Shamil Iliasov (Climate change centre, Kyrgyz Republic), Svetlana Dolgikh (Hydrometeorological Service, Republic of Kazakhstan), Annukka Lipponen (United Nations Economic Commission for Europe, Switzerland), Viktor Novikov and Lesya Nikolaeva (Zoi Environment Network, Switzerland)

Projected impacts of climate change on hydrology, water resource use and adaptation needs for the Chu and Talas cross-border rivers' basin, Central Asia

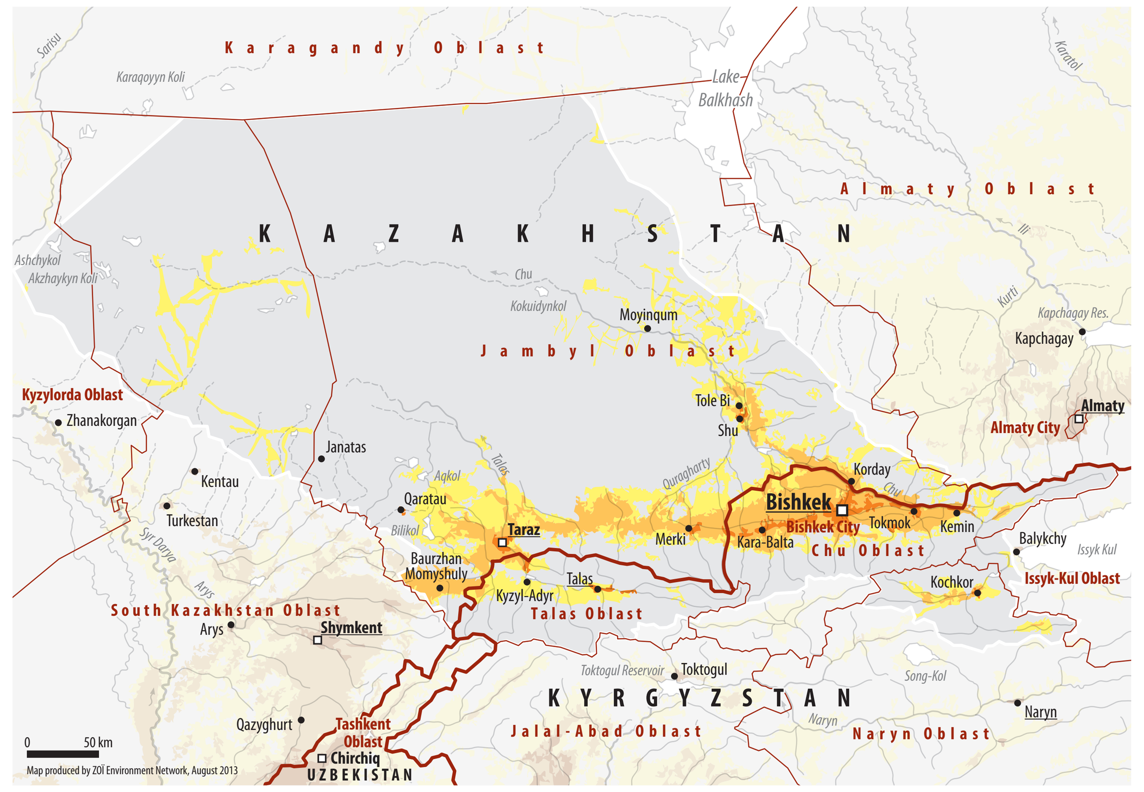
INTRODUCTION

The transboundary Chu and Talas Rivers, with total annual discharge of some 8 km^3, originate in the mountains of Kyrgyzstan. The main water source is seasonal snowpack but glacial melt also contributes importantly to the flow. Exposure to climate-induced extreme events, dependence on natural resources and low adaptive capacity all make the region vulnerable to climatic variability and change.

Kazakh and Kyrgyz scientists working under the United Nations Economic Commission for Europe and the United Nations Development Programme project "Promoting Cooperation to Adapt to Climate Change in the Chu and Talas Transboundary Basin", produced for the first time a comprehensive assessment of climate change impacts on water resources in the Chu and Talas river basins. The cooperative approach combined scientific data and water practitioners' views with decision-making needs, and resulted in the identification of future needs and the development of an initial set of adaptation measures and recommendations.

Geography of the Chu and Talas river basins

Basin borders
National borders



Administrative division and population density in the Chu and Talas river basins

National borders
Oblast borders
Oblast capital
Basin borders
Population density (inhabitants per km^2)

METHODS

Using a common approach for the Kazakhstan and Kyrgyzstan parts of the basins, scientists analysed the observed long-term trends, variability and projections of future climate and hydrology of the Chu and Talas river basins, and then elaborated the historical, current and forecast demands and main uses of water in the basins.

