Food and Agriculture Organization of the United Nations

Urmia Lake Restoration Program

Integrated Programme for Sustainable Water Resources Management in Lake Urmia Basin

(GCP/IRA/066/JPN)

Project workplan

29 November 2017

Submitted for approval by the ULRP Steering Committee

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Preface

This document details the workplan for the FAO project GCP/IRA/066/JPN ("FAO Urmia project") prepared by the project expert task force, under the coordination of the Lead Technical Officer, Aziz Elbehri. The workplan document is based on expert mission reports, secondary data sources and the guidance from the Urmia Lake Restoration Programme (ULRP). The workplan document was written in line with the project document signed by the FAO, the Japanese Government (donor) and the Government of the I.R. of Iran, and details the planned activities within each of the four key components (water accounting, drought management, livelihood, and watershed management) framed under an integrated approach.

During the rapid assessment, FAO mobilized a number of subject-matter experts to participate in field missions and to engage in in-depth and wide-ranging discussions with stakeholders in Tehran and in Urmia Lake Basin (the full list partners consulted is shown in annex 2). Participating expert include: Poolad Karimi (water accounting), Jiro Ariyama (hydrology), Charles Batchelor (irrigation), Somayeh Shadkam (drought modeling), Aziz Elbehri (socio-economics and livelihoods), Ursula Hermelinl (markets and trade), Rachael McDonnell (drought management), Hanspeter Schreirer (watershed management), Gianluca Franceschini (land cover mapping) and Fabio Grita, who served as a temporary Chief Technical Advisor (from January to July). The experts were assisted by a team of national technical consultants focusing on particular components, including Amin Roozbahani (water accounting), Mohammed Vesal and Sara Torabi (livelihood). During the workplan preparation data collection and project documentation benefited from the contribution of Jiro Ariyama and Amin Roozbahani as well as from a team of national project support staff including Shahriar Rahmani, Shahnian Ali, Rana Heidari and Nayab Nikzad. This team also supported the missions' logistics while travels and visas for international experts were assisted by Niloofar Dehgan and Magid Ahmadi in the FAO Office representation in Tehran. The communications outreach during the FAO field missions were provided by Mehdi Sayyari and Mehdi Ansari.

It is important to stress that throughout the rapid assessment phase, the whole FAO project team benefited from the dedication and guidance of The ULRP officers, especially Mr. Masoud Tajrishy, Mr. Hossein Shahbaz and Mr. Behdad Chehrenegar in ULRP Tehran Office. Special recognition goes to Mr. Shahbaz, the project ULRP focal point, who played an essential role in ensuring high-quality exchanges between the visiting experts and national partners during all the field missions.

Finally, the organization of the field missions and the preparation of the workplan and the inception workshop (especially following the departure of the temporary CTA in July) was supervised by Pasquale Steduto, project budget holder and coordinated by Aziz Elbehri, the project Lead Technical Officer.

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AREEO	Agriculture Research, Education & Extension Organization
ASI	Agricultural Stress Index
BCM	billion cubic metres
CCIMA	Chamber of Commerce, Industries, Mines and Agriculture
DoE	Department of Environment
DSS	Decision Support Systems
ET	evaporation and transpiration
FAO	Food and Agriculture Organization of the United Nations
FAO-TF	Food and Agriculture Organization Task Force
FRWO	Forest, Rangeland and Watershed management Organization
GIS	geographical information systems
ICARDA	International Center for Agricultural Research in the Dry Areas
ICBA	International Center for Biosaline Agriculture
IDMP	Integrated Drought Management Programme
IRIB	Islamic Republic of Iran Broadcasting
IRIMO	Islamic Republic of Iran Meteorological Organization
ITSR	Institute for Trade Studies and Research, Tehran
LU	Lake Urmia
LUB	Lake Urmia Basin
MAJ	Ministry of Agriculture-Jahad
MCM	million cubic meters
MEA	Ministry of Interior Affairs
MIMT	Ministry of Industry, Mines and Trade
MoE	Ministry of Energy
MPO	Management and Planning Organization
MRUD	Ministry of Roads & Urban Development
MSRT	Ministry of Science, Research and Technology, Iran
NGO	non-governmental organization
NRD	Natural Resource Department
RISTIP	Research Institute for Science, Technology and Industry Policy/Tehran
SCI	Statistical Centre of Iran
SES	socio-ecological system
SPEI	Standardized Precipitation and Evapotranspiration Index
SPI	Standardized Precipitation Index
TMU	Tarbiat Modares University
TPO	Trade Promotion Organization of Iran/Tehran
ULRP	Urmia Lake Restoration Programme
ULRPNC	Urmia Lake Restoration Programme National Committee
UNESCO	United Nations Educational, Scientific and Cultural Organization
WA	water accounting
WA+	water accounting plus
WM	watershed management
WMO	World Meteorological Organization

1. BACKGROUND

Lake Urmia is a vast hyper-saline lake in the north-west of the Islamic Republic of Iran, formed in a natural depression at the lowest point within the enclosed Lake Urmia Basin. Water enters through several rivers but is dispersed only through evaporation. The area of the basin is enormous: 51 876 km^2. In 1976 Lake Urmia was recognized as a Ramsar Site and a UNESCO Biosphere Reserve. The lake has shrunk dramatically from a little over 5 000 km^2 in 1995 to less than 2 000 km^2 by 2007. Growing population and the expansion of intensive irrigated agriculture exacerbated by a long period of drought, have all contributed to the lake's decline. The negative impacts, social, economic and environmental, are huge.

The revival of the lake is a national priority, strongly advocated by the Iranian government who, in 2013, formed an ad-hoc, cross-sectoral, high-level committee, the Urmia Lake Restoration Programme National Committee (ULRPNC) to create a monitoring system and to define/implement interventions for restoring the ecological conditions of the lake. Under the guidance of the Urmia Lake Restoration Programme (ULRP) – the technical and operational arm of ULRNC – several studies, projects and interventions took place in various parts of the Lake Urmia Basin with funds provided by the government.

ULRP is operating on a ten-year action plan divided into three phases:

1. Stabilization Phase (2014-2016): the objectives of this Phase are the stabilization of the water level in Lake Urmia and the implementation of projects to decrease the possible negative effects of lower water levels.

2. Restoration Phase (2017-2022): the purpose of this phase is to implement solutions that will gradually raise the water level in the lake.

3. Final Restoration Phase (2023): the projected purpose of this phase is the sustainability of actions undertaken and the required enforcement of those measures to protect the lake after it is restored and to ensure those conditions are maintained into the future.

Specifically, ULRP was created to halt and reverse the loss of water from the lake, in part through a 40 percent reduction in the amount of water taken from the basin within five years. The ULRP is also empowered to assist national stakeholders with advanced tools and methodologies to monitor water consumption and drought, to improve productivity and management of agricultural water and provide sustainable alternative income-generating options for communities affected by the shrinkage of the lake basin and reduced water allocation.

The ULRP commissioned several studies as part of its work programme, aimed to reduce the adverse effects of lower water levels in the lake. However, despite Iran's broad spectrum of technical and engineering competence and knowledge, some critical areas needed support and outside assistance including the socio-economics and coordination between different programmes and objectives. These limitations threatened to limit the effectiveness of current solutions and jeopardized future options for the sustainable rehabilitation of the Lake Urmia Basin.

Following an official request to FAO from Dr Issa Kalantari, ULRP Director, a multidisciplinary mission undertook a rapid assessment of modalities and the scope for possible technical assistance from FAO to restore Lake Urmia in February 2015. The mission findings delivered some critical insights about the restoration of the lake. First that the problem is firmly linked to whole-basin water balance (inflow-outflow) and that it needs multi-faceted approaches and interventions, starting with:

i) reducing water consumption by upstream development activities;

(ii) managing drought, climate variability, and related risks from lower precipitation; and

(iii) offering alternative livelihood options for farmers and affected communities to compensate for lost incomes and reduced irrigation water. The purpose of this document is to describe the activities carried out during the consultancy assignment, highlight the key findings and indicate follow-up actions, as discussed and agreed with ULRP and the FAO Task Force (FAO-TF).

2. BRIEF OVERVIEW OF THE LAKE URMIA BASIN

Lake Urmia Basin, Iran's largest hyper-saline water body, is located in north-west Iran and covers an area of about 52 000 square kms (Figure 1). The Lake Urmia Basin falls within three provinces: East Azerbaijan (39 percent), West Azerbaijan (51 percent) and the Southern Province of Kurdistan (10 percent). The lake's mean annual precipitation varies between 300 and 400 mm (Iran Ministry of Energy, 2014a) and about 77 percent of the precipitation occurs between December and May of each year (Water Research Institute and DLG, 2006).

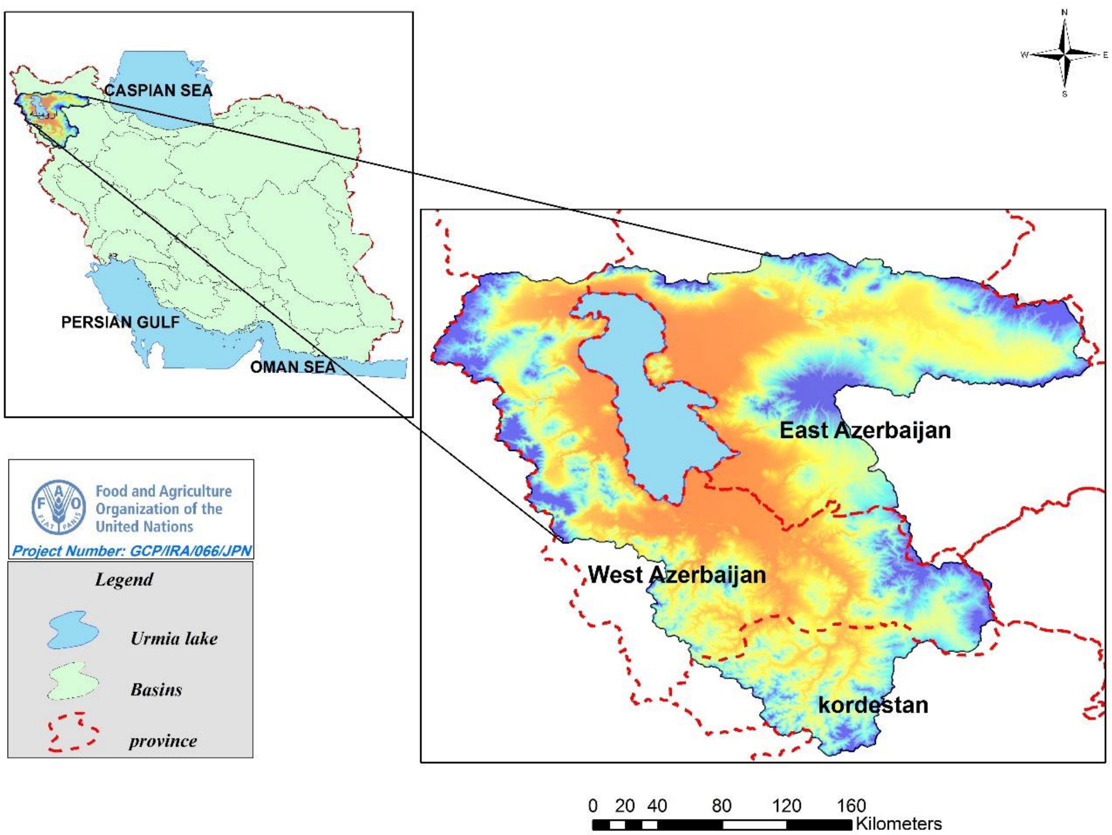

Figure 1. Map showing the location and surrounding topography of Lake Urmia

According to the latest population census of 2016, the population of the lake basin is estimated at 5.2 million with 50 percent in East Azerbaijan, 45 percent in West Azerbaijan and 5 percent in Kurdistan Province. Figure 2 shows the cities and counties within the basin. The majority of the population within the basin are made up of Shia Turks, while in the western and southern parts of Lake Urmia Basin the population are Sunni Kurds.

