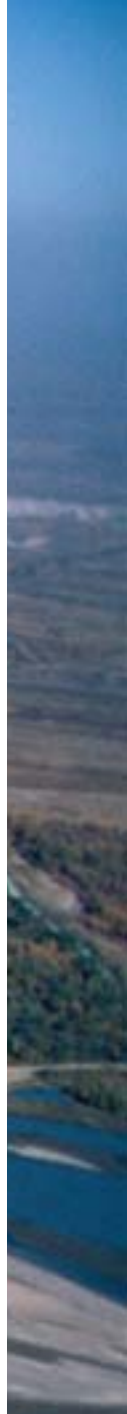
Water Resources

Lifeblood of the Region

Water has long been the fundamental concern of Central Asia's peoples. Few parts of the region are naturally water endowed, and it is unevenly distributed geographically. This scarcity has caused people to adapt in both positive and negative ways. Vast power projects and irrigation schemes have diverted most of the water flow, transforming terrain, ecology, and even climate. On the one hand, powerful electrical grids and rich agricultural areas have helped the region flourish; on the other, water, air, land, and biodiversity have been degraded.

In this chapter, major river basins, inland seas, lakes, and reservoirs of Central Asia are presented. The substantial economic and ecological benefits they provide are described, along with the threats facing them—and consequently the threats facing the economies and ecology of the country themselves—as a result of human activities.



The Amu Darya River in Karakalpakstan, Uzbekistan, with a canal (left) taking water to irrigate cotton fields. **Upper right:** Irrigation lifeline, Dostyk main canal in Makktaaral Rayon in South Kasakhstan Oblast, Kazakhstan. **Lower right:** The Charyn River in the Balkhash Lake basin, Kazakhstan.

Major River Basins in Central Asia

1:10 000 000

200 100 0 200

Kilometers

N

55°0'E

75°0'E

50°0'N

40°0'N

RUSSIAN FEDERATION

KAZAKHSTAN

ASTANA

UZBEKISTAN

TURKMENISTAN

KYRGYZ REPUBLIC

TAJIKISTAN

BISHKEK

TASHKENT

DUSHANBE

ASHGABAT

AZERBAIJAN

IRAN

AFGHANISTAN

PEOPLE'S REPUBLIC OF CHINA

Caspian Sea

Aral Sea

Lake Balkhash

Lake Zaisan

Lake Issyk-Kul

Ishim

Nura

Irtysh

Ural

Emba

Syr Darya

Chui

Ili

Naryn

Amu Darya

Karakum Canal

Pyandzh

1

2

- National capital
- International boundary
- Rivers and canals

River basins

- Amu Darya
- Balkhash-Alakol
- Ob-Irtysh
- Syr Darya
- Ural
- 1 Chui-Talas
- 2 Zarafshan

Boundaries are not necessarily authoritative.

Data sources:
IUCN-The World Conservation Union, the International Water Management Institute (IWMI), the Ramsar Convention Bureau, and the World Resources Institute (WRI). 2003. Watersheds of the World_CD. http://multimedia.wri.org/watersheds_2003/index.html
National Hydro-meteorological Service of Tajikistan, Map of Main River Basins in Tajikistan, Dushanbe, 2003
Institute Kazgiprovodhoz, Map of Main River Basins in Kazakhstan, Almaty, 2004

Updated by GIS-Service Ltd., 2009

Projection: Lambert Conformal Conic
Datum: WGS 1984

GIS/Cartography:
V. Sibagatulin, GIS-Service Ltd., Kyrgyz Republic, 2009

River Basin Facts

	Amu Darya	Syr Darya	Lake Balkhash	Chui-Talas	Ob-Irtysh	Ural	Zarafshan
Central Asian countries in basin	Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, Uzbekistan	Kazakhstan, Kyrgyz Republic, Tajikistan, Uzbekistan	Kazakhstan	Kazakhstan, Kyrgyz Republic	Kazakhstan	Kazakhstan	Tajikistan, Uzbekistan
Source	Pianj and Vakhsh rivers, fed largely by water from melted snow	Naryn and Karadarya rivers	Ili, Karatal, Aksu, Lepsi, Chui-Sarysu, Kapal, Koksu rivers	Chui River, fed mainly by glaciers and melting snow; and Talas River, formed by the confluence of the Karakol and Uchkosha rivers.	Irtysh River (chief tributary of the Ob); Tobol and Ishim (tributaries of the Irtysh River).	Ural River	Most upstream weir of the irrigation system for the Karakul Oasis, considered the "mouth" of the Zarafshan River
Recipient	Aral Sea	Aral Sea	Lake Balkhash	Desert sink	Arctic Ocean	Caspian Sea	Desert sink
Basin area (square kilometers)	534,739	782,617	512,015	Chui: 62,500, Talas: 52,700 Total: 115,200	1,673,470	244,334	12,200
Share of irrigated cropland (% of basin area)	0.4	5.4	1.9	Chui: 3.0, Talas: 3.0, Total: 6.0	3	0.9	No data

Sources: International Union for Conservation of Nature (IUCN), the International Water Management Institute (IWMI), the Ramsar Convention Bureau, and the World Resources Institute (WRI). 2003. *Watersheds of the World.* http://multimedia.wri.org/watersheds_2003/index.html

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River Basins

Seven major basins feed the region: the Amu Darya, Balkhash, Chui and Talas, Ob and Irtysh, Syr Darya, Ural, and Zarafshan. Most water resources come from the Amu Darya and Syr Darya rivers, along whose banks farmers have planted for millennia.

Over the past century, the nature of these rivers has changed as a result of increasing human activities. Large dams and reservoirs in upstream parts of the Amu Darya and Syr Darya have significantly affected downstream flow regimes. Diversion of huge volumes of water for agriculture and industry further changed the hydrological regimes downstream and diminished river deltas.

Renewable groundwater forms naturally in catchment areas and by filtration in irrigated lands. The return flow from fields to rivers adds significant volumes to water resources, but it also takes salts and pollutants into the rivers, reducing the productivity of natural land areas, rivers, and reservoirs.

Global climate change has also affected the river basins throughout Central Asia. Mountain glaciers are gradually melting and resulting in significant changes in river flows as well as changing the ecology of the basins themselves.

Flood damage, both from glacier melt and untimely release of waters from reservoirs for hydropower generation, is a serious transboundary problem. Cooperative water management among the region's five countries is key to protecting water resources. It must provide for the sustainable, multipurpose use of transboundary watercourses for such vital interests as irrigation, urban/communal water supply, hydropower, and fishing.

The Ural River in West Kazakhstan.

Upper: The Amu Darya River shortly before drying out in the Aral Sea in Moynaq town, former fishing port on the Aral Sea, now 180 km from the sea. **Lower:** Water comes to the desert with the Karakum Canal; photo taken in the 1970s.

AMU DARYA RIVER BASIN

The Amu Darya River, called the Oxus in the ancient Greek period, begins in Tajikistan as the confluence of the Pianj River (which begins in Afghanistan and forms its border with Tajikistan for several hundred kilometers) and Vakhsh River (which begins in the Kyrgyz Republic). The Amu Darya basin—534,700 square kilometers in all—unfolds westward from the mountains of the Kyrgyz Republic and Tajikistan, descending and contracting into the Karakum Desert of Turkmenistan and Uzbekistan as the river arcs gradually clockwise to the southern end of the Aral Sea, a total distance of 2,400 kilometers. The river splits into a delta with numerous arms as it approaches the Aral Sea. But in dry years since the 1960s, its waters, exhausted from diversion for irrigation, do not reach the sea.

Near the river's entrance into Turkmenistan, the Soviets built the Karakum Canal, the longest such structure in the world, that takes a third of the Amu Darya's water and sends it to the parched southwestern parts of Turkmenistan to irrigate expanding cotton-growing areas.

