Kyrgyz Republic

UN environment programme



Atlas
of environmental change

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ISBN: 978-92-807-4211-4
Job number: ROE/2693/GA
DOI: https://doi.org/10.59117/20.500.11822/47208

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Recommended bibliographic reference:
United Nations Environment Programme (2026). *Atlas of Environmental Change – Kyrgyz Republic. Geneva.* https://wedocs.unep.org/20.500.11822/47208

Suggested citation
United Nations Environment Programme (2026). *Atlas of Environmental Change - Kyrgyz Republic. Geneva.* https://wedocs.unep.org/20.500.11822/47208
Production: Geneva
URL: https://www.unep.org/resources/report/atlas-environmental-change-kyrgyz-republic

Approved for publication by the Academic Council of the Institute of Geography of the Russian Academy of Sciences.

ATLAS OF ENVIRONMENTAL CHANGE



KYRGYZ REPUBLIC

Geneva – 2026

UN environment programme

INSTITUTE OF GEOGRAPHY
Russian Academy of Sciences

Founded in 1918

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION INSTITUTE OF GEOGRAPHY OF THE RUSSIAN ACADEMY OF SCIENCES (IG RAS)

FEDERAL STATE BUDGETARY EDUCATIONAL INSTITUTION OF HIGHER EDUCATION «LOMONOSOV MOSCOW STATE UNIVERSITY»,
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Imagery from the Russian segment of the International Space Station (ISS):
Ph.D. L.V. Desinov, I.L. Ivonin.

Acknowledgement:
Amanaliev Mars Kydyrgychevich – Head of the Ozone Center of the Kyrgyz Republic;
Kydyrmyshev Ernst Borukchuevich – Deputy Director of the State Enterprise «Kyrgyzgiprozem» under the Plant Protection Department under the Ministry of Agriculture of the Kyrgyz Republic;
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Shaydyldaeva Nargiza Myktybekovna – GIS specialist of CAIAG;
Bekbosun uulu Joldosh – GIS Specialist, Junior Researcher, Forest Research and Production Center, Institute of Biology of the National Academy of Sciences of the Kyrgyz Republic;
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Foreword: Atlas of Environmental Change for the Kyrgyz Republic

The Atlas of Environmental Change for the Kyrgyz Republic has been developed using global, regional and national datasets spanning six decades and has combined both historical information and the latest satellite technology. The Atlas provides detailed information on the Kyrgyz Republic's environment, focusing on terrestrial and aquatic ecosystems, in the context of progress towards fulfilling the goals of the three Rio Conventions as well as SDG6 and SDG15.

The information contained within the Atlas can assist the Kyrgyz Republic to monitor the environment and provide reports in accord with existing Multilateral Environmental Agreements (MEAs) as well as meet national state of environment reporting needs. It also provides a solid evidence base for policy and decision-makers to manage the environment sustainably.

The Atlas is underpinned by datasets sourced from global, regional and national institutions and has been made available to the government through a Geoportal, allowing the information to be continually used and updated based on national priorities.

The environmental changes impacting our world today are evident in the Kyrgyz Republic. Over the past sixty years, the average annual temperature in the country has increased by 1.2°C compared to a global average of 0.6°C, a rate of increase that is expected to accelerate in the coming decades. On average, 200 emergencies are registered per year, 90 per cent of which are of a natural origin such as flooding, earthquakes, mudslides, rockfalls and avalanches. In 2022, natural disasters took the lives of almost 150 people and, between 2012-2018, resulted in annual average economic losses of USD 27 million.

Given that water resources are one of the most important and vulnerable components of the natural environment, the rational use of these resources and the preservation of water quality are crucial for human well-being and sustainable development. Notably, water resources are the backbone of the Kyrgyz Republic's energy sector, with up to 93 per cent of electricity generated by hydropower plants. Policies which support greater local stewardship and transboundary cooperation, such as Integrated Water Resources Management, have been proven to help manage water resources effectively.

As a global hotspot in terms of biodiversity, another of the Kyrgyz Republic's natural treasures is its wildlife. In 2000, protected areas (PAs) made up only 0.5 million hectares of the country, increasing to 1.5 million hectares by 2023. The national system of PAs includes 10 reserves, 13 national parks, 19 natural monuments and 45 botanical, forest and zoological reserves. By 2040, PAs are planned to cover 10 per cent of the country and protect 60 to 65 per cent of the republic's species that are included in the Red Book of the International Union for Conservation of Nature (IUCN).

While the high mountains that are home to some of these species have limited viability as arable land, agriculture plays a very important role in the economy, accounting for 12 per cent of GDP. Around two thirds of the population live in rural areas and is completely dependent on the produce from their household plots.

All the forests in this mountainous country are legally protected from industrial logging. Since 2000, forest cover has increased from 6.2 per cent to 6.9 per cent of the Kyrgyz Republic's total area due to afforestation. As such, now the main threats to forest ecosystems are related to illegal logging and unregulated grazing in walnut forests.

Understanding environmental change is the first step toward action. The Atlas not only documents these transformations, it also highlights opportunities for restoration, conservation, and sustainable management of natural resources.



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Executive Summary

The project to create digital online environmental atlases of change in Central Asia for three target countries – Kyrgyzstan, Tajikistan and Uzbekistan – aims to harmonize national statistical systems for use in the preparation of national reports to the secretariats of four key environmental global agreements – the UNCCD, UNFCCC, UNCBD and SDGs (water, life on land) – in accordance with international standards. Harmonization of approaches to data collection and processing should contribute to the fulfillment of international obligations in the field of environmental protection by these countries.

For Kyrgyzstan, as is the case with all Central Asian countries, the state of water resources is a key factor in sustainable development. For most of the SDG indicators related to water resources management, Kyrgyzstan demonstrates a positive trend, which is confirmed for the most part by national sources. However, there is no positive trend in relation to the important indicator of the degree of implementation of integrated water resources management (IWRM) at all levels (SDG 6.5), which is a concern given the transboundary nature of most of the country's rivers. A solution to this problem can be facilitated by the national water information systems developed in each of the three countries participating in the project, provided that they are harmonized. The integration of these systems will enhance mutual trust and optimize the management of transboundary water resources. Ensuring access to safe water and modern sanitation facilities, especially for women and children, should also be a priority for the country.

Kyrgyzstan, like other countries in the region, has both limited land resources for agricultural production and modest opportunities for their expansion against the backdrop of a growing population and corresponding growth in the number of individual households. All objectives (SDG15.3) related to land management are complex and do not provide up-to-date statistics to unambiguously assess trends, such as those related to productivity and carbon balance for different land cover classes. This project recommends that participating countries intensify their cooperation with the developers of global resources, such as the FAO Global Soil Organic Carbon Map and ISRIC SoilGrids, to validate these models based on regional material.

Kyrgyzstan's geographic limitations also impact its forest resources. As highlighted in this project, global source data on forest area and biomass stocks in forest ecosystems differ significantly from published national statistical data and, therefore, cannot be used as the sole source for assessing trends and planning actions for sustainable forest management. Given this discrepancy, the conduct of regular national forest inventories using harmonized definitions, methodologies and within a comparable time frame is a prerequisite for the unambiguous determination of trends in forest area and condition. In this regard, the Kyrgyz Republic has an advantage over other the other two target countries due to a recent forest inventory that was undertaken according to international standards, although these new statistics do not allow an assessment of trends because they cannot be directly compared with previously published data.

The relative floristic and faunistic richness of Central Asian countries, including Kyrgyzstan, is associated with the presence of high-mountain ecosystems that act as islands of biodiversity among monotonous arid and semi-arid plains. Among all the problems considered in the Atlas, biodiversity, as an object of environmental policy, is the most harmonized in terminology and research methods: the targeted countries have similar classification systems for PAs (inherited from the Soviet system) and provide the same type of information on the boundaries of PAs to global databases. Further measures to address biodiversity issues at the regional level should include the development of a common algorithm for inventories of protected species, mapping of their habitats and formats for providing such information.

All countries in the region, including Kyrgyzstan, recognize climate change as the main cause of the increasing frequency and intensity of natural disasters. Under the Paris Agreement, countries committed to supporting climate-vulnerable populations through climate change mitigation and adaptation policies and measures. To achieve these goals, the development a unified methodology for risk assessmentand management for the participating countries was proposed. The Kyrgyz Republic has a well-developed emergency response operation system, and the accumulated statistics allow the developmentof models to ensure the ongoing monitoring and prevention of risks associated with exodynamic processes. The countries of the region could establish an exchange mechanism to share their experiencein this area, which would be facilitated by the data of electronic atlases of environmental change made available via a Geoportal.

Abbreviations

AGB –Aboveground plant biomass
and Environment Protection
CAFC – Central Asia Forest Cover
CCI – Climate Change Initiative
CITES – Convention on International Trade in Endangered Species
of Wild Fauna and Flora.
CMIP – Coupled Model Intercomparison Project
ECE – Economic Commission for Europe
ESA – European Space Agency
FAO – Food and Agriculture Organization of the United Nations
FSC–Forest Stewardship Council
GEF – Global Environment Facility
GLIMS – Global Ice and Measurements From Space
GSOCM – FAO Global Soil Organic Carbon Map
IBA – Important Bird and Biodiversity Area
IPCC– Intergovernmental Panel on Climate Change
IUCN– International Union for Conservation of Nature
IWRM– Integrated Water Resources Management
KBA – Key Biodiversity Areas
LDN – Land Degradation Neutrality
MGCI – Mountain Green Cover Index
OSM – OpenStreetMap
PEFC–Programme for the Endorsement of Forest Certification
SDGs – Sustainable Development Goals
SFM – Sustainable Forest Management
SOC – Soil Organic Carbon
UNCBD – United Nations Convention on Biological Diversity
UNCCD – United Nations Convention to Combat Desertification
UNDP –United Nations Development Programme
UNECE – United Nations Economic Commission for Europe
UNEP – United Nations Environment Programme
UNEP-WCMC – UN Environment Programme World Conservation
Monitoring Centre
UNFCCC– United Nations Framework Convention on Climate Change
WDPA – World Database of Protected Areas
WMO – World Meteorological Organization
WUA – Water User Association
WUE – Water Use Efficiency
WUEMoCA – Water Use Efficiency Monitor in Central Asia
WWF – WorldWildlifeFund

Main sources of spatial data

Climate Change
ECMWF ERA5
Climatology lab TerraClimate database
Local Climate Zones (LCZ)
CHELSA
CHPclim

Settlements and Infrastructure
High Resolution Settlement Layer
LandScan Population Data
POMELO Model Population Density Maps
WSF – World Settlements Footprint
OSM – Open Street Map
Topographic maps of the General Staff of the USSR

Water Resources
Global irrigation areas (2001 to 2015)
Global surface water dynamics 1999–2021
HydroSHEDS
WRI Aqueduct 4.0
Water Information System of the Water Resources Service of the Kyrgyz Republic

Land Resources
GLC_FCS30D Global 30-meter Land Cover Change Dataset (1985–2022)
ESA CCI-LC
ESA WorldCover 2021 (10m)
Global Land Cover and Land Use Change, 2000–2020
GlobCover Global Land Cover
GISD30: global 30-m impervious surface dynamic dataset from 1985 to 2020
Global Soil Salinity Maps (1986–2016)
Global 2010 Bare Ground (30 m)
Bare Earth's Surface Spectra 1980–2019
Global cropland expansion in the 21st century
GIMMS Normalized Difference Vegetation Index 1982–2022
FAO Global Map of Irrigated Areas

Forest Resources
Global Forest Change
ETH Global Sentinel-2 10m Canopy Height
Global 2010 Tree Cover
Forest Landscape Integrity Index
EOWEB (DLR) Treecover
Tree Canopy Change (1982–2016)
Global Forest Carbon Fluxes (2001–2022)
Central Asia Forest Cover

Biodiversity
The World Database on Protected Areas (WDPA)
BERI v2: Bioclimatic Ecosystem Resilience Index
BHI v2: Biodiversity Habitat Index
Biodiversity Intactness Index (BII)

Natural Disasters
Global georeferenced Database of Dams
Global large flood events
Global Landslide Catalog
Geocoded Disasters (GDIS) Dataset (1960 – 2018)
USGS Global Earthquake dataset

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Introduction



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1. 1. Project objectives

This atlas is the main practical result of the four-year project «Capacity Development and Technology Transfer to Improve the Acquisition and Use of Data and Information in Support of Environmental Monitoring in Central Asia». The project was implemented by the United Nations Environment Programme (UNEP) in cooperation with the Faculty of Geography of Lomonosov Moscow State University (MSU) and the Institute of Geography of the Russian Academy of Sciences (IGRAN) with the financial support of the Ministry of Foreign Affairs of the Russian Federation *(https://atlascentralasia.com/)*. As the name of the project suggests, its' goal is to increase the scientific and technical capacity of government agencies responsible for the environment in Central Asian countries to monitor, assess and sustainably manage terrestrial and aquatic ecosystems and natural resources, including those of a transboundary nature, by increasing their access to global sources of real-time information.

The proposed tool in the format of digital online environmental atlases (Atlas of Environmental Change in Central Asia) aims to harmonize national statistical systems for use in the preparation of national reports to the secretariats of four key environmental global agreements – UNCCD, UNFCCC, UNCBD and SDGs (Water, Life on Land) – in accordance with international standards.

1.2. Target audience of the project

The target audience of the project as a circle of policy-makers or decision-makers, i.e. endowed with certain authority and responsible for the consequences of the adopted and implemented management action. Among the decision-makers there are also those responsible for the preparation of national reports within the framework of various international initiatives, such as the aforementioned Rio Conventions and the agreement on the SDGs adopted by the international community in 2015. The quality of national reports is largely determined by the reliability of the data used. Our analysis of published national environmental reports shows that data are often drawn from global resources or national sources whose quality is unclear. At the same time, the set of indicators used from global sources and cartographic images turns out to be very different even in neighboring countries of the same region, which makes it difficult to compare them with each other in terms of environmental status and trends.



Red Mountains of the Kyrgyz Republic

The proposed atlas is dedicated to the Republic of Kyrgyzstan. To date, the Republic of Kyrgyzstan does not have a unified methodology for collecting and presenting spatial environmental data. According to the UNECE (2013) report[1] «on the assessment of assessments», the availability of environmental indicators and information is a challenge for Kyrgyzstan due to the limited environmental monitoring base covering only some parts of the country. On the websites of national institutions, the required environmental information is very scarce compared to the databases of international organizations and is insufficient for the preparation of reports in which trends in the state of the environment can be assessed.

There is a formal procedure for written requests if the necessary information is not available online. But usually, the government or national agency requested either provides approximate estimates or does not provide the requested information at all. In order to provide reliable data, additional time and resources are needed to hire qualified experts in the preparation of these data. In some cases, where the data are available in paper format, the responsible agency needs time to provide copies of the data. There is a legal requirement for the exchange of data and information between government agencies for the preparation of reports on international agreements, which is also proving to be inefficient due to the above-mentioned data availability problems.

The difference in the indicators of national and international sources is the most serious problem for the implementation of the project. Many of the data found in national sources are incomplete or unreliable due to uncertain methodologies. Spatial information and cartographic data are either not available or outdated, while systematic monitoring of ecosystems is practically not carried out in the country. Most national assessments on land-use and land-cover change, land degradation, pastures, forests and other types of ecosystems, and water quality do not have a clear methodological basis. At the same time, the global data sources themselves in some cases show significant discrepancies in relation to the same indicators – for example, forest area. This makes the verification of the results of the use of global information resources especially important for the correct assessment of environmental changes. One of the stages of the project was the analysis of the quality of data available in national, international and scientific publications on the state of the environment in the Republic of Kyrgyzstan

1 UNECE WGEMA (2013) Assessment of Assessments on Air, Climate Change, Biodiversity and Waste in Kazakhstan and Kyrgyzstan. CAREC. Xinjiang. Microsoft Word - AoA Kazakhstan Kyrgyzstan with ES in Eng and Russ Nov 2013 (unece.org)

1.3. Methodology and data sources

At the first stage of the project, indicators of countries' progress in the implementation of the SDGs and key global Rio Conventions (UNFCCC, UNCCD, UNCBD) were selected, which determine the thematic content of the electronic atlases.

Five thematic areas and 44 related indicators and sub-indicators were selected: water (14), land (7), forests (7), biodiversity (11) and natural disasters (5). In addition to the five thematic sections, the atlases present data on climate change and population dynamics as the main drivers of environmental transformation in these countries.

All indicators were approved during an online meeting on May 27, 2021. During the workshop, representatives of UNEP, IGRAN and MSU presented the concept of the project, in particular, the methodology for the development of the electronic atlas «Changes in the Countries of Central Asia», technological aspects of access to its' content, announced a series of training seminars for interested participants from partner countries on the collection and processing of thematic geospatial data based on the IGRAN platform.

It is expected that the information collected in this project, obtained through the analysis of global and macro-regional databases and spatial information, will be particularly important in the context of the shortage of national indicators. Global environmental data sources provide information obtained in a uniform manner and make it possible to compare the situation in different regions and countries within the same region. In addition, global data sources are regularly updated, which makes it possible to identify temporary changes in the territory of the republics. Global data sets provide an opportunity to improve and develop the system of national statistics on the state of the environment, ensuring the correctness of its' indicators. On the other hand, global sources should be verified on the basis of national and local spatial and statistical data.

The quality of the information related to the selected environmental themes and indicators is checked in terms of consistency and reliability on national and local spatial and statistical materials. The project used a «multi-tiered» approach, similar to the one adopted in the SDG manual[2], but modified according to the conditions of low availability and reliability of environmental statistics in the target countries *(Table 1)*.

Table 1. Quality levels of source data

Level of quality of the initial data	Definition
Level 1. (poor data quality)	the availability of global/regional data sources that do not provide information on the temporal trend of the phenomenon under consideration and do not correspond to national estimates
Level 2. (medium data quality)	the availability of global/regional data sources that provide information on the temporal trend of the phenomenon under consideration, but do not correspond to national estimates
Level 3. (good data quality)	the availability of global/regional data sources that correspond to national estimates, but do not provide information on the dynamics of the phenomenon under consideration
Level 4. (high data quality)	the availability of global/regional data sources that provide information on the temporal trend of the phenomenon under consideration and are consistent with national estimates

Mapping of water-related SDG indicators requires basic layers such as water bodies, irrigation canals, hydrological basin boundaries and administrative boundaries. Each of these, with the exception of administrative boundaries, can be derived using the HydroLAKES, HydroRIVERS, and HydroBASINS global datasets. National boundaries are requested from the National Focal Points. A complete set of SDG water indicators related to basin management, water availability, water use efficiency can be derived from the global HydroSHEDS and the WUEMoCA regional dataset. The quality of the data for these indicators should be classified as quality level 2. Water safety indicators depend entirely on existing national statistics on wastewater treatment, sanitation and water pollution.

SDG indicators on land resources provided by global data include land cover change and carbon stocks. There are no national spatial data for the verification of global land cover products (ESA Copernicus and CCI), so the quality of



Moonlight Night over Chon-Ashuu Pass in Tien Shan mountains

2 Tier Classification for Global SDG Indicators (2019) Tier Classification of SDG Indicators_11 December 2019_web.xlsx (un.org).

the data available for the Land Cover Change indicator can be classified as Level 2. The WCMC dataset shows a high level of compliance with national aggregated data on above-ground carbon stocks, and the FAO GSOCM is in an acceptable manner consistent with national estimates of soil organic carbon stocks within forest areas, but these sources do not provide information on carbon stock dynamics. In addition, there are no published national estimates of carbon stocks outside forests. The described indicator should be attributed to quality level 3.

SDG indicators on forest resources provided by global or regional data include forest area, forest types, above-ground biomass stocks in forests and mountain green cover index. The Central Asia Forest Cover (CAFC) estimate for Kyrgyzstan aligns well with national data but does not provide information on the dynamics of forest areas. In 2024, the results of the latest forest inventory, carried out in accordance with international standards and FAO methodology, were published. In addition to detailing the types of forests, these results provided valuable information on the reserves of wood and carbon in Kyrgyzstan's forests. However, according to the published data, it is difficult to evaluate the dynamics of forest areas and trends in the state of forest ecosystems over the past decades. While the Mountain Green Cover Index is provided by the UN Open SDG Data Hub there are no national statistics associated with this index, however, data on the SDG indicators for forests can generally be assigned quality level 3. Information about the boundaries of PAs is contained in the World Database of Protected Areas (WDPA), which is regularly updated, although the WDPA's boundaries of PAs may not always correspond to official ones. The boundaries of the Pas used in this Atlas were provided by partners from Kyrgyzstan, which helped to update the international database. The distribution of red-listed species in the territory of the republic was mapped according to the data of the second edition of the Red Book of the Kyrgyz Republic (2006). The quality of these data on the SDG indicator on biodiversity should be classified as quality level 3. Global resources were also mobilized to assess the representativeness of the PA system in relation to international classifications of high-value complexes, such as global ecoregions, Key Biodiversity Areas (KBAs), Important Bird Areas (IBAs) and Ramsar sites. These resources can also be classified as Level 3, as all of these categories of high-value complexes are recognized in the Kyrgyz Republic, which is a party to the relevant conventions and agreements.

Indicators of the intensity of natural disasters and their temporal trends (over the past 30 years) cannot be obtained from global databases due to their incompleteness. The project relied on cartographic materials published in the republic on risk assessment in relation to various categories of natural disasters. The area indicators of individual representative glaciers contained in the Global Ice and Measurements from Space (GLIMS) database correspond to the national data of the Kyrgyz Republic. While the data set includes measurements taken in different years, meaning some may not be comparable, the quality of data on glacial areas should be classified as quality level 3. Finally, indicators of economic and human losses associated with different types of natural disasters depend entirely on the existing departmental statistics on emergency situations.

Most of the maps (75 per cent) presented in the Atlas of Environmental Change for the Kyrgyz Republic are based on global resources, a significant portion of which can be verified by national data, i.e. these resources are quality level 3. The prospects for mapping the SDGs are associated with the further improvement of these resources on the way to their verification at the regional, national and local levels, as well as the provision of data on temporary changes in the state of the environment (as required by the 4th level of data quality). This project also involves the further development of the relevant information base, which will be presented on a separate Geoportal and will become available to our partners in the target countries.

1.4. Geoportal and spatial data

An important result of the project, which increases the potential for the practical use of the atlas, is a geoportal, which contains spatial data on the territory of the Kyrgyz Republic, concerning the issues of climate change, water deficit, conservation of forest ecosystems and biodiversity, as well as disaster management. The Geoportal is an important tool for a wide range of government agencies and institutions involved in nature resources management, environmental protection, risk management and area planning. Among such organizations are: the Ministry of Natural Resources, Ecology and Technical Supervision (for monitoring the state of natural resources, developing environmental measures); Ministry of Emergency Situations (for analysis and forecasting of risks associated with natural and man-made disasters, taking into account the location of risk recipients); Ministry of Agriculture (for water and land management, as well as assessing the impact of climate change on agricultural regions); the State Agency for Environmental Protection and Forestry (to monitor the state of forest ecosystems, biodiversity and develop measures for their conservation and restoration); Ministry of Economy and Regional Development (to develop strategies for socio-economic development, taking into account spatial data and the potential of territories). The geoportal can also be used by research institutes and universities to conduct scientific research, model natural processes and develop recommendations for sustainable development.

The geoportal includes more than 320 vector and more 140 raster layers obtained from global and national sources, through the analysis of remote sensing data, as well as by digitizing thematic maps available at the Institute of Geography of the Russian Academy of Sciences.

The Geoportal is built on the Geonode platform. The main features of the platform include:

- Data management: Geoportal managers have the ability to update data, upload new spatial data, or delete data that is no longer relevant.
- Visualization: interactive display of maps and layers, formation of legend systems.
- Spatial analysis: Perform basic data operations such as layering, filtering by attributes, performing spatial analysis, and creating new thematic maps.
- Integration and exchange of data: data published on the geoportal can be integrated with other geographic information systems and geoportals of the departments of the Kyrgyz Republic.

The functionality of the geoportal allows consumers to solve a wide range of tasks, including: assessing the vulnerability of territories to climate change; monitoring of water resources; analysis of changes in the area and state of forest ecosystems; monitoring of the state of agricultural ecosystems; identification of areas of increased probability of natural disasters and assessment of the risk associated with their implementation.

A more detailed description of the geoportal functionality and examples of solving typical tasks are given in the Geoportal User Manual.

Drivers of Change



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Central Asia is one of the driest regions in the world and climate change is a significant factor in the region's ongoing transformations in the field of aquatic ecosystems and resources, terrestrial ecosystems and biodiversity as well as agriculture and settlement systems. Rising temperatures and changes in the precipitation regime have led to increased water scarcity, aridization of landscapes and increased threats to the unique species of flora and fauna throughout the region. The agricultural sector faces unpredictability and changes in agroclimatic characteristics during the growing season, which poses risks to both food security and rural communities.

The climate of the Kyrgyz Republic is largely determined by its geographical location in the centre of the Eurasian continent. Being a considerable distance from any oceans, where humid atmospheric masses are formed, and in the immediate vicinity of vast deserts, which supply hot dry winds from Kazakhstan and Uzbekistan in summer, results in a very dry climate. However, the republic's geography and location do not prevent the penetration of the Siberian anticyclone from the north in winter. These two factors combine to create the distinct continentality of the republic's climate *(Map. Climate types)*.

Mountains occupy more than 93 per cent of the territory of Kyrgyzstan. Almost the entire republic lies inside one of the greatest mountain systems in the world — the Tien Shan. The mountainous relief of the country also serves as a powerful climate-forming factor, since high ridges intercept precipitation and altitudinal zonation is clearly manifested in changes in the temperature regime. In this regard, it is possible to distinguish four climatic zones in the following altitude ranges: Arid plains and foothill belts (~6 per cent of the country's area) extend up to 1200 m; — steppe (and in some places forest) middle mountains with moderate precipitation (more than 22 per cent of the area) extend up to 2200 m; a more humid belt of alpine meadows (~31 per cent of the area) up to 3500 m; finally, there is a nival belt (~41 per cent of the area) above 3500 m. The altitude range of 2000–2200 m largely marks the vertical differentiation of the Tien Shan climate *(Map. Local climatic zones)*.

The geographical locations of the ridges of this mountain system are also important in the distribution of seasonal temperatures and precipitation *(Map. Mean seasonal temperatures; Map. Mean seasonal precipitation)*. The Northern Tien Shan is strongly influenced by the Siberian anticyclone, which brings little precipitation during the cold period *(Map. Mean monthly precipitation in winter)*. The Western Tien Shan is moderately influenced by the southwestern cyclonic circulation, delivering up to 50 mm of precipitation per month in the autumn-winter period and up to 80 mm per month from March to June *(Map. Mean monthly precipitation in spring; Map. Mean monthly precipitation in autumn)*. Isolated by high ridges, the central Tien Shan receives approximately 10 mm of solid precipitation per month with the remaining 130 mm per month being provided by convective processes in the warm season *(Map. Mean monthly precipitation in summer)*[3].

In the Kyrgyz Republic, the average annual temperature has increased by 1.2 °C over 60 years, which exceeded the average global warming rate (0.6°C) in the same period *(Map. Trend of mean annual air temperature, 1960–2023)*. Over the past 30 years, the rate of increase in average annual temperatures has increased and now stands at approximately 0.03°C per year, compared to 0.01°C from 1960–1990 *(Map. Trend of mean annual air temperature, 1990–2023)*. Differences in warming are differentiated at different altitude levels, ranging from 0.6°C in the highlands to 2.4°C in the foothills over the past century.

A significant increase in average temperatures (0.45ºC) has been recorded in the spring months over the last ten years, with March and February in particular recording the largest temperature increases of 0.85ºC and 0.42ºC respectively.

3 Azen et al. (1997) Climatic and Hydrologic Changes in the Tien Shan, Central Asia. American Meteorological Society. 1394-1404.

The summer months are characterized by the lowest rate of temperature increase: according to the literature, in July and August the indicators are 0.09ºC and 0.08ºC respectively for the last ten years, while global databases show values for the warm season just below those for the annual temperature trend *(Map. Trend of mean air temperature in the warm period, 1960–2023; Map. Trend of maximum air temperature, 1960–2023)*. In recent decades, warming has noticeably intensified in the summer months, echoing the overall dynamics of the country's average annual temperatures *(Map. Trend of mean air temperature in the warm period, 1990–2023)*.

The most dramatic increase in the average annual temperature has been observed in the Bishkek region while slightly lower than average increases have occurred in the Osh region *(Table 2)*. Separately, it should be noted that in summer, especially in August, in the Suusamyr depression and other mountainous areas, there is a slight tendency toward average lower temperatures.

Climate change is weaker in the long-term dynamics of precipitation in the country. In general, statistics on precipitation fluctuations show that inter-annual variability persists without significant increases or decreases[4].

However, changes in the moisture regime between 1960 and 1990 has resulted in an increase in precipitation of 40 mm, or 5-6 per cent *(Map. Precipitation trend, 1960–2023)*. This corresponds to previously published data on an increase in precipitation by 100 mm, or approximately 12–14 per cent, in the period from 1940 to 1991 and is associated with the weakening influence of the Siberian anticyclone and increased westerly transport of air masses. The increase in precipitation was primarily observed at altitudes below 2000 m in the northern and western Tien Shan. Above 2000 m, these trends are not pronounced. Furthermore, while mean annual and summer precipitation trends are similar, in the central Tien Shan, there has been a decrease in precipitation during the warm period where, between 1990 and 2023, average annual precipitation decreased by 10 mm, or 2.4 per cent.[5] The decrease in precipitation is most pronounced in the western Tien Shan and the Fergana Valley *(Map. Precipitation trend, 1990–2023)*.

Table 2. Trends in climate indicators in the Kyrgyz Republic and its' regions.

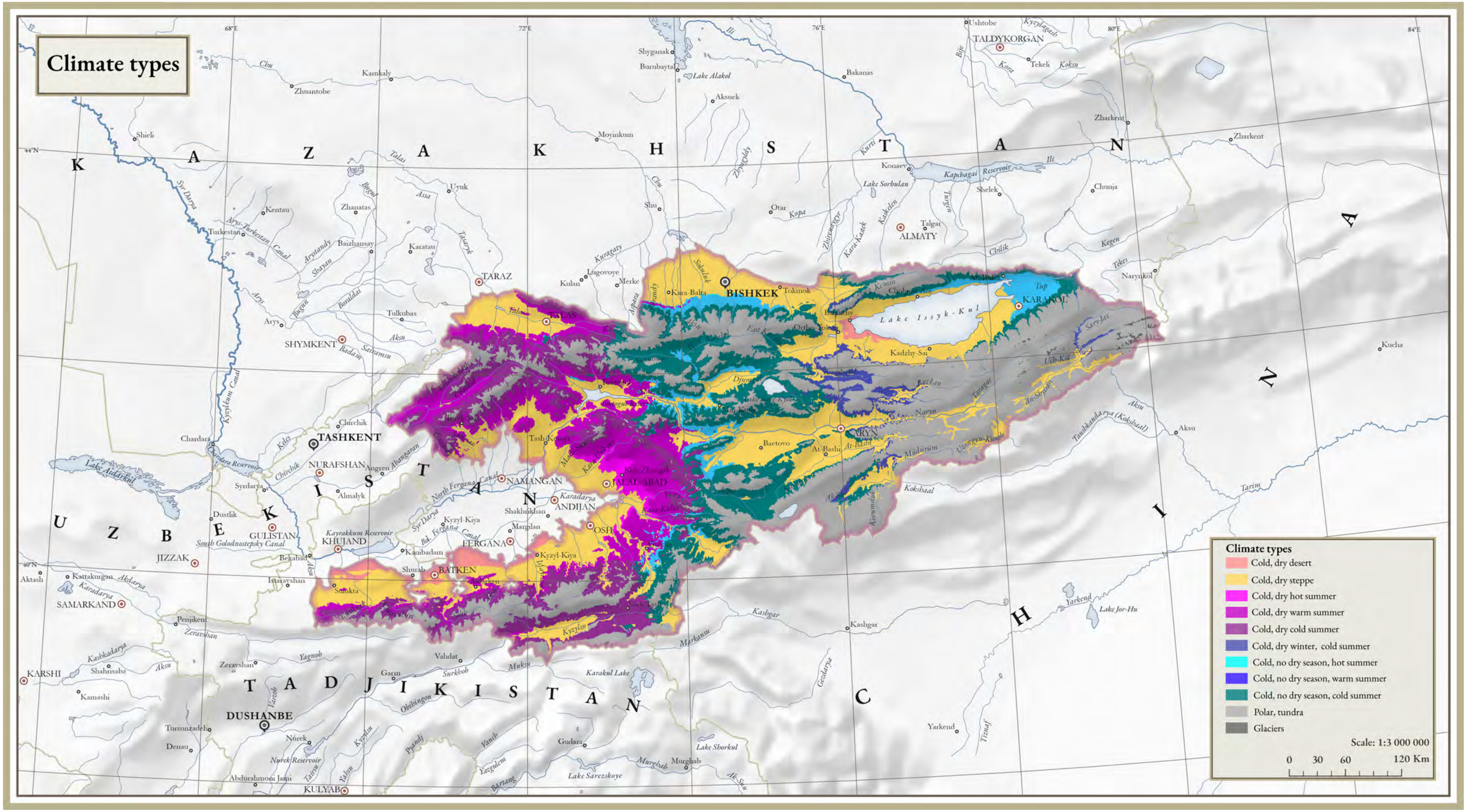
Indicator	The Kyrgyz Republic and its' regions		
	National average	Maximum	Minimum
Trend in the average annual temperature (1960–23), °C per year	0.019	0.025 Bishkek	0.016 Osh region
Trend of average annual temperature (1990–23), °C per year	0.03	0.042 Bishkek	0.027 Osh region
Trend in summer temperatures (1960–23), °C per year	0.017	0.025 Bishkek	0.014 Osh region
Trend in summer temperatures (1990–23), °C per year	0.03	0.05 Bishkek	0.029 Issyk-Kul region
Trend of maximum temperatures (1960–23), °C per year	0.026	0.029 Issyk-Kul region	0.024 Osh region
Average annual precipitation trend (1960–23), mm per year	0.47	0.67 Issyk-Kul region	0.080 Chui region
Average annual precipitation trend (1990–23), mm per year	-0.33	0.9 Issyk-Kul region	-1.759 Osh region
Trend in climate water deficit (1960–23), mm/year	0.06	0.8 Bishkek	-0.7 Batken region
Climate water deficit trend (1990–23), mm/year	2.35	3.23 Osh region	1.51 Chui region
Trend in snow thickness (1960–23), mm per year	-0.3	0.26 Bishkek	-1.12 Issyk-Kul region
Trend in snow thickness (1990–23), mm per year	-1	0.2 Issyk-Kul region	-2.06 Batken region
Projected temperature increase by 2040, ºC per year from the baseline period (1970–2000)	2.46	2.6 Batken region	2.3 Issyk-Kul region
Projected change in precipitation by 2040.% of the baseline period (1970 – 2000)	5	11 Talas region	2.0 Osh region

There was also a slight increase in snow cover thickness between 1960 and 1990 but a widespread decrease, by an average of 30 mm, in the last three decades as a result of reduced precipitation and the duration of the cold period *(Map. Snow thickness trend, 1960–2023; Map. Snow thickness trend, 1990–2023)*.

Climate water scarcity trend calculations show only a slight change in this indicator in all irrigation areas of the country in the period 1960–2023 but a rapid increase, of some 14–16 per cent, in the last decades *(Map. Climate water deficit, 1960; Map. Climate water deficit, 1990; Map. Climate water deficit, 2023)*. Thus, after 1990, this process has intensified dramatically *(Map. Trend of climate water deficit, 1960–2023; Map. Trend of climate water deficit, 1990–2023)*. Water shortages have worsened in all irrigation areas of the country, especially in the Fergana Valley, where the deficit has increased by almost 100 mm since 1990 following a decrease in precipitation coupled with a moderate increase in temperatures in this region. In the Chu Valley, the change in climate deficit is 45 mm, or 6–8 per cent, over the same period.

Projections based on an ensemble of CMIP6 models indicate an estimated increase in annual air temperature in the Kyrgyz Republic by 1.5–1.9°C in the period from 2021 to 2050 and by 1.9–4.0°C in the period from 2051 to 2080 relative to the baseline period taken from 1981–2010. The data presented in the Atlas also suggest a significant increase in average annual temperature of 2.46°C by 2040 compared to 1970, when the average annual temperature was 11.3°C. This forecast for the increase in average annual temperature is approximately twice the trend over the past three decades *(Map. Expected temperature change by 2040)*. These projections focus on the fact that the maximum increase in temperatures is expected in the summer. As for precipitation, it is predicted to increase moderately, by 5–6 per cent, by mid-century and by 6–10 per cent by the end of the century *(Map. Expected precipitation change by 2040)*. Winters will be characterized by a more noticeable rate of increase in precipitation while in the summers only a small increase is expected. The certainty of these forecasts is lower than in relation to the average annual temperature due to the highly volatile nature of the moisture regime in the region.

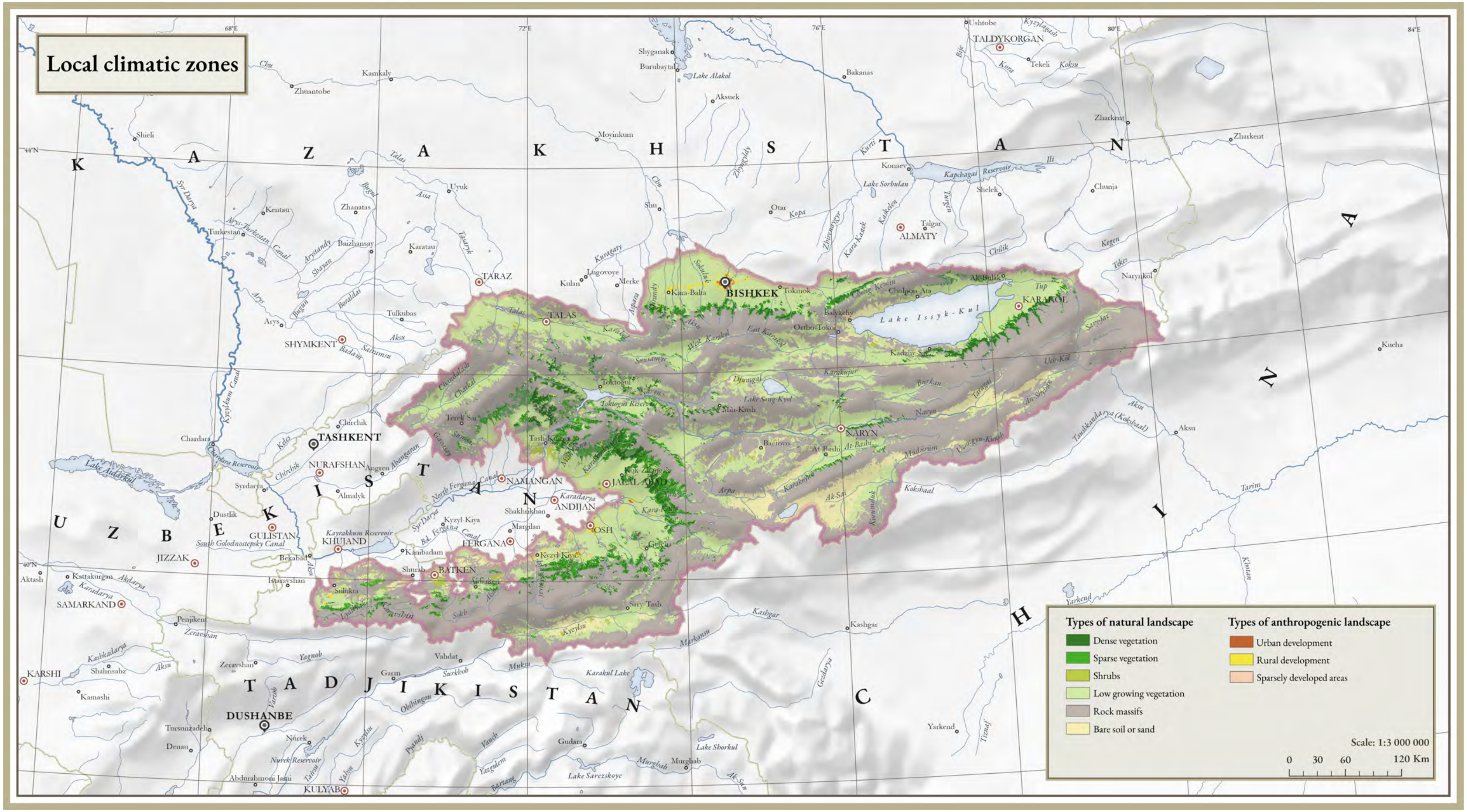
4 Third National Communication of the Kyrgyz Republic under the UN Framework Convention on Climate Change (2016) Bishkek.
5 Azen et al. (1997).



Updated global Köppen-Geiger classification with unprecedented one km resolution (1980–2016) based on three air temperature datasets (WorldClim V1 and V2 and CHELSA V1.2) and four precipitation datasets (WorldClim V1 and V2, CHELSA V1.2 and CHPclim V1). At the same time, vegetation is considered as a «crystallized, visible climate», which is reflected in the characteristics of the zones[6].

6 Beck et al. (2018) Wood: Present and future Köppen-Geiger climate classification maps at 1-km resolution, Nature Scientific Data.

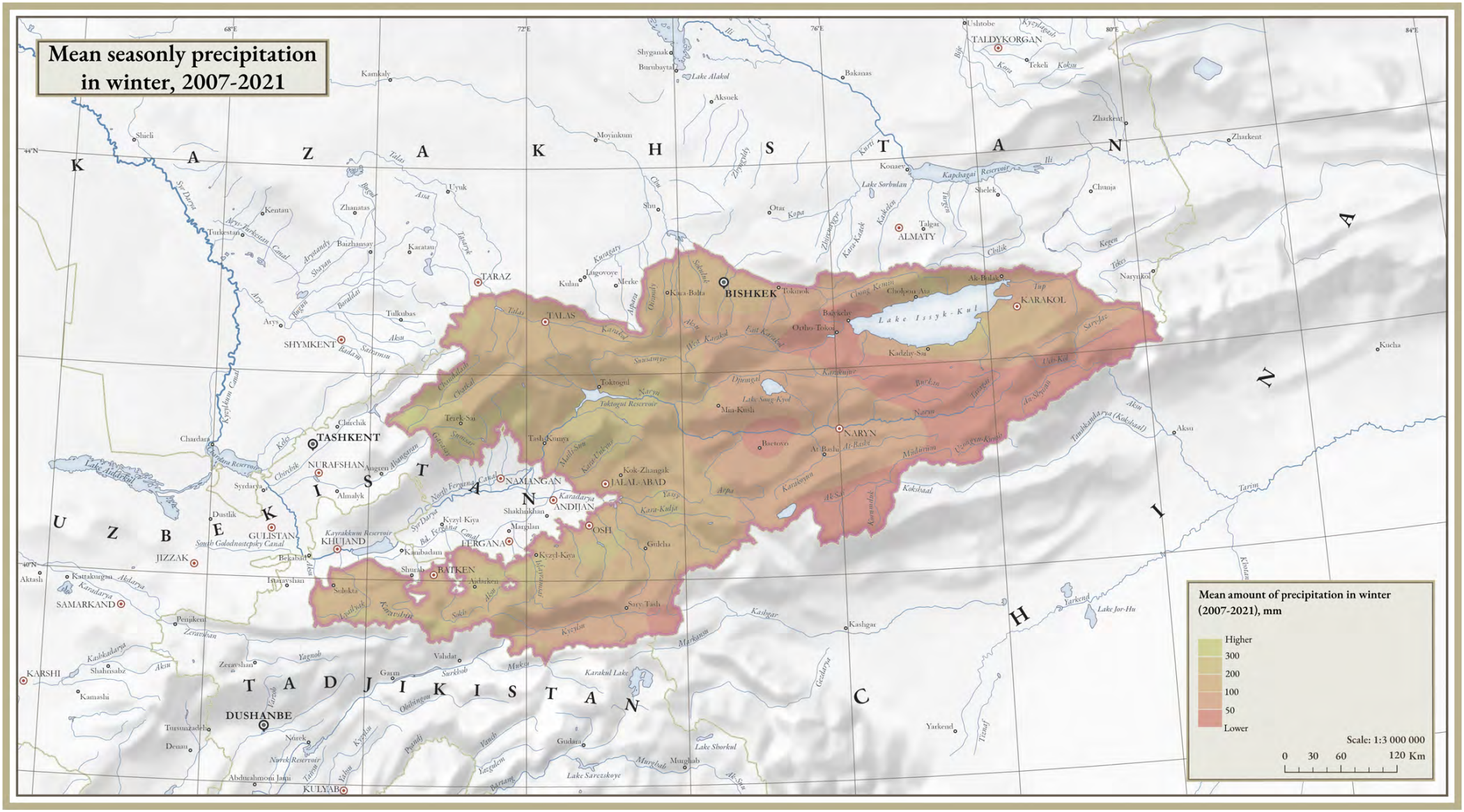
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Local Climate Zones (LCZs)– A land-use classification that is meteorologically significant. Each LCZ is a piece of land, at a local scale, with physical characteristics of the underlying surface that make it different from other LCZs in terms of temperature and other meteorological conditions. One of the practical applications of LCZs is to assess the representativeness of the network of national weather stations to account for the influence of surface conditions on their readings[7].

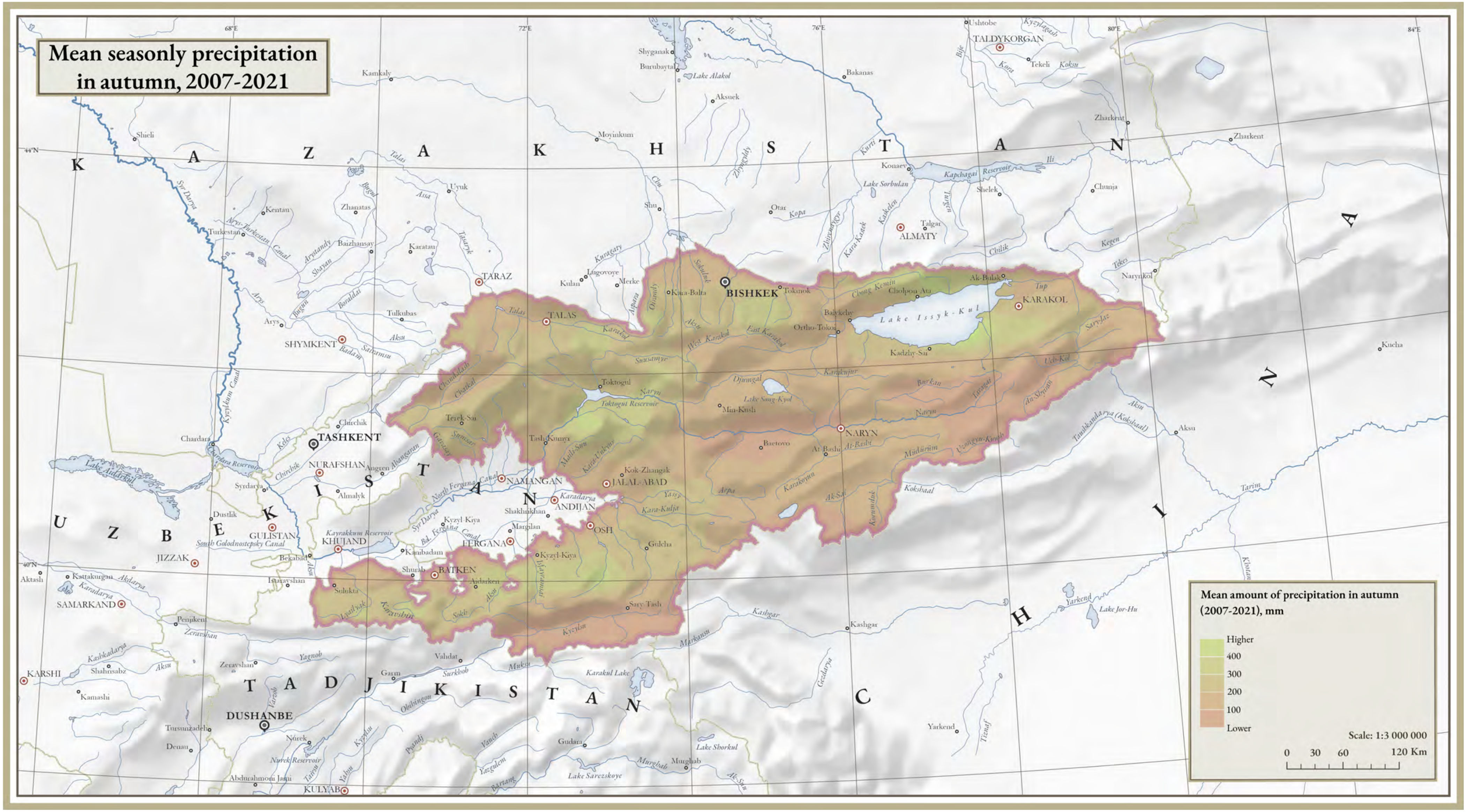
7 Stewart I.D., Oke T.R. (2012) Local Climate Zones for Urban Temperature Studies. Vol. 93: Issue 12. Local Climate Zones for Urban Temperature Studies in: Bulletin of the American Meteorological Society Volume 93 Issue 12 (2012) (ametsoc.org)

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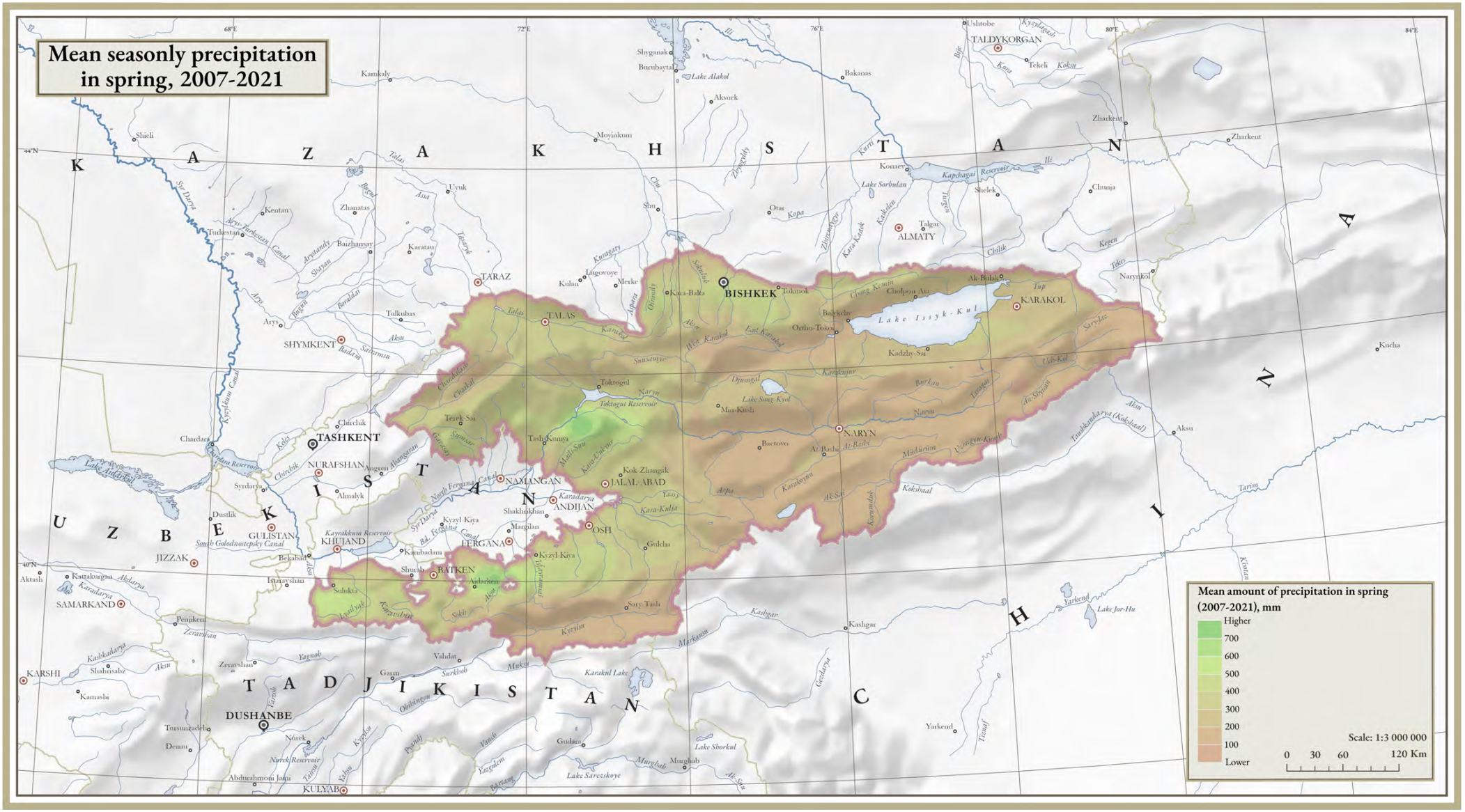
Based on ERA-5 Land reanalysis using the ECMWF1 model. The reanalysis is based on remote sensing data and data obtained from World Meteorological Organization (WMO) meteorological stations, more than 40 of which are in the Kyrgyz Republic. The resolution of the used version of ERA5 is 11 km, the time span is from 1950 to the present, the temporary resolution is one day.

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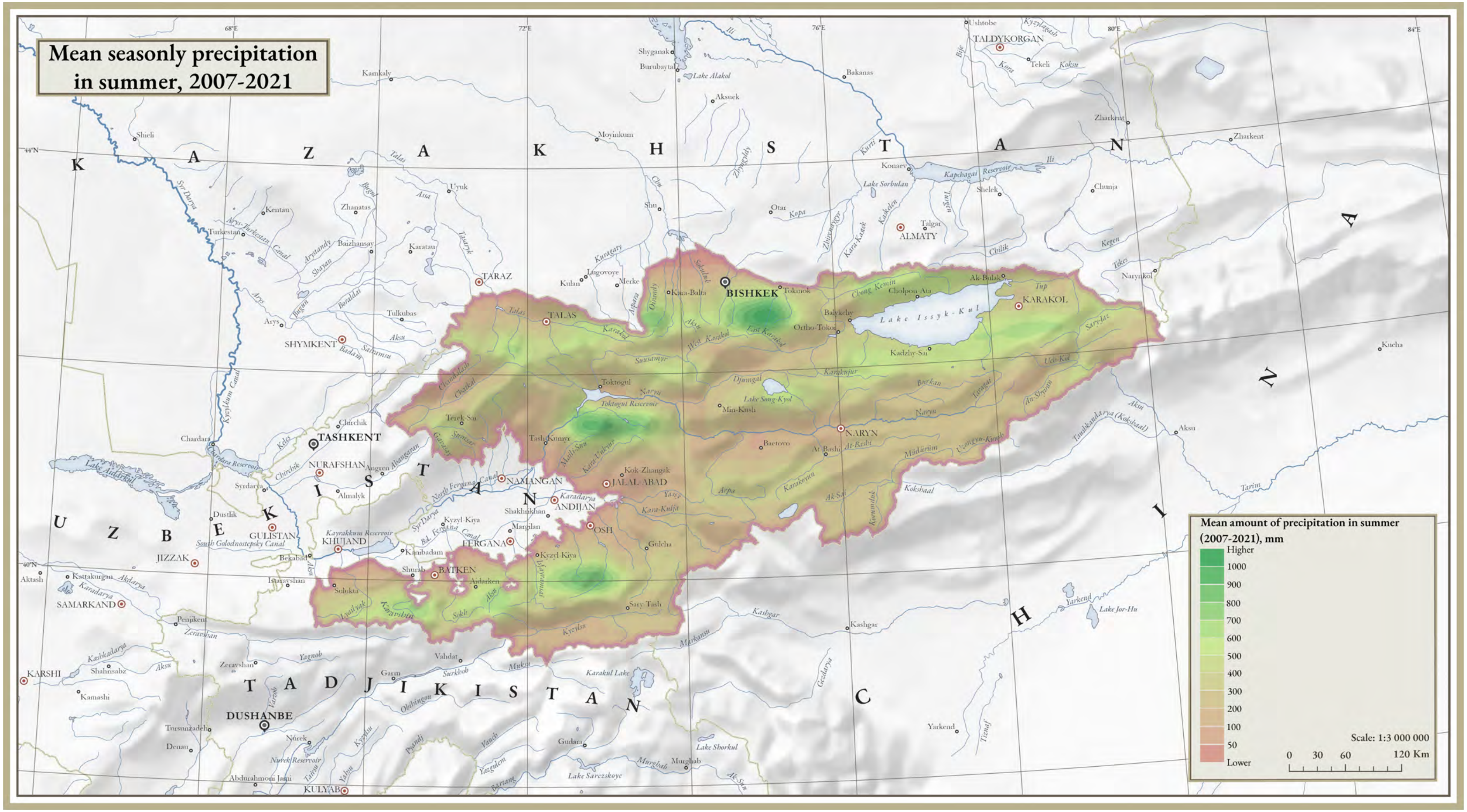
According to ERA5 Land re-analysis (see note to the above map, 'Mean monthly precipitation in winter').

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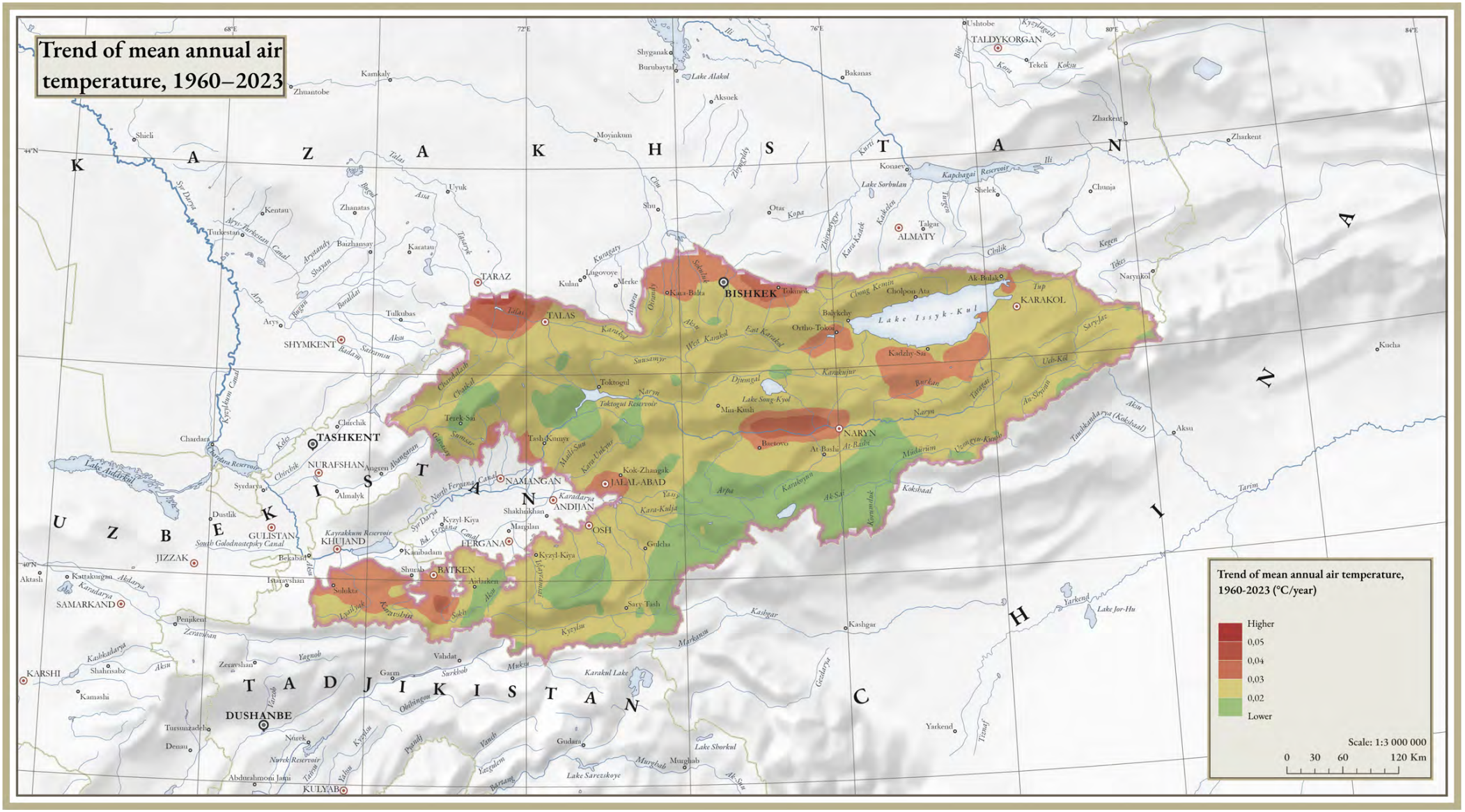
According to ERA5 Land re-analysis (see note to the above map, ‘Mean monthly precipitation in winter’).

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According to ERA5 Land reanalysis (see note to the above map, 'Mean monthly precipitation in winter').

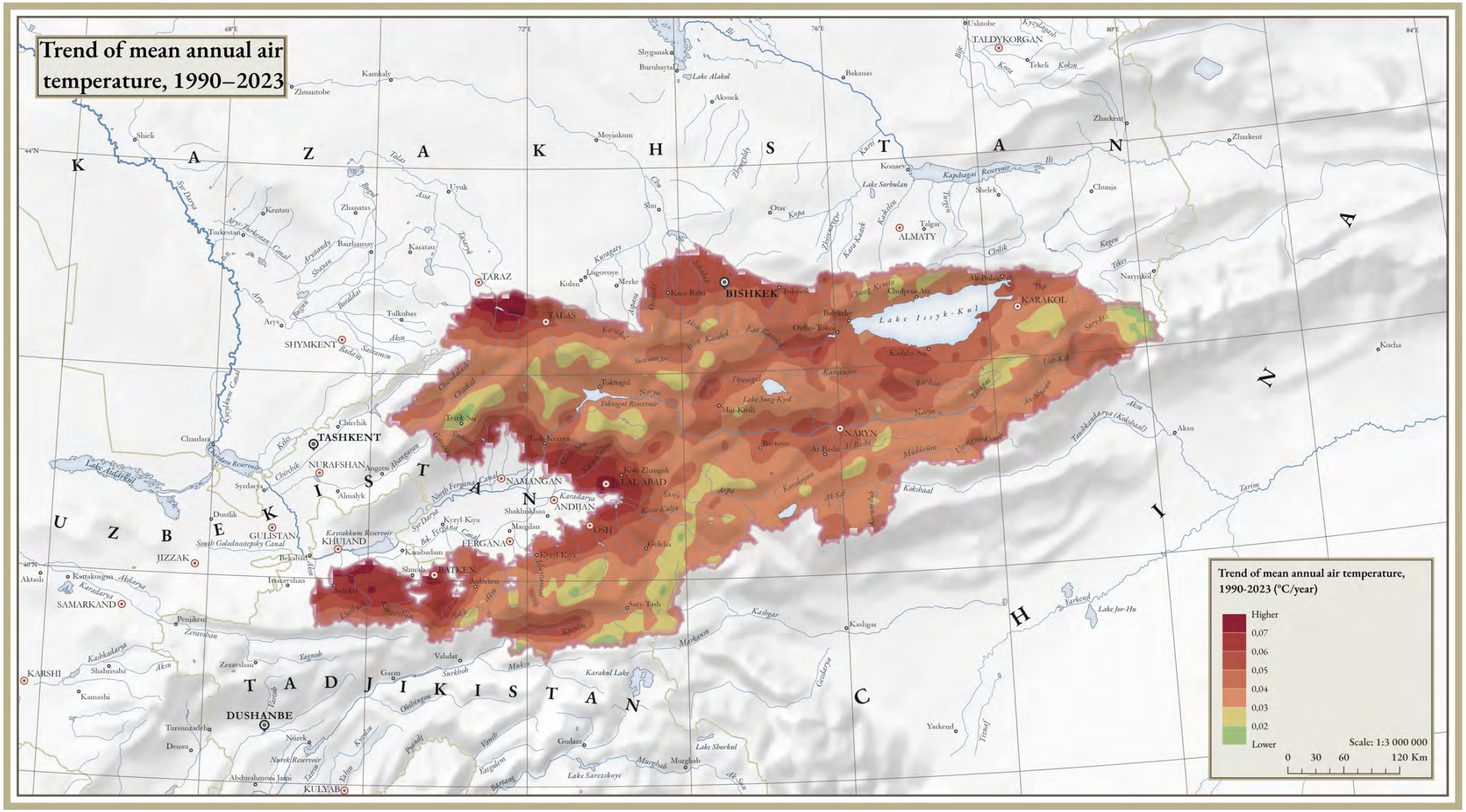
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Based on the ERA5 Land reanalysis using the ECMWF model[8]. The reanalysis is based on remote sensing data and data obtained from World Meteorological Organization (WMO) meteorological stations, more than 40 of which are in the Kyrgyz Republic[9]. The resolution of the used version of ERA5 is 11 km, time span is from 1950 to the present, the temporary resolution is one day. The trends were determined by the Sens method.

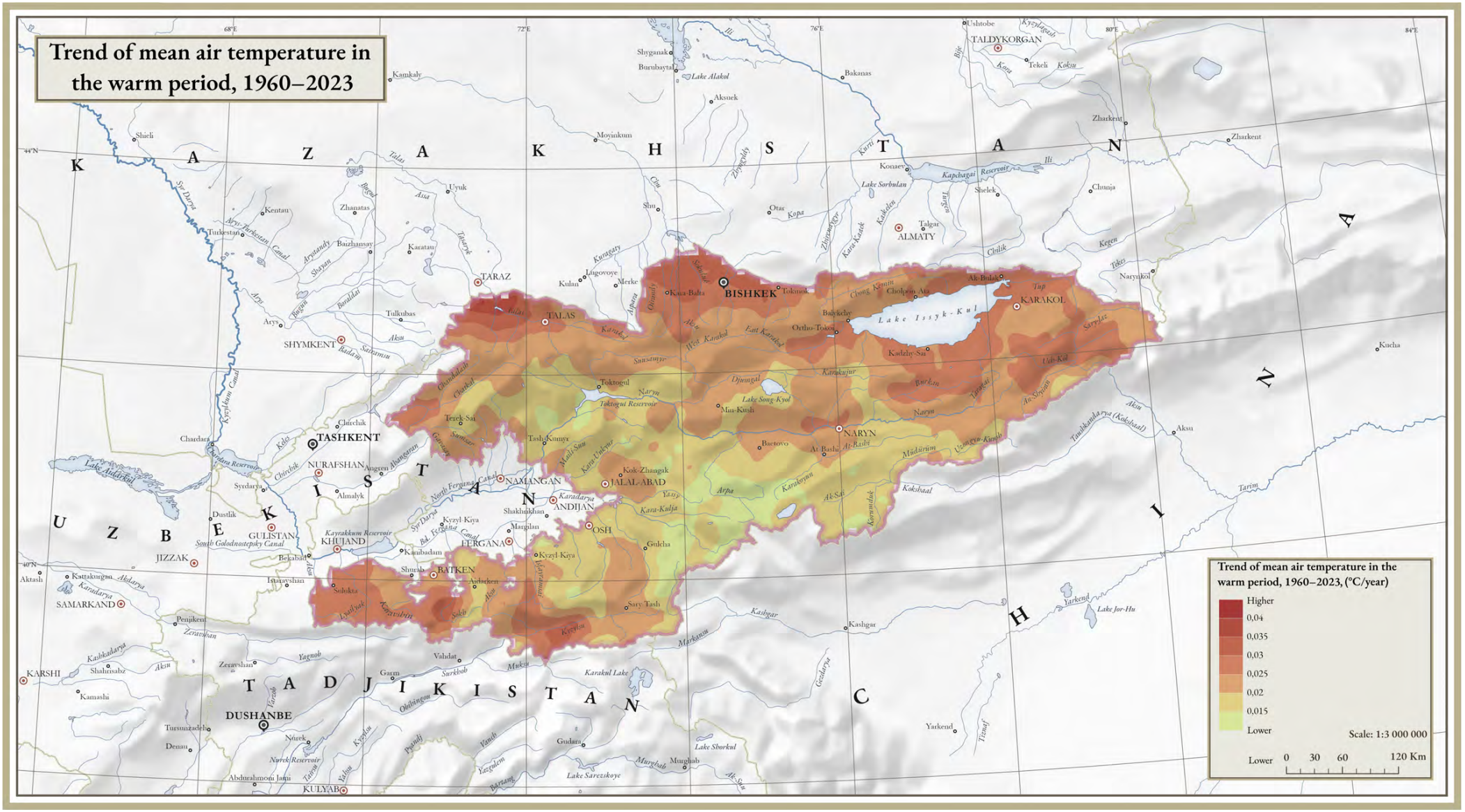
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8 https://www.ecmwf.int/en/elibrary/80895-ifs-documentation-cy45r1-part-iv-physical-processes
9 https://confluence.ecmwf.int/display/CKB/ERA5%3A+data+documentation#heading-Observations



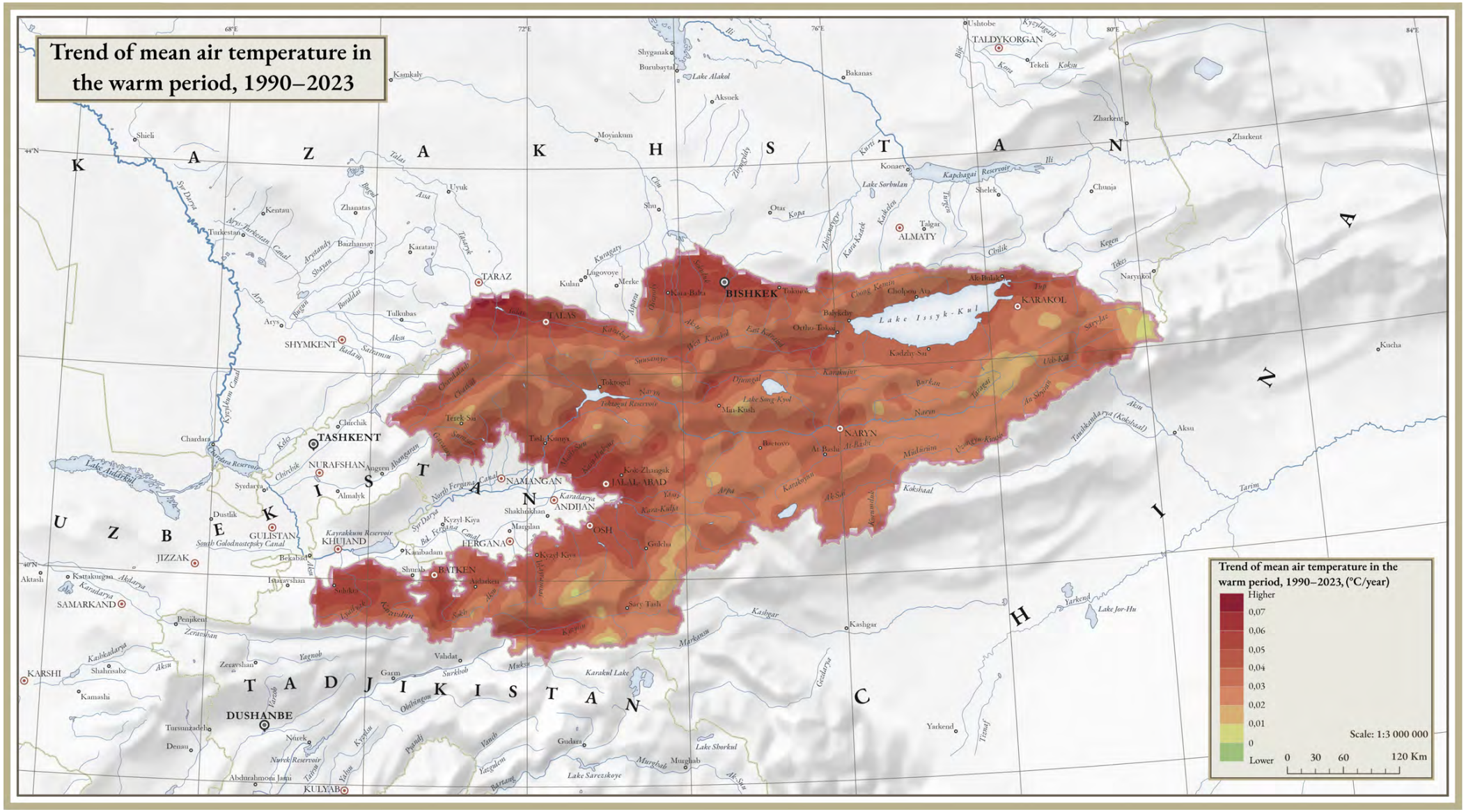
Based on the ERA5 Land reanalysis using the ECMWF model (see note to the above map, ‘Trend of mean annual air temperature, 1960–2023’).

