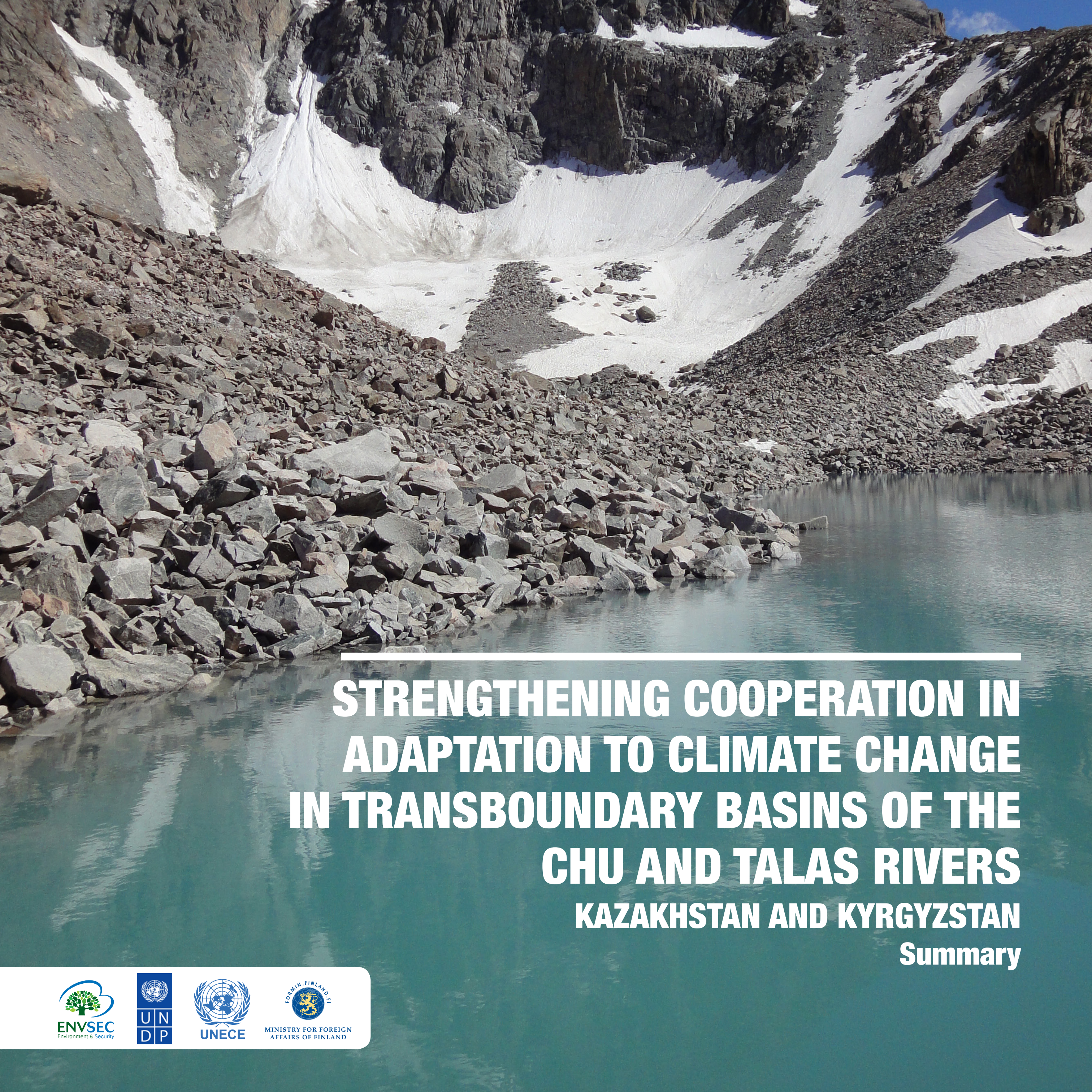

STRENGTHENING COOPERATION IN ADAPTATION TO CLIMATE CHANGE IN TRANSBOUNDARY BASINS OF THE CHU AND TALAS RIVERS

KAZAKHSTAN AND KYRGYZSTAN

Summary

ENVSEC Environment & Security

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Strengthening Cooperation in Adaptation to Climate Change
in Transboundary Basins of the Chu and Talas Rivers,
Kazakhstan and Kyrgyzstan

Summary

Summary of the full report on the “Strengthening Cooperation in Adaptation to Climate Change in Transboundary Basins of the Chu and Talas Rivers (Kazakhstan and Kyrgyzstan)” was prepared by Zoï Environment Network in close cooperation with the United Nations Economic Commission for Europe (UNECE) Water Convention Secretariat and the authors of the full report and experts of Kazakhstan and Kyrgyzstan in the framework of the Environment and Security Initiative (ENVSEC). Financial support was provided by the Government of Finland.

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KAZAKHSTAN AND KYRGYZSTAN

Summary

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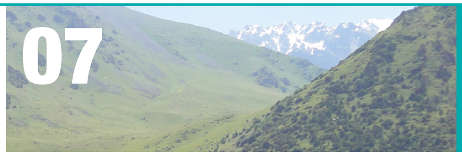

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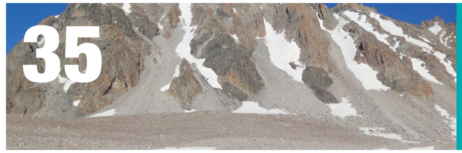


Ala-Archa Natural Park, the Chu River basin

INTRODUCTION

Climate change, once only a topic of scientific debate, has become in recent years an issue requiring the development and implementation of practical actions. Central Asia, due to ongoing global climate change, expects an increasing freshwater deficit and adverse changes in the flows of major rivers; therefore, there is an urgent need to study the impact of climate change on water resources in the region.

Most of the water flows in Central Asia, as well as almost all water resources in the region, are formed in the mountains, mainly due to melting of seasonal snow cover and glaciers. Changes in snow and ice cover in the upper basin resulting from global warming can significantly affect the hydrological regime and water resources of Central Asia with dramatic consequences for the water supply serving the population and economy of the region.

Surface water in Central Asia is a vital resource, and is particularly sensitive to climate change. The Chu River (in Kazakhstan it is called the Shu) and the Talas River flow through Kazakhstan and Kyrgyzstan. These rivers support the livelihoods of more than 3 million people in the two republics, and are the major sources of water used in agriculture.

The interests of the two countries in the sharing of these rivers calls for cooperation – a common approach to management, a rational use of water resources and in the face of future climate change, the development of joint actions on adaptation.

The project, "Strengthening cooperation on adaptation to climate change in transboundary basins of the Chu and Talas Rivers", has made an attempt to combine two areas that were previously unrelated – the joint management of transboundary water resources and the development of recommendations on adaptation to climate change. Experts involved in the project have examined the impact of climate change on the situation in the basins of the Chu and Talas Rivers, and have focused primarily on agriculture, which depends on the availability of water resources.

The project has been implemented in the framework of the Environment and Security Initiative (ENVSEC, www.envsec.org) with support from the Government of Finland and the European Union (in the early stages of the project). It is intended to expand the opportunities of Kazakhstan and Kyrgyzstan in the field of adaptation to climate change and to facilitate dialogue and cooperation between the two countries in the development of transboundary strategies for adaptation, thereby preventing disagreements in the use of water resources.

The key project objectives include:

- Simulation of possible changes in the basins of the Chu and Talas Rivers associated with climatic conditions, and development of proposals for joint action
- Preparation of a joint report on the possible impacts of climate change in the region, with special attention directed to water use in agriculture, as a major water consumer in the river basins
- Development of a set of possible adaptation measures to help alleviate potential tensions caused by changes in the water regime.

These adaptation measures could be applied as necessary. The final part of this report lists some types of possible practical actions, which, however, need further elaboration, based on the priorities and resources of both countries.

The project partners are the United Nations Development Programme (UNDP), United Nations Economic Commission for Europe (UNECE), the Organization for Security and Cooperation in Europe (OSCE), the Department of Water Resources and Irrigation with the Ministry of Agriculture and Land Reclamation of the Kyrgyz Republic, the Ministry of Environment and Water Resources of the Republic of Kazakhstan and the Secretariat of the Commission of the Republic of Kazakhstan and the Kyrgyz Republic on the use of the interstate water facilities on the Chu and Talas Rivers.