Various other transboundary rivers, including the Pamir, Kafirnigan, Surkhan Darya, and (formerly) Zarafshan rivers, flow into the Amu Darya basin. All the rivers in the basin influence the system to some extent. Some of the Pianj River's water, for example, is diverted for irrigation. Its catchment includes the dangerous Sarez Lake, described below. On the Vakhsh River in Tajikistan, the planned extension of a mining and aluminum processing plant in Tursunzade could have

Amu Darya River Basin Facts	
Basin area (square kilometers)	534,739
Average population density (people per square kilometer)	39
Cities (100,000 or more people)	9 (Bukhara, Chadzhev, Dushanbe, Kashi, Mazar-E Sharif, Navoi, Nuku, Samarkand, Urgench)
Land Cover and Use	**Area, % basin area**
Forest	0.1
Grassland, savanna, and shrubland	57.3
Wetlands	0.0
Cropland	22.4
Irrigated cropland	7.5
Dryland	77.8
Urban and Industrial	3.7
Loss of original forest cover	98.6
Economy	Agriculture: cotton, wheat, rice, silkworm breeding, cattle breeding. Industry: hydropower, mining and aluminum processing, chemical industry, light industry.
Environmental Issues	Heavy disturbance by water management activities in Surkhan Darya tributary. Sarez Lake is a potential threat to population living near the middle and lower Amu Darya. Mineralization as a result of discharge of collector-drainage waters. Soil salinity, decreased soil fertility. Drought.

Sources: International Union for Conservation of Nature (IUCN), the International Water Management Institute (IWMI), the Ramsar Convention Bureau, and the World Resources Institute (WRI). 2003. *Watersheds of the World.* http://multimedia.wri.org/watersheds_2003/index.html

United Nations Economic Commission for Europe. *Our Waters: Joining Hands Across Borders.* 2007. www.unece.org/env/water/publications/pub76.htm

Amu Darya Basin

- National capital
- Provincial/oblast capital
- Rivers and canals
- International boundary

Hydropower plant

- < 1 million kilowatts
- 1–3 million kilowatts
- Under construction or suspended
- Amu Darya River Basin

Boundaries are not necessarily authoritative.

1:7 000 000

100 50 0 100 200

Kilometers

Data sources:
IUCN-The World Conservation Union, the International Water Management Institute (IWMI), the Ramsar Convention Bureau, and the World Resources Institute (WRI). 2003. Watersheds of the World_CD. http://multimedia.wri.org/watersheds_2003/index.html. Updated by GIS-Service Ltd., 2009

Projection: Equidistant Conic
Datum: WGS 1984

GIS/Cartography: V. Sibagatulin, GIS-Service Ltd., Kyrgyz Republic, 2009

repercussions on users downstream, not least because a large reservoir is needed for hydropower to run the plant.

As the Amu Darya travels through Turkmenistan and then Uzbekistan, it receives returned water from irrigation and groundwater, which add pollutants from agriculture (pesticides and fertilizer), industry (toxic chemicals), and domestic sources. Health problems from drinking the water are common.

Soil erosion from upstream countries causes sediments to build up downstream along the river and Karakum Canal, and almost complete silting up of the Kalif lakes. The average capacity of the canal and the reservoirs on the river has fallen by more than half as a result. The sediments also damage irrigation infrastructure. The new Zeid reservoir is expected to take up much of the sedimentation in the Karakum Canal. But there are other issues: parts of the canal have not been maintained and huge losses from seepage and leakage occur; also the flood approach to irrigation results in salinization of the soil and returned water to the canal.

Upper: The meandering Syr Darya River in the Kyzyl Orda region, Kazakhstan. **Lower:** Sunset along the Syr Darya River near the city of Kyzyl Orda.

SYR DARYA RIVER BASIN

The Syr Darya River has its origins in the Fergana Valley, where two large rivers—the Naryn and Karadarya—that flow down from the Tien Shan Mountains in the Kyrgyz Republic into Uzbekistan, meet in the eastern part of the valley in Uzbekistan. From Tajikistan, the Syr Darya enters Kazakhstan where it makes a long counterclockwise arc into the northeastern edge of the Aral Sea, marking the northeasterly edge of the Kyzylkum Desert.

The Syr Darya basin covers some 800,000 square kilometers, over the river's course, a distance of about 2,200 kilometers. However, only a quarter of that area provides water into the system and its annual flow of roughly 37 cubic kilometers is small compared to that of its sister, the Amu Darya (97 cubic kilometers), which has a smaller basin area.

Syr Darya River Basin Facts

Basin area (square kilometers)	782,700 (of which 218,400 are in Kazakhstan)
Average population density (people per square kilometer)	26
Cities (100,000 or more people)	11 (Andizhan, Bishkek, Dhambul, Dzhizak, Fergana, Kyzyl Orda, Namangan, Osh, Shymkent, Tashkent, Zhezkazgan)

Land Cover and Use	Area, % basin area
Forest	2.4
Grassland, savanna, and shrubland	67.4
Wetlands	2.0
Cropland	22.2
Irrigated cropland	5.4
Dryland	93.7
Urban and industrial	3.2
Loss of original forest cover	45.4

Economy	Agriculture: cotton, wheat, rice; cattle breeding. Industry: hydropower, manufacturing, chemical industry, light industry.
Environmental Issues	Changing hydrological river regime. Soil salinity, decreased soil fertility. Drought. In downstream, frequent flooding of human settlements during winter. Water pollution by industrial wastewater and agriculture in Kazakhstan, Tajikistan, and Uzbekistan. Mineralization as a result of discharge of collector-drainage waters.

Sources: International Union for Conservation of Nature (IUCN), the International Water Management Institute (IWMI), the Ramsar Convention Bureau, and the World Resources Institute (WRI). 2003. *Watersheds of the World.* http://multimedia.wri.org/watersheds_2003/index.html

United Nations Economic Commission for Europe. 2007. *Our Waters: Joining Hands Across Borders.* www.unece.org/env/water/publications/pub76.htm

Syr Darya Basin

- National capital
- Provincial/oblast capital
- Rivers and canals
- International boundary

Hydropower plant

- < 1 million kilowatts
- 1–3 million kilowatts
- Under construction or suspended
- Syr Darya River Basin

Boundaries are not necessarily authoritative.

1:7 000 000

100 50 0 100 200

Kilometers

Data source:
IUCN-The World Conservation Union, the International Water Management Institute (IWMI), the Ramsar Convention Bureau, and the World Resources Institute (WRI). 2003. *Watersheds of the World*_CD. http://multimedia.wri.org/watersheds_2003/index.html
Updated by GIS-Service Ltd., 2009

Projection: Equidistant Conic
Datum: WGS 1984

GIS/Cartography:
V. Sibagatulin, GIS-Service Ltd., Kyrgyz R epublic, 2009

In the basin headwaters, the Naryn River already contains pollutants from industrial and domestic wastes, discharges from livestock breeding, and wastes from ore mining. The Syr Darya's waters change further as they pass through the Fergana Valley. In both Tajikistan and Uzbekistan, industrial wastewater and agricultural return water from irrigation cause significant pollution, which only increases as the river continues through industrial areas, croplands, and livestock breeding areas of Kazakhstan.

The Syr Darya's course is punctuated by hydropower stations and large reservoirs, such as the Kajrakkum and Chardarin. Much of its water is used for irrigating the major cotton-growing areas of the region. Nevertheless, downstream flooding occurs in winter, particularly in Kyzyl Orda, Kazakhstan, due to water release from the Toktogul Reservoir in the Kyrgyz Republic for hydropower production. Yet, floods become droughts: there is sometimes not enough water to satisfy irrigation and other human needs.

