VOLUME 27 | FEBRUARY 2021

SPOTLIGHT

Using geospatial analytics to understand climate change and water management in Central Asia

Gain a geospatial perspective on real-world problems.

See how Maxar satellite imagery and advanced analytics can be applied to solve the world's most complex challenges.

MAXAR

WATER-MANAGEMENT CHALLENGES MEET CLIMATE CHANGE IN CENTRAL ASIA

Central Asia—Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan—is home to stunning mountains, rushing rivers and stretching deserts. Its glaciers feed a thriving agricultural spread of grains and cotton, supporting nearly 74 million inhabitants across five countries. The region is one of the world's largest semiarid areas, making it a hot spot for climate change.

With temperatures increasing, drought and flooding have become ever-present challenges. In addition to climate-related shifts, poor water management in the region exacerbates already tenuous water-sharing arrangements among countries with differing priorities. The ecological impacts of both climate change and poor water management are evident in the collapse of water infrastructure and the destruction of natural water bodies. Among these are the recent failure of the Sardoba Reservoir dam in Uzbekistan and the dessication of the Aral Sea bordering Uzbekistan and Kazakhstan. Collaboration among Central Asian nations will be paramount in reacting to and preparing for future water-management challenges in the region.

CENTRAL ASIA

CENTRAL ASIA INCLUDES KAZAKHSTAN, KYRGYZSTAN, TAJIKISTAN, TURKMENISTAN AND UZBEKISTAN.

SUMMARY OF UNIQUE TOOLS & APPLICATIONS

Global Weather Interactive (GWI) is an application within Weather Desk™, which serves as the industry's leading archive of global historical weather information. GWI provides custom access to more than 900 domestic and 6,000 international weather stations for analysis of temperature extrema, precipitation and derived parameters, such as average temperature, average precipitation and normal departures for each. For this study, departure from average was analyzed for temperature and precipitation over Central Asia.

Advanced imagery analytics leverages Maxar's advanced imagery-analysis expertise. This capability unlocks the power of the spectral information contained within satellite imagery to effectively map and classify water bodies and inundated areas. When combined with Maxar's industry-leading high-resolution archive of satellite imagery, advanced imagery analytics enables our analysts to extract and deliver new insights with unprecedented speed and precision. For this study, advanced imagery analytics was used to detect flooding in Kazakhstan after the breach of the Sardoba Reservoir.

Intermittent Water is Maxar's tool using Landsat imagery to measure the change of present water over the previous 30 years for a given area. For this study, Intermittent Water was used to evaluate the impact of climate change and water usage affecting the Aral Sea, which has experienced a dramatic reduction in size.

GLACIAL MELT AND FLOODING

ISMOIL SOMONI PEAK, TAJIKISTAN
(GENNADIY RATUSHENKO | WORLD BANK)

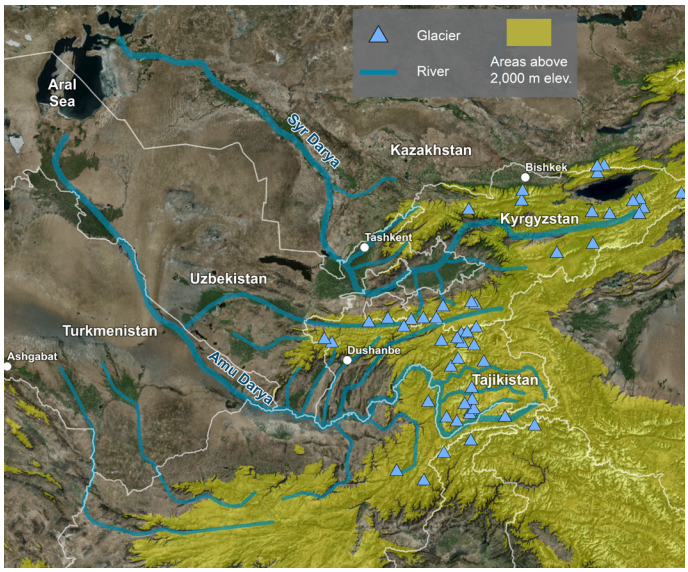
Central Asia is one of the most climate-vulnerable regions of the world because of rising temperatures and melting glaciers. Frequent floods plague the region, as do drought and aridity. Since the collapse of the Soviet Union, water allocation has been a source of strain for the five countries which share major waterways—to the point that water diplomacy is now taught in universities. The management of water for agriculture and hydropower is another cause for tension, with upstream countries requiring water for power generation and downstream countries requiring water for irrigation. About 60% of the region consists of desert, with most desert areas unsuitable for agricultural use, except along the margins of the Amu Darya and Syr Darya river systems, which are highly dependent on seasonal snow and glacial melt. These two rivers drain into the Aral Sea and provide most of the region's water resources. Increasing glacial melt and changing precipitation trends are expected to increase transboundary disasters across the Central Asian nations.

