UNESCO Chair on
Coastal Geo-Hazard Analysis
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Abstract:

Lake Urmia is one of the most important and valuable water ecosystems in Iran and is known as the largest and saltiest permanent lake in Iran and one of the largest supersaturated lakes in the world, and because of its unique ecological values as an international park and wetland and because of the nature suitable for the permanent and temporary living of all kinds of rare birds of the world and the natural beauty of its coasts and islands have been introduced as a biosphere reserve by "UNESCO" in 1976.

The catchment area of Lake Urmia with an area of about 5,801 square kilometers. This basin is located in the northwest of Iran and is surrounded by the northern part of Zagros mountains, the southern slope of Sabalan Mountain and the northern, western and southern slopes of Sahand mountain.

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Standard Instruction for Salt Extraction from Urmia Lake with Enviromental Considerations (part II)

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Standard Instruction for Salt Extraction from Urmia Lake with Environmental Considerations (part II)

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Contents

Introduction..... 1
2- Instruction for Salt Extraction 6
2-1- DRY SALT 11
2-2- Machinery and Extraction equipment's..... 12
2-3- Extraction Zone 15
2-4- Extraction Time (schedule) 15
2-5- Extraction Amount..... 16
2-6- Depth of Extraction 17
2-7- Temporary Depot 17
2-8- Loading and Transportation 24
Conclusion 30
Reference: 33

Table of Figures

Figure 1: Lake Urmia water level fluctuation in the last 90 years (between 1930 and 2020), modified from (Darvishi Khatouni and Mohammadi, 2011). m.a.s.l meter above sea level. 2
Figure 2: Lake Urmia bathymetry based on measured water depth in both (a) wet (April) and (b) dry (September) seasons of 2019 5

Table of Table

Table 1: Salt storage in conical pile 21
Table 2: Salt storage in linear pile 23
Table 3: Environmental Supervision Checklist 26

Introduction

Lake Urmia is considered the largest salt water lake in Iran, and second- largest hypersaline lake in the world, and has severe restrictions on water resources and becoming a Salt Lake increasingly. The annual precipitation is relatively low (350 mm/y; Figure 1) while the evaporation is high (over 1,000 mm/y) (Lak et al., 2022).

Figure 1: Lake Urmia water level fluctuation in the last 90 years (between 1930 and 2020), modified from (Darvishi Khatouni and Mohammadi, 2011). m.a.s.l meter above sea level.

Evaluation of lakes drying up is one the most important subjects in ecosystem changes. The Urmia Lake which is located in NW Iran formerly covered an area around 60,000 km^2, before 1989, contained almost 30,000 million m^3 of water. Urmia Lake provides important cultural, economic, aesthetic, recreational and scientific values. The Lake area has decreased by 90% in recent decades. The lake area has been treated by multiple anthropogenic activities, including increased agricultural activity, Urban expansion, extensive construction of dams and anthropogenic changes to the lake system including a constructed causeway as well as sever climate changes- induced droughts. As a result, the salinity of the lake has sharply increased which is disturbing the ecosystems, local agriculture and livelihoods, regional health, as well as tourism (Unaided Nation Environment Programmed: UNEP,2012). In this respect, it is of high important to identify the responsible regional factors to develop strategies against this tremendous decline process.

The lake experiences an extremely rapid water level fall of about 6 m in the last two decades due to human intervention. The rapid water level fall has affected the lake area, water volume, the lake water composition and the brine type.

Lake Urmia is an intra-continental lake with a present day elevation of about 1, 27105 m.a.s.l (meter above sea level). The lake is surrounded by the west Alborz-Azerbaijan mountains (4811 m.a.s.l) with a mean

