydrologic and topographic conditions, have some halophytic vegetation.

• Soils of the plateaus and hills which in general include brown soils and lithosols. These are generally medium to fine texture and well drained soils which are widely used for rain-fed cereal cultivation.

• Soils of the dissected slopes and mountains; these soils are in general stony, shallow over bedrock, without a definite profile development. These are basically calcareous lithosols and are associated with a great proportion of un-weathered rock fragments, but may show some initial weathering and even accumulation of organic matter. In some occasions where soil depth allows and slopes are accessible, rain-fed cultivation is practiced.

Regarding land forms and land capabilities, the following information is abstracted from the existing references [12]:

- Mountains: 38% of the total basin area, 19710 km^2, is covered by mountains. Soils in these steep land forms are generally very shallow and may support very limited varieties of plants. The poor vegetation cover on these lands has low suitability for controlled grazing.

- Hills: 21% of the total basin area or about 10890 km^2 is placed in this category. The soils in this land type consist of shallow to moderately deep soils of light to medium texture. These lands are moderately suitable for rain-fed and

grazing uses.

- Plateau and upper terraces: this land type comprises 11.2% of the total basin area, equal to about 5810 km^2 . These lands include deep to very deep with moderate to heavy textured soils. Grazing and dry farming are typical land uses and vegetation typical to steppe lands, and seasonal pastures are the main land covers of this category. Relief, erosion and presence of cobble and gravel are the most important limitation to manage these soils.

- Piedmont plains: These lands comprise 3,995 Km^2 (7.7%) of the total Basin area. The soils are semi deep to very deep with heavy to very heavy texture often with calcaric layer. Typical land uses are irrigated and dry farming. Relief, gravel, heaviness of soil texture, salinity, high water table and flooding hazards are the main limitations of these lands. The soils in this land type are moderately suitable for irrigated farming and horticulture and are slightly suitable for dry farming.

- River alluvial plains: This type of land covers an area of 1,454 Km^2 (about 2.8%) of the total Basin area. The soils are deep to very deep with moderate to very heavy texture. Horticulture, irrigated farming and seasonal pasture are the most important land uses. The major limitations of these soils are: high water table, salinity, heavy texture and flooding hazards. These lands are generally suitable for irrigated farming and horticulture, while in some occasions require corrective measures such as surface and or subsurface drainage and land leveling.

- Low lands: The area of this category is about 3,270 Km^2 or 6.3% of the total basin area. Two major land units are identified which are deep saline soils and those influenced by high water table. The soil texture is generally heavy and occasionally salty flats are observed in this land type. The main land cover and land uses are halophytic plant, seasonal and occasional pasture, bare lands and irrigated farming. Major limitations are: high water table, poor drainage, very high salinity and high alkalinity. These lands normally remain water logged particularly in rainy seasons. These land types have low suitability for grazing.

- Flood plains: This land type comprises 1193 km^2 or only 2.3% of the total basin area. The soils in this category are deep with heavy texture, and because of the prevailing high water table are usually salt affected. These lands are

normally covered with intensive halophytic vegetation or are bare. Major limitation of the lands are poor drainage, flooding and high salinity. The lands have low suitability for grazing pasture.

- Miscellaneous lands: These lands include gravelly colluvial or alluvial fans and/or complex lands and in general comprise minor portion of the basin area. This type of land has low suitability for grazing and /or other uses.

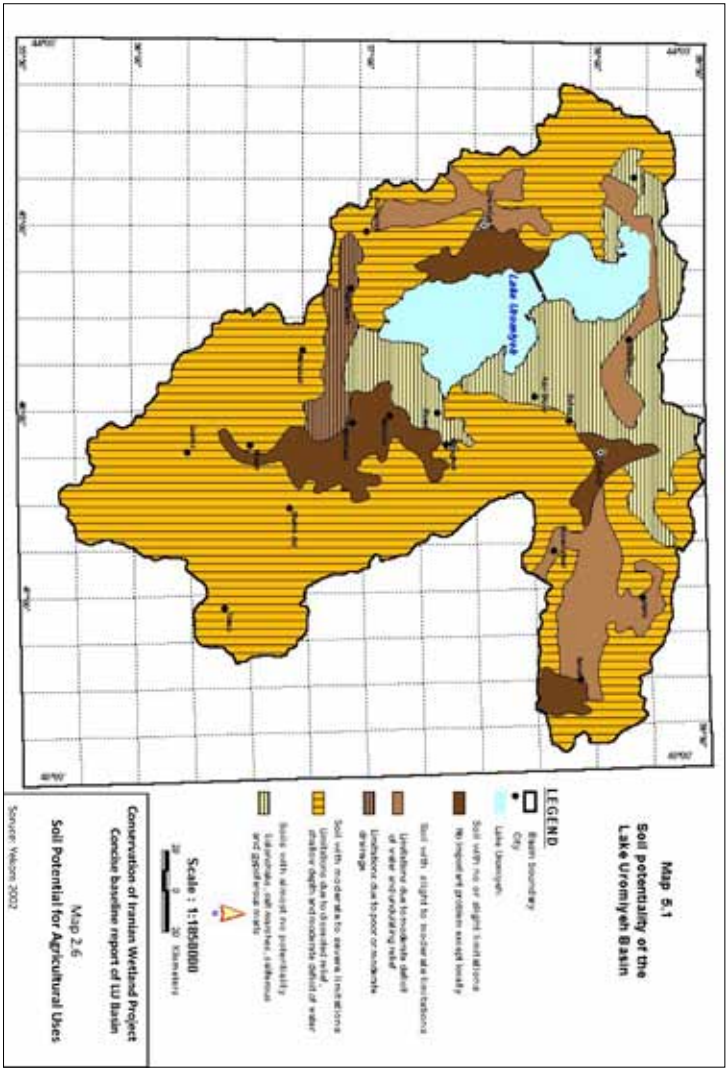
Based on Map 2-6, suitability of land resources within the catchment could be described as follow:

- Lands with no important or little limitation for cultivation and irrigation which are very suitable for producing most irrigated crops. These include about 440 thosands ha (8.45% of the basin's area);

- Lands with slight to moderate limitation due to topography and or natral drainage. These lands are generally suitable for irrigation and producing most irrigated crops and include about 640 thosands ha or (12.28% of the basin).

- Lands with moderate to severe limitation for producing irrigated crops which include about 2.9 million hectares or (56% of the basin land resources). Limitations mainly come from dissected topography, shallow depth of soils, and access to water for irrigation.

- Lands with no potential for irrigation and crop production which includes severely saline or water logged areas. These lands are about 740 thousands of hectares or (14.2% of the basin).


Map 5.1
Soil potentiality of the
Lake Uromiyeh Basin
LEGEND
Basin boundary
City
Lake Uromiyeh
Soil with no or slight limitations
No important problem except locally
Soil with slight to moderate limitations
Limitations due to moderate deficit of water and undulating relief
Limitations due to poor or moderate drainage
Soil with moderate to severe limitations
Limitations due to restricted root zone, deficit of water
shallow depth and moderate deficit of water
Lake Uromiyeh
Scale : 1:1850000
30 0 30 Kilometers
Conservation of Iranian Wetland Project
Concise baseline report of UU Basin
Map 2.6
Soil Potential for Agricultural Uses
Source: Yekom 2002

3. CLIMATE

3.1. General climatology

Considering the latitude and altitude of the basin area, its general climate is very similar to the middle latitude, semi-high plains with cold winters and relatively temperate summers. Based on data from four example climatological stations, the most important climatic indicators of the LU basin are presented in Table 3.1.

Climate in the LU basin follows a rather simple pattern regarding the coverage area and temperature types. The climatic zones of the LU basin are presented in Map 3.1.

Mean annual climatological indicators of example stations in the LU Basin

No.	Station	Elevation	Average annual daily temperature (°c)			Absolute temperature (°c)		Frost	Relative humidity	Average wind speed	Total sunshine	Haze
		m.	Max	Ave.	Min	Max.	Min.	Days	%	Km/hr	hrs	Days.
1	Uromiyeh	1313	17.0	10.8	4.7	38.4	-22.8	111.8	58	1.5	2724	4.7
2	Tabriz	1361	17.6	12.1	16.7	42.5	-25.4	101.0	52	2.9	2743	19.3
3	Saghez	1476	18.8	11.1	3.4	42.6	-36.0	118.1	53	1.6	2713	4.1
4	Sarab	1800	15.1	8.2	1.3	39.5	-30.0	143.1	64	2.2	2773	0.3

3.2. Precipitation

Average annual precipitation in the Basin has been varying between 203 and 688 mm during the period of 1964-1992. In the same period, the basin-wide average annual precipitation amounts to 372 mm [12].

Precipitation in the selected station over the basin during 1971-2006 indicates the range of variation in average annual precipitation within the stations being between 160-620 mm/yr with an average of 340 mm/yr. During this period the maximum annual precipitation of a single station was 1125 mm in Sananeh station in 2006.

Considerable part of the annual precipitation is in the form of snow. Map 3.2 displays the distribution pattern of the annual precipitation over the basin.

Precipitation regime in Lu Basin follows that of Mediterranean one with the maximum occurring in spring. Little precipitation occurs during summer

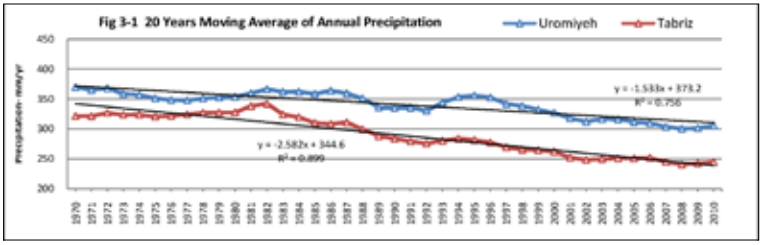
months. The average monthly precipitation in the LU Basin is presented in Table 3.2.

Table 3.2 Monthly precipitation distribution in the Lake Uromiyeh Basin

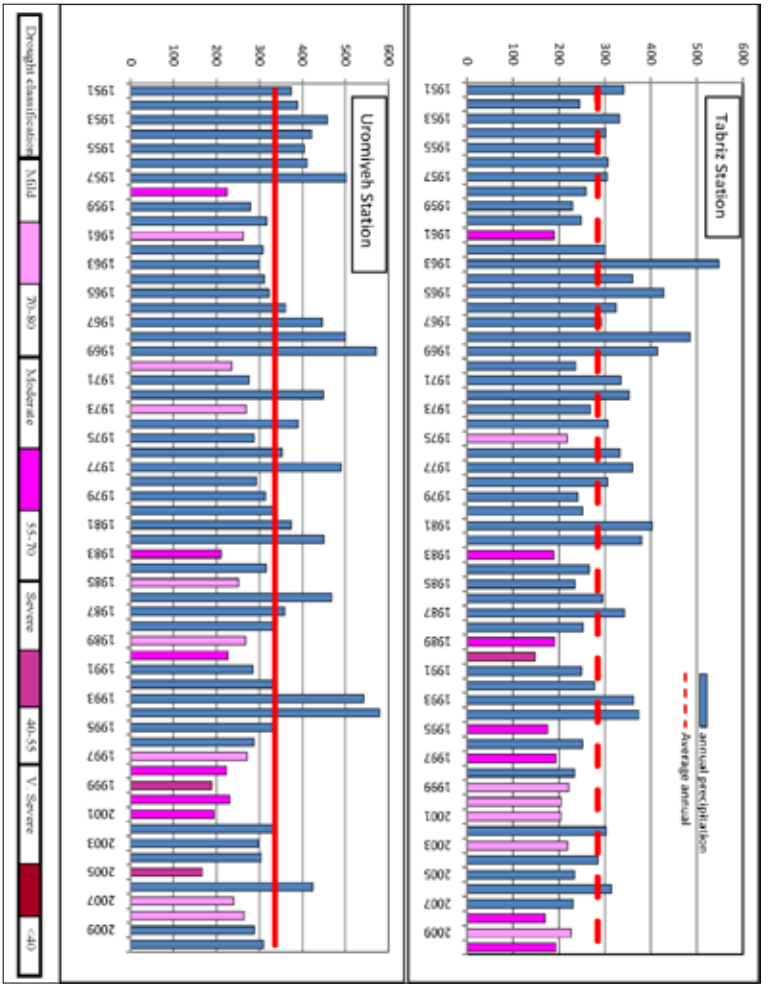
Month	% of annual precipitation	Month	% of annual precipitation	Month	% of annual precipitation	Month	% of annual precipitation
October	6.4	January	16.2	April	8.6	July	1.7
November	10.2	February	16.6	May	8.8	August	1.0
December	9.8	March	6.6	June	12.7	September	1.4
Autumn	26.4	Winter	39.4	Spring	30.1	Summer	4.1

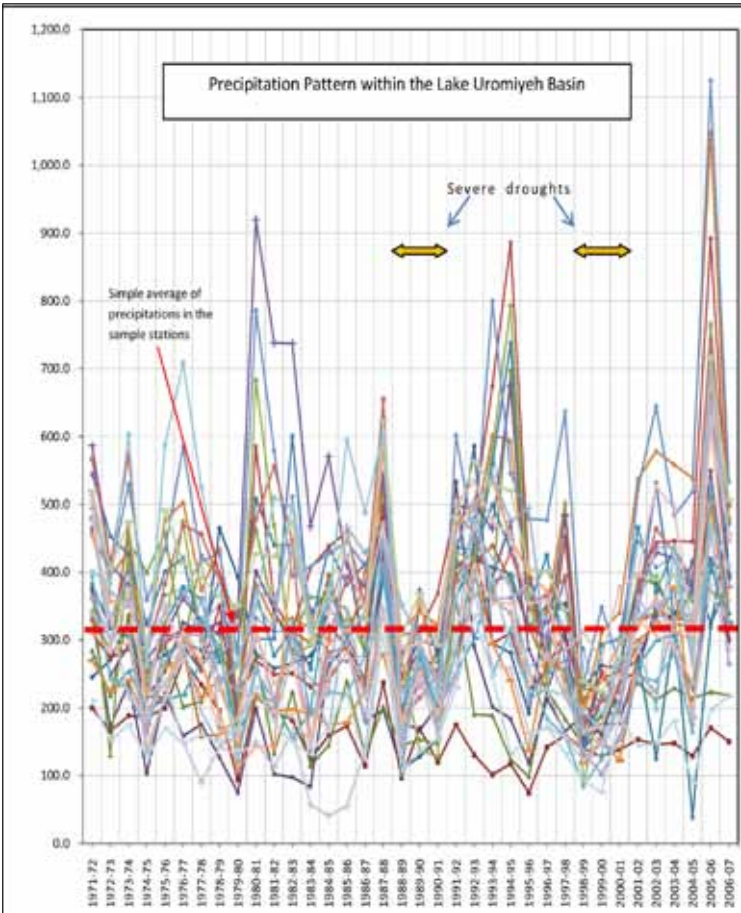
Though drought is a common occurrence in Iran, since around 2000 a persistent drought has seriously affected the hydrological status of the LU basin.

Using the 20 years moving averages of annual precipitation over 60 years of data in Tabriz and Uromiyeh synoptic stations, a significant decreasing trend was detected in both stations (Figure 3-1). During the period 1970-2010, the decrease in average annual precipitation in Tabriz was about 90 mm, about two fold of that in Uromiyeh (50 mm) for the same period.



To verify the occurrence of droughts within the basin, a simple presentation of the annual precipitation of two typical stations of Tabriz and Uromiyeh as well as 35 sample stations over the basin are displayed in Figures 3-2 and 3-3 respectively. In addition to several annual droughts, two basin-wide more severe and longer droughts each of about 3 years persistence occurred during 1989-91 and 1998-2001.


Tabriz Station
annual precipitation
Average annual
Uromiyeh Station
Drought classification
Mild
70-80
Moderate
55-70
Severe
40-55
V. Severe
<40


Precipitation Pattern within the Lake Uromiyeh Basin
Severe droughts
Simple average of precipitations in the sample stations
1,200.0
1,100.0
1,000.0
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
1971-72
1972-73
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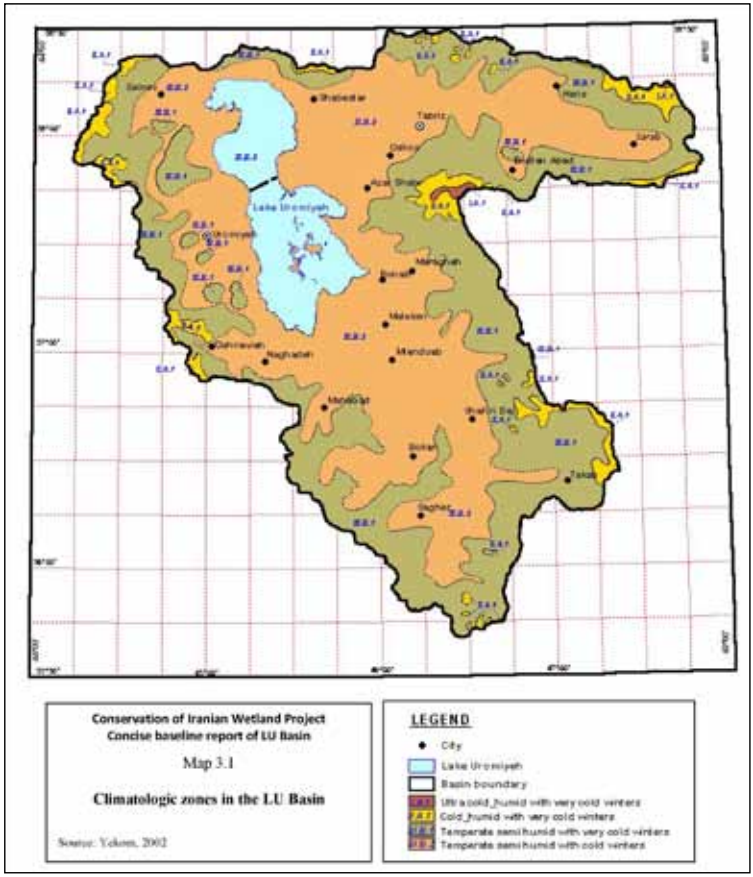
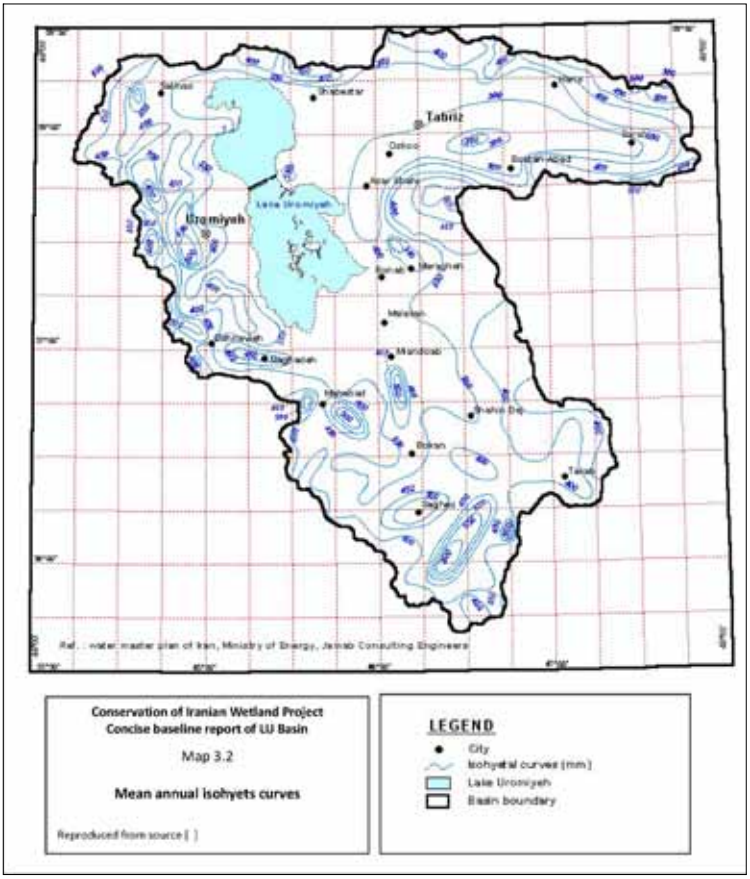
2001-02
2002-03
2003-04
2004-05
2005-06
2006-07

Fig 3-3


Conservation of Iranian Wetland Project
Concise baseline report of LU Basin
Map 3.1
Climatologic zones in the LU Basin
Source: Yekom, 2002
LEGEND
City
Lake Uromiyeh
Basin boundary
Ultra cold humid with very cold winters
Cold humid with very cold winters
Temperate semi humid with very cold winters
Temperate semi humid with cold winters



3.3. Temperature

The records of the average annual temperature in the basin vary between 6.4ºC and 13.2ºC. The isotherms of maximum, mean and minimum temperatures for the LU Basin are shown in Map 3.3.