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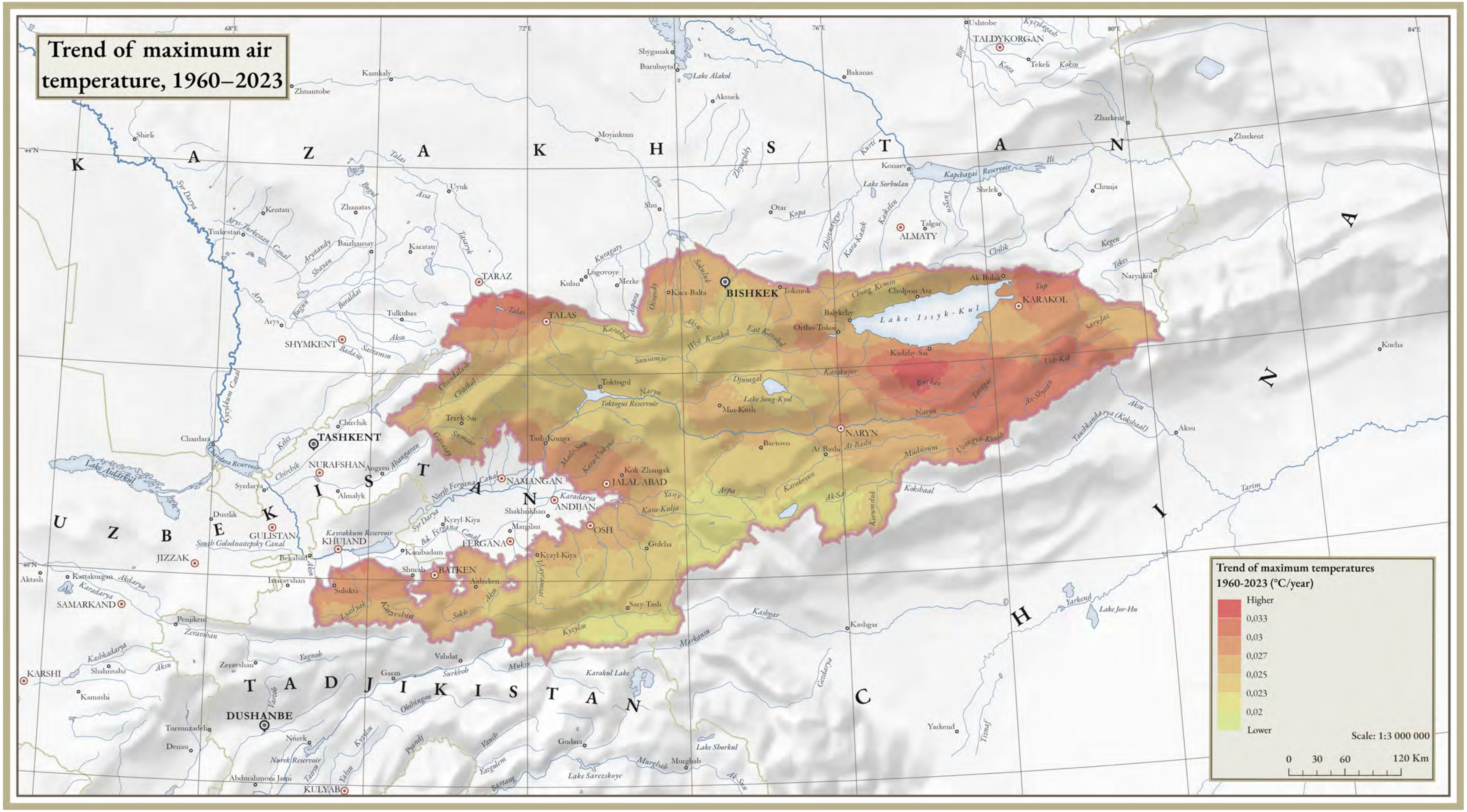
Based on the ERA5 Land reanalysis using the ECMWF model (see note to the above map, 'Trend of mean annual air temperature, 1960–2023').
The average temperature for April–October was taken into account in the calculation of the warm period temperature trend.

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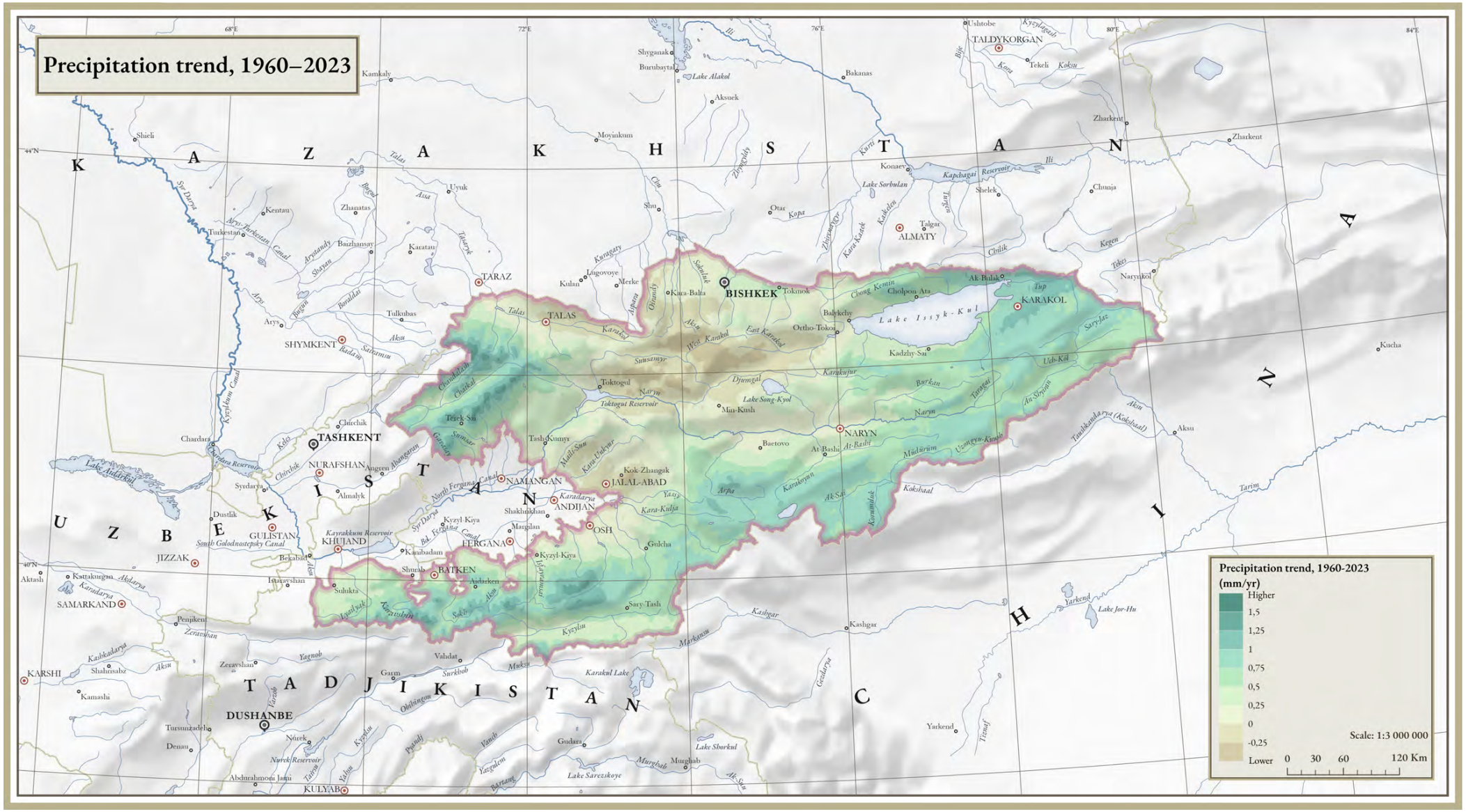
Based on the ERA5 Land reanalysis using the ECMWF model (see note to the above map, 'Trend of mean annual air temperature, 1960–2023').

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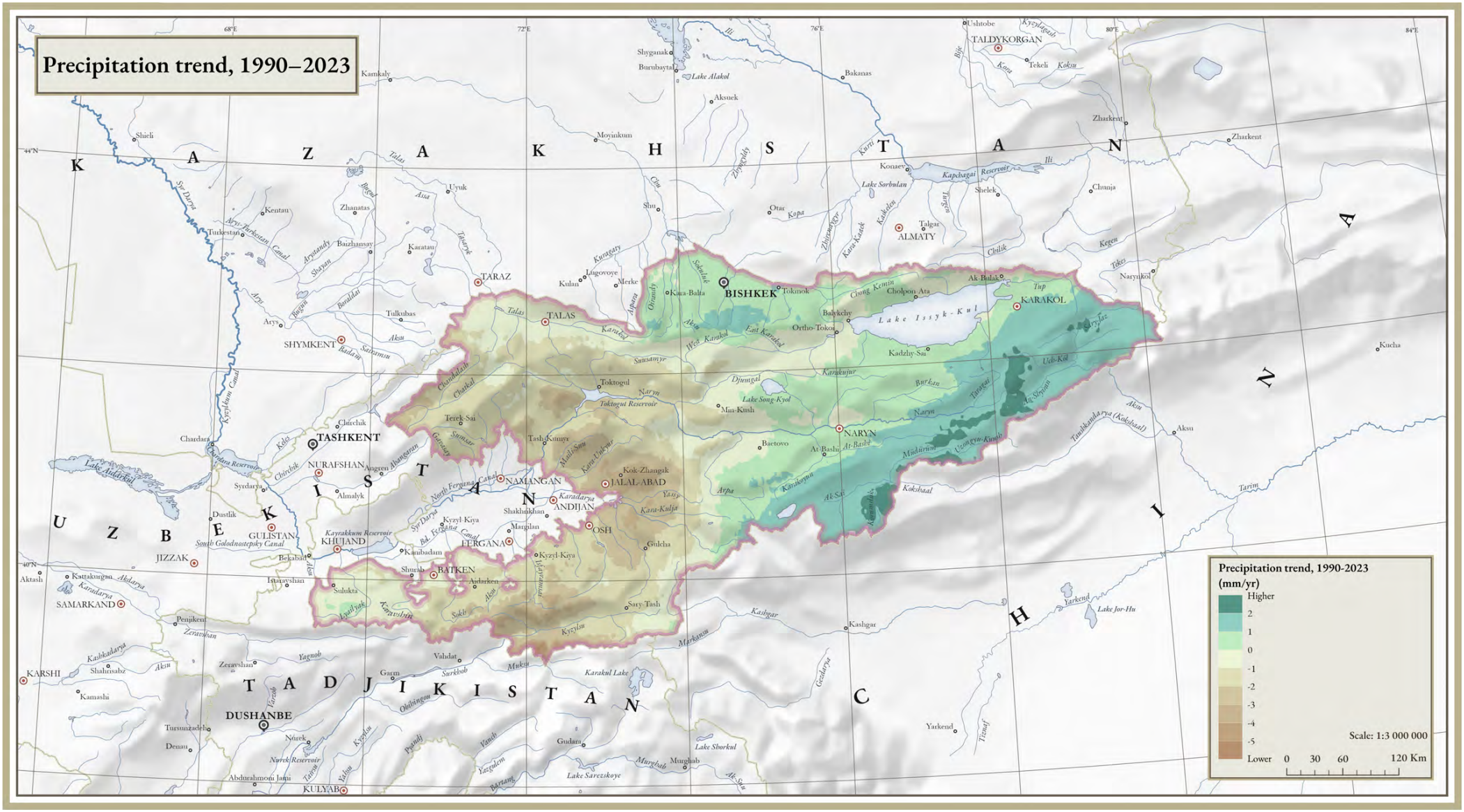
Based on TerraClimate obtained by reanalysis of WorldClim data, CRU Ts4.0, JRA55. TerraClimate shows a high degree of compliance with a number of observations at weather stations from various networks, including SNOTEL and RAWS. Spatial resolution – 4 km, time coverage is from 1958 to the present, the temporary resolution is 1 month.

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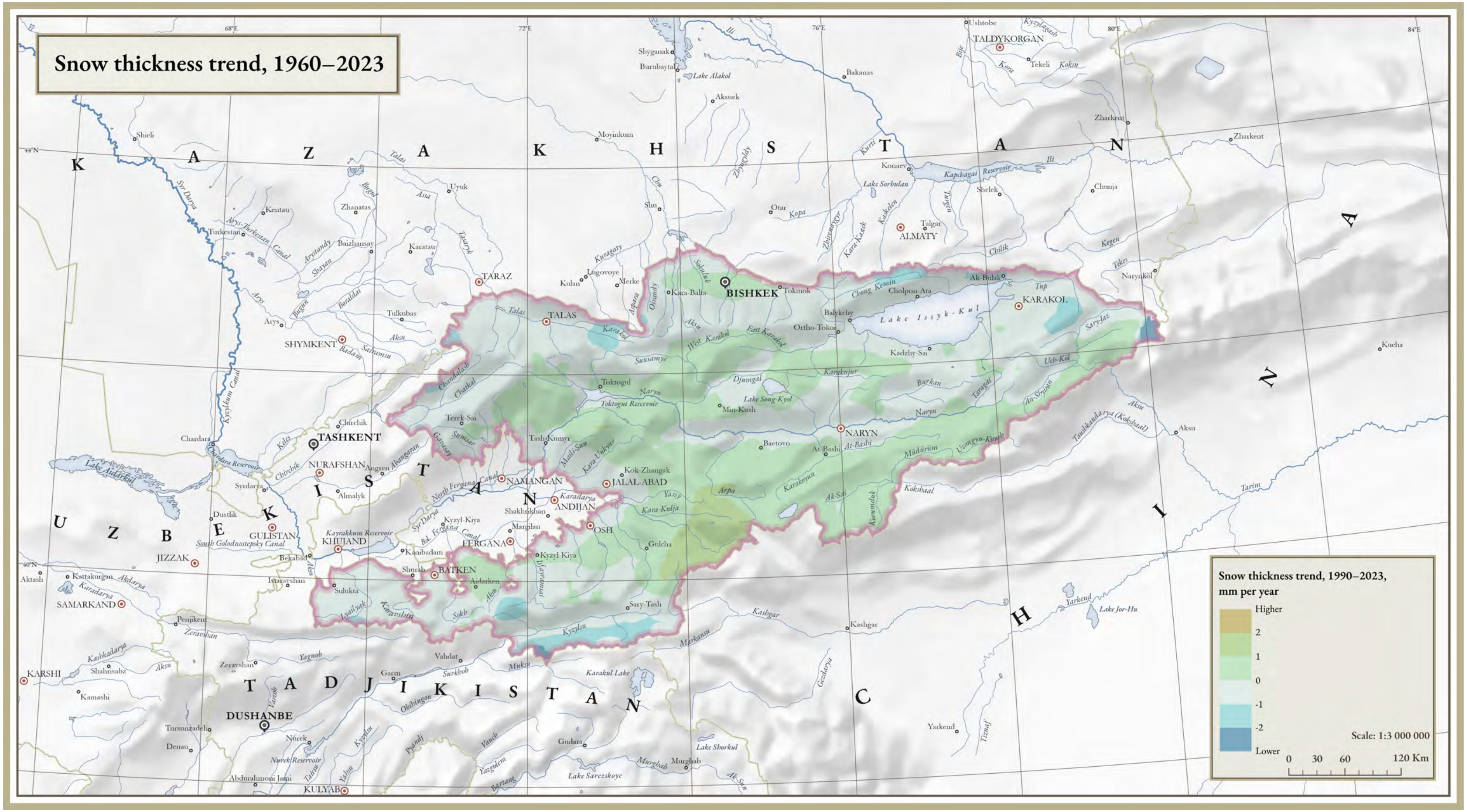
Based on TerraClimate (see note to the above map, ‘Trend of maximum air temperature, 1960–2023’).

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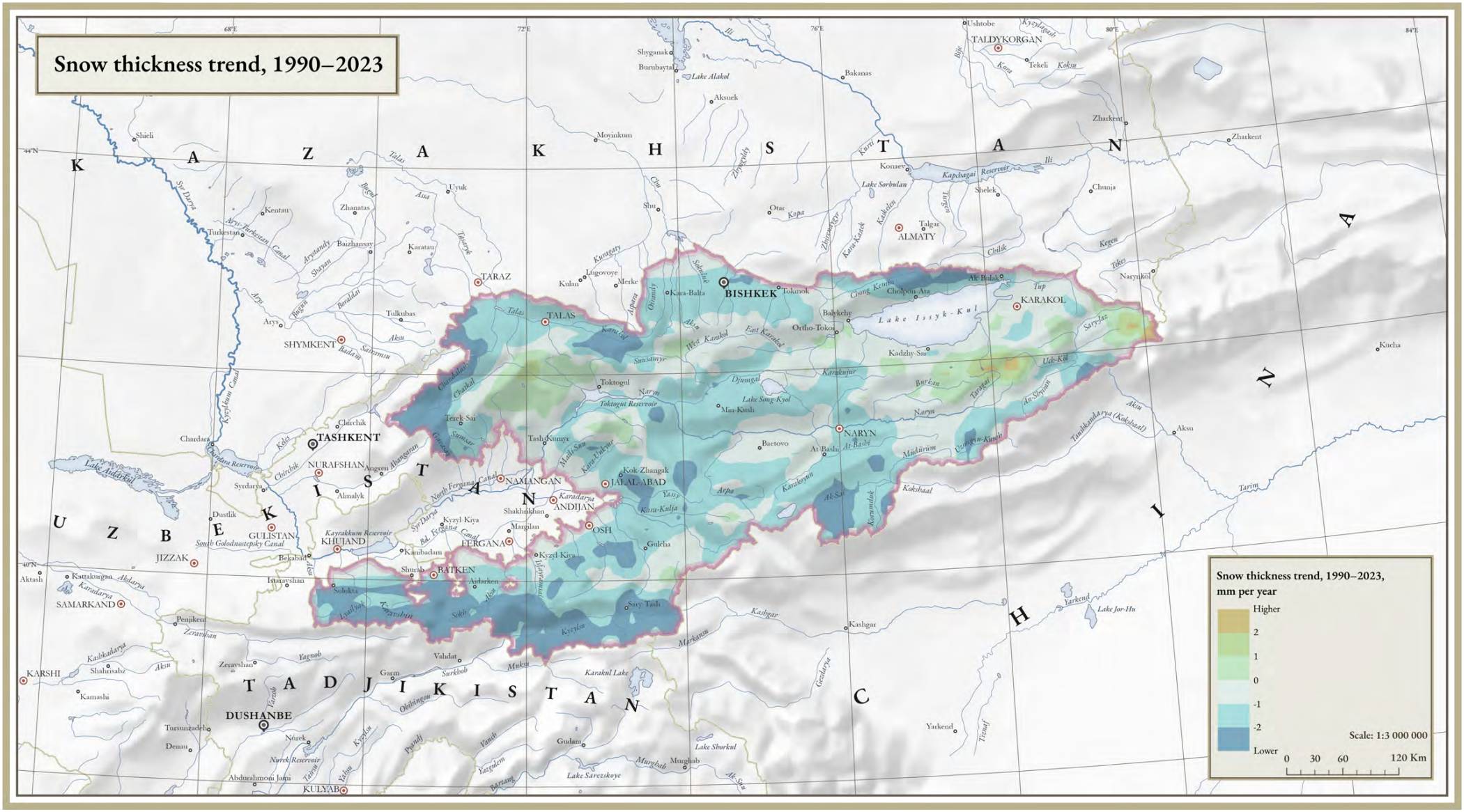
Based on TerraClimate (see note to the above map, 'Trend of maximum air temperature, 1960–2023').

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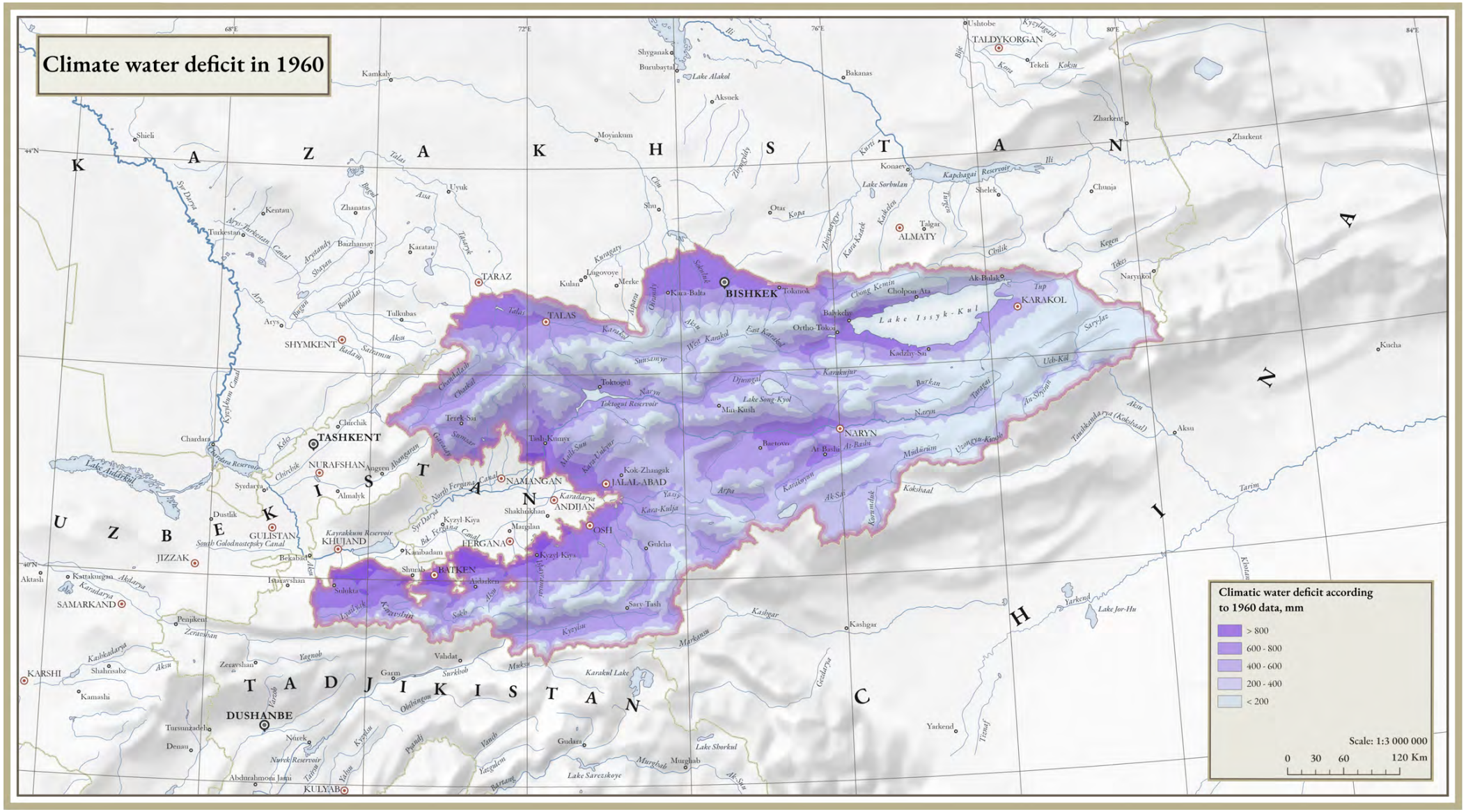
According to ERA5 Land (see note to the above map, ‘Trend of mean annual temperature, 1960–2023’), the model takes into account the amount of solid precipitation, the duration of the snow accumulation period, the intensity of snow melting, the temperatures of both the air and soil surface as well as the intensity of absorption of solar radiation by the soil. Dynamics not accounted for: snow transported by the wind, its compaction over time and transformation of the snow layer under the influence of liquid precipitation.

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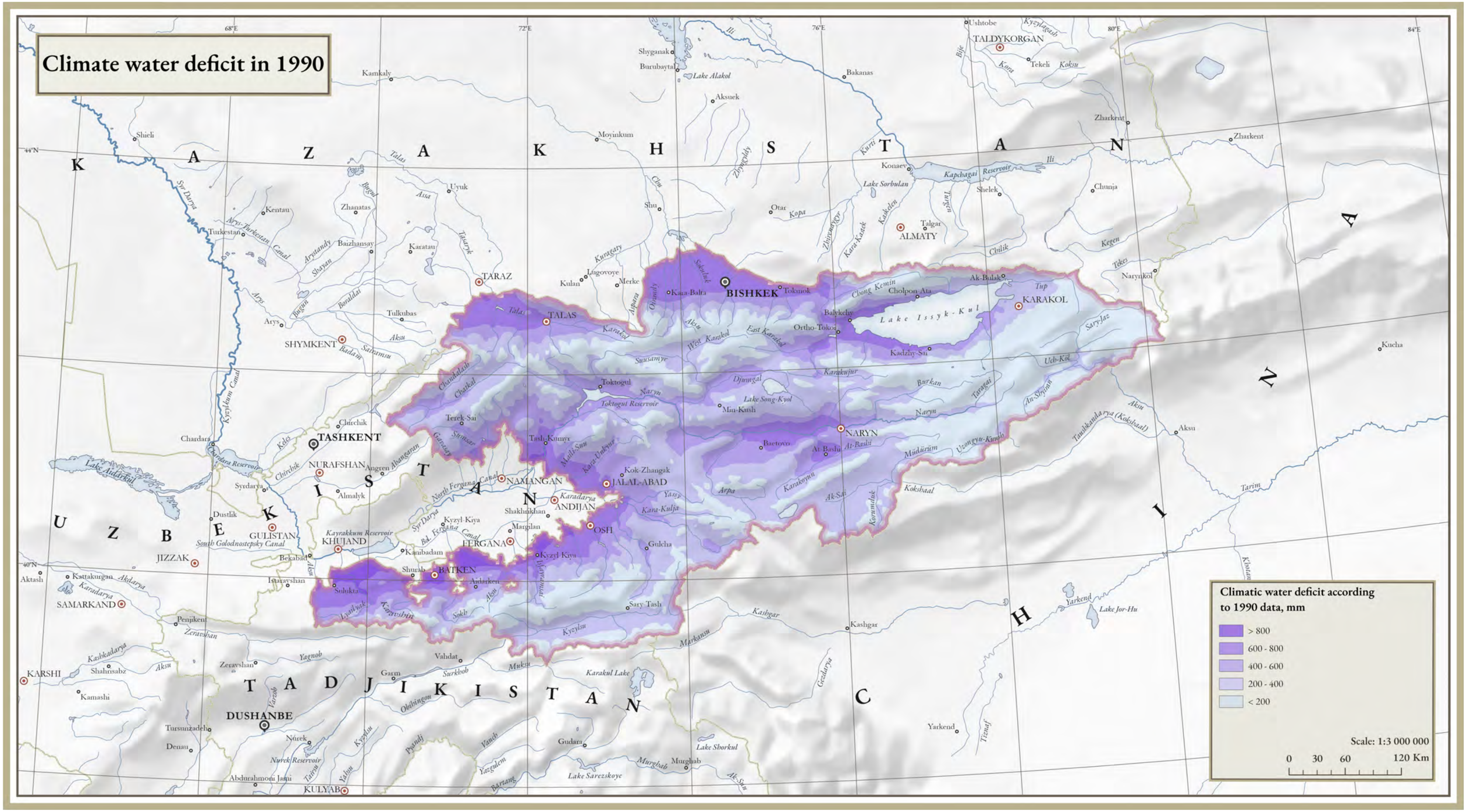
According to ERA5 Land (See note to the above map, ‘Snow thickness trend, 1960–2023’).

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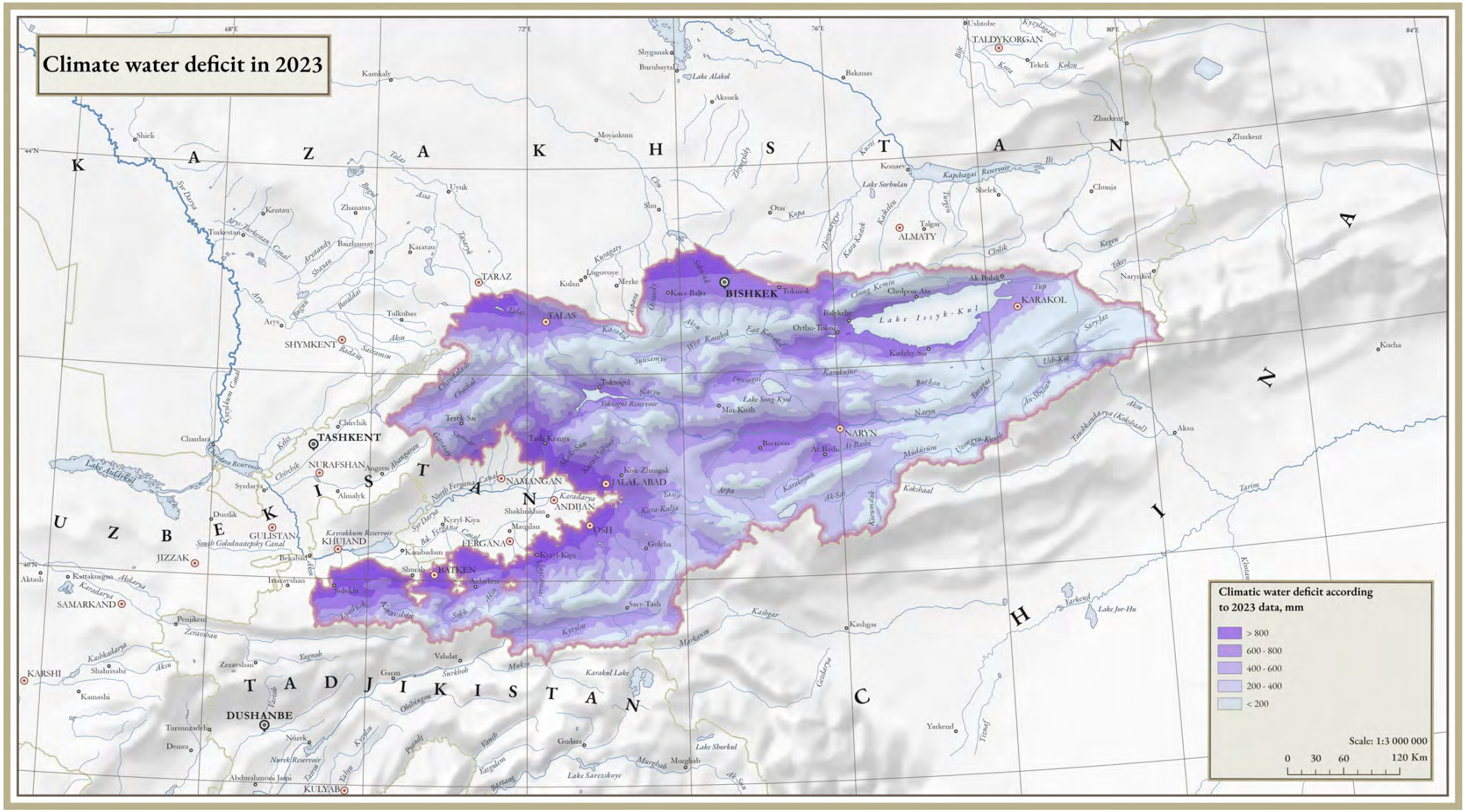
Climatic water scarcity is the difference between how much water can evaporate from soil and vegetation surfaces under given climatic conditions (taking into account the average daily temperature, wind speed and underlying surface) and the amount of precipitation in this area. Based on Terraclimate (see note to the above map, 'Trend of maximal temperature, 1960–2023').

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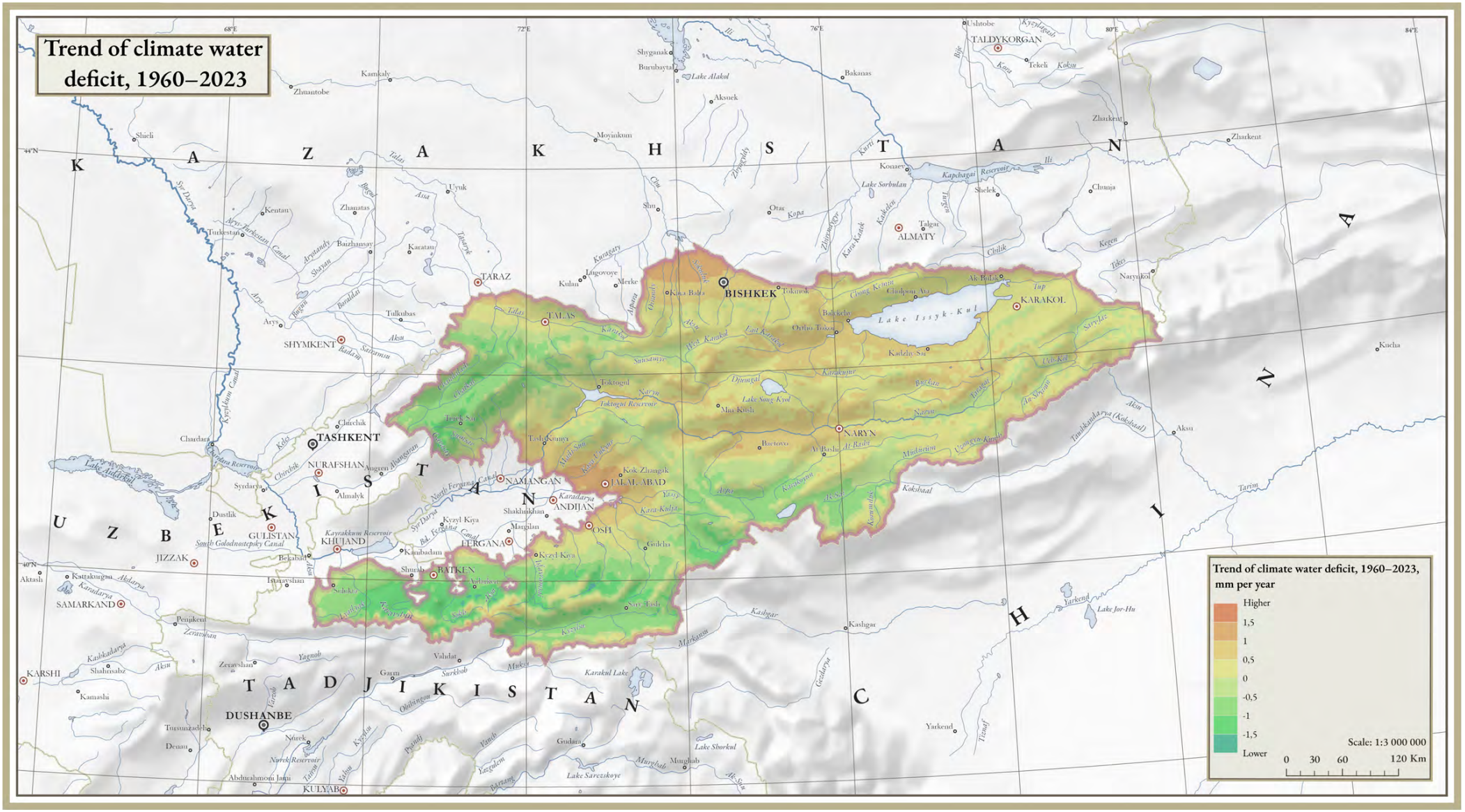
Based on Terraclimate (see note to the above map, 'Climatic water deficit in 1960').

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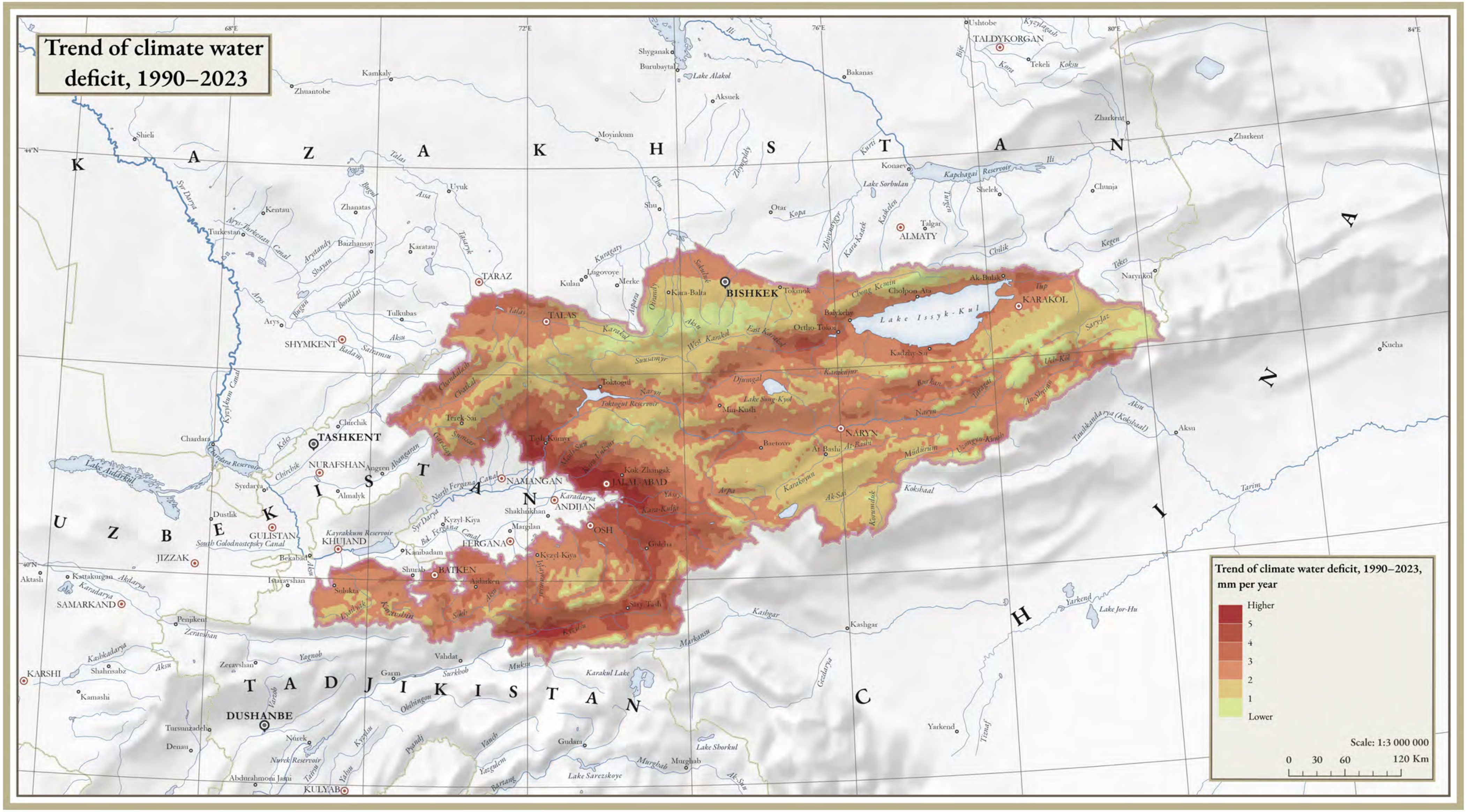
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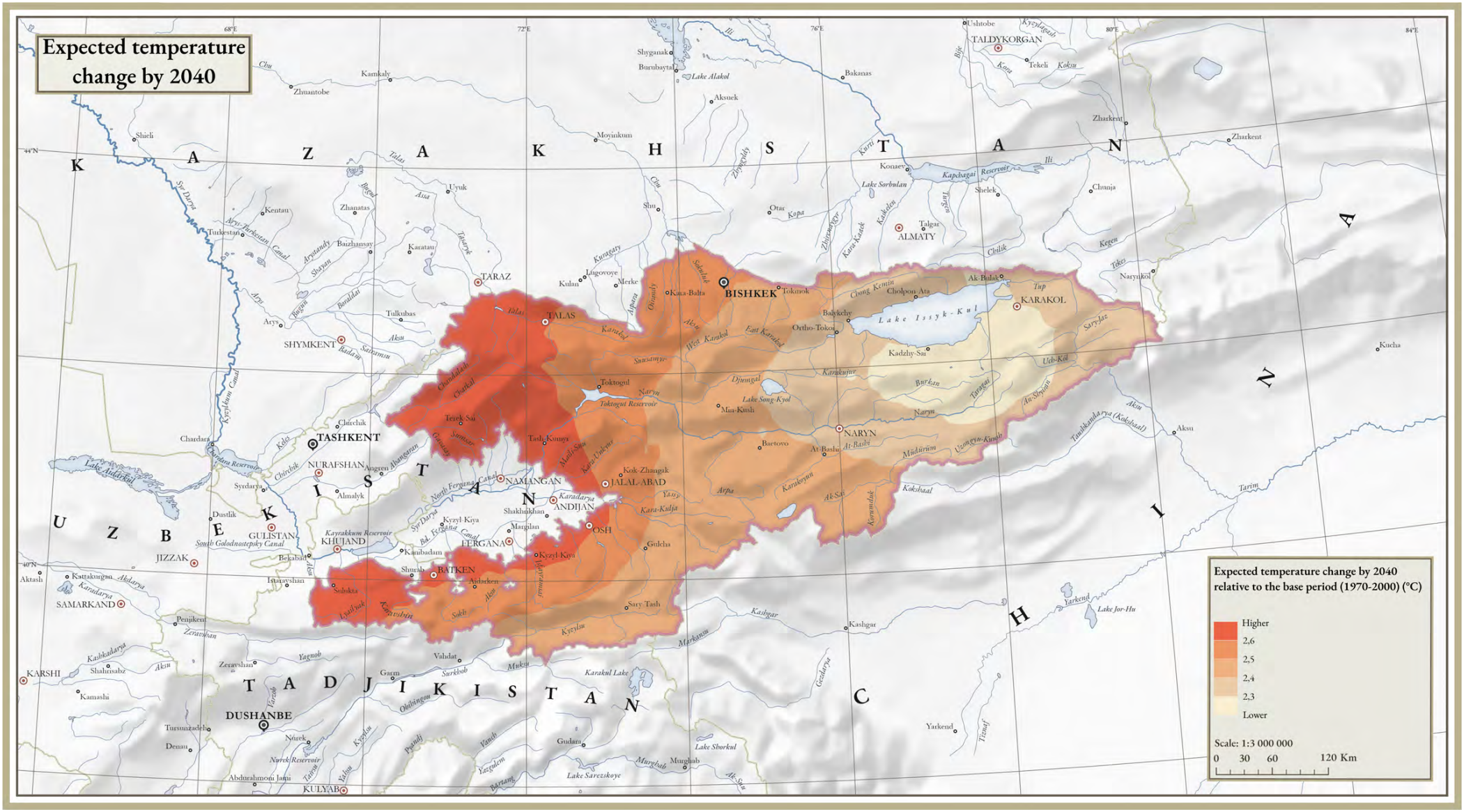
Based on Terraclimate (see note to the above map, ‘Trend of maximum air temperature, 1960–2023’). Trend is identified by the Sens method.

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Based on Terraclimate (see note to the above map, ‘Trend of maximum air temperature, 1960–2023’).

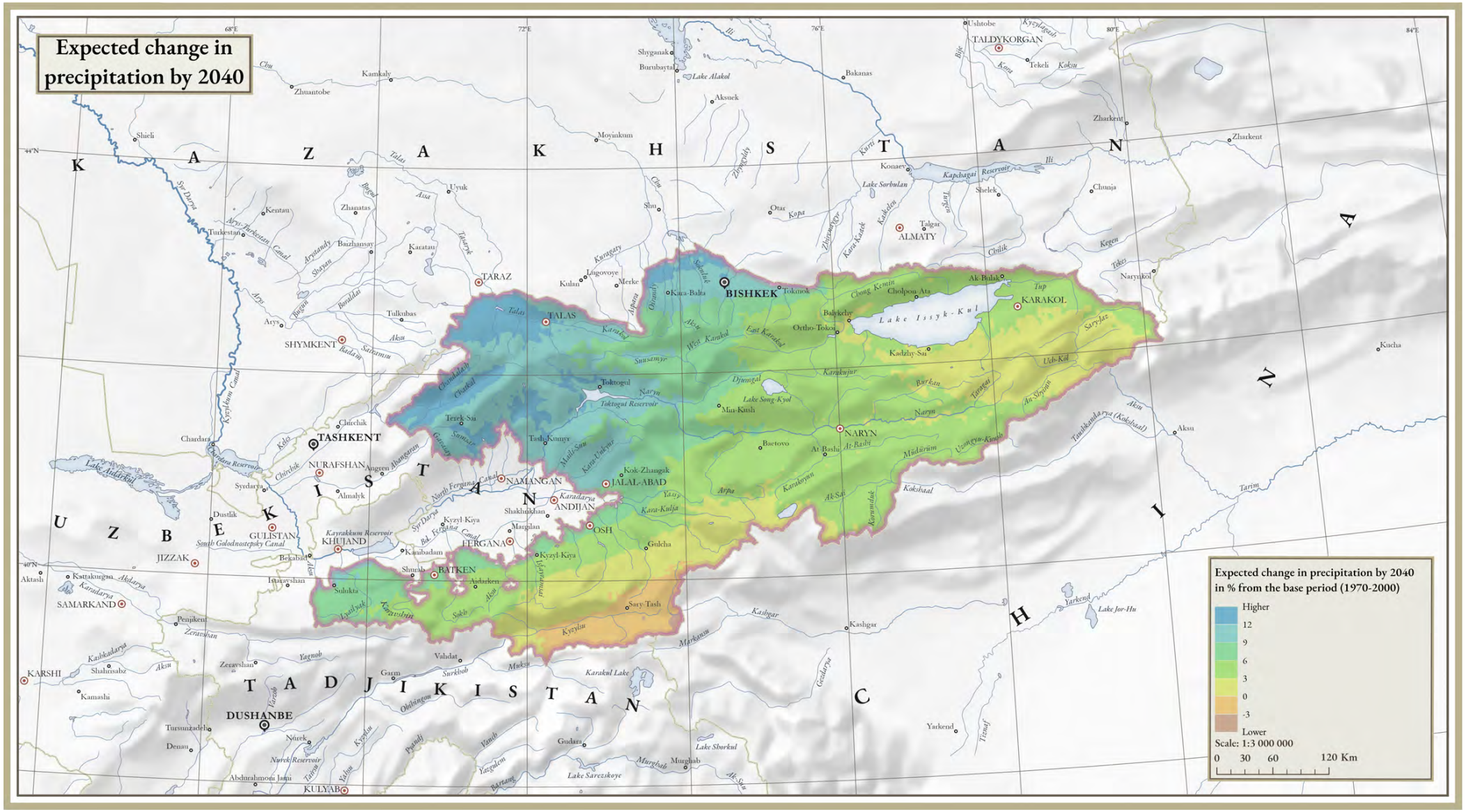
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Based on the results of the HadGEM3-GC31-LL model[10] in the implementation of the SSP126 scenario. Spatial resolution – 100 km, time span – from 2000 to 2100.

10 https://wcrp-cmip.org/cmip6/

The initial scale of the map is 1:3,000,000. The map image has been changed for the layout of the pages.



Based on the results of the HadGEM3-GC31-LL model (see note to the above map, 'Expected temperature change by 2040').

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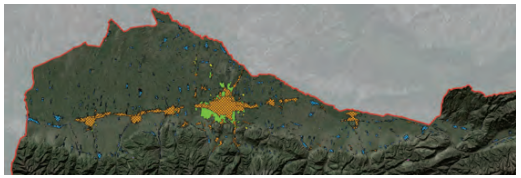


Fig 1. Dynamics of built-up areas in the Bishkek region in 1970–2023

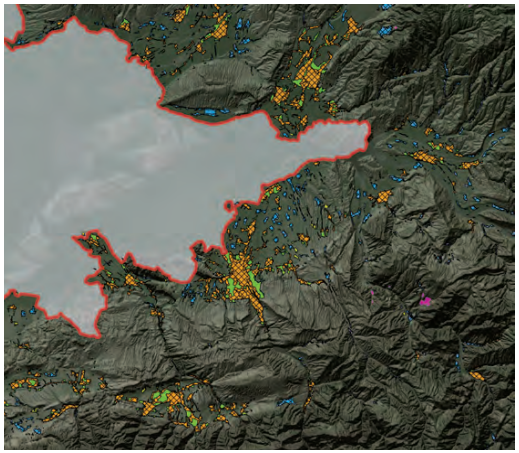


Fig 2. Dynamics of built-up areas in the Osh region in 1970–2023

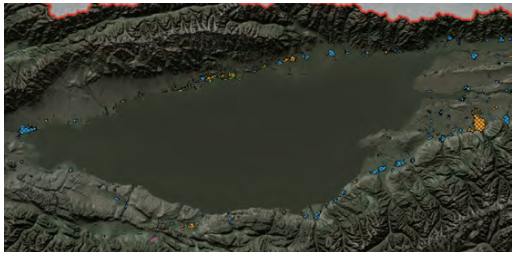
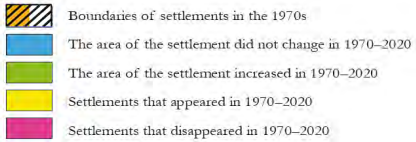


Fig 3. Dynamics of built-up areas in the Issyk-Kul region in 1970–2023



Between 2012 and 2023, the population of the Kyrgyz Republic grew by some 1.8 per cent per year and, by 2023, it stood at approximately 7.0 million[11]. The overall fertility rate in the country is 3.9 children per woman, although in rural areas this figure rises to 4.4 children. The areas of maximum annual population growth is in the cities of Osh (3.05 per cent) and Bishkek (2.8 per cent). This reflects a new wave of urbanization, characteristic of countries in which cities are becoming centres of economic growth and provide a higher quality of life than rural areas. Internal migration rates are high and, in this regard, women are much more active than men[12]. The number of Kyrgyz emigrants (mainly to Russia and Kazakhstan) is estimated to be approximately 800,000 (2022)[13].

Outside the above-mentioned cities, the Batken and Jalal-Abad regions also show significant annual population growth (more than 2 per cent) with other regions experiencing a lower rate of increase. The differences in population growth between regions may predicated on a variety of economic conditions and the availability of resources, including water, which is particularly relevant in agricultural areas. In recent years, there has been a decrease in the population growth rate in the Talas and Issyk-Kul regions.



Costume of a resident of the Alai Valley, costume of a resident of the Fergana region

In general, Kyrgyzstan is a country with a low population density but with characteristically uneven spatial distribution. The average population density in 2023 was approximately 35.2 people per km² according to the National Statistical Committee of Kyrgyzstan, however, there are sparsely populated areas (mainly mountainous areas) where this figure is much lower than the more densely populated valleys and cities *(Map. Share of built-up area to river basin area)*.

The most populated region is the Chu Valley, where there is a concentration of both industrial enterprises and agriculture. The valley accounts for 10.1 per cent of Kyrgyzstan's area but contains 31.4 per cent of the total population, including the residents of the capital, Bishkek. Another densely populated area is the Osh region, where 21 per cent of the country's population lives and the density is 50 people per km². Less densely populated regions include the Jalal-Abad, Issyk-Kul and Talas regions, where the population densities are 38.9, 33.6 and 24 people per km², respectively. Naryn is the least populated of Kyrgyzstan's regions, accounting for only 4.4 per cent of the total population, however, it is the largest of the regions of Kyrgyzstan (22.6 per cent of the country) and, as such, has a population density of only 6.8 people per km². This is due to the Naryn region being located in the remote central part of the country, in the Inner Tien Shan, which also has the highest average altitude.



Costumes of the inhabitants of the Tien Shan, Issyk-Kul Basin and Chui Valley

Over the past 10 years, the population of Kyrgyzstan has increased by 24 per cent, which has been accompanied by an increase in its population density and the rating of the country's regions in terms of population density has not undergone significant changes in this period.

There are 32 sizeable urban centres/settlements in the Republic of Kyrgyzstan, although only one, the capital Bishkek, has a population of more than 1 million (1.145 million in 2023). Other large cities include Osh (312,500 people); Jalal-Abad (129,400 people) and Kyzyl-Kiya (61,200 people). The

11 Kyrgyzstan. Brief Statistical Handbook (2023) National Statistical Committee of the Kyrgyz Republic. Bishkek.
12 Report on the results of the study 'Climate Change and Gender in the Batken Region' (2022) UNDP. Bishkek (in Russian). Отчёт по результатам исследования «Изменение климата и гендерная проблематика в Баткенской области».pdf.
13 National Statistical Committee of Kyrgyzstan (NSC KR) (2023e). Population and Housing Census of Kyrgyzstan 2022.

populations of each of the other 28 cities does not exceed 40,000 people.

There has been a significant increase in the number and area of settlements in Kyrgyzstan in recent decades *(Table 3)*. A comparison of modern satellite images and cartographic materials of the late Soviet period shows that since 1970 the total built-up area has increased by 32 per cent – from 1922 km2 to 2536.5 km². Approximately 84 per cent of this increase was due to the expansion of existing large settlements *(Map. Dynamics built-up areas, 1970–2023)*, with the remaining 16 per cent being due to the establishment of new settlements. During this period, some small (on average covering approximately 0.3 km²) separate settlements marked on the maps of the 1970s were abandoned by their inhabitants – 143 of them were identified *(Map. Disappeared settlements since 1970s)*. In contrast, more than 3200 new individual



Barskoon Pass, Kyrgyz Republic, 3828 m

Table 3. Change in the number of settlements in the regions of Kyrgyzstan, 1970– 2023

Region	Number of settlements in 1970	Number of settlements that have emerged	Number of disappeared settlements	Share of settlements that have emerged, %	Share of disappeared settlements, %
Batken	196	281	18.0	143	9.2
Chui	352	657	5.0	187	1.4
Jalal-Abad	447	475	33.0	106	7.4
Naryn	149	184	51.0	123	34.2
Osh	572	373	30.0	65	5.2
Talas	96	155	0.0	161	0.0
Issyk-Kul	202	1078	6.0	534	3.0
Kyrgyzstan	2014	3203	143	159	7.1

Table 4. Change in built-up areas in the regions of Kyrgyzstan, 1970– 2023

Region	Area in the 1970s, km²	Area in 2023, km²	Increase in built-up areas, %	Stable, km²	Emerged, km²	Disappeared, km²	Expanded, km²
Batken	166.5	285.4	71	71.2	25.8	5.6	194.0
Chui	545.0	691.6	27	215.0	33.5	0.9	444.0
Jalal-Abad	364.6	478.8	31	190.7	20.1	8.7	276.7
Naryn	99.4	135.5	36	60.3	8.6	17.7	84.3
Osh	398.3	520.2	31	149.4	19.5	8.5	359.8
Talas	121.2	142.5	18	91.0	3.9	0.0	47.7
Issyk-Kul	227.2	282.5	24	184.8	19.6	2.5	80.5
Kyrgyzstan	1 922	2536.5	32	962	131	44.0	1487



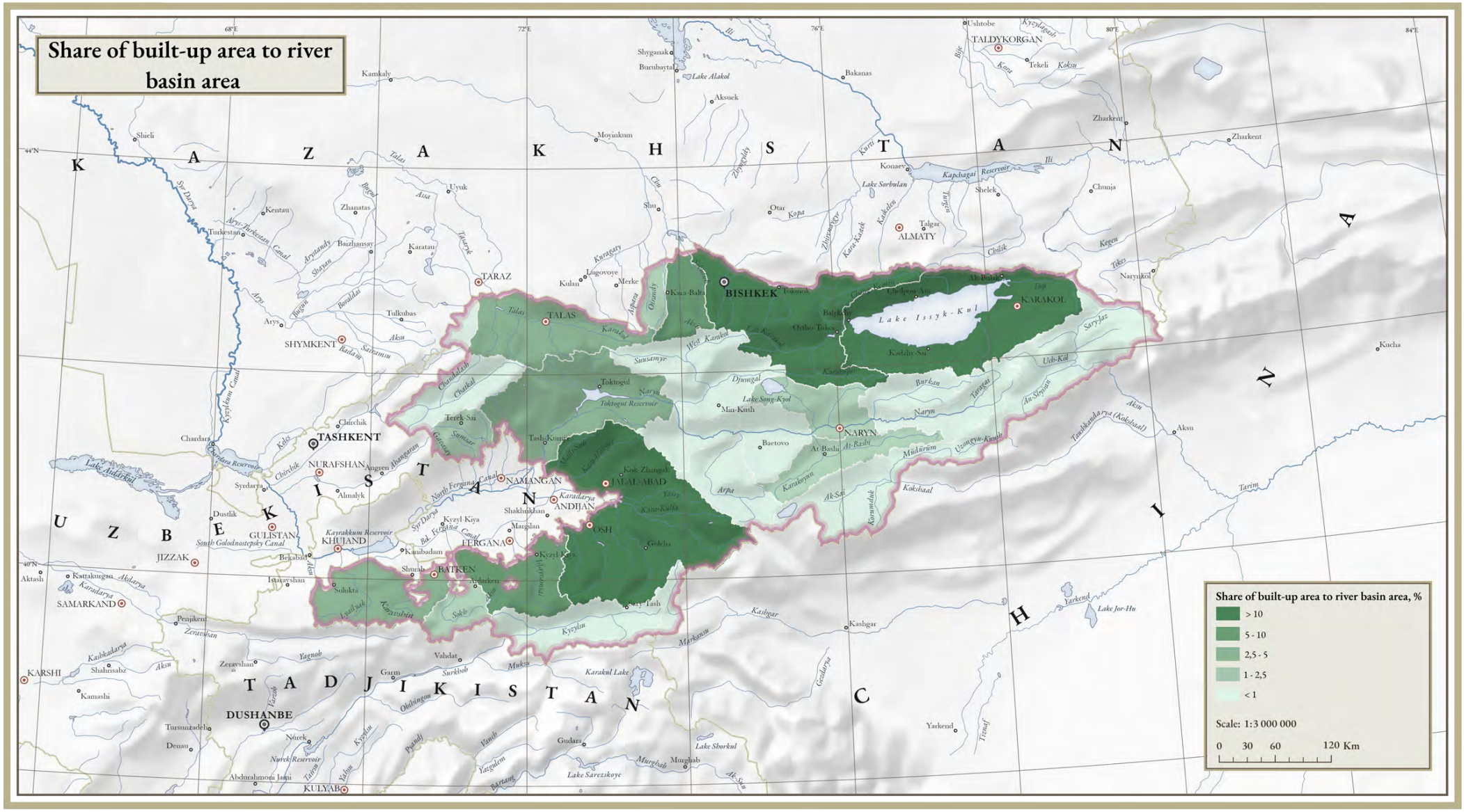
View of Bishkek from the mountains

settlements (with an average area of approximately 0.04 km²) have appeared since 1970 *(Table 4)*.

This dynamic testifies to a concentration of Kyrgyzstan's population in general: existing large settlements are expanding and in places with high population density, new relatively large settlements are being formed by the merger of smaller ones. The largest expansion of human settlements since the 1970s can be observed in regions that are centres of irrigated agriculture, namely Chui and Osh – where the urbanized area has gone up by 146.6 and 121.9 km², respectively *(Fig.1; Fig.2)*, and in Jalal-Abad, where the increase amounted to 114.2 km². Largest expansion of built-up areas took place in the Issyk-Kul region – by 184 km² *(Fig.3)*, while the smallest increases were in the Naryn and Talas regions: 36.1 and 21.3 km², respectively.

Infrastructure. For the landlocked Kyrgyz Republic, international road transport corridors are the only way to access the markets of goods and services of the CIS countries and further abroad. The most important of these roads run between Bishkek – Osh, Bishkek – Naryn – Torugart, Sary-Tash – Karamyk, Osh – Sary-Tash – Erkeshtam, Osh – Batken – Razzakov and, finally, Talas – Taraz – Suusamyr.

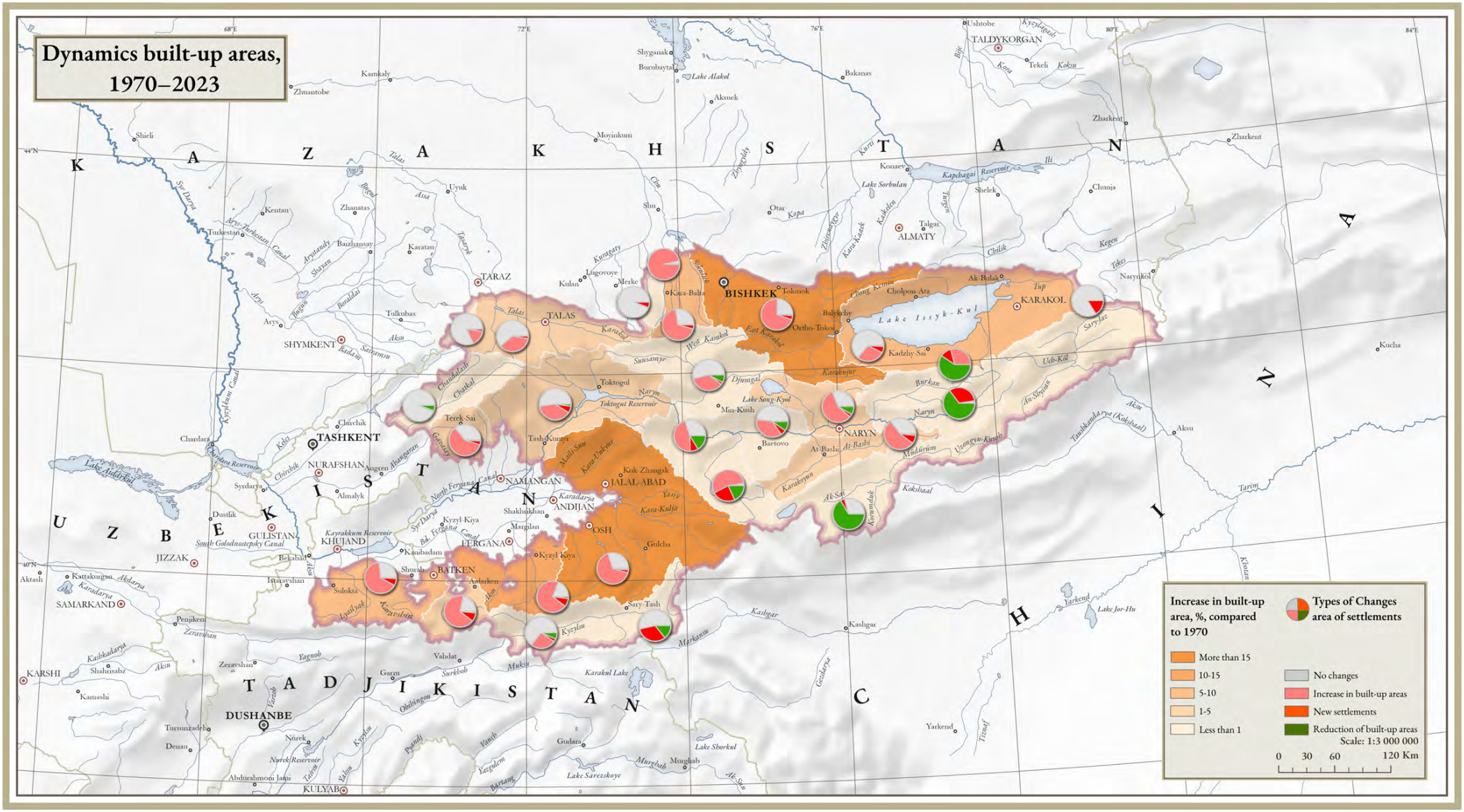
Given its difficult mountainous terrain, Kyrgyzstan has a relatively dense network of roads, some 17 km per 100 km², with a total length of 34,000 km *(Map. Road density)*. Approximately 18,800 km of these roads are public and 15,200 km belong to inner-city spaces, as well as rural settlements, industrial enterprises and other subjects. In the country, highways that are of international importance have a length of 4,163 km while nationally and locally important highways account for 5,678 km and 8,969 km (including 1,621 km of unpaved roads) of the road network, respectively.



According to the DLR World Settlement Footprint[14], obtained by classifying Sentinel 1 radar imagery and Sentinel 2 and Landsat optical imagery. Spatial resolution 10 m, time span is 1985–2020, depending on the version, catchment boundaries have a sixth level of detail according to HydroSHED data.