Increasing glacier melt in the coming decades will have significant effects on the larger populations of the region. It is predicted that up to one-third of Central Asia's glaciers may melt before 2050, reducing predictable water supply by 12% across the region; between 1961 and 2012, Central Asian glaciers lost roughly 27% of their mass. New meltwater lakes are forming, which trigger glacial lake outburst floods (GLOFs).

In 2007, the United Nations Environment Programme classified GLOFs as the largest and most extensive glacial hazard with the highest potential damage. These floods can develop into mudslides and endanger valleys below. Recurring river floods take place in the mountainous regions, and flash floods are common throughout Central Asia, triggered by rainfall and GLOFs. It is estimated that 1 million people in Central Asia are affected by flooding each year.

Countries in Central Asia are subject to natural disasters, including droughts, heat waves, floods, landslides and mudflows that are responsible for land degradation and infrastructure damage. In Kazakhstan, seasonal floods occur yearly from February to July, and the country's rivers, water reservoirs and lakes all could trigger flood events. These floods cause damage across multiple settlements and require extensive evacuations of vulnerable communities. They are known to break dams, wash away bridges and destroy infrastructure and roadways. In the spring, when temperatures tend to rise quickly, a combination of heavy rainfall and melting glaciers contribute to runoff that causes overcapacitated riverbeds and flatlands to flood.

RIVERS AND GLACIERS IN CENTRAL ASIA



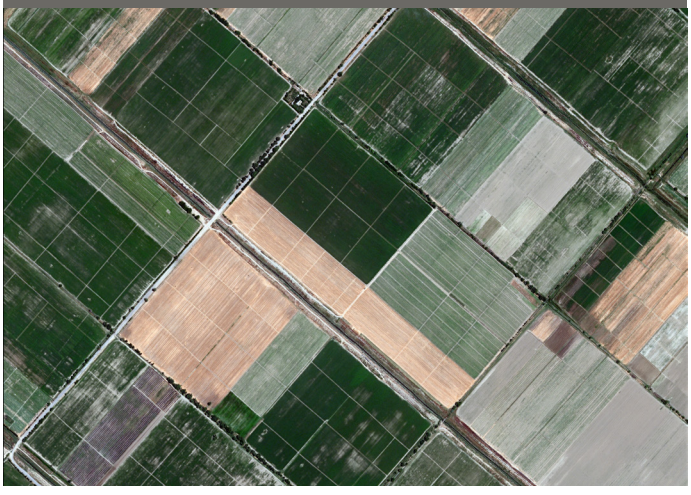
THE RIVERS AMU DARYA AND SYR DARYA (BLUE) FLOW OUT FROM ELEVATIONS HIGHER THAN 2,000 M (GREEN), WHERE MAJOR GLACIERS (TRIANGLES) EXPERIENCE SIGNIFICANT SHRINKAGE.