Geography of the Chu and Talas River basins

Basin borders

National borders

Orto-Tokoyskoye Reservoir, the Chu River, Kyrgyzstan

GENERAL DESCRIPTION OF THE CHU AND TALAS RIVER BASINS

The basins of the Chu and Talas Rivers are located in Kazakhstan and Kyrgyzstan. The rivers originate on the slopes of the Kyrgyz Range in Kyrgyzstan, then flow through the Turan Lowlands in Kazakhstan (the Chu River flows through the Chuy Valley) and disappear in the Muyunkum Desert.

Vegetation and soils in the basin are noted for wide diversity: landscapes of deserts and semi-deserts typical of the plains and intermountain valleys are replaced at higher altitudes by steppe, meadow and forest complexes, subalpine and alpine meadows and grasslands. Mixed grass swards, rich in different vegetation types, are characteristic of meadow steppes where the soil structure provides for rapid absorption of moisture, so short-term run-off is formed only during high intensity rainfalls. The total forest cover in the lower reaches, floodplains and deltas of the Chu and Talas Rivers is 6.2 per cent (the average for Kazakhstan is 3.8 per cent). The desert and semi-desert soils located on the flat part of the basin lack a solid structure, are very poor in humus and have high permeability, but precipitation does not penetrate below the surface, and the permanent non-recharging water regime eliminates the possibility for the formation of subsurface flow.

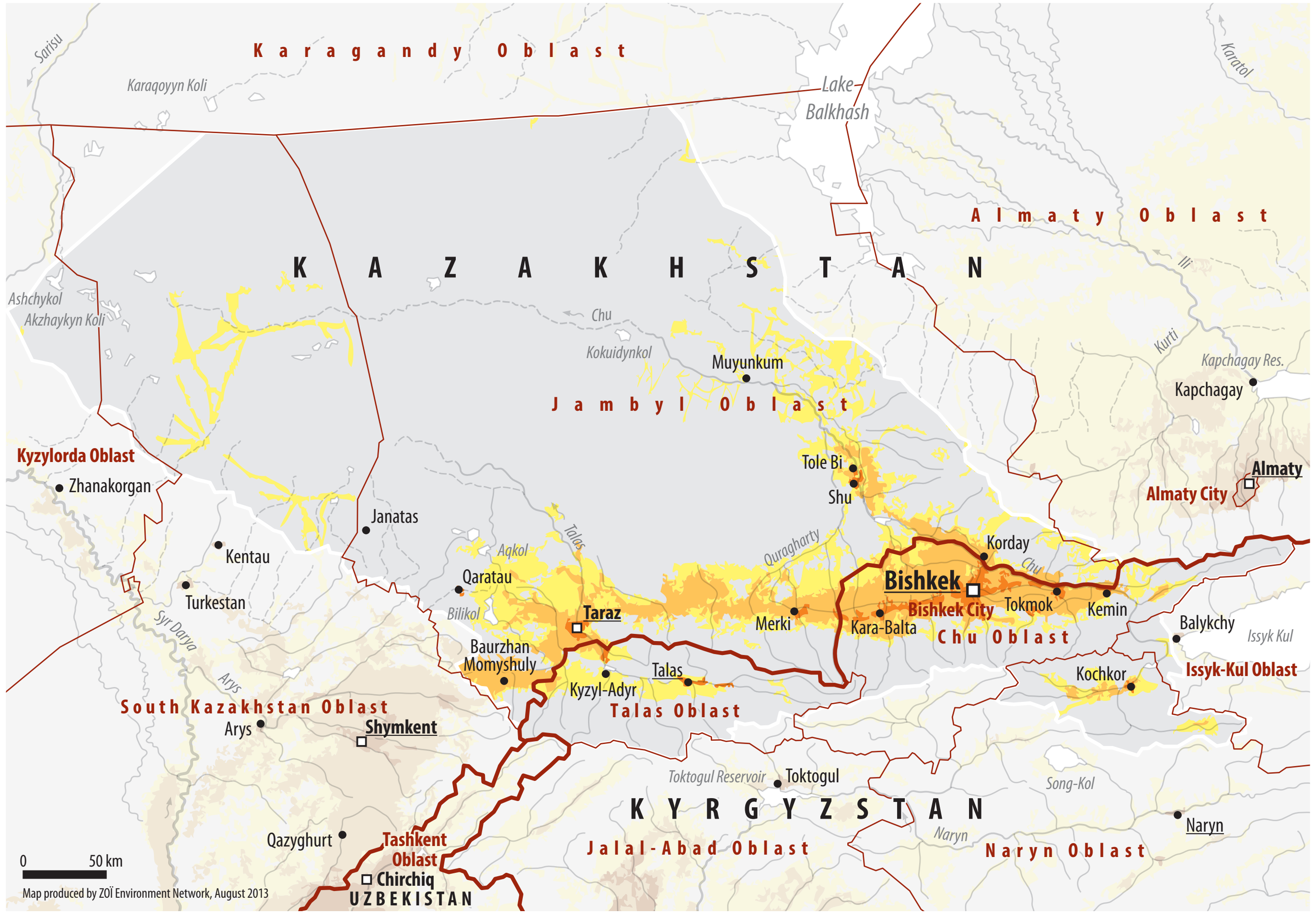
The Chu and Talas River basins are marked by a variety of forms of river network – permanent streams, drying rivers, dry riverbeds of alluvial plains, artificial water bodies (irrigation canals), ponds, reservoirs and outflows of groundwater and return water. In the Chu basin there are over 5 000 small rivers and about 500 lakes, and in the Talas basin there are more than 3 500 rivers and about 1 500 lakes.

The Chu River, the main river in the north of Kyrgyzstan, is formed by the confluence of the Kochkor and Dzhuvanaryk Rivers. The total area of the Chu basin is 68 000 square kilometres, with 57 per cent of this area in Kyrgyzstan and 43 per cent in Kazakhstan. The main tributaries of the Chu include the Chon-Kemin and Kuragaty Rivers. On the flatlands the riverbed divides into several branches: the Gulyaevskiye (Furmanovskiye) floodwater, the Ulanbelskiye floodwater which accumulate winter run-off and the Kamkalinskiye floodwater which accumulate spring run-off. The river flows into the Aschicol and Akzhaykyn lake systems. The watershed divide between the basins of the Chu River and Lake Issyk-Kul is vaguely expressed, and even in the 1950s floodwaters flowed along the Kutemaldy branch from the river into the lake. Currently, the Chu basin in Kyrgyzstan has 17 reservoirs with capacity of more than 1 million cubic metres, and Kazakhstan has 14 reservoirs with a total capacity of more than 5 million cubic metres.

The Talas River originates at the junction of the Kyrgyz and Talas ranges, flows through Kazakhstan and disappears in the sands of the Muyunkum. The total area of the basin is 53 000 square kilometres, 78 per cent of which is in Kazakhstan and 22 per cent in Kyrgyzstan. The main tributaries are the Urmaral, Kara Buura, Kumushtak, Kalba and Besh-Tash. The Talas River is formed by the confluence of the Karakol and Uchkosha rivers and flows in the direction of former Ucharalsky overflows where it divides into a number of branches, forming numerous lakes and wetlands with reeds. On the flatlands the Talas River has no tributaries and is intensively used for irrigation, forming a dense irrigation network; the remaining water is lost to evaporation and infiltration. Along the lower reaches of the river, within the Zhambyl oblast of Kazakhstan, there are estuaries covering 75 000 hectares.

Most of the mountain lakes are small waterbodies of glacial and rock-dammed origin. The largest lakes are Bilikol and Akkol (the Assa River flows through the latter); among the rock-dammed lakes are Kelukok, Kelkogur and Keltor. A large group of salt lakes is located in the lower reaches of the Chu River; the largest of them is Lake Akzhaykyn with the area of about 50 square kilometres.

