UN environment programme

Atlas

of environmental change



Republic of Uzbekistan

Disclaimer

© 2026 United Nations Environment Programme

ISBN: 978-92-807-4242-8

Job number: ROE/2724/GA

DOI: 10.59117/20.500.11822/48932

This publication may be reproduced in whole or in part and in any form for educational or non-commercial purposes without special permission from the copyright holder, provided that the source is acknowledged. The United Nations Environment Programme would appreciate receiving a copy of any publication that uses this publication as source material. No use of this publication for resale or any other commercial purpose is permitted without the prior written permission of the United Nations Environment Programme. Requests for such permission, indicating the purpose and extent of the reproduction, should be addressed to: unep-communication-director@un.org

Disclaimer of Liability
The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of a commercial company or product in this document does not imply endorsement by the United Nations Environment Programme or the authors of this publication. The use of information from this document for advertising purposes is not permitted. Trade names and symbols are cited for editorial purposes without any intention of infringement of trademark or copyright laws.

The views expressed in this publication are solely those of the authors and do not necessarily reflect the views of the United Nations Environment Programme. We regret any errors or omissions that may inadvertently have occurred in this work.

© Maps, photographs and illustrations, as indicated.
© Footage from the International Space Station: RSC Energia, Institute of Geography of the Russian Academy of Sciences
© Photos: Shutterstock. Web - https://www.shutterstock.com/. Date accessed - November 1, 2025.

Recommended bibliographic citation:
United Nations Environment Programme (2026). Atlas of Environmental Change - Republic of Uzbekistan. Geneva. https://wedocs.unep.org/20.500.11822/48932

Production: Geneva
URL: https://www.unep.org/resources/report/atlas-environmental-change-republic-uzbekistan

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

ATLAS OF ENVIRONMENTAL CHANGE



REPUBLIC OF UZBEKISTAN

Geneva – 2026

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
FEDERAL STATE BUDGETARY SCIENTIFIC INSTITUTION INSTITUTE OF GEOGRAPHY OF THE RUSSIAN ACADEMY OF SCIENCES (IG RAS)

FEDERAL STATE BUDGETARY EDUCATIONAL INSTITUTION OF HIGHER EDUCATION "LOMONOSOV MOSCOW STATE UNIVERSITY", Faculty of Geography

MINISTRY OF ECOLOGY, ENVIRONMENTAL PROTECTION AND CLIMATE CHANGE

Responsible Editors: A.A. Medvedev, PhD (Geography); N.M. Dronin, PhD (Geography)
Project Coordinators: M. Billo (UNEP); O. Atymtaev (UNEP)
Scientific Reviewer: S.A. Bulanov, DSc (Geography)
Proofreader: M.G. Alkhazova
Cartographic Design: V.E. Klepikov
Graphic Design: A.B. Kalinicheva; A.V. Kudikov
Layout and Typesetting: G.Yu. Iakutov, A.I. Ponomareva
Lead Authors: A.A. Medvedev, PhD (Geography); N.M. Dronin, PhD (Geography); V.S. Dekhnich, PhD (Geography)
Cartographic Editors: N.A. Alekseenko, PhD (Geography); I.F. Petrova, PhD (Geography)
Collection and Preparation of Spatial Data: N.O. Telnova; A.G. Khropov; B.M. Kuramagomedov; A.N. Narykov; G.V. Pinigin; S.T. Kudyakova; R.A. Koshutin; A.V. Kudikov; D.A. Petrakov, PhD (Geography); A.S. Turchaninova, PhD (Geography); N.A. Kostenkov
Remote Sensing Data Processing: M.V. Zimin, PhD (Geography); N.O. Telnova; A.V. Sonyushkin, PhD (Engineering); O.V. Tutubalina, PhD (Geography); I.I. Sereda
Imagery from the Russian Segment of the International Space Station (ISS):
L.V. Desinov, PhD (Geography); I.L. Ivonin

Acknowledgments: Aziz Abdukhakimov, Minister of Ecology, Environmental Protection, and Climate Change of the Republic of Uzbekistan
Bakhtiyor Pulatov
Jakhongir Talipov
Zhavokhir Abdukhalikov
Nuriddin Samatov
Farrukh Khurramov

Preface: Atlas of Environmental Change for the Republic of Uzbekistan

The Atlas of Environmental Change for the Republic of Uzbekistan has been developed based on global, regional and national datasets covering a period of six decades utilizing both historical information and the latest satellite technologies. It presents detailed information on the environment, with a focus on terrestrial and aquatic ecosystems, the republic's advances in implementing the three Rio Conventions and its progress towards achieving Sustainable Development Goals 6 and 15.

The environmental changes affecting our world today are also evident in the Republic of Uzbekistan. As such, the information contained in the Atlas can assist the Republic of Uzbekistan in monitoring environmental conditions and meeting reporting requirements under multilateral environmental agreements (MEAs). Additionally, the Atlas helps facilitate the preparation of a national state-of-the-environment report and provides a robust evidence base for policymakers and decision-makers, supporting sustainable environmental management.

The information presented here is grounded in data obtained from global, regional and national institutions and is available to the Government through the Geoportal, enabling the Atlas' continuous use and keeping it up to date, in line with national priorities.

The increase in mean annual air temperature in Uzbekistan has been 1.6°C since 1960, significantly exceeding the global rate of warming (0.96°C), of even greater concern is that, in the Aral Sea region, this increase is in the order of 1.8 to 2.5°C. Over the past decade, an increase in the frequency of droughts has been observed, particularly in the summer–autumn period and especially in the lower reaches of the Amu Darya.

Water resources are among the most important and most vulnerable components of the natural environment. While a decline in the flows of the Amu Darya and Syr Darya has not been pronounced to date, increased variability in river runoff has become apparent. In extremely hot and dry years, basin runoff can decrease by 25 to 50 per cent, which seriously exacerbates existing water deficits in irrigated areas. Compounding this issue, river-water quality also depends on the magnitude of these flows. Nonetheless, the Government has consistently demonstrated a responsible approach to interstate agreements on the allocation of transboundary water resources in Central Asia.

Irrigated lands have formed the backbone of Uzbekistan's economy throughout its long history. Nearly half of the country's population lives in rural areas and depends directly on the products they produce. The condition of irrigated lands and rangelands is critical for the country's sustainable development. Despite challenging circumstances involving the republic's agriculture and population growth, Uzbekistan has achieved near self-sufficiency in food.

Like many of its Central Asian neighbours, Uzbekistan is a country dominated by desert and semi-desert landscapes. A priority task is, therefore, the expansion and restoration of forest ecosystems. In 2021, at the initiative of the President, a national project called 'Yashil Makon' ('Green Space') was launched, with the goal of planting one billion trees and shrubs across the country over the next five years and increasing the share of urban green spaces from the current 7.6 per cent to 30 per cent. Uzbekistan's forestry programme is an important component of State policy for biodiversity conservation.

As understanding environmental change is the first step toward action, this Atlas not only documents ongoing environmental transformations but also highlights opportunities for the restoration, conservation and sustainable management of Uzbekistan's natural resources.



Arnold Kreilhuber

Director and Regional Representative
United Nations Environment Programme (UNEP)
Regional Office for Europe



Olga Solomina

Director
Institute of Geography
Russian Academy of Sciences

Executive Summary

The project to create digital atlases of environmental change in Central Asia for three target countries – Kyrgyzstan, Tajikistan and Uzbekistan – aims to harmonize these republics' statistical systems for use in the preparation of their respective national reports in accordance with international standards to the secretariats overseeing four key environmental global agreements – the United Nations Convention to Combat Desertification (UNCCD), the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Convention on Biological Diversity (UNCBD) and the Sustainable Development Goals (SDGs) pertaining to water and life on land. This is important because the harmonization of these national reports, in terms of their approaches to data collection and processing, contributes to the fulfillment of international obligations in the field of environmental protection by these countries.

For Uzbekistan, as for all countries of Central Asia, the state of water resources is a key factor in sustainable development. In this regard, Uzbekistan faces several challenges as its water resources are almost entirely transboundary and precipitation is extremely low in its lowland areas. The country's domestic water policy is still adapting to the SDG framework and Integrated Water Resources Management (IWRM) reform, which began 20 years ago with the establishment of Basin Irrigation System Administrations (BISAs), and needs further improvement. One particular concern with the latter is that these BISAs operate according to administrative boundaries. Furthermore, transboundary groundwater is not covered by any interstate agreements, while data on access to safe drinking water and sanitation are highly inconsistent at the national level. The latter is a pressing issue as these two key indicators are known to be low in rural areas, where half of the republic's population resides. Most rivers and water bodies, including reservoirs, are classified as moderately polluted (Category III) under the national assessment system; however, the available data have not allowed trends to be tracked over a long period (since 2000, for example).

Uzbekistan has limited land resources for agricultural production. Opportunities for their expansion are very limited due to the overall water deficit, which has already led to the Aral Sea disaster. All targets (SDG 15.3) related to land resource management are complex and multifaceted and, for Uzbekistan, there is a lack of up-to-date statistics that would allow an unambiguous assessment of trends, such as with productivity and carbon balance, for different land-cover classes. To help address these issues, this project recommends that the Atlas' target countries intensify engagement with developers of resources, such as the FAO Global Soil Organic Carbon Map and ISRIC SoilGrids, to calibrate these models using regional data.

Even when compared to the other lightly-forested countries of the region, Uzbekistan has very limited forest resources. As is noted throughout this project, indicators from global sources on Uzbekistan's forest area and biomass stocks in forest ecosystems differ significantly from published national statistics; therefore, national statistics cannot be used as the sole source for assessing trends and planning actions for sustainable forest management (SFM). In this regard, conducting regular national forest inventories, using harmonized definitions, methodologies and comparable timing, is a necessity for unambiguously determining trends in the area and condition of Uzbekistan's forests.

The relative richness of flora and fauna in the countries of Central Asia, including Uzbekistan, is largely associated with the presence of mountain systems that serve as islands of biodiversity amid monotonous arid and semi-arid plains. Among all the issues considered in the prohect, biodiversity, as an object of national environmental policies, stands out throughout the region as an issue reported on using a fairly coherent alignment of terminology, methods and research objectives. Indeed, the countries of Central Asia even have similar systems for classifying protected objects and provide uniform information on the boundaries of protected areas (PAs). Nevertheless, further measures to address biodiversity issues at the regional level should include developing a unified algorithm for inventorying protected species, mapping their ranges, expanding transboundary PAs and establishing mechanisms for information exchange and provision.

The Government of Uzbekistan recognizes climate change as a major cause of the increasing frequency and intensity of natural disasters. Under the Paris Agreement, Uzbekistan has committed to supporting population groups vulnerable to climate change by implementing policies and measures to mitigate and adapt to the changes being wrought. To achieve these goals, it is proposed to develop a unified methodology for risk assessment and management for countries participating in the convention. The geomorphometric indices and assessment models obtained within this project and presented in the Atlas can serve as the informational basis for such actions.

Abbreviations

BOD - Biochemical Oxygen Demand
CAFC – Central Asia Forest Cover
CACILM - Central Asian Countries Initiative for Land Management
CCI – Climate Change Initiative
CMIP – Coupled Model Intercomparison Project
ECE – Economic Commission for Europe
ESA – European Space Agency
EVI - Enhanced Vegetation Index
FAO – Food and Agriculture Organization of the United Nations
FSC–Forest Stewardship Council
GEF – Global Environment Facility
GHG -Greenhouse Gas
GLIMS – Global Ice and Measurements from Space
GSOCM – FAO Global Soil Organic Carbon Map
IBA – Important Bird and Biodiversity Area
ICWC - Interstate Commission for Water Coordination
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
MPC - Maximum Permissible Concentrations
MSK-64 - Medvedev–Sponheuer–Karnik scale
NDVI - Normalized Difference Vegetation Index
OSM – OpenStreetMap
PEFC– Programme for the Endorsement of Forest Certification
POPs - Persistent Organic Pollutants
RRI-CA - Ramsar Regional Initiative for Central Asia
SDGs – Sustainable Development Goals
SFF - State Forest Fund
SFM – Sustainable Forest Management
SOC – Soil Organic Carbon
SWE - Snow Water Equivalent
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
WPI - Water Pollution Index
WUA – Water User Association
WUE – Water Use Efficiency
WUEMoCA – Water Use Efficiency Monitor in Central Asia
WWF – World Wildlife Fund

Key Spatial Data Sources

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

Population 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

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

Содержание

Foreword 2
Executive Summary 3
Abbreviations 4
Main sources of spatial data 4
1.1.Introduction 6
1.1.Project Objectives 7
1.2.Target Audience of the Project 7
1.3.Methodology and Data Sources 8
1.4.Geoportal and Spatial data 10
2.2.Drivers of Change 12
2.1.Climate Change 13
2.2.Demography and Infrastructure Development 38
3.3.Water Resources 46
3.1.Key Aspects 47
3.2.General Characteristics 47
3.3.Progress towards the SDGs 65
3.4.Responses 71
4.4.Land Resources 82
4.1.Key Aspects 83
4.2.General Characteristics 83
4.3.Progress towards the SDGs 100
4.4.Responses 107
5.5.Forest Resources 126
5.1.Key Aspects 127
5.2.General Characteristics 127
5.3.Progress towards the SDGs 136
5.4.Responses 140
6.6.Biodiversity 148
6.1.Key Aspects 149
6.2.General Characteristics 149
6.3.Progress towards the SDGs 171
6.4.Responses 176
7.7.Natural Disasters 184
7.1.Key Aspects 185
7.2.General Characteristics 185
7.3.Progress towards the SDGs 202
7.4.Responses 203
Literature 207

Introduction



© Institute of Geography RAS, © PJSC RSC Energia



1.1. Project objectives

This Atlas has been developed under the auspices of the 'Capacity development and technology transfer to improve the generation and use of data and information in support of monitoring the environment in Central Asia' project, 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 (IGRAS), with financial support from the Russian Federation (https://atlascentralasia.com/). As the name of the project suggests, its goal is to increase the scientific and technical capacity of Central Asian government agencies responsible for the environment to monitor, assess and sustainably manage their respective terrestrial and aquatic ecosystems as well as their countries' natural resources, including those of a transboundary nature. This Atlas facilitates that increased capacity by providing ready access to global sources delivering real-time information.

The proposed format of this tool, namely an online digital environmental atlas (The Atlas of Environmental Change in Central Asia), aims to harmonize national statistical systems throughout the region for use in the preparation of national reports to the secretariats overseeing four key environmental global agreements – UNCCD, UNFCCC, UNCBD and SDGs related to water, and life on land – in accordance with international standards.

1.2. Target audience of the project

The target audience of this project is primarily policymakers and/or decision-makers, particularly those endowed with a measure of authority over and responsibility for the adoption and implementation of environment-related management action plans in the selected countries. Within this audience, the Atlas will be a particularly useful tool for decision-makers 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. This project's analysis of published national environmental reports has shown that the quality of national reports is largely determined by the reliability of the input data used, and these data are often drawn from global resources or national sources whose quality is unclear. Furthermore, the set of indicators used by individual countries from their chosen global sources and cartographic images varies considerably, even among neighbouring countries of the Central Asia which makes it difficult to compare both indicators and countries with each other in terms of environmental status and trends.