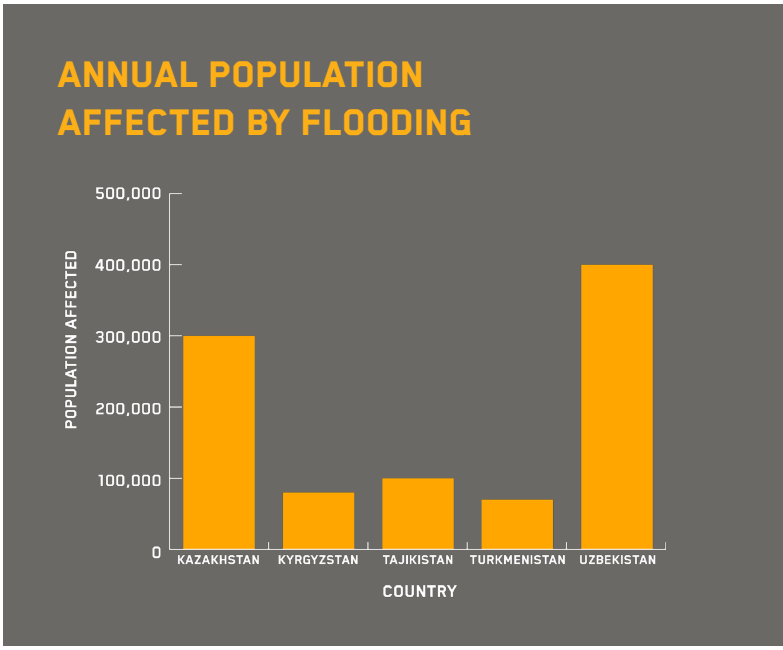
CLIMATE CHANGE: FOCUS ON KAZAKHSTAN

Central Asia contains arid and semiarid zones, with diverse landscapes including rangelands, grasslands, woodlands and deserts. The contrast between high mountains and grassy steppes provides a dramatic landscape connected by rivers and lakes. Climate change in the region is predicted to increase periods of drought, alter rainfall patterns, increase storm intensity and increase the average temperature by 3.60 to 10.26 degrees Fahrenheit in annual mean temperatures by 2085, according to the U.S. Agency for International Development (USAID). Precipitation across the region is difficult to project and will be highly variable, with USAID predicting precipitation will increase from November to April across the region.

Kazakhstan's terrain is 70% desert or semidesert, with almost 13% of the population living under a high-drought hazard—the highest in Central Asia. When snowmelt from rising air temperatures is coupled with high precipitation, the abundance of water cannot be absorbed into the terrain and often leads to mudslides and flooding. A portion of the country's border is along the landlocked Caspian Sea, leaving minimal exposure to moderating maritime weather patterns and causing extremely cold winters and hot summers with heavy rainfall in the south and east mountains. Of the 22 disaster events that Kazakhstan suffered from 1993 through 2018, 12 correspond to flood events.

AGRICULTURE, SOUTHERN KAZAKHSTAN
AUGUST 8, 2019 | WORLDVIEW-2





(DATA FROM THE WORLD BANK)

Flooding significantly threatens the region's agricultural production. Agriculture accounts for 5% of Kazakhstan's gross domestic product and employs 25% of the population. Cotton is grown in southern oblasts (districts) in Kazakhstan, while grains including wheat and barley are growth in the north. Although Kazakhstan is larger in area than its Central Asian neighbors, its cotton production is relatively lower as it concentrates on grain and other food cultivation; Kazakhstan is among the top 10 wheat-exporting nations globally. Land degradation from waterlogging and soil salinity now affects up to 33% of Kazakhstan's irrigated lands, reducing crop production and affecting the 2 million people dependent on the agricultural sector. These issues also affect neighboring countries in Central Asia, which have seen agricultural declines due to soil salinity, land degradation and limited water resources. Climate change trends are expected to exacerbate the frequent droughts, floods and landslides responsible for land degradation.