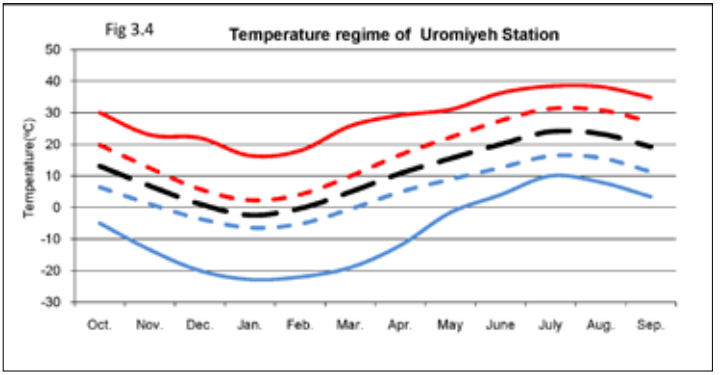
The ambient air temperature is recorded in more than 50 meteorological stations. The following general conclusion can be drawn:

• At all stations, July 23-August 22 (Mordad) is the warmest month, and only

at Rostaman Station the maximum is in June 22-July 22 (Tir).

• At 20 stations, December 22-January 20 (Dey) is the coldest month, whereas in the other 29 stations Bahman (January 21-February 20) is the coldest month.

The difference in average temperatures of the coldest and warmest months in the Basin varies -in different stations- between 25.8°C to 28.3°C. Figure 3.4 shows the temperature regime of the Uromiyeh station.



As an indication of the climate change, trends in average seasonal temperatures of the two sample stations (Tabriz and Uromiyeh) were verified. Moving average technique was used to analyze the 60 years of seasonal temperatures data for Uromiyeh and Tabriz Synoptic stations (Fig 3-5). While Uromiyeh Station shows very slight and comparatively less significant negative trends in the average seasonal temperatures, Tabriz shows similar but positive and more significant trends particularly in summer and spring seasons. In Tabriz, the 20 year average of mean temperatures of summer seasons have raised in the order of 1.2 oC during 1970-2005 period.

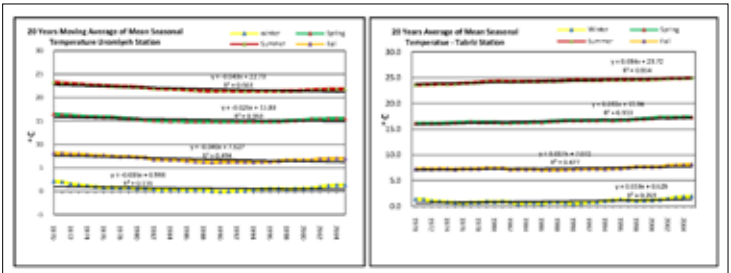


Fig 3-5 20 Years moving averages of Temperature of Tabriz and Uromiyeh

3.4. Evaporation

The annual average evaporation (class A pan) in the LU basin is 1500 mm, and varies between 1000 mm (at Areshtenab Meteorological Station-1950 m above sea level) and 2100 mm (at Sahlan Meteorological Station-1400 m above sea level).

The evaporation varies according to the geographical conditions (Latitude and altitude), as well as distance from the Lake. Closer to the Lake, evaporation is lesser which reflects the role of the lake in humidifying the environment. The mean annual evaporation of stations around the Lake varies between 1250 (Sharafkhaneh) to 2000 (Mahabad) mm/yr. The mean annual evaporation from the Lake surface is estimated at around 1000 mm/yr.

The iso-evaporation curves based on standard class A pan measurements within the LU basin is shown in Map 3.4.

3.5. Relative humidity

The annual and monthly average of relative humidity in the Lake Uromiyeh Basin for a number of meteorological stations near to the Lake are shown in Table 3.3. As it is depicted from this table the monthly relative humidity varies between 42% and 85%, whereas the average annual relative humidity of the station vary between 57-76%.

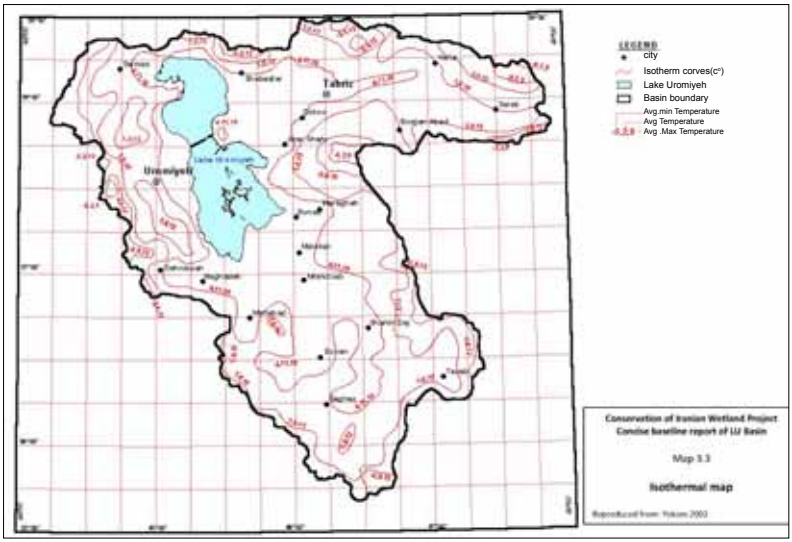
Table 3.3 Mean relative humidity

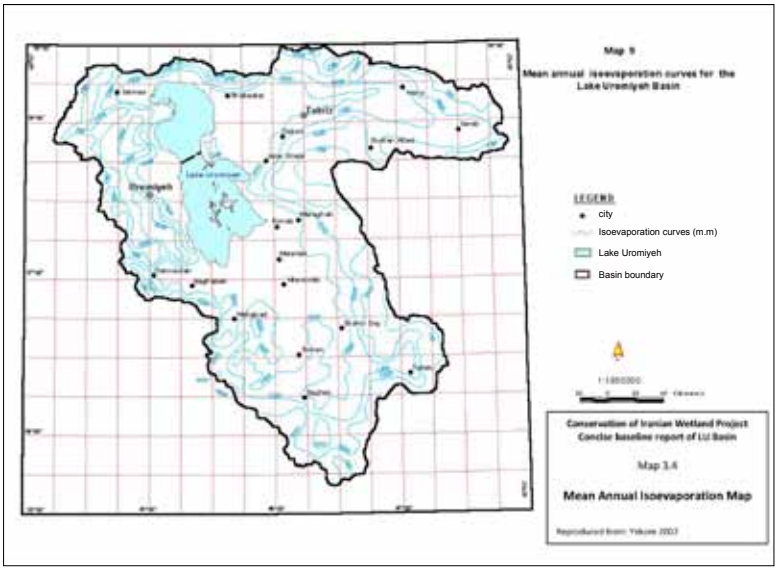
Station	Elev.	Jan.	Feb	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Ajichai	1500	78	80	75	67	63	57	50	48	53	64	74	80	66
Saqqez	1476	72	71	67	63	51	49	43	42	42	52	66	71	57
Osko	1500	82	83	74	65	66	53	49	48	52	64	73	81	66
Tekmehdash	1873	85	83	80	65	62	56	51	50	52	64	72	81	67
Liqhvan	2250	66	71	74	66	59	53	48	47	44	54	62	64	59
Sarab	1800	77	77	69	65	50	58	54	51	54	65	69	75	64
Bostanabad	1750	77	75	69	65	58	55	55	57	60	71	72	76	66
Bukan	1375	70	73	72	69	67	60	55	52	52	58	64	70	64
Maragheh	1420	73	78	75	70	68	59	54	56	59	63	67	75	66
Barandouzchai	1300	74	77	76	75	74	73	71	73	71	90	76	78	76
Nazluchai	1345	72	78	75	74	67	63	63	64	66	71	75	75	70
Mahabad	1350	74	74	70	63	57	53	48	50	48	58	67	75	61
Miandoab	1300	76	78	68	62	60	52	47	45	47	55	67	76	61
Uromiyeh	1313	76	74	68	62	60	54	49	49	50	58	69	74	62

3.6. Wind

Tabriz and Uromiyeh synoptic stations are the closest stations to the Lake Uromiyeh which measure the wind speed and direction. The maximum wind speed recorded at the Uromiyeh station using the data of 1951-1985 is 60 knots (31 m/s) in January 1951 with a southwest direction, while the maximum wind speed recorded in Tabriz station is 52 knots (26 m/s). Statistical analysis of the wind data indicates that with a return period of 50 years, the strongest wind in Tabriz will have a speed of about 28.8 m/s with southeast direction and in Uromiyeh will have a speed of 31.9 m/s with southwest direction.

In the LU basin the maximum average dominant wind speed is 3.2 m/s with a south-west direction. In general, the strongest winds occur in the region with west and southwesterly directions.


LEGEND
city
Isotherm corves(c°)
Lake Uromiyeh
Basin boundary
Avg.min Temperature
Avg Temperature
Avg .Max Temperature
Tabriz
Uromiyeh
Conservation of Iranian Wetland Project
Concise baseline report of LU Basin
Map 3.3
Isothermal map


Map 9
Mean annual isoevaporation curves for the Lake Uromiyeh Basin
LEGEND
city
Isoevaporation curves (m.m)
Lake Uromiyeh
Basin boundary
Tabriz
Uromiyeh
Conservation of Iranian Wetland Project
Concise baseline report of LU Basin
Map 3.4
Mean Annual Isoevaporation Map

4. WATER RESOURCES

This chapter will briefly describe the surface and ground water resources of the basin and some of the key hydrological and hydro-geological attributes thereof.

4.1. Hydrology

Hydrology, both quantitative and qualitative, is the most complicated physical attribute in the management of the LU and its satellite wetlands. Its complications come from several sources of surface and ground water in the three provinces involved (Map 2.1), and the different policies and strategies in the provinces for their management.

The basin consists of 11 main sub-basins as shown in Map4.1. Also it includes 17 permanent rivers, 12 seasonal rivers and 39 flood-ways. Most of the surface water is flowing in the West Azerbaijan in the southern and western part of the basin: The Simineh rud and Zarrineh rud rivers comprise 51.6 % of the long term total surface water inflow into the Lake (Fig.4.1).

Based on historic data (!344/80-1965-01), the annual flow of the rivers into the Lake averages at 4327 mcm/yr, and varies between 12,574 mcm (in 1347-48/ 1969) to less than 243 mcm (in 1379-80/2000) [13]. This shows that the rivers' discharges vary rather widely over the seasons and years.

River flows are the main source of water supply for agricultural activities as well. According to the existing information in 2006 about 400,000 hectares of cultivated lands in the LU basin were irrigated. Of the total water consumption of 5600 mcm for irrigation about 59% was supplied from surface water resources [2].

Though drought is a common event in the region, during 2000s an exceptionally continuous and long lasting drought occurred in the basin which continued until the end 2011. This severe drought was exacerbated with additional water abstraction for irrigation in both provinces of Azerbaijan, and resulted in cutting off the majority of inflows into the Lake and caused a significant part of the lake (estimated at 40-50%) to desiccate (Map 4.2).

Quality of surface water resources also varies widely. Based on the data collected during 1969-2005, the average EC of Lake's water is measured at 382 dS/m (close to 270 gr/lit) (ranging between 577-279 dS/m- 400-200 gr/lit)). During the hydrologically normal years, the average salt concentration of LU is

205 g/l. In 2010 the salt concentration was measured at 380 g/l. In 2011-2012 lake's water level continued recessing and salt concentration increased to as high as 550 gr/lit. More than 90% of salts are in the form of Sodium Chloride.

Generally with the exception of Aji chai, all the other rivers have good quality water suitable for almost all uses. However, Aji Chai located in the north eastern part of the basin, flows over contaminating formations (Salt dome terrains) and receives considerable amount of dissolved salts, i.e. more than 1,270,000 tons/yr. Considering that the average annual salt inflow into the Lake is around 2,355,000 tons, Aji chai per se discharges more than half of the total annual salt load which flows into LU [13]. The rivers that occur in the western and southern catchments generally contain higher quality flows than those in the eastern catchments.

The sediment load of the rivers around the lake is in general very high. The reason is the high erosion capacity of the surface geology along with sparse and low vegetation cover over the catchment area. Also the common tradition of down slope-ward ploughing (perpendicular to the contour lines) of rain-fed lands in steep foot hills significantly contributes to this process. Again, Aji Chai produces the highest sediment load amongst the rivers around the Lake. The total sediment load flowing into LU by the rivers is estimated at 5.8 million tones /yr.

Map 4.2 : Main river systems in the LU basin

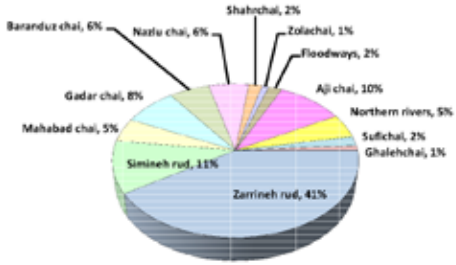


Fig 4.1 Contribution of different rivers in water supply to LU (historic data)

30 March 2011 6 November 2012

Map 4-2 LU water status during the drought

4.2. Hydrogeology

The Lake is surrounded from north, west and south by metamorphic and igneous rocks and calcareous formation. The alluvial aquifers in between

the mountains and the Lake are formed by erosion and deposition of these formations. Towards the lake, the grain size of the sediments gradually changes from course to fine.

Due to the activities of the major rivers, including Zola Chai, Nazlu Chai, Shahr Chai, Barandooz Chai, Gadar Chai, Simineh Roud and Zarineh Roud, fairly vast alluvial fans are formed in the river valleys and around the Lake. The alluvial fans generally have high permeability. Basin-wide, the average thickness of the alluvial aquifer is about 100 meters but varies widely in different parts (200 meters in Uromiyeh and 300 meters in Tabriz plains and 30 m in Mahabad and Azar Shahr).

Significant ground water aquifers exist in different parts of the basin. The alluvial aquifers are mostly phreatic, but in some places the sediments are inter-bedded with fine materials like clays and silts forming artesian aquifers. The alluvial aquifers are mostly recharged by the surface rivers and to a lesser extent by the precipitation.

Within the entire LU basin, 25 ground water resources, mostly alluvial aquifers, have been studied of which 13 are located around the Lake. These are Uromiyeh, Salmas, Tassouj, Shabestar, Sofian, Tabriz, Azar Shahr, Shiramin, Ajabshir, Marageh, Miandoab, Naghadeh and Rashkan.

Despite their rich potential, Karstic resources have not been studied in detail yet.

Based on 2008 data, close to 74000 wells, 1579 springs and 5747 qanats are producing about 2440 mcm/yr of which more than 90% comes from wells.

Investigations conducted on the ground water resources did not show salt water intrusion into fresh ground water resources until the 1970s. However, because of agricultural, industrial and residential developments during the last three decades, and enormous increase in the use of groundwater as the main additional source of water supply, the situation has changed.

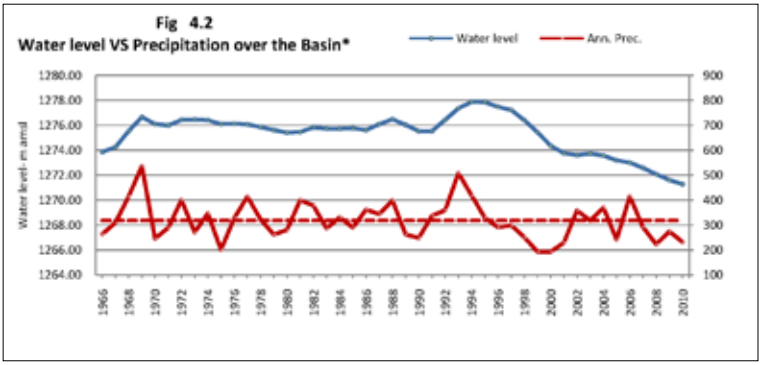
According to the existing information the contribution of ground water to the Lake water resources is estimated at around 220 mcm/yr part of which evaporates in the wetlands around the Lake before it reaches the main Lake's water body [2].

The alluvial aquifers of coastal areas have been over-exploited over the last decades. This and the long lasting drought over the last decades have disturbed

the groundwater balance and the equilibrium between salt and fresh water resources. As a consequence, in some part of coastal aquifers salty groundwater has intruded into fresh ground water resources and has impacted their quality. In order to control the over- extraction from the water resources of the coastal aquifers, further development of groundwater is banned in some parts or restricted in the others.

4.3. The Lake

Lake Uromiyeh has an average surface area of ca. 5000 km^2 when its water level is at 1276 meters above mean sea level. However considering the contour line of 1277.1 as the marginal boundary of LU, its area raises close to 6000 km2.



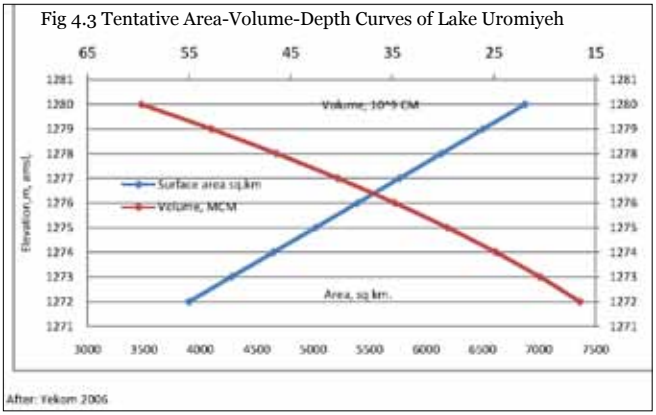
The length of the Lake varies between 130 to 140 km and it reaches a maximum width of 50 km in the southern part of the Lake. Considering the normal hydrological conditions, the Lake has an average depth of about 5.4 meters, with a max. depth around 15 meters in the northern parts.

Based on the data collected up to the late 1990s, the maximum variation of water level between normal wet and dry years was about 2.7 meters. During the extended drought period in 2000s, the Lake's water level reached a minimum below 1270 m. amsl, in which more than 40 % of the Lake's bed was exposed (Map 4.2).

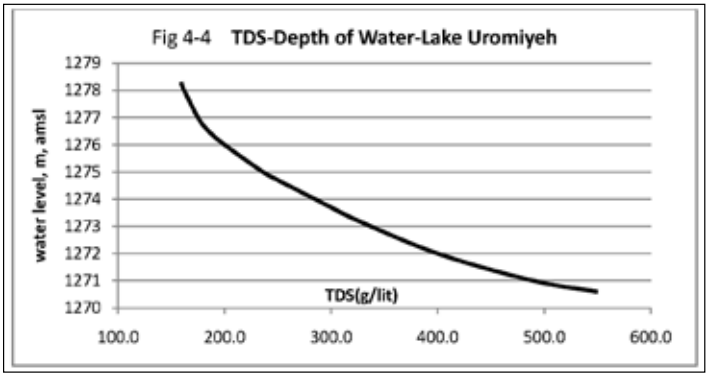
Considering 5.4 m to be an average depth of the Lake, the average volume of the water body of the Lake is estimated at 30,000 MCM. Figure 4.3 depicts the

tentative curves relating area, volume with the elevation of the water surface.

Fig 4.3 Tentative Area-Volume-Depth Curves of Lake Uromiyeh



Quality of Lake water is directly related with the volume of inflows into the Lake (water levels), the higher inflows into the Lake (higher water levels) dilutes the concentration of dissolved salts and results in lower salinity. Figure 4-4 reflects the relation between water level and its salinity(EC). It shows that during the drought period, when water level dropped to below 1271, the salt concentration in water reached records of 550 gr/lit.



4.4. The Satellite Wetlands

Generally, the satellite wetlands in the south and south-west of the Lake have been receiving water from fresh water resources of rivers such as Gadar chai, Mahabad chai, Simineh roud or Zarrineh roud. However, a few of them are fed mainly by surface runoffs from rainfall or ground water seepage. Because of several irrigation development projects conducted during the last decades, some of these wetlands are presently receiving lesser water from rivers, but instead are fed by drainage return flows from the irrigation system. Examples are Soldouz, Kanibrazan, Goppy babaali. Yadegarlou wetland, part of a Ramsar Site is desiccated because of construction of a deep drainage channel across its boundary and Shur Gol, part of the same Ramsar Site has been converted into the Hassanlou storage reservoir.

Based on the available studies [9], hydrological attributes of some of the satellite wetlands are displayed in Table 4.1.

Table 4.1 Summary hydrological attributes of the satellite wetlands

Wetland	**Area of water body[1],** ha	**Storage capacity[1]** MM^3	**Max. depth of water,** m	**Annual inflows[2]** MM^3	**Source**
Yadegarlou	230	0.5	0.6	?	Irrigation return flow, river flows
Dorgeh Sangi	490	3.5	1.6	4-5	
Soldouz	180	0.8	1.0	10-12	Spills from Lake-return flows
Kanibrazan	690	3	1.1	7-10	Drainage flows
Goppy babaali	500	4	1.0	4-6	Drainage +return flows
Shur Gol (Hassanlou)	1120	-	-	-	Converted into Lake

1-When wetland is fairly full of water

2- In normal hydrological years

5. LIMNOLOGY

5.1. Lake Uromiyeh

Because of hypersaline quality of LU water, only few vertebrates constitute living organisms of this vast water body. *Artemia urmiana* is the most important species identified. It is an endemic brine shrimp that is the main food source for the migratory birds that visit this lake. *Artemia urmiana* itself feed from *Dunaliella sp.* and *Tetraselmis sp.* which are among phytoplankton identified in LU.