Reservoir on the Naryn River, before it joins the Karadarya River to become the Syr Darya.

Above: Beach on Lake Balkhash contrasts with industry from the city of Balkhash. Lake Balkhash could face a similar fate as the Aral Sea if water management in flowing rivers is not improved. **Right:** Lake Balkhash seen from the space shuttle Discovery.

LAKE BALKHASH BASIN

Sharing its area rather equally between south-eastern Kazakhstan and northwestern People's Republic of China, Lake Balkhash basin is one of the planet's largest lake ecosystems. Its varying elevation levels are also the most diverse of any basin in Central Asia. Three major rivers in the basin drain into crescent-shaped Lake Balkhash. Chief among them is the Ili, which provides 80% of the lake's river flow. Lake Balkhash is an important fishery and reservoir, and the Ili forms a large lake delta with wetlands that are rich in biodiversity and forage for animals. Other rivers, including the Karatal, provide surface and subsurface flow. All help feed the more than 24,000 lakes and reservoirs found in the basin.

Lake Balkhash Water Basin Facts

Basin area (square kilometers)	512,015
Average population density (people per square kilometer)	11
Cities (100,000 or more people)	2 (Almaty, Taldykorgan in Kazakhstan)

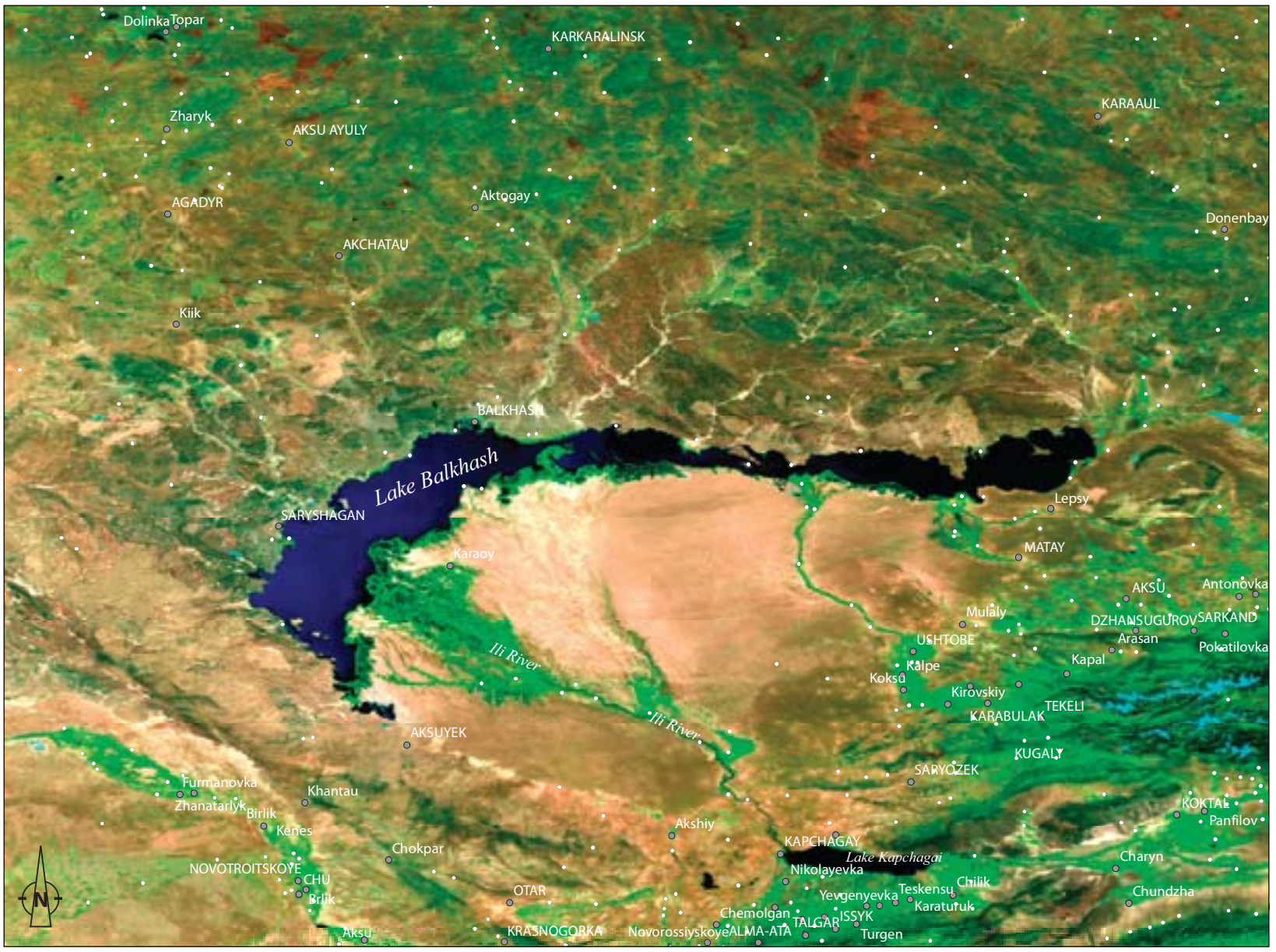
Land Cover and Use	**Area, % basin area**
Forest	4.0
Grassland, savanna, and shrubland	61.1
Wetlands	4.7
Cropland	23.2
Irrigated cropland	1.9
Dryland	94.5
Urban and industrial	1.5
Loss of original forest cover	26.3

Economy	Agriculture: rice, cattle breeding, poultry, and pig farming. Mining.
Environmental Issues	Unsustainable water use. Desertification, loss of agricultural lands and productivity. Ecologically disruptive mining. High level of water pollution due to industrial wastes. Overall decline in biodiversity, declining ecosystems.

Sources: International Union for Conservation of Nature (IUCN), the International Water Management Institute (IWMI), the Ramsar Convention Bureau, and the World Resources Institute (WRI). 2003. *Watersheds of the World.* http://multimedia.wri.org/watersheds_2003/index.html

Kreuzberg, E. 2005. Ecosystem Approach in Basin Management in Central Asia: from Theory to Practice (on the Example of Ili-Balkhash basin). CAREC: Almaty. p2.

Lake Balkhash



60 30 0 60 Kilometers

1:4,500,000

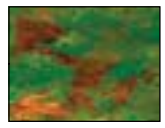
City
Town

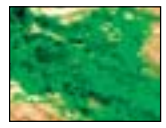

Bare Area/
Sparsely Vegetated


Pastureland


Pastureland


Mixed Vegetation/
Snow


Pastureland/
Burnt Area


Irrigated Land


Desert

Satellite Image: MODIS (MOD09GA, 500m)
Image Acquisition Date: 28 August 2008
Projection: Geographic, WGS84

Prepared by C. Y. Ji, 2009

This ready supply of water has brought increasing agriculture and industry to the area. Today, more than 3 million people live in the basin, over 600,000 of them in Almaty, Kazakhstan's business center and former capital. Economic development has meant construction of dams and reservoirs, and irrigation projects for hydropower, freshwater, and irrigation.

While there is more than enough water to support current agricultural practices, the irrigation and drainage systems used in Kazakhstan for growing rice and other crops have affected the hydrology of Lake Balkhash, compounded by decreases in Ili River flow caused by increased water use from an expanding population in the parts of the basin in the People's Republic of China. This has led to degradation of the lake's coastal areas, and aquatic and wetland ecosystems. It is also resulting in diminishing lake size and salinization, placing Lake Balkhash in jeopardy of becoming a second Aral Sea. Lake Balkhash plays an important role in maintaining the region's natural and climatic balance, making its protection a vital concern for all.

Upper left: A serene Chui River.
Lower left: Irrigation canal in Chui oblast.
Right: Rapids in the upper Chui River.