RISING TEMPERATURES ACROSS CENTRAL ASIA

DEPARTURE FROM NORMAL TEMPERATURES JANUARY 1, 2020, THROUGH MAY 31, 2020

Central Asia experienced higher-than-average temperatures from January 1, 2020, through May 31, 2020, with Kazakhstan witnessing the greatest departure from average. Maxar's GWI tool from WeatherDesk determined the deviation from 30-year average temperatures. Glaciers across Tajikistan and Kyrgyzstan experienced moderate to high temperature increases during the first half of 2020. Over the past 50 years, temperatures have increased by an average 1.26 degrees Fahrenheit across Central Asia, increasing runoff and contributing to unpredictable flooding. The World Bank estimates that the average temperature in Central Asia could increase by more than 10 degrees Fahrenheit in the coming decades, resulting in the disappearance of more than one-third of the region's glaciers by 2050.

Predicted climate effects include decreased crop productivity, increased competition over limited water resources, decreased energy production and the further melting of glaciers and permafrost. The World Bank estimates that agricultural yields could be reduced by 30% in Tajikistan alone before 2100. High volumes of rainfall, increased storm intensity and changing rainfall patterns leading to increased storm frequency create additional challenges for water management across the region.

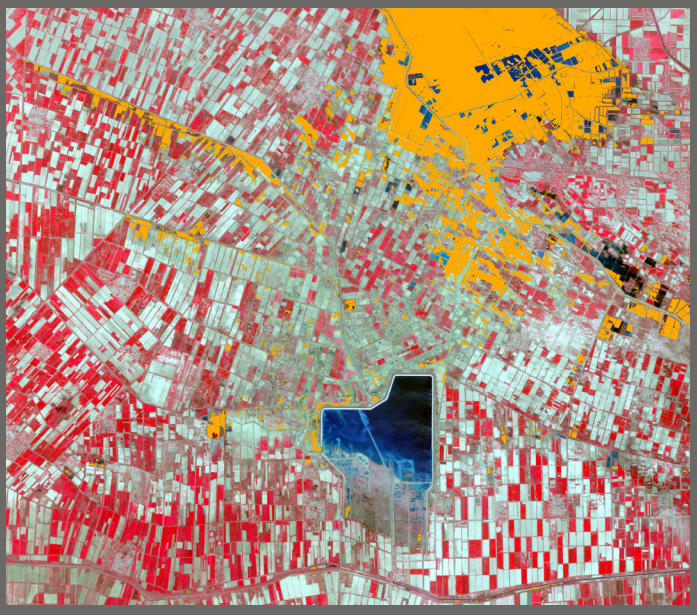
AGING WATER INFRASTRUCTURE IN CENTRAL ASIA

Among the climate-related hazards in Central Asia, accidents caused by dam malfunction or failure occur frequently and inflict heavy damages. Dams are exposed to earthquake vibrations, mudflows and landslides and are susceptible to surging glacial melt runoff. In addition to exposure to the elements, many of the dams fail because of delayed repairs and aging facilities, resulting in declining reliability and technical capacity. Dams and hydropower facilities provide about 90% of the water for irrigation and 40% for power generation for the region, affecting the security of at least half of the region's residents. The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) has noted 653 major hydrotechnical facilities and more than 200 water reservoirs in Kazakhstan alone. In March 2010, a dam south of the Kyzylagash settlement in the Almaty province of Kazakhstan failed and flooded the settlement. Heavy rain, melting snow and aging infrastructure contributed to the dam's collapse.

The safety of Central Asian communities will depend on the extent to which local governments are able to assess and respond to failing hydrological infrastructure. The United Nations Economic Commission for Europe (UNECE) has counted more than 100 dams in Central Asia that are cause for safety concern, with most located on transboundary rivers. The growth of populations in areas downstream from such dams brings with it considerable risk to life, property and livelihoods.

