بسم الله الرحمن الرحیم

Looking Ahead, Lake Urmia Integrated Watershed Management with an Eye on Future Global Warming Impacts and Vulnerabilities

Lake Urmia Restoration Committee
Ministry of Energy of IRI
Bahram Taheri
bahramtaheri1011@yahoo.com

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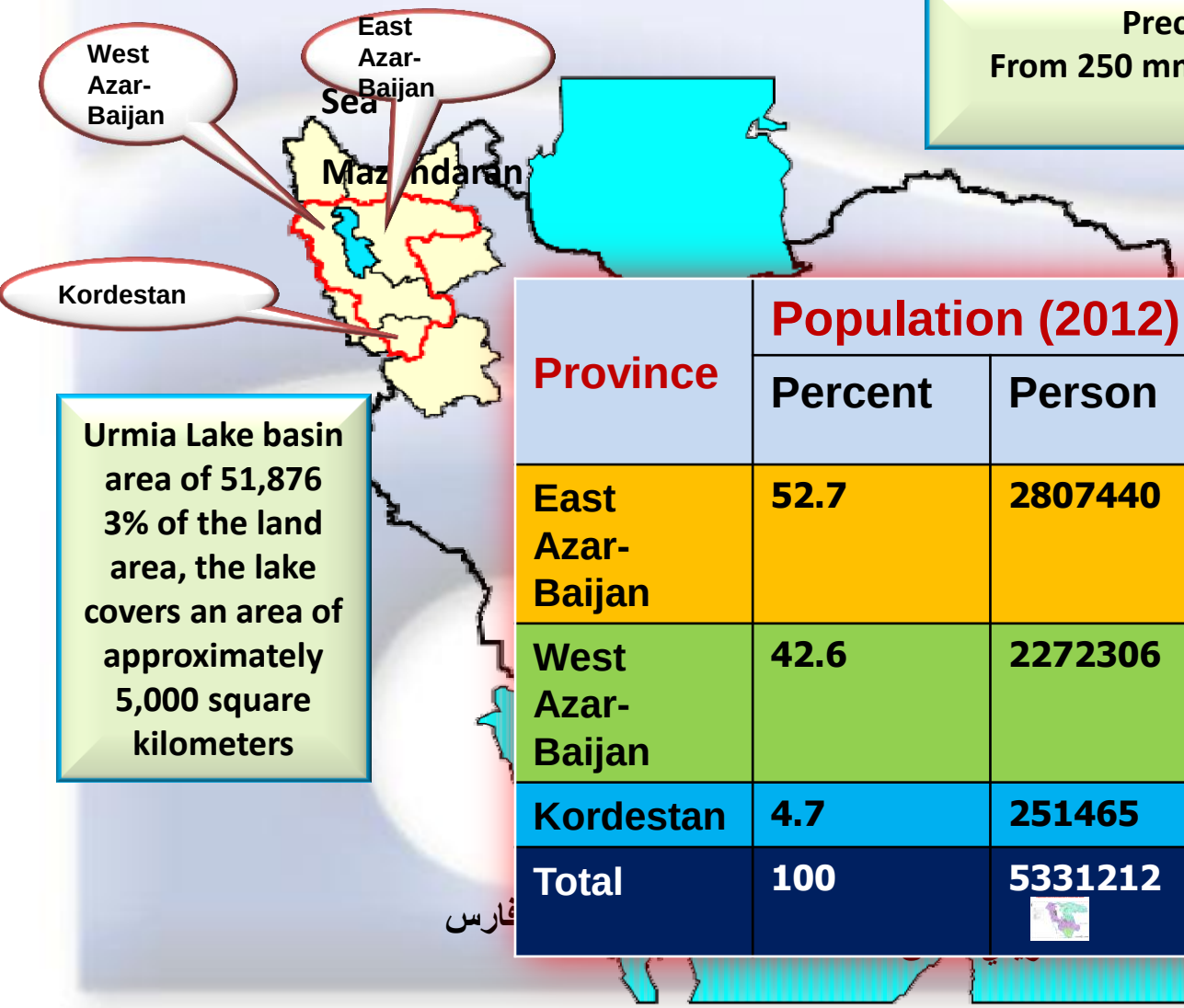
Session on "Caspian Region Environmental and Energy Studies"

Sub-basin no.1 Aji chi
Sub-basin no. 2 Sofi chi
Sub-basin no. 3 Zarineh Rood
Sub-basin no. 4 Simineh Rood
Sub-basin no. 5 Mahabad
Sub-basin no. 6 Gadar chi
Sub-basin no. 7 Nazloo chi
Sub-basin no. 8 Shahr chi
Sub-basin no. 9 Zola chi
Sub-basin no. 10 Barandooz
Sub-basin no. 11 Tasouj

Figure : The 6 main basins in Iran and the 11 sub-basins in Uromiyeh Lake basin

Beneficiary states of the basin of Lake Urmia



Precipitation in the basin:
From 250 mm to 1000 mm in the highlands areas

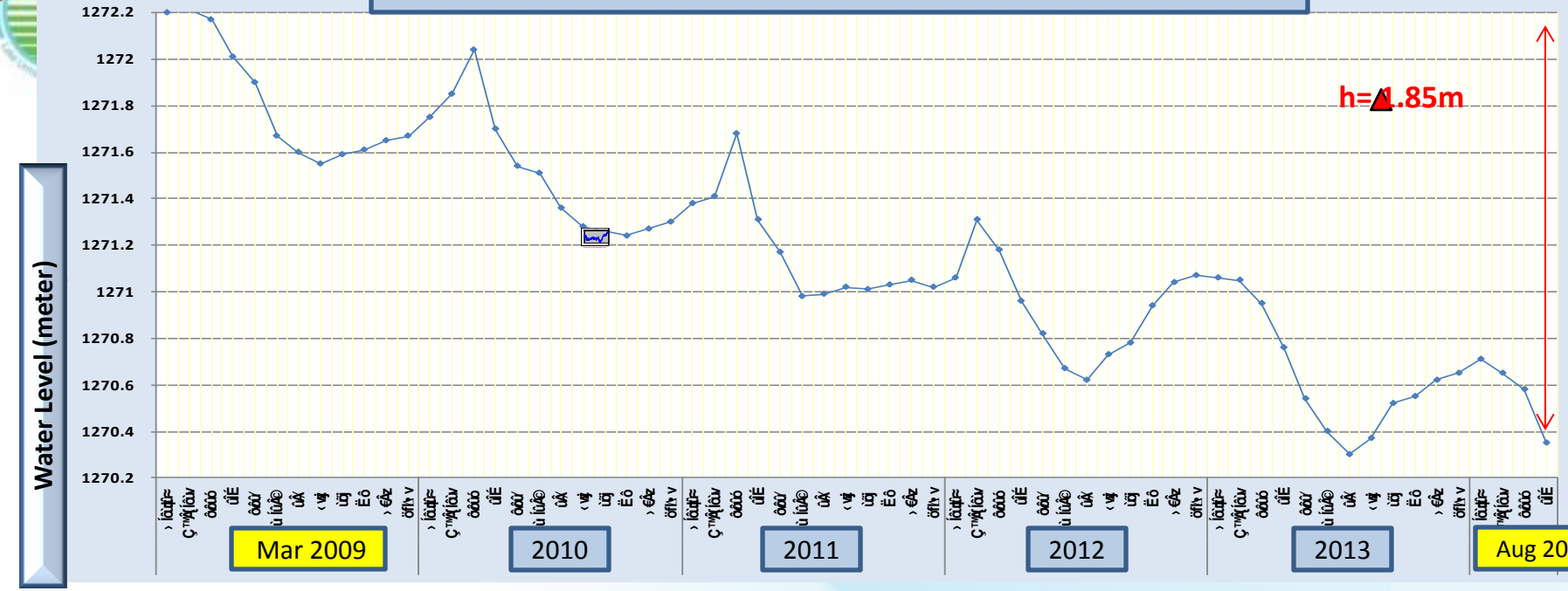
Urmia Lake basin area of 51,876 3% of the land area, the lake covers an area of approximately 5,000 square kilometers

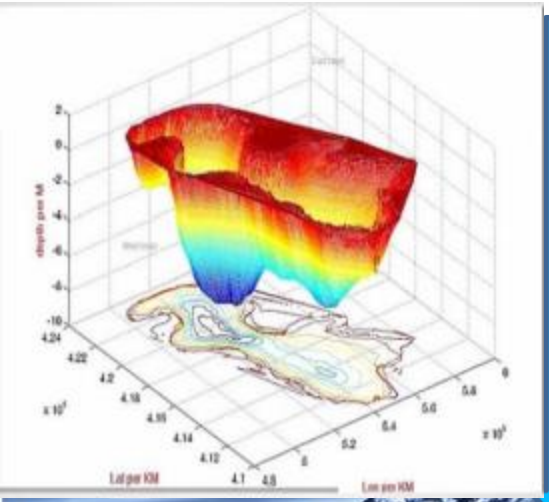
Province	Population (2012)		Area	
	Percent	Person	Percent	Km 2
East Azar-Baijan	52.7	2807440	42.7	20117.7
West Azar-Baijan	42.6	2272306	46.1	21701.6
Kordestan	4.7	251465	11.2	5284.9
Total	100	5331212	100	47104.2

Latest status of water resources (rainfall and runoff) in the basin of Lake Urmia

Parameters analyzed	Total catchment	Statistical period
Precipitation mm	**385**	Long-term average rainfall Year 1994-95
	317	Recent 18-year average 1995-96 to 2011-12
	-68	Difference
Runoff stations leading to Lake Urmia MCM	**4939**	Long-term average runoff year 1994-95
	2440	Average runoff in the past 18 years 1995-96 to 2011-12
	-2499	Difference
	50% reduction in runoff, 17.6% reduction in rainfall	

water level fluctuations in the Lake





Urmia Lake

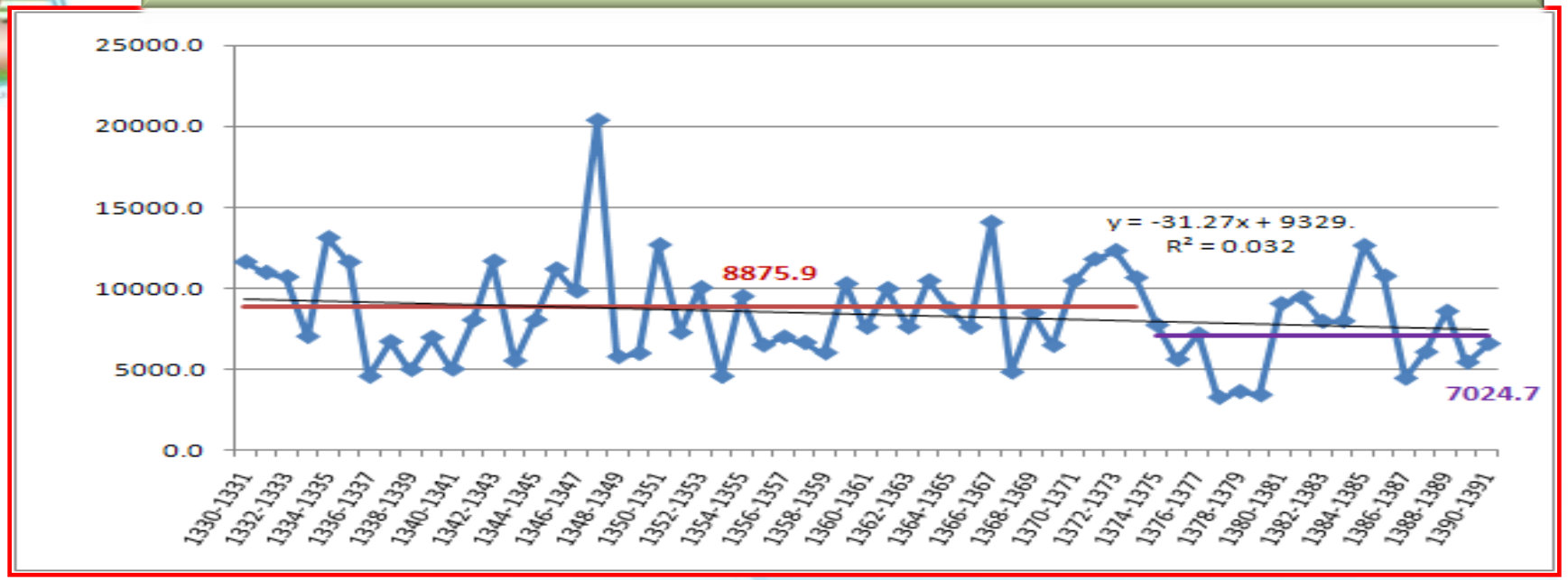
The maximum level =1277.78 m

Ecological level=1274.1 m

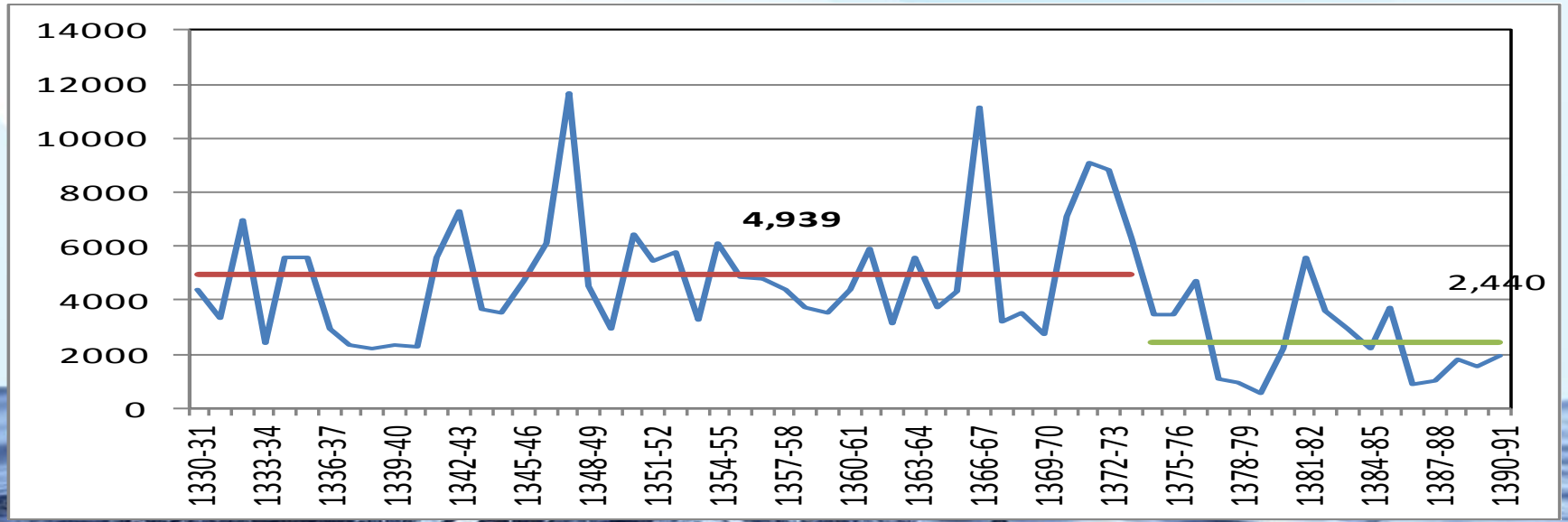
Current level=1270.35 m

3.75 m =Shortage

Long-term potential of renewable water resources in the Lake Basin MCM



Long series of total water resources



Lake Basin Water Resources

Surface and groundwater **Potential of renewable water resources**

8.875 BCM First Period (1955-2000)

7.024 BCM Second Period (2000-2014)

Consumption in total basin 4.825 BCM

Surface water Consumption
2.732 BCM

Annual Agricultural Water Use 4.293BCM

Urban & Industrial Use 532MCM

Groundwater **Consumption**
2.093 BCM

Summary of Total Consumptions Lake Basin

Annual Water Consumption in the Lake Basin	Drinking MCM	Industry MCM	Agriculture MCM	TOTAL MCM
Surface water	276	33	2424	2733
Groundwater	190	35	1867	2092
TOTAL MCM	466	68	4291	4825

for Irrigated 500,000 ha =Area

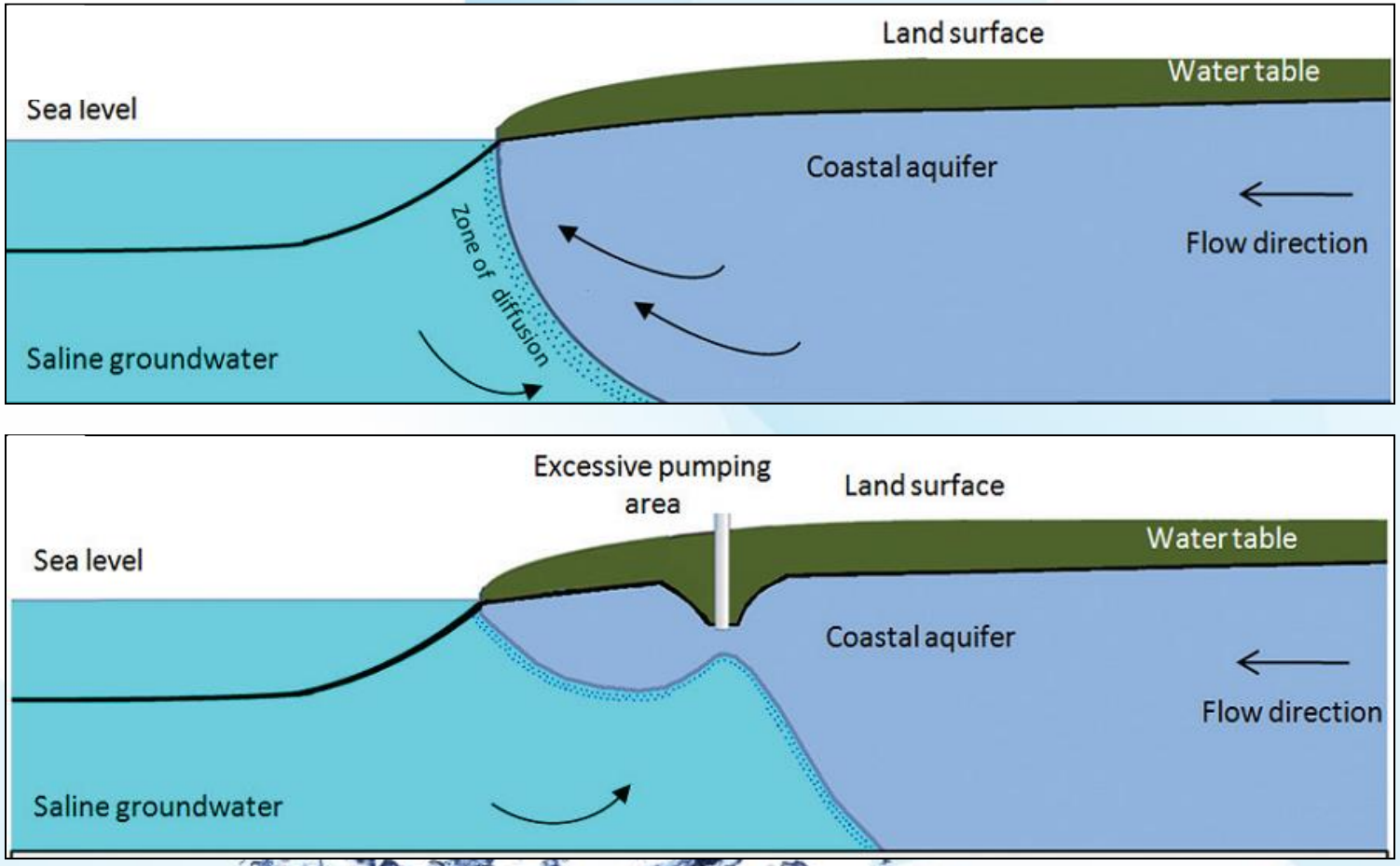
Symptoms and hazards threatening the sustainability of Lake Urmia:

- ✓ Significant fall of the lake's water level
- ✓ Increase in the lake water salinity
- ✓ Salt and dust storms
- ✓ Considerable reduction in ecological functions of the lake
- ✓ Micro-level climate change, tiny but important effects from global impacts, due to vulnerability

Main Factors in Drying the Lake

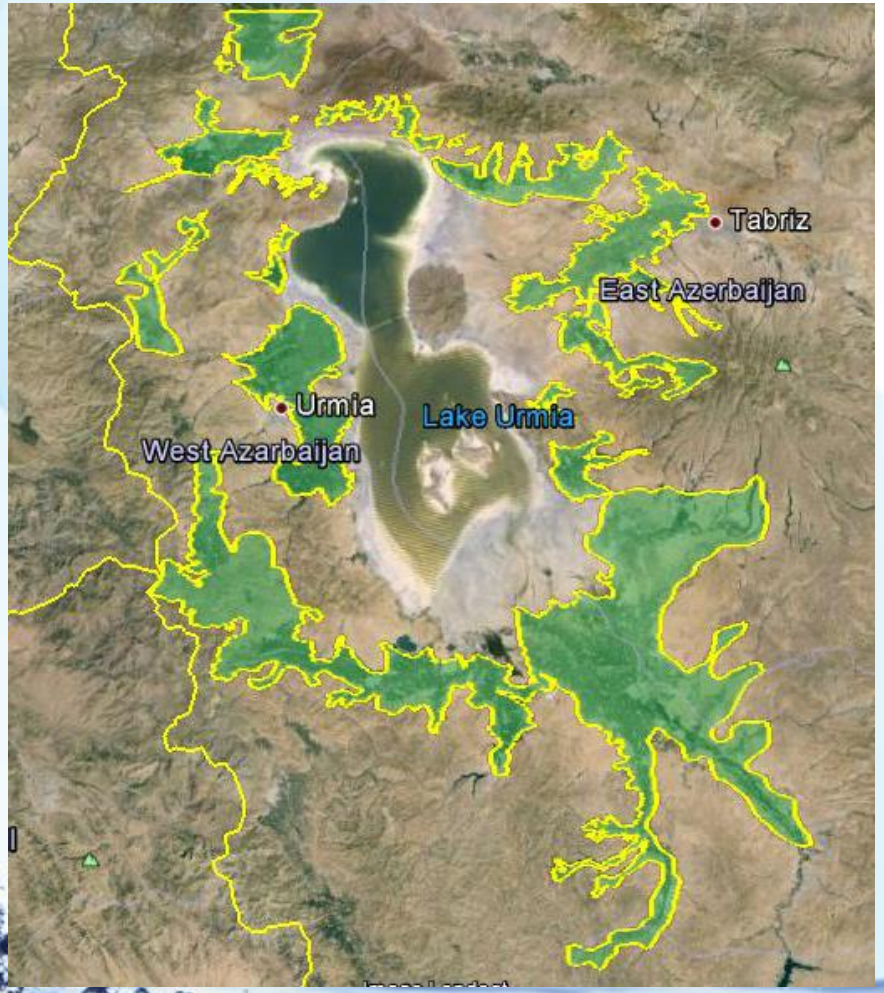
- ✓ Drought in the Region (Decreased precipitation, Increased Temperature ,…)
- ✓ Unsustainable development of the Irrigated Lands
- ✓ Changing Land Use
- ✓ Dam Construction
- ✓ The Cause Way
- ✓ Difficulty in the economic development Plan