Climate change projections, including air temperatures and rainfall, were determined for the basin area with a spatial resolution of 0.5 degrees based on the integration of 15 climate change model outputs (derived from the IPCC Fourth and Fifth Assessment Reports) for three 30-year time periods with midpoints in 2030, 2050 and 2085. The scientists selected two IPCC emission scenarios – A2, characterized by relatively slow technological change, introduction of renewable and energy efficiency improvements, and A1B, assuming a balanced mix of technologies and energy supply sources, with technology improvements. The project assessed the combined effect of changes in temperature and precipitation regimes using the ratio of precipitation to evapotranspiration. Impacts on glaciers and on surface water flow were modelled in the Kyrgyz part of the basin, where the flow is generated, using locally designed hydrology and glacier models. The hydrological models (DMR and DMHum; Kuzmichenok 2003) took into account topographical features and moisture conditions (500 m cell size). The project also reviewed the current use of water resources, agricultural policies and local economic patterns and used demographic and other factors to predict future water demand.

KNOWLEDGE GAPS AND RESEARCH NEEDS

The Kazakh-Kyrgyz research cooperation in the framework of the project led to the greater exchange of information and expertise. Notably, it contributed to the preparation of the National Communications under the United Nations Framework Convention on Climate Change. The project also provided insights for preparation of sectoral action plans for climate change adaptation in Kyrgyzstan.

Several areas emerged as areas of future research needs.

The impacts of climate change on groundwater have not been assessed. Groundwater was not taken into account in the hydrological modelling, as there was no adequate monitoring or other information available, but including groundwater could influence the modelling results. Nor did this project examine the impact of changing climatic conditions on water-related disasters and hydrological extremes.

Additional aspects that were identified as meriting further study include soil fertility, the effects of increasing aridity on yields of major crops, fodder crops (due to the importance of animal husbandry), and the ecological state of water resources.

This research would benefit from a consideration of the conclusions and the new generation models of the IPCC Fifth Assessment Report, and from broadening and extending the assessment of vulnerability.

An economic study of the prioritized adaptation measures in terms of costs and benefits would allow comparisons and the identification of appropriate actions to increase resilience to climate change.

RESULTS

Observed historical changes

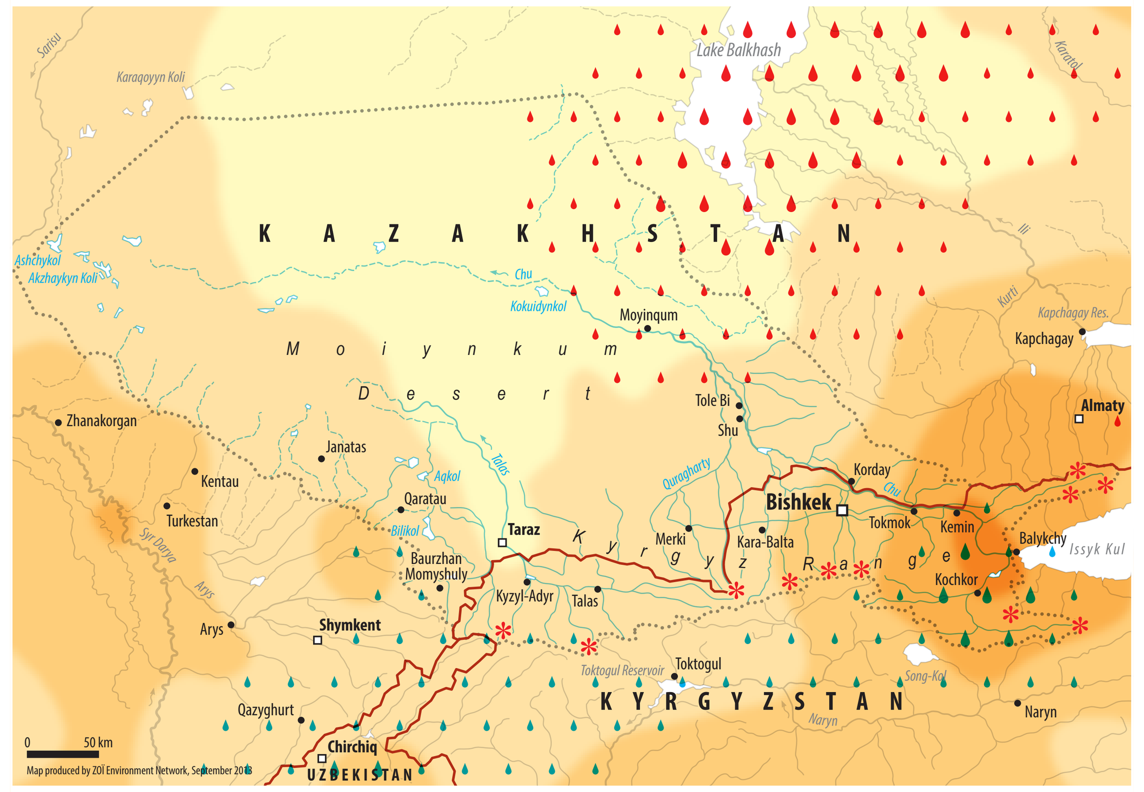
Growth of the average annual air temperatures in the Chu and Talas basins for the period of 1941-2009 reached 0.30°C per decade. In the last thirty years, the growth in average annual air temperature was significant – at least 0.4°C per decade, with the most significant rate of increase seen in spring temperatures, and the lowest in the summer.

