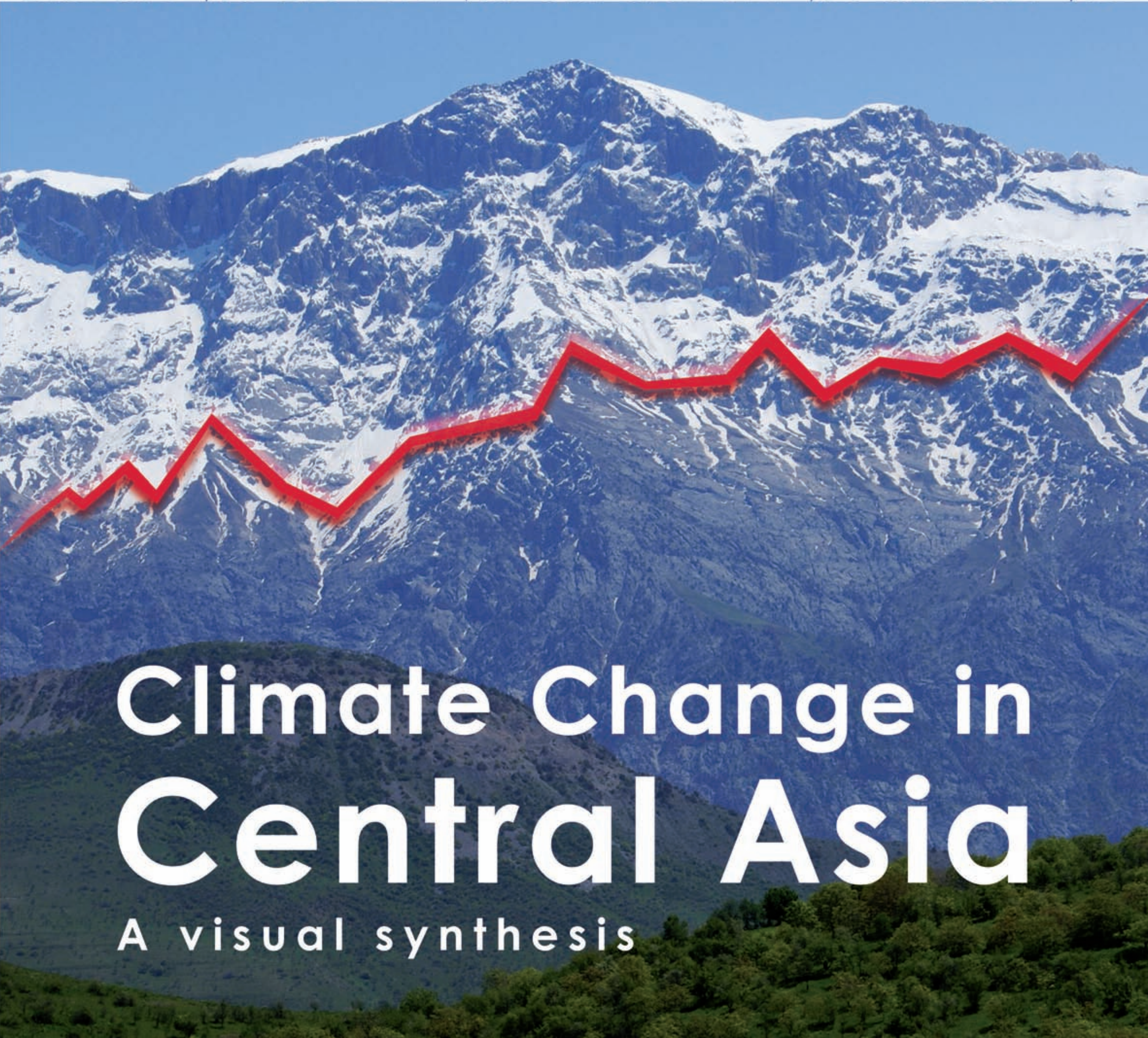

Climate Change in Central Asia

A visual synthesis

Climate Change in Central Asia

A visual synthesis

based on official country information from the communications to the UNFCCC, scientific papers and news reports

This is a Zoï environment publication produced in close cooperation with the Governments of Switzerland, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan.

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Photos on the cover page:
The Pamir mountains, Tajikistan
The Amu Darya river delta, Uzbekistan

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Contents

Foreword

Central Asia is facing complex environmental challenges, in particular in the areas of water, energy, agriculture and industry. The challenges are getting bigger in the context of climate change. There is a lot of scientific information about the effects of climate change for different sectors. However, there is a lack of information which is easily accessible and directly applicable.

This booklet – produced by Zoï Environment Network in close cooperation with the countries – attempts to provide a synthesis of what climate change may mean for Central Asia. It builds upon the latest (Second) series of the official national communications on climate change by the Central Asian states under the UN Framework Convention on Climate Change. The booklet is written in a highly visual format, understandable for decision makers and also useful for educational purposes.

Switzerland has a long-standing engagement in Central Asia. This cooperation is characterized by an early focus on environmental issues, thereby contributing to strengthening environmental monitoring systems, to address issues of water management, and to approach mountain development in an integrated manner. Switzerland and the Central Asian republics are members of the same constituency in the Global Environment Facility: another reason to cultivate good relations and find a common approach to solve environmental problems. Switzerland has supported the production of this publication, giving another strong message that climate change is real and needs to be addressed immediately, also in Central Asia.

Bern / Geneva 8 December 2009

Thomas Kolly
Head, International Affairs Division
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Otto Simonett
Director
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Climate change in Central Asia: key findings, trends and projections

INDICATORS	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
Air temperature [1]	↑	↑	↑	↑	↑
Precipitation and snow [1]	↑	↑↓	↑↓	↑↓	↑↓
Climate aridisation and desertification	↑	↑	↑	↑	↑
Extreme weather events and climate-related hazards [2]	↑	↑	↑		↑
Melting ice and permafrost [1]	↑	↑	↑		↑
Water resources availability in the future [3]	↑↓	↓	↓	↓	↓
Health [4]	↑	↑	↑	↑	↑
1) Greenhouse gas emissions 1990-2005	↓	↓	↓		↑
2) Greenhouse gas emissions 2000-2005	↑	↑	↑	↑	↓
Policy instruments, actions and awareness	↑	↑	↑	↑	↑
Climate observation and weather services [2]	↓	↓	↓	↓	↓

↑ increase, enhancement ↓ decrease, reduction ↑↓ mixed trends

1) 1950-2005 2) 1990-2009 3) 2050-2100 4) infectious and vector-born diseases, heat stress

Sources: Second National Communications of Kazakhstan, 2009; Kyrgyzstan, 2009; Tajikistan, 2008; Uzbekistan, 2008; Technical Needs Assessment and the Initial Communication of Turkmenistan

Cultivated lands, the Tajik-Afghan border

Central Asia at a Glance


RUSSIA
KAZAKHSTAN
TURKMENISTAN
UZBEKISTAN
TAJIKISTAN
AFGHANISTAN
PAKISTAN
IRAN
Caspian Sea
Aral Sea
Lake Balkhash
Volga
Ural
Irtysh
Syr Darya
Amu Darya
Chu
Ili
Saransk
Chistopol
Ufa
Ulyanovsk
Penza
Tolyatti
Samara
Chelyabinsk
Petropavlovsk
Omsk
Buzuluk
Kumertau
Magnitogorsk
Kostanay
Kokshetau
Saratov
Rudniy
Stepnogorsk
Pavlodar
Orenburg
Atbasar
Oral
Orsk
Astana
Volgograd
Aktobe
Arkalyk
Temirtau
Karaganda
Atyrau
Zhezkazgan
Astrakhan
Balkhash
Aral
Baikonur
Taldykorgan
Kyzylorda
Makhachkala
Aktau
Zhanaozen
Kentau
Zhanatas
Derbent
Bishkek
Taraz
Kara-Balta
Turkestan
Balykchy
Nukus
Uchkuduk
Mingachevir
Shymkent
Toktogul
Dashoguz
Urganch
Naryn
Tashkent
Ali Bayramli
Angren
Jalalabad
Baku
Kokand
Osh
Turkmenbashi
Navoiy
Jizakh
Ferghana
Balkanabat
Khujand
Bukhara
Samarkand
Turkmenabat
Karshi
Rasht
Ashgabat
Dushanbe
Gonbad-e Kavus
Mary
Termiz
Qurghonteppa
Khorug
Sari
Bojnurd
Karaj
Gorgan
Kunduz
Tehran
Mazar-e Sharif
Gilgit
Neyshabur
Mashad
Hamadan
Qom
Mingora
Arak

When Central Asia is called to mind, it raises romantic memories of the Silk Road with its seas (the Caspian and the Aral), vast barren lands (Kara-Kum, Kyzyl-Kum), limitless Kazakh steppes, gorgeous ice-covered mountains of Tien Shan, Pamir, Alai and Atlay, vital rivers (Amu Darya, Syr Darya, Ural, Irtysh, Ili).

But there is no romance any more in a region with major environmental problems and the threat of climate change facing the population of the five nations of Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) growing at a rate of 2% on average every year. There are now more than 60 million people, most of them young and living along the main rivers or around oases, as used to be the case in the days of the Silk Road.

Nestling between the Russian Federation, Iran, Afghanistan and China, Central Asia was a unified area under the Soviet Union with a common heritage in terms of language, culture, education and infrastructure, and with a united energy, water, agricultural and industrial system. After gaining independence in 1991, it was left with a legacy that still has negative impacts on the engines of the economy: agriculture and energy.

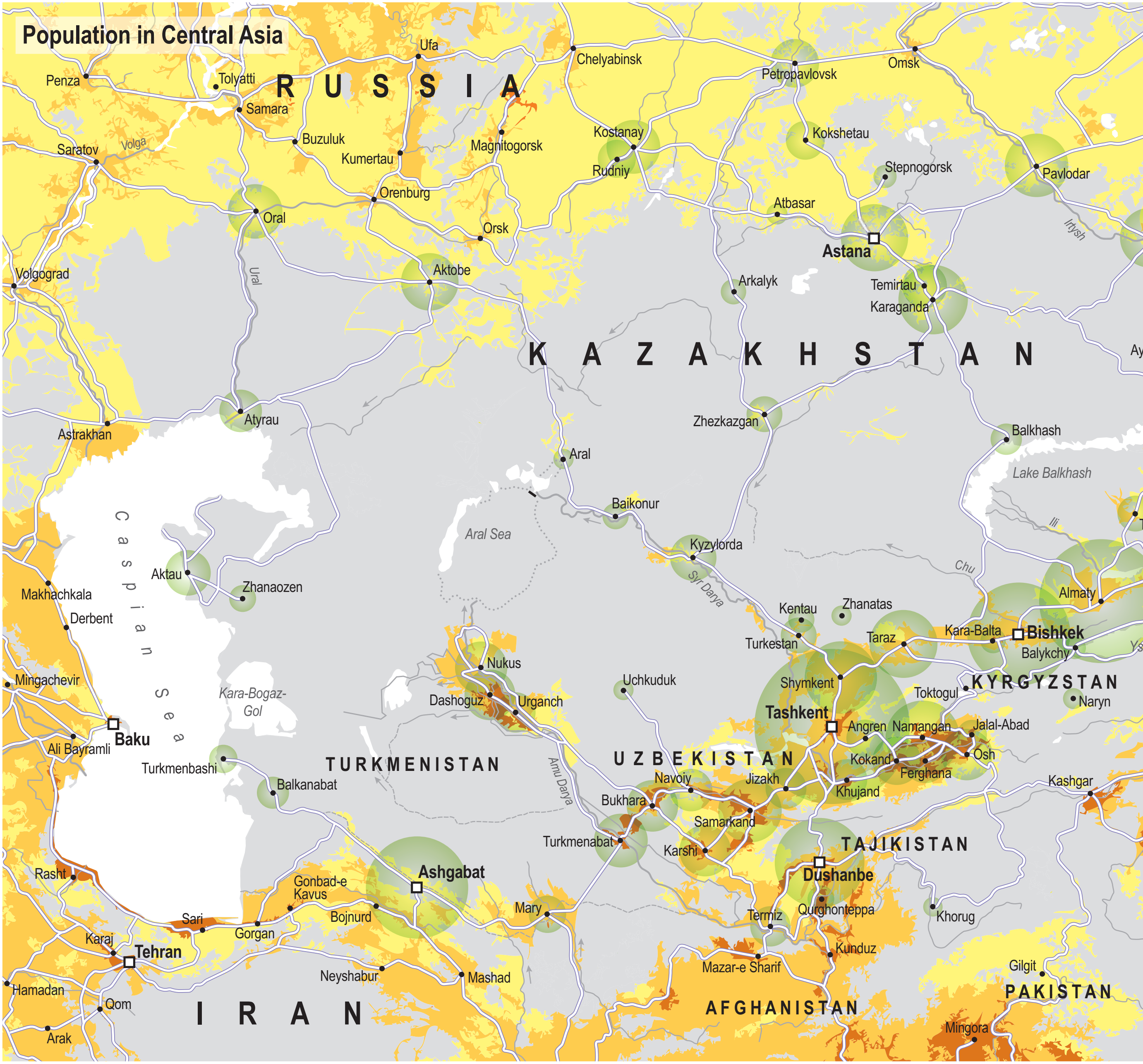
The exploitation of natural resources in the name of “progress” without concern to the environment has had catastrophic consequences. The drying up of the Aral Sea is probably the best known case.

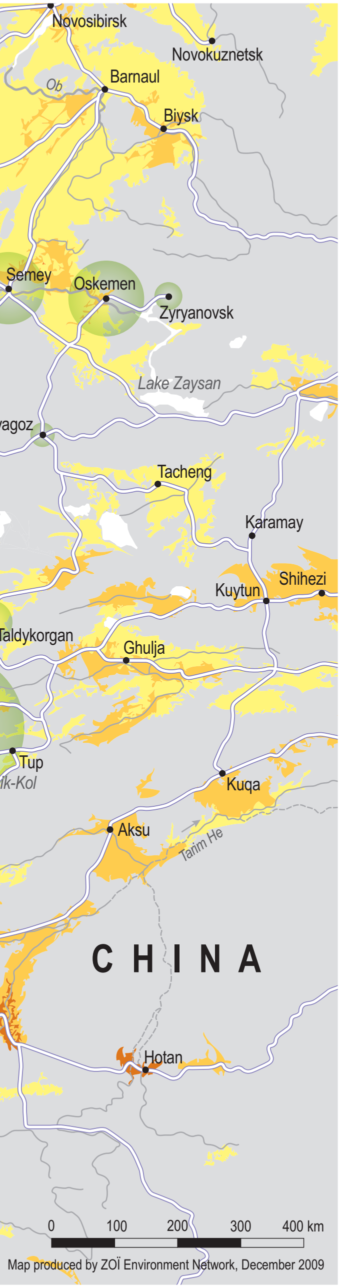
As a result the irrigated agriculture is inefficient, the quality and amount of land and water resources are declining, the reforms are too slow, and unemployment is rising.

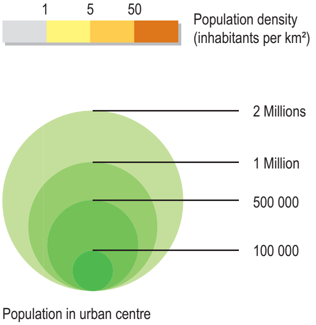
But those are not the only challenges facing the region.

Toxic waste from mining and heavy industries and deposits of radioactive waste in disaster-prone areas endanger the health of millions of people. Extraction of hydrocarbons is booming in Kazakhstan, Turkmenistan and Uzbekistan. Hydropower development projects are being implemented at full speed in Kyrgyzstan and Tajikistan. However, competition for energy sources is also straining the relations between the states of the region.

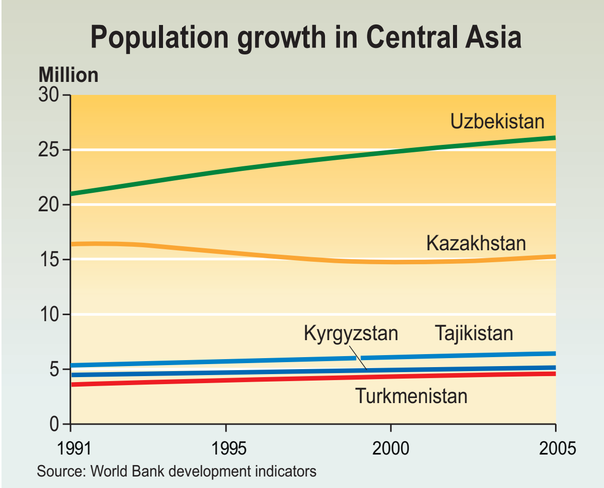
The situation is difficult and will deteriorate further with a changing climate.

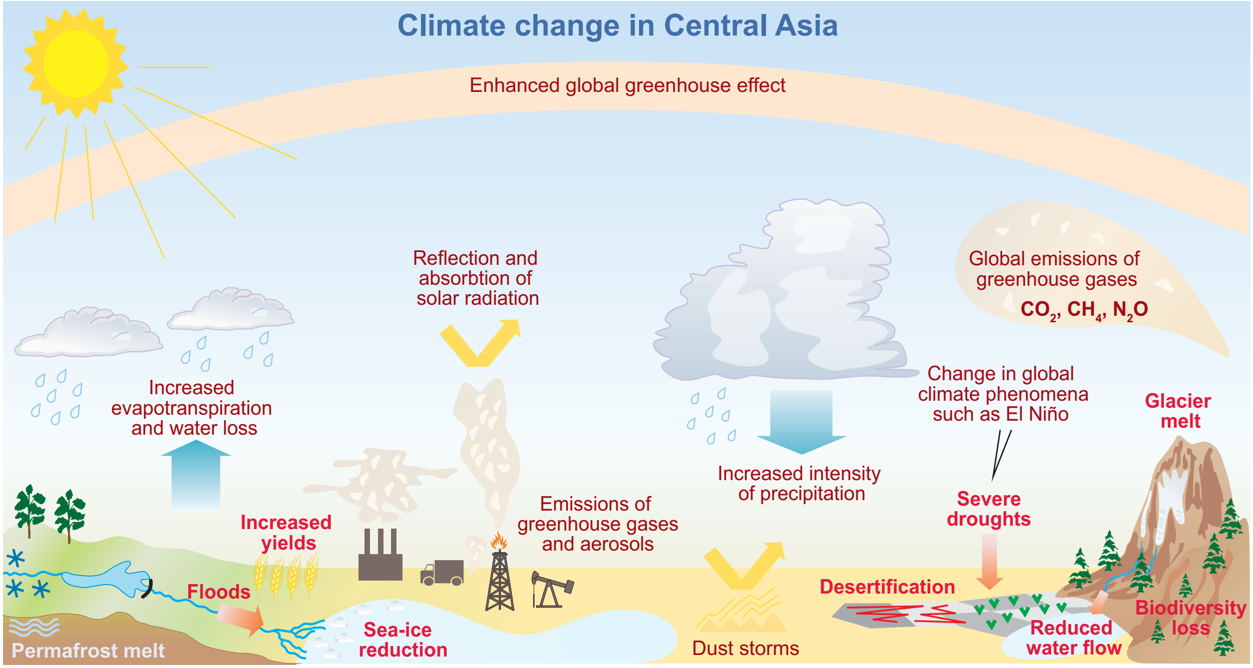

Population in Central Asia
RUSSIA
KAZAKHSTAN
UZBEKISTAN
TURKMENISTAN
KYRGYZSTAN
TAJIKISTAN
AFGHANISTAN
PAKISTAN
IRAN
Caspian Sea
Aral Sea
Lake Balkhash
Kara-Bogaz-Gol
Volga
Ural
Irtysh
Ili
Chu
Syr Darya
Amu Darya
Penza
Tolyatti
Samara
Ufa
Chelyabinsk
Petropavlovsk
Omsk
Saratov
Buzuluk
Kumertau
Magnitogorsk
Kostanay
Rudniy
Kokshetau
Stepnogorsk
Pavlodar
Orenburg
Oral
Orsk
Atbasar
Astana
Volgograd
Aktobe
Arkalyk
Temirtau
Karaganda
Atyrau
Astrakhan
Zhezkazgan
Balkhash
Aral
Baikonur
Kyzylorda
Aktau
Zhanaozen
Makhachkala
Derbent
Kentau
Zhanatas
Turkestan
Taraz
Kara-Balta
Bishkek
Almaty
Balykchy
Nukus
Uchkuduk
Shymkent
Toktogul
Naryn
Mingachevir
Dashoguz
Urganch
Tashkent
Angren
Namangan
Jalal-Abad
Baku
Ali Bayramli
Turkmenbashi
Balkanabat
Navoiy
Jizakh
Kokand
Osh
Ferghana
Khujand
Bukhara
Samarkand
Kashgar
Turkmenabat
Karshi
Dushanbe
Ashgabat
Rasht
Gonbad-e Kavus
Bojnurd
Mary
Termiz
Qurghonteppa
Khorug
Sari
Gorgan
Karaj
Tehran
Kunduz
Mazar-e Sharif
Neyshabur
Mashad
Gilgit
Hamadan
Qom
Arak
Mingora





Sources: LandScan Global Population Database. Oak Ridge, TN: Oak Ridge National Laboratory; World Gazetteer



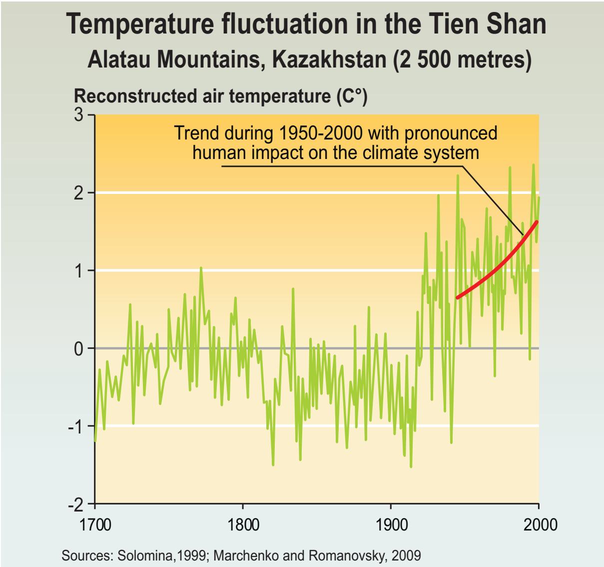


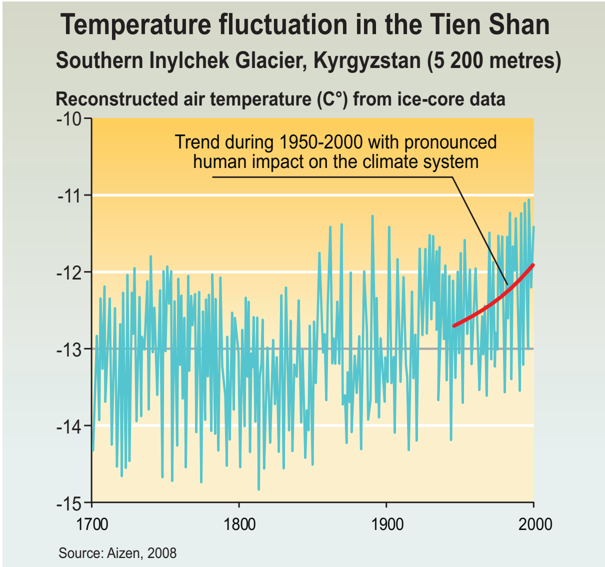
Science is warning us. Without mitigation of the human-induced causes of climate warming, the implications for the global ecosystem and for humanity could be serious.