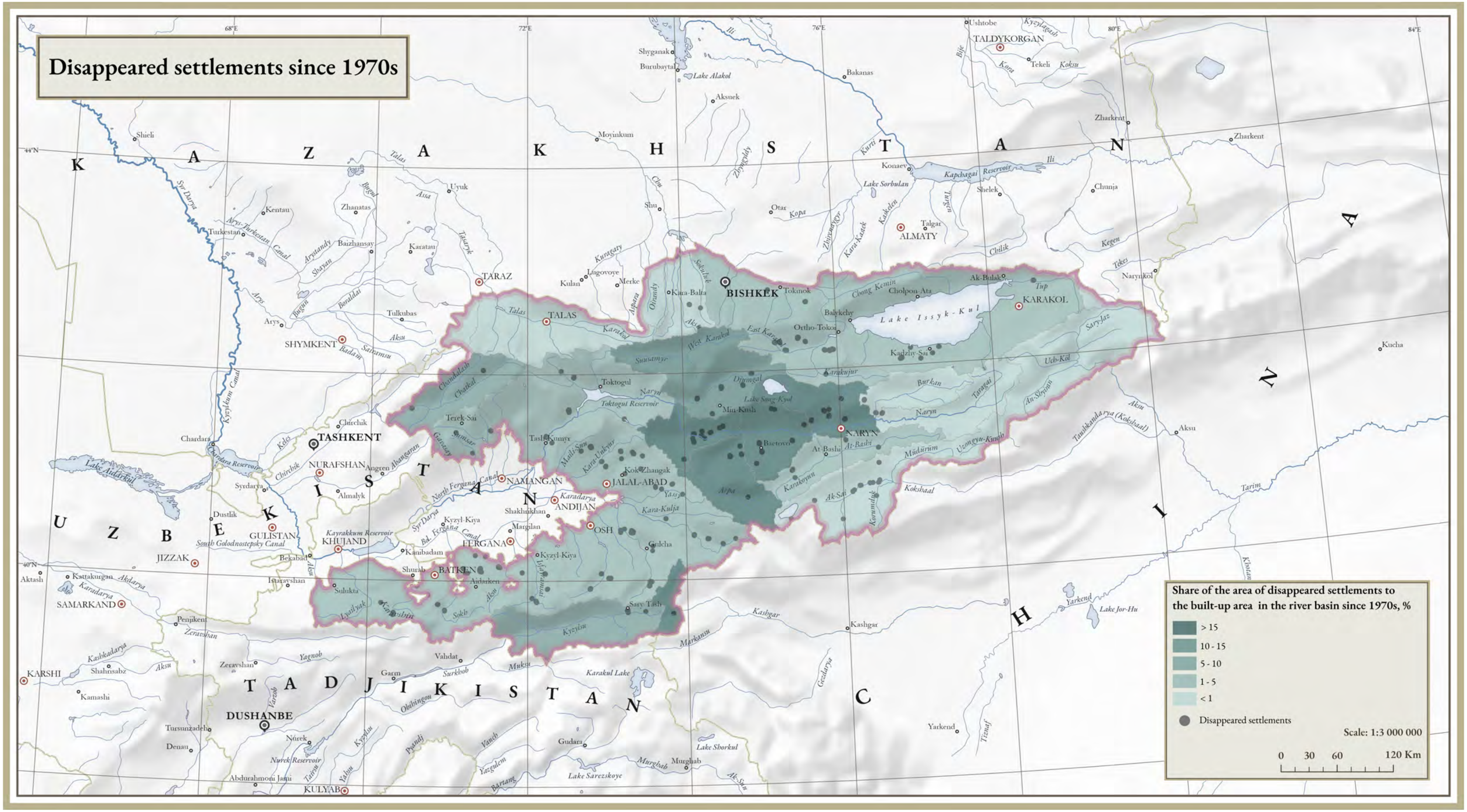
14 Marconcini et al. (2020) World Settlement Footprint (WSF) 2015. Dataset. https://doi.org/10.6084/m9.figshare.10048412.v1

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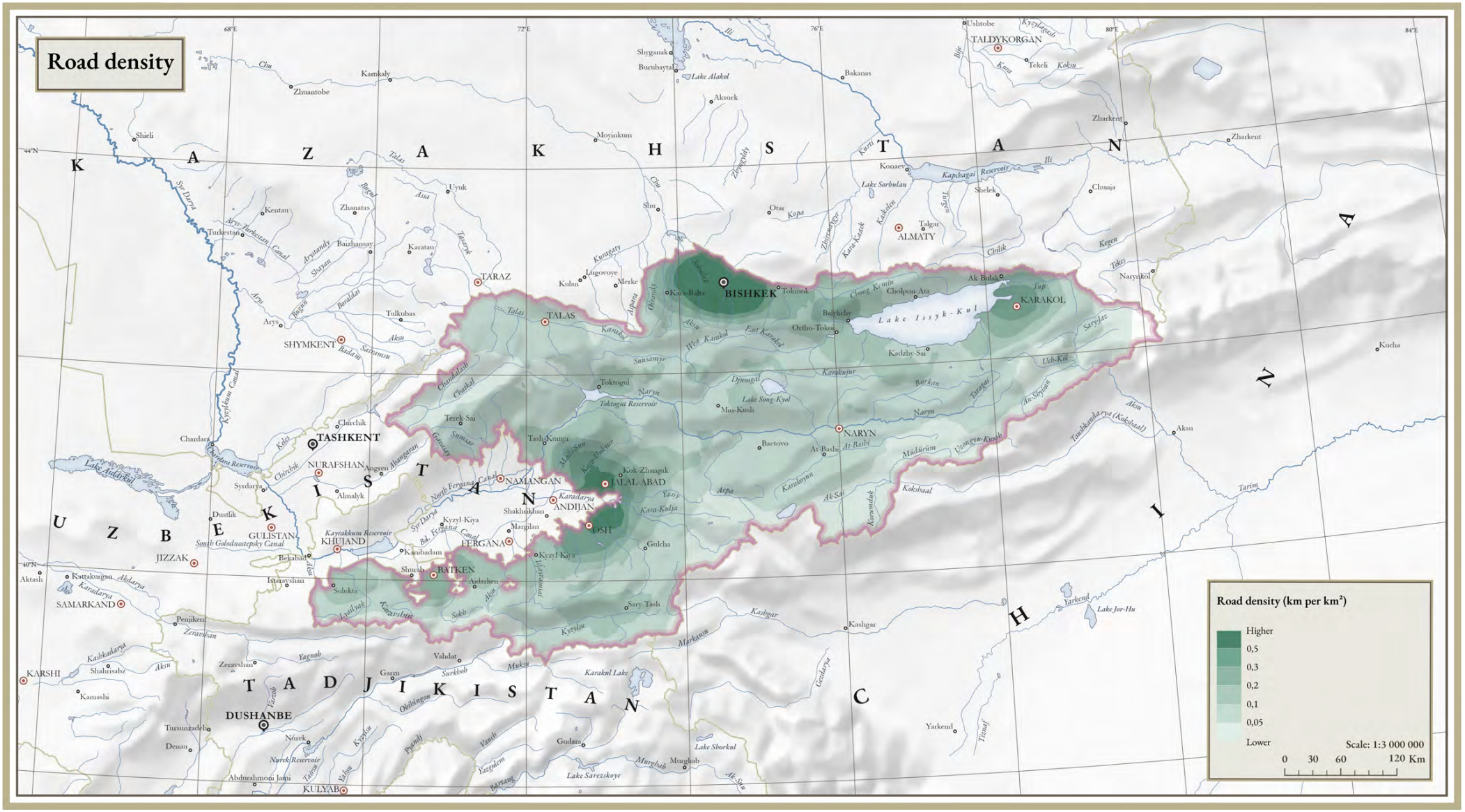
Current built-up areas according to the DLR World Settlement Footprint. The built-up areas of 1970 appear as per the maps of the General Staff of the USSR. The dynamics of development is determined by the method of GIS analysis. Watershed boundaries have a sixth level of detail according to HydroSHED data.

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See note to the above map, 'Dynamic of built-up areas, 1970–2023'.

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Based on OSM[15].

15 https://www.openstreetmap.org/

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Water Resources



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3.1. Key aspects

- Water resources are the backbone of the Kyrgyz Republic's energy sector, with between 87 and 93 per cent of electricity being generated by hydropower plants.
- The water use regime in Kyrgyzstan largely determines the water situation in downstream countries.
- There has been an increase in both the populations and the area of settlements in river valleys with a high need for irrigation.
- Despite an abundance of water resources, some river basins in Kyrgyzstan have high levels of water stress.
- There has been a significant improvement in the water supply provided to the population, however, access to sanitation facilities remains low in some regions.

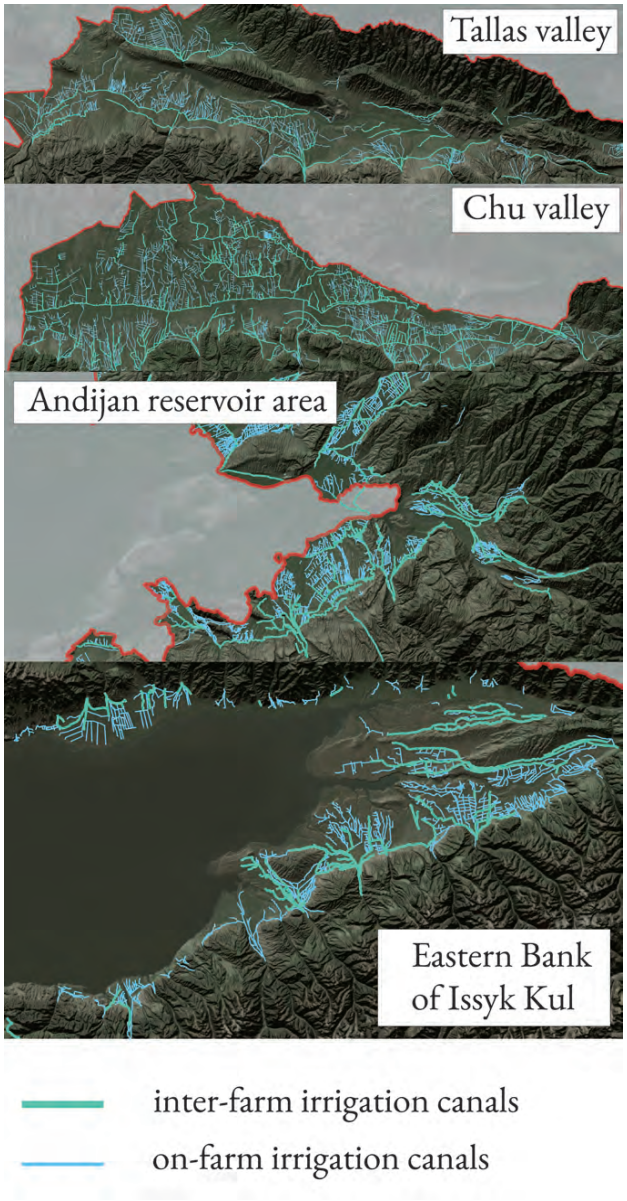


Fig. 4. Irrigated network in the main oases of Kyrgyzstan

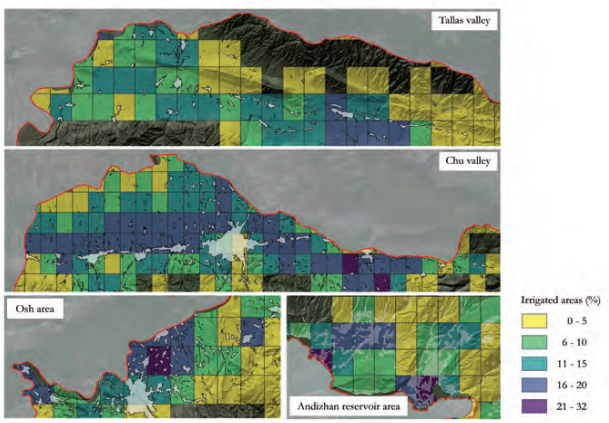


Fig. 5. Density of irrigated network in the main oases of Kyrgyzstan
See note to *Map. Irrigated areas*.

3.2. General characteristics

Many arid regions around the globe are characterized by an extremely sparse hydrographic network, in Central Asia's case, this network is approximately two metres per km². In the face of severely inadequate rainfall, transboundary rivers, which originate in high mountains covered with glaciers, play a vital role for the region whose agriculture is entirely dependent on irrigation.

One of the most serious environmental problems in Central Asia is the situation with the Aral Sea, which currently contains less than 15 per cent of the maximum recorded volume of water. Sea levels have dropped significantly and the exposed bottom leads to sandstorms that carry salt and sand over long distances. These changes affect not only the local climate and ecological situation, but also the state of soils, water bodies and glaciers in more remote regions.

The share of the three Central Asian target countries of this project in contributing surface runoff to the Aral basin is distributed as follows: the Kyrgyz Republic – 25.1 per cent, Tajikistan – 43.4 per cent and Uzbekistan – 9.6 per cent. The remaining 21.9 per cent comes from Kazakhstan, Turkmenistan and Afghanistan. The area of the Aral Sea basin is 1.5 million km² and only 0.1 million km², or 6.5 per cent, is arable land. Uzbekistan has the largest share of arable land in the basin – 51 per cent (52,100 km²) and is followed by Tajikistan with 8.6 per cent (8,700 km²). All the arable land of these two countries is located within the boundaries of the Aral Sea basin. Kyrgyzstan has the smallest area of arable land in the basin – 2,300 km² (2.3 per cent) and most of the arable land of the republic is located outside the basin boundaries[16].

Water resources are simultaneously one of the most important and vulnerable components of Kyrgyzstan's natural environment, which is changing very quickly under the influence of human activities and climate change. The well-being of the population and the sustainable development of the economy of Kyrgyzstan depend on the rational use of these resources and the preservation of their quality. The use of water resources in Kyrgyzstan is typical for other countries of the region as almost all, up to 95 per cent, are necessary for irrigated agriculture and other agricultural water supply. The remaining 5 per cent is diverted into water supply for the population (3.5 per cent) and the needs of industry (no more than 1.5 per cent). At the same time, Kyrgyzstan uses only 20 to 25 per cent of its available water reserves, providing a large transit flow to the downstream countries of the region. Another important feature of Kyrgyzstan's water use is that hydropower accounts for 87 to 93 per cent of the country's electricity production. The Lower Naryn cascade of hydroelectric power plants are of the greatest importance for the country's energy sector, together with the large Toktogul reservoir of multiannual regulation *(Map. Main hydraulic facilities. Dams)*.

The total length of the main rivers and their tributaries in Kyrgyzstan exceeds 35,000 km, with the Naryn, Karadarya, Talas and Chu being the river basins. These rivers, of which the Karadarya and Naryn basins have the largest flows *(Map. Volume of annual runoff)*, are key components of the hydrological landscape, contributing significantly to the supply of fresh water and hydropower generation. Most of the country's territory is located within transboundary river basins and, therefore, the water use regime of Kyrgyzstan largely determines the water supply for agriculture and industry in downstream Tajikistan and Uzbekistan. In addition, the flow of the Sarydjaz River, which is one of the largest transboundary (with China) rivers of the Tien Shan, is formed on the territory of Kyrgyzstan.

It should also be noted that watersheds with high water runoff are characterized by a high density of irrigated land and settlements, the observed growth of which is quite pronounced in such areas. Since the 1970s, the total area of settlements in the Karadarya and Naryn basins has increased by a third.

In Kyrgyzstan, there are more than 2000 lakes that have a total surface area of 6,836 km², a significant part of which is located in mountainous areas. The largest lake, Issyk-Kul, is in the Tien Shan Mountains in the northeast of the country while other large lakes include Son-Kul, Sary-Chelek, Chatyr-Kul and Karasu.



There are more than 12 large reservoirs in Kyrgyzstan with a total volume of 21.25 billion m³ with the largest of them, the above-mentioned Toktogul reservoir, being located on the Naryn River. It should also be noted that a significant part of the flow of the large Tajik Kayrakkum reservoir is formed in the Syr Darya basin on the territory of Kyrgyzstan *(Map. Volume of lakes and reservoirs)*.

The total length of irrigation canals in Kyrgyzstan is 5,900 km (2023) and their state, as well as that of the drainage canal network, is very important for the sustainable development of agriculture in Kyrgyzstan. There are four zones in the republic with a high density of irrigation canals: the first is near Bishkek in the Chu River valley; the second is in the Talas River valley in the north-west of the country; the third is in the area around the Andijan reservoir in the south-west of the country and the fourth is in the Issyk-Kul basin *(Map. Density of irrigation channels)*.

Irrigated land in the Kyrgyz Republic is a key element of its agricultural landscape, supporting the agrarian economy and ensuring the country's food security *(Map. Irrigated areas)*. These above-mentioned zones are distributed over geographically different territories of the republic with each one demonstrating distinctive characteristics *(Fig. 4; Fig.5)*:

1. Located in the southern part of the country, the Fergana Valley is a major centre of irrigated agriculture. The relatively flat terrain and abundant water resources, mainly coming from the Syr Darya River and its tributaries, make it highly suitable for intensive agriculture. The main crops grown here include cotton, fruits, vegetables and cereals.
2. The Chu Valley, located in the northern Kyrgyzstan, is

16 UNECE (2004) Strengthening cooperation for rational and efficient use of water and energy resources in Central Asia. effuse_en.pdf (unece.org).

another significant region with extensive irrigated agricultural activities. Fed by melting glaciers and rainfall, the Chu River is a vital source of water for irrigation and the valley is favourable for the cultivation of a variety of crops, including wheat, corn, potatoes and fodder plants.

3. The Talas Valley, located in northwest, is characterized by fertile plains and an ample water supply from the Talas River. Irrigation in this valley supports the production of cereals, potatoes, vegetables and fruits.

4. The Issyk-Kul basin, home to the largest lake in Kyrgyzstan, has a temperate climate that allows for diversified crop production, including the cultivation of cereals, potatoes and vegetables, which is facilitated by the presence of numerous (approximately 80) freshwater tributaries to the saltwater lake.

In addition to river valleys, irrigation is also practiced in some mountainous areas where terrace farming methods are used. Gravity irrigation systems using mountain streams and small rivers are often practiced in these places.

Climate change in Central Asia is expected to reduce river flows while increasing water demand due to higher levels of evaporation (evapotranspiration). The main irrigation areas already have a tense water balance *(Map. Water balance)*, although modelling results show a relatively stable water situation in the medium term (2040–2050)[17]. For the highest mountain areas, which are characterized by a predominance of runoff from glacier melt over seasonal snowmelt and minimal groundwater contribution to the total flow (approximately 2 per cent), a slight increase in the maximum discharge is predicted in the medium term and a sharp decrease in the long term (with a significant shift to an earlier date) *(Box 1)*. For high-mountain areas, for which a relatively equal share in the formation of glacier and snow cover runoff is assumed with a share of groundwater runoff of no more than 5 per cent, a constant volume of runoff is expected in the middle term and a decrease in runoff in the long term. For mid- and low-mountain areas (1,000 to 3,000 meters above sea level), in which liquid precipitation and groundwater contribute up to 10 per cent, this is expected to prevail as there will be no increase in runoff during the initial period of warming and the subsequent decrease in runoff will be weakly pronounced, the calendar shift of the flooding period will be approximately 15 days. Moreover, in the medium term, there will be a compensatory effect produced by glaciers, mollifying extreme fluctuations in runoff in mid-mountain and foothill areas in both hot dry years and in very cool humid years.

17 Third National … 2016.

Box 1. Change in the area of reservoirs in Central Asia as an indicator of climate change

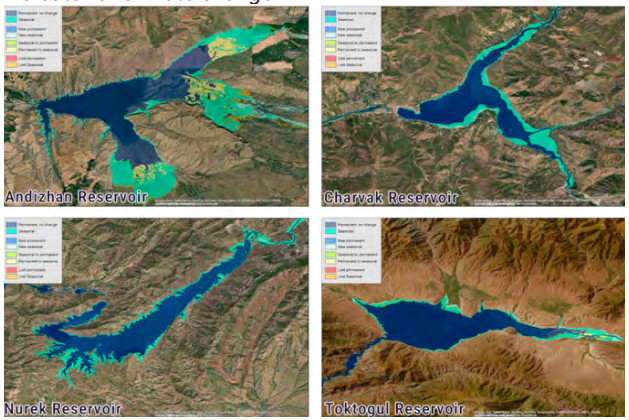


Fig. 6. Dynamics of flood zones in large reservoirs in the target countries[18]

Reservoirs in the upper reaches of rivers are hydrologically very different from those located in the lower reaches. Downstream of the reservoirs, the hydrological characteristics of rivers differ significantly from the more natural ones upstream as they are completely dependent on water from the reservoirs. Upstream of the reservoirs, the anthropogenic impact is small and, thus, the upstream area can be considered as a natural system without human intervention and changes in its hydrological regime can serve as an indicator of environmental changes in the whole catchment[19].

A reduction in the flow into reservoirs may indicate a change in the climate in the catchment area, manifested in a decrease in precipitation, a shift of the snow cover to a greater height and/or a retreat of glaciers. Excluding the base runoff, the values of each factor cannot be directly measured and are subject to modelling based on some assumptions.

The Nurek (Tajikistan, Amu Darya basin) and Toktogul (Kyrgyzstan, Syrdarya basin) reservoirs in the upper reaches have very large catchment basins with maximum observed peak inflows of up to 2200 and 1800 m³/s, respectively. The Andijan (Kyrgyzstan, Syr Darya basin) and Charvak reservoirs (Uzbekistan, Syr Darya basin) in the upper reaches have smaller drainage basins and peak inflows of 700 to 800 m³/s. The observed reduction in the flood zone of the Andijan reservoir may indicate the ongoing impacts of climate change in the Syr Darya basin *(Fig.6)*. In the case of the Syr Darya, the contribution of glaciers to inflow is only 10.7 per cent and the contribution of snowmelt is estimated at 35.2 per cent while the snow cover reacts very quickly to warming *(Table 5)*. For the Amu Darya, the contribution of glaciers to inflow is 38 per cent and the contribution of snow melting is 26.9 per cent.

18 According to the Freshwater Ecosystems Explorer (see note to the above map, 'Areas of aquatic ecosystems').

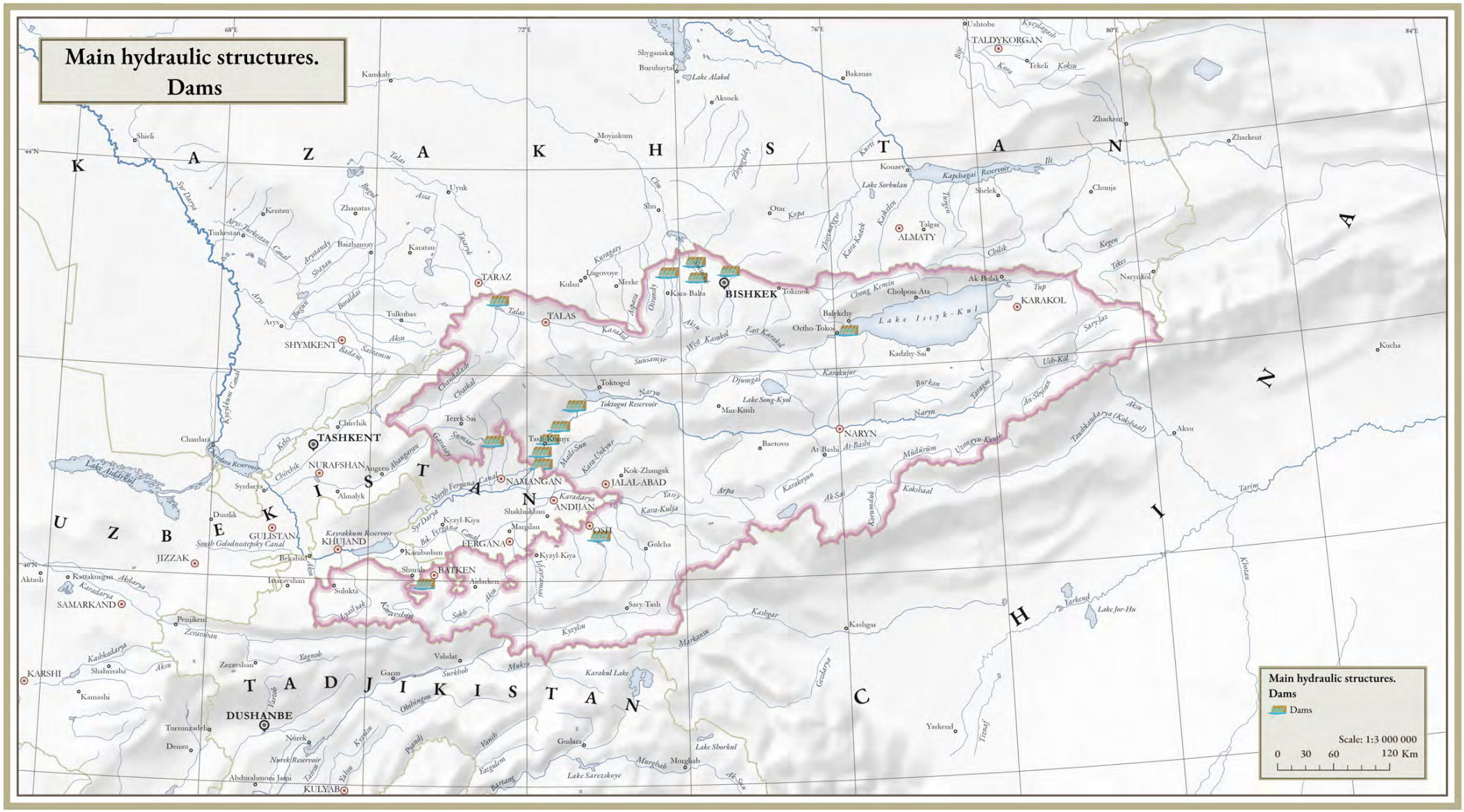
19 Immerzeel et al. (2012). Climate Change Impacts on the Upstream Water Resources of the Amu and Syr Darya River Basins. ADB. Report Future Water

Table 5. Sources of flow to the main reservoirs of Central Asia and the forecast of its reduction due to climate change[20]

Reservoir	Contribution of sources (%)				Average runoff (m³/s)	Forecast of maximum changes (%)	
	Glaciers	Snow	Rains	Ground water		2021–30	2041–50
Nurek	59.3	22.4	6.5	11.8	527	-18.8	-49.1
Toktogul	11.7	42.2	27.6	18.5	520	-9.1	-18.8
Andijan	14.8	43.4	22.3	19.6	110	-8.9	-25.2
Charvak	22.0	40.7	21.1	16.2	109	-26.4	-34

Overall flow changes for all reservoirs are likely to be negative over the next 30 years as, in general, glaciers in highland Asia are showing a negative mass balance. At present, the Toktogul and Nurek reservoirs are both showing a slight decrease in their volume, however, their future promises to be different to other reservoirs due to the very different contribution of glaciers to their inflows *(Table 5)*. By 2050, the Nurek reservoir will experience a much greater reduction in water inflow than the Toktogul reservoir, even if all the glaciers in the basin of the latter disappear. A comparison with the Charvak and Andijan reservoirs yields similar results, albeit where the former is expected to be more sensitive to climate change in the medium term due to the higher contribution of glacier melting.

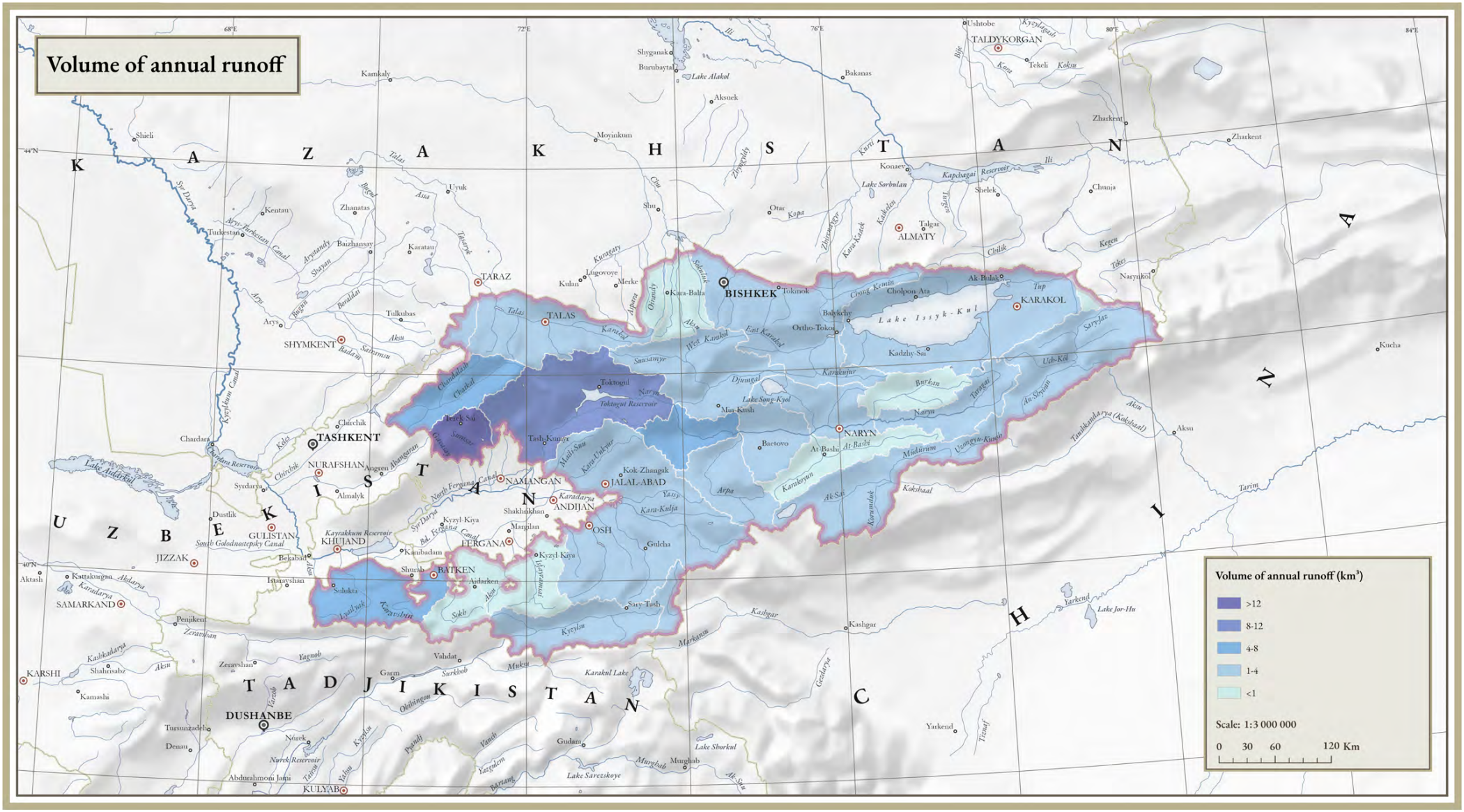
20 Ibid.



Based on the GDW database global dataset[21], comprising more than 38,000 dams, was developed by digitizing visible dams using Google Earth satellite imagery.

21 GlobalDamWatch.org - GOODD

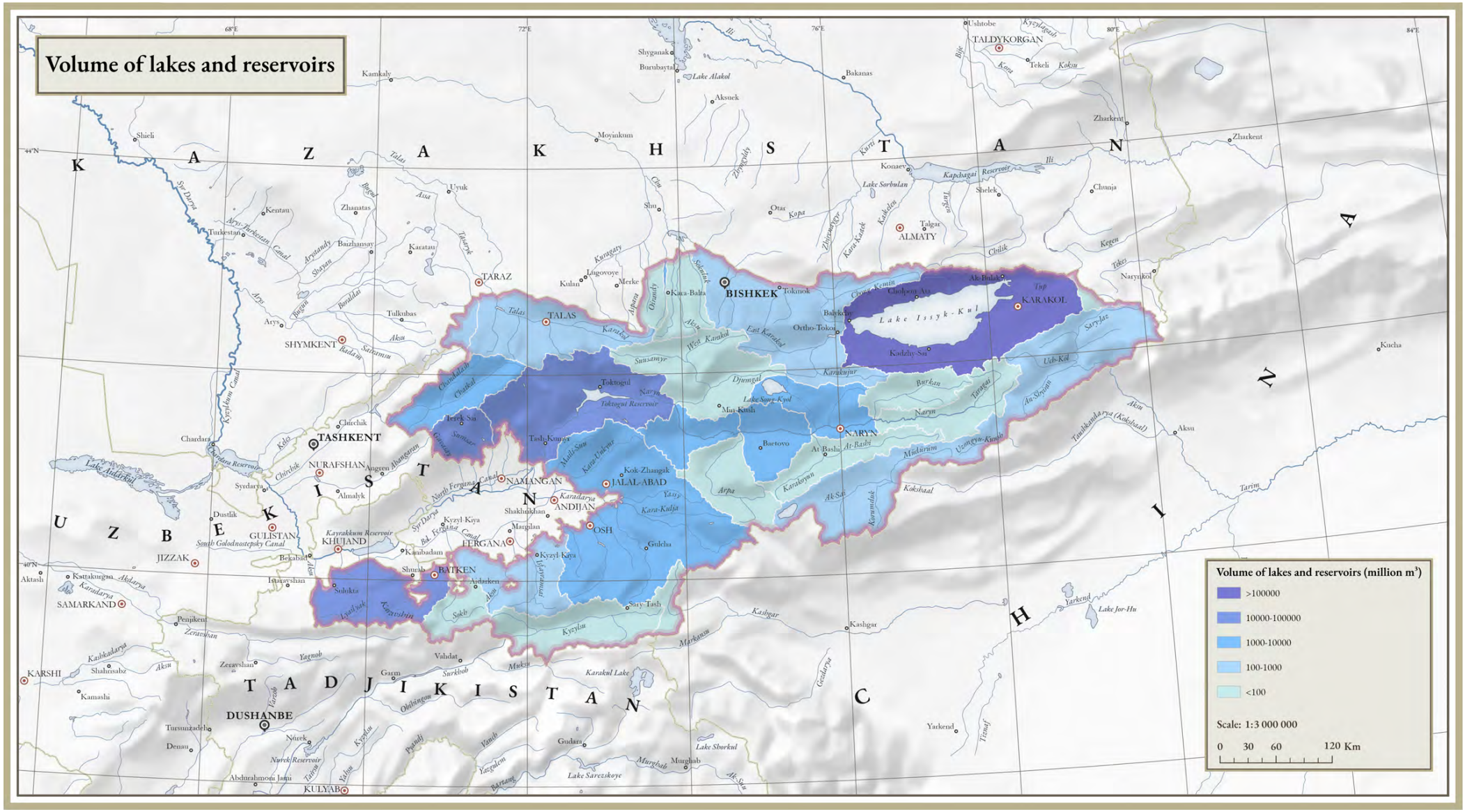
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Based on HydroSHED calculations using the WaterGAP 2.2 model[22] and considering climatic variables, underlying surface features, water use patterns, as well as the presence of natural and artificial reservoirs.

22 http://www.watergap.de/

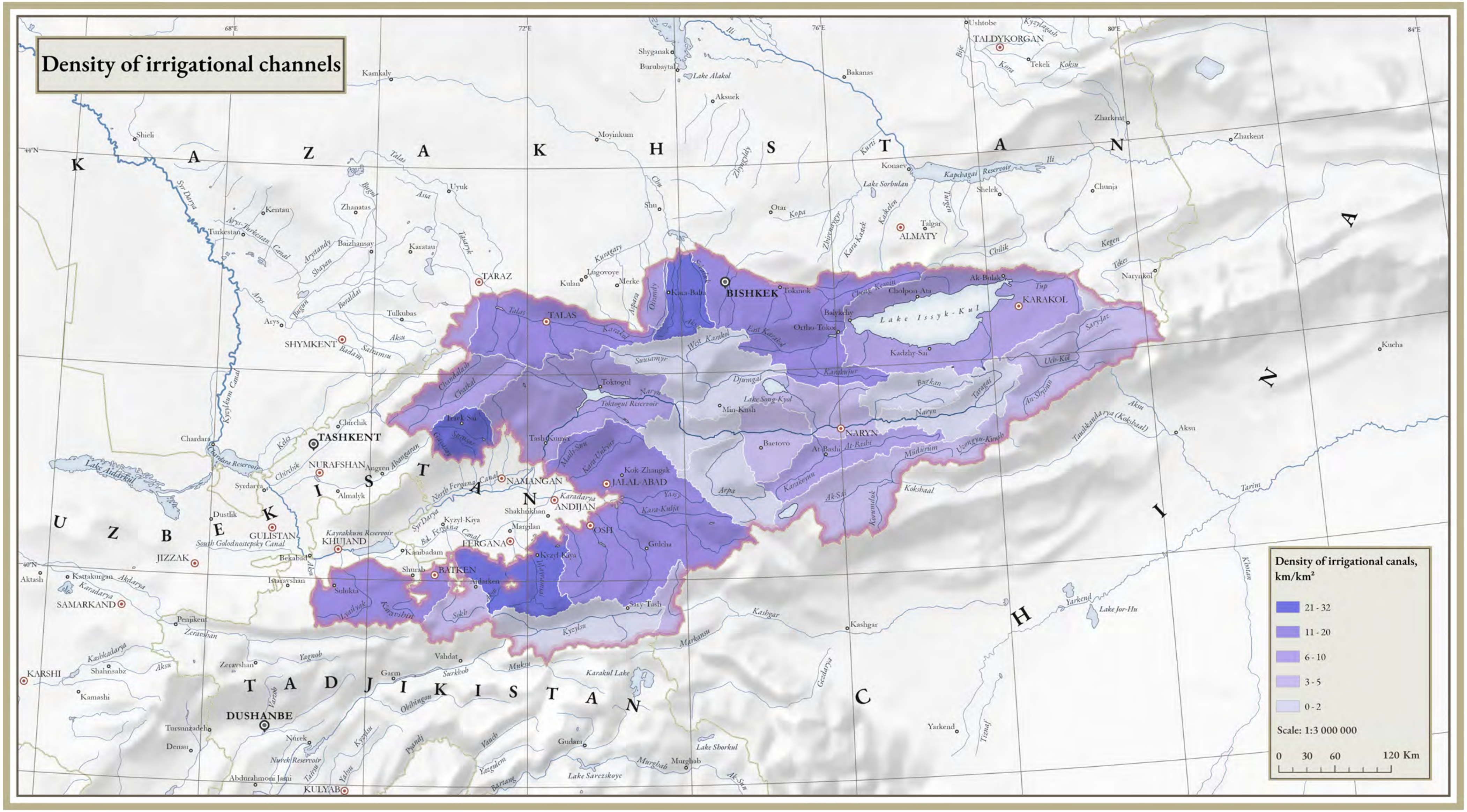
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Based on HydroSHED data and a geostatistical model[23] taking into account the size of the lakes, the features of the terrain within a radius of 100 m and the available bathymetric data.
The volume of reservoirsis based on GRanD data collected from national sources and remote sensing materials.

23 https://www.nature.com/articles/ncomms13603

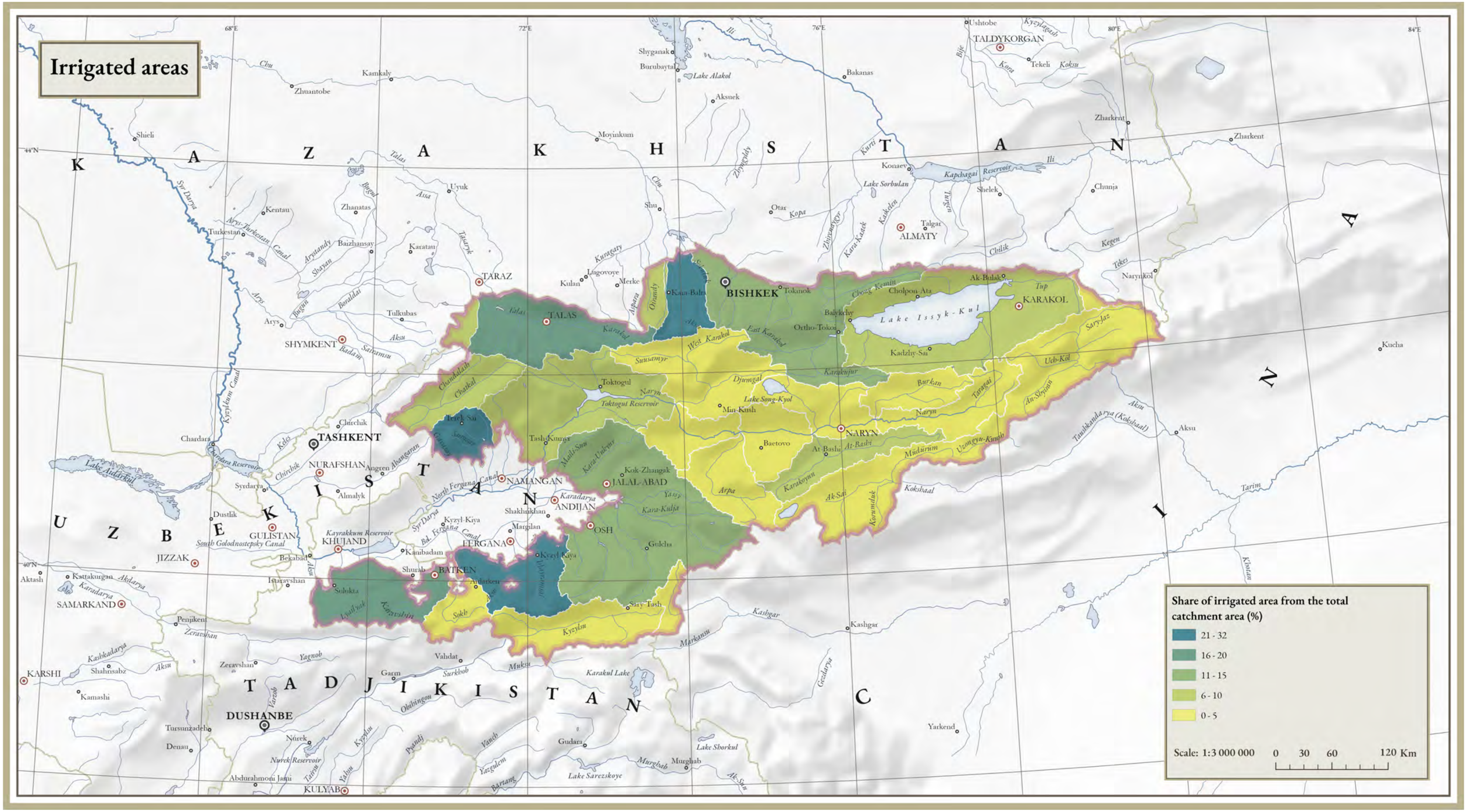
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Based on OSM[24], supplemented by visual interpretation.

24 OSM. OpenStreetMap. https://www.openstreetmap.org/#map=3/69.62/-74.90

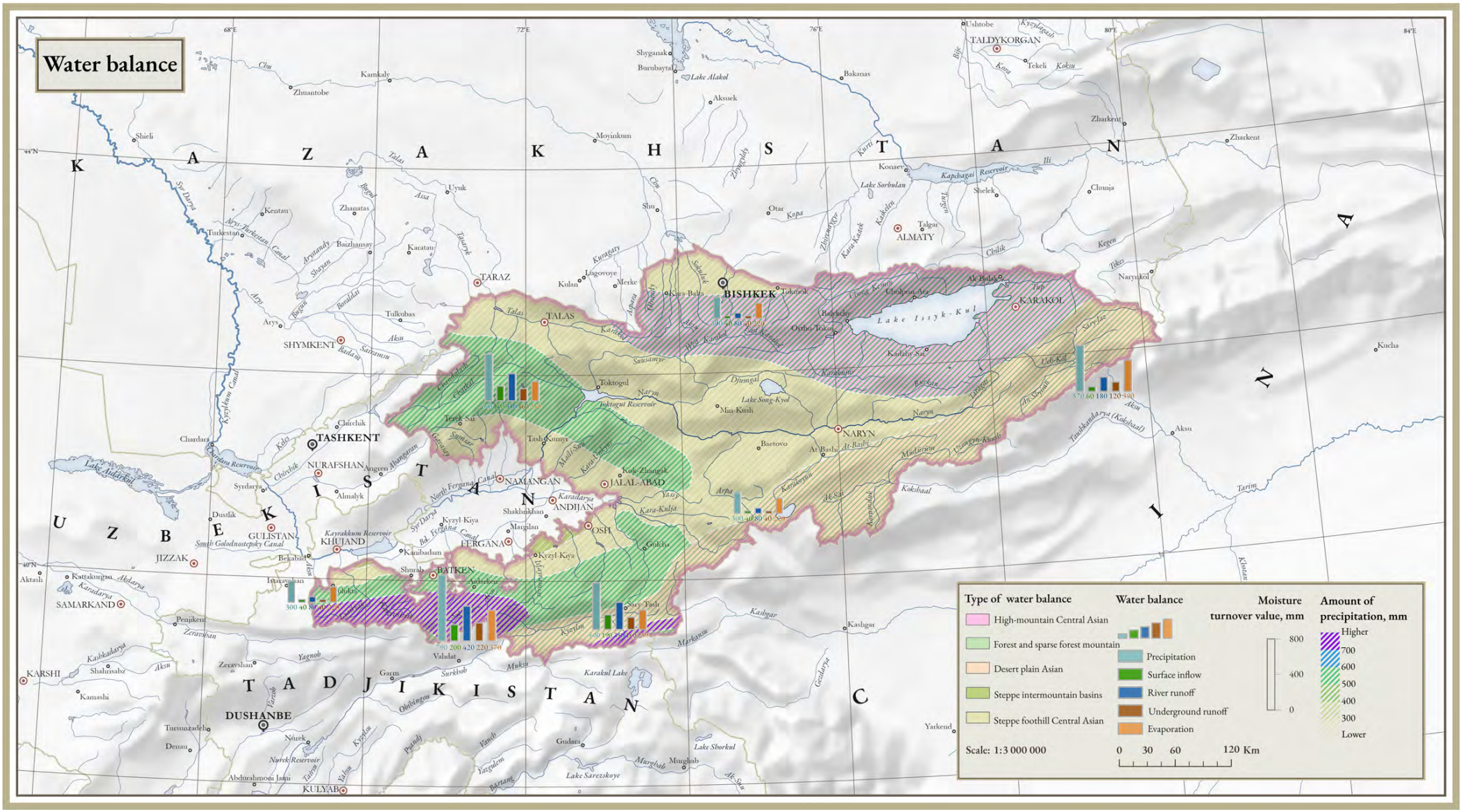
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According to the FAO's Global Map of Irrigated Areas[25] modelling, taking into account remote sensing data, landcover classifications and statistics on irrigated areas available to the FAO, in the context of States and their regions, spatial resolution of the source is five arc minutes.

25 AQUASTAT - FAO's Global Information System on Water and Agriculture. fao.org/aquastat/en/geospatial-information/global-maps-irrigated-areas/

The initial scale of the map is 1:3,000,000. The map image has been changed for the layout of the pages.



Map of the types of water balance of the USSR: [Maps]: for higher educational institutions. and preparation. for printing by Factory No. 10 of the GUGK in 1985; ed. by I.S. Osadchuk; Special. Contents. Developer. employees of Moscow State University: V.D. Bykov, Dr. Geogr. Sciences; T.G. Svatkova, Cand. Geogr. Sciences; performers: I.V. Sedelnikova, L.V. Titova.

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3.3. Progress towards the SDGs

Water resources are a key target of the national and international policies of the Kyrgyz Republic . As the republic is in the upper reaches of many rivers and is a resource-forming region for both transboundary surface and groundwater. In this regard, transboundary cooperation and integrated water resources management are an important component of sustainable development not only of the Kyrgyz Republic but of the entire region.

The global legal framework for water resources management is based on the UN Convention on the Protection and Use of Transboundary Watercourses and International Lakes (1992). The Convention provides a framework for the joint management of shared water resources and for addressing environmental problems related to transboundary waters. Among five Central Asian countries, the Convention was only ratified by the downstream States of the Syr Darya and Amu Darya rivers, namely Uzbekistan (in September 2007), Kazakhstan (in January 2000) and Turkmenistan (in August 2012). However, all the countries of the region understand the importance of international cooperation in the management of their transboundary water resources. This is evidenced by a number of agreements signed by all Central Asian countries. Among these international agreements, the most important one is the «Agreement on Cooperation in the Field of Management, Use and Protection of Water Resources in Interstate Sources» (1992) which established not only equal rights for all countries of the region to use its water resources but also their equal responsibility for the protection and rational exploitation of these resources *(Article 1)*. In particular, this agreement provides for the need to carry out agreed ecological releases in each specific year, based on its hydrological and climatic features of the year *(Article 5)*. The practical result of the agreement was the establishment of the Interstate Commission for Water Coordination (ICWC). The agreement of 1992 is also enshrined in other important regional multilateral environmental agreements, such as the 1993 Aral Sea Basin Programme, the 1994 Nukus Declaration on the Management of the Aral Sea Basin and the revised mandate of the 1999 International Fund for Saving the Aral Sea.

While most transboundary river basins in the Central Asia are not managed under bilateral agreements due to the potential of creating water conflicts at the local level, there are several bilateral agreements between countries in the region on the management of their shared water resources. The most well-known is the programme of long-term bilateral cooperation between Kyrgyzstan and Kazakhstan, with the active participation of various international organizations, within the framework of the Chu-Talas Water Commission. Another example that has had positive results is the Agreement between Kyrgyzstan and Uzbekistan on the joint use of the Orto-Tokoy reservoir in the Jalal-Abad region, which was ratified in 2018.

The domestic water policy of the Kyrgyz Republic is currently being adapted to meet the needs of the Sustainable Development Goals, in particular:

• SDG 6.5 calls for the implementation of integrated water resources management (IWRM) at all levels, including areas of transboundary cooperation by 2030. The Water Code of Kyrgyzstan stipulates the need for a basin approach in the distribution of water among all water users, however, traditionally water resources management has been and still is carried out by administrative units which, as a rule, 'cut' different water basins. Thus, the task of transitioning to true basin-wide management has not yet been realized and, consequently, indicators 6.5.1 and 6.5.2 related to this principle have not been achieved.

In the country profile on the UN SDGs for 2020, the degree of IWRM implementation in Kyrgyzstan (indicator 6.5.1) was 31.0 per cent and the share of the transboundary basin area with a valid water cooperation agreement (indicator 6.5.2) was 27.2 per cent.



Summer landscape of the mountain lake Kel-Suu

• SDG 6.4 says that by 2030 States should "significantly increase water efficiency in all sectors of the economy and ensure sustainable water supply and abstraction to address water scarcity". The target to meet this goal is dictated by two indicators: 6.4.1 (Water consumption per unit of GDP, m³/USD 1000) and 6.4.2 (Water stress level: freshwater abstraction in relation to available freshwater resources). In the 2020 UN SDG country profile, water use efficiency (WUE) was USD 0.9, a figure that is two times lower than in Uzbekistan and seven times lower than in Kazakhstan. The agricultural sector is of particular importance for this indicator due to the high level of water losses in irrigation.

Almost all of Kyrgyzstan is characterized by a moderate to high level of water stress *(Map. Water stress)*. A low (10 to 20 per cent) level of water stress is characteristic of the catchment area of the Toktogul reservoir; medium stress levels (20 to 40 per cent) are present for Issyk-Kul and Son-Kul lakes while high stress levels (40 to 80 per cent) exist in the Chu and Talas river basins, around the Andijan reservoir as well as in the areas adjacent to the Fergana Valley and the city of Osh. A significant factor of note here is the high levels of water stress that exist in transboundary water zones, large areas of irrigated land and in proximity to high-density human settlements. Nevertheless, there is a trend towards decreasing water stress in Kyrgyzstan as, over the past 20 years, this figure has decreased by an average of 15 per cent – from 65 to 50 per cent . Compared to other Central Asian countries, Kyrgyzstan is doing well in this indicator and is second only to Kazakhstan (34 per cent). The total volume of water consumption in the republic is estimated at 10 to 12 billion m³ per year, with water lost during transportation in riverbeds, canals and irrigation infrastructure being 1.7 to 2.3 billion m³, some 17 to 20 per cent of water consumed by irrigation *(Map. Water loss during transportation, 2017–2021)*.

• SDG 6.1 deals with universal and equitable access to safe and affordable drinking water. In recent years, Kyrgyzstan has made significant improvements in providing its population with access to water supplies, indicating notable progress in all its regions *(Map. Population with access to sustainable water supply)*. According to national data, the share of the population with access to safe and affordable water services increased from 92.4 per cent in 2011 to 96.35 per cent by 2022. Particularly impressive is the growth observed in the Batken region, where the share of the population with access to quality water supplies increased from 69.7 per cent in 2011 to 88.29 per cent in 2022. However, according to FAO data, only 76 per cent of the population of Kyrgyzstan has access to safe

drinking water supply in 2022. Despite some discrepancies in the figures provided by national and global sources, the FAO data also confirm the overall positive trend as from 2014 to 2021 there was an increase of 6 per cent.

High levels of water availability can be observed in the Chui and Talas regions as well as in the city of Bishkek, where access to a water supply is close to 100 per cent. Nevertheless, differences in data between national and international sources highlight the importance of harmonizing reporting methodologies to ensure the accuracy and comparability of indicators at the international level. This will allow for more effective monitoring of progress towards the SDGs and the development of targeted strategies to further improve the water supply situation in Kyrgyzstan.

Humans depend on water resources to varying degrees in their daily lives, however, this is especially salient in rural areas. Most women in rural areas are engaged in domestic duties, with only 38.5 per cent being employed, while 71.3 per cent of men are employed. Even formally employed women in rural areas are required to do more than five hours of domestic work per day. This later activity requires significant water consumption as, for example, there must be access to clean water for cooking. The delivery of water to domestic households is, in most cases (56.8 per cent), the responsibility of girls aged 15 and over. According to statistics, tap water in rural areas is infrequently supplied directly to households (19.2 per cent, compared to 73.2 per cent in urban areas), to a nearby courtyard (36.5 per cent) or, if neither of the above is applicable, from a public source that can be located a considerable distance away. However, more than 10 per cent of rural water sources used for daily domestic needs are unprotected including approximately 7 per cent drawn directly from rivers or canals, which creates an increased risk of spreading infectious diseases. Limited access to clean water and the poor sanitation which results exacerbate the situation of rural women, increases the burden of their domestic duties and ultimately negatively affects their health and employment opportunities.



Panorama of Son-Kul Lake

• SDG 6.2 requires access to adequate and equitable sanitation and hygiene services for all. Kyrgyzstan has seen a marked increase in the percentage of the population that has readily available sanitation facilities, which went from 25.41 per cent in 2011 to 40.01 per cent by 2021, indicating significant improvements in sanitation infrastructure over the decade. However, this progress has had marked regional differences as, for example, Bishkek attained a high level of access (approximately 97 to 99 per cent) by 2013 and has maintained this, which stands in stark contrast to lower rates in regions such as Batken and Jalal-Abad regions. The data also show uneven variations in gaining access to sanitation facilities, such as the sharp increase observed in the Issyk-Kul region in 2020 and the consistently gradual improvement in the Naryn region. Despite the overall positive trend, there are still problematic areas, such as the Osh region, where access to sanitation infrastructure remains low *(Map. Population with access to sustainable sanitations systems)*.

Women and children are the groups most sensitive to the availability and quality of sanitation infrastructure in rural areas. Most of the toilets in rural areas (85.3 per cent) are located in the courtyards of households, schools and administrative buildings, are unheated and do not meet either modern sanitary or hygienic requirements. This lack of safe and comfortable sanitation infrastructure creates health problems, such as urinary tract infections and other problems, that are exacerbated by low temperatures at night, especially in winter whilst also being dangerous for children.

• SDG 6.3 focuses on the reduction of pollution, elimination of discharges and minimization of releases of hazardous chemicals and materials. According to official sources , Kyrgyzstan has a high level of wastewater treatment (indicator 6.3.1), this figure already stood at 89.9 per cent in 2010 and rose to 96.97 per cent by 2022, indicating improvement in this area. Within the country, however, there are again significant regional disparities: in the Issyk-Kul, Naryn and Talas regions, as well as in Bishkek, wastewater treatment rates are consistently high and close to 100 per cent, while in the Chui and Jalal-Abad regions, the rates are lower *(Map. Wastewater treatment)*. A marked improvement occurred in the Batken region, where the level of wastewater treatment increased from 91.1 per cent in 2014 to 96.17 per

cent by 2022. Nevertheless, it is important to note a significant discrepancy between these national data and the UN SDG Country Profile[26], according to which the level of wastewater treatment in Kyrgyzstan does not exceed 20 per cent, which indicates fundamental differences in the methodologies of data collection and analysis. According to the literature, of the annual volume of wastewater of 900 to 1150 million m³, only 30 to 55 per cent of wastewater undergoes biological, physicochemical or mechanical treatment[27].

According to the Kyrgyz National Statistics Committee, indicator 6.3.2 (Proportion of water bodies with high water quality) is still under development. To date, the National Statistical Committee (2019) reported a relatively small proportion of samples that do not meet hygienic standards: 1.4 per cent for sanitary and chemical indicators, 8.6 per cent for microbiological indicators (indicator 6.1.1.2b). The SDG implementation report provides similar data[28], while a UNECE report cites data that 17 per cent of samples do not meet microbiological requirements and 11 per cent do not meet sanitary and chemical requirements, which is higher than official local statistics[29].

Sustainable Development Goal 6.b deals with support for and strengthening of the participation of citizens' self-government in improving water and sanitation management.

In this area, Kyrgyzstan has had notable results, as several public associations have been established in the country that are directly related to water resources management. In 2017, 658 local associations with a focus on this issue were registered and where, typically, their governing bodies are appointed by an election held at a general meeting of association members. One such example is the Rural Public Association of Drinking Water Consumers (RPADWCs), which was established to provide the rural population with safe drinking water. Other examples include the more than 1,800 Village Health Committees (VHCs) that work to improve the sanitary and hygiene aspects of living conditions of their respective local populations to prevent diseases related to water pollution. While the foregoing is a positive development, the representation of women in these local self-government bodies is insufficient, averaging only 36.1 per cent throughout the country. However, regional differences with respect to this

26 UN SDG Country Profile Sustainable Development Report 2024 (sdgindex.org).
27 Karimov T.K., Baigazy kyzy N.B. Karimova M.T. (2024) Ecological and sanitary safety of water supply sources of the Kyrgyz Republic. BIO Web of Conferences 107, 03007 https://doi.org/10.1051/bioconf/202410703007
28 Voluntary… (2020).
29 UNECE (2008) Second Environmental Performance Review. Bishkek.



Aerial view of the mountain lake Son-Kul

indicator are significant. The lowest participation rates are in the Batken (20.7 per cent) and Osh (22.9 per cent) regions while the highest level of participation is in the capital's Chui region, where women hold more administrative positions than men (59.9 per cent)[30].

Water User Associations (WUAs), of which there were 486 in 2017, are designed to coordinate agricultural producers on a territorial basis for the rational distribution and use of water in irrigation networks. These WUAs should each be a self-governing group of farmers cooperating to ensure the fair and equitable distribution of water between and within neighbouring WUAs located at different locations relative to irrigation canals (at the beginning, middle, end of the irrigation network). In this context, the most pressing problem is the accuracy of the calculations used to determine each WUA's water needs for irrigation *(Box 2)*.

As is the case with VHCs, the issue of skewed gender participation rates in WUAs is evident with the low representation of women in the governing bodies of these associations. However, a significant contributing factor here is the predominance of farms managed by men, which is four to nine times as many as those managed by women[31].

• SDG 6.6 seeks to protect and restore aquatic ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes by the target date of 2030.

Indicator 6.6.1 (Gradual change in the size of aquatic ecosystems) is directly related to the implementation of the Ramsar Convention, which was ratified by Kyrgyzstan in 2002. The country is also one of the three key partners (along with Kazakhstan and Turkmenistan) in the Ramsar Regional Initiative for Central Asia, a project organized to strengthen cooperation and synergies between members for the effective implementation of the Ramsar Convention and its Strategic Plan for 2016–2024 at the national and regional levels. Lakes Issyk-Kul (since 1976), Chatyr-Kul (since 2005) and Son-Kul (since 2011), which together account for approximately 90 per cent of the wetland area in the country, are included in the Ramsar List. The stability of the size of these aquatic ecosystems over time is primarily due to the basins of these very large lakes *(Map. Areas of aquatic ecosystems)*. Nevertheless, over the past 20 years, there have been trends towards the decline of aquatic ecosystems in central Kyrgyzstan, especially in the Karakoyun and Naryn river basin *(Map. Change of area of permanently flooded ecosystems relative to the base period)*. Accordingly, a noticeable positive trend can be observed in seasonally flooded ecosystems, the area of which has almost doubled compared to the baseline period *(Map. Change in the area of seasonally flooded ecosystems)*. This trend is observed in all the basins of Kyrgyzstan except for the one around the Toktogul reservoir.

30 National Gender.... (2016).
31 Ibid.

Box 2. Overestimated demand for water from WUAs in Osh region

A study from 2009[32] evaluated the efficiency of irrigation planning by four WUAs in Japalak, Zhany-Aryk, Isan, and Myrza-Azhy, each being an administrative district along the main Aravan Akbuura canal in the Osh region. The study noted that WUA irrigation planning was based on predefined irrigation water demand tables (known as 'hydromodules'), which were developed as early as the 1970s by the Central Asian Cotton Industry Research Institute.

The calculation of irrigation requirements for these 'hydromodules' was based on the average climatic conditions of the area, soil type, depth to the groundwater level and the water demands of the crops. Before the start of the irrigation season, the managers of the WUAs collected the necessary information on sown areas and crop rotations for all plots to assess ten-day and seasonal water needs.

The planned water supply project was provided to the Canal Management Organization, which had the authority to evaluate them based on the coefficients approved by the Ministry of Agriculture, Water and Manufacturing. This allowed the organization to adjust (reduce) the submitted water supply plan depending on the available water reserves in the irrigation network. The study compared planned seasonal water supplies and actual supplies with data from the FAO model (CropWat 4), which the authors consider more feasible than the Soviet method of calculating water demand.

The required water volumes calculated for each of the four WUAs using the FAO model were similar due to almost identical soil, crop and climatic conditions and each calculation returned a figure of between 4700 and 5600 m³/ha/season from 2003 to 2007. Actual water supply provided by each WUA ranged from 4500 to 7600 m³/ha/season, with the exception of the one in Myrza-Azhy in 2007. These results meant there was a big difference between was found to be required under the FAO model and what was the planned water supply. The discrepancy was created largely by the fact that the volumes of water requested by the WUAs varied greatly – from 8300 to 12100 m³/ha/season – despite each one having similar climatic and soil conditions for their respective irrigation plots (as shown by FAO calculations). On the whole, this confirms the extremely unreliable nature of calculations based on Soviet methodology *(Fig.5)*, meaning that current methods for developing water use plans (water demand) throughout Central Asia need to be reviewed and based on more realistic estimates.

32 Kazbekov et al. Evaluating planning and delivery performance of Water User Associations (WUAs) in Osh Province, Kyrgyzstan. Agric. Water Manage. (2009), doi:10.1016/j.agwat.2009.04.002.

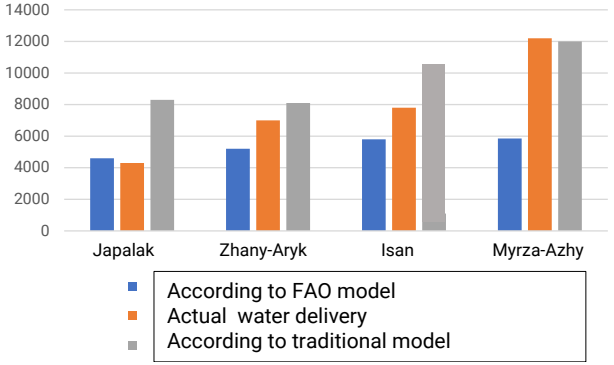
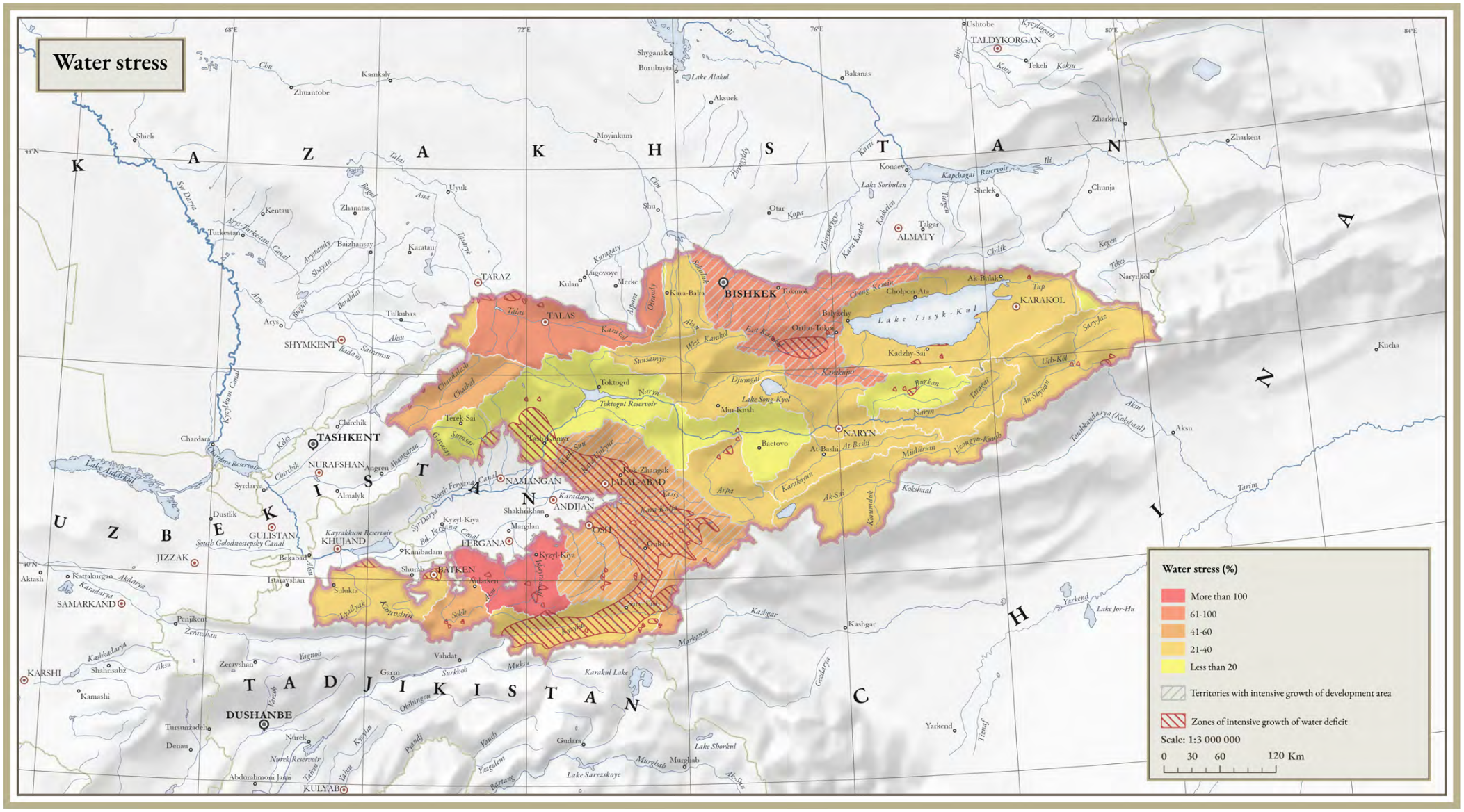


Fig. 7. Water demand calculated by different models and actual water delivery to WUAs for 2000–2007 (m³/ha/season)

3.4. Responses

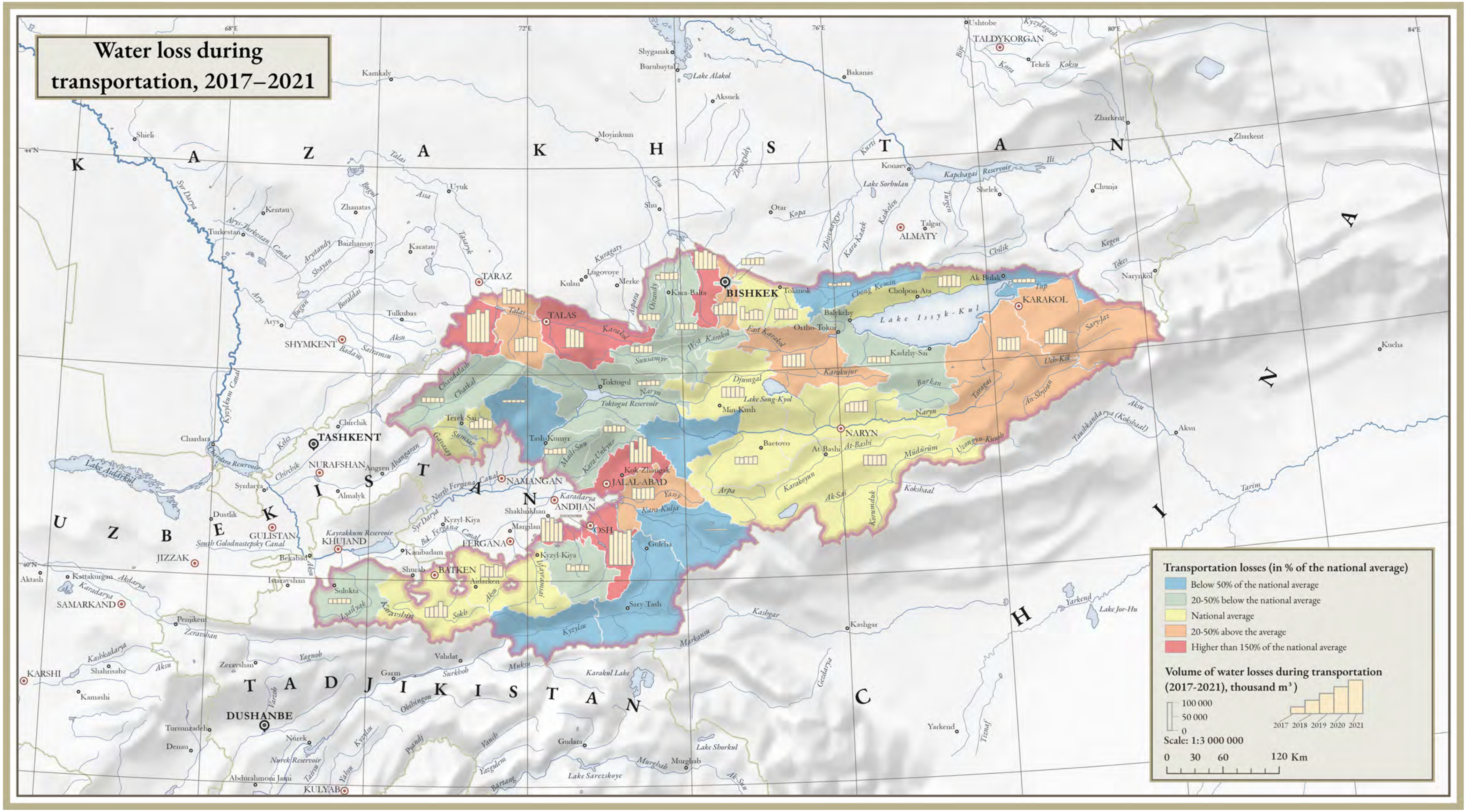
- Expansion of water allocation agreements and other arrangements between co-owner countries of river basins.
- Implementation of IWRM principles as an important component of sustainable development, not only in Kyrgyzstan but also in all neighbouring countries.
- Implementation of special measures to significantly improve water use efficiency, including the introduction of the FAO's methodology for calculating water demands in the irrigation sector.
- Guaranteeing equal representation of women in local governments and public associations dealing with safe water use.



According to Aqueduct[33] calculations based on FAO Aquastat water consumption data, ERA5 climate data (see note to the above map, 'Trend annual air temperature, 1960–2023') and runoff modelling results using the WaterGAP model (see note to the above map, 'Volume of annual runoff').