Currently, the flow of the Chu and Talas Rivers is regulated in Kyrgyzstan by the Ortho-Tokoy and Kirov reservoirs.



Administrative divisions of the Chu and Talas River basins

National borders

Oblast borders

Talas — Oblast capital

Population density (inhabitants per km²): 1, 5, 50

Hydrography in the Chu and Talas River basins

- Hydrological stations
- Meteorological stations
- Reservoirs
- Water sampling
- Canals
- Lakes
- Glaciers
- Cropland
- Marshland
- Basin borders

Annual precipitation

Millimetres per year

200 300 400 500 750

0 50 km

Map produced by Zoï Environment Network, September 2013

Source: WorldClim (www.worldclim.org)

Water resources of the Chu and Talas Rivers

The main water source for the rivers of the Chu and Talas River basins is seasonal snow melt, with rain-water playing a secondary role. During low water periods, groundwater contributes to river recharge. The river basins are flooded in warm seasons. Annual average consumption of exploitable water resources in the upper part of the Chu River basin, taking into account sources of groundwater and return water, is 179 cubic metres per second, and in the Talas River basin 56 cubic metres per second.

Both basins have groundwater discharges that are formed in the lower part of the flow dispersion where groundwater is close to the surface. The total contribution of the groundwater discharge to the water balance is 41 cubic metres per second for the Chu River and about three cubic metres per second for the Talas River.

It is very important that the calculation of exploitable water volume takes into account drainage water from irrigated fields returning to the river network both over the surface and through recharging groundwater. The volume of return water is not constant and depends directly on the state of canals and irrigation systems, the availability and condition of the drainage network and the watering norms for the irrigated areas.

The Upper Reaches of the Ala-Archa River, the Chu River Basin, Kyrgyzstan

USE AND PROTECTION OF WATER RESOURCES IN THE CHU AND TALAS RIVER BASINS

At the state level, the Committee on Water Resources regulates water in Kazakhstan. The Committee covers eight basin inspections, including the Shu-Talas. The state programme documents include important Concept of Transition of Kazakhstan to a “green economy”, approved by Presidential Decree in 2013. The State Programme for Water Management in Kazakhstan has been prepared with estimated figures for individual water basins in the country. In 2007, specifically for the Chu and Talas River basins, research institutes of the Committee on Water Resources developed schemes of complex use and protection of water resources. Since 2011, the “Ak-Bulak” programme aimed at providing drinking water has been implemented; the programme is scheduled to run to 2020.

In Kyrgyzstan, the Department of Water Resources and Irrigation within the Ministry of Agriculture and Land Reclamation includes the Talas and Chu basin division of water management and subordinate enterprises. Public measures are supplemented by project activities with the participation of the international community. Reforms in the water sector heavily rely on the establishment of water user associations and the transfer of the management of irrigation networks to the associations. This process is assumed to continue until 2017-2018.

Hydrological study and monitoring
The basin hydrology is well studied despite the fact that the monitoring system does not meet all the recommendations of the World Meteorological Organization. By 2010 the number of observation points in the basins had been reduced to 16 in Kazakhstan and to 22 in Kyrgyzstan, so currently one point covers over 3 000 square kilometres. The reduction in the network is linked to the partial elimination of the hydrometeorological observation network, which, in turn, was caused by changes in the structure of government bodies and funding in the countries early in the period of independence.

Water user associations in Kyrgyzstan
After gaining independence Kyrgyzstan launched land and agrarian reforms that resulted in the dissolution of collective and state farms, and farmlands transferred to private ownership. The irrigation networks, previously owned by collective and state farms, became ownerless; instead of a single water user represented by a collective or state farm there appeared from 10 to 2 000 water users, thus complicating the operation of irrigation networks and water distribution among consumers. To solve this problem, water user associations have been created to assume control of irrigation networks, but the associations are encountering a number of financial, legal, organizational and personnel problems, hindering the regular operation and development of the network.

The associations are in the process of formation, so operations of the irrigation network are not yet fully functioning. Repair and maintenance of irrigation facilities require significant long-term investments, and the associations do not currently have the necessary funds. For the purpose of joint operation and maintenance of the canals of inter-farm value, the Federation of Water User Associations has been established, and is facing the same problems.

Economic problems resulted in declines in the supply of appliances, tools and other equipment for hydrometeorological stations and posts. Collection and exchange of data are hindered, and in Kyrgyzstan observation and forecasting functions are divided among multiple agencies, thus making coordination more challenging. In the last decade, however, efforts to restore the water resources monitoring system have been intensified.

To calculate the volume of run-off and to predict water volumes in the basin, it is very important to conduct observations on the state of glaciers, but, unfortunately, information about glaciers located in Kyrgyzstan is not current in most cases.

The shrinking of the network of hydrometeorological and glaciological observations in the basins has made it difficult to provide assessments of climatic and hydrological changes.

Use of water resources
Over the past 10 years, the volume of water intake in both countries has fallen by an average of 10 per cent, but no water deficit has been reported. The volume of return water has remained fairly stable in recent years.

Despite the fact that during normal water years there is no water deficit in the basin, the region experiences certain difficulties in water supply: lack of water in dry years, the poor state of irrigation canals and unauthorized water extraction cause problems with water supply for the systems of the Western Great Chuy Canal and the lower basin of the Talas River.

The regulation of flows of the Chu River between the two countries is an ongoing issue. Between 2006 and 2011 Kazakhstan often received less water than it required: the water supply was no higher than 90 per cent, and in dry years it was as low as 77 per cent. Seasonal distribution was also a problem. In normal and dry years, the bulk of water supplied to Kazakhstan comes outside the growing season, and in the growing season the country receives less than it is due.

In dry years, the use of water resources amounts to 100 per cent, especially in the Talas River basin. Importantly, the water basins are mainly used for irrigation (95-99 per cent), but due to the poor state of irrigation systems, water losses remain very high – 23 per cent of water intake in the Chu River basin and 27 per cent in the Talas River basin. These figures may not reflect the actual water loss, however, because in both basins there are problems in metering water taken for irrigation, and in the collection and compilation of data on the use of water for rural water supply, industry and utilities. In this regard, activities to improve metering of the volume of water withdrawn are to be implemented.

In the future, it is necessary to strive to ensure that the volume of river water intake in both the upper and lower parts of the Chu and Talas Rivers should not be increased. Currently, when water resources in these basins are not fully used, water requirements of natural systems are considered and ultimately can be met by reducing the consumption of water in agriculture (i.e., as a result of reduction of losses and the use of efficient irrigation methods).

From the ecological point of view, it is important to ensure the water quality of the Chu and Talas Rivers. Salinity in the Kyrgyz part of the Chu River basin is within accepted limits, as is the value of the BOD5 index for the city of Bishkek. Water pollution in terms of BOD5 in the Kazakh part of the basin is higher than normal, but its value is much lower than it was in the Soviet era. The Talas River is being polluted in both countries, but in the lower part of the basin most pollution comes from industrial sources.

International cooperation in the basins
The division of the flow of the Chu River between Kazakhstan and Kyrgyzstan is based on the "Regulations on the division of the flow in the Chu River basin" as of 24 February 1983 and the Protocol as of 18 February 1985, under which Kazakhstan receives 2 790 million cubic metres of water (42 per cent), and Kyrgyzstan retains 3 850 million cubic metres (58 per cent).

As for the Talas River, the division of water between Kazakhstan and Kyrgyzstan is based on the "Regulations on the division of the flow of the Talas River" as of 31 January 1983 and the Protocol as of 18 July 1983. According to these documents, the water resources of the Talas River to be divided in the Kirov reservoir total more than 1.5 billion cubic metres, and must be distributed equally.

In order to develop mutually beneficial cooperation in water use on a sound legal basis, in 2000 in Astana (Kazakhstan) an intergovernmental agreement "On the use of the interstate water facilities on the Chu and Talas Rivers" was signed. The agreement entered into force in 2002. The agreement provides for co-financing of the costs of operation and maintenance of the interstate water resources management facilities located on the territory of Kyrgyzstan. These facilities include the Ortho-Tokoy Reservoir, the Bypass Chuy reinforced concrete canals, the West and East Chuy canals with associated waterworks and the Chumysh hydro system on the Chu River.

