Consequences of Drying Lake Systems Around the World

Summary of the February 15, 2019 report prepared by AECOM for the Great Salt Lake Advisory Council

Mono Lake, California. by King of Hearts / Wikimedia Commons / CC-BY-SA-3.0

A study commissioned by the Great Salt Lake Advisory Council finds that drying of saline lakes around the world costs billions of dollars in economic losses and mitigation efforts and causes severe harms to human health and the environment.

GREAT SALT LAKE ADVISORY COUNCIL

The Great Salt Lake Advisory Council was established in 2010 to advise Utah administrative and legislative bodies on the sustainable use, protection and development of Great Salt Lake.

Lake Urmia, Iran. Photo by Tolga Subaşı

Saline Lakes are Drying and Shrinking Worldwide — Harming Health, Economies, and Wildlife

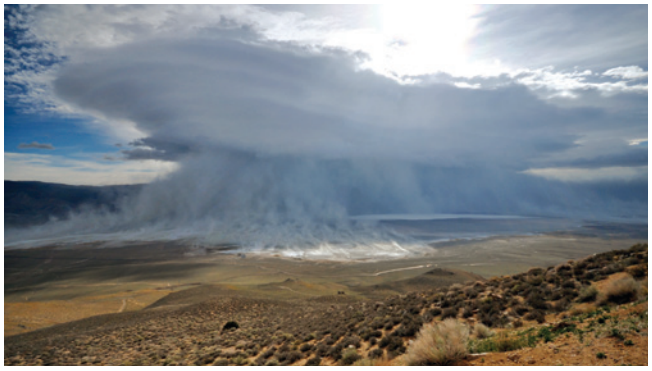
Saline lakes and their wetlands are unique, diverse ecosystems that sustain valuable economic and recreational activity, including tourism, mining, fisheries, and aquaculture industries. These lakes and their wetlands also provide vital habitat for millions of migratory shorebirds and waterfowl, fish, brine shrimp, and plants. Additionally, these lakes aid with temperature and humidity moderation, help protect air quality, contribute to lake effect rain and snow, and help retain property values.

Many saline lakes around the world are drying up at alarming rates, risking the loss of the economic, environmental, and quality of life benefits they provide.

While there are more than 25 significant saline lakes in decline around the world, the *Consequences of Drying Lakes* report focuses on eight terminal saline lakes that share important characteristics with Great Salt Lake: *Lake Urmia and Bakhtegan Lake in Iran; Aral Sea between Kazakhstan and Uzbekistan; Lake Poopó in Boliva; Owens Lake, Salton Sea, and Mono Lake in California; and the Dead Sea in Israel and Jordan.*

Saline lakes – such as Great Salt Lake — naturally rise and fall with seasonal and varying weather conditions. However, human activities, particularly diverting too much water, have consequences that can cause long-term drying, or desiccation, that is difficult to reverse and costly to mitigate.

As less water flows into saline lake systems, negative effects become persistent, not only for the plants and animals that rely on them, but for people's livelihoods and human health

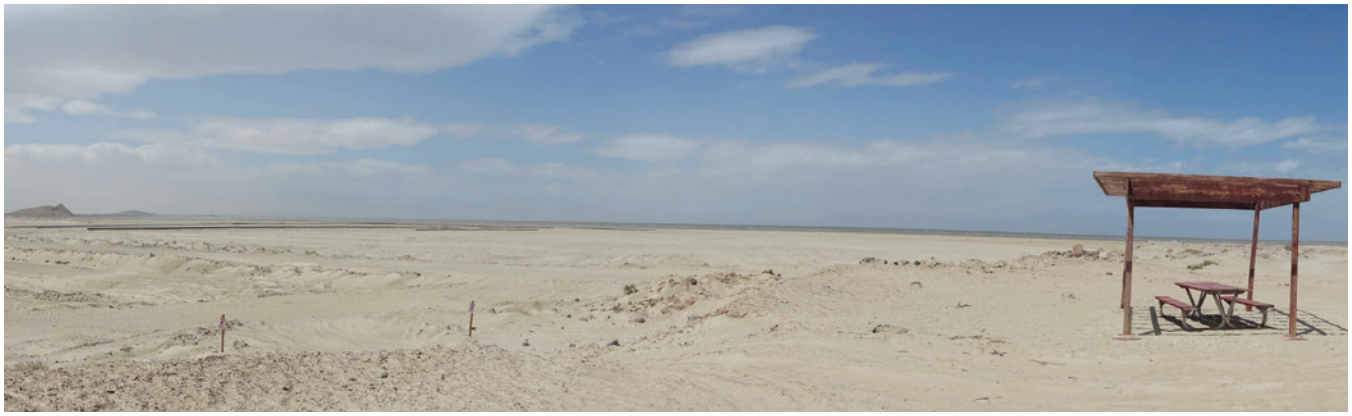


Dust storm at Owens Lake in March 2010. Photo by Brian Russell/Great Basin Unified Air Pollution Control District