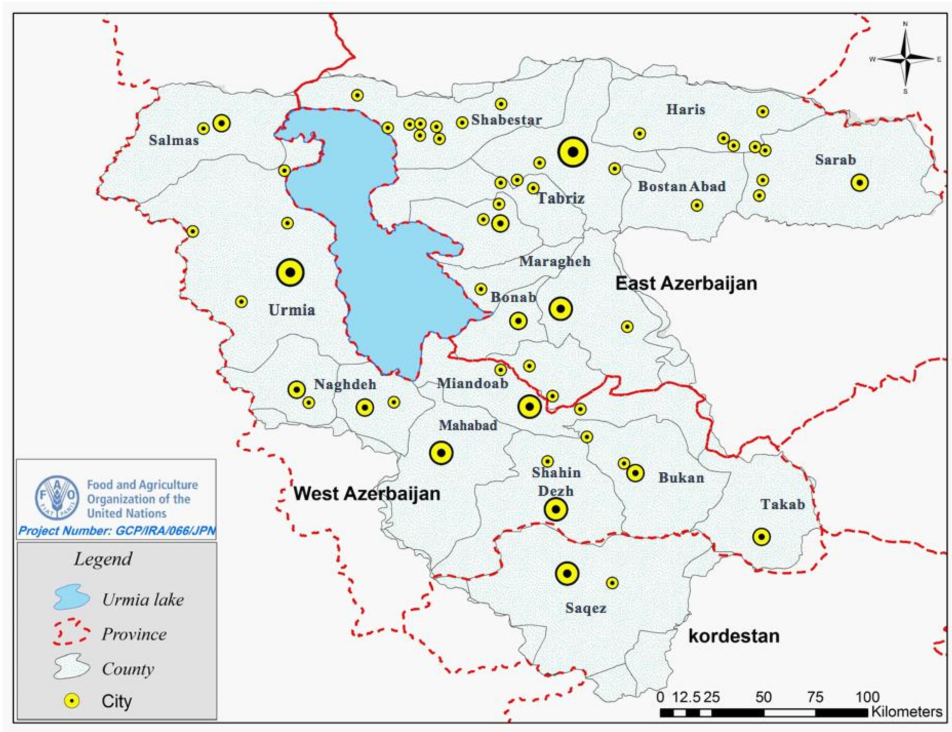

Figure 2. Counties in the Lake Urmia Basin

C. Hydrological data

Lake Urmia is a closed basin where all the rainfall drains towards the central area. The lake is supplied by direct precipitation and has 17 permanent rivers and 12 seasonal rivers most of which discharge water into the southern part of the lake (Iran Ministry of Energy, 2014a). Figure 3 shows the river network within the basin and its 24 sub-basins. Most of the water that discharges into the lake comes from the south.[1] River inflows are highest in spring as a result of snowmelt while groundwater supplies a very small fraction of the water inputs. All the water inflows into Lake Urmia depend on precipitation and can vary depending on climatic conditions in the basin, in particular precipitation, temperature and humidity.

[1] The long-term water discharge to the lake was estimated to be 2 933.89 million cubic metres (MCM) and 67.69 MCM from east and west stations, respectively.

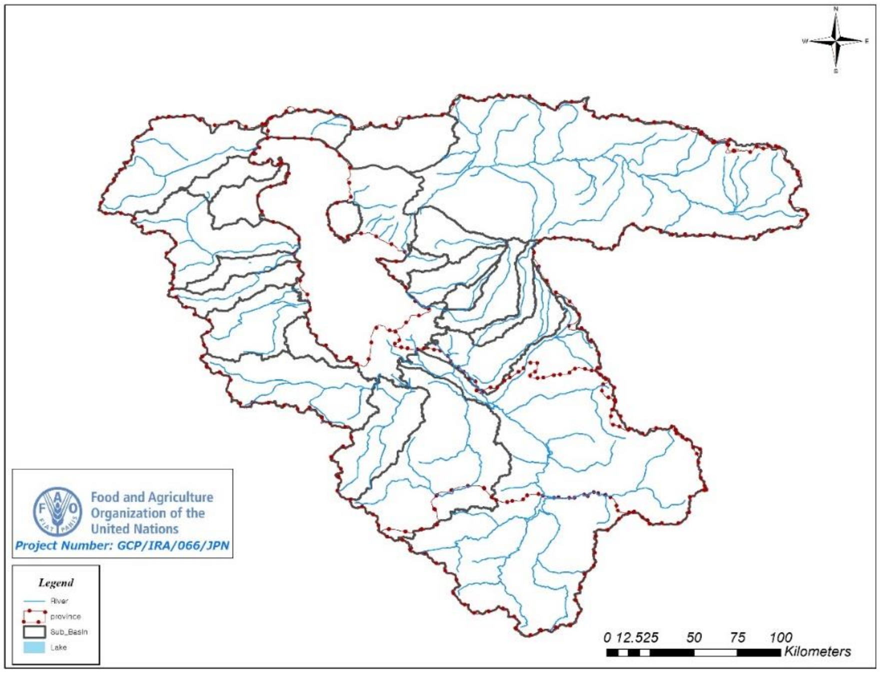

Figure 3. Rivers and sub-basins within the Lake Urmia Basin

In West Azerbaijan, there are 4 sub-basins that are covered under the programme implementation measure to reduce agricultural water consumption by 40 percent (see Figure 4). These are : Rozeh chai, Barandooz chai, Shahr chai and Nazloo chai sub-basins. Within these areas, two subbasins serve as pilot areas monitoring by Urmia University: Bibakran river basin (450 km$^{2)}$ and Moghana river basin (70 km^2).

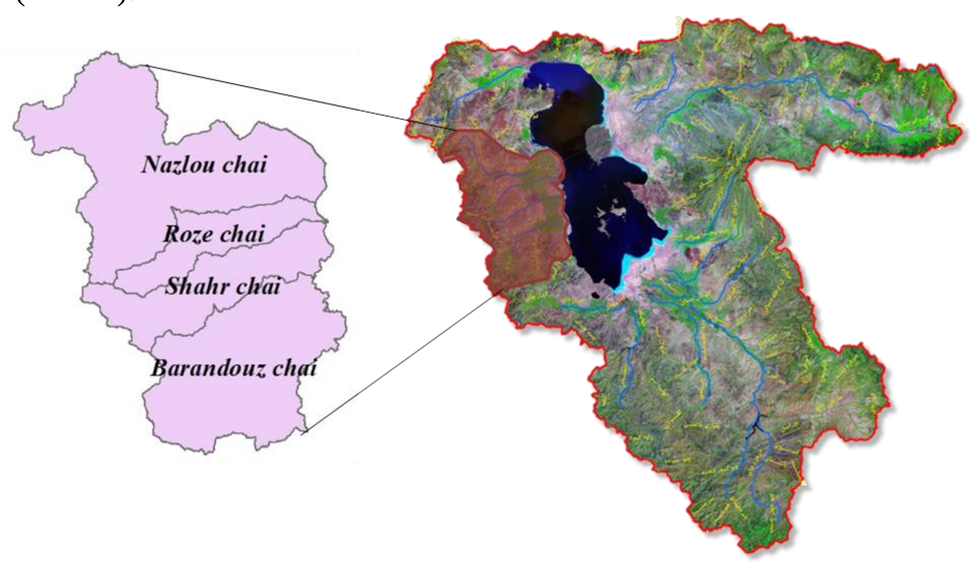

Figure 4. Location Map of Nazlou Chai, Roze Chai, Shahr Chai and Barandouz Chai sub-basins

In East Azerbaijan, the biggest sub-basin is AjiChai which covers 33 percent of total basin irrigated agricultural land comprising a total area of 150 000 ha) (Figure 5). Within the basin, the Sarab study area covers 12 500 km^2.

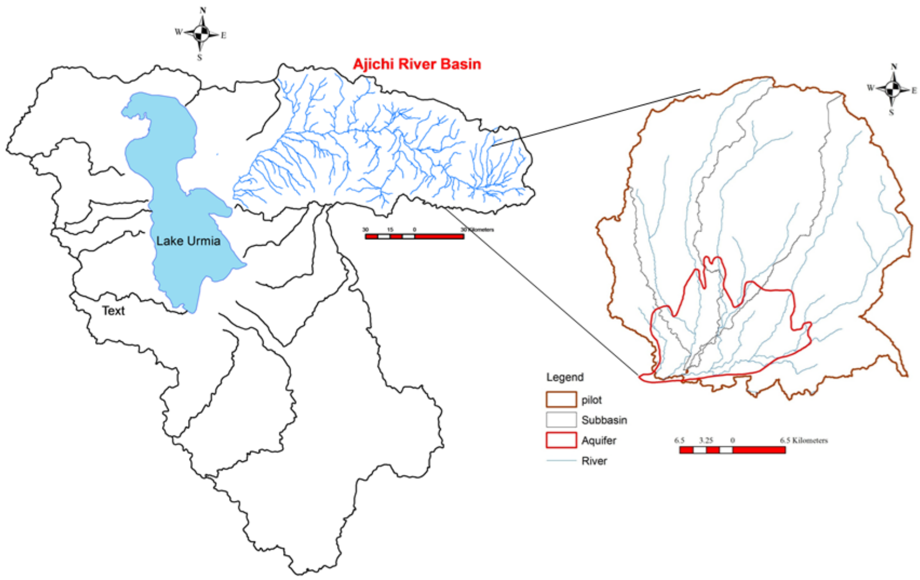

Figure 5. Aji Chai sub-basin and Sarab study area

There are also smaller sub-basins south of AjiChai, including Soofi Chay where the natural resource department is undertaking field work in the pilot area Haris Maraghe to collect metrological, hydrometric rainfall and vegetation and animal data. (Figure 6)