To implement the agreement, in 2006 the Commission of the Republic of Kazakhstan and the Kyrgyz Republic on the use of the interstate water facilities on the Chu and Talas Rivers (ChTVK) was established. Among the main objectives of ChTVK are the organization and coordination of the activities for the implementation of the agreement; a comprehensive analysis and prediction of the state of transboundary water bodies; the coordination of limits, regulations and procedures of water consumption; the organization of joint actions in emergency situations; the exchange of hydrological forecasts; and the monitoring of water resources, etc. In addition, ChTVK regulates equity participation of the Republic of Kazakhstan in the maintenance of interstate water facilities. Efficient work of ChTVK is ensured by the establishment and functioning of its secretariat and five working groups.

During its work the Commission identified several shortcomings in the agreement, and as a result a number of amendments and supplements were introduced. In particular, the agreement does not provide for the financing of the Secretariat of the Commission, nor for simplified procedures for personnel crossing the border nor for exemption from customs duties and taxes of goods and transport approved by the Commission. In addition, there arose the need to expand the list of interstate water resources management facilities.

Another urgent issue – water quality in the transboundary basin – has not been resolved yet: the discharge of sewage water and water pollution by industrial enterprises significantly affect the quality of water in the rivers; this problem is particularly acute in dry periods.

During the implementation of the integrated water resources management policy in transboundary basins, the members of the Commission came to a decision about the need to develop a new draft agreement, and to create an Interstate Basin Council in the future. (Currently both countries have basin councils that can become a part of the future interstate structure). To facilitate the creation of a body to help coordinate the use and management of water resources, as well as to support the work of the Commission, a strategic paper, "Integrated water resources management in the basins of the Chu and Talas Rivers", has been prepared. This document is based on the principles of sustainable development, a basin and integrated approach to water resources management, public participation, as well as transparency and accountability in decision-making on water management.

To promote the cooperation between the countries, an action plan aimed at supplying irrigation water for irrigated land was to be developed and was to include a draft agreement for the division of waters of the Aspara River, exploring the possibility of feeding the Western Great Chuy Canal from mountain springs and construction of a seasonal reservoir on the Aspara. Construction of a seasonal reservoir on the Aspara River is under active discussion; the State programme titled "Management of water resources in the Republic of Kazakhstan until 2040" was developed and approved by the Government of the Republic of Kazakhstan.

A number of international organizations and technical assistance programmes of individual countries, including the Asian Development Bank, UNECE, OSCE, the Swiss Agency for Development and Cooperation, and others support the ChTVK activities.

With the participation and involvement of international organizations, bilateral technical assistance programmes and non-governmental organizations, a number of international projects working to solve the water problems of the region have been implemented and are still running in this area. These include:

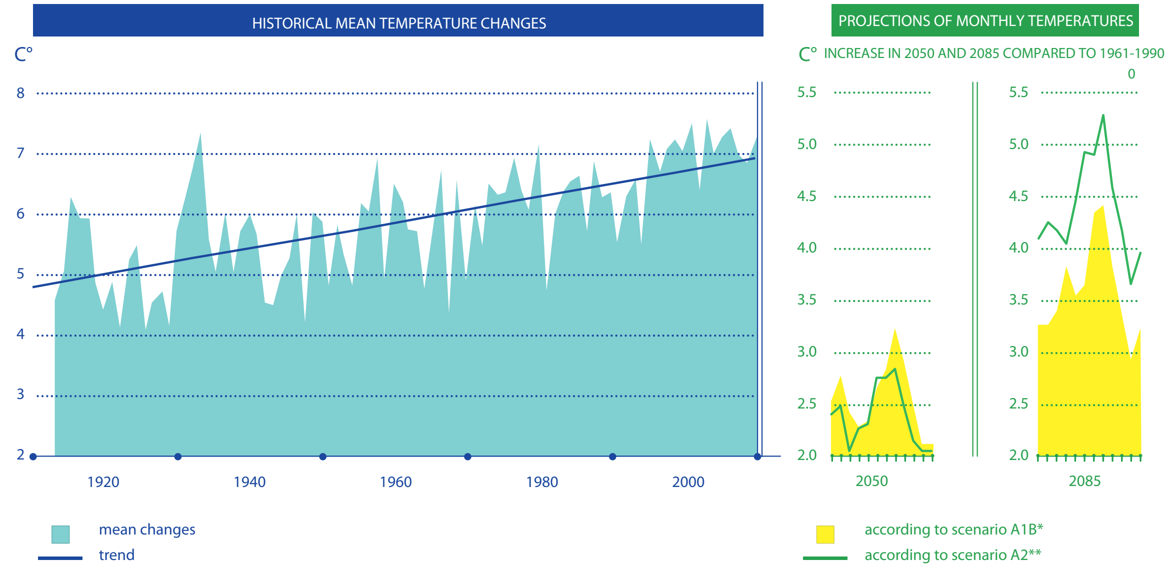
- "Support for the establishment of the Commission on the Chu and Talas Rivers between Kazakhstan and Kyrgyzstan" (OSCE, UNECE, UNESCAP, with the participation of the Russian-Estonian Centre for Transboundary Cooperation, 2003)
- "Improvement of water resources management in Central Asia" (Asian Development Bank, 2005-2008 (phase I), 2009-2013 (phase II))
- "Development of cooperation in the Chu and Talas River basins" (UNECE, OSCE)
- "Promotion of international cooperation on water resources management of transboundary rivers of Chu and Talas" (Swiss Agency for Development and Cooperation, 2009-2013 (phase I), 2014-2016 (phase II))
- "Strengthening cooperation on adaptation to climate change in the Chu-Talas Transboundary Basin" (Environment and Security Initiative, UNDP, UNECE, OSCE, 2010-2013)
- "Creation and maintenance of a database of land and water resources of the transboundary basin" (GIZ, 2013)
- "Dam Safety in Central Asia: Capacity Building for Regional Cooperation" (UNECE, 2007-2011 (II phase), 2013-2016 (III phase))

Arable farming in the upper reaches of the Talas River, Kyrgyzstan

CLIMATE CHANGE AND ITS IMPACT

During the period of instrumental observations from 1920 to 2010, the temperature in the basins increased, with the most dramatic rise observed in the last 20 years. The most significant increases in surface temperature were registered in February, November and March (the relatively cold period of the year), while the rise in temperature during the warm season was insignificant. Unfortunately, the observed trends do not coincide with the expected changes calculated on the basis of atmosphere-ocean general circulation climate models recommended by the Intergovernmental Panel on Climate Change (IPCC). It is difficult to determine if this discrepancy is due to deficiencies in the models or if observed trends will change dramatically in the near future. The inter-annual variability in growth has not been observed, moreover, it has consistently been reduced, which can be regarded as a positive factor in terms of the possible effects of climate change.