CHUI AND TALAS RIVER BASINS

The Chui and Talas river basins rest within the eastern section of the Turan depression and northern Tien Shan Mountains. The Chui River basin encloses 62,500 square kilometers, of which 35,900 are in Kazakhstan and 26,600 in the Kyrgyz Republic. The length of the Chui Valley is 1,186 kilometers (km), with 850 km in Kazakhstan. The Talas basin encloses 52,700 square kilometers—41,270 in Kazakhstan and 11,430 in the Kyrgyz Republic. The Talas River is 444 km long, with 217 km in the Kyrgyz Republic.

The climate of the basins changes as the rivers descend from an elevation of 2,400 meters in highly mountainous and mountainous steppe zones in the Kyrgyz Republic to mountainous steppe, desert-steppe, and desert zones at 500 meters elevation in Kazakhstan. Water resources for the two basins come from surface, subsurface, and return waters, with average annual flows of 6.64 and 1.62 cubic kilometers for the Chui basin and Talas basin, respectively.

The combined population of the basins is approximately 1.6 million, with a population density in the Chui basin—which contains the Kyrgyz Republic's capital Bishkek—far higher than that in the Talas basin. Agriculture plays a dominant role in the economy of each basin. More than two-thirds of total agricultural production come from irrigated lands, flood plains, and pastures. Agricultural processing, construction, and mining are the primary industries.

Water quality of both surface and subsurface water in the basins is considered satisfactory, but the basins are not without problems. Biodiversity is decreasing. There is soil erosion in foothill valleys and damage to riverbeds during flooding in the Kyrgyz Republic. Discharges of the Chui and Talas rivers have fallen in Kazakhstan, degrading delta lake systems, flood plains, and meadows. Pollution from domestic and livestock discharges, mining and processing industries, and transport is also a factor. Projected increasing socioeconomic development in the region between 2010 and 2020 could result in decreased water availability and even water deficits, making it vital to begin planning and implementing measures to protect the resources of these important basins.

Chui and Talas River Basin Facts

Basin area (square kilometers)	Chui: 62,500 Talas: 52,700 Total: 115,200
Average population density (people per square kilometer)	14
Economy	Agriculture. Industry: mining, agricultural processing, construction enterprises. Hydropower, underdeveloped.
Environmental Issues	Deforestation, decrease in biodiversity. Intensive soil erosion. Decreases in environmental discharges resulting in degradation of lake systems. Water pollution. Worsening status of water protection zones.

Sources: ADB. 2007. Final Report - RETA 6163: Improved Management of Shared Water Resources in Central Asia Volume I: Improving Trans-boundary Water Management on a Pilot Basis (Chui and Talas River Basins). Manila.

United Nations Economic Commission for Europe. 2007. *Our Waters: Joining Hands Across Borders.* www.unece.org/env/water/publications/pub76.htm

OB BASIN AND IRTYSH SUB-BASIN

The Ob River combines with its main tributary, the Irtysh, to form the Ob-Irtysh basin. This massive basin, which stretches from Mongolia to Western Siberia, empties into the Arctic Ocean. It falls mainly within the Russian Federation (73.8%), and Kazakhstan (24.7%), with the remaining 1.5% in the People's Republic of China and Mongolia. Included in the Ob basin is the Irtysh sub-basin. The catchment within the sub-basin marks Kazakhstan's primary contribution to the greater basin. The Irtysh River, 4,248 kilometers in length, begins in Mongolia's Altai Mountains and flows through the People's Republic of China and Kazakhstan (1,200 kilometers) before joining the Ob River in the Russian Federation. The Irtysh is fed by the Tobol and Ishim rivers, which begin in Kazakhstan.

Within Kazakhstan, the Irtysh is regulated by large hydroelectric power stations and serves as a transportation artery for the country's interior. Within the People's Republic of China, the Irtysh is used for irrigation, which severely decreases its flow. A proposed 300-kilometer irrigation canal there will further divert Irtysh water, and could result in economic and ecological damage in the greater basin.

The Irtysh River is severely affected by pollution from irrigation, mining, and wastewater. And it is primarily for this reason that Kazakhstan and the Russian Federation have embarked on joint projects to protect the river. Involving the People's Republic of China in the management of Irtysh waters is the next step. The Irtysh sub-basin is the main source of water for central Kazakhstan and its health is essential to the well-being of the region.

Ob-Irtysh River Basin Facts	
Water basin area square kilometers)	1,673,470
Average population density (people per square kilometer)	11
Cities (100,000 or more people)	12: Astana, Kamenogorsk/Oskemen (Kazakhstan), Sverdlovsk (Ukraine), Tyumen (Russia), Colyabinks, Kurgan, Kostanay, Kokshetau, Petropavlovsk, Omsk, Pavlodar, Semipalatinsk, Ust', Astrakhan (Russia)
Land Cover and Use	**Area, % basin area**
Forest	17.0
Grassland, savanna and shrubland	14.0
Wetlands	7.7
Cropland	51.4
Irrigated cropland	3.0
Dryland	—
Urban and industrial	5.4
Loss of original forest cover	52.0
Economy	Agriculture. Oil and gas. Hydroelectric power production. Water transport.
Environmental Issues	Decreased water flow because of high withdrawals for industry in the People's Republic of China. Severe water pollution from industry, mining, and agriculture.

Sources: International Union for Conservation of Nature (IUCN), the International Water Management Institute (IWMI), the Ramsar Convention Bureau, and the World Resources Institute (WRI). 2003. *Watersheds of the World*. http://multimedia.wri.org/watersheds_2003/index.html

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Upper: The Irtysh River in spring in Pavlodar, Kazakhstan; the Blagoveshchensky Cathedral in the background. **Lower:** The city of Astana behind the Ishim River embarkment. The river is one of the tributaries of the Irtysh River.

Bridge over the Ural River at sunrise in Atyrau, Kazakhstan. The Ural separates Europe from Asia.

URAL BASIN

The Ural basin comprises some 244,000 square kilometers—more than 60% of which is in Kazakhstan—and stretches from the headwaters of the Ural River in the southeastern Ural Mountains of the Russian Federation to Kazakhstan's Caspian Sea Depression. Of the Ural River's 2,428 kilometers length, nearly half, 1,082 kilometers, is in Kazakhstan. The basin includes about 240 lakes, plus the human-made Iriklin Reservoir, which has a surface area of 260 square kilometers and storage capacity of 3,260 cubic kilometers.

The basin's living resources include the sturgeons. As the only unregulated river flowing into the Caspian Sea, the Ural River holds special advantages for these prized fish. For one, there are no large dams or weirs, so migrating sturgeon can swim unobstructed to upstream breeding grounds. For another, the river's meandering course and mostly natural floodplain offer ideal places for fish, especially sturgeon, to spawn. And it is why the transboundary Ural Basin Project has been set up to create and manage an International Ural Sturgeon Park. The park aims to preserve Ural sturgeon populations and provide a basis for restocking in other regions.

But the Ural River faces threats: major industrial pollution from the Russian Federation, and wastewater discharge from the Kazakh cities of Uralsk and Atyrau. Also contributing to pollution are surface water runoff, seepage from sewage ponds, and surface runoff from Caspian Sea oil sites. Somewhat mitigating this is spring snow melt, which releases large quantities of water into the river to flush contaminants accumulated during the rest of the year. And though overall pollution increased in the 1990s, there seems to have been a slight decrease in pollution since 2000—a very good sign.