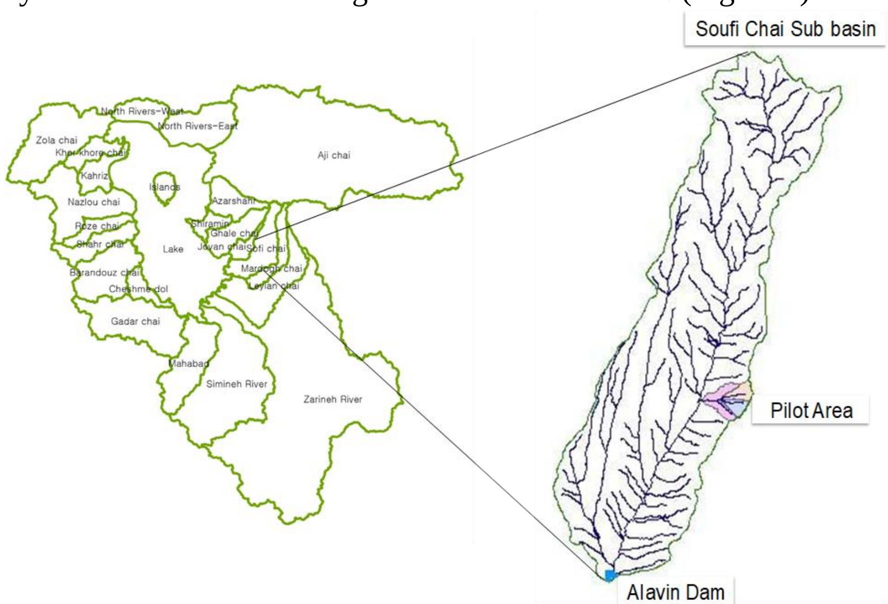

Figure 6. Soofi Chai sub-basin

Two main rivers feed the southern part of the Lake Urmia Basin. The Zarrineh Rood and Simineh Rood rivers together have a potential discharge of about 3 billion cubic metres per year and are considered big rivers in Iran, which, along with numerous natural and social advantages, has led to the development of agricultural activities in the watershed basins. The construction of irrigation networks such as Miandoab along with dams such as Kazemi Bukhan, have created facilities at the basin level, which now covers about 150 000 hectares of traditional and modern irrigated and cultivated areas. The two rivers provide about 50 percent of Lake Urmia's water supply but in recent years, with the expansion and exploitation of these resources, they no longer provide water directly to the lake and instead have become the main cause of its water crisis.

In this area there are 4 sub-basins, the largest of which is the Zarinehrood sub-basin – a large area that covers 35 percent of the basin area but is the source of 50 percent of the water inflow to the lake (Figure 7). The Zarrinehroud could be a good candidate as a pilot area for the FAO project in addition to its suitability for watershed management issues (erosion, mining, land use change).

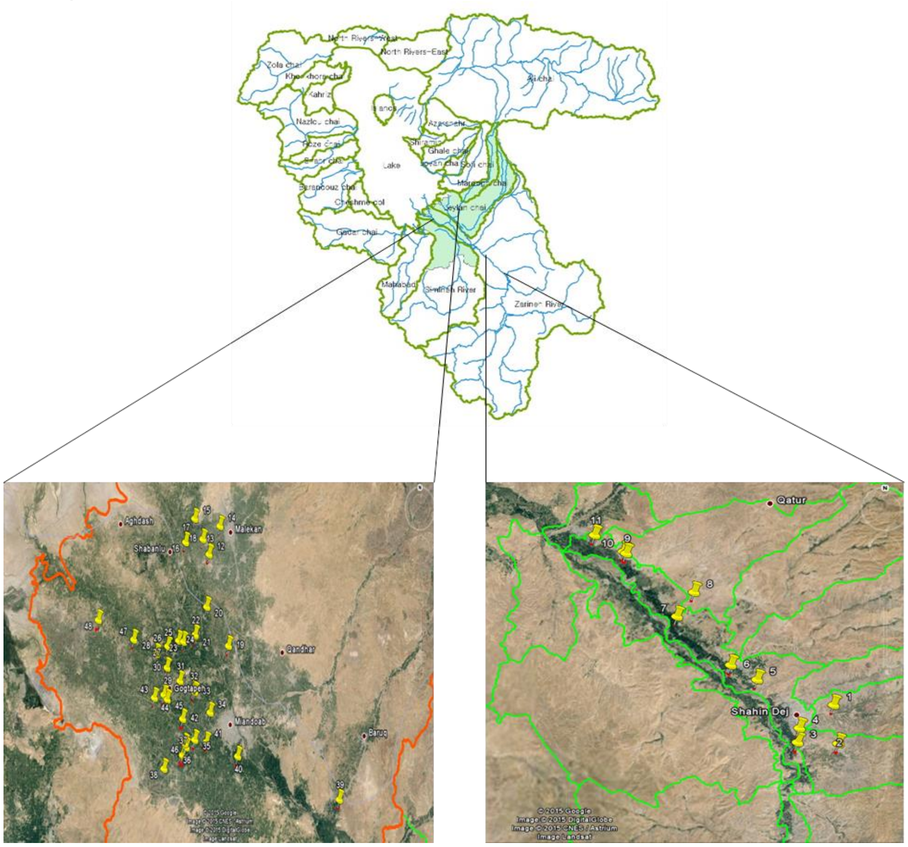

Figure 7. Miandoab and Saein-Ghale Regions

In 2013, the Ministry of Energy conducted a study to report on long-term average annual precipitation and average inflow into the lake for two different periods: (i) from 1951-1952 to 2012-2013 and (ii) from 2002-2003 to 2012-2013. The study found that for the first period, average annual precipitation and inflow into the Lake was **385.8** mm and **4.9** BCM, respectively. For the second period, average annual precipitation was **316.9** mm and the average inflow was **2.4** BCM (or less than half the long-term average). (Figures 8 and 9).

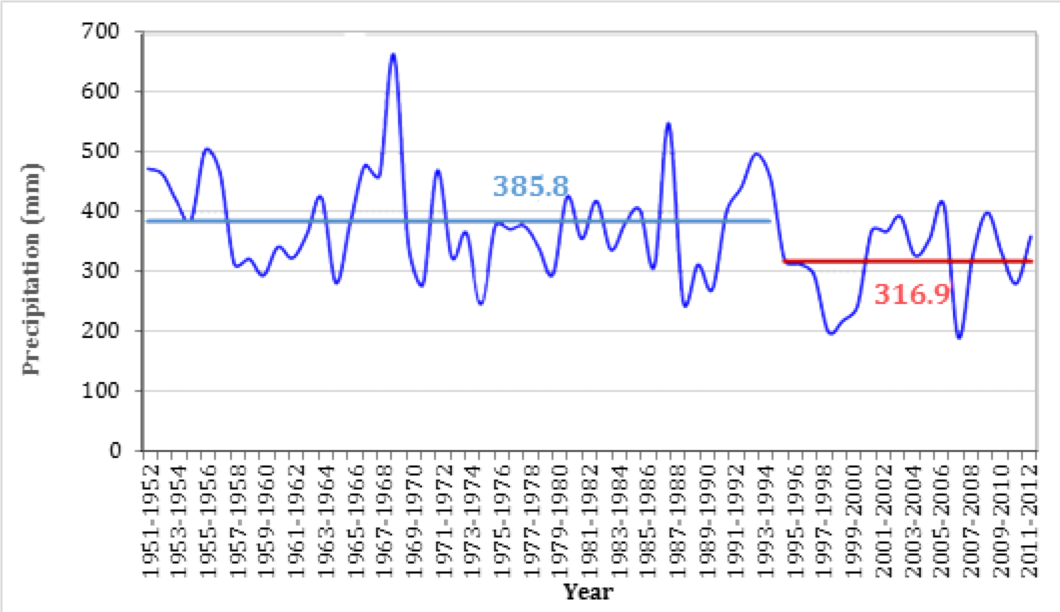

Figure 8. ***Long-term mean precipitation series in Urmia lake basin (Ministry of Energy, 2013)***

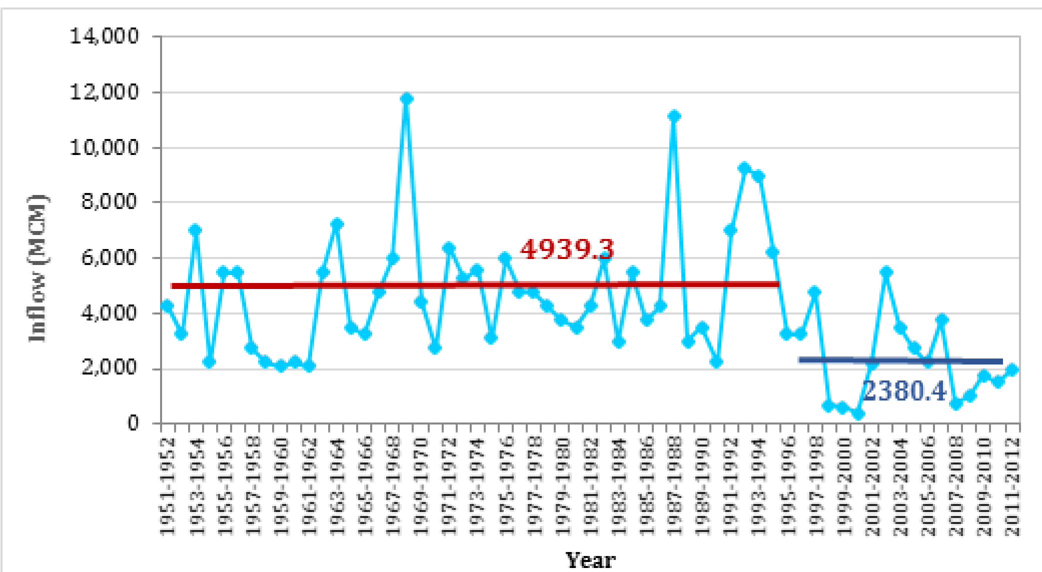

Figure 9. The variation of runoff entering the lake in Lake Urmia Basin (Ministry of Energy, 2013)

From 2002-2003 to 2012-2013 the mean temperature increased from 10.7℃ to 11.7℃ (Figure 10).