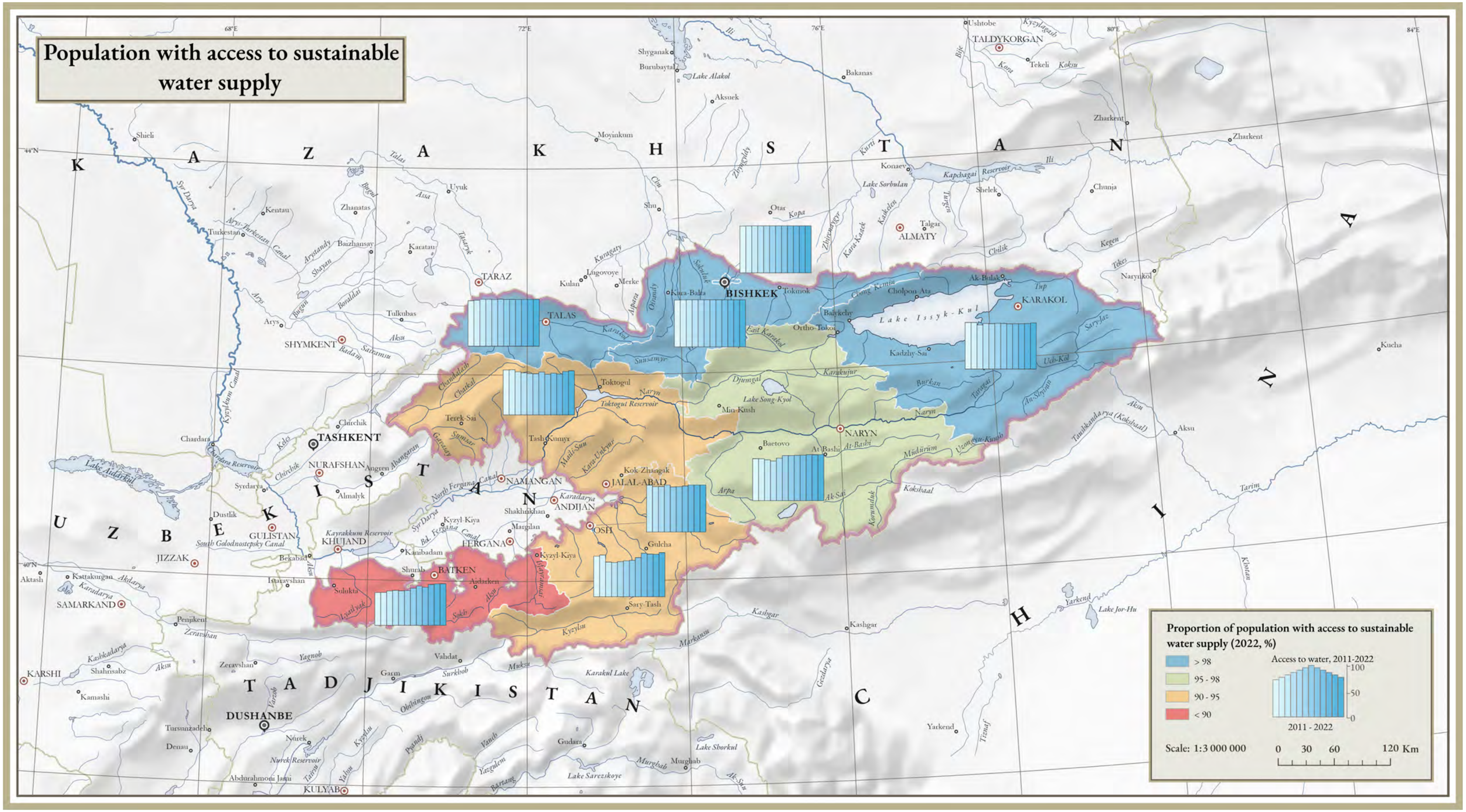
33 https://www.wri.org/research/aqueduct-40-updated-decision-relevant-global-water-risk-indicators

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National statistical data taken from 2-TP Vodkhoz.

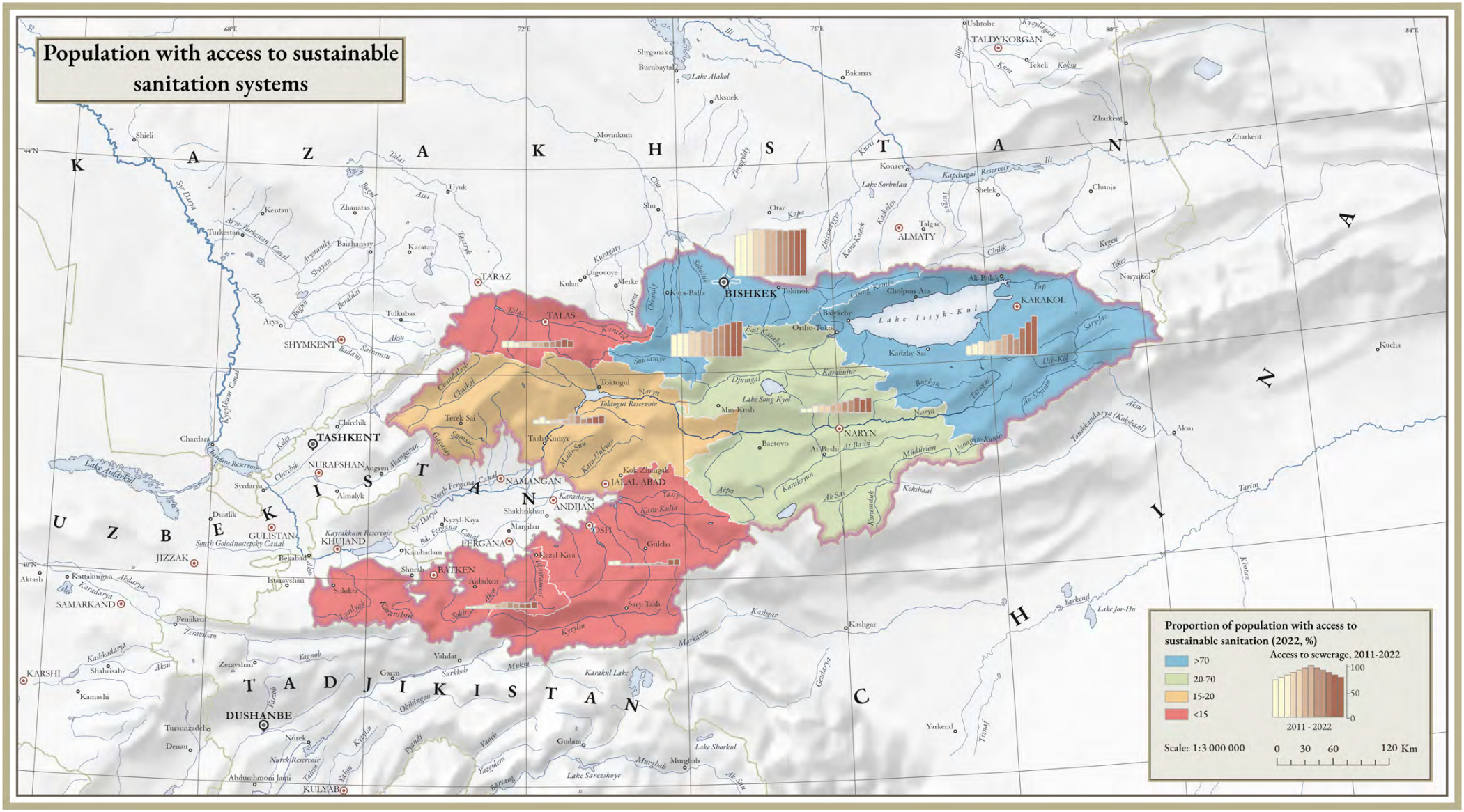
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According to the Bureau of Statistics of the Kyrgyz Republic[34].

34 https://sustainabledevelopment-kyrgyzstan.github.io/6-1-1/

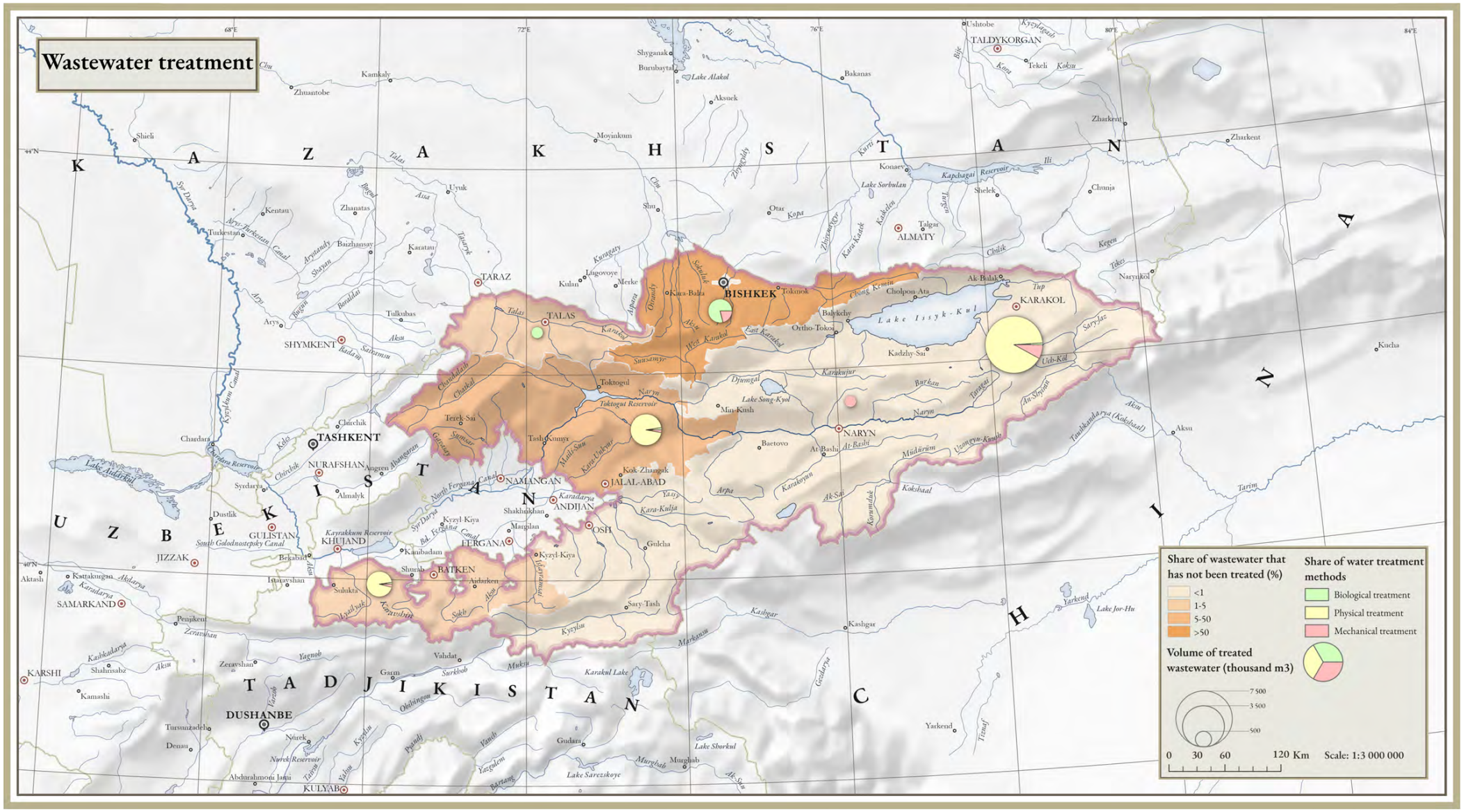
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According to the Bureau of Statistics of the Kyrgyz Republic[35].

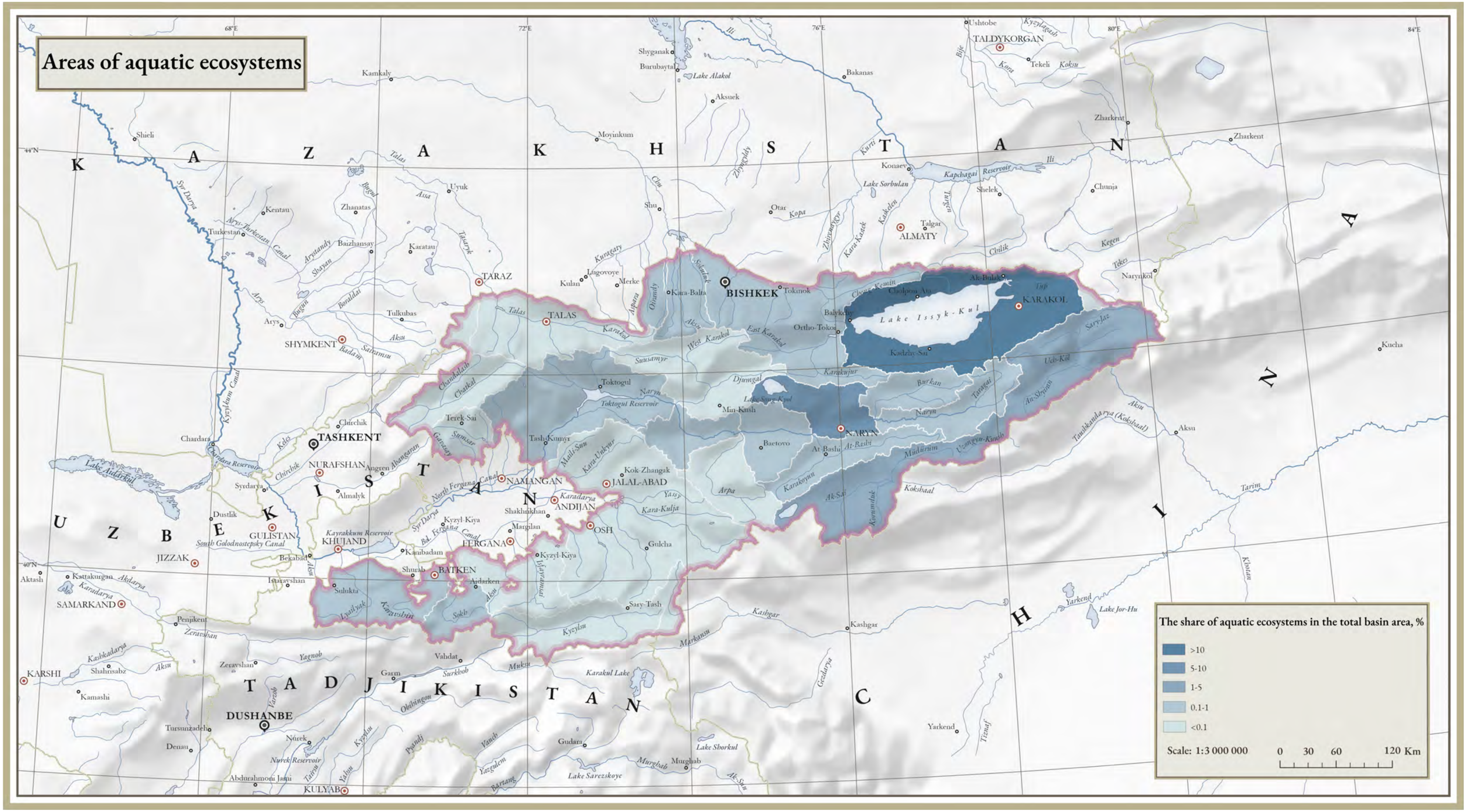
35 https://sustainabledevelopment-kyrgyzstan.github.io/6-1-1/

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National statistical data taken from 2-TP Vodkhoz.

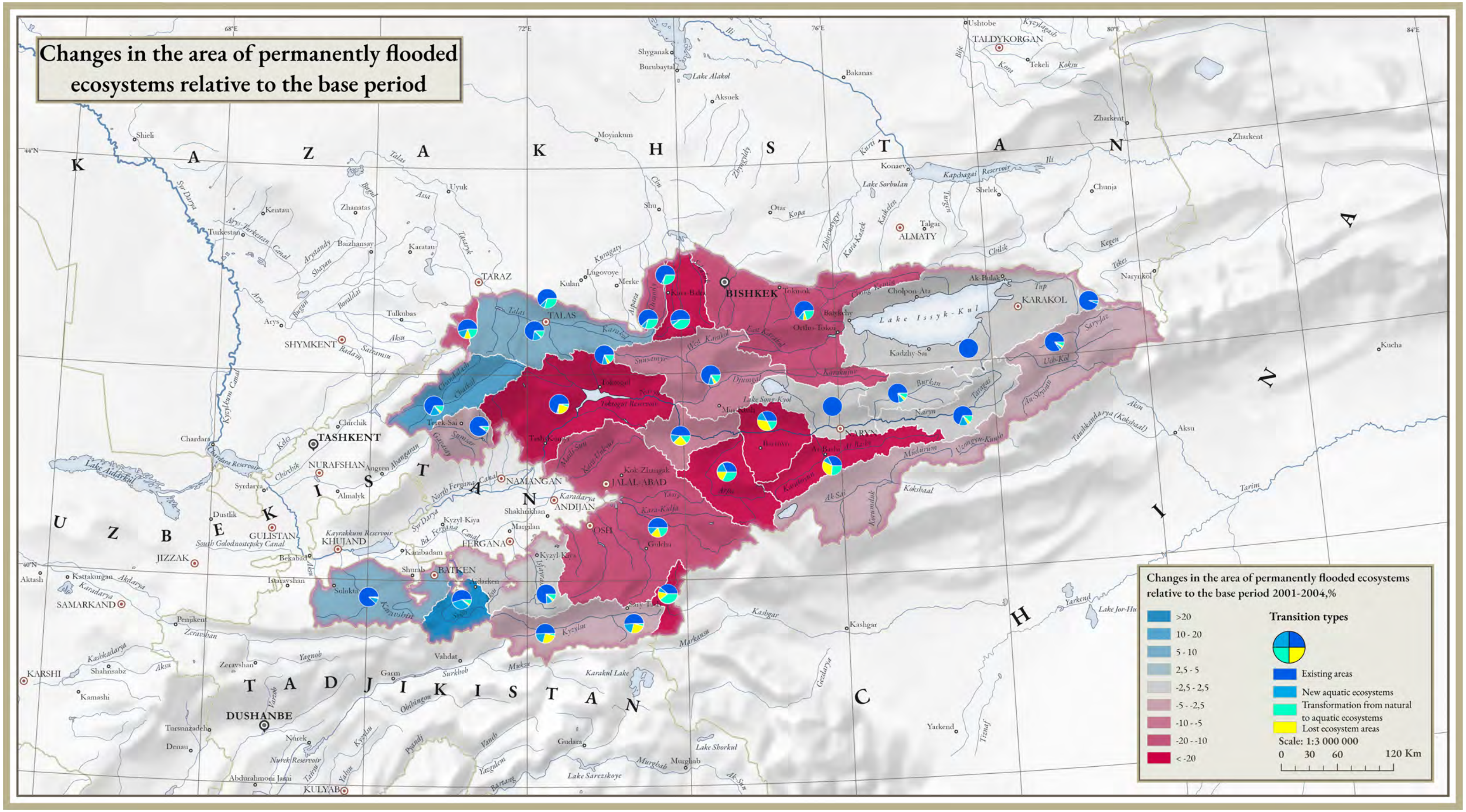
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According to Freshwater Ecosystems Explorer[36], obtained by the automatic classification of Sentinel, Landsat MODIS satellite images.

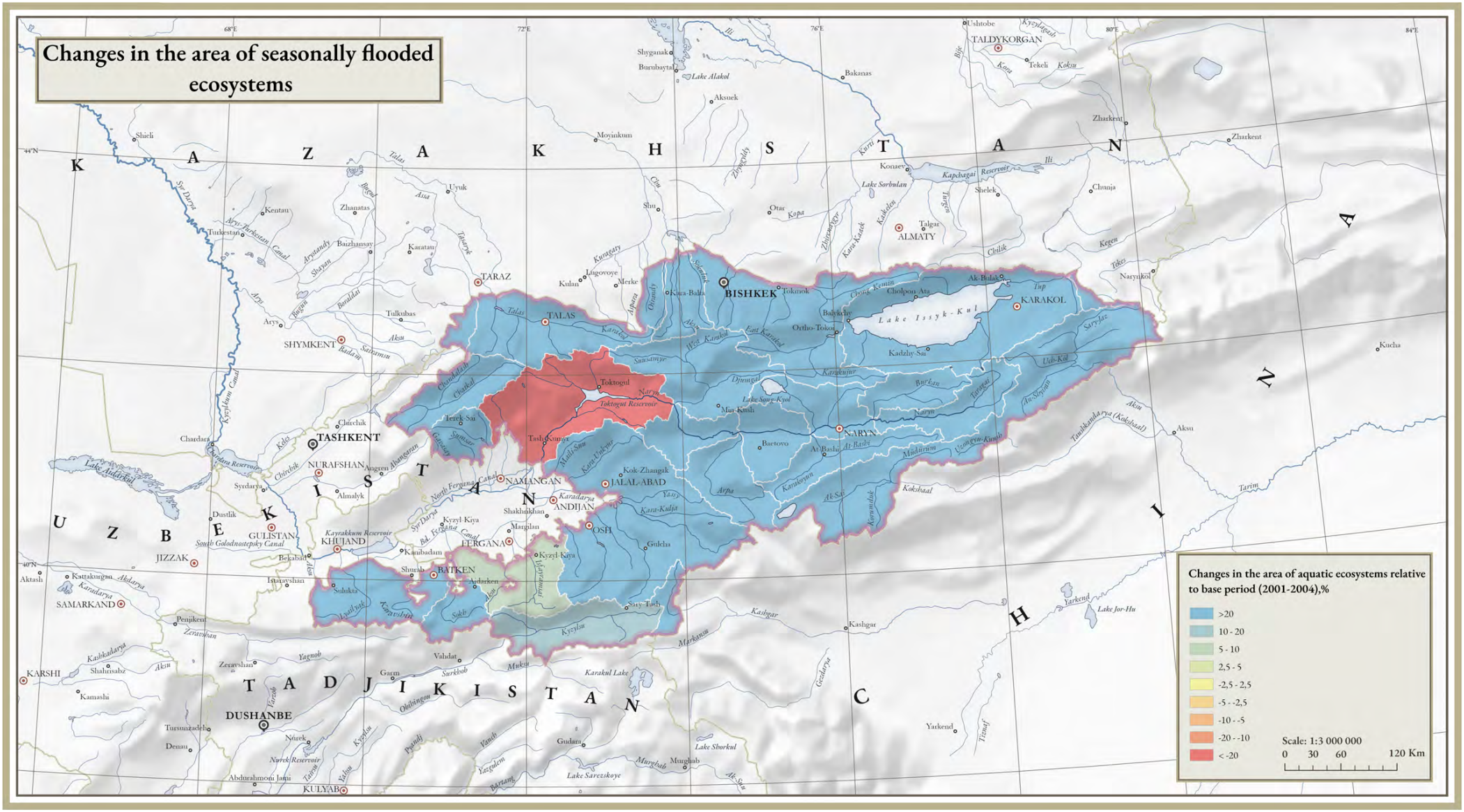
36 https://map.sdg661.app/

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According to the Freshwater Ecosystems Explorer (see note to the above map, 'Area of aquatic ecosystems').

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According to the Freshwater Ecosystems Explorer (see note to the above map, 'Area of aquatic ecosystems').

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Land Resources



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4.1. Key aspects

- In Kyrgyzstan, land resources for agricultural production are limited, as are opportunities to expand them.
- Approximately 65 per cent of the total population of the country live in rural areas, where the poverty rate is around 23.2 per cent, which is noticeably higher than in urban areas.
- Kyrgyzstan's productive lands are geographically located in arid zones, while its water resources are unevenly distributed throughout the country.
- Due to the growth of the population and the number of individual farms, the provision of arable land per capita is falling.
- Unregulated grazing of an increasing number of cattle in personal subsidiary farms has led to a decrease in the fodder productivity of pastures and to their degradation.

4.2. General characteristics

The agricultural sector plays a very important role in the economy of the Kyrgyz Republic, accounting for 12 per cent of GDP. Most of the population (65 per cent) lives in rural areas and is completely dependent on produce from their plots. At the same time, poverty rates and the share of those employed in agriculture are high compared to, for example, Kazakhstan. In 2019, 1.3 million Kyrgyzstanis lived below the poverty line, of which 73.8 per cent were residents of rural settlements.[37]

A significant amount of cotton is grown in Kyrgyzstan, Tajikistan and Uzbekistan, the three target countries of the Atlas. Central Asia is mostly desert and cotton production depends on irrigation. This has led to more than 80 per cent of arable land in these three countries being irrigated. The emphasis on intensive cotton cultivation in the countries sharing the Amu Darya and Syr Darya basins played an extremely negative role in the drying and pollution of the Aral Sea due to high water consumption and the use of fertilizers (which led to the irretrievable discharge of drainage water into endorheic depressions). Cotton monoculture in the Soviet period depleted the soil and led to serious plant diseases that adversely affect cotton yields to this day. This explains the current reduction in cotton cultivation by a third in the region. The main areas used for cotton cultivation in Kyrgyzstan are located in the Osh and Jalal-Abad regions, however, at 26,000 hectares, the area allocated is the smallest in the region but has only decreased by 10 per cent in the past 30 years. Moreover, Kyrgyzstan is the only country in the region where cotton yields have increased during this period.[38]

Food security is a top priority for the countries of the region, however, there is a general shortage of arable land with little to no opportunity to redress this situation. In the Kyrgyz Republic, for example, the main limiting factor is the complex mountainous terrain, which imposes physical limits on available arable land. As such, governments in the region aim to diversify their crop production by increasing the share of wheat and vegetables cultivated as well as the area allocated to fruit plantations. Furthermore, the governments encourages the population to actively sow and grow agricultural products on their household plots. Nevertheless, all such steps rely upon a sustainable water supply as this is essential for food security and the economic viability of agriculture.

Agricultural land in Kyrgyzstan occupies 10.8 million hectares, or 54 per cent of the republic's area. Arable land

37 Report on the results ...(2022).

38 Djanibekov N., Charyyeva S. and Sanaev G. (2020). Cotton Sector Reforms in Central Asia. IAMO Annual. Cotton sector reforms in Central Asia (iamo.de).

has an area of 1.2 million hectares, 89 per cent of which is irrigated. Pastures occupy 9.2 million hectares, of which 4.1 million hectares are distant pastures *(Map. Landcover 2021)*.[39] Large areas of the country are occupied by rock complexes devoid of developed soil and vegetation cover, particularly in the eastern Tien Shan *(Map. Bare soil)*.

Soils, the main resource for agricultural production, show significant heterogeneity due to the country's high-altitude landscape and the diversity of climatic conditions. In the lowland desert-steppe regions, grey soils predominate, which are combined with brown semi-desert and light chestnut soils *(Map. Soil types)*. These types of soils are characterized by varying degrees of fertility and humidity while also being adapted to conditions with low rainfall and high evaporation rates. Serozems (grey soils) in Kyrgyzstan occupy an important place in the agricultural sector as they are used to grow a variety of crops *(Map. Agroproductive soil groupings)*.

As altitude changes in the mountains, the soils change their composition and structure, turning into mountain medium-humus black soils, which, due to the high content of organic substances, are very fertile and ideal for horticulture and viticulture. On the slopes, under spruce forests, mountain brown-grey forest soils are formed, and under walnut and juniper forests – mountain brown soils. Both of these categories of soils are characterized by good humus content and structure which makes them suitable for forestry and fruit farming. The highest mountainous areas of the country are covered with mountain-meadow and mountain-peat soils, which support rich alpine flora and serve as pastures for cattle breeding. In the Chu Valley, serozems prevail with varying degrees of nutrient supply, a circumstance that requires a careful approach to the use of fertilizers and agricultural activities. In the highlands of Kyrgyzstan, takyr-like soils that are characterized by readily freezing and are subject to cryogenic processes are common, these soils require special attention to be paid when using them in economic activities.

As previously noted, Kyrgyzstan's productive lands are geographically located in zones with an arid climate while its water resources are unevenly distributed. This has required the creation of a large irrigation network which, given the mountainous landscape and high costs of building and maintaining reservoirs and inter-farm irrigation systems, poses a challenge for the sustainable development of the agricultural sector. Arable land per capita is only 0.3 hectares,



On a rainy summer day in the Grigorievskoye gorge in the area of spruce forests, the area of Lake Issyk-Kul

which the United Nations Conference on Sustainable Development recognizes as an indicator of an unsustainable land use zone. With an annual population growth rate of 1.4 per cent, Kyrgyzstan's arable land per capita could shrink to 0.2 hectares by 2025 and, with an average yield of 2.5 to 2.6 tons of grain per hectare, means the country will become increasingly dependent on food imports.

The average amount of arable land available to each farm decreased from 2.3 to 2.0 hectares between 2015 and 2019 due to an increase in the number of individual farms. The small-scale nature of the vast majority of agricultural producers, coupled with the constant growth in the number of farms with limited access to a key resource – land, has led to an increase in the number of inefficient farms which negatively affects agricultural production indicators in general. Kyrgyzstan's government is trying to strategically solve the problems of restoring agricultural cooperatives to increase the share of agricultural products of domestic origin in the country's large retail chains to 30 per cent by 2025.[40]

The shortage of arable land is exacerbated by areas suffering from soil degradation, which accounts for over 35 per cent of productive land, and the problem is compounded by the expansion of residential areas along with the construction of roads and other infrastructure projects. This trend may negatively affect the country's food security, particularly for the rural communities, which represent most of the population.

The poverty rate in rural areas of the Kyrgyz Republic in 2019 was 23.2 per cent, which is significantly higher than in cities (14.7 per cent). Dangerous natural phenomena, including floods, landslides, mudflows and frosts, pose a real threat to cultivated areas, resulting in the loss of affected the land from agricultural use and incurring a corresponding loss of crops and livestock.

Pasture land occupies near 85 per cent of Kyrgyzstan's agricultural land. These pastures are mainly on mountain slopes covered with herbaceous vegetation which hinders the development of erosion processes. In the republic, there is a constant increase in livestock numbers on individual farms and, consequently, an increase in the load on pastures. Exceeding the load norms by several times, in combination with unregulated grazing, leads to the degradation of pastures, with winter pastures being especially vulnerable. In the literature, there are various estimates of the degradation of rangelands where, for example, the latest estimates based on satellite images indicate that between 2000 to 2004 and 2016 to 2020, strong degradation (decrease in productivity) occurred on 82.3 per cent of winter pastures, 29.4 to 33.5 per cent of seasonal spring-autumn pastures and 43.2 per cent of summer pastures.[41]

39 Program for the Development of Pasture Economy of the Kyrgyz Republic for 2012–2015 (2012) Bishkek.

40 The Program for the Development of Agricultural Cooperation in the Kyrgyz Republic for 2023–2027 kyr220394.pdf (fao.org).

41 Pasture condition maps in Kyrgyzstan. Technical note. (2021) IFAD. Pp.15. EO4SD_condition_maps_ver2.5_ORANGE.pdf (un.org).

According to official statistics, for the period from 2006 to 2020, the number of cattle in Kyrgyzstan increased by 46 per cent while the number of small ruminants increased by 55 per cent. However, the actual increase in the number of these domestic animals is likely much higher than that given in official statistics *(Box 3)*. In general, the growth of meat and milk production is provided almost exclusively by increasing the number of animals and, given the lack of high-quality fodder and inefficient use of the natural fodder base, this places an even more excessive load on pastures in the immediate vicinity (within a radius of 2.5 km) of settlements. This load is also further exacerbated by the predominance of small cattle and the high cost of driving them to summer mountain pastures.

The livestock sector is a major contributor to anthropogenic greenhouse gas emissions in Kyrgyzstan, amounting to 4.1 million tons, or 26 per cent of the country's greenhouse gas emissions.[42] Over the past decade, this contribution has increased due to the constant increase in the number of livestock and associated animal waste.

Box 3. Real pressures on pastures are likely to be grossly underestimated, especially in the Jalal-Abad region[43]

Most agricultural land is pasture and, therefore, the state of land resources depends to a large extent on the management of this type of land. To establish a system of rational and responsible management, the 2009 'Law On Pastures' was drafted and adopted, which is associated with the emergence of Association of Pasture Users (APUs) and their executive bodies – pasture committees (PCs). The organ of an APU are democratically elected. Thus, the law was aimed at strengthening the role of local authorities and public organizations in pasture management.

Prior to the adoption of this law, Kyrgyzstan's pasture management was carried out in a complex way: winter use at the village level was controlled by local governments, spring and autumn pastures were leased from district state administrations, and remote summer pastures were managed by regional state administrations. Local communities and pasture users were excluded from the decision-making process. This was thought to be the main reason for the unsustainable use of pastures, which manifested itself in many local conflicts over pastures. Furthermore, the low accuracy of national livestock statistics remains a critical problem and contributes negatively to the sustainable use of pastures.

The main sources of these national statistics are APUs and their executive bodies – the PCs, which transmit primary data to the local, district, regional and national levels. The problem is that primary data on the number of livestock can be underestimated by pasture users to evade payment for pasture usage and to receive poverty subsidies. However, reliable data on livestock numbers is needed by the PCs to draw up sustainable plans and receive proper payments as using under reported livestock numbers leads to the overloading and degradation of pastures, causing conflicts within and between local communities.

A report published in 2013 (four years after the adoption of the 'Law on Pastures') shows very low accuracy of data on the number of livestock as recorded in five settlements in the Batken region, two in the Naryn region and five in the Jalal-Abad region. Estimates of the real number of grazing cattle were determined using interviews with the chairmen and members of both the relevant PCs and PUAs. All 12 settlements were found to have provided highly distorted statistics regarding their livestock numbers. The largest undercount was from a settlement in the Jalal-Abad region, which reported 2645 animals in pasture whereas the actual number was 6557 (a difference of 247.9 per cent). On average, for every 100 declared head of livestock there are 45 unregistered, means an average of 31 per cent of livestock are hidden from PCs and not reflected in their data.

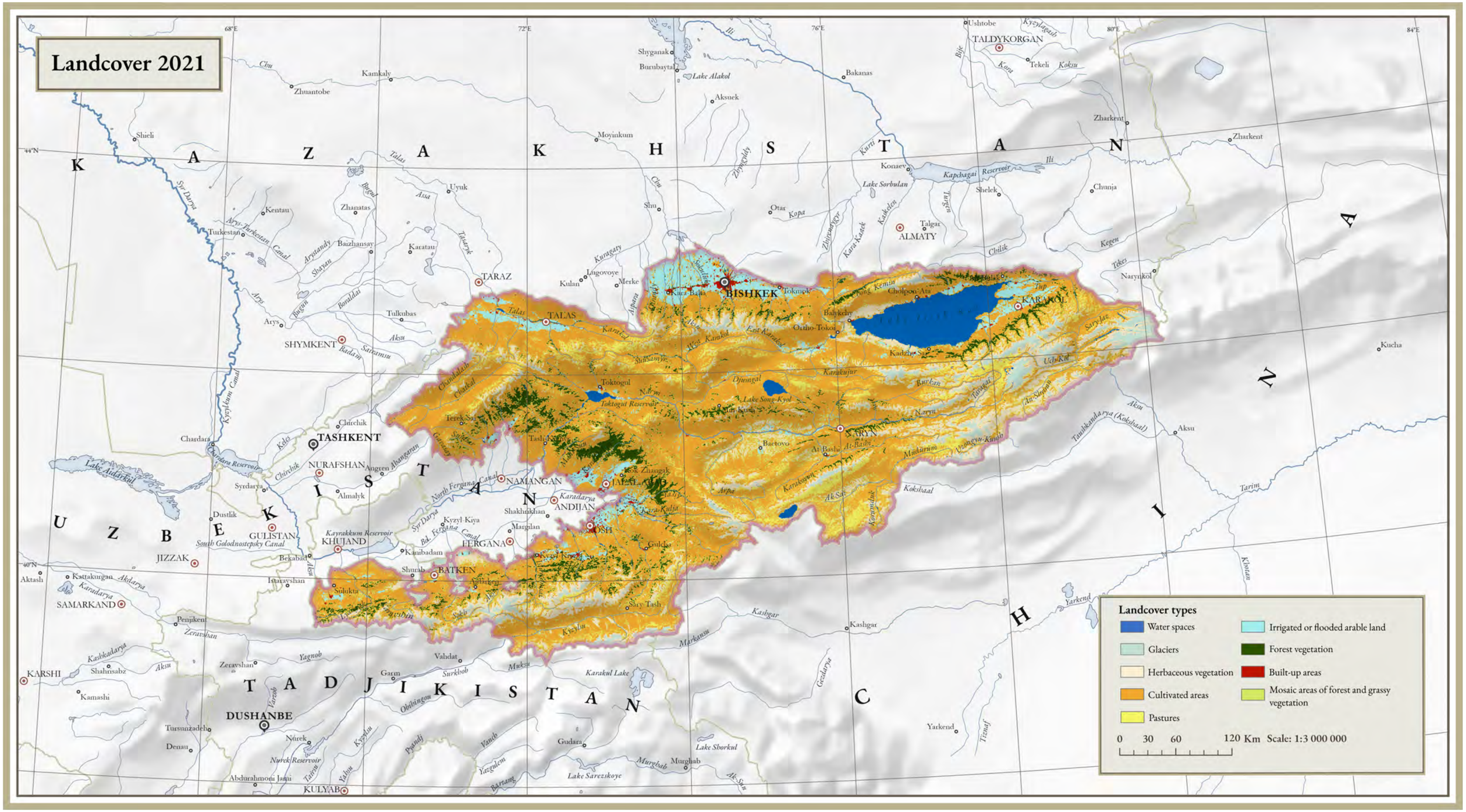


Issyk-Ata Gorge

42 Lopes et al. (2021) Understanding the role of ruminant systems on greenhouse gas emissions and soil health in selected Central Asian countries: An assessment of ruminant systems and grassland soils in Tajikistan, Kyrgyzstan and Uzbekistan. Rome, FAO. https://doi.org/10.4060/cb4447en.

43 Mestre I., Ibraimova A., Azhibekov B. (2013) Conflicts over pasture resources in the Kyrgyz Republic. [Research Report] CAMP Alatoo; ACTED; USAID. ffhal-01901568f

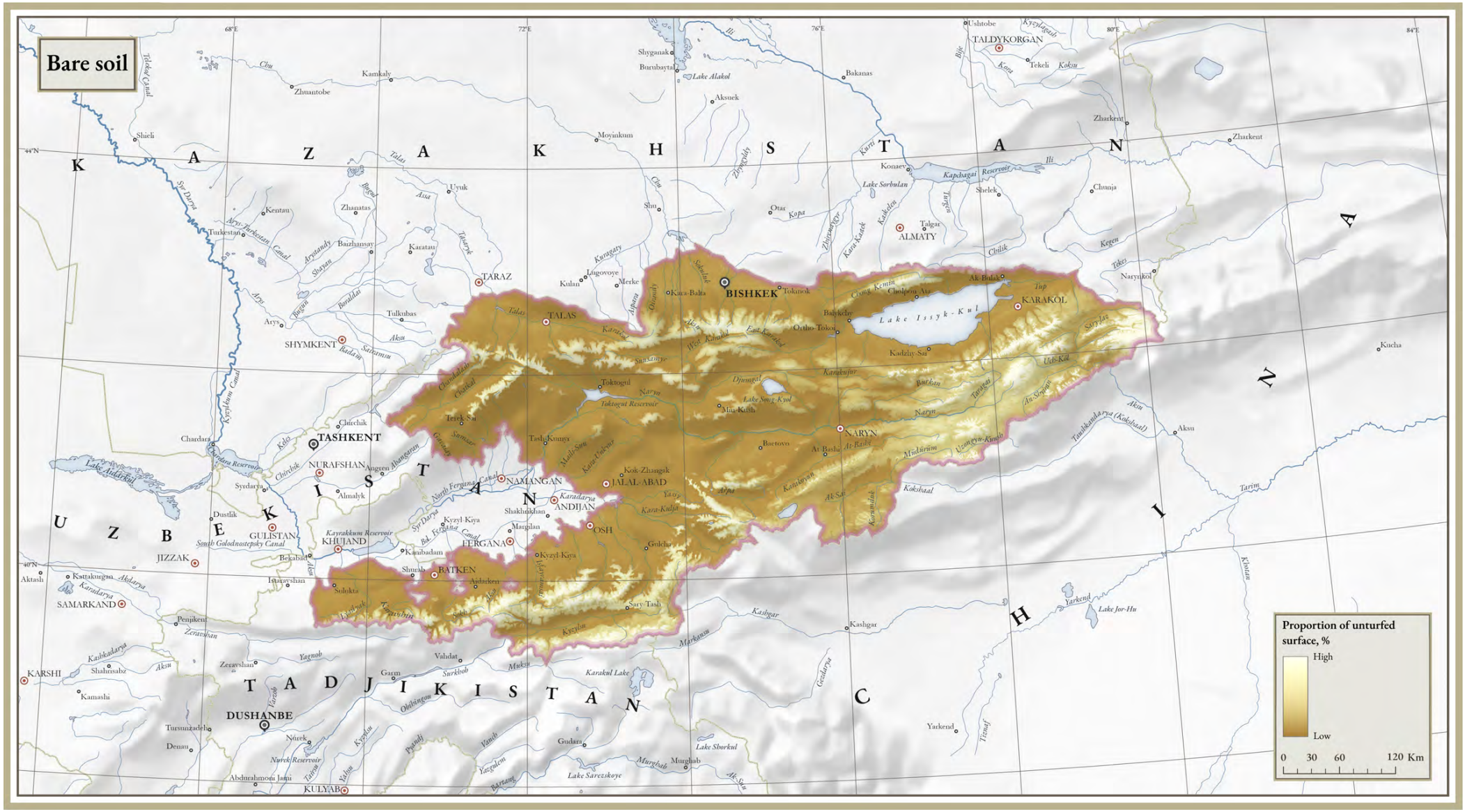




According to ESA WorldCover 2021[44] data obtained from the results of the automatic classification of Sentinel 1 and 2 satellite images, spatial resolution – 10 m.

44 https://doi.org/10.5281/zenodo.5571936%C2%A0

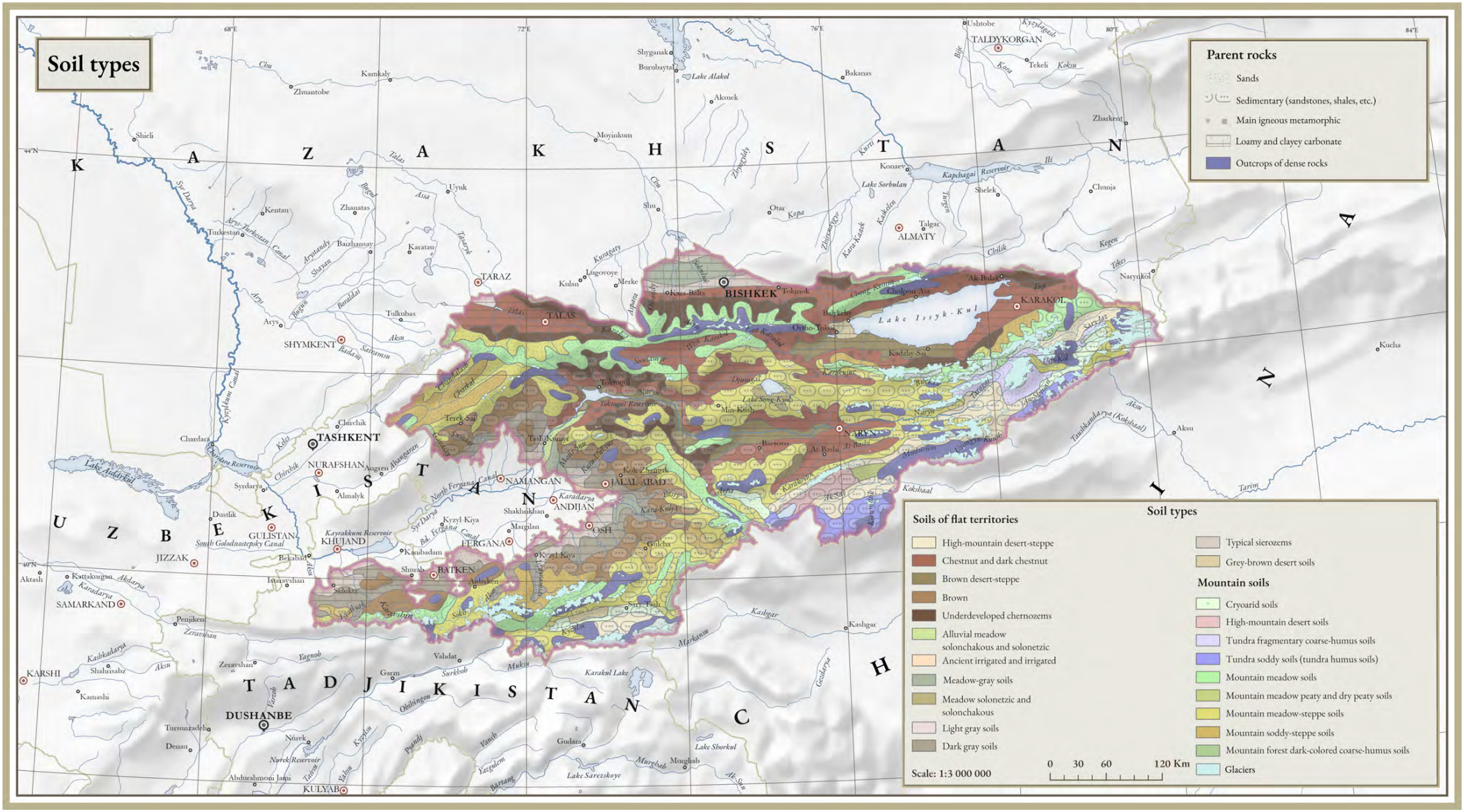
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According to Global 2010 Bare Ground[45], obtained using Landsat 7 satellite images and regression tree models. Spatial resolution – 30 m, time span – 2010.

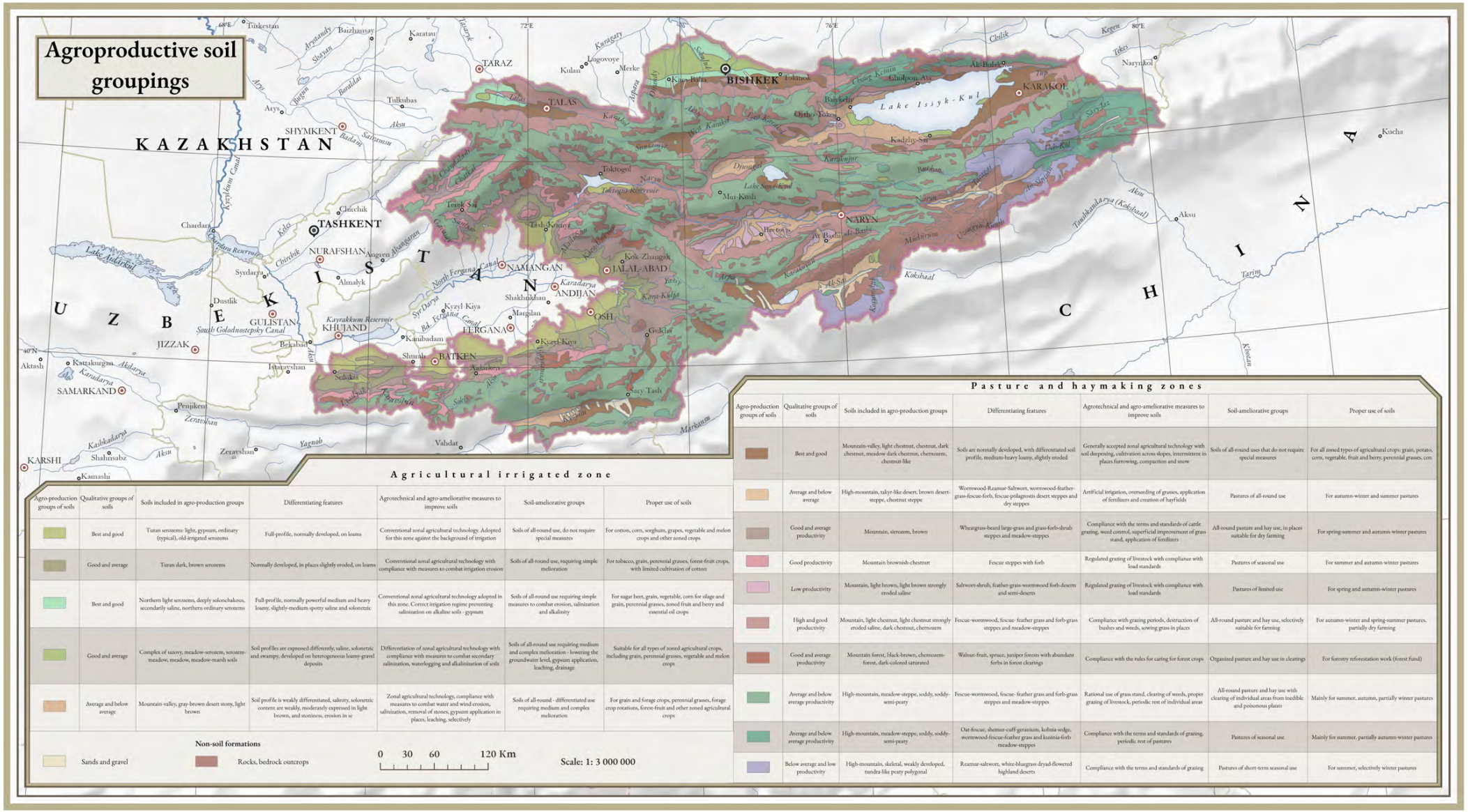
45 Hansen et al. (2013) High-Resolution Global Maps of 21st-Century Forest Cover Change: Science, v. 342, no. 6160, p. 850-853, at http://www.sciencemag.org/content/342/6160/850.abstract.

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Taken from the Atlas of the Kyrgyz Soviet Socialist Republic. T. 1. Natural conditions and resources. Moscow, GUGK Publ., 1987.

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Taken from the Atlas of the Kyrgyz Soviet Socialist Republic. T. 1. Natural conditions and resources. Moscow, GUGK Publ., 1987.

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4.3. Progress towards the SDGs

The concept of Land Degradation Neutrality (LDN) is included in SDG 15.3, which calls for «combating desertification, restoring degraded land and soils, including land affected by desertification, drought and floods, and striving to achieve a land degradation neutral world by 2030».[46]

The main indicator 15.3.1 of progress towards the target is reduction in the proportion of degraded land (irrigated and rain-fed) of total land area. To improve the performance of the Kyrgyz Republic in the implementation of the UN Convention to Combat Desertification, with the support of the Global Environment Facility and UNDP, national voluntary LDN targets were developed based on the SDG Goal 15.3.1 indicator calculation methodology. According to Kyrgyzstan's National Statistics Committee, indicator 15.3.1 is still under development, nevertheless, the country has committed to restoring 120,000 hectares of degraded land by 2030.

In line with international practice, indicator 15.3.1 is complex and includes three sub-indicators, namely, change in land cover and land use, land productivity/net primary land productivity and above-ground and soil carbon stocks. In accordance with the principle of 'one-out-all-out', an area is defined as degraded if at least one of the sub-indicators shows a clear negative trend.

In the Kyrgyz Republic, the transformation of the agricultural sector and the corresponding changes in land cover and land use began in the early 1990s in the course of land privatization and continue to this day. Three periods are distinguished: the first saw a decline in production in the agricultural sector and a reduction in sown areas (by 13 per cent) in 1990–1995; the second saw a restoration of cultivated areas and a rapid increase in production as a result of land privatization in 1995–2002 while the third period saw some stagnation of production as a result of the excessive fragmentation of land into small individual farms.[47]

Over the past 30 years, the structure of crops has also undergone significant changes as a result of a radical reduction in the area used for fodder crops coupled with an increase in the planting of cereals, vegetables and cotton. However, despite all of the above changes, the area of irrigated arable land has remained stable since the mid-1990s, despite the growth of the rural population and, as a result, the expansion of built-up areas *(Map. Landcover 2000; Map. Landcover 2010; Map. Landcover 2021)*. In this regard, changes are noticeable on the 2021 land cover map, however, it was constructed using higher spatial resolution (10 m) data than that used from 2000 to 2010 (300 m) where the latter was also processed using a different methodology. The apparent changes are due to this difference and not to actual land-use dynamics.



Lead ore deposit «Ak-Tyuz»

The availability of primary data for Kyrgyzstan to judge trends in relation to indicator 15.3.1 is clearly insufficient and the estimates given in the literature are inconsistent. Global monitoring of land productivity is currently based on time series assessments of reflective vegetation characteristics using remote sensing techniques. The most commonly used is the NDVI and its improved version, EVI. These two indices show trends in biomass over time and can be used to assess the status of most categories of agricultural and forest land. In general, these indices indicate the predominance of positive trends in the vegetation cover in the Kyrgyz Republic *(Map. Dynamics of the normalized vegetation index; Map. Dynamics of the enhanced vegetation index)*. A positive trend using EVI can be observed in 82.8 per cent of the republic's area, while the remaining 17.2 per cent shows a certain negative trend in the period from 2000–2023.

Studies on the applicability of the Leaf Area Index (LAI) for land degradation assessment in the Kyrgyz Republic are rare,[48] although where available, the LAI generally shows similar results to other vegetation indices *(Map. Dynamics of the leaf area index)*. As an integrated indicator of changes in the quality of agricultural land, the LPD Index *(Map. Land productivity dynamics)* has been developed to integrate various indices, however, this approach causes many technical problems.[49] Interpretation of this index in relation to the degree of degradation or improvement of land resources in the Kyrgyz Republic is difficult at this stage.

The FAO overview report[50] on the state of land resources in the Kyrgyz Republic (in the context of LDN) was based on calculations of linear trends in the time series of the annual NDVI using nonparametric methods. The report determined that 22.65 per cent of land (of all categories) was degraded or under stress in the period 2001–2020 and 6.79 per cent improved its productivity, meaning approximately 70 per cent of the republic's area showed pronounced trends. The total area of land degraded during this period amounts to 3.5 million hectares, of which 250,000 hectares is arable land and 2.9 million hectares is mountain pasture. According to the country's profile in the UN SDGs[51], the share of degraded land in the country's total area was 10.6 per cent (approximately 2 million hectares) in 2015, a figure that had reduced to 9.6 per cent by 2019.

National sources show that almost all irrigated areas of the republic are, to some degree, subject to secondary salinization due to an increase in the groundwater level primarily as a result of the poor technical condition of collector and drainage networks *(Map. Soil salinization)*. Since 1990, the area with unsatisfactory condition of irrigated soils has increased by 20,000 hectares (some 2 per cent of the total irrigated land area), which is not a critical change[52]. According to the State Agency of the Government of the Kyrgyz Republic, 86 per cent (880,000 hectares) of irrigated land are in good condition, 6 per cent are in a satisfactory condition and 8.4 per cent are in an unsatisfactory condition. Thus, approximately 84,000 hectares can be considered as degraded, of which 50,700 hectares are subject to secondary salinization of soils and 27,000 hectares to flooding[53]. The area of arable land subject to wind erosion is even smaller, amounting to only 651 hectares, while water erosion affects 715 hectares[54]. These data show an even better state of croplands compared to the above FAO estimates using remote sensing techniques.

46 FAO (2022) Overview of land degradation neutrality (LDN) in Europe and Central Asia. Rome. https://doi.org/10.4060/cb7986en.

47 Akramov K.T., Omuraliev N (2009) Institutional Change, Rural Services, and Agricultural Performance in Kyrgyzstan. IFPRI Discussion Paper 00904.

48 Klein et al. (2013) Monitoring and assessment of mountainous ecosystems in Kyrgyzstan using remote sensing based vegetation parameter. Global and Planetary Change.

49 Yuran Cuia, Xiaosong Li. (2022) A new global land productivity dynamic product based on the consistency of various vegetation biophysical indicators. BIG EARTH DATA2022, VOL. 6, NO. 1, 36–53.

50 FAO (2021) Overview of land degradation neutrality (LDN) in Europe and Central Asia. LDN in Kyrgyzstan. [online]. Rome. http://www.fao.org/3/cb8112en/cb8112en.pdf

51 UN Statistics Division. Country SDG Profile – Kyrgyzstan. SDG Country Profiles

52 Study and selection of salt-tolerant crops for cultivation on saline soils (2018) FAO-Public Foundation «Centre for Training, Consultation and Innovation», Bishkek. (in Russian).

53 Atlas of Natural and Man-made Hazards in the Kyrgyz Republic (2020) Bishkek. Ministry of Emergency Situations of the Kyrgyz Republic, 96 p. (in Russian).

54 National report on the state of environment of the Kyrgyz Republic for 2015-2018 (2019) Short version. NSC KR.



Apricot orchard with colorful leaves in autumn near Lake Issyk-Kul

The Kyrgyz Republic also proposed a national indicator to support its efforts towards meeting SDG15.3.1.1, namely, "the area of arable land unused for various reasons". According to the National Statistics Committee, the unused area in 2019 amounted to 63,300 hectares (approximately 6 per cent of all cultivated areas), having decreased by 4,000 hectares since 2015.

Kyrgyzstan's national statistics generally do not show a decrease in the productivity of arable land. Indeed, crop production increased by 60 per cent between 1991 and 2005, while in Uzbekistan and Tajikistan there was practically no increase in production. At the same time, the average productivity of arable land in Kyrgyzstan remains low and returns approximately USD1000 per hectare of cultivated area.[55]

Some 85 per cent of agricultural land is occupied by pastures *(Map. Types of pastures located below 2000 m asl)* and their condition is more worrying as the available global and national estimates of Kyrgyzstan's pasture degradation are very high. According to the Ministry of Agriculture and Land Reclamation, approximately 70 per cent of pastures are subject to degradation to varying degrees. Analysis of data on pasture yields obtained from various government organizations showed that the average pasture yield is only 0.21 t/ha of dry weight, which is almost three times lower than yields obtained in the 1990s *(Map. Productivity of pastures below 2000 m asl)*[56].

According to remote sensing data, over the past 20 years most of the winter pastures have experienced severe degradation while seasonal and summer pastures have

55 Akramov, Omuraliev (2009).

56 Program for the Development of Pasture Economy in the Kyrgyz Republic for 2012-2015. «Программа развития пастбищного хозяйства Кыргызской Республики» (in Russian).

degraded approximately 30-40 per cent of their area in this period. However, there is a level of uncertainty surrounding these estimates that could be significantly reduced by the provision of better field data, including the geography of grazing in different seasons of the year.[57]

In remote sensing studies, the NDVI index is widely used as an indicator of land productivity, a positive trend of which means an improvement in the condition of the land and, conversely, a negative trend indicates its deterioration. However, in the case of rangelands, their degradation may not be expressed as a decrease in biomass but in its increase due to the gradual spread of plant species that are not eaten by livestock. Degraded pastures are populated with weeds, subshrubs and shrubs (caragana) species, which may have long growing seasons, and their gradual expansion may be the source of the observed positive trend in the dynamics of green biomass on all types of pastures, including the most degraded winter pastures *(Map. Types of pastures located below 2000 m asl; Map. Dynamics of the enhanced vegetation index) (Table 6)*.

Table 6. Trend in state of pasturelands using remote sensing methods

Type of land	Average EVI trend per year	Proportion of area with EVI growth (%)	Proportion of area with decreasing EVI (%)
Spring-autumn pastures	0.00028	72.9	27.1
Sand	0.00027	76.2	23.8
Summer pastures	0.00033	78.5	21.5
Winter pastures	0.00033	82.7	17.3
Forest and shrubs	0.00100	83.6	16.4
Badlands	0.00037	84.0	16.0
Arable lands	0.00059	91.8	8.2
Perennial plantations	0.00111	93.4	6.6
Haying	0.00063	94.8	5.2

Field studies show that this form of degradation is characteristic of large tracts of pastures in the mountain steppe and subalpine meadow steppe in the northern, central and western Tien Shan. By way of specific example, over the past 20 years, shrub vegetation has increased by approximately 40 per cent in the valleys near settlements.[58]

The degree of shrub spreading in valleys and on their slopes can serve as evidence of the degradation of pastures at the local level *(Map. Bushiness of the land)*. The first national estimates of shrubs only appeared in 2023 during the last forest inventory (see section 5) when a separate category of 'shrub forest' was identified, denoting large shrub thickets with a sparse stand (no more than six trees per hectare). This new categorization revealed that the Tallas, Chui and Naryn regions are the bushiest, in which about or more than half of the forested lands are shrub thickets. The Batken region is the least bushiest, where the area of shrub thickets is 11 per cent of the forested area, while the average for the country is 32 per cent. In all likelihood, some portion of these 'shrub forests' has formed in areas of completely degraded pastures.

Of the three LDN indicators, estimating and monitoring soil carbon stocks is the most problematic due to the lack of data on organic carbon trends by soil type and land use. Changes in soil organic carbon (SOC) content occur very slowly, so a series of observations should span several decades. The first SOC surveys using a unified methodology were launched in the Kyrgyz Republic only in 2018 as part of an international cooperation programme.[59]

Compared to other Central Asian countries, the Kyrgyz Republic has a relatively high organic carbon content in its soils. The total carbon content in its soils (in the upper 30-centimetre layer of soils and at its density of 1250 kg/m³) is estimated at 1.46 billion tons, in above-ground biomass this figure is 67.5 million tons and in above-ground biomass it stands at 66.8 million tons.[60] The average SOC content in soils in the Kyrgyz Republic is 73 tons per hectare, or 1.9 per cent, close to the 2 per cent threshold of used for assessing soil health in terms of its productivity and potential for carbon sequestration. For comparison, the average SOC content in the soils of Uzbekistan is 0.35 per cent while in Tajikistan it is 1.3 per cent.

The general pattern identified using sample surveys is that an increase in the carbon content occurs in the upper soil layer as altitude increases, while the impact of precipitation on this figure is not certain. In rangeland soils, SOC increases from 0.78–1.20 per cent (30–46 tons per hectare) in low-altitude landscapes to 2.19–2.83 per cent (84–109 tons per hectare) in mid-altitude and 3.54–4.16 per cent (136–160 tons per hectare) in the alpine high-altitude belt *(Map. Soil carbon content)*. Differences in SOC content in soils enduring different types of land use (arable land, pastures, forests) are also clear. In arable soils, the SOC is 1.5–2 times higher than in pasture soils located in the same altitudinal zones, which probably reflects the natural differences in these areas. The highest SOC values were found in soils in forests which contained up to 7.96 per cent. Among the types of soils, chernozems in the Issyk-Kul region are especially distinguished, in which the SOC content reaches 6-10 per cent. However, the available data are insufficient to assess the extent of soil degradation and to identify trends.



View of the Ak-Sai canyon in the Issyk-Kul region

The annual contribution of agricultural soils (1.07 million hectares of irrigated land and 130,000 hectares of rainfed land) to the total GHG emissions of the country is estimated at 36.1 per cent, which translates to approximately 1.5 tons per hectare or 2 million tons in total, which is a relatively high value compared to European countries (average 0.6–0.7 tons per hectare). An increase in the SOC content on arable land is possible by changing farming techniques in favour of non-moldboard ploughing, abandoning summer fallows, growing cover fodder crops and using mulch. This can significantly reduce the loss of soil carbon and even lead to an increase in its content, thereby ensuring a positive carbon balance in the local soil-atmosphere system. It is estimated that such conservation agriculture can lead to an increase in SOC content of 0.1 – 0.2 tons per hectare per year.[61]

In contrast, pastures, which total 9.4 million hectares, are organic carbon reservoirs due to the inflow of waste products from domestic animals and the decay of the

57 Pasture condition maps in Kyrgyzstan. Technical note. (2021) IFAD. P.15. EO4SD_condition_maps_ver2.5_ORANGE.pdf (un.org).

58 Zhumanova et al. (2018) Assessment of vegetation degradation in mountainous pastures of the Western Tien-Shan, Kyrgyzstan, using eMODIS NDVI. Ecological Indicators. Volume 95, Part 1, 527-543.

59 Corintenberg et al. (2021) Methodology for estimating organic carbon stocks in soils of agricultural ecosystems in Kyrgyzstan to improve reporting on land degradation and climate change neutral balance. Department of Soil Science and Department of Resource Economics, Humboldt University of Berlin, Germany. (in Russian).

60 Aichi Biodiversity Target 11 Country Dossier: KYRGYZSTAN (2021) Aichi Biodiversity Target 11 Country Dossier: KYRGYZSTAN (cbd.int).

61 Lal, R., 2004. Carbon sequestration in soils of central Asia. Land Degradation & Development. NoP15. P. 563–572.

underground parts of plants. Models show that pasture soils in Kyrgyzstan annually receive two tons of carbon per hectare in the southern regions of the country, three tons per hectare in the northern regions and 3.5 tons per hectare in the Issyk-Kul region[62]. However, this does not exclude a decrease in the productivity of pastures due to overgrazing.

SDG 2.4 was designed «to ensure sustainable food production systems and implement sustainable agricultural practices that increase productivity and production, help maintain ecosystems, strengthen adaptive capacity to climate change, extreme weather, drought, floods and other disasters, and progressively improve land and soil quality by 2030.» Nationalized indicator 2.4.1 is identical to the global indicator and deals with the «proportion of agricultural land under productive and sustainable agriculture».

Two sub-indicators can also be used to help with this SDG, namely, the share of drip irrigation and the share of organic agriculture. There is no exact data on either of these sub-indicators for Kyrgyzstan, however, according to media reports in 2021, only 2,500 hectares of arable land was equipped with drip irrigation systems,[63] while organic farming is estimated to cover only 15,000 hectares, or 1.2 per cent of arable land. In 2019, Kyrgyzstan established the first government department for organic agriculture in Central Asia and, in March 2023, a law was adopted on the standardization of labelling and certification of organic products. According to the National Statistics Committee, a means to measure indicator 2.4.1 is under development.

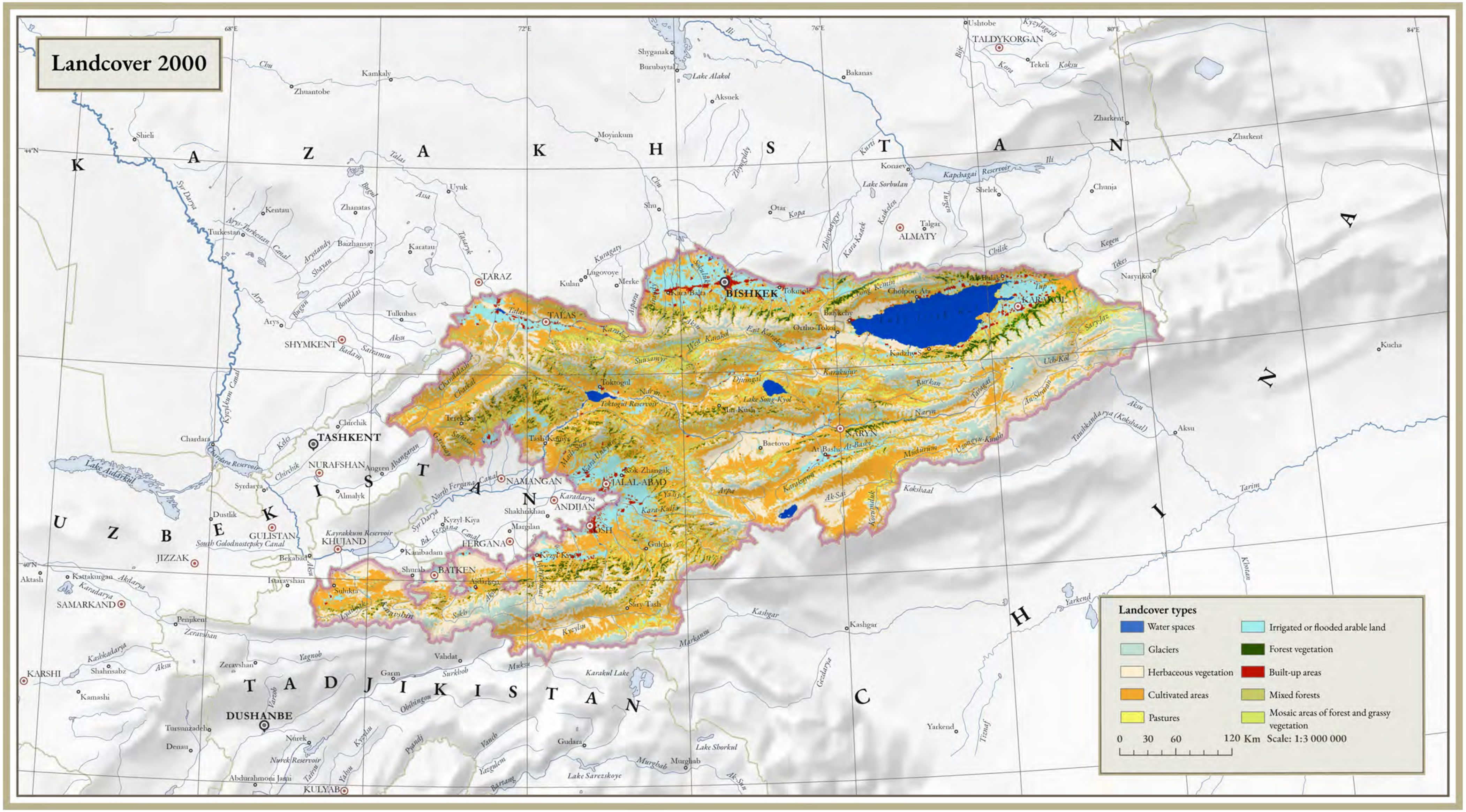
4.4. Responses

- Support for cooperatives to overcome the trend of increasing the number of small individual peasant farms against the background of a shortage of land resources.
- Collect and provide up-to-date data on degraded lands in line with the SDG methodology, which includes three components: land cover change, land productivity change and carbon stocks.
- Collect and provide up-to-date statistics on the share of drip irrigation and organic farming to assess progress in the transition to sustainable agriculture.
- Further development of local self-government bodies and support of public institutions for effective pasture management.



Aerial view of sheep running freely across a green field

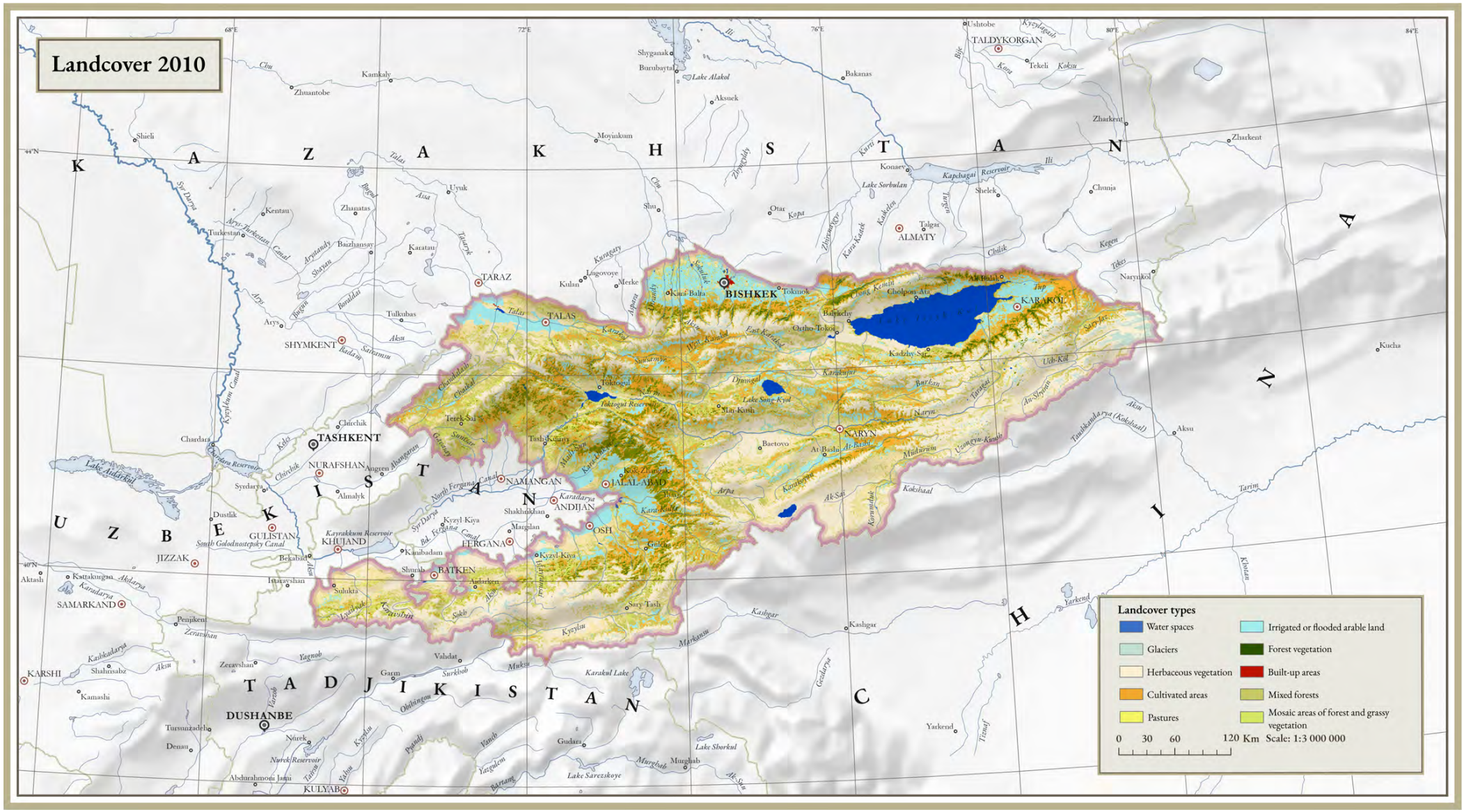
62 Lopes et al. (2021).
63 Kyrgyzstan to start production of equipment for drip irrigation - | 24.KG.