Ural Water Basin Facts	
Water basin area (square kilometers)	244,334
Average population density (people per square kilometer)	15
Cities (100,000 or more people)	4: Atyrau, Uralsk, Aktyubinsk (Kazakhstan), Orenburg (Russia)
Land Cover and Use	**Area, % basin area**
Forest	2.3
Grassland, savanna and shrubland	33.4
Wetlands	0.2
Cropland	59.3
Irrigated cropland	0.9
Dryland	100
Urban and industrial	4.2
Loss of original forest cover	32.3
Economy	Agriculture: fisheries. Industry: oil and gas.
Environmental Issues	High water pollution due to industry, municipal wastewaters, and surface runoff during flooding. Silting of Ural River mouth. Poaching of sturgeon.

Sources: International Union for Conservation of Nature (IUCN), the International Water Management Institute (IWMI), the Ramsar Convention Bureau, and the World Resources Institute (WRI). 2003. *Watersheds of the World.* http://multimedia.wri.org/watersheds_2003/index.html

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ZARAFSHAN RIVER BASIN

The Zarafshan, or Zeravshan, River basin has the honor of being Central Asia's most ancient seat of agriculture; the region's earliest cities were founded there.

But the nature of the Zarafshan River basin has changed over the past half century. Formerly, it was a sub-basin of the Amu Darya basin but its connection was lost as more and more water from the river and its 70 tributaries was diverted for irrigation.

Third largest river in Uzbekistan, the Zarafshan begins under the name of Mostchokh-Darya in a high glacier in Tajikistan and winds its way down the 180-kilometer long Zarafshan inter-mountain depression. The river continues through Tajikistan for a further 120 kilometers and then flows through the Zarafshan Valley, in the Samarkand area of Uzbekistan.

Tajikistan uses only about 8% of the river's discharge. Virtually all the remainder is used to irrigate more than 600,000 hectares in Uzbekistan, supporting its second most important agricultural center—in a country where agriculture is the main livelihood of the rural population. There are many dams and barrages along the way, and a great number of canals for irrigation and water supply. Formerly, the river connected the cities of Samarkand, Navoi, and Bukhara but now it no longer reaches Bukhara. What water remains flows out into and is swallowed by the desert, and well before the Zarafshan can connect with the Amu Darya.

Zarafshan River's waters—the only source of drinking water in the Samarkand area—have not been managed well. Pollution from irrigation return water and waste waters from cities, such as Samarkand, Kattakurgan, and Navoi, have reduced the water quality, while Uzbekistan's irrigation systems are in urgent need of rehabilitation if agricultural productivity losses through increasing leakage and poor drainage are to be overcome. This will become increasingly important in the future because Tajikistan is planning to tap the upper reaches of the Zarafshan for hydropower generation, which could further affect Uzbekistan's agricultural output.

Zarafshan River Basin Facts

Basin area (square kilometers)	12,200*
Average population density (people per square kilometer)	Densely populated*
Cities (100,000 or more people)	Bukhara, Navoi, Samarkand
Economy	Agriculture (Uzbekistan). Industry: mining (Tajikistan).
Environmental issues	Deterioration of water quality (high salinity, polluted waters) due to return water from irrigation and wastewaters from Samarkand, Kattakurgan, and Navoi.

*It is difficult to determine the size of the catchment area; this estimate is based on total area of the mountain part of the catchment.

Sources: United Nations Economic Commission for Europe. 2007. *Our Waters: Joining Hands Across Borders.* www.unece.org/env/water/publications/pub76.htm

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Upper: A helicopter takes tourists over the frozen upper reaches of the Zarafshan. **Lower:** The Zarafshan River in the Ayni district of Tajikistan.

Above: Salt-encrusted wastelands from the present shore of the Aral Sea. **Lower:** A person standing on a cliff near Moynaq town on the former shore of the Aral Sea, now 180 km away.

Two Inland Seas

ARAL SEA

Sharing its area with Kazakhstan and Uzbekistan, the Aral Sea was fed primarily by the Amu Darya and Syr Darya rivers. The Chui, Murgabi, Tadjen, and Talas rivers are also part of the Aral Sea basin. Their waters, however, are used for irrigation or lost in the plains and never reach the Aral Sea. And little of the Amu Darya water reaches there; most is diverted to irrigation, especially through the Karakum Canal in Turkmenistan.

In some ways there are two Aral Seas: the Aral Sea that was—the world's fourth largest inland lake, and the Aral Sea that is—a shrunken body of water that is gradually drying up. The Aral Sea that was existed until the late 1950s. It covered an area of 68,300 square kilometers, had a water surface of 66,100 square kilometers, a water volume of 1,066 cubic kilometers, and was teeming with life. It supported sea ports and a thriving commercial fishing industry, which peaked at an annual catch of 46,000 tons in the 1960s.

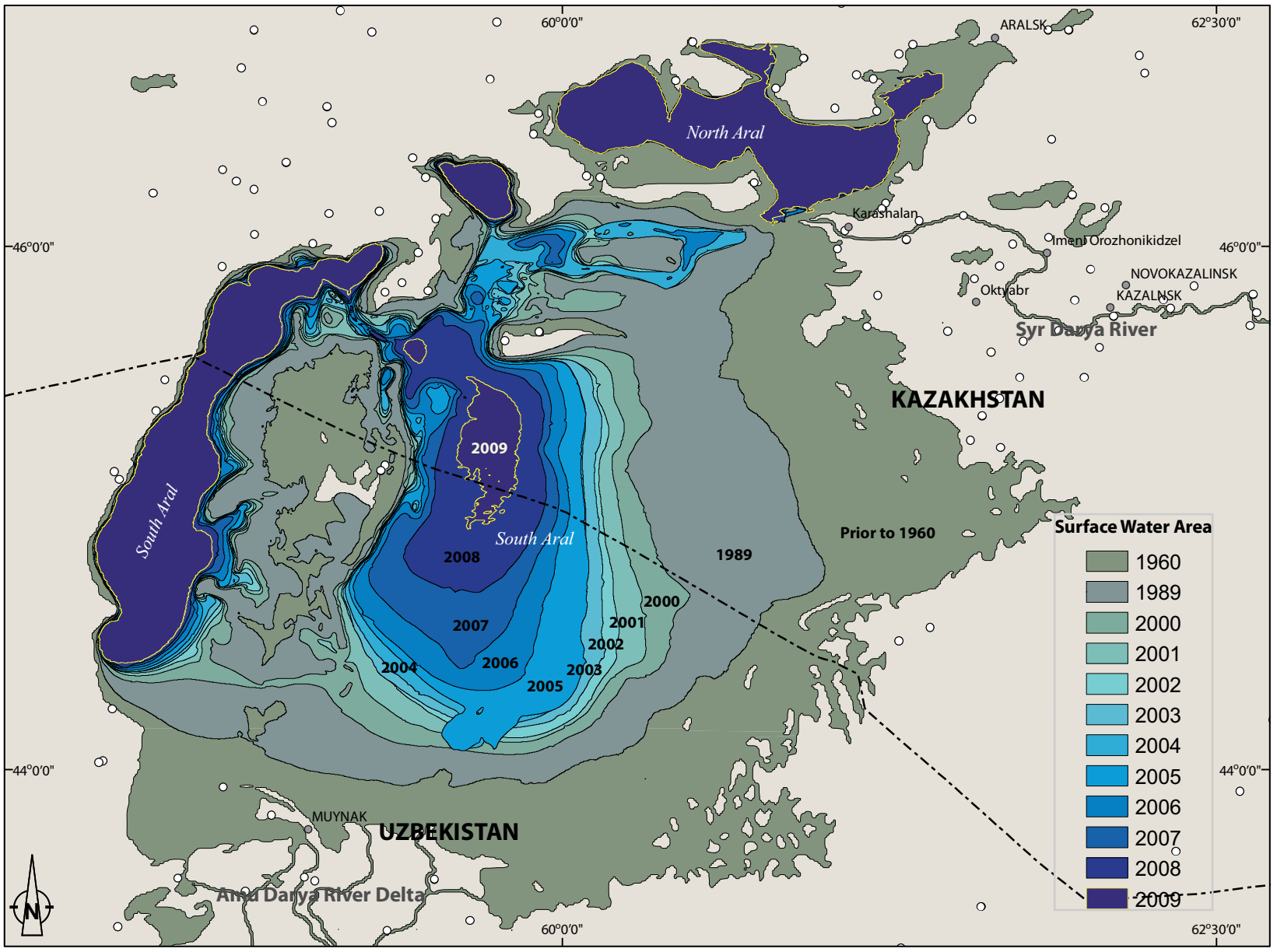
Formation of the Aral Sea that is began in the same decade, when much of the water from its primary tributaries, the Amu Darya and Syr Darya rivers, began to be diverted for power generation and irrigation for 7 million hectares of agricultural land—primarily planted to cotton. By the 1980s, water from the basins that feed these rivers was completely utilized and the Aral Sea began to shrink. By 1986, the sea had split into two bodies of water: the Big and Small seas. By 2002, water level in the Big Sea had fallen by 22 meters. By 2005, the Aral Sea had shrunk to half its former size and its water volume had diminished by 75%.