- Exposed lakebeds can create a public health hazard, becoming sources of fine dust, often with high concentrations of chemical substances that can be transported long distances in dust storms. This dust is associated with increases in asthma attacks, lung diseases, infections, and hospitalizations.
  - After water was diverted upstream of *Owens Lake* and most of the lakebed was exposed, it became one of the largest sources of particulate matter in the United States.
- Windblown dust, which can be transported hundreds of miles, can also increase salt content in soils, interfering with plant growth and in some lake regions impairing farm production.
  - Agricultural output near *Aral Sea* has declined by 30-50 percent as a result of salinity, water deficiency, climatic changes, and reduced labor productivity.
- Dust storms have the potential to put property values at risk.
  - At *Salton Sea* it was estimated the impact on property values could be as much as $7 billion in a rural area with a much lower population than Great Salt Lake.
  - Dessication of the *Dead Sea* has led to more than 1000 sinkholes that damage roads, infrastructure, and private property.
- The viability of industries and livelihoods, including mineral extraction, commercial fishing or harvesting, and tourism, have been impaired or threatened.
  - At the *Aral Sea* an estimated 60,000 people lost their livelihoods when the fishery collapsed.
  - *Salton Sea's* annual recreation and tourism once contributed an estimated $550 million annually to the local economy but, as of 2007, that number had dwindled to $26.5 million.
- As inflows decrease and water levels recede, salinity levels rise. Changes in salinity have resulted in the loss of fish species and reduced availability of invertebrates, a primary food source for many birds. Disappearance of habitat and changes in the food supply have caused extensive bird losses at times.
  - Salinity changes at *Lake Urmia* lowered brine shrimp survival and in turn migratory bird populations that feed on brine shrimp dropped substantially, and thousands of birds died from starvation.

Dust control efforts at Owens Lake. Photo by Phillip Kiddoo/Great Basin Unified Air Pollution Control District

Note: For comparison purposes, dollar values obtained from literature have been normalized to U.S. dollars with a 2019 base year using Office of Management and Budget GDP deflator.

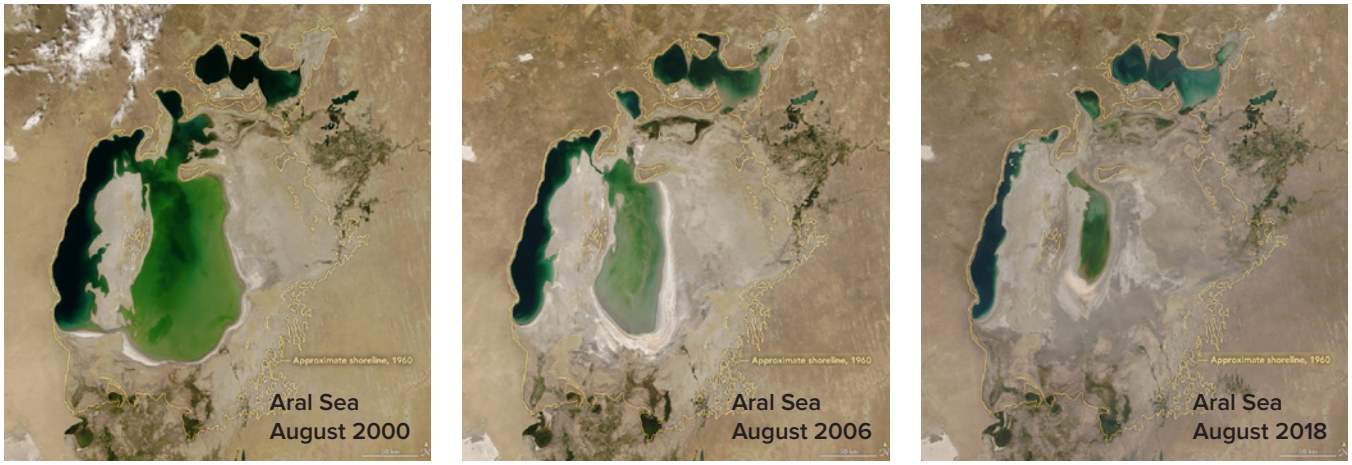


Red Hill Bay habitat restoration area near Sonny Bono National Wildlife Refuge on the south shore of the Salton Sea on April 19, 2018.
Photo by Martha Harbison/Audubon