elevation of 2000 m. Lake Urmia, is 15-50 km wide, its lake surface area accounts for ca. 5490 m^2, and its catchment to ca. 51876 km^2 is comparable in side with the Great Salt Lake in the U.S.A. (Lak et al.,2022). Similar to other hypersaline lakes, Lake Urmia experiences rapid seasonal water level fluctuation, which were the maximum lake water depth is ca. 235 cm in the welt season and ca. 242 cm in the dry season (Figure 2). Twenty-eight perennial and ephemeral rivers, snow and rain (average annual precipitation ca. 330 mm), and under ground-water spring are contributing to the hydrological budget of the lake. The lake water salinity ranges between 120 and 380 g/L, depending a season and water depth conditions. A wide spectrum of exposed sedimentary, igneous, and metamorphic rocks alone with unconsolidated fluvial and alluvial sediment, is the main source of the clastic sediments and soluble ions of the lake. More than 80% of the lake water input enters the lake from the south. Several rivers from the east and north of the lake are draining evaporitic-continental sedimentary rocks and supply most of the dissolved ions (>80%) and suspended louds in to the lake. Construction of the causeway in the coastal part of the lake has divided the lake into a northern and southern part.

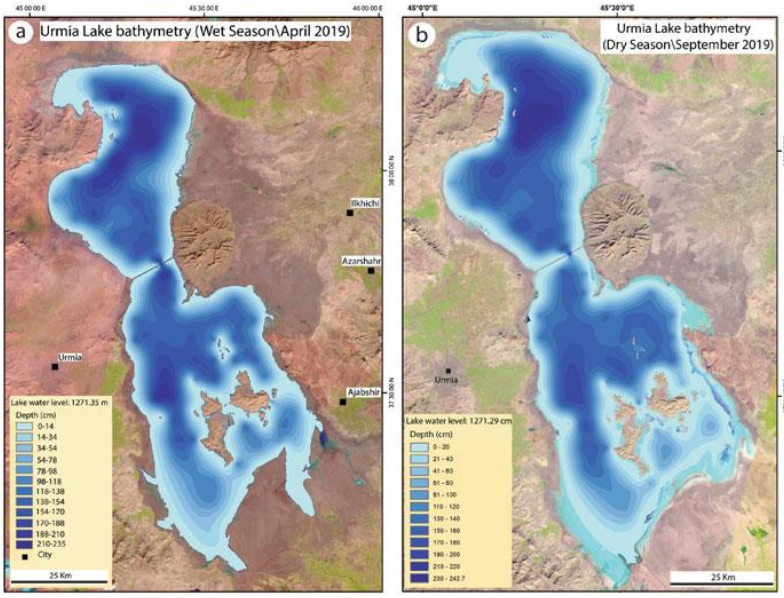

Figure 2: Lake Urmia bathymetry based on measured water depth in both (a) wet (April) and (b) dry (September) seasons of 2019

It is worth noting that the causeway extremely changed the hydrodynamic system, the water physicochemical composition and parameters, and the limnic sediment distribution pattern in the last 30 years. In addition, the construction of several dams on the rivers, the extraction and diversion of ground water, and an extreme expansion of agricultural lands led to a rapid water level fall by ca. 6 m from 1996 Due to this water level fall, over 60% of the lake a large part, of the lake area is now exposed as a muddy-salty and salt plain.

Sedimentary records of Lake Urmia, indicates that before the extreme water level fall the lake experienced a clastic-biochemical lacustrine setting terrigeneous and biochemical sediments were the major and minor lake sediment components respectively (Lak et al., 2022). For the last two decades following the rapid water level fall, the lake has now changed to a playa environment with sediment types that changed from terrigeneous-biochemical to chemical in nature with almost pure evaporate mineral precipitations (halite, sylvite, gypsum). In addition, the sedimentary records indicate that the lake water changed from a brackish to saline and finally to a hypersaline system (Mohammadi, 2005).

2- Instruction for Salt Extraction

Lake Urmia with more than of 6 billion tons salt, is confronted with dryness due to some factors. As a result, a huge amount of salt will be deposited in lake floor. The problem is future wind erosion that will disperse salt particles, therefor it will cause a non-pleasant condition for surrounding environment, including lands, agriculture, livestock, pastures, wildlife and finally rural and urban human communities.

One of the positive effect of salt extraction is related to the time when Lake Urmia is dewatered. Whatever quantity of salt decreases in the lake, the salinity level from supersaturated will change to saturated, or will be closer to the long-term salinity of

the lake, which is around 180 to 220 grams per liter. Lake Urmia has only one living animal in salt water, and the maximum salinity tolerable for this species is determined to be 240 grams per liter.