This Atlas focuses on the Republic of Uzbekistan, which currently lacks a unified methodology for collecting and providing spatial environmental data. As such, the significance of this project is linked to the existing challenges this creates for the country in collecting, updating and processing geospatial information on the state of its environment.

In October 2018, the Coordination Council for the implementation of the National Sustainable Development Goals was established in Uzbekistan to advance the 2030 Agenda. The Environmental Protection Concept to 2030, approved in October 2019 (by Presidential Decree No. 5863, 2019), which resulted in the documentation of a completely new framework for Uzbekistan that sets out nationalized SDGs and a means to measure their achievement. The list of nationalized SDGs includes 16 national goals (out of the 17 global goals, which excludes Goal 14 on oceans), 125 national targets and 206 indicators. Of the 46 environmental indicators within the national SDG indicator system, only nine currently have data available online and are free of methodological issues. Furthermore, some national

environmental indicators have a more limited scope than their counterparts in the global SDG indicator system and the 2030 targets. Data on water and land resources as well as subsoil, soil protection, environmental monitoring, environmental control, environmental assessment and environmental certification are either absent or insufficiently presented on the new website of the State Committee on Ecology and Environmental Protection (SCEEP) (http://environment.gov.uz).

Discrepancies between data obtained from national and international sources were the most serious implementational challenge this project had to overcome. Many indicators found in national sources were incomplete or unreliable due to unclear methodologies for their derivation. Spatial information and cartographic data were either unavailable or outdated, while systematic ecosystem monitoring has traditionally been virtually absent in the country. Most national assessments concerning land use and land-cover change, land degradation, rangelands, forests and other ecosystem types, as well as water quality, lack a clear methodological basis. In this assessment report, the present research team tested several global datasets at the national level and found substantial divergence between them and the corresponding national indicators. At the same time, some global data sources show significant discrepancies for the same indicators (e.g., forest area). This makes verification of the results obtained from global information resources particularly important for the project. The objective of this report is to analyse the quality of environmental data for the Republic of Uzbekistan available in national, international and scientific publications.

1.3. Methodology and Data Sources

At the first stage of the project, indicators of progress by countries in implementing the SDGs and the key global Rio Conventions (UNFCCC, UNCCD, UNCBD)—which determine the thematic content of these electronic atlases—were selected. Five thematic areas and their corresponding indicators based on SDG guidance were chosen: water resources, land resources, forest resources, biodiversity and natural disasters. Some SDG indicators are composite and can be further divided into a number of sub-indicators. For example, the thematic area of natural disasters can be considered using several sub-indicators related to specific environmental risks (floods, landslides, avalanches, etc.). In addition, it was decided that it would be beneficial that the atlases include several base maps, such as relief, administrative units, biogeographic provinces, hydrological basins, demographics, settlements and infrastructure. Finally, it was deemed necessary to



Tashkent at night from the ISS

Table 1. Levels of Source Data Quality

Data Quality Level	Definition
Level 1 (low data quality)	Availability of global/regional data sources that do not provide information on the temporal dynamics of the phenomenon under consideration and do not align with national assessments.
Level 2 (medium data quality)	Availability of global/regional data sources that do provide information on the temporal dynamics of the phenomenon under consideration and do not align with national assessments.
Level 3 (good data quality)	Availability of global/regional data sources that do align with national assessments and do not provide information on the temporal dynamics of the phenomenon under consideration.
Level 4 (high data quality)	Availability of global/regional data sources that do provide information on the temporal dynamics of the phenomenon under consideration and do align with national assessments.

consider the main drivers of environmental change, namely climate change and population growth. These drivers are illustrated by a series of maps in the first two sections of the Atlas presented here.

The use of all these specifics and indicators were approved during an online meeting held on 27 May 2021, at which representatives of the UNEP, IGRAS and MSU presented the project concept—in particular, the methodology for developing the electronic Atlas on environmental changes in the countries of Central Asia as well as the technological aspects of accessing its content. This meeting also saw the announcement of a series of training workshops for interested participants from partner countries on the collection and processing of thematic geospatial data based on the IG RAS platform.

It is foreseen that the information collected in this project, obtained from analyses of global and macro-regional databases and spatial information, will be particularly important in contexts where national indicators are limited. Global sources of environmental data provide information derived using a unified methodology and allow comparison of the situation across different regions and among countries within the same region. In addition, global data sources are regularly updated, enabling the detection of temporal changes within the three considered republics. A final point in this regard is that global datasets offer opportunities to improve and develop national environmental statistics systems by strengthening the validity of their indicators, notwithstanding that global sources must still be verified against national and local spatial and statistical data.

The quality of information related to the selected thematic areas and indicators is assessed in terms of consistency and degree of reliability using national and local spatial and statistical materials. This project employed a multi-level approach, analogous to that adopted in the SDG guidance, albeit modified to reflect the limited availability and reliability of environmental statistics in the target countries *(see Table 1)*.

To effectively map SDG indicators regarding water resources, base layers such as water bodies, irrigation canals, hydrological basin boundaries and administrative unit boundaries were required. Each of these layers, except administrative boundaries, were obtained using global datasets generated by HydroLAKES, HydroRIVERS and HydroBASINS while national boundaries were provided by national coordinators. The full set of water-related SDG indicators associated with basin management (6.5.2), water availability (6.4.2) and water-use efficiency (6.4.1) were derived from the global HydroSHEDS dataset and the regional WUEMoCA dataset. The data for these indicators needed to be labelled as data quality level 2. Indicators of water security (6.1.1; 6.2.1; 6.2.1; 6.3.1; 6.3.2; 6.3.2) depended entirely on existing national statistics on wastewater treatment, sanitation conditions and water pollution.

SDG indicators for land resources supported by global data include land-cover change and carbon stocks. There are no national spatial data for verifying global land-cover products (ESA Copernicus and CCI); therefore, the quality of the data available for the 'Land-cover change' indicator needed to also be classified as level 2. The absence of global sources on the dynamics of Uzbekistan's soil carbon stocks, as well as the insufficient detail of national indicators for verification, provide grounds for assigning the quality of data on carbon stocks as level 3.

SDG indicators for forest resources supported by global or regional data include forest area, forest types, above-ground biomass stocks in forests and the Mountain Green Cover Index (MGCI). This indicator was classified as data quality level two as there is no global dataset that aligns well with national data on Uzbekistan's forest area. However, while global land-cover products are updated regularly, allowing the main trends in this forest area to be identified, all currently available global land-cover products have either insufficient resolution or low accuracy to adequately assess Central Asian conditions. In addition, Uzbekistan lacks published national spatial data on forest types, leading to the data quality for 'Forest types' in Uzbekistan being considered as level 2. By way of a specific example of an issue here, the dataset provides what would be a useful estimate of above-ground forest biomass, however, this is only for 2010. The data quality for above-ground biomass in Uzbekistan can be assigned to level 1. Furthermore, the MGCI, provided by the UN Statistics Division's SDG Open Data Hub, cannot be compared to national statistical data related to the index as the relevant national data is lacking, meaning this indicator was categorized as level 2.

Data on the boundaries of protected areas, both Important Bird and Biodiversity Area (IBAs) and Key Biodiversity Areas (KBAs), are present in the global World Database on Protected Areas (WDPA) database, the BirdLife International database and the KBA database. All these databases are updated by national coordinators and thus allowed the data quality for the SDG indicator in the field of biodiversity to be categorized as level 4.

Data on the area of individual representative glaciers contained in the Global Ice and Measurements from Space (GLIMS) database correspond to Uzbekistan's national indicators. However, these datasets present measurements made in different years, making some of them non-comparable. Information on changes in glacier area and volume in the GLIMS database is incomplete and resulted in the relevant data quality being classed as level 3. Indicators of economic and human losses associated with various types of natural disasters depend entirely on existing agency statistics on emergency situations.

1.4. Geoportal and Spatial Data

An important project outcome that enhances the practical utility of the Atlas is the geoportal, which hosts spatial data for the territory of the Republic of Uzbekistan covering issues of climate change, water scarcity, conservation of forest ecosystems and biodiversity as well as disaster risk management. The geoportal is an invaluable tool for a wide range of government bodies and institutions engaged in natural resource use, environmental protection, risk management and spatial planning. In the Republic of Uzbekistan, such government bodies and institutions include: the State Committee on Ecology and Environmental Protection and the Ministry of Water Management (monitors the state of natural resources and develops environmental measures); the Ministry of Emergency Situations (analyses and forecasts natural and technological disasters risks, taking into account the location of exposed receptors); the Ministry of Agriculture (manages water and land resources, assesses related climate change impacts); the State Committee on Forestry (tracks the state of forest ecosystems and biodiversity, develops conservation and restoration measures); and the Ministry of Economy and Industry (devises socio-economic development strategies incorporating spatial data to unlock territorial potential).

Beyond these governmental users, the geoportal will also be useful for research institutes and universities that conduct scientific studies, model natural processes and develop recommendations for sustainable development.

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

The geoportal is built on the **GeoNode** platform which provides key capabilities such as:

- **Data management:** Administrators responsible for the geoportal can constantly update datasets, upload new spatial data and remove data that are no longer current.
- **Visualization:** Provides a readily understandable interactive display of maps and layers that allows for the creation of intuitive legend/symbology systems.
- **Spatial analysis:** Provides the ability to perform basic data operations such as adding layer overlays, attribute filtering, spatial analysis and the creation of thematic maps.
- **Integration and data exchange:** Data published on the geoportal can be readily integrated with other geographic information systems, including the geoportals of various relevant agencies within the Republic of Uzbekistan.

The geoportal's functionality enables a wide range of tasks to be undertaken, including assessing territorial vulnerability to climate change; monitoring water resources; analysing changes in the extent and condition of forest ecosystems; monitoring the state of agricultural ecosystems; identifying zones of elevated likelihood of natural hazards and assessing the risks associated with their realization.

A more detailed description of the geoportal's functionality, coupled with examples of how it can be used for typical tasks undertaken by its target audience of users, are provided in the Geoportal User Guide.



View of Tashkent



Bukhara, the historical city of Uzbekistan

Drivers of Change



© Institute of Geography RAS, © PJSC RSC Energia

2.1. Climate change

Climate change in Central Asia is a major driver of ongoing transformations in agriculture, settlement systems, water ecosystems and resources as well as terrestrial ecosystems and their biodiversity. Central Asia is already among the driest regions of the world with rising temperatures and shifts in precipitation regimes intensifying water scarcity that exacerbates aridification and threatens the region's unique flora and fauna. The agricultural sector faces increasing unpredictability and shifts in agro-climatic characteristics during the growing season, creating risks to food security and rural livelihoods.

Most of the Republic of Uzbekistan (80 per cent) consists of arid and semi-arid plains, bordered by mountains (20 per cent) to the south, southeast and east. The country lies at the junction of several major atmospheric circulation processes. One is the westerly air flow associated with the North Atlantic Oscillation (NAO) which, as it weakens in winter, NAO strengthens the Siberian High. This results in cold waves from the Arctic reaching Uzbekistan, bringing cooler, dry, precipitation-free weather. However, there can be variations in this pattern, as the onset of a weaker Siberian High, often linked to a stronger NAO, leads to milder regional conditions. In summer, when these air masses are less active, another important atmospheric process prevails: a thermal low. Its formation is facilitated by the extensive deserts (the Kyzylkum and Karakum) and mountain ranges to the south and southeast (the highest peak is mount Hazret-Sultan at 4,643 m above sea level).

Large water bodies, such as the Caspian and Aral Seas, also contribute to Central Asia's climate. Over the past four decades, the Aral Sea's area has decreased by about 57 per cent, its volume by roughly 80 per cent and its depth by 64 per cent. The Aral Sea basin today constitutes a salt desert ("Aralkum") that influences the environmental conditions of the entire region. The lack of a well-developed network of meteorological stations in the basin prevents direct quantitative assessment of the Aral Sea's past climatic influence for comparison with present-day conditions in the Aral Sea region (Priaralye). Models indicate that the consequences of the Aral Sea's decline over the last 50 years have been largely local and that this part of Central Asia is, overall, more strongly affected by continental and global climate change issues. By way of one example here, the Aral Sea basin is one of the main sources of dust and sand storms in the region, however, their intensity shows no definite trends (the dustiest periods were 1966–1970, 1984–1986 and 2000–2002).

According to the global Köppen–Geiger classification, the prevailing climate types in Uzbekistan are cold desert and cold semi-arid; only at the lower elevations of the western spurs of the Tian Shan, Western Gissar and Jizzakh mountains does a 'snow' climate appear, although these areas are also characterized by dry, hot summers. Upslope this climatic zone transitions to cooler variants of the summer season *(see map 'Climate types')*. Climate transformation over the past 60 years in Uzbekistan has resulted in only a moderate reduction to the extent of the mountain climate type. Modelling shows that by 2100, the climate types and their spatial distribution will not fundamentally change, except in the Jizzakh mountains, which will be subsumed by the cold semi-arid (steppe) climate typical of the surrounding plains *(see map 'Climate types, projection for 2100')*[1].

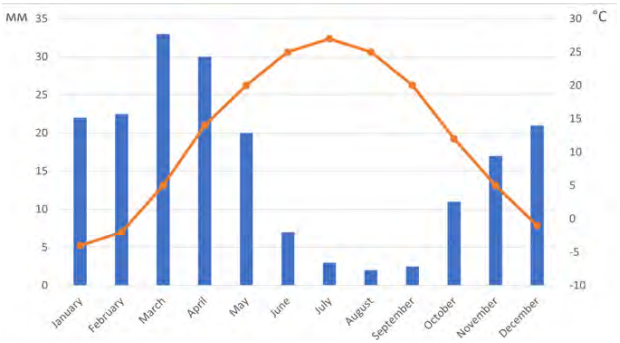


Fig. 1. Mean monthly air temperature and precipitation in Uzbekistan, 1901–2016[2].

Overall, Uzbekistan's climate is decidedly continental with pronounced seasonal temperature contrasts. While the mean annual temperature is 16.4 °C, in summer, thermal lows typically establish clear, dry and hot conditions with mean temperatures exceeding 33 °C across the Central Asian lowlands in July, with maxima up to 50 °C in the south and 46 °C in the north. In winter, the region is subject to incursions of cold air masses from the north (the Arctic) or northeast (the Siberian High). Temperatures can drop to −40 °C in the north and −20 °C in the south. Mean January temperatures range from −8 to −10 °C in the north and +2 to +3 °C in the south. Features of this thermal regime directly influence intra-annual vegetation dynamics, however, these dynamics do not strongly differentiate the desert (except the Ustyurt Plateau), steppe and forest (mountain) regions of the country *(see maps 'Average long-term dates marking the beginning of the growing season, 2000-2024'; 'Average long-term dates marking the onset of the peak of the growing season, 2000-2024'; 'Average length of the growing season, 2000-2024'; 'Average long-term dates marking the end of the growing season, 2000-2024')*[3].