Based on ESA CCI (2000 to 2010) and ESA Worldcover (2021)[64] Land Cover products. CCI Landcover is obtained by classifying ENVISAT and Proba-V satellite images. The spatial resolution is 300 m for the period 2000 — 2010 and 10 m for 2021.

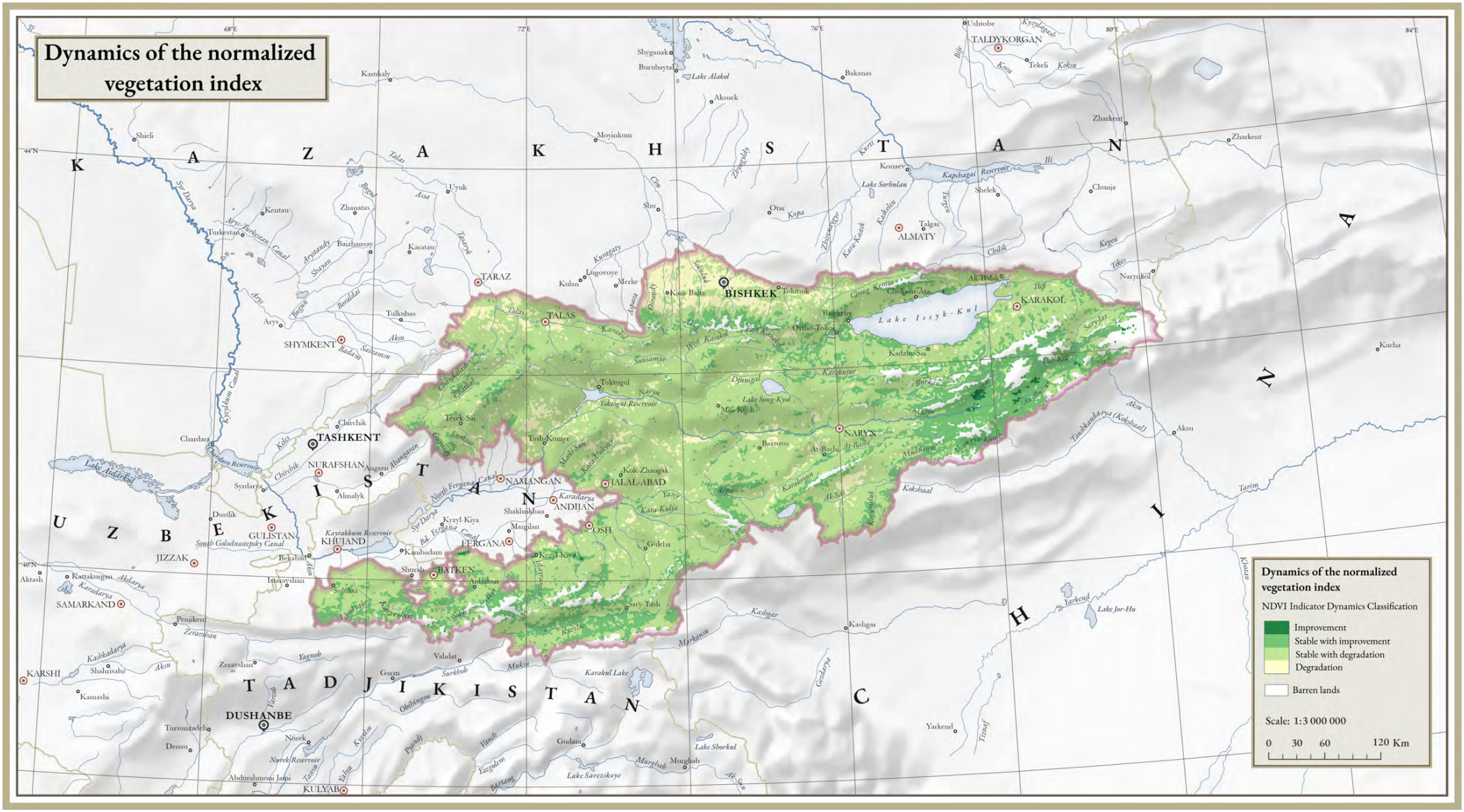
64 https://doi.org/10.5281/zenodo.5571936%C2%A0

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See note to the above map, ‘Landcover 2000’.

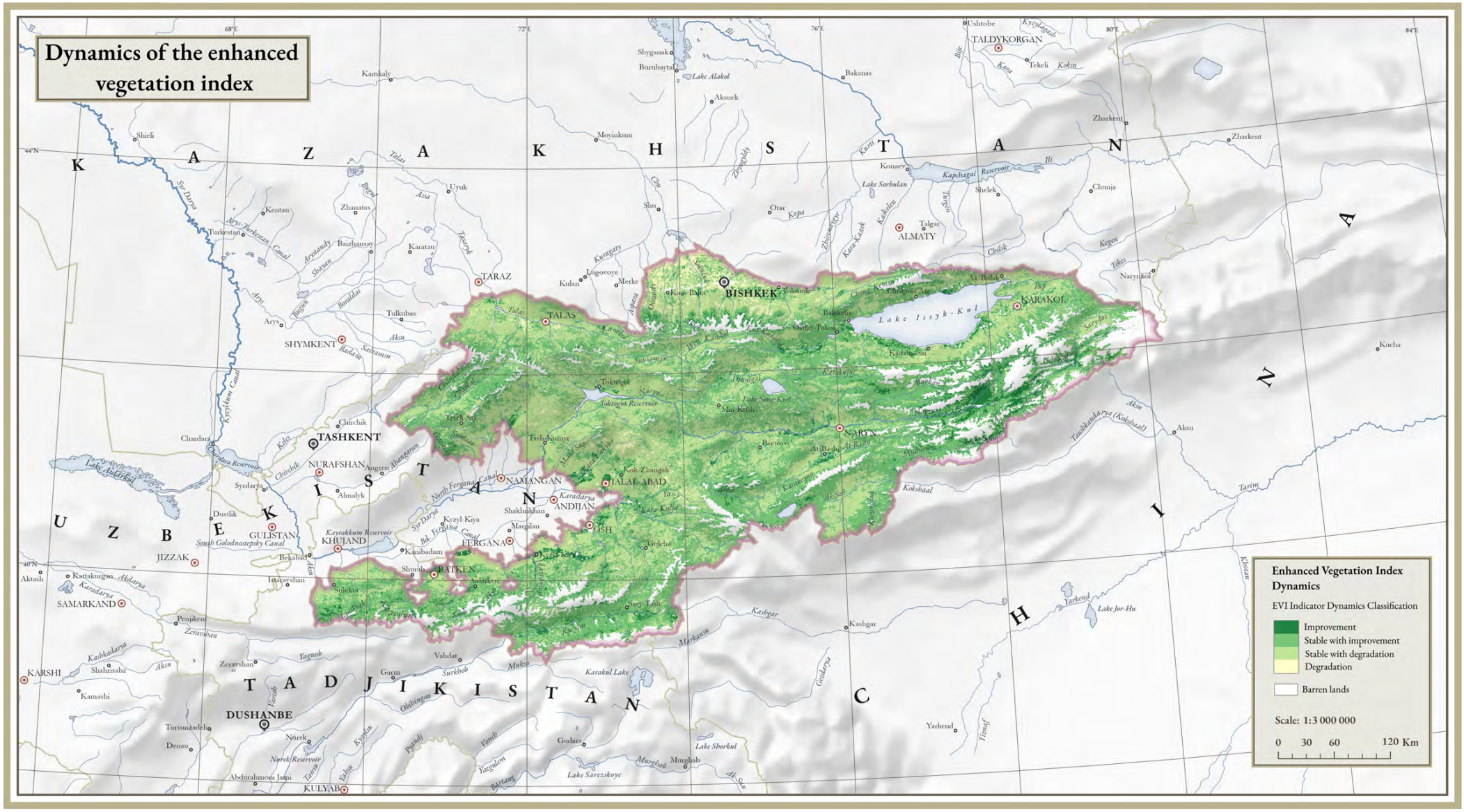
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The change in the Normalized Vegetation Index (NDVI) shows a trend in the amount of green biomass produced in a given location. According to the Global Land Productivity Dynamic Dataset[65], obtainedby processing SPOT Vegetation and MODIS data, the dynamics of the NDVI index is given for the period 1999—2013.

65 Yuran Cui, Xiaosong Li (2022). Global Land Productivity Dynamic Dataset Product. V1. Science Data Bank. https://doi.org/10.11922/sciencedb.j00076.00084.

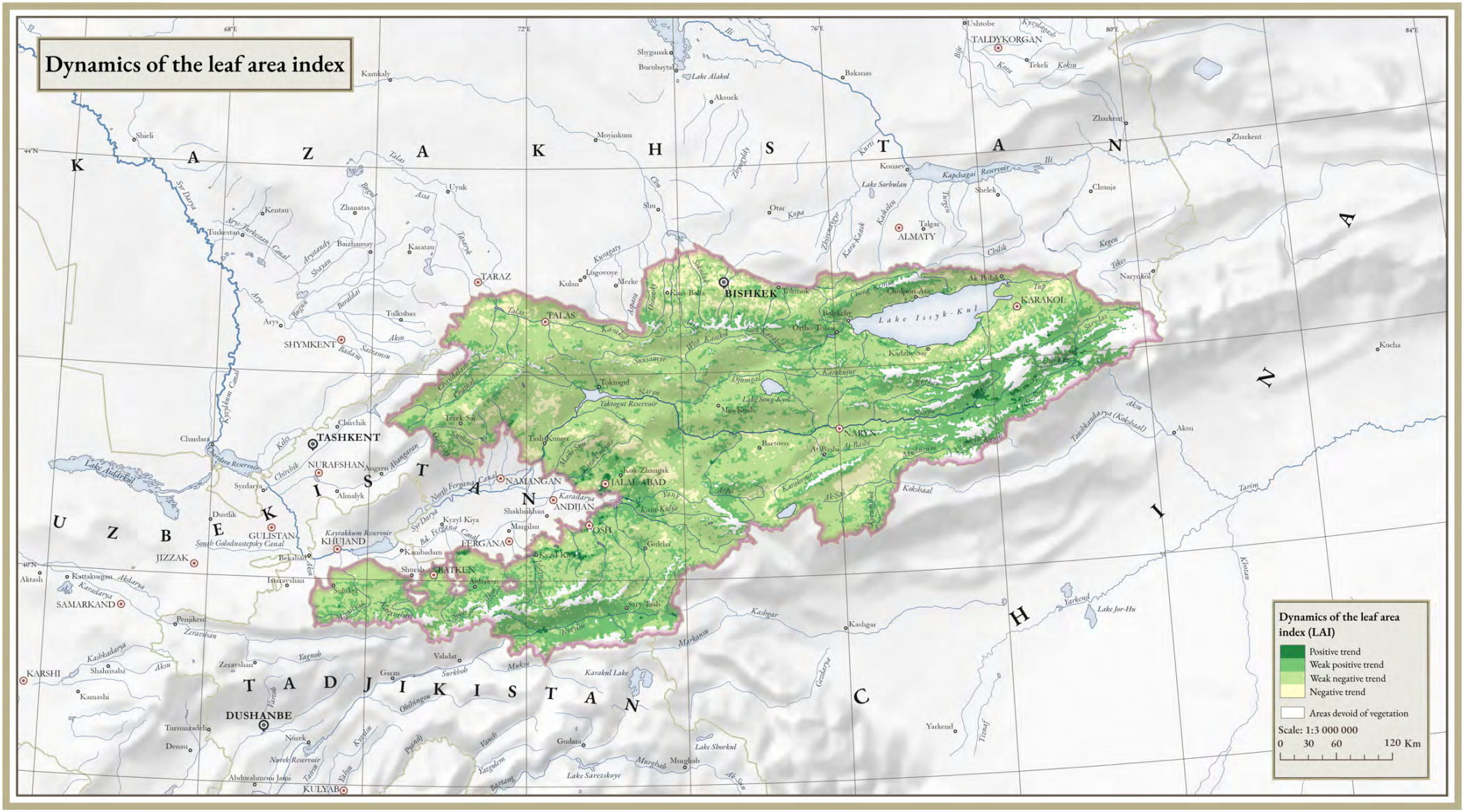
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The Enhanced Vegetation Index (EVI) is similar to the NDVI and is designed to quantify the dynamics of vegetation biomass over a given period. However, EVI corrects for some atmospheric conditions and canopy background noise and is more accurate in areas with dense vegetation. The above map was created according to the Global Land Productivity Dynamic Dataset[66] obtained by processing SPOT Vegetation and MODIS data. The dynamics of the NDVI index is given for the period 1999–2013.

66 Cui, Li (2022).

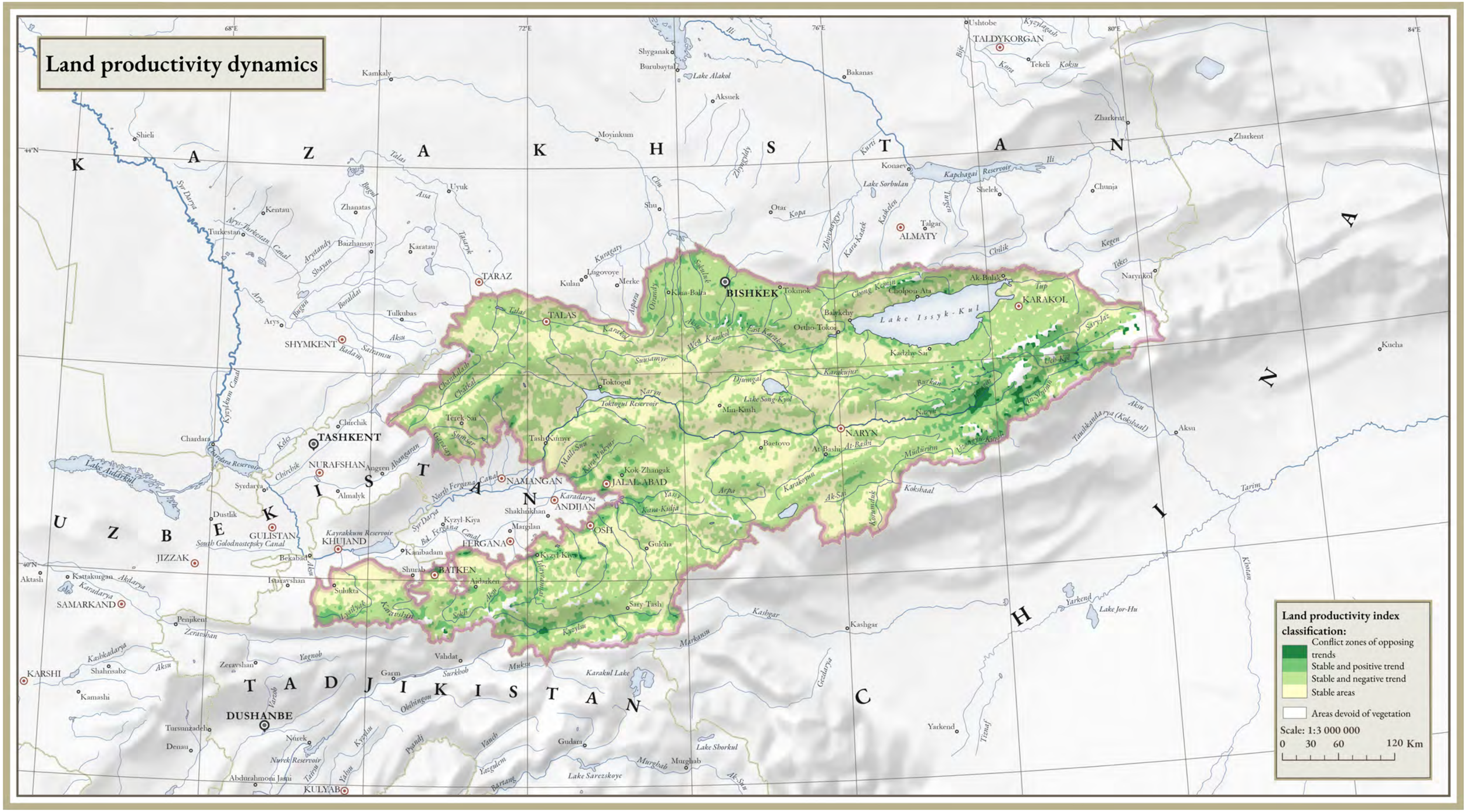
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Leaf area index (LAI) measures the projection of green leaf area per unit area of ground in a hardwood canopy, as well as half of the total surface area of needles per unit area of land in a softwood canopy[67]. The above map was created according to the Global Land Productivity Dynamic Dataset[68], obtained by processing SPOT Vegetation and MODIS data. The dynamics of the NDVI index is given for the period 1999–2013.

67 Copernicus Land Monitoring Service. land.copernicus.eu
68 Cui, Li (2022).

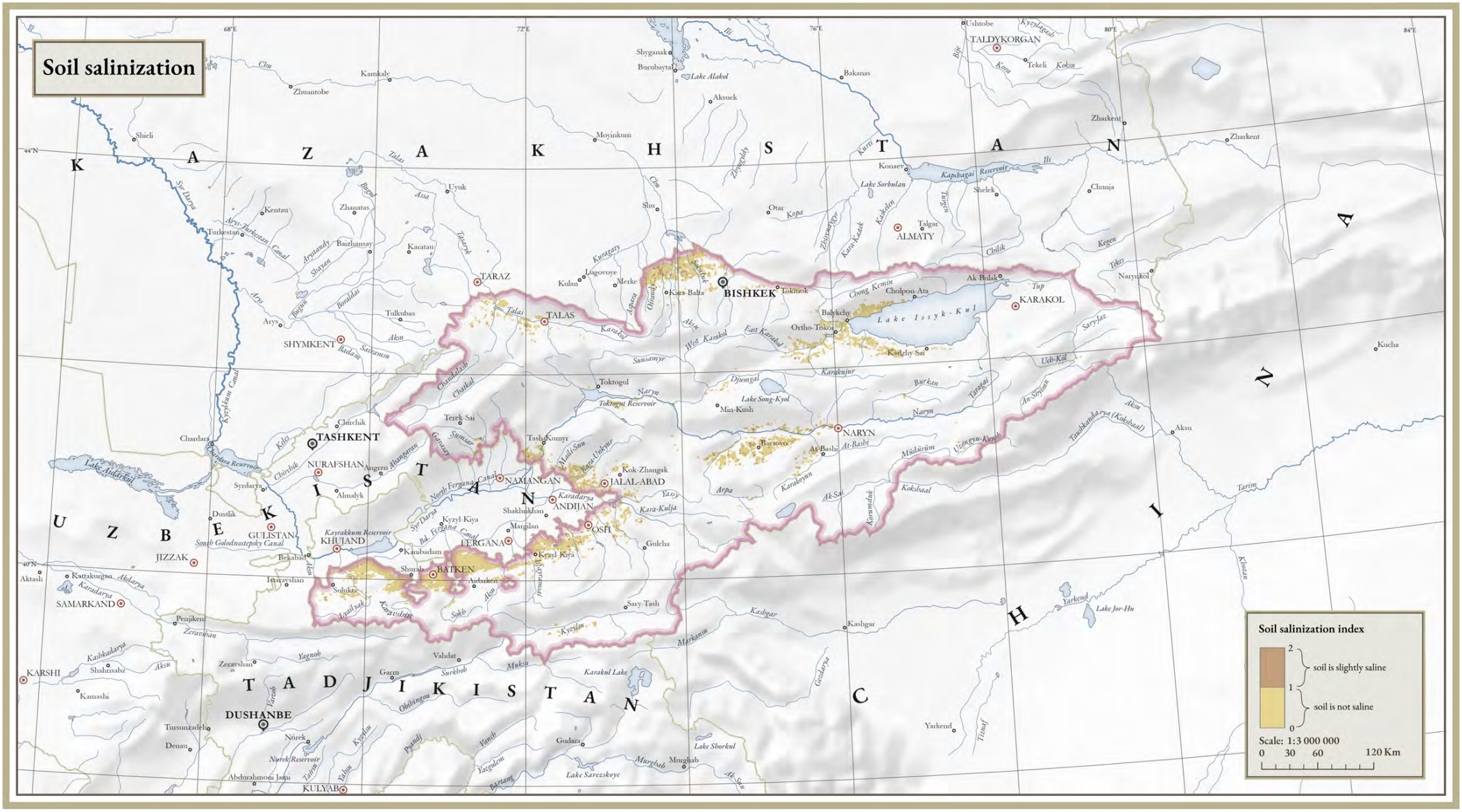
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Land productivity dynamics (LPD) is estimated by integrating information on the dynamics of four biophysical indices: EVI, LAI, NDVI, NPP. (compared to the average indicators in this zone). The above map was created according to the Global Land Productivity Dynamic Dataset[69], obtained by processing SPOT Vegetation and MODIS data. The dynamics of the NDVI index is given for the period 1999–2013[70].

69 Cui, Li (2022).
70 UN (2020) Map of the World [online] https://www. un.org/geospatial/, modified with Google Earth Engine Application developed for the region. https://projectgeffao. users.earthengine.app/view/reu-ldn-assessment

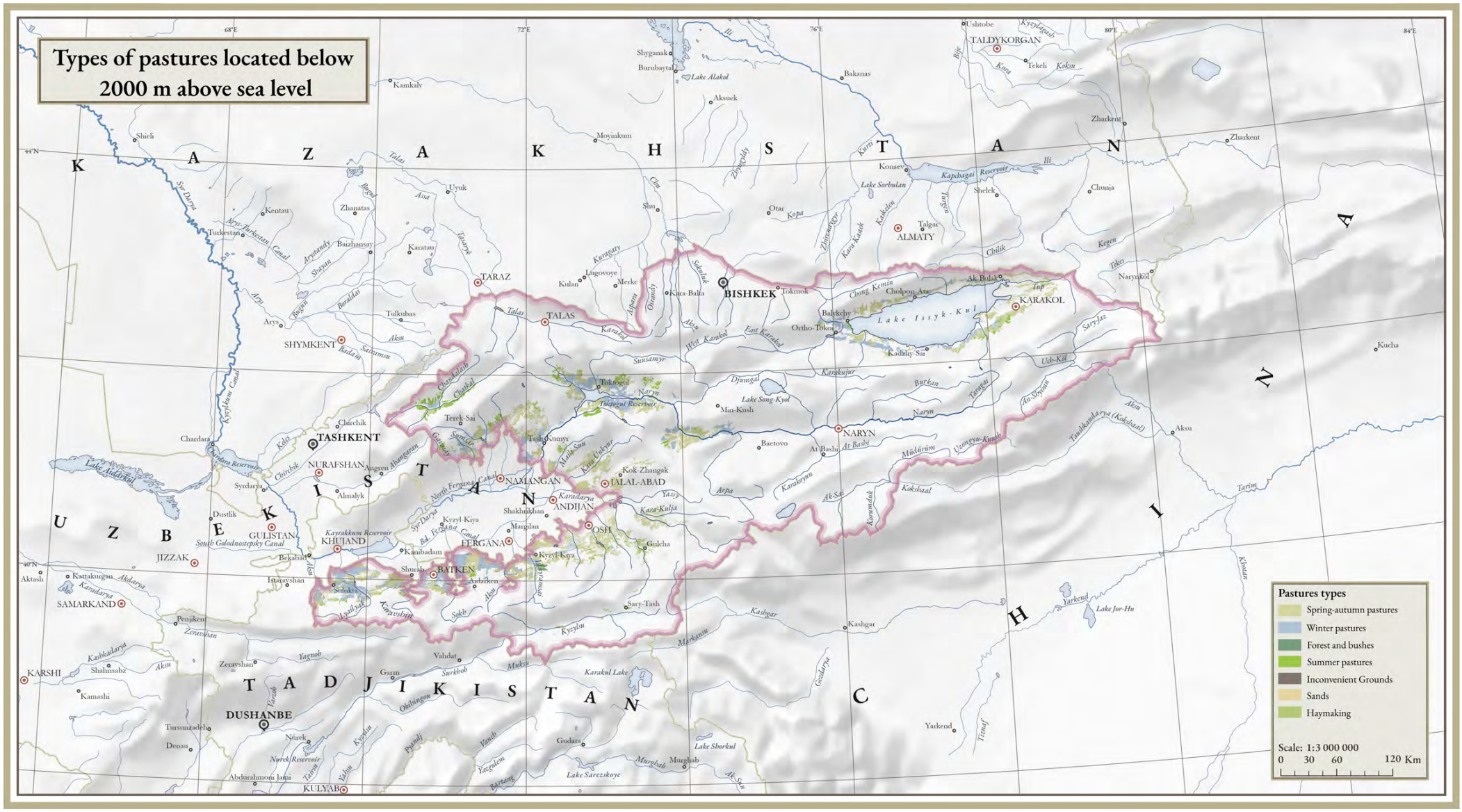
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Based on the Global Soil Salinity Map[71], obtained using the 'Random Forest' algorithm by combining satellite data, field survey results aggregated by the WoSIS database. Spatial resolution –250 m, time span – 1986–2016. Published estimates are deemed to be approximately 70 per cent accurate.

71 Ivushkin et al. (2019) Global mapping of soil salinity change. Remote sensing of environment, Vol. 231, 111260

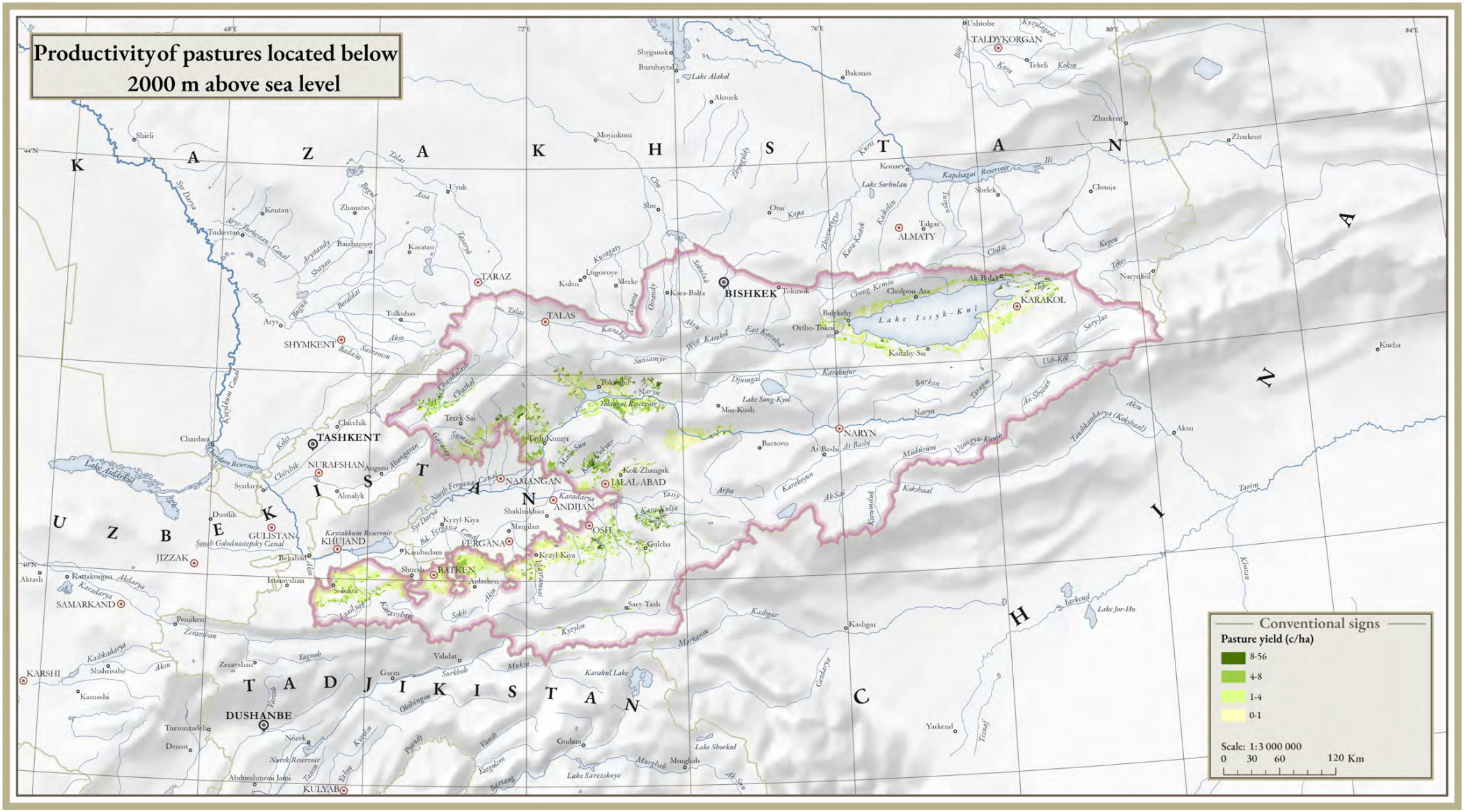
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Geoinformation and Climate Data Portal of the Kyrgyz Republic[72]. The pastures of three regions for which cadastral work was carried out are shown.

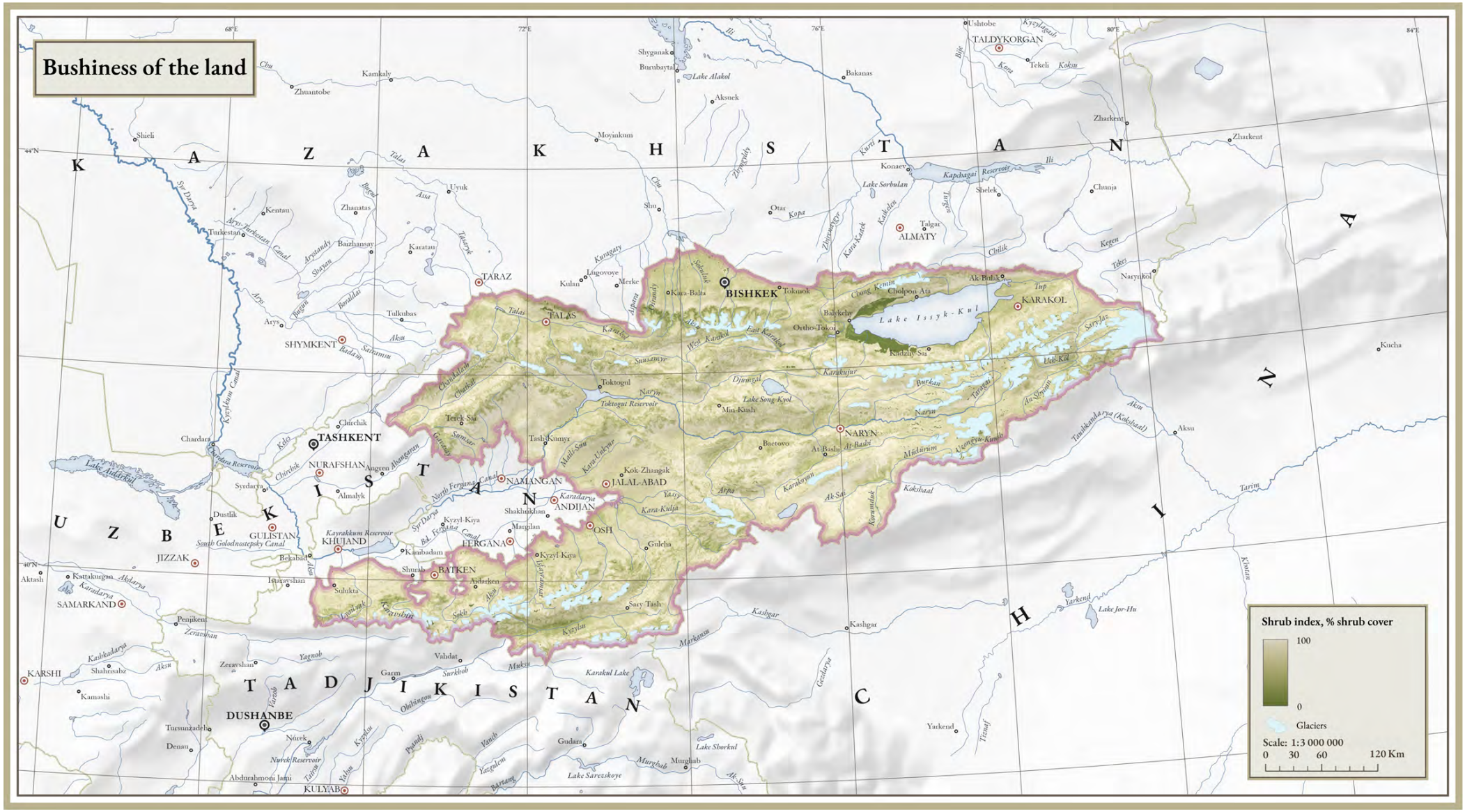
72 http://nsdi.kg/.

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See note to the above map, ‘Types of pastures located below 2000 v asl.’.

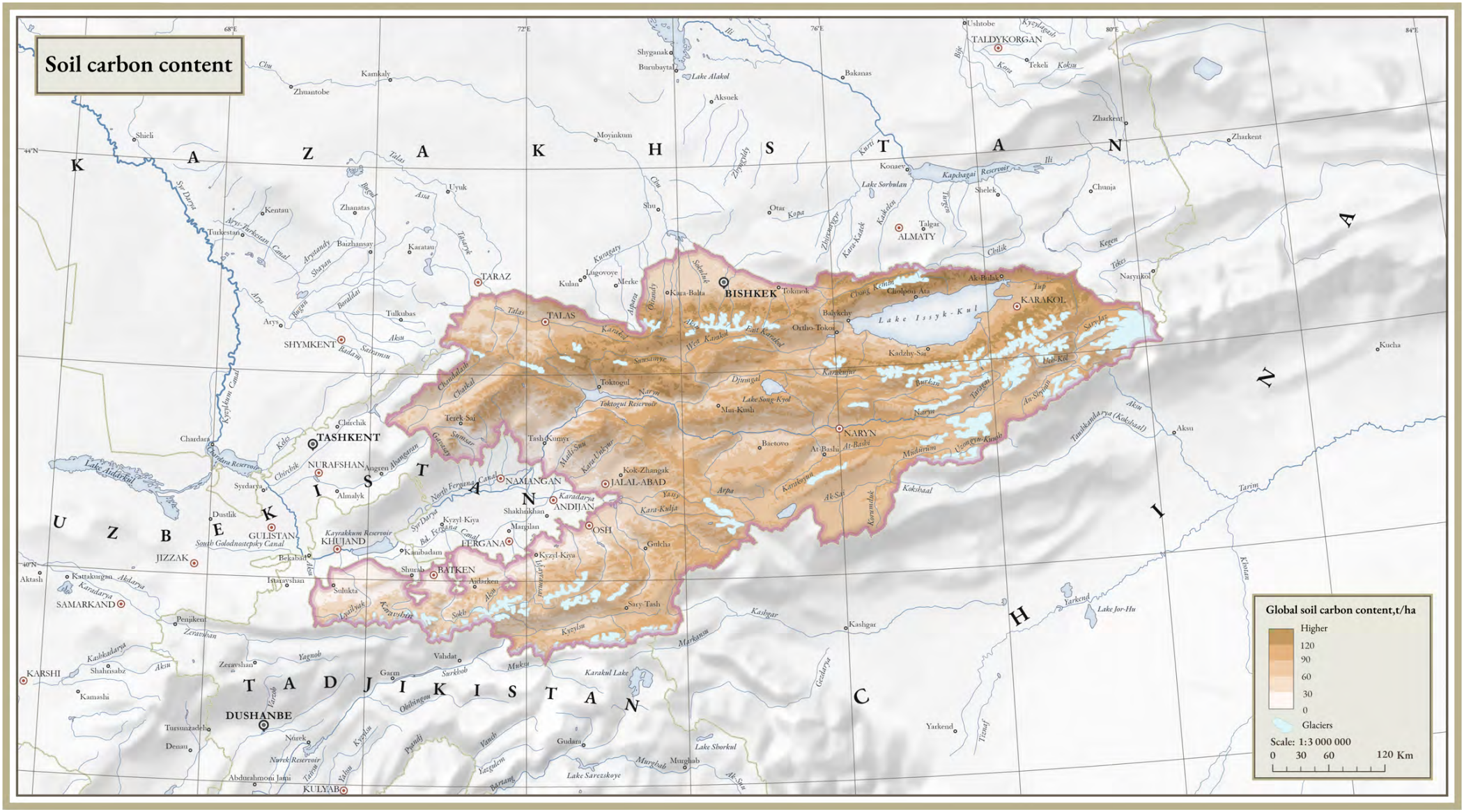
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Developed within the framework of the Copernicus Programme (CGLS-LC100) with the allocation of areas where the area covered by shrub vegetation exceeds 30 per cent. The resolution is 100 m[73], time span is 2015–2019.

73 FAO Map Catalog - Food and Agriculture Organization of the United Nations

The initial scale of the map is 1:3,000,000. The map image has been changed for the layout of the pages.



Based on the Global Soil Organic Carbon Map (GSOC v1.5.0) developed by the Global Soil Partnership (GSP)[74].

74 FAO and ITPS (2020) Global Soil Organic Carbon Map V1.5: Technical report. Rome, FAO. https://doi.org/10.4060/ca7597en.

The initial scale of the map is 1:3,000,000. The map image has been changed for the layout of the pages.

Forest Resources



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5.1. Key aspects

- Due to its arid natural conditions, the area of primary forests in Kyrgyz Republic is small and requires special attention for the conservation of the related forest ecosystems.
- All forests in the Kyrgyz Republic are legally protected from industrial logging.
- Since 2000, forest cover in the country has increased from 6.2 per cent to 6.9 per cent of the total land area due to the implementation of afforestation plans.
- The main threats to forest ecosystems are related to illegal logging and unregulated grazing in walnut forests.

5.2. General characteristics

As of 1 January 2008, the State Forest Fund of the Kyrgyz Republic covered 3.53 million hectares, of which 928,400 hectares (26 per cent), or 4.65 per cent of the total territory of the country, were covered with forests. In 2008–2010, in what was the first forest inventory undertaken in Central Asia in accordance with international standards, a national forest inventory was carried out in Kyrgyzstan based on satellite images and FAO definitions and during which the national land-use classification was revised. The inventory showed that the State Forest Fund managed 1.11 million hectares of forests and that approximately 1 million people lived in proximity to these forests, many of which use the forests for various individual and economic purposes. Significant areas of forests (277,000 hectares) are also located outside the State Forest Fund, these forests are easily accessible to the local population and are not controlled by local governments.[75] Thus, the total area of forests in the Kyrgyz Republic amounted to 1.3 million hectares, or 6.49 per cent of the total area of the country.

In 2020–2023, the second national forest inventory was carried out in the Kyrgyz Republic using modern tools, equipment and software with the support and participation of international specialists.[76] During the field work, 1244 profiles and 2489 sample plots were described in detail, making the data much more granular than in previous efforts and resulting in this inventory of forest formations being the most accurate *(Map. Forest types)*. In this latest inventory, the area of forests amounted to 1.19 million hectares, or 5.96 per cent of the total area of the country.

As previously note, in 2023 a separate category of 'shrub forest' was created for areas with a predominance of shrub forms and where the average number of trees was no more than six per hectare, although, according to the FAO classification, such complexes do not belong to forests and are defined as 'other forest lands'. Nevertheless, the area of 'shrub forest' in Kyrgyzstan was taken into account in this inventory and gave an additional 645,200 hectares of forested land. Thus, the total forested land area is 1.72 million hectares, or 8.59 per cent of the total area of the country. It has to be noted that these data are not comparable to any previously published data as the collection and evaluation methodologies differed significantly from previous results. Nevertheless, according to UNSTAT, forest areas have increased slightly since 2000 – from 6.2 per cent to 6.9 per cent.[77]

The Jalal-Abad region has the largest proportion of forest cover (excluding 'shrub forests') with 15.83 per cent of the total area of the region being forested, with moderate forest cover in the Batken (8.79 per cent) and Osh (6.91 per cent) regions. These three regions are followed by the Issyk-Kul, Talas and Chui regions, where forest areas occupy much smaller relative areas – 3.0 per cent, 2.5 per cent and 2.45 per cent, respectively. In the Naryn region, forests a minimal area, only1.58 per cent. Taking into account 'shrub forests', the forest-cover figures for these regions will be similar *(Map. Forests species composition by region)*.

75 On Amendments to the Forest Code of the Kyrgyz Republic (2020) 16ba19c12e765ab480f069adb16a558acecac3ef.doc (live.com)
76 Second National... (2022).
77 UNSD - Data Commons for the SDGs.

Forests have a limited distribution in the territory of the Kyrgyz Republic but are nevertheless distinguished by great biodiversity. Ecological conditions for the growth of natural forests are localized in the altitude zone from 700 m to 3500 m where approximately 90 per cent of forest ecosystems are found and are much less fragmented than at other altitudes *(Map. Forest landscape integrity)*. The importance of these forests in the conservation of biodiversity and other ecosystem services (such as prevention of dangerous slope processes, flow regulation and climate mitigation) is very high.

Forest ecosystems of the Kyrgyz Republic can be grouped according to the prevailing species into four types of forests: spruce, juniper, walnut and floodplain (tugai) *(Map. Tree species)*.[78] The 2023 forest inventory uses its own classification, distinguishing separately between 'walnut stands' and 'pistachio forests', as well as 'other broad-leaved and mixed forests' (which also include fruit tree species) and 'shrub forests'. At the same time, tugai forests are not distinguished as an independent type, although they differ from all other classes by being found only in a very specific landscape, namely the floodplains of rivers.

In spruce forests, the dominant species is Schrenck's spruce (Picea Schrenkiana), characterized by having a height of up to 40 m, a narrowly cylindrical crown, often drooping branches, dark grey bark, smooth young shoots and sharp, tetrahedral leaves 2–3.5 cm long with longitudinal rows of white wax spots. According to the first national inventory, the total area of spruce forest is approximately 284,450 hectares, or some 16.6 per cent of the country's total forested area. These mountain forests are located mainly in the northern part, bordering the Issyk-Kul basin.[79]

Spruce forests are also found in the valley of the Naryn river and in some places on the slopes of the Kyrgyz and Talas ranges. Of particular ecological value is a large transboundary area of Tien Shan coniferous forests along the borders of the Kyrgyz Republic, Kazakhstan and China *(see Box 4)*. Within these spruce forests are stands of Semenov's fir (Abies semonovii), however, it is listed in the Red Book of the Kyrgyz Republic as the total area of these stands is only 3,400 hectares and their geographical distribution is limited to the Jalal-Abad region. Also growing within the republic's spruce forests are several introduced species, such as hanging birch, Scots pine and Siberian larch.

78 Forestry Development and Best Practices of Forest Management in Kyrgyzstan (2018) Asia-Pacific Network for Sustainable Forest Management and Rehabilitation. China Forestry Publishing House.
79 Ibid.

Juniper (the local name of which is archa) forests are the most typical type of forest ecosystem for Kyrgyzstan. Juniper communities occupy some 292,900 hectares, however, they are presented in two forms: tree-like and shrubby. Turkestan juniper (Juniperus turkestanica), hemispherical juniper (J. semiglobosa) and Zeravshan juniper (J. seravshanica) form tall stands that can be considered as true forest ecosystems while the approximate 110,400 hectares occupied by juniper types with a creeping shape are, according to formal criteria, not forests. Juniper ecosystems are distinguished by an extremely wide ecological niche and can occupy a variety of habitats being present in semi-desert foothills with grey soils, steppe lowlands with rich chernozem soils, middle mountains ranges with brown soils distinguished by good structure and humus as well as in highland areas of the alpine belt with mountain-meadow soils. Creeping forms of juniper are more widespread as they can be found everywhere, including on bare rocky scree. The main massifs of juniper trees are found on the slopes of the Turkestan and Alai ranges in the Osh and Batken regions. In the Jalal-Abad region, tree-form juniper is found in the districts of Chatkal, Ala-Buki and Aksy while in the Chui and Talas regions, juniper forests are present but do not form continuous stands.

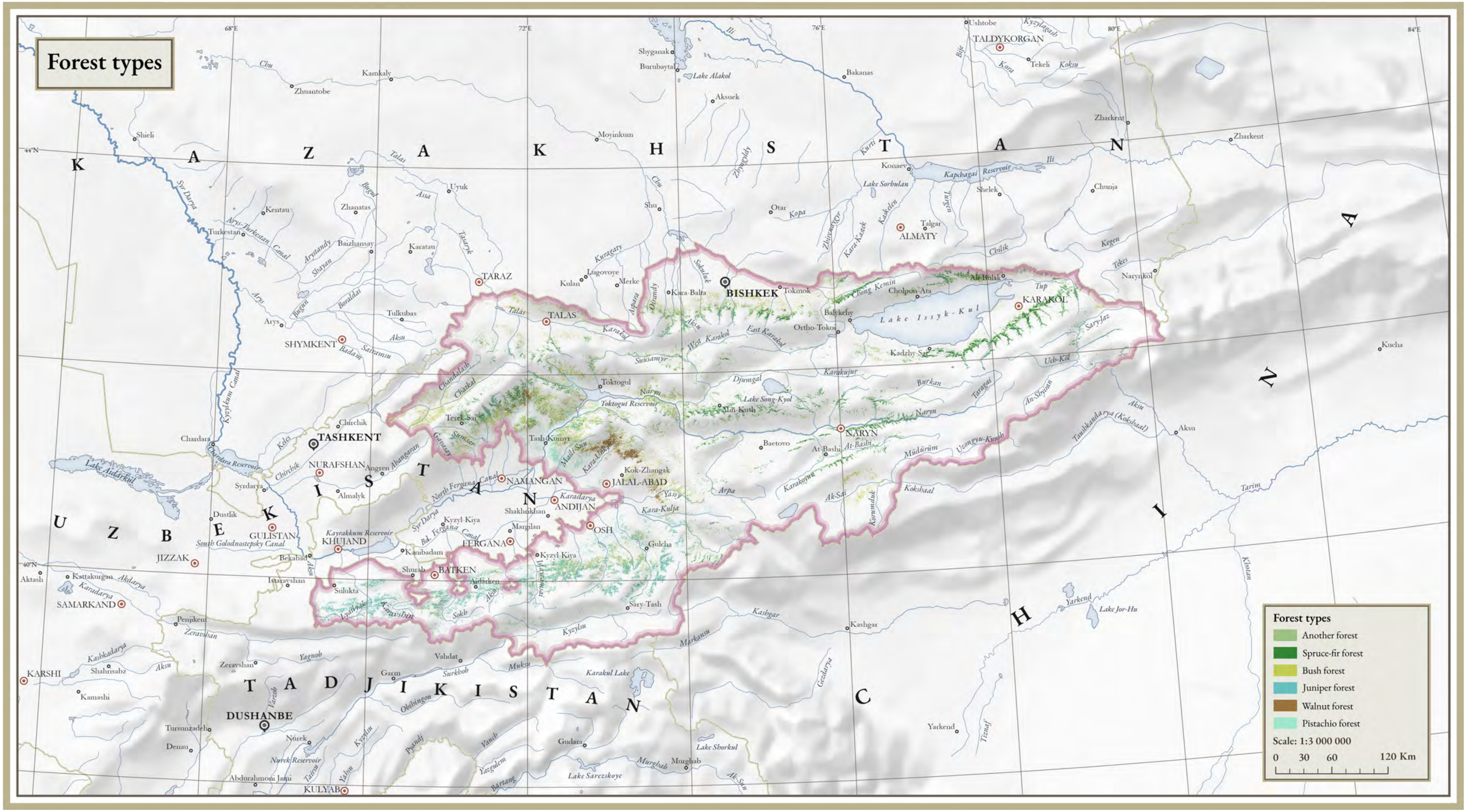
Juniper forests can be found across a wide range of altitudes, from 600 m to 3600 m above sea level, and on extremely steep slopes, a fact that contributes to their great ecological role in the prevention of scree, landslide and mudflow phenomena in the mountains of Kyrgyzstan. In addition, they have certain aesthetic merits and can live for hundreds of years, which makes their ecosystems attractive for recreation and tourism. The republic's first national park, Kyrgyz-Ata, was created specifically for the protection of juniper trees in 1992 in the Nookat district of the Osh region.

Nut-fruit forests are a very peculiar type of ecosystem and play an exceptionally important role for local people since they serve as a source of various wild plants (walnuts, pistachios, etc.). These forests occupy an area of 122,000 hectares and are readily accessible to 256,000 households (1.27 million people). In this category, walnut forest is the most common subtype and accounts for 7.7 per cent of all forested areas. Nut-fruit forests are found mainly in the south of the country, in the Osh and Jalal-Abad regions, and are also distinguished by their large altitudinal range of habitats, from 700 m to 3000 m. In the lowest semi-desert belt (700–900 m above sea level), this type of forest is formed by the xerophilous sparse forest of the real pistachio (Pistacia vera) combined with the presence of other woody shrub species, such as Bukhara almond, southern carcass and Griffith's crimson. Pistachio is an extremely hardy species and grows even on bare rocks and high altitude (900–1100 m) elements of steppe vegetation also appear in sparse pistachio forests. True nut-fruit forests of walnut (Juglans regia), Sievers apple (Malus sieversii) and Korzhinsky pear (Pyrus korshinskyi) are found up to 3000 m, meaning they are present up to the subalpine meadow belt in places such as the south-eastern slopes of the Chatkal and south-western macro-slopes of the Fergana ranges *(see Box 5)*.

Tugai forests exist only on the floodplains of mountain and rivers since a prerequisite for their development is a location with annual flooding (tugai in the Turkic language means flooded forest). Tugai forests are mixed stands with a relatively rich composition of tree species. The native species are black poplar (Populus nigra), turanga (Populus diversifolia), glaucous poplar (Populus pruinosa Schrenk), white willow (Salix alba) and grey willow (Salix cinerea). These species are distinguished by abundant annual bearing that coincides with the flood period. The species composition of tugai forests can differ markedly depending on the moisture conditions in the floodplain river valleys. The Naryn, Chu, Talas, Suusamyr, Sary-Jaz, Jyrgalan and many other small rivers are all covered with tugai thickets along the riverbeds. Tugai forests play an important role in water protection, however, due to their being readily accessible, they are subject to illegal logging and unregulated grazing, transforming them into sparse forest stands.



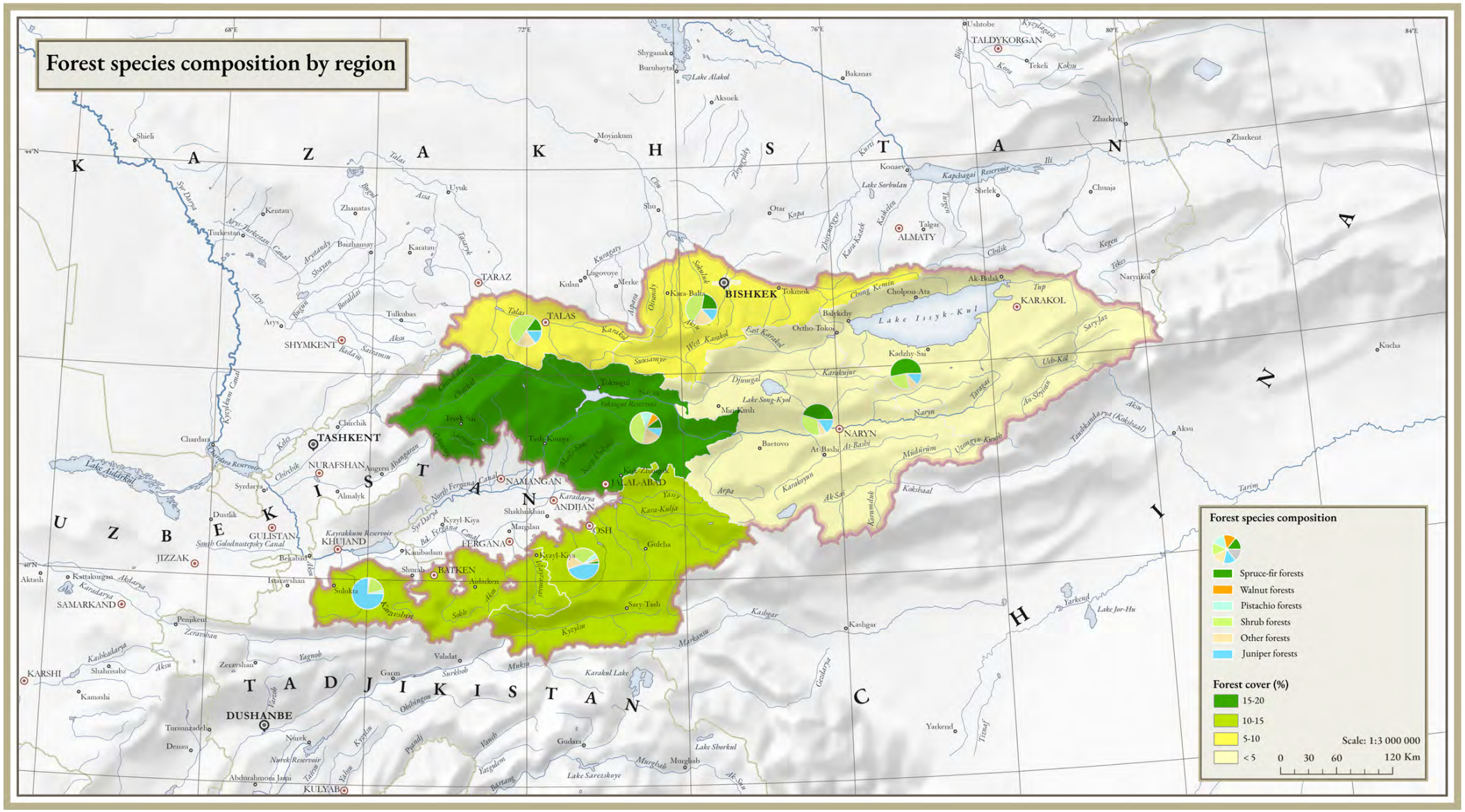
The valley of the Ala-Archa National Park in the vicinity of Bishkek, against the backdrop of the Tien Shan Mountains



National Forest Inventory Data, 2020–2022[80].

80 Second National Forest Inventory in Kyrgyzstan (2022) Report on the results of NFI#2. Forest Service under the Ministry of Agriculture of the Kyrgyz Republic.

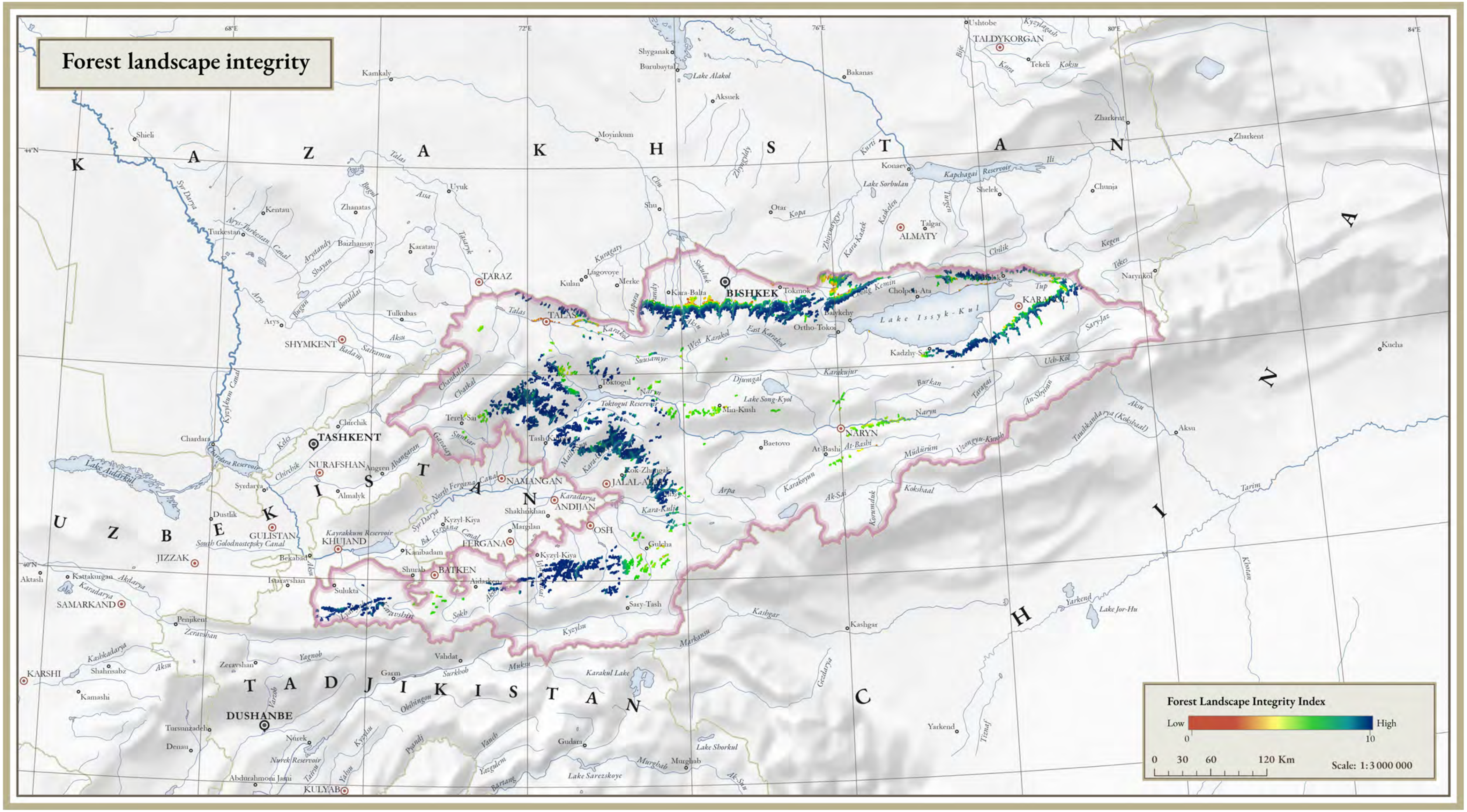
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National Forest Inventory Data, 2020–2022[81].

81 Second National… (2022).

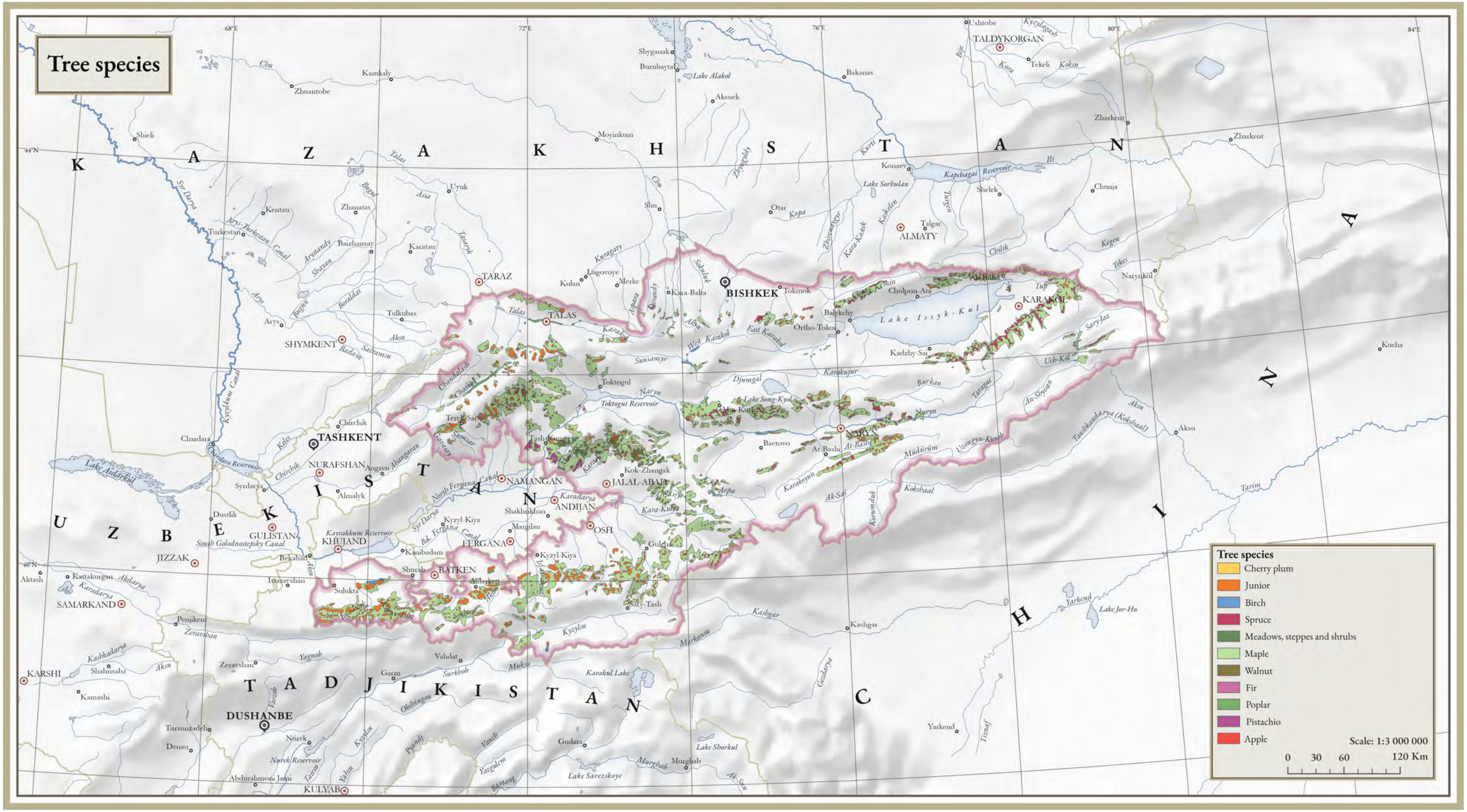
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According to the Forest Landscape Integrity Index[82], calculated using a combination of satellite data (such as global maps of forest cover and loss), observed and inferred human impacts as well as changes in forest connectivity. The index is calculated in a resolution of 300 m, time coverage is 2019.

82 Grantham et al. (2020) Anthropogenic modification of forests means only 40% of remaining forests have high ecosystem integrity. Nat Commun 11, 5978. https://doi.org/10.1038/s41467-020-19493-3

The initial scale of the map is 1:3,000,000. The map image has been changed for the layout of the pages.



Atlas of the Kyrgyz Soviet Socialist Republic. T. 1. Natural conditions and resources. Moscow, GUGK Publ., 1987.

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5.3. Progress towards the SDGs

The National Development Strategy of the Kyrgyz Republic for 2018–2040 was adopted in accordance with the Decree of the President of the Kyrgyz Republic No221, dated 31 October 2018. This strategy sets out a long-term vision for environmental protection, climate change adaptation and disaster risk reduction throughout the republic. The State Agency for Environmental Protection and Forestry has developed the 'Concept for the Development of the Forest Sector until 2040'. This concept aims to preserve forest ecosystems and increase forested areas by the creation of economically sustainable forestry, improved joint forest management and the introduction of digital infrastructure. This concept is in line with the targets of SDG15 which prioritize the tasks of «protecting, restoring terrestrial ecosystems and their sustainable use, sustainably managing forests, combating desertification, halting and reversing land degradation, and halting biodiversity loss.» To achieve these goals, two main indicators of progress have been proposed.

• SDG 15.1 requires that, by 2020, the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in accordance with obligations under international agreements.

According to the Forest Code of the Kyrgyz Republic (1999), all forests are considered a particularly valuable ecological and nature conservation resource, which is reflected in the allocation of water conservation, protective and anti-erosion, sanitary-hygienic and health-improving forests, as well as forests of specially protected natural areas, as the main categories. The category of protected ecosystems includes all walnut and fruit, juniper and pistachio forests, even if they are not formally located within the boundaries of any PAs. Since 2017, logging, all types of economic activities (such as grazing, timber harvesting and the harvesting of wild plants) that can damage these valuable ecosystems, as well as the export of forest-forming species, have been prohibited in these forests until at least 2030 *(see Box 5)*. The latest version of the code also emphasizes the role of forests in carbon sequestration, however, so far there is no climate-regulating category of forests. The code also prohibits commercial logging in all categories of forests. However, the average annual production of firewood fuel in 2002–2004 was 330,000 m³, which is almost 15 times higher than the authorized level of supply.[83]

83 UNECE (2008).



A mountain river flowing through lush forests on a cloudy day

• SDG 15.2 requires, by 2020, the promotion of the sustainable management of all types of forests, a halt to deforestation, restoration of degraded forests and significantly increasing reforestation and afforestation worldwide. The relevant indicator is 'progress towards sustainable forestry', which can be measured by a set of other indicators, such as the annual rate of change in forest areas; the stock of above-ground biomass in forests; the share of forest areas located within legally established protected zones; the share of forest areas managed under a long-term forest plan and forest areas managed under an independently validated forest management certification scheme.

The Kyrgyz Republic has extensive experience in reforestation. In 1930, the forests of the Kyrgyz Republic occupied 1.2 million hectares, by the mid-1950s, this area had halved to 619,000 hectares.[84] Thus, given that the second national forest inventory (2020–2023) indicates forest now occupies 1.19 million hectares, approximately half of the republic's forests are the result of reforestation work, which includes the establishment of tree nurseries and breeding laboratories in all regions of the country. One specific example of the work undertaken in is programme is efforts towards the revival of the Nedzvetsky apple tree (Malus niedzwetzkyana) in the Sary-Chelek Nature Reserve. Having noted the above, however, the forested area in the republic appears to have been stable over the past 30 years *(Map. Forest cover in 1990–2000; Map. Forest cover in 2000–2019)*.

The Bonn Global Initiative, adopted in 2015 at 'the Bonn Challenge', called on all countries to restore 350 million hectares of forest landscapes by 2030. In 2018, as a part of a regional initiative, the countries of the Caucasus and Central Asia made voluntary commitments to restore 3 million hectares of forests by 2030. The Kyrgyz Republic has set a national goal for afforestation amounting to 323,000 hectares

84 Forestry Development… (2018).

in deforested and degraded pastures. While this goal seems very ambitious as it involves the creation of 26,000 hectares of forest plantations every year, much potential for the restoration and expansion of forest areas exists throughout the country exists *(Map. Potential reforestation)*. Every year, forestry and nature parks organize forest plantings on approximately 2000 hectares, including in mountainous areas of Kyrgyzstan where this is carried out manually. This has yielded result as, for example, in 2008–2012, forest plantations were planted on an area of 9,446.9 hectares.[85] However, the trend is negative as, according to the National Statistical Agency of the Kyrgyz Republic, the annual increase in forest area in 2019 amounted to only 412 hectares, which is 60 per cent less than it was in 2013.

The scale of forest degradation in Kyrgyzstan is difficult to assess due to the lack of comparable primary forest inventory data. The economic crisis in the 1990s and general socio-political instability posed high risks to the state of forests in the river valleys in the vicinity of settlements *(Map. Changes in forest cover density)*. The use of remote sensing methods shows that walnut forests are the only type of forest ecosystems that have demonstrated a general negative trend in dynamics over the past 20 years, and this strikingly distinguishes it from all other types of forests *(see Map. Forest types; Map. Dynamics of enhanced vegetation index) (Table 7)*. In the vicinity of the walnut forests, there are many thousands of households that actively make use of the 'gifts of nature', collecting wild fruits and nuts, other wild plants, fuel wood, as well as utilizing these forested areas for haymaking and grazing their numerous livestock.[86]

Table 7. Assessment of the state of different types of forests by remote sensing methods

Forest type	Average EVI trend per year	Proportion of area with EVI growth (%)	Proportion of area with decreasing EVI (%)
Walnut forest	-0.00013	36.6	63.4
Spruce-fir forest	0.00010	62.1	37.9
Other forests	0.00018	63.7	36.3
Shrub forest	0.00023	71.6	28.4
Pistachio Forest	0.00028	75.6	24.4
Juniper Forest	0.00037	83.6	16.4

85 The representation of forest ecosystems and, walnut forests
86 Forestry Development... (2018)

in particular, in the system of PAs is extremely insufficient and does not guarantee their full protection from being degraded by actions of local populations. Walnut forests occupy significant relative areas only in the Dushman Nature Reserve *(Map. Species composition of forests in protected areas)* for which a strict protection regime was introduced in 2012. This led to a conflict situation with the local population that traditionally considered it their right to exploit these forests for their needs. According to our data, up to 85 per cent of the territory of the reserve is characterized by negative dynamics of EVI. The country's second largest walnut forest in the Sary-Chelek Biosphere Reserve is also nominally protected, however, this protection has failed to prevent economic activity even in the core of the reserve *(see Box 5)*.