Global warming may reach from 3° to 6° Celsius by the second half of the century. But a mere 2°Celsius rise in temperature could have serious consequences for human life. This would be the case for Central Asia.

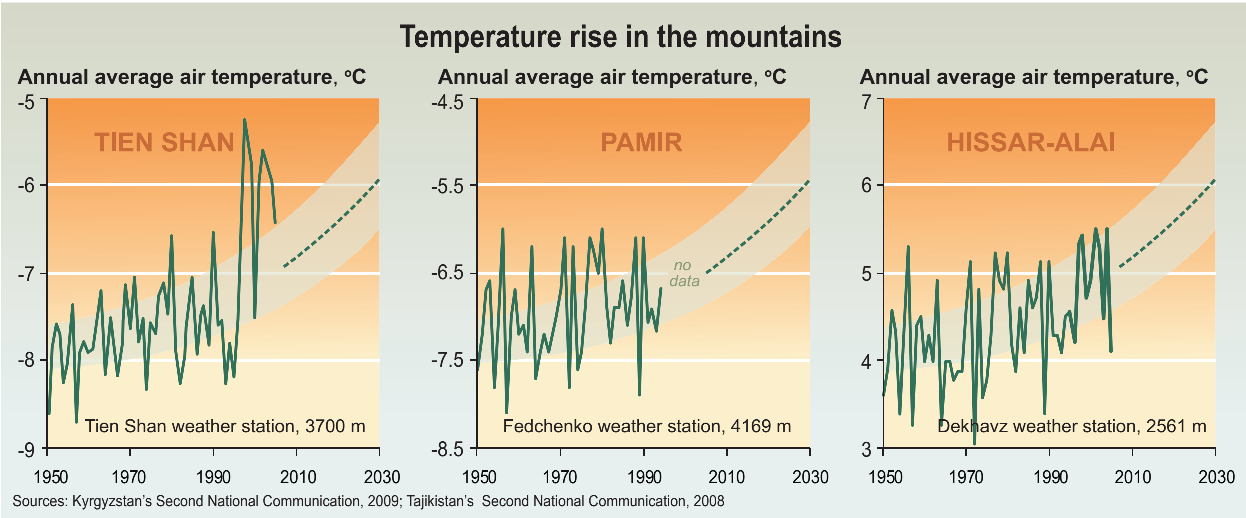
Climate change scenarios for Central Asia suggest a 1° to 3°C increase in temperature by 2030-50. But it could be even higher. If emissions are unmitigated and greenhouse gas continues to accumulate, temperatures could exceed today's by 3° to 6°C by the end of the century.

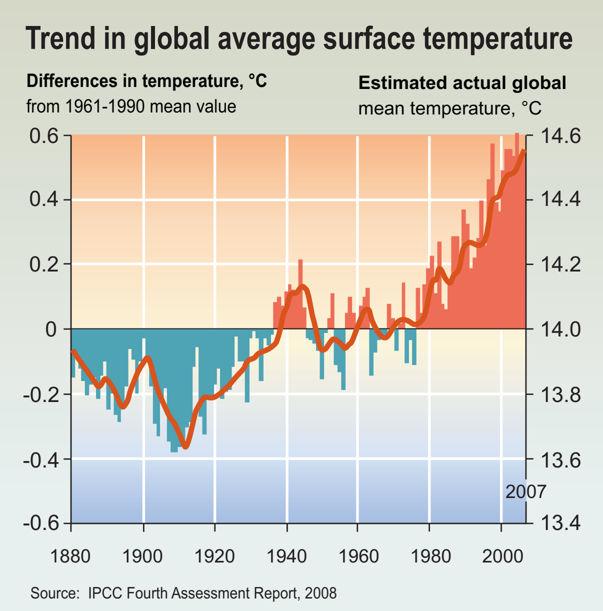
At the same time climate change is projected to cause more precipitation in northern of Central Asia and less in the south. What exactly will the local impact be and when will these weather changes occur, especially in the mountains? This is still unknown.





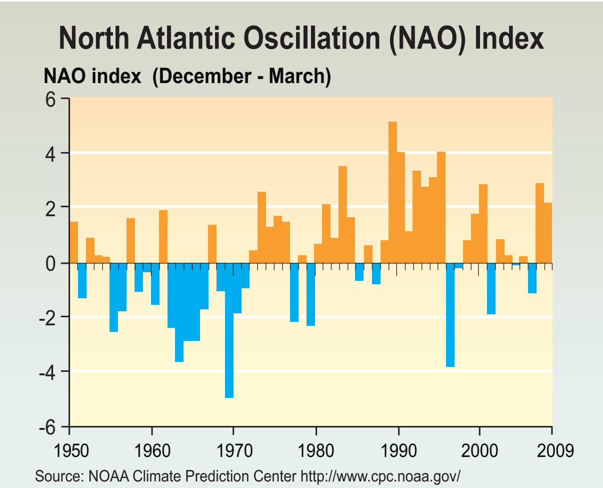
Researchers have reconstructed the climatic conditions of the past 300 years, showing that climate has warmed rapidly especially in recent decades. They have come to this conclusion after conducting a survey of bio-indicators in the Tien Shan Mountains – where scientists analysed tree-rings of junipers, pines and other species, soil wedges, lichens and lake sediments – and on the Kyrgyz high-altitude glaciers where ice core samples were collected at 5 200m.

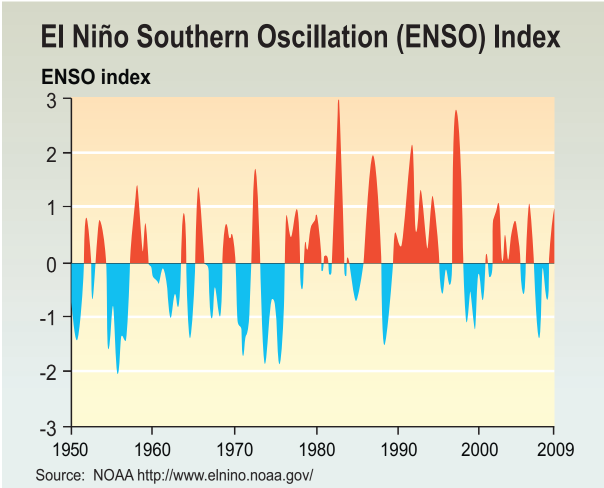




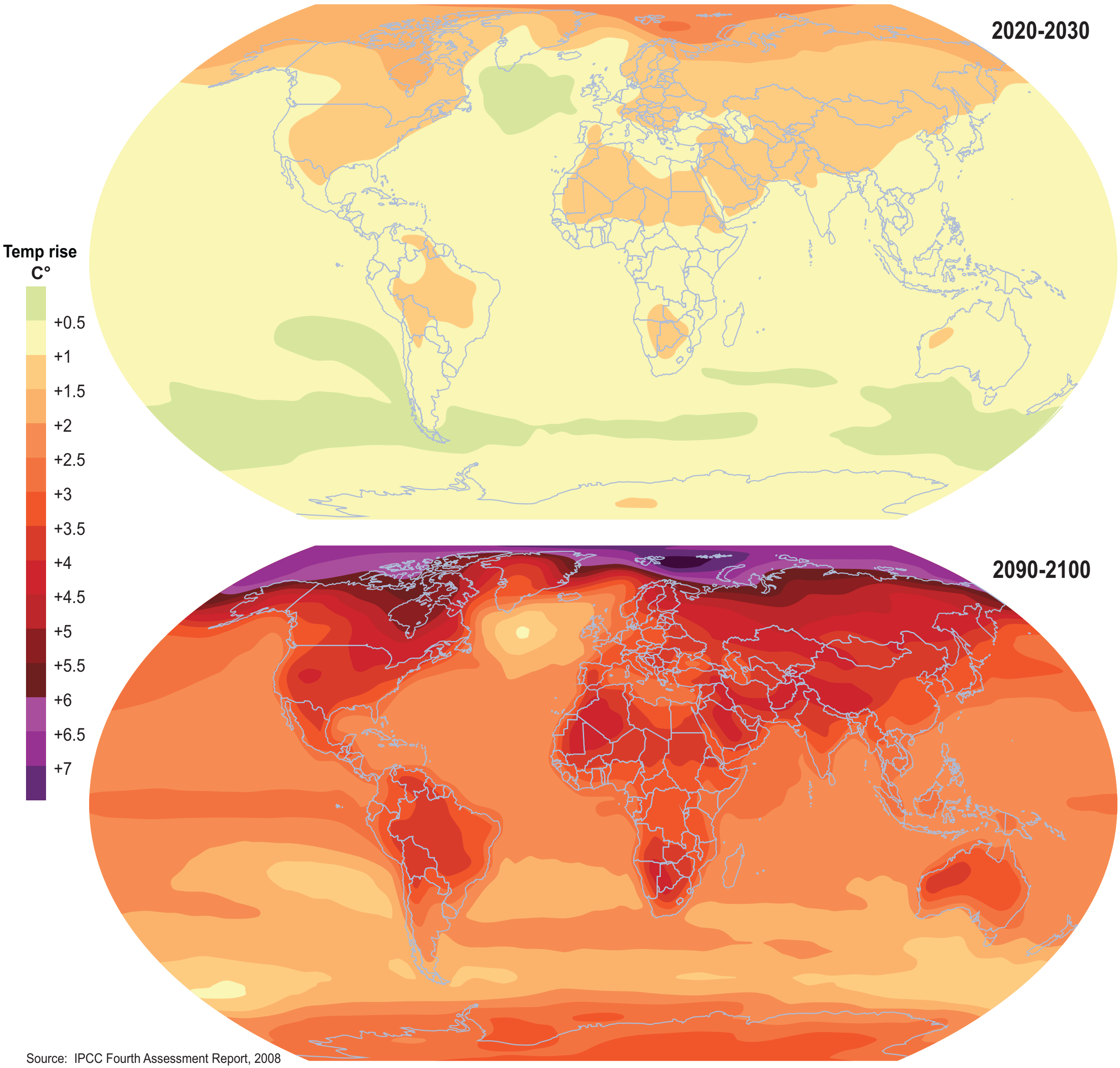
Scientific observations have pointed to increases in global average air and ocean temperatures, rising global sea levels, and depletion of snow and ice reserves. Warming does not only concern the Earth's surface but also its atmosphere and the first few hundred metres of the oceans nearest the surface. Although temperature increase is widespread across the world (global average growth was 0.8°C from 1880 to 2008), it is most apparent in the northern polar regions. It is widely accepted that global warming, especially since the mid-20th century, can be attributed to an enhanced greenhouse effect, caused by emissions from human activities which are still increasing.

Global climate phenomena such as El Niño Southern Oscillation (ENSO) and the North Atlantic Oscillation (NAO) are linked to the climatic conditions and trends prevailing in Central Asia. For example, strong El Niño events seem to enhance the risk of droughts in the southern part and around the Caspian Sea while a strong negative NAO causes more precipitation in southern parts of Europe, the Mediterranean basin and Central Asia.





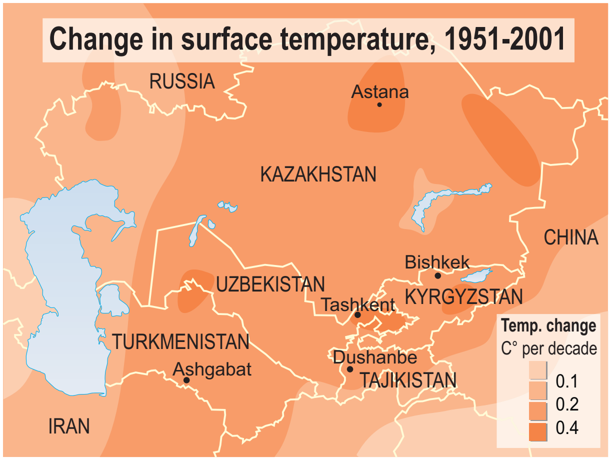
Global climate warming under A1B emission scenario



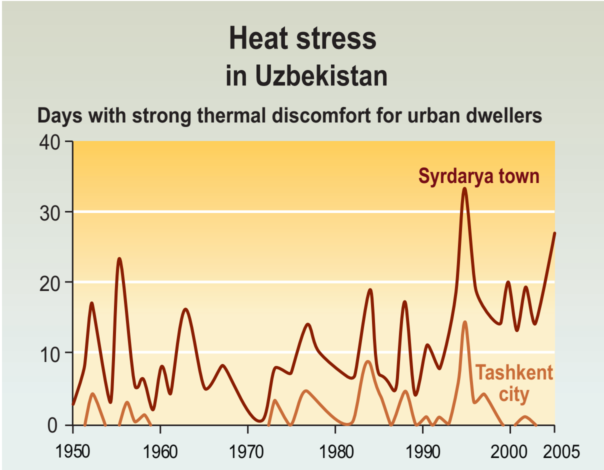
Source: IPCC Fourth Assessment Report, 2008

Karakul Lake, Tajikistan

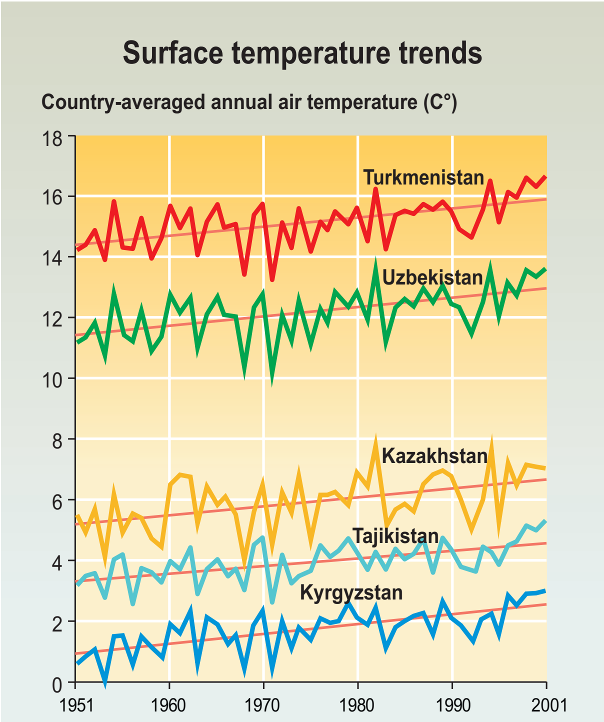
Regional Climate Change



Sources: U.K. Climate Research Unit (data synthesis is available at: www.climatewizard.org), compilation of information from the Second (and the First) National Communications



Source: Uzbekistan's Second National Communication, 2008



Source: U.K. Climate Research Unit data synthesis at: www.climatewizard.org

Weather records clearly confirm that the surface temperature is rising in Central Asia.

It increased by 0.65°C between two thirty-year climate reference periods (1942-1972 ad 1973-2003).

For instance:

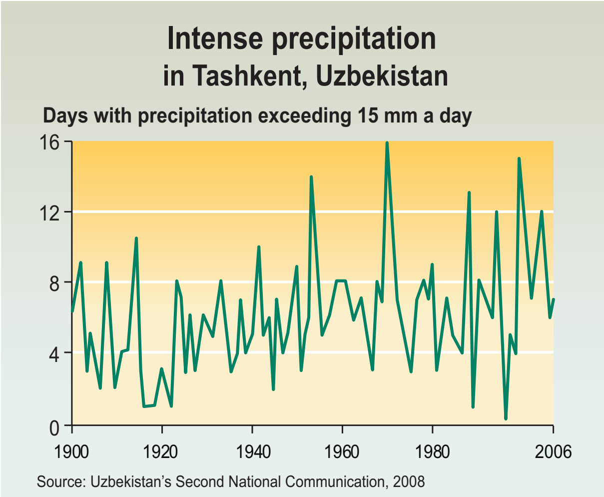
- In Turkmenistan the temperature has increased by 0.6-0.8°C over the past 50-70 years.

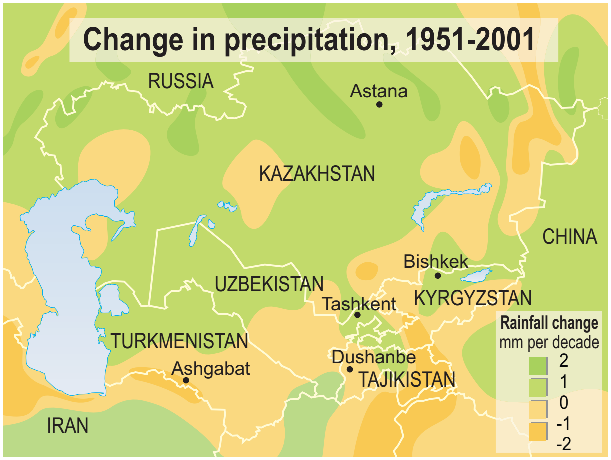
- In Kazakhstan and Uzbekistan the temperature has increased by 0.8-1.3°C over the past 100 years with increasing rates since the 1950s at 0.3°C per decade.

- In the small mountainous republics of Kyrgyzstan and Tajikistan, temperatures have increased by 0.3-1.2°C, depending on the location of the observation site.

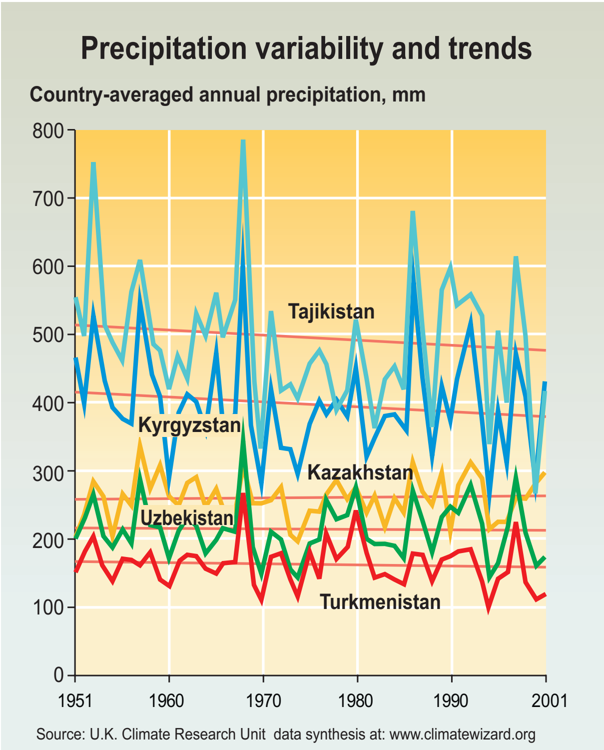
Almost everywhere in the region, climate warming in the winter months is more pronounced than in other seasons. It accounts for the majority of the temperature increase.

Since the 1950s the number of days with temperature above 40°C has been increasing in the southern densely populated areas of Central Asia. This obviously has a negative impact on agriculture and rural and urban populations affected by heat wave discomfort.





Sources: U.K. Climate Research Unit (data synthesis is available at: www.climatewizard.org), compilation of information from the Second (and First) National Communications



- The northern and western parts of Central Asia, such as the semi-desert lowlands of Turkmenistan, Uzbekistan, and Kazakhstan, have experienced an increase in precipitation (although small in absolute terms).

- Winter precipitation has particularly increased in Kazakhstan.

- A slight increase in precipitation has also occurred in the mountains of Uzbekistan, northern parts of Kyrgyzstan and central Tajikistan (the western Pamir and Turkestan-Alay).

- A negative change in precipitation was observed in the southern and eastern parts of Turkmenistan, Kazakhstan, Tajikistan (notably in the eastern Pamir), and in the central Tien Shan of Kyrgyzstan. In many instances, rainfall intensity has increased.

- Rising air temperatures impact on climate aridity which is expected to increase, especially in the lowlands. Higher surface temperatures result in increased evaporation and reduced soil moisture content, especially during the dry summer months, thereby amplifying the risk of droughts.

Alai Valley, Kyrgyzstan

Water Towers

Glaciers of Central Asia
0
100
200
300 km
Map produced by ZOÏ Environment Network, December 2009
Glaciers mentioned in the report
Glacial lakes and GLOF risk areas
Lake Balkhash
Taldykorgan
Ghulja
Ili
Chu
KAZAKHSTAN
Kapchagay Lake
Almaty
Ts. Tyuyksu
Syr Darya
Turkestan
Taraz
Bishkek
Ysyk-Kol
South Inylchek
Kara-Batkak
7439
Jengish (Pobeda) Peak
Akshirak massif
Petrov
Aksu
Shymkent
KYRGYZSTAN
5982
Dankova Peak
Tashkent
Namangan
Kokand
Osh
UZBEKISTAN
Khujand
Ferghana
Jizzakh
Hotan He
Kashgar
CHINA
Samarkand
5509
Raigorodsky
Abramov
7134
Piramida Peak
Zeravshan
Lenin Peak
Yarkant He
Fedchenko
7495
Ismoil Somoni Peak
7719
Kongur Shan
TAJIKISTAN
Dushanbe
Hotan
Termiz
Amu Darya
Mazar-e Sharif
Disthegil Sar
7885
8611
7788
Rakaposhi
K2
PAKISTAN
AFGHANISTAN

The melt paths

The gorgeous mountains of Central Asia with their narrow white-water river canyons, walnut forests, glaciers and snow leopards make a huge impression on the traveller going along the Silk Road. The scenery is extraordinary. But will it last?

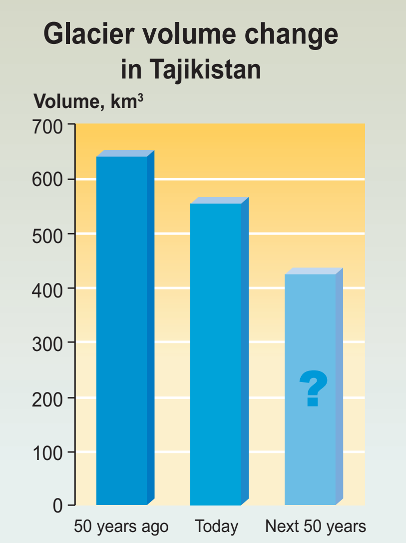
Glaciers cover 4% of Kyrgyzstan and 6% of Tajikistan. They are also present in Kazakhstan and Uzbekistan covering an area of 12,000-14,000 km^2 within Central Asia. Frozen water reserves contained in the glaciers is about 1,000 km^3 – the equivalent of 10 years of water flowing down the rivers Amu Darya and Syr Darya.

Melt water from snow, glacier and permafrost supplies around 80% of the total river runoff in Central Asia. Glaciers are crucial to the agricultural economy of the region. They produce water in the hottest and driest period of the year in summer and compensate for low precipitation.

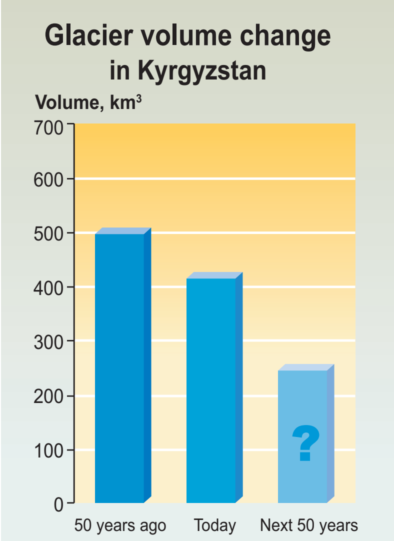
But nowadays, the traveller on the Silk Road may be struck by a disturbing phenomenon.

Glaciers are melting! Some of the small ones (smaller than 0.5 km^2) have totally melted. The changing climate of the last 100 years, especially since the 1950s, has had a negative impact on the glaciers, snow covers and permafrost.