For Uzbekistan as a whole, mean annual precipitation is only 150 to 200 mm, while evapotranspiration can reach 2,500 mm, a combination that results in extremely arid conditions and necessitating irrigation for all crops. In the mountains (spurs of the Tian Shan and Gissar–Alai) along the southeastern and eastern margins of the country, precipitation is ~400 mm in the foothills and up to 800 mm on windward slopes. Precipitation throughout the republic exhibits substantial interannual and seasonal variability. It falls mainly in winter and spring *(see Figure 1)*, with March and April receiving the highest amounts (30 to 35 mm per month). From June to August, precipitation is extremely scarce as typically <5 mm falls per month.

Since the 1950s, the rate of increase in mean annual temperature in Uzbekistan has been 0.27 °C per decade, significantly exceeding the average annual global warming rate of 0.16 °C. In Uzbekistan in spring, average warming rates are increasing 0.39 °C per decade, in summer 0.25 °C and in autumn 0.31 °C. Interestingly, seasonal differences in temperature trends are weakly expressed, however, regional differences in the rates of increase in mean annual temperatures are more pronounced: in the north the trend was 0.30 to 0.43 °C per decade, while in the southern mountain areas it was only 0.10 to 0.14 °C per decade *(see map 'Annual air temperature trend, 1960-2023')*. Over the last 30 years, accelerated warming has been observed, especially in the Priaralye and on the Ustyurt Plateau *(see map 'Annual air temperature trend, 1990-2023')*. The dynamics of summer temperatures differ little from the mean annual *(see map 'Warm period air temperature trend, 1960–2023'; 'Warm period air temperature trend, 1990–2023')*. Rising temperatures are also reflected in fewer frost days Uzbekistan experiences in winter and more days with extreme heat in summer. In this regard, the central Kyzylkum Desert has seen the number of days with temperatures above 40 °C increase from about 10 in the 1950s to more than 20 at present. The greatest changes in the frequency of extremely

1 harma et al. (2018) Impact of Desiccation of Aral Sea on the Regional Climate of Central Asia Using WRF Model. Pure Appl. Geophys. 175: 465 - 478.

2 Climate Change Knowledge Portal. Climate Change Knowledge Portal | Climate Change Knowledge Portal.

3 Zhang et al. (2020).Aeolian Dust in Central Asia: Spatial Distribution and Temporal Variability. Atmos. Environ. 238, 117734.

high temperatures occurred in the Republic of Karakalpakstan, an autonomous republic within Uzbekistan, which indicates that this region is the most vulnerable to climate change *(see map 'Maximum air temperature trend, 1960–2023')*.

In Uzbekistan, the network of meteorological stations did not experience the same decline in the 1990s as in other Central Asian countries[4]. A detailed analysis of data from 68 representative meteorological stations shows a mosaic of meso-scale patterns in the geographic distribution of air-temperature anomalies relative to the norm. This mosaic is driven by features of the underlying surfaces, such as their relief, hydrography, soil types, presence of bare surfaces and even urban forms *(see map 'Local climatic zones')*. Even within relatively homogeneous landscapes, climate change in Uzbekistan is fairly complex in both time and across meteorological variables. The most notable trends in temperature from 1990 to 2016 (relative to the 1961–1990 baseline) were increases of 1.2 °C (0.46 °C per decade), recorded on the Ustyurt Plateau in the Priaralye. These regions have simultaneously experienced small differences between their warm and cold seasons in the magnitude of the temperature trend. By contrast, the irrigated Khorezm region, located in the lower Amu Darya, shows very moderate mean annual warming, no higher than 0.5 °C (0.19 °C per decade), with particularly small summer changes—0.2 °C (0.08 °C per decade). Similarly minor trends are observed in the southern Karakum desert, although in its central and northern parts, the mean annual air-temperature trend returned more substantial values, some 0.8 °C (0.38 °C per decade), with little seasonal contrast. Significant temperature trends without notable seasonal differences can be observed in the semi-arid belt within the Bukhara and Samarkand regions while the Fergana Valley exhibits elevated temperature trends in all seasons. Other parts of the country show marked seasonal contrasts; for example, in the Jizzakh Region the cold-season trend shows an annual temperature rise of 0.9 °C (0.3 °C per decade), while the summer trend is only 0.4 °C rise.

From the foregoing, three regions stand out as having the highest air-temperature trends (increases of 1.0 to 1.2 °C) over the past 30 years: Karakalpakstan, the south-western semi-arid belt within the Bukhara and Samarkand regions as well as the Fergana Valley. The smallest increases (0.4 to 0.6 °C) were observed in desert areas (the Central Kyzylkum) and mountain regions (the Western Tian Shan and Northern Upper Amu Darya). In contrast to the magnitude of these temperature differences, the spatial differentiation of trends in mean annual precipitation is weakly pronounced. The Republic of Karakalpakstan stands out on most indicators, showing the greatest susceptibility to climate change in Uzbekistan *(see Table 2)*.

4 Assessment of drought challenges and drought monitoring models in Central Asian region/ (2020) Center for Emergency Situations and Disaster Risk Reduction. ESCAP. 55 P.

Table 2. Trends of climatic indicators in the Republic of Uzbekistan and its regions

Indicator	National average	Maximum	Minimum
Trend in mean annual temperature (1960–2023), °C/year	0.031	0.035 (Republic of Karakalpakstan)	0.018 (Fergana Valley)
Trend in mean annual temperature (1990–2023), °C/year	0.055	0.061 (Syr Darya Region)	0.037 (Fergana Valley)
Trend in maximum air temperature (1960–2023), °C/year	0.033	0.040 (Republic of Karakalpakstan)	0.026 (Fergana Valley)
Trend in warm-season temperature (1960–2023), °C/year	0.028	0.032 (Republic of Karakalpakstan)	0.013 (Fergana Valley)
Trend in warm-season temperature (1990–2023), °C/year	0.063	0.073 (Republic of Karakalpakstan)	0.036 (Fergana Valley)
Trend in precipitation (1960–2023), mm/year	0.163	0.810 (Kashkadarya Region)	−0.135 (Navoi Region)
Trend in precipitation (1990–2023), mm/year	−0.971	−0.489 (Khorezm Region)	−2.241 (Tashkent Region)
Trend in climatic water deficit (1960–2023), mm/year	1.161	2.425 (Republic of Karakalpakstan)	0.124 (Namangan Region)
Trend in climatic water deficit (1990–2023), mm/year	4.448	5.420 (Republic of Karakalpakstan)	3.182 (Fergana Valley)
Trend in snow water equivalent (1960–2024), mm/year	−0.065	0.007 (Fergana Valley)	−0.256 (Tashkent Region)
Trend in snow water equivalent (1990–2024), mm/year	−0.199	−1.263 (Tashkent Region)	−0.030 (Khorezm Region)
Expected temperature change by 2040 relative to the baseline (1970–2000), °C	2.651	2.787 (Syr Darya Region)	2.557 (Bukhara Region)
Expected change in precipitation by 2040, per cent of baseline (1970–2000)	7.138	15.191 (Tashkent City)	3.704 (Khorezm Region)

Trends in precipitation totals are weakly expressed for both the 1960 to 2023 and 1990 to 2023 periods *(see maps 'Precipitation trend, 1960–2023'; 'Precipitation trend, 1990–2023')*. At the same time, the dynamics of solid precipitation (snow) are of particular interest in the context of climate change. On the plains of Uzbekistan, some winters are essentially snowless and any snow that does fall melts rapidly upon reaching the ground; in the mountains at elevations above 1,900 to 2,000 m, however, snowfall is abundant and persists on the ground for months, fostering even small glaciers on the southern slopes of the Gissar Range. With rising temperatures, a shortening of the snow-cover season and a reduction in snow water equivalent (SWE) are expected as snow cover typically responds quickly to thermal-regime changes. This aspect is critical for Uzbekistan, since the Amu Darya and Syr Darya receive large snowmelt contributions to their flows, some 35.2 per cent and 26.9 per cent respectively. Snowmelt is also the primary source of runoff for the Zaravshan, Surkhandarya,

Kashkadarya and Chirchik rivers. Data show strong contrasts in the rates of change in SWE and the spatial extent of snow cover between the two analysed periods (1960 to 2024 and 1990 to 2024), demonstrating a rapid reduction of snow cover over the last 30 years in the spurs of the Western Tian Shan and Pamir–Alai *(see maps 'Snow cover depth trend, 1960–2024'; 'Snow cover depth trend, 1990–2024')*. For comparative purposes, in neighboring Tajikistan, such trends are not pronounced. The correlation between snow accumulation in Uzbekistan's mountain regions and river discharge underpins Uzhydromet's forecasts of water deficit in the lower Amu Darya during the growing season[5]. Regression-based climate models indicate decreases in snow-covered area with rising mean annual temperatures across all Uzbek basins, with the fastest reductions in basins occupying lower topographic positions. Thus, a reduction in runoff into Uzbekistan's key river basins is possible in the near term[6].

Rising temperatures coupled with the absence of a clear positive trend in precipitation have created a growing atmospheric moisture deficit *(see maps 'Climatic water deficit in 1990'; 'Climatic water deficit in 2023')*. From 1950 to 2019, this deficit increased by 45 per cent in the Aral Sea region, by 30 per cent on the Ustyurt Plateau and by 17 per cent in Khorezm, results that exceed natural climatic variability by factors of 1.8 to 2.6[7]. A sharp intensification of the climatic moisture deficit has occurred in Uzbekistan in the current century, as highlighted when comparing trend maps for the last three to six decades *(see maps 'Climatic water deficit trend, 1960-2023'; 'Climatic water deficit trend, 1990–2023')*.

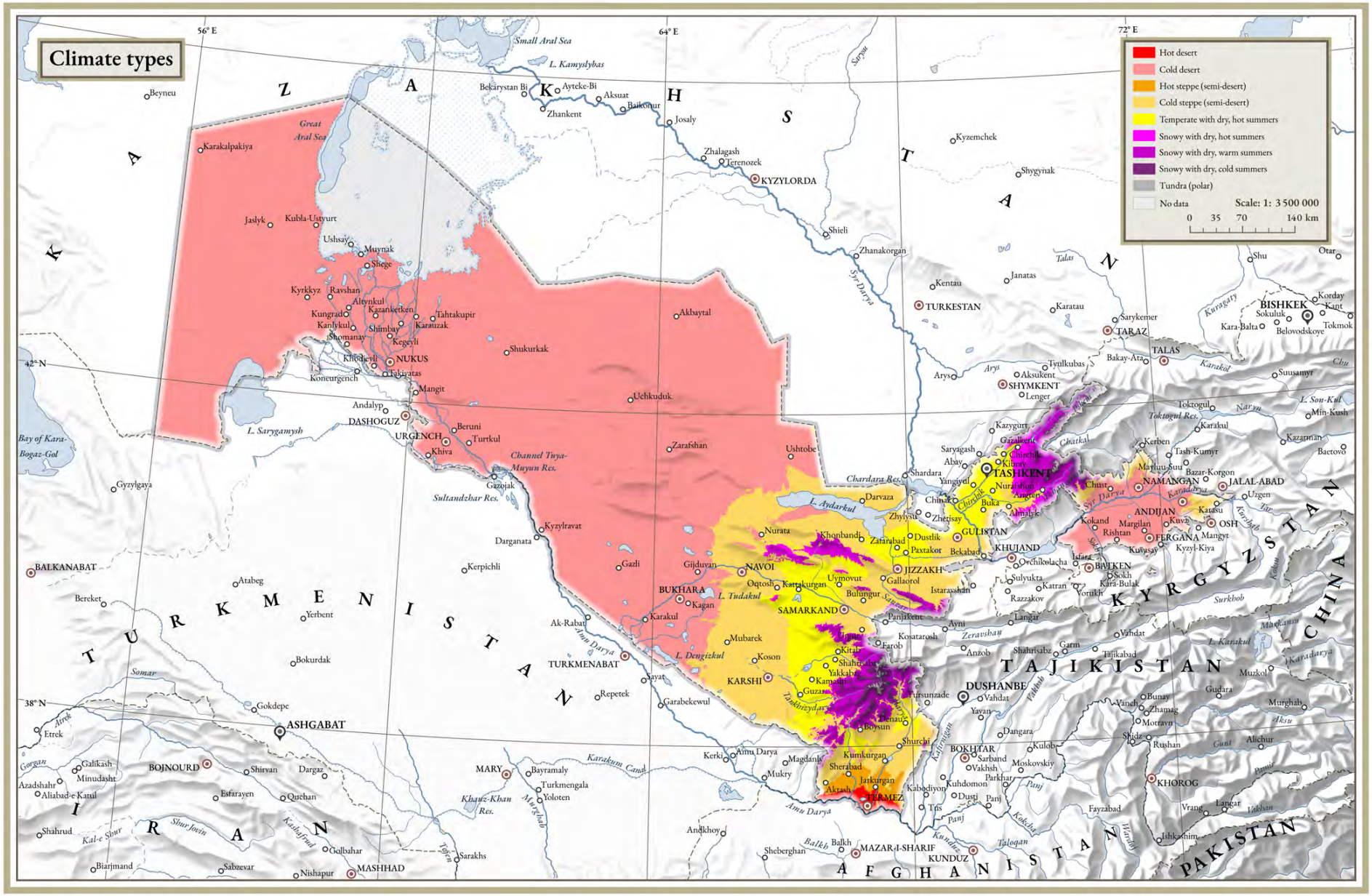
Uzbekistan employs a fairly elaborate regional classification of atmospheric processes for synoptic analysis of observed thermal-regime changes[8]. Fifteen process types are distinguished (north-westerly cold incursions, westerly cyclones, 'diving' cyclones, etc.). This analysis indicates that the observed climatic changes may result from shifts in the frequency and intensity of some of these processes. The main circulation shift identified in Uzbekistan has been a reduction in cold incursions, which have dropped from 64.8 days in the baseline period to 37.3 days, a phenomenon that has been accompanied by weak-gradient high- and low-pressure field increases rising from 16.5 days in the baseline period to 65.8 days. Given that other circulation processes have changed only slightly, the overall conclusion is that regional atmospheric circulation over Central Asia is an integral part of the Northern Hemisphere's general circulation and is changing under the influence of global warming in that hemisphere.