Changes in the above-ground biomass stock in forests are also an important indicator of the state of forests in the republic. Complete data on above-ground biomass stocks in different types of forests were obtained for the first time during the last forest inventory, which significantly improved the data available in global sources *(Map. Forest aboveground biomass)*. The total timber stock in Kyrgyzstan is 76.3 million m³, including 60.6 million m³ on State Forest Fund lands and 15.7 million m³ outside Fund lands. The average wood stock per hectare in the forests of Kyrgyzstan (excluding 'shrub forests') is 44.4 m³ per hectare.

The largest timber reserves are in the spruce/fir forests



Nut and fruit forest

of the Issyk-Kul region, which contain 25.4 million m³ with a relatively high wood stock of 118.6 m³ per hectare. The lowest values of absolute and per hectare wood stocks are found in the Batken region, where juniper forests prevail, and these values are equal to 4.3 million m³ and 28.8 m³, respectively.

For the first time, the number of trees in the Kyrgyz Republic was calculated. In total, there are 325.7 million trees, of which the most numerous groups are formed by Tien Shan spruce, which has a population of 100 million trees, various juniper species – 84 million trees and hawthorn-mountain ash-mulberry (categorized in 'other broad-leaved and mixed forests') – 55 million trees.[87]

The latest version of the Kyrgyz Republic's Forest Code emphasizes the role of forests in carbon sequestration, however, the climate-regulating category of forests has not yet been identified in official documents. One achievement of the 2023 inventory was a carbon stock assessment of the republic's forest ecosystems *(Map. Aboveground carbon stock in forests)*. The total carbon stock on forested lands stands at 98.3 million tons, or 57.25 tons of carbon per hectare. There is, however, considerable variation by forest type as spruce forests contain an average of 190.7 tons of carbon per hectare while the coniferous forests of the Issyk-Kul region have the highest amount of carbon accumulation in aboveground biomass at 213.9 tons per hectare *(Box 4)*. The minimum values were recorded in the coniferous forests of the Tallas district, which contained only 50.5 tons of carbon per hectare.

Walnut forests have a relatively high level of carbon storage, some 158 tons per hectare, and the Jalal-Abad region is distinguished by having the country's maximum absolute and relative values of carbon content in the aboveground biomass of walnut forests – 12.67 million tons and 164.9 tons per hectare, respectively. Juniper forests, which prevail in the Osh and Batken regions, are characterized by low amounts of stored carbon in their aboveground biomass – 25.63 tons per hectare while 'shrub forests' accumulate carbon, on average, at rate of only 0.47 tons per hectare.

Despite the importance of these data, it is not possible to assess trends in carbon stocks in the forests of the Kyrgyz Republic over the past decades, whether due to climate change or anthropogenic factors (forest grazing, illegal felling etc.).

According to the SDG 15.2.1 Guidelines, progress towards sustainable forestry can also be measured by the proportion of forest area under a long-term forest plan and the area of forests under an independently validated forest management certification scheme.



Mountain forest in the vicinity of the village of Arslanbob

The share of Kyrgyzstan's forest areas for which there is a long-term forest management plan is 82.6 per cent, a figure that has increased by 11 per cent over the past five years. In official reports, the existence of such long-term plans is presented as fulfilling the indicator requirements of SDG 15.2.1 as the plans contain regulatory requirements for the use and protection of forest resources and emphasize the importance of social and cultural use of forests by local communities. Interestingly, while an increase in the forest area under a management plan is interpreted by the State as progress towards sustainable forest management, work was carried out to develop a Sustainable Forest Management Plan from 2016 to 2019, however, this was never approved.

A forest management certification scheme involves the application of international standards, which are generally higher than those established by national regulatory frameworks. Compliance with these standards is established by independent accredited organizations and any increase in the area of certified forests is thus seen as an important additional indicator of progress towards sustainable forest management. Forest certification data are submitted to the FAO annually by the head offices of relevant forest certification schemes. These figures include the area certified by each scheme, as well as the areas that are certified under the two main schemes (FSC, PEFC). To date, there is no forest certification scheme operational in Kyrgyzstan and the UN

87 Second National.....(2022).

SDG Indicators Database states that «in 2022, the area of forests under an independently verified forest management certification scheme amounted to 0.0 thousand hectares.»

• SDG 15.4 requires efforts to ensure the conservation of mountain ecosystems, including their biodiversity, with a view to enhancing their ability to provide the benefits needed for sustainable development by 2030.

The main indicator in this context is the Mountain Green Cover Index (MGCI), which measures changes in mountain green cover. The notion of 'green cover' includes a wide variety of landscape cover, including forests, shrub thickets, meadow communities, agricultural land, fruit plantations and others. A decrease in the MGCI will mean an increase in anthropogenic stress on mountain ecosystems while an increase in this indicator is associated with an improved vegetation cover, possibly related to land restoration programmes, afforestation or reforestation. The indicator is based on the use of Collect Earth, numerous very high-resolution images from Google Earth and Bing Maps as well as Landsat 7 and 8 data from the Google Earth Engine. These sources are 99 per cent accurate at the global level but lower at the national level, especially for small countries. According to the republic's National Statistics Committee, a national version of the Mountain Green Coverage Index is under development.

Box 4. Estimating Potential Carbon Sequestration from Reforestation on the Northern Slope of the Tien Shan

A 2016 study assessed the carbon sequestration potential of spruce forests (Picea Schrenkiana) on the northern slopes of the Tien Shan Mountains in Kyrgyzstan, Kazakhstan, and China.[88] The research methods were designed to model the potential distribution of P. schrenkiana forests based on climatic indicators and topography by using remote sensing to map the actual distribution of forests and agricultural land with potential for reforestation. Additionally, the methodology allowed the measurement of organic carbon in soils from forests and former forests to estimate carbon losses due to deforestation and possible sequestration during reforestation.

Based on the reconstruction of the previously forested area, the study found a significant reduction in the current forest area, going from 84.16 million hectares in the 1950s to 24.25 million hectares in 2016, meaning only 28.81 per cent of the 1950s forest cover remained. The most significant losses of soil carbon were associated with the conversion of forests to cropland, which covered an area of 26.77 million hectares (accounting for 45 per cent of the deforested area). The study found that the SOC content of arable land is 177.4 tons per hectare, which is half as much as in forest soils where it was recorded as 349.1 tons per hectare. This means that the loss of SOC in the upper layers of tilled soil is 51 per cent, which is higher than usually reported in the literature, which cites a figure of approximately 30 per cent. In addition, a positive correlation was found between AGBC and SOC with a ratio of 0.6459. The total potential for SOC fixation in the area resulting from the full reforestation of cropland is estimated at 459.7 million tons (± 75.49 million tons) and could increase to 820.4 million tons if both the aboveground (296.9 million tons) and belowground biomass (63.8 million tons) are taken into account.

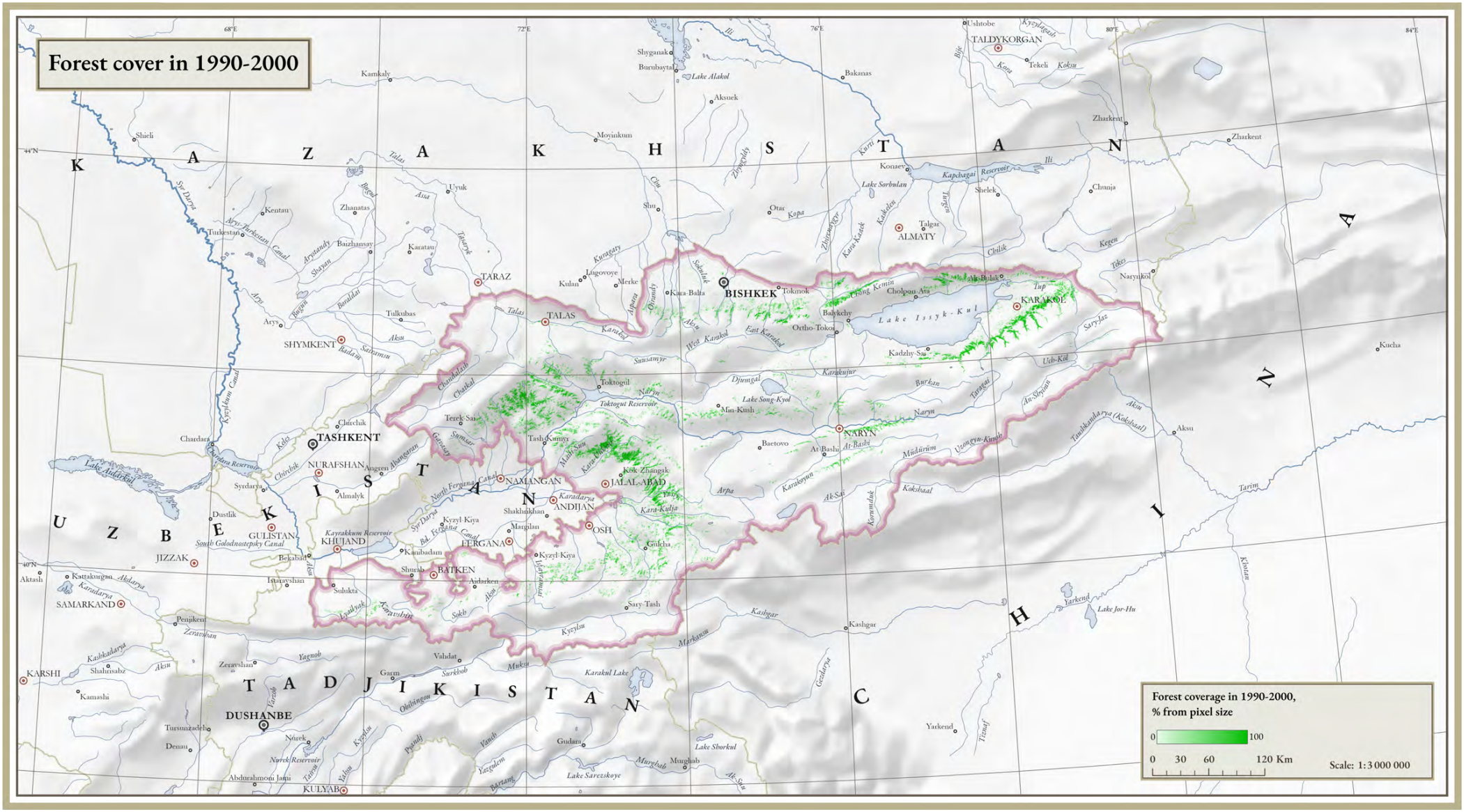
88 Li et al. (2016) Carbon sequestration potential of cropland reforestation on the northern slope of the Tianshan Mountains. Canadian Journal of Soil Science, 96: 461–471. 27 July 2016. https://doi.org/10.1139/cjss-2015-0122.



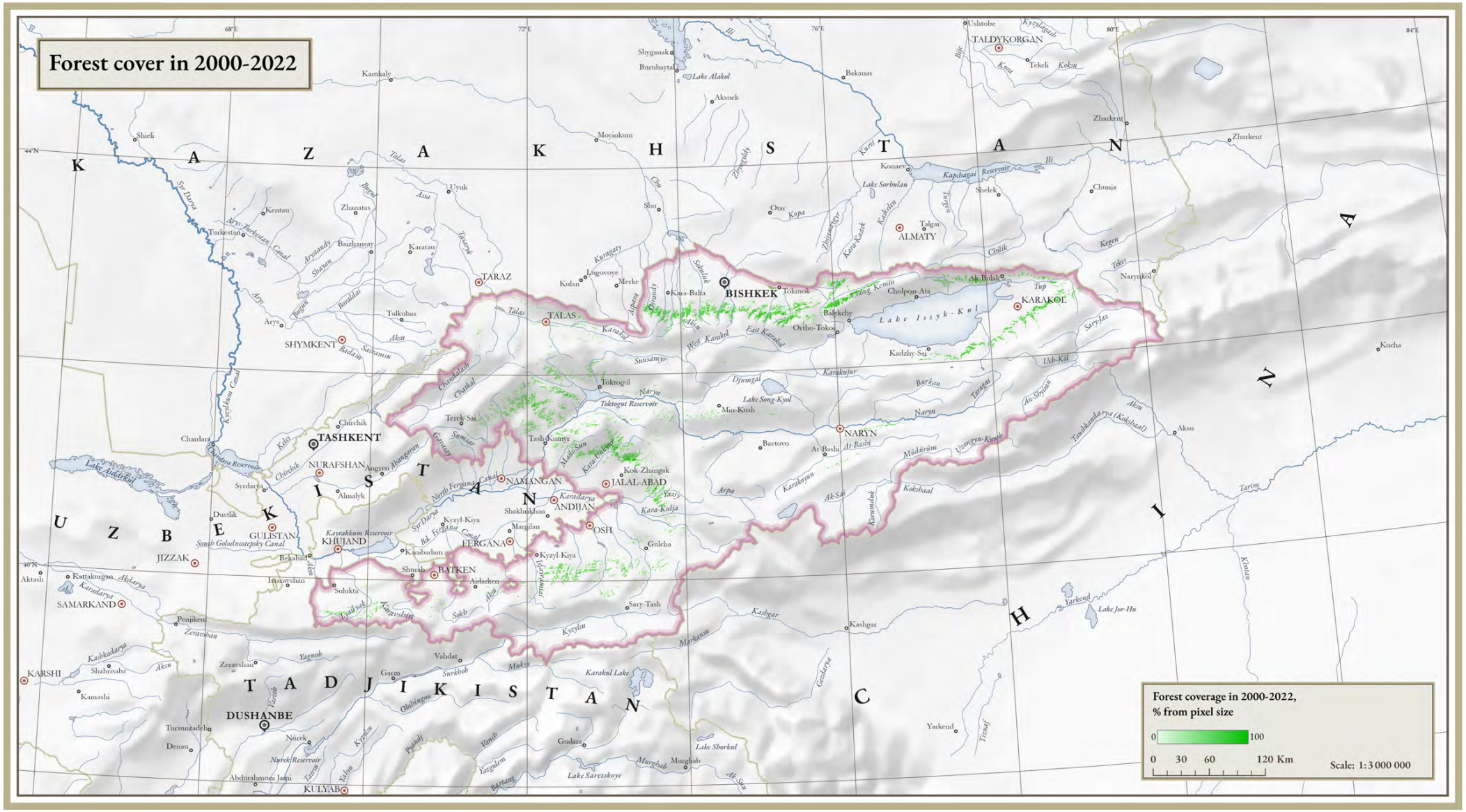
Landscape of the Sary-Chelek Nature Reserve

5.4. Responses

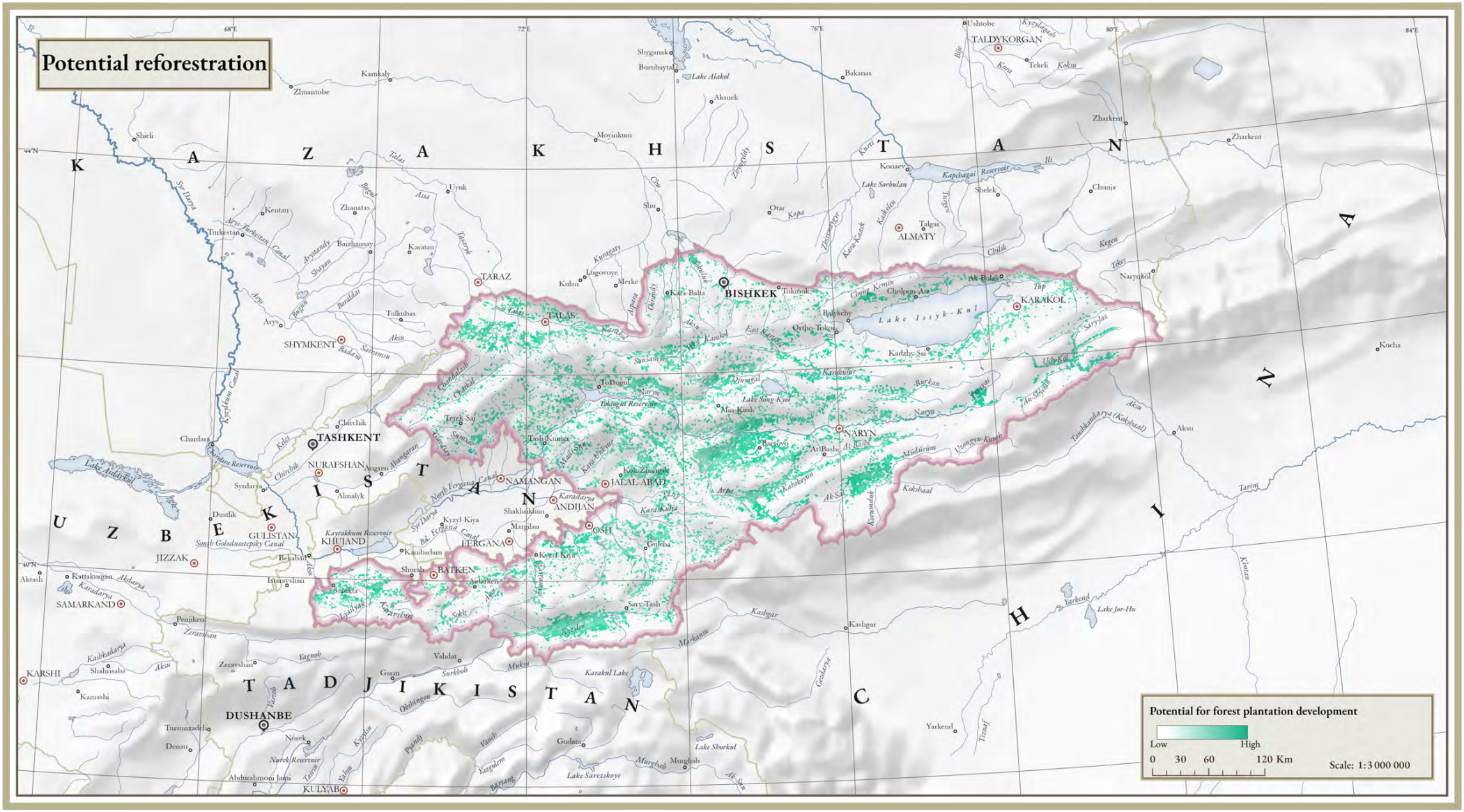
- Prioritization of the protection walnut forests in the system of monitoring and defence of forest resources of the republic.
- Strengthening the monitoring system of forest ecosystems and creating an information base for sustainable forest management.
- Establishing a system for accounting for the carbon balance of forests provided by global remote databases and national sources.
- International certification of the republic's forests with prioritization of social and cultural functions of forest ecosystems.



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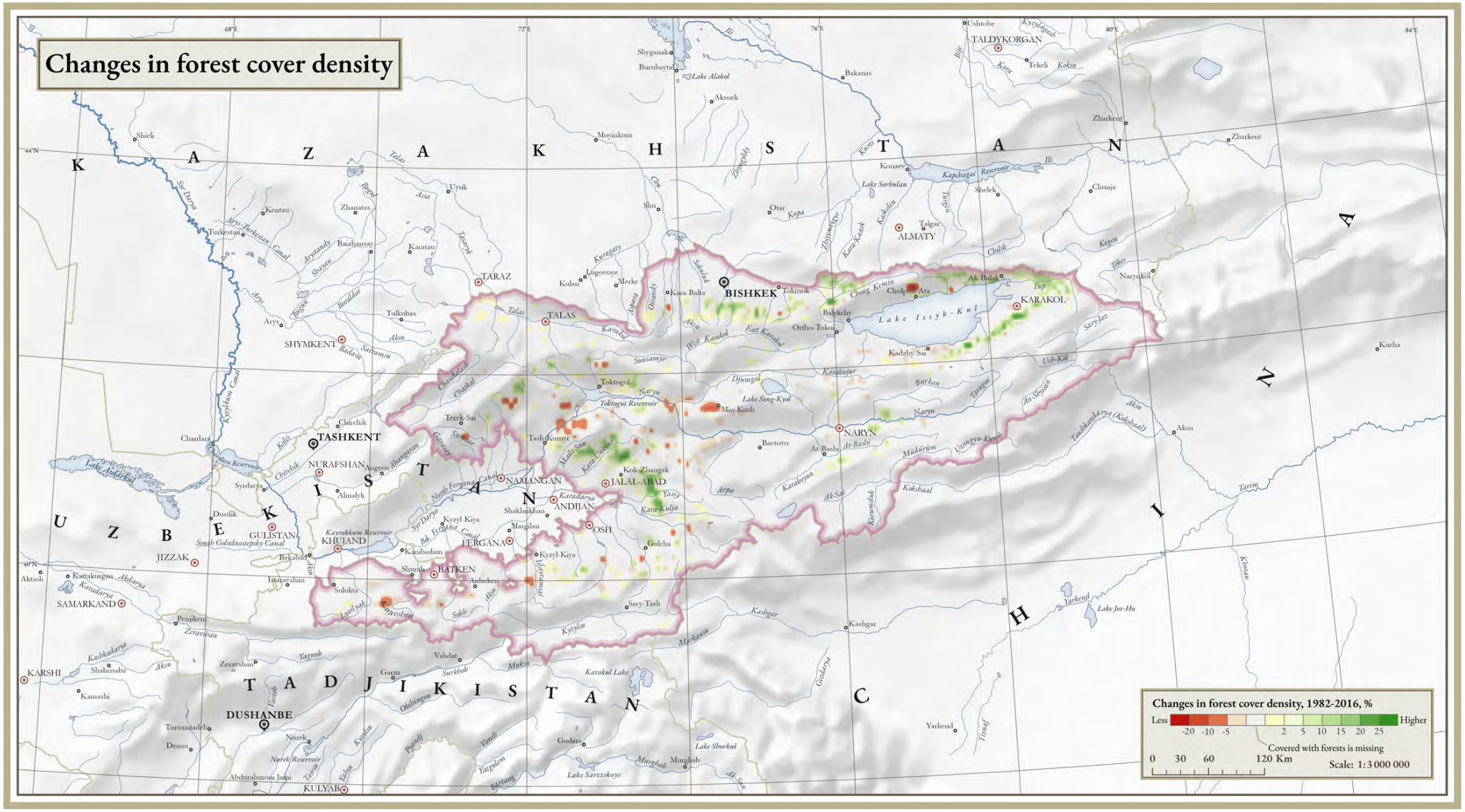
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According to the Global Reforestation Map[89], obtained using satellite imagery with a spatial resolution of 250 m. Reforestation potential was determined by comparing maps of potential and current forest cover, taking into account data on population density, land use and urbanized areas and then distinguishing three categories of restoration: large-scale, mosaic and remote.

89 Griscom et al. (2017). Global Reforestation Potential Map. https://zenodo.org/record/883444

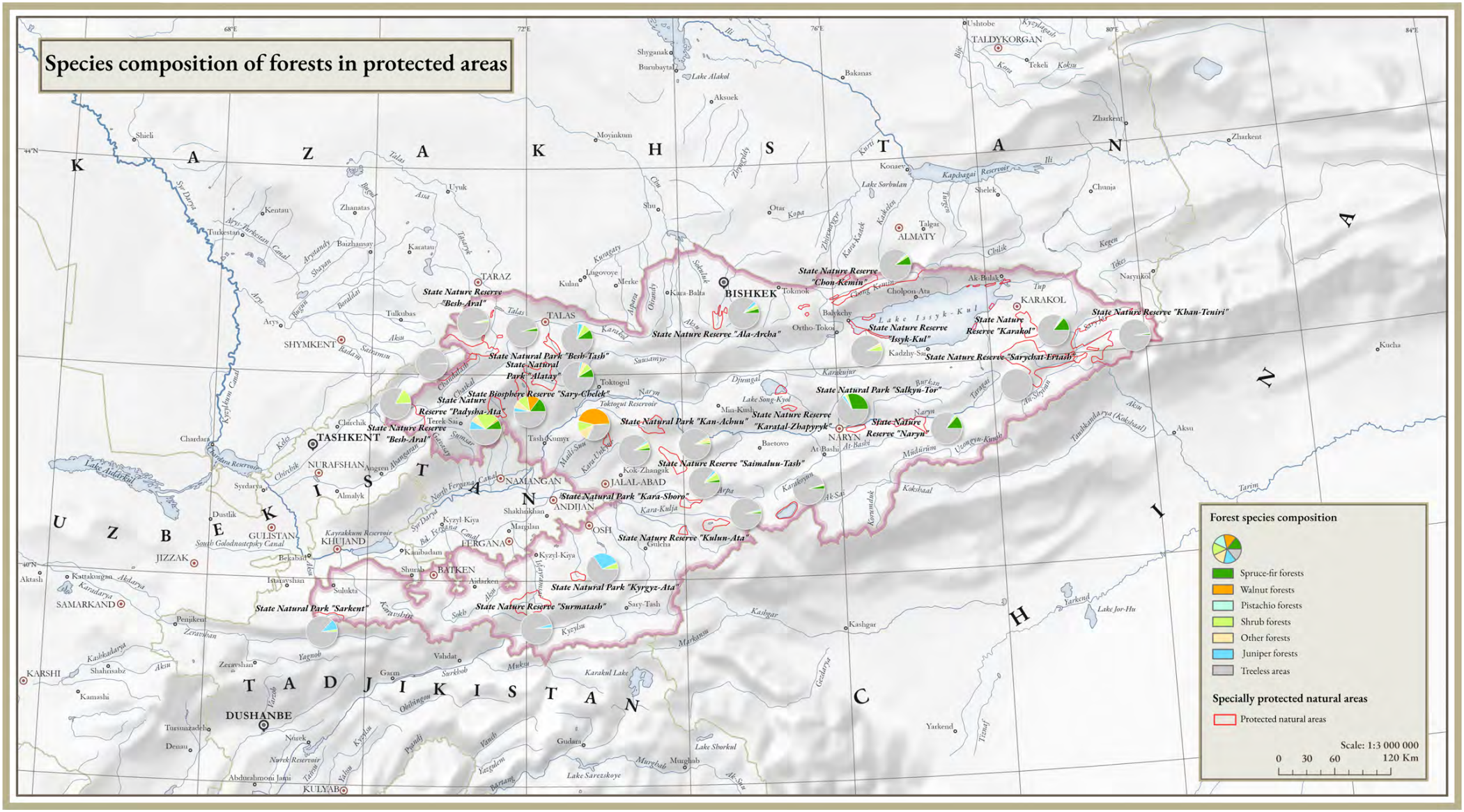
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Based on an analysis of satellite data with a spatial resolution of 0.05° × 0.05° for 1982–2016 with the allocation of three classes of landscape cover: cultivated land, residential areas and forest areas[90].

90 Song et al. (2018) Global land change from 1982 to 2016. Nature 560, 639–643. https://doi.org/10.1038/s41586-018-0411-9

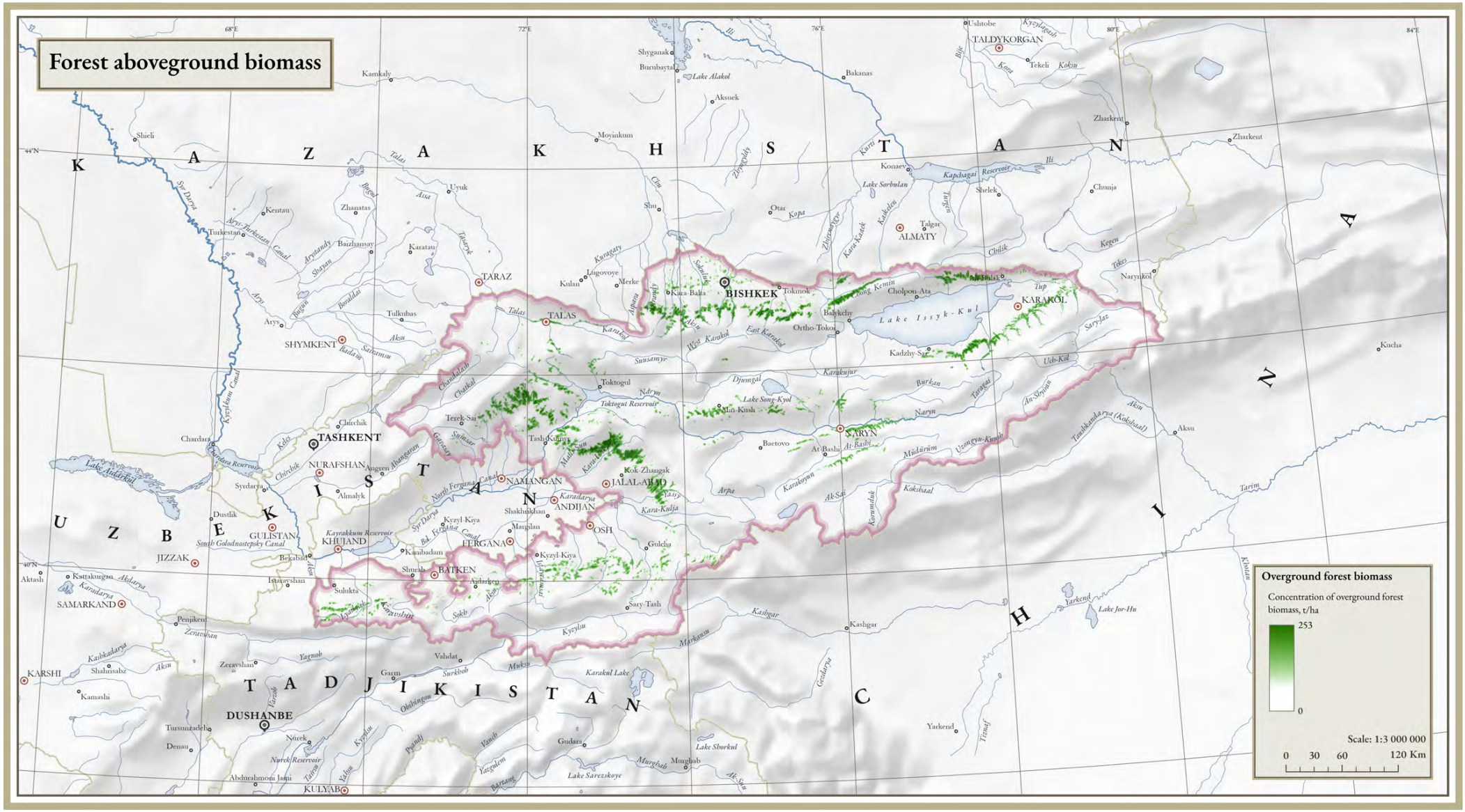
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National Forest Inventory Data, 2020–2022[91].

91 Second National… (2022).

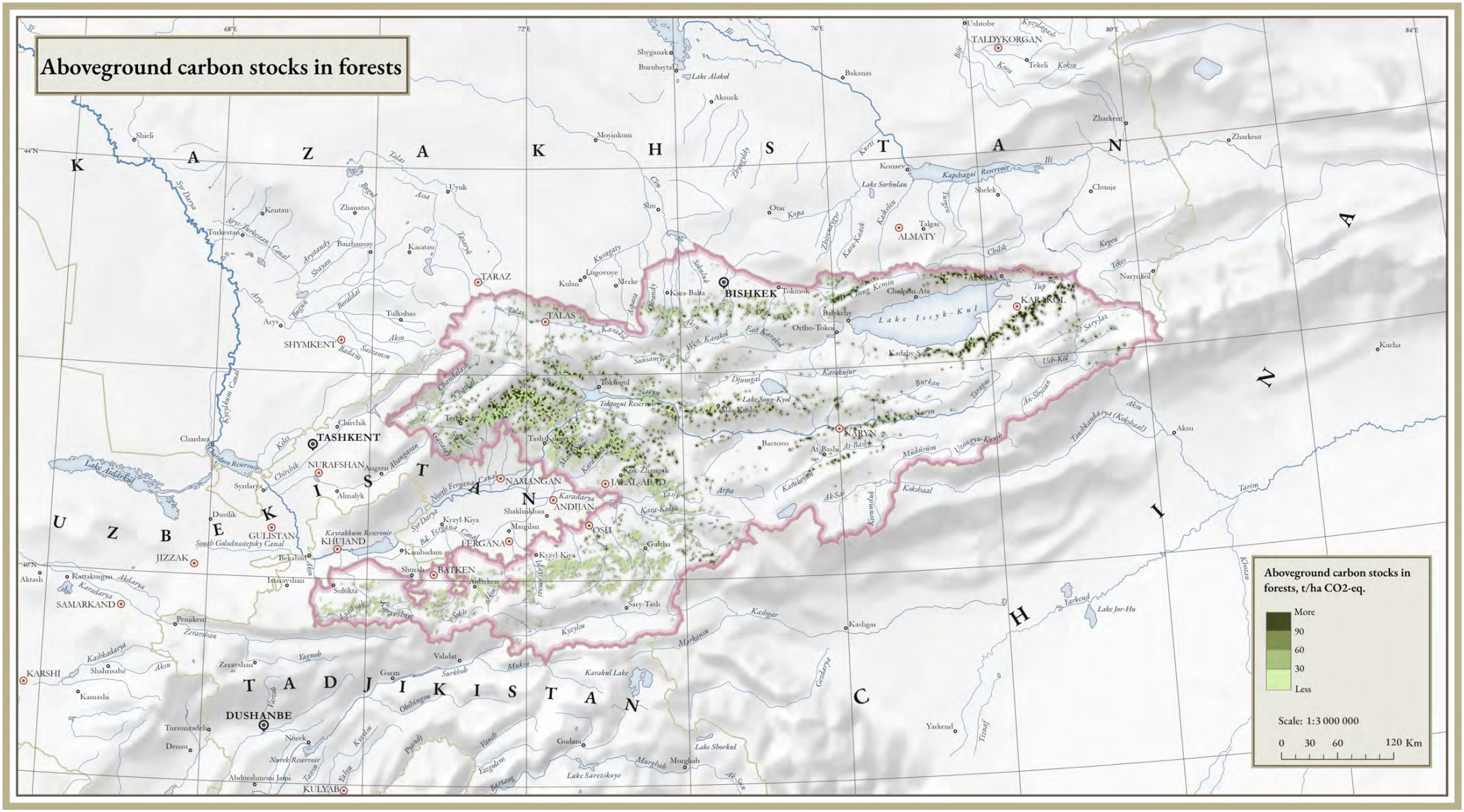
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According to ESA CCI Global Forest Aboveground biomass[92], based on the results of an analysis of radar satellite data. Spatial resolution 100 m, time span 2010–2021.

92 https://climate.esa.int/en/projects/biomass/

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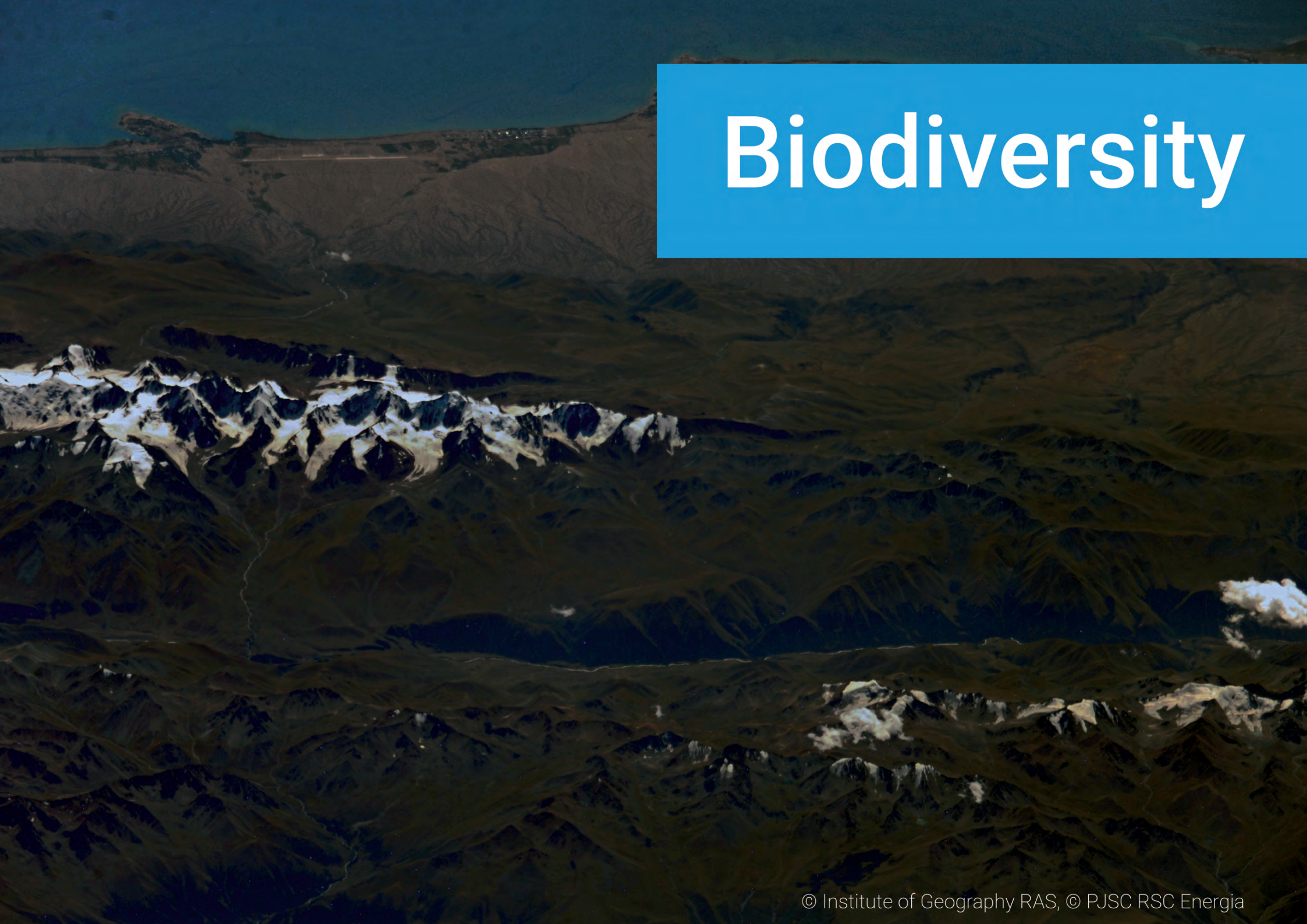


National Forest Inventory Data, 2020–2022[93].

93 Second National… (2022).

The initial scale of the map is 1:3,000,000. The map image has been changed for the layout of the pages.

Biodiversity



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6.1. Key aspects

- The Kyrgyz Republic is one of the 36 global IUCN 'biodiversity hotspots'.
- The greatest diversity of the republic's ecosystems is concentrated in the mid-mountain zone, at an altitude of 2000–3000 m above sea level, where most classes of ecosystems are represented.
- The 'biodiversity hotspots' in Kyrgyzstan are subject to significant anthropogenic impact.
- Habitat disturbance threatens the extinction of 92 species of animals and 65 species of plants, this constitutes approximately one per cent of Kyrgyzstan's species diversity.

6.2. General characteristics

The vegetation and landscape cover of Central Asia is characterized by diversity due to the arid climate, meaning any change in the hydrothermal regime will play a large role in the distribution of species, especially due to the role the complex terrain plays. The region has two main ecological and geobotanical provinces, Turan and Kazakhstan, which differ in climatic and hydrological conditions but both have a predominance of heat-loving flora of the Paleogene and Neogene periods. The Turan province is close to the nature of the Iranian-Arabian region, with its characteristic subtropical features, while the Kazakhstan province is associated with a temperate climatic zone.

The Kyrgyz Republic, located in the heart of Eurasia and surrounded by arid and supra-arid plains, is deeply influenced by the desert zone. The country's location, approximately 3,000 km from any oceans, dictates the general aridity and continental nature of its climate. Almost 90 per cent of the territory of the Kyrgyz Republic is located at an altitude more than 1,500 meters above sea level and the relative floristic and faunistic richness in the Kyrgyz Republic is mainly due to the presence of the Tien Shan and Pamir-Alai high-mountain systems.

As in any mountainous country, the main regularities of the landscape arrangement of the territory are the presence of a pronounced vertical zonality, although differences between the north and south as well as the east and west of the country are also noticeable. These differences can be reflected in the different variants of landscape zoning of the country *(Map. Vertical zonation of landscapes; Map. Sectorality of landscapes)*. Given these circumstances, precipitation is a secondary factor in the distribution of vegetation cover types in mountainous areas. According to the classification of landscapes widely used in the Kyrgyz Republic[94], 20 classes of natural ecosystems are distinguished where the first criterion for classification lies in the vegetation cover which is then divided into three main groups: forest, shrub and meadow *(Map. Vegetation; Map. Geobotanical associations)*. Diversity within biomes is determined by their altitudinal variants (in the group of meadow ecosystems) and by the predominant species (in the group of forest ecosystems). Among the classes of ecosystems, cryophilic high-mountain meadows and steppes predominate, together occupying 24.5 per cent of the country's area. Mid-mountain and foothill steppes account for 9.3 per cent while spruce and juniper forests account for 1.39 and 1.34 per cent, respectively. The rarest ecosystems are tugai, occupying only 0.014 per cent of the country's territory. For comparison, the area of swamps and lakes is 3.57 per cent and anthropogenic complexes ('cultural lands' in the terminology of the classification) occupy 6.28 per cent.[95]

The richest ecosystems in terms of landscape diversity are the belt of middle mountains with altitudes from 2,000 to 3,000 meters above sea level. Fourteen of the 20 classes of ecosystems (70 per cent) are represented here even though

94 Balbakova F. (2023) Ecosystems conservation and analysis of the representativeness of protected areas of the Kyrgyz Republic in a climate change. Natural Resources Conservation and Research. Vol. 6, 2. (PDF) Ecosystems conservation and analysis of the representativeness of protected areas of the Kyrgyz Republic in a climate change

95 Third national report on biodiversity conservation of the Kyrgyz Republic (2005) Bishkek. CBD Third National Report - Kyrgyzstan (English version)



Juniperus zarafshanica

this altitude level occupies only 30.8 per cent of the republic's area. The steppe ecosystems prevailing here serve as habitats for 41 per cent of all the species listed in the Red Book of Kyrgyzstan (2006), including 37 (42 per cent) of the 89 species of red-listed higher plants, 27 (51 per cent) of the 53 listed species of birds and 13 (50 per cent) of the 26 listed species of mammals. By way of a contrasting example, Kyrgyzstan's coniferous forests contain only 2.6 per cent of its red-listed species. Other classes of ecosystems are, on average, each home to 12-14 per cent of the country's Red Book listed species. The glacial-nival belt (above 3500 m) is represented by a small set of ecosystem classes whereas alpine meadows are relatively diverse in floristic terms where, among the herbs growing here, there are 21 per cent of red-listed plant species[96].

Regional (sectoral) differences in landscape terms are also significant in Kyrgyzstan. The most diverse are the Western and Central Tien Shan, where 16 out of 20 classes (80 per cent) of ecosystems are identified, while the least diverse is the Fergana biogeographical province with only five classes (25 per cent) of ecosystems. The other regions contain an average of 10-13 classes (50-65 per cent) of ecosystems[97].

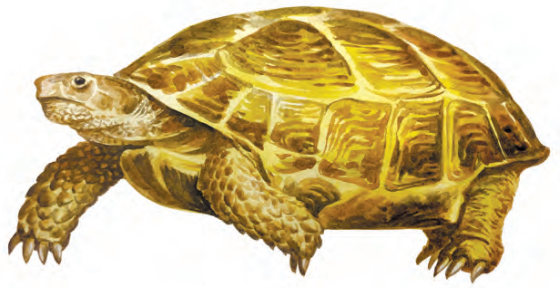
An assessment of the state of landscapes using NDVI or EVI shows the predominance of positive trends in the dynamics of green biomass in all categories of landscapes *(see Map. Dynamics of enhanced vegetation index; Map. Landscapes and their representation in the PA system) (Table 8)*. Compared to other categories, medium-mountain forest and forest-meadow forests have lower trend values, mainly due to the deteriorating condition of walnut forests. Plain (valley) and piedmont desert and semi-desert landscapes, which are almost completely developed for irrigated agriculture, also show lower trend values than the national average.

96 Ibid.

97 Biodiversity Strategy and Action Plan. Project. (1998). Bishkek kg-nbsap-01-ru.pdf (cbd.int).



Kaufman's Tulip



Central Asian tortoise

Table 8. Assessment of the state of landscapes by remote sensing methods

Landscape categories	Average EVI trend per year	Proportion of area with EVI growth (%)	Proportion of area with decreasing EVI (%)
Desert and semi-desert landscapes (plain and foothill)	0.00039	78.3	21.7
Steppe (piedmont and low-mountain)	0.00049	83.7	16.3
Meadow and meadow-steppe (low-mountain and medium-mountainous)	0.00066	92.9	7.1
Forest and forest-meadow (mid-mountain)	0.00019	68.8	31.2
Meadow subalpine and alpine (highland)	0.00039	86.1	13.9
Tundra and glacial-nival (high-mountain)	0.00057	93.7	6.3
Tugai and meadow-marsh	0.00046	85.7	14.3
In general, for all categories of landscapes	0.00039	82.8	17.2

According to the IUCN, the mountain systems of Central Asia form one of the 36 global 'biodiversity hotspots', namely, a region with more than 1500 endemic plants with a significant (more than 70 per cent) loss of natural habitats. The inclusion of these mountains in the IUCN list took place in 2011, during its revision. In addition to 1500 (out of a total of 5500 species) endemic plant species, 17 endemic species of animals live in the Central Asian hotspot, including seven (out of 116) species of mammals, one (out of 59) reptile, four (out of 8) – amphibians and five (out of 27) freshwater fish. Despite the complex high-mountain terrain, the anthropogenic impact on the flora and fauna of the Pamirs and Tien Shan is recognized as significant. Of the approximately 6700 species (excluding lower plants, protozoa and invertebrates) found in Central Asia, 68 species (1 per cent) are included in the IUCN global Red List as threatened with global extinction.[98]

The Central Asian 'biodiversity hotspot', with an area of 860,000 km², spans parts of seven countries: south-eastern Kazakhstan, most of Kyrgyzstan and Tajikistan, eastern Uzbekistan, western China, north-eastern Afghanistan and south-eastern Turkmenistan[99]. Of these, the Kyrgyz Republic (199,900 km²) and Tajikistan (141,100 km²) lie almost completely within the boundaries of this 'biodiversity hotspot', with the Kyrgyz Republic (39.18°–43.24°N, 69.23°–80.20°E) being at its centre.

98 Biodiversity hotspot in the Central Asian mountain region. Characteristics of ecosystems (2017) IUCN. Critical Ecosystem Partnership Fund. 230 p. (in Russian). cepf.net/sites/default/files/mountains-central-asia-ecosystem-profile-rus.pdf

99 Mountains of Central Asia Biodiversity Hotspot. Ecosystem Profile (2017) Critical Ecosystem Partnership Fund. mountains-central-asia-ecosystem-profile-eng.pdf



Acantholimon pamirensis



Kraschenninnikovia ceratoides

Almost all systematic groups of wildlife are present in Kyrgyz Republic: approximately 3,600 species of fungi and other lower plants, 3,869 species of higher plants, 101 species of protozoa, 14,600 insects and other arthropods, more than 1,500 other invertebrates, 75 species of fish, four species of amphibians, 33 species of reptiles, 390 species of birds and 84 species of mammals. These figures are high for Central Asia.

To provide some context, the above figures mean that an area of only 0.13 per cent of the planet's surface contains one per cent of all species known to modern science, a species density 7.7 times higher than the global average per km². In relation to certain categories of wildlife, this indicator of species richness is even higher. In the Kyrgyz Republic, 4.98 per cent of all known lower and 1.52 per cent of higher plants have been identified; these figures i nclude 3.54 per cent of the world's worms, 4.07 per cent of its birds and 2.07 per cent of its mammals.[100]

The first edition of the Red Book of Kyrgyz Republic (1985) listed 108 species, 43 of which were animals (including 13 species of mammals and 20 species of birds) along with 65 species of higher plants. The second edition, which was published in 2006, listed 201 species, a figured comprised of 115 species of animals (including 23 species of mammals and 53 species of birds) and 83 species of plants.[101] The increase in the number of listed species reflected the progress made in scientific research on the flora and fauna of Kyrgyz Republic as well as the elimination of gaps in evidence and, to a lesser extent, changes in the ecological status of species. The second edition also began using the IUCN classification of species in relation to the probability of their extinction. The 'endangered' group has three categories – vulnerable (VU), endangered (EN) and critical (CR), where the latter refers to species on the verge of extinction. In the current edition of the book (2006), 15 species of mammals, 26 species of birds and 65 species of plants are included in this group. Losses in the class of mammals include three extinct species, and in the class of birds – four species.

However, the IUCN Red Book for the Kyrgyz Republic contains the names of 43 species, including 13 species of plants, five species of mammals, 15 species of birds, three species of fish, three species of reptiles and one species of insects. The 'endangered' group includes 18 species, including two species of mammals, five species of birds, one species of fish, and 10 species of higher plants. Of the 10 bird species, only the sociable lapwing *(Vanellus gregarius)* has the status of a critically endangered species (CR), although five species of plants are also recognized as being on the verge of extinction: limestone zhuzgun *(Calligonum calcareum)*, Knorring's hawthorn *(Crataegus knorringiana)*, Toktogul knotweed *(Polygonum toktogulicum)*, Tien Shan Siberian (*Sibiraea tianschanica)* and Korzhinsky pear *(Pyrus korshinskyi)*.[102] These are all endemic plant species that only grow on dry slopes in shrub thickets and light forests at altitudes of 1200–1700 m.

100 Biodiversity Strategy...(1998). kg-nbsap-01-ru.pdf (cbd.int)

101 Red Book of the Kyrgyz Republic (2006) State Agency for Environmental Protection and Forestry under the Government of the Kyrgyz Republic, Institute of Biology and Soil of the National Academy of Sciences of the Kyrgyz Republic. Ecological Movement of Kyrgyzstan «Aleine». 2nd ed. Bishkek. 544 p. (in Russian).

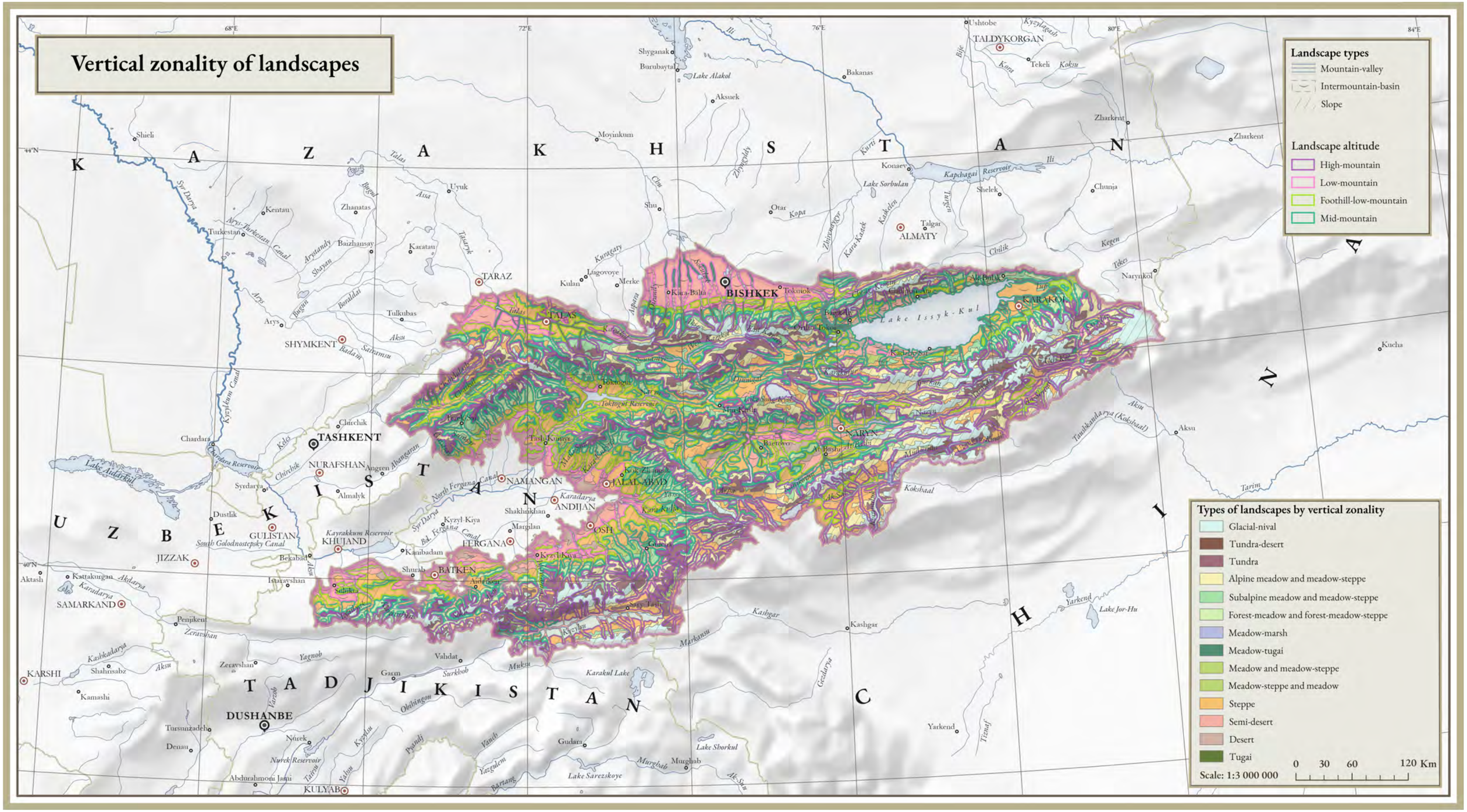
102 IUCN Red List version 2020-1.



Pistacia vera

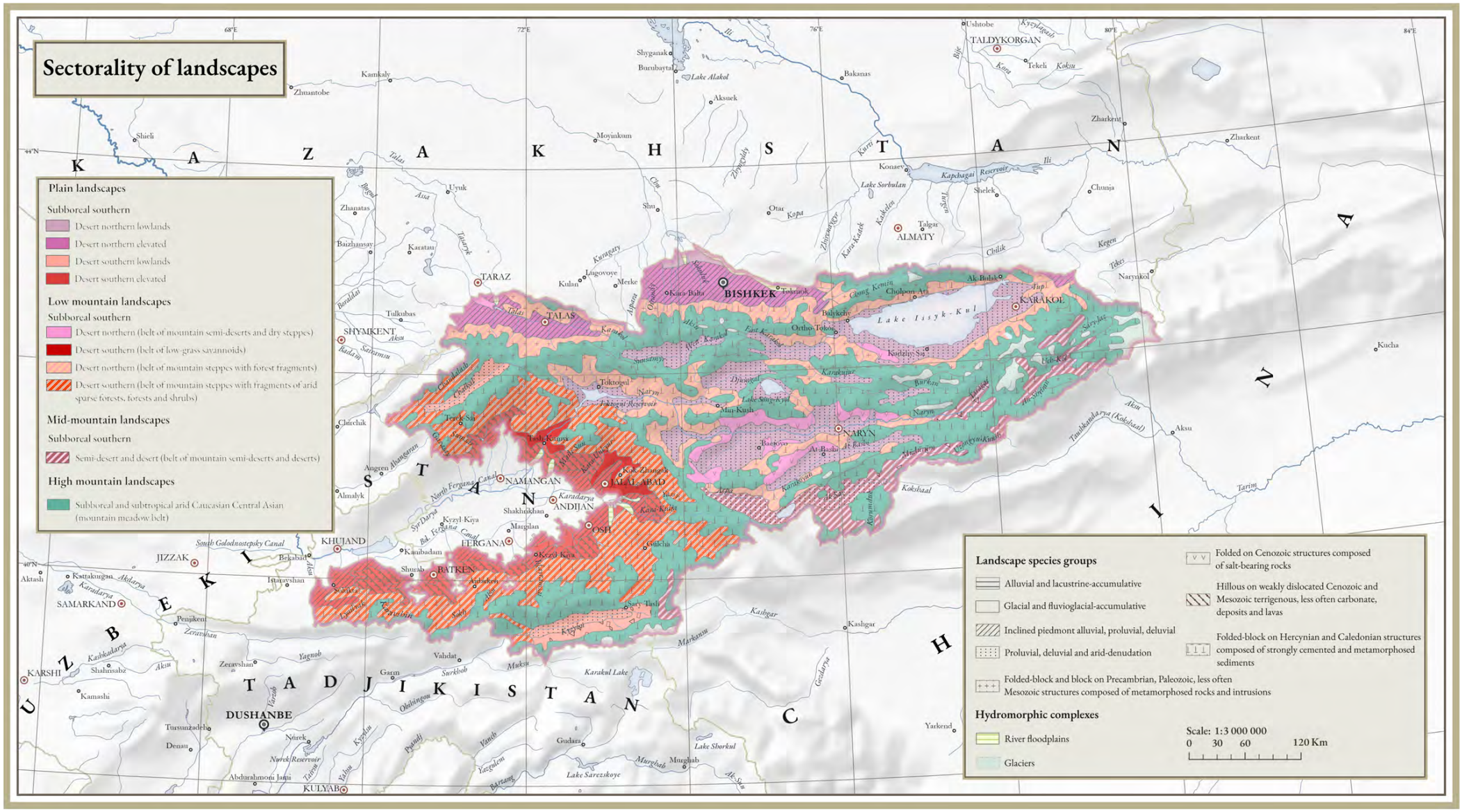


Herd of yaks



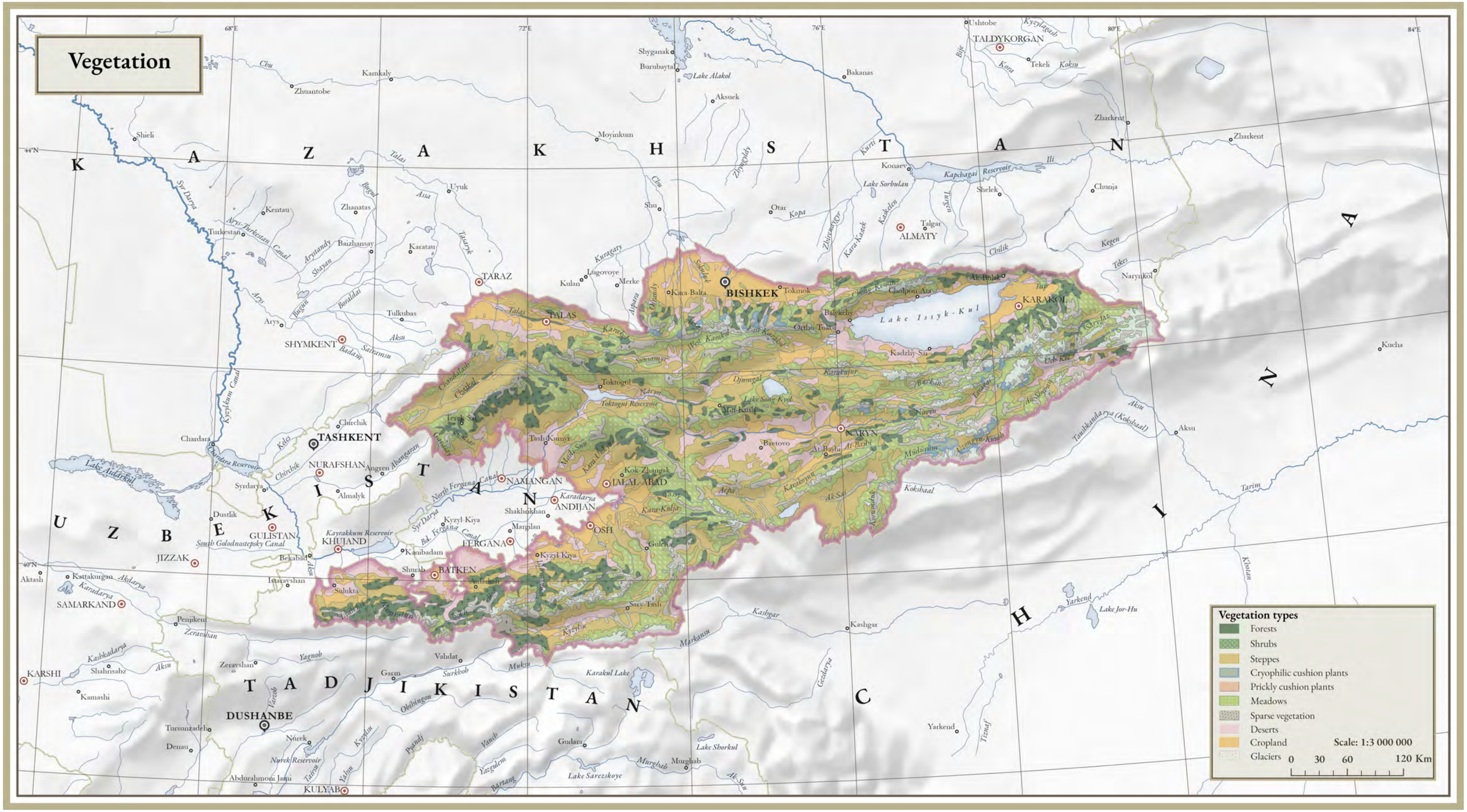
Landscape map of the USSR: 1980 / compilation. in the PGO Hydrospetsgeologia; Holes. Ed. by I. S. Gudilin; ed. coll.: K. F. Belyakova et al.; designed and printed in Leningrad. Cards. VSEGEI factory; cartographer V. A. Kalinin; hydrogeologist I. D. Chikina. - 1:2 500 000.

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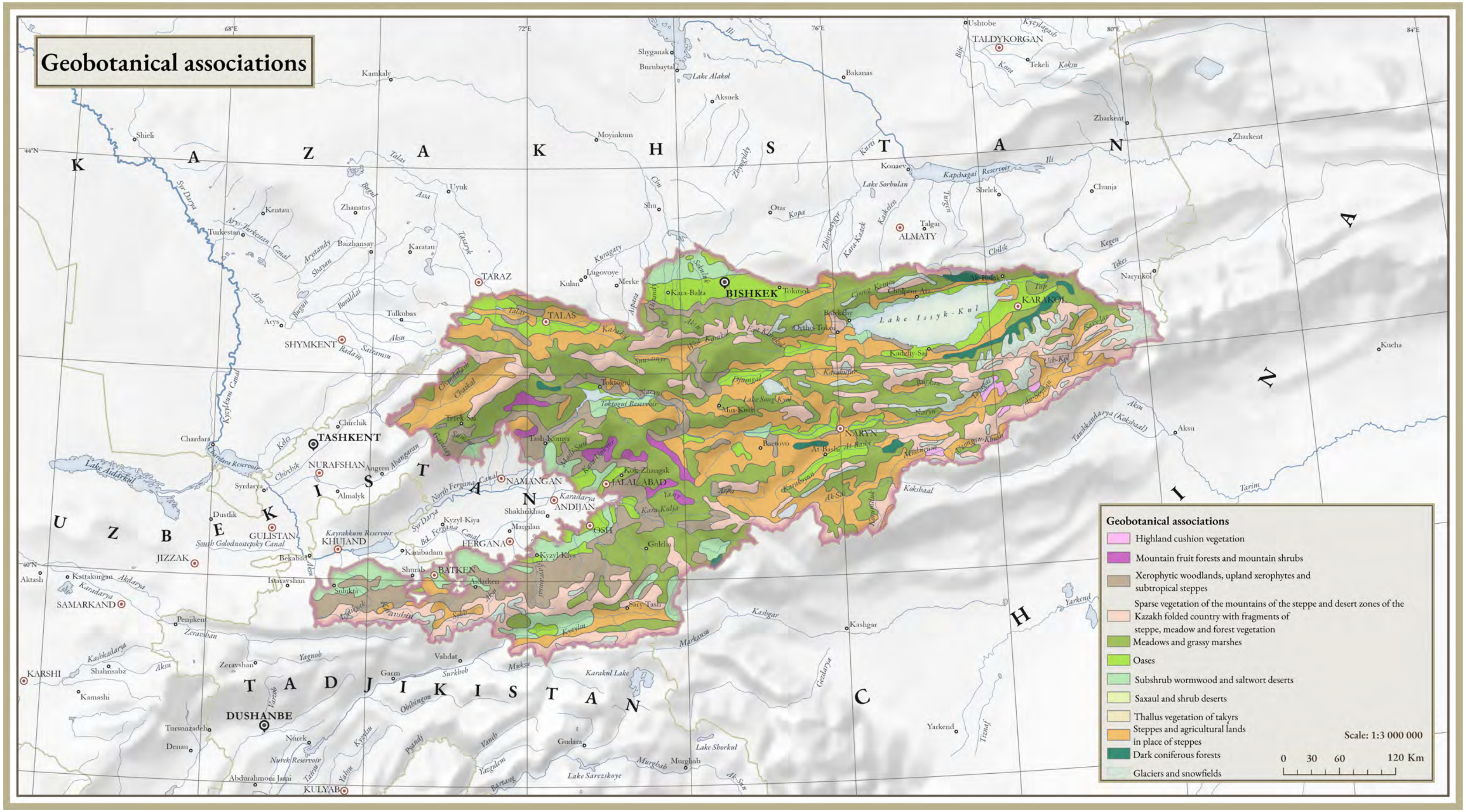
Landscape map of the USSR: for higher educational institutions. and preparation. for printing by Factory No 10 in 1988; ed. by B. N. Kostyuk; Special. Contents. Developer. Sotr. Research Institute of Geography of Leningrad State University: A. G. Isachenko, Dr. Geogr. Nauk [i dr.]; Holes. Ed. by A. F. Voronin. - 1:4 000 000.

The initial scale of the map is 1:3,000,000. The map image has been changed for the layout of the pages.



Atlas of the Kyrgyz Soviet Socialist Republic. T. 1. Natural conditions and resources. Moscow, GUGK Publ., 1987.

The initial scale of the map is 1:3,000,000. The map image has been changed for the layout of the pages.



Geobotanical map of the USSR. in 1954 by B.N. Gorodkov, T.I. Isachenko [and others]; under the leadership. and eds. by E. M. Lavrenko and V. B. Sochava. - 1:4 000 000.

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Tien Shan brown bear

6.3. Progress towards the SDGs

The Sustainable Development Goals on biodiversity include SDG 15.1, which requires, by 2020, that steps are taken to ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services in accordance with obligations under international agreements. Pursuant to this, indicator 15.1.2 focuses on improvements in the proportion of significant sites for terrestrial and freshwater biodiversity.

The main tool for biodiversity protection in the Kyrgyz Republic has traditionally been the establishment of specially protected natural areas (PA), in other words, in situ protection *(Map. Landscapes and their representation in the PA system)*. In 2000, PAs in Kyrgyzstan totalled only 500,000 hectares, or 2.5 per cent of the country's area. In the 2000s, three reserves were established (Kulunatinsky, Padysha-Ata, Surmatashsky). By 2005, PAs had doubled to 900,000 hectares, mainly due to the creation in 2001 of one of the largest biosphere reserves in the world – the 'Issyk-Kel', which is located within the administrative borders of the Issyk-Kul administrative region. The core of the new biosphere reserve (140,000 hectares) includes the Ramsar wetlands and the Issyk-Kul State Reserve, which was the first reserve created in the republic back in 1948. Certain problems of managing this vast biosphere territory, where 500,000 people live and 340 economic entities operate, are recognized.[103] International environmental organizations adhere to the position that PAs should be large enough to guarantee their manageability.[104]

The network of PAs has been expanded since 2015 through the creation of the state natural parks of Kan-Achuu (30,500 hectares), Alatai (56,800 hectares) in the Jalal-Abad region and Khan-Tengri in the Issyk-Kul region (275,800 hectares). With the establishment of the Khan-Tengri Nature Park, PAs in the snow leopard habitat in the Central Tien Shan were expanded to 40 per cent.[105] In 2016, the Sary-Chelek State Biosphere Reserve and the Besh-Aral and Padysh-Ata State Reserves were included in the UNESCO World Natural Heritage List within the framework of the transnational (border) area designated as the 'Western Tien Shan' (prepared jointly by the Kyrgyz Republic, the Republic of Kazakhstan and the Republic of Uzbekistan).



Griffon Vulture

By 2023, a network of PAs totalling 1.5 million hectares, or 7.38 per cent of the republic's area, was created and now includes 10 reserves, 13 national parks, 19 natural monuments and 45 botanical, forest and zoological reserves. This significant expansion of these PAs was achieved through the simultaneous expansion of reserves and national parks.

The optimality of the national PA system is determined by its coherence and representativeness in relation to the main landscape types, key biodiversity areas (both KBAs and IBAs) as well as the Red Book species habitats. However, the coherence of the PA system in Kyrgyz Republic is estimated at 0.35 (on a scale of 0-1, where one is maximum connectivity), meaning that the PA system has a rather disparate spatial structure.[106]

The degree of provision of the environmental regime for the main types of natural complexes can be assessed according to the Aichi goals, which require an extension of the protection regime to at least 17 per cent of the country's area. The UNCBD Secretariat identified eight main types of ecoregions in Kyrgyz Republic *(Map. Ecoregions)*,[107] with the average representation of ecoregions falling within the PA system ranges from 2 to 5 per cent, which is extremely low by international standards. This issue is highlighted, for example, by the fact that there are no PAs in the Alai-Western, Tien Shan steppe, Central Asian northern deserts or high-mountain glacial-stony ecoregions.