As a national park, Urmia Lake is one of the four environmental zones in the country, and any activity within the limit of this zone is possible by obtaining a permit from the Environmental Protection Organization. The eastern and western Azerbaijan industries and mines organizations are obliged to inquire only for special areas that are eligible for mining activities.

By carrying out fluid modelling using ANSYS FLUET software and particle diffusion modelling by ADMS software, as well as examining the research conducted in the field of particle diffusion and the resulting pollution in different conditions, important and useful information earned that provide a basis for determine the basic instruction for salt extraction with regards to environmental point of view. Examining the shape of salt accumulation stacks, its location, the effects using barriers in front of the stacks, the effects of humidity and other such things can be the main results of the CFD analysis in this study. Thus, the investigation of the topography of the area around the lake, wind direction, climatic conditions and finally the distribution of particles expansion from salt extraction are the results of analysis with the help of ADMS software in this research.

Therefore, considering all the issues raised and the discussion related to the modelling done, (which indicates the dispersion of particles as a result of salt extraction), the main purpose of this instruction is provide a general guidance in order to create minimal adverse effects caused by salt extraction, with an emphasis on reducing dispersion of fine particles in Lake Urmia. Although the discussion of an industrial extraction from the lake has been raised for several years, but due to the lack of definition of a principle and specific plan regarding industrial extraction, the focus of this instruction will mainly cover the general issued related to extraction in this area. Therefore, it is necessary to communicate this instruction to all exploitations and supervisors.

The general considerations of salt extraction according to the environmental regulations of mineral activities[1]are as follows:

- Creating a suitable corridor for the passage and migration of wildlife in coordination with environmental protection organization of the relevant province, according to the technical information provided by the organization in the protected areas and wildlife shelters of Urmia Lake, National Park.

1Environmental regulations of mining activities based on the approval of the Council of Ministers, in the meeting dated 2014/12/04, No. 1395 to 2937.

- It is mandatory to direct the flow of surface water upstream of the salt extraction area outside the site, and return to the original flow after the extraction site location. Necessary and continues measurements should be taken to prevent the emission of dust caused by the extraction, movement of vehicles, and transportation of minerals, together with crushing operations.

Among the other mandatory and general considerations in salt extraction based on environmental standard, as well as regulations and guidelines for mining activities with regard to the special condition of Lake Urmia as a national park, are as follows:

- The applicant for salt extraction must have an establishment license and approval from the General Deportment of Environmental Protection of the Province, as well as an exploitation license from the Industrial, Mine and Trade Organization of the province.
- There is a need to employ all standards related to pollution, air, sound, water, soil and waste within the scope of salt extraction activities.
- During the extraction process, measurement and control of air pollution with an emphasis on the amount of fine dusts should be carried out.
- The non-construction of any near access roads and using of existing routes should be observed.

- In order to access to the extraction site, it might be in some area's machines have traffic problems. In order to facilitate access to the site, the surface of these parts of the road should be improved by using the soil inside the lake. Also, by using the salt sediments inside the lake, it is possible to reconstruct the surface of the damage road, so that traffic can be carried out easily.
- After the extraction operation, surface of the salt should be levelled in order to reduce the contact of the surface with air to prevent wind erosion. The use of biological mulch in coordination with the provincial environmental protection, to control the change of the surface it is recommended.
- The existing and used roads (dirty) should be sprinkled regularly and by using biological mulch and by observing environmental principles to prevent the creation of dusts.
- Avoid creating non-elegant vision.
- Do not destroy vegetation in the area.
- Any processing within the lake area is prohibited and processing operations must be carried out in accordance with the rules and criteria for the establishment of industries in permitted places, and by obtaining a permit from the General Environmental Department of the Province.
- After the completion of salt extraction from a site in one working season, stabilization, salt

recovery and restoration measures should be carried out in order to prevent the release of fine dust particles.

- After stopping the extraction, in the case of strong wind, measures should be taken to prevent and distribution of salt particles during the work stoppage.
- The industrial operator is obliged to use the services of the environmental inspector to carry out the salt extraction activity and submit the relevant contract to the environmental department of the province. It is obvious that the inspector is required to submit all reports, completion check lists and amount of salt extraction to the General Department of Environmental Protection.