The UNECE has instituted a capacity building project for dam safety in Central Asia, which will harmonize emergency notifications among countries that share water basins. This coordination will be crucial in alerting downstream communities of impending flood incidents. The project will also ensure that each country implements a regulatory framework so that dam safety is tracked.

ADVANCED IMAGERY ANALYTICS: FLOOD EXTENT DETECTION

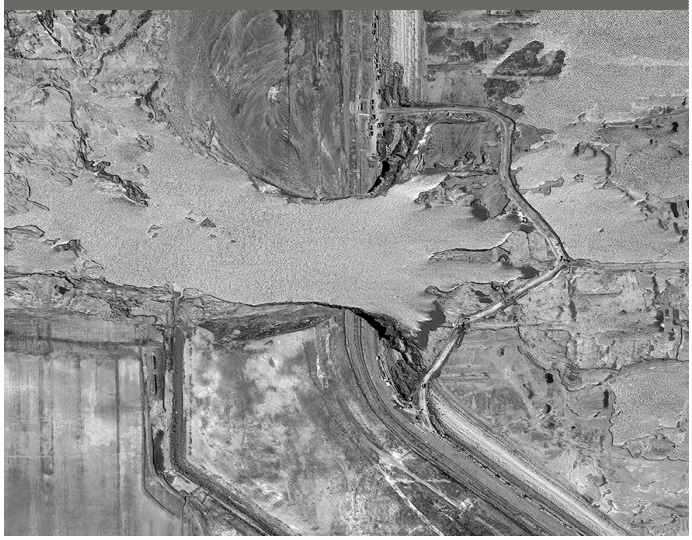


Maxar analysts deployed advanced imagery analytics in response to the breach of the Sardoba Reservoir dam in Uzbekistan by exploiting both Maxar's high-resolution and Sentinel-2's moderate-resolution imagery to identify flooded areas. Analysis revealed existing water bodies and new water extent after the breach of the dam. Identifying flooded areas (orange in the imagery to the left) showed the extent to which agricultural lands downhill from the reservoir became inundated after the dam failure. Maxar's advanced imagery analytics can aid a variety of groups, from disaster recovery teams to insurance managers, to evaluate pre- and post-event water extent.

SARDOBA RESERVOIR BREACH: BEFORE AND AFTER

BEFORE BREACH | AUGUST 24, 2019 | WORLDVIEW-2

AFTER BREACH | MAY 6, 2020 | WORLDVIEW-1



The Sardoba Reservoir is in the Syr Darya region of Uzbekistan. Completed in 2017, it held more than 240 billion gallons of water for irrigation of the surrounding agricultural lands.

On May 1, 2020, the western wall of the dam around the Sardoba Reservoir in Uzbekistan broke after a week of heavy rainfall, inundating regions of the country and neighboring Kazakhstan. The breach caused the Syr Darya river to overflow, flooding the Maktaaral district of the Turkestan province and five villages in Kazakhstan. The International Federation of Red Cross and Red Crescent Societies reported that Kazakhstan evacuated around 33,000 people from the five affected villages as well as 12 other villages in flood-risk zones. In Uzbekistan, around 70,000 people from 22 villages were evacuated.

Displacement from flooding was not the only consequence of the dam breach: According to the deputy head of the regional department of agriculture in Kazakhstan, Turganbek Ospanov, more than 7,600 hectares of crops were flooded, and 85% of the flooded crops were cotton, the main agriculture product of the district in southern Kazakhstan.

Tension between Uzbekistan and Kazakhstan emerged as a result of the Sardoba Reservoir dam breach, though it was short-lived as both nations agreed to work on a cooperative resolution. While the Uzbek state agency in charge of dams pointed to heavy rains and strong winds as the cause for the breach, sources reporting to Radio Free Europe decried local corruption, which may have led to poor-quality materials used in the dam's construction. Restoration efforts are underway.