Introduction



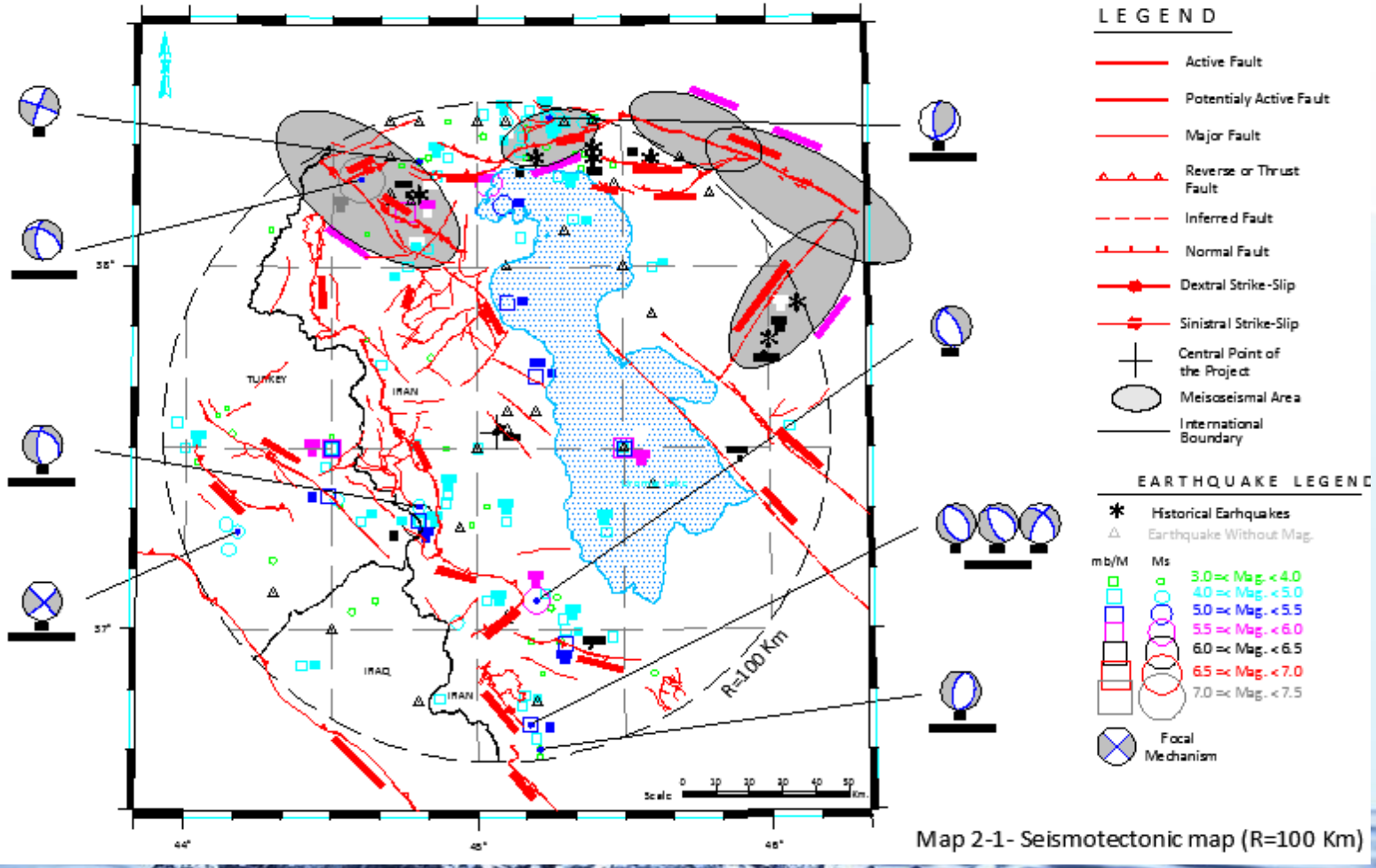
2 Typical type of Salt Water Intrusion

Irrigated Cultivation and Dried up Periphery



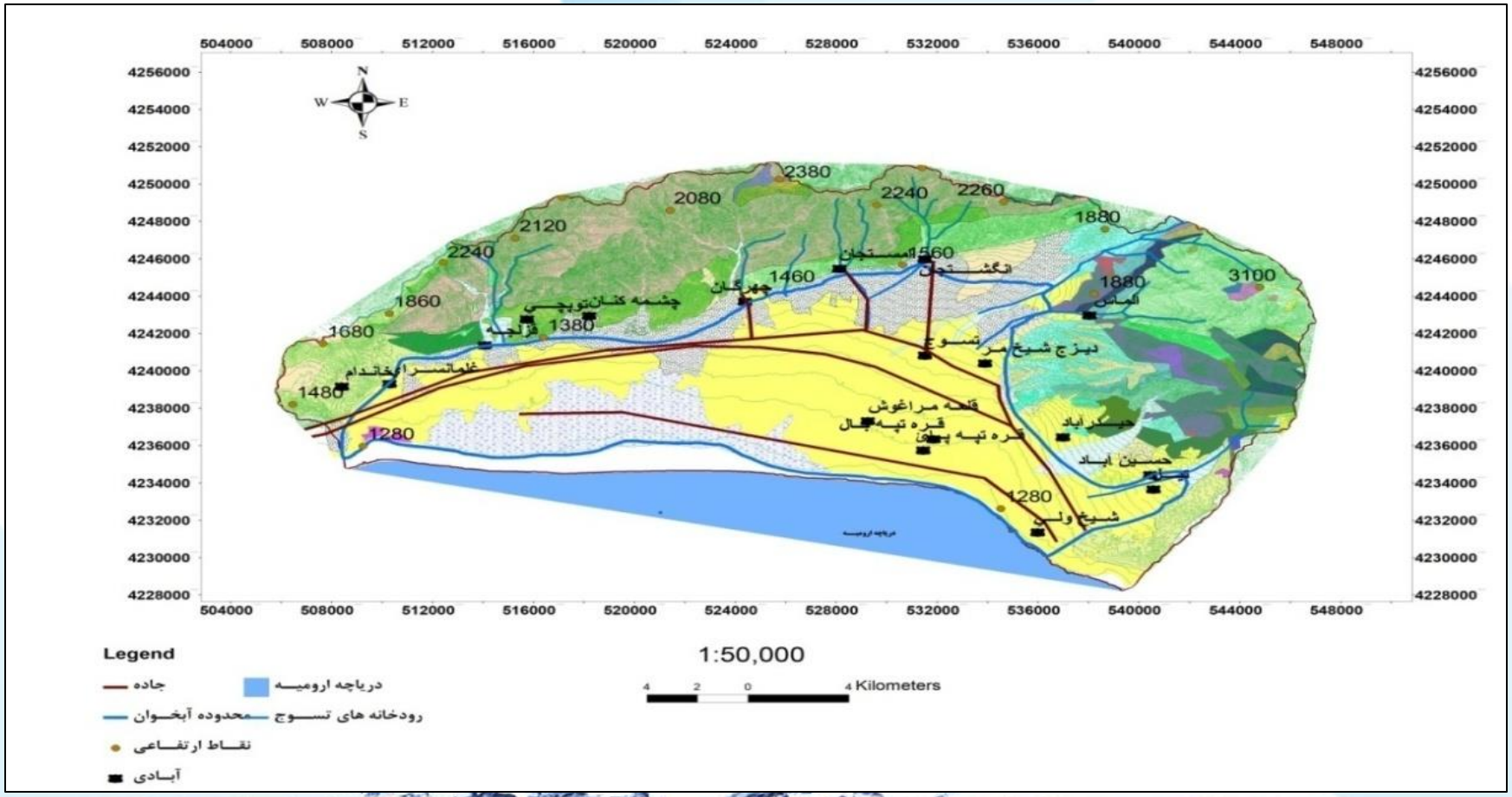
Left, GW Watertable and at the Right, Cultivated Lands

Seismotectonic Map



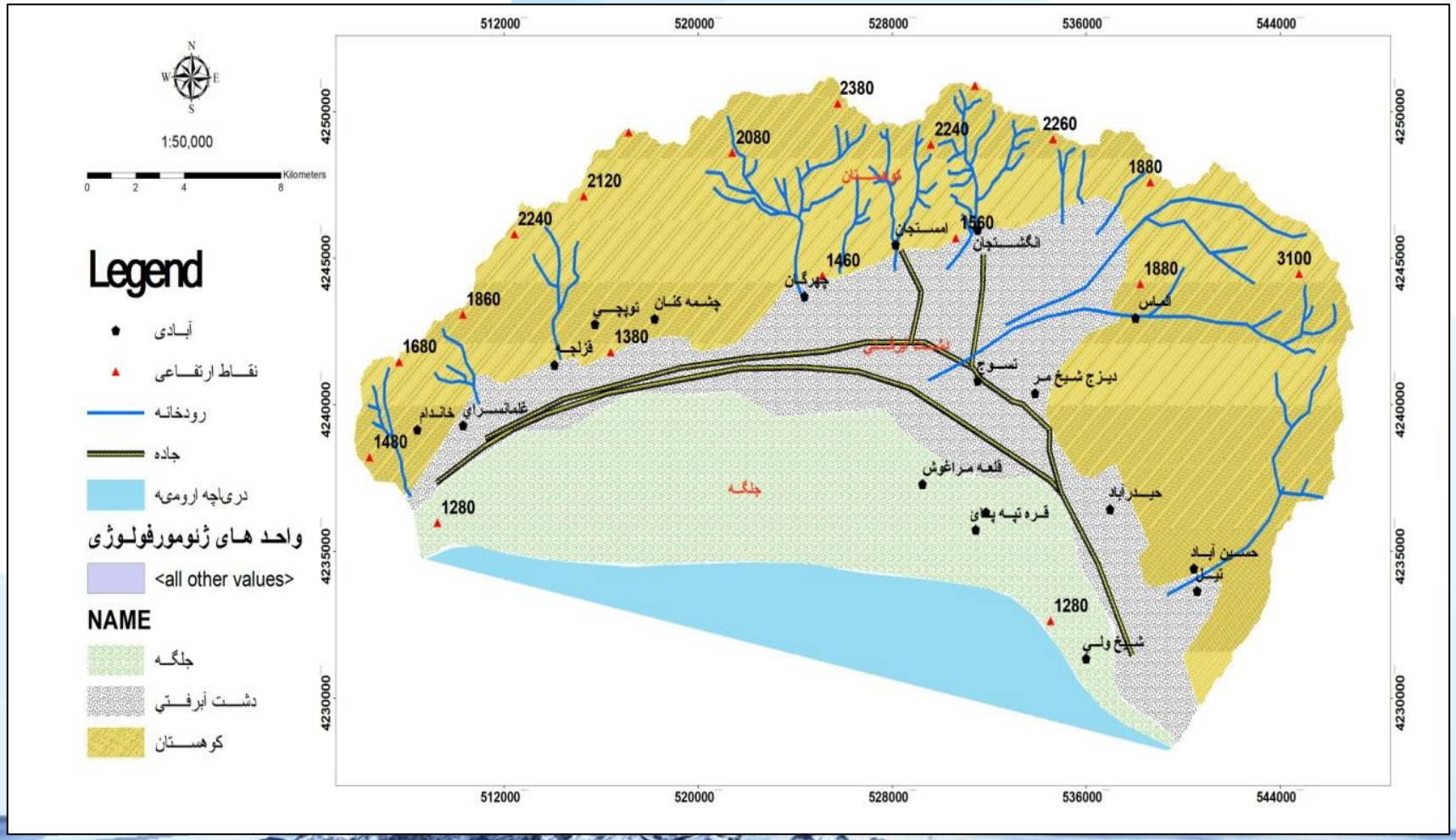
Map 2-1- Seismotectonic map (R=100 Km)

The Northeast Case Study



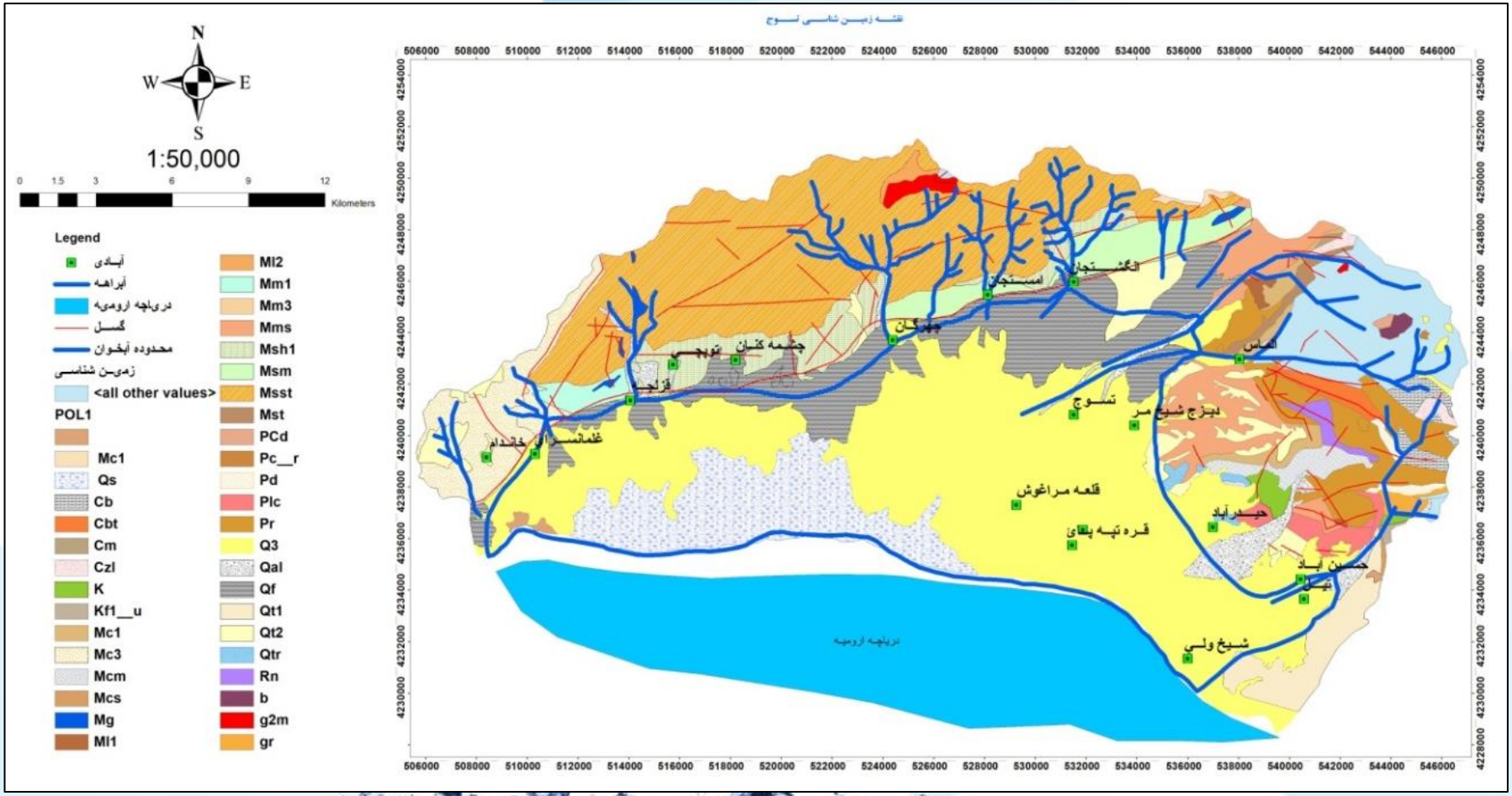
Location of the Survey Area

The Northeast Case Study



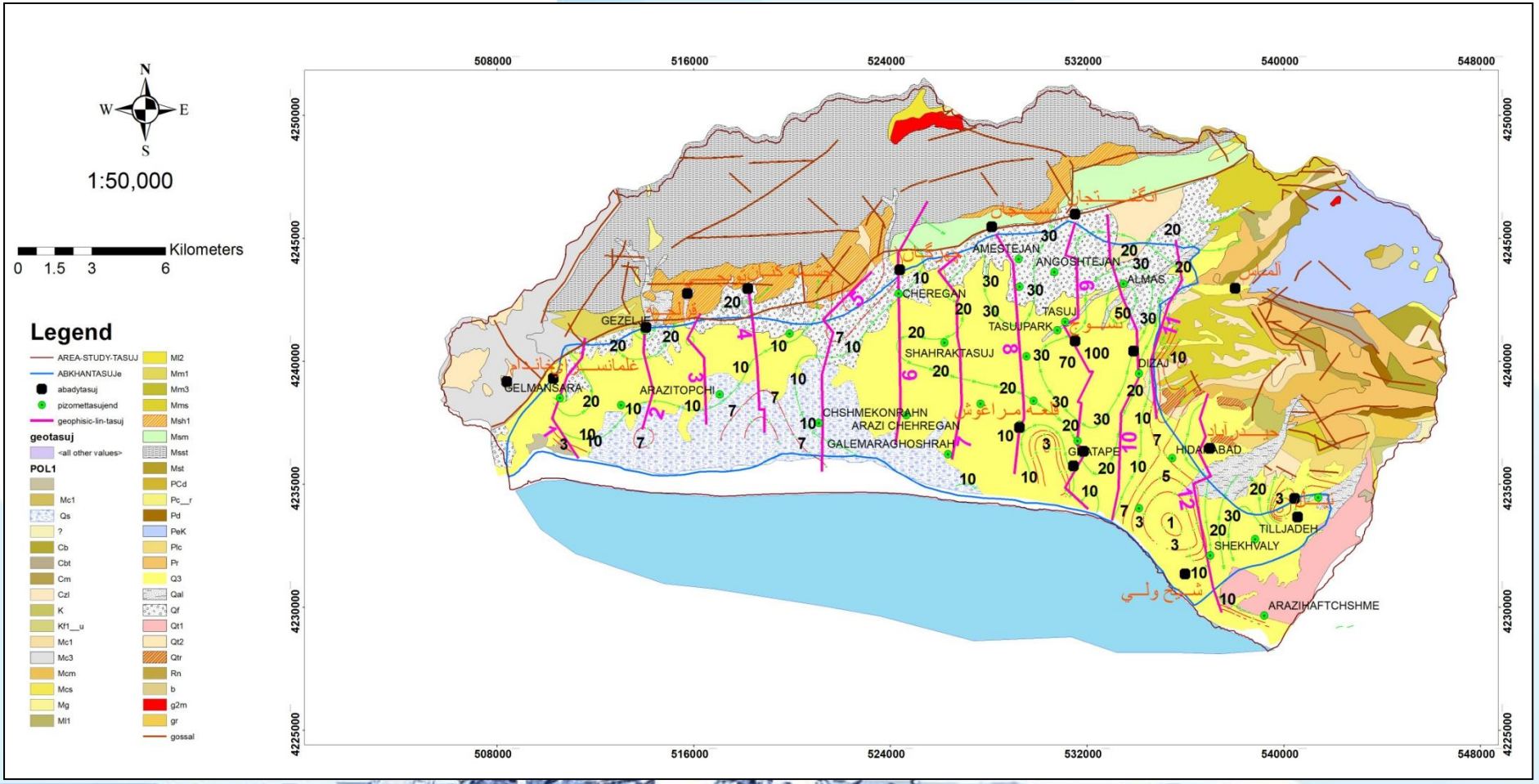
Geomorphology of the Survey Area

The Newest Case Study



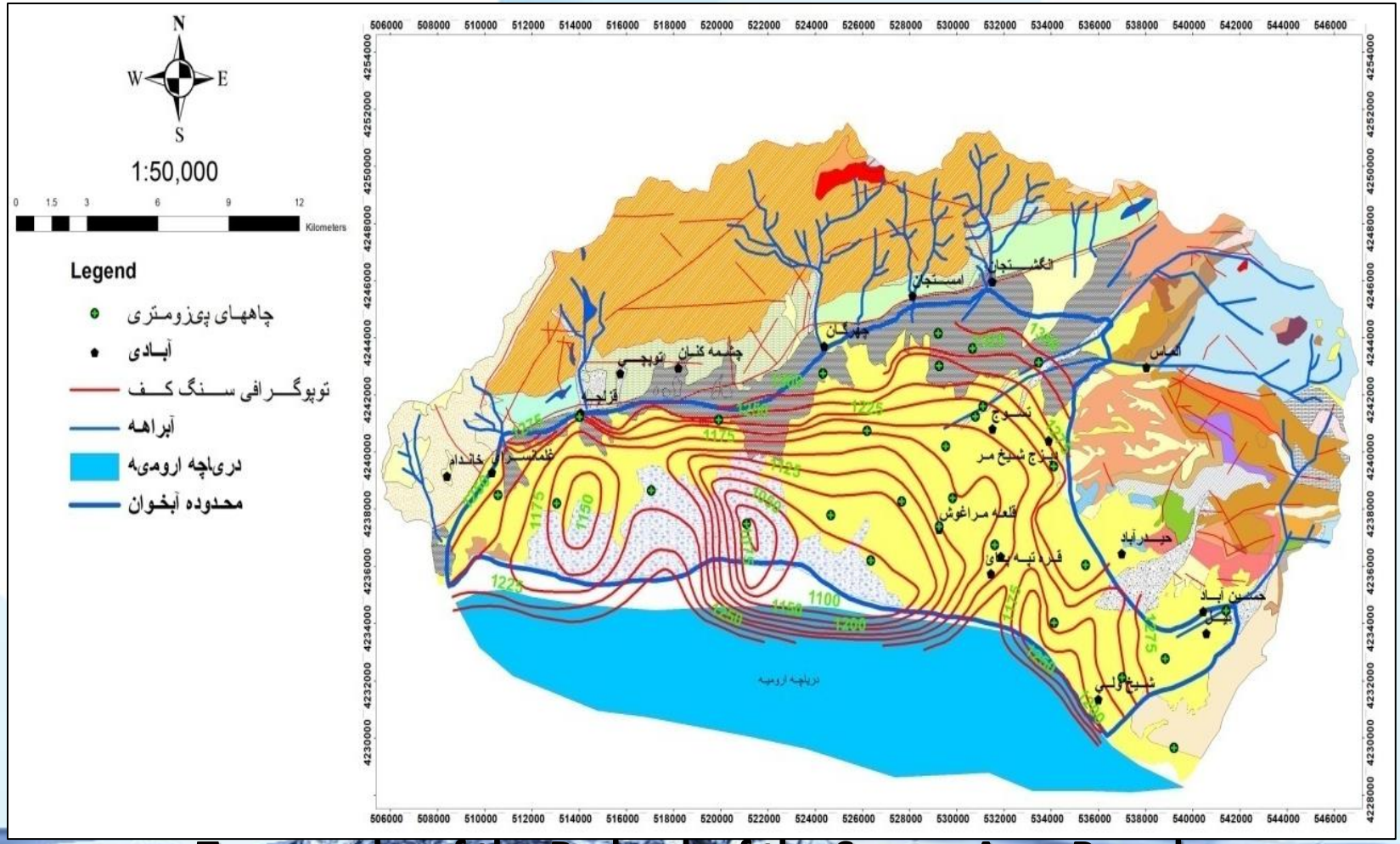
Geological Information of the Survey Area