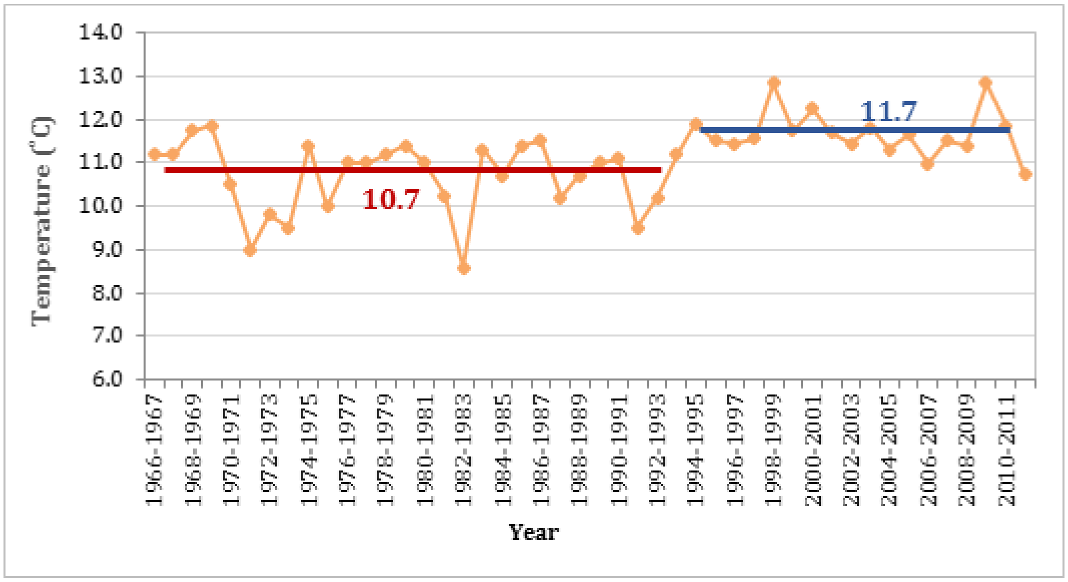

Figure 10. Mean temperature fluctuations in Lake Urmia Basin (Ministry of Energy, 2013)

In 1995, after recording the lake's highest level (1 278.48 cm), water level has fallen on average 40 cm annually within the last two decades, reaching its lowest level in September 2015 when the southern part of the lake became totally dry. The average precipitation as well as the number of rainy days in the Lake Urmia Basin has fallen significantly during recent years compared to previous periods. This has resulted in a drop in runoff and surface water inflow throughout the basin.

3. FAO LAKE URMIA PROJECT – INCEPTION AND KEY OUTPUTS

The overall objective of this project, the Integrated Programme for Sustainable Water Resources Management in the Urmia Lake Basin, funded by the Government of Japan, is as follows: to increase efforts to halt and reverse the drying up of Lake Urmia by reaching a target of 40 percent reduction in water consumption within the Lake Urmia Basin. The project set out a multi-disciplinary framework covering several key interrelated areas centred around five core outputs or components:

1. An advanced water accounting (WA) system for the entire Lake Urmia Basin;
2. A drought management system based on risk/vulnerability assessment and preparedness response for the basin;
3. A socio-economic livelihood programme with viable and sustainable alternatives to current agricultural activities upstream of the lake to reduce water consumption significantly while protecting the income and livelihood of affected communities;
4. An integrated watershed management (WM) programme;

5. A capacity development programme to strengthen stakeholders at different levels.

Formulating the project to achieve these outputs requires a high degree of integration to produce measurable impacts that advance the primary goal of increasing water inflows into Lake Urmia. Under this project, FAO will:

(i) Coordinate inputs and expertise from national and international partners to ensure the highest technical standards with regard to project outputs;

(ii) Provide technical inputs and expertise to design a methodology that will manage drought and monitor water consumption and agricultural water productivity; and

(iii) Hold consultations with international and national experts and qualified institutions worldwide to ensure the broadest possible agreement on the methodology used. The project will place special emphasis on alternative income-generation scenarios and employment options, changes to cropping systems and value chain improvement for farmers, rural populations and other socio-economic groups, to achieve the principal target of reduced water consumption.

4. RAPID ASSESSMENT OF LAKE URMIA SITUATION

Preliminary consultations

The complexity of the project, developing a detailed plan of action inclusive of field activities, monitoring and evaluation and capacity development to transfer advanced methodologies to national staff requires an in-depth assessment of the scientific, technical indicators as well as socio-economic, policy and governance parameters. These are essential to create an enabling environment to adopt successful water-saving practices that improve water inflow to the lake without negative impacts on farmers and community incomes and livelihoods.

In-depth consultations and analysis of available data, tools and methodologies were necessary during the rapid assessment phase to translate the project document into a workplan that met national partner expectations to deliver on the key project outputs and outcomes.

However, preliminary consultations with national stakeholders only began in January 2017 with the recruitment of a temporary project manager (Chief Technical Advisor). These consultations made for better familiarity with the Lake Urmia Basin situation and becoming acquainted with relevant national stakeholders including university experts engaged with ULRP in field activities. The consultations also helped define the initial extent of FAO’s expected contribution to the programme coordinated by ULRP. In particular, FAO was encouraged to provide guidance in the following areas: a) improve existing environmental and socio-economic monitoring systems, to analyse the causes and effects of the lake’s ecological degradation; b) introduce new technologies and methods to assess the environmental and socio-economic situation of the basin; and c) develop a sound, sustainable plan of action to reduce water consumption and increase water inflow to Lake Urmia.

Consultative workshop (April 2017)

A consultative workshop took place under an agreement between FAO and ULRP for a scientific forum to evaluate the current state of knowledge, assessment and interventions taking place within the Lake Urmia basin. The workshop combined presentations by national and international experts and presented an opportunity for wide-ranging inputs and decisions by over 100 invitees from different government and non-governmental entities. While the workshop gave further appreciation of the scope and breadth of the challenges and opportunities for restoration, the consultation also revealed gaps and limitations in current approaches to that restoration. These included weaker contributions from socio-economics, a lack of robust proposals for livelihood options. There was also weak coordination among agencies and departments with multiple often uncoordinated approaches, understanding and even diverse quantitative assessments of the situation on the ground.

The ULRP leadership articulated the key messages from the consultative workshop with a clear request for FAO to facilitate an in-depth rapid assessment of all the key components within the FAO project and to provide an action plan to guide ULRP in implementing interventions on the ground. These interventions aim to meet these twin goals: (1) to increase measurably the water inflow into the lake through water-related actions and programmes; and (2) to ensure there are no negative impacts on the livelihood of local farmers and communities, making it more likely they will accept and adopt the proposed alternative practices needed to restore Lake Urmia.

Rapid assessment through extended field missions (July – October 2017)

Following the consultative workshop in April, FAO and ULRP agreed to undertake further field missions to complete an in-depth rapid assessment of the situation leading to an acceptable workplan. Three field missions took place involving a multi-disciplinary team of experts, the first from 1-14 July 2017, followed by one from 3-9 October and the final mission from 25-30 October by Hanspeter Schreier, an expert on watershed management.

Specifically the rapid assessment, through the field missions and analysis of available sources, set out several objectives:

(i) Review the current situation of the Lake Urmia Basin from various perspectives with a focus on water saving: climatic variability, water availability and consumption, water distribution infrastructure and management, irrigation efficiency, water allocation, cropping patterns and their changes, adequacy of agricultural practices, national and local markets, import and export dynamics and opportunities, challenges to farmers and their coping strategies, the role and importance of livestock, assignment of water rights, government incentives, environmental degradation and illegal use of water;

(ii) Review existing systems and tools: water accounting, hydrologic and economic models, Decision Support Systems (DSS) and a value chain;

(iii) Identify national/provincial technical capacity and promote collaboration: obtain information on existing studies and research and discuss potential collaboration. Discuss areas of collaboration with the Universities of Urmia and Tabriz and define the coordination mechanism;

(iv) Identify relevant data from various sources and identify those gaps the project could fill;

(v) Gather farmers' opinions and concerns on current farming conditions and critical issues that influence their decisions and choices.

Key insights from the rapid assessment are summarized below by area.

Water management system in the Lake Urmia Basin

Governance of water in Iran is shared between several authorities with the Ministry of Energy, provincial bodies and the water authority taking the lead. At provincial level, the Water Authority assesses water availability and is in charge of allocation for all major uses. The Authority periodically measures the amount of water in a river and stored water in dams. It receives water demand estimates at sub-basin level from the Ministry of Agriculture and drought projections from the Climate Research Centre of Mashhad. The Water Auuthority then determines water allocation for different users, giving priority to domestic use (drinking water), followed by industry, environmental flows and finally agriculture. The amount of water released for agriculture is based on demand estimates from the Ministry of Agriculture and the allocation to farmers is announced for each sub-basin. The Ministry of Agriculture is in turn responsible for water distribution to farmers' fields once water reaches the second and third level water canals**.**

Every five years the Water Authority collects data on supply and demand from various sources and uses this information to set planning and water allocation quotas. To date, measuring actual water consumption has not been factored into the current water management system. Estimates of current availability and water flows are uncertain owing to several factors, including variations in inter-seasonal precipitation ranging from less than 200 mm to over 500 mm and the failure to measure the amount of water delivered to fields through inefficient irrigation practices. Another challenge comes from farmers' uncontrolled use of groundwater, including unauthorized wells, which complicates monitoring of water consumption in the Lake Urmia Basin.

The data collected in Lake Urmia does not include water consumption at field level and the limited data that exist are either out of date or deposited in inaccessible archives. Relying only on guesstimates for water consumption or availability is not good enough for Lake Urmia restoration purposes. This is a significant data gap.

Monitoring water consumption is critical to an efficient WM system, especially with growing water shortages. Water consumption is largely mirrored by evaporation and transpiration (ET). As a prerequisite to water saving, ET data and a monitoring system are needed to assess actual consumption as a first step towards increased water productivity, greater crop productivity, continuous monitoring of consumption and tracking water savings.

Water accounting (WA) assesses trends in water supply and consumption over time and location to determine the extent of changes needed in current usage. It maps out where water is consumed and can identify hot spots with excessive water use that need remedial action. WA can detect any expansion of agricultural land or improvement in water consumption. This is, *per se*, an important decision-making support tool.

WA differs from water balancing as the former provides more detailed and interpreted information about water availability, accessibility, sustainability and water flows within the domain. There are several approaches to WA, but our WA approach combines ground-measured data, remote sensing for ET and land use and a potential hydrological model to inform us on temporal and spatial variability of water supply, use and consumption. It should be emphasized that WA provides an estimate of actual water consumption, not just demand as measured by crop water requirements.

One of the practical applications of WA is to identify low performance hotspots where water consumption is high and productivity is low, using that information as a basis for corrective interventions at pilot site level. Having WA information will support action plans tailored to local conditions and each specific situation. Since WA can provide a typology of land use regarding ET levels, some related to irrigation problems, it can initiate an appropriate response from all stakeholders including farmers and relevant government agencies. The specific types of actions to recommend will depend on other parameters including socio-economic, livelihood and policy considerations.