Artemia urmiana can survive high ranges of variation in salinity and temperature of water. The optimal temperature and salinity for Artemia are 18 - 25 degrees centigrade and 60-70 g/l of salt respectively. At lower salinities, species of fish will inhabit the water body and would rapidly deplete the Artemia population. However, above a salinity of 250 g/l Artemia cysts are unable to hatch. Such conditions occur in the Lake during drought periods, when inadequate fresh water flows into the lake to keep its salinity lower than thresholds. When the salinity of water is within the range, the density of Artemia may reach as high as 4000 individuals per liter.

5.2. Satellite wetlands

Being recharged by return and/or drainage flows from the irrigation system, the quality of water in the satellite wetlands varies considerably in the range of fresh to brackish depending on the season. Table 5.1 represents some quality indicators of wetlands' waters.

Table 5-1 Summary water quality of wetlands (2004 surveys)

Wetland	EC	pH	DO	BOD	COD
	dS/m		ppm		
Yadegarlou					
Dorgeh Sangi	10-55	8.3-9.1	6.5-7.6	11.4-12.3	88-272
Soldouz	2-20	8.0-9.9	7.4-10.0	10-12.3	36-272
Kanibrazan	2-15	8.4-9.9	5.3-10.4	1.2-17	36-130
Goppy babaali	5-32	6-8.6	5.5-16	2.5-10	35-160

Normally all the satellite wetlands are rich in invertebrates particularly phytoplankton. Composition of the species vary considerably according the season and water stages. However surveys during 2004 indicated that *Diatom* is the dominant group of phytoplankton in all the wetlands, while other groups including *Cryptophyceae*, *Chlorophyceae*, *Desmideae* and *Myxophyceae* also do exist in different levels of abundance. *Copepodae* is the dominant group of zooplankton in the wetlands.

With the exception of Kanibrazan and Soldouz benthic diversity in the wetlands is not very rich. In almost all conditions, most of the benthic population is comprised of *Chironomids* which are usually indicators of contaminated water.

In general the primary production of all the wetlands is high and in most cases the water body shows eutrophic condition. In all wetlands and more significantly in Dorgeh Sangi and Kanibrazan, mass growth of *Spirogira spirali*, *Caldifora sp.* and *Lyngbia sp.* is common. Nutrient rich drainage water as main source of water supply to the wetlands should be accounted as main reason for the prevailing conditions.

Algal growth in Dorgeh sangi Dorgeh Sangi

Algal growth in the drainage channel-Kani brazan

Growth of alga inside Kani brazan wetland

5.3. River flows

Very little information is available about limnological attributes of river flows which are the main source of water supply to the areas and wetlands within LU Basin. However in some cases, for instance Gadar chai surveys have been conducted in 2003. The study requested by WAECO included sampling and identification of limnological attributes in 5 stations along the entire river length. In addition to invertebrates, the study revealed that ten fish species exist in the river, one of which is exotic and was probably released from upstream fish farms.

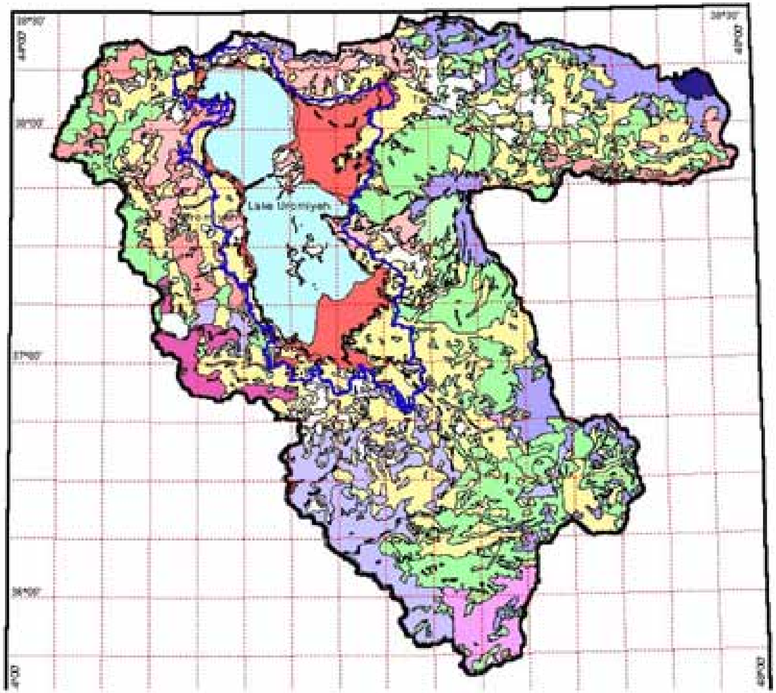
6. FLORA

6.1. Lake Uromiyeh Basin

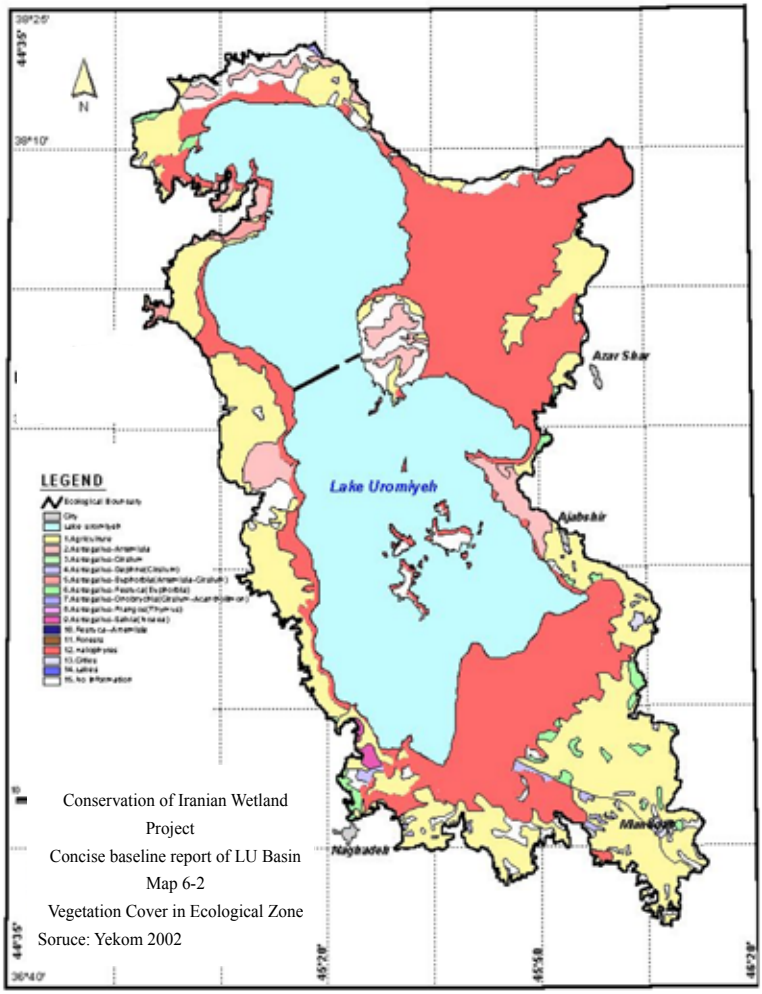
According to existing knowledge on the flora of the LU Basin, about 1500 vascular plant species have been identified within this area belonging to 85 families of which 85% are of Dicotyledons and 14% to Monocotyledons. The families with largest species diversity are Asteraceae, Papilionaceae, Lamiaceae, Caryophyllaceae and Poaceae. The floristic richness increases from salt marshes and low lands towards higher elevated territories and mountains. Of the total plant species within the basin, 353 species are economically and 290 species are ecologically important. Map 6.1 displays spatial distribution of the main vegetation communities over the basin on the basis of analysis of satellite images of early 1990s.

6.2. Ecological zone

Study of existing reports reveals that about 546 plant species of 299 genera and 64 families occur within the ecological zone of LU. Dicotyledons and Monocotyledons contain more than 99% of the plant species. The majority of species are annual or perennial herbs of grass types. It is estimated that 32.2% of all the species are annual, 9.1% biennial, 47.1% perennial and 11.5% shrubs and trees. 17.8% of the total species are halophytes around the Lake and salt marshes. The most important species that make up the halophytic vegetation are *Atriplex*, *Salsola*, *Suaeda*, *Salicornia*, *Halostchys*, *Halocnemum*, *Frankenia*, *Tamarix*, *Juncus*, *Plantago* and *Cressa*. Map 6.2 shows the distribution of vegetation communities within the Ecological zone.



Conservation of Iranian Wetland Project
Concise baseline report of LU Basin
Map 6-1
Vegetation cover in Lake Uromiyeh Basin
Reproduced from Yekom 2002



Conservation of Iranian Wetland Project
Concise baseline report of LU Basin
Map 6-2
Vegetation Cover in Ecological Zone
Soruce: Yekom 2002

Dense reed beds just at the outlet of the drainage canal which extends towards Solduz Wetland at the right hand

Shoenoplectus in the eastern Kanibrazan, May 2004

A typical patch of *Phragmatis* in the middle wetland, Kanibrazan, Oct 2004

Gerdeh gheet wetland, looking south towards Mamyand village, *Tamarix* woodlands + Gadar River (View from Gerdeh Sagav, July 04)

6.3. Wetland areas

Satellite wetlands around the Lake usually encompass a rich floristic diversity. Floristic composition of seven of these wetlands located in the south and south west of the Lake was surveyed and mapped in 2004 [9]. Depending on the quantity and persistence of water, different vegetation communities have evolved around and inside the wetlands. In Soldouz, for example, an intensive reed bed *Phragmites australis* has grown at the outlet of the drainage canal just upstream of the lake, while in Kani brazan patches of *Phragmites australis*

have grown in the inner parts; with a rather intensive and uniform growth of *Juncus maritimus* in the eastern and northern parts of the wetland. Over the intermittently inundated marginal lands around the wetland, different vegetation cover has created a rich diversity of wetland and terrestrial flora.

In Gerdeh gheet wetland an extensive growth of *Tamarix* has created a very typical and spectacular landscape.

Domestic animals grazing the pasture lands east of Dorge Sangi wetland.

Submerged vegetation, Kanibrazan Oct. 2004

Growth of alga in Kani brazan, July 2004

Dorgeh sangi, Shorgol (Hassanlou), Kani brazan encompass considerable pasturelands by and around the wetland which are normally supported by the ground water table. These grazing lands, still accounted as part of the wetland areas have great economical importance in animal husbandry of the rural areas.

Floral species and vegetation communities identified in satellite wetlands are presented in Table 6.1.

Table 6.1 Vegetation communities and species in satellite wetlands

Wetlands	Vegetation communities	Floral species
Dorgeh Sangi	10	42
Yadergarlu	Dry land veg. communities only	
Soldouz	13	42
Gerdeh gheet wetland (dry)	3	11
Lake Kobi	20	57
Kanibrazan	11	45

Kani brazan wetland seems to be the only satellite wetland in southwest of the Lake which encompass intensive submerged vegetation *Najas graminea*. Other wetlands do not contain such vegetation, most likely because of the quality of water in the wetland.

As discussed earlier, the growth of algae could be found in almost all the wetlands indicating the eautrophic status of water bodies. Nutrient-rich water recharging the wetlands and fertilizer runoff from agricultural lands surrounding the wetlands are the main reasons for eautrophic status of wetlands and is therefore an important issue in the management of the wetlands.

7. HABITATS

7.1. Introduction

Lake Uromiyeh, together with its islands and satellite wetlands as well as its marginal salt lands comprises a unique ecosystem with different important habitats.

Information on these habitats is not consistent. Some of them have been investigated and detailed information is available which provides a basis for their evaluation. However some of them have not been investigated and only limited general information is available on them. In this chapter a quick review of the attributes of the habitats listed below will be presented. Abbreviations used for classification of these habitats are: Ramsar Sites (RS), Important Bird Areas (IBA), No Hunting Areas (NHA), Biosphere Reserves (BR), and National Park (NP). There are some wetlands which are National Important Bird Areas (NIBA). Map 7.1 displays locations of these habitats.

1. Lake Uromiyeh including its islands (Kaboodan/ Ghoyoon Daghi, Arezu, Ashk, Espir and Doghuzlar) (RS, NP, BR, IBA)
2. Ghara Gheshlaq marshes (IBA & NHA)
3. Gerde Gheet and Mamiyand (IBA & NHA)
4. Nowruzlu reservoir (IBA)
5. Islami Peninsula (NHA)
6. Shur Gol (RS & IBA)
7. Yadegarlu (RS & IBA)
8. Dorgeh Sangi (RS & IBA)
9. Lake Kobi/ Gopi Babaali (RS & IBA)
10. Ghara Gol Wetland (NIBA)
11. Agh Ziarat (IBA)
12. Kani Berazan (IBA,RS)
13. Shaitan Abad (NIBA)
14. Islam Abad/ Juhood Abad (NIBA)
15. Gopi Ghazan and Garous (NIBA)
16. Jamal Aabad (NIBA)
17. Changiz Goli (NIBA)
18. Ghorigol (RS,IBA)

There are additional areas of natural habitats, which have not yet been studied/ designated but have major importance for the ecosystem. These are mainly permanent rivers and deltas of the main rivers such as Zarrineh Roud, Simineh Roud, Mahabad Chai, Nazlu Chai, Barandooz Chai, Shahr Chai, Sofi Chai, Sofian Chai, Mardoogh Chai, Agh Chai, Rozeh Chai and Gadar Chai.

Furthermore a few artificial reservoirs of storage dams and diversion wiers have created habitats, which are valuable places for hosting birds and aquatic fauna. These are Yussef Kandi, Bokan, Shahrchai, Hassanlo and Mahabad reservoirs wherein important bird species feed, breed, rest and/or shelter.

This chapter is mainly based on the information from Yekom 2001 and Pandam 2005 “, and CIWP 2012 for Gharagheshlaqh”.

7.2. Lake Uromiyeh (RS, NP, BR, IBA)

7.2.1. Water Body

Lake Uromiyeh is a large, shallow, hypersaline lake with several islands, and is surrounded by extensive brackish to saline marshes, mainly at the southern end. The Lake has a very high ecosystem value because of its great scenic beauty and spectacular concentrations of waterbirds. It is believed that the Lakeside mud has special medicinal properties.

The Lake is protected as a National Park, Ramsar Site and Biosphere Reserve. It is of great scenic beauty with extensive salty flats and shingle beaches. The physical attributes of the lake was already presented in previous chapters.

The Lake includes 56, mostly small, uninhabited islands; the largest, Kaboodan, comprises 3125 ha of hilly terrain covered with steppe vegetation and scattered trees of oak and wild pistachio. The Lake is particularly known for *Artemia urmiana*, which is the main food for migratory waterbirds who visit the lake. However, as a result of the recent extremely high salinities, Artemia has ceased to breed and densities in the lake are very low (and only around the freshwater inflows).

The Lake has been extremely important for breeding *Phoenicopterus ruber* (Flamingos), *Pelecanus onocrotalus*, *Tadorna tadorna*, *Tadorna ferruginea*, *Recurvirostra avosetta*, *Tringa totanus*, *Larus armenicus*, *Larus genei*,

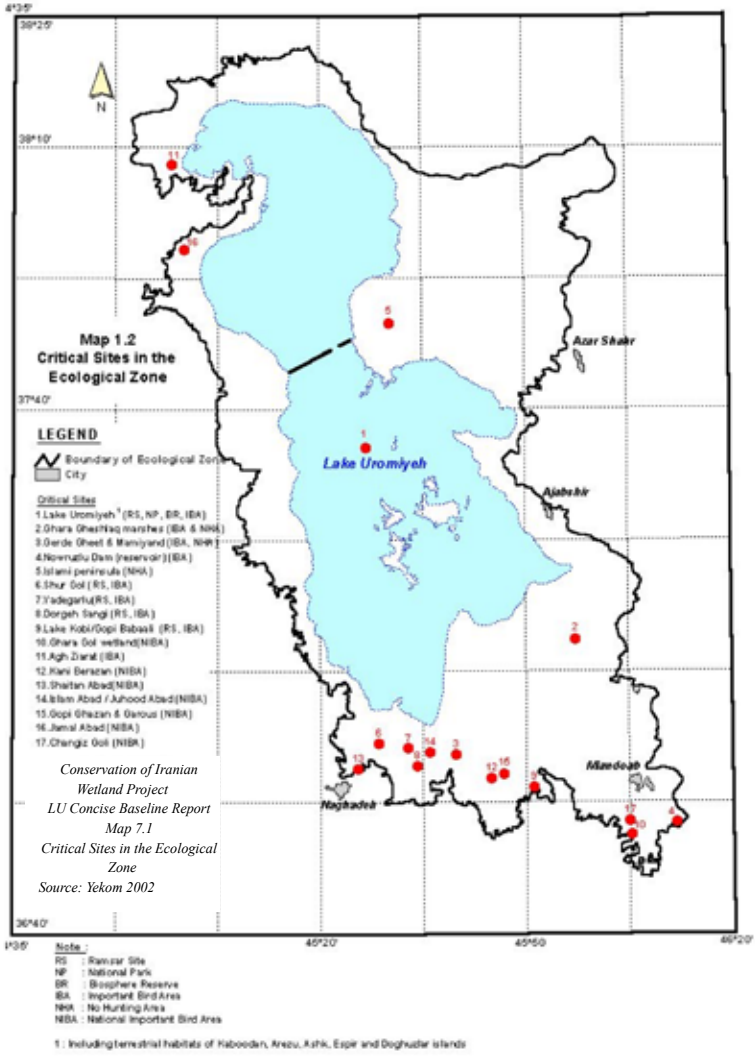
Egretta garzetta, Platalea leucorodia, Burhinus oedicnemus, Marmaronetta angustirostris, and Aythya nyroca. However as a result of increased salinities of recent years, the number of waterbirds breeding in the lake has crashed, with virtually no breeding of flamingos in recent years.

The vast mudflats surrounding the Lake have been important autumn staging areas for migratory shorebirds particularly *Anas querquedula*, while the open waters of the Lake occasionally support huge numbers of *Podiceps nigricollis*. Over 425,000 waterfowl of at least 53 species were recorded in LU during an aerial survey in August 1973 (Scott 1973), and around 150,000 during another aerial survey in August 2001 (recorded by DOE). However due to the increased salinities of water in recent years, the number of migratory waterbirds using the lake has collapsed as a result of the low Artemia densities.

The Lake has been an important moulting area for *Tadorna tadorna* and flamingos and in mid-winter may support large numbers of wintering waterfowl. However, these populations have also declined as a result of the current conditions.

7.2.2. Islands and coasts

There are about 56 generally small islands in the Lake. These have been particularly known to be important breeding areas for numerous bird species: *Falco biarmicus, Neophron percnopterus, Falco cherrug and Falco peregrinus* have been recorded during the summer months and may breed. *Gyps fulvus*, *Aegypius monachus*, *Haliaeetus albicilla* and *Falco columbarius* occur in winter. However, it is expected that populations of these birds of prey will also have been severely affected by the current ecological crisis.



Conservation of Iranian Wetland Project
LU Concise Baseline Report
Map 7.1
Critical Sites in the Ecological Zone
Source: Yekom 2002

Several of the islands, notably Ashk and Kaboodan, support close to 50 plant species including 2 endemic, 7 native and 5 vulnerable species.

In these islands and under a conservation program, DOE has introduced *Ovis ammon* and *Dama mesopotamica* (Persian fallow deer). However these populations have become extremely stressed as result of these shortages of freshwater on the islands. DOE is also conducting research on (former) breeding colony of flamingos, including ringing of flamingo, Pelican and Spoonbill chicks since 1970 and is regularly continued. Gulls were also ringed since late 1970s but in much smaller number. Several aerial censuses of breeding waterbirds were conducted since 1970s, the last one being undertaken in August 2001.

• Kaboodan (Ghoyoon Daghi) island (3125 ha) [12]

Kaboodan island is the largest island of the Lake. This island is mountainous with a top at about 1800 m a.m.s.l. and a steppic feature. It was designated as National Park in 1975 for its unique support to breeding birds. Also the island provides habitat for wild sheep (*Ovis orientalis gmelini*) and Iranian fallow deer (*Dama mesopotamica*), which have been released for conservation purposes. The shorelines of the island provide important habitat for breeding birds including Flamingo (*Phoenicopterus ruber*), Shelduck (*Tadorna tadorna*), Gulls, white Pelican (*Pelecanus onocrotalus*) and *Tadorna ferruginea*. Being a National Park, the island is protected under DOE regulations. As a result of the drying out of the Lake, the fauna and flora of this and the other islands is extremely threatened.