Historically, annual changes vary considerably. The observed changes in the rainfall in the basins for 1936-2005 include an increase in the intensity of rainfall in some areas. The maximum length of rainless periods decreased in almost the entire basin area.

A slight increasing trend in total river flow in the Talas can be observed from 1930 through 2010, mainly over the last two decades.

Predictions

Within the range of scenarios selected, a significant increase in surface air temperatures of 3-6°C may be expected in the basin area by the end of the century, especially in summer and autumn. This change is likely to be accompanied by an increase in rainfall during the cold season and a decrease in the warm half of the year. Mountains will likely receive more rain than snow due to the milder winters, while the area and volume of glaciers is predicted to decline. The precipitation change scenarios contain a great deal of uncertainty. Nevertheless, even if the predicted inter-annual change in total precipitation is small, the increase in temperature may result in a deterioration of moisture conditions during the summer-autumn period. The increased river flow is likely till 2020-2030. Subsequent average flow reduction and seasonal hydrology change is projected by 2080: for the Chu river from 4.1 to 3.4 km^3 per year, for the Talas river from 2.3 km^3 to 1.9 km^3 per year.



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

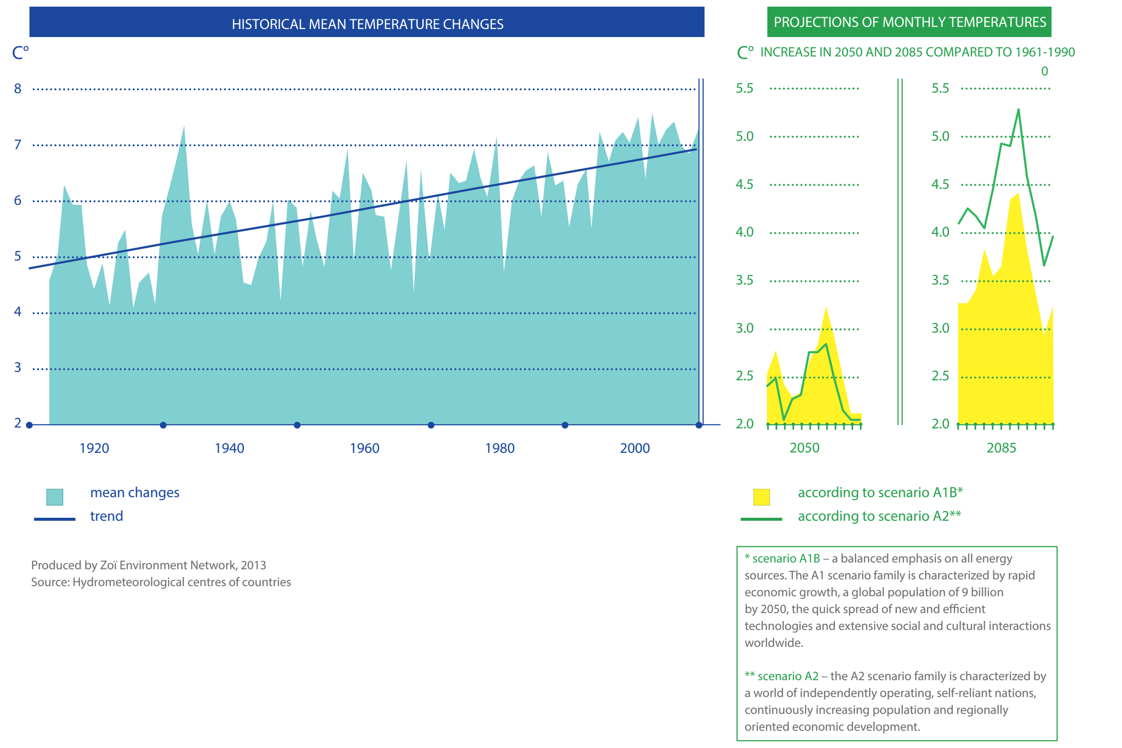
Precipitation change
1990-2002 compared to 1961-1990 (%)
+10% +5% -5% -10%