Drought management in the Lake Urmia Basin

Discussions with the staff of the Islamic Republic of Iran Meteorological Organization (IRIMO), Tarbiat Modares University (TMU) and the Statistical Centre provided valuable insights into the current thinking on drought in Iran and how this applies to Lake Urmia. Analysis undertaken at IRIMO highlights that precipitation levels have been falling compared to the 1980s and earlier. Conversely temperatures are rising and it is generally acknowledged that aridity is growing and droughts are increasing. The analysis by IRIMO shows that over the last seven years, 12 percent of Iran had experienced very severe drought; 32 percent severe; 38 percent average drought and 15 percent mild or little drought. It was clear from the discussions that effective drought management is now critical for many parts of Iran, including the Lake Urmia region.
An Integrated Drought Management Programme (IDMP) as defined by the World Meteorological Organization and the Global Water Partnership, is composed of three pillars: (i) Drought monitoring and early warning systems; (ii) Vulnerability and impact assessment; and (iii) Mitigation and response. The IDMP offers a useful framework for assessing drought management in the context of the Lake Urmia region.

With respect to drought monitoring and early warning systems, IRIMO and TMU have developed many different single indicator indices for drought with distinctions between meteorological, agricultural and hydrological drought. Meteorological records from ground, radar and satellite imagery are used to determine maps of the Standardized Precipitation Index (SPI) and the Standardized Precipitation and Evapotranspiration Index (SPEI) for current and future climate conditions. For agricultural drought, values for an Agricultural Stress Index (ASI) have been determined from satellite imagery data.

For early warning systems, IRIMO has been working on a system targeting farmers with meteorological data (called TAHAK) in which both short-term and long-term weather data are broadcast to more than a million farmers across the country. This information, which includes appropriate timing for certain agricultural practices (cultivation, harvesting, application of anti-pesticides and fertilizers, etc.) is also supplied at the city/regional and village level.

The drought indices produced by IRIMO and TMU follow international standards and best practice. However, there is a need to design a system that gives drought decision-makers one integrated map of drought that is further verified by an evaluator network within Lake Urmia Basin to confirm conditions and their severity. The multiple maps give different and sometimes contradictory views of the situation.

Vulnerability and impact assessment – There has been little assessment to identify the impacts of past drought on various sectors and communities. Meteorological data will support the compilation of past drought history but there appears to be no systematic assessment of the impacts on crop yields, water resources, household incomes and expenditure and health. In discussions at the Statistical Centre, the need for data to support studies in these areas was recognised and there is a strong opportunity to add to this information through household surveys when adaptive capacity along with impacts on individuals and families are better identified.

Mitigation and response to drought – Beyond drought monitoring, early warning systems and a vulnerability impact assessment, there is also a need for drought management action plans. Such plans will use drought maps as triggers and draw on the findings of vulnerability and impact assessments to prioritize actions to help mitigate their impacts on people, the economy and the environment. It appears at the moment there has been little work in this area for Lake Urmia. TMU has developed a water allocation model for periods of drought as well as more normal conditions. These are not currently used or widely accepted as a decision-making tool. During periods of varying severity there is need for a plan to decide which users should reduce their consumption and by how much.

Watershed management

Consultations with the Natural Resources Departments of East Azerbaijan and West Azerbaijan show an established practice of building different check dams and other conservation efforts. In the headwaters, there are many protective structures and biological activities to control the erosion problem. Some structures were built over the past 20 years and proved to be very effective including those that stabilized landslides. There were also efforts to protect against major floods.

Based on field missions and consultations with local staff, several key issues emerged as important considerations for watershed management in relation to the restoration of Lake Urmia. The issues are: a) upland or headwater issues; b) agricultural activities in mid-sections of the watersheds; c) urban issues; d) lowland issues around the lake; e) collaboration and integration between government agencies; and f) data gaps**.** Each is discussed below.

a) *Upland or headwater issues*. Marls and shale materials dominate the geology of the watershed and are some of the most fragile rocks, highly prone to erosion. Two processes exacerbate the erosion problem. Very high livestock density has led to overgrazing and agricultural expansion of wheat, barley and potatoes in narrow and long fields. Reduced livestock density will restore plant cover while planting hedgerows (shrubs planted along contour strips) is an option to minimize erosion and provide additional fodder for livestock. The long, narrow wheat and barley fields in the upland area are ploughed in a downstream direction. While it is somewhat difficult to conduct contour ploughing because the fields are so narrow, some terracing or building soil interception mounds is needed across the slopes (every 10-20 m). This will significantly reduce erosion in such fields. The Natural Resources Department has initiated a large number of check dams and biological measures to solve the sediment problem but much more effort is needed to address erosion in the upland agricultural fields.

b) *Agricultural activities in the mid-section of the watershed*. One of the most striking observations made during the field missions is the presence of a vast amount of apples for bulk purchase on side roads. Most become compost because no processing facilities appear to be available for value added production such as apple juice or dried apples. Since apples require a lot of water to grow, a moratorium on apple expansion would be welcome from the perspective of water in the lake. Moreover, older apple orchards could be removed as they become less productive.

c) *Urban issues***.** Five million people live in the basin and according to information provided by our Iranian partners the average daily water consumption is around 220 litres per person per day. The average water consumption in many urban areas (particularly in Europe) with efficient water management practices is about 150 litres per person per day. The urban population needs to be part of the solution for the lake. Hence, there is need for a public education programme to reduce urban water consumption. Some initiatives like reducing water pressure within the system, initiating a low flush toilet rebate programme and installing water saving devices in all new houses could assist in maintaining water levels in the lake.

d) *Lowland issues around the lake*. There are extensive wetlands around the lake that have been impacted by agricultural expansion (cultivation and grazing). They need better protection and restoration efforts, because wetlands provide an excellent water storage and purification system that will help the lake's recovery**.**

e) *Collaboration between government agencies and integration***.** While technical capacity is well developed, collaboration between government departments appears to be lacking. The NRD staff only work in the headwaters but should also be able to work in the agricultural area. A joint effort by all responsible agencies is needed to initiate a collaborative plan. It appears

ULRP has been given the task to take the lead, to promote collaboration and integration and to implement an action plan**.**

f) *Data gaps.* There are two major data gaps that need close attention: Land use change information and groundwater information.

Land use change information. – There were many observation that agricultural expansion has been rapid over the past 10 years but little quantitative information is available. A rapid land use classification of the current and past agricultural situation could easily be made using satellite imagery. This would provide clear information on where in the basin the different agricultural activities have increased the most and thus help in selecting case study sub-basins for detailed work. We need a rough estimate in hectares of the land area under different crops in the basin (apples, wheat, barley, potatoes, grapes etc.). This will help us estimate how much water is used for all the various crops and to set priorities for different actions.

A lot of geographical information system (GIS) data is available and combining land classification with soil, climate, and land stability information will greatly facilitate the selection of test catchments. GIS is an ideal platform for data integration and could become the initial collaboration tool.

Groundwater – There seems to be considerable disagreement among experts on the groundwater contribution to the lake with an apparent lack of usage information for agriculture. Steps should be taken to identify and map key aquifers, produce an inventory of groundwater wells, provide estimates of groundwater use, determine if extractions rates are in balance with recharge rates, and conduct research to determine where groundwater-surface water interactions are taking place within the watershed. This is critical information because during drought periods one of the few options is reliance on groundwater.

Socio-economics, livelihoods and governance

The ULRP objective to reduce water use in agriculture by 40 percent is likely to have significant livelihood implications for farmers, rural households and communities within the Lake Urmia Basin. A key question for farmers is how to promote alternative livelihoods and income sources that require less water. This means changes to current farming practices (cropping and irrigation), improving the economic added value of current agricultural output, through markets, as well as finding alternative income sources outside agriculture. These livelihood options require not only more efficient water management, improved cropping practices, but also better markets and appropriate policies and governance structures to steer the transformation towards the desired objectives.

Reliance on irrigation for crop production in Lake Urmia. Since the 1990s, irrigated agriculture expanded significantly with government encouragement and increased availability of water following huge infrastructure investments in water systems. Farmers converted thousands of hectares of rain-fed areas into irrigated land – largely by planting fruit trees and converting farms into orchards, often before they received water allocation permits or a statement of rights. As a result of these changes, farmers became increasingly dependent on irrigation water for agriculture and their livelihood.

Consultations with farmers during field missions revealed they are increasingly aware of water scarcity and the dire predicament of Lake Urmia. But implementing conservation options is not easy given their dependence on irrigation water for agricultural production. Approaches differ among stakeholders. Some accept the need to change crops, others focus on working within existing cropping systems, while others emphasise expanding job opportunities in agro-processing and even beyond agriculture into tourism, salt extraction, Artemia and algae extraction.

As part of the Lake Urmia restoration efforts, the government began recently to encourage a shift towards certain crops and to discourage others, including banning conversion of farm lands into orchards. Still there are several constraints that require resolution to ensure more effective and permanent measures that can contribute to the lake's restoration. First, water is allocated by cultivation area rather than the actual needs of the crop. This encourages overuse and hence waste of irrigation water. Discussions with farmers reveal that currently they pay a water fee at the start of the season based on predetermined allocation rights but without taking into account the actual amount used. Farmers receiving water in their fields consume as much as possible, irrespective of actual crop needs. When crops need water and irrigation water is not available, they drill underground wells, whether legal or illegal. In downstream areas with a reduced allocation, farmers pump water from the nearby river (environment entitlement) into irrigation channels.

The second challenge facing current Lake Urmia restoration initiatives is the limited coordination between the three core water system pillars: distribution management, distribution structures, and farm level water use. Water distribution is decided centrally (top-down) based on general inquiries. The distribution structures would be more efficient if proper gauges were used. Likewise, the absence of input from farmers in determining water needs as regards timing can help improve water efficiency, cut overuse and reduce illegal wells, illegal pumping and other extra water withdrawals.

Beyond production: harnessing markets for improved livelihoods under water scarcity.
Improving livelihoods under the Lake Urmia restoration programme requires not only shifting from crops that need a lot of water to those that need less, but also addressing existing market failures, developing new markets, improving value addition and tapping into unexplored trade opportunities. New trade options imply exploring the potential shift from agriculture or agro-based activities to manufacturing, and developing non-agricultural income generating activities within the Lake Urmia Basin economy.

While the field visits during the missions did not allow for an in-depth assessment of the market failures within the dominant value chains (apart from the visible oversupply of unsold apples on side roads), several consultants offered a good first approximation of the challenges and opportunities for exports and trade from East and West Azerbaijan provinces in particular. The Lake Urmia Basin region produces a range of high quality products, including fruits, with great trade and export potential and there is relatively high export readiness in terms of both product quality and trade infrastructure (e.g. certification and customs procedures). At the same time, there is a noticeable absence of trade and export orientation, market awareness or knowledge about trading in general, due in part to the general policy orientation in which the production choices may be based on internal use or consumption as a priority. Another likely constraint is the negative political environment facing Iran coupled with the effects of trade sanctions which create higher risks and depress investment opportunities.