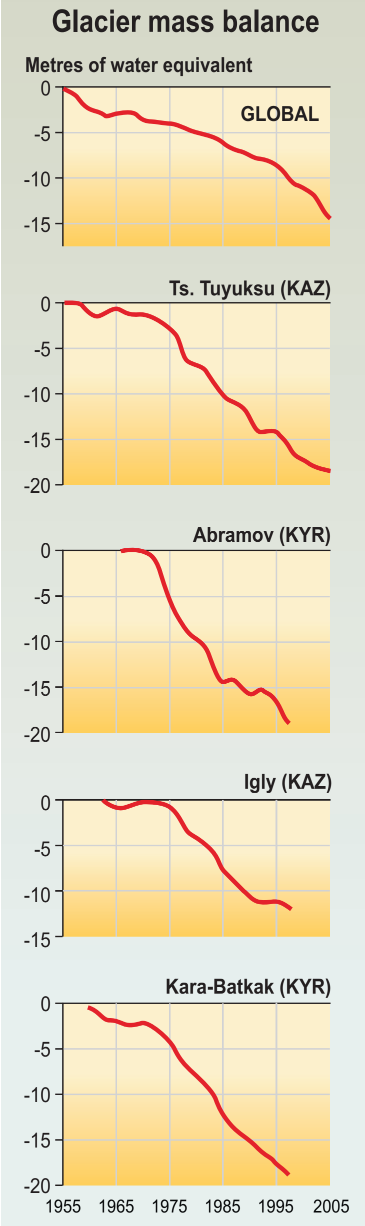
Today's rate of glacier loss in Central Asia is 0.2-1% per year.



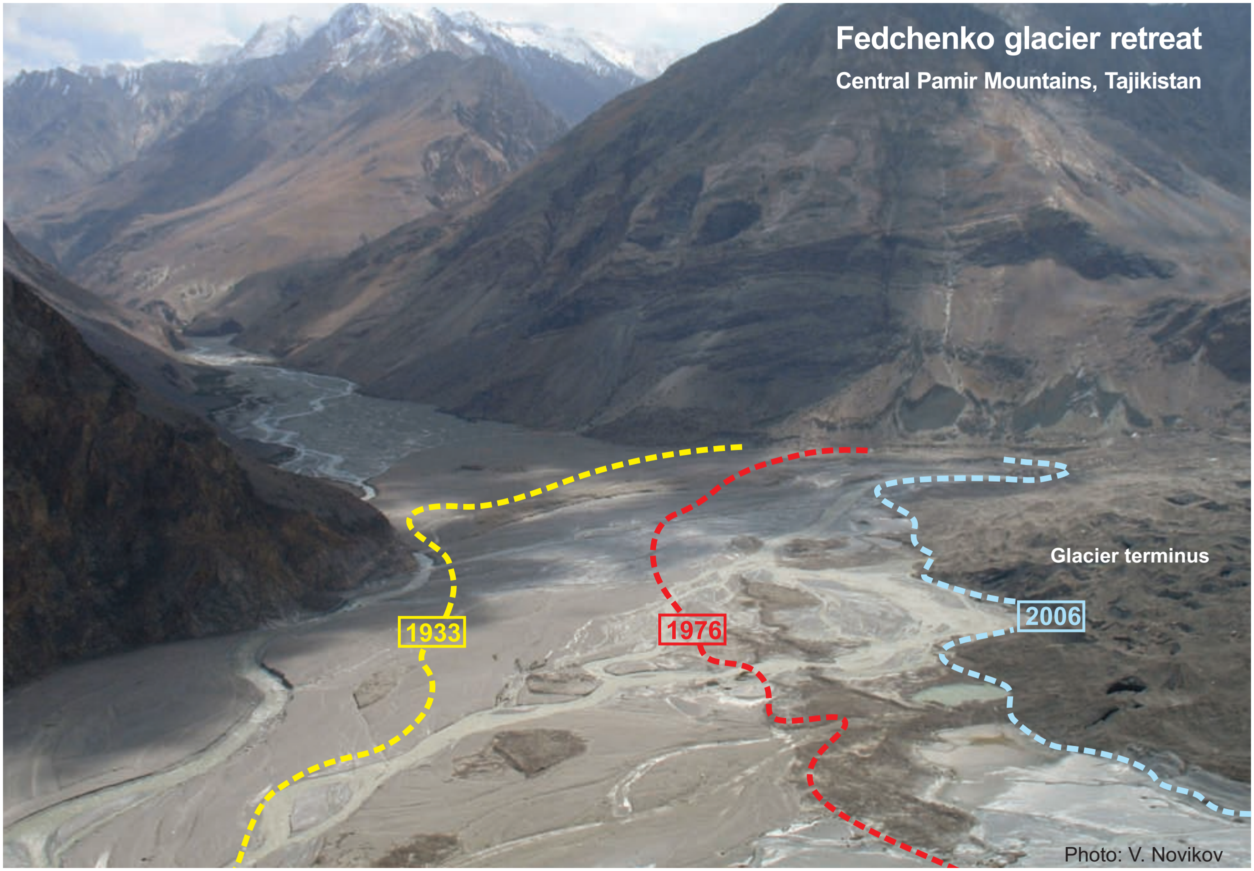
Source: Tajikistan's Second National Communication, 2008



Source: Kyrgyzstan's Second National Communication, 2009



Source: UNEP/WGMS, 2008



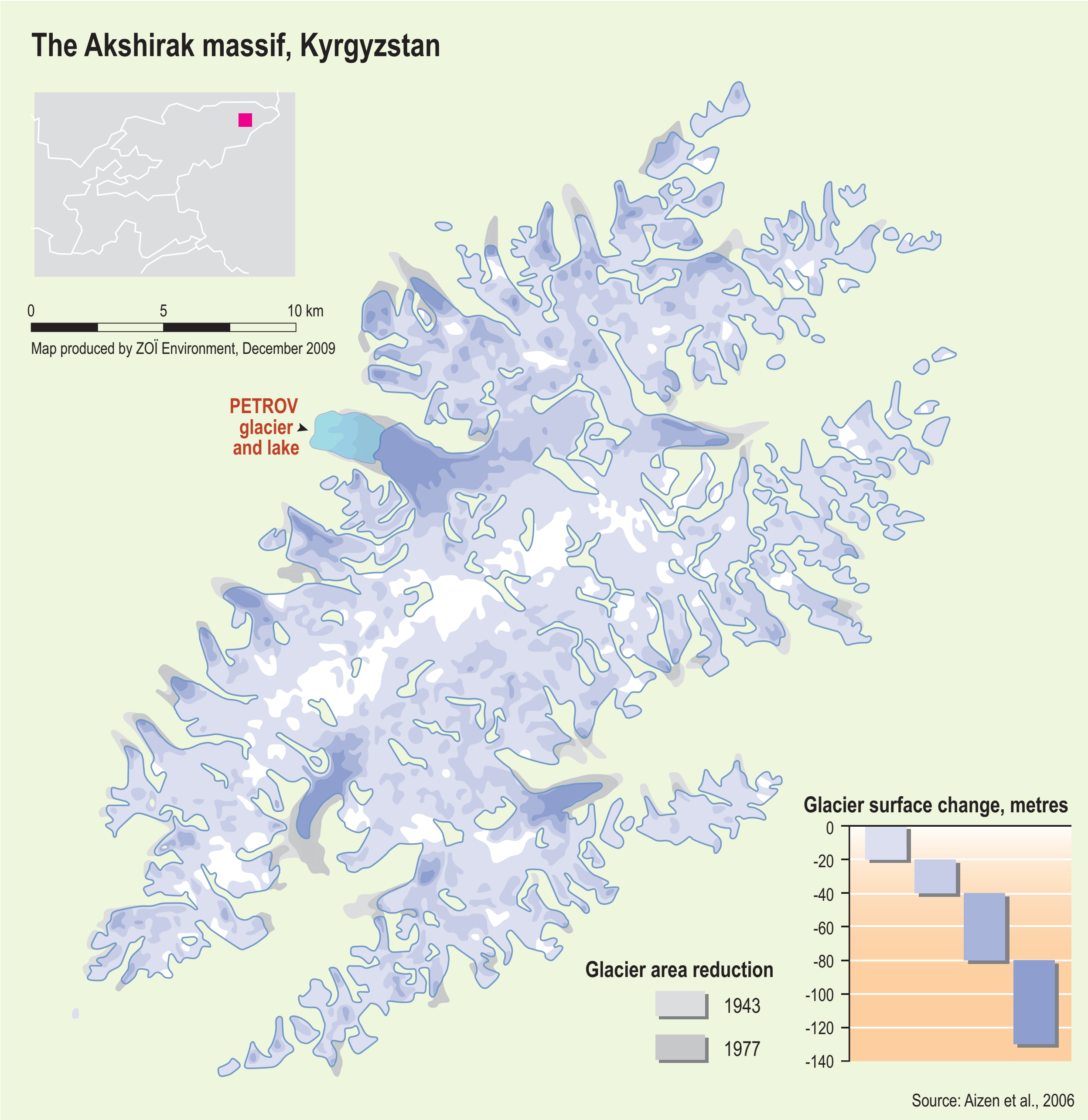
In the last 50-60 years,between 14% to 30% of the Tien Shan and Pamir glaciers have melted. This trend is worrying and comparable with ice reduction in the European Alps and the Caucasus.

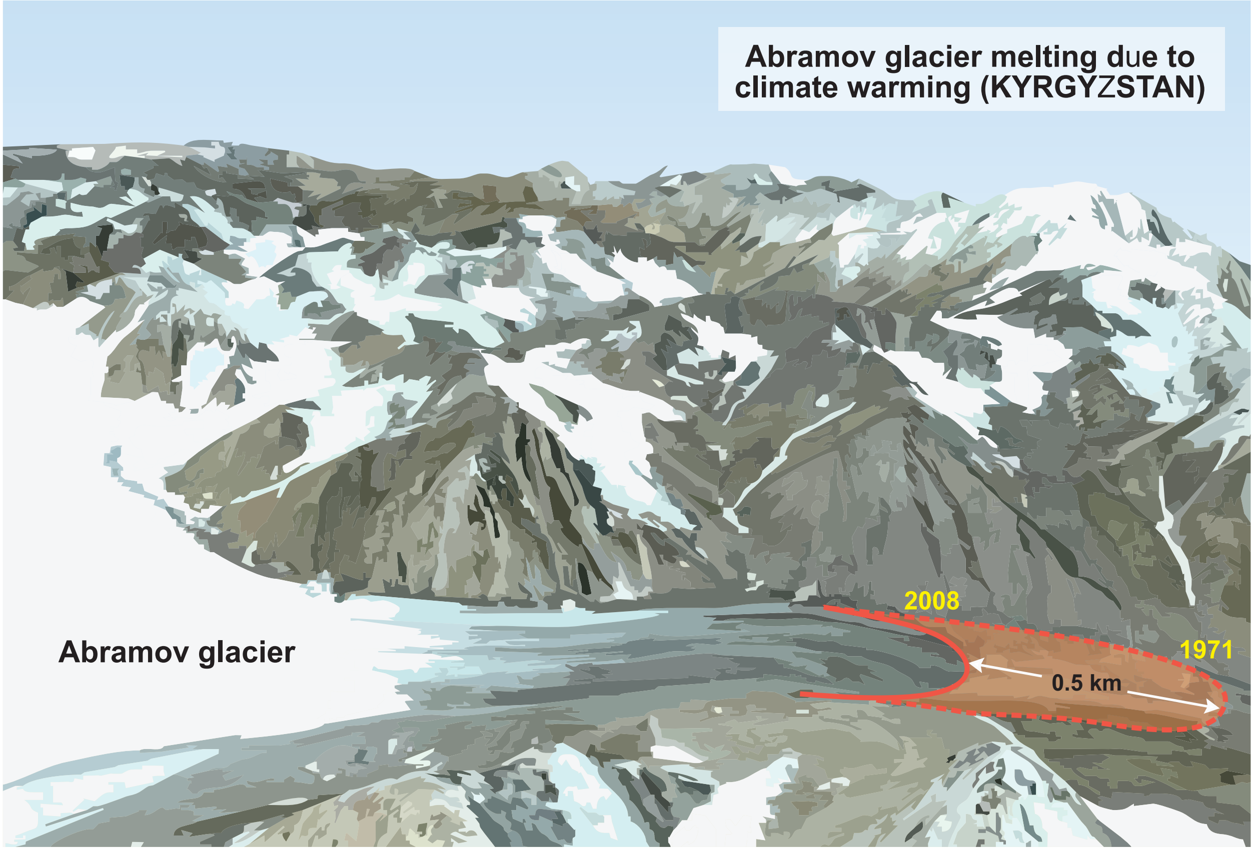
The degradation – even slowly – of the largest glacier of Central Asia, the Fedchenko in the central Pamir Mountains of Tajikistan, and another ice giant the Inylchek glacier in eastern Kyrgyzstan provide vivid evidence of the warmer climate in the region.

The Fedchenko glacier, which exceeds 70 km in length and 2 km in width, and has an ice thickness of 1 km, shrank by 1 km in length during the 20th century. Almost all of its right hand tributaries have separated from the main glacier body and the lower part of the glacier is cracked and covered with numerous lakes.

Other disturbing examples and figures:

The glaciers of the Akshirak massif (containing over 170 glaciers and covering an area of 300 km^2) in central Kyrgyzstan, where the country's main gold mine, Kumtor, is located, shrank by 4% from 1943 to 1977, and by 9% from 1977 to 2003. The ice volume in the Akshirak massif reduced by 10 km^3 and the glaciers' surfaces thinned substantially.


The Akshirak massif, Kyrgyzstan
0
5
10 km
Map produced by ZOÏ Environment, December 2009
PETROV
glacier
and lake
Glacier area reduction
1943
1977
Glacier surface change, metres
0
-20
-40
-60
-80
-100
-120
-140
Source: Aizen et al., 2006

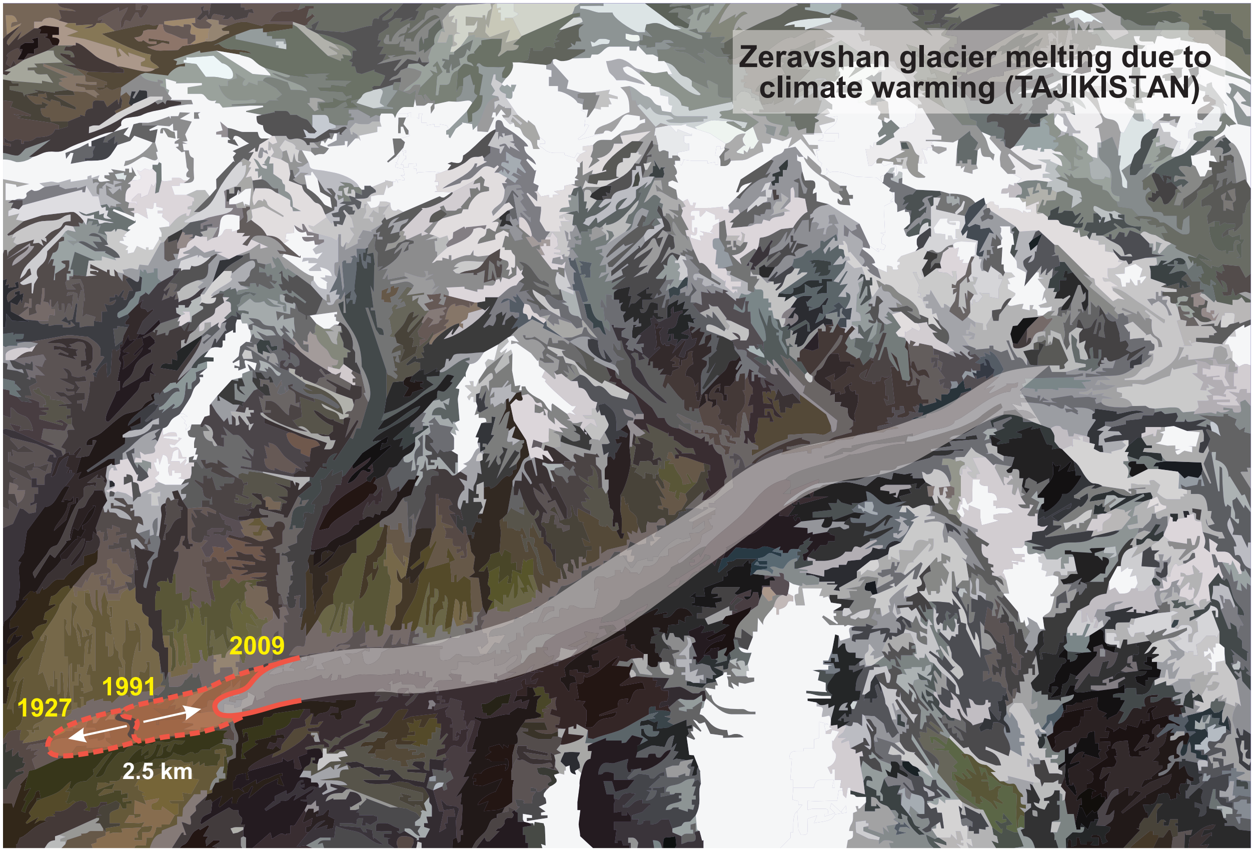


Sources: Uzhydromet; Uzbekistan's Initial National Communication, 1999

Background image is based on the digital elevation model adapted from Google Earth

Petrov glacier (69 km^2) in the north Akshirak massif retreated by 1.8 km between 1957 and 2007. A large glacial lake has formed on top of its terminal moraine and is spreading steadily. If its dam and level stability are not addressed, there could be an outbreak of water with floods threatening villages and infrastructure, including tailing ponds containing cyanide. By 2006, the surface of this glacial lake had exceeded 3.8 km^2 with water volume 60 million m^3.

The well-known Abramov glacier (WGMC reference), located in the Alay range in southern Kyrgyzstan on the border with Tajikistan, shrank by at least 500 m and lost 20% of its ice mass since the 1970s.



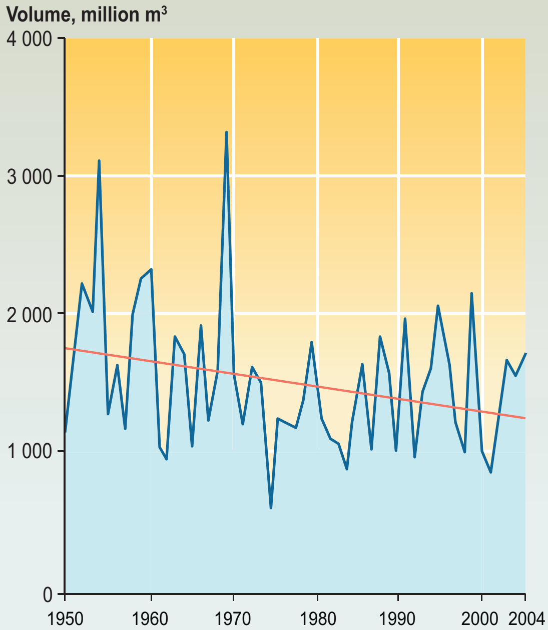
Source: Tajikhydromet

Background image is based on the digital elevation model adapted from Google Earth

Zeravshan glacier – a source of the Zarafshan river which provides water for 0.5 million ha of irrigated, densely populated ancient oases at Pandjikent, Samarkand and Bukhara – retreated by 2.5 km between 1927 and 2009. Intense melting during 1991-2009 contributed to almost halving (1.2 km) the length of the glacier.

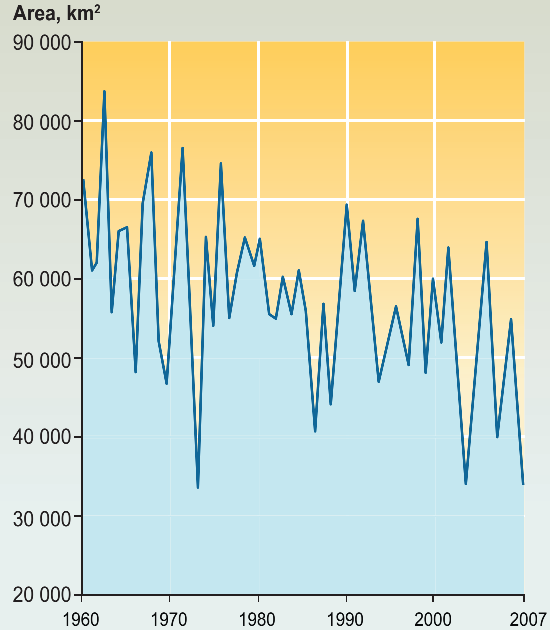
In Kazakhstan, the surface and the ice volume of the Tsentralny Tyuyksu glacier (WGMC reference) in the Zailiysky Alatau range of the Tien Shan Mountains shrank by more than 30% in the past 50 years, receded by 1 km and lost more than 40 million m^3 of ice.

Snow reserves in the Pskem river basin, Uzbekistan



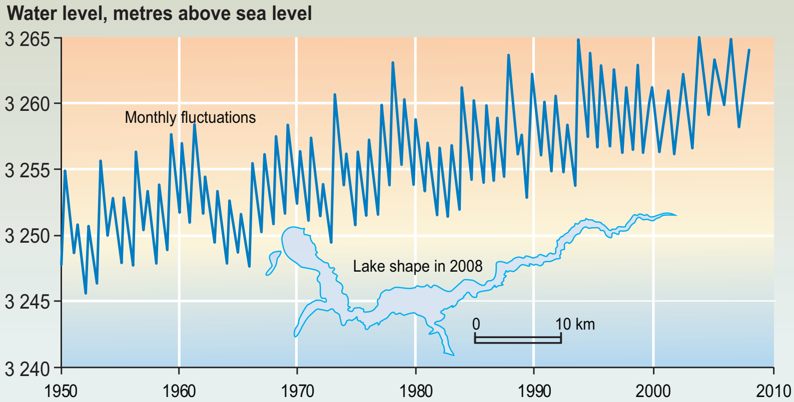
Source: Uzbekistan's Second National Communication, 2008

Extent of winter ice cover in the northern Caspian Sea



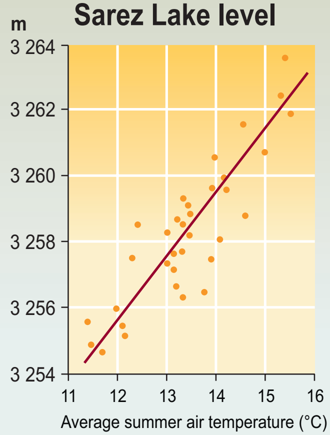
Sources: Rodionov, 1998; Kouraev, 2008

Sarez Lake level fluctuation



Source: Tajikistan's Second National Communication, 2008

Climate factors and Sarez Lake level



Flood hazards

Climate change is contributing to the risk of floods and mudflows in Central Asia. There has been a series of glacial outburst floods in the mountains of Tajikistan, Uzbekistan and Kyrgyzstan, making it even more urgent to monitor these hazards.

With glaciers melting, glacial lakes appear every summer in the mountains. Some of them grow significantly and, if contained by unstable moraines, they occasionally burst releasing large amounts of water in destructive flashfloods, sometimes with serious impacts on life and property.

Annually, more than 200 potentially risky glacial lakes appear in the mountainous regions above Almaty and Bishkek cities, around Issyk-Kul Lake and the densely populated Ferghana Valley, and in the narrow Pamir and Hissar-Alai valleys. Experts suggest that this number is likely to grow with climate change. There have already been deadly floods in the past decade, including the Shahimardan (Uzbekistan and Kyrgyzstan, 1998), Dasht (Tajikistan, 2002) and Issyk-Kul (2008).