• Ashk island (2570 ha) [12]

Ashk island is mountainous (peak 1499 m.a.s.l), with sporadically trees. It was designated as National Park in 1975. Iranian Fallow deer (*Dama mesopotamica*) have been introduced to this island in 1977 for conservation purposes. The island has been habitat for colonies of flamingo (*Phoenicopterus ruber*), *Tadorna tadorna*, *Tadorna ferruginea*, *Larus sp.*and Alectoris chukar. The island is protected by DOE.

• Espir island (1250 ha) [12]

Espir island is mountainous territory with steppe feature and sporadically trees. There is no fresh water or spring in the island. The island has been a very important place for breeding flamingo (*Phoentcopterus ruber*). The island has also been used as breeding habitat for White Pelican (*Pelecanus onocrotalus*), *Larus sp.*, *Tadorna tadorna* and *Tadorna ferruginea*. The island is protected under DOE regulations.

• Arezu island (800 ha) [12]

Arezu island is less undulating territory and was designated as National Park in 1975. The island has steppe feature with scattered trees particularly in the lower areas. It has been a very good habitat for breeding of Shelduck (*Tadorna tadorna*), *Tadorna ferruginea*, White Pelican (*Pelecanus onocrotalus*), Flamingo (*Phoenicopterus ruber*) and *Larus sp.* DOE protects the island.

• Doghuzlar Island [12]

Doghuzlar islands are a complex of small islands located at the southeast of the Lake and were designated as National Park in 1975. The island has been the main breeding place of White Pelican (*Pelecanus onocrotalus*) and Flamingo (*Phoenicopterus ruber*). *Plegadis falcinellus*, *Tadorna tadorna* and *Alectoris chukar* also inhabit it.

• Islami Peninsula (34000 ha)[12]

Islami peninsula is a hilly (and in some parts flat) land, located at the north east of Lake Uromiyeh, and provides important habitat for mammals and birds. The beaches of this peninsula have previously been valuable for breeding birds like *Tadorna tadorna* and *Tadorna ferruginea*. The peninsula has been protected as a No Hunting Area (NHA) for 3 consecutive periods of 5 years.

The high level parts of the peninsula are important habitats for fallow deer and wild sheep. The main threat to the peninsula is cutting the trees, over-grazing and changing the lands to dry farming. There are shortages of information regarding the wildlife of the peninsula and no hunting conditions of the area.

7.3. Wetlands around the Lake

7.3.1. Qhara Gheshlaq marshes (30000 ha)[4]

Gharagheshlaqh is a complex shallow and interconnected wetland in the south eastern part of Lake created at the downstream outlet of Sufichai and Zarrinehrud rivers. The wetland is associated with a terrestrial no-hunting area with an area of about 57000 hectare of which about 30000 ha is defined as wetland [4].

The wetland receives water from Sufichai and its tributaries(Mordaqh chai,and Malekan chai) as well as overflows by Zarrinehrud and Siminehrud rivers. However periodically during high water stages of Lake, part of the wetland is submerged by Lake's hypersaline water.

The wetland is very important from ecological point of view particularly for migratory birds. Existing bird count data shows that in 1984, a total of more than 60000 aquatic birds have visited the wetland. The wetland is defined as an important bird area (A1, A4iii and B1i).

"Mishmorgh" (Great Bustard, *Otis darta*), a vulnerable and protected species inhabits in terrestrial part of this no-hunting area.

The vegetation cover of the wetland area is dominated by halophytes and Tamarix with discrete patches of *Phragmites australis* mainly along water courses.

7.3.2. Gerde Gheet and Mamiyand Wetland (600ha) [9]

The wetland is a freshwater marsh, located in the south uplands of Lake Uromiyeh and 30 km north of Naghadeh city with an average elevation of 1300 m.a.s.l. It receives tail-water of the Gadar River flow, provided that Lake's water level is high enough to control the river water level to flow over the wetland.

In the absence of river flows to recharge the wetland since more than a decade, presently a vast intensive Tamarix woodland covers the area and provides a spectacular landscape on the lands both sides of the Gadar River.

The former wetland is said to support a wintering habitat for more than 55 waterbirds species, including breeding habitat for *Ardea purpurea*, and was a feeding area for several other species.

Gerde Gheet is a No Hunting Area (NHA) and is protected (not very effectively) by DOE.

A water development project carried out in Gadar Chai will dramatically impact water resources of this wetland.

7.3.3. Nowruzlu Reservoir (1000 ha)[12]

Nowruzlu is a small reservoir, located at the south west of LU and 15 km from Miandoab city with adjacent arable lands along the Zarrineh Roud, situated in a region of undulating plains set between ranges of rocky hills.

There is a small marshy area with some reed-beds and shrubby vegetation where the river enters the reservoir. The plain is heavily populated, with several villages and a complex network of gravel and asphalted roads.

The reservoir is an important feeding area for *Pelecanus onocrotalus* and *Platalea leucorodia* from the breeding colonies at LU, and is a breeding area for small colonies of *Nycticorax nycticorax*. Flocks of *Anser albifrons* and *Anser anser* frequently visit the area in winter, and small numbers of ducks (*Aythya ferina*, *Mergus albellus* and *Mergus merganser*) use the reservoir during cold weather. The surrounding plains are reported to have been an important breeding area for *Otis tarda*.

There is a dense vegetation of Phragmites where the river enters the wetland and there is scattered vegetation of *Artemisia* sp. around the reservoir. There is no information about the important fishes in the wetland.

The wetland is not protected, and hunting permission is issued regularly. Agricultural land and associated pollution threatens the wetland. Cutting trees and reeds by local population may cause severe damage to the wetland and reduces its ecological functioning for the region. Therefore it is required to have intensive protection and manage activities. The wetland has high ecological potential and needs more surveys.

7.3.4. Shur Gol (former wetland of 1100 ha)[9]

Shur Gol (Hassanlu) was a wetland in the South-west of LU. It was designated as part of a complex Ramsar Site in 1975 (together with Yadegarlu and Dorgeh Sangi).

During 2000s the wetland was converted into a small reservoir by the construction of the Hassanlou dam which is collecting water for irrigation development in the surrounding lands.

A small part of the former wetland has recently been restored and is changing into an effective wetland.

Hassanlu wetland converted into an artificial reserovir

7.3.5. Yadegarlu wetland (350 ha)[9]

Yadegarlu was a small, shallow freshwater wetland with peripheral eutrophic marshes, situated at the south west of LU. It was designated as a Ramsar Site in 1975 (together with Shur Gol and Dorgeh Sangi), and has been identified as an important Bird area.

Yadegarlu wetland, April 2002

The wetland is surrounded by irrigated agricultural lands and supplied by return flows.

The wetland was fed by return flows from upstream irrigated lands. However the existing irrigation canals are sometimes used to convey river flows to the wetland.

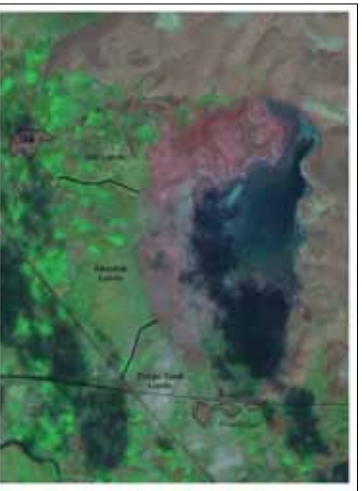
Originally, the wetland was dominated by sedges (Carex) and grasses, with very little aquatic vegetation. The main plant species were *Carex pendula*, *Phragmites australis* and some other plants including, *Hordeum marinum*, *Trichophyllum botrachium*, *Cyperus alternifolius*, and *Salsola sogdians*.

The wetland was especially important for breeding waterbirds, and provided a good habitat for at least 40 species of waterbird and waders, such as *Marmaronetta angustirostris*, *Plegadis falcinellus*, *Cygnus columbianus*, *Aythya nyroca, Ciconia ciconia, Anser erythropus* and *Anser albifrons*.

Construction of a rather deep drainage channel in the northern border of the wetland has resulted in its complete dessication. However both DOE and WAWA and local NGOs are searching ways to restore it.

7.3.6. Dorgeh Sangi (Siran goli), (735 ha)[9]

Dorgeh Sangi is a freshwater to brackish wetland at the southern end of LU just at the crossing of Naghadeh-Mahabad road. The wetland has been designated as part of a Ramsar Site (together with Shur Gol and Yadegarlu), and an 'Important Bird Area', but has no legal protection. The wetland includes a water body (about 490 ha.) and adjacent waterlogged pasture land (245 ha).


Dorgeh Sangi Wetland

The wetland is recharged mainly by return flows from irrigated lands. However irrigation canals are occasionally used to convey river flows to the wetland.

There is relatively little aquatic vegetation, but extensive bare mudflats are exposed at low water level. Also a sizable grass area covers western part of the wetland which is in fact a grazing land for domestic animals.

Inside the wetland, especially at the southeast corner, there is a dense vegetation of emergent plants such as *Phragmites sp.* and *Carex sp.* The vegetation at the margin of wetland includes *Carex distanus*, *Kochia scoparia*, *Cynondon dactylon*, *Noaea mucronata*, *Salsola kali*, and *Melica persica.*

7.3.7. Lake Kobi /Gopi Baba-ali (1200 ha)[9]

This is a freshwater to brackish Lake with associated marshes in a plain 75 km to the south of Lake Uromiyeh on the way between Mahabad and Miandoab cities. Rolling steppic hills, with some villages and farmland to the north and south, surround it. The Lake was designated as a Ramsar Site in 1975 and has been identified as an Important Bird Area.

The total area of the wetland is 1200 ha. Including the lake (max. 500 ha) and an adjcacent waterlogged pastureland.

The Lake is generally a shallow, eutrophic wetland which originally received water from surface runoffs. In early 2000s a constructed outlet in the drainage canal facilitated drainwater to flow into the wetland.

The Lake supports a limited growth of submerged vegetation; sedge and Phragmites marshes around much of the shoreline, together with grasslands and pastures.

The wetland is particularly important for feeding Flamingos and also breeding, passage and wintering waterbirds. The marshlands support a variety of breeding waterbirds, notably *Plegadis falcinellus*, *Ardeola ralloides*, *Egretta garzetta*, *Aythya nyroca*, *Ciconia ciconia*, and *Podiceps nigricollis* is usually observed at the Lake. *Oxyura leucocephala*, *Marmaronetta angustirostris* and *Sterna albifrons* are sometimes seen during the summer, probably just for feeding in the Lake.

Goppy wetland

7.3.8. Ghara Gol wetland (210 ha)[12]

Ghara Gol is a seasonal wetland located at the south west of Miandoab city that receives water from Simineh Roud, and is covered mainly with reeds and Tamarix. It is a very good habitat for native and migratory waterbirds due to some dense vegetation and safe breeding habitat. The most important birds of the wetland are *Marmaronetta angustirostris* and *Pelecanus onocrotalus*.

Recently, the stakeholders have diverted some water from Simineh Roud by construction of a temporary diversion structure and a channel to the wetland.

7.3.9. Agh Ziarat wetland[12]

Agh Ziarat is a flat muddy and marshy area at the north west of LU, south of Salmas city. The marshes are important for wintering and passage birds. The

area is an important place for ecotourism. Some parts of the wetland are covered by reed beds, which provide suitable habitats for waterfowl and shorebirds. No more information is available on this wetland.

7.3.10. Gopi Ghazan & Garous [12]

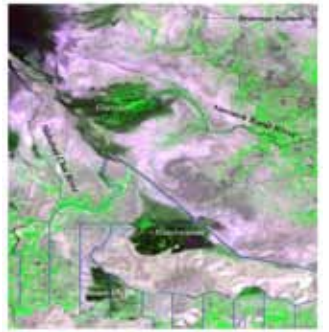
The Gopi Ghazan & Garous is a complex of large and small wetlands, located at the north east of Mahabad city and the north of Mahabad River and Simineh Roud. Gopi Ghazan and Garous connect to each other in high flows of the Mahabad and Simineh Roud. Garous wetland is mainly located at the delta area of Mahabad River, which contains fresh and less saline water, which are rich in nutrients; the wetland is therefore eutrophic.

It is a very good habitat for breeding waterbirds due to existing reeds and Tamarix around it. Garous wetland supports migratory birds and is a breeding place for birds like *Oxyura leucocephala*, *Marmaronetta angustirostris* and *Pelecanus onocrotalus*.

7.3.11. Kani Brazan wetland (690 ha)[9]

Kani Berazan is a freshwater, vegetated wetland located 30 km to the north east of Mahabad city, with an average elevation of 1370 m.a.s.l. It originally used to receive water from Mahabad Chai, but during the last decades a drainage canal of the Mahabad irrigation system crosses the wetland which provides permanent flow to the wetland. The total area of the wetland is 690 ha including the southern deeper lake (460 ha) and shallower northern marsh (230 ha).

The wetland is a Ramsar site, an Important Bird Area, providing breeding habitat for many species of ducks such as *Marmaronetta angustirostris*, *Aythya nyroca*, *Oxyura leucocephala*, *Ardea purpurea*, *Sterna albifrons*, and some shorebirds and also *Circus pygargus*. The wetland is an important wintering ground



Kani brazan wetland

for a few *Anser erythropus*.

Despite the wetland has been designated as a Ramsar Site in 2011, it is not formally protected.

Kani Berazan includes several reed patches of Phragmates, *Thlaspi arvense*, *Euclidium syriacum, Malcolmia africana, Sisymbrium loeselii* (critical) *Tragopogon porphyrrhocophalus, Salsola ericoides, Halothamnus urearescells*, *H.glaucus, Analasis aphylla, Erodiues australis*, and a larger area of Juncus maritimus. Due to its fresh water, there are important stands of *Phragmites sp.* and *Typha latifolia*.

7.3.12. Shaitan Abad wetland (25 ha.)[12]

This is small fresh water to brackish wetland, located at the very south of LU at the border of the Ecological Zoneand 6 km from Naghadeh city receiving water from Gadar River. This wetland is known to be an important habitat for waterbirds, with extensive plant cover. The main threats to Shaitan Abad are drainage and hunting. The wetland is not protected.

Intensive agricultural activities and residual pesticides and fertilizers of return flows are threatening the wetland. There is no information about the present situation of this wetland, as well as important birds.

7.3.13. Islam Abad / Juhood Abad (180 ha)[12]

Islam Abad wetland is located 25 km from Naghadeh city, is a very good habitat for water birds, which is not protected properly. The migratory birds of the wetland are *Circus aeruginosus, Phoenicopterus ruber*, and *Circus cyaneus*.

7.3.14. Jamal Abad[12]

Jamal Abad wetland is a beautiful seasonal wetland; located at the northwest of LU having various vegetation-mainly Tamarix. It is a favorable habitat for most of the native and migrant birds. It is dramatically impacted by human's interference.

7.3.15. Changiz Goli wetland (5 ha.)[12]

Changiz Goli is a freshwater, eutrophic wetland located 12 km south of Miandoab city with an average elevation of 1300 m.a.s.l.

The wetland is very important for a variety of waterbirds, situated in the uplands of the south east of LU. The extensive marshes are eutrophic and rich in vegetation. The site is not protected, and is under pressure by excessive hunting and grazing.

The wetland is especially important for wintering and occasionally breeding waterbirds, noteably *Ciconia ciconia, Oxyura leucocephala, Pelecanus onocrotalus, Aythya nyroca*, some species of swans, *Mergus sp*, *Grus grus* and *Anser erythropus*.

7.3.16. Ghorigol wetland

Ghorigole, a fresh-brackish water wetland of about 200 ha in a small closed basin of about 3150 ha is located about 30 Kms south of Tabriz. The main sources of water supply to the wetland are precipitation and the excess flows from existing springs. The wetland freezes during cold periods in winter time. It is hosting 92 species of migratory birds. The total number of birds counted in the wetland exceed 4000 pcs. The wetland is famous for hosting *Marmaronetta angustirostris, Aythya nyroca, Oxyura leucocephala*, protected species that use the wetland for wintering and breeding. The wetland was designated in 1975 as a Ramsar site. In 1994 it was declared as a no hunting prohibited area by DOE. The wetland has good tourism potensial.

8. FAUNA

8.1. Mammals

According to the available information, 27 species of mammals have been recorded from the Basin (Table 8.1). With the exception of reference books and some DOE publications and reports on LU National Park, there is little information about mammals, particularly on smaller ones. The most notable mammals recorded within the LU Ecological Zone are as follows:

Table 8-1 Mammals recorded in LU Ecological Zone

No	Genus & Species	No	Genus & Species
1	*Allactaga sp.*	*15*	*Meriones libycus*
2	*Apodemus mystacinus*	*16*	*Microtus arvalis*
3	*Canis aureus*	17	*Mus musculus*
4	*Canis lupus*	18	*Mustela nivialis*
5	*Capra aegagrus aegagrus*	*19*	*Ovis orientalis gmelini*
6	Cricetulus migratorius	20	*Pantherapardus saxicolor*
7	*Crocidura russula*	21	*Rhinolophus ferrumequinum*
8	*Dama mesopotamica*	*22*	*Rhinolophus hipposideros*
9	*Felis chaus*	23	*Sus scrofa*
10	*Felis silvestris*	24	*Taphozous nudiventris*
11	*Hystrix indica*	*25*	*Ursus arctos*
12	*Lutra lutra*	26	*Vormela peregusna*
13	*Lynx lynx*	27	*Vulpes vulpes*
14	*Meles meles*		

a) Persian Fallow Deer (*Dama mesopotamica*)

This animal was sometimes thought to be extinct. Few decades ago, a few of these animals were released in Ashk and Kaboodan Islands and due to the conservation measures applied the population increased considerably such that until the recent drought, LU was an exporting center for these mammals.

b) Armenian Wild Sheep (*Ovis orientalis gmelini*)

This animal is considered vulnerable by IUCN and lives in the north-west of Iran, where it is mostly observed in the gentle slopes of mountainous areas. This wild sheep has been introduced to the Kaboodan island about a century ago. Until before recent dessication ot the lake, a healthy population of this sheep was living in this island.

8.2. Birds

8.2.1. Water birds

Water birds have been the most important components of the faunal diversity of Lake Uromiyeh. Compared to several other wetlands in Iran, the diversity of water birds in LU and its satellite wetlands is high, and many species occur in numbers that make the area of international importance.

Water birds in the Lake and many of its satellite wetlands are counted annually during midwinter water bird count program of DOE, and data is available since 1970 with some interruptions during 1980s. For a shorter period in 2003-03, water birds in the southwestern satellite wetlands were counted monthly [9].

Based on the existing information, 239 species of birds have been recorded within Lake Uromiyeh Basin and 212 within the National Park (the Lake and its satellite wetlands). These belong to 16 orders, and 21 families. The Anatidae and Accipitridae (each 29 species) and Turdidae (18 species) are the most diverse families. 71 of these species are protected under national law.

In terms of life-history, 78 bird species have bred in or around the Lake, while 170 species are migratory, using the area for wintering, stationing or feeding as part of their migratory cycle. About 50 species are showing evidence of declines, and 11 globally threatened bird species have been recorded [12]. Maps 8.1 and 8.2 display feeding and nesting habitats of threatened some threatened species in LU ecological zone.

Greater Flamingo (*Phoenicopterus ruber*) was previously one of the most conspicuous and abundant bird species of LU, occurring in internationally important numbers (records of up to 100,000 individuals, about 20% of the regional population). The islands inside the Lake have previously provided the most significant breeding site in Eurasia. Flamingos occur all year round on

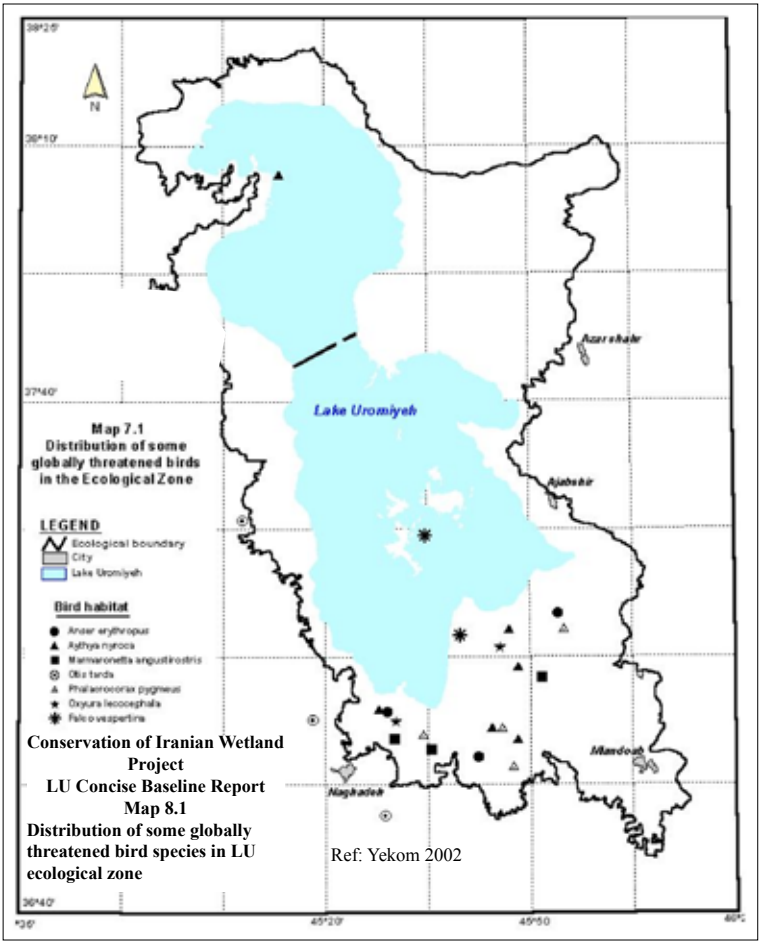
LU and usually feed on Artemia and invertebrates in shallow parts of satellite wetlands.