The incredible retreat of the Aral Sea shoreline has left towns and villages that were once thriving fishing ports stranded tens of kilometers inland. The once vibrant commercial fishing industry has virtually ceased to exist as reduced river flow to the Aral Sea, combined with pollutants from irrigation runoff, have killed plant and animal life, and left most of the sea virtually dead.

But the Small Sea, or North Aral Sea, in Kazakhstan is now recovering, thanks to the 13-kilometer

Large fishing vessels lie beached on what was once the shore of the Aral Sea.

Aral Sea



Boundaries of surface water area:
Prior to 1960: IUCN Elevation and Rivers Dataset
1989: Landsat TM
2000–2009: MODIS

Prepared by C. Y. Ji, 2009

Right: People walk across the Kokaral Dam on the North Aral Sea in Kazakhstan.

Kokaral dam completed in 2005, to separate it from the rest of the sea, and hydrological improvements in Kazakhstan's part of the Syr Darya River, which flows into the North Aral Sea. Four years later, the North Aral Sea surface area is already 50% higher than the lowest level and water is creeping back toward the former fishing town of Aral, 100 kilometers from the shore in 2005 and now only 35 kilometers away. There are plans for more dikes and canals to increase water levels further. Fish are returning and catches increasing dramatically as salinity levels fall to more normal conditions. At issue, however, is whether these works will worsen conditions in the rest of the Aral Sea.

CASPIAN SEA

To say the Caspian Sea is the world's largest inland body of water does not capture its immensity. To put its size in proportion, it is larger in area than America's Great Lakes or Africa's Lake Victoria, and contains 40% of the world's inland waters—some 78,100 cubic kilometers of water. It measures about 1,200 kilometers in length, 196-495 kilometers in width, and has an area of 378,000 square kilometers. It provides immense resources and invaluable shipping routes to the countries that share its 7,000-kilometer coastline: Armenia, Azerbaijan, Iran, Kazakhstan, the Russian Federation, and Turkmenistan.

The Caspian was once a part of the ancient Tethys Sea, which subsumed the Mediterranean, Black, and Aral seas. It became completely isolated during the mid-Pliocene Epoch, roughly 1 million years ago. The present sea is shallow in the north, with an average depth of 5 meters, and reaches a maximum depth of more than 1,000 meters in the south. More than 130 streams and rivers feed the Caspian, with a total annual inflow estimated at 300 cubic kilometers. Five rivers account for most of the freshwater inflow: the Kura, Sulak, Terek, Ural, and Volga. The Volga provides roughly 80% of the Caspian's total inflow. However, the Volga's water is heavily used for industrial and agricultural purposes, such that the flow into the Caspian now is only a tenth of the natural flow rate.

For almost a full century, the water level of the Caspian Sea slowly fell, until it began to rise again suddenly in 1977—and is still slowly rising—for reasons unknown. This natural cycle has masked the loss of river flow input. Thus, the Caspian remains apparently immune to humanity's efforts to tame it but its future is an uncertain one, which complicates development around its shores and efforts to rehabilitate inflowing river systems.

The sea's once-flourishing fisheries have declined due to damming of most rivers—which prevents some commercial species, including sturgeons for which the sea is famous, from migrating upriver to their spawning grounds—and pollution from agriculture, land-based industry, and the oil industry on the sea itself. Oil platforms dot the Caspian.

Fishing still provides a source of income for countries around its shores, but the greatest Caspian revenue comes from extraction of hydrocarbons. Estimates for Caspian region oil are as high as 49 billion barrels, while proven gas reserves are estimated at 232 trillion cubic feet. Both Kazakhstan and Turkmenistan contribute large amounts of oil-related and agricultural pollution to the Caspian. A major concern on the Kazakhstan coast is radioactive uranium waste in open pits: the Koshkarata dumping ground near the sea contained more than 400 million tons of toxic and radioactive waste by 1965.

Rehabilitation may be around the corner. A European Union–funded Regional Water Quality Monitoring Programme and Pollution Action Plan for specific areas included surveys of Kazakhstan and Turkmenistan waters in the Caspian. But workable and enforceable solutions still seem far off, given the Caspian countries' reluctance to cooperate on these matters so far.

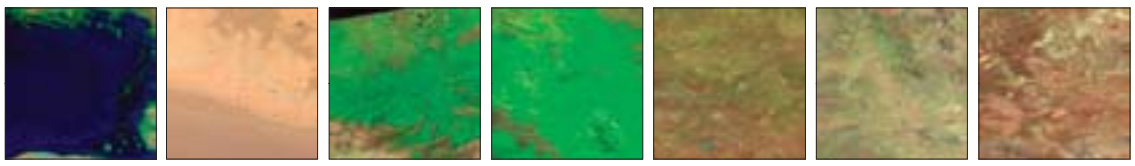
Top: Caspian Sea shore, Turkmenbashi, Turkmenistan. **Middle:** Housing development area in Aktau, on the Caspian Sea in southwestern Kazakhstan. It is now a center of oil and gas industry. **Bottom:** The Caspian Sea shore at Aktau.

Caspian Sea

80 40 0 80 Kilometers

1:6,000,000

International boundary



Water | Bare Area | Irrigated Land | Irrigated Land | Pastureland | Pastureland | Pastureland

Satellite Image: MODIS MOD09A1 (500m)
Image Acquisition Date: September 2008
Projection: Geographic WGS84

Prepared by C. Y JI, 2009

Left: Blocking the Kara-Bogaz-Gol sea gulf to build the dam separating the gulf from the sea in 1980. **Upper right:** Lake Aydarkul. **Lower right:** Lake Issyk-Kul is the second largest alpine lake in the world and the most popular summer holiday destination in Central Asia.

Outstanding Lakes

KARA-BOGAZ-GOL

Although named Kara-Bogaz-Gol or "mighty strait lake" in Turkmen language, this enormous gulf basin can more correctly be considered the world's largest lagoon. Situated in Uzbekistan on the Caspian Sea's eastern coast, it is separated from the Caspian by a strait of sandbars. Under natural conditions, the basin serves as an evaporative sink for the Caspian. Around 1900, when Caspian sea level was high, annual outflow from the Caspian to the Kara-Bogaz-Gol stood at roughly 30 cubic kilometers of water. Later falls in the Caspian's sea level reduced outflow by half. A solid dam was built across the strait in 1980 to arrest declines from evaporation. After the closure, sea level in the Caspian rose more than 11 centimeters. But it also accelerated evaporation of the highly saline Kara-Bogaz-Gol until parts of it came to resemble a salt bowl. The dam was breached in 1984 to allow replenishment of the gulf basin, and was completely removed in 1992.