Tashkent aerial panorama view of city center

Climate projections going up to 2040 indicate a continuation of the trends observed in recent decades in Uzbekistan, including an acceleration of warming *(see map 'Expected change in air temperature by 2040')*. By mid-century, most scenarios show temperature increases of between two to 2.5 °C in summer, with stronger effects in winter and spring. In the mountains, greater warming is projected in winter and spring, whereas in the Priaralye and in middle reaches of the Syr Darya and Amu Darya, more pronounced summer warming is expected[9]. With respect to mean annual precipitation, global circulation models project only minor changes for Uzbekistan *(see map 'Expected precipitation trend by 2040')*. Some seasonal shifts by region are possible, with mountain areas projected to receive more winter precipitation while summers on the south-western plains are expected to become drier. The precipitation regime is not expected to change in most irrigated areas, except in the Fergana Valley where a modest increase is projected. Overall, Uzbekistan's climate is not expected to differ markedly from the present, retaining large seasonal and diurnal temperature contrasts and very low precipitation over most of the plains (100 to 200 mm), increasing to 800 to 900 mm per year in the mountains.

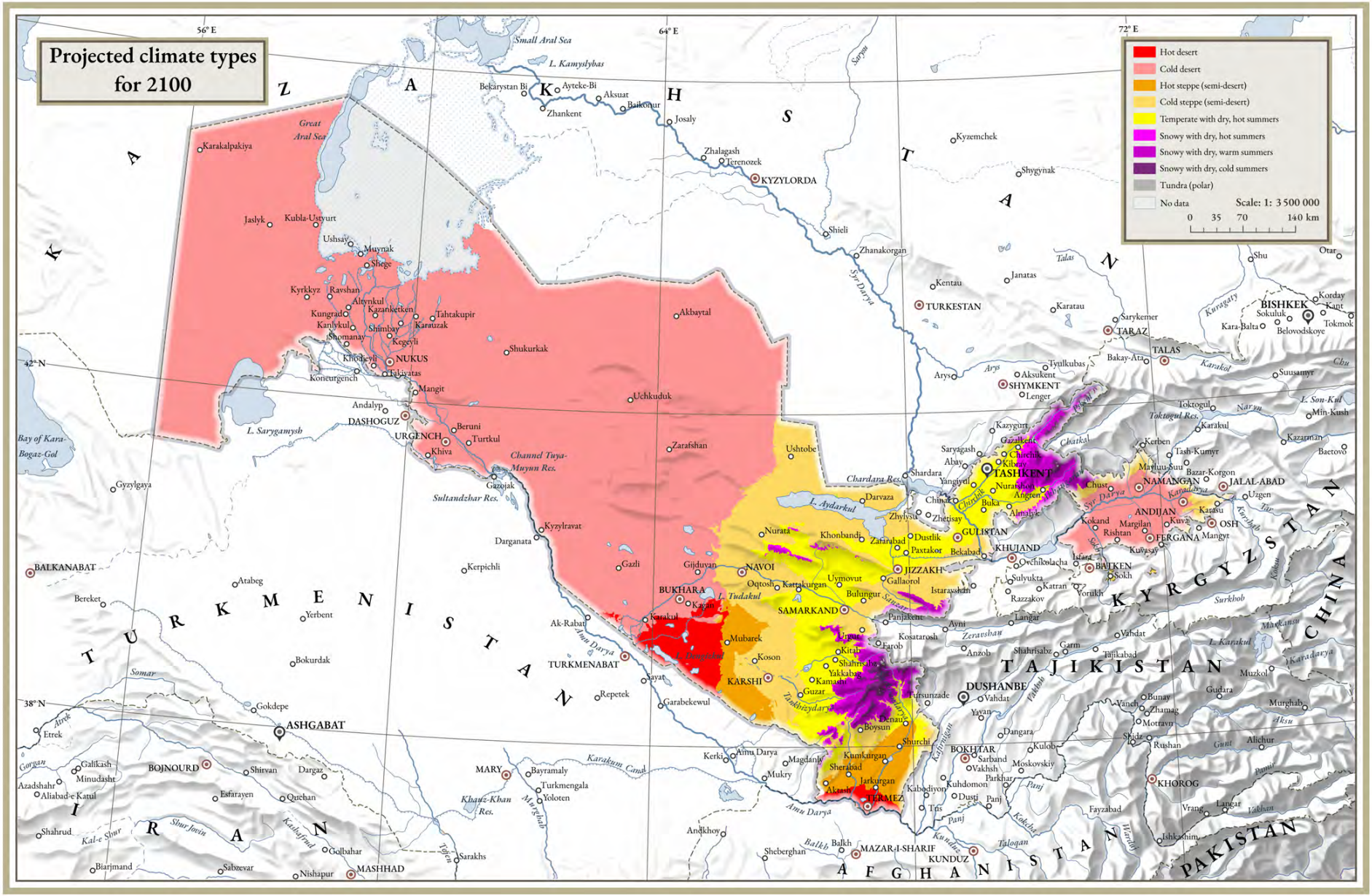
5 Assessment of drought... 2020.
6 Handbook on water resources management in Uzbekistan (2019) ed. by V. Sokolov. Tashkent. 325 P. handbook_wrm_uzb_ru.pdf (in Russian)
7 Fourth National Communication of the Republic of Uzbekistan to the UN Framework Convention on Climate Change (2024) UzHydromet: Tashkent. 582 P.
8 Kholmatjanov et al. (2020). Analysis of Temperature Change in Uzbekistan and the Regional Atmospheric Circulation of Middle Asia during 1961- 2016. Climate. 8, 101.
9 Rakhmatova et al. (2024) Assessing the Potential Impacts of Climate Change on Drought in Uzbekistan: Findings from RCP and SSP Scenarios. Atmosphere. 15, 866.



Updated global Köppen-Geiger classification with unprecedented one km resolution and temporal coverage from 1980 to 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). Vegetation is simultaneously presented as a 'crystallized, visible climate', which is reflected in the characteristics of the zones.[10]

10 Beck et al. (2018) Present and future Köppen-Geiger climate classification maps at 1-km resolution. Sci Data, 5. 180214.

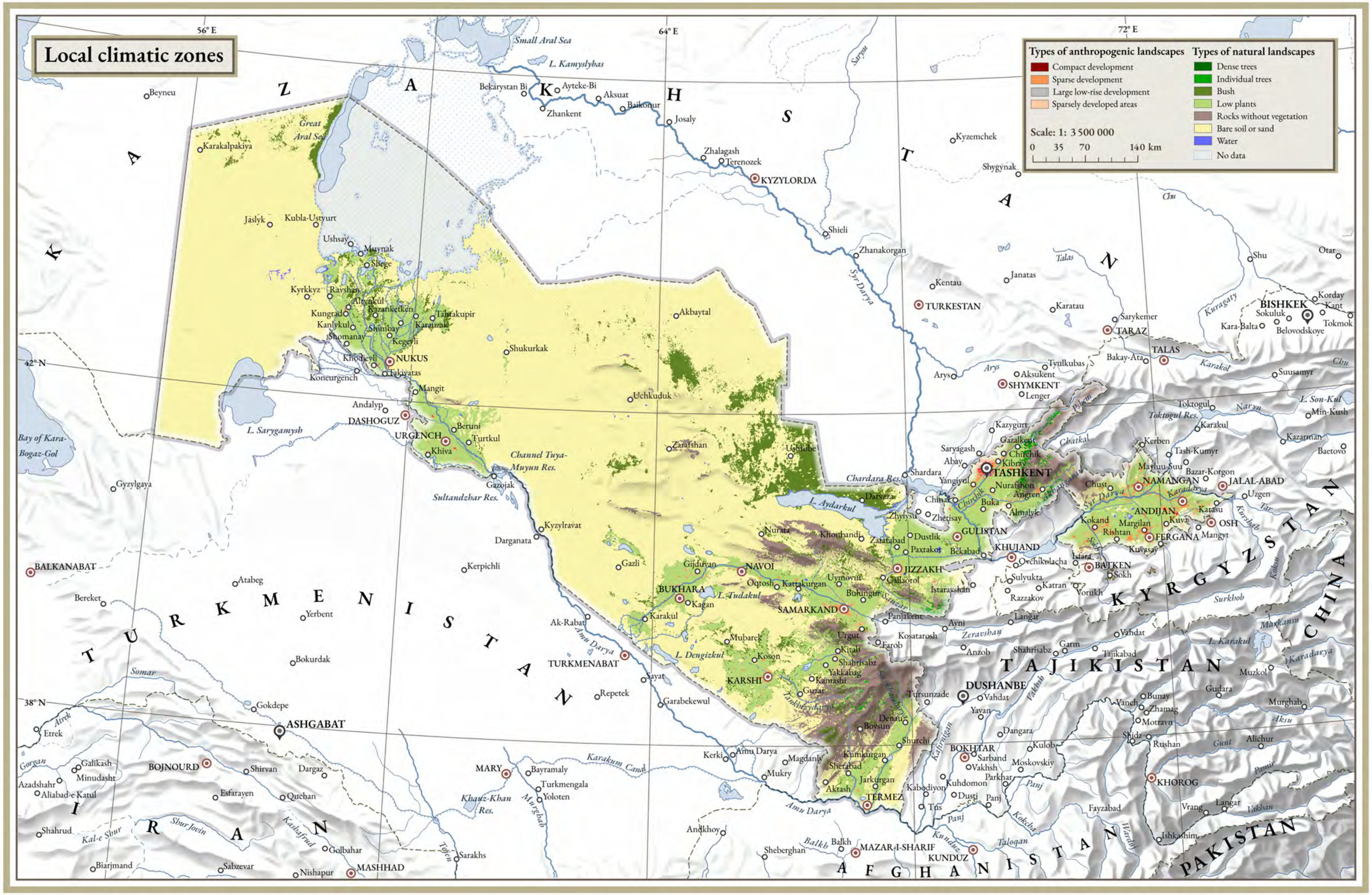
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Based on H. E. Beck et al.[11]: 1 km resolution; time span: modern climate 1980–2016 and future climate 2071–2100 (RCP 8.5); technology: Köppen–Geiger classification based on monthly temperature and precipitation from an ensemble of highly detailed, topographically adjusted climate fields; for the future, the CMIP5 model ensemble anomaly method with subsequent classification was applied.

11 Beck et al. (2023) High - resolution (1 km) Köppen - Geiger maps for 1901 - 2099 based on constrained CMIP6 projections. Sci Data. 10, 724.

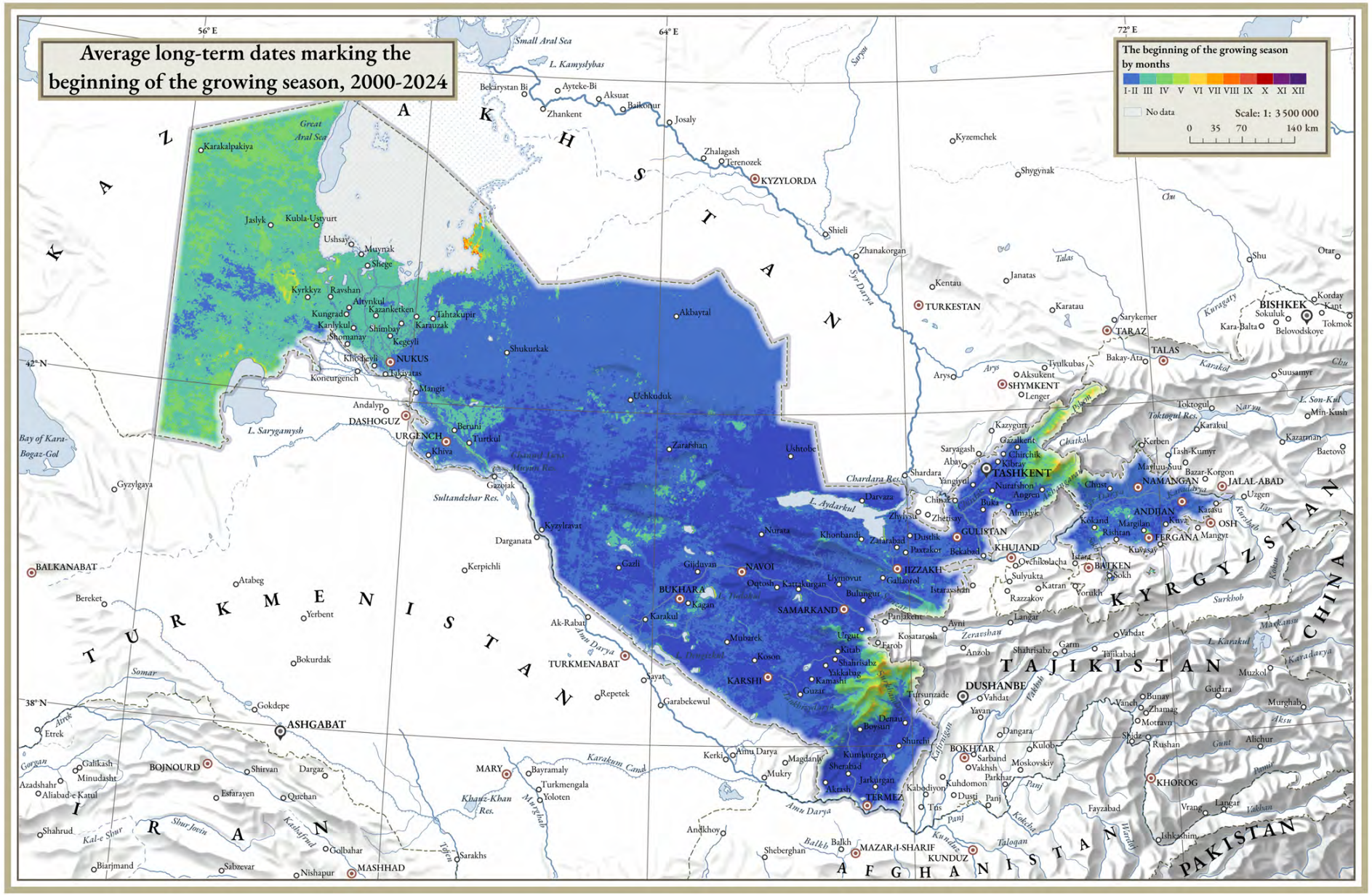
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Local Climate Zones (LCZs) are land-use classifications that are considered 'meteorologically significant.'[12] Each LCZ represents a land area (landscape type) at a local scale with underlying surface physical characteristics that distinguish it from other LCZs in terms of temperature and other meteorological conditions. One practical application of LCZs is to assess the representativeness of a national weather station network to account for the influence of the underlying surface on their readings.