Temperature changes in the Chu and Talas River basins



Produced by Zoï Environment Network, 2013
Source: Hydrometeorological centres of countries

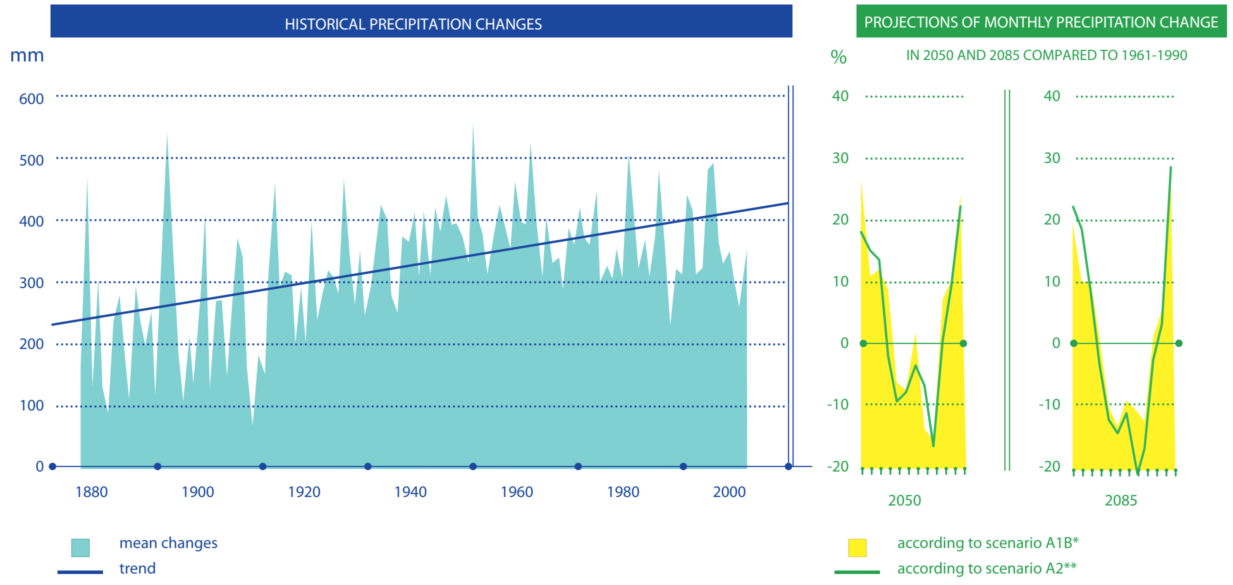
* scenario A1B – a balanced emphasis on all energy sources. The A1 scenario family is characterized by rapid economic growth, a global population of 9 billion by 2050, the quick spread of new and efficient technologies and extensive social and cultural interactions worldwide.

** scenario A2 – the A2 scenario family is characterized by a world of independently operating, self-reliant nations, continuously increasing population and regionally oriented economic development.

No unambiguous trend in rainfall is apparent. On average, in the basin during the period of instrument observations there was an increase in rainfall, which has been replaced by a slight reduction over the past 20 years. An analysis of the period from the 1940s to the present reveals that since the 1970s, the number of dry years has exceeded the number of wet years. The analysis of changes in different seasons shows a decline of traditional maximum precipitation in spring and autumn accompanied by an increase, though insignificant, in rainfall in winter and summer.

Experts in Kazakhstan and Kyrgyzstan describe the overall growth of aridity and the declining availability of water resources as the most likely and serious impacts of climate change in the basin. These changes are expected in the context of a significant projected increase by mid-century in the demand for water as a result of economic development and population growth.

Precipitation changes in the Chu and Talas River basins



Produced by Zoï Environment Network, 2013
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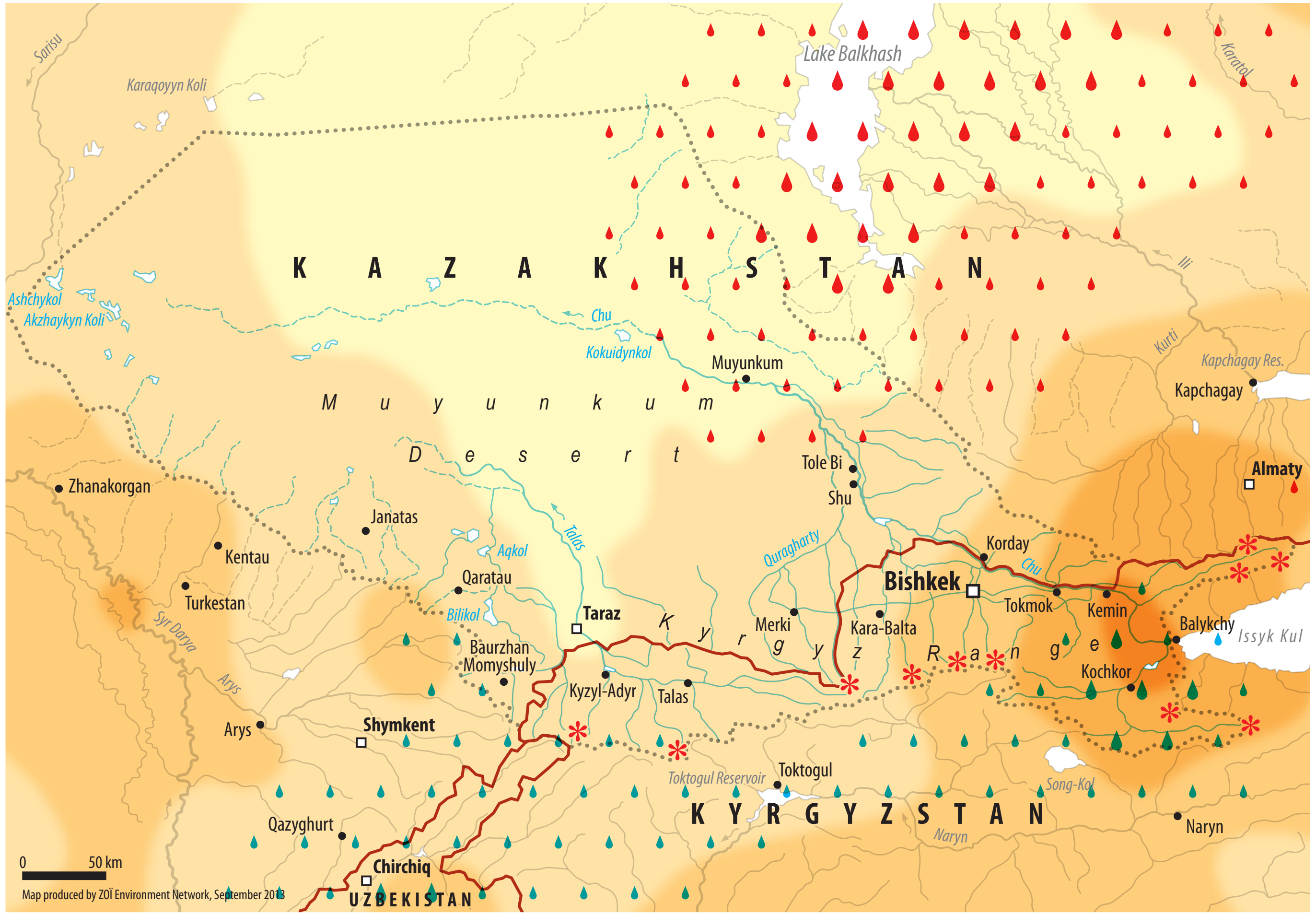


Synthesis of climate changes in the Chu and Talas River basins

Temperature change

1990-2002 compared to 1961-1990 (° Celsius)

+0.5 +0.6 +0.7 +0.8

Precipitation change

1990-2002 compared to 1961-1990 (%)

+10%

+5%

-5%

-10%

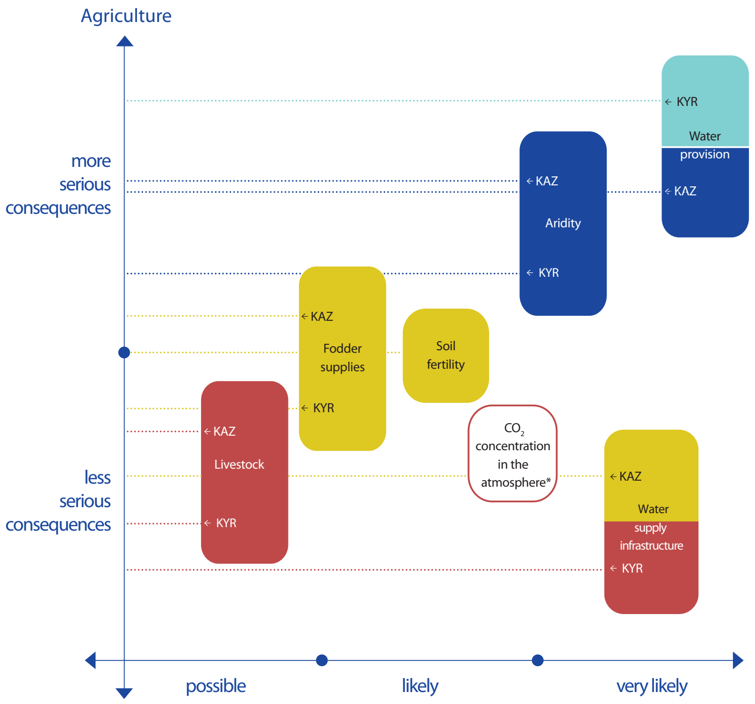
Melting of glaciers due to climate change

Basin borders

National borders

The Institute of Water Issues and Hydropower with the National Academy of Sciences of Kyrgyzstan investigated the possible effects of climate change on glaciers and surface run-off and made the appropriate calculations for the main river basins of Kyrgyzstan, including the Chu and Talas. According to the calculations, with the current level of precipitation (average for 1961-1990) glaciers in the Talas River basin will have disappeared by 2050, and as a result of the forecasted climate change, glaciers in both basins may be fully exhausted by 2100. Change in parameters of river run-off is likely to begin in the period from 2020 to 2030. (Calculations are based on worst-case scenarios of greenhouse gas emissions and models of climate change scenarios available at the time of calculation; thus the use of additional scenarios and current models would help clarify the results obtained).