LAKE AYDARKUL

Numerous lakes are found in the low-lying regions of the Aral Sea basin. The largest lakes are created by drainage water, principally irrigation effluent. Of these lakes, Aydarkul, with a surface area of 30 square kilometers, is the biggest. Lake Aydarkul rests in the Arnarsay depression astride the border of Kazakhstan and Uzbekistan. It owes its existence primarily to winter discharge from the Toktogul water reservoir. Drainage from irrigated fields in the Kazakh and Uzbeki Golodnaya steppe also contributes water to the Aydarkul.

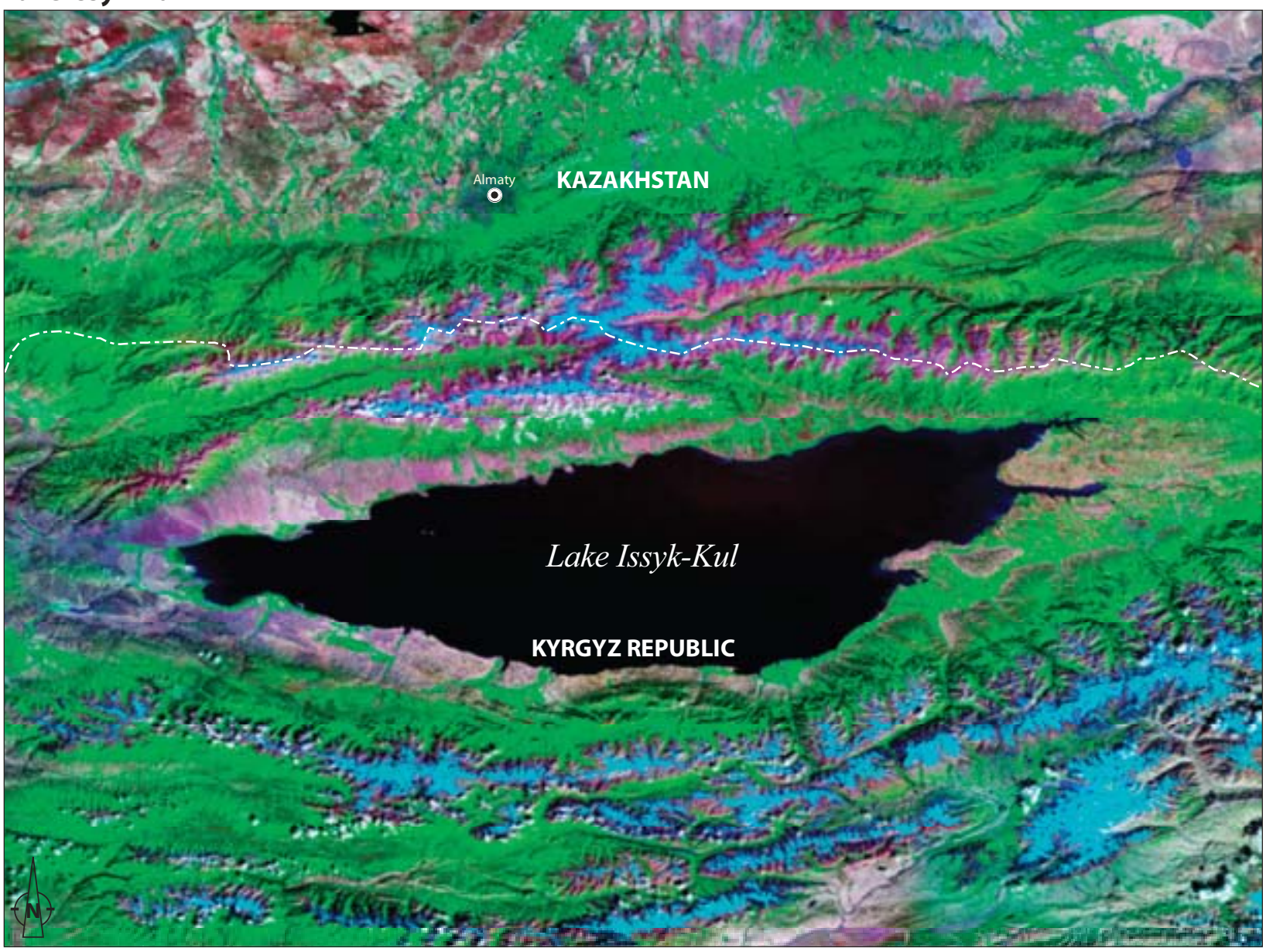
Given its source, Aydarkul would appear to be less than inviting. However, it is actually quite beautiful. Turquoise in color and home to many species of fish, it offers a welcome contrast to the desert and steppe that surround it. Its excellent beaches are eye-catching, as are the pink pelicans, swans, and white herons that thrive in its less than pristine waters.

LAKE ISSYK-KUL

Lake Issyk-Kul is located high in the northern Tien Shan of eastern Kyrgyz Republic. Noted for its natural and cultural heritage, long history as a site for recreation and spas, and clear, clean blue waters, Issyk-Kul ranks high in global lists of special categories. It is the world's ninth largest lake by volume, second largest lying above 1,200 meters, and one of the planet's 20 rare ancient lakes, having been formed roughly 25 million years ago.

Measuring 180 kilometers in length and 60 kilometers in width at its widest point, Issyk-Kul has an average depth of 200 meters, and a maximum depth of 668 meters. Of the 118 streams and rivers that flow toward Issyk-Kul, 49 drain into it. Lake volume is 1,738 cubic kilometers and, as may be expected, water level varies by season, rising in spring and summer from snow and glacial melt, and falling in autumn and winter. High salinity keeps the lake from freezing (Issykl-Kul—Ysyk Köl, Issyk-kol—means "warm lake" in Kyrgyz language), making it a vital winter stopover for migratory birds.

Lake Issyk-Kul

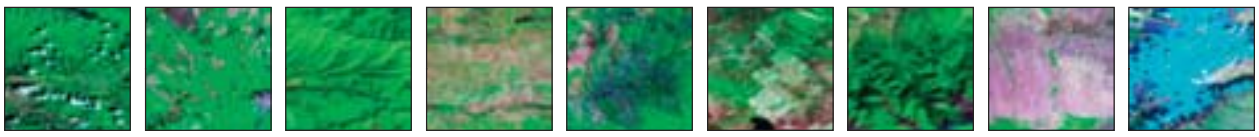


25 12.5 0 25 Kilometers

1:1,500,000

Provincial capital

International boundary



Satellite Image: Landsat ETM+ (15m)
Image Acquisition Date: circa 2000 (+/- 3 years)
Projection: Geographic, WGS84

Prepared by C. Y. Ji, 2009

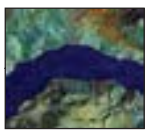
Increasing development and resource exploitation, however, put the lake at risk. Diversion of water has resulted in water level drop of some 2.5 meters in the last few decades. Poor agricultural practices, mining, and introduction of non-native species have all compromised the lake's natural biodiversity. In response, the Government of the Kyrgyz Republic created the Issyk-Kul Biosphere Reserve. The goal for creating this 43,000-square kilometer-protected area is conservation as well as support for long-range social and economic development geared toward restoring the lake's natural resources.

A long pier extends into Lake Issyk-Kul.