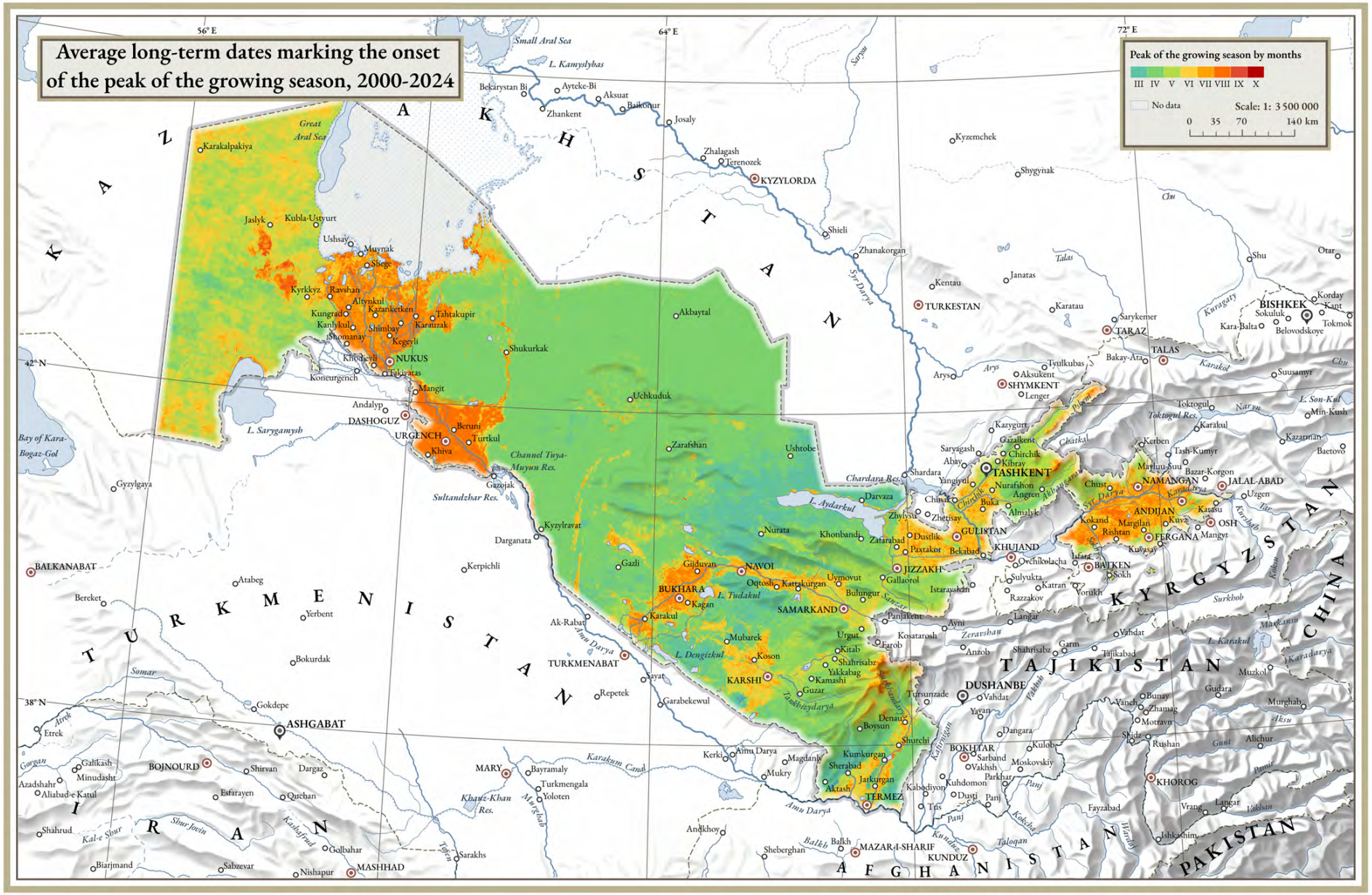
12 Stewart I.D., Oke T.R (2012). Local Climate Zones for Urban Temperature Studies. Bulletin of the American Meteorological Society. 93, 12. (ametsoc.org).

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



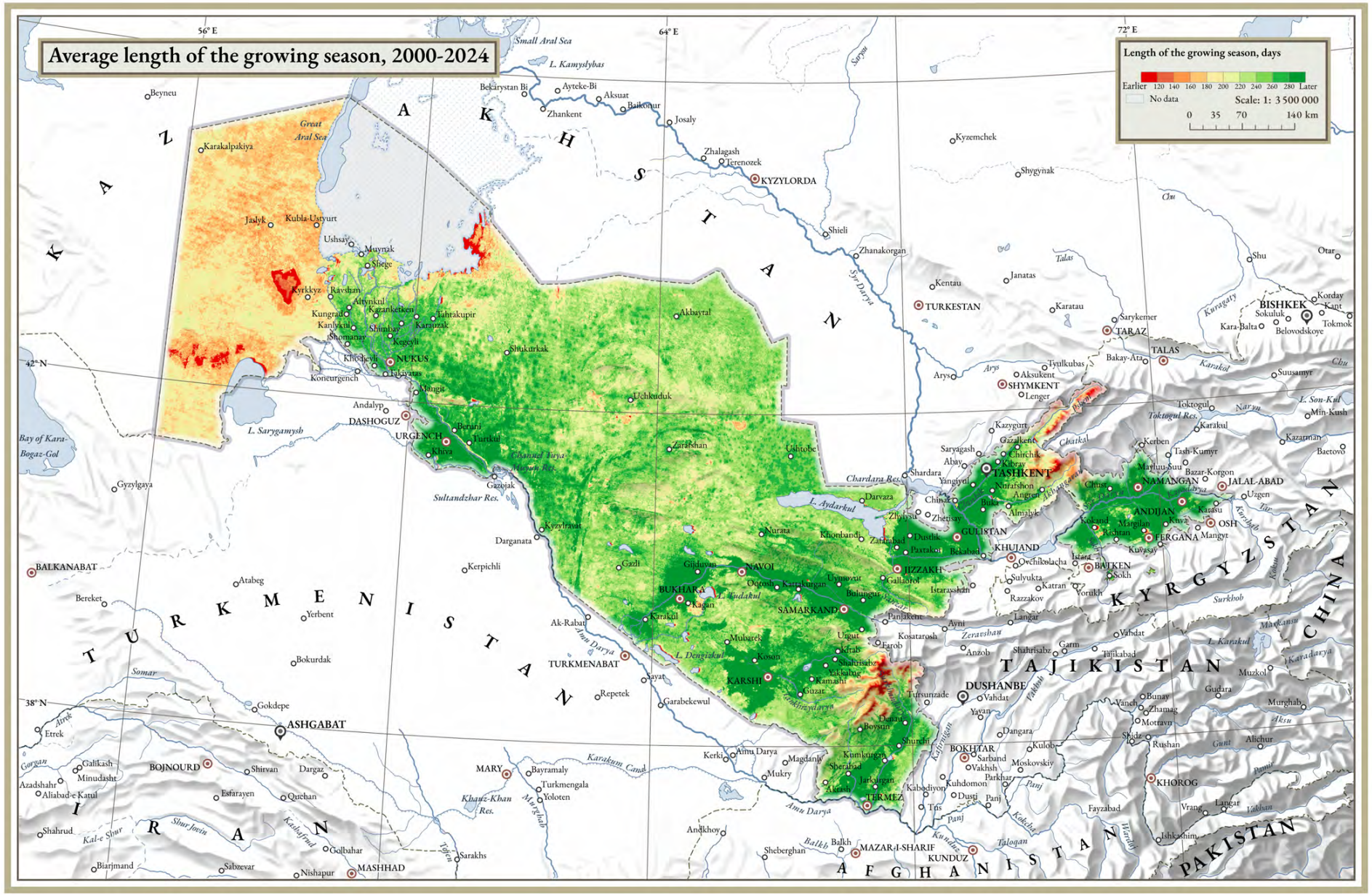
Results of processing time series of images from the MODIS satellite (2004–2024).

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



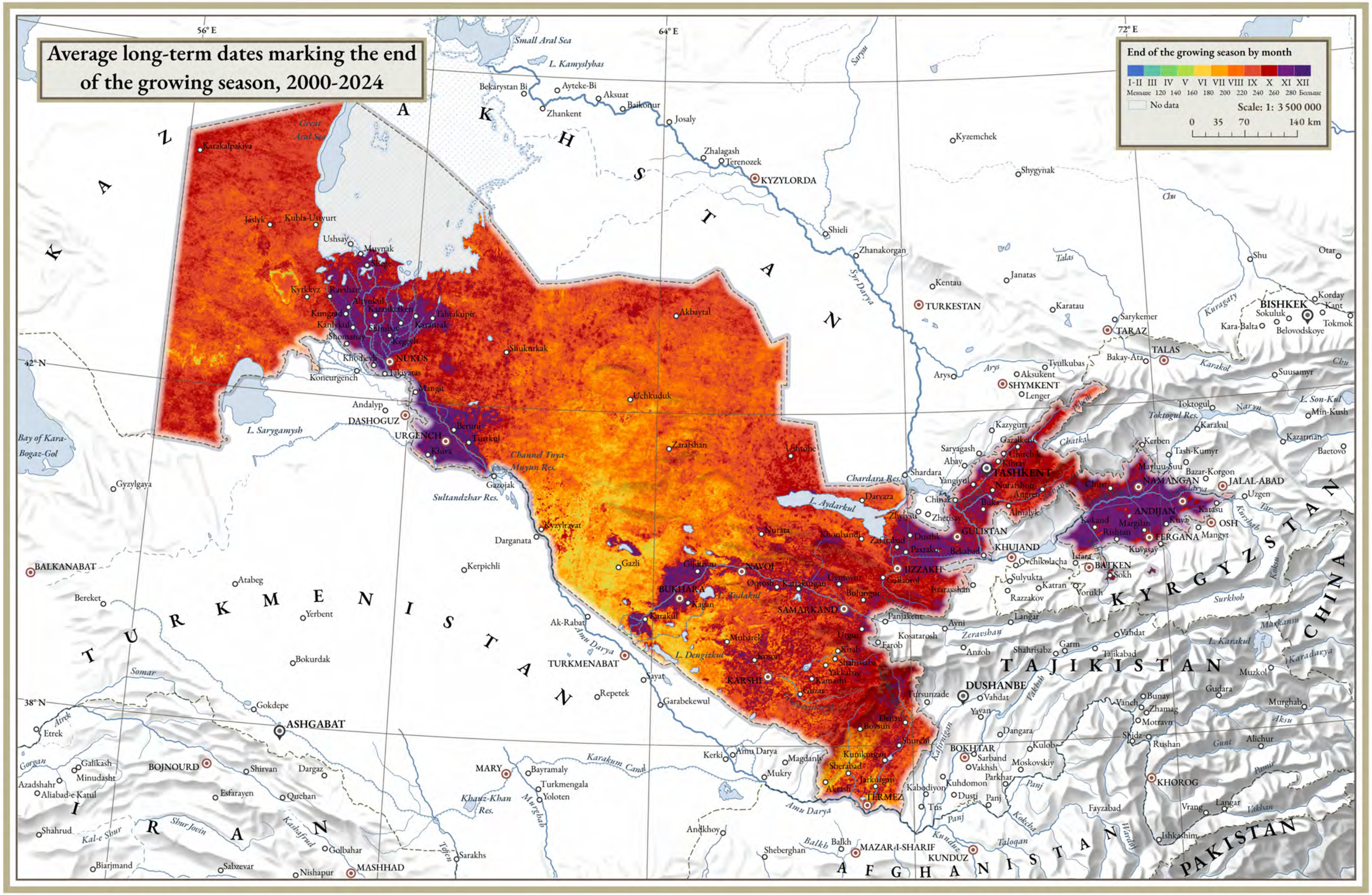
Results of processing time series of images from the MODIS satellite (2004–2024).

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



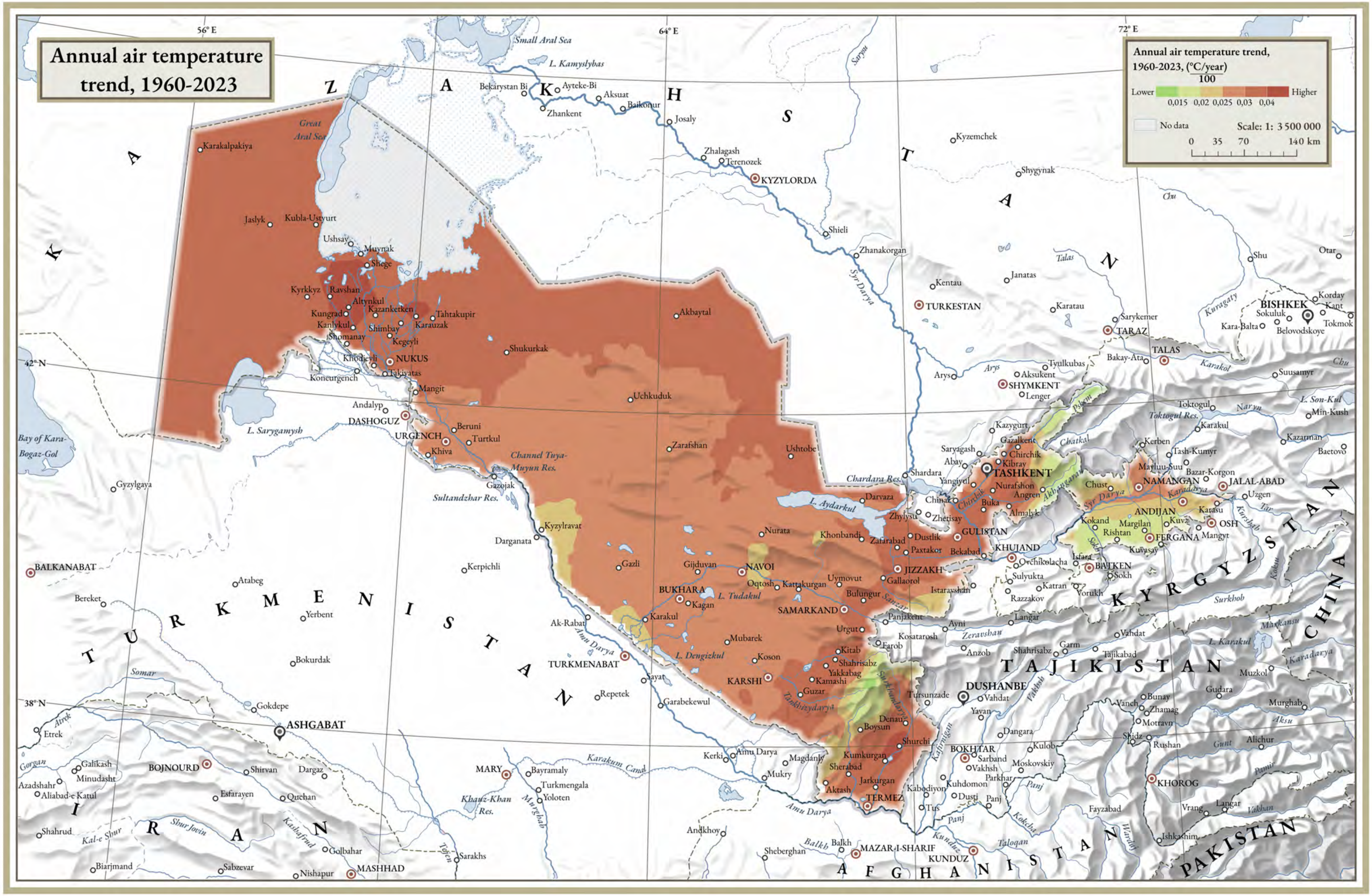
Results of processing time series of images from the MODIS satellite (2004–2024).