The main tool for biodiversity protection is the identification and monitoring, in IUCN terminology, of Key Biodiversity Areas (KBAs) *(Map. Key biodiversity areas)*. The criterion for their identification is the regular presence of globally endangered species or highly endemic species that have a very small distribution area limited to a given habitat. A total of 32 KBAs have been identified in the Kyrgyz Republic, which is significantly more than previously proposed by local experts as 'biodiversity hotspots', of which these experts suggested there were only eight.[108]

In the absence of detailed information on the geography and status of species populations, KBAs in the Kyrgyz Republic were identified by international and national experts primarily using information on the presence of red-listed species included in national lists. Therefore, the status of the majority of KBAs still needs to be scientifically substantiated and, in the IUCN documents, the description of many KBAs in Kyrgyz Republic is accompanied by a note that the status of the species «that initiated the designation is not confirmed to meet the KBA's global criteria.» This explains why the KBA Global Database only contains information on 12 KBAs identified in the Kyrgyz Republic.[109]

In 2022, according to the UNECE,[110] the average share of

103 Turdumatov T.K. (2021) Kyrgyzstan, National Report, 2021 on threats to Lake Issyk-Kul according to the event on the preparation of measures to mitigate negative anthropogenic impacts for the conservation of Ramsar and potential Ramsar sites. Bishkek.
104 Biodiversity Hotspot … (2017)
105 Voluntary…. (2020).
106 Aichi Biodiversity Target 11 Country Dossier: KYRGYZSTAN (2021) Aichi Biodiversity Target 11 Country Dossier: KYRGYZSTAN (cbd.int)
107 Olson et al. (2001) Terrestrial ecoregions of the world: a new map of life on Earth. Bioscience 51(11):933-938.
108 Aichi Biodiversity….2021.
109 World Database of KBAs.
110 Average proportion of Freshwater Key Biodiversity Areas (KBAs) covered by protected areas - Sustainable Development Goals - United Nations Economic Commission for Europe (unece.org)

PAs covering freshwater key biodiversity areas (PAs) was 35.4 per cent and for terrestrial ecosystems this figure dropped to 23.6 per cent. According to the dossier of the UNCBD Secretariat, only two KBAs, namely those of the Son-Kul and Chatyr-Kul lakes, enjoy an adequate conservation regime since more than 85 per cent of their area lies within PAs. At the same time, both lakes experienced a transformation of their ecosystems after the introduction of commercial fish species because, in their truly 'natural state', they were fishless. This introduction of species and associated impacts is contrary to the principles of the Ramsar Convention.[111]

While 55– 57 per cent of the Western and Eastern Issyk-Kul regions fall within PAs , such areas are practically absent in the remaining eight KBAs (from the global IUCN list), including Eastern and Western Alai, the Tash-Rabat gorge, the northern part of the Chu River valley and the valley of the Karkyra.

On the territory of Kyrgyz Republic, 10 key ornithological areas (IBAs) have been identified under a programme using similar criteria for the designation of KBAs, in the case of IBAs, this programme was developed by BirdLife International. Furthermore, both the Western and Eastern Issyk-Kul regions as well as lake Son-Kul, lake Chatyr-Kul, the Karkyra Valley and, finally, Eastern and Western Alay are all listed in two or all three international systems for the protection of global biodiversity (KBAs, IBAs and/or Ramsar sites).

By 2040, Kyrgyzstan plans to expand its network of PAs to 10 per cent of the country's total area, ostensibly providing protection to 60–65 per cent of the species included in the UICN Red Book.

Sustainable Development Goal 15.4 is centred around ensuring the conservation of mountain ecosystems, including their biodiversity, to enhance their ability to provide sustainable development benefits by 2030.

In support of this SDG, indicator 15.4.1 uses the measurement of the proportion of PAs in mountain areas. In the Kyrgyz Republic in 2020, this figure was 6.18 per cent, 0.17 per cent higher than in 2013. However, the most sensitive ecosystems in the Kyrgyz Republic, including mountain forests and alpine meadows, are less protected than the 'lifeless' glacial-nival zone *(Map. Landscapes and their representation in the PA system)*.

The least protected in the country are tugai forests which grow only on floodplains, since only 0.04 per cent fall within PAs, and the most landscape- and species-rich steppe mid-mountain belt, of which only 3.57 per cent is inside PAs *(Table 9)*.

Sustainable Development Goal 15.5 is centred on the urgent and significant action needed to reduce the degradation of natural habitats, halt biodiversity loss as well as protect threatened species and prevent extinction by the target date of 2020.

Table 9. Share of protected areas in different natural zones

Natural areas	Proportion of protected areas
Glacial-nival	19.7%
Tundra	10.3%
Meadow and forest-meadow	7.34%
Steppe	3.57%
Semi-desert	2.22%
Desert	0.36%
Tugai and marsh-meadow	0.04%

Progress towards the above SDG can be monitored by Indicator 15.5.1, which uses data from the IUCN Red List to calculate an index that aggregates changes in extinction risk across groups of species. According to the National Statistics Committee, this indicator is under development, however, the Kyrgyz Republic proposed a nuanced nationalized version, Indicator 15.5.1.1 that is entitled «Proportion of species from the (national) Red Book from all types of relevant systematic groups (classes)».



Walnut tree

In the Kyrgyz Republic, 84 species of mammals, 390 species of birds, 75 species of fish, four species of amphibians, 33 species of reptiles, 14,600 insects and other arthropods, 3,869 species of higher plants and approximately 3,600 species of fungi have been documented. From the above numbers, the Red Book of the Kyrgyz Republic (2006) lists 23 species of mammals, 53 species of birds, seven species of fish, 8 species of reptiles and two amphibians, 18 species of insects, 83 species of higher plants and six species of fungi.[112] Accordingly, the share of red-listed species in systematic groups is 27 per cent for mammals, 13.6 per cent for birds, 9.3 per cent for fish, 24 per cent for reptiles and 50 per cent amphibians, 2.1 per cent for higher plants and less than 0.2 per cent for fungi and insects. Thus, a special risk group includes amphibians, mammals and reptiles. However, in the IUCN Red Book, five species of higher plants and one species of bird endemic to the Kyrgyz Republic are listed among the critically endangered (CR). Due to this ambiguity, the nationalized indicator is not a reliable indicator for assessing policies designed to prevent biodiversity loss.



Sievers apple tree

The series of maps presented here on the geography of Red Book listed species in the Kyrgyz Republic is based on data of their distribution as presented in the national Red Book *(Map. Red Book species: plants; Map. Red Book species: mammals; Map. Red Book species: birds; Map. Red Book species: amphibians and reptiles; Map. Red Book species: fishes; Map. Red Book species: arthropods)*. These data show that most species should be protected ex situ, as the role of PAs in defending threatened species listed in the national Red Book, appears to be very limited due to their relatively small size and the insufficient resources for the implementation of a strict protection regime *(Box 5)*. Despite the fact that many reserves, being scientific organizations and the most stringent in terms of protection of biodiversity, have existed

111 Biodiversity conservation priorities of the Kyrgyz Republic until 2024. CBD Strategy and Action Plan - Kyrgyzstan (English version)

112 Shukurov. E. Red Book of the Kyrgyz Republic (in Russian) Красная книга Кыргызской Республики » Информационный портал о Кыргызстане, новости Кыргызстана и туризма (open.kg)

for more than 40 years, most of them have not yet carried out a complete inventory of their flora and fauna, specific lists of reliably identified endemic and rare species are still absent in the «Chronicles of Nature» - the main reporting documents on reserves. This situation is typical even in relation to mammals and birds, not to mention entomofauna, lower plants and fungi.[113] According to the index of representativeness of the PA system, which shows the distribution of rare species of plants, vertebrates and invertebrates in SPNAs, the Kyrgyz Republic has been rated at 36.3 (out of 100) as an indicator of how well the republic's protection regime actually protects species in need of protection.[114]

To monitor biodiversity globally, several pioneering indices have been proposed which are complex in nature and based on hypotheses that still require verification at different spatial levels *(Map. Dynamic species diversity; Map. Biodiversity Habitat Index; Map. Bioclimatic Ecosystem Resilience Index; Map. Biodiversity Intactness Index)*. At this stage, an interpretation of these indices in relation to the ongoing changes in landscape and species diversity due to natural (climatic) and anthropogenic factors in the Kyrgyz Republic may be difficult and further research is required. On a scale from 0 to 100 points, the country is rated at 93.5 on the Species Diversity Index, which means that since 2001 there has been no loss of populations due to degradation of their habitat, on the Habitat Diversity Index (47.1 points), on the Ecosystem Bioclimatic Resilience Index (59.1 points) and on the Environmental Vulnerability Index (71 points), where the latter shows the share of ecosystems in their natural state.[115]



Jeyran

Sustainable Development Goal 15.7 focuses on the need to take urgent action to end poaching and illegal trade in protected species and address both the supply of and demand for protected wildlife.

It is difficult to estimate the true extent of the poaching and illegal trade in protected species in the Kyrgyz Republic as there is no data on the current size of wildlife populations. Indicators related to SDG 15.7 are virtually non-existent, however, the republic has proposed a nationalized indicator, SDG 15.7.1.1, under the heading 'Proportion of wildlife species that are subject to poaching or trade in the total number of species of the relevant systematic groups (classes)'. While the National Statistics Committee has stated that this indicator is under development, the official national report[116] showed that in 2014 and 2018 this share was 15.4 per cent and 9.9 per cent for mammals, respectively, 3.7 per cent and 2.5 per cent for birds, respectively and 2.2 per cent for amphibians and reptiles for both years.

Another nationalized indicator is 15.7.1.2 under the heading of 'Number of permits issued for the export and import of animals and plants, their parts and derivatives falling under the CITES Convention'. Having a valid permit is a legal requirement for such exports and imports and, for example, in accordance with the CITES Convention the republic allows strictly regulated and limited hunting for Argali mountain sheep *(Ovis ammon)* as these are the main commercial hunting trophy sought in the region. From 2000 to 2010, 668 samples of hunting trophies were exported from the Kyrgyz Republic, which generally corresponded to the number of issued permits. These export figures are on par with those of Tajikistan (705) but far exceed the numbers from Kazakhstan (126) and Uzbekistan (13). However, it is widely accepted that the level of illegal hunting in the country is unknown.[117]

In 2012, the Kyrgyz Republic backed the development of an 'International Action Plan for a Single Species' aimed at the conservation of the Argali. Furthermore, in 2013, the republic initiated the first World Snow Leopard Forum, which was attended by representatives of the governments of 12 countries of Central and South Asia. Snow leopards are dangerous predators for domestic animals, however, even cases where one leopard kills an entire herd of small livestock, it must be caught, relocated to and released in a remote area, a commendable stance for a group of countries with heavily agriculture-reliant economies. This forum also set a goal to determine the boundaries of snow leopard habitats and monitor 20 areas within that range. The forum resulted in the establishment of the International Secretariat of the Global Program for the Protection of the Snow Leopard and Ecosystems in Bishkek in 2014, which was also the location of the second World Snow Leopard Forum that was held in 2017.

The Kyrgyz Republic actively participates in biodiversity conventions, including the Cartagena and Nagoya Protocols as well as the Ramsar, Bonn and CITES Conventions. On a regional scale, the republic is an active participant in the Mammal Initiative of Central Asia.



Central Asian goat

Sustainable Development Goal 15.8 requires that, by 2020, States take action to prevent invasive alien species from invading and significantly reduce their impact on terrestrial and aquatic ecosystems as well as take measures to prevent the restriction or eradication of priority species.

Attention to the problem of alien species and their inventory in Central Asian countries has only appeared in recent years, which explains uncertainty in estimates regarding the proportion of alien species in different systematic groups. According to the Kyrgyz Republic's 2020 national report, most invasive species in the country are plants, of which there are 81, while alien insects total 30 species, a figure that drops to nine for fish, two for birds and one species each for mammals and

113 IUCN Regional Programme for West, Central Asia and North Africa (IUCN-WESCANA) (in Russian). http://iucnca.net/reserve123
114 Protected Area Representatives & Connectedness Indices – GEO BON
115 2024 Environmental Performance Index - Bioclimatic Ecosystem Resilience
116 Monitoring of the Sustainable Development Goal Indicators in the Kyrgyz Republic 2014-2018 (2020) National Statistical Committee of the Kyrgyz Republic: A Statistical Compendium Bishkek
117 Mallon D (2013) Trophy hunting for species included in the CITES lists in Central Asia. Secretariat of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Geneva, Switzerland. Pp. 59.

reptiles.[118] However, the latest scientific summary shows that the total number of invasive species of vascular plants alone stands at 151 species, of which 58 are naturalized and the rest were introduced unintendedly occasionally. These data were recently included in the Global Database of Naturalized Alien Flora. According to local experts, the total number of invasive species, including accidentally introduced ones, is relatively small, which can be explained by the Kyrgyz Republic's harsh climatic conditions and the prevailing mountainous terrain.[119]

Several instruments, such as the Law of the Kyrgyz Republic On Veterinary Medicine (No. 175, enacted December 30, 2014), the Decision of the Commission of the Customs Union of the Eurasian Economic Community entitled 'On the Application of Veterinary and Sanitary Measures in the Customs Union' (No. 317, passed June 18, 2010) and the International Terrestrial Animal Health Code (dating from 2019) – can be considered as designed to control the emergence and spread of invasive species. However, there are currently no specific effective mechanisms to combat the spread of alien species in the Kyrgyz Republic and a system to register adventitious species that have entered the country has not been established, meaning the risks of invasive species is not being assessed.

Box 5. Human impacts on the biodiversity of the forests of the Sary-Chelek Biosphere Reserve

Forests in the Kyrgyz Republic are particularly important ecosystems as they contain a large proportion of endemic plants and invertebrates. One key local sub-type within the category of forests is walnut-fruit forests and, in the Kyrgyz Republic, the largest massifs of these occupy the south-eastern slopes of the Chatkal and south-western slopes of the Fergana ranges.

A study[120] in the Sary-Chelek Biosphere Reserve in Kyrgyz Republic (Aksy district) aimed to assess the impact on forest biodiversity of the approximately 5000 inhabitants of Arkyt, a village located within the boundaries of a walnut forest.

The pressure on the reserve's forest was estimated via interviews with the local population of the village. Ninety-six per cent of respondents confirmed that they collect walnuts «from time to time» and did so exclusively for the purpose of selling them. This figure was 87 and 84 per cent respectively when respondents were asked about their harvesting of wild apple and pear trees. For 91 and 88 per cent of respondents, walnuts and pears were the most frequent sources of fuelwood, respectively. The majority (93 per cent) of respondents confirmed that their cattle graze in the forest, sometimes even in the core of the reserve. Furthermore, 84 per cent of respondents confirmed they had witnessed a decrease in the availability of forest resources (fruits, walnuts, fuelwood and wood), as well as a decrease in the quality of grazing in the readily accessible surrounding forest (i.e., within a radius of approximately five km from the village).

Within the biosphere reserve, the study team established 32 quarter hectare sites to record the number patches of viable undergrowth of valuable species which reached 1.5 m in height and the thickness of the trunk was at least 10 cm. The assessment here was conducted to reveal traces of the economically-driven impacts of the local population, in the form of the consequences of grazing livestock, collecting nuts and wild fruits as well as the presence of stumps and cut stems. Contrary to expectations, the study modelled the returned data and found that grazing and harvesting can have a positive effect on walnut regeneration due to the trees' low shade tolerance. This challenges traditional views on forest management through strict restrictions on all human activities and suggests that controlled grazing, harvesting of timber and wild plants can support forest biodiversity.

However, other field studies, such as the one conducted in Arstanbap village[121] and some others, revealed different impacts on different tree species. While the Sievers apple tree *(Malus sieversii)*, which is onsidered a vulnerable species (VU), showed its resilience and high rates of regeneration despite intensive fruit harvesting, the Korzhinsky pear *(Pyrus korshinskyi)*, a species recognized as critically endangered (CR), proved to be less resilient. Thus, anthropogenic impacts on Kyrgyzstan's walnut-forests ecosystems varies between different tree species, with some demonstrating positive outcomes to the constant presence of a local human population whiles for others the outcomes are negative. The study highlights the complexity of human-wildlife interactions in walnut forest ecosystems. It suggests that conservation strategies must be tailored to individual species given their unique responses to human activities. Furthermore, the results obtained require a reassessment of traditional conservation practices and the need for more nuanced approaches in the management of biodiversity of Kyrgyzstan's mountain forest ecosystems.



Snow leopard

6.5. Responses

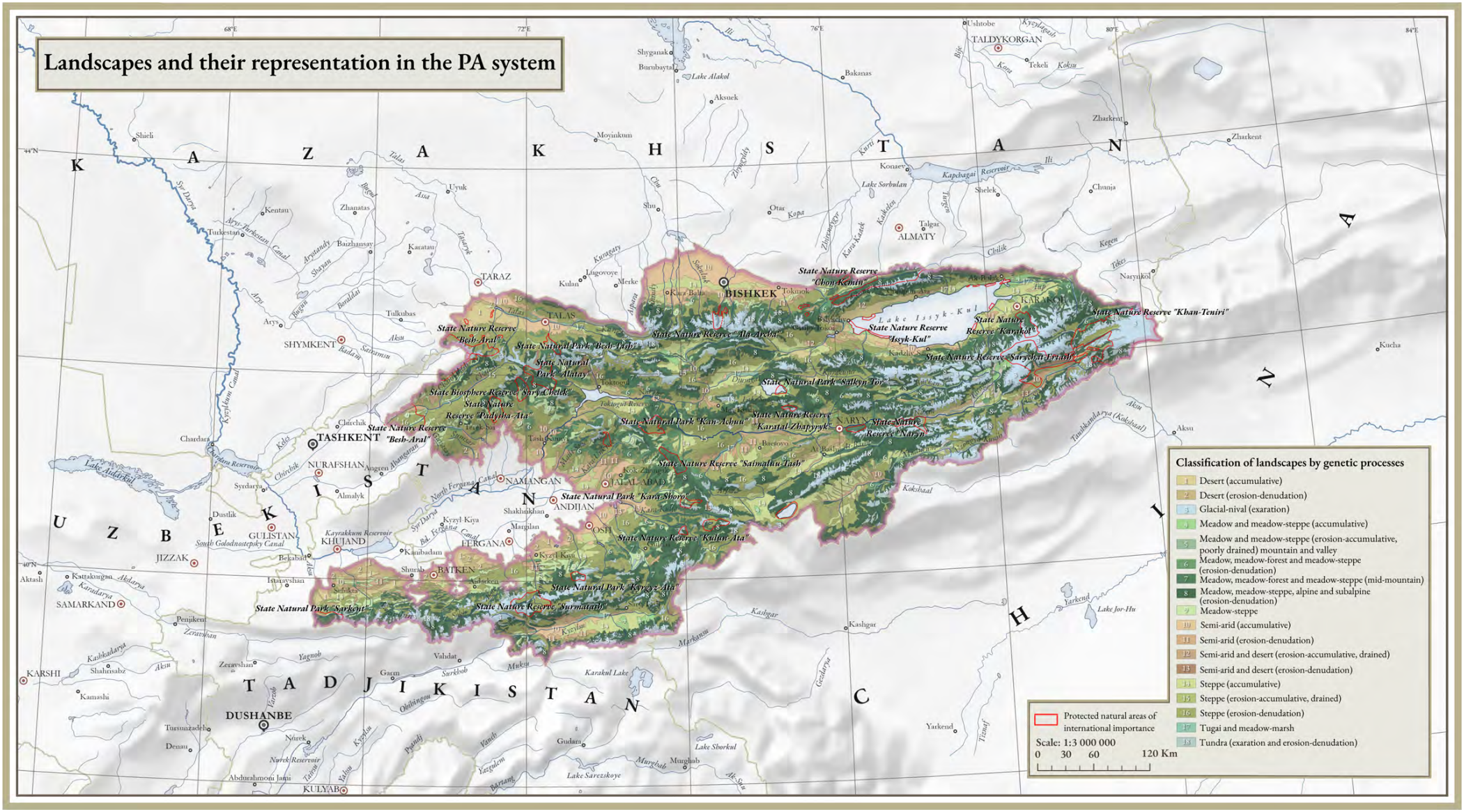
- Ensuring a fuller representation of biodiversity 'hot spots' in the State system of PAs .
- Increase in the share of mountain forests in the State system of PAs.
- Reassessment of forest ecosystem conservation practices in favour of greater participation of local communities in forest biodiversity management.
- Conduct an assessment of the risk of introduced alien species and the development of an accounting system for the penetration of adventitious species into the territory of the republic.

118 Voluntary … (2020).

119 Sennikov A.N., Lazkov G.A. (2024) Alien Plants of Kyrgyzstan: The First Complete Inventory, Distributions and Main Patterns. Plants, 13, 286. https://doi.org/10.3390/plants13020286

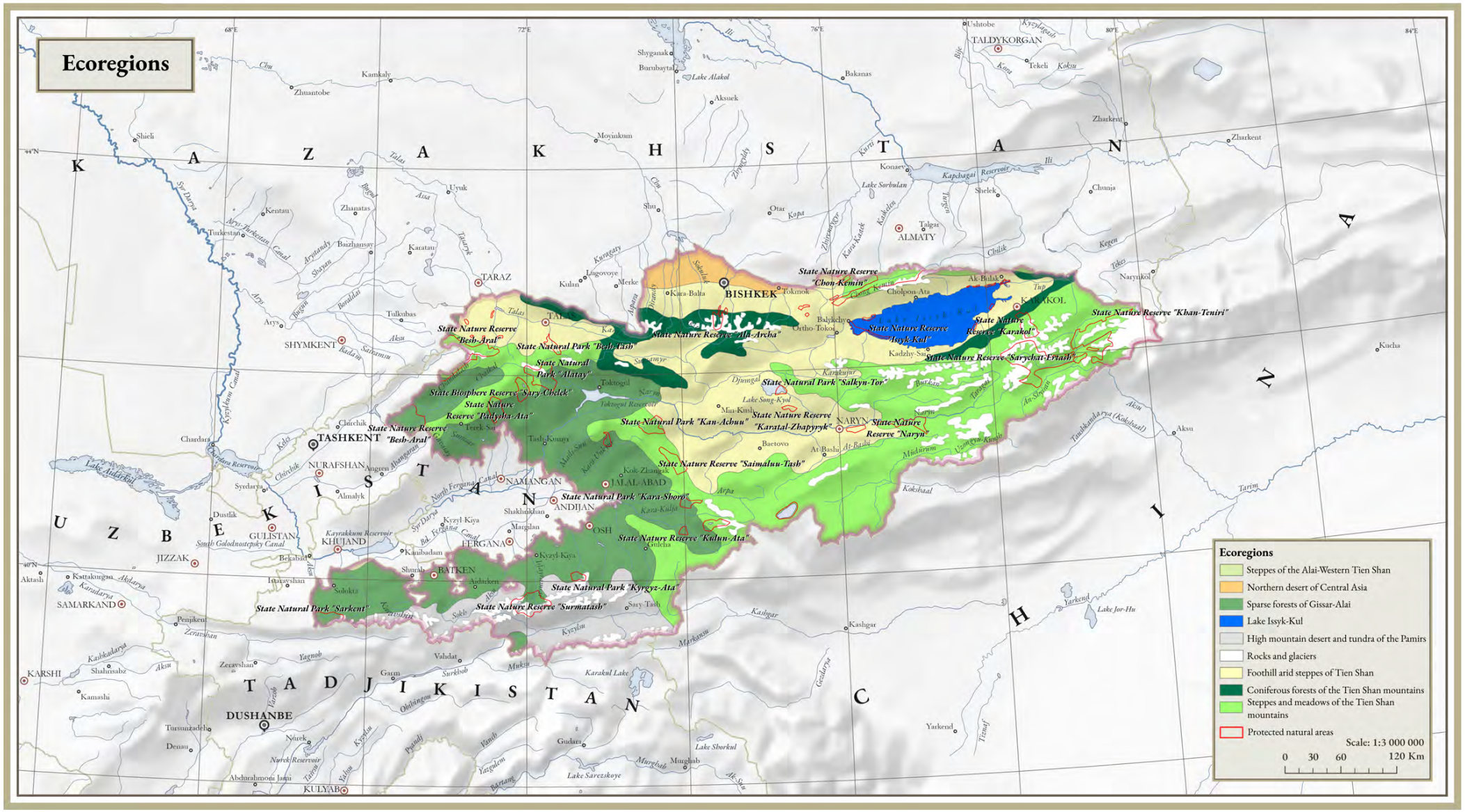
120 Cantarello et al. (2014) Human impacts on forest biodiversity in protected walnut-fruit forests in Kyrgyzstan. Journal of Sustainable Forestry, 33:454–481. DOI: 10.1080/10549811.2014.901918)/

121 Orozumbekov et al. (2014) Status, distribution and use of threatened tree species in the walnut-fruit forests of Kyrgyzstan. Forests, Trees and Livelihoods. http://dx.doi.org/10.1080/14728028.2014.928604.



Information System of the Water Resources Service of the Kyrgyz Republic.

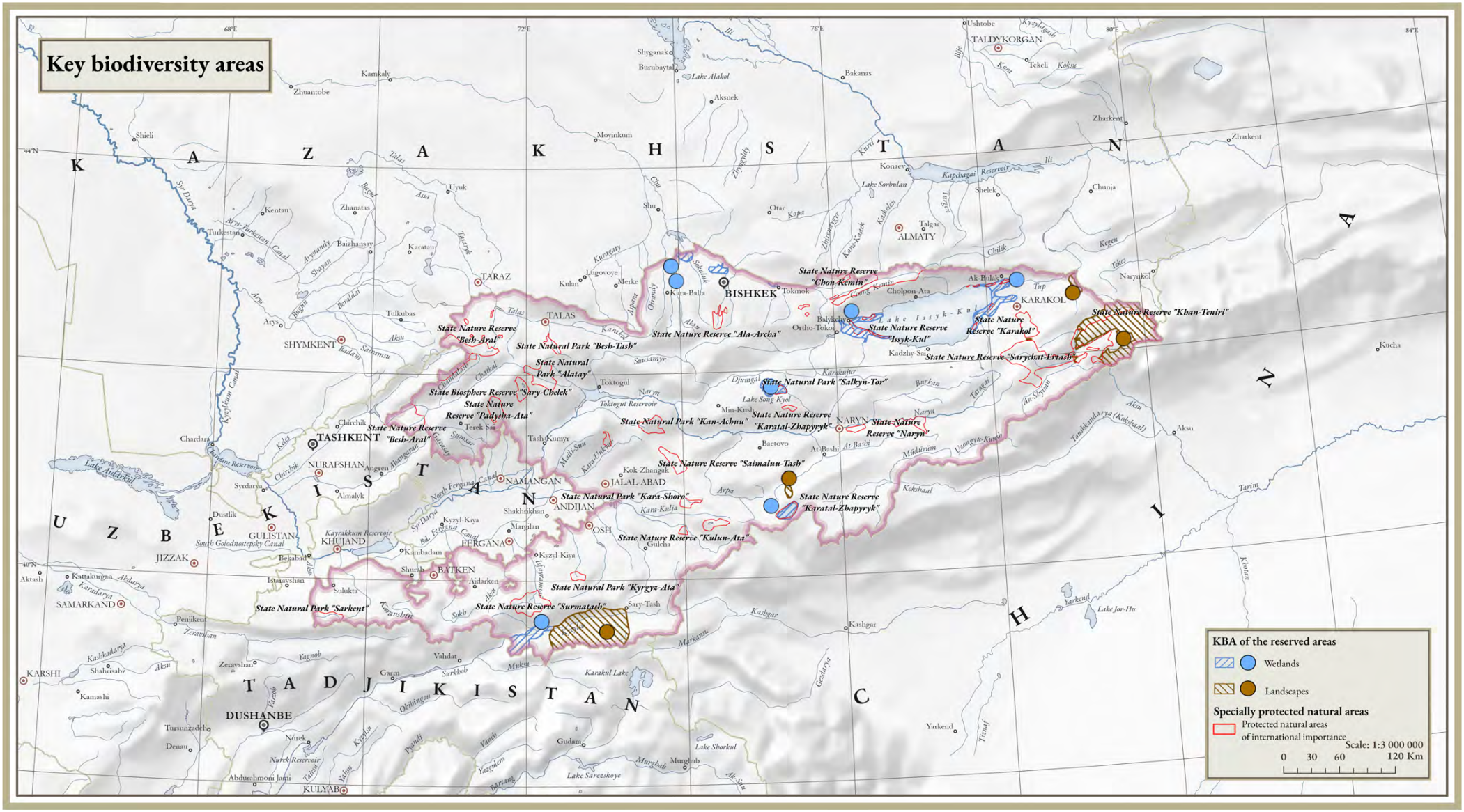
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Ecoregions are relatively large areas of land that are important for the protection of global biodiversity as they are clearly distinguished from each other by their habitat and species complexes[122].

122 Terrestrial Ecoregions of the World | Publications | WWF

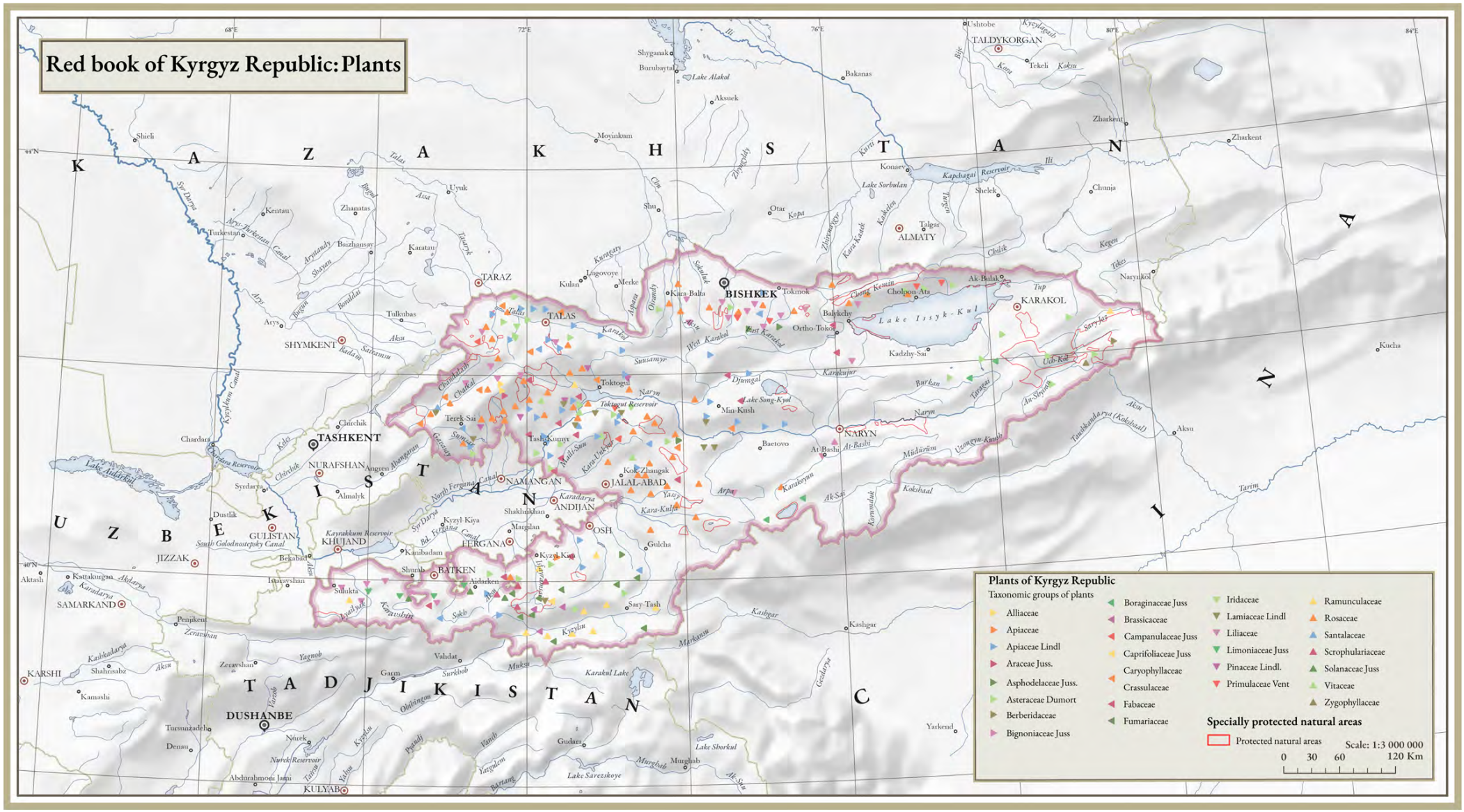
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KBAs are land or water complexes with a large proportion of endemic species in different taxonomic groups (excluding microorganisms) which determine their special value for the protection of biodiversity on a regional and global scale[123].

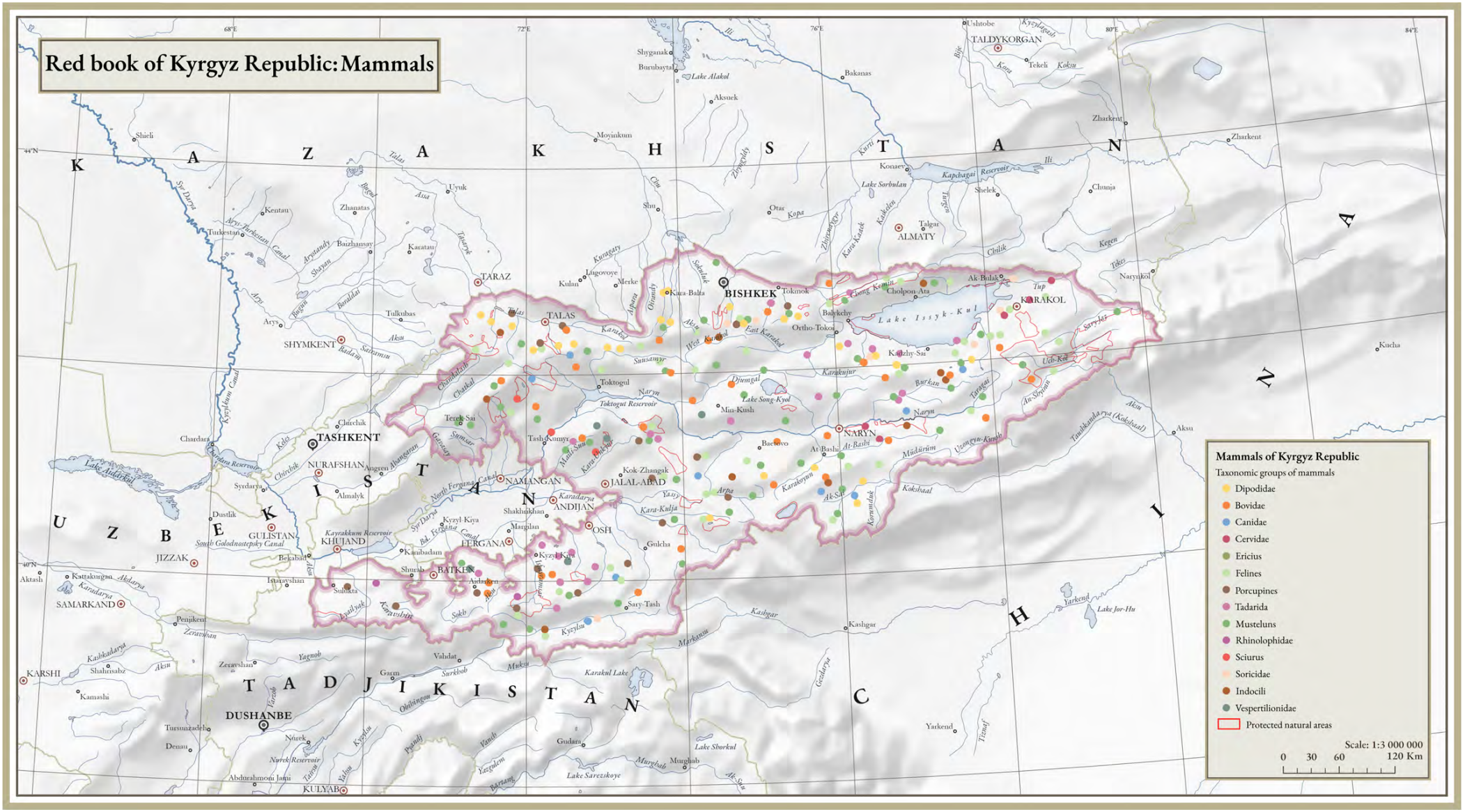
123 BirdLife International (2024) Important Bird and Biodiversity Area (IBA) digital boundaries: September 2024 version. BirdLife International, Cambridge, UK. http://datazone.birdlife.org/site/requestgis.

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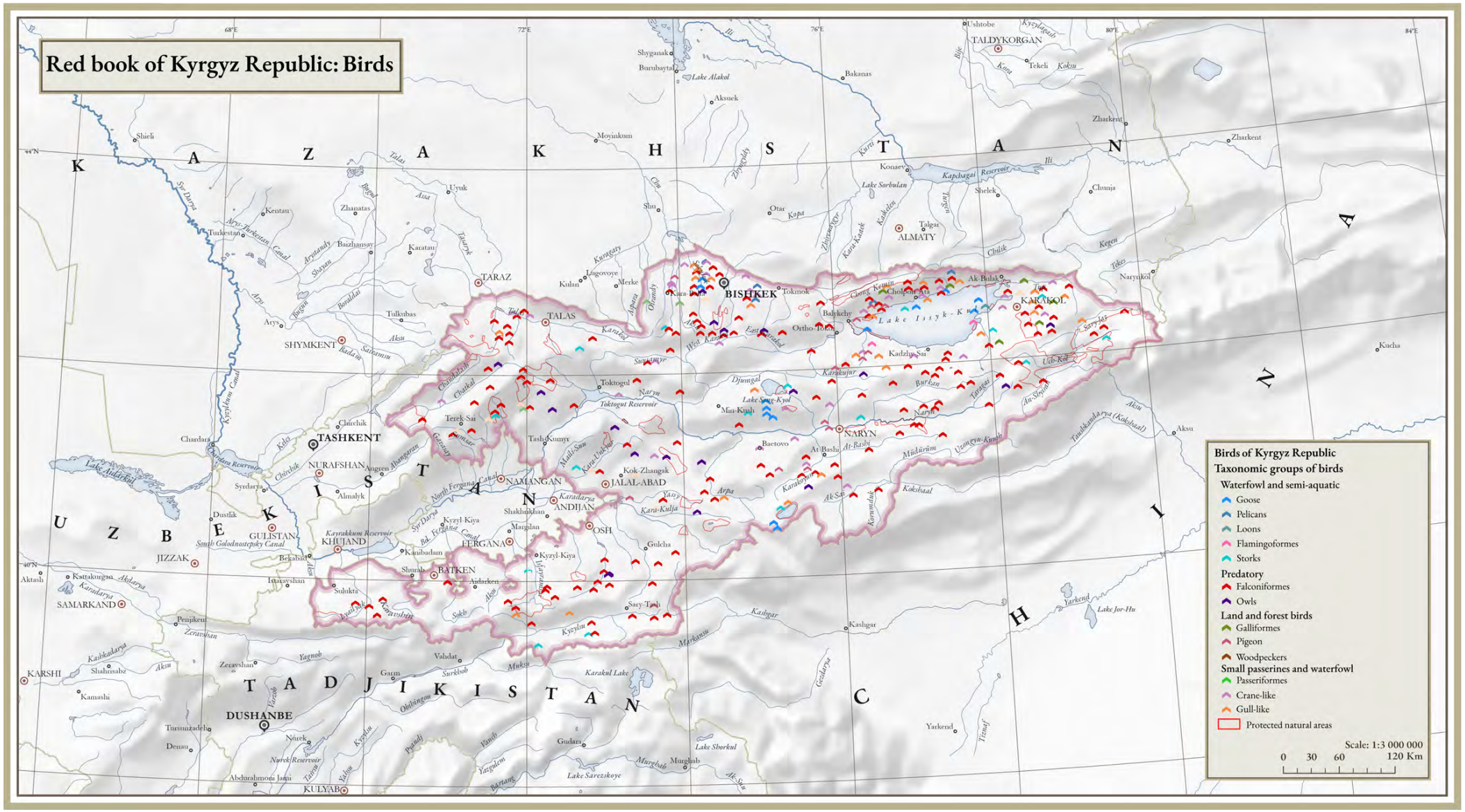
Red Book of the Kyrgyz Republic (2006). 2nd edition. Bishkek.

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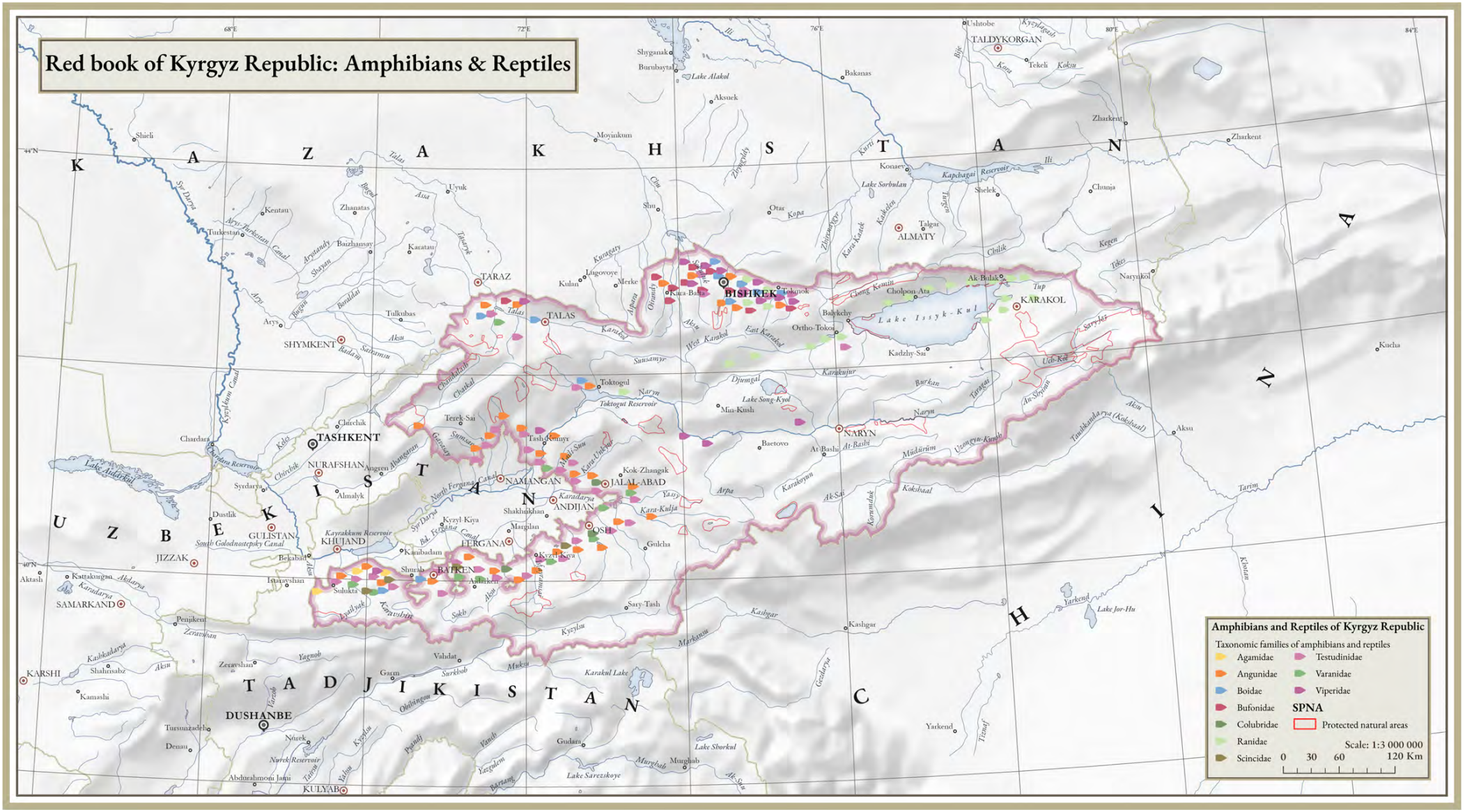
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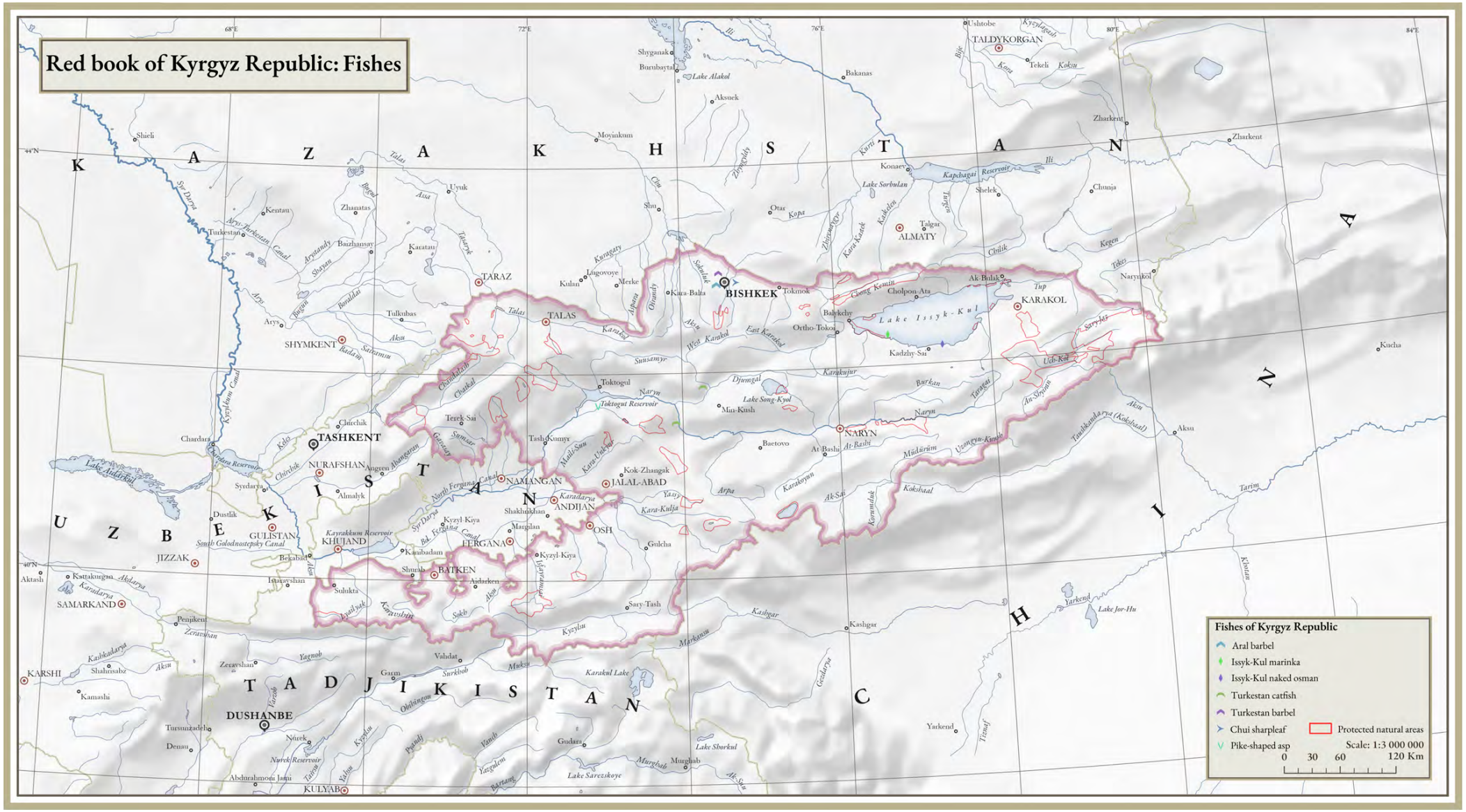
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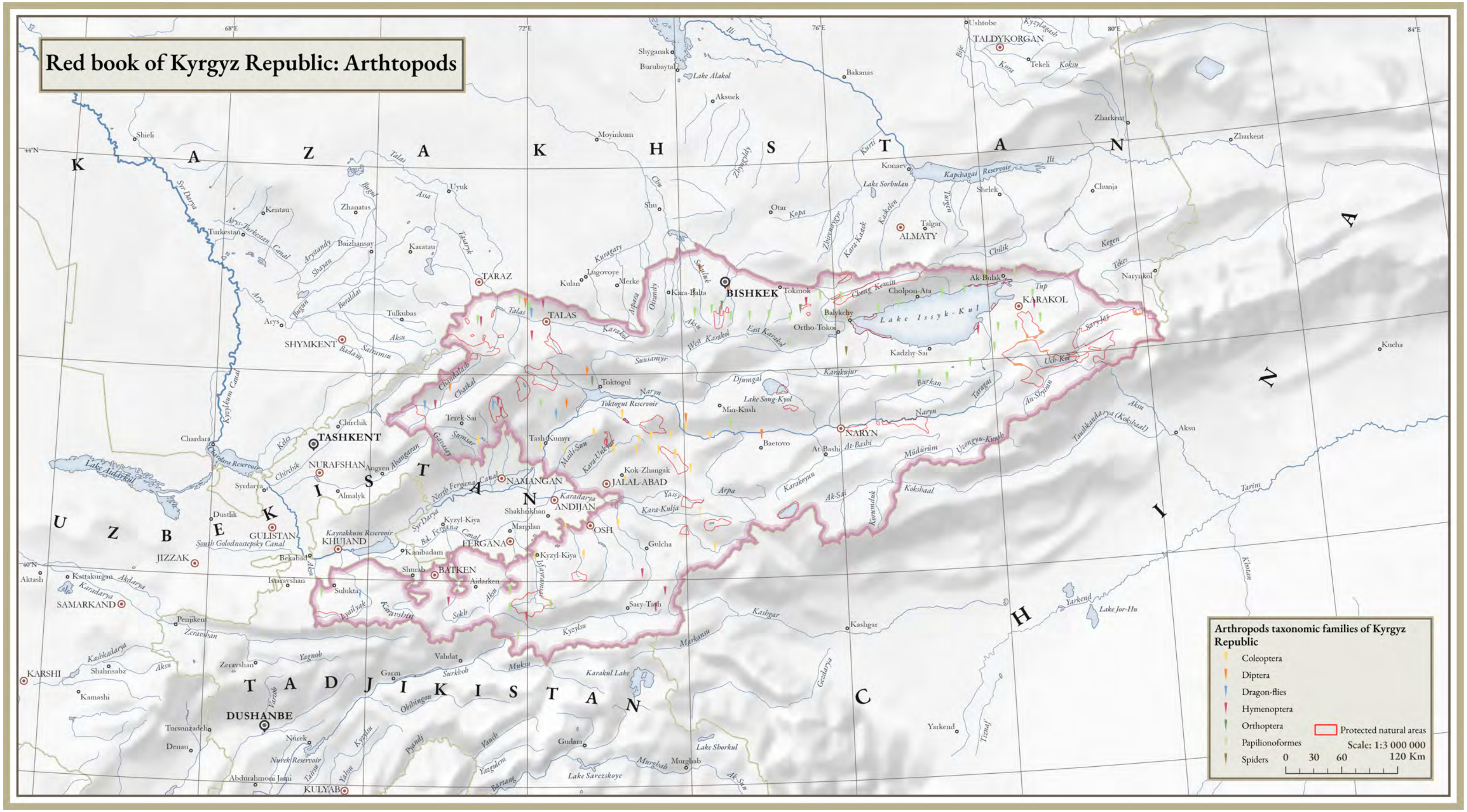
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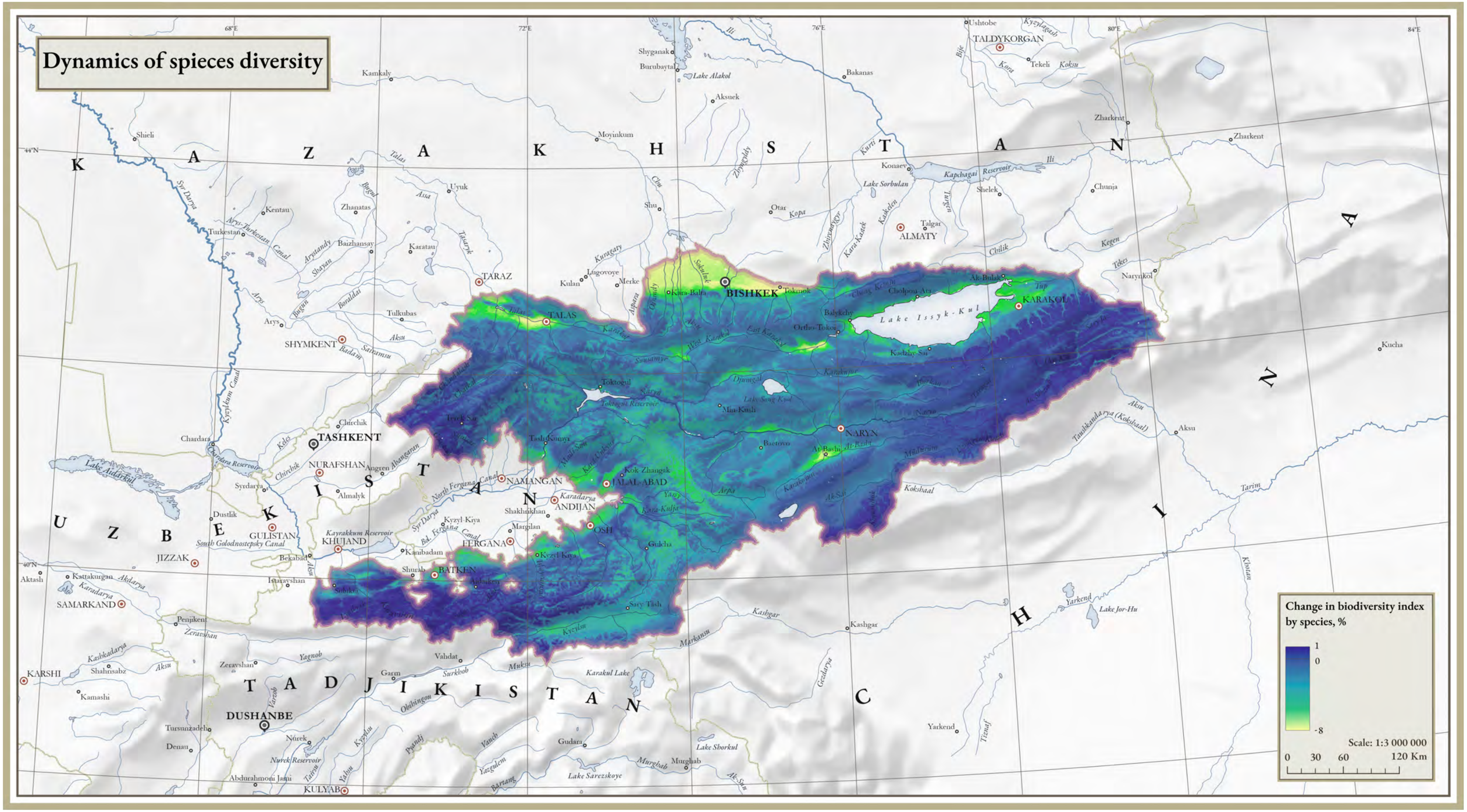
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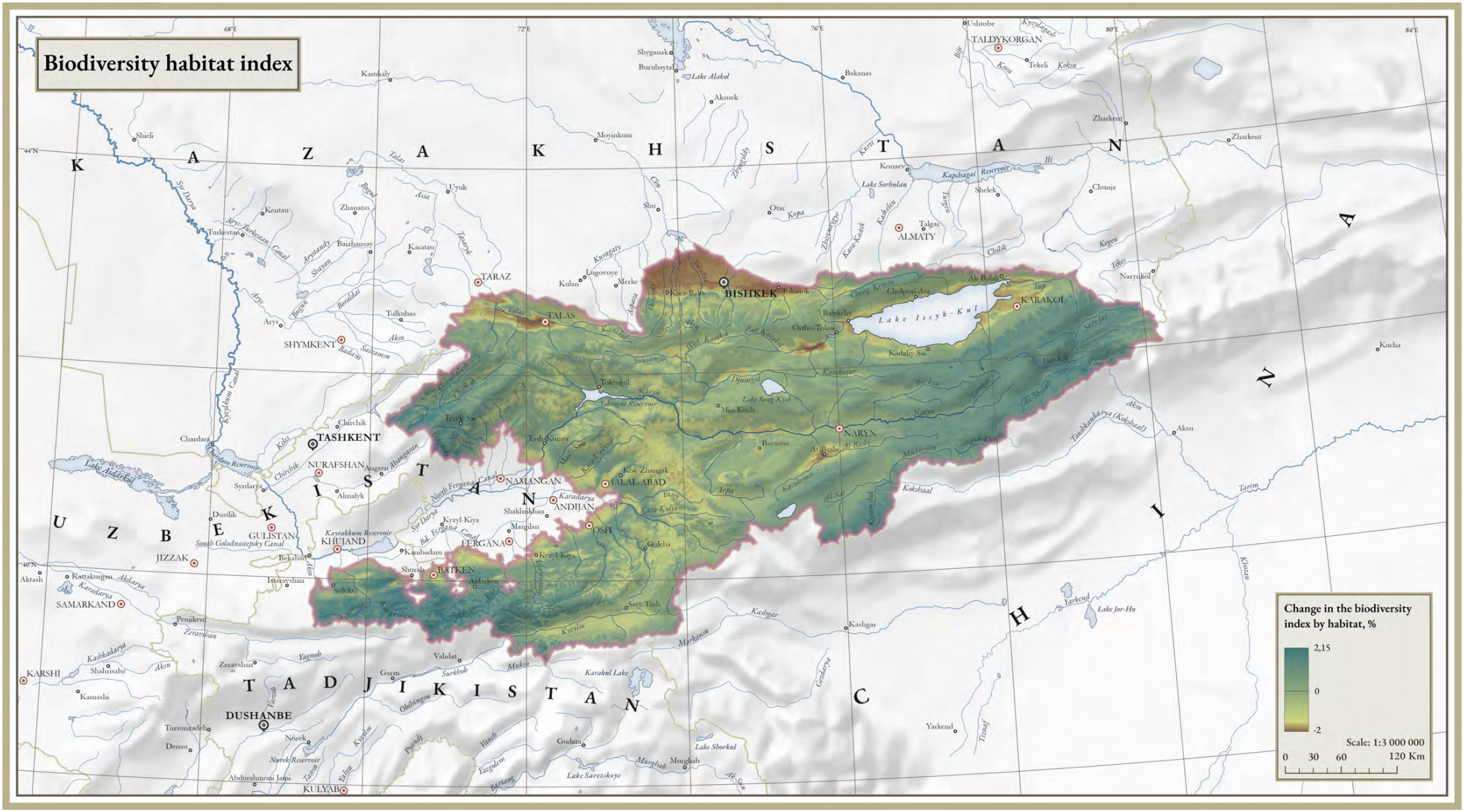
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According to the Biodiversity Habitat Index (BHI v2), the Proportion of Species Maps is a global product with a resolution of up to 30 arcseconds (approximately one km) and covers 2000–2020 in five-year increments. The model estimates the number of species that will be conserved within ecosystems (landscape) based on their area, connectivity and integrity[124].

124 Harwood et al. (2022) BHI v2: Biodiversity Habitat Index: 30s global time series. v1. CSIRO. Data Collection. https://doi.org/10.25919/3j75-f539.

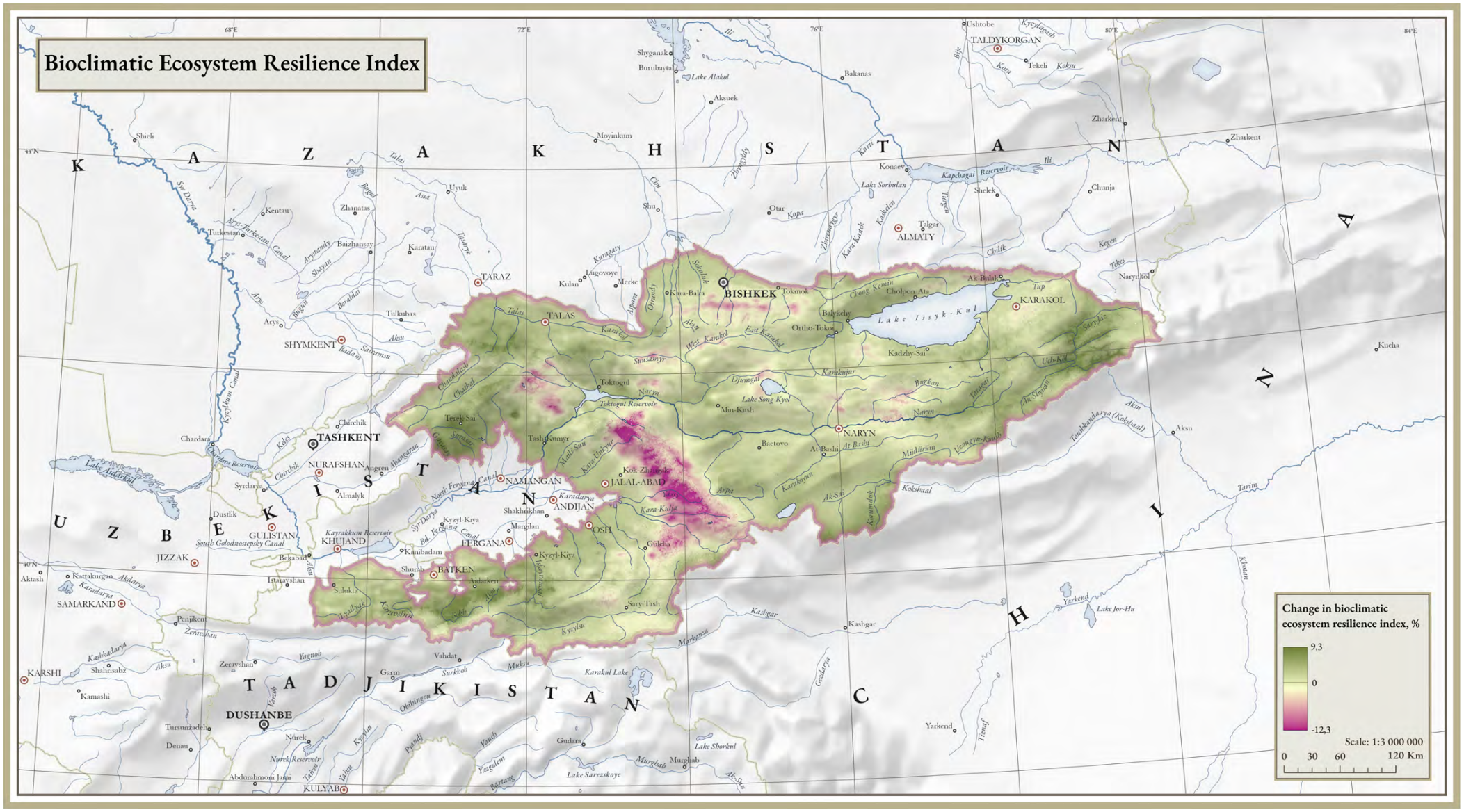
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The BHI v2 is a global product with a resolution of up to 30 arc seconds (approximately one km), covering the period from 2000 to 2020 (in 5-year increments). The model assesses the level of species diversity that will be conserved within a given type of ecosystem (landscape) depending on its area, connectivity and integrity[125].

125 Harwood et al. (2022).

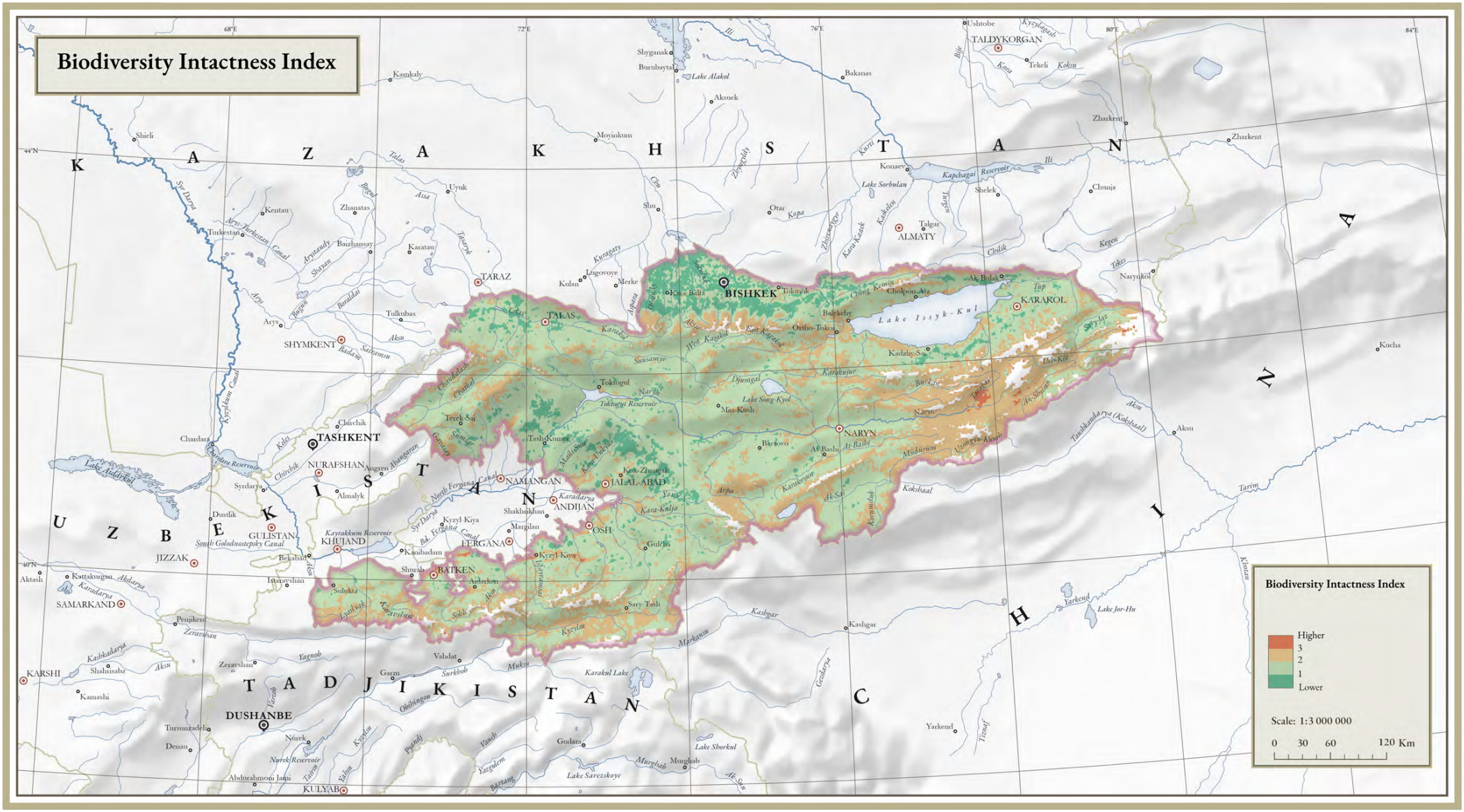
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The Bioclimatic Ecosystem Resilience Index is a global product with a resolution of up to 30 arc seconds (approximately one km), covering the period from 2000 to 2020 (in five-year increments). The model is designed to assess the ability of natural ecosystems to conserve species diversity in the face of climate change, depending on their area, connectivity and integrity[126].

126 Harwood et al. (2022).

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The Biodiversity Intactness Index is a model-based indicator with global application that compares the average abundance and diversity of native terrestrial species in a natural ecosystem and on disturbed land that is/was part of that ecosystem[127].

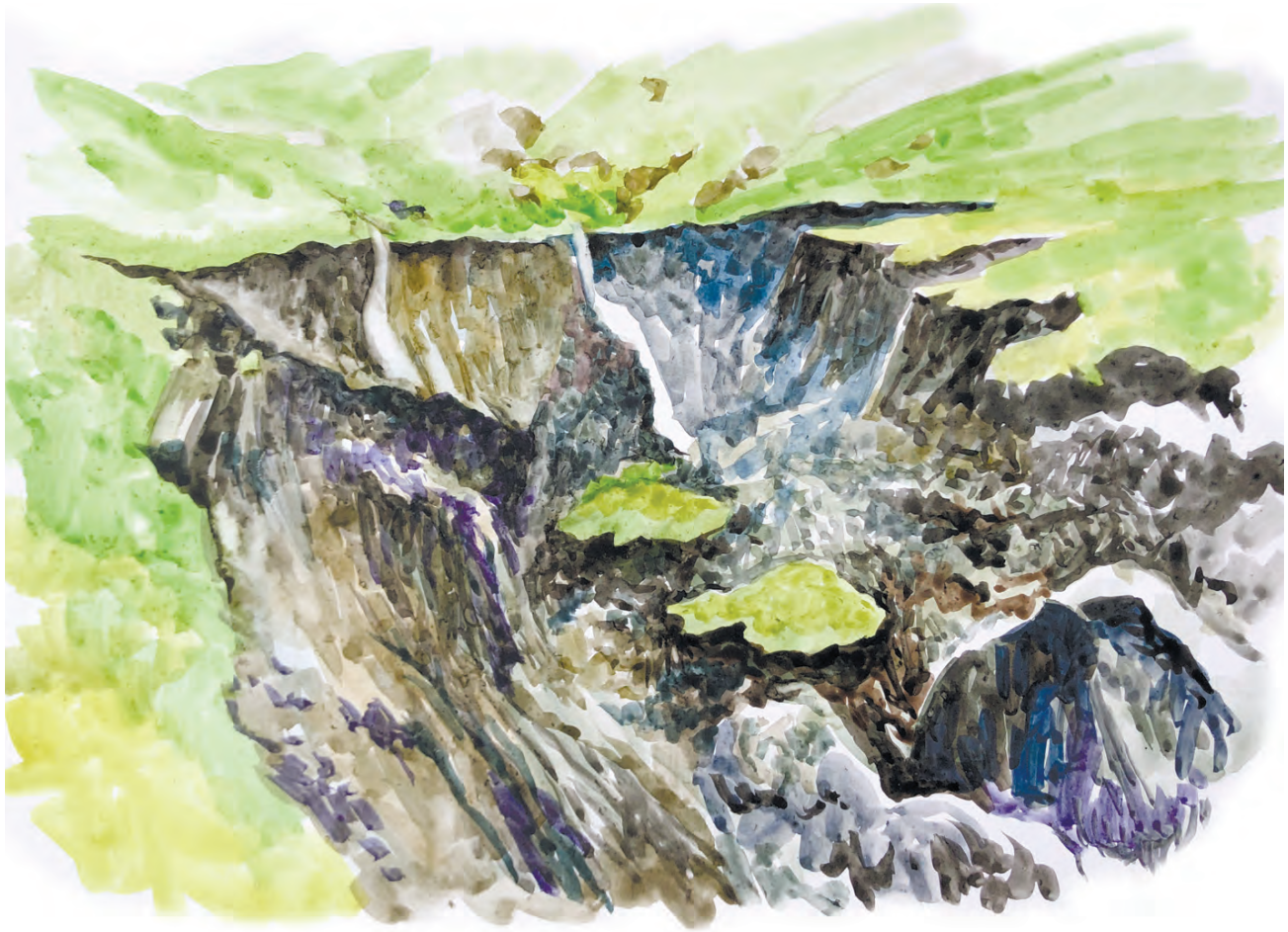
127 Biodiversity Intactness Index | Natural History Museum

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Natural Disasters



© Institute of Geography RAS, © PJSC RSC Energia



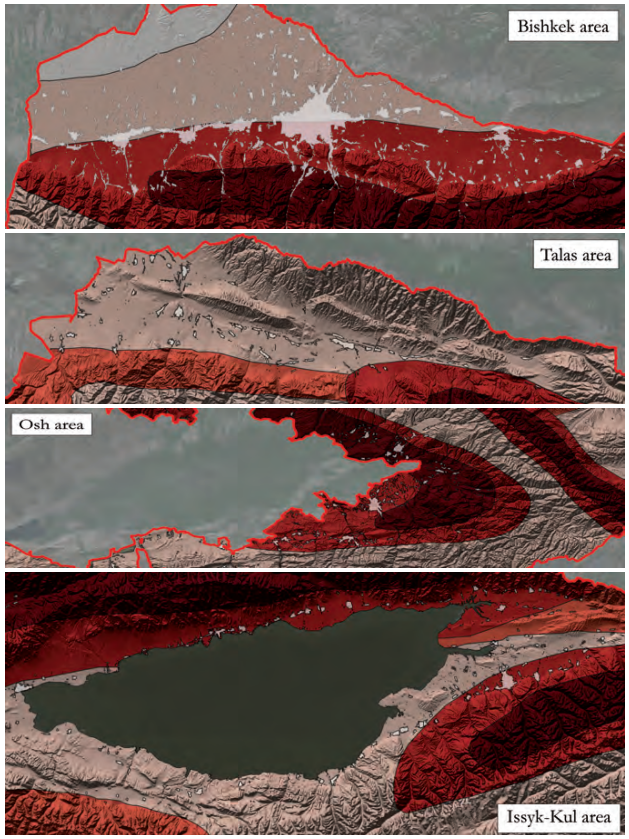


Fig. 8. Settlements in areas of potentially high seismic risk

7.1. Key aspects

- The Kyrgyz Republic occupies an area that is extremely prone to numerous natural disasters.
- On average, approximately 200 disasters are registered per year, 90 per cent of which are of a natural origin.
- In recent decades, there has been an upward trend in the number of disasters.
- Mudflows, floods and avalanches are the most common and dangerous natural disasters that befall the Kyrgyz Republic.
- Natural disasters in the republic occur very unevenly, both spatially and temporally, which makes them very difficult to predict and mitigate.