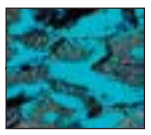
Lake Sarez

5 2.5 0 5 Kilometers

1:300,000


Lake


Bare Rock


Snow/Glacier


Alpine Meadow


Tundra

Satellite Image: Landsat ETM+ (15m)
Image Acquisition Date: circa 2000 (+/- 3 years)
Projection: Geographic, WGS84

Prepared by C. Y. Ji, 2009

LAKE SAREZ

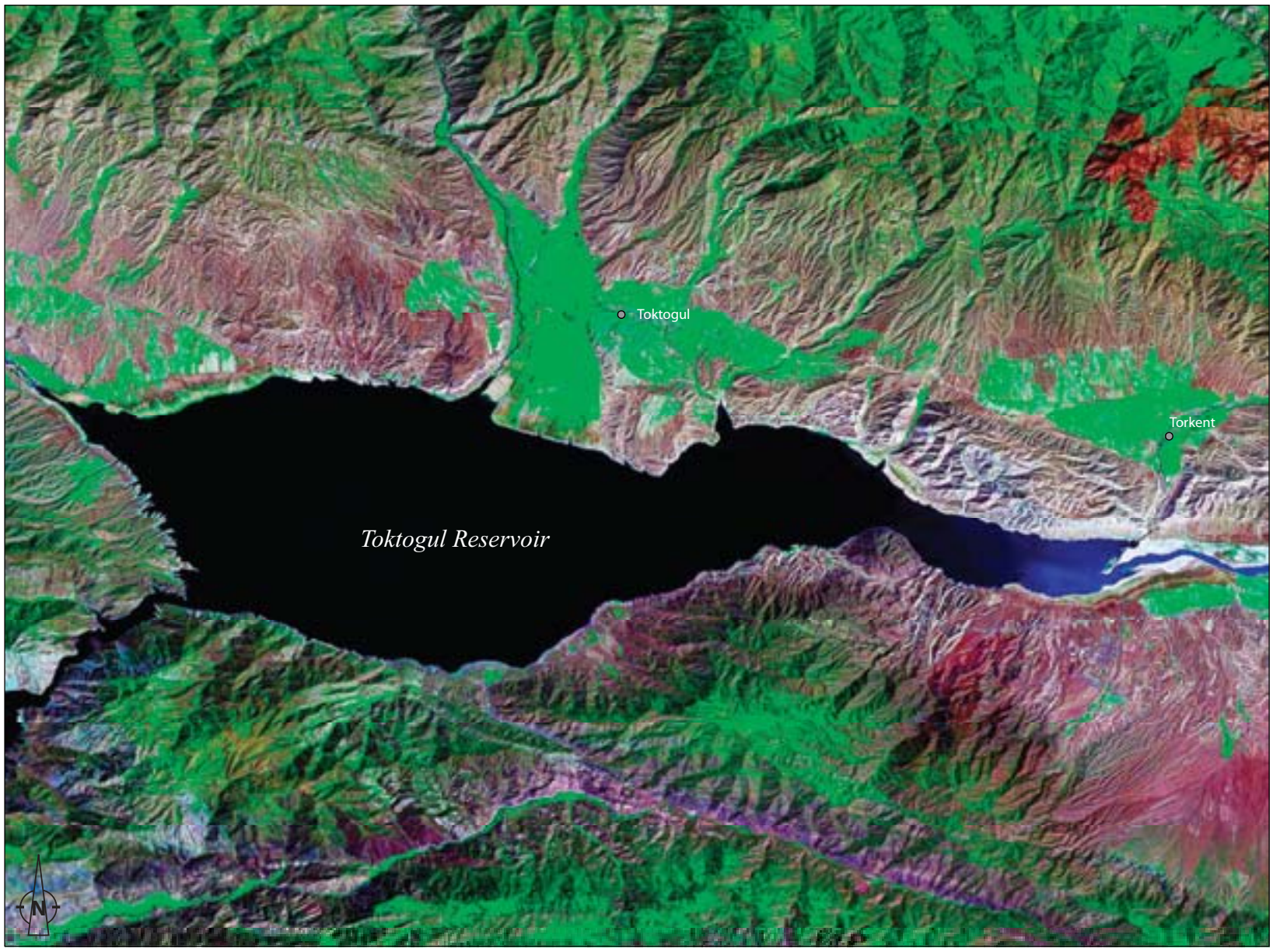
In February 1911, an earthquake shook the Murgab River valley in the East Pamir mountains in what is now Tajikistan. Giant rock masses hurtled down mountain slopes, blocking the Murgab River with a 5-kilometer wide, 200-meter-high natural dam (Usol Dam)—Lake Sarez was born. Central Asia is home to several rock-dammed lakes of which Sarez is the largest. Ominously, the waters of Sarez are constantly rising. Recent reports suggest its volume is approaching 16 billion cubic meters and growing steadily. This poses incredible danger.

The lake's growing size—which builds pressure behind the dam—and the area's highly seismic nature create devastating potential. The canyon surrounding the lake is eroding at an annual rate of 30–40 meters, and seepage through the dam has significantly increased. Should a debacle occur, a catastrophic flash flood would roar down from the lake's 3,200-meter height, engulfing 70,000 square kilometers and 6 million people in Tajikistan, Turkmenistan, and Uzbekistan. To minimize this risk, the Government of Tajikistan, with the aid of international donors, has launched a safety program. It includes a monitoring and early-warning system that came on line in 2005.

Lake Sarez, looking toward the dam. A diversion tunnel has been proposed that would relieve some pressure on the dam and generate hydropower.

Beautiful, clear, and dangerous, the 60-kilometer long and 3-kilometer-wide Lake Sarez sits high up in the mountains of Pamir. The lake was formed in 1911 as the result of a powerful earthquake.

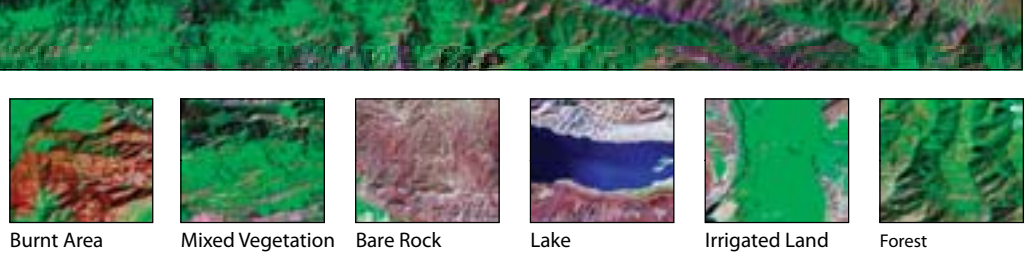
Toktogul Reservoir



5 2.5 0 5 Kilometers

1:250,000

City



Satellite Image: Landsat ETM+ (15m)
Image Acquisition Date: circa 2000 (+/- 3 years)
Projection: Geographic, WGS84

Prepared by C. Y. Ji, 2009

Right: Mountains climb into the distance behind Toktogul Reservoir.

TOKTOGUL RESERVOIR

The Toktogul Reservoir is the largest of a string of reservoirs built along the Naryn River in the Kyrgyz Republic. It has a capacity of 19.5 cubic kilometers. Completed in 1976, it was designed to irrigate lands in the Syr Darya basin. It has helped bring approximately 400,000 formerly unused hectares of land into production, and improved irrigation for roughly 1 million hectares in downstream Kazakhstan and Uzbekistan. Ideally, the reservoir is guided by a fixed irrigation schedule: water is allowed to accumulate in winter and early spring and released during the growing season.

This schedule worked well under Soviet centralized water management, when costs borne by the Kyrgyz Republic for the maintenance of the Toktogul hydropower plant and of the republic's lower Naryn plants were offset by receipt of supplies of equipment, fuel, and goods from the former Soviet Union. When the Soviet Union disintegrated, however, supplies to the Kyrgyz Republic stopped and effective water management coordination has presented an ongoing challenge to the region ever since.

Toktogul Reservoir.