FLOODING OF THE KAZAKHSTAN COUNTRYSIDE

NAIMAN BUKARBAY VILLAGE, SOUTHERN KAZAKHSTAN | MAY 7, 2020 | GEOEYE-1

AUGUST 24, 2019 | WORLDVIEW-2

MAY 7, 2020 | GEOEYE-1

MAXAR'S LIBRARY OF HIGH-RESOLUTION IMAGERY WAS USED TO SHOW THE FLOODING OF NAIMAN BUKARBAY VILLAGE IN THE SOUTH KAZAKHSTAN OBLAST, THE SOUTHERNMOST DISTRICT OF THE COUNTRY. PRE-FLOOD AGRICULTURAL AND GRAZING LANDS ARE VISIBLE PRIOR TO THE BREACH OF THE SARDOBA RESERVOIR DAM IN UZBEKISTAN (BOTTOM LEFT). WATERLOGGED FARMLAND AROUND THE VILLAGE CAN BE SEEN SUBERMGED AS THE WATER ENCROACHES ON HOMESTEADS (TOP AND BOTTOM RIGHT).

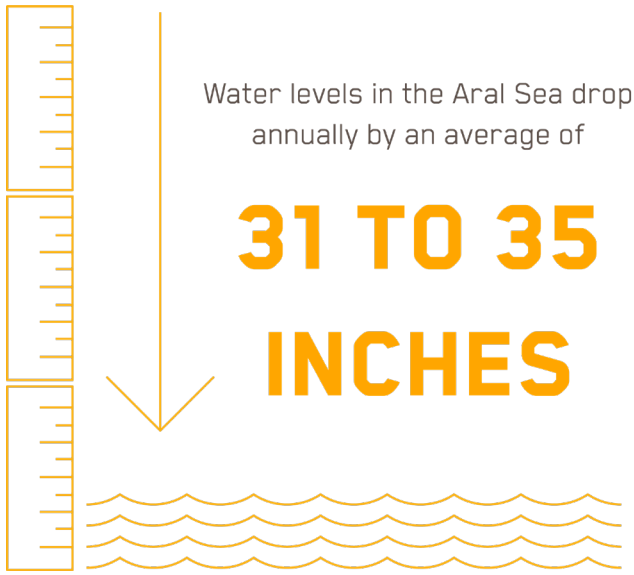
DESICCATION OF THE ARAL SEA

In addition to climate change, poor water management in Central Asia has taken a toll on the environment and on water-sharing agreements among nations. The population of Central Asia is expected to grow to 86 million people by 2040, increasing the need for reliable water across the region. Conflict over water allocation for hydropower versus irrigation has plagued the five Central Asian nations since the fall of the Soviet Union, when the new nations experienced the complexity of sharing two major rivers, the Amu Darya and Syr Darya. The most visible example of poor water management is the Aral Sea crisis.

The Aral Sea sits on Kazakhstan's southern border with Uzbekistan. Once considered the world's fourth-largest lake, the Aral Sea has lost more than 90% of its size in the last 50 years, according to NASA. This dramatic reduction is due to the rerouting of the major rivers that feed the Aral Sea—the Amu Darya and Syr Darya—for irrigation. The Soviet government designed river-diverting mechanisms to irrigate the deserts of Central Asia to cultivate rice, cereals, cotton and melons, all of which drew water from the arteries of the Aral Sea. After the Soviet Union's collapse, water usage fell under the purview of independent nations, each of which had different priorities.

The water level of the Aral Sea has dropped approximately 75 feet since the start of water diversion in the 1960s and drops by 31 to 35 inches every year. A primary result of decreased river inflow is the shrinking of the main Aral Sea into smaller parts with varied saline concentrations. As inflow to the Sea decreased, salinity of the remaining water rose, challenging the fishing industry and reducing commercial fishing catches from more than 43,000 tons in 1960 to zero by 1980. Research from Columbia University shows the population of the Aral Sea basin grew dramatically from during this time period, rising from 13.8 million people to 33.2 million people; this demographic growth changed the need for water consumption through industry, fisheries, power generation and public use of water and has been a main driver of environmental change in the region. Competition for this scarce resource affects the ways in which people generate income, with up to 5 million people in the Aral Sea basin affected by the ecological crisis, including 100,000 people displaced as a result.