Measures to control dust, such as re-establishing habitat or stable conditions, are costly and often restore only a portion of the benefits lost

- The *Urmia Lake* Restoration Plan is estimated at over $500 million, and the full estimated cost for related restoration programs is nearly $1.4 billion.
- At the *Aral Sea,* restoration work is projected to be more than $270 million for the Small Aral Sea restoration project. A comprehensive program to renovate irrigation and drainage systems to reduce water consumption was estimated to cost $24.4 - $33.6 billion.
- *Owens Lake* dust mitigation measure costs are estimated to reach $3.6 billion by 2025. This is estimated to be approximately 2 months of every Los Angeles ratepayer's annual water bill. Great Salt Lake is 19 times the size of *Owens Lake*.
- *Salton Sea* is one of the few remaining wetland habitats for bird species in California. Restoration options for the sea were estimated to be as high as $16.9 billion. The current 10 year, Phase 1 habitat restoration plan to control dust and provide habitat for birds and other wildlife would address approximately 60% of exposed acreage (29,800 acres of 48,300) at an estimated capital cost of $427 million.

The Consequences of Drying Lakes report examines the drivers behind the drying of each of the eight lakes, the resulting adverse impacts, and the measures studied or implemented to reduce the harm or replace water and habitat.



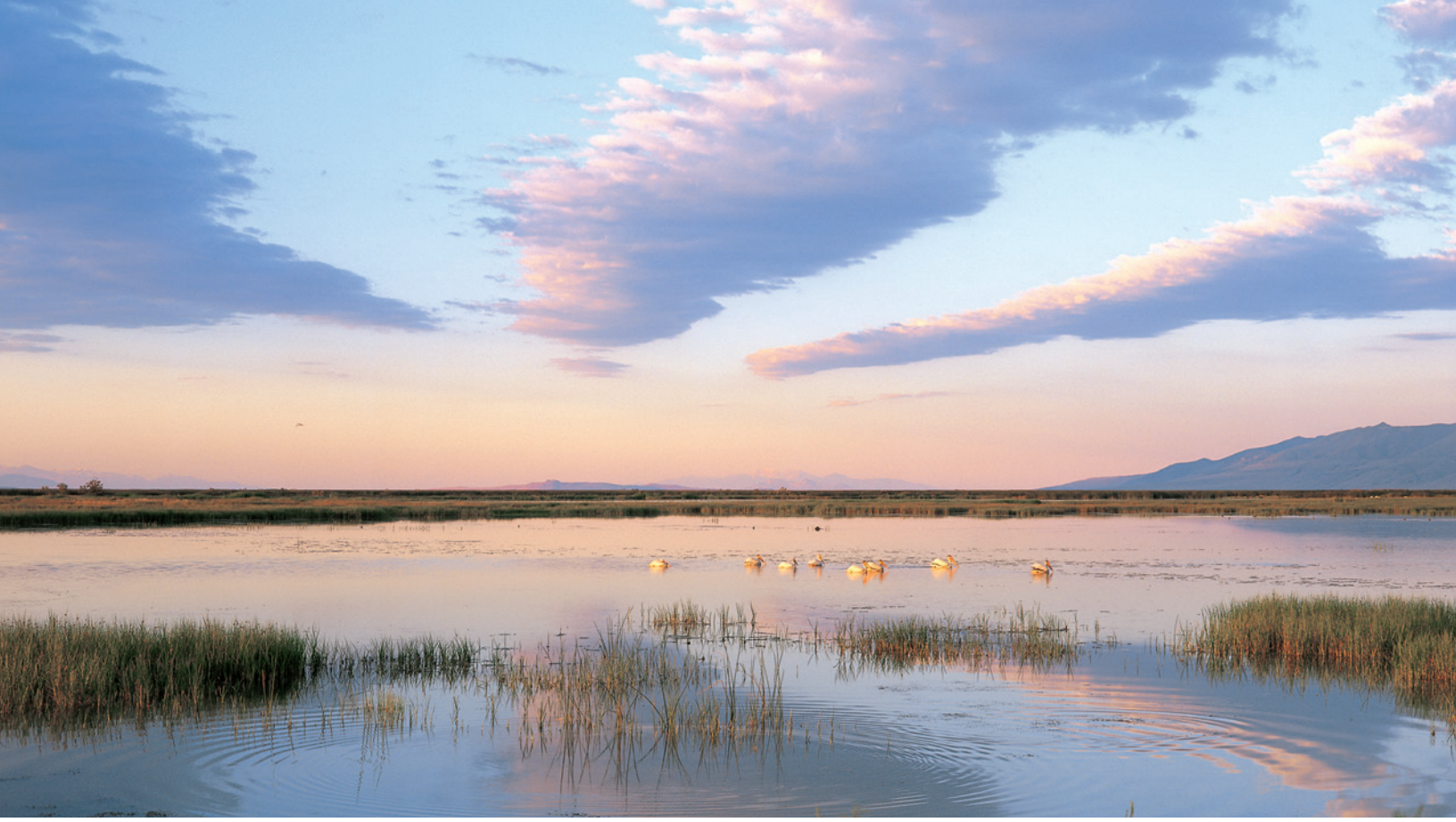
Images by NASA/Earth Observatory

CONSEQUENCES OF DRYING LAKE SYSTEMS – SUMMARY TABLE

DRYING LAKES	CAUSE AND EXTENT OF DRYING	ECONOMIC CONSEQUENCES	SOCIAL CONSEQUENCES	ENVIRONMENTAL CONSEQUENCES
LAKE URMIA – IRAN • Watershed Area: 20,100 sq. mi. • Watershed Population: 6.4M • Salinity: 21 – 24% • Largest lake in Iran • World's 2nd largest hypersaline lake	• Upstream dams and reservoirs diverting water • Expanded agricultural water use (64B cu. ft. to 194B cu. ft.) • Precipitation declines and increased temperatures • Lake reduced from 2400 sq. mi. to 400 sq. mi. • 86% of lake became a salt desert between 1998 and 2014	• $1.4B restoration program • $56M - cost to transfer water from Kani Sib River • $1.6M annual recreation value in jeopardy • Impact to agriculture industry — increasing soil salinity, reducing productivity	• Public health impacts from dust storms (PM10) • Increased potential for displacing farmers due to soil salinization and productivity losses	• Brine shrimp density decreases and population viability at risk • Thousands of starving migratory birds dependent on brine shrimp
ARAL SEA – KAZAKHSTAN AND UZBEKISTAN • Watershed Area: 700,000 sq. mi. • Watershed Population: 60M • Salinity: +10%	• Large scale water diversion project – canals, dams, and reservoirs • One-tenth of its original size - (60,000 sq. mi.)	• >$270M for restoration • $24.4-$33.6B to improve irrigation systems • 70% of irrigated land impacted by salinity from dust storms • Agricultural output decline of 30-50% • 60,000 people lost their livelihood when fishery was lost	• Public health impacts from dust storms (PM10) • High levels of esophageal cancer, respiratory illnesses, and eye problems in the surrounding region	• Desertification in the region; salt flats on portions of lake bed • Extinction of indigenous fish populations • ~50% reduction in the number of mammal species and bird species • Native plants replaced by salt tolerant plants; • Vegetation inhibited altogether on salt flats