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Results of processing time series of images from the MODIS satellite (2004–2024).

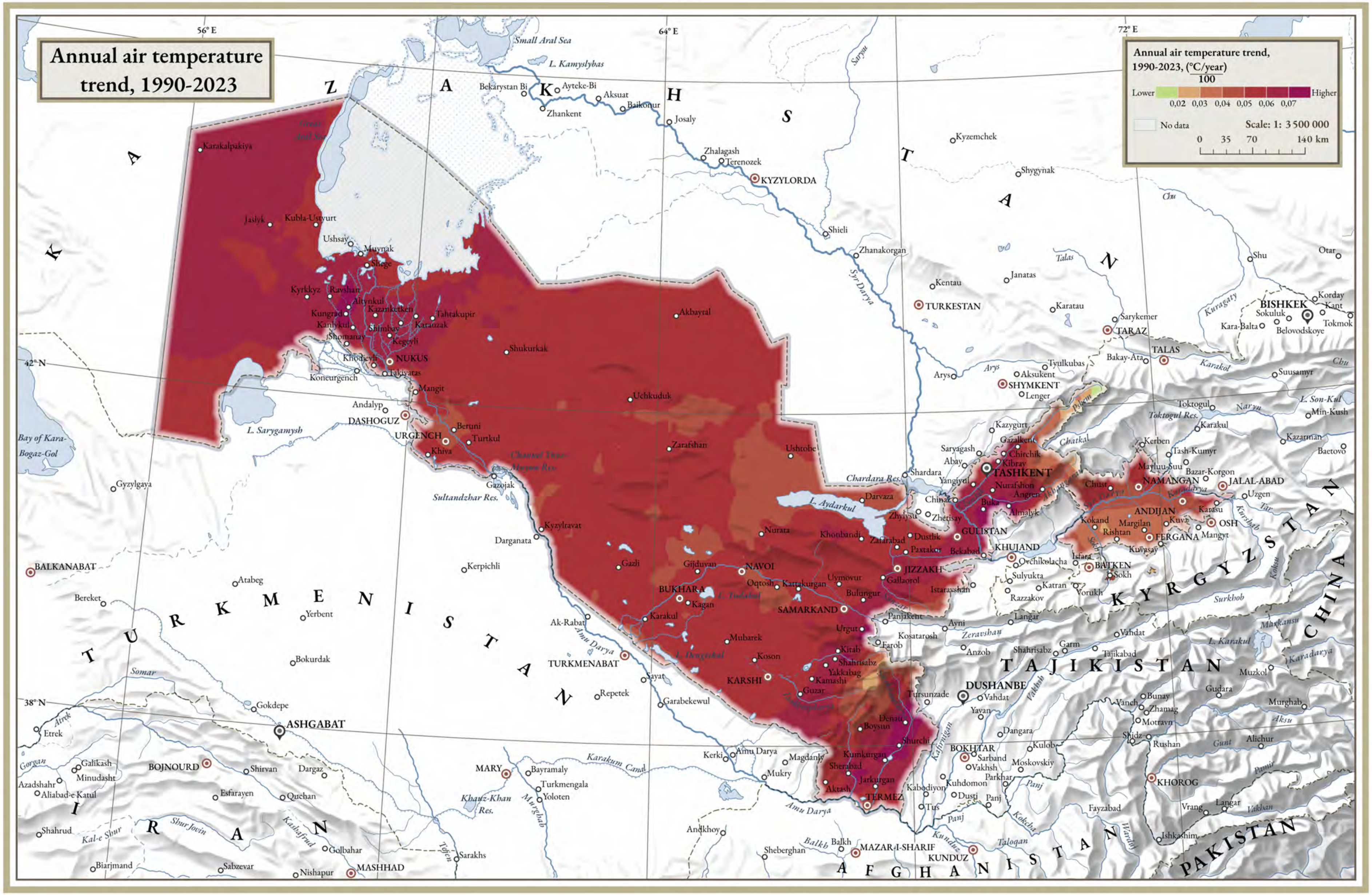
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Based on ERA-5 Land reanalysis data using the ECMWF model.[13] The reanalysis is based on data from WMO meteorological stations and remote sensing data.[14] The resolution of the ERA5 version used is 11 km, the time span is from 1950 to the present, and the temporal resolution is 1 day. Trends were determined using the Sens method.

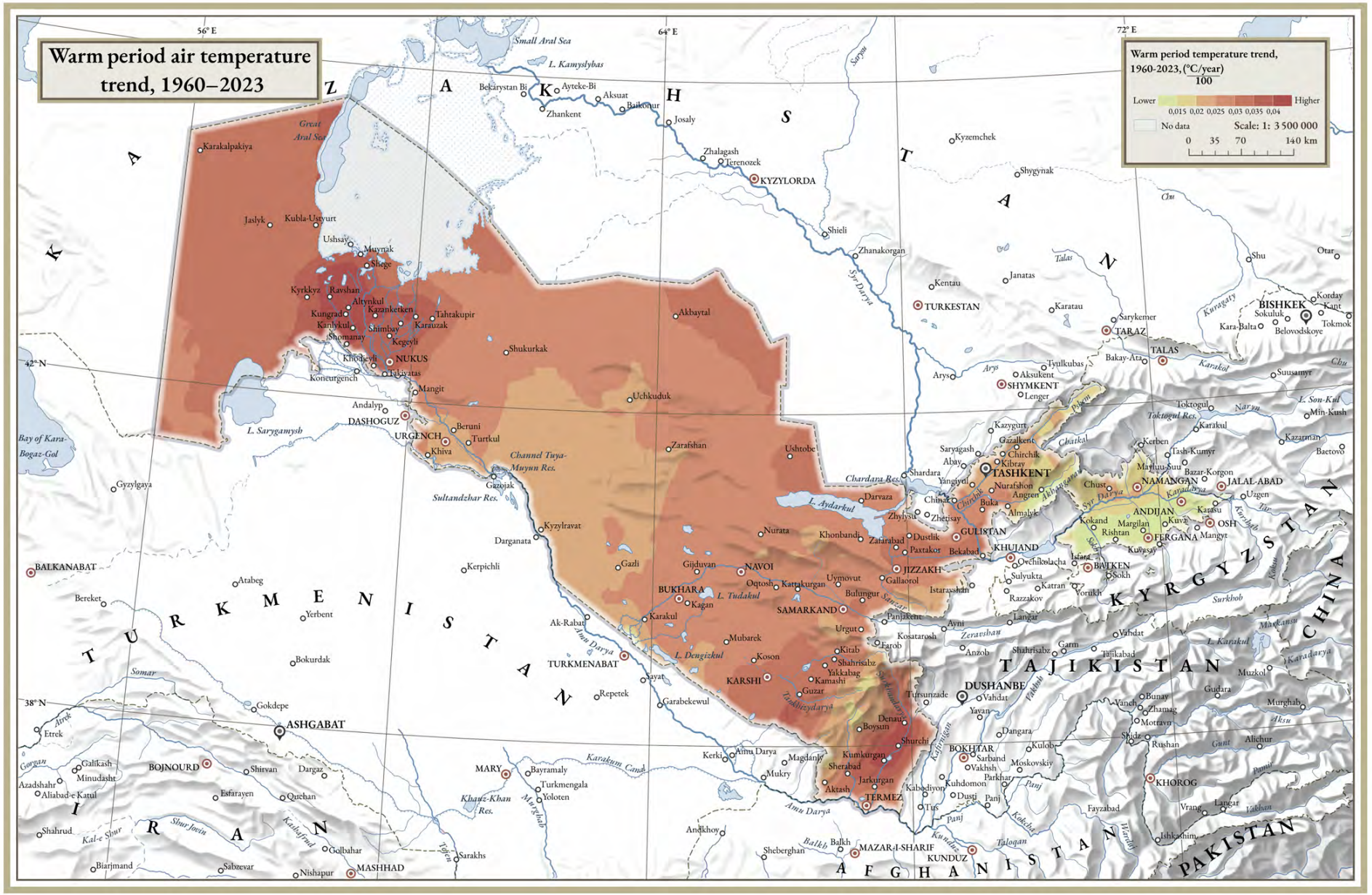
13 https://www.ecmwf.int/en/elibrary/80895-ifs-documentation-cy45r1-part-iv-physical-processes
14 https://confluence.ecmwf.int/display/CKB/ERA5%3A+data+documentation#heading-Observations

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



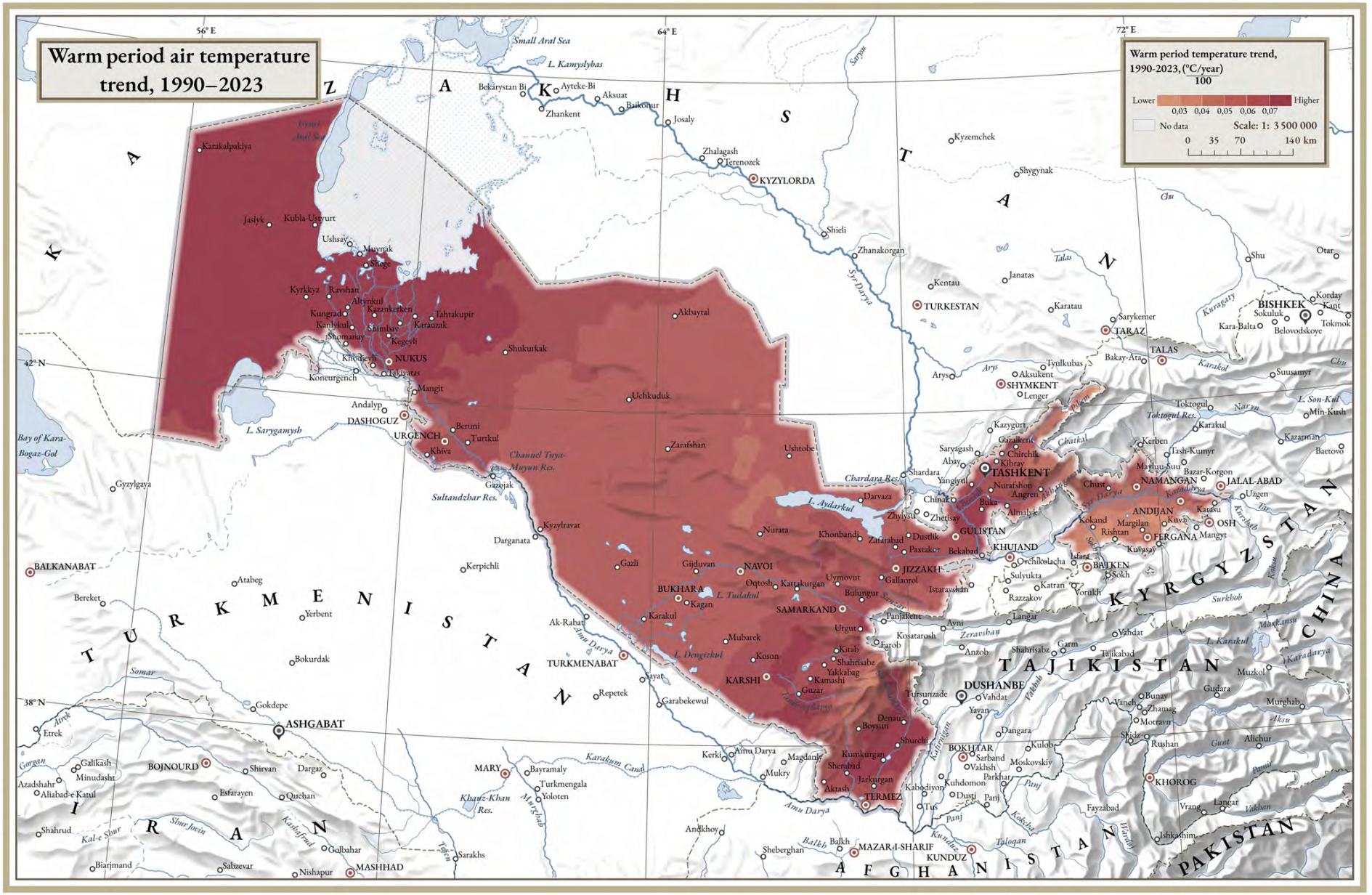
Based on ERA-5 Land reanalysis data (see notes for the map ‘Trend in mean annual temperature, 1960–2023’).

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



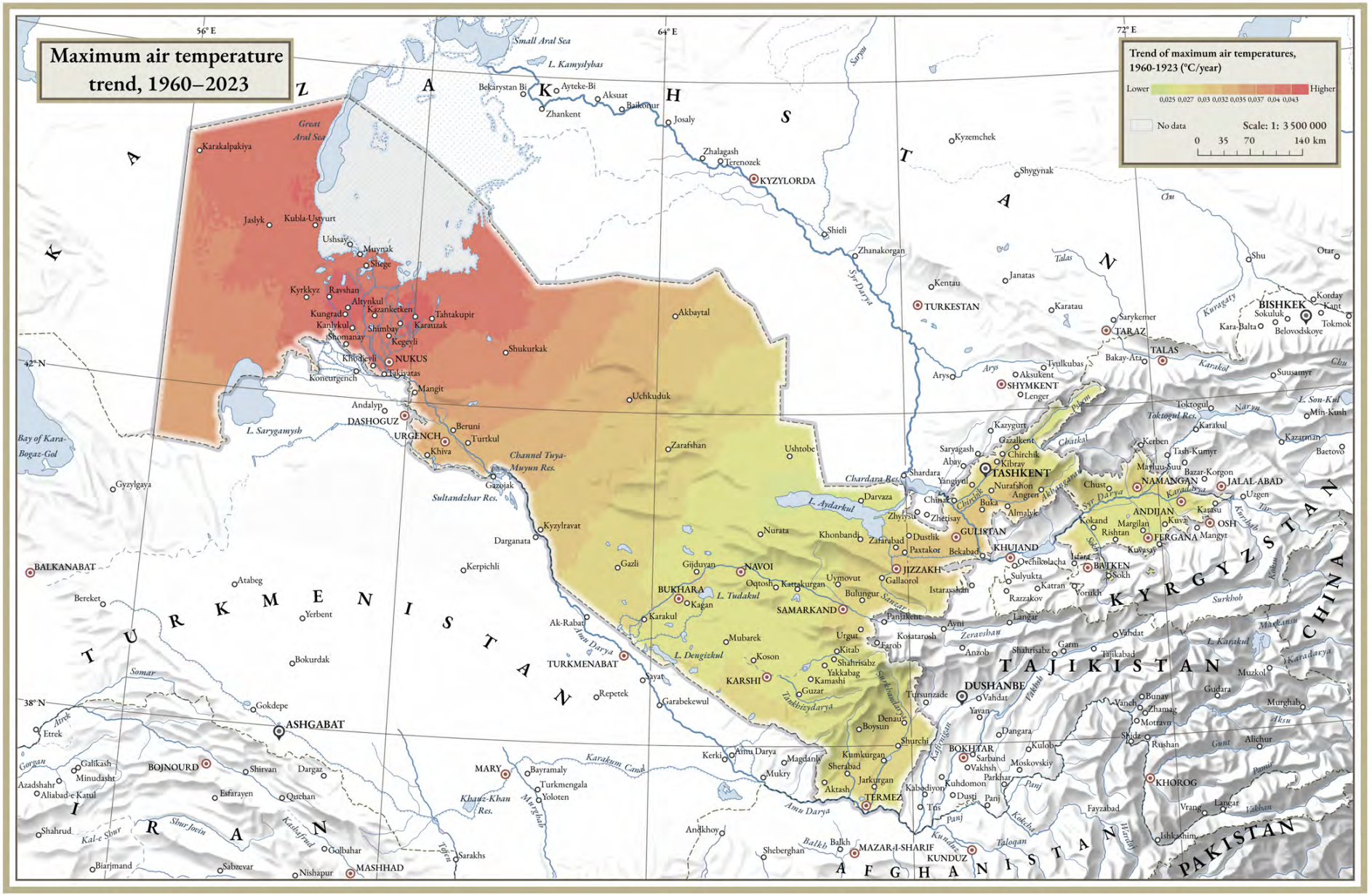
Based on ERA-5 Land reanalysis data (see notes for the map 'Trend in Average Annual Temperature, 1960–2023'). The average temperature for April–October was used to calculate the warm period temperature trend.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