Efforts to save the Aral Sea are underway and have drawn international attention and support. The United Nations Development Programme has convened experts to explore ideas to revive the Aral Sea, with further meetings scheduled with the World Bank, Asian Development Bank and the World Environmental Fund. Solutions include diversification of the agrarian sector and the implementation of water-saving technology for drip irrigation. Despite these efforts, effects of the Aral Sea decrease continue to be felt throughout the basin.

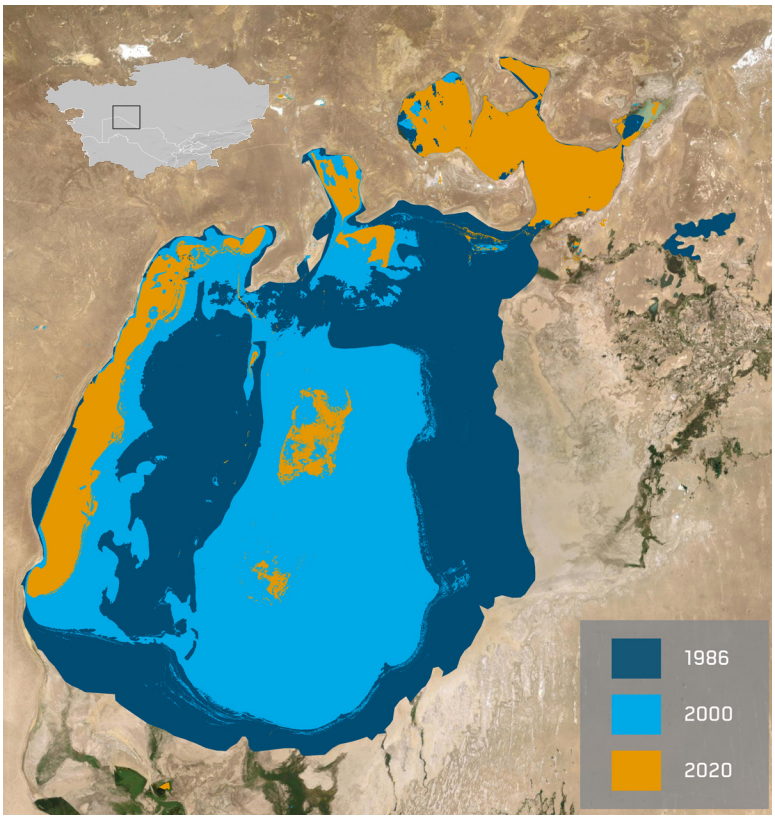


SALINIZATION AND EROSION

Salinization of the surrounding land has been one of the worst consequences of the crisis. As the groundwater level decreased, salt accumulated in the subsoils, leading to increased salt deposits in soil profiles. This leads to soil erosion, which requires the use of heavy fertilizers, further degrading the environment and polluting groundwater.

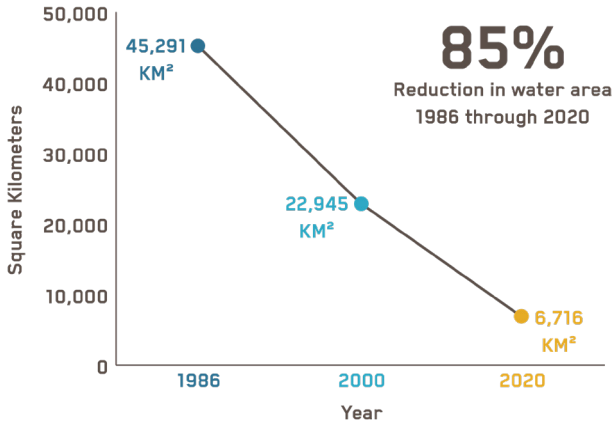
INTERMITTENT WATER SHOWS SEA DECREASE

ARAL SEA EXTENT



MAXAR INTERMITTENT WATER WAS USED TO EVALUATE THE EFFECTS OF CLIMATE CHANGE AND WATER USAGE ON THE ARAL SEA.