A flock of flamingo (more than 3000 individual), feeding in Goppy Baba-ali Lake, summer 2004

White pelican (*Pelecanus onocrotalus*) is another important waterbird which has regularly occurred and formerly bred on the LU islands. The previously recorded population of about 200-500 pairs are of international significance. They feed on fish in freshwater wetlands of the Zarrineh Rud and Simineh Rud deltas and Kanibrazan Wetland.

Pelicans in Kani Brazan Wetland

Large numbers of shelducks, other ducks, grebes, waders and other water birds formerly visited LU and its surrounding wetlands during their non-breeding season (August–April). From the existing data it is clear that very large numbers of birds pass through the Ecological Zone in late summer on their southward migration. The outstanding importance of LU at this time for water birds was exemplified by the results of an aerial survey in August 1973, which revealed over 425,000 individuals of at least 53 species (Scott, 1995), including 146,000 small waders, 21,000 *Anas querquedula* and 13,600 *Recurvirostra avocetta*. The Lake also used to be an important molting area for Shelduck (*T. tadorna*).



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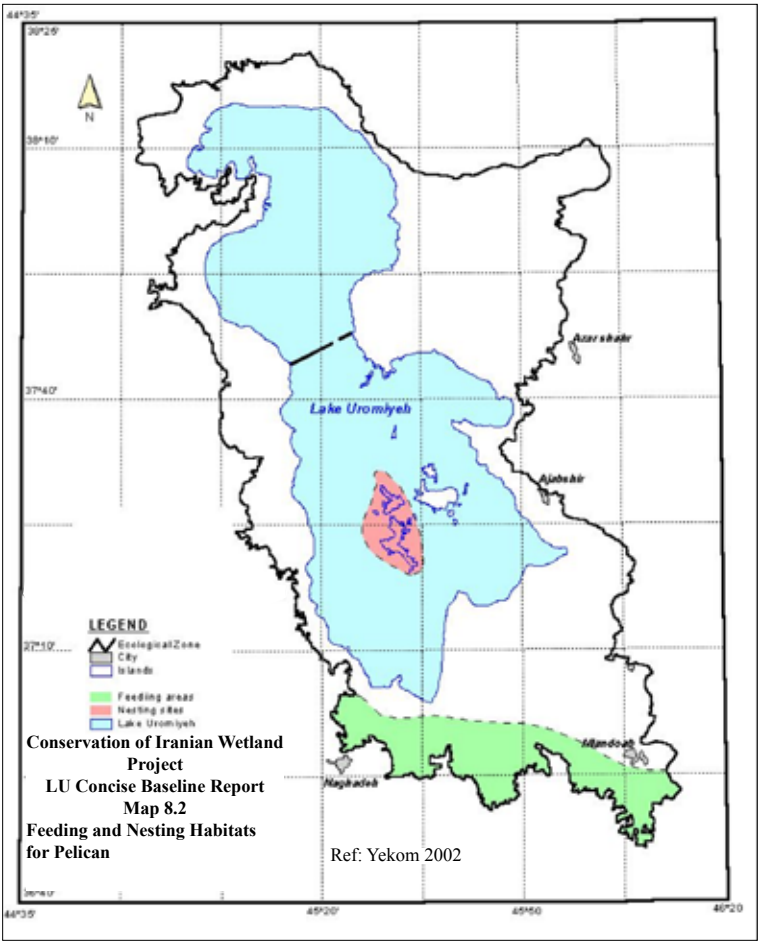
Map 8.1
Distribution of some globally threatened bird species in LU ecological zone

Ref: Yekom 2002



The persisting drought since late 1990s exacerbated by human interventions on water resources development projects has dramatically reduced the population of birds which usually visit the Lake. However during the same period, the satellite wetlands have played a more significant role in hosting the migratory waterbirds.

Regardless of the droughts of the recent decade and based on the existing records, LU and its satellite wetlands usually host waterbird populations

exceeding 20,000 criterion 3a of Ramsar Convention. Also available data indicates that at least 14 species (Table 8-2) of waterbirds occur in numbers exceeding the Ramsar 1% criterion for international importance within the Ecological Zone (Criterion 3c). Both these criteria suggest that LU and several of its satellite wetlands are internationally important.

Table 8.2 Species with population exceeding Ramsar criterion 3c [12]

	Species		Species
1	*Phoenicopterus ruber*	*8*	*Tadorna ferruginea*
2	*Podiceps nigricollis*	*9*	*Anas querquedula*
3	*Pelecanus onocrotalus*	*10*	*Marmaronetta angustirostris*
4	*Ciconia ciconia*	*11*	*Oxyura leucocephala*
5	*Phalacrocorax pygmeus*	*12*	*Himantopus himantopus*
6	*Cygnus bewickii*	*13*	*Tringa totanus*
7	*Tadorna tadorna*	*14*	*Limicola falcinellus*

During 2004-5 a program of monthly bird counts was conducted in a few of the satellite wetlands in the south-west of LU [9]. The result of this study is summarized in the table below.

Table 8.3 Summary monthly bird counts in the satellite wetlands [9]

Satellite Wetlands	Summed Peak counts	Species >1% bio-geographic population	No. globally threatened species	No. breeding bird species
Hassanlou Reservoir	8,979	-	-	-
Dorgeh Sangi	20,166	-	1	12
Yadergarlou	-	-	-	-
Soldouz	22,651	-	4	10
Gherde Gheet	-	-	-	-
Lake Kobi	14,524	-	1	1
Kanibrazan	38,625	4	4	3

With a total sum of peak count of the wetlands all together of over 105,000

individuals, the table reveals the very considerable importance of these satellite wetlands for waterbirds despite the ecological crisis within Lake Uromiyeh itself. Dorgeh Sangi, Soldouz and Kanibrazan wetlands individually have summed peak counts above the 20,000 threshold of 3a Ramsar Criterion.

The wetlands are also of considerable importance for globally threatened waterbird species, particularly *Oxyura leucocephala* and *Marmaronetta angustirostris*.

Figure 8.1 shows the seasonal patterns of numbers of waterbirds counted in the surveyed satellite wetlands. Generally, numbers are highest in spring and autumn, emphasizing the importance of these wetlands as migration staging points.

8.2.2. Terrestrial birds

The islands in the Lake are the only known breeding locality for *Falco biarmicus* in Iran, and also provide nesting sites for *Neophron percnoptorus*. *Falco cherrug* and *Falco peregrinus* have been recorded during the summer months and may breed; *Gyps fulvus* and *Aegypius monachus* are regular visitors from the surrounding hills; and *Haliaeetus albicilla* and *Falco columbarius* occur in winter. *Gyps fulvus* have been observed breeding regularly on the high cliffs of the Kaboodan Island. *Otis tarda* was a regular visitor to the plains around the Lake

8.2.3. Globally threatened species and species of local concern

There are 11 bird species in the IUCN (2000) category of globally threatened species that have been recorded in the Ecological Zone of Lake Uromiyeh (Table 8.4). The distribution of these species (Map 8.1) emphasizes the tremendous importance of the freshwater and brackish wetlands in the south of the Lake.

Table 8-4Globally threatened bird species (IUCN, 2000) recorded within the Ecological Zone [12]

No	Species	Notes
1	*Anser erythropus*	The wintering population has declined in recent years. It is reported from the wetlands to the south of Lake Uromiyeh
2	*Aythya nyroca*	Breeds in the southern wetlands.
3	*Branta ruficollis*	A winter migrant to Iran. There are a few old records of this bird from Changiz Goli and Lake Gopi, but no information in recent years.
4	*Falco naumanni*	Some in Islands, but mostly were seen breeding around the Lake.
5	*Falco vespertinus*	Probably breed / Usually observed in late summer
6	*Marmaronetta angustirostris*	Breeds and winters in the Southern wetlands, declining.
7	*Otis tarda*	Breeds on natural steppes and arable fields of southwest of the region
8	*Oxyura leucocephala*	Breeds in the southern wetlands.
9	*Pelecanus crispus*	A single old record from Changiz Goli
10	*Phalacrocorax pygmeus*	Breeds in small population/ Wintering to the area
11	*Vanellus gregarius*	A single record from Yadegarlu

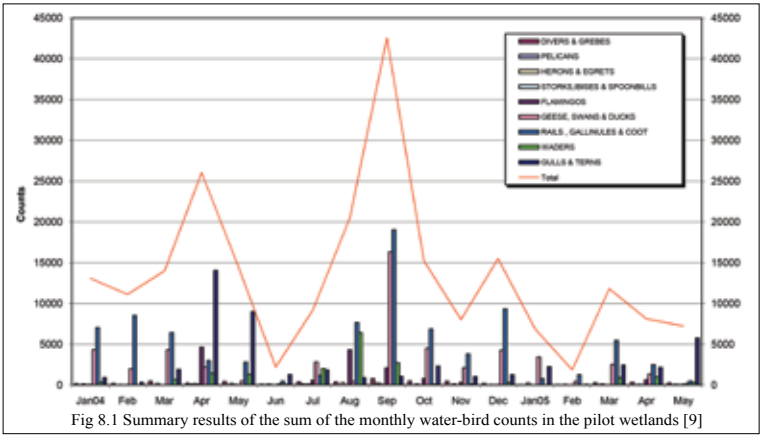


Fig 8.1 Summary results of the sum of the monthly water-bird counts in the pilot wetlands [9]

8.3. Fish

Due to the hypersalinity of LU water, no fish species occur in the Lake itself.

However considerable fish populations occur in the rivers which discharge into the Lake and the wetlands around it. The fish of the surrounding wetlands are an important food source for fish-eating birds (particularly for *Pelecanus onocrotalus* which breeds on LU), and are also trapped and harvested by local people.

According to existing information, 26 species of fish (belonging to 5 families and 17 genera) have been recorded in the water resources of the Basin. As indicated in Table 8.5, 17 species belong to Cyprinidae of which 5 species including (*Ctenopharyngodon idella*, *Cyprinus carpio*, *Oncorhynchus mykiss*, *Carassius auratus*, and *Pseudorasbora parva*), as well as Gambusia holbrooki (Poecilidae) are exotic fishes introduced to the ecosystem. The first three species are widely used in fish farming units in E. and W. Azerbaijan. These species have either been introduced to, or escaped into, natural freshwater habitats; particularly during the last 3 decades. The impacts of the occurrence of these exotic species in the water resources of the basin have not been evaluated in detail.

Satellite fresh or brackish water wetlands around the Lake provide important habitats for fishes. About 11 to 15 fish species of 4 families (Balitoridae, Siluridae, Poecilidae and Cyprinidae) have been recorded. These include at least 3 species which are endemic to the LU Basin: *Acanthalburnus urmianus*, *Leuciscus ulanus*, *Chalcalburnus atropatenae*, and 2 species, which are endemic to the LU and Caspian (Aras) Basins: *Capoeta capoeta gracilis, Gobio persus*, and 3 species which are endemic to Iran and the LU Basin: *Leuciscus persus*, *Leuciscus ulanus*, *Silurus glanis*. There are 5 introduced /exotic fish species in the Ecological Zone (satellite wetlands): *Carassius auratus, Pseudorasbora parva*, *Ctenopharyngodon idella, Gambusia holbrooki*, and *Hypophthalmichthys molitrix*. Among species living in Ecological Zone: *Capoeta capoeta*, and Silurus glanis are reported to be included in the diet of young white pelican (*Pelecanus onocrotalus*), on Doghuzlar Islands (Behrouzi, 1992).

8.4. Amphibians

Seven species of amphibians have been reported from LU Basin terrestrial and

aquatic habitats which are indicated in Table 8-6. Due to the existing habitats in the region, the densities of amphibians seem rather high, although the impacts of the drought and water resource development projects require further study.

Table 8.5 Species list, distribution and main habitats of fish species recorded in the LU Basin[12]

No	Scientific name	Family	Main habitats / needs	Rivers (Chais), wetlands reported	Status			Remark
					EZ	En	Ex	
1	*Acanthalburnus urmianus*	Cyprinidae	Low speed flow, freshwater, wetlands, mudsilt beds	Shahr, Barandooz, Sofi, Mahabad and Mardoogh	*	*		Endemic to LUB
2	*Alburnoides bipunctatus*	Cyprinidae	Middle part stream fresh water	Zola, Shahr, Barandooz, Zarrineh, Simineh, Sofi, Aji and Mardoogh	*	*		Iran, Iraq, Abundant. Small, Beauty
3	*Alburnoides filippi*	Cyprinidae	Upstream of rivers, fresh wetland	Sofi, Shahr	?			
4	*Chalcalburnus atropatenae*	Cyprinidae	Fresh waters, middle part of rivers	Shahr, Mahabad, Zarrineh, Sofi, Aji, Mardoogh & Jighato, Ghaleh		*		Sport fishing
5	*Barbus mursa*	Cyprinidae	Medium/fast current, clean water rubble stone beds	Simineh, Sofi		*		
6	*Barbus lacerta*	Cyprinidae	Upstream (Trout Zone) Carnivorous	Barandooz, Shahr, Simineh, Sofi, Ghaleh, Aji, Mardoogh		*		Sport fishing
7	*Capoeta buhsei*	Cyprinidae	Stream with rubble stone beds, high density of aquatic plants	Nazlu, Barandooz, Shahr		*		
8	*Capoeta capoeta gracilis*	Cyprinidae	Mountainous area, clean water	Barandooz, Azar Shahr, Ghaleh, Shahr, Gori Gol, Aji, Sofi, Simineh, Mardoogh, Zarrineh	?	*		Endemic to LU & Caspian sea

No	Scientific name	Family	Main habitats / needs	Rivers (Chais), wetlands reported	Status			Remark
					EZ	En	Ex	
9	*Gobio persus*	Cyprinidae	Rivers with medium / fast current	Eastern and south eastern rivers of Lake Zarrineh, Mardoogh	?			Endemic to LU Critical Sites
10	*Leuciscus cephalus orientalis*	Cyprinidae	Slow / still flow water / wetland freshwater and lakes	Sofi, Aji, Zarrineh, Shahr, Barandoz, Mardoogh	*	*		Endemic to Iran
11	*Leuciscus gaderanus*	Cyprinidae	Similar to *L.cephalus*	Simineh, Zarrineh, Mardoogh	?	*		More studies needed
12	*Leuciscus ulanus*	Cyprinidae	Fresh water / no more information available	Endemic to Lake Uromiyeh Basin, Mahabad	*			Endemic to LUB
13	*Carassius auratus*	Cyprinidae	Fresh, semi-brackish water, downstream of rivers, wetland	Mardoogh	*		*	Resistant to salinity, turbidity, temperature.
14	*Pseudorasbora parva*	Cyprinidae	Like *Gambusia*, tolerant to water quality changes (Tem. DO) and turbidity	Mardoogh, Aji, Simineh	*		*	Parthenogenesis, tolerant to Low water quality
15	*Cyprinus carpio*	Cyprinidae	Like *Gambusia*, tolerant to low quality of water	Yusef kandi reservoir (Mahabad) and other reservoir and ponds	*		*	Fish farming.
16	*Ctenopharyngodon idella*	Cyprinidae	Ponds, wetland, mid/ downstream, tolerant/ aquatic plants	Same as above	*		*	Fish farming
17	*Hypophthalmichthys molitrix*	Cyprinidae	Similar to No 16 feed mostly on phytoplankton	Same as above	*		*	Fish farming
18	*Nemacheilus malapterurus*	Balitoridae	Upstream / middle stream, with rubble stone beds, cold, high DO, Carnivorous	Aji, Shahr, Mardoogh		*		Forage fish & aquarium
19	*Nemacheilus persa*	Balitoridae	Similar to No. 18	Zarrineh and Sofi		*		Forage fish & aquarium
20	*Nemacheilus bergianus*	Balitoridae	Similar to No. 18	Mardoogh, Aji, Ghaleh, Sofi		*		

No	Scientific name	Family	Main habitats / needs	Rivers (Chais), wetlands reported	Status			Remark
					EZ	En	Ex	
21	*Nemacheilus angorae*	Balitoridae	Similar to No 18	Simineh, Aji, Shahr, Sofi		*		
22	*Nemacheilus brandti*	Balitoridae	no more information	Shahr		*		
23	*Silurus glanis*	Siluridae	Fresh water river delta with some aquatic plants.	Mahabad, Zarrineh	*	*		Endemic to Iran & LU
24	*Salmo trutta fario*	Salmonidae	Upstream, fresh and fast flow clean waters	Lighvan, Mardoogh, Zarrineh		*		
25	*Oncorhynchus mykiss*	Salmonidae	Upstream / fresh clean water. Carnivorous	Mardoogh, and some upper part of stream			*	From fish farm
26	*Gambusia holbrooki*	Poeciliidae	Fresh, brackish, warm area with aquatic plants, slow current.	Simineh, Aji.	*		*	For biological control of Anople food competition with local species

EZ= Present in Ecological Zone Ex= Exotic species En= Endemic LUB= LU Basin LU= LU

Table 8-6 Amphibians reported from LU Basin and Ecological Zone[12]

No	Species	Family	Order	Main Habitats	status	Remarks
1	*Neurergus crocatus*	Salamandridae	Caudata	Mountains: wetlands.	Rare	Endemic.
2	*Pelobates syriacus syriacus*	Salamandridae	Anura	Around freshwater and wetlands (E.Az)	Common	-
3	*Bufo viridis viridis*	Bufonidae	Anura	Agri.lands, orchards & rarely in wetland areas	Common	E. & W. Azerbaijan
4	*Bufo viridis arabicus*	Bufonidae	Anura	Farm lands, orchards, woods on ditch shore	Common	South of Lake Uromiyeh.
5	*Hyla arborea*	Hylidae	Anura	Grasslands, bushes and greeneries	Common	E. & W. Azerbaijan.
6	*Rana camerani*	Ranidae	Anura	Ponds and still waters	Common	E. & W. Azerbaijan & Aras river shores.
7	*Rana ridibunda*	Ranidae	Anura	Lakes and Ponds	Common	-

Within the Ecological Zone, there are a few records of amphibians from Dorgeh Sangi, Kani Berazan and Kaboodan Island. However, due to the suitable habitats in the region, it seems that the diversity of amphibians should likely be higher. Based on the available information, the most common species reported were: *Bufo viridis viridis, Bufo viridis arabicus, Hyla arborea, Rana camerai, Rana ridibunda,* and *Neurergus crocatus* may also occur, but this endemic species mainly live in the mountainous territories west of Lake Uromiyeh, Kurdistan, and northern Iraq.

8.5. Reptiles

Based on the existing references, Anderson 1999, The Lizards of Iran, and Latifi 1985,1991, Snakes of Iran, as well as some other books / papers, 33 species of reptiles belonging to 7 families have been reported from the LU Basin (Table 8-7). As could be observed few of the species are endemic and hence of particular ecological significance.