The Northeast Case Study



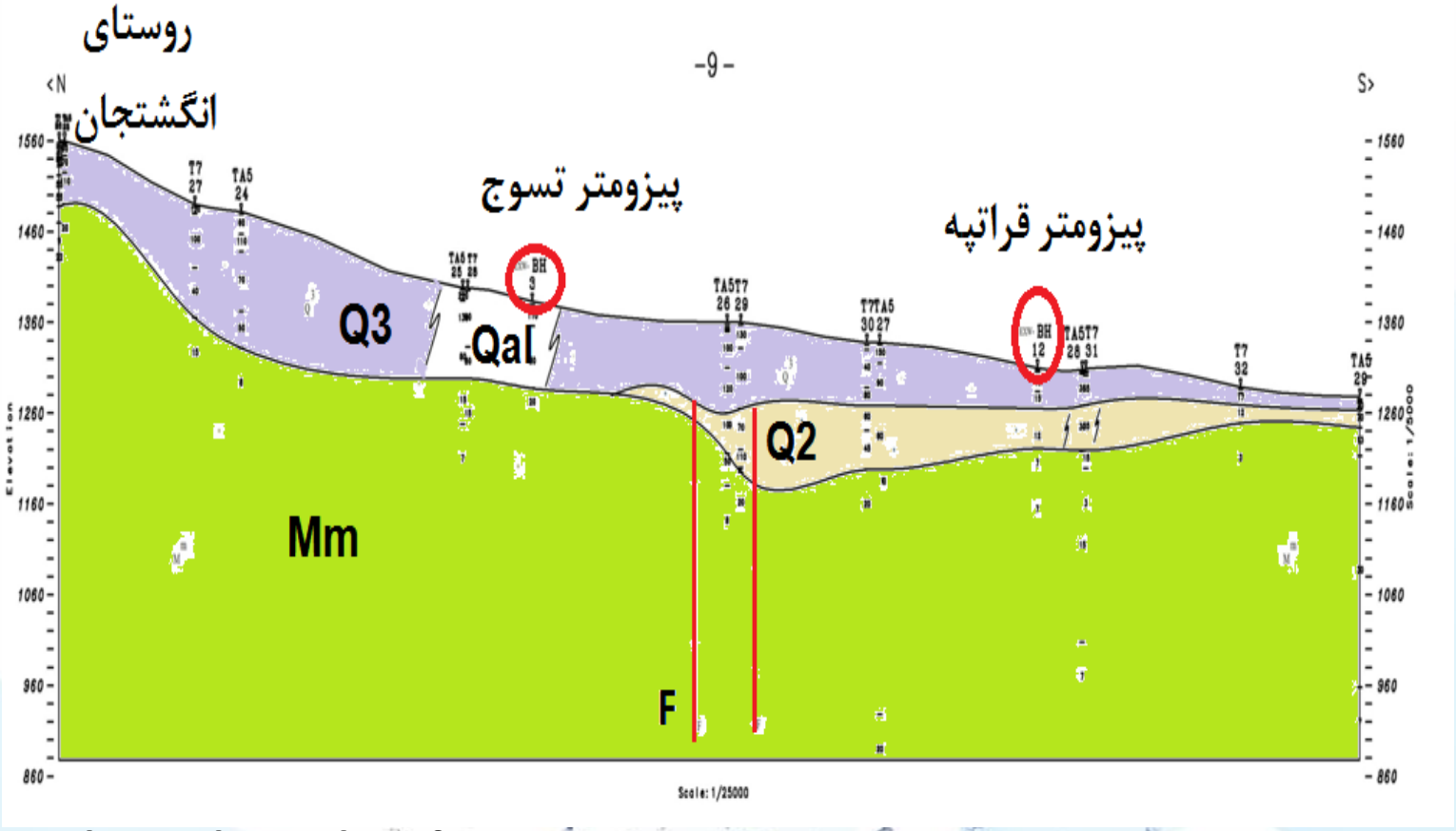
Location Map for Geophysical Measurement

The Newest Case Study



Topography of the Bedrock of the Survey Area Based on Pisometric Wells

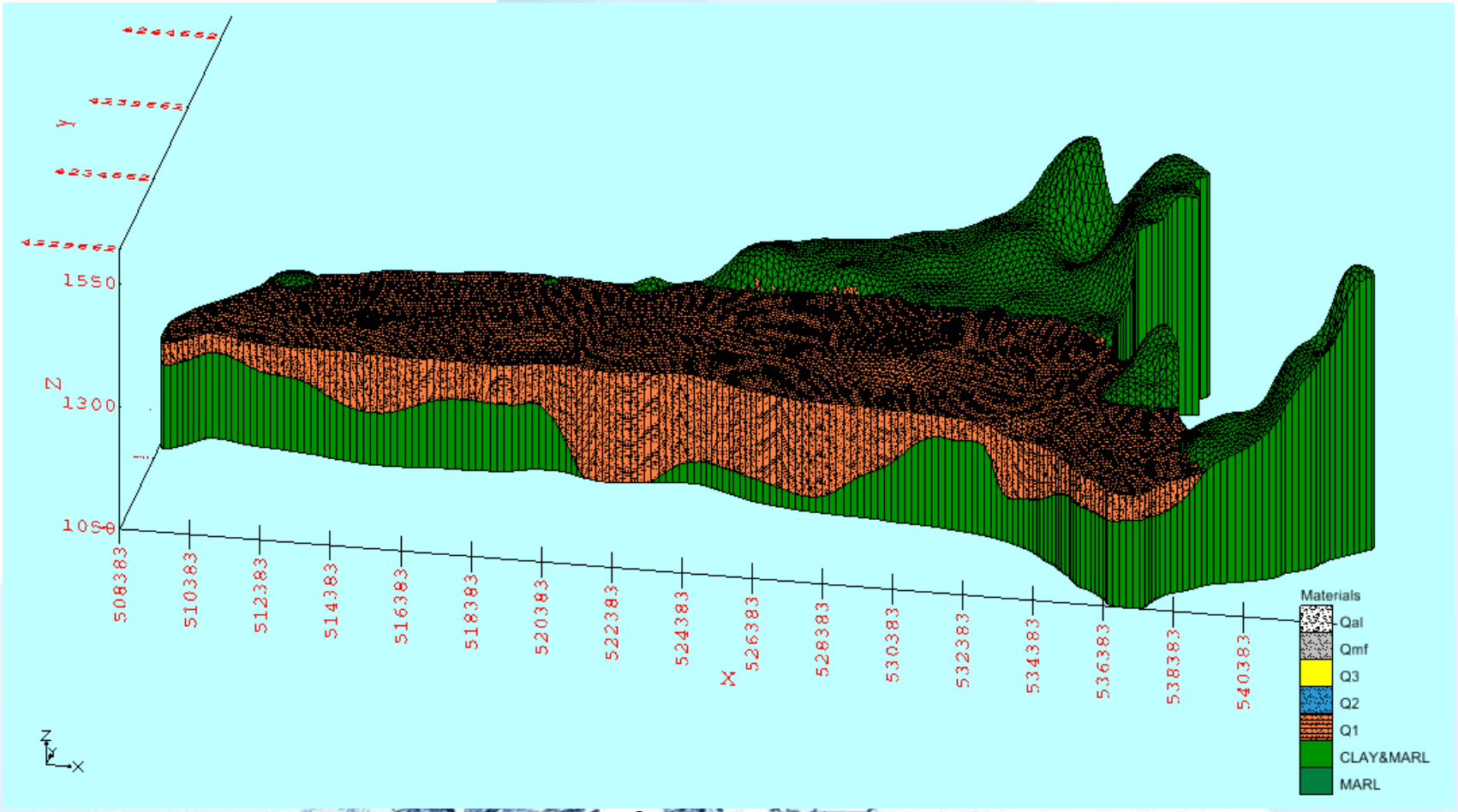
The Northeast Case Study



Geophysical Results of Resistivity measurement

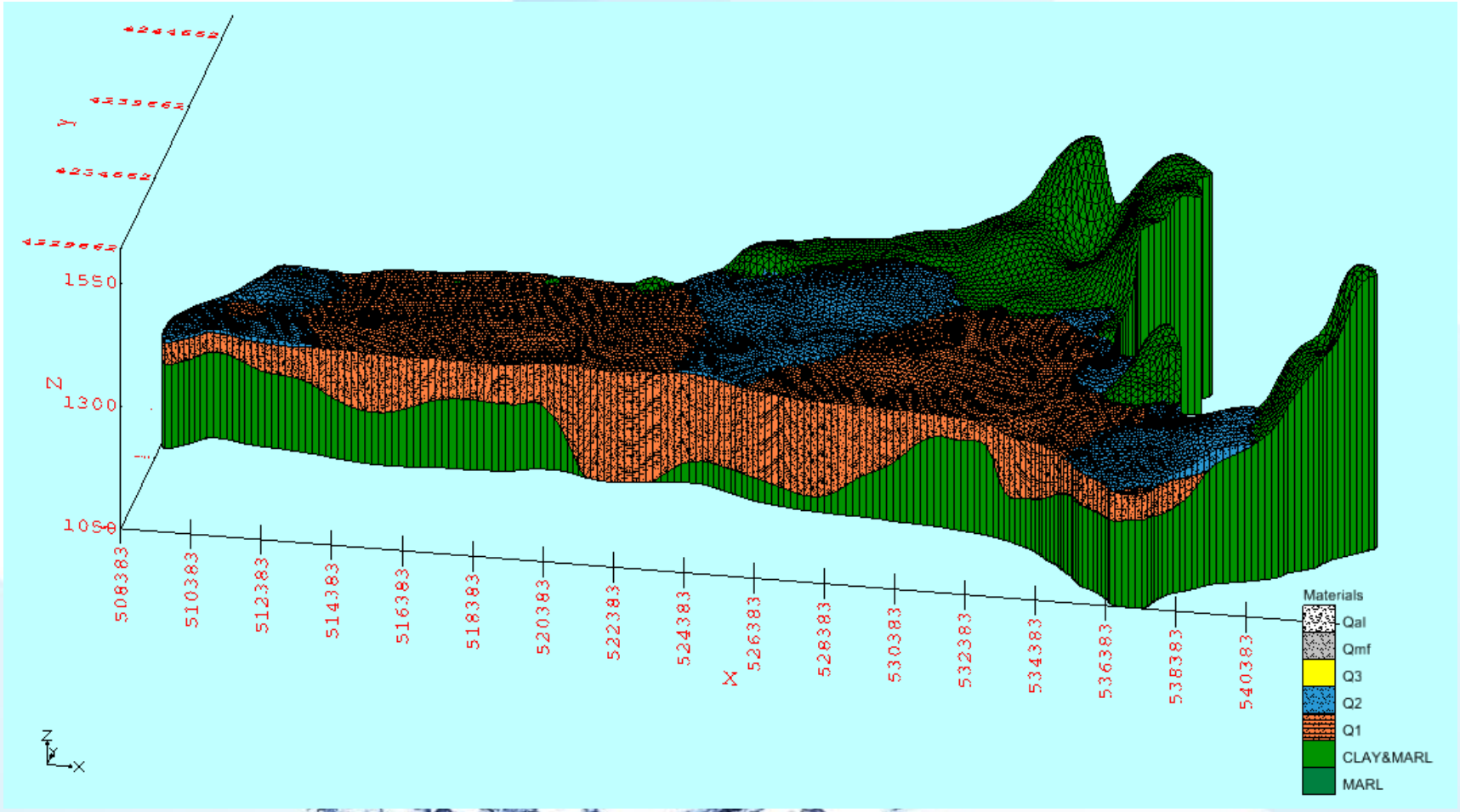
- **Detection Fault Zone, Different Kind of Lithology and sediments is an important result in the Primary Geophysical Study**

The Northeast Case Study



Conceptual model of Stratigraphy Deposits

The Northeast Case Study



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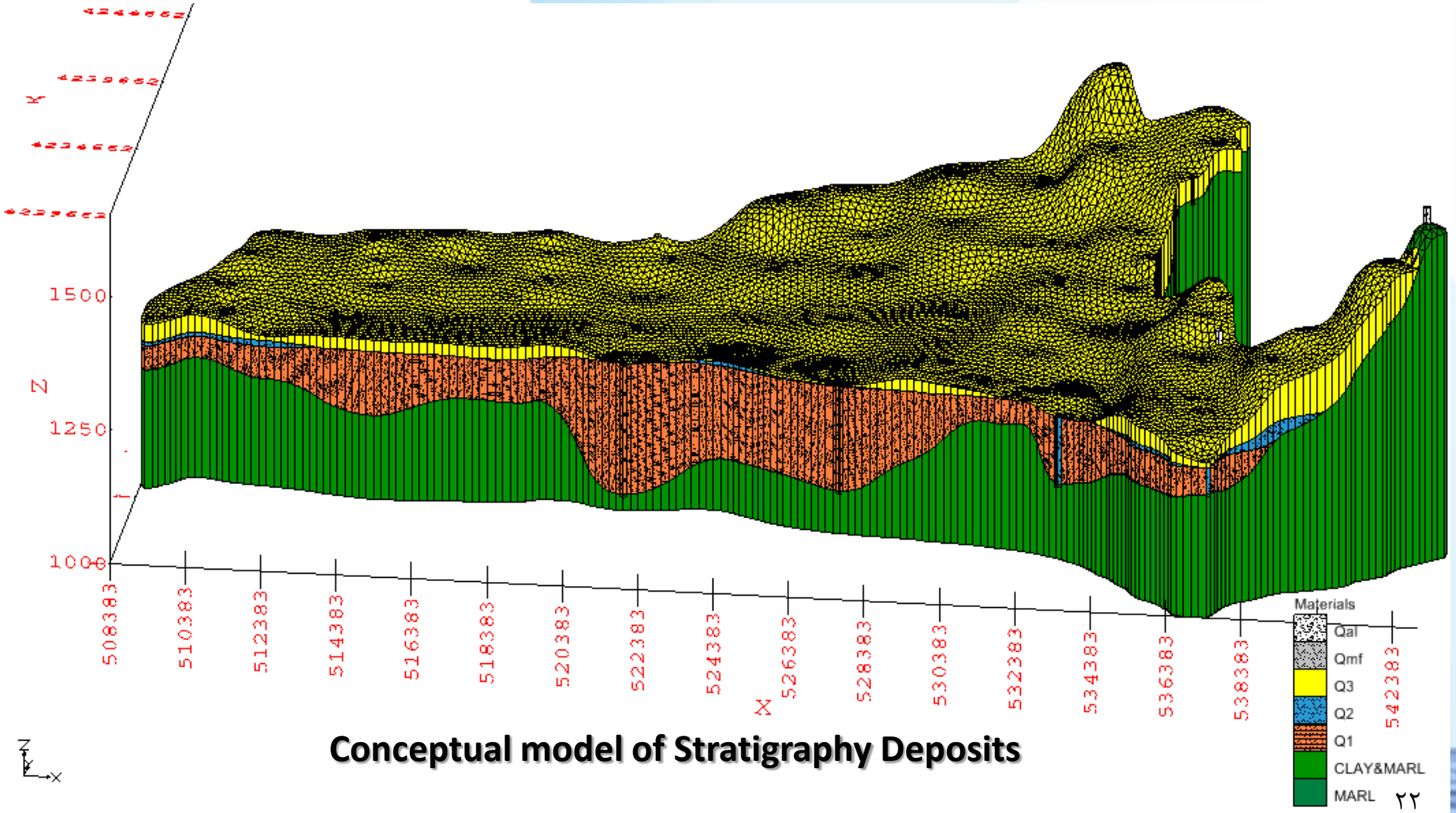

Conceptual model of Stratigraphy Deposits

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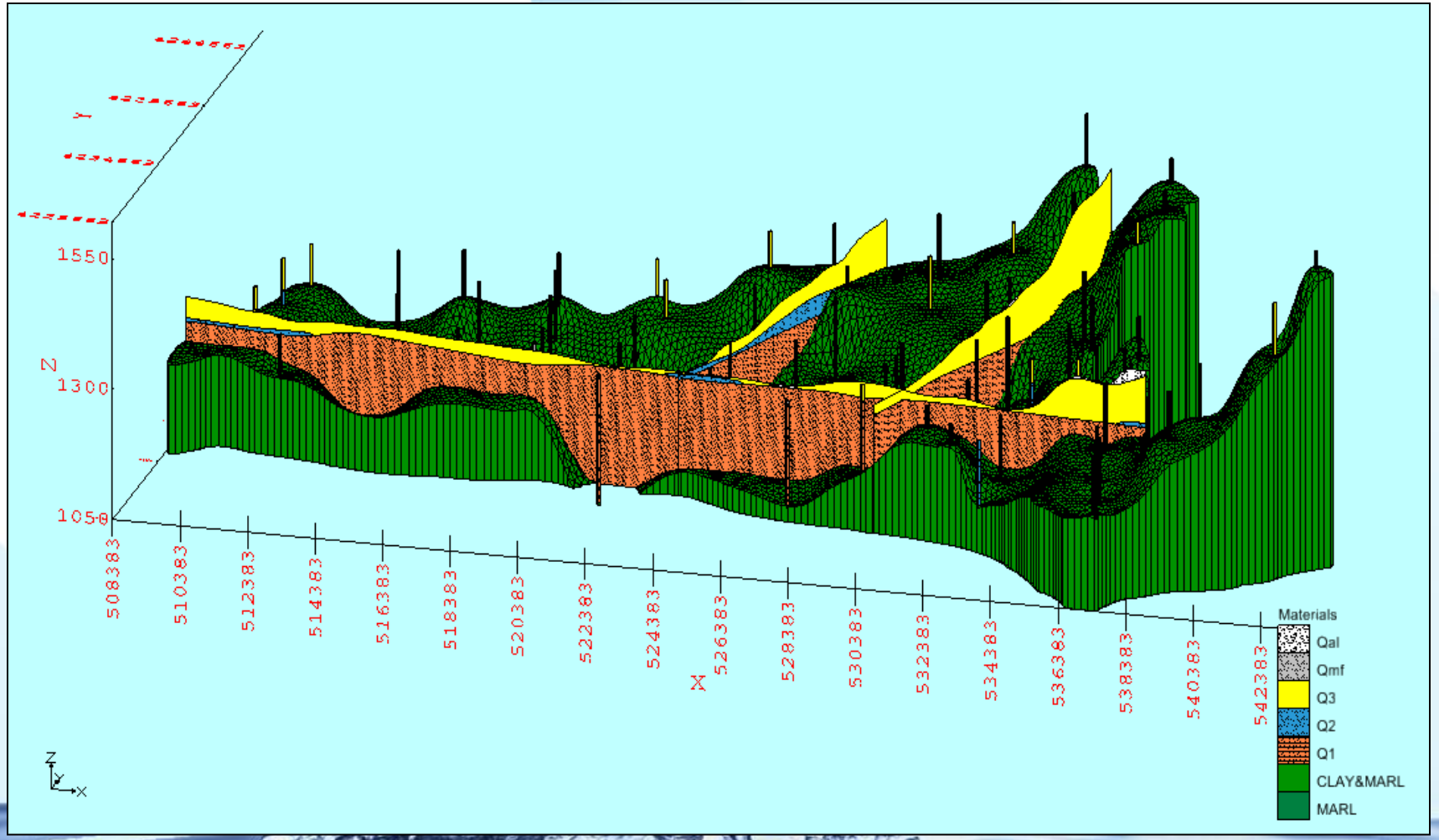
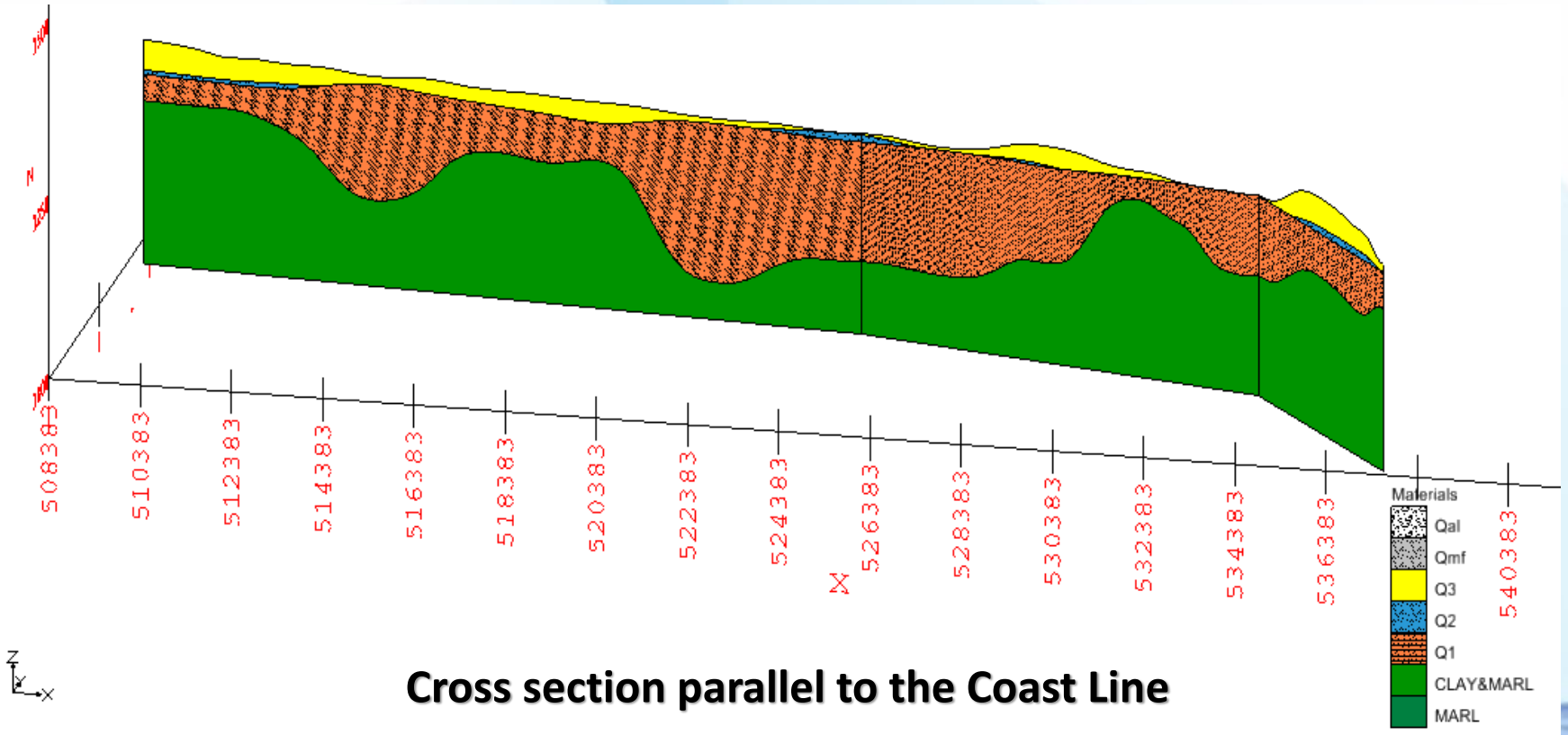