ARAL SEA DECREASE IN WATER AREA



SHIP GRAVEYARD, ARAL SEA, KAZAKHSTAN (ADRIANE LOCHNER | EURASIANET)

CONCLUSION

Rising temperatures and melting glaciers in Central Asia have led to strain on old dams and irrigation infrastructure, resulting in calamities that are expected to continue as climate change and water management challenge the region. While localized and seasonal surges of rain and glacier melt threaten low-elevation communities, drought and water scarcity from rising temperatures affect communities dependent on river outflow for their livelihoods. The continuing competition for this scarce resource can be seen in the energy sector through hydropower and in the agricultural sector through irrigation. Because of the transboundary nature of water use in Central Asia, many countries have collaborated on water sharing and maintenance, though water management along borders remains difficult.

ESCAP has collaborated with the Russian Federation Federal State Statistics Service and the Food and Agriculture Organization of the United Nations to hold workshops that address the 2030 Agenda for Sustainable Development. In October 2019, one such workshop was held in Almaty, Kazakhstan, with the aim of reaching target 6.4 of the Agenda: "By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity." With international partners rallying around this shared goal, Central Asian nations will continue to combat climate change and work toward sustainable water sharing.

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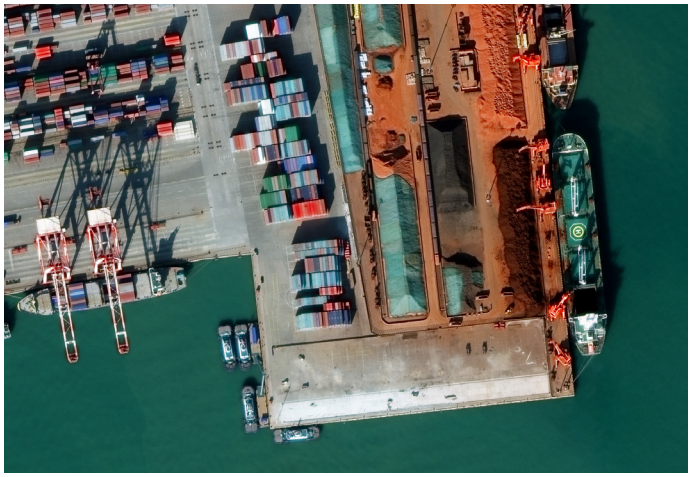

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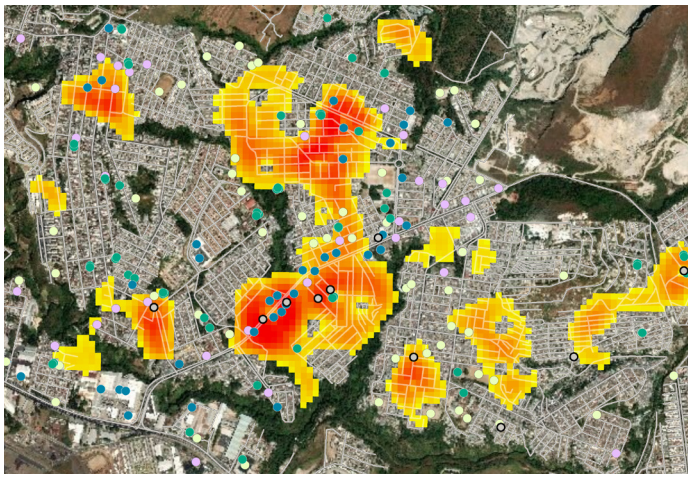

EXPERTISE

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