LAKE POOPO' – BOLIVA • Watershed Area: 360,000 sq. mi. • Watershed Population: 10,000	• Reduced precipitation, increased temperatures and reduced inflows • Dry lakebed - 380 sq. mi.	• Complete loss of fishing industry	• Displaced fishermen and indigenous people that depended on the lake	• Millions of dead fish • Die off of hundreds of birds • Loss of habitat and wildlife in surrounding areas
OWENS LAKE – CALIFORNIA • Watershed Area: 1,000 sq. mi. • Dry lakebed 110 sq. mi. • Salinity: 6 – 7%	• Diversion of Owens River by City of Los Angeles • Resulting dry lakebed with some mudflats • Dust control measures on 43 sq. mi. (27,500 ac.) including areas of shallow flooding, surface tillage, managed vegetation and gravel blanket	• $3.6B mitigation costs through 2025 • $5M in noncompliance	• Public health impacts from dust storms (PM10 and PM2.5) • USEPA declared the dry lakebed to be the source of the worst dust problem in the U.S	• Rehydration efforts provide habitat for 100,000 shorebirds annually
SALTON SEA – CALIFORNIA • Watershed Area - 8,400 sq. mi. • Watershed Population: 650,000 • Salinity: +6%	• Diversion of water supply for urban uses and loss of agricultural drain water inflows • ~77 sq. mi. lakebed exposed by 2028	• Up to $16.9B for mitigation • $472M for habitat restoration and dust control on ~30,000 acres • $550M annual recreational value reduced to $26.5M; visitors reduced to 340,000 annually • Loss of fishing industry • Loss of $1.9B agricultural industry • Property value loss up to $7B	• Public health impacts from dust storms estimated at ~$40B • Respiratory-related emergency room visits for children are over twice statewide average in California • Childhood asthma hospitalization rates are highest in California and 3 times state average	• $2.8B in annual ecological benefit is declining as sea shrinks • Fish populations declined by over 95% • One of the few remaining wetland habitats for avian species in California
DEAD SEA – ISRAEL AND JORDAN • Watershed Area - 17,000 sq. mi. • Salinity: 34%	• Diversion of water for drinking, irrigation, industrial use and mineral extraction • Reduced in size – from 50 mi. to 30 mi. in length.	• $11B for initial reclamation • $440M for annual O&M • Without reclamation, potential loss of $85M to $265M in annual revenue to the region • Infrastructure and property damage from 1,000 sink holes	• Sink holes cause serious injuries • Sink holes threaten tourism industry, the main livelihood of the region	• Threat to wildlife and ecosystem • Environmental hazards, such as steep slopes and earthquake-associated landslides
BAKHTEGAN LAKE – IRAN • Watershed Area - 12,200 sq. mi. • Second largest lake in Iran	• Reduced precipitation, increased temperatures, and dams that divert water for irrigation • Expected shrinkage by 2017 from 140 sq. mi. to 80 sq. mi.	• Water scarcity threatens agricultural sector (loss of $2.4B from severe drought)	• Potential loss of agricultural and tourism jobs • Water scarcity could stimulate social conflicts	• Loss of wetland habitat; threats to designated protected zone wildlife sanctuary • High number of Flamingo mortalities
MONO LAKE – CALIFORNIA • Watershed Area- 800 sq. mi. • Population: 14,000 • Salinity: 5 – 10%	• Upstream water diversions by Los Angeles • 30% surface area reduction (55,000 ac to 38,000 ac) by 1995 • Since 1995, legal requirements imposed to retain lake at minimum of 6,377 ft.	• Potential for changes in tourism levels	• Public health impacts from dust storms and particulate matter (PM10)	• One of world's largest California Gull breeding colonies at risk from predators using land bridge exposed by low water levels * • Brine shrimp population viability threatened • Loss of wetland habitat