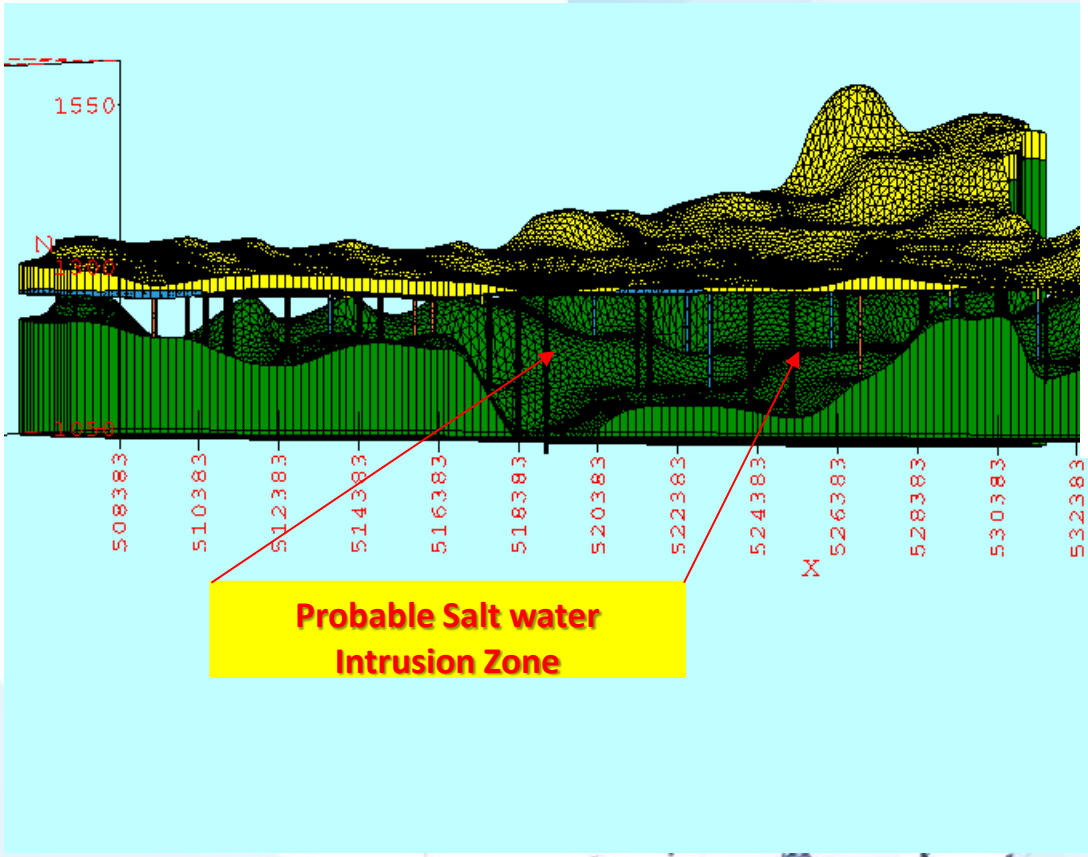
Cross section deposits

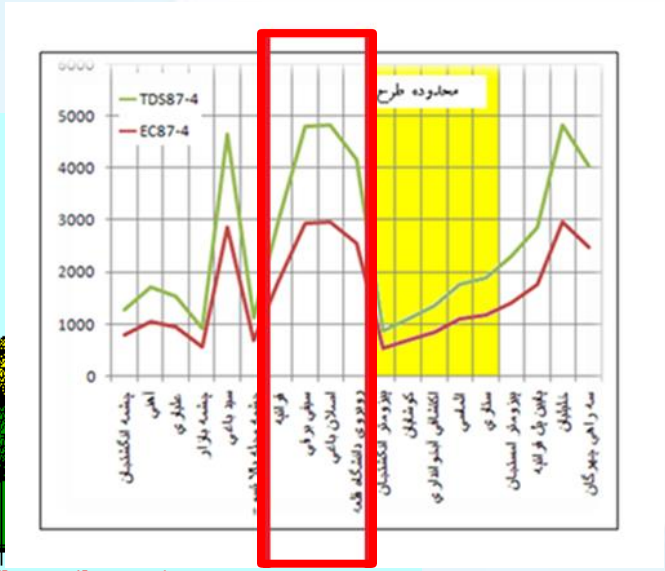
The Northeast Case Study



Cross section parallel to the Coast Line

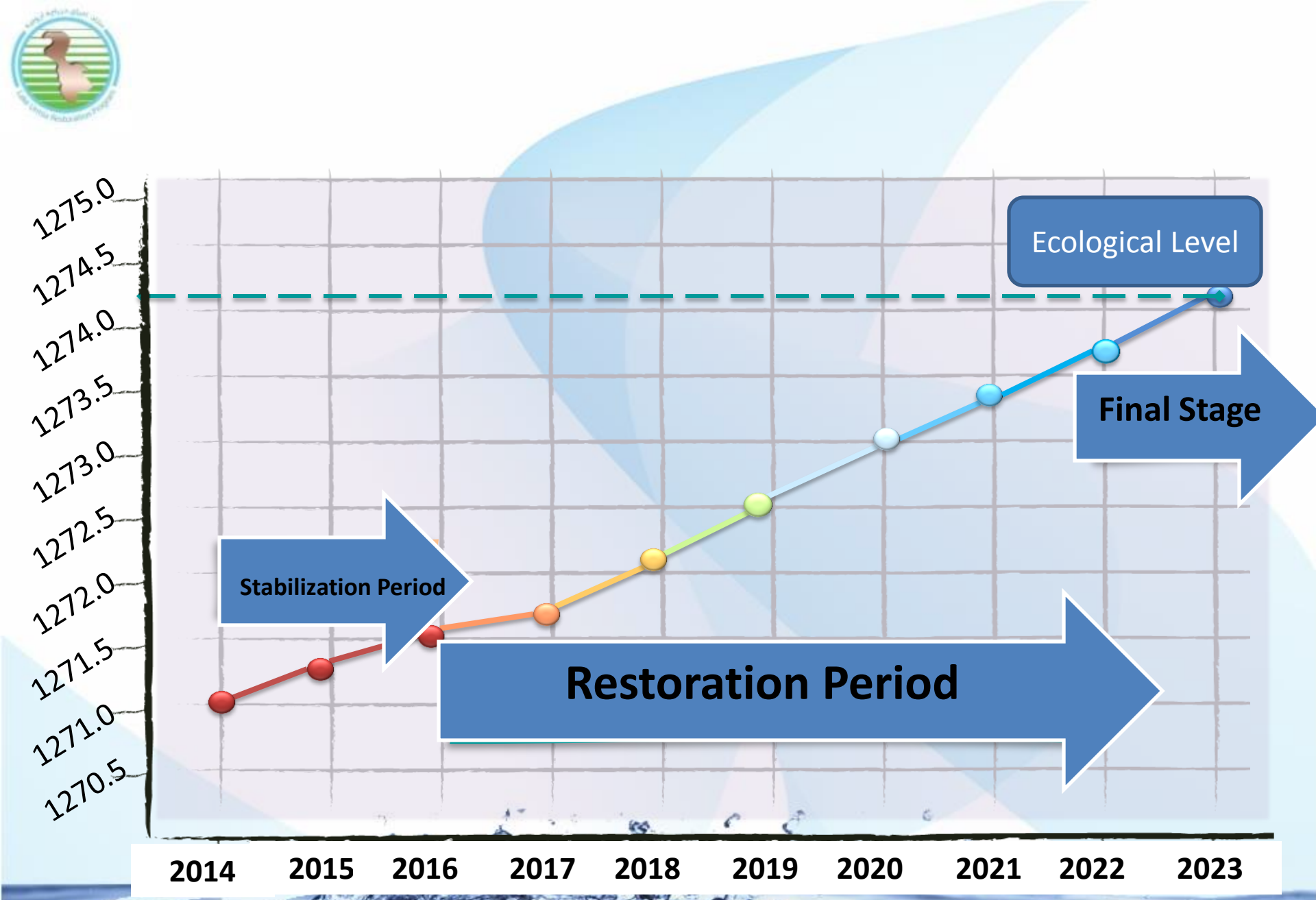
The Newest Case Study





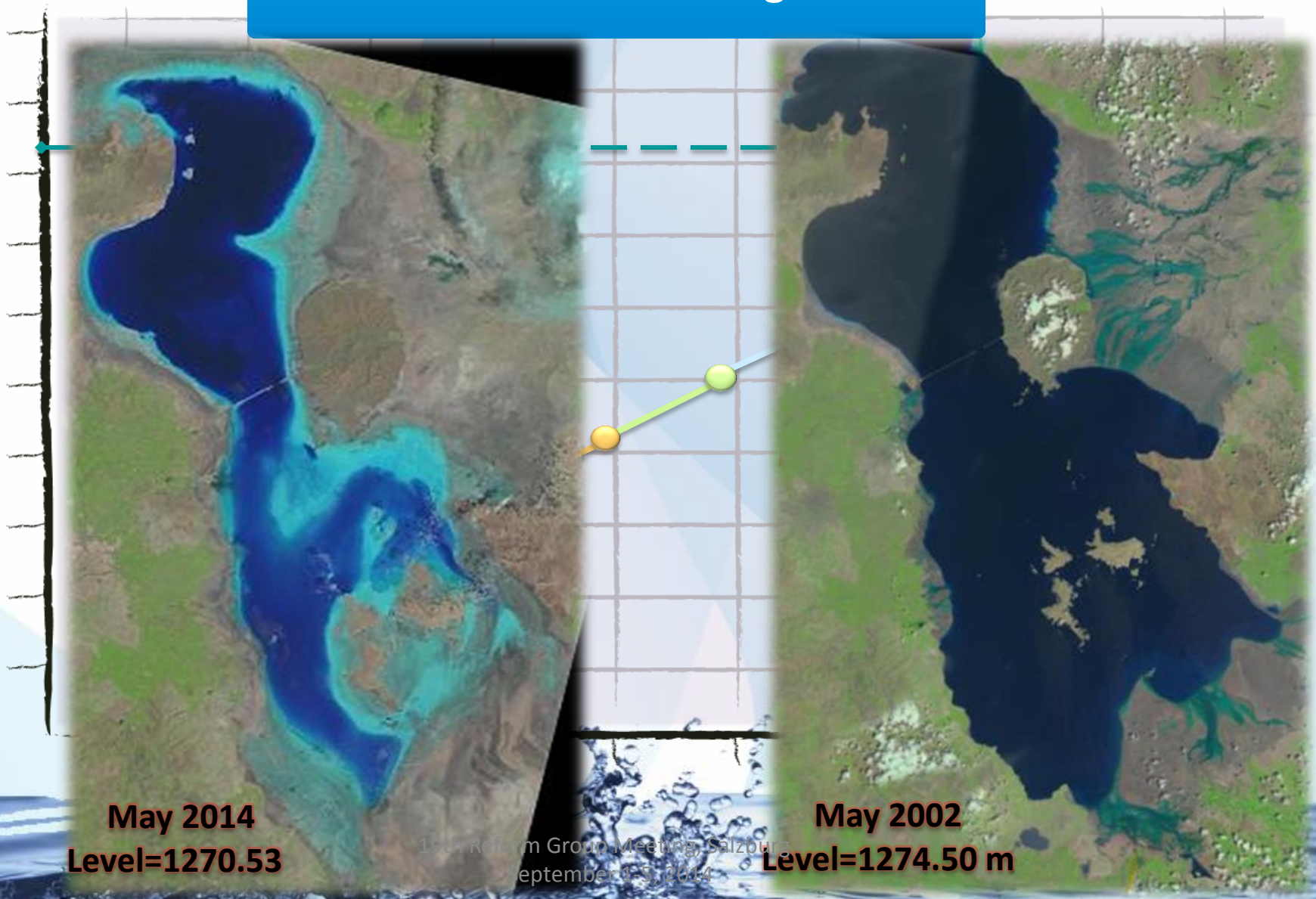
The Important Result of Geophysical and HyroGeomorphological Interdisciplinary in Salt Water Intrusion Prediction Area

Actions & Plans for Restoration of The LU

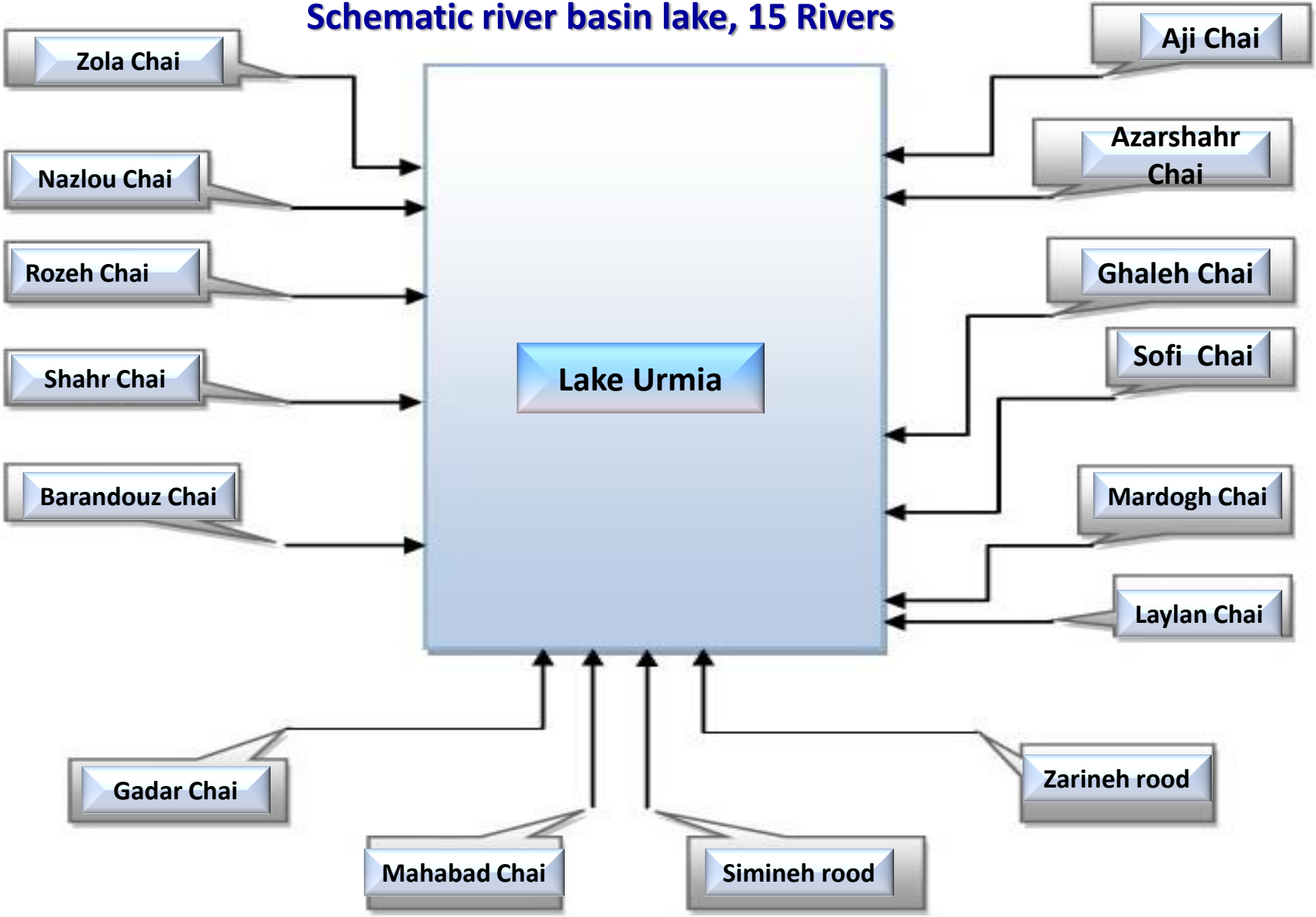

1275.0
1274.5
1274.0
1273.5
1273.0
1272.5
1272.0
1271.5
1271.0
1270.5
Ecological Level
Final Stage
Stabilization Period
Restoration Period
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023

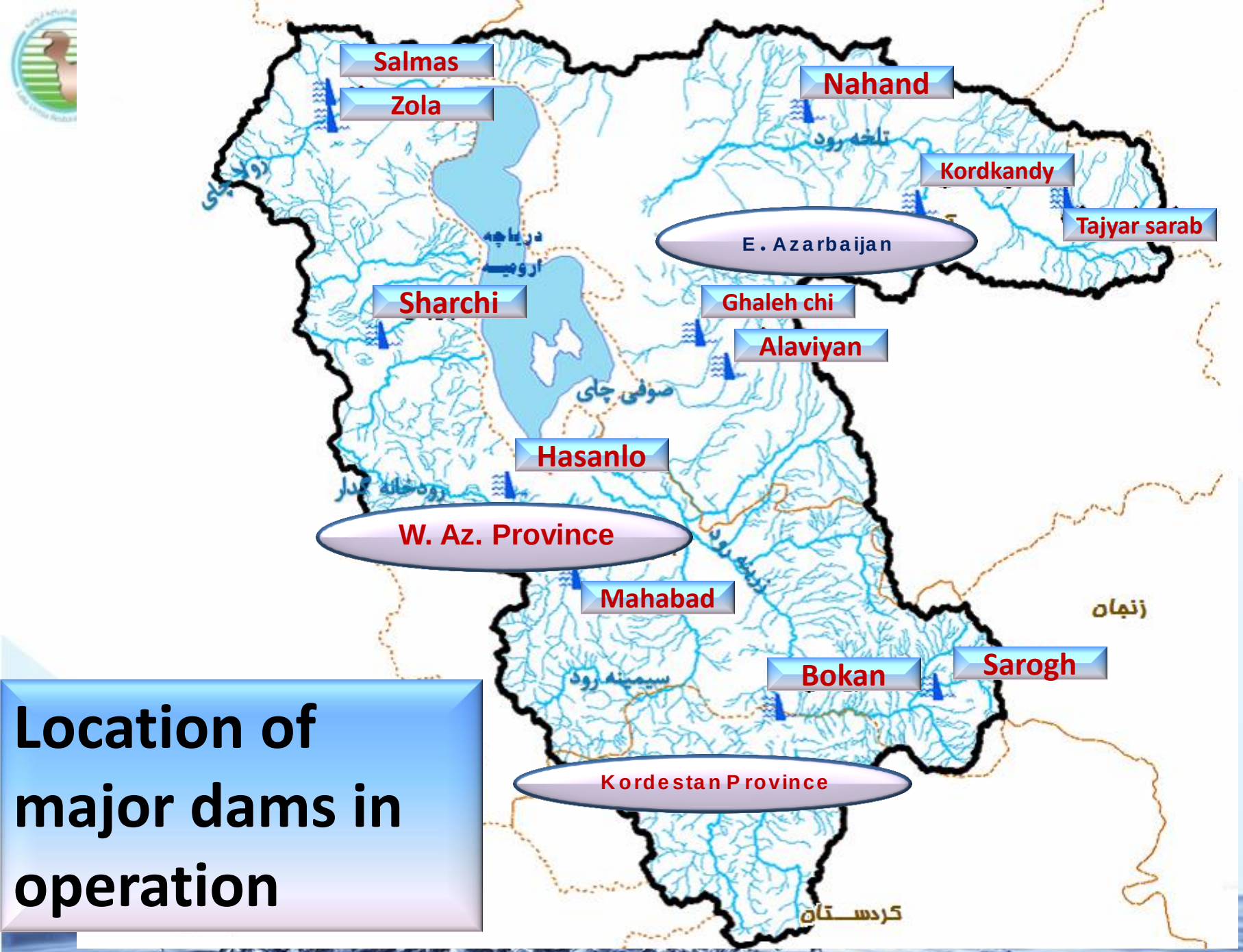
Vision for 2023

Restoration of the Ecological Level



Schematic river basin lake, 15 Rivers





Location of major dams in operation

Number of Dams and Regulated Water Resources Volume within Lake Urmia Basin

Provinces	Under Operation		Under Construction		Under Study		Total	
	No.	Regulated Water Volume (MCM)	No.	Regulated Water Volume (MCM)	No.	Regulated Water Volume (MCM)	No.	Regulated Water Volume (MCM)
East Azar-Baijan	62	316.2	3	332.3	8	123.1	73	771.6
West Azar-Baijan	14	1751.8	6	951.6	17	253.7	37	2957.1
Kordestan			1	86	6	136.3	7	222.3
Total	76	2068	10	1369.9	31	513.1	117	3951