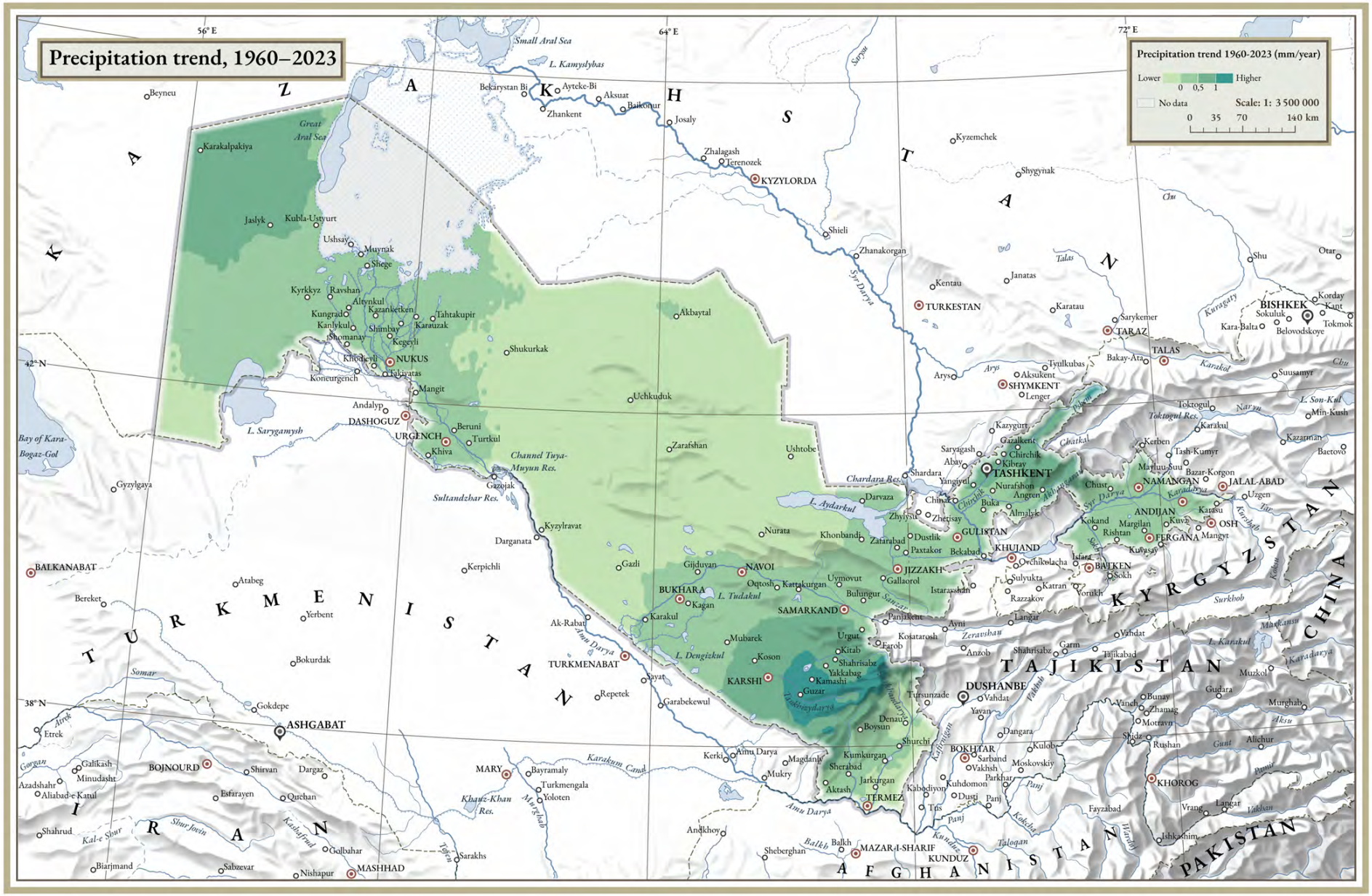
Based on ERA-5 Land reanalysis data (see notes for the map 'Trend in mean annual temperature, 1960–2023'). The average temperature for April–October was used in calculating the warm period temperature trend.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



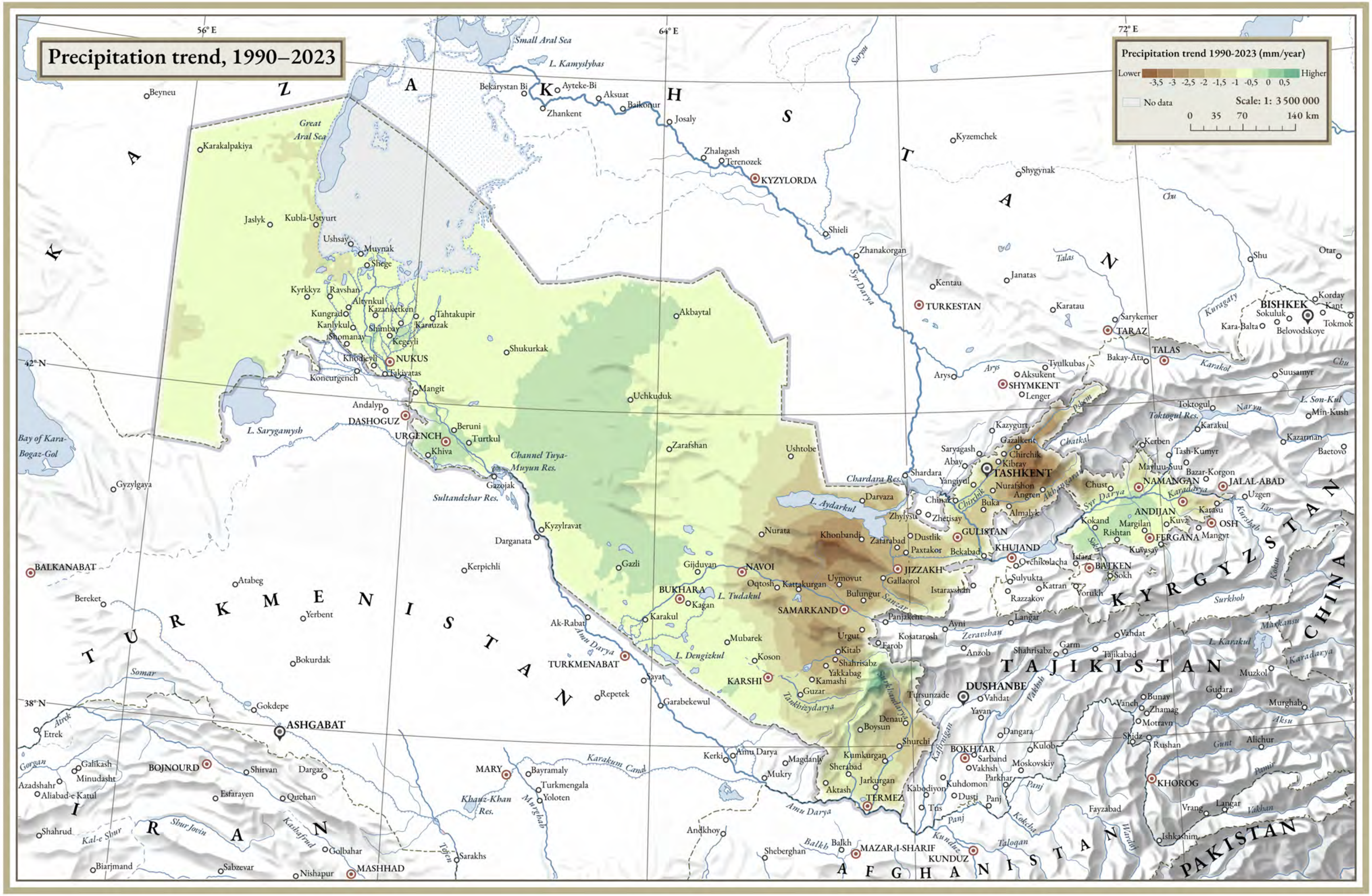
Based on TerraClimate data obtained through reanalysis of WorldClim, CRU Ts4.0, and JRA55 data, TerraClimate demonstrates a high degree of agreement with a range of observations at weather stations from various networks, including SNOTEL and RAWS. The spatial resolution is 4 km; the temporal coverage is from 1958 to the present, with a temporal resolution of 1 month.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



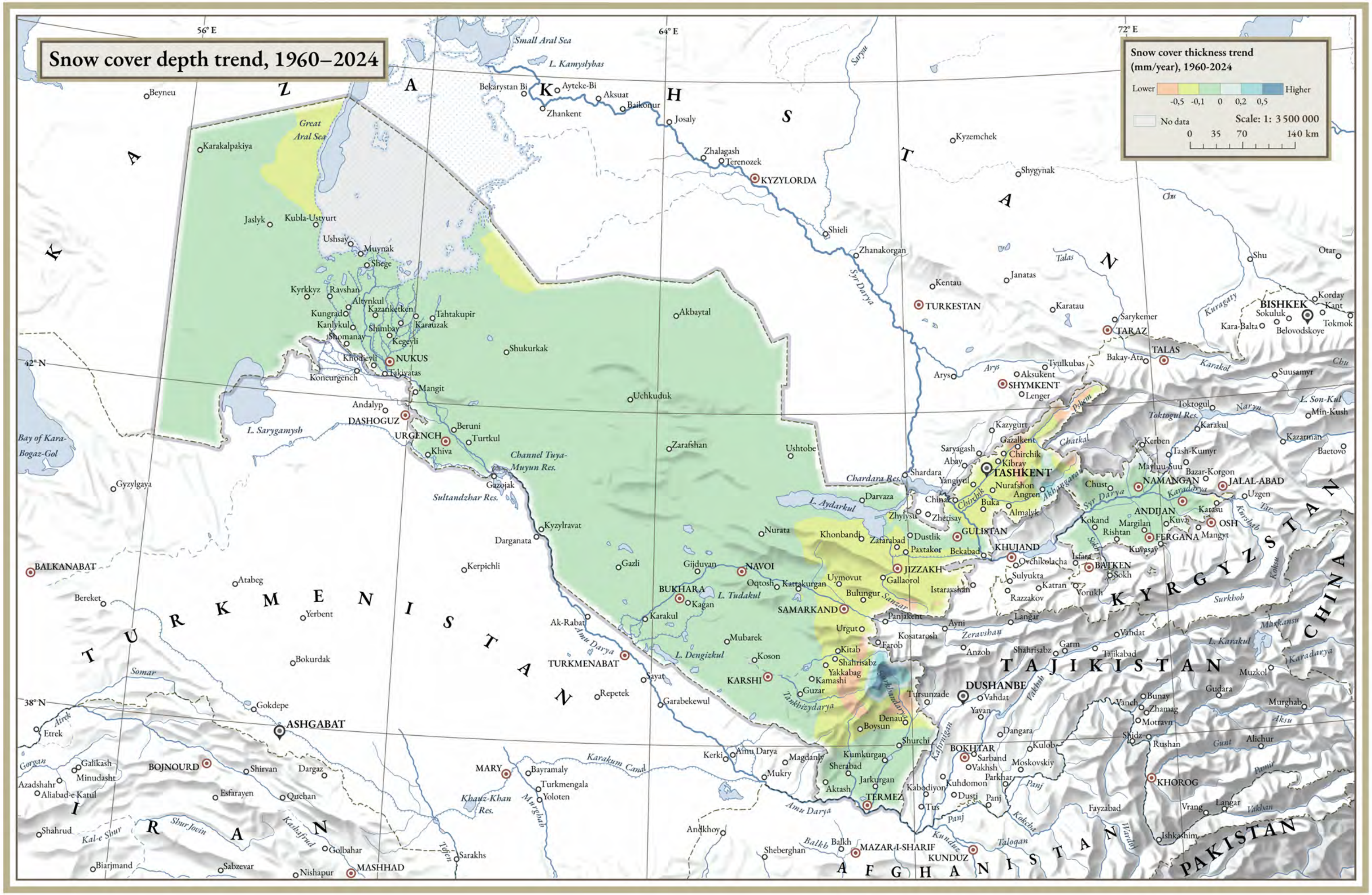
According to TerraClimate (see notes for the map 'Trend of maximum temperatures, 1960–2023').