Abbreviations: M = million; B = billion; sq. mi. = square miles; ac = acres; cu. ft. – cubic feet; O&M = Operations & Maintenance
Note: To facilitate comparisons among the studies, values obtained from the literature are normalized to U.S. dollars with a 2019 base year using the Office of Management and Budget's GDP deflator.

*Mono Lake Committee Newsletters — 2017 WIN-SPR and SUM



Great Salt Lake, Utah. Photo by Gary Crandall

It's Not Too Late to Take Steps for Great Salt Lake

Great Salt Lake is the largest salt water lake in the Western Hemisphere and eighth-largest terminal lake in the world. The lake system contributes more than $1.3 billion annually to the local economy from commercial and recreational sources, not to mention aesthetic and quality of life benefits. Complementing this is the rich, diverse and distinctive ecosystem that boasts premier wetlands, immense populations of migratory birds, and a wealth of other terrestrial and aquatic wildlife.

This vitally important resource with its surrounding wetlands is, however, threatened by long-term, declining water levels that could severely and adversely impact the ecological integrity of the lake and the economic viability and quality of life of those who rely on the lake, including those who live in the vicinity.

To protect public health in Great Salt Lake's surrounding area (where 75% of the Utah population lives), its regional economy, and the essential wildlife habitat, it is critical that we act now *"to ensure adequate water flows to Great Salt Lake and its wetlands, to maintain a healthy and sustainable lake system."* (*Concurrent Resolution to Address Declining Water Levels of the Great Salt Lake (HCR010) https://le.utah.gov/~2019/bills/static/HCR010.html.)* Utahns, now and in the future, depend upon efforts to protect Great Salt Lake and its wetlands.

Where to learn more

View this summary and the entire report on *Consequences of Drying Lakes Around the World* and learn more about the work of the Great Salt Lake Advisory Council by visiting: https://deq.utah.gov/great-salt-lake-advisory-council

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