Table 8-7 Reptiles in Lake Uromiyeh Basin [12]

No.	Species	Family	Ecological zone	Main habitats and needs
Turtles				
1	*Mauremys caspica caspica*	Testudinidae	*	Freshwater, aquatic, Plants
2	*Testudo graeca ibera*	Testudinidae	*	Forest lands, bushes for laying eggs
Lizards				
3	*Laudakia caucasia*	Agamidae		Irano-Turani (central plateau). Mountains 2100-2700 m, rocks, slopes with grass, L.U
4	*Trapelus ruderatus ruderatus*		*	Irano-Turani (central plateau), Sahara-Sandy. Subshrubs area, open spaces, rocks up to-2400 m.
5	*Phrynocephalus helio scopus*		*	Aral-Caspian, Irano-Turani (central plateau). Clay soil, rock, L.U
6	*Trapelus ruderatus*			Aral-Caspian, Irano-Turani (central plateau). Sub-shrubs

No.	Species	Family	Ecological zone	Main habitats and needs
7	*Eremias strauchi*	Lacertidae		Aral-Caspian, Irano-Turani (central plateau). Dry foothills, steppes mountains
8	*Lacerta cappadoccia Urmiana*			Irano-Turani (central plateau) Rocks, dry foothills, rocks in valleys & river banks
9	*Lacerta cappadocica urmiana*		*	Irano-Turani (central plateau) River banks
10	*Eremias pleskei*	Lacertidae		Irano-Turani (central plateau). Dry foothills, steppes mountains within Halophyts.
11	*Eremias persica*			Sandy/ sand, sub-shrubs
12	*Eremias strauchi*			Irano-Turani (central plateau), Aral-Caspian. Mountains up to 3500 m sandy/ gravel/ soils.
13	*Eremias arguta*			Steppes, sagebrush, *Artemisia*
14	*Lacerta brandti*			Irano-Turani (central plateau). Grasslands dry valleys semi-desert area, foothills.
15	*Lacerta media media*		*	Grasslands, sub-shrubs, around wetlands
16	*Lacerta strigata*		*	Irano-Turani (central plateau), Mediterranean. Grasslands prefer close to forests and scrub, agr. Farm
17	*Lacerta trilineata media*		*	Mediterranean. Grasslands scattered woods
18	*Ophisops elegans elegans*			Mediterranean, Irano-Turani (central plateau). Foot slopes, dry grasslands
19	*Eremias arguuta*			Mountains, grasslands
20	*Ophisops elegans*		*	Grasslands, agr.farm, mountain, foothills, etc.
21	*Ablepharus bivittatus*	Scincidae		Irano-Turani (central plateau). Habitats: sub-shrubs, dry to semi rocks
22	*Mabuya aurata affinis*		*	Sahara-Sandy, Irano-Turani (central plateau). Foothills, Rocks, L.U Islands
23	*Eumeces schneideri*		*	Sahara-Sandy, Irano-Turani (central plateau). Grasslands, sub-shrubs, slopes, around L.U & Islands

No.	Species	Family	Ecological zone	Main habitats and needs
		Snakes		
24	*Eryx tataricus*	Boidae	*	Plains, semidesert
25	*Eryx miliaris*		*	Plains, semidesert
26	*Eryx elegans*		*	Sady desert from Uromiyeh
27	*Natrix natrix*	Colubridae		Under rocks, reportes from Mianeh
28	*Natrix tessellate*			Forests, wetlands, reported from Tabriz
29	*Coluber najadum*		*	Wetlands, Khoy, Uromiyeh
30	*Hierophis jugularis*			Mountains, from Uromiyeh & Takab
31	*Coluber ravergieri*			Semi desert, Uromiyeh, Miandoab
32	*Elaphe hohenackeri*			Forest mountain from Mianeh
33	*Eirenis punctatolineata*		*	Rocky area from Uromiyeh & Saghez
34	*Eirenis collaris*			Rocky area from Maku
35	*Telescopus fallax*		*	Dry & rocky, Uromiyeh
36	*Malpolon monspessulanus*			Desert, foothills, Tabriz
37	*Vipera ursinii*	Viperidae		Endemic Plains, mountains, Takab & Tabriz
38	*Vipera albicornuta*			?
39	*Vipera raddei kurdistanica*			Mountain grasslands, Uromiyeh Takab
40	*Vipera wagneri*			Endemic Mountain cracks, Uromiyeh, Tabriz
41	*Macrovipera lebetina*			Mountain, bushes, Uromiyeh, Khuy

8.6. Invertebrates

With the exception of *Artemia urmiana* on which considerable research works have been conducted by research institutes and/or universities, there is generally little information on other invertebrates in aquatic habitats of LU

Basin. However the pilot satellite wetlands were surveyed in 2002-03 for their aquatic invertebrates including plankton and benthos.

8.6.1. *Artemia urmiana*

Artemia urmiana is a brine-shrimp crustacean of the order Anostraca, which is endemic to LU. Adults are 8-21 mm long. Due to the absence of fish in the Lake, Artemia are able to reach very high densities, up to 4000 individuals per liter. Artemia is a filter feeder, and eats micro-phytoplankton smaller than 50 micron. *Dunaliella sp*. and *Tetraselmis sp*. are two species preferred by Artemia.

The optimal temperature and salinity for Artemia to survive are from 18 to 25 degrees centigrade and 60-70 g/l of salt. At lower salinities, fish are able to survive and would rapidly exploit the Artemia population. However, above a salinity of 250 g/l Artemia cysts are unable to hatch. Such conditions occur in LU during drought periods as have occurred throughout the last decade, although suitable conditions for Artemia may still be found at the river mouths.

In stressed conditions Artemia is a parthenogenetic organism, and females lay about 70-160 eggs and die afterwards. In good conditions these eggs can survive for 4 years, and as soon as the temperature allows, the eggs will hatch in 16-18 hours and change to Nauplii. In suitable conditions, Artemia is viviparous and during her life each female can produce 3 layings of 60-70 live Nauplii. These Nauplii mature in 20 days.

Artemia plays an important role in the food chain as an extremely abundant

primary consumer. It is also the most important food for flamingos and some other bird species (waders, grebes, shelduck). Artemia is also used widely in aquaculture for the rearing of crustacea and fishes. The cysts of Artemia are collected, dried and processed commercially.

8.6.2. Plankton

Satellite wetlands have generally high capacities for primary production. This is primarily because most of the wetlands (Kanibrazan, Goppy Baba ali, Soldouz) are mainly fed by drainage water from agricultural areas which are rich in fertilizer residues. Presence of an open outlet in Soldouz and Kanibrazan enable these wetlands to remain fresh and sustains their productivity, while in closed wetlands (Dorgeh Sangi and Gopy lake), high concentration of phytoplankton in late summer-early autumn usually results in saprotrophic conditions, degradation of water quality and precipitation of algal masses.

Investigations made on pilot wetlands revealed that generally seven groups of phytoplankton prevail in which diatoms dominate. Tables 8.8 and 8.9 display the annual average composition of phyto and zooplankton in the pilot satellite wetlands.

Table 8-8 Composition of phytoplankton groups in pilot wetland, 2003-04, (%)[9]

Phytoplankton groups	Wetlands			
	Soldouz	Gopy lake	Kanibrazan	Dorgeh Sangi
Chlorophyceae	6.2	3.6	18.2	7.9
Cryptophytae	25.6	2.1	5.8	17.4
Cyanophyceae	15.9	5.9	8.1	8.2
Desmidae	17.1	1.7	6.9	2.3
Diatom	12	85.5	58.6	44.1
Dynophyceae	8.4	0.3		9.1
Euglenuphyceae	14.7	0.7	2.3	10.8

Table 8-9 Zooplankton species observed in pilot satellite wetlands (2003-04) [9]

Zooplankton species	Kani-brazan	Gopy lake	Soldouz	Dorgeh sangi
Acroperus harpae		*		*
Alona quadrangularis	*	*	*	
Amoeba proteus	*			
Byhoterphes longimanus			*	
Chydorus sphaericus		*	*	
Daphnia				*
Diaptomus	*			
Dileptus anser	*			
Egg.	*	*	*	*
Eodiaptomus graciloides	*	*		*
Euchlanis			*	
Harpactocoida			*	*
Lejdigia acanthocercoides			*	
Lejdigia quadrangularis			*	
Leptodora kindtii	*			
Macrocyclops albidus		*		
Monostyla		*		
Naupolii	*	*	*	*
Osteracoda	*	*	*	*
Paramecium Aurelia	*			
Paramecium caudatum				*
Sida crystauina		*		
Simocephalus velulus			*	
Vorticella sp	*			

8.6.3. Benthos

List of benthos groups and species according to the 2003-04 surveys are displayed in Table 8-10. Chironomids are dominant species in population representing moderate to severe contamination of water.

Table 8-10 Benthos composition in pilot satellite wetlands (2003-04) [9]

Family	species	Kani-brazan	Gopy lake	Soldouz	Dorgeh sangi
Ceratopogonidae	*Bezzia sp.*	*			
Chironomidae	*Chironomus sp.*	*	*	*	*
	Saniotoma sp.			*	*
	Spaniotoma sp			*	
Cordulegasteridae	*Cordulegaster boltonii*	*		*	
Dixidae	*Dixa sp*				*
Corixidae	*Corixa punctata*	*	*	*	*
	Micronecta poweri			*	
Gerridae	*Gerris najas*		*		
Limnaeidae	*Limnea auriculata*	*			
	Limnea peregra	*	*	*	*
	Limnea sp.	*			
	Limnea truncatula	*	*	*	
Dytiscidae	*Derenectes depressus*		*	*	
Surphidae	*Myosis sp.*				*
Naididae	*Nais sp.*	*	*	*	*
Nemouridae	*Nemoura sp.*	*			
	Amphinemura sulcicollis			*	
Physidae	*Physa fontinalis*	*			
Planorbidae	*Planorbis contortus*	*			
	Planorbis vortex	*		*	*
Tabanidae	*Tabanus sp.*	*			
Valvatidae	*Valvata cristata*	*	*		
Gomphidae	*Gomphous vulgatissimus*		*	*	*
Nepidae	*Nepa rubra*		*	*	*
	Ranatra linears		*		
Platycnemidae	*Engallagma cyathigerum*		*	*	*
	Engallagma lyathigerum				*
Gyrinidae	*Gyrinus natator*			*	

9. HUMAN POPULATION AND RURAL FACILITIES

9.1. Background / available information

The earliest documents for population data is that of 1956 national census. Since then, population information is updated through 10 yearly national censuses. Information on population is obtainable from Census Center. Presently rural health houses also update information on village population (deaths and births).

9.2. Administrative boundaries

Lake Uromiyeh is located in between the West and East Azerbaijan provinces while part of its basin is located in Kurdistan province. Thus three provinces with different management policies and requirements are impacting the wetlands mainly through use of water resources.

There are numerous towns and villages within the LU Basin. Maps 9.1 and 9.2 give a distribution pattern of them. As could be observed, most of the populated centers are located in the western and southern parts of the ecological zone of LU in the West Azerbaijan. Based on 1991 information, of 3129 villages and 36 urban centers within the basin, 11 cities and 1008 villages are located in the East Azerbaijan and 25 cities and 1831 villages are located in the West Azerbaijan. The basin in Kurdistan Province encompasses 1 city and 290 villages.

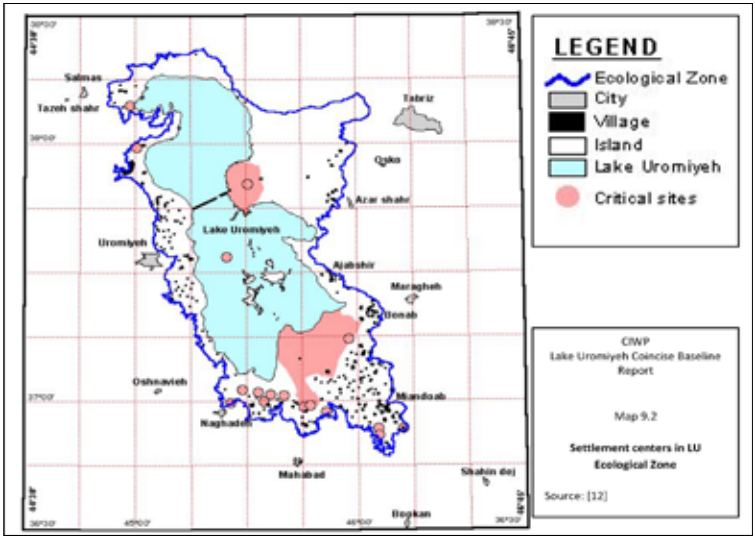
9.3. Population and Ethnic status

9.3.1. Population

Population within LU Basin and the rate it increases is one of the main driving forces for increasing use of water resources and releasing contamination into the environment. Indeed increasing human uses of water resources is the main cause for decreasing inflows into the Lake and other wetlands. The trends in population increase within LU basin is displayed in Table 9.1. Table 9.2 indicates the distribution pattern of population in the sub-basins.

Table 9.1 Trends in population growth

Year	Population			Cumulative increase %
	Rural	Urban	Total	
1976	1,440,731	1,223,338	2,664,069	
1986	1,565,892	1,565,892	3,131,784	17.6
1996	1,607,845	2,750,724	4,358,569	63.6
2002			4,800,000	80.2
2006	1,523,201	3,390,352	4,913,553	84.4
2010			5,900,000	121.5



The basin's population is distributed in three provinces as indicated in Fig 9.1 which shows about 13% more population inhabit in East Azerbaijan whereas a larger part of the basin area is located. Using 2006 provincial population data

of the three involved provinces, different attributes of the population including age and gender distribution, literacy, occupation etc, are discussed as below. Figures 9.2 and 9.3 show the age and gender distribution pattern of the population.

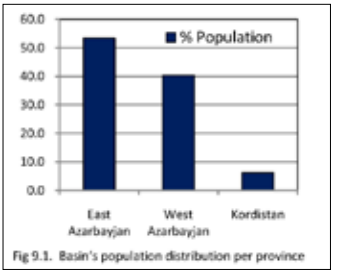


Fig 9.1. Basin's population distribution per province

Generally speaking, a larger part (about 60%) of the population composition is comprised of young people aged less than 40 years.

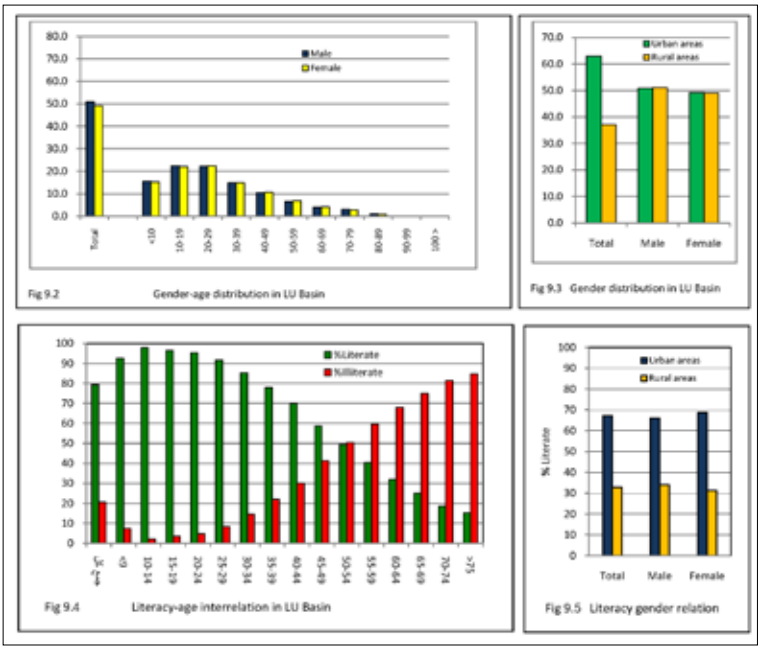


Fig 9.2 Gender-age distribution in LU Basin

Fig 9.3 Gender distribution in LU Basin

Fig 9.4 Literacy-age interrelation in LU Basin

Fig 9.5 Literacy gender relation

Gender is about balanced with slight excess of males. However about 2/3 of the population is living in urban areas, the settlement centers with population exceeding 5000.

Literacy has increased during the last decades. Close to 80% of the entire

population of the basin is literate Figs 9.4 and 9.5. Literacy is higher in the ages of less than 50. Also it is slightly higher in the urban population compared with rural population. Interesting to note is that in the urban areas, the percentage of literate females is slightly higher than males, while in the rural areas, the percentage is higher among males.

9.3.2. Ethnic attributes.

The majority of the population within the LU Basin is comprised of Turks. They are Shiite Muslims and speak in Turkish. However in the western and particularly southern parts of the Basin, higher proportion of the population is comprised of Kurds who usually are Sunni Muslims and speak in Kurdish. In the western parts of the basin, i.e. West Azerbaijan, Kurds are generally able to speak in Turkish as well as in Farsi.

The Kurd population has maintained many of their tribal cultures. They wear Kurdish dress which is a typical one particularly for men. In rural areas, Kurd women do most of the house works but also much of the heavier tasks that are usually undertaken by men.

Kurds and Turks have their own cultural activities including music and dancing styles which are easily identified. Both Kurds and Turks are rich in music and singing arts. Dancing is an important part of the social ceremonies particularly among Kurds.

9.3.3. Land tenure

Land tenure within the LU basin could be generally categorized in state lands, individual properties, common properties, and endowed properties. The following is a very brief description of each.

State lands include rangelands, natural pasturelands in low lying water logged areas, natural water bodies such as rivers, lakes, wetlands, forests and mountains. Different governmental organizations are responsible for managing these lands. For example deputy minister for natural resources of MOJA is responsible for rangeland and natural pasturelands and wetlands are under jurisdiction of DOE. Ministry of Energy is responsible for all water resources particularly rivers and reservoirs. Worth to mention is that although the lands of natural resources belong to the government, use of these resources is usually admitted to the local

villagers around that land. This type of property is usually known as the "right for utilization". This type of property is generally a common property allocated to a specific village and their settlers and the right is transferred as heritage. The clear example for this type of property is pasturelands on which herders of a specific village or group of villages can graze their herds.

Individual property is applied to the lands with specific boundary which is owned (written on formal papers) by a specific person or shared among specific persons.

Jointly owned properties (called Mosha) refer to the cases that a specific land is registered and owned by a group of farmers without the boundaries of individual properties being defined. According to the traditions, the piece(s) of land allocated to each member for cultivation is annually determined by lottery.

Endowed type of property (Waqf) is applied to those lands whose property is assigned by individual persons to social (normally religious) entities such as mosques, schools, hospitals, etc. In most cases these lands are leased (short or longtime) to individuals for utilization, while the property remains by the owner entity.

9.4. Rural facilities

According to the existing statistical data, almost all the villages within the provinces are benefiting from electricity and are covered by mobile telephone and different provincial and national Radio-TV stations. In most cases access roads are entirely or partly asphalted and daily services provide continuous transportation. All the population within the villages is provided with teaching facilities at the lowest level "primary schools". Higher level education facilities (high school) are not available in all villages but are provided for more populated villages. In many villages groundwater or spring flows are distributed through pipeline system for domestic uses.. However gas fuel is generally provided in cylinders. Also most villages are covered by services provided by hygiene houses that are usually equipped with a nurse or sometime a medical doctor. These centers provide casual and emergency services for the villagers.

The above description is not intended to display a perception that villages have every facility required for a healthy community. Indeed villages are suffering many fundamental deficiencies in different areas.

10. DESCRIPTION OF MAIN HUMAN ACTIVITIES AND THEIR IMPACTS

The predominant human activity in the entire basin as well as in the Ecological Zone is agriculture. However during the period, the population has significantly increased resulting in expansion of existing settlement areas and conversion of lands into urban areas. Industries have also developed during the last 3-4 decades. To support such developments, several water resources projects have been constructed and/or are under development. All these activities have impacts on reducing the inflows into the Lake.

10.1. Agricultural activities

Irrigated agriculture and horticulture for long have been the main occupation in the area. Rain-fed cultivation of cereals and to lesser extent peas is also a common practice in all parts of the basin.

Main winter crop in the area is cereals (including wheat and barley). Summer crops include alfalfa, potato, tobacco, cotton and cash crops (tomato, eggplant, cucumber, sugar beet, etc).

Hortilcuture is also an important activity particularly in the West Azarbayjan. Apple and grape are the dominant garden production, while other fruits such as peaches, plums, berries, are also largely produced.

Land use of the LU basin has been studied in several cases during the last 3 decades. The studies conducted by Yekon consultants in 2002 (IIP) was on the basis of interpretation of satellite images and produced a map which could show the distribution of different land uses.

Table 10-1 Land use within the LU basin and ecological zone (ha)

Category	LUB (1990)	LUEZ (1990)	LUEZ (2002)
Irrigated farms	299,000	116,870	128,220
Irrigated land /orchards-mixed	67,000	14,730	23,140
Orchards/trees	180,400	46,060	47,420
Rain-fed farms	15,500		
Rain-fed farms /rangelands	783,600	37,760	38,420
Rangelands	2,912,700		123,290

Category	LUB (1990)	LUEZ (1990)	LUEZ (2002)
Lake Uromiyeh	523,940	523,940	483,300
Forestlands	30,900		
Wetland /fishpond/ reservoirs	5,150	2,470	8,880
Salt lands	123,700	115,320	231,540
Marsh vegetation	15,500		
Bad lands / highly eroded lands	128,900		
Others	67,000	2,890	15,200

According to 2006 data, the irrigated area in the basin exceeds 400,000 ha. This area was 150000 in 1979 (8).

Agricultural sector is the main water user in the basin. Also it is releasing significant chemical residues into water resources. It is estimated that close to 90% of water resources are used in this sector. According to 2006 data, the volume of water used in agriculture is estimated at 5600 mcm/yr. This volume has been 1800 mcm/yr in 1979. Basin-wide average efficiency of water use for irrigation is estimated at 30%, (8). This reveals that quite a noticeable ground is available for improving on-farm water application practices for saving water resources.