Some large mountain lakes, such as Sarez Lake in Tajikistan which formed in 1911 as the result of a rock slide in the central Pamir mountains, represent a serious risk. Situated at an altitude of 3,000 metres, the lake is over 60 km long, almost 500 metres deep and contains 17 km^3 of water. If there were a new rockslide into the lake there are fears that a high wave could form, and depending on its volume, the season and the location of the slide, this could cause a destructive flood. In spite of declining precipitation, the water level in the lake is increasing, which is likely due to intensified glacier and permafrost melt caused by climate warming.

Other lakes, such as Karakul, show similar increases in water level and surface area due to more intense glacier and permafrost melt and water inflow.

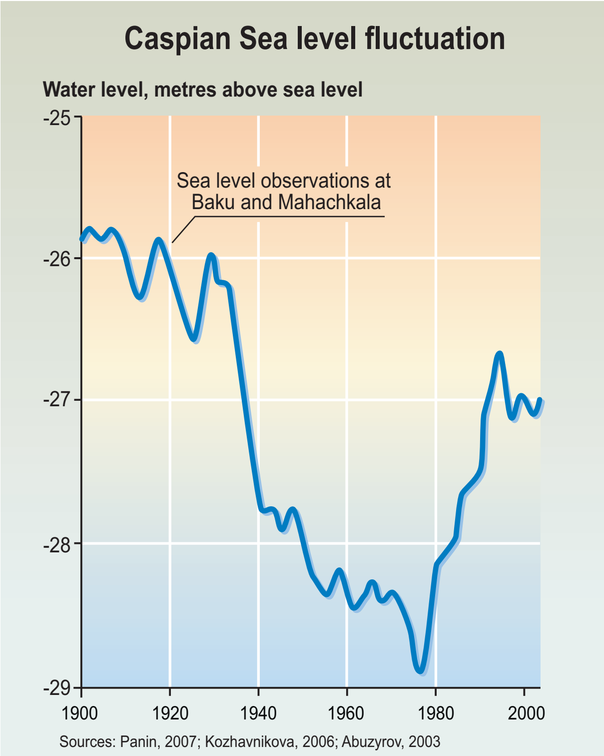
Not only are glaciers melting more than before, but they are doing so earlier in the year, over a longer period lasting till late autumn.

The snow covering the top of the mountains – so impressive when seen from the Silk Road – is also slowly disappearing. Yet it plays a critical role in the water cycle and existence of the glaciers.

Over the past 20 years, the seasonal snow-covered area of the Tien Shan mountains has decreased by as much as 15%.

In summer, rain instead of snow appears more often in high mountain regions, further decreasing the long-term water storage capacities of high-altitude glaciers.

The high-altitude areas of Central Asia also provide a favourable environment for permafrost. However, over the last three decades the permafrost's temperature has increased by 0.3-0.6°C. This has released previously frozen water into the environment and contributed to increasing the rivers' runoff.



Caspian Sea

Fluctuating sea level is also a matter of concern for the Caspian Sea coastal communities, threatening major cities and towns, farmland, industrial activities and oilfields. In a scenario of a 2-3 meter rise, many coastal settlements could be flooded and agricultural land lost, not to mention possible flooding of oil wells and sites used for waste storage. All this could be further aggravated by storm surges with the highest impact in the northern flat coastal regions in Kazakhstan.

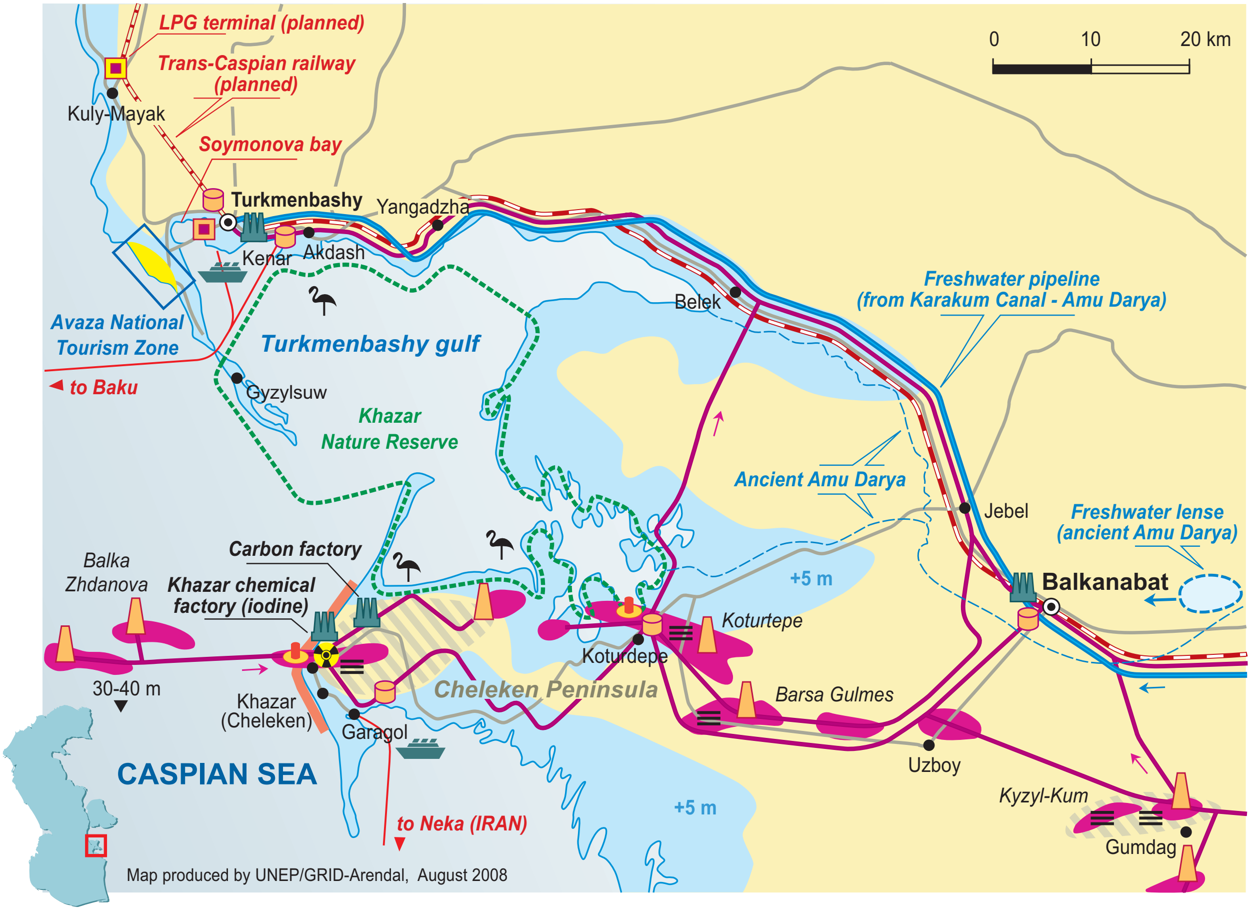
The Caspian Sea level has been fluctuating for many years. It has fallen and risen, often rapidly, many times in the past. This is often blamed on water diversion and dams.

In the last 10 years the Caspian level has been around minus 26.5 m and relatively stable. But this trend could be reversed as experts suggest that the increased rainfall observed since the 1970s in the northern parts of the Caspian basin will in the long run increase water flow in the Volga and Ural rivers and contribute to sea level rise. This could greatly affect the Atyrau province of Kazakhstan and Cheleken peninsula in Turkmenistan, where seawater has already submerged roads, a fragment of the town of Khazar and some industrial infrastructure.

Climate warming does not only affect the level of the Caspian Sea, but also its winter ice cover.

Satellite and meteorological data show that the extent and duration of sea ice, which covers approximately 70-75% of the northern Caspian Sea in winter, is declining. Because of milder winters with higher than normal temperatures, the extent of ice has been much smaller than usual during the last 10 years.

Environmental issues around the Cheleken peninsula, Turkmenistan



Important biodiversity:
- Protected areas
- Habitats of endangered species

Industrial infrastructure:
- Industries
- Tanker terminals and ports

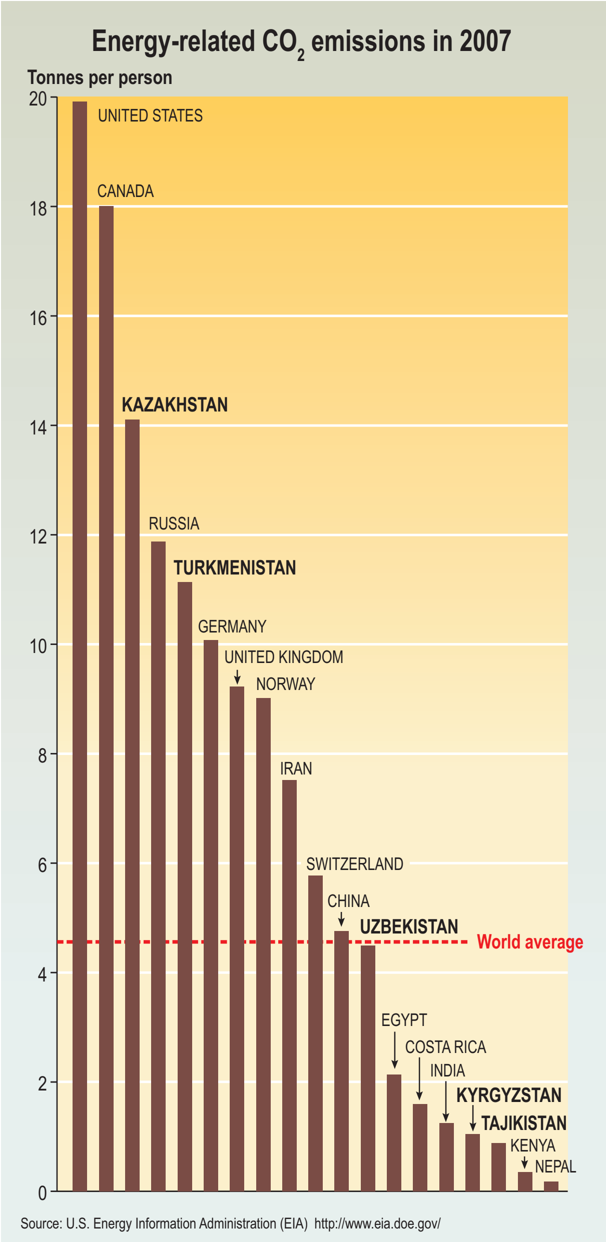
Energy production and distribution:
- Oil and gas fields
- Major energy producing areas
- Processing plants and stations
- Oil tanks
- Oil and gas pipelines

Environmental concerns:
- Radioactive waste
- Abandoned and flooded oil wells
- Historical pollution due to oil spills
- Soil degradation and scrap metal
- Flood risk zone (+5 m sea level raise)

Source: ENVSEC Eastern Caspian assessment report 2008

Aluminium smelter, Tajikistan

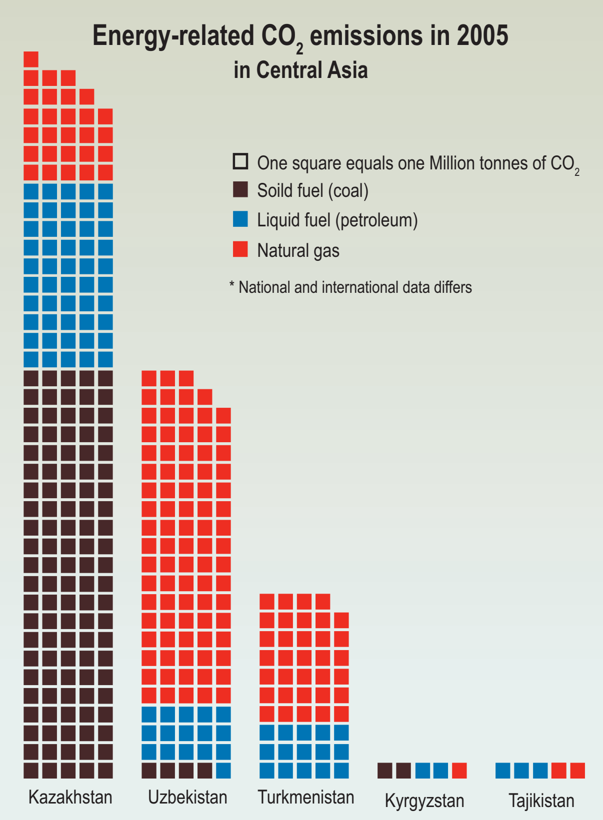
Greenhouse Gas Emissions and Mitigation



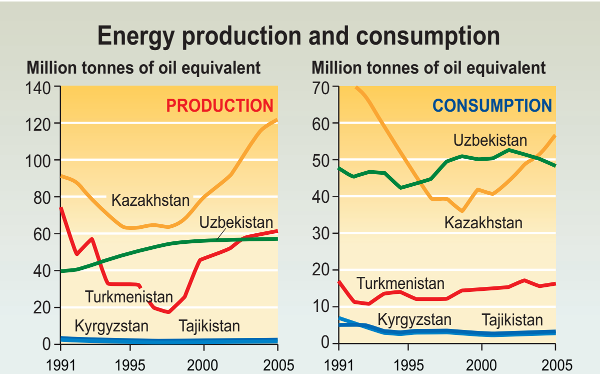
Gone are the days when merchants were travelling on horses, donkeys and camel caravans without polluting the air with CO_2!

Nowadays Central Asia contributes to the pollution of the global atmosphere with its production and consumption of coal, oil and gas, as well as its expansion of irrigated land and application of fertilizers.

Globally, Central Asia has been a good pupil with its total (GHG) emissions declining from about 630 to 530 million tonnes from 1990 to 2005*. However the figures and trends differ from one country to the next.



Sources: Second National Communications of Kazakhstan 2009, Kyrgyzstan 2009, Tajikistan 2008, Uzbekistan 2008, U.S. Energy Information Administration (EIA) http://www.eia.doe.gov/



Source: World Bank development indicators

Tajikistan and Kyrgyzstan hold the record for the lowest GHG pollution in the region (1-2 tonnes of CO_2 per person), mostly because hydropower is their main energy source and they produce and consume only small amounts of fossil fuel. In addition, after the Soviet Union disintegrated in 1991, both countries experienced significant economic and industrial decline and an energy crisis. They have only recently started to recover.

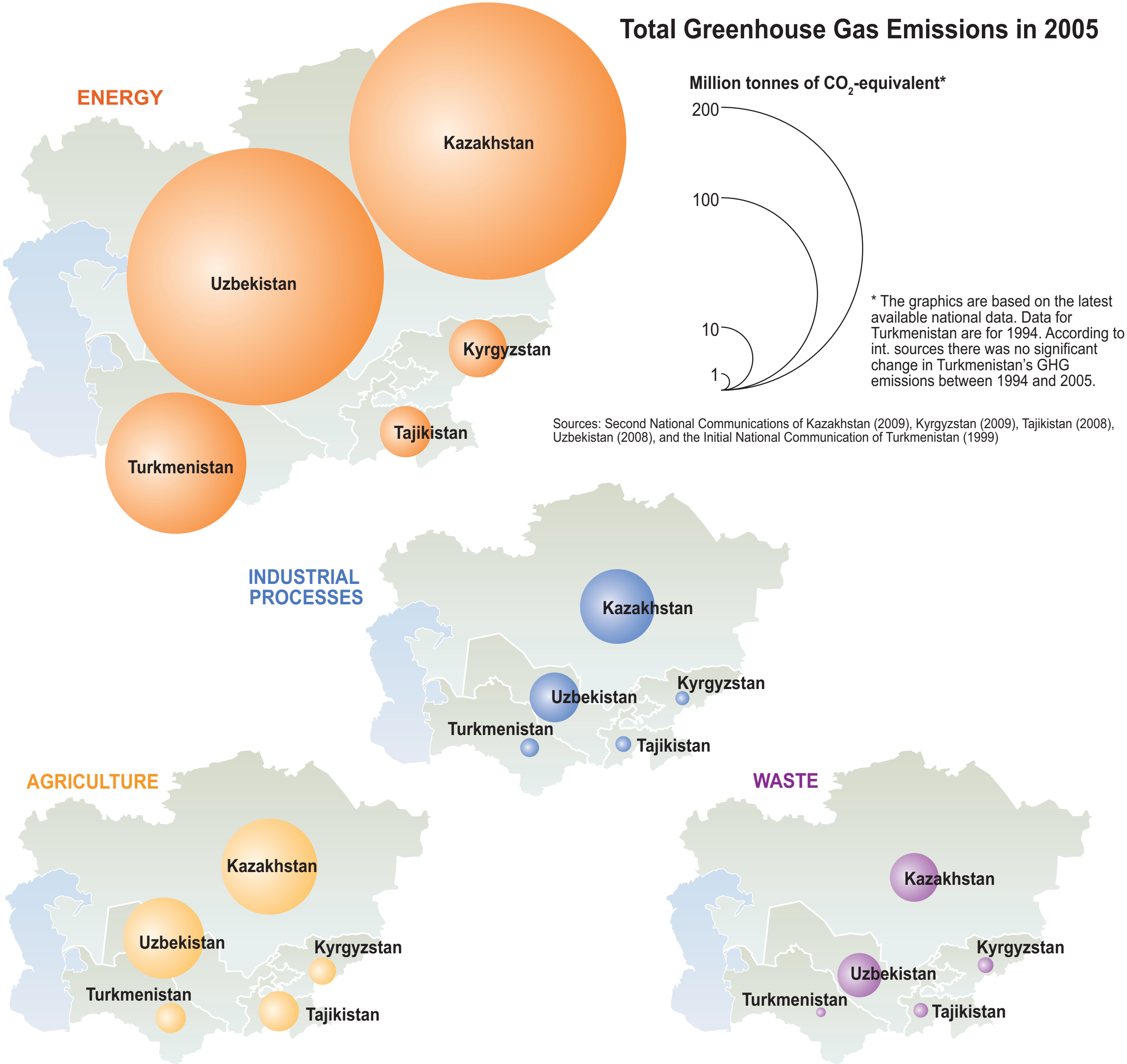
In contrast, the energy-rich Kazakhstan, Uzbekistan and Turkmenistan have not substantially reduced their GHG emissions. Among the three countries, those who release the highest CO_2 per capita are Kazakhstan and Turkmenistan (12-14 tonnes of CO_2 per person) essentially because of massive fossil fuel extraction and transport. The lion's share of electricity is generated by coal-powered plants in Kazakhstan. Uzbekistan, which is the most populous state with a more diversified economy than the others, emits just above 4 tonnes of CO_2 per person which is nearly equal to the world average.**

**estimates are based on the best available information combining national and international data*

*** total emissions in CO_2-equivalent per capita are higher*

Central Asia

Total Greenhouse Gas Emissions in 2005

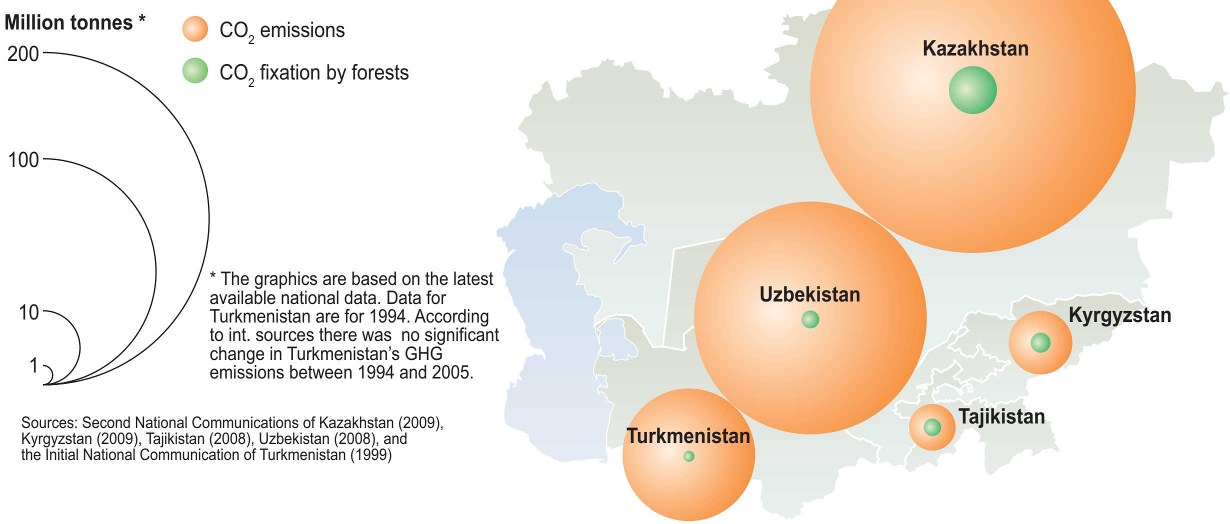


* The graphics are based on the latest available national data. Data for Turkmenistan are for 1994. According to int. sources there was no significant change in Turkmenistan's GHG emissions between 1994 and 2005.

Sources: Second National Communications of Kazakhstan (2009), Kyrgyzstan (2009), Tajikistan (2008), Uzbekistan (2008), and the Initial National Communication of Turkmenistan (1999)

Central Asia

Carbon Dioxide (CO_2) Emission and Fixation in 2005



* The graphics are based on the latest available national data. Data for Turkmenistan are for 1994. According to int. sources there was no significant change in Turkmenistan's GHG emissions between 1994 and 2005.

Sources: Second National Communications of Kazakhstan (2009), Kyrgyzstan (2009), Tajikistan (2008), Uzbekistan (2008), and the Initial National Communication of Turkmenistan (1999)

Kazakhstan

• The region's largest emitter of greenhouse gases.

• Its total emissions in 2005 amounted to 243 million tonnes of greenhouse gases in CO_2-equivalent (more than other four countries combined), including 197 million tonnes from energy production and use, 15 million tonnes from industry, 23 million tonnes from agriculture, and 8 million tonnes from waste.

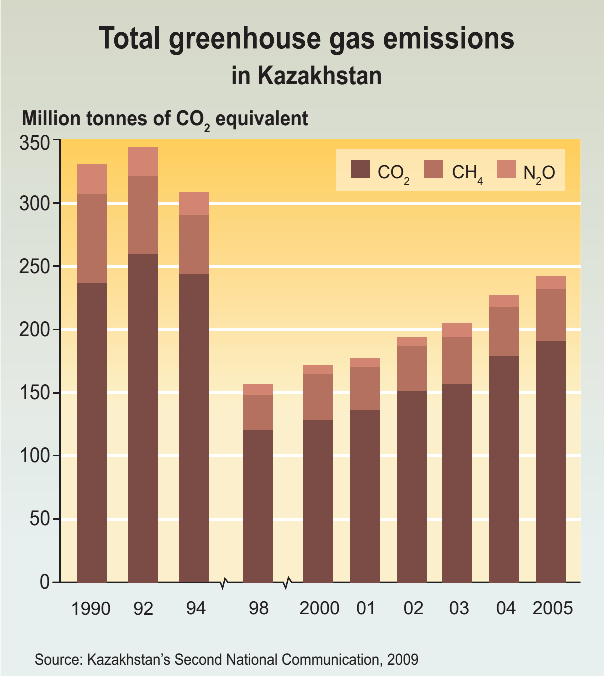
• Total GHG emissions in 2005 were 26% below the 1990 level because the economy plummeted in the early 1990s, much as almost everywhere else in the former Soviet Union.