Correlations between the probability and severity of problems and the potential for adaptation in the Chu and Talas River basins



Current adaptation potential:

- high
- medium
- low

* positive impact, adaptation action not needed

Produced by Zoï Environment Network, 2013
Source: experts' data

Flow change and food security in the Kyrgyz part of the basin

A quantitative assessment of changes in the characteristics of surface water resources in the Chu River basin from 1929 to 2010 was carried out for two cross-sections (in the village of Kochkorka and on the border with Kazakhstan). At the second point the annual consumption for the period varied from 62.8 to 99.4 cubic metres per second and has a slight tendency to increase. The water regime of the Talas River, especially below the town of Talas, is highly distorted due to intakes. Water use in the spring and summer months can be reduced to 1.5-3.0 cubic metres per second, while in autumn and winter the average water consumption index does not fall below 15-20 cubic metres per second; the long-term annual average water consumption rate for the Talas River is 46.3 cubic metres per second. Evaluation of surface water resources in the basin of the Talas River for the period from 1930 to 2010 showed that the volume of flow has a slight tendency to increase.

To calculate the amount of water required to ensure food security in the most populous Kyrgyz part of the basin, four options for the conditions have been considered:

1) The provision of food from the basin's own resources
2) Option 1 with export of surplus production
3) Option 2 without importing of substitute products
4) Option 2 with importing of substitute products

For each of these options, calculations of water requirements in the case of temperature increases by 2100 of 4.0°C and 6.4°C have been made.

For the first option, when the temperature rises by 4°C, the actual shortage of water resources in the Chu River basin by the beginning of 2040 will be about 135 million cubic metres, and when the temperature increases by 6.4°C, this figure will be about 285 million cubic metres. Results for the remaining three options are presented on the graphic on page 32.

On the basis of the predicted water consumption, an economic evaluation of changes has been carried out. So, for example, in the Chu River basin, according to the forecast, by the beginning of 2040 the damage for the first option, in the view of growing population, will be about US $10 million, when the temperature rises by 4°C, and twice this figure when the temperature rises by 6.4°C.

Since all calculations were made for the existing limits of water consumption and water systems and contemporary agricultural output, it can be assumed that water shortages may occur earlier.

Forecast of water consumption in the Kazakh part of the basin

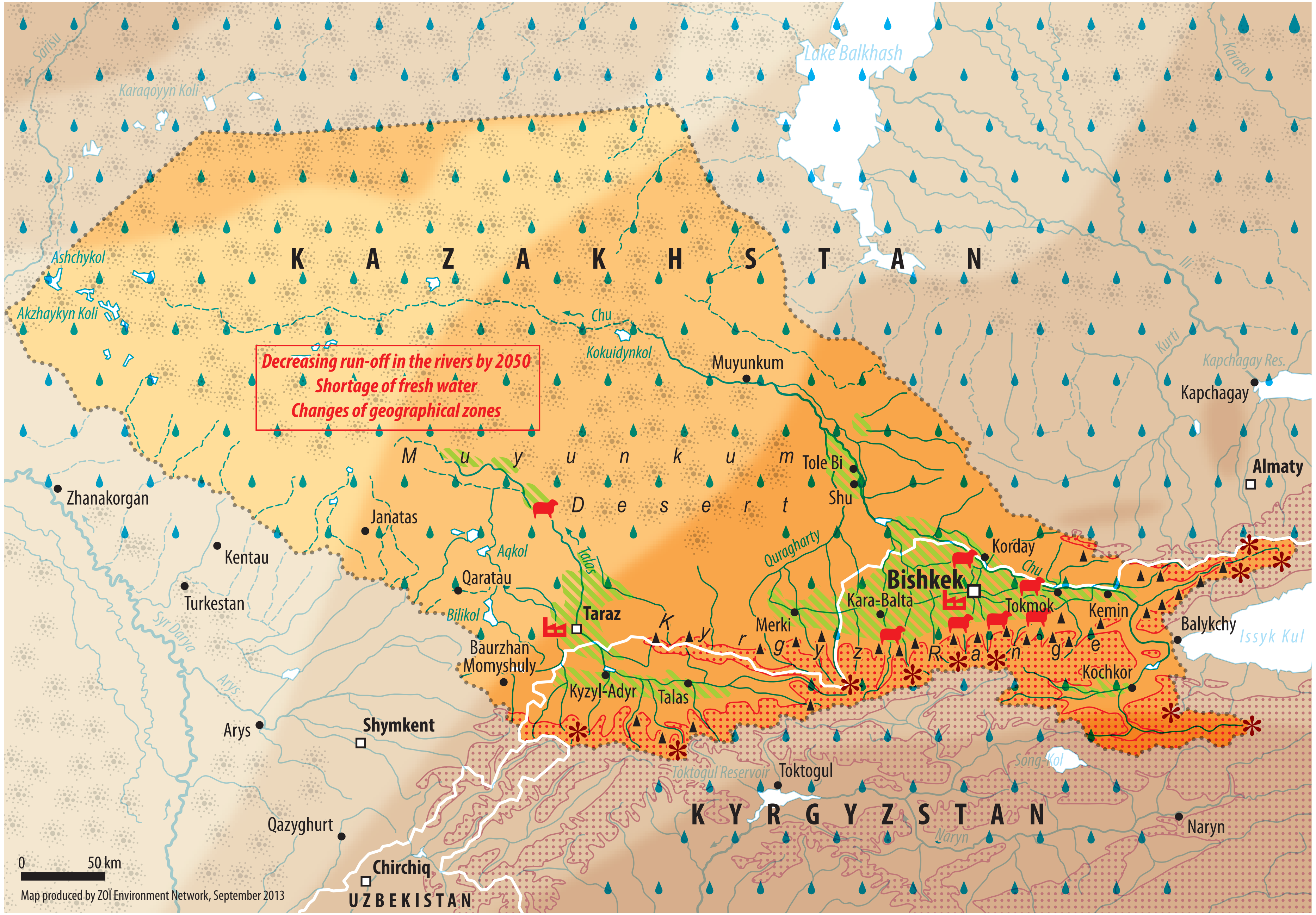
The water consumption forecast till 2020 foresees in the Kazakh part of the Chu River basin an increase of water withdrawal up to 1.195 billion cubic metres, and in the Talas River basin up to 1.048 billion cubic metres. Ensuring adequate environmental flows will require a reduction in the amount of water used in agriculture. According to the State Programme of the Republic of Kazakhstan on Water Management, even without climate change impacts, a water deficit of 1.7 billion cubic metres per year is expected. The consequences of climate change can exacerbate the projected water shortages.

It is assumed that by the 2080s, with an increase in temperature by 2°C, the moisture coefficient will be reduced from 0.24 to 0.18 or even lower. In such a scenario, by 2030-2050 the water necessary to irrigate one hectare (irrigation net rate), will increase depending on the crop by 200-400 cubic metres, and by 2085 it will increase by additional 200-400 cubic metres. Given that the current coefficient of performance (COP) of irrigation systems is about 0.5, it can be expected that after improvement of irrigation methods and introduction of more careful use of water (using advanced irrigation methods, such as sprinkling, the subsurface and ridge method and drip irrigation) the COP of irrigation systems will be:

- In 2030: 0.58-0.62 with consumption of 8 100 cubic metres of water per hectare
- In 2050: 0.66-0.70 with consumption of 7 400 cubic metres of water per hectare
- In 2085: 0.80 with consumption of 6 800 cubic metres of water per hectare

These figures can be compared with 2010 water consumption, which amounted to about 10 000 cubic metres per hectare.