Melting of glaciers due to climate change
Basin borders
National borders

Source: ClimateWizard (www.climatewizard.org)

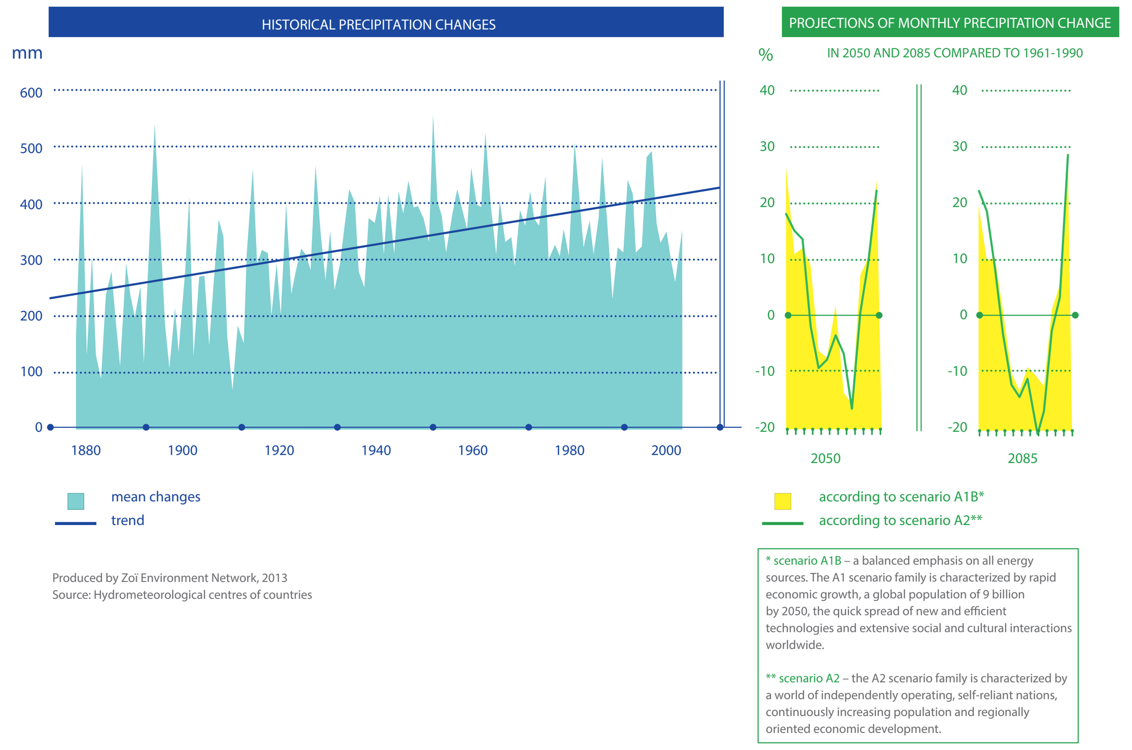
According to emission scenarios A1B and A2, projected warming for 2085 compared to the reference period (1961-1990) is expected to be significant in all months, probably with highest rates in summer.

Temperature changes in Chu and Talas river basins



Precipitation is projected to increase most during the winter months and decrease during the warm part of the year under the A1B and A2 IPCC SRES emission scenarios. But the recently released IPCC Fifth Assessment report with new regional climate change scenarios suggest that some increase in precipitation is likely from April to September (RCP 4.5). As climate change knowledge and projections evolve, findings may change.

Precipitation changes in the Chu and Talas river basins



PRACTICAL RELEVANCE

Current water management challenges in the basins include a degraded condition of the irrigation systems and a difficult regional economic situation that precludes significant investment in infrastructure development. Most of the water use (>90%) is for agriculture, where the current water-use efficiency is low and losses are high.