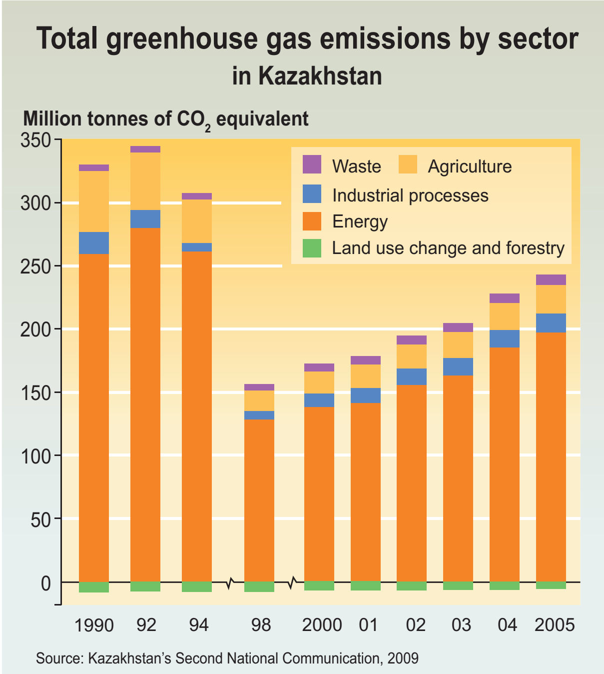
• But since 1998 economic development and emission trends have been reversed and started to grow.

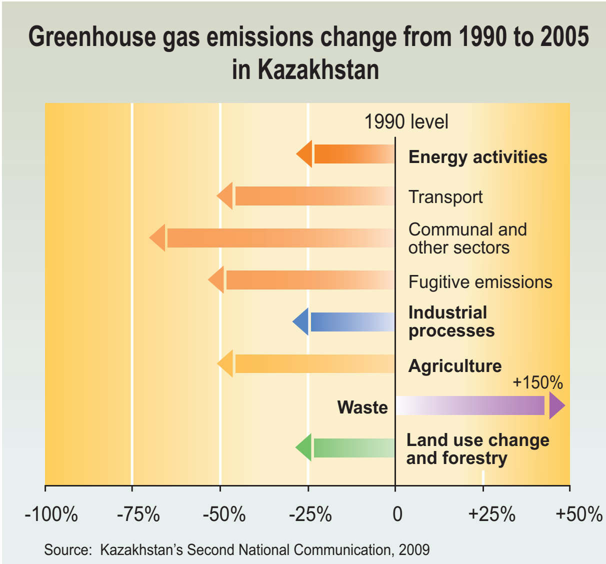
• Energy production is a key source of GHG emissions.

• The total GHG emissions per person in 2005 exceeded 16 tonnes, including 12 tonnes of CO_2. The CO_2 absorption in forestry and the land use sector totalled 6 million tonnes, including more than 4 million tonnes by forests.

• Overall, the country's forest carbon sequestration potential covers only 2% of current national CO_2 emissions.


Total greenhouse gas emissions
in Kazakhstan
Million tonnes of CO_2 equivalent
350
300
250
200
150
100
50
0
CO_2
CH_4
N_2O
1990
92
94
98
2000
01
02
03
04
2005
Source: Kazakhstan's Second National Communication, 2009


Total greenhouse gas emissions by sector
in Kazakhstan
Million tonnes of CO_2 equivalent
350
300
250
200
150
100
50
0
Waste
Agriculture
Industrial processes
Energy
Land use change and forestry
1990
92
94
98
2000
01
02
03
04
2005
Source: Kazakhstan's Second National Communication, 2009


Greenhouse gas emissions change from 1990 to 2005
in Kazakhstan
1990 level
Energy activities
Transport
Communal and
other sectors
Fugitive emissions
Industrial
processes
Agriculture
+150%
Waste
Land use change
and forestry
-100%
-75%
-50%
-25%
0
+25%
+50%
Source: Kazakhstan's Second National Communication, 2009

Kyrgyzstan

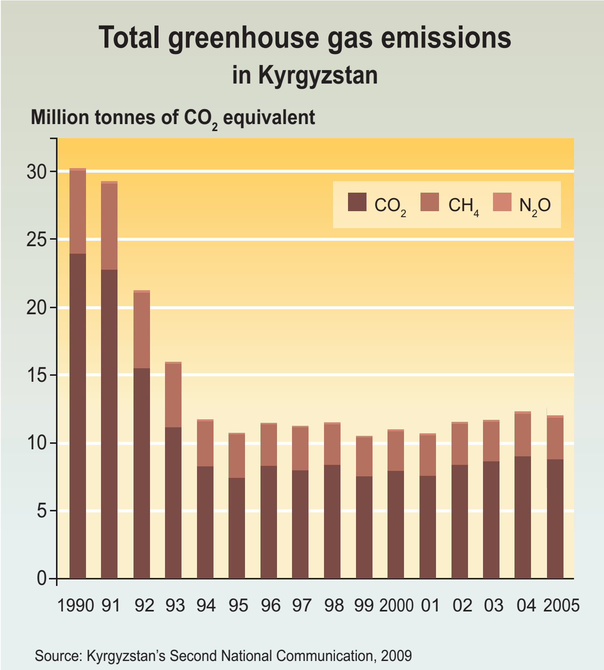
• Total emissions in 2005 amounted to 12 million tonnes of greenhouse gases in CO_2-equivalent, including 9 million tonnes from energy use, 0.5 million tonnes from industrial processes, 2 million tonnes from agriculture, and 0.6 million tonnes from waste.

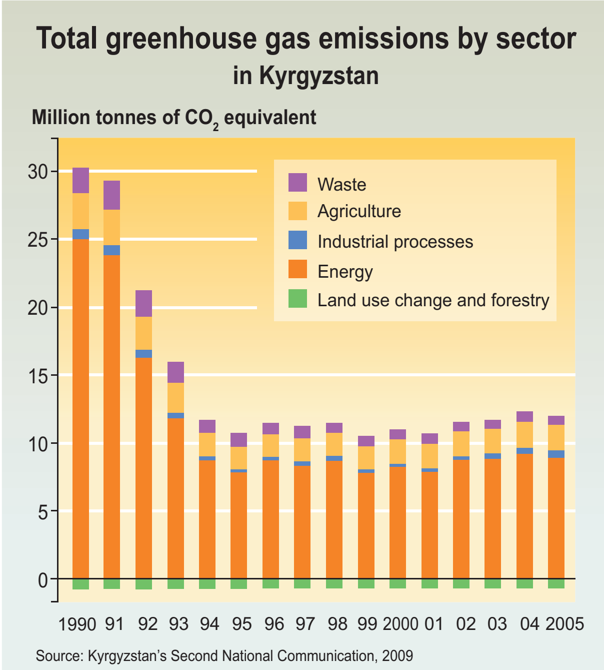
• The country's emissions in 2005 were 2.5 times (250%) below the 1990 level. Such a dramatic decline in emissions is mainly due to an almost threefold reduction in fossil fuel use after independence.

• In the same period electricity generation, mainly by hydroelectric plants, and electricity consumption have increased.

• The country's GHG emissions, after an initially strong decline at the beginning of the 1990s, stabilized in 1994-95 and have continued to grow since then, which is related to economic growth and GDP change.

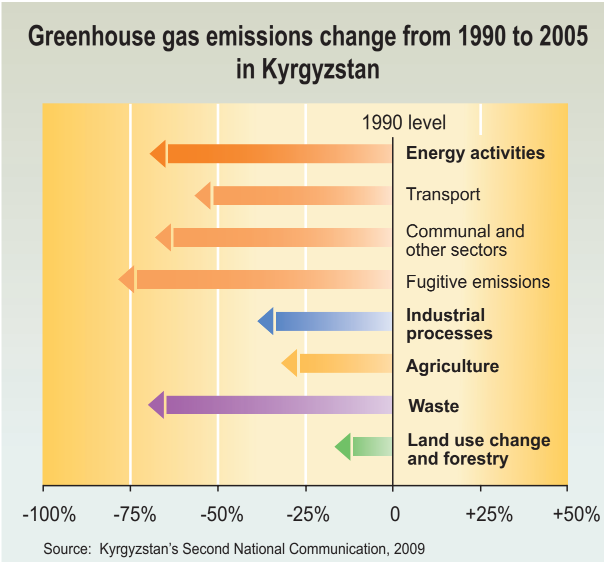
• Energy use and agriculture are the two key sources of GHG emissions. Total GHG emissions per person in 2005 were 2.5 tonnes, including 1.7 tonnes of CO_2.





• Forests and tree plantations in Kyrgyzstan annually absorb 0.7 million tonnes of CO_2, which totals about 10-15% of the country's CO_2 emissions.

• The capital city of Bishkek and Chui province contribute more than half of the total national emissions.



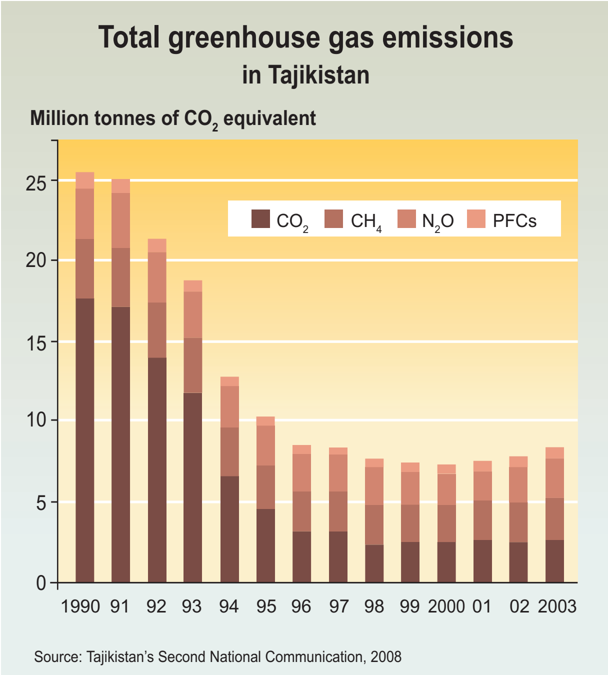
Tajikistan

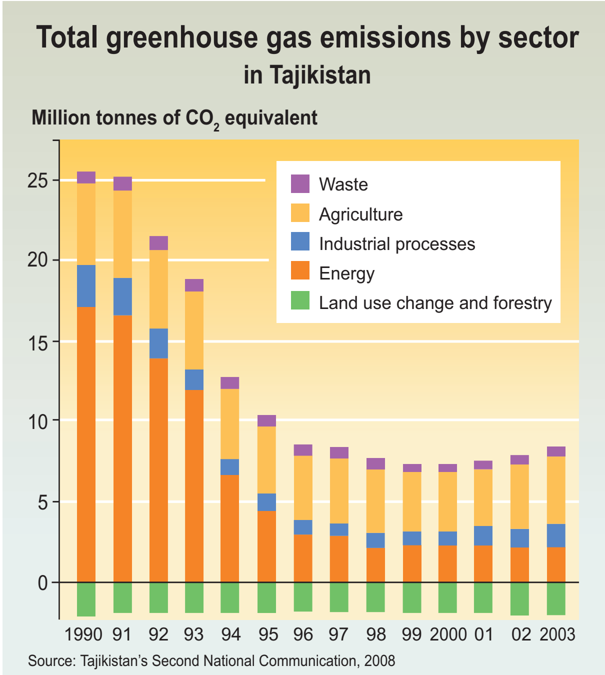
- Total emissions in 2003 amounted to 8.3 million tonnes of greenhouse gases in CO_2-equivalent which is three times (300%) lower than the country's peak GHG emissions of 25 million tonnes in 1990.

- Over the same period electricity generation, almost totally by hydroelectric plants (96-98%), and consumption have increased.

- This dramatic decline in GHG emissions is mainly related to the serious economic decline and civil instability in the early 1990s and the overall reduction in fossil fuel use and industrial output after independence.

- The lowest GHG emissions were reported in 2000 at 7.4 million tonnes of CO_2-equivalent.

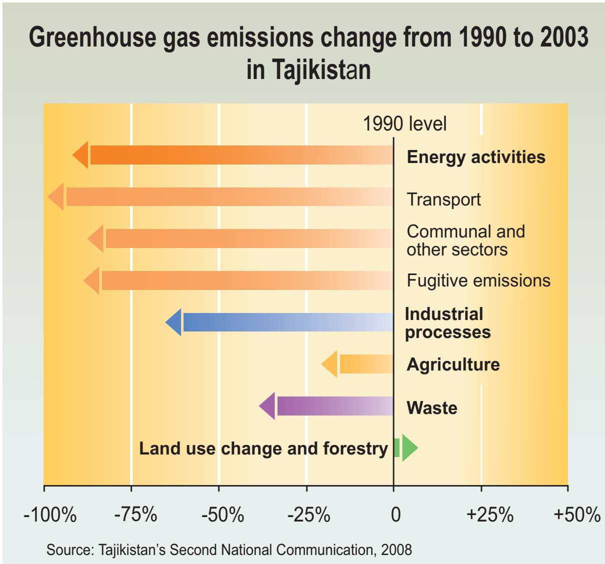




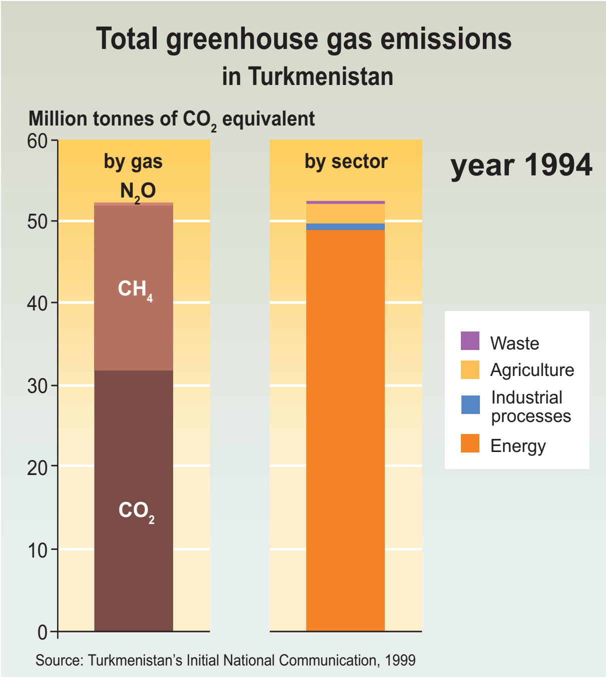
• In 1990-2003 proportional contributions by GHG emission sources significantly changed: in 1990 the energy sector was the major emission source, accounting for 70% of total emissions, yet by 2003 its contribution had fallen to 30%, whereas the share of the agricultural sector increased to almost 50%.

• The total GHG emissions per person in Tajikistan in 2000-2003 were 1-2 tonnes, including 1 tonne of CO_2.

• Forests and tree plantations in Tajikistan annually absorb 0.7 million tonnes of CO_2, accounting for 15-20% of the country's CO_2 emissions.



Turkmenistan



• Total emissions in 1994 (the latest official reporting date) amounted to 52 million tonnes of greenhouse gases in CO_2-equivalent, including 32 million tonnes of CO_2.

• The energy production sector is a main contributor to total national emissions.

• According to World Bank and US Energy Information Administration data, Turkmenistan's current GHG emissions from the extraction and burning of fossil fuels are close to 1990 levels.

Uzbekistan

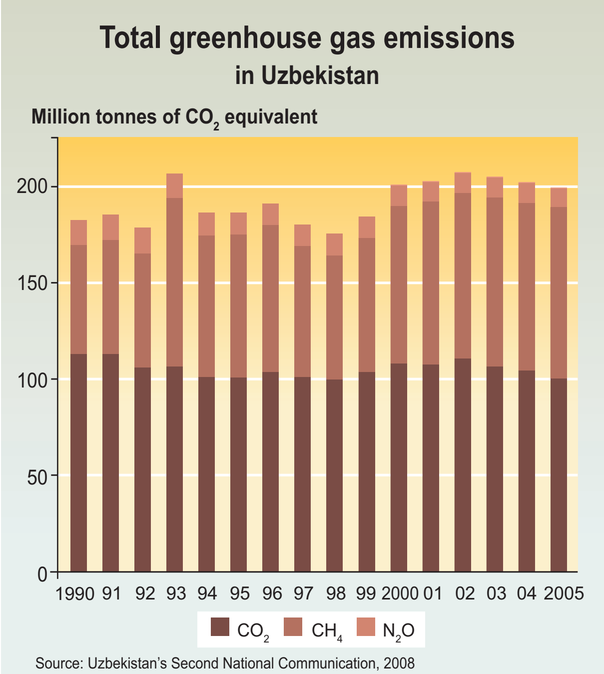
• Total emissions in 2005 amounted to 199.8 million tonnes of greenhouse gases in CO_2-equivalent.

• Almost 50% of all emissions consist of carbon dioxide (CO_2), 45% is methane (CH_4) and the rest (5%) other gases.

• Total emissions are 9% above the 1990 level.

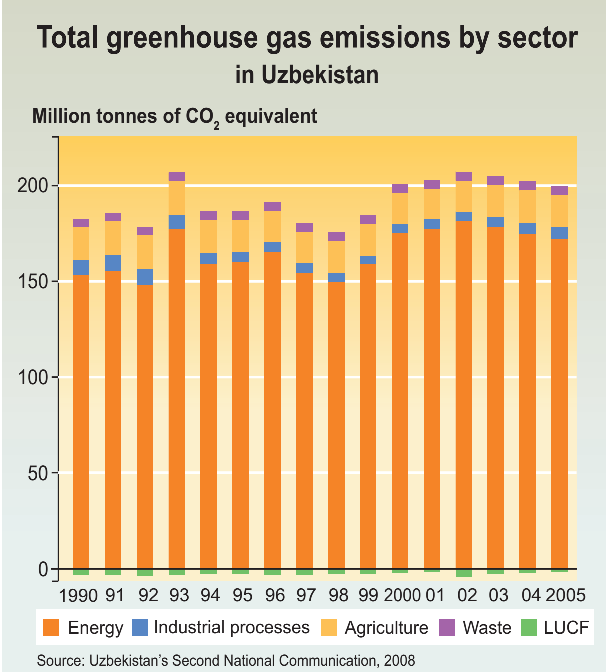
• Total per capita GHG emissions in 2005 were 7 tonnes.

• Energy production and use (86%) and agriculture (8%) are the two key sources of emissions.



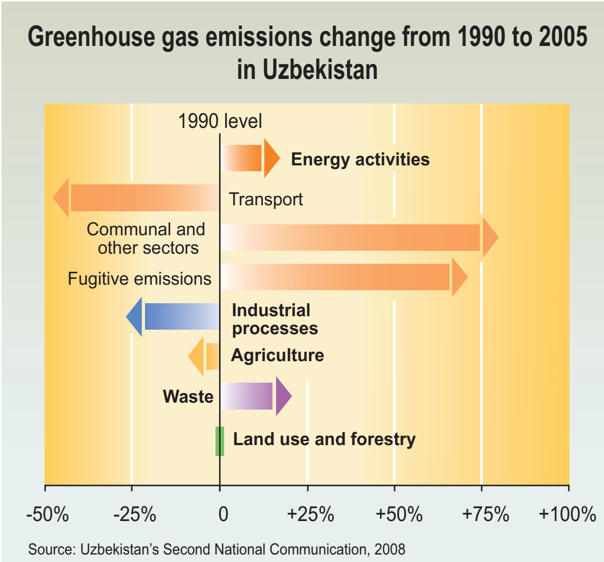
Total greenhouse gas emissions in Uzbekistan

Source: Uzbekistan's Second National Communication, 2008



Total greenhouse gas emissions by sector in Uzbekistan

Source: Uzbekistan's Second National Communication, 2008

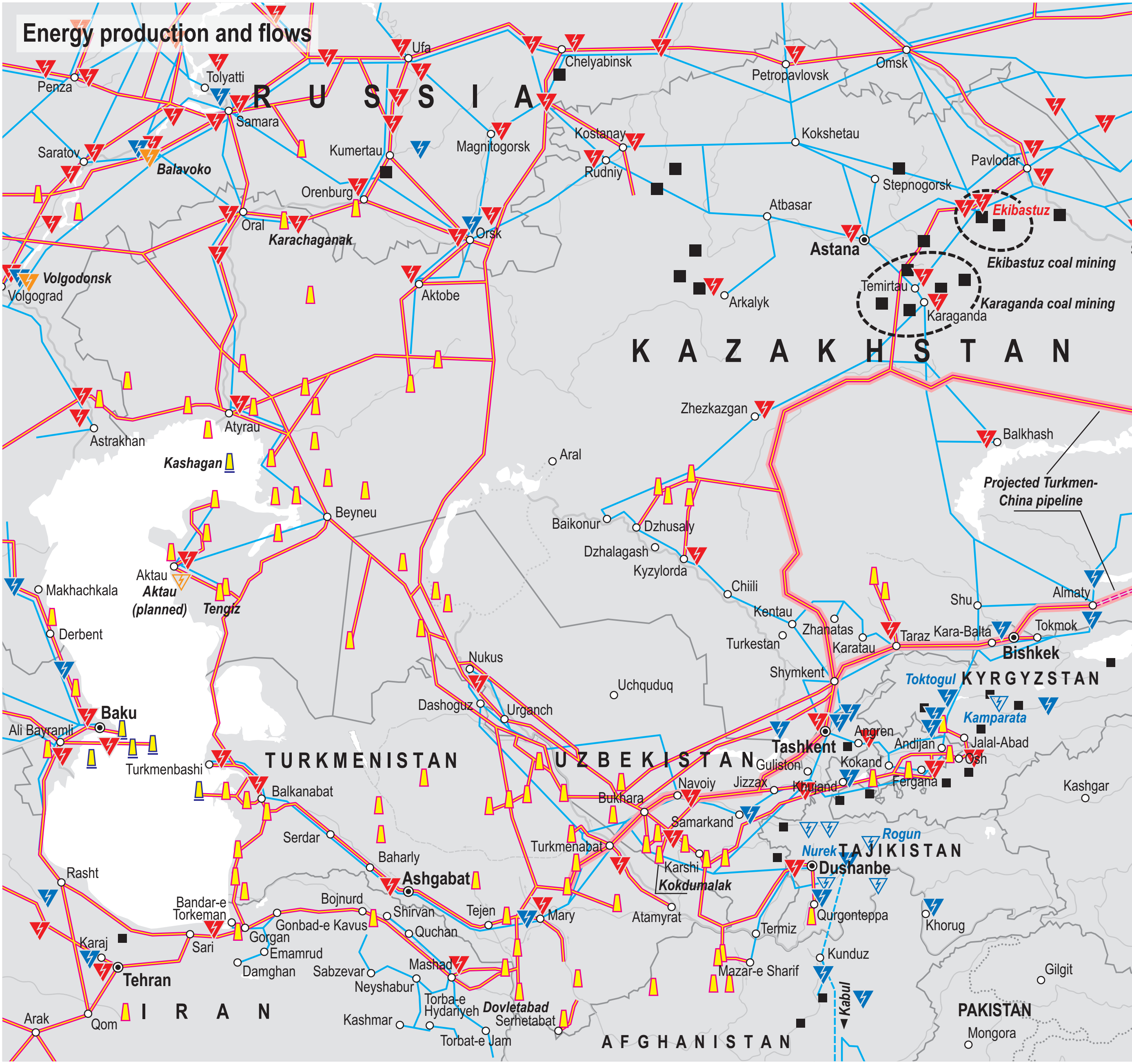


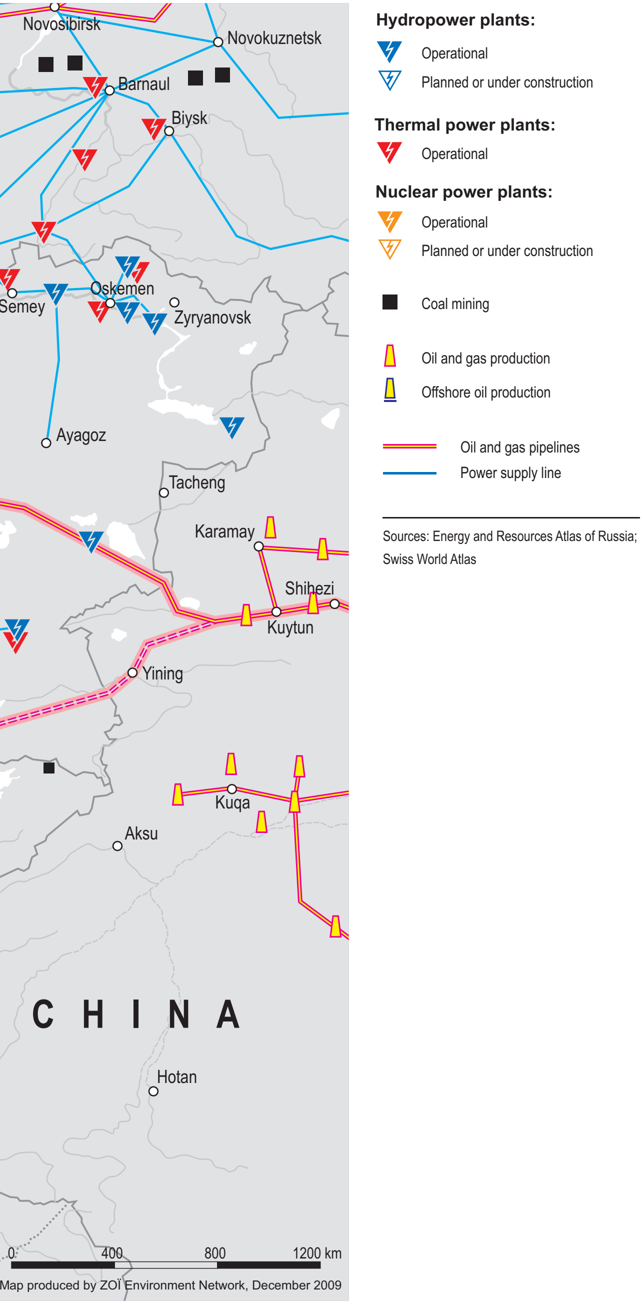
Greenhouse gas emissions change from 1990 to 2005 in Uzbekistan