2-1- DRY SALT

Extraction dry salt of the lake is mainly done by using specific machinery. Salt sheets, after cracking and crushing (or without crushing) are removed from the ground and transported. At the site, no special operation is done, but during extraction' machines will proceed to the temporary depot and remove salts. At this stage only a temporary shed for guarding and office work it will remain in the site, but will be removed from the site, while operation is finished. Therefore, after the execution of operation any kind of construction, even, for guard building is prohibited.

2-2- Machinery and Extraction equipment's

The requirements for using machines are as follows:

- The necessary tools used for extraction and transportation must be periodically and regally inspected, based on a checklist, and any repair and oil change and ete…. are prohibited during the main activity.
- The use of worn out and unauthorized cars, due to pollution is prohibited.
- Due to the seasonal withdrawals, machines and installation are not an allowed to use permanently.
- The maximum number of loaders that can be used for salt extraction in a 20-hectare site, is determined by 2 machines, which must be removed from the area as soon as possible at the end of activity.
- In order to reducing dusts during extraction, it is necessary to use various types of construction machinery with special purposes. The types of machinery used to break and extract salt from the site are as follows:

GRADER

Grader is a heavy machine that has a large blade for leveling surfaces. Among the applications of this type of machines are the spreading of materials, precise slope making, digging, cutting

and erasing of trenches and other similar operations. Also, it is used for salt extraction and breaking salt surfaces.

BULLDOZER

It is one of the construction machines whose movement is crawling by means of chain wheels. This machine has a steel blade in the front, which has the ability to remove large volumes of materials on the ground. It is useful for removing and transportation of salts, using universal blade.

LOADER

It is one of the most practical constructional machines. This machine is made in different sizes, and due to its great performance and flexibility, is very helpful and efficient.

Among the uses of the loader is earth work, cutting underground excavation, loading tracks, lifting and transporting materials. A variety of accessories such as snow flows, lift track cranes, can be installed on the loader and used for special applications. There two types of loaders, rubber and chains wheels, which are determined according to the type of ground materials.

Using of rubber wheel loader, it is not allowed in the lands with loose cover, due to the breaking of the salt sheets under the tires, and resulting fine dust particles. It is preferable to use chain wheel loader in wet and muddy lands (contain brine).

DRILLING MACHINE

It is among the heavy construction and engineering machines. It has an arm, a bucket joint, and a rotating cabin at the top, and a chain or roller wheel at the bottom. One of the capabilities of this machine is the installation of a hammer (picker), which is very efficient. Installing a hydraulic or pneumatic hammer instead of a bucket makes it possible to demolish the surfaces by means of a set of these two devices (shovel and hammer). Due to the expensive maintenance of this machine, loader is preferable for high volume soft soils. Excavator, it is used for quick digging of canals and pits, demolition and dredging, soil removal, land leveling and mining.

SALT EXTRACTION MACHINE

The "Salt Harvester" is a specific machine for salt extraction. Extraction is done by breaking the salt floor by rotating the rotary drill and cutting the parts with a blade like a snow plow, then the salt is transferred to the transport tracks by conveyor lift. In the new systems, it is possible to extract salt without breaking the salt sheets and also without truck and driver. In these systems, rotating cutters are used to prevent crushing and creating salt particles. Also, this method has a higher efficiency. This system has the ability to accommodate cutting speed with the speed of the vehicle and GPS navigation. The weight of this

machine is 200 to 400 tons, with the extracting capacity between 200 to 400 tons per hour.

2-3- Extraction Zone

- The area of salt extraction on the site should be marked by rods
- Salt extraction in one area should be specified as a zoning (site). Salt extraction starts from one site and after finishing it, the user can enter the next site for extraction. Simultaneous extraction from several and scattered sites is not allowed.
- The area of the extraction zone (for industries) should be a maximum of 20 hectares.
- The extraction zone should be determined in such a way that it has the minimum dimensions in the direction of the prevailing wind. Therefore, in order to have the least particles dispersion, this zone should be longitudinal in the direction of prevailing wind.
- The set-back zone of open-pit mine, according to the approval of the supreme council of mines, is equal to 150 meters.