7.2. General characteristics

Due to its geographical location and a mix of both natural and anthropogenic factors, the Kyrgyz Republic is prone to numerous natural disasters. The natural factors that contribute are the country's high degree of seismicity, its complex geological structure, including high-mountain relief with an abundance of steep slopes and deep gorges (94 per cent of the republic is more than 1000 m above sea level), climate change and the presence of glaciers (40 per cent of the territory is above 3000 m above sea level), the melting of which leads to the formation of glacial lakes of a breakthrough type *(Map. Hypsometric map; Map. Types of relief)*. Anthropogenic factors include excessive pressure on mountain land resources, overgrazing of mountain steppes and meadows as well as the deterioration of preventive disaster infrastructure inherited from Soviet times.

Monitoring of major emergencies in the Kyrgyz Republic has been carried out since 1951, however, only data from 1990 onwards can be used for analysis as this when a modern system of data collection and processing began to be used. These data show that the number of disasters has increased dramatically since 1990.[128]

On average, approximately 200 disasters have been registered annually, the majority of which (90 per cent) were of a natural nature. An analysis of the numbers of disasters points to an increasing trend, with the average number per year between 1991 and 2000 being 123, a figure that rose to 235 between 2001 and 2010 and stood at 313 from 2011 to 2016. Due to climate change, the average annual number of disasters is expected to increase by an average of 214 even if global warming is limited to 1°C, additionally, the direct economic damage incurred may increase several fold from current figures.[129]

Many of the dangerous processes leading to disasters have a pronounced seasonal character and their manifestation is largely determined not by a shift in average climate values, which change relatively slowly, but by a change in the number of extreme values. Precipitation variability is not yet statistically significant and analysis of the expected transformation shows only further minor changes in the moisture regime. However, the transformations of the observed mean annual temperature at present compared to the reference period are already statistically significant and an analysis of the changes shows a significant increase in temperature variability.

The rate of increase in the frequency of various natural disasters differs, however, the highest increase is for mudflows and floods and, since 1990, there has been a significant rate of increase in the frequency of their manifestation. Extrapolation of the observed trends to the near future makes it possible to predict the increase in the frequency of mudflows and floods (up by 68 per cent) based on an increase in average annual temperatures of 1°C.[130] Due to their exceptional prevalence and frequency, as well as the size of the resultant damaged areas, they should be classified as the most dangerous of Kyrgyzstan's natural disasters driven by climate change. Pronounced upward trends also apply to such phenomena as storm winds and snowstorms while statistics on avalanches and the onset of spring floods show a less certain trend. In relation to disasters such as damaging hail and landslides, trends are not pronounced.[131]

In 2020, the Ministry of Emergency Situations of the Kyrgyz Republic (MES KR) systematized its statistics on natural and man-made disasters over the past 20 years in the format of an atlas.[132] According to these data, the main types of disasters can be arranged in the following order of decreasing frequency of occurrence per annum: mudflows and floods (70), avalanches (34), noticeable earthquakes (up to 29), landslides (18) and flooding (six), each of which is dealt with below.

Earthquakes. Almost the entirety of the Kyrgyz Republic falls within a zone of high seismic activity that has three main zones of seismicity: the sublatitudinally elongated North Tien-Shan; the Talaso-Fergana zone with its fault line named after the chain of surrounding ridges; and the South Tien-Shan (Alay) zone, an area of sublatitudinal strike in the extreme south of the republic *(Map. Seismic zones)*. These zones are associated with the strongest (magnitude of 9-10) earthquakes in the historical past that have a recurrence period of 500-1000 years. Most settlements in the Kyrgyz Republic are located in one of these high seismicity zones *(Fig. 8)*. Every year, seismographic devices record approximately 3,000 earthquakes with a magnitude of less than five,[133] however, an average of only 10-20 of these 3000 earthquakes belong to the category of 'perceptible'.[134]

Earthquakes with a strength of five or more on the MSK-64 scale are considered to be disasters. The last time a strong earthquake occurred in the Kyrgyz Republic was on 20 July 2011 in the Fergana Valley, on the border with Uzbekistan and Tajikistan. It had a strength of 6.1 on the MSK-64 scale and resulted in at least 800 houses being damaged. An associated rockfall blocked the highway between Batken and Osh and 14 people were killed in Uzbekistan with another 86 injured.



Road after the earthquake in Chui region

Earthquake epicentres are often located in areas of the Kyrgyz Republic containing detached low-rise buildings, most of which are already somewhat unstable due to a number of shortcomings arising from their handicraft construction: the use of fragile local building materials (for example, adobe) even for the construction of load-bearing walls, the weak adhesion of mortar to bricks, shallow foundations, asymmetrical layouts of premises, built-in niches, additional buildings adjacent to the main house and so forth. Historically, almost all the buildings in the republic that have been seriously damaged by earthquakes did not meet modern standards for construction in areas of high seismicity.

Furthermore, the country's near ubiquitous mountain terrain being subject to seismic shocks means there is an inherently high risk of rock collapses and rockfalls, which pose a direct threat to roads, railways, power and communication lines as well as to settlements *(Map. High risk areas for landslides and rockfalls) (Fig. 9)*.

128 Ilyasov et al. (2013) Climate profile of the Kyrgyz Republic. Bishkek. 99 p. kgz_Kyrgyzstan-Climate-profile_ENG_for-web-opt.pdf.
129 Resolution 'On the Approval of Priority Areas of Adaptation to Climate Change in the Kyrgyz Republic until 2017' (in Russian) Постановление Правительства КР от 2 октября 2013 года № 549 (minjust.gov.kg)
130 Ordobaev et al. (2015) Hazardous natural processes in the Kyrgyz Republic. Bishkek: KRSU Publ., p. 292 p. (in Russian).
131 Ilyasov et al. (2013).
132 Atlas…(2020).
133 Ordobaev et al. (2015).
134 Atlas….(2020).

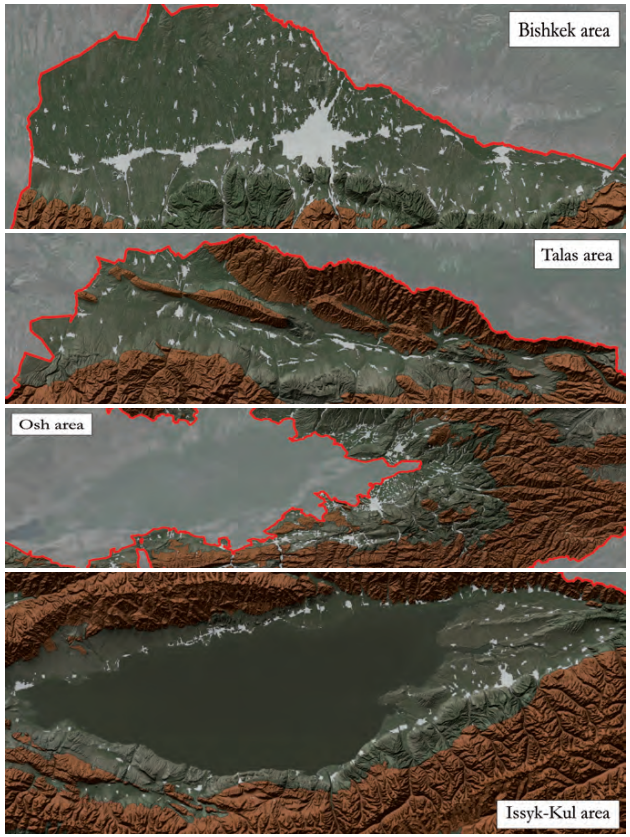


Fig. 9. Settlements in areas of high rock collapses and rockfalls

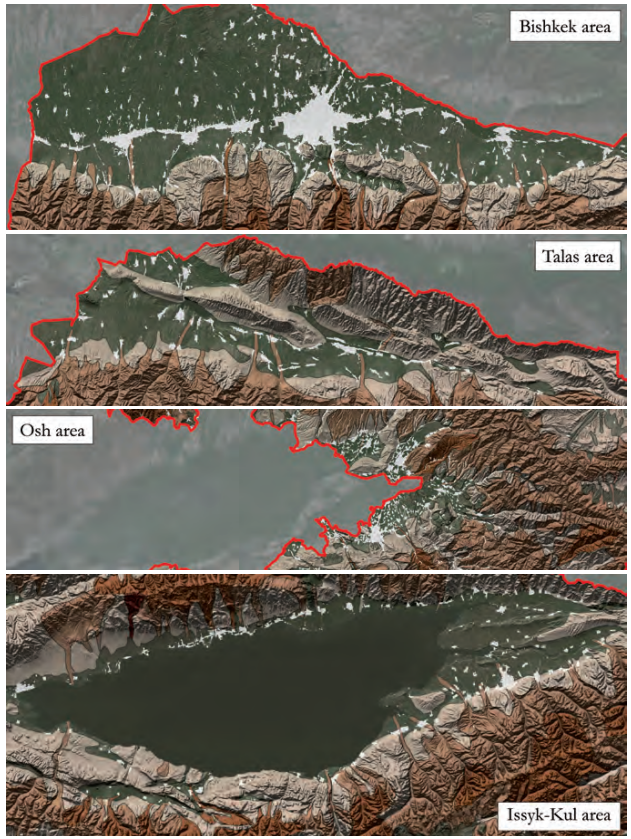


Fig. 10. Settlements in areas of high mudflow risk

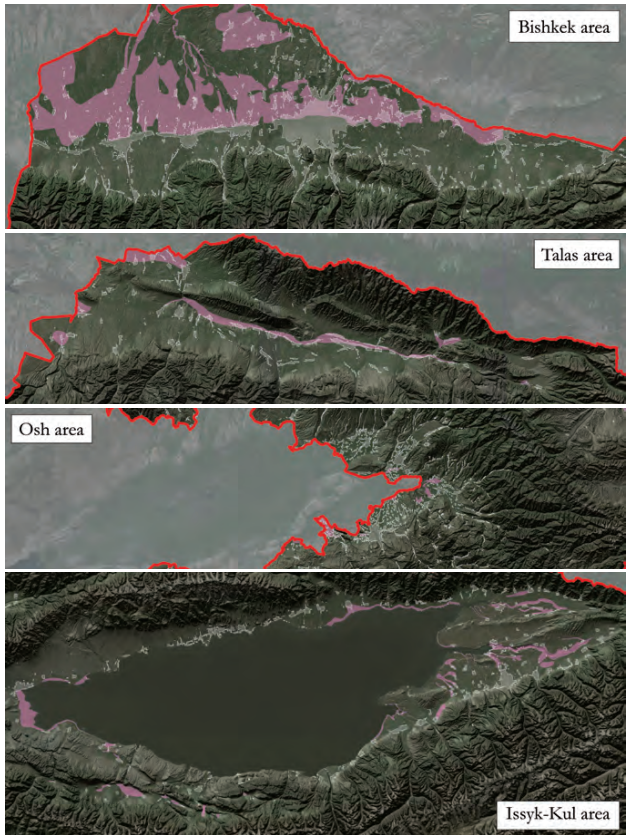


Fig. 11. Settlements in areas of high flooding risk

Mudflow risk:

- Territory of the IV degree of danger with the possible manifestation of catastrophic mudflows.
- Territory of the IV degree of danger with the possible manifestation of mudflows up to 1000 m3/sec.
- Territory of the III degree of danger with the possible manifestation of mudflows up to 100 m3/sec.
- Territory of the IV degree of danger with the possible manifestation of mudflows up to 10 m3/sec.

Settlements in areas of high rock collapses and rockfalls risk

- Zone of high rock collapses and rockfalls risk
- Settlements' borders

Settlements in areas of high flooding risk

- Zone of high flooding risk
- Settlements' borders

Mudflows and floods. In terms of prevalence and frequency of manifestations, mudflows and floods rank first among dangerous natural processes in the Kyrgyz Republic *(Map. High risk areas for mudflows)*. These events account for up to 30 per cent of all disasters that befall the country each year and are particularly dangerous for humans because settlements have gravitated towards alluvial cones and temporary watercourses. This naturally also leads to transport infrastructure, irrigation systems, important hydraulic facilities, agricultural fields and the like being present in mudflow and food zones, which increases the potential for large material losses.

Approximately 3900 mudflow basins have been identified in Kyrgyz Republic, in the valley of each large river there are several hundred (300–700) mudflow hazard sites, usually at the outlet of lateral temporary and permanent tributaries to the main river. The main precondition for the advent of a mudflow is the accumulation of loose and clastic material in the middle and upper parts of a valley. A mudflow hazard is at its maximum in foothills, adyrs and mountains of medium altitude (up to 2500 m) that are dissected by river valleys with dry beds which, under certain conditions, can channel water and mud flows.

While some areas of the Kyrgyz Republic experience annual mudflows, approximately 80 per cent of the total number of known cases of mudflows occur as a result of heavy rains, while snowmelt (often in combination with rain) causes their occurrence in up to 15 per cent of cases. However, as a result of intense precipitation, floods also occur, especially at the exits from mountain valleys *(Fig.11)*. The slight slopes of the plains mountain rivers empty onto lead to low river flow speeds, preventing large volumes of water from passing through their channels during floods. As a result, rivers more readily overflow their banks, flooding vast areas of lowlands *(Map. Flood risk zones)*.

The most powerful and sudden mudflows and floods can be caused by the breakthrough of high-altitude lakes, located in mountainous, and especially in high-mountainous, areas. There are 200 high-altitude lakes in the Kyrgyz Republic that are deemed to have a high probability of breakthrough and 300 settlements in the associated zones of potential catastrophic floods *(Map. Ice accumulation in river basins)*. Over the past half a century, approximately 70 dangerous instances of breakthroughs of glacial lakes have been registered, leading to significant destruction and human casualties. However, it is likely that most past breakthroughs remained unrecorded due to the remoteness and uninhabited nature of many high-altitude valleys where such breakthroughs occurred.

Avalanches. Dangerous avalanches are prone to occur on 53 per cent of the country's territory (approximately 105,000 km²) and account for 12.34 per cent of all natural disasters. Local experts have identified 779 avalanche areas with more than 30,000 avalanche centres, of which approximately1,000 are estimated to pose a grave threat to the local populations and infrastructure.[135] Although the general conditions for avalanche formation, namely steep mountain slopes and sufficient winter precipitation, are common, there are marked regional differences in the risks of avalanches. The most affected regions are Jalal-Abad and Osh, where the number of avalanches reaches 40.9 per cent and 25.9 per cent of the total number of such events in the country, respectively. In the Talas and Batken regions, these figures are only 1.0 per cent and 0.5 per cent, respectively while in other regions the figures vary between 8 and 13 per cent *(Map. Avalanche activity)*.



Avalanche from Khan-Tengri Peak in Central Tien Shan

Avalanche activity is determined by macroclimatic processes with the most dangerous situation manifesting when contrasting air masses collide, such as when a mass of warm and humid air from the Mediterranean interacts with cold Arctic air. Avalanches are often formed by freshly fallen wet snow or by blizzard snow, with the former being the most numerous and the latter being the most voluminous. This results in avalanche danger varying by season and, in the Kyrgyz Republic, records indicate more than half of all avalanches occur in March while the least active months are November and May, which account for only 1.5-2.5 per cent of the total number of avalanches per year. The distribution of avalanche activity along the high-altitude tiers of the republic is quite even, with a slight preponderance for altitudes from 1700 to 2000 m. The total number of avalanches in the Kyrgyz Republic per year is unknown since only a small proportion of avalanche-prone areas are monitored. Despite this relatively small data source, the number of recorded avalanches averages 800 to 1500 per year, of which approximately 100 can pose a real threat to human populations and infrastructure. Shepherds, hunters, climbers and mountain tourists die under avalanches that also damage power poles, block roads, bury livestock and wild animals, flatten forest and shrub plantations and block river channels, leaving a swathe of damage and debris that may then indirectly result in mudflows. The remnants of a large avalanche can persevere during the summer season.

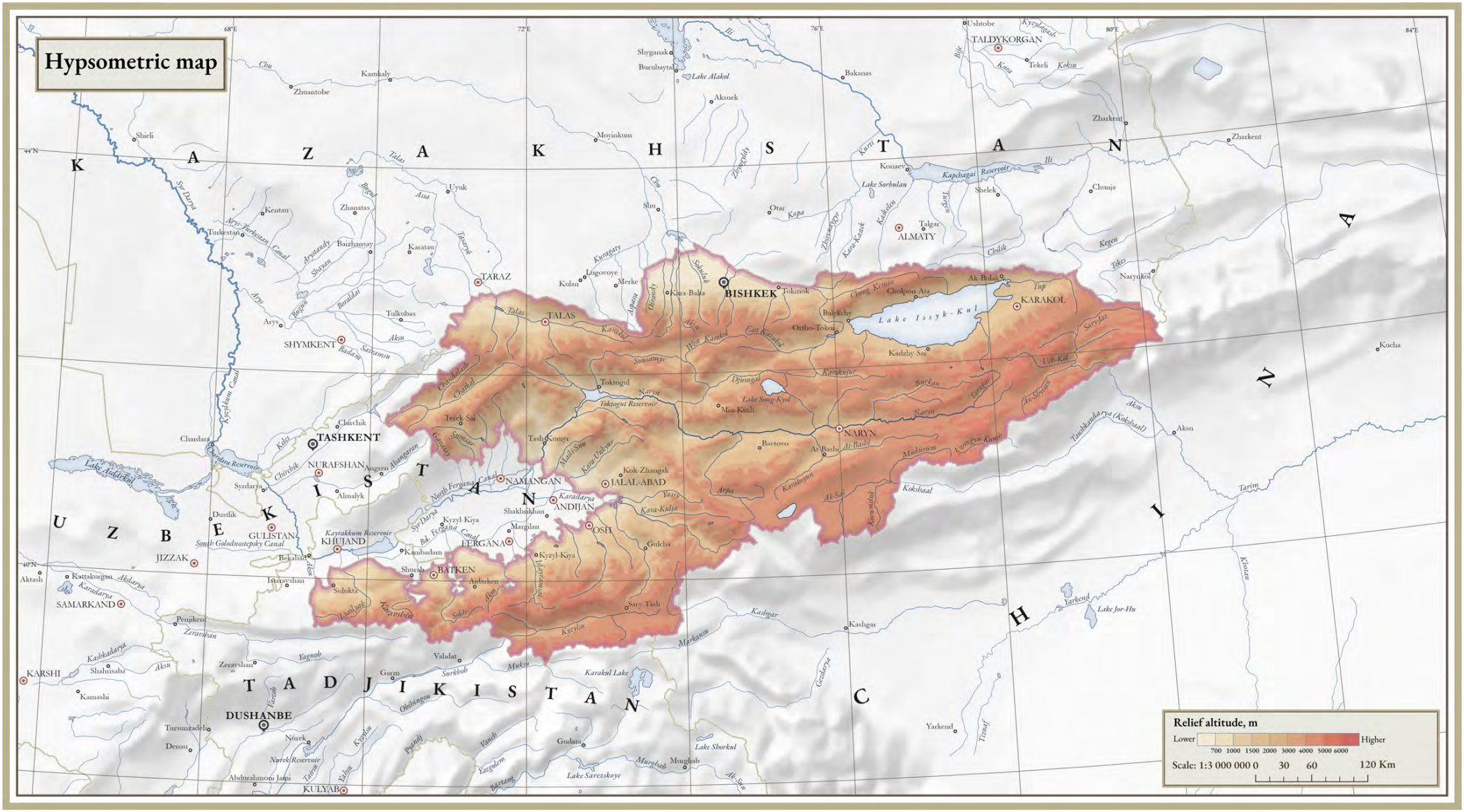
Landslides. There are more than 5000 active landslides on the territory of the Kyrgyz Republic, of which 3500 are located in the southern region of the country, where in some areas up to 30-40 landslides are recorded per km², which formed at different times. That is why the mountain frame of the Fergana Valley is called the «landslide belt». There, alongside much infrastructure, some 600 settlements were affected to varying degrees by landslide processes, including the mining towns of Mailuu -Suu, Sulukta and Min-Kush. Up to 10,000 residential buildings are located in these potentially hazardous areas.

Between 1991 and 2022, 593 severe landslides were reported in the Kyrgyz Republic, resulting in 275 deaths. When analyzing landslide numbers by decade, the frequency does not show a definite trend: in 1991–2000 there were 221 landslides that resulted in 127 deaths, 2001–2010 saw 228 landslides causing 105 deaths and 2011–2020 there were 142 landslides with 43 victims.

Heavy rains can be a trigger for landslides. However, the main problems in predicting landslide activity are related to the fact that these risks do not currently increase as a result of intense precipitation but as a result of the infiltration of atmospheric moisture into soils for a fairly long period (at least five months). This process leads to a gradual increase in pore pressure and a decrease in the strength characteristics of soils on slopes. The country has seen a significant increase in the number and size of its built-up areas, mainly due to the spontaneous expansion of large settlements or mergers of several small settlements. This expansion, which inherently increases the risks associated with landslides, has resulted from an allocation of plots for new construction that is decided upon without taking such risks into account. This approach, coupled with the fact there is no zoning of the country according to the severity of landslide risks, is compounding a growing problem. [136]

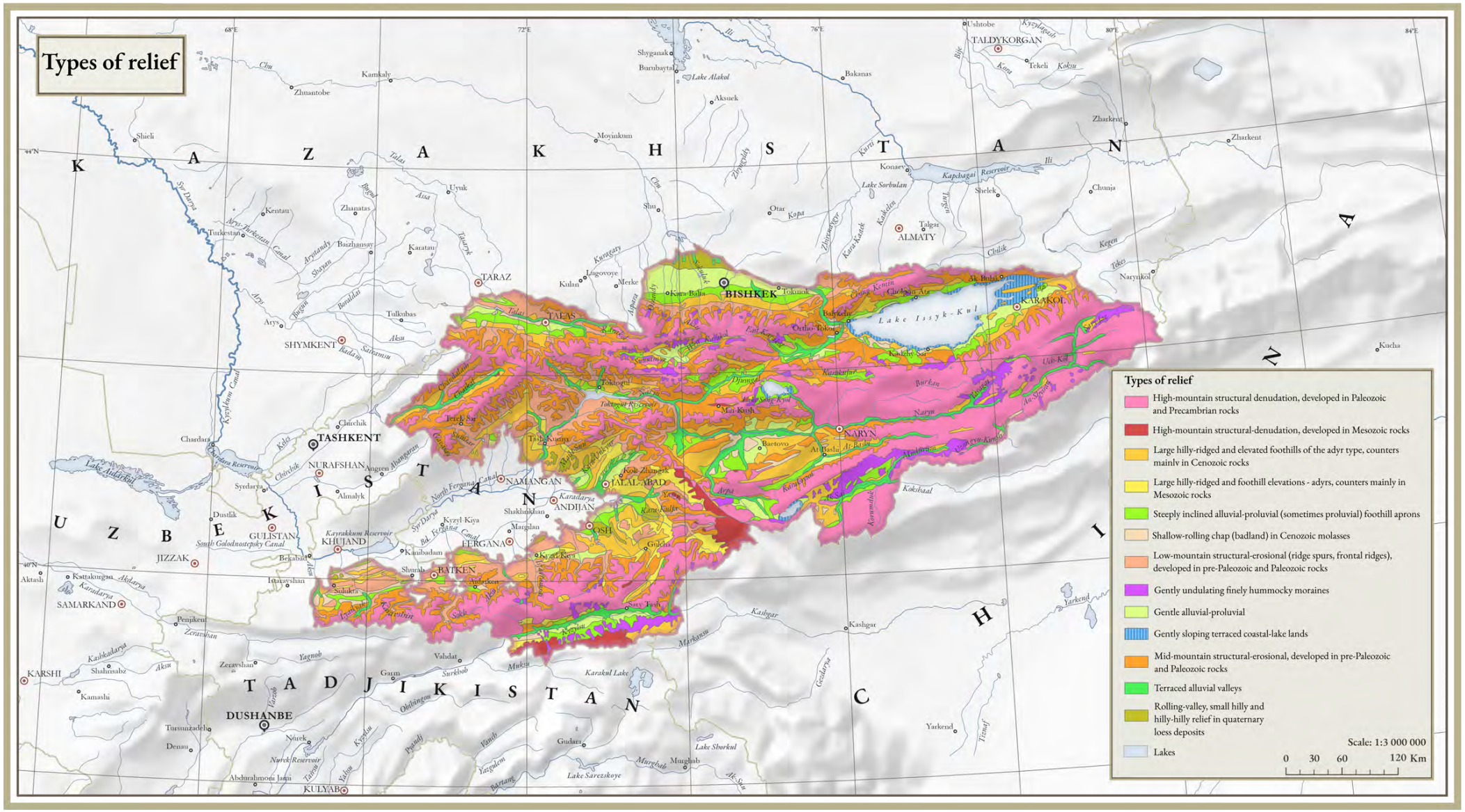
135 Ilyasov et al. (2013).

136 Atlas….(2020).



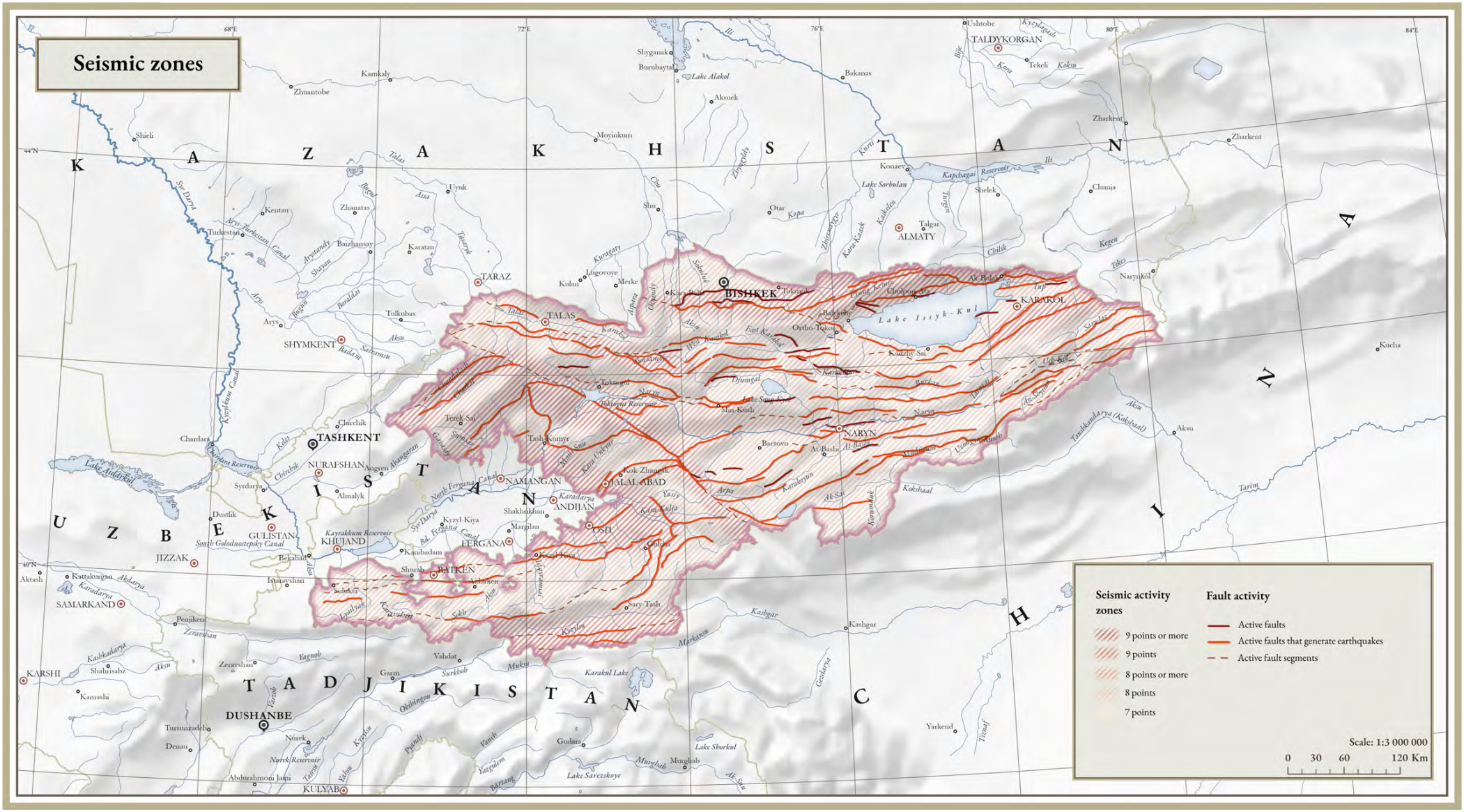
Shuttle Radar Topography Mission (SRTM) 1 Arc-Second Global data. https://doi.org/10.5066/F7PR7TFT.

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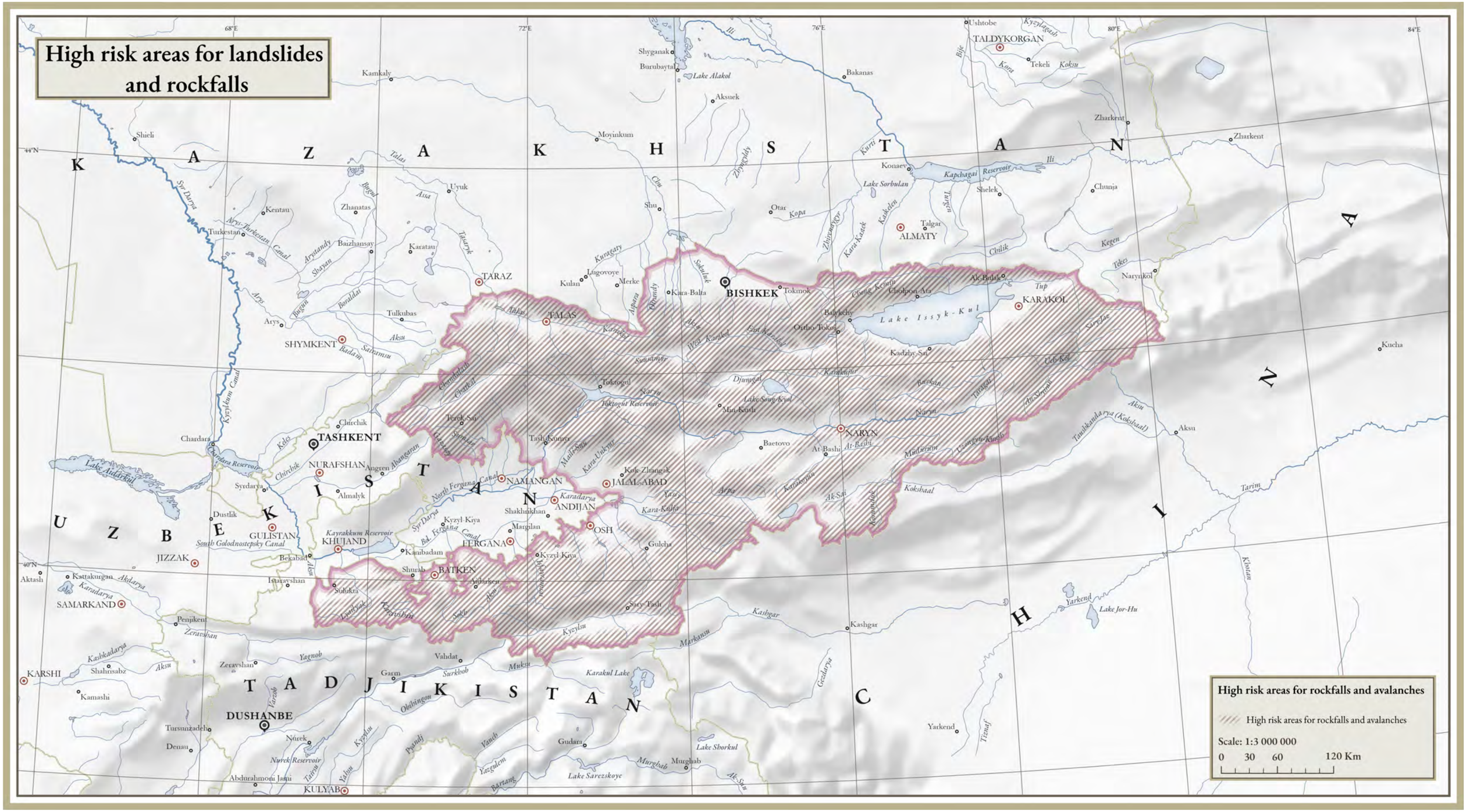
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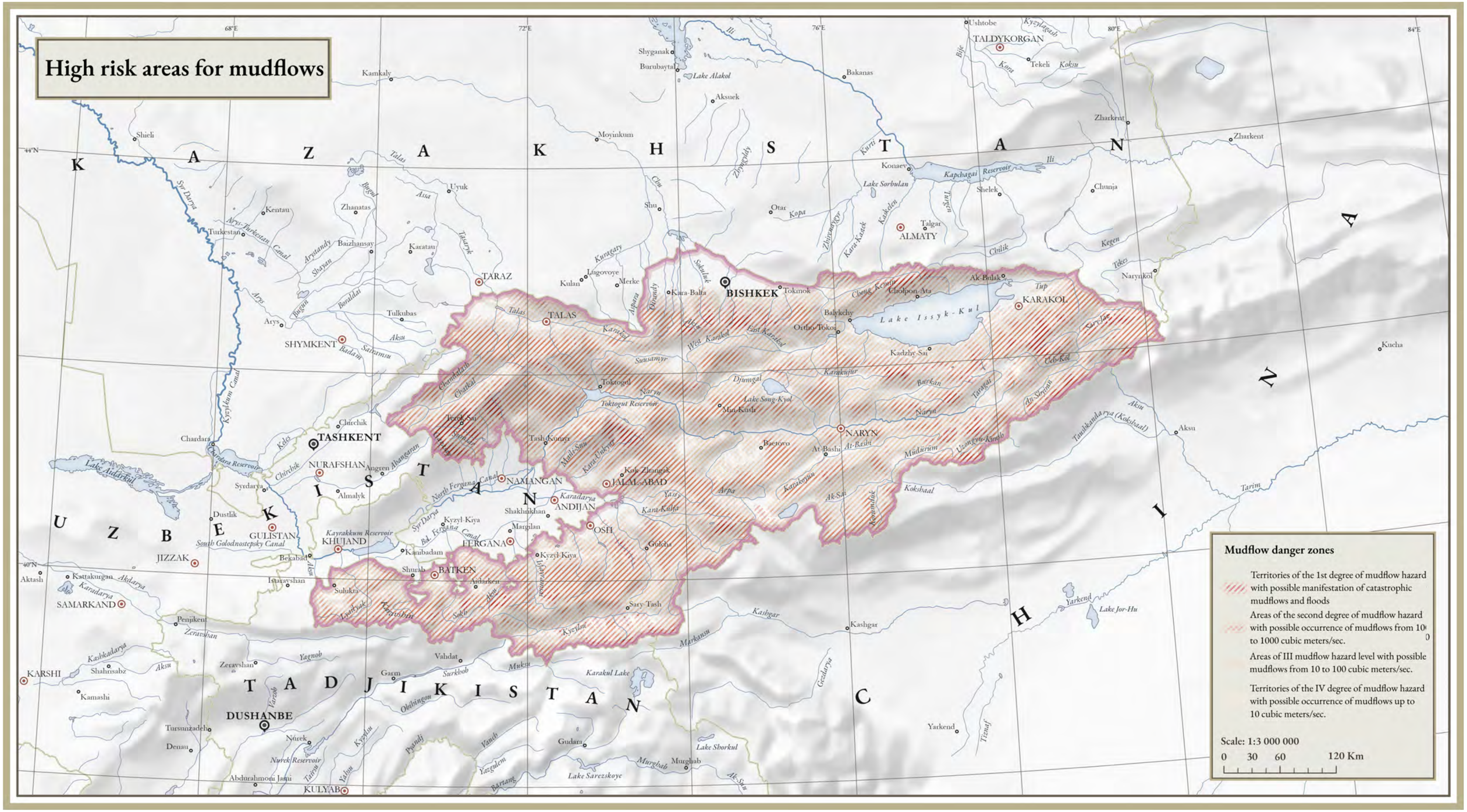
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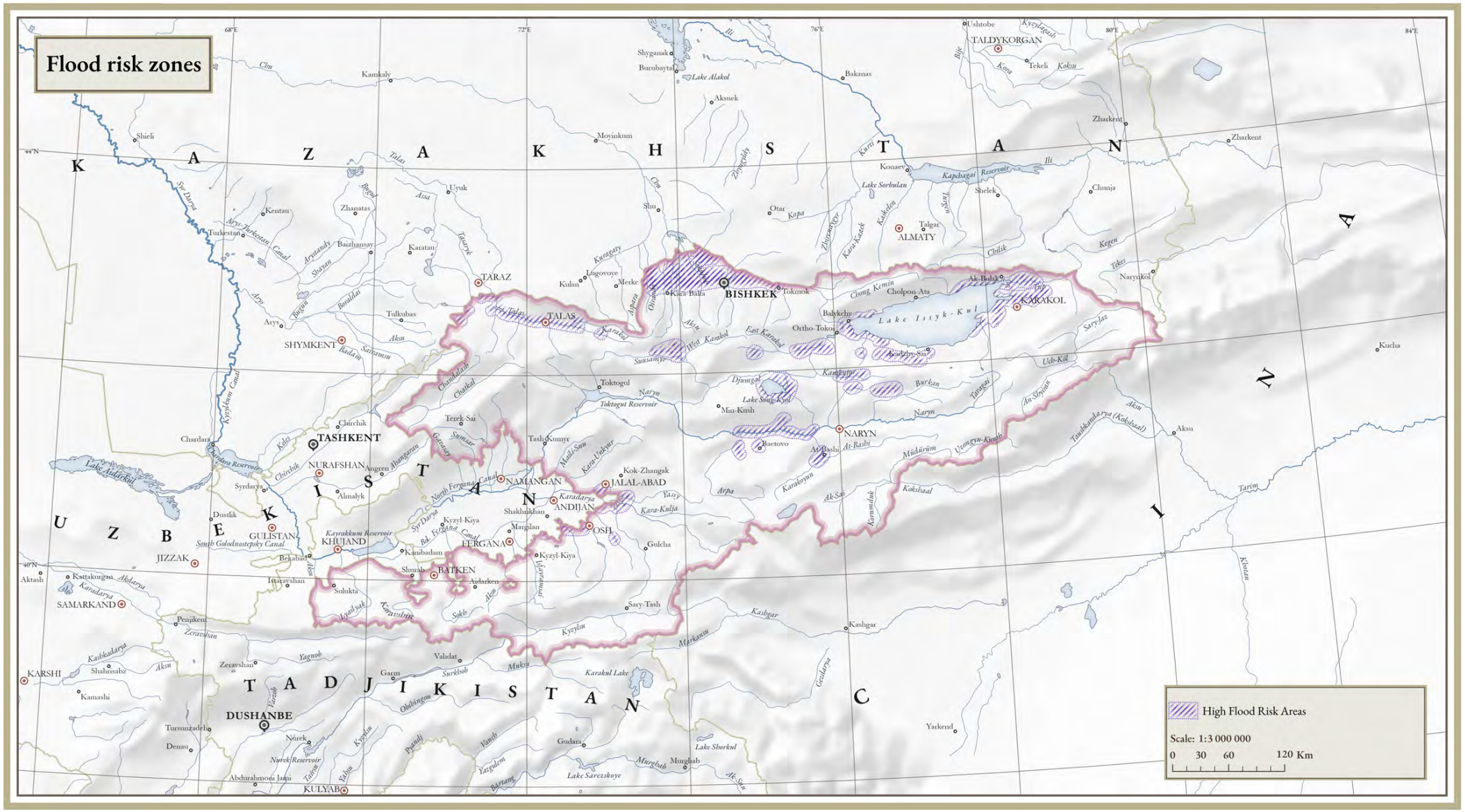
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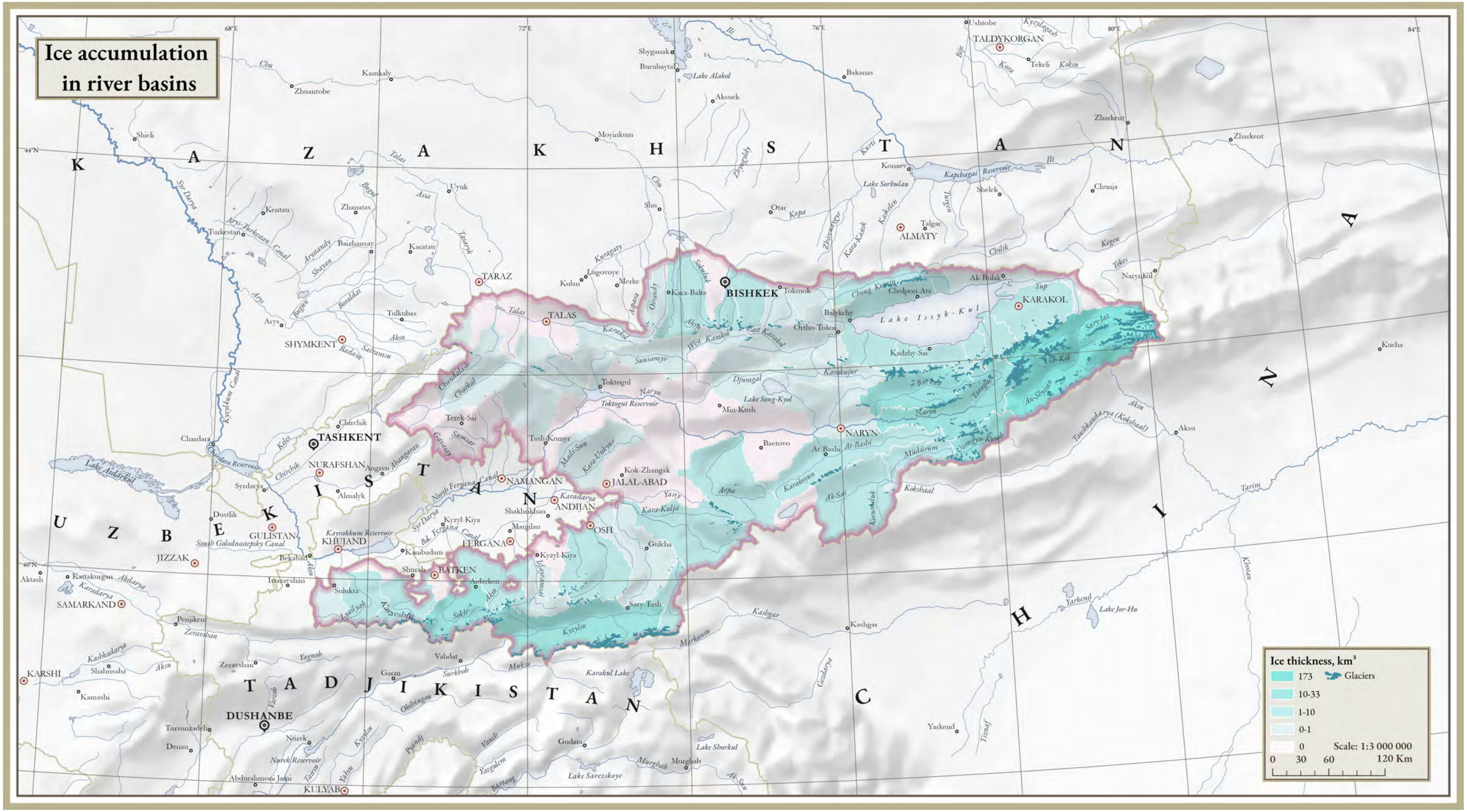
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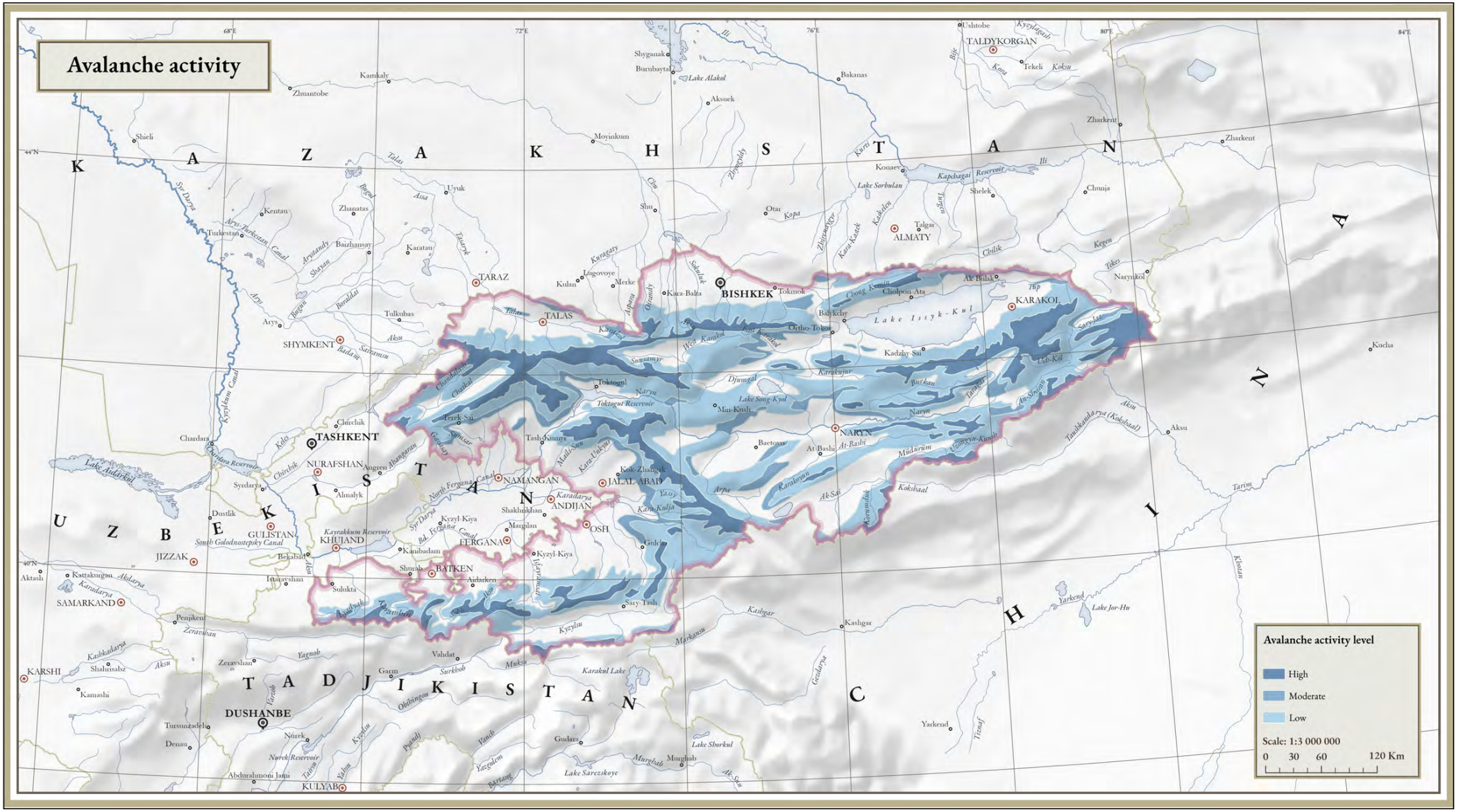
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Global GLIMS database[137]. The GLIMS database is suitable for estimations of ice volume at the water-basins level and is useful for risk assessments of natural hazards as such floods and mudflows.

137 http://www.glims.org/maps/gtng

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Information System of the Water Resources Service of the Kyrgyz Republic.

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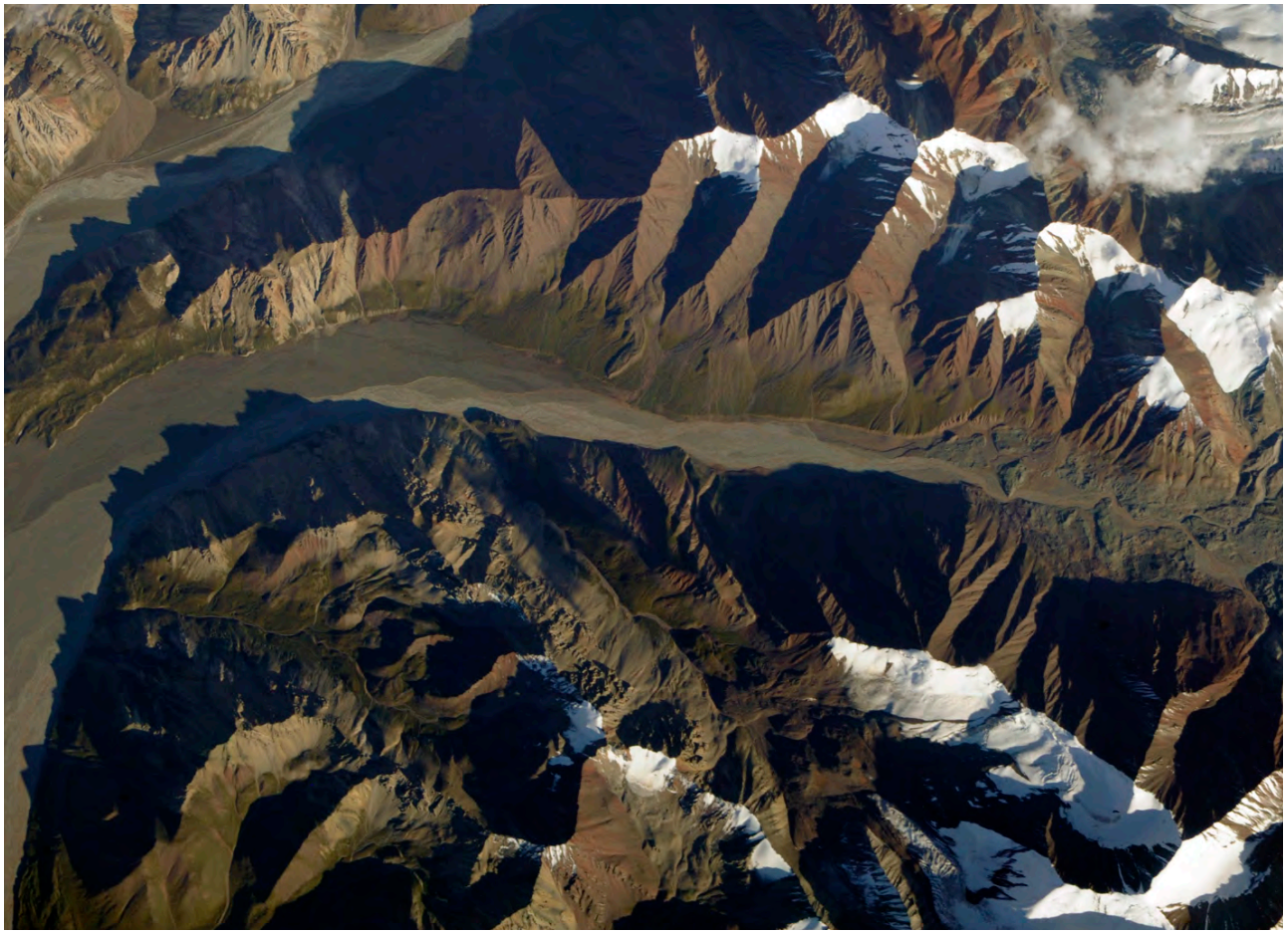
7.3. Progress towards the SDGs

The Government of Kyrgyz Republic recognizes climate change in the country as the primary driver of increases in the frequency and intensity of natural disasters, with a tendency to increase vulnerability of population and infrastructure to these disasters. In 2019, the Kyrgyz Republic ratified the Paris Agreement on Climate Change, committing to support vulnerable groups so they can adapt to climate change through the implementation of climate change mitigation and adaptation policies and measures. This support is concretized by targets that are reflected in the nationalized SDG 13.1.

This particular SDG centres on building resilience and adaptive capacity to climate hazards and natural disasters in all countries and the associated headline indicator, SDG 13.1.2, is entitled 'Proportion of local authorities adopting and implementing local disaster risk reduction strategies'.

In 2013, the Kyrgyz Republic completed its first comprehensive assessment of the country's vulnerability to climate change. This assessment served as the basis on which priority areas for adaptation to climate change were identified. Within the framework of the resultant adaptation project, four sectoral programmes were developed, including the prevention of natural disasters, with specific measures that were to be taken and the necessary funding for their implementation.[138] In 2016 and 2017, an analysis of the risks of disasters was carried out, taking into account the causes, intensity and scale of natural disasters, in accordance with the SDG goals and priorities of the Sendai Framework for Action to reduce such risks. In 2018, the Government adopted the Concept of Comprehensive Protection of the Population and Territory of the Kyrgyz Republic from Disasters for 2018–2030 and the Plan for its Implementation for 2018–2022. The main objectives of these documents are: the rational use of natural resources in a changing climate, mitigation of the consequences of disasters and the reduction of damage suffered by the population, including through the formation of a safer settlement system in the republic *(Box. 6)*. Despite these initiatives, indicator SDG 13.1.2 is still under development and, by 2019, only 49 out of 484 municipalities had developed disaster risk reduction strategies at the local level.

The impact of climate change on public health is difficult to isolate from several other important social, economic and behavioural factors, so such estimates are highly uncertain. In countries, such as the Kyrgyz Republic, with a predominantly rural population and a patriarchal way of life, women, especially



pregnant women, those with infants as well as those caring for sick and elderly family members, are highly vulnerable to weather anomalies. This should be taken into account in national and local climate change adaptation strategies. In the Ministry of Emergency Situations of the Kyrgyz Republic, the representation of women in administrative positions is relatively high (40.6 per cent of the total number of employees), but only men hold political and leading positions. This leads to the fact that the interests of women and children may not be fully taken into account when developing plans and carrying out measures in emergencies.[139]

Sustainable Development Goal 11.5 requires that, by 2030, States significantly reduce the number of deaths and the number of people affected, and substantially reduce the direct economic losses caused by natural disasters, including water-related disasters, with a particular focus on protecting the poor and those in vulnerable situations.

To assist reach the targets of the above SDG, indicator 11.5.1 is entitled 'Number of deaths, missing persons and direct victims of natural disasters per 100,000 population'. Data on the annual number of human fatalities in the Kyrgyz Republic resulting from natural disasters vary from dozens

138 Voluntary … (2020).

139 Report on the results ….(2022).

to one hundred people (the maximum recorded was 281 people in 2008)[140]. In 2022, the natural-disaster related death toll was 135, 73 per cent of whom were men. Geographically, the largest number of deaths, missing or directly affected by natural disasters was observed in the Batken region, which accounted for 72 per cent (97 people) of the national total; 13 per cent in Jalal-Abad region, 7 per cent in Chui region and 4 per cent in Issyk-Kul and 4 per cent in Osh region *(Map. Death toll from natural disasters)*. In the other regions, no individuals were recorded as killed, missing or directly affected by natural disasters in 2022. During 2007–2022, the trend towards a decrease in the number of victims can be seen in national statistics *(Fig.12)*.

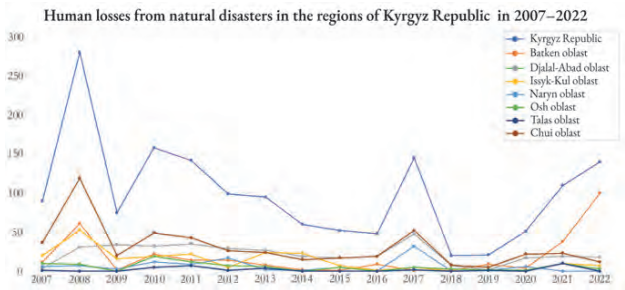


Fig. 12. Human losses from natural disasters in the regions of Kyrgyz Republic in 2007–2022

Another natural-disaster related indicator is 11.5.2, entitled 'Direct economic losses relative to global GDP, damage to critical infrastructure, and disruption of essential services associated with natural disasters'.

The republic's national statistics[141] of direct economic damage resulting from the total or partial destruction of tangible assets present in disaster-affected areas show significant regional variation in 2007–2022 *(Fig.13)*. The Batken and Osh regions proved to be the most vulnerable as economic damage in some years amounted to 4-6 per cent of their GDP *(Map. Economic losses from natural disasters)*. The Naryn and Jalal-Abad regions experienced significantly smaller economic losses during this period, although in some years this still exceeded one per cent of their GDPs. The least vulnerable regions, in which the economic damage was less than 0.5 per cent of GDP, were the Talas and Chui regions. The regional data do not allow a determination of the trends in this regard due to large fluctuations in losses from year to year, however, national data show a slight trend towards reduced economic losses in the period for which national statistics are provided.

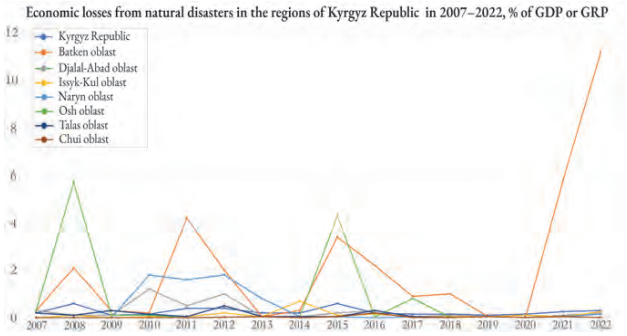


Fig. 13. Economic losses from natural disasters in the regions of Kyrgyz Republic in 2007–2022

Form the foregoing it is apparent that economic losses associated with natural disasters are very unevenly distributed among the regions of the country. In 2001–2007, the average annual damage amounted to USD 35 million while from 2012 to 2018 the damage ranged from USD 2.5 million to 26.2 million per annum a year, or from 0.06 to 0.53 per cent of the country's GDP *(Fig.13)*.[142] These figures are broadly verified by the National Statistical Committee which gives similar estimates of USD 3.5 million–27 million for 2012–2018.

Box 6. The problem of resettlement of families from dangerous areas in Kyrgyz Republic[143]

On 29 April 2017, a landslide hit residential buildings in the village of Ayuu, a settlement in the Uzgen district of the Osh region, killing 24 people. Prior to the landslide, people were warned of the danger and a special decree on resettlement was issued, however, many locals ignored this and remained in situ. Employees of the district department of the Ministry of Emergency Situations of the Kyrgyz Republic resorted to cutting off electricity and blocking roads to some villages, these actions were taken in order to force 180 families to temporarily move from landslide areas. As a result, 160 families were temporarily relocated to a safer area, while 20 families remained in their homes, despite difficult living conditions and a high risk of landslides.

According to the MES KR, there are currently 1190 families living in landslide zones in the Jalal-Abad region, of which 797 have already received a loan from the State to assist in moving to new land plots that have been allocated to them in safer areas, however, they have not moved. For the other 393 families, local authorities are still resolving issues with the allocation of land in a safer zone.

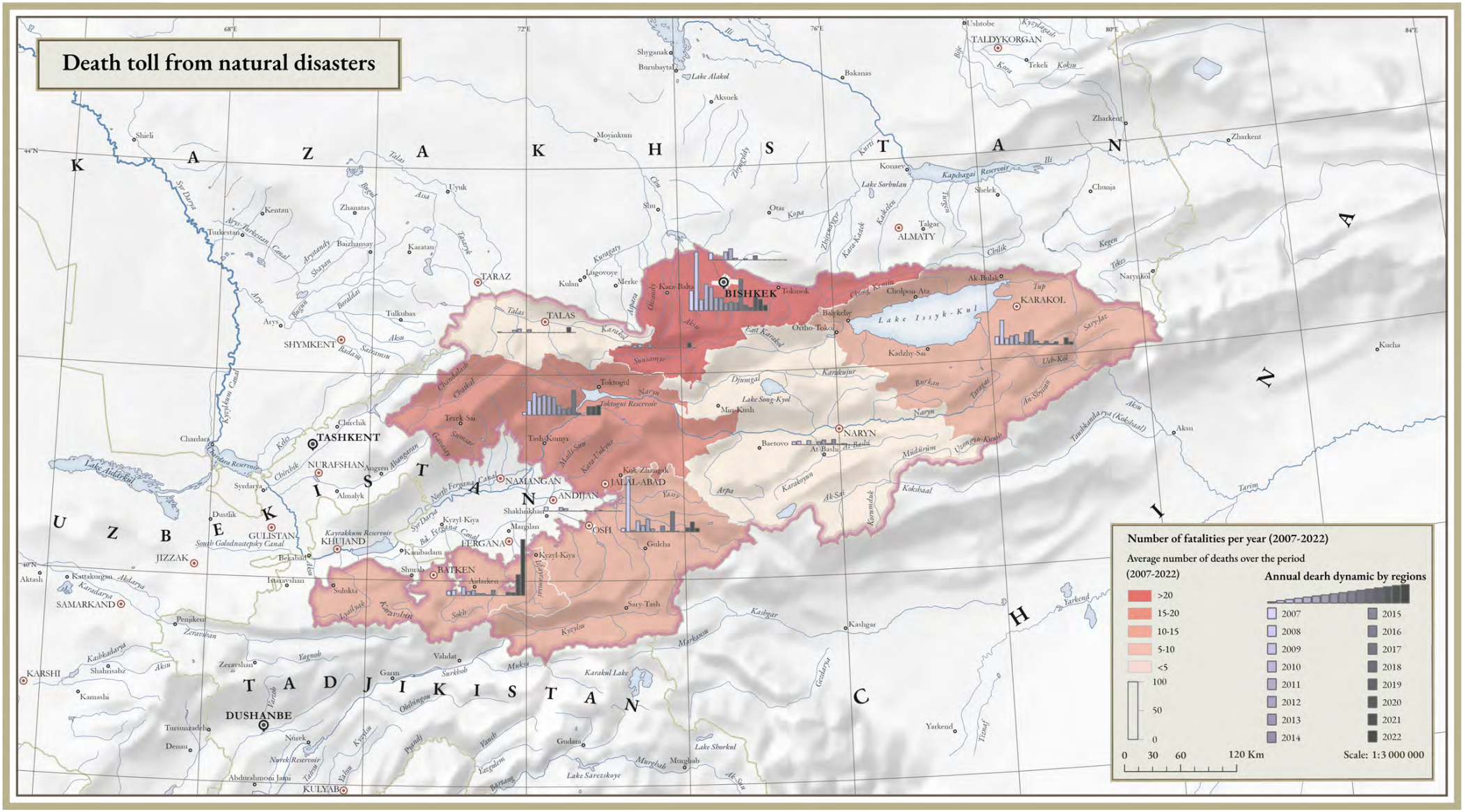
The MES KR has done a lot of work to identify dangerous areas throughout the country and issued appropriate relocation orders to affected residents. In 2021, 3859 families were ordered to relocate, of which 2488 families who agreed to leave were allocated money and plots to resettle elsewhere. But more than 1,000 families continue to live in potentially dangerous zones, explaining this by their reluctance to leave the lands of their ancestors.

Since 2022, ministry staff have been regularly visiting danger zones in continued efforts to persuade the local population to leave.

7.4. Responses

- Support the development and adoption by local authorities of specific disaster-related risk reduction strategies.
- Improvement of the system of monitoring and prevention of natural disasters, especially in relation to mudflows and avalanches.
- Development of a climate insurance system to adequately compensate affected individuals for losses from natural disasters.
- Realization of programmes for the resettlement of people living in high-risk zones.

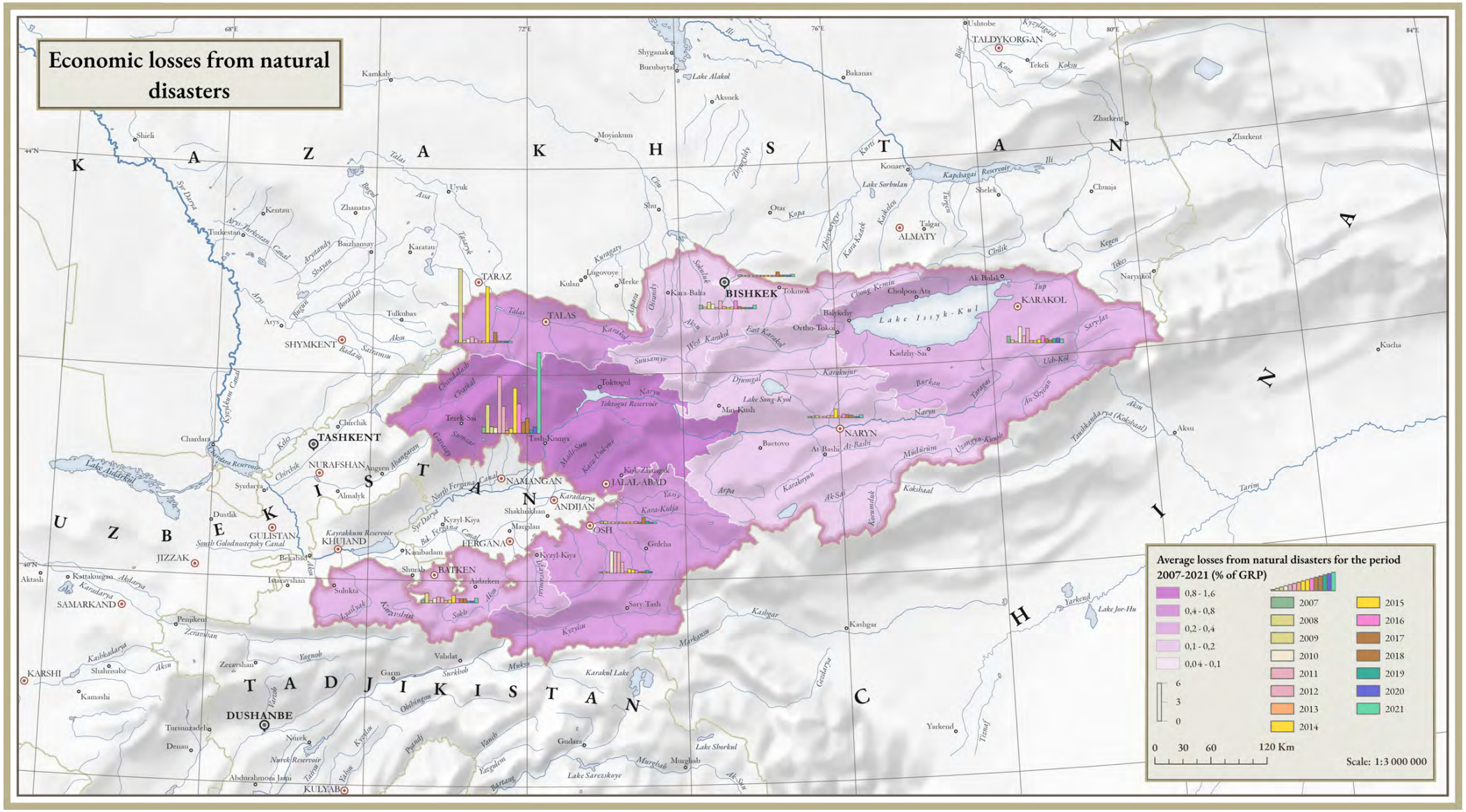
140 Indicator 11.5.2 - Direct economic loss in relation to global GDP, damage to critical infrastructure and number of disruptions to basic services, attributed to disasters - Indicators For The Sustainable Development Goals (sustainabledevelopment-kyrgyzstan.github.io)
141 Ibid.
142 Voluntary... (2020).
143 Informburo 6 March 2018 (in Russian). https://informburo.kz/novosti/v-kyrgyzstane-prinuditelno-pereselyayut-lyudey-s-opolzneopasnyh-uchastkov-.html?ysclid=l6xdrtwghk697008639.



According to the Bureau of Statistics of the Kyrgyz Republic[144].

144 https://sustainabledevelopment-kyrgyzstan.github.io/6-1-1/

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According to the Bureau of Statistics of the Kyrgyz Republic[145].

145 https://sustainabledevelopment-kyrgyzstan.github.io/6-1-1/

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