Source: Uzbekistan's Second National Communication, 2008

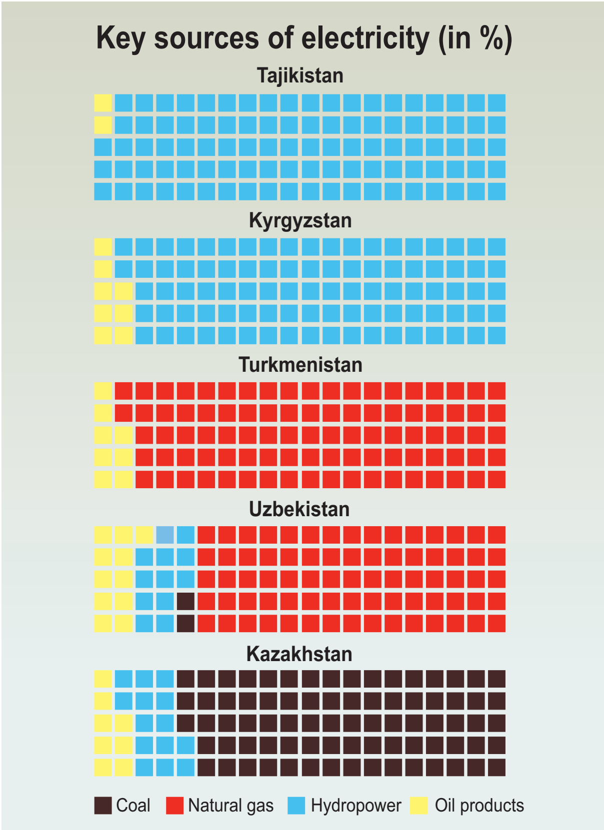
- Emission trends differ by type of gas: CO_2 emissions fell by 11% due to declining industrial production, while CH_4 emissions increased due to growth in fossil fuel extraction, agriculture, population and waste generation.

- National emissions could double (i.e. exceed 400 million tonnes in CO_2-equivalent) in the next 10-15 years if no mitigation and energy-saving measures are implemented.


Energy production and flows
R U S S I A
K A Z A K H S T A N
TURKMENISTAN
U Z B E K I S T A N
KYRGYZSTAN
TAJIKISTAN
I R A N
A F G H A N I S T A N
PAKISTAN
Penza
Tolyatti
Ufa
Chelyabinsk
Petropavlovsk
Omsk
Samara
Saratov
Balavoko
Kumertau
Magnitogorsk
Kostanay
Rudniy
Kokshetau
Pavlodar
Stepnogorsk
Orenburg
Oral
Karachaganak
Orsk
Atbasar
Ekibastuz
Astana
Ekibastuz coal mining
Volgodonsk
Volgograd
Aktobe
Temirtau
Arkalyk
Karaganda
Karaganda coal mining
Zhezkazgan
Atyrau
Astrakhan
Balkhash
Kashagan
Aral
Projected Turkmen-China pipeline
Beyneu
Baikonur
Dzhusaly
Dzhalagash
Kyzylorda
Aktau
Aktau (planned)
Tengiz
Makhachkala
Chiili
Almaty
Shu
Kentau
Zhanatas
Tokmok
Kara-Balta
Turkestan
Karatau
Taraz
Bishkek
Derbent
Nukus
Shymkent
Toktogul
Uchquduq
Dashoguz
Urganch
Kamparata
Baku
Ali Bayramli
Tashkent
Angren
Andijan
Jalal-Abad
Turkmenbashi
Guliston
Kokand
Osh
Navoiy
Jizzax
Khujand
Fergana
Kashgar
Balkanabat
Bukhara
Samarkand
Rogun
Serdar
Baharly
Turkmenabat
Nurek
Dushanbe
Rasht
Ashgabat
Karshi
Kokdumalak
Bandar-e Torkeman
Bojnurd
Shirvan
Tejen
Mary
Atamyrat
Qurgonteppa
Khorug
Karaj
Sari
Gorgan
Gonbad-e Kavus
Quchan
Termiz
Emamrud
Kunduz
Tehran
Damghan
Sabzevar
Mashad
Mazar-e Sharif
Gilgit
Neyshabur
Arak
Qom
Torba-e Hydariyeh
Dovletabad
Serhetabat
Kabul
Kashmar
Torbat-e Jam
Mongora



Sources of electricity in Central Asia comprise: brown coal (the least climate friendly type of primary energy), which provides 78% of Kazakhstan's electricity, natural gas (more climate friendly type of primary energy) which is used for generating 80% or more electricity in both Uzbekistan and Turkmenistan and, finally, hydropower (the most climate friendly type of primary energy) which contributes to more than 90% of electricity generation in Kyrgyzstan and Tajikistan. Such an energy mix is closely related to the available dominant primary energy potential and clearly defines the national GHG emission profiles and GHG emission intensity per capita and per GDP.



Mitigation

If humanity wants to decrease or at least delay the impacts of the changing climate, it is imperative to drastically decrease GHG emissions. The next two or three decades will be crucial for our planet. There is considerable potential for reaching such a goal.

Mitigation measures can bring several benefits. First of all, the reduction in GHG emissions from the energy and transport sector can also result in major and rapid health benefits from reduced air pollution in urban areas. The use of renewable energies also offers opportunities for reducing firewood consumption and therefore deforestation. Policies that put a price on GHG emissions could create incentives for producers and consumers to invest significantly in products, technologies and processes generating few GHG emissions.

All Central Asian nations have adopted plans and strategies to combat global climate warming mainly by cutting GHG emissions and increasing energy efficiency. If they implement the full set of proposed measures, the countries could reduce energy consumption by 15-40% depending on sectors and regions. However total GHG emissions from Central Asia are projected to grow in the coming decade, all over the region and in almost all scenarios reported by the countries. From the perspective of mitigating global climate change this is a very unfortunate development and one wonders whether much more could not be done. For instance, a more substantial shift to renewable energy generation by the countries may well be possible and also economically feasible. More could also be done in the agricultural sector.

In view of the growing national and regional energy demand in Pakistan, India, China and Afghanistan, the Central Asian states have chosen to increase their power generation capacities both using renewable (mainly hydropower) and non-renewable resources such as coal-fired plants. For countries like Tajikistan and Kyrgyzstan, coal-fired plants would serve as a short term solution to overcome problematic winter energy deficits and increase the country's own energy security. In countries like Kazakhstan and Uzbekistan, already rich in non-renewable energy sources, the increase of their power generation capacities would increase the rate of use of these resources (mostly oil and gas but also coal). For example, Uzbekistan's National Energy Strategy envisages increased coal use in the power generation sector from today's 3-5% to 15-17% in the coming years. Economic and energy security considerations are the basis for such strategic decisions. As a consequence GHG emissions are expected to grow throughout the region, especially in the region's largest economies (Kazakhstan, Uzbekistan and Turkmenistan) which are already the biggest emitters.

The introduction of energy efficiency measures and cleaner technologies can help flatten the emissions curb. For example, in Uzbekistan, energy efficiency measures could help to avoid 40 million tonnes of GHG emissions in CO_2-equivalent per year. In the country's power generating sector, the proposed technological improvements could increase energy production by 20% without additional usage of fossil fuels.

The transfer of vehicles to compressed natural gas, a measure promoted by the Uzbek government, could further reduce CO_2 emissions by 400 thousand tonnes per year. More than 60 Clean Development Mechanism (CDM) projects with a total potential for CO_2 emission reductions of 14 million tonnes were prepared by Uzbekistan's chemical, oil and gas, electric power industries and stakeholders in the waste sector for implementation with the involvement of foreign companies under the Kyoto Protocol.

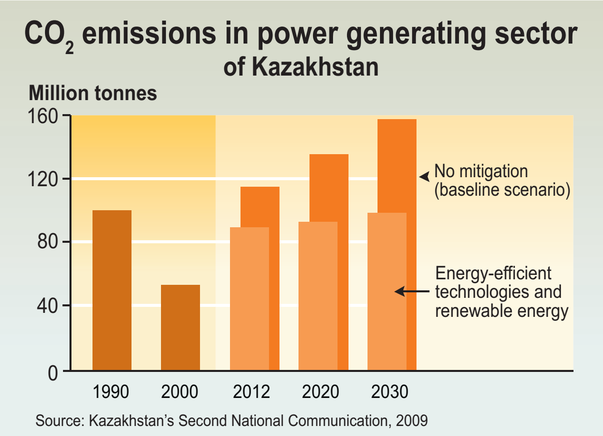
In Kazakhstan, improved technologies at coal-fired plants which constitute the bulk of national power capacity, and other energy efficiency measures

Mitigation techniques available today and tomorrow

	Strategies available today	Strategies available tomorrow*
ENERGY	• improved efficiency of coal-fired plants • reduction of heat, electricity and natural gas losses in local and national energy networks • increased energy prices, reduction of subsidies • minimasing gas flaring in fossil energy production • increased capture of methane and its convertion to energy in coal mining industry	• carbon capture and storage • cleaner technologies
TRANSPORT	• hybrid and more fuel-efficient vehicles • biofuels • use of compact low fuel consumption cars • shifts from road to rail and public transport • cycling and walking • transport planning, improved quality of roads	• second generation biofuels • higher-efficiency aircraft • advanced electric and hybrid vehicles with more powerful and reliable batteries
BUILDINGS	• more efficient appliances • efficient lighting, use of daylight • improved insulation • passive and active solar design • alternative refrigeration fluids	• integrated design of commercial buildings • solar photovoltaics integrated in buildings
INDUSTRY	• more efficient electrical equipment • heat and power recovery • material recycling and substitution • control of non-CO2 emissions	• advanced energy efficiency • CCS for cement, ammonia and iron manufacture • inert electrodes for aluminium production
AGRICULTURE	• improved crop and pasture management to increase soil carbon storage • restoration of degraded lands, sustainable farming • improved rice-growing techniques and livestock and manure management to reduce methane emissions • more efficient application of nitrogen fertilizers	• improved crop yields
FORESTRY	• afforestation and reforestation • reducing deforestation • improved management of forest resources • use of wood for bio-energy to replace fossil fuels	• improved remote sensing technology to analyse the carbon sequestration potential of vegetation and soils, and map changes in land-use
WASTE	• recovering methane from landfills • waste incineration with energy recovery • composting organic waste • recycling and minimising waste	• bio-covers and bio-filters to optimize methane oxidization

* expected to be available commercially before 2030 according to the IPCC

Sources: UNEP, 2009; synthesis of information from the Second National Communications



could reduce CO_2 emissions by 30-50 million tonnes a year by 2020-25. In addition to conventional fuels, Kazakhstan plans to develop its vast wind and solar power potential. The increased use of small renewable energy sources can help to reduce CO_2 emissions by 0.5-2.5 million tonnes a year. Additional benefits could be achieved in improving the residential heating sector.

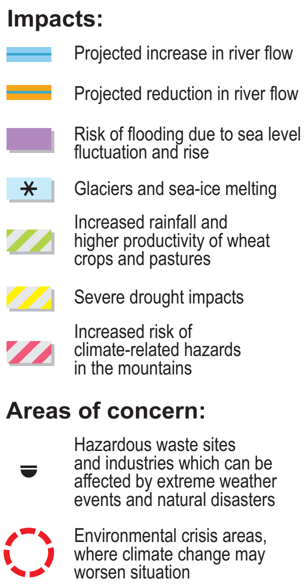
In an effort to reduce energy loss in the residential and commercial sector and combat its energy deficit, Tajikistan has recently banned the use of energy inefficient "Soviet-type" bulbs. Although this can be seen as a step in the right direction in terms of decreasing energy demand and increasing energy efficiency, a number of issues remain to be addressed. Essential energy losses occur during energy transmission and distribution. The new lamps are considerably more expensive than the usual bulbs and not affordable for poor people. Finally the environmental context is also important as many energy-efficient lamps available at the local market may contain mercury and the country has no capacities to correctly collect and recycle these lamps.

Darwaza, Turkmenistan

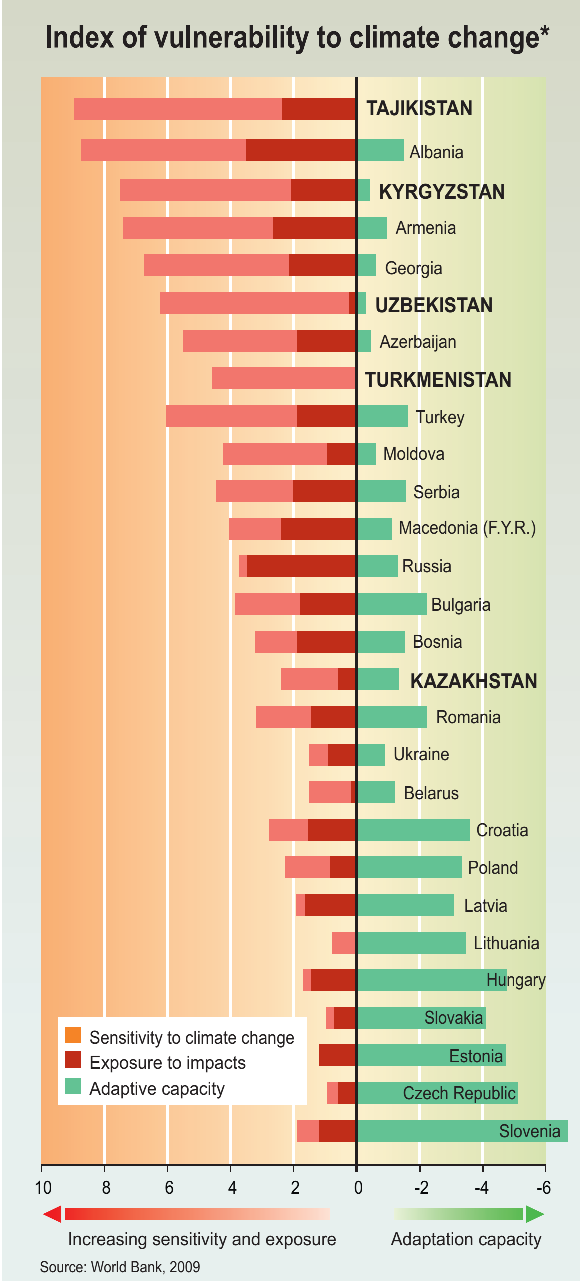
Teresken plants collected as fuel in the Pamirs

Impacts of Climate Change Adaptation

Climate change impacts
RUSSIA
KAZAKHSTAN
UZBEKISTAN
TURKMENISTAN
KYRGYZSTAN
TAJIKISTAN
AFGHANISTAN
IRAN
PAKISTAN
Caspian Sea
Aral Sea
Lake Balkhash
Kara-Bogaz-Gol
Volga
Ural
Irtysh
Syr Darya
Amu Darya
Kura
Atrek
Murghab
Ili
Chu
Penza
Ufa
Chelyabinsk
Tolyatti
Samara
Saratov
Buzuluk
Kumertau
Magnitogorsk
Kostanay
Rudniy
Petropavlovsk
Omsk
Kokshetau
Stepnogorsk
Pavlodar
Orenburg
Oral
Orsk
Atbasar
Astana
Aktobe
Arkalyk
Temirtau
Karaganda
Volgograd
Astrakhan
Atyrau
Zhezkazgan
Balkhash
Aral
Baikonur
Kyzylorda
Aktau
Zhanaozen
Makhachkala
Derbent
Kentau
Zhanatas
Turkestan
Taraz
Almaty
Bishkek
Kara-Balta
Balykchy
Shymkent
Toktogul
Naryn
Nukus
Uchkuduk
Mingachevir
Dashoguz
Urganch
Tashkent
Angren
Jalal-Abad
Ferghana
Osh
Baku
Ali Bayramli
Turkmenbashi
Balkanabat
Navoiy
Jizzakh
Khujand
Kashgar
Bukhara
Katta-Kurgan
Turkmenabat
Karshi
Dushanbe
Ashgabat
Rasht
Gonbad-e Kavus
Bojnurd
Mary
Termiz
Qurghonteppa
Khorug
Sari
Gorgan
Karaj
Tehran
Mazar-e Sharif
Kunduz
Gilgit
Neyshabur
Mashad
Hamadan
Qom
Arak
Mingora



** Vulnerability to climate change is a combination of: i) exposure to hazards, measuring the strength of future climate change relative to today's climate, ii) sensitivity, indicating which economic sectors and ecosystem services are likely to be affected in view of climate change, e.g. renewable water resources, agriculture and hydropower production, and iii) adaptive capacity to climate change, e.g. social, economic, and institutional settings to respond to weather shocks and variability.*



Central Asia is particularly vulnerable to climate change.

The World Bank has given the highest vulnerability rank to four of the five Central Asia countries among 28 nations of Europe, Caucasus and Central Asia. The most vulnerable are Tajikistan and Kyrgyzstan.

Over the next 10 to 20 years, climate change will exacerbate this situation dominated by socio-economic factors and legacies from the past – notably a dire environment situation and degrading infrastructure.

But something could be done to reverse the situation.

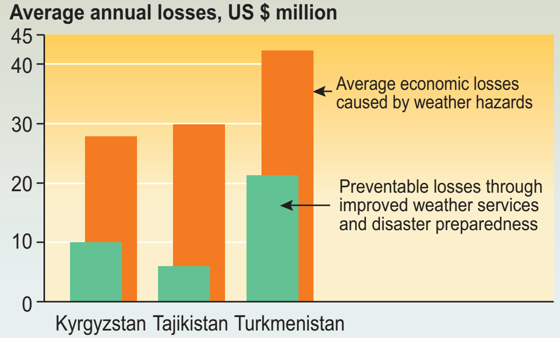
The next two decades offer a window of opportunity for Central Asian states to make their development more resilient to climate change by improving key sectors, such as water resource management, land use, biodiversity protection, addressing environmental pollution, and strengthening cooperation between states on forecasting and mitigation of disaster risks.

If nothing is done to mitigate the impact, it is the economy (agriculture, stock raising), and the health and security of the population which will be most at risk.

In the health sector, temperature and heat stress contribute to cardiovascular disease. Climate warming causes increased malaria risk and malaria outbreaks, as well as vector-borne diseases and intestinal infections (typhoid, salmonellas, dysentery, helminthiasis) due to heavy rainfall, increased temperatures and inappropriate communal water supply. Children and women in rural areas will be the most at risk.

There is little doubt that climate change will force people to move from the affected areas with a high level of environmental stress and impacts on agriculture and water resources.

Economic losses from weather hazards



Source: World Bank, 2009

In Tajikistan and Kyrgyzstan, average annual economic losses reach 1-1.5% GDP (equivalent to US$25-30 million). Estimates foresee that in some years, the impact will reach 5% GDP.

Northern Kazakhstan is the bread basket of the region. Climate warming and increased CO_2 concentration in the atmosphere may have a beneficial effect on vegetation and will increase the production of wheat and productivity of pastures. But a future increase in temperature by 4-6°C by 2080-2100 and extreme weather events could jeopardize the short term benefit and even depress crop productivity. It is expected, for instance, that cereals and vegetable production, could decrease by 10-15% after 2050.

Sheep breeding (mostly in Turkmenistan and Kazakhstan) is sensitive to heat stress and high temperatures exceeding the limits of animal's endurance. Climate warming and desertification would have a huge impact on pasture productivity, constrain sheep breeding and reduce wool production by 10-20%. Grazing conditions and pasture productivity can improve in winter and spring, but deteriorate in summer and autumn.

In Uzbekistan and Kyrgyzstan pasture degradation linked to climate change is not expected. Other factors such as grazing pressure and regulations, availability of water and impacts of dust storms from the Aral Sea area are expected to be the main hazards.

A 10% increase in precipitation in the mountains prone to erosion could double the volume of sediment transported by the Vakhsh and Naryn rivers. This would increase the intensity of sedimentation in reservoirs and, in turn, reduce energy potential. The two rivers are the main sources of hydropower generation in Tajikistan and Kyrgyzstan

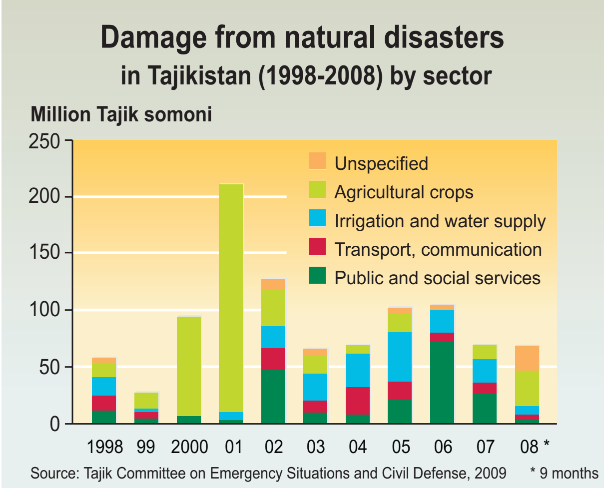
The population of Central Asia is rapidly growing, putting pressure on demand for water. This will be dramatic in case of scarcity. If no measures are taken, if no new economic development models are put into place, there is a strong risk of disputes over water-sharing.