Impacts from agriculture on the environment and the LU (including its satellite wetlands) are tremendous. Not only 90% of surface and ground water resources are used in this sector but also considerable amount of chemicals (estimatedly 200,000 Tons of fertilizer and 4,000 Tons of pesticides and herbicides) are applied annually. Residues of these chemicals when transferred to the water resources seriously impact their qualify and ecological attributes. The traditional downslope ploughing of steep foot-hills for rainfed cultivation is also a very important factor for soil erosion in the farms and sedimentation in water resources (rivers and wetlands).

10.2. Animal husbandry

The large extent of rangelands all over the basin, and particularly productive pasture lands in the lower parts (around the Lake and the satellite wetlands)

in the west and south of the Lake has encouraged evolution and development of animal husbandry. Sheep, cows and bufallos are widely bred and constitute one of the main sources of livelihood in rural communities. In several cases so called semi-industrial cow breeding units have been established in which cows are bred for their milk or their meat. In fewer cases, semi industrial sheep breeding units have also been established.

10.3. Industries

Industries have an increasing share in the overall activities in both east and west Azerbaijans. Since long time ago these provinces have been famous for their handicrafts. Several centers in the East Azerbaijan are particularly famous for weaving carpets, and West Azerbaijan is more famous for their wood crafts.

Heavy industries including petroleum industries, car and tractor industries, chemical industries, food and sweet industries, etc have been established during the last 50 years, and still new units are going to be established.

Industries have their great impact on the water resources mainly from the quality of effluents they release into the water resources. Rivers and wetlands are the two main receivers that suffer from these effluents.

10.4. Water resources development

Water resources developments are among the activities with most significant environmental impacts on water resources and the Lake. These projects have been priority governmental programs of water authorities in both east and west Azerbaijans.

During the last decades, several water resources projects have been developed based on construction of storage dams for controlling river flows and irrigation systems for water distribution. While farmers also developed ground resources wherever alluvial aquifers allowed construction of shallow (hand dug) or deep wells.

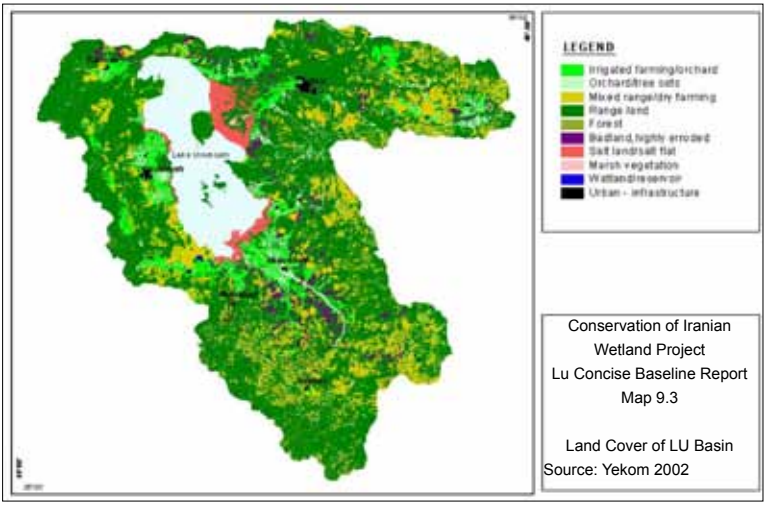
The earlier irrigation projects in the basin were those developed in the Zarrineh Rud, Simineh Rud and Mahabad rivers during 1960s and 1970s. During the last 2 decades similar developments have been accelerated and water authorities in

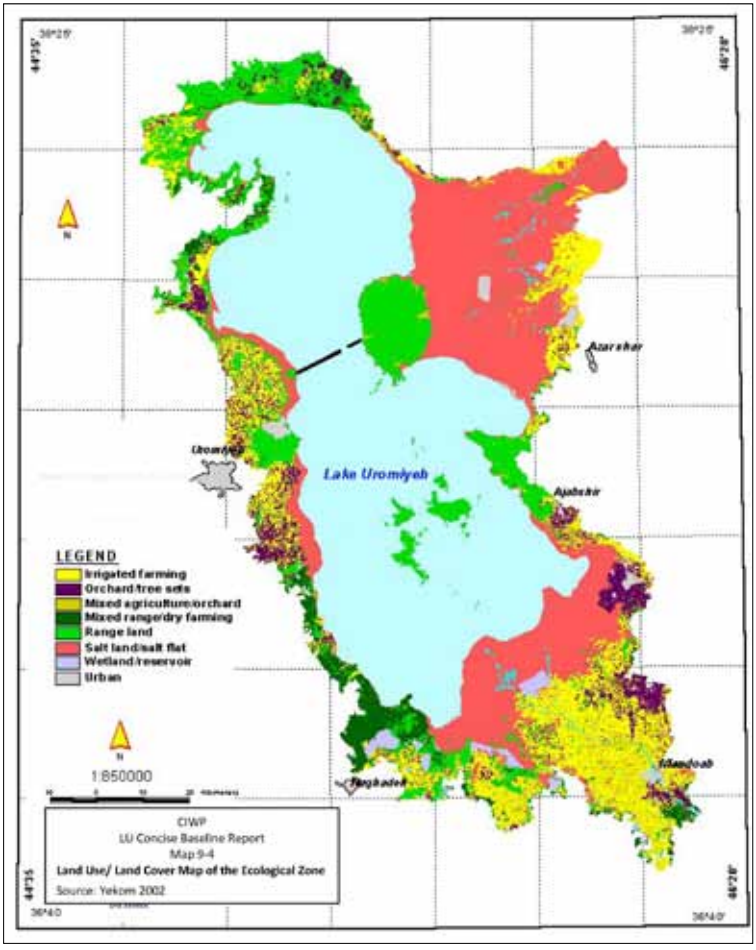
both East and West Azerbaijans have focused on construction of storage dams and developing irrigation systems. Table 10-2 displays a list of water resources development works [8].

Table 10-2 Dams in LU basin

	Operational		Under construction		Under study	
	No.	Capacity mcm	No.	Capacity mcm	No.	Capacity mcm
E. Azerbaijan	22	234	4	387	10	139
W. Azeerbaijan	7	1478	11	1027	4	456
Kurdistan			1	86	3	62
Total	29	1712	16	1500	17	657

Irrigation development projects not only consume additional volume of water for crop production but also additional chemical pollutants are released into river flows that eventually reach the wetlands and the Lake. Both of these processes are imposing huge pressure on the wetlanls and on the lake.





10.5. Road construction (Shahid Kalantary bridge across LU)

One of the major human activities with great impact on the ecology of the Lake is construction of Shahid Kalantary road across the Lake. It has practically interrupted the free flow of water between the two sides of the road and has

created stagnant (trapped) water bodies both sides of the road.

10.6. Stakeholders

Several stakeholders are involved in the management and conservation of the wetlands. The most influential of these stakeholders are the decision-making organizations which are either governmental or affiliated with the government. A list of the major stakeholders grouped in 13 categories are displayed in Table 10-3

The stakeholder groups include people directly using the Lake and surrounding wetlands (eg. Artemia and salt harvesters). It also includes people living and working in the surrounding towns and villages throughout the Basin. Some stakeholder groups are based outside the Basin, such as Ministries in Tehran. International stakeholders include organization related to environment and wetland conservation. Foreign tourists and international waterbird watchers who follow the migratory waterbirds which use the Lake as part of their annual migration cycle could also be among the stakeholders.

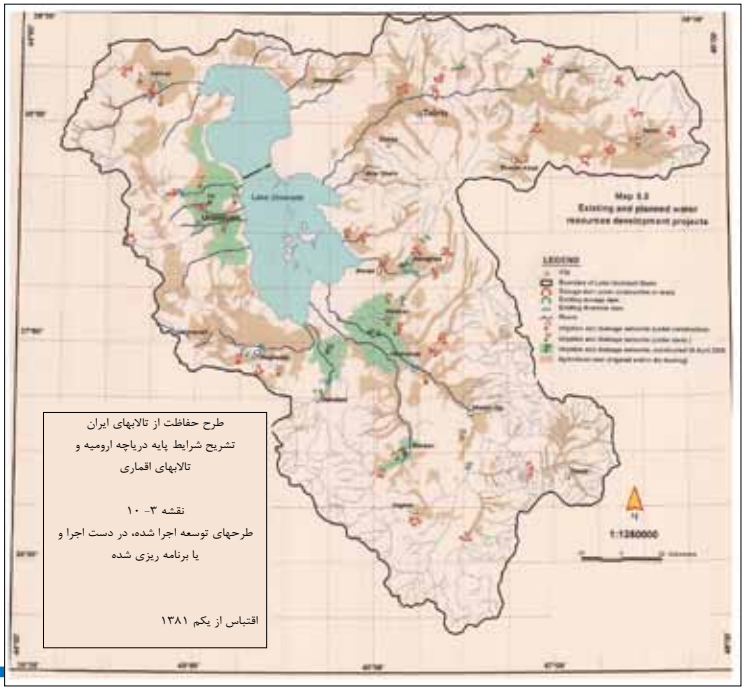


Table 10-3 Stakeholder groups in Lake Uromiyeh and surrounding wetlands (Provincial level)

	Organization	Areas of influence / impacts
1	West and East Azarbayjan. Province Governors	High level management and decision making, Inter-sectoral coordination for provincial level plans and programmes (Provincial MPO)
2	WA Province Environment Conservation Directorate Office	Provincial headquarter for management of the lake as well as wetlands within West Azarbayjan Preparation and implementation of management plans for the lake and satellite wetlands in WA. Technical support to lake management and satellite wetlands in WA. Financial support to lake management and satellite wetlands in WA. Administrative support to lake management and satellite wetlands in WA Provincial support to environmental NGOs in WA.
3	EA. Province Environment Conservation Directorate Office.	Provincial headquarter for management of the satellite wetlands in EA. Preparation and implementation of management plans for the satellite wetlands in EA. Technical support to management of the satellite wetlands in EA. Financial support to management of the satellite wetlands in EA. Administrative support to management of the satellite wetlands in EA Provincial support to environmental NGOs in EA.
4	Kurdistan DOE	Facilitation of ecosystem based management approach among stakeholders Support Biodiversity Support public awareness
5	W&E Azarbayjan and Kordestan Provincial Jihad Agriculture Organizations	Provincial headquarter for planning agriculture, animal husbandry and veterinary plans and activities Provincial headquarter for agro-chemical management Provincial headquarter for agricultural extension, research and education supports Provincial support for fishery and aquaculture activities, introduction of species and/or propagation of fish larva Provincial support for rangeland management within the catchments Provincial support to nomadic affairs management Provincial support for land property and land use
6	W& E Azarbayjan and Kordestan Provincial Water Authorities (and their affiliated local offices)	Provincial level decision maker on water resources development plans and programs Decision makers in reservoir operation Water right allocation from rivers and springs Issuing license for water well construction and water withdrawal Water flow measurements/ monitoring (surface and ground water) Water quality measurements/ monitoring Lake water level measurement

	Organization	Areas of influence / impacts
7	W& East Azerbaijan and Kurdestan Provincial Health and Sanitation offices	Provincial level decision-maker on rural health and sanitation plans and programs
8	W&E Azarbayjan and Kordestan Provincial Cultural Heritage and Tourism Organization	Provincial level decision-making on cultural heritage and tourism
9	Universities	Conduct research programs
10	W&E Azarbayjan Provincial Roads and Transportation Offices	Construction of Kalantary road in the Lake as well as roads and railway system development with occasional impact on the satellite wetlands, and shipping in the lake.
11	W&E Azarbayjan Provincial Industries and Mines Offices	Decision makers in industrial and mine development programs; Facilitators in communication with individual industries within the basin

Table 10-3 Stakeholder groups in Lake Uromiyeh and surrounding wetlands (Local level)

	Organization	Areas of influence / impacts
	Local level	
1	Local Offices of Governor in towns and cities	Local level inter-sectoral coordination
2	Local Offices of Environmental Conservation in towns and cities	Wetland management (protection); Management of the protected areas around the Lake; Support local NGOs
3	Local offices for irrigation network management	Control of water (fresh or return flows) entering into the wetlands
4	Local offices of Jihad Agriculture in towns and cities	Rationing for agro-chemicals Rural services for agricultural extension Rural services for animal husbandry
5	Local Offices for Natural Resources	Rangeland management at local level

	Organization	Areas of influence / impacts
6	Local offices for Veterinary services	Control of animal diseases including poultry and birds
7	Farmers	Casual encroachment into the wetland areas; Use of chemicals at farm level; Conversion of pasture lands around the wetlands for agriculture; Careless use of water at farm level (low efficiency)
8	Reed harvesters	Harvesting of reeds
9	Artemia harvesters	Harvesting of Artemia
10	Salt harvesters	Local people, small scale traditional harvesters Industries, large scale salt harvesters
11	Local communities, rural population	Discharging sewage and wastes into the wetland, Rural physical development (affecting naturalness around the wetland) Influence on political sources
12	Fishers	Harvesting fish from the wetland
13	Buffalo herders	Grazing buffalo in the wetland, harvesting reeds
14	Hunters	Hunting water birds
15	Visitors	Waste residues around the wetland
16	Health and Sanitation Office	Health services to rural people, Health houses at villages
17	Local NGOs	Facilitating communicating with local people
18	Islamic councils	Facilitating communication with wetland stakeholders Influence on political sources

11. ENVIRONMENTAL POLICIES, LEGISLATIONS and INSTITUTIONS RELATED TO MANAGEMENT OF LAKE UROMIYEH AND SATELLITE WETLANDS

Lake Uromiyeh together with several satellite wetlands are registered as a national park, protected area, Ramsar site and Biosphere Reserve. From an administrative point of view and while about half of the Lake is located in the East Azerbaijan province, LU is under jurisdiction of DOE office of West Azarbaijan. This section provides an overview of the existing policies and legislations relevant to LU. It describes national policies and key environmental legislation relevant to the Lake.

The key policy for conservation of environment is described in Article 50 of constitutional laws of IRI. It states:

"Conservation of the environment in which the existing as well as the future generations of IR. Iran should sustain their progressive social life, is considered as a public duty. Thus, economical or any other activities that may cause contamination over, or endanger the environment, would be prohibited."

The details of policies for conservation of the environment are determined within the Five Year National Plans for the Social, Cultural and Economical Development (FYP). As far as the environment is concerned, the general content of the policies included in the FYPs are summarized below:

- Emphasis on the conservation, restoration, improvement and optimal utilization of natural resources;
- Developing the criteria, standards and indicators on all environmental issues and improving the existing legal and administrative frameworks in the areas relevant to conservation of the environment;
- Conservation and restoration of the renewable natural resources; preservation of rare and threatened flora and fauna; control of desertification processes and attempts to restore the affected lands; controlling the contamination of the soil, air, surface and ground water resources as well as the marine environment; controlling damage to wildlife habitats;
- Optimum use of agricultural chemicals (fertilizers and pesticides, etc), and promoting integrated pest management approaches.

The FYPs also include articles related to policies of the Ministry of Energy, which are relevant to water bodies and wetland areas. These are mainly in the field of controlling the use, measuring the quantity and monitoring the quality of water resources.

Similarly MoJA follows the general policies to optimize the use of agro-chemicals and to control the use of dangerous pesticides.

11.1. National Legislation on conservation of the environment

Many different laws, by-laws and regulations have been developed to describe and instruct different areas in conservation of the environment. DOE has collected many of these laws, by-laws, etc. in a publication titled: "Collections of the Laws and By-Laws in Conservation of Environment, DOE, 1997, revised 2004". Those legislations relevant to LU are summarized below:

• The Law of "Conservation and Enhancement of the Environment" issued and approved in 1974 and amended in 1992. This law includes many of the important articles that are now governing the activities of the DOE.

• The Executive By-law of "Conservation and Enhancement of the Environment" issued in 1976, amended in 1995. This By-law includes regulations and instructions which are effective in management of the National Parks, National Natural Heritages, Wildlife Refuges, and Protected Areas;

• The Executive By-law for "Prevention of water resources from being contaminated" issued in 1994. This By-law determines the shared responsibilities of DOE, and the Ministries of Energy, Jihad-Agriculture, Industries and Mining, Interior, Medication, Hygiene and Medical Education, to prevent the water resources from being contaminated.

• The Law of "Protection and Utilization of the Aquatic Resources" issued in 1995 and its Executive By-law issued in 1999. This Law and By-law originally determines the authorities and responsibilities of Shilat (Fishery) Organization in improving, enriching and developing the aquatic resources within the inland waters, and the shared authorities and responsibilities of the Shilat and DOE wherever these inland waters are among the protected areas or internationally important wetlands;

• The Executive By-law for hygienic controlling and supervision over the chemical materials and poisons issued in 1999. This By-law focuses on the control of, and supervision over, the packing and distribution of chemicals and poisonous materials. DOE is one of the several members of the committee which coordinates the supervision and control measures and draws up the instructions;

• Instructions for grazing of domestic animals in the Protected Areas and Wildlife Refuges.

• Standards for waste discharges from different sources

• Specific implications of legislation currently applied to the protection of wetlands

The executive by-law for Conservation and Enhancement of the Wildlife Refuges, approved and issued on Feb 21, 1976. This by-law includes 49 articles in 9 sections. Section two of this by-law covers the regulations for protection not only of the Wildlife Refuges but also the National Wildlife Parks, National Natural Heritages, and Protected Areas including:

• Entrance to the wildlife refuges and protected areas for scientific research, sight-seeing, photography and recreation is allowable provided that no damage is imposed over the vegetation cover and no disturbance is made to the wildlife;

• Harvesting of trees and bushes, encroaching into the wildlife habitats and any type of disturbance to the natural condition within the wildlife refuges and protected areas is prohibited.

- NB 1. Exception to this regulation is the erection of industries and workshops which are permissible according to the regulations and laws;

- NB 2. Grazing of domestic animals in the wildlife refuges and protected areas is allowed provided the quantity and quality of the grazing is in compliance with the regulations established by the DOE and the Natural Resources Department of MOJA;

- NB 3. Grazing of domestic animals in the protected areas and the wildlife refuges requires permission from the DOE and an advance subscription. Grazing of animals without such permission or beyond the permitted quantities is prohibited. If violated, animals would be driven out of the protected areas and the herd-keepers would be fined;

- NB 4. Fishing and hunting within the protected areas and wildlife refuges requires advance subscription and permission from the DOE or its regional offices;

• Ministries and governmental organizations are allowed to perform studies and investigations within the wildlife refuges and protected areas, provided the protective measures and regulations are carefully observed;

• Carrying any type of guns / armour within the protected areas and wildlife refuges for the non locally-resident individuals is prohibited, unless they have received in advance the permission from DOE or its regional offices.

• Legislations concerning other areas in relation to conservation of wetlands and LU

There are legislations that concern different areas which potentially can help conservation of the wetlands. These are:

• Legislation concerning water resources
• Legislation concerning forests and rangelands
• Legislation concerning top soil erosion
• Legislation pertaining to the human environment
  - Requirements for conducting EIA
  - Legislation on water and soil pollution
  - Legislation concerning land use and land tenure
  - Legal definitions on natural resources and national lands
  - Land ownership on natural resources

Discussion on adequacy of existing legislation

Four areas seem to be of particular concern regarding the adequacy of national legislation for the management of Lake Uromiyeh.

1) The legislation for protected areas and special ecosystems covers only those activities which are being undertaken within the protected area. However, much of the threats which face Lake Uromiyeh originate from the Basin – outside the protected area – for example, water resource use, pollution etc…

2) The legislation on water use does not adequately account for maintaining the downstream needs of wetland ecosystems. New legislation is required

which allocates water according to multiple needs, within the framework of integrated river basin management.

3) While providing a strong basis for environmental protection, the National Park legislation forbids most activities within the area. This is generally contrary to the principles of sustainable development, which might encourage sustainable activities, such as ecotourism or salt harvest within the Lake.

4) The EIA legislation, which focuses mainly on very large projects, seems inadequate for the needs of a National Park. It would seem appropriate that all significant developments which may affect such a sensitive area should be subject to EIA (eg. fish-farms, Artemia fishery, etc.) and SEIA. In particular, the cumulative impacts of developments, such as dam-building need to be addressed.

11.2. International Conventions

IR Iran is a contracting party to several international conventions related to the environment. The most significant of these relating to LU are described below:

Ramsar Convention on Wetlands

IR Iran is the birthplace of the Ramsar Convention, the Final Act of the Convention having been negotiated in the town of Ramsar on the Caspian Coast in 1971. IR Iran ratified the Convention in 1975, and up to now has designated 22 wetlands of international importance under the Convention (so-called "Ramsar Sites"). The main obligations of Iran under this Convention are:

- To designate wetlands of international importance as Ramsar sites
- To maintain the ecological character of designated Ramsar sites
- To make wise use of all wetlands within the Iranian territory
- To establish biological reserves on wetlands
- To cooperate internationally for wetland conservation

Four of the Iranian Ramsar Sites are located in the LU Basin:

- Lake Uromiyeh
- Lake Kobi (Goppy)
- Shur Gol, Yadegarlu and Dorgeh sangi

• Ghori gol

And DOE has succeeded in registering Kani brazan (in 2011) as a new Iranian Ramsar Site.