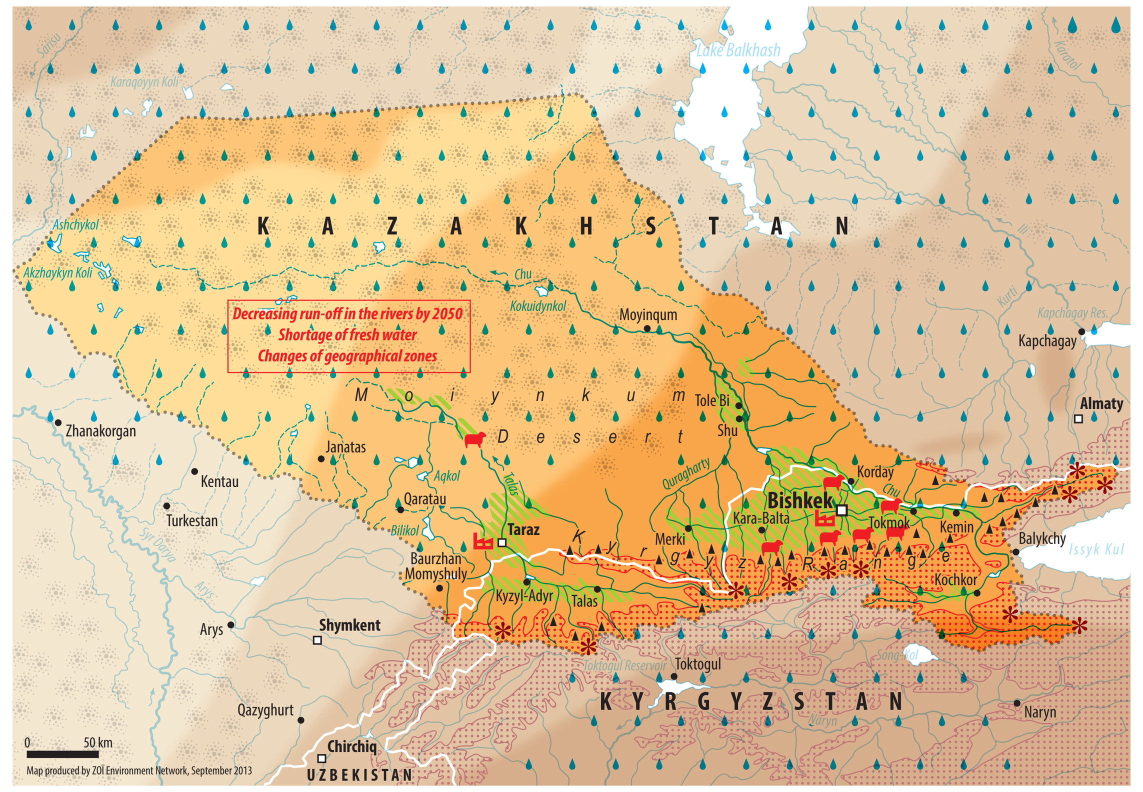
Effective management of these transboundary basins calls for dialogue, cooperation and coordination between the countries to avoid the potential negative effects of unilateral action. The inter-State allocation of waters of the two rivers was agreed in 1983, and a bilateral Kazakh-Kyrgyz Commission in 2006 established the use of shared water management infrastructure to implement the present inter-State agreement (2000).

Water deficits are already occurring, mainly because of the water use for irrigation: In the basin of the Talas, in years of low water availability, all water is used. In the Chu basin, predicted water availability decreases are expected to lead to water security concerns.

The vulnerability assessment suggests that climate change stress on water resources could be significantly relieved by improving water use efficiency in irrigated agriculture, the broad introduction of the integrated water resource management approaches in the transboundary basin, improved agrometeorological and hydrological services and the training of farmers and other key water users. River ecosystems and river-dependent communities, especially in the downstream part of the Chu and Talas rivers will benefit from securing the "ecological" flow – a minimum acceptable discharge to sustain ecosystem.

The vulnerability assessment of the agricultural sector, which is the key water user in the basin, led to identification of potential adaptation measures, which were discussed with relevant authorities and stakeholders. The proposed adaptation measures range from technical to policy and financial measures, among others. The technical measures include rehabilitating irrigation systems to reduce water losses, modernizing water reservoirs and adjusting river regulation to environmental flow needs, changing of land use and diversifying crops. The policy and financial measures include, for example, a revision of subsidy practice.

Future plans, especially those with a long-term horizon, should take into account the projected climate change implications for river hydrology and those sectors of the economy dependent on water use. A management approach that prepares for changes and copes well with the variability would be of value.



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%

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

Basin borders
National borders

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

Source: ClimateWizard (www.climatewizard.org)