The analysis and forecasts of the development of irrigated agriculture in the Zhambyl oblast in Kazakhstan (the boundaries of the Chu and Talas River basins basically coincide with its borders) considered the following parameters: the required water resources and their transboundary nature; ensured food security in the region; the need to maintain soil fertility with mandatory introduction of crop rotation; and the creation of highly profitable agricultural production. Possible impacts of climate change were not considered in the calculations. Diversifying industry, improving farming culture, implementing up-to-date water-saving and resource-saving technologies in production and using new, as well as currently unused irrigated land, are expected to achieve a reduction of 20-30 per cent in water intake for irrigation from natural water bodies and to bring the share of groundwater and drainage water for irrigation to 20 per cent of total water consumption. These steps are also expected to reduce irrigation norms by up to 7 100 cubic metres of water per hectare and to improve the efficiency of irrigation systems and methods by up to 0.75-0.80, and to increase yields of irrigated crops by a factor of 1.5-2.3. Such measures as those described above reduce vulnerability to climate change and serve also adaptation to it.



Synthesis of climate projections and impacts in the Chu and Talas River basins

Projected temperature change

2050s compared to 1961-1990 (° Celsius)

+2.8 +2.9 +3.0

Projected precipitation change

2050s compared to 1961-1990 (%)

+10%

+5%

Basin borders

National borders

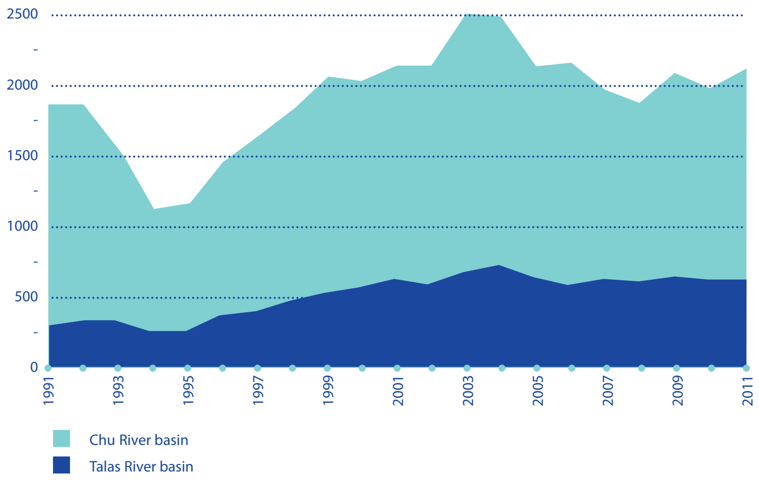
Even though precipitation is projected to increase, the effect of higher evapotranspiration due to higher temperatures will lead to a more arid climate.

Source: ClimateWizard (www.climatewizard.org)

Model for temperature and precipitation change:
IPCC Fourth Assessment
Emission scenario: Medium A1B
General circulation model: Ensemble Average

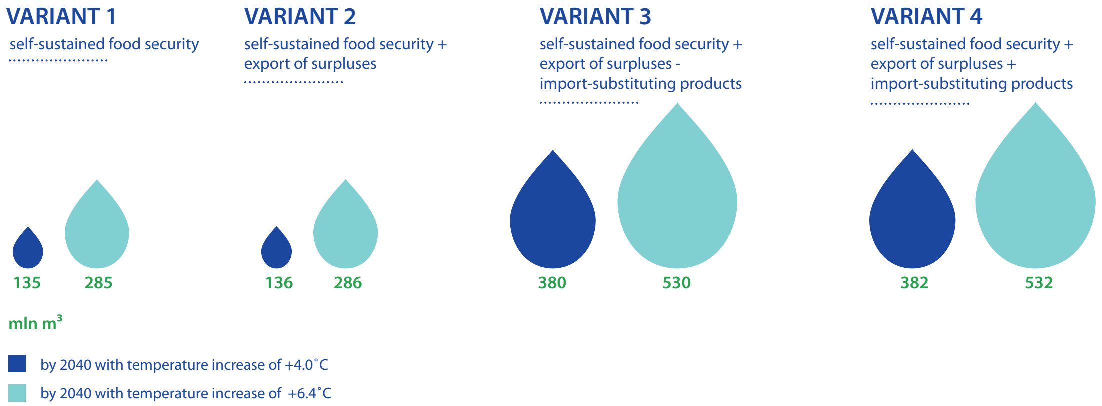
- Melting of glaciers due to climate change
- Shortage of water resources by 2050 for industry
- Shortage of water resources by 2050 for agriculture
- Decrease in productivity of forests
- Decrease in productivity of pastures
- Decrease in snow cover (territories over 2 500 metres)
- Increase in desertification

Main agricultural production



Produced by Zoï Environment Network, 2013
Source: statistical data

Projections of water shortages for agriculture in Chu River basin by 2040



Produced by Zoï Environment Network, 2013
Source: experts' estimates

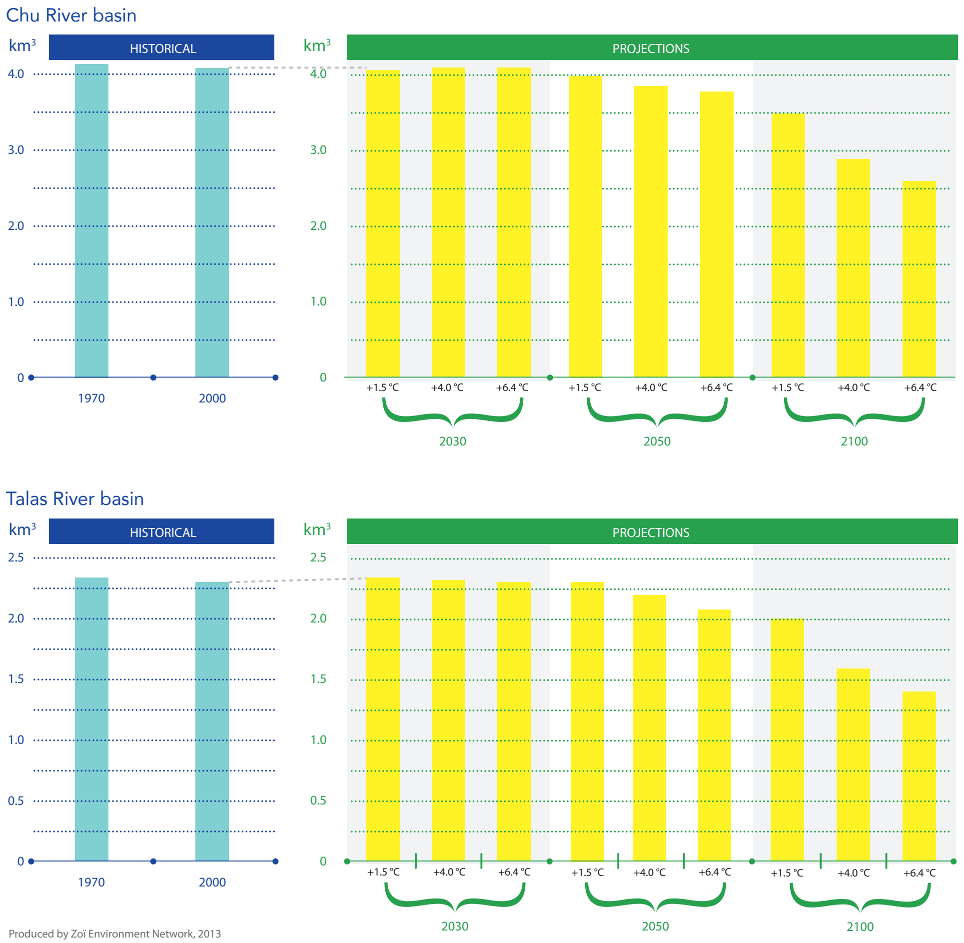
Climate change may affect the number and severity of associated natural disasters such as mudslides, floods, landslides, avalanches, water-logging, torrential rains, drought, hurricanes, hail and heavy snowfall. In areas with insufficient water, extreme adverse events are observed in dry years. In spring and summer, during the snowmelt and after heavy rains on the mountain rivers of the Chu and Talas basins, dangerous floods and mudslides can form. The main factors contributing to the formation of debris flows can be divided into landscape-climatic, geological and geomorphological, and anthropogenic. The latter include deforestation, overgrazing, the plowing of slopes, and the effects of mining, road construction and civil engineering.