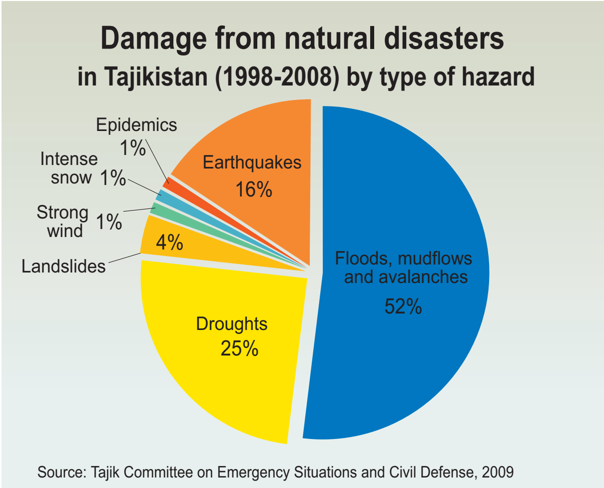
In scenarios of high climate warming by +5+6°C and lack of precipitation, water resources in the main rivers would fall by 15-40%.

With less fresh water and land suitable for agricultural use, people will have to move to places where they can survive. Droughts and crop failures will push inhabitants of the rain-fed areas and arid pastures towards cities and irrigated land.

Water is both a key resource for agricultural production and for electricity generation in the region. Competition for the control of this vital resource is likely to increase while the flow of the rivers may decline in the next 50 years.

As mountain countries Kyrgyzstan and Tajikistan will probably have enough water for their own needs but may not be able to meet demand in their role as regional water suppliers.

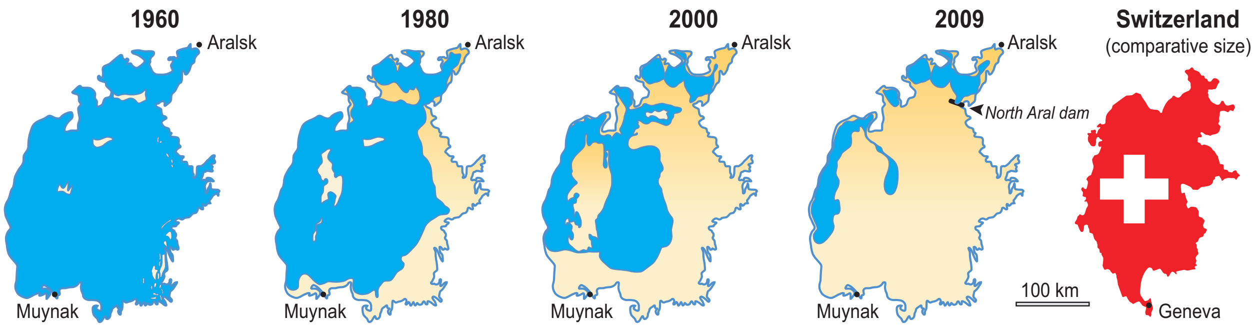


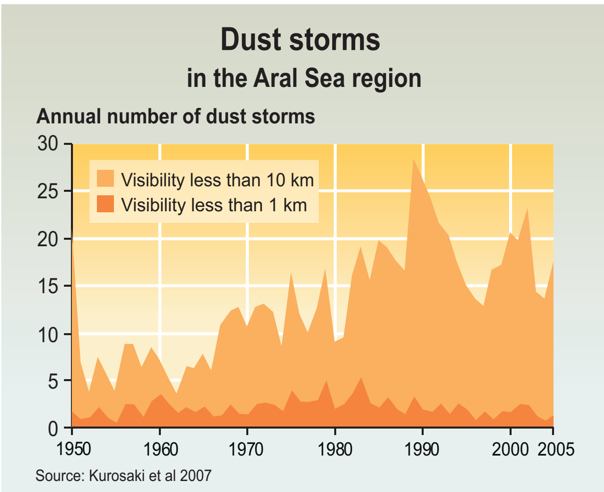


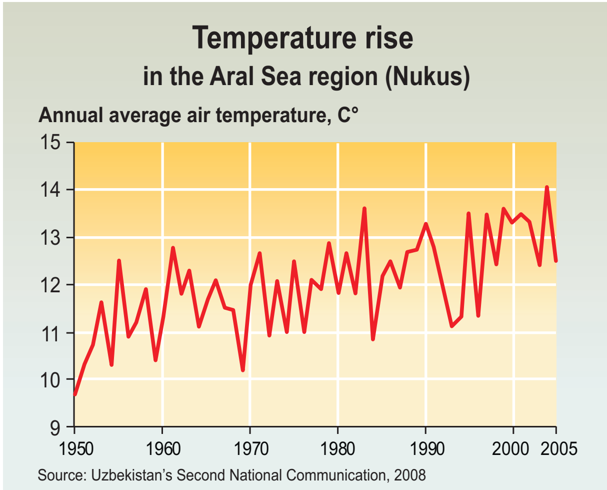
Turkmenistan and Uzbekistan, as downstream states, with extensive irrigated agriculture and high dependence on external water supplies may suffer the most from water deficit.

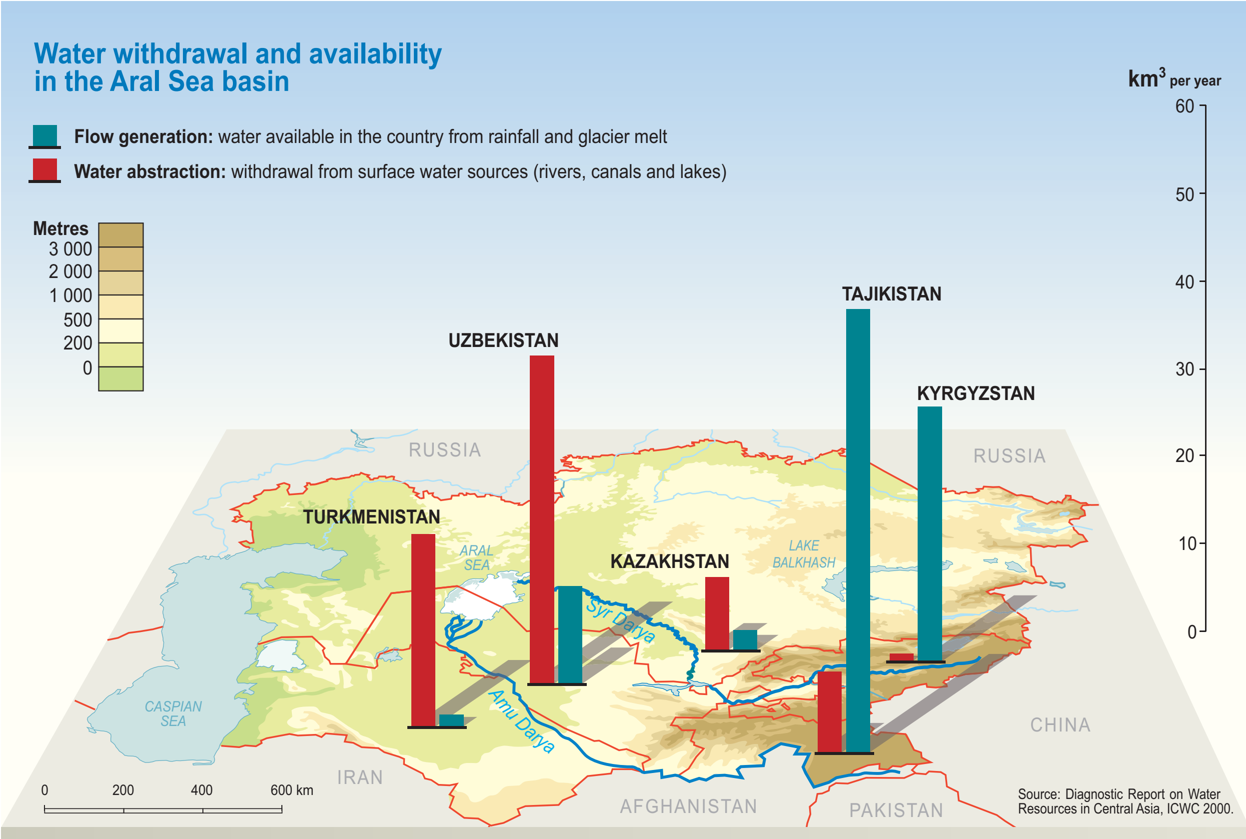
Ship wreck, the Aral Sea region

The shrinking Aral Sea









THE MAP DOES NOT IMPLY THE EXPRESSION OF ANY OPINION ON THE PART OF THE AGENCIES CONCERNING THE LEGAL STATUS OF ANY COUNTRY, TERRITORY, CITY OR AREA OF ITS AUTHORITY, OR DELINEATION OF ITS FRONTIERS AND BOUNDARIES.

MAP BY VIKTOR NOVIKOV AND PHILIPPE REKACEWICZ - UNEP/GRID-ARENDAL - APRIL 2005

The Aral Sea near extinction

One of the striking examples is the tragedy of the environmental mismanagement of the Aral Sea basin and the danger it represents for the economy and the populations in a changing climate.

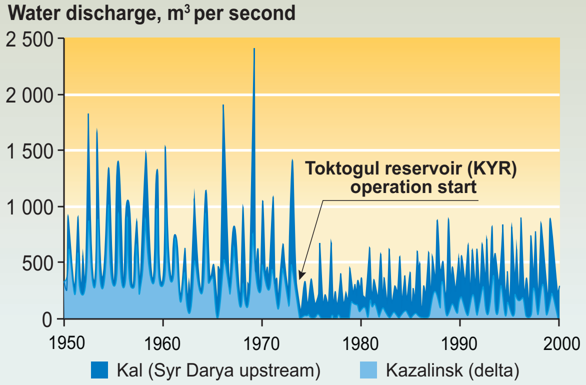
The Aral Sea is now near extinction. It used to be the fourth largest lake in the world.

It has shrunk dramatically over the last five decades from 68,000 km^2 to less than 10,000 km^2, humans having used up almost all of the natural river flow.

As a result, population in the arid regions adjoining the Aral Sea must endure increasingly inhospitable conditions. There is less water to drink. It is not safe. Agricultural production is declining with desertification and worsening climate conditions.

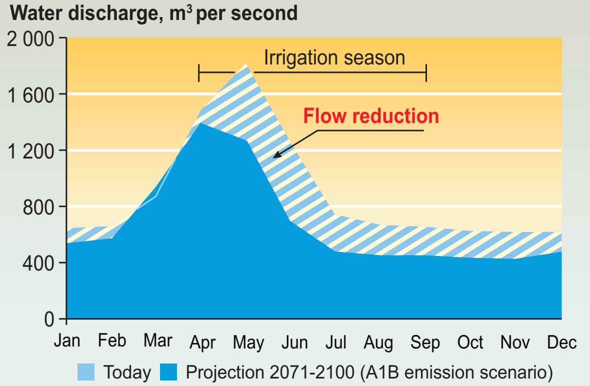
Following the desert expansion after the Aral dried up, there have been more powerful dust storms with more health problems and ecological stress.

Long-term flow of the Syr Darya



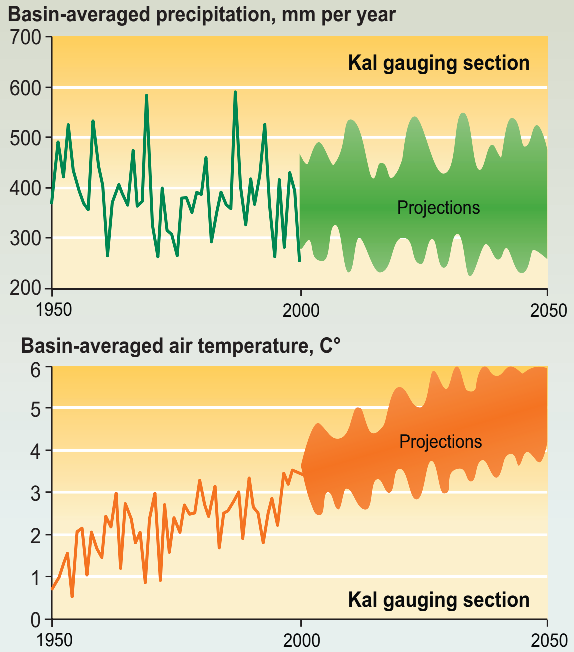
Source: Shiklomanov, 2009

Average seasonal flow of the Syr Darya



Source: Shiklomanov 2009

Climate change projections for the Syr Darya basin



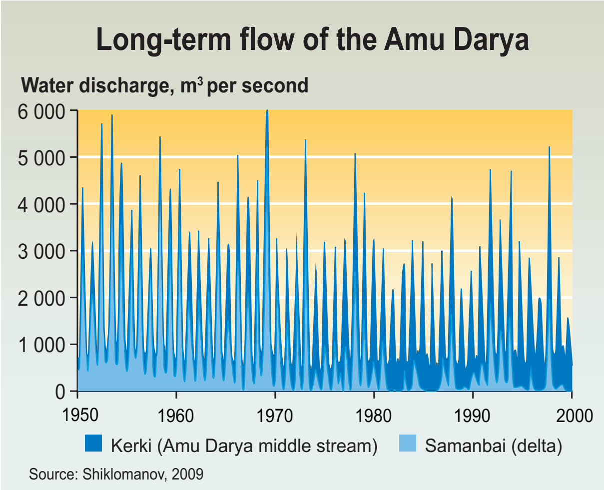
Source: Shiklomanov, 2009

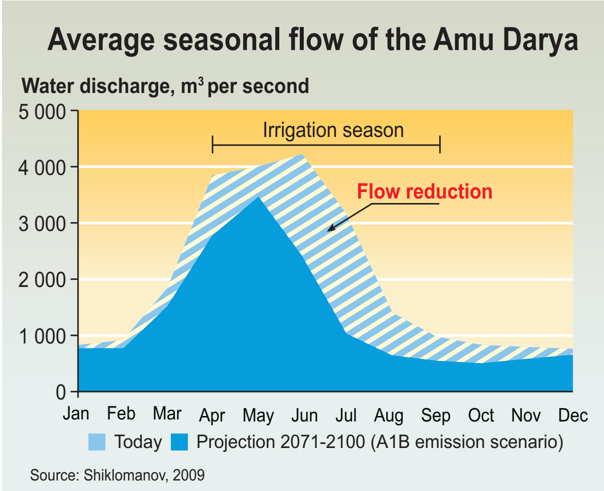
The flow of the rivers

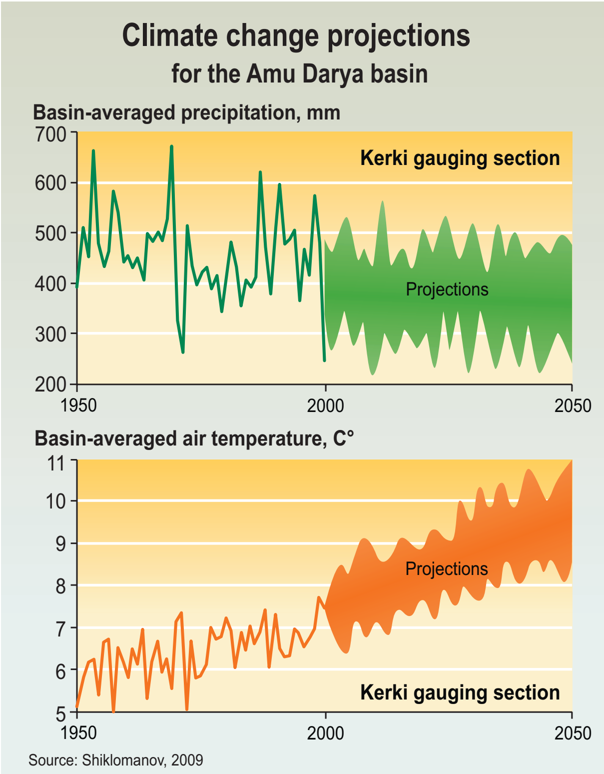
So far, the good news is that, in spite of observable reduction in glacier size and volume, the flow of Central Asia rivers has not changed significantly. In selected river basins, the intensified glacier and permafrost melting has even increased discharge of rivers by 6-8% while runoff from glacier-free river basins has dropped slightly.

However, in the longer-term regional water resources are under threat. In strong climate warming scenarios (+5+6°C warming), water resources in the main rivers will decline dramatically. By 2050 the water flow of the Amu Darya may be reduced by 10-15% and the Syr Darya by 5%, as a result of the loss of glaciers and permafrost, higher temperatures, increased evaporation and reduced surface runoff.

The severe 2000-01 drought in southern parts of Central Asia may serve as a model for the future. During this drought Tajikistan and Afghanistan experienced a substantial failure of rain-fed crops while water shortages strongly affected the lower reaches of the Amu Darya river, especially Karakalpakstan in Uzbekistan.







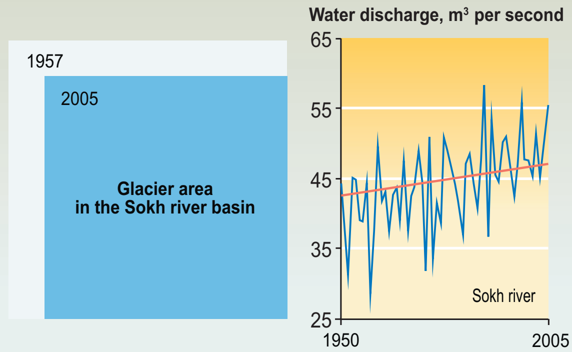
Models for other major river basins in Kazakhstan (Ural and Irtysh) suggest that in the long-term some increase in water flow due to enhanced precipitation and runoff is likely.

Examples of water resource change and climate impacts:

The Amu Darya river:

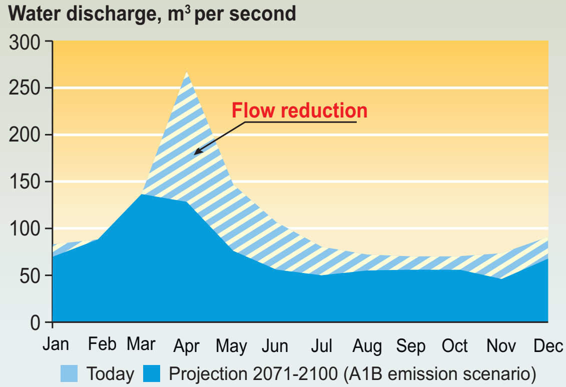
- A key source of water for Afghanistan, Tajikistan, Uzbekistan, and Turkmenistan, is highly dependent on melt waters from glaciers and permafrost which promote summer peak flow (June-September) in the Panj and Vaksh rivers, contributing more than 40% of seasonal river flow. This ideally coincides with the critical period of highest water demand for irrigation. But it seems that water formation in the Amu Darya basin is decreasing. Even more worrying is a trend related to low-water years, as water levels are reaching more and more extreme minimums. For example, such a situation occurred in 2000, 2001 and 2008.

Small rivers and melting glaciers

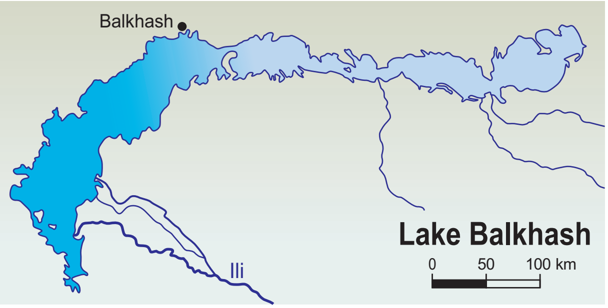


Sources: Uzbekistan's Second National Communication, 2008; Glazirin, 2008

Average seasonal flow of the Ili river



Source: Shiklomanov 2009

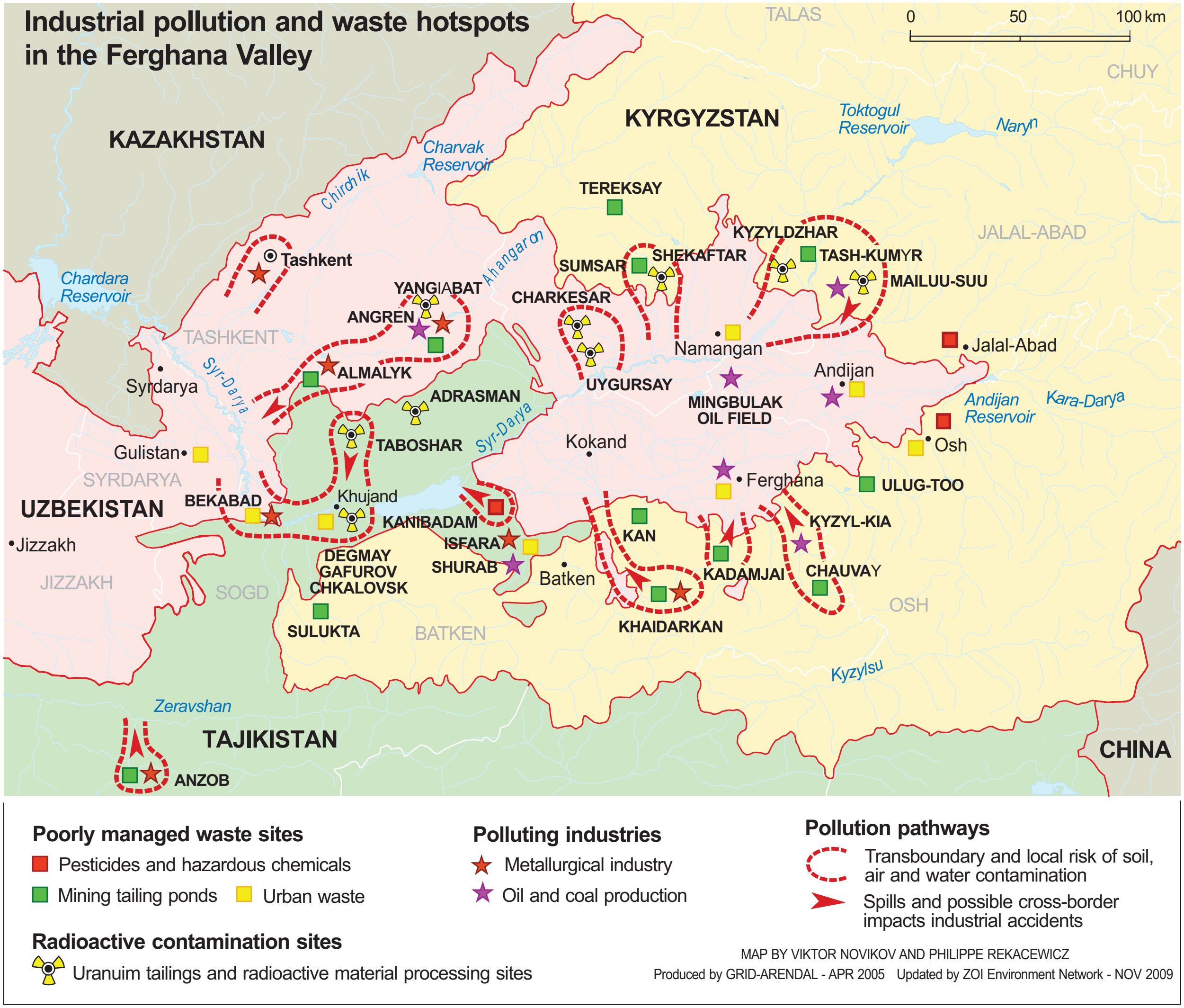


The Sokh river:

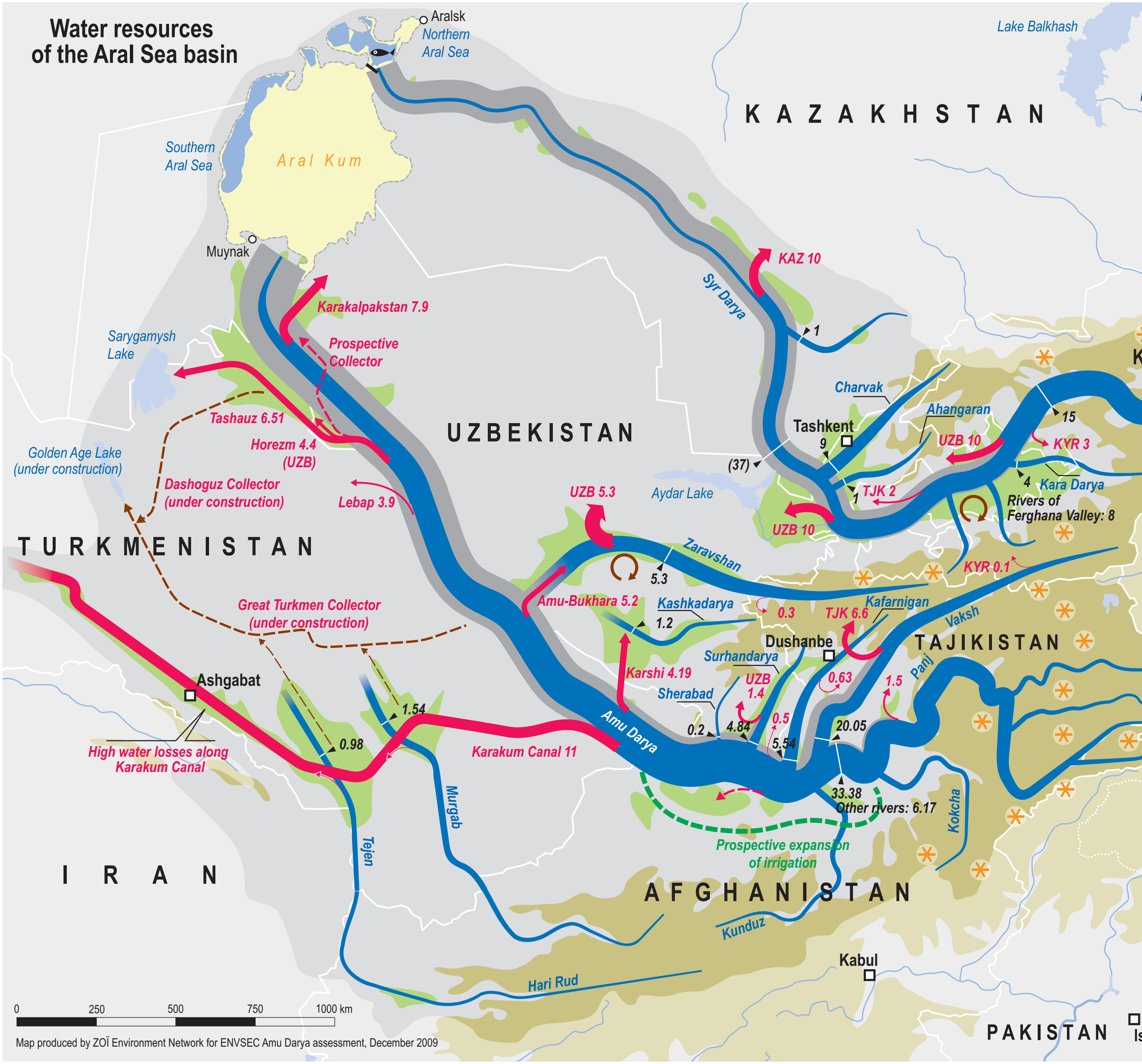
- Originating in the juniper-covered Turkestan mountains of Kyrgyzstan and flowing into the Uzbek part of the Ferghana Valley, is a typical mountain river fed by glacial and snow waters. The glacier area in the Sokh river basin has been constantly shrinking. At the same time, intense ice and permafrost melting augmented the river flow. If climate warming in the Sokh river basin continues at the current rate and intensifies, the available ice and snow reserves could be exhausted in two to three decades, then the river flow may abate and the whole river hydrography change.

Lake Balkhash:

- Central Asia's second-largest lake in Kazakhstan, covering 16,000 km^2 and extending 600 km in length. Located in Kazakhstan's most populous region, it may now be drying out. The lake is fed principally by the Ili river, which starts in China and provides 80% of water inflow. The lake has no outlet. Climate warming has increased water evaporation from the lake, which combined with growing water diversion by both countries for economic needs and the construction of dams, has already reduced the depth of the lake and raised its saline content. Increased precipitation and intense glacier melting in the last five decades have so far have contributed to a 10% increase in river flow. However, experts suggest that further climate warming may exhaust glaciers and snow reserves. On top of this, rapid socio-economic development, especially in the Chinese part of the Ili river basin, will contribute to declining water flow and greater environmental and social stress in the area. Unless strategic environmental management measures are not taken urgently, the lake's pollution by industrial, mining and refinery enterprises, as well as the agricultural sector, will only worsen this precarious situation.On the contrary, snow and rain-fed rivers with small or no glaciers in southern parts of Central Asia such as Murghab, Tedzhen and Atrek are already experiencing some reduction in water flow.

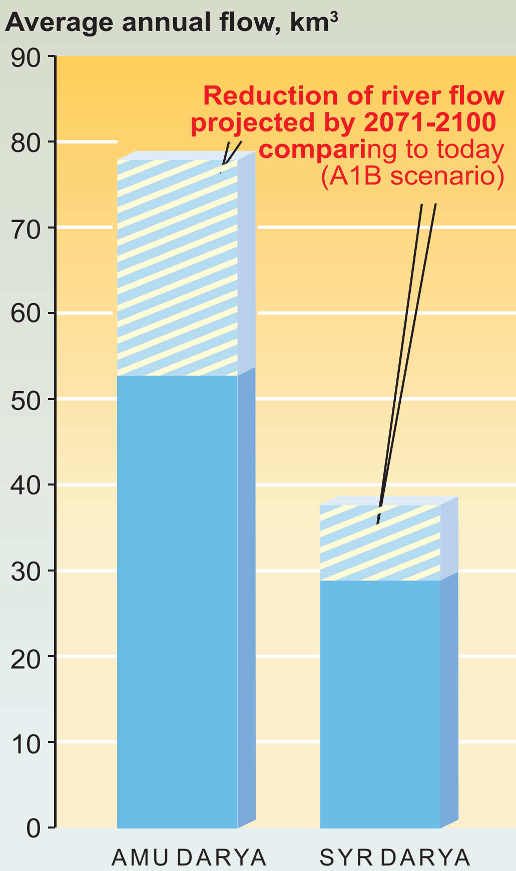


The Soviet Union used the Ferghana valley as one of its main sources of metal and uranium ore, exploring some 50 deposits in the area. The legacy of these past operations remains since hazardous wastes sites were not remediated and are often located in weather-sensitive, flood-prone locations, near towns and along rivers and drainage zones. The Ferghana valley is already prone to natural hazards like floods and mudslides. Pollutant spills and natural disasters could affect a population far beyond people living in the vicinity. Unfortunately the impacts of adverse weather are compounded by poor environmental monitoring and control mechanisms.

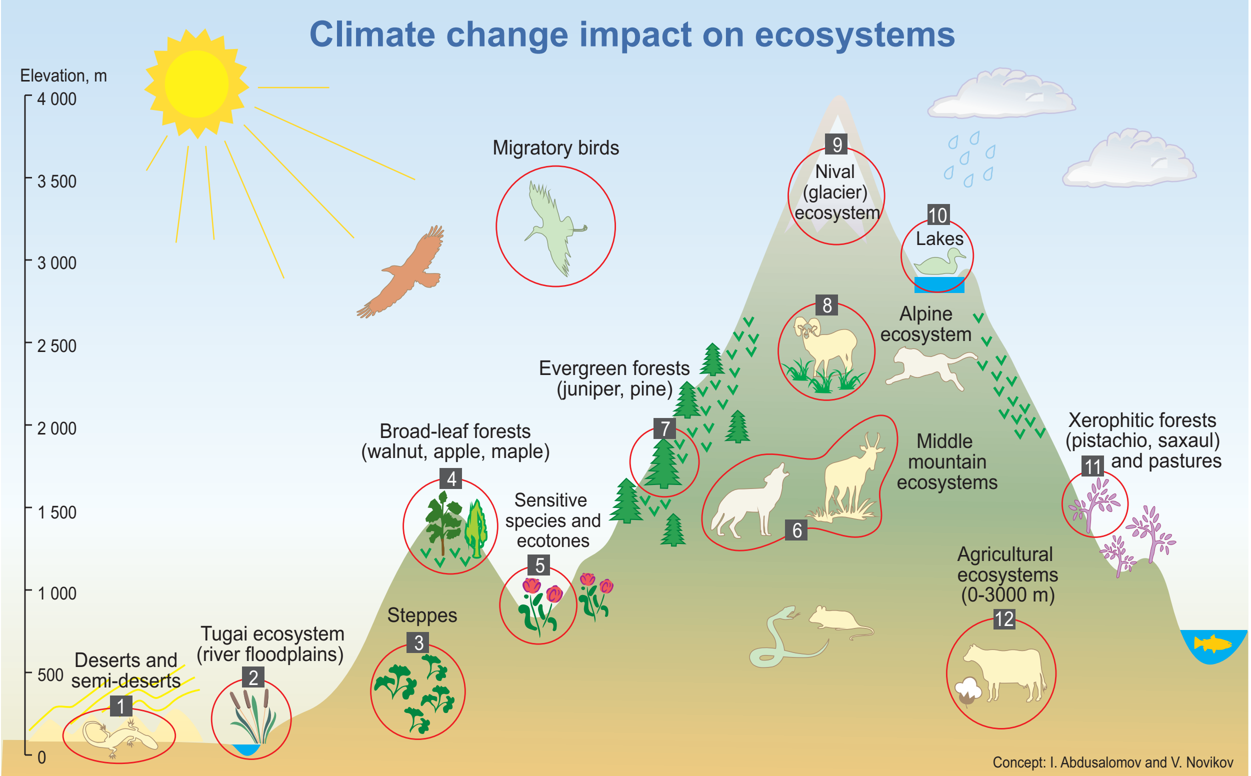


Water resources of the Aral Sea basin
Aralsk
Northern Aral Sea
Lake Balkhash
KAZAKHSTAN
Southern Aral Sea
Aral Kum
Muynak
Karakalpakstan 7.9
Prospective Collector
KAZ 10
Syr Darya
Sarygamysh Lake
Tashauz 6.51
Horezm 4.4 (UZB)
UZBEKISTAN
Charvak
Ahangaran
Tashkent
UZB 10
KYR 3
15
Golden Age Lake (under construction)
Dashoguz Collector (under construction)
Lebap 3.9
UZB 5.3
Aydar Lake
(37)
TJK 2
Kara Darya
Rivers of Ferghana Valley: 8
UZB 10
TURKMENISTAN
Zaravshan
5.3
KYR 0.1
Amu-Bukhara 5.2
Kashkadarya
0.3
TJK 6.6
Kafarnigan
Vaksh
Great Turkmen Collector (under construction)
1.2
Dushanbe
TAJIKISTAN
Surhandarya
Karshi 4.19
UZB 1.4
0.63
1.5
Panj
Ashgabat
Sherabad
1.54
0.2
4.84
0.5
20.05
Amu Darya
0.98
5.54
High water losses along Karakum Canal
Karakum Canal 11
33.38
Other rivers: 6.17
Murgab
Kokcha
Tejen
Prospective expansion of irrigation
IRAN
AFGHANISTAN
Kunduz
Kabul
Hari Rud
0
250
500
750
1000 km
PAKISTAN
Map produced by ZOÏ Environment Network for ENVSEC Amu Darya assessment, December 2009

Climate change impact on flow of large rivers



Sources: Uzbekistan's Second National Communication, 2008;, Kyrgyzstan's Second National Communication, 2009; Shiklomanov, 2009



1 - Increased climate aridity, expansion of desert areas

2 - Ecosystem degradation due to reduced river flow, increased risk of fires and diseases

3 - Increased ecosystem productivity in northern parts of Central Asia, northward shift of vegetation

4 - Forest degradation due to reduced runoff, increased risk of droughts and diseases

5 - Changes in species composition, risk of extinction of endangered and vulnerable species

6 - Alteration of food-chains, change in the balance of predators and herbivorous animals

7 - Shift of forest communities to higher altitudes, risk of fires

8 - Degradation and reduction of habitats, reduction of forage

9 - Glacier melt and vegetation succession, alpine habitat loss

10 - Physical and biological changes in high mountain lakes

11 - Changes in phenology (earlier ripening, fading), pest attacks

12 - Mixed negative and positive effects of climate warming

Climate change is increasingly becoming a factor defining the future conditions of the region's ecosystems and adds to environmental stress on sensitive flora and fauna species. Vegetation succession can be observed at many alpine sites of Central Asia, which were covered by ice until recently. Mountain species see their ecosystems changing. Droughts, a more arid climate and the reduction of water flow in the rivers strongly affect aquatic and tugai floodplain forest ecosystems.

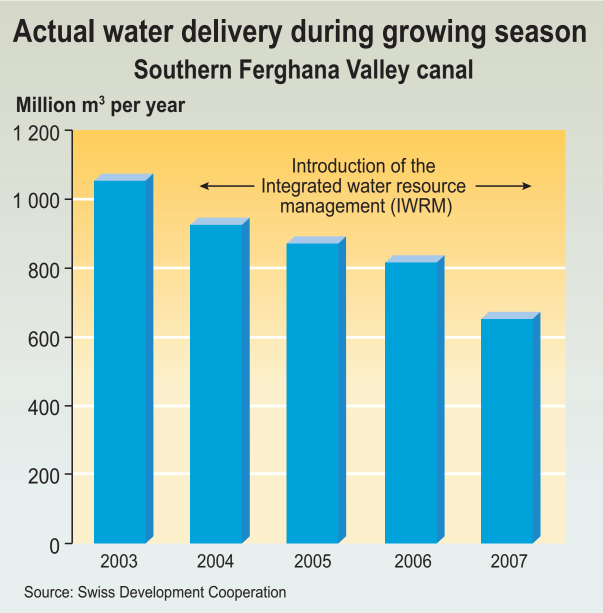
The areas annually affected by locust (mainly in southern Central Asia) significantly increased. Pest attacks in southern Tajikistan in 2003-05 halved the cotton harvest in the most hit districts. The risk of forest fires and of spreading forest diseases has amplified. Scientists warn that the southern limits of forest areas in Kazakhstan can experience significant changes due to climate warming.

Adaptation

With climate change, population growth and plans for steadily increasing agricultural output, water will become a fundamental issue for the region.

Less water will be available in the period of highest demand for irrigation in the future. The prospects of climate change impacts on the large river basins of Central Asia such as the Amu Darya and the Syr Darya are mainly pessimistic and suggest a reduction of the rivers' water flow in the long-term. In the light of this, policy and technical measures for improving water monitoring, the efficiency of water use and water recycling should receive much more attention. A serious adaptation effort needs to be developed not only by single countries but also regionally since issues like transboundary water management are a matter of concern for the whole of Central Asia.

Demonstration projects implemented in the Ferghana Valley on integrated water resource management (IWRM) received high scores for water conservation and delivery efficiency. This positive experience could be expanded into other priority regions.



Demonstration projects on flexible and climate-resilient agricultural practices will be important to enhance economic and food security. Health issues such as heat stress, risk of infections and vector-borne diseases could be addressed through a number of social, policy and technical measures.

An effective and timely response to severe droughts, heat waves, disease and natural disasters, as well as safety in the energy and transport sectors, depend on the quality of weather services and early warning. In the past 15 years climate and environmental monitoring systems in Tajikistan, Kyrgyzstan and Turkmenistan have deteriorated. These countries are consequently having difficulty fulfilling national, regional and international obligations on weather and water data reporting and exchange. The World Bank estimates that each US dollar invested in modernizing climate observation systems and weather services in Central Asia may yield US$2-3.5 (200-350%) in economic benefits by avoiding damage from natural disasters and improved and safer operation of businesses. Therefore, environmental observation and early warning systems need to be strengthened as a priority.

The Global Environment Facility (The GEF) is one of the main financial mechanisms under the UN Framework Convention on Climate Change. The GEF contributed more than US$25 million of co-financing for demonstration projects in Central Asia on improving energy efficiency, application of small renewable energies in rural and remote regions, sustainable transportation, waste management, other climate-friendly technologies and adaptation. These projects are not only limited by the national scale. Many projects are community-based, while individuals and small businesses with innovative ideas can apply for GEF Small Grants. However, the existing level of climate finance is limited. It is hoped that with the beginning of the GEF-5 cycle in 2010, more projects on climate change mitigation and adaptation will be financed in Central Asia.

	Adaptation options
WATER USE	• improved climate and water monitoring and forecasting • integrated water resource managment (IWRM) • revision of water consumption norms and regulations • broad introducation of efficient irrigation technologies • water re-use and re-cycling, drainage water managment • improved water quality control and pollution prevention • water saving incentives and training for farmers • rehabilitation of water pipelines and canals
AGRICULTURE	• improved agrometeorological and veterenary services, training, scientific and technical support for farmers • selection and introduction of drought- and pest-resistant and low water consumption crops, crops protection • conservation of valuable agro-biodiversity • water storage for reliable water supply in dry years • crop rotation and shift towards more suitable areas • rehabilitation of degraded pastures and croplands • remote sensing and mapping of pasture conditions • insurance, strategic food and forrage reserves
HEALTH	• malaria prevention and control • improved drinking water quality and sanitation facilities • new regulations for farmers working in the field in summer • public awareness and early warning • new urban planning principles, better microclimate control
TRANSPORT and ENERGY	• adjustment of hydropower plant operations according to stream flow change and projected climatic impacts • improved security of energy supply and transfer networks • revised road construction norms and traffic load • protection of vulnerable transport infrastructure
ECOSYSTEMS	• systematic research and monitoring • protection of important ecological corridors and sites • conservation of endangered species • public awareness, responsible eco-tourism
DISASTER RISK REDUCTION	• improved capacities for monitoring and forecasting of extreme weather events, hazard mapping • engineering protection measures and early warning • insurance and risk management, public awareness

Source: synthesis of the Second National Communications and the National Strategies/Action Plans on Climate Change

Environment and Security issues in the Aral Sea basin

- water
- biodiversity
- geopolitics
- global change

Factor: Global Climate Change

Changing precipitation patterns, melting ice, transboundary water resource depletion, natural disasters

Increased uncertainties

Irrigated Agriculture

Soil salinization, chemicals washout, inefficient water use, collector-drainage water management

Impact on livelihoods,
local and cross-border issues

Aral Sea region; Amu Darya and Syr Darya deltas

Soil and biodiversity degradation, accumulation of toxic chemicals, water pollution and lack of safe drinking and irrigation water

Impact on livelihoods,
environmental migration

TURKMENISTAN KAZAKHSTAN UZBEKISTAN

LOWLAND

Factor: Global Financial Crisis

Migration workers, large investment projects

Increased uncertainties

Factor: Afghanistan

**Insecurity and weak institutions,
drugs production and trade,
people displacement and migration,
uncontrolled environment degradation**

Direct security risks,
impact on livelihoods

Energy and Hydropower

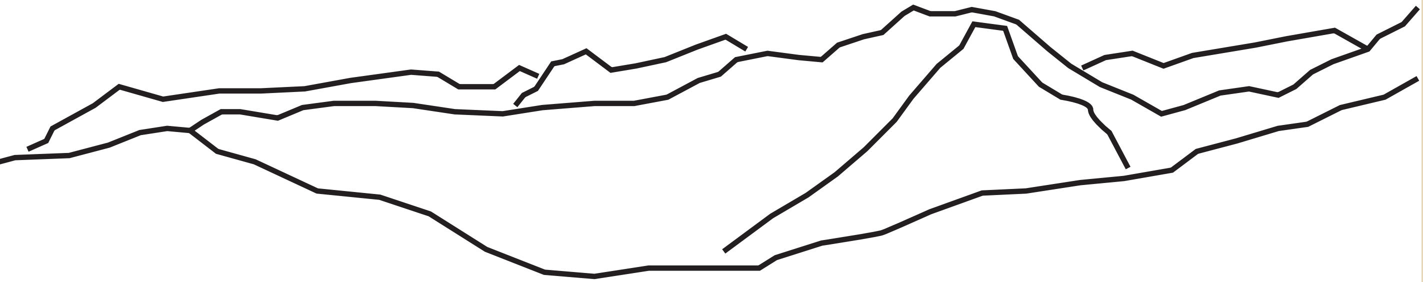
Disruption of energy supply for population and businesses, economic development constrains

Impact on livelihoods,
international disputes

Biodiversity

**Mountain pastures, agro-biodiversity,
rare and globally endangered species**

Impact on livelihoods,
income distribution



TAJIKISTAN **KYRGYZSTAN** **AFGHANISTAN**

HIGHLAND

Concept: Otto Simonett and Viktor Novikov

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NOAA's El Nino page: http://www.elnino.noaa.gov/

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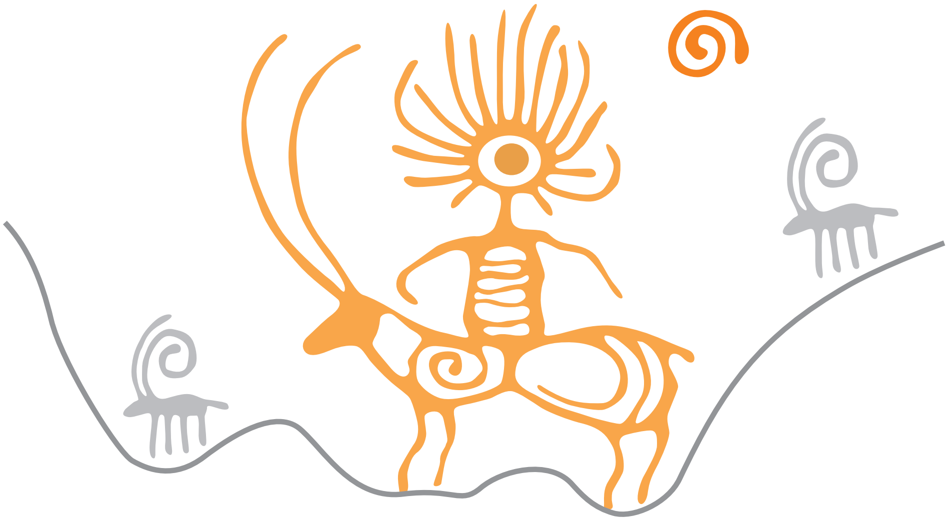

Rock painting B.C., Kyrgyzstan

For most of us, Central Asia is something like Far Far Away the fictional kingdom featured in the Shrek or Aladdin animated movies.

Camel caravans plodding along the trails of the ancient Silk Road; the snow-capped peaks of the Tien-Shan, Pamirs and Alai in the background; and we have time to drink tea all day. The idea of man-made climate change met a similar fate of disbelief when it was 'discovered' and 'broadcast' in the 1980s: something remote, definitely not happening here! While the international community debated and reached agreements on climate change, for the vast majority of the world's population the concept remained abstract and fictitious. This has only changed very recently; the impacts of climate change are affecting the everyday life of most of us, and all of us are going to be part of mitigation and adaptation efforts; globally, locally and in our homes. Obviously, there are no longer such places as Far Far Away, not even in Central Asia.

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