Number of wells in Lake Urmia catchment					
Provinces	Deep	Semi-deep	Electric	Diesel	Total
West Azar-Baijan	2518	50331	12991	39857	52849
East Azar-Baijan	4457	27506	13537	18426	31966
Kordestan	1	2426	1159	1268	2427
TOTAL	6438	80804	27863	59378	87242

Discharge from wells in the Lake Basin MCM					
Provinces	Deep	Semi-deep	Electric	Diesel	Total
West Azar-Baijan	378	815	414	779	1193
East Azar-Baijan	479	311	461	329	790
Kordestan	0.03	38	21	17	39
TOTAL	857	1164	897	1124	2022

Approved Plans in the Meeting of 4/29/2014

1. Prevention of New water Consumption Project developments, especially in agricultural sector (No new water allocations)

Approved Plans in the Meeting of 4/29/2014

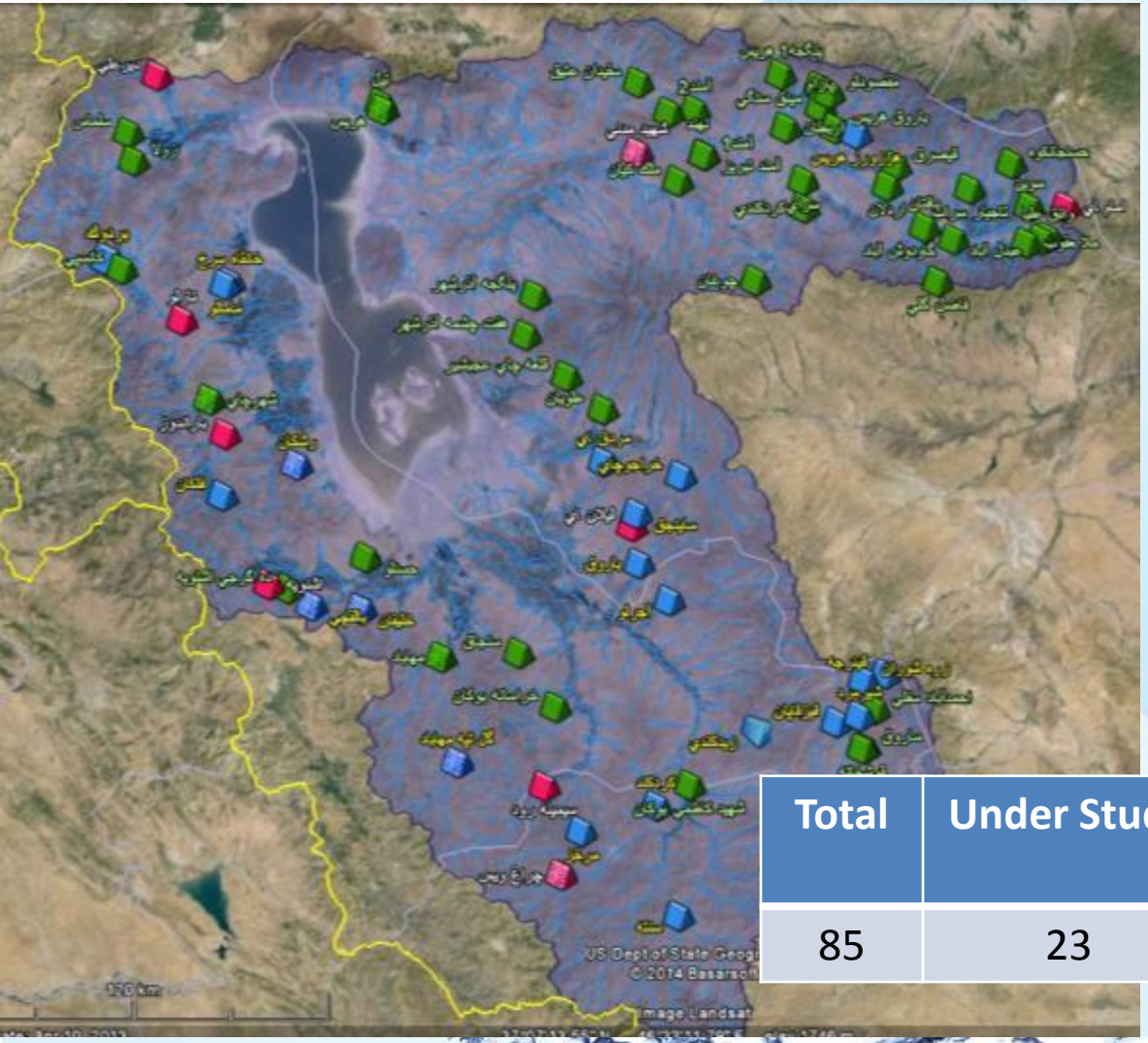
2. Prevention of unauthorized removal and consumption of surface water (Monitoring and Enforcement)

More than 16,000 pumps are pumping water from the surface and groundwater resources, mostly unauthorized.
2000 mobile pumps extract more then 100 MCM/Year alone.
One critical effect of Energy Consumption on Water Resources

Approved Plans in the Meeting of 4/29/2014

3. No new dam construction projects, no new added irrigation schemes and water supply downstream of the existing dams' lakes, storage of water in Madani Dam's reservoir exclusively for the purpose of releasing it to Lake Urmia.

Locations of Dams



Total	Under Study	Under Construction	Operational
85	23	9	53

Approved Plans

4. Appropriation of funds to accelerate the river basin(s) water transfer to the Lake.

5. Development and implementation of a comprehensive program of education, information sharing, public awareness and participation of local communities in order to explain the consequences of the current situation and the importance of restoration of the lake

6. Organizing Lake Urmia Basin's wells and installation of smart meters and withdrawal volume control in order to increase river inflows to the Lake

Water Withdrawals/year in MCM					
Total	Diesel	Electric	Semi-Deep	Deep Wells	
2022	1124	897	1194	829	**MCM**
87,242	**59,378**	**27,863**	**80,804**	**6,438**	**# of Wells**

Approved Plans

7. Transmission of treated waste water from the surrounding cities to the lake, through rivers

Approved Plans

8. Controlling and reducing water consumption in agriculture

- Reduction of 40% of the surface and groundwater consumption by purchasing the “water rights” within the next two years .

- Implementation of appropriate programs to increase productivity in the agricultural sector with the remaining 60% of water by the Ministry of Agriculture

- Financing development of technologies and methodologies required to increase the water productivity (agriculture and industry)

Approved Plans

9. Transfer of water from to the lake's southern part, islands, lagoons and wetlands

10. Preparing Lake Basin's Land Cadastre

Approved Plans

11. Performance monitoring of the execution of approved plans by the government ministries and agencies through the Lake Urmia Restoration Commission

12. The design and implementation of a comprehensive Integrated Water Management System for the Lake's Watershed and a DSS to that effect.

13. Comprehensive study of the environmental effects of the lake's causeway and implementation of corrective measures

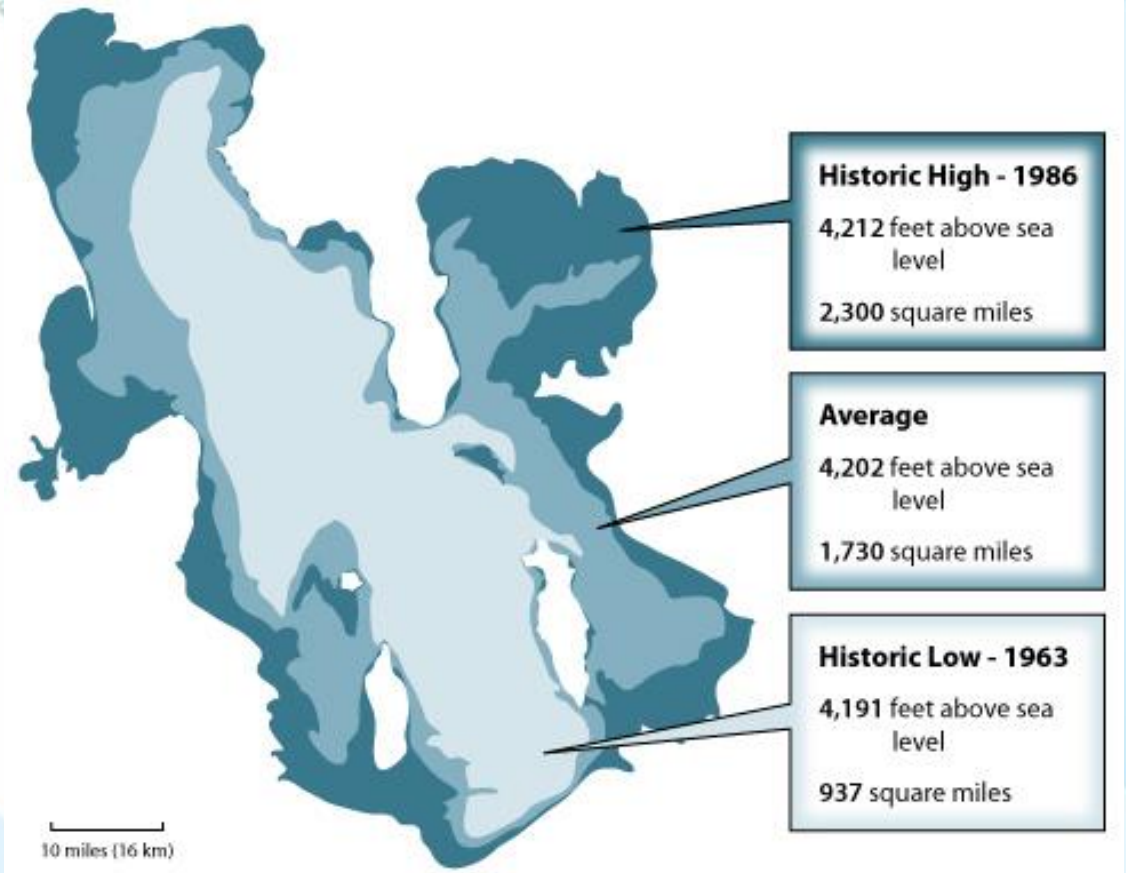
Then and Now

http://www.geocreationism.com/images/lake_van_and_lake_urmia_chelys.jpg

A Shared VISION between LU and GSL

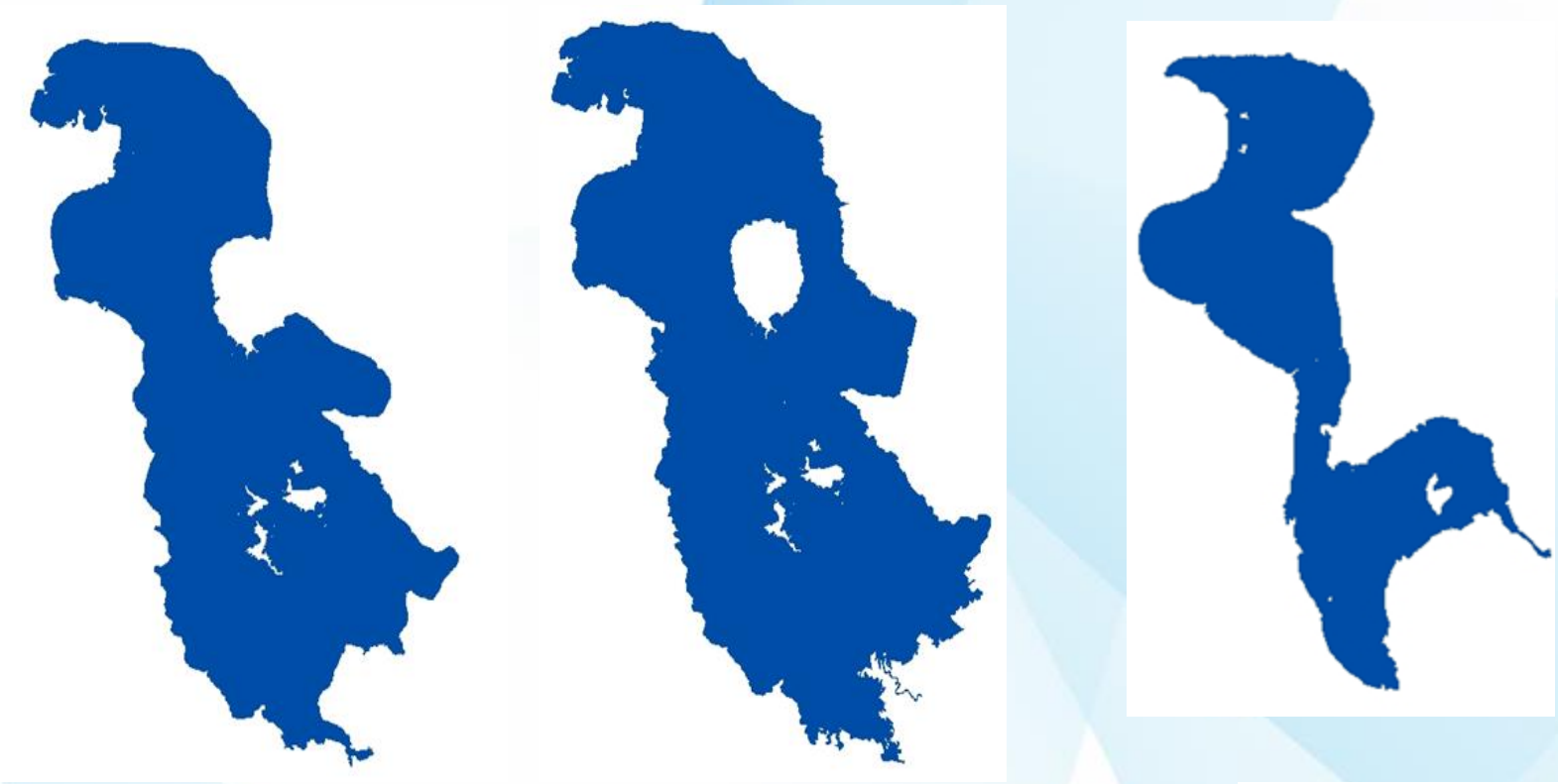
- ✓ GSL and LU are unique and complex ecosystems of regional and hemispherical importance. Sustainable use of their natural resources will ensure that the ecological health (e.g., water quality, shoreline condition, salinity, aquatic organisms, wildlife, wetlands), scenic attributes, extractive industries (e.g., minerals, brine shrimp, microorganisms), and recreation opportunities (e.g., bird watching, hunting, sailing) will be maintained into the future. Relevant authorities will coordinate, as necessary, to ensure that the management of these resources is based on a holistic view of the lake-wide ecosystem—including the use of adaptive management, as necessary—to ensure long-term sustainability. Responsible stewardship of the lake's resources will provide lasting benefit to the Public Trust.

GSL Historic E-A Values



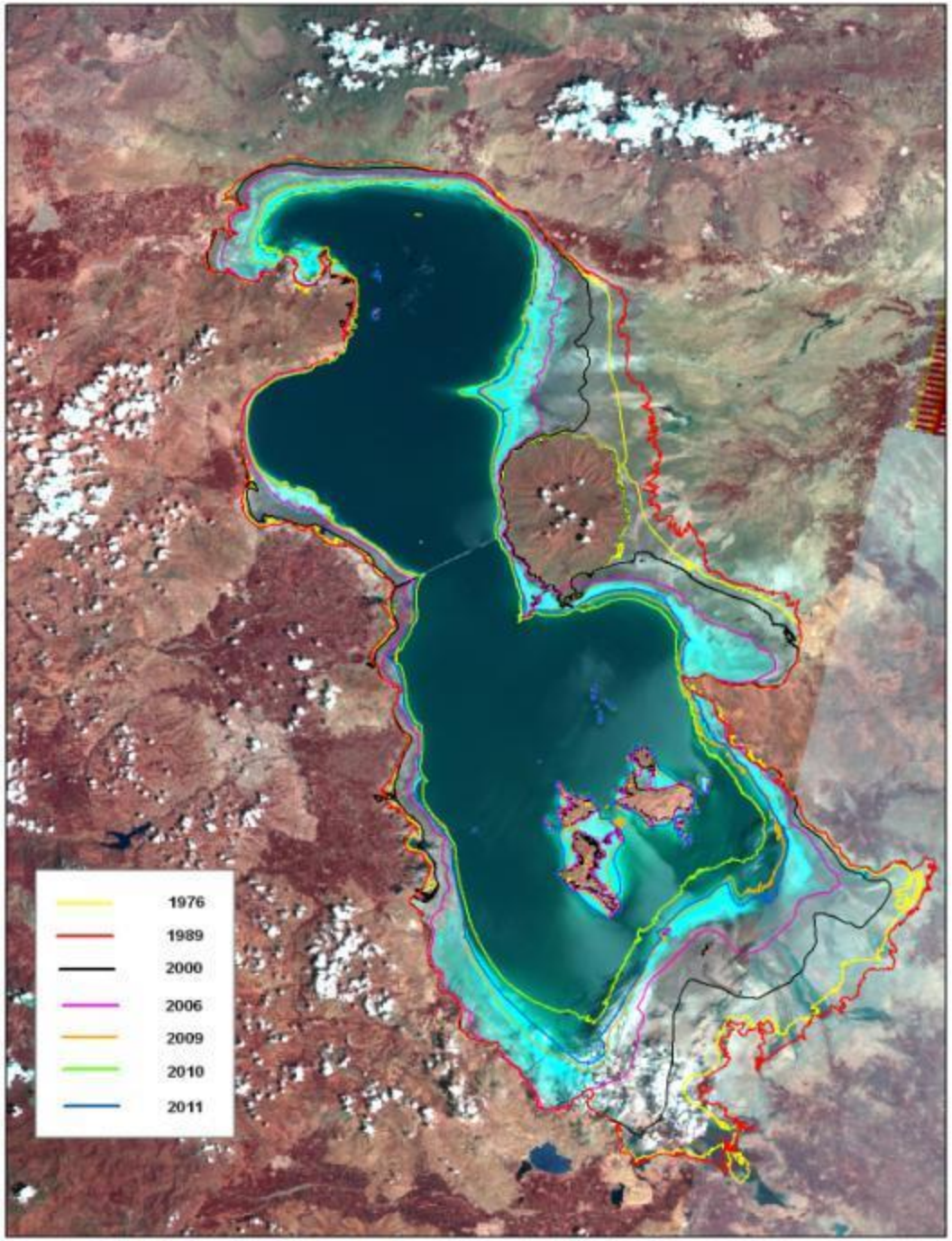
	Elevation	Elevation	Area	Area
	ft	m	SQ Mi	Sq Km
Historic High	4212	1284	2300	5954
Average	4202	1281	1730	4479
Historic Low	4191	1277	937	2426

Variations of LU Surface Area

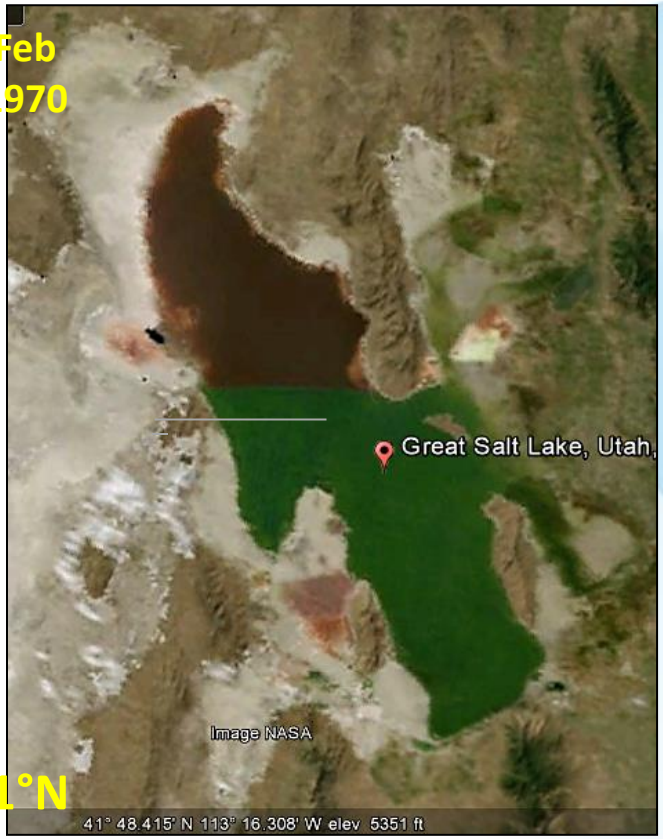


Curtsey of: N. Alizadeh et al

Changes in Water Elevation and Area of the Lake between 1976 and 2011



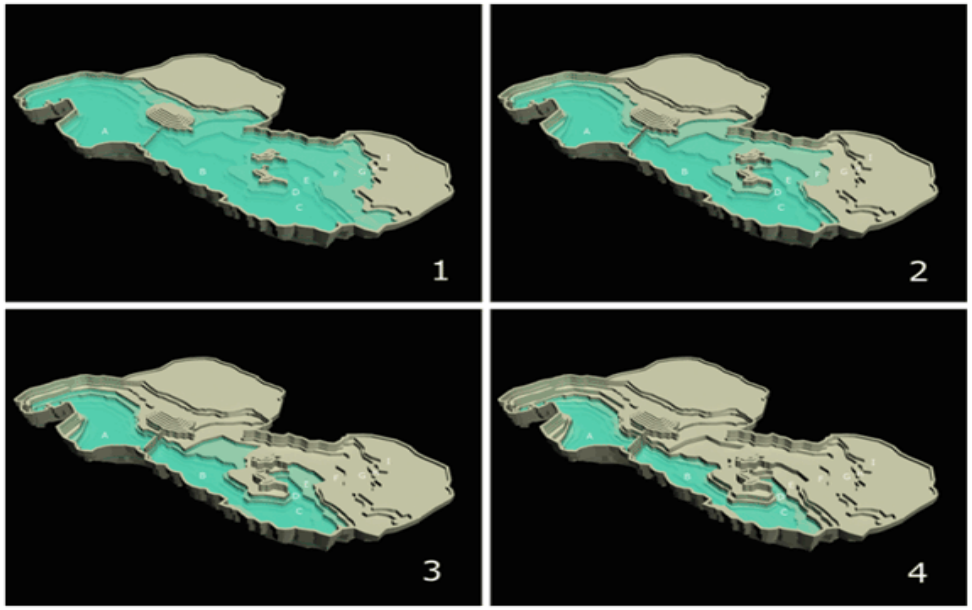
Remarkable similarity Between the Sister Lakes