2-4- Extraction Time (schedule)

- The timing of salt extraction should be such that any extraction of salt and similar minerals takes place seasonally and in non-raining seasons. Based on the several years of experience, the best

possible time to extract salt from salt deposits inside the lake is from the beginning of the summer until the end of the autumn. Otherwise, while rain started, together with surficial water currents, most parts of the lake become marshy, so traffic problem arises. However, the peak of mine activity can be matched with the months of lowest rainfall.

- Outside of the above time frame (from the beginning of summer to the end of autumn), it is forbidden to extract salt.
- During the precipitation all extraction activities should be stopped.
- During strong winds salt extraction should be stopped.
- Extraction permits are only seasonal, and can be extended for the following seasons by approval of Environmental Organization.
- The mining activities must be done in a shortest possible time.

2-5- Extraction Amount

- The amount of permitted extraction should be based on the tonnage mentioned in the mining license issued by the Industries and Mines Organization, according to the country's mining law and executive regulations.

2-6- Depth of Extraction

- The depth of extraction varies based on the depth of salt on the lake surface.
- The depth of extraction should be such that caused no damage to the lake floor.

2-7- Temporary Depot

- In the case of evacuation of salt in the depot, the temporary strong wind flow will cause turbulence and release of particles as well as dispersion of fine dust in the air.
- In order to prevent the dispersion of fine dust in the depot, the following items must be taking into consideration:
    - The temporary depot must be located inside the extraction site.
    - Creating barrier's in the wind direction to prevent the spread of particles.
    - The place of temporary storage of salt should be established by observing the aspects of preserving agricultural and pasture lands, preventing erosion and polluted sea wages.
    - The place of salt accumulation should be at least 300 meters away from the drinking water, irrigation and industrial sources. The place of the temporary depot should be at least 100 meters away from road sides streams. The minimum

distance to the water wells is about 300 meters.

- The storage place must not be located inside the flood plains and should be at least 300 meters away from surface water sources, such as ponds, rivers, lakes, and wetlands.
- The amount of extraction from the temporary pile depot should be proportional to the it's frequency of storage.
- Operation and collection of salt in the lake should be well planned that no temporary salt to be remained in the area at the end of the activity.
- The area of accumulation should be 1.5 meters higher than the surface around and surface should be completely integrated and preferably impermeable.
- Salt usually does not absorb air humidity of less than 75%. In order to prevent it from dissolved and rendered, the salt in the area of accumulation should not be exposed to snow or rain, therefore the place of the temporary salt depot must be impermeable to water. In this regard, storage should be located in a closed space using vegetable fiber covers, tarpaulin, polyethylene, polyurethane or polypropylene. In order to prevent

dispersion of fine dust from the temporary depot and other environmental effects, the storage should be done in a closed place or to use fiber, plant, tarpaulin, polyethylene, polyurethane, or polypropylene.

- If the cover is not used, the accumulation in the open environment must be taken in a short period of time. Designing and creating a sprinkler system to prevent the dispersion of fine dust can also be effective.
- If the dimensions of the accumulation pile are more and the number of piles less, hence the amount of surface that is exposed to rain water and air will be reduced. As a result, the reduction of the surface will optimize the method of controlling the dispersion of fine dust from the piles and penetration of rain water.
- The floor of the storage area should have a proper drainage system to remove the brine and rain water.
- The floor of the accumulation area and the access roads should have a slope of at least 1% against the direction of the accumulation site.

- The slope of water drainage must be towards the surface and underground water resources.
- The dimensions of the temporary depot and the accumulation slope, based on the volume of salt (Salt Storage Handbook (2013)) should be according to the following tables:

Table 1: Salt storage in conical pile

row	the amount of salt	diameter	occupant area	height	length of the lateral slope	pile volume	effected area
	ton	m	m^2	m	m	m^3	m^2
1	21.8	5.89	27.41	1.83	3.35	17	31.49
2	45.4	7.52	44.5	244	4.57	35.38	52.49
3	72.6	8.81	60.85	2.74	5.18	56.6	71.81
4	90.7	9.5	71.07	3.05	5.49	70.75	83.98
5	181.4	11.99	112.69	381	7.01	141.5	133.3
6	272.2	13.72	148.18	4.27	8.23	212.25	174.37
7	362.9	15.06	178	4.72	8.84	283	209.95
8	453.6	16.25	208.1	5.18	9.75	353.75	245.26
9	544.3	17.27	235.04	5.49	10.36	424.5	276.84
10	635	18.16	259.19	5.64	10.67	495.25	305.64
11	725.8	19	283.35	5.94	11.28	566	335.37
12	816.5	19.76	307.5	6.25	11.53	636.75	362.31
13	907.2	20.45	328.87	6.4	12.19	707.5	383.32