Overall the rapid assessment of markets and trade reveal a significant under-developed export potential, with strong interest in trade opportunities and learning how to develop them. In the context of the lake's restoration, there is particular interest in exploring the export potential for products in and outside agriculture linked to water saving. More analysis is required to validate early insights on the trade obstacles and constraints facing exporters, such as payment difficulties (bank transactions), inadequate packaging facilities and refrigerated vehicles to meet international standards, unfavourable market access conditions for Iran (sanctions and tariffs), trade regulations and trans-border trade. Given the link between water conservation and trade, it is important to look beyond agriculture and include manufacturing to prepare a coherent trade development strategy that can play to Iran's comparative advantage while at the same time guarding against creating perverse incentives to produce more and hence consume more scarce water. Switching from agrobased income sources to manufacturing may need to be tested empirically.

Enabling environment for livelihood options: role of policy and governance. Livelihood options and changes to agricultural production, markets and trade developments including outside agriculture, require a closer look at policy, institutional and governance structure. They also need appropriate policies and initiatives that will support the required socio-ecological transformation.

Developing livelihood options in the context of Lake Urmia's restoration is a multi-stakeholder process that requires solid, rigorous and agreed quantitative indicators and milestones. It also requires appropriate governance to ensure inclusive decision-making processes and assurances that any solutions have buy in and support from all stakeholders if we are to achieve a sustainable and quantifiable restoration of the lake.

As a first step, this requires mapping out the policies and regulations in place, the institutions mandated to enforce them and to identify possible opportunities for better synergies and improved coordination. There is also recognition that national policies and regulations may need to be revisited or altered to encourage the necessary changes in agriculture. But such policy dialogue will need some baseline data at the farm level that is representative of the whole basin.

Putting it together: FAO socio-ecological system approach to the restoration of Lake Urmia (underlying theory of change)

The theory of change underlying the approach to the FAO project is to apply an integrated socio-ecological framework to the restoration of Lake Urmia. The transition from rapid assessment to pilot/interventions phase requires an integrated framework based on the underlying assumption that restoration requires a socio-ecological approach. The framework's starting point is the overall project goal: reducing water consumption in agriculture by 40 percent over a four-year period. The new project approach is based on awareness that the Lake Urmia problem is a socio-ecological one and therefore both the biophysical and the socio-economic aspects must be considered in any technical proposals to reduce water consumption. Any viable solution needs to be economically, socially and institutionally acceptable.

The structure of the SES (socio-ecological system) framework adopted here is taken from Ostrom (2005, 2007) and is described briefly through six distinct criteria:

1. Specific policy problem or defined-goal requiring assessment/action (with trade-offs);
2. Defined geographical unit (landscape, geographic territory, specific agro-ecological zone);
3. Targeted set of agricultural/food subsystems within the defined geographical unit;
4. Explicit ecological /biophysical subsystem (covering either climate, land, or water or a combination of all three);
5. Explicit socio-economic subsystem (farms, households, markets, institutions);
6. Analysis of governance issues (at appropriate scale);

The narrative describing each of these criteria is presented in Table 1 below.

Table 1. A short summary of a socio-ecological framework for the Lake Urmia Basin

Key criteria for SES framework	**How these criteria apply to Lake Urmia**
Specific policy problem or defined goal requiring assessment/action (with trade-offs)	• National determination to save Lake Urmia from drying up and reverse the process through measures that ensure stabilization of water inflows and then progressive restoration of previous water levels
	• Restore Lake Urmia over a number of years and sustain the economic livelihood of the population living within the basin or who are dependent on the basin
	• Implement the national programme that calls for a progressive reduction of aggregate water allocation to irrigation around the basin (by 40 percent over a five year period) while providing alternative livelihood options for the affected populations and ensuring acceptance by the local population (especially farmers) and ready participation in the national programme coordinated by ULRP
Defined geographical unit (landscape, geographic territory, specific agro-ecological zone)	• Lake Urmia Basin (52 000 km^2) – a well-defined closed basin with a network of rivers flowing towards the lake from elevated headwaters, some of which are forested

Targeted set of agricultural/food subsystems within the defined geographical unit	• Irrigated orchards and crops; rainfed crops; livestock systems within rangelands; and derived agrifood and processed industries within the Lake Urmia Basin area (or shipped to rest of Iran and beyond)
Explicit ecological /biophysical subsystem (covering either climate, land, or water or a combination of all three)	Critical parameters of the biophysical system include:
	• Climate parameters: precipitations (whose level affects water inflow into the lake and the amount of groundwater extracted); temperature (affecting ET and crop water demand);
	• Water – hydrology and a network of water management (both surface and groundwater) affect water inflow into Lake Urmia;
	• Land use (irrigated orchards, irrigated crops, rainfed crops, rangeland for animal grazing, wetlands) affect water use levels; land quality (determines water filtration rates and affects water hydrological cycle within the lake including links between the lake and groundwater;
	• Interactions and feedbacks between the parameters of the biophysical system (creating a climate-land and water nexus);
Explicit socio-economic subsystem (farms; households, markets; institutions)	• Socio-economic subsystem made up of agents (needs and capabilities) and resources (technology and management) and institutions (rules, policies and governance structures);
	• Relevant system agents (main stakeholders in Lake Urmia Basin): ministries and departments; provincial governments and departments; farmers and rural households (including farmers' and women's associations); private sector actors (including producers, traders, processors) in markets and value chains, service providers including banking, input suppliers, extension agents
	• Farms - basic socio-economic units for land, water and crop/animal management (technical and economic efficiency; crop/land/water productivity; farms are the basic unit for analyzing interventions (like changing cropping patterns and irrigation practices; addressing input use and technology in production and post-production), economic unit of analysis for restoration of the lake requires measures and interventions at the farm and household level linked to crop, livestock, land and water management

	• Households - basic socio-economic unit that provide labour, assets, knowledge and management of resource units (land, water and crops/animals); household analysis is key to understand the income dynamics, including diversification options with limited irrigation possibilities
	• Markets - multi-agent socio-economic unit – linked to households (via exchange of goods, including food, and farm inputs) which in turn are linked to farms (through an exchange of labour, assets/tools, know-how or management in exchange for products, including food); markets are units where exchange takes place between producers (farmers) and traders including foreigners (trade)
Analysis of governance issues (at appropriate scale)	• Governance structure defines policies and institutions that regulate Lake Urmia – governance is invoked when multiple institutions or agencies need to coordinate policies, rules or management decisions
	• Critical governance issues requiring special attention for Lake Urmia restoration include: (i) drought management; (ii) water distribution, allocation; (iii) water irrigation management including groundwater use; (iv) integrated watershed management; (v) producer organizations, farmer cooperatives, water users' associations, private sector agents and local authorities need to form multi-stakeholder structures to manage water resources that benefit Lake Urmia, to ensure sustainable management of land and water, generate economic value added and equitably shared and support incomes and livelihoods.

The key components of the FAO project cover different aspects of the above socio-ecological framework. The full project cycle has three distinct stages:

(1) Rapid assessment phase to evaluate the different components individually and develop data and information needs along distinct disciplinary lines: hydrology, agronomy, climate science, socio-economics of households, markets and trade analyses and policies and institutional analyses. The assessment of individual components, the baseline data produced and methodologies developed within a broad multi-disciplinary framework while defining the component requirements: data, methodologies and indicators.

(2) Scenario development and pilot level interventions is the stage that enacts the integration of the different components. At this stage we move into integration of different layers of data, information and analyses and use multi-stakeholder participatory approaches (like multiple-criteria decision methods), to design and implement site-specific interventions, and to measure their outcomes. This stage combines qualitative and quantitative

approaches and places greater weight on the coordination and governance involving multiple stakeholders. The aim is to highlight the linkages between the different components of the socio-ecological framework, to make them more explicit and implement them in a coordinated way. The pilot level interventions should have measurable outcomes in terms of changes to water inflows into the lake as well as a neutral impact on farmers and household incomes and livelihood, to be defined by measuring socio-economic indicators before and after.

(3) Impact assessment at the pilot site level, to measure a select set of indicators that evaluate the impact of the pilot interventions, especially on changes in water inflows to the lake but also other critical livelihood parameters. If successful, the pilot interventions will also be evaluated for replication and scalability and application to other Lake Urmia Basin sites.

5. DETAILED WORKPLAN

COMPONENT 1: WATER ACCOUNTING

Output description in project document: *An advanced water-accounting system for the entire Lake Urmia Basin*

Activities

Water accounting plus (WA+) uses remote sensing data to monitor water consumption. It employs maps of evapotranspiration, land-use/land cover (cropland, rangeland, bare, forest, urban, water) and precipitation produced with remotely-sensed images. WA+ can be applied at different scales from the basin and irrigation schemes to farm and landholding. WA+ has many advantages including using data from open access databases and open source software to reduce the costs of upscaling. WA+ provides a strong information base at a specific time and again after implementing water-saving interventions. The measured differences indicate whether the interventions are effective. With WA+ in place, the system will continue to monitor changes in water consumption. Implementing WA+ produces not only fact sheets and a prototype system but equally important, training for national analysts to integrate this approach into their work.

Water accounting activities until the end of June 2018 will aim to: 1) inform pilot site and intervention selection; and 2) complete and present a prototype WA+ system that covers the entire Lake Urmia Basin. From July 2018, the focus will be on: 1) monitoring water use in pilot areas; 2) assessing real water saving from project interventions; 3) assessing the contribution of pilot activities to increase the flow in streams; 4) connecting field/pilot level water accounts to those of the sub-basin and basin to understand the potential gains of upscaling pilot activities in terms of lake inflow; 5) support local stakeholders to improve and adjust water accounting systems to their needs, if necessary. The FAO Task Force (TF) plans to complete a rapid assessment by the end of March 2018 and the pilot selection by the end of June 2018.

BASIN-WIDE ACTIVITIES

Activity 1.1A – Land use mapping

- FAO will engage formally with Tabriz University researchers and provide technical support to produce a land use map for the whole of the Lake Urmia Basin.
- As part of the agreement with Tabriz University:
  - Land use mapping exercise will cover: (1) land use classification; (2) land use field validation;
  - Field validation data gathering from existing studies and/or cadastral maps by the end of January 2018;
  - Production of land use map and confusion matrix by Tabriz University staff by the end of March 2018.

Activity 1.1B – Remote sensing training for land use cover (provided by FAO)

- FAO will provide technical support via a training workshop to Tabriz University staff on advanced remote sensing techniques.