4300 km²	Area	5100 km²
4.4 m	Mean Depth	6 m
1280 m	Elevation	1275 m

Both have causeways dividing them; both have watersheds in 3 states

LU and GSL are both like flat Frying Pans



Lake Tahoe
192 sq. miles
1,645 feet max. depth

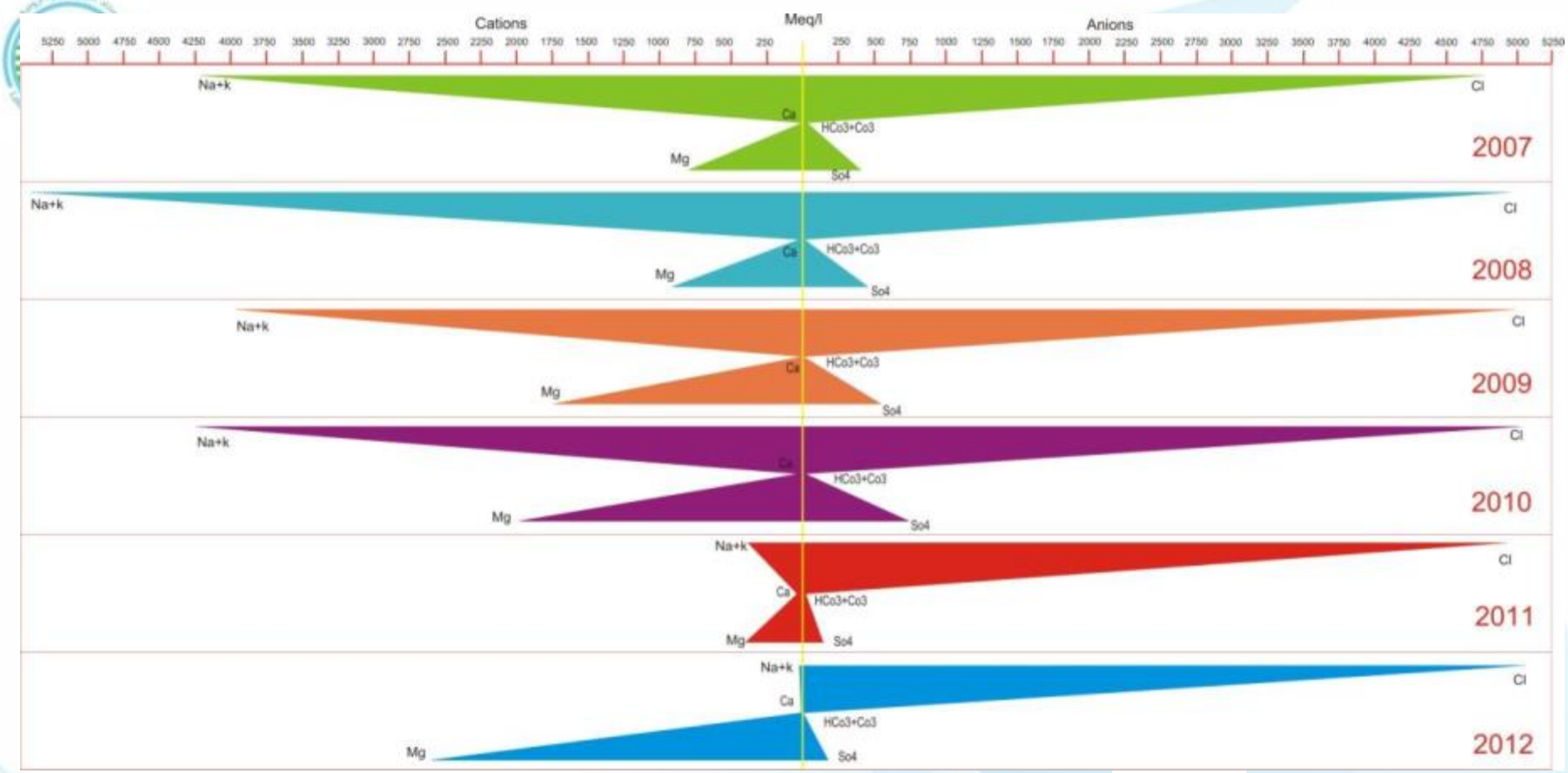
Pyramid Lake
188 sq. miles
356 feet max. depth

Mono Lake
69 sq. miles
160 feet max. depth

Great Salt Lake
1730 sq. miles
33 feet max. depth

Approved Plans

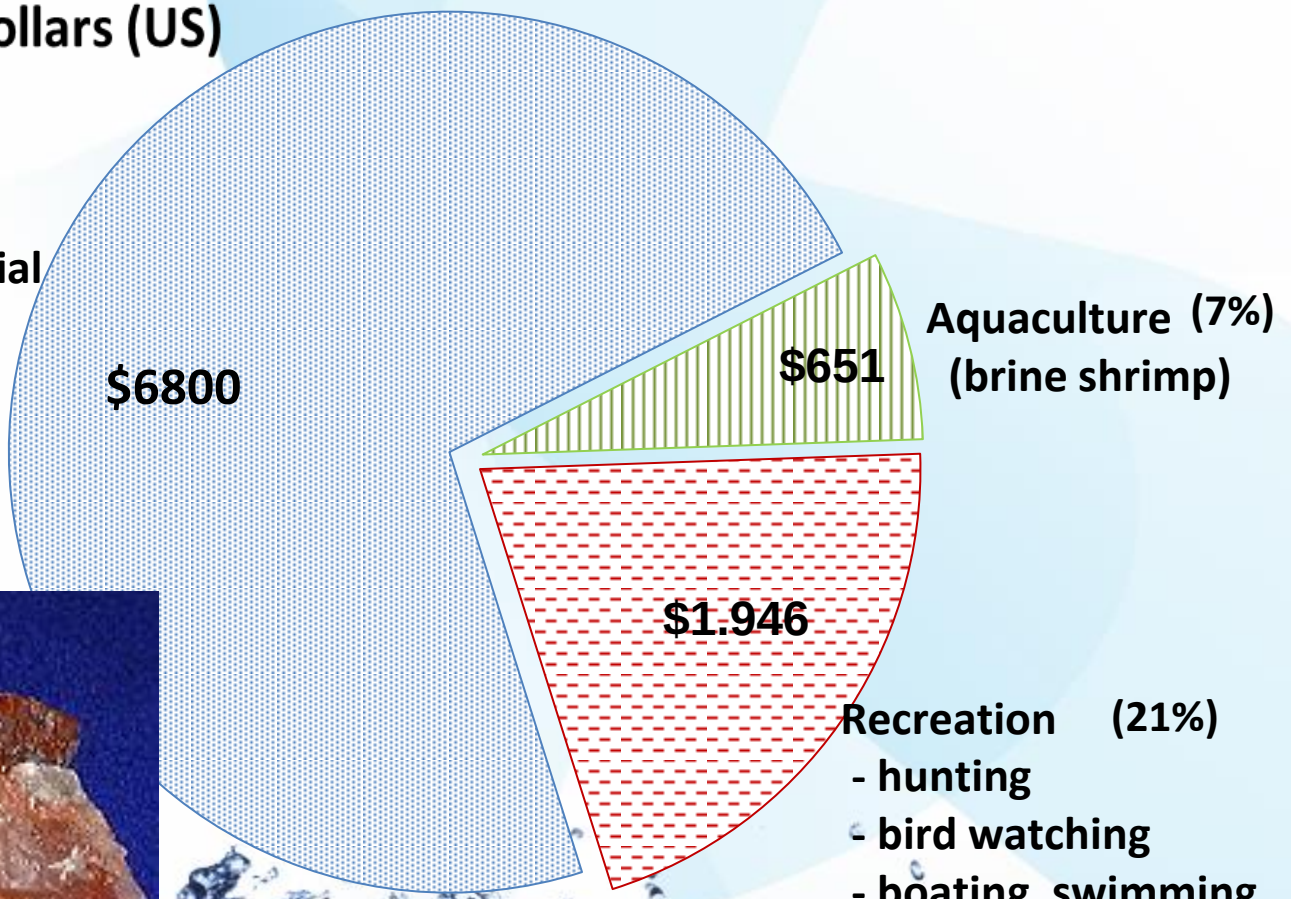
14. Assessing the feasibility of industrial salt mining in the Lake's basin in compliance with environmental considerations



Changing of major Ions of brine to 3 new stages in wet, semi arid and arid conditions from 2007 to 2011

During the time, sodium concentrations have decreased compared to Mg concentration, which indicates huge amounts of Halite have been deposited on Lake's periphery and bed. That is, sodium has passed from solution phase to solid phase

Economic Value of the Great Salt Lake – $9.4 Billion (US)
8% of the gross economic product of the State of Utah
(Makes people interested in the lake)



(Bioeconomics 2012)

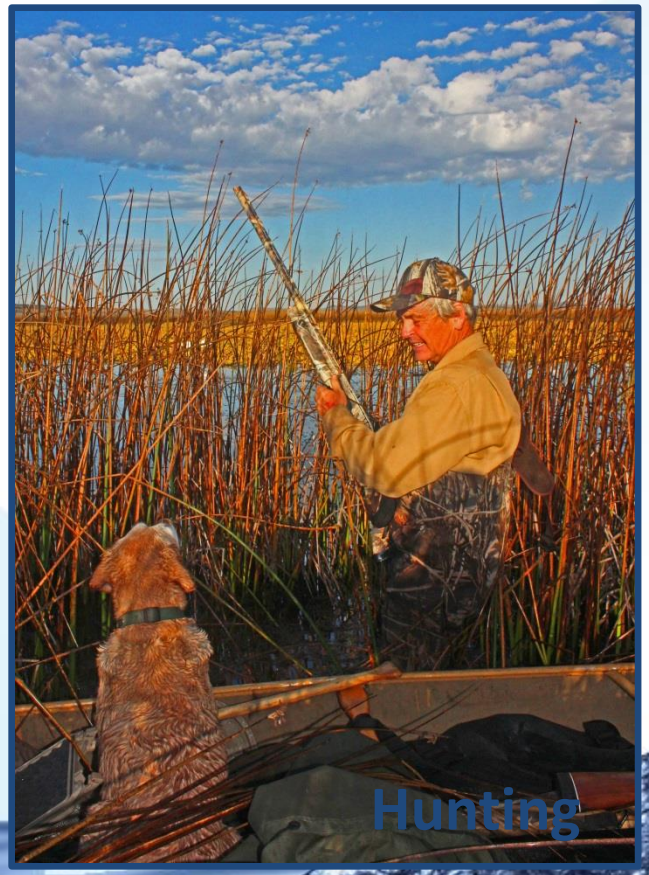
Salt and Mineral Harvest

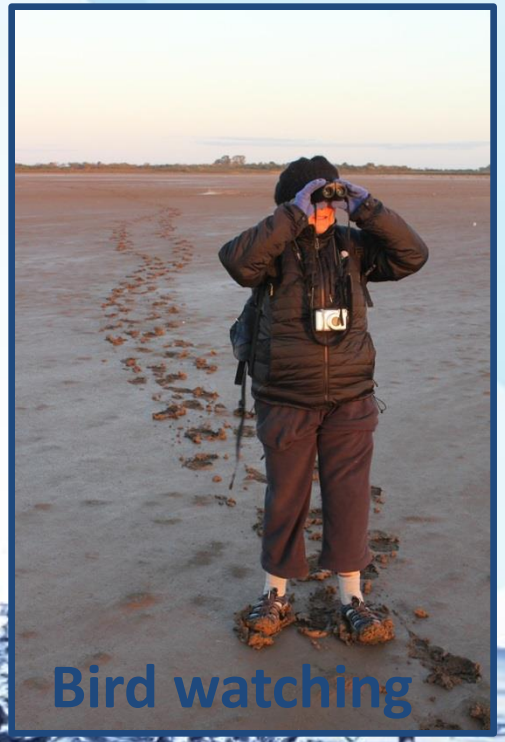
$ 6800 Million

- magnesium (Mg)
- potash (KSO_4)
- titanium (Ti)
- salt (NaCl)

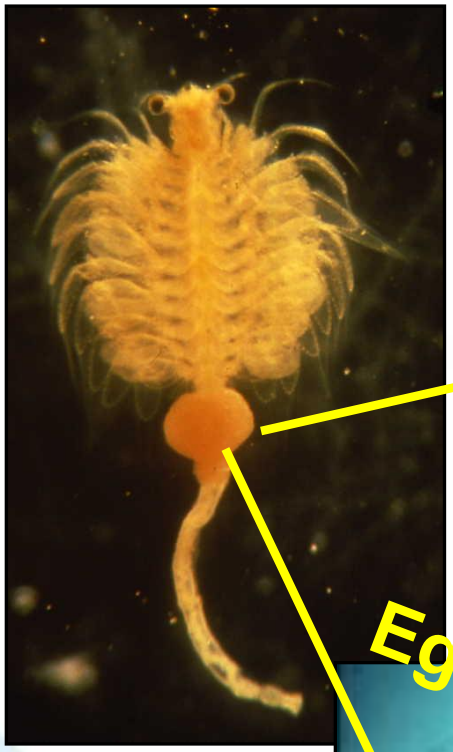
Great Salt Lake Resources

Recreation ($650 million)



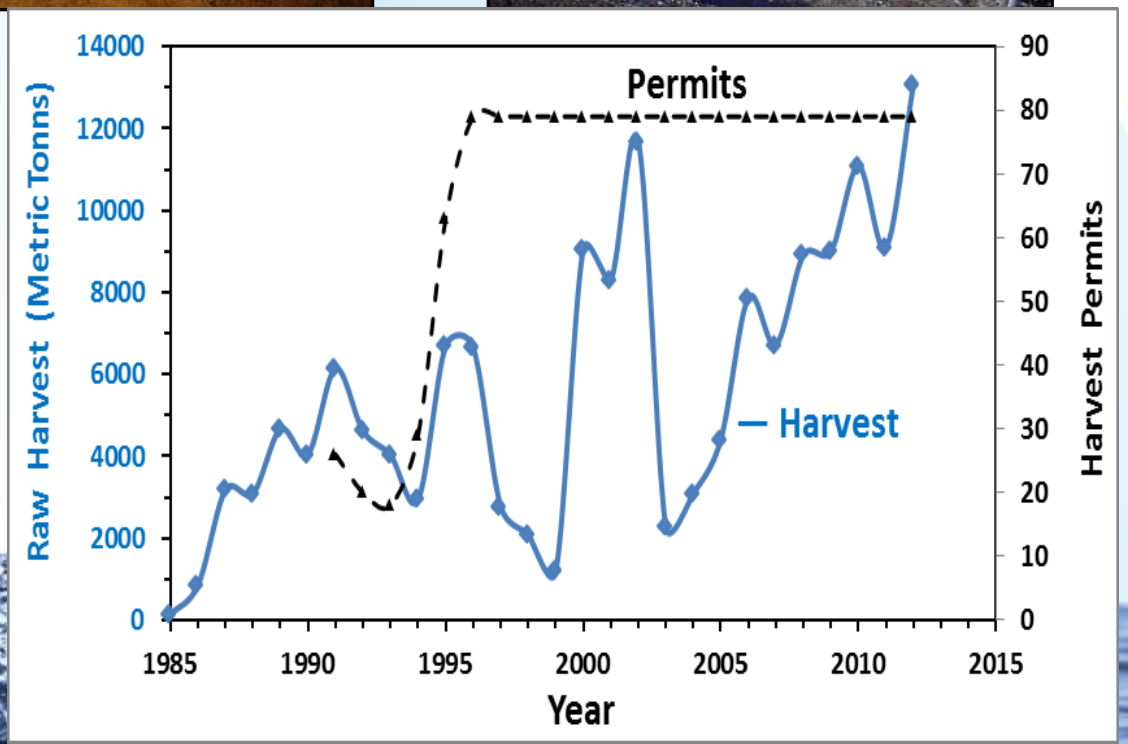


Brine Shrimp
(Artemia franciscana)



Egg (cysts)

$650 million of total economic benefit



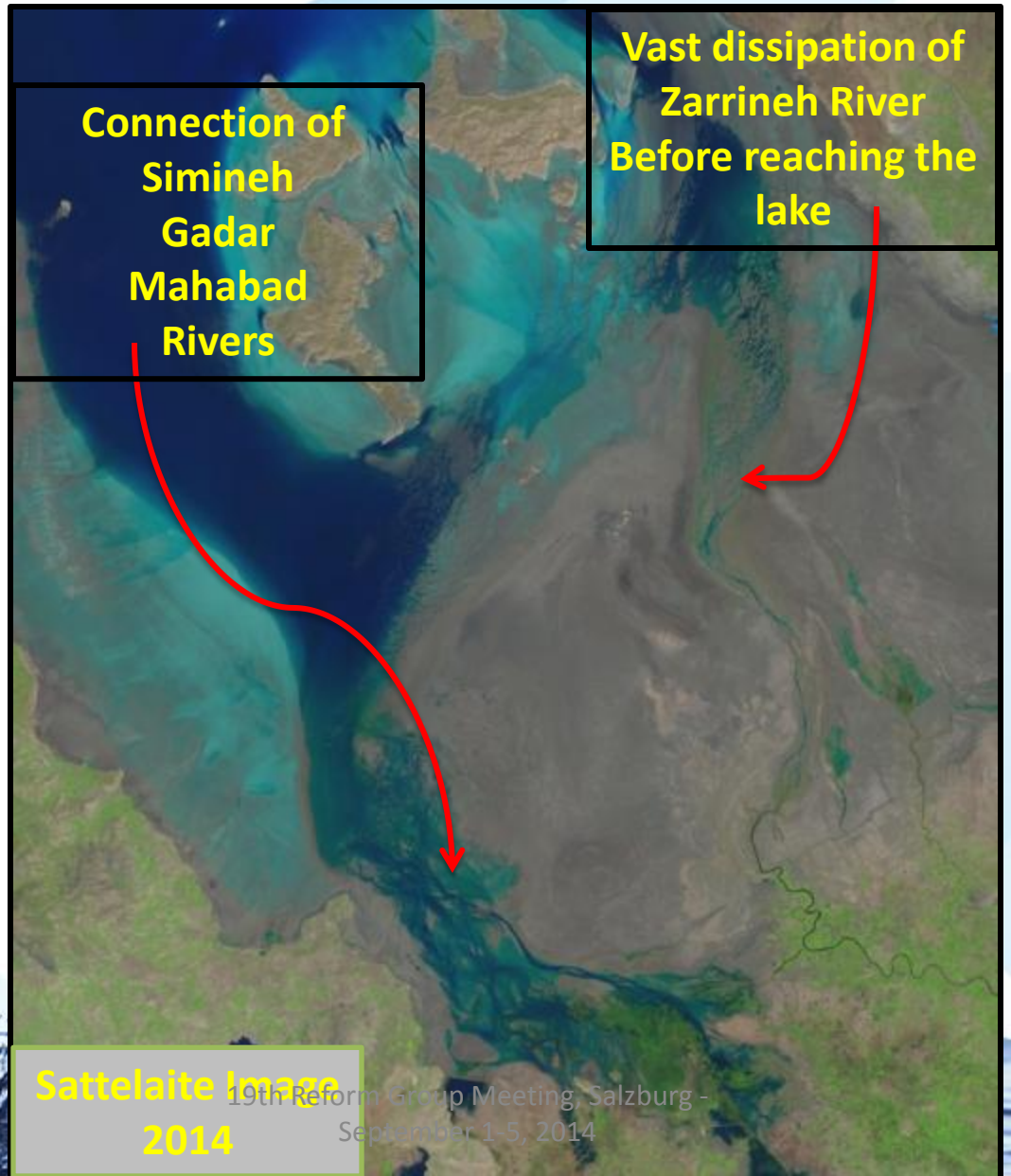
Existence Values
(Intangible values)

If you have a sick child you love, you have to make sacrifices to save the child. Who is going to make those sacrifices to save Lake Urmia?