14	1814.40	25.76	522.3	8.08	15.24	1415.00	615.93
15	2721.6	29.51	685.6	9.3	17.37	2122.50	809.6
16	3628.8	32.46	824.95	10.21	19.2	2830	972.66
17	4536	35.06	963.37	10.97	20.73	3537.50	1136.17
18	5443.2	37.19	1086.93	11.73	21.95	4245	1282.95
19	6350.4	39.11	1203.98	12.34	23.16	4952.50	1420.44
20	7257.6	40.9	1312.68	12.8	24.05	5660	1549.57
21	8164.8	42.62	1430.66	13.41	25.3	6367.50	1687.99
22	9072	44.1	1524.49	13.87	25.91	7075.00	17911.47

Table 2: Salt storage in linear pile

row	the amount of salt	width	occupant height	volume	area
	ton	m	m	m^3	m^2
1	2.18	5.89	1.83	1.67	2.14
2	3.45	7.52	2.44	2.72	2.69
3	4.72	8.81	2.74	3.71	3.16
4	5.72	9.5	3.05	4.47	3.44
5	8.8	11.99	3.81	6.88	4.27
6	11.52	13.72	4.27	9	4.92
7	13.88	15.06	4.72	10.84	5.39
8	16.24	16.25	5.18	12.65	5.85
9	18.33	17.27	5.49	14.3	6.22
10	20.23	18.16	5.64	15.76	6.5
11	22.14	19	5.94	17.26	6.87
12	23.86	19.76	6.25	18.6	7.15
13	25.67	20.45	6.4	20.04	7.34
14	40.64	25.76	8.08	31.7	9.29
15	53.34	29.51	9.3	41.6	10.59
16	64.59	32.46	10.21	50.37	11.71
17	75.48	35.05	10.97	58.86	12.63
18	84.91	37.19	11.73	66.22	13.38

2-8- Loading and Transportation

Loading salt is like transporting soil and sand and is operational easily. The machines used to transport salt are:

All types of trucks:

Lorry is one of the motorized cargo vehicles whose loading part is connected to the carrier. Lorries are usually used to transport goods and heavy materials.

The trucks used to transport salt are of the following types:

Body Truck: A truck whose maximum height of the resistant wall of the cargo room is about 105 m, from the floor of the room.

Tip Truck: A truck with a room, which is unloaded by a compressor device.

Ceiled Truck: A truck whose cargo area is covered.

Medium size truck or van

- If the traffic path is dirt-road, sprinkling water is necessary to prevent the creation of dust.
- Trucks should not be over loaded in order to prevent overflowing so as a result less dust is produced.
- The movement of the salt transport vehicles inside Lake Urmia is possible only at a distance of 200 m, from the frontage of the lake, and the

movement of vehicles are not allowed outside the above limit.

- If the vehicle is unroofed, it is necessary to have suitable equipment's to cover the roof.
- The covering of the transportation vehicles, should be made of impermeable material, tarpaulin, ete … .

Although facilities and equipment such as conveyor belts and rail tanks can also be used during extraction, but considering the fact that most of the extracting time in this area will be seasonal and temporary, hence it is preferable to prevent the creation of any facilities and constructions in the extraction area.

In order to review and monitor the requirements presented in this instruction, a checklist has been prepared, which must be completed by the environmental supervisor and referred it to the environmental department of the province along with the relevant report.