Convention on Biological Diversity

IR Iran ratified this Convention in 1996. The objectives of the Convention are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of the genetic resources by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources. Some of the articles of the Convention are summarized below:

• Develop or adapt natianal strategies, plans or programs for the conservation and sustainable use of biological diversity;

• Integrate as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programs and policies;

• Identify components of biological diversity important for its conservation and sustainable use;

• Monitor the components of biological diversity, paying particular attention to those requiring urgent conservation measures;

• Identify processes and activities which are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity;

• Establish protected areas where special measures need to be taken to conserve the biological diversity and develop the necessary guidelines for their management;

• Regulate or manage biological resources important to conservation of biological diversity within the protected areas;

• Promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species;

• Promote environmentally sound and sustainable development in areas adjacent to protected areas with a view to furthering protection of these areas;

• Rehabilitate or restore degraded ecosystems and promote the recovery of

threatened species;

• Develop or maintain necessary legislation and/or other regulatory provisions for the protection of threatened species and populations;

• Regulate or mitigate processes that have significant adverse effect on biological diversity.

• Cooperate in providing financial support;

Convention on International Trade of Endangered Species (CITES).

Iran has ratified this convention in Feb 1975. Based on the existing information more than 24 bird and 5 mammal species that fall into the list of Convention do occur within the LU ecological zone.

11.3. Institution for Conservation of Lake Uromiyeh

Management of Lake Uromiyeh is under sole jurisdiction of W. Azerbaijan DOE while depending on the location, the satellite wetlands are managed by the relevant province.

However, management of water resources in the three provinces involved in Lake Uromiyeh is the responsibility of water authorities in the provinces.

Discussions in the workshops for management of Lake Uromiyeh revealed that the authorities required for sustainable management of the Lake is beyond the formal authorities of W A DOE and a strong high level inter-provincial cooperation would be needed to cope the threats against the Lake. Thus pursuant to the sequences for establishing an ecosystem based management for the Lake, following administrations were organized by the Cabinet:

- National Level Executive Headquarter (EH) consisting of: 1st Vice President (chairman), Ministries of Energy, Jihad Agriculture, Interior, Roads, Housing and Urbanization, Head of MPO, Head of DOE (Secretariat), Governors of East and West Azerbaijan and Kurdistan. This headquarter has organized a Technical Committee to provide technical assistance to the EH to decide on the particular threats which is facing or will face the Lake.

This EH is authorized to make highest level decisions on any issue (particularly development programs) that may affect the Lake or any of its satellite wetlands.

- Regional Level Management Council, consisting of the Provincial Governors and head of provincial offices from each of the three provinces involved. West Azerbaijan DOE was assigned as the secretariat for this Regional Council. This council in turn has organized three provincial committees to provide technical assistance to the council on different issues relevant to the Lake. This council is capable to decide on any action within each province that has the potential to affect the Lake (i.e. land and water resources development).

This administrative arrangement is one of the most important achievements of CIWP towards conservation of Lake Uromiyeh.

12. ACHIEVEMENTS FOR THE CONSERVATION OF LAKE UROMIYEH

While during the implementation of CIWP a persistent drought exacerbated by unsustainable use of water resources severely impacted the overall situations in the Lake and its surroundings, significant works have been undertaken for the mitigation of threats and conservation of the resources and better management of LU through the Conservation of Iranian Wetlands Project. This final chapter therefore provides a brief description of the prevailing conditions in the Lake and its satellite wetlands, as well as its achievements.

12.1. Impacts from persistent drought and mitigation measures undertaken

Since the early 2000s, the Lake Uromiyeh Basin (and indeed much of Iran) has been subject to an intense and persistent drought. As a result, the lake water level continuously receded (see Map 4.2) and reached levels below 1270 in 2012 which is lowest ever recorded since the start of observations in 1966. Evidently this drought has been exacerbated by increasing ground water abstraction by water wells as well as control of river flows by storage dams. Also long-term climate change may be responsible for part of the situation.

The ongoing drought has placed a very significant constraint on the achievement of several of the planned outcomes from the CIWP, in particular the recovery of biodiversity and the implementation of sustainable use of the Lake's resources (ecotourism). Importantly, however, the management plans and institutional mechanisms are now in place for these outcomes to be achieved as soon as the drought conditions ease.

Impacts

Following the recent decline in water levels, large areas of the lakebed desiccated and the remaining part of the lake has turned brownish in colour, apparently due to a change in metabolism of *Donaliella salina* at high salinity levels. The high salinity (>300g/l) has caused a severe decline in biodiversity (both species richness and biomass). The endemic *Artemia urmiana* populations have stopped hatching, except at the mouths of incoming streams where salinities are lower. As a result, species that feed on brine shrimp have declined dramatically. The previously large flamingo *Phoenicopterus ruber*

roseus populations (up to 20,000 pairs in the past) have largely abandoned their breeding islands, and the vast numbers of migratory waterbirds (particularly shorebirds, gulls, terns and ducks) that visit the lake have greatly reduced in numbers. Increasing salinity levels have also affected the White pelicans *Pelecanus onocrotalus*, which used to nest in the islands. Yellow deer *Dama mesopotamica* and Armenian wild sheep *Ovis orientalis gmelini* populations on the islands suffered from lack of water and food due to the drought, and rangers often cannot reach the islands to provide supplementary food and water. The island ecosystems are now being interconnected and these large mammals might start moving out of the islands towards the mainland, which would make them more vulnerable to hunting, etc.

Biodiversity in the satellite wetlands around Lake Uromiyeh has suffered less, as several of them receive significant return flows of irrigation waste water (eg Kaniberazan) or are supplemented by water from local dams (eg Soldouz, ShurGol). These satellite wetlands provide a valuable refuge for waterbirds and other species of flora and fauna and need to be highly protected from anthropogenic pressures such as hunting and harvesting, as well as water pollution. Other satellite wetlands which do not receive such water, such as GaraQueshlaq have dried out or become very temporary wetlands.

Mitigation measures

Lake Uromiyeh and its surrounding satellite wetlands are experiencing a highly unsustainable situation with regard to water resource management, aggravated by short-term droughts and the likely impacts of long-term climatic change. Lake water level has fallen, the shoreline has receded dramatically and salinity levels have doubled. The results have been catastrophic for the livelihoods of local communities, biodiversity and the micro-climate of the area.

This unsustainable sitation with regard to the Lake's water resources has brought about considerable concerns for the government. A high-level National Committee for Lake Uromiyeh has been established under the Cabinet, and a Regional Basin Council comprising the Governors of the three provinces and related Ministers has been established to coordinate the decisions for mitigating threats to water resources and conservation of the Lake and its satellite wetlands.

With support of the CIWP, and in line with the management plan, many

mitigatory and adaptive measures to combat the drought situation in Lake Uromiyeh have already been undertaken by the Provincial agencies (most notably DOE, the Water Authorities and Jihad Agriculture), NGOs and local communities. These include:

- Intensive work to define the water rights of Lake Uromiyeh, and the provincial allocations that are required to sustain the Lake. These allocations have now been formally approved at the highest level, and will start to be made in the 2011-12 hydrological year.
- Conservation and restoration of the satellite wetlands as drought refuges for biodiversity, including: restoration of Soldouz, Yadergarloo, GheerdeGheet, GoriGol; designation of Kanibrazan as a Ramsar Site, preparation of management plans for GoriGol and Gharagheshlagh wetlands. These measures have required close coordination with, and support from, the water authorities for the allocations of water – and many have been undertaken by NGOs;
- Rescue and washing salt from flamingos (DOE);
- Providing water and food for to the mammals in the lake's islands (DOE);
- Experimental cloud seeding in E.&W. Azerbaijan;
- Attempts to block illegal wells;
- Moratorium on all new dams and irrigation projects;
- Public awareness, training and capacity building through training workshops, festivals, dissemination of publications, CDs, and advertisement material, etc;
- Support of scientific researches, universities, scientific seminars and conferences to address the LU issues;
- Support "2nd National Congress of Environmental Crisis of Urmia Lake" which was held by Naghadeh University;
- Study visit for high level managers and experts from National DOE, MOE and MOJA from LU to visit critical situation of the Lake was organized and implemented in July 2010.

The highest priorities for recovery of the Lake are to assure the agreed water allocations, and to roll-out the sustainable measures on agricultural water and chemical uses across the basin.

12.2. Conservation of Iranian Wetland Projects

Lake Uromiyeh and its several satellite wetlands are among the most important

wetlands of Iran and many of them are of high international significance. Because of such significance a number of studies have been conducted during the last two decades to encourage their conservation. The first was the study for planning ecosystem management of the Lake which was undertaken in the framework of the Irrigation Improvement Project (IIP) with support from the World Bank and FAO. The subsequent study was that conducted in the framework of the Partners for Water Project with support from the Ministry of Energy and the Ministry of Agriculture and Nature Management and Fisheries of the Netherlands. This component of the study aimed in evaluating the baseline environmental condition of pilot wetlands including Shurgul, Dorgeh Sangi, Yadegarlou, Soldouz, Gerdeh gheet, Kanibrazan, and Goppy Baba-ali, as the basis for development of typical management plan for wetlands.

CIWP is a project of the Iranian Government, led by the DOE,with international technical and financial support from UNDP and the Global Environment Facility (GEF). The project was launched in 2005 and will end in December 2012. It aims to improve the management of Iranian wetland ecosystems by building national and local capacity to apply integrated, participatory approaches and ecosystem-based management.

The Ecosystem Approach is the primary framework for action under the Convention on Biological Diversity (CBD). It is defined as "A strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way". Ecosystem-based management therefore promotes conservation of environment, and allows for wise use of the economical resources. It puts people, and in particular indigenous communities in the center of the ecosystem and recognizes the importance of working at ecosystem-scale, which for wetlands is normally within their watershed/basin system. In such a system, conservation of the environment is a duty not only for environmental bodies, but for all the organizations and stakeholders that benefit from or impact on the wetland. Management activities therefore require the participation of all stakeholders and the indigenous population. Such a system changes attitudes from top-down governmental control, to bottom-up, participatory, inter-sectoral working, which provides a very strong and suitable ground for both conservation of the environment and sustainable development.

The main goal of CIWP has been to catalyze the sustainability of Iran's system of wetland protected areas thereby enhancing its effectiveness as a tool for conserving globally significant biodiversity. The project's objective is to systematically remove or substantially mitigate threats facing globally significant biodiversity and sustainability at three demonstration sites (Lake Uromiyeh, Lake Parishan and Shadegan Wetland). The lessons learned through work at these sites have been used to enhance the management systems in other wetland protected areas throughout the country. The approach is built on the premise that if the local communities, managers of the governmental organizations, and the public are aware of the values and functions of the wetland, and if stakeholders could participate in management decisions related to the wetland, they would better cooperate in its management and support its conservation. Based on the above target and approach, the following objectives were defined:

- Rising knowledge of decision-makers and awareness of stakeholders in relation to wetlands;
- Developing capacity among stakeholders (training, provision of equipment, participation);
- Providing mechanisms for sustainable management of the wetland (inter-sectoral committees, basin-wide management plans, laws and regulations, monitoring). It is expected that with the execution of the project, the capacity for local management of wetlands will rise, inter-sectoral cooperation will be established, and necessary institutions will be organized for sustainable management of the wetland.

12.3. Key outcomes from CIWP at Lake Uromiyeh

Project activities including preparatory works, coordination, training, awareness raising, studies and surveys, planning and implementations for LU wetland started from the earlier stages of the project and continued to the end of the Project. In addition to the establishment of the Regional Council for LU Management, other Key outcomes and crucial changes which have been achieved are listed below:

1- Developing an ecosystem-based management plan: The first step in undertaking the project was to raise awareness on the ecosystem approach, and

prepare for developing an integrated management plan in collaboration with and participation of all the main stakeholders. Several training and consultation workshops were arranged in Tabriz and in Uromiyeh to discuss the threats and opportunities, strengths and weaknesses, desires and requirements in relation to the wetland resources. This enabled all the stakeholders to agree a common VISION and GOAL for the Lake as below:

VISION: In 25 years, Lake Uromiyeh will have adequate water to sustain an attractive landscape and rich biodiversity where people and local communities can make wise use of its resources, and will enhance cooperation between the involved provincial organizations"

GOAL: To establish an ecosystem based management for the lake and its satellite wetlands within the context of sustainable development with effective involvement of all stakeholders including local communities.

The National Council of "Lake Uromiyeh Management" comprised of ministers of Jihad Agriculture, Energy, Industries and Mines, and Head of DOE are now involved in supervising the activities towards sustaining the Lake and follow the progress of the actions planned for its management. Governors of the three provinces have organized the provincial councils for Lake management and each province has its own local management committee who all share in a common concern of sustaining the Lake and its ecological attributes. It was a great achievement that the 3 provinces as well as the Ministry of Energy (Water Deputy) have agreed on the water right of the Lake and the share of each province in releasing water to sustain Lake's ecology.

Table 12-1 Share of provinces to supply LU water right

Provinces	Potential water resources	Share in water supply to the Lake
East Azerbaijan	1360	270
West Azerbaijan	3982	1870
Kurdistan	1583	959
Total	6925	3100

Along with the development of the management plan, a monitoring plan was also developed to facilitate and instruct monitoring and evaluation of the performances of the organizations as well as people in Lake management. The Lake Uromiyeh

Secretariat was assigned to coordinate this annual monitoring and evaluations.

In 2010, the Management Plan was approved by the Government of Iran and an administrative arrangement was established to support its execution (see chapter 11.3).

2- Habitat Classification and Zoning of the wetland: Following MedWet methodology, the habitat classification map of the wetland was prepared. Also in collaboration with the local communities and through consultation workshops, zoning maps of the wetland were drawn up to provide protection to the most sensitive zones, and to identify areas where different human activities could occur.

3- Marking LU's boundaries: To resolve the present conflicts and to prevent future disputes over the boundary of the Lake, a plan has been developed and carried out for delineation and marking of the Lake boundaries.

4- Developing a monitoring plan for LU: Monitoring the changes in ecological condition of a wetland and the uses made of its resources is a crucial requirement for its proper management. Following the development of the Mangement Plan, a monitoring plan was also developed for LU. The first integrated monitoring report was prepared for the year 2009.

5- Public Awareness: Many activities have been conducted to raise public awareness in wetland values and functions, mainly with the participation of local communities. There have been numerous media broadcasts and publications about the Lake, as well as a festival. This public awareness program will continue to increase and update public awareness of the Lake's status.

6- Developing Strategic Plan for Ecotourism: Local workshops were held for consultation on developing ecotourism in Kanibrazan wetland area in which the stakeholders encouraged the idea as a potential source for alternative livelihood for part of the local community.

7- Developing management plans for Gori Gol and Gharagheshlagh wetlands: Ghori Gol,a Ramsar Site east of Tabriz is suffering from several threats due to unsustainable use of land and water resources around the wetland. Also Gharagheshlagh, a 46000 ha hunting prohibited area southeast of the Lake and a wetland downstream of the Zarrineh roud River, is in need of further conservation measures. With support from CIWP and EA-DOE and collaboration of the local people a participatory approach was followed to analyse the strengths and weaknesses as well as threats and opportunities for the

purpose of developing ecosystem based management plans complemented with monitoring plans. In this process the stakeholders agreed on defined visions and goals for the management of the wetlands and specified the objectives and action-plans for mitigating the threats and conservation of the resources.

8- Reasearch works and Studies conducted: Within the framework of CIWP works, following research works and studies have been conducted:

- Base line environmental study in Gharagheshlagh area;
- Evaluation of damages to Yadegarlou wetland;
- Investigation of spatial and temporal variations of soil salinity in Uromiyeh Plain;
- Analysing and documentating ecological variations in LU during last 40 years;
- Feasibility studies for establishing alternative sources for livelihood of local population in Gharagheshalgh hunting prohibited area;
- Environmental evaluation of Yousef Kandi village adjacent to Ghori Gol wetland in E. Azarbaijan on the basis of concepts of environment friendly village development.

9- Planning for drought risk management: Recognizing drought as a crucial issue in LU management,CIWPlaunched in 2010 a project for developing a plan for Drought Risk Management (DRM). The Objectives of this project were to:

- Evaluate temporal and spatial patterns of drought in the LU basin
- Evaluate methodologies to monitor drought
- Identify types of drought and measures to alleviate loss and meet LU water requirements
- Institutionalize measures for drought management

The two years study of the project was undertaken by eligible well qualified academic team from Tarbiat Modarres University and concluded in a comprehensive analysis of the historic trends in hydroclimatic records, drought behavior in the LU basin, and developing a risk management plan and monitoring system. The study also provided sofware for monitoring and analyzing the drought information. Overall, the outcome of the study was presented in 10 volumes of different reports with the following titles:

- Vol 1: Study Area and Data
- Vol 2: February 2010 Workshop on LU Drought Risk Management

- Vol 3: Trends of Hydro-Climatic Variables in LU basin
- Vol 4: Drought Behavior in LU basin
- Vol 5: Drought Management Organization for LU basin
- Vol 6: Drought Monitoring System for LU basin
- Vol 7: Agricultural Water Allocation Model for Drought
- Vol 8: Agriculture and Agricultural Water Allocation During Drought
- Vol 9: Water Allocation Model of LU Basin and Status of Provinces and Lake During Drought
- Vol 10: Operational Component of the Plan

In the risk management plan, two main senarios with different options have been proposed that facilitate planners in the provinces to allocate appropriate volume of water to different sectors according to different levels of drought. In both the scenarios, conservation of the lake in parallel with the optimum use of water for agricultural production has been considered as the first priority. However in the most severe conditions, the priority for allocating water will be griven to fruit gardens. In every condition, domestic water uses have priority over all other uses. The study confirmed that the main strategy to combat the drought is to save water resources in the agricultural sector. This will be acheiveable through improving water use efficiencies, optimizing cropping patterns according to the available water resources and adopting deficit irrigation techniques.

10- Water management and sustainable agriculture: Studies have revealed that while agricultural sector consumes more than 95% of the basin's water resources, there is a great potential to increase water application efficiencies at farm level and save considerable volume of water for restoring and sustaining the Lake without hampering agricultural productions and farmers' incomes. This potential source of water can even replace in part the need for constructing new storage dams.

Agricultural sector is furthermore a major source of producing substantial volume of chemicals residues which eventually end in contaminating water resources and wetlands.

Based on the above considerations, CIWP in coordination with MOJA launched a program to establish Field Farmer Schools and demonstration farms to demonstrate and at the same time teach local farmers of the ways that can result in saving water at

farm level as well as sustaining agricultural procedures through optimizing the use of agricultural chemicals i.e. fertilizers and pesticides. The program succeeded to show the farmers that this potential is achievable. However applying these findings over the vast LU basin to achieve the final results will require a major investment of both Water and Jihad Agriculture Authorities and effective supports from political decision makers and legislative organization.

12.4. Looking forward

There can be no doubt that the CIWP has brought about a significant change in the attitudes and approaches to the management of Lake Uromiyeh. Before the project, management was solely in the hands of the DOE, and there were significant tensions between stakeholders. Today, there is a common agreed goal for the management of the Lake, and all stakeholders are working together to achieve this. The CIWP will end in December 2012, and the challenge is to ensure that these changed approaches are now sustained in the long-term for the benefit of both the people and biodiversity of Lake Uromiyeh and its satellite wetlands.

Sustainablitiy of the ecosystem management approaches for LU depends on few crucial actions: strengthening of management systems, encouraging public participations, raising public awareness and establishing alternative livelihood potentials for local communities.

Govenmental organizations involved should first advocate the participation of stakeholders in wetland management and support in effective manner the local management agents through providing their administrative, legal, instrumental, technical and tranining requirements, and set down necessary options to improve on farm water and chemical management which could end in saving water and optimizing the use of agricultural chemicals.

Local organizations need to expand and maintain participation of local people and stakeholders and to improve their roles, responsibiltites and authorities in wetland management and conservation.

Raising public awareness on the vital values of wetland and the priority their conservation has through providing necessary trainings which could effectively result in wise use of wetlands and conservation of their resources. Particularly, training school students on the related issues should be given higher priority.

13. MAJOR GAPS IN INFORMATION

Considering ecosystem based management of LU, provision and or access to the following additional information would help better formulation of the plan:

- Ecological attributes of the major rivers within the basin;
- Detailed plans for water and agricultural development projects and their impacts on water budget of the Lake;
- Monitoring of water inflows to the lake.
- A comprehensive knowledge of the ecological and economic attributes of the satellite wetlands;
- Optimum water requirement of crops in connection with their production levels.
- More detailed and regular monitoring of the biodiversity

14. References for further reading

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