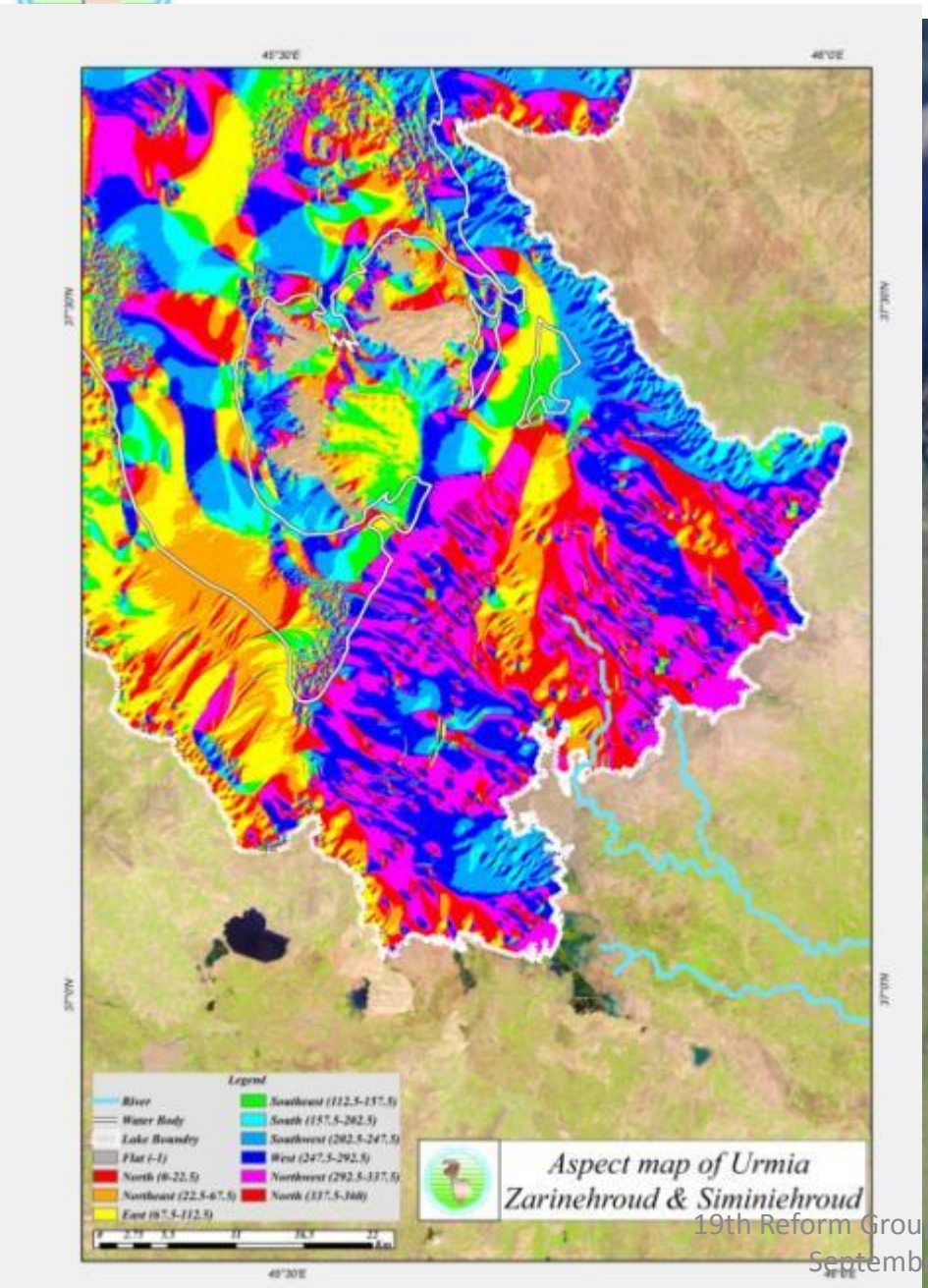
Additional Measures Suggested by the Lake Restoration Steering Committee (Approved on 6/29/2014)

15. Direct transfer of rivers' water to the remaining water body of the lake
16. Identification of dust production sources and their stabilization
17. Study and implementation of ecological priorities in the southern Lake Urmia National Park

Water Losses Before Rivers Reach the Water Body



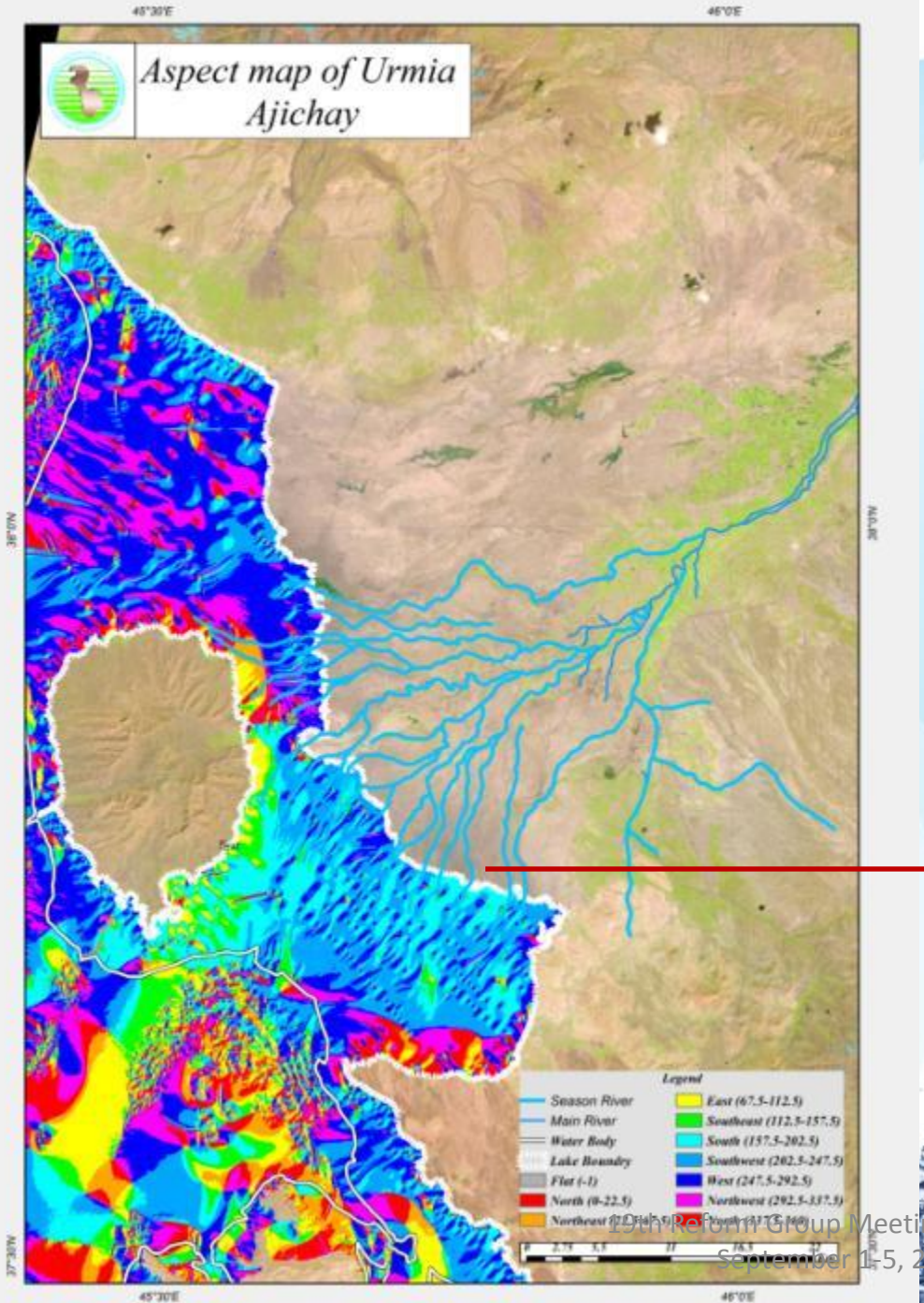
Slopes of the southern shores of the Lake




نظام آباد
پل میاندوآب

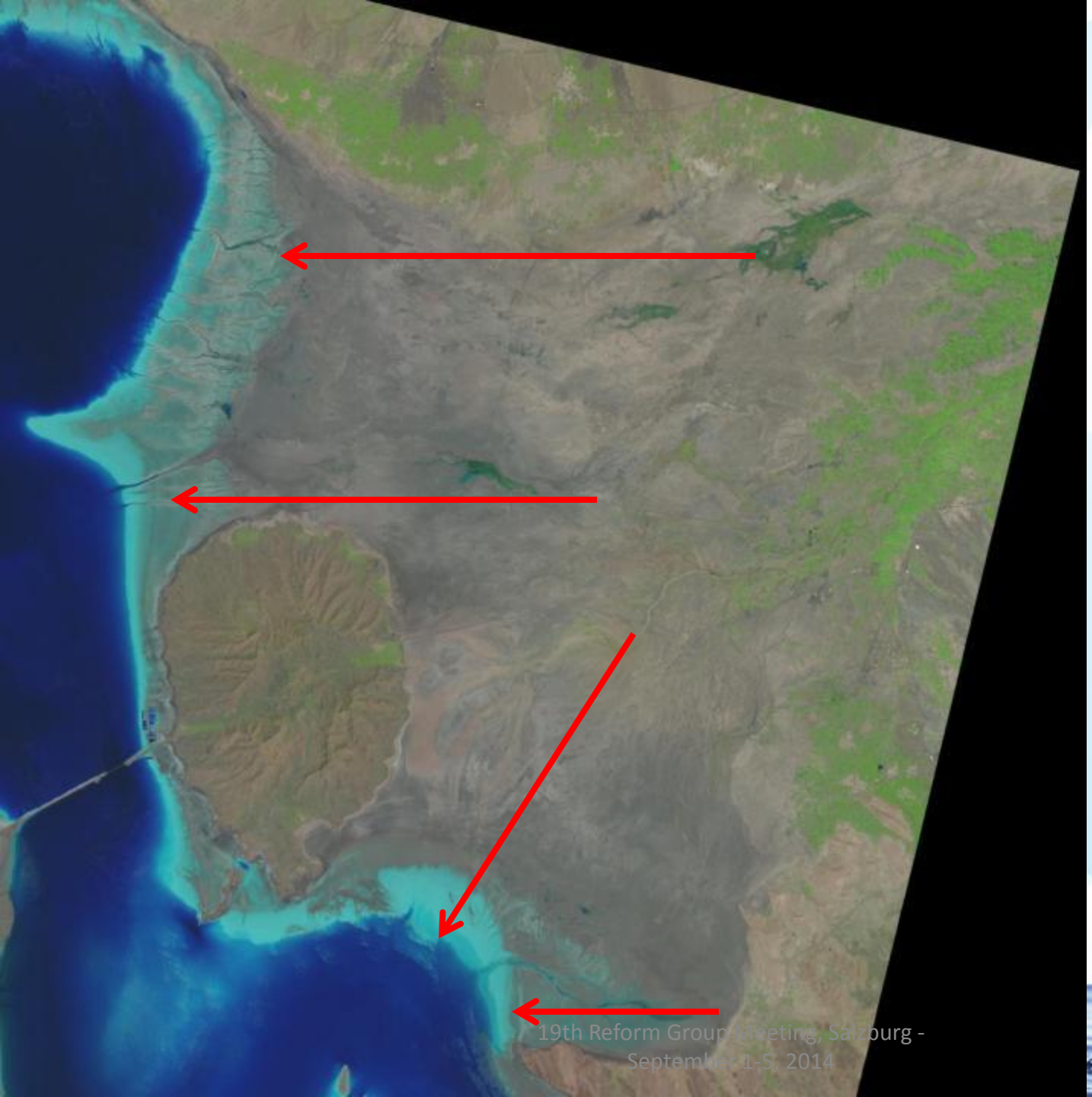

45°30'E
46°0'E
37°30'N
37°0'N
Conection plan of
Zarinehroud to Siminiehroud
Plan 2
Plan 1
Legend
River
Water Body
Lake Boundry
Plan 1
Plan 2
Plan 1
Plan 2
0
4.75
9.5
19
28.5
38

طرح‌های اتصال زرینه‌رود به سیمینه‌رود



Slopes of the Eastern Shores

Aji Chai



Routs Which Need Modific ation

16. Identification of dust production sources and their stabilization

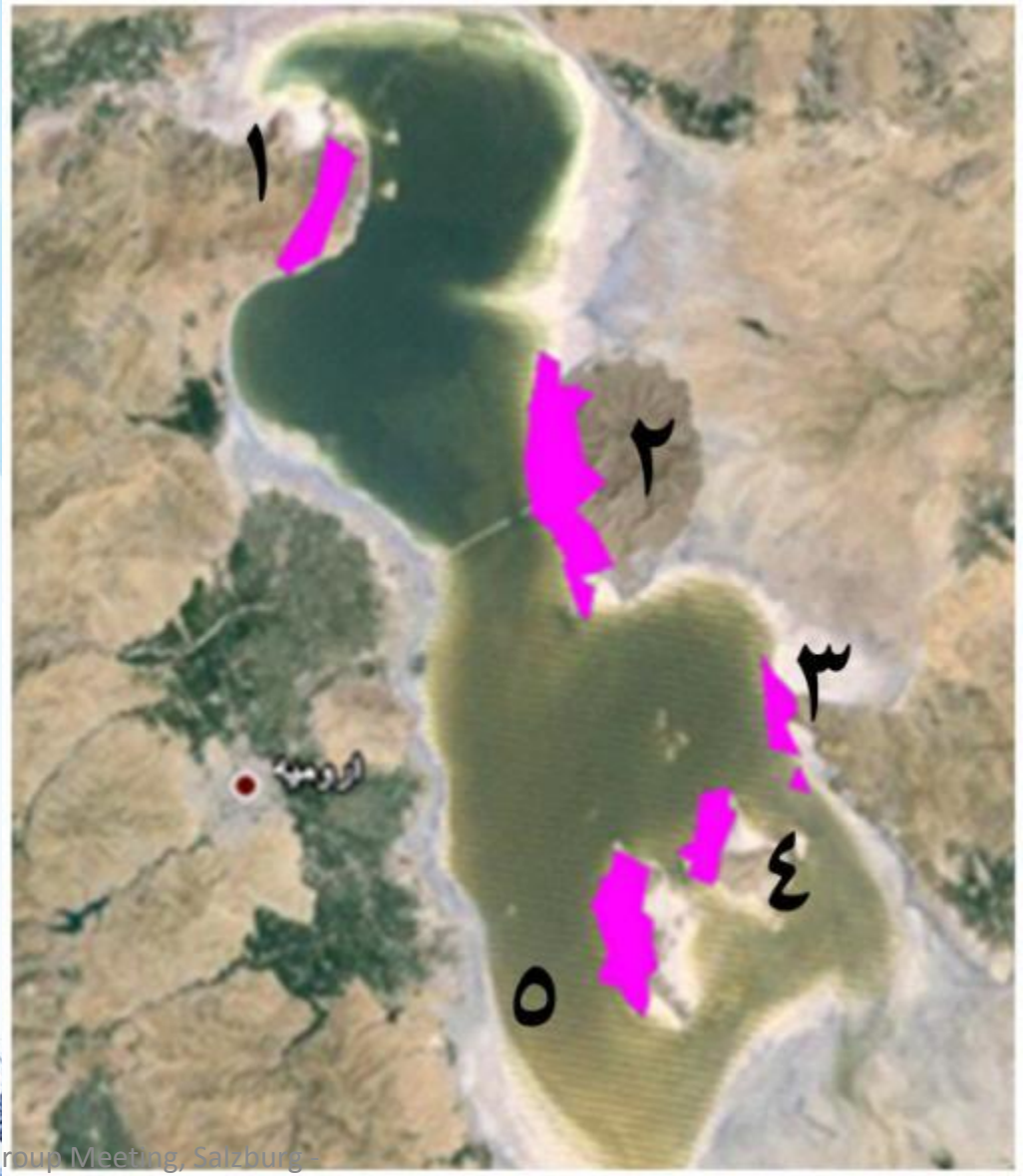
Thick Layers of Salt after Water Evaporation

Silty-Clay Dusts

Sand Dunes on the Southern Shores

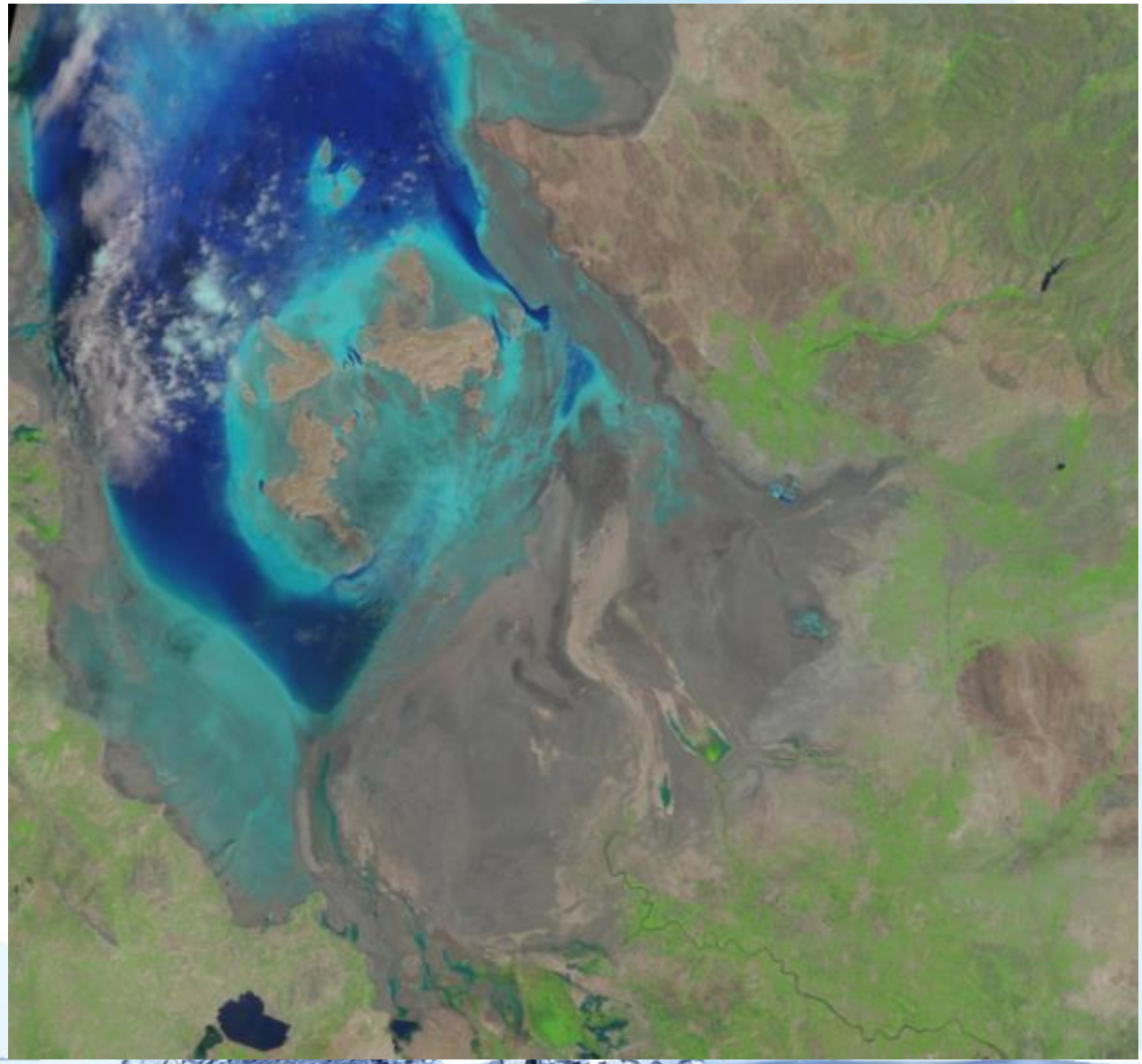
Centers of Observed Dust Storms

Frequency	Area Square Km	No.
1	39	1
6	88	2
1	23	3
4	23	4
4	44	5

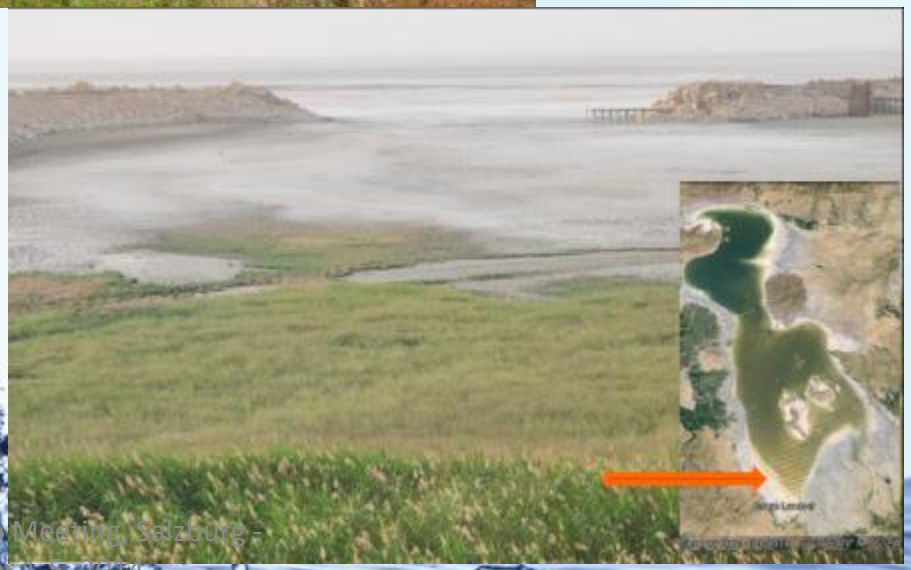


17. Study and implementation of ecological priorities in the southern Lake Urmia National Park

محدوده جنوبی دریاچه – اردیبهشت ۱۳۹۳



Southern Shores



Additional Approved Measures

- ✓ 18. Coordination with the judiciary in order to facilitate and accelerate the implementation of law against digging water wells, specially wells affecting surface water
- ✓ 19. Identification of zones affecting river discharges to the Lake and applying sound water management policies to preserve and protect them
- ✓ 20. Accelerating water transfer projects as temporary measures to prevent lake's total disappearnace

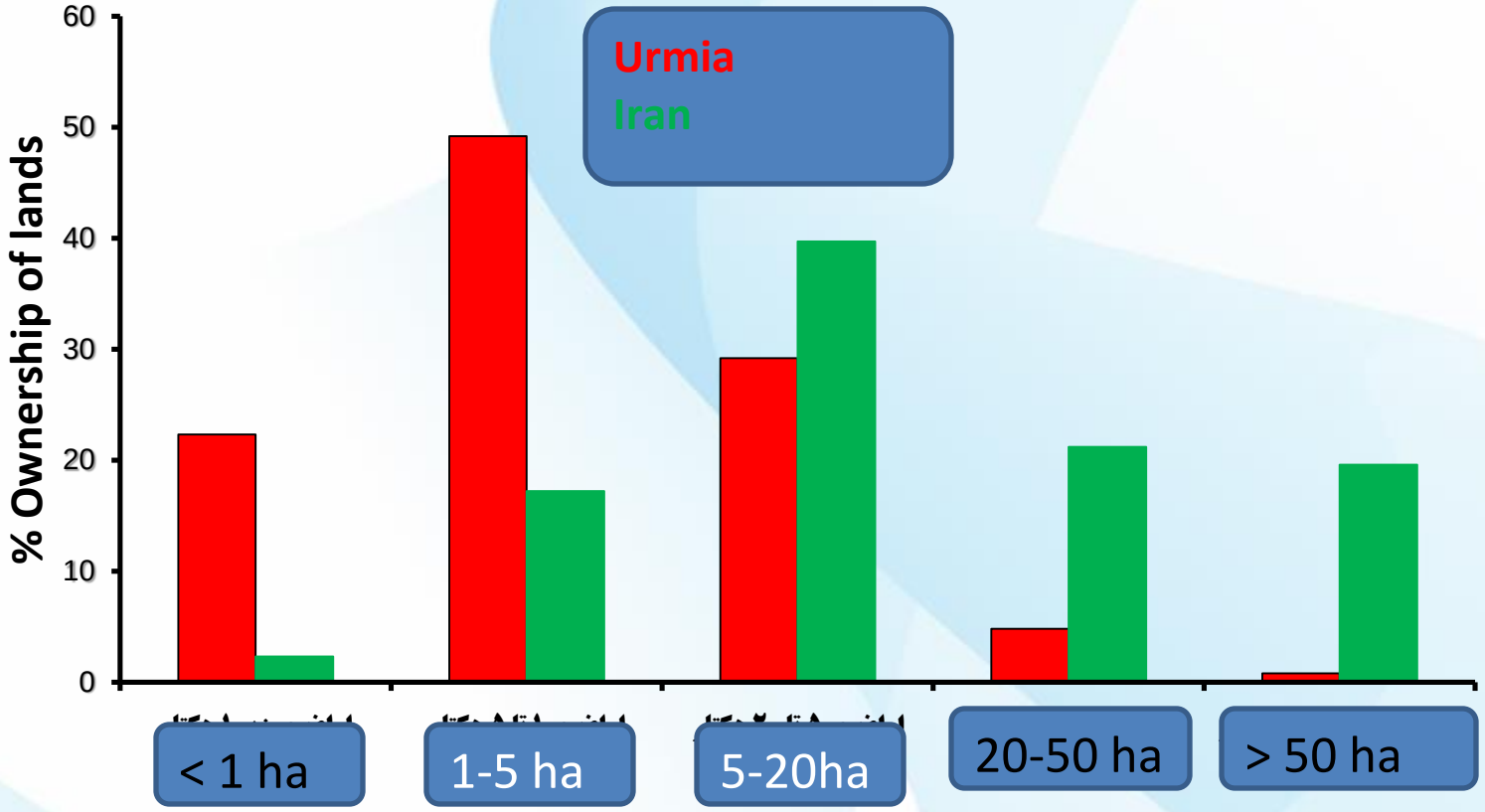
Additional Approved Measures

21. Establishing the “LU Future Studies Research Center” in Urmia (To account for large scale, complex issues and the effects of the global climate change)
22. Conducting an extensive study on the adverse health, safety, environment and social effects due to lake’s deterioration, preparing and implementing programs to prevent , reduce and mange the risks
23. Providing employment opportunities and alternative livelihood programs by relevant agencies