Table 3: Environmental Supervision Checklist

Row	Environmental obligations	confirm	fail
General requirements			
1	Exploitation license from of industry, mining and trade organization		
2	Approval of the General Department of Environmental Protection of the province		
3	Creation of wildlife passage corridor if necessary		
4	Not changing the course of rivers, disrupting the drainage of rivers and natural waterways		
5	Non-destruction of landscapes, forest lands, pastures and high-quality agricultural lands		
6	Not creating an inelegant landscape in the region		
7	No destruction of vegetation		
8	Conducting the upstream surface water		
9	Non-construction of permanent buildings in the site		
10	Not to place permanent facilities and equipment in the area		
Salt extraction			
Measurement and control of pollution			
1	Controlling the emission of fine dust particles in crushing operations		

2	Use of biological mulch in the extracted		
3	Measuring the concentration of particles in the environment (if needed)		
4	To consider standards related to air, sound, water, soil and waste pollution		
Extraction zone			
5	Barring of the extraction site		
6	Emplacement the site with the smallest dimensions (maximum 20 hectares) in the direction of the prevailing wind		
7	Observing the legal privacy of open pit mines (at least 150 meters)		
8	Respecting the privacy of springs, canals and underground water (at least 500 meter)		
Extraction schedule			
9	Extraction in non-rainy seasons (summer to late autumn)		
10	Stopping extraction activities during possible rain		
11	Stopping extraction activities during strong winds		
12	To observe the minimum time for extraction		
Withdrawal amount			
13	To observe extraction tonnage based on exploitation license		

Depth of extraction			
14	Depth to the salt depth on the lake		
15	No destruction of the lake bed		
Transportation			
Access routs			
1	Not to build new access roads		
2	Improving the existing access routes using barrow materials from the lake area (if needed)		
3	Watering access roads (dirt-road)		
4	Use of biological mulch on access roads		
5	No spreading of salt on the side of the access roads		
6	Respecting the traffic of machinery (up to 200 meters from the lake)		
7	Not using oily compounds to stabilize the soil		
8	Preventing the creation of runoff on the surface of the roads		
Machinery			
9	Approval of technical examination of machinery and equipment		
10	Not using worn out machinery		
11	Non-smearing of the salt collection surface and roads, with oil and grease from vehicles		

12	Creating a cover on transport vehicles		
13	It is preferable to use long walls vehicles		
Temporary depot			
1	Creating barrier in the wind direction		
2	Observing the protection of agricultural lands and pastures in the depot site		
3	Prevention of erosion and production of polluted sewage		
4	Respect limits from drinking water sources (at least 300 meters)		
5	Respect limits from roads and streams (at least 100 meters)		
6	Conformity of the withdrawal from the temporary depot with the storage frequency		
7	Placement of the storage area at a height of 1.5 meters		
8	Using a cover on the stored materials to prevent the penetration of rain and wind		
9	Watering the temporary depot to prevent the spread of fine dust		
10	Reducing of the level of pile accumulation		
11	Checking the dimensions of the stacking pile with the instruction tables		

12	Creating a drainage system for brine and rain water		
13	Creating a proper drainage slope		
14	Complete collection of the temporary depot at the end of the activity in each season		
The end of the extraction operation			
1	Collecting and removing all established facilities and equipment's		
2	Complete elimination of the temporary depot		
3	Leveling of the removed surface		
4	Salt stabilization, restoration and reconstruction measures at the site		
5	Cleaning the soil of access paths to the primary situation		

Conclusion

The main goal of this research was compilation of an instruction for salt extraction in Urmia Lake with regards to environmental considerations.

With due to the problems occurred during the last several years, a great parts of the Urmia Lake dried up, and became a brackish area. Accordingly, salt extraction from the lake coast in traditional and industrial methods attracted the view of economic sectors.

Since the result of mining, could be creation of salt dusts, compilation of an instruction for salt extraction came into consideration.

In this regard, different pollutant factors such as salt machinery transportation, accumulation and extraction operations, salt piles and traffic roads investigated. In addition to mentioned agents, geographical situation and topography around the lake, meteorological and climate conditions (such as speed and wind direction, precipitation, …) also studied. In this stage, in addition to modelling for determination of concentration, the manner of pollutant spreading during salt recovery operations, different arrangement styles (number, from and dimension), salt piles, confinement of salt also analyzed.

Following enforceable investigations and modelling and obtaining important and effective information, existing instruction compiled and presented with the following items:

- Machinery and equipment's
- Extraction zone
- Extraction time
- Extraction amount
- Extraction depth
- Temporary depot
- Loading and Transportation

In the present instruction, for each of the above items, regulations and obligations of environmental legislation are also given.

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