Currently, due to insufficient environmental flows of water in the lower reaches of the Chu and Talas Rivers (Kazakhstan), irreversible processes related to desertification and its consequences are under way. It is necessary to develop specific and comprehensive measures to ensure the availability and regulation of water in the lower reaches.

Unfortunately, there is no long-term data on natural disasters, and therefore it is difficult to analyze, let alone, predict its dynamics. Other types of damage resulting from climate change may include damage from changes in the boundaries of geographic areas.

In Kyrgyzstan, there have been several studies of economic losses from climate-related natural disasters. According to various sources (World Bank, Emergency Ministry), in 2005 the average damages from mudslides came to about US $135 000; from floods, more than US $100 000; from landslides, more than US $70 000; and from avalanches, more than US $120 000. Using the above data, we can determine that the increase in the total damage caused by climate-related disasters, as the temperature rises by one degree Celsius, will be over US $3 million. It should be noted that only the direct damage was being assessed.

River flow projections for the Chu and Talas under different warming scenarios for 2030, 2050 and 2100



Produced by Zoï Environment Network, 2013
Source: Institute of water and hydropower of the Academy of Science of the Republic of Kyrgyzstan

Glaciers in the Chu River basin, Kyrgyzstan

RECOMMENDATIONS AND SUGGESTIONS REGARDING CLIMATE CHANGE ADAPTATION MEASURES

The efficient use of water resources, especially in the projected conditions of the decline in river flows, affects the livelihoods of about 3 million people in both republics, so measures aimed at saving water are vital.

Within the "Strengthening cooperation in adaptation to climate change in transboundary basins of the Chu and Talas Rivers" project, a joint coordinated analysis of climate change trends has been carried out for the first time. The results of the analysis have provided the basis for planning the joint efforts of Kazakhstan and Kyrgyzstan on adaptation to climate change in these river basins.

Adaptation measures, shown in the table, have been prepared with the help of the UNECE Guidance on Water Resources and Adaptation to Climate Change and "Guidance on Water and Adaptation to Climate Change" publication (2009). They were discussed with experts at a seminar in the city of Bishkek in February 2014 and were finalized following this discussion. The most urgent measures are highlighted ** and less urgent *.

Research, monitoring, data exchange and demonstration projects on climate change and resource conservation in the region

** Develop and implement a water-balance and hydrological basin model that takes into account the impact of climate change on socio-economic development, the provision of water and water security

** Open the databases and the results of the climatic and hydrological data, models and scenarios for public use, and further develop the knowledge base

** Optimize and automate the network of observation stations and monitoring points for climate, water resources and glaciers

** Implement a demonstration project for the study of local opportunities and measures to conserve water and soil and for improvement of water metering; promote the widespread adoption of such projects

* Enhance the reliability of weather forecasts, and improve agrometeorological services and methods of informing users

* Promote the development of services and access to electronic information, including the web portal of ChTVK

Raising public awareness about climate change and integration of relevant issues in the plans and activities of the Chu-Talas Commission and countries

** Communicate the results of projects and research and climate change issues in the Chu-Talas basin and exchange experience with other countries and river basins

** Strengthen the cooperation with the developers of industry strategies for adaptation to climate change in the countries and the region as a whole

* Gradually integrate climate change scenario data into the planning for the use of water in a transboundary context

* Participate in regional and international forums on climate change and water-basin cooperation

* Conduct information campaigns on careful and rational use of water, and provide training on climate change issues at the local level

Reduction of damage from extreme floods, water shortage (drought) and other severe weather events

** Conduct assessments (modelling) of parameters (or variables) of extremely high and low water availability, taking into account climate change and vulnerable infrastructure

** Improve early warning for dangerous events and forecasts of hydrometeorological phenomena, and facilitate the exchange of information between the countries and the dissemination of information among the major users

** Provide for mutual sharing of information about the danger of floods and droughts, and coordinate the adoption of measures to protect the population and infrastructure

* Provide adequate insurance against the risk of hazards to farmers and water organizations

Interstate interaction and cooperation on adaptation and improvement of resilience to climate change

** Capitalize on synergies and mutual benefits for the river basin from implementation of national strategies and projects on climate change

** Integrate important climate change adaptation parameters into regional projects on water resources, agriculture and water supply

** Estimate the cost and cost-effectiveness of adaptation measures and the possibility of sharing costs and benefits between the countries

* Update and enforce the rules of operation of interstate water facilities in view of climate change

Enhancing efficiency of the use of water resources in agriculture

** Improve the efficiency of irrigation water use by implementing available methods for accounting, planning and regulation and by strengthening water user associations

** Increase the yield from irrigated land through crop rotation, diversification of cultivated products, the use of high-yielding[1] varieties adapted to climate change, efficient tillage and the selection of appropriate fertilizers

** Attract financing and micro-credits for the introduction of water-saving technologies on irrigated land with severe water shortages

Protection of water ecosystems and the part of the basin where the flow is generated, and ensuring water quality

** Develop scenarios of combined pressure on water ecosystems (human activities + climate change) and, based on the above, adjust the development plans

** Provide the necessary level of protection of river and mountain ecosystems to maintain the ecology of rivers, water quality and minimum ecological flow, as well as to reduce the risk of floods and droughts

* Strengthen and, where appropriate, harmonize regulatory documents concerning water protection zones and the efficiency of enforcement

[1] Precautions and assessment of risk should be in place when introducing GMO varieties

Agro-technical adaptation methods	*Long-term investments in improving resistance to climate change in densely populated areas of the Chu-Talas basin*
** Familiarize farmers with regional and international experience of sustainable agriculture, and facilitate participation and provide training in land-use methods and sustainable agriculture ** Introduce soil conservation technologies for the tillage of rain-fed and irrigated soils and for locally adapted and international varieties ** Monitor the status of soil fertility and geo-botanic and soil surveys * Introduce agro-climatic zoning, taking into account the preservation of local crops and integrated landscape planning * Promote the effective protection from pests and diseases[2]	** Modernize and increase the safety of dams, existing reservoirs and riverbank constructions, and reduce the level and intensity of siltation on the basis of projected climate change ** Modernize the main and on-farm irrigation networks in order to reduce water losses, based on the forecast of water volumes of the main rivers in the basin ** Introduce automated accounting and water distribution systems and the principles of integrated water resources management throughout the basins ** Rehabilitate saline and abandoned land (chemical and biological reclamation), and promote the recovery of natural floodplains and riverbeds * Construct[3] water regulating facilities (reservoirs, canals, pumping stations) to improve water security under the conditions of climate change

[2] With the use of current and environmentally friendly methods and means

[3] In a coordinated approach between the countries

The analysis shows that the two countries still have differences in the economic assessment of water data and in determining the trends in water use in the basin. To ensure the proper planning of joint actions on adaptation, it is essential to harmonize economic information, as well as the forecasting and analytical methods related to water resources.

Joint monitoring, data comparability and bringing methodology and standards to the international level will help improve the accuracy of data on the quantity and quality of water resources, and help develop mutual trust between the Kyrgyz Republic and the Republic of Kazakhstan.

One of the important recommendations for the Chu-Talas Basin Commission based on the results of the work is to organize and lead the development and implementation of specific adaptation measures to climate change in the basins, including the principles of integrated water resources management in transboundary basins.

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