2006 Economic Statistics of the Basin

% Water Consumption	% Employment	% Basin Gross Product	Sector
1	36.5	58	Service
1.4	34.2	27	Industry
89	29.3	15	Agriculture

Land Ownership in the Basin



Additional Approved Measures

24. Feasibility study of using new technologies to revive the Lake
25. Study of the Caspian Sea Water Transfer Project
26. Study of indigenous halophytes and the feasibility of planting them on the dried lake bed

Fundamental Solution

Budget	• Development Plans, Balanced Budgeting • Tax reformation
Water Resources	• Revision of role of water in National Development Plan • Capping the agricultural water use to around 40% of renewable water
Energy Consumption	• Moving in direction of renewable energies • Revision of the fossil fuel role in the national development plan

Comparison of Iran's GDP

Rank	Country	Nominal GDP	Agr. %	Industry %	Services%	Agr. Net	Ind. Net	Services Net
0	World	71,707,302	5.90%	30.50%	63.60%	4,230,731	21,870,727	45,605,844
1	United States	15,684,750	1.12%	19.10%	79.70%	188,217	2,995,787	12,500,746
2	China	9,181,377	10.00%	43.90%	46.10%	918,138	3,611,671	3,792,665
3	Japan	5,963,969	1.20%	27.50%	71.40%	71,568	1,640,091	4,258,274
4	Germany	3,400,579	0.80%	28.10%	71.10%	27,205	955,563	2,417,812
5	France	2,608,699	1.90%	18.30%	79.80%	49,565	477,392	2,081,742
6	United Kingdom	2,440,505	0.70%	21%	78.30%	17,084	512,506	1,910,915
7	Brazil	2,395,968	5.40%	27.40%	67.20%	129,382	656,495	1,610,090
8	Russia	2,021,960	3.90%	36%	60.10%	78,856	727,906	1,215,198
25	Iran	482,445	11.20%	40.60%	48.20%	54,034	195,873	232,538

Share of agriculture in GDP

Rank	Country	Nominal GDP	Agr. %	Industry %	Services%	Agr. Net	Ind. Net	Services Net
1	India	1,841,710	17.40%	25.80%	56.90%	320,458	475,161	1,047,933
2	Indonesia	894,854	14.30%	46.90%	38.80%	127,964	419,687	347,203
3	Iran	482,445	11.20%	40.60%	48.20%	54,034	195,873	232,538
4	China	9,181,377	10.00%	43.90%	46.10%	918,138	3,611,671	3,792,665
5	Turkey	783,064	8.90%	28.10%	63%	69,693	220,041	493,330
6	World	**71,707,302**	**5.90%**	**30.50%**	**63.60%**	**4,230,731**	**21,870,727**	**45,605,844**
21	Switzerland	622,855	1.30%	27.70%	71%	8,097	172,531	442,227
22	Japan	5,963,969	1.20%	27.50%	71.40%	71,568	1,640,091	4,258,274
23	United States	15,684,750	1.12%	19.10%	79.70%	188,217	2,995,787	12,500,746
24	Germany	3,400,579	0.80%	28.10%	71.10%	27,205	955,563	2,417,812
25	United Kingdom	2,440,505	0.70%	21%	78.30%	17,084	512,506	1,910,915
26	Belgium	513,396	0.70%	21.60%	77.70%	3,594	110,894	398,909

Share of industry in the GDP

Rank	Country	Nominal GDP	Agr. %	Industry %	Services%	Agr. Net	Ind. Net	Services Net
1	Saudi Arabia	657,049	2%	66.90%	31.10%	13,141	439,566	204,342
2	Indonesia	894,854	14.30%	46.90%	38.80%	127,964	419,687	347,203
3	China	9,181,377	10.00%	43.90%	46.10%	918,138	3,611,671	3,792,665
4	Iran	482,445	11.20%	40.60%	48.20%	54,034	195,873	232,538
5	South Korea	1,151,271	2.70%	39.80%	57.50%	31,084	458,206	661,981
22	Netherlands	770,224	2.80%	24.10%	73.20%	21,566	185,624	563,804
23	Belgium	513,396	0.70%	21.60%	77.70%	3,594	110,894	398,909
24	United Kingdom	2,440,505	0.70%	21%	78.30%	17,084	512,506	1,910,915
25	United States	15,684,750	1.12%	19.10%	79.70%	188,217	2,995,787	12,500,746
26	France	2,608,699	1.90%	18.30%	79.80%	49,565	477,392	2,081,742

Share of services in GDP

Rank	Country	Nominal GDP	Agr. %	Industry %	Services %	Agr. Net	Ind. Net	Services Net
1	France	2,608,699	1.90%	18.30%	79.80%	49,565	477,392	2,081,742
2	United States	15,684,750	1.12%	19.10%	79.70%	188,217	2,995,787	12,500,746
3	United Kingdom	2,440,505	0.70%	21%	78.30%	17,084	512,506	1,910,915
4	Belgium	513,396	0.70%	21.60%	77.70%	3,594	110,894	398,909
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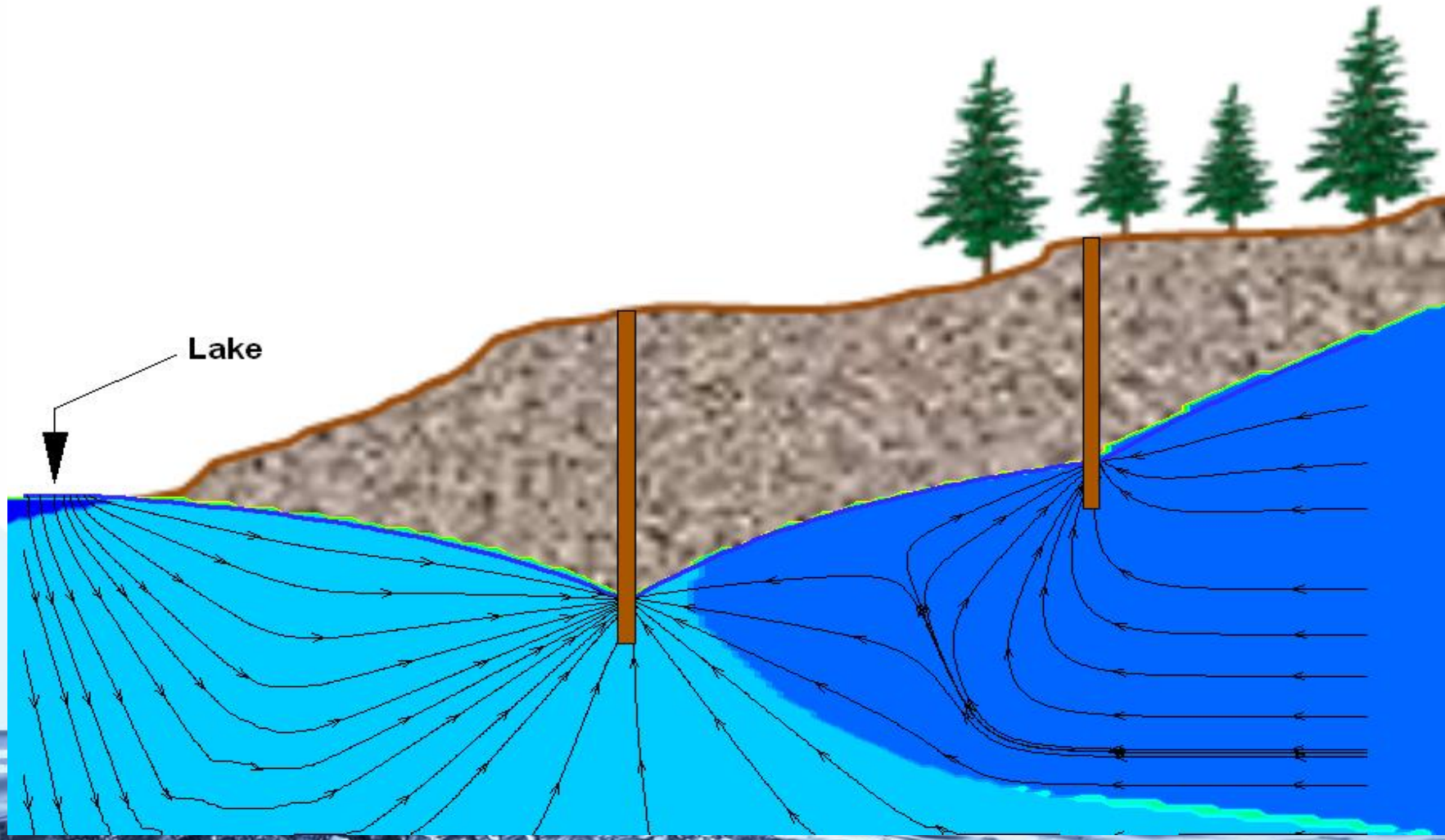
Calculation of Salt Entry to the LU from Caspian Project

	For Conserved Area	3500	km2
Estimated	Net Evap m/y	0.85	m
Total Evap/yr	Needed water	2.975	B C M

Transferred water/year	Salt/Liter	Salt Content/Year	SG	Volume	Average Thickness
In iters	in Grams	In Tons	tons/m3	m3/year	mm/year
2.975E+12	13	38,675,000	2.17	17,822,581	5.09

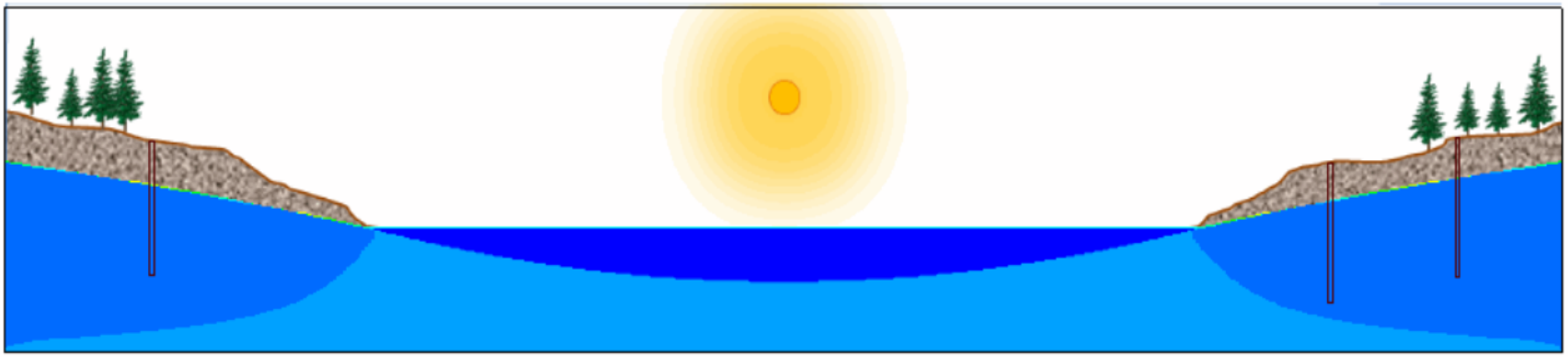
total initial Vol.	Salt	Salt Content	Age in yrs	Salt Entry	Salt Entry Ratio
m3	gr/lit	tons	Estimated	per year in Tons	Casp/Naural
30000000000	100	3000000000	20000	150000	258

Saltwater Intrusion



Saltwater Intrusion

Lake's water level depletion and salt water intrusion into fresh water due to excessive extraction of water from wells.



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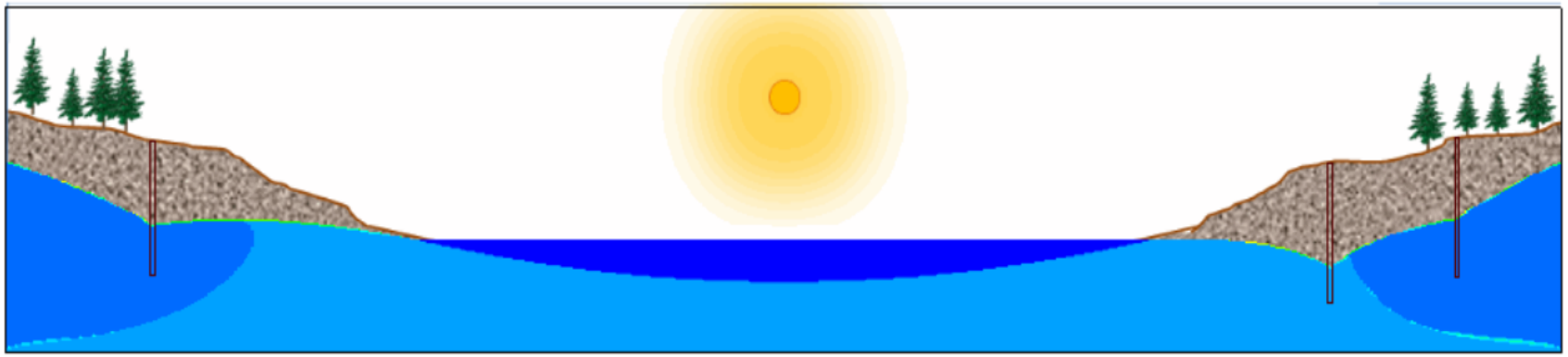

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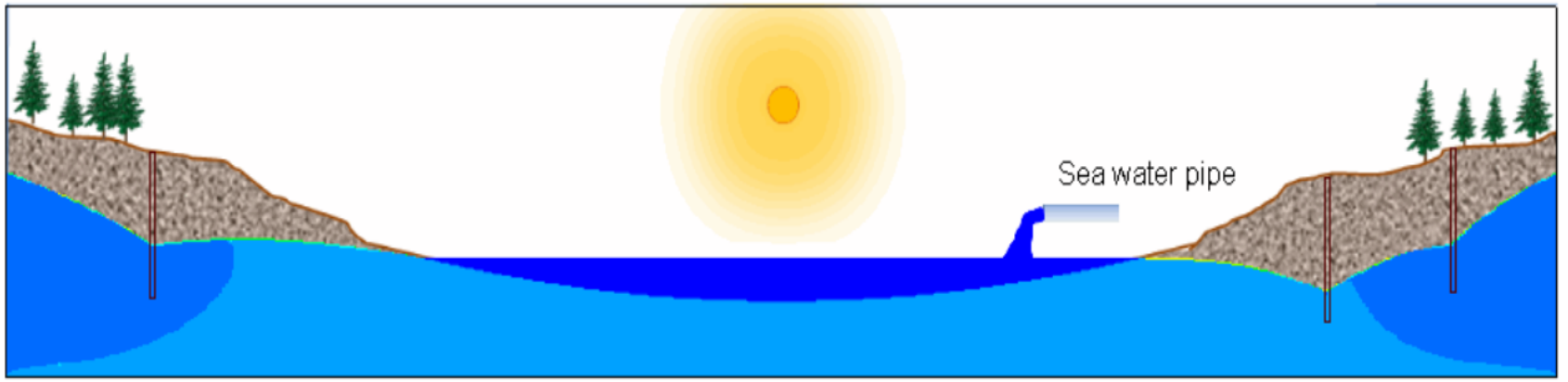
Saltwater Intrusion

Amplification of salt water intrusion caused by recharging the lake with sea water



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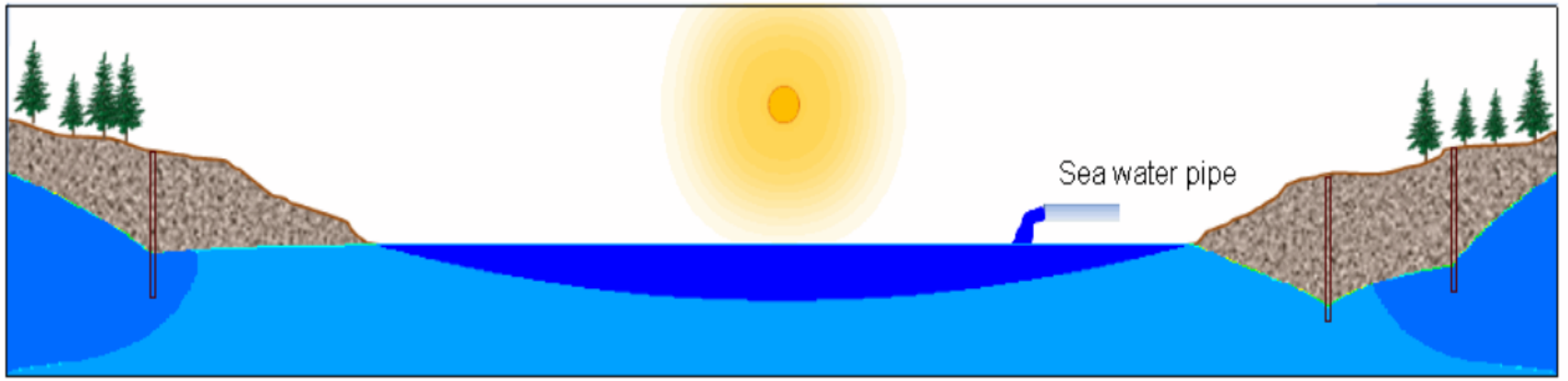

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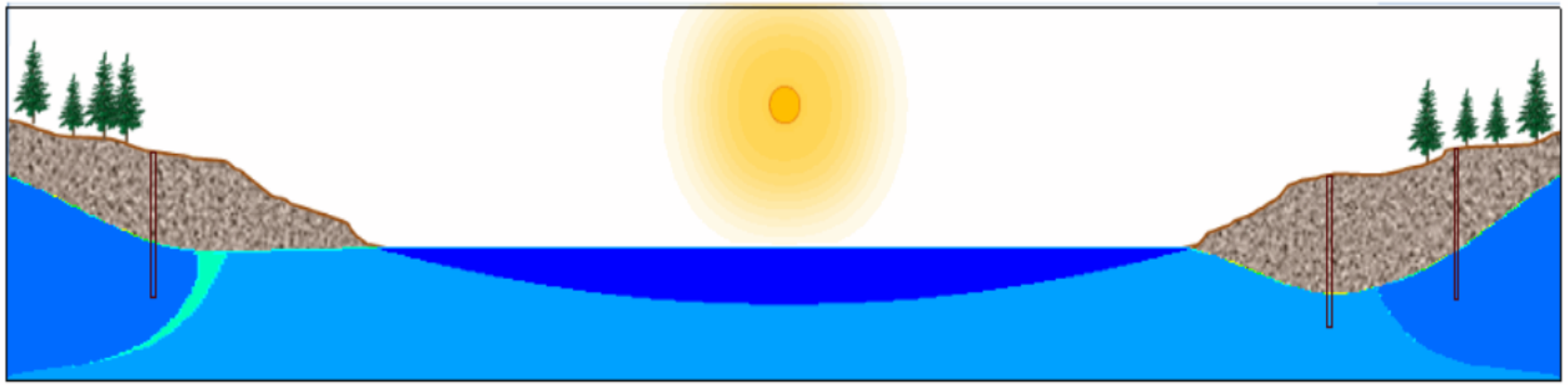
Saltwater Intrusion

Stopping of the water extraction from the wells



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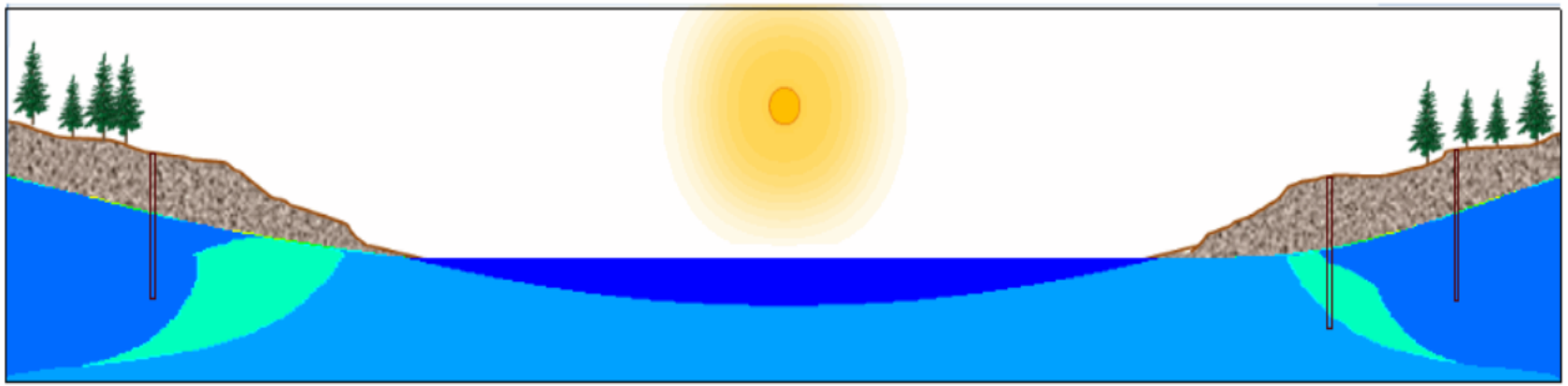
Stopping of the water extraction from the wells



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2- Dr. Razieh Lak from the Iranian Geosciences Institute

3- Dr. Moradi, Dr. Golabian, Dr. Zeynalpour

4- Kalantari Commission's Colleagues

5- Ministry of Energy of Iran (Departments and Staff)

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Thanks for patiently Listening!

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Questions?

bahramtaheri1011@yahoo.com