Activity 1.2 – Evapotranspiration maps (ET)

- FAO will partner with IHE Delft Institute of Water Education for the production of an initial 250m resolution ET map for a year by the end of April 2018.
- Selection of sub-basins for simple calibration by the end of April 2018.
- Data collection on groundwater storage change and stream flow for calibration sites by the end of April 2018.
- ET map calibration with water balance approach for the sub-basin(s), using ET as a residual value, by the end of April 2018.

Activity 1.3A – Water accounting

- Calculation of ET for each land use type by the end of April 2018.
- Production of a basic WA+ package, including some model outputs regarding water use by the end of April 2018. (Note: Calibration of some of the models/algorithms used in this package may take place later through data collection during the pilot project implementation.)
- Additional analysis for pilot site selection in January–May 2018, if necessary.

Activity 1.3B – Water accounting training

- Training on GIS and coding for water accounting by the end of March 2018. This training will be at least four days and have 15 or fewer participants who should have experience in coding and GIS. Potential participants are qualified staff from the Ministry of Energy, Ministry of Jihad Agriculture, ULRP, and Meteorological Organization. Young professors, post-doctoral researchers and graduate students should also be invited

- Training for interpretation of water accounting products in late spring/early summer 2018. This training may invite a wider range of stakeholders than the technical training described above.
- Needs assessment for additional training in April-June 2018.

PILOT-SITE ACTIVITIES:

After the pilot selection phase, the TF will conduct the following activities.

Activity 1.4 – Land use mapping (pilot site level)

- Land use mapping of the pilot sites with more land use classes than the basin scale map (maximum three pilot sites);
- Additional field data collection and better land use classification accuracy if necessary.

Activity 1.5 – Evapotranspiration maps (pilot site level)

- Remote-sensing based ET mapping for the pilot sites with 30 m resolution;
- Field measurement of ET at the pilot sites. TF will likely employ weather stations equipped with infra-red sensor;
- Calibration/validation of satellite-based ET map using the field-collected ET data.

Activity 1.6 – Water Accounting (pilot site level)

- Impact assessment of reduction in use of water and "real water saving" for the pilot sites;
- Water accounting of fields and pilot sites;
- Calibration/validation of the pilot-scale and basin-scale WA systems using field-collected data;
- Connecting field/pilot level water accounts to those of sub-basin and basin to understand the potential gains of upscaling pilot activities in terms of inflow to the lake;
- Additional groundwater and surface water data collection for the pilot sites if existing monitoring network is not sufficient;

- Addition of functions to the pilot- and/or basin-scale WA systems depending on local needs and technical and financial feasibility. Potential additional functions include, but are not limited to, linking the decision support system/models/algorithms produced by other groups, production of a drought-related index and water productivity analysis.

Activity 1.7 – Water accounting training tailored for pilot sites (delivered as needed)

The contents here will be finalized after training needs assessment in April-June 2018.

- Training on pySEBAL to produce high resolution ET maps;
- Training on additional functions mentioned above if needed and where technically and financially feasible;
- If governmental organizations want training for their staff, participants in the technical training may become trainers. TF may assist and advise trainers to ensure proper knowledge transfer.

Implementation and partnerships:
- FAO
- IHE Delft (water accounting)
- Tabriz University (land use mapping; capacity development)
- Urmia University (water accounting; capacity development)

COMPONENT 2: DROUGHT MANAGEMENT

Output description in project document: *A drought management system based on a risk/vulnerability assessment and preparedness response for the Lake Urmia Basin*

Activities

Activity 2.1 – Development of a monitoring system for drought management in the basin
- Review the work undertaken to date;
- Collect climate data – past/projected temperatures; past/projected precipitation trends to determine variations in the amount of water saved by agricultural activity based on different rates of temperature increases;
- Organize a workshop with experts, assess needs, suitability and modalities to produce a combined drought index (CDI) map for Lake Urmia Basin produced by trained specialists;
- Develop a drought monitoring development plan for Lake Urmia through a multi-stakeholder workshop;
- With the CDI in place, outputs should be validated through a multi-stakeholder group from relevant government departments concerned with drought monitoring, drought assessment and response;

- The agreed map system will be generated periodically and form the basis of a drought management planning proposal.

Activity 2.2 – Establishment of a stakeholder team to address vulnerability and impact assessment

- Assemble a team of experts (national and international) to develop an implementation plan for the vulnerability/impact assessment;
- Identify data needs;
- Carry out a vulnerability impact assessment (6 months);
- Make regular conference calls between national and international experts with periodic face to face meetings to support the work;
- The findings will contribute important insights to the drought management planning proposal.

Activity 2.3 – Establishment of the management and operational unit and related governance to control drought in the basin

- Support multi-ministerial/provincial technical meetings to develop and validate composite drought index outputs, review drought plans for the basin and advise a higher-level committee on drought to include representatives of the three provinces as well as key sectors, ministries and agencies;
- Review current plans, laws, policies and governance systems related to drought management, study to be carried out by national experts supported by their international counterparts. The report on drought management will serve as basis to review the current system against best national practice in four key areas: (i) drought laws; (ii) drought declaration and planned actions; (iii) drought governance; and (iv) technical solutions. Starting from the current situation, suggested improvements to the system will take into account the findings of the vulnerability and impact assessment.

Implementation and partnerships (component 2):

- FAO in coordination with ULRP
- ICBA, international expertise on drought issues
- Proposed national agencies to be involved in drought monitoring, management and governance, to be validated by ULRP:
    - IRIMO
    - Ministry of Agriculture and FRWO
    - Ministry of Energy and provincial water authorities
    - Ministry of the Environment
    - Representatives of three provincial governments linked to Lake Urmia
    - Mashhad Climate Centre
    - University departments with relevant expertise in drought management and related fields: Modares University and universities near the lake: Tabriz and Urmia
    - Others

COMPONENT 3: LIVELIHOOD

Output description in project document: *A socio-economic livelihood programme with viable and sustainable alternatives to current agricultural activities upstream of the lake to reduce water consumption significantly*

Activities: The socio-economic and livelihood related activities to be operationally designed and carried out fall under three distinct headings: (i) farm and households; (ii) markets; and (iii) institutions, covering also policies and governance considerations.

Activity 3.1 – Generate a socio-economic and livelihood baseline for farms/households in the Lake Urmia basin

A farm-household survey was prepared and designed to collect the following information. Representing the whole basin including all the different localities and sub-basins the survey used a socio-economic baseline for a systematic farm-household analysis of a representative sample of the Lake Urmia farm/household population covering:

- household information such as assets, labour allocation and employment;
- farming practices including crops, orchards and livestock and on-farm agro-based activities;
- water resource management, irrigation techniques and cropping trends under increased water scarcity and reduced water allocation;
- agricultural and agri-food markets including supply chains, market efficiency, price, value addition, market risks and potential for income and employment from agro-processing, trade and value chain developments;
- market, price and climate risks facing farmers and households within the basin and approaches to coping with drought, floods and related risks.

Activity 3.2A – Markets and supply chain situation analysis for Lake Urmia Basin

- Collect, compile, translate and analyze production, consumption, exports and imports data at detailed homogenized system (HS) level for major agricultural and non-agricultural products produced, imported and exported from Lake Urmia Basin.
- Identify commodities currently grown or suitable for the basin, with: (i) high and low water requirements for unit production; (ii) high and low economic water efficiency (production/unit of water used); and (iii) high and low value added potential through agro-processing, marketing and trade.

Activity 3.2B – Analysis of trade potential for selected products in Lake Urmia basin

- Analyze the trade potential for crops with high water use efficiency per unit of production, high water productivity and high value addition potential.
- Analyze trade potential for the Lake Urmia Basin for key agricultural, non-agricultural farm products and locally manufactured goods and evaluate destinations (exports) and suppliers (imports) with high growth potential.

- Conduct a market/value chain profile analysis for selected commodities with high export potential and/or high water economic efficiency via face-to-face interviews with exporters, producers, and other value chain actors.

Activity 3.2C – Capacity development in markets and trade, producers, exporters and policy:

- **Trade-related training workshops** to raise business capacity for trade (exporters) and for marketing (producer cooperatives); training to cover basic trade concepts (tariffs, rules of origin, non-tariff measures etc.); how to identify attractive markets through basic trade analysis; and market profiling that focuses on the target market;
- **Missions and foreign trips** to potential markets in neighboring countries to learn about trade procedures and acquire best practices for marketing and trade;
- **Trade policy workshops** to analyze and identify critical policy, regulatory and other constraints to marketing and trade, including incentives/disincentives to trade and marketing.

Activity 3.3A – Policy and institutional mapping study

A policy and institutional mapping analysis is required as a prerequisite to evaluate policies that facilitate adoption of effective Lake Urmia restoration actions. This analysis should cover:

- Water policies, water rights, and water governance issues including coordination between ministries and provincial departments;
- Land policies, including regulations on land tenure as well as restrictions on land use and crop management;
- Drought monitoring, flood management, disaster and other interventions, including governance and coordination issues across government agencies;
- Trade policies, export and import regulations, incentives and disincentives, including investments;
- Food and nutrition policies, including subsidies and investment incentives for production, agro-processing and marketing including food price policies and price regulations;
- Policy and institutional mapping also covers producer organizations (cooperatives), water user associations and women's associations and their priority areas for institutional capacity development.

Activity 3.3B – Policy analysis, institutional reforms and governance linked to Lake Urmia restoration

- Policy analysis should identify the institutions mandated to enforce reforms, evaluate the synergies and tradeoffs between different policy objectives and determine which policies need to be promoted to facilitate restoration of Lake Urmia and which should be revised.
- The aim of the policy and institutional analysis is to prepare recommendations on ways to improve governance and coordination between the relevant institutions (national, provincial and local) concerned with restoration of the lake, including institutions involved in water resource management, agriculture and land use (crops, orchards and

livestock), climate, drought and flood management, watershed management, food security, income security and employment, agro-processing and value chain development and trade.

Activity 3.4A – Scenario development at pilot sites using multi-criteria decision analysis

Note: *The pilot stage phase could include up to three main sites in three contrasting locations within the basin. Possible examples, yet to be finalised, are: (i) Mahabad area; (ii) Zarineh Rood; and (iii) AjiChai sub-basin.*

For each pilot site area, organize multi-stakeholder validation workshops:

- To present and discuss with a variety of local stakeholders the findings from the WA, drought vulnerability assessment, watershed management, and livelihood results (household, market and governance);
- Multi-stakeholder meetings using multi-criteria decision analysis methods to prepare several alternative action plan scenarios suitable to the pilot site and subject to weighting by all key stakeholders in relation to a 40 percent reduction in water consumption by agriculture.

Activity 3.4B – Capacity development and training workshops to support action plan implementation

- Provide specialized training for ministerial or provincial staff mandated to implement the pilot level interventions;
- Provide training for pilot-level producer cooperatives, livestock groups, women's groups or water user associations;
- Provide technical training in water balancing, water accounting, drought, watershed management and livelihood including trade to ministry or university staff mandated to monitor and measure the impact of the scenario actions on lake inflow changes.

Implementation and partnerships (component 3):

- FAO TF on livelihood in coordination with ULRP;
- Statistical Centre of Iran – support for field household survey;
- ITC Geneva – trade export potential; trade business capacity/training;
- Lake Urmia Basin universities, provincial government entities, various government and non-governmental stakeholders.

COMPONENT 4: WATERSHED MANAGEMENT

Output description in project document: *Integrated watershed management*

Activities

Basin-wide activities

Activity 4.1 – Integrate watershed management issues into socio-economic assessment

- ***Farm-household survey:***

  - Headwater areas: cropping practices, including field ploughing techniques and terracing, aimed at controlling/reducing erosion;
  - Headwater areas: irrigation practices for crops behind check dams;
  - Analyze livestock grazing, density and socio-economics and livelihoods for livestock systems and explore options for reducing those densities;

- ***Market and supply chain analysis:***

  - Market analysis for major fruit crops;
  - Food supply chains, including processing, marketing and food loss (imputed water loss through food chains).

- ***Policy and institutional mapping and analysis:***

  - Crop land use options and policies including retirement of old orchards; implications for water saving/inflows into Lake Urmia;
  - Compilation of statistical data on areas under different crops/orchards; analysis of water consumption for different crops to help prioritize different actions (pilot stage)

Activity 4.2 – Assessment of non-agriculture water saving options within Lake Urmia basin

- ***Urban water use* –** Survey of urban households, firms and businesses to quantify water consumption and explore options for urban water saving options, especially major cities within the basin;

- ***Other technical options for water diversion to Lake Urmia* –** Explore the feasibility of pipelines that divert runoff water below the turbines and directs it to the lake; analyze the feasibility of pilot stormwater retention structures at selected sites;

- ***Examine the role of wetlands (lowlands) in restoration of the lake* –** Review existing studies on wetland conservation, restoration programmes and impacts on restoration of Lake Urmia.

Activity 4.3 – Groundwater study – Carry out a study on groundwater resources by mapping aquifers and a wells' inventory, groundwater use, extraction versus recharge rates and groundwater and surface water interactions; critical information for drought management.

Activity 4.4 – GIS-data system for Lake Urmia – To integrate GIS data with other layered data including land use, soil, climate and other biophysical and socio-economic parameters.

Pilot site phase

Activity 4.5 – Scenario design workshops – Application of integrated watershed management principles and use of baseline data and information from rapid assessment phase to identify and design agricultural and non-agricultural water saving interventions using multi-stakeholder participatory processes.

Activity 4.6 – Analysis of payments for environmental services in headwaters and mid-altitude agricultural areas where orchards dominate.

Implementation and partnerships (component 4):

- FAO in coordination with ULRP
- International expertise: Hanspeter Schreier
- National research partners: Urmia University, Tabriz University
- National stakeholders: FRWO, provincial natural resource departments, others

6. WORKPLAN TIMELINE AND SCHEDULE

Table 2. Workplan projected timeline per activity (up to end of 2019)

Category	Actions	2017			2018												2019												2020					
		10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
		RAPID ASSESSMENT						PILOT SELECTION-SCENARIO DESIGN			PILOT INTERVENTIONS STAGE																		PROJECT IMPACT ASSESSMENT					
WATER ACCOUNTING	**BASIN-WIDE ACTIVITIES**																																	
	Activity 1.1A Land use mapping																																	
	Activity 1.1B. Land use training																																	
	Activity 1.2 – ET maps																																	
	Activity 1.3 Water Accounting																																	
	Activity 1.3A- WA training																																	
	PILOT-SITE ACTIVITIES:																																	
	Activity 1.4 - Land use mapping																																	
	Activity 1.5 – 30 meter ET maps																																	
	Activity 1.6 - Water Accounting																																	
	Activity 1.7 - WA training																																	
DROUGHT	Activity 2.1 Drought monitoring																																	
	Activity 2.2 Drought vulnerability																																	
	Activity 2.3 Drought governance																																	
LIVELIHOOD	Activity 3.1 Farm-HH survey																																	
	Activity 3.2A. Market situation																																	
	Activity 3.2B. Trade potential																																	
	Activity 3.2C. Trade training/CD																																	
	Activity 3.3A. Policy mapping																																	
	Activity 3.3B. Water governance																																	
	Activity 3.4A. Scenario design																																	
	Activity 3.4B. Livelihood CD																																	
WATERSHED MANAGEMENT	**BASIN-WIDE ACTIVITIES:**																																	
	Activity 4.1 – WM and livelihood																																	
	Activity 4.2 – Urban water saving																																	
	Activity 4.3 Groundwater study																																	
	Activity 4.4 – GIS-data system																																	
	PILOT PHASE																																	
	Activity 4.5 – Scenario workshops																																	
	Activity 4.6: PES options																																	
TRAINING and CD	Activity 1.1B. Land use training																																	
	Activity 1.3A & 1.7 - WA training																																	
	Activity 3.2C. Trade training/CD																																	
	Activity 3.4B. Livelihood CD																																	
	Cross-cutting CD																																	

ANNEXES

Annex 1. Secondary data, reports and maps on Lake Urmia Basin: status of compilation, review and translations

In addition to the field visits by the project task force of specialists, the rapid assessment also covered the collection and review of available data sources covering the various project components. The data collection and partial translations were handled by the national project support staff under the guidance of the FAO project task force. However, to date the bulk of the relevant reports, maps and data sources are in Farsi awaiting translations into English as necessary.

For the purposes of this project, the required secondary data include:

- Land use
- Hydrologic and climatic data such as precipitation, ET, flow and groundwater table
- Water infrastructure data including dams, gauges, canals and measurements from them
- Water use/demand data such as reservoir releases, water allocation, sectoral demand
- Soil type, soil quality, and land cover data
- Farming practices related to crops, livestock, water irrigation, among others
- Farm economics, including labor and other input use, technologies, and prices
- Socio-economic data such as household assets, employment, education, rural and urban populations, and institutions related to agriculture and water management
- Data on trade and markets, including trade regulations and policies
- Policy information related to the agriculture and food, land, and water.

Some biophysical data such as flows from dams, stream flows, and groundwater elevations, were already collected from government organizations with the help of project support staff. However, other critical data, known to exist, are not readily available or are of lower quality. The task force is continuing the efforts to access these data from the originating sources with ULRP assistance. Still critical data gaps were identified during the rapid assessment. In this case, the collection of such data was integrated within the workplan program. Examples include the collection of farm and household socio-economic data, detailed land use maps and water consumption at the plot level.

Annexe 2. List of meetings with all partners, organizations and agencies during the rapid assessment field missions, July and October 2017

Main Organization	Department Full Name	July 1-14	Oct 3-9	Oct 25-30
Chamber of Commerce, Industries, Mine and Agriculture (CCIMA)	Chamber of Commerce/Tehran	✓		
	Chamber of Commerce/Urmia	✓		
Department of Environment (DoE)	Department of Environment/Tehran	✓	✓	
	Department of Environment/Tabriz	✓		✓
	Department of Environment/Urmia	✓		✓
	Futurology Center of Lake Urmia	✓		
Forest, Rangeland and Watershed management Organization (FRWO)	FRWO	✓	✓	✓
	Natural Resource Department/Tabriz	✓	✓	✓
	Natural Resource Department/Urmia	✓	✓	✓
International Center for Agricultural Research in the Dry Areas (ICARDA)	ICARDA	✓	✓	
Islamic Republic of Iran Broadcasting (IRIB)	Islamic Republic of Iran Broadcasting	✓		
	Tabriz Radio	✓		
Management and Planning Organization (MPO)	Statistical Centre of Iran/Tehran (SCI)		✓	
	Management and Planning Organization/Tabriz	✓		
	Management and Planning Organization/Urmia	✓		
Ministry of Agriculture-Jahad (MAJ)	Agriculture Research, Education & Extension Organization (AREEO)	✓	✓	
	Ministry of Agriculture-Jahad (MAJ)	✓	✓	
	Agriculture and Natural Resource Research Centre/Tabriz			✓
	Agriculture and Natural Resource Research Centre/Urmia	✓	✓	
	Agriculture-Jahad/Tabriz	✓		✓
	Agriculture-Jahad/Urmia	✓	✓	✓
Ministry of Energy (MoE)	Ministry of Energy/Tehran	✓		
	Water Resource Management of Iran/Tehran	✓	✓	

	Regional Water Company of East Azerbaijan/Tabriz	✓		✓
	Regional Water Company of West Azerbaijan/Urmia	✓	✓	
Ministry of Industry, Mine and Trade (MIMT)	Institute for Trade Studies and Research,Tehran (ITSR)	✓		
	Ministry of Industries and Business, Policy and Planning Office/Tehran	✓		
	Ministry of Industries and Business, Statistics Centre/Tehran	✓		
	Ministry of Industry, Mines and Trade/Tehran	✓		
	Trade Promotion Organization of Iran/Tehran (TPO)	✓		
	Ministry of Industry, Mines and Trade/Urmia	✓		
Ministry of Interior Affairs (MEA)	Governor-General's Office of East Azerbaijan/Tabriz	✓		✓
	Governor-General's Office of West Azerbaijan/Urmia	✓		
	Islamic Council of Village/Tabriz	✓		
Ministry of Roads & Urban Development (MRUD)	Islamic Republic of Iran Meteorological Organization/Tehran (IRIMO)		✓	
	Islamic Republic of Iran Meteorological Organization/Tabriz (IRIMO)	✓		
Ministry of Science, Research and Technology Iran (MSRT)	Institute of Higher Education and Research in Planning and Management/Tehran	✓		
University of Amirkabir	University of Amirkabir /Tehran)	✓	✓	
University of Sharif	Research Institute for Science, Technology and Industry Policy/Tehran (RISTIP)	✓		
University of Tabriz	University of Tabriz	✓	✓	
University of Tarbiat Modares	University of Tarbiat Modares/Tehran	✓	✓	
University of Tehran	Natural Resources Faculty	✓	✓	
University of Urmia	University of Urmia	✓	✓	
Urmia Lake Restoration Programme National Committee (ULRPNC)	Urmia Lake Restoration Programme (Tehran-ULRP)	✓	✓	✓
	Urmia Lake Restoration Programme, Provincial Office (ULRP-Tabriz)	✓	✓	✓

	Urmia Lake Restoration Programme, Provincial Office (ULRP-Urmia)	✓	✓	
NGO	Urmia Lake Restoration Association/Tabriz			✓
	Agriculture Association/Tabriz	✓		
	Engineering Association/Tabriz	✓		
	House of Farmers/Tabriz	✓		
	House of Farmers/Urmia	✓	✓	
	Yekom Consulting Company/Tehran	✓	✓	

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