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



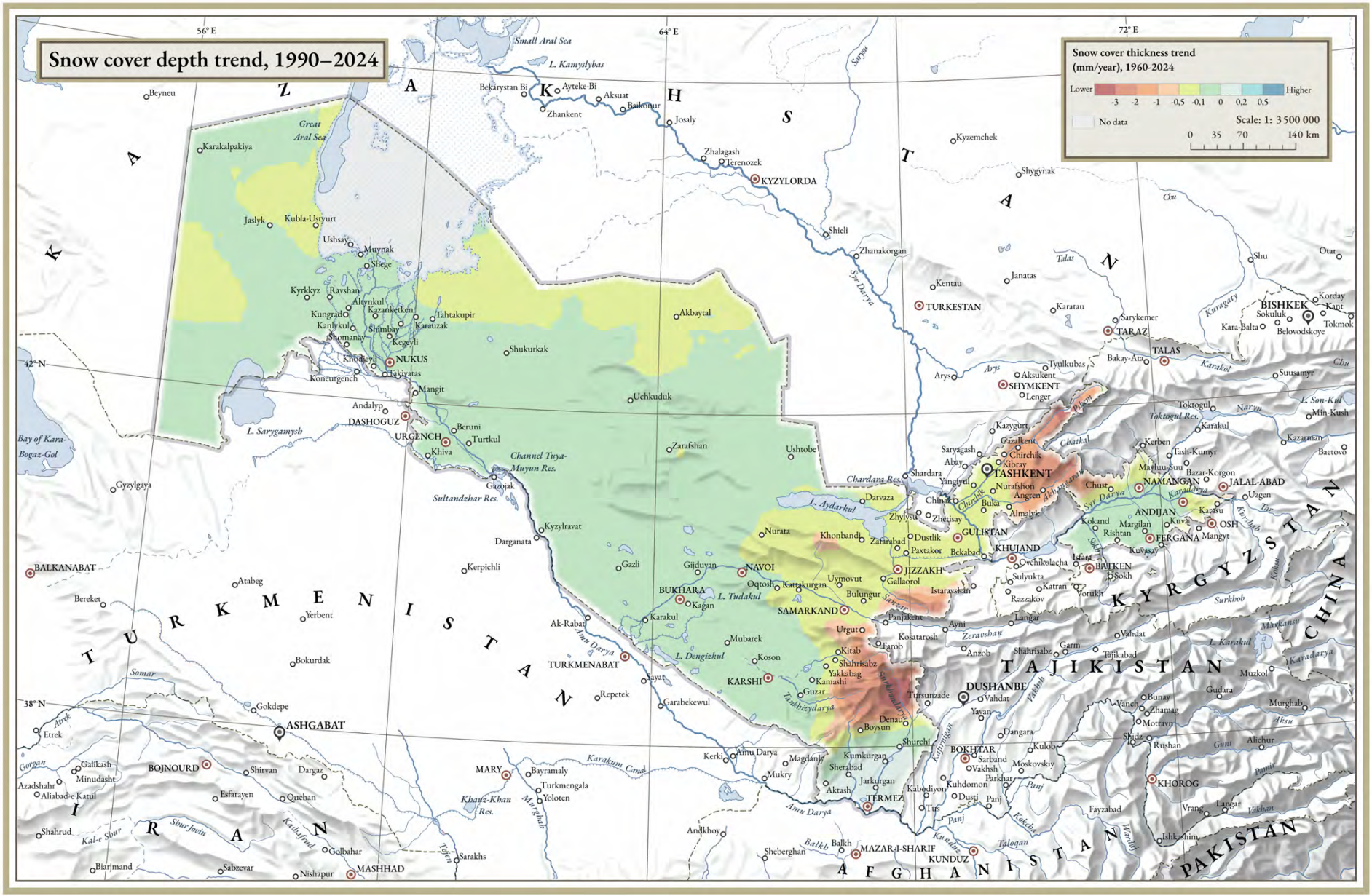
According to TerraClimate (see notes for the map 'Trend of maximum temperatures, 1960–2023').

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



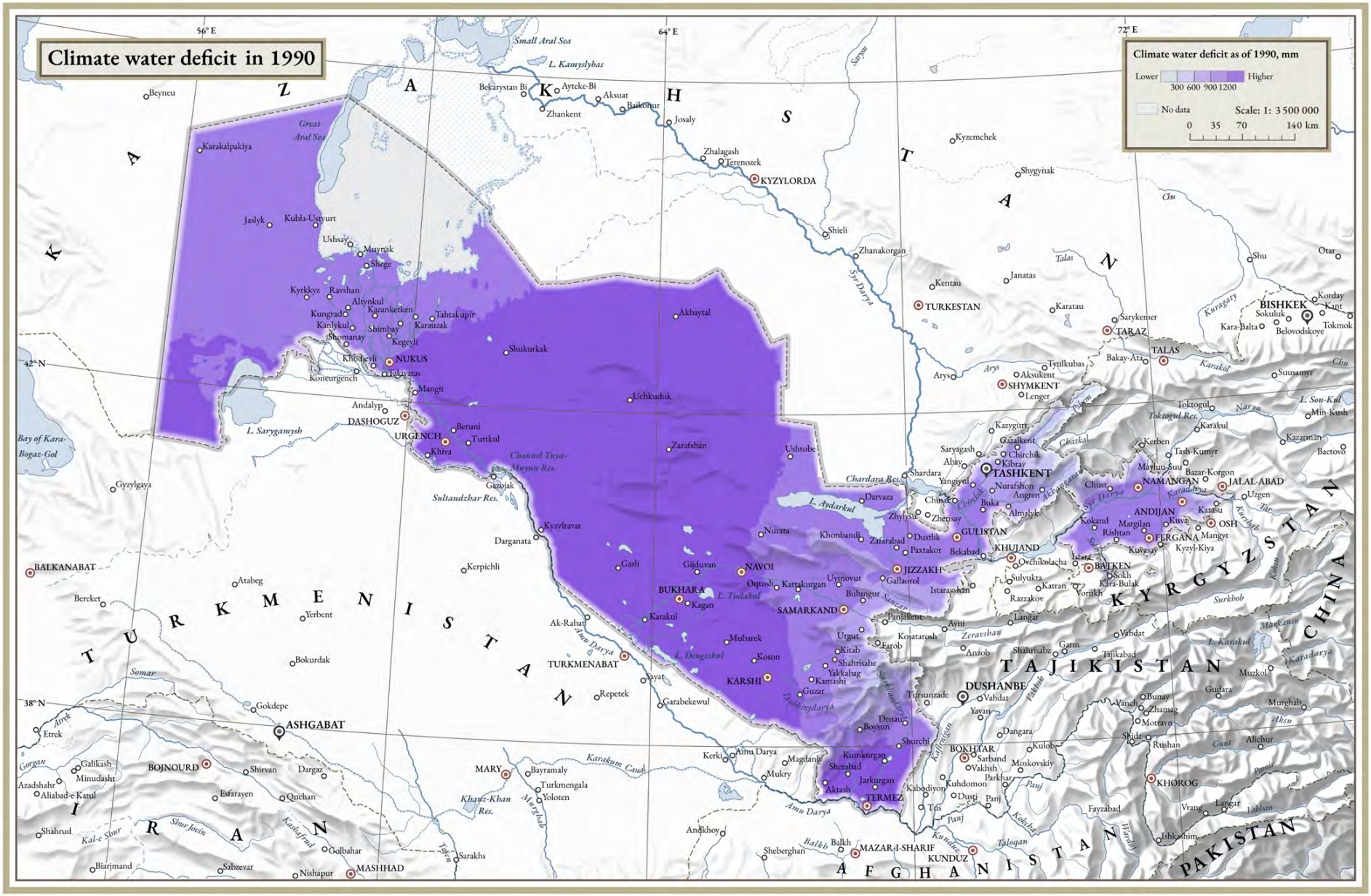
According to ERA5 Land data (see the notes for the map 'Trend in Average Annual Temperature, 1960–2024'), the model takes into account the amount of solid precipitation, the duration of the snow accumulation period, the rate of snowmelt, air and soil surface temperature, and the intensity of solar radiation absorption by the soil. Limitations: it does not account for wind transport of snow, its compaction over time, or the transformation of the snow layer under the influence of liquid precipitation.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



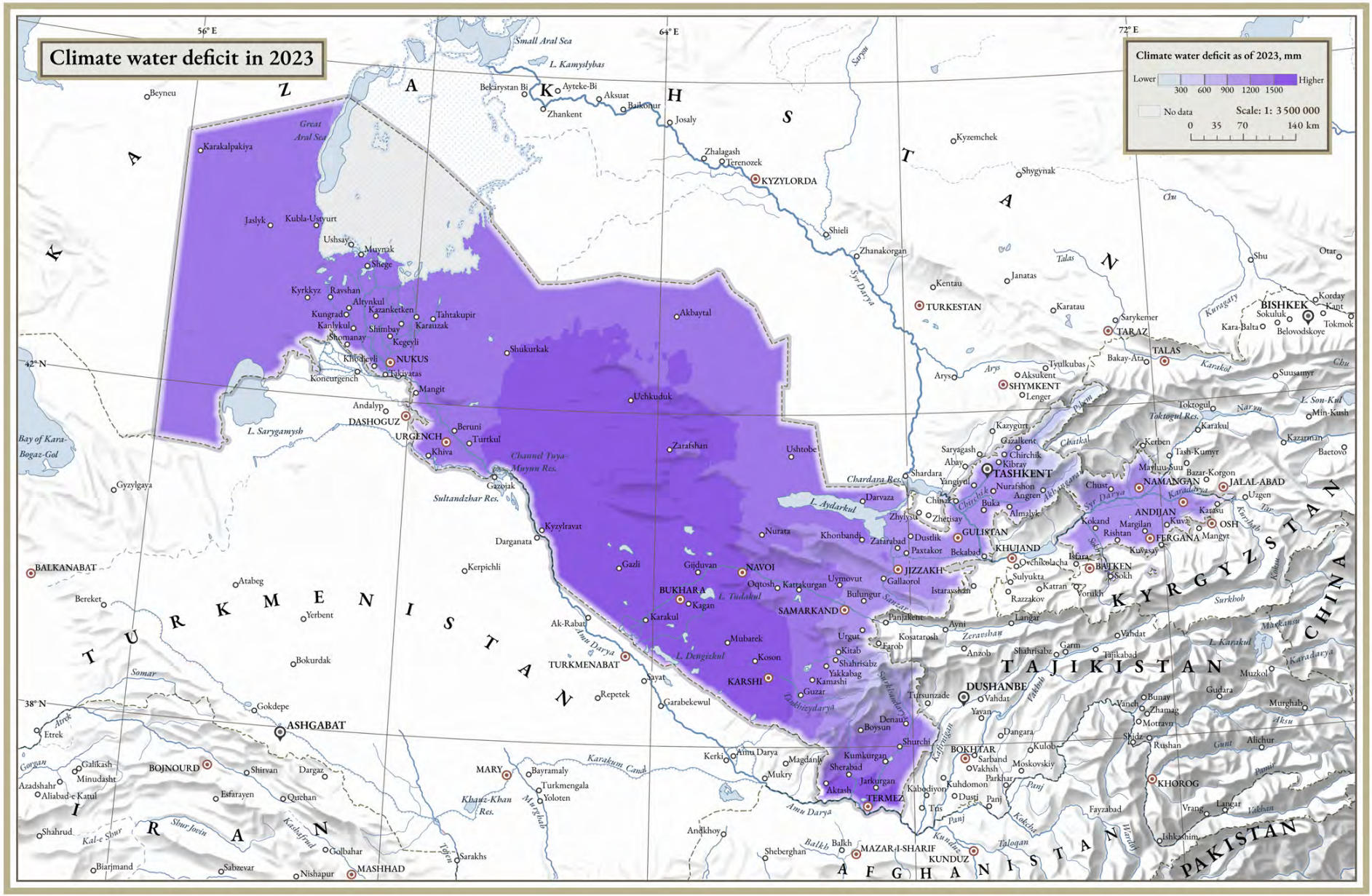
According to ERA5 Land (see notes for the map ‘Snow depth trend, 1960–2024’)

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



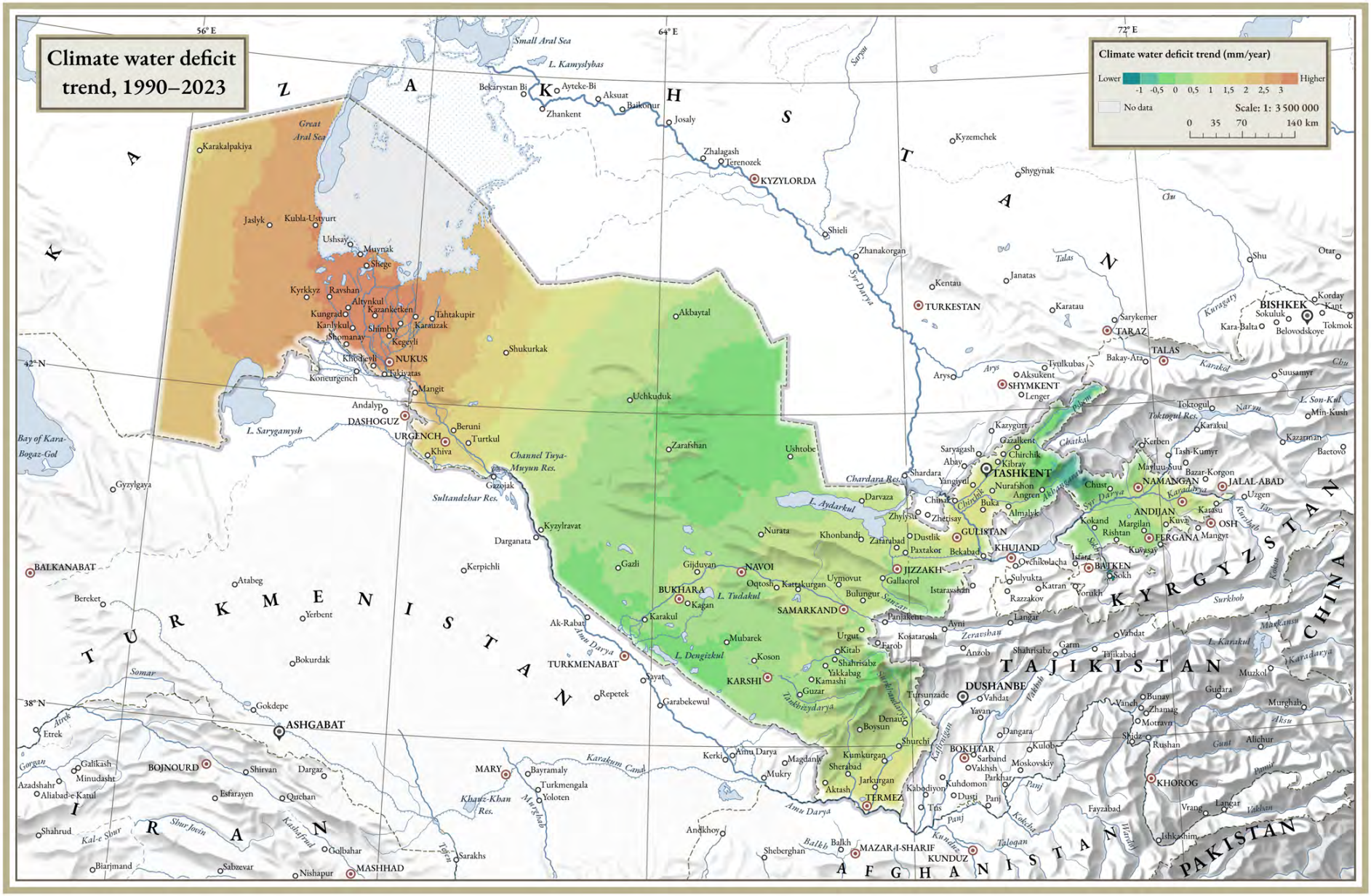
Climatic water deficit is the difference between the amount of water that can evaporate from the soil and vegetation surface under given climatic conditions (taking into account average daily temperature, wind speed, and underlying surface conditions) and the amount of precipitation in that area. According to TerraClimate (see the notes for the map 'Maximum Temperature Trend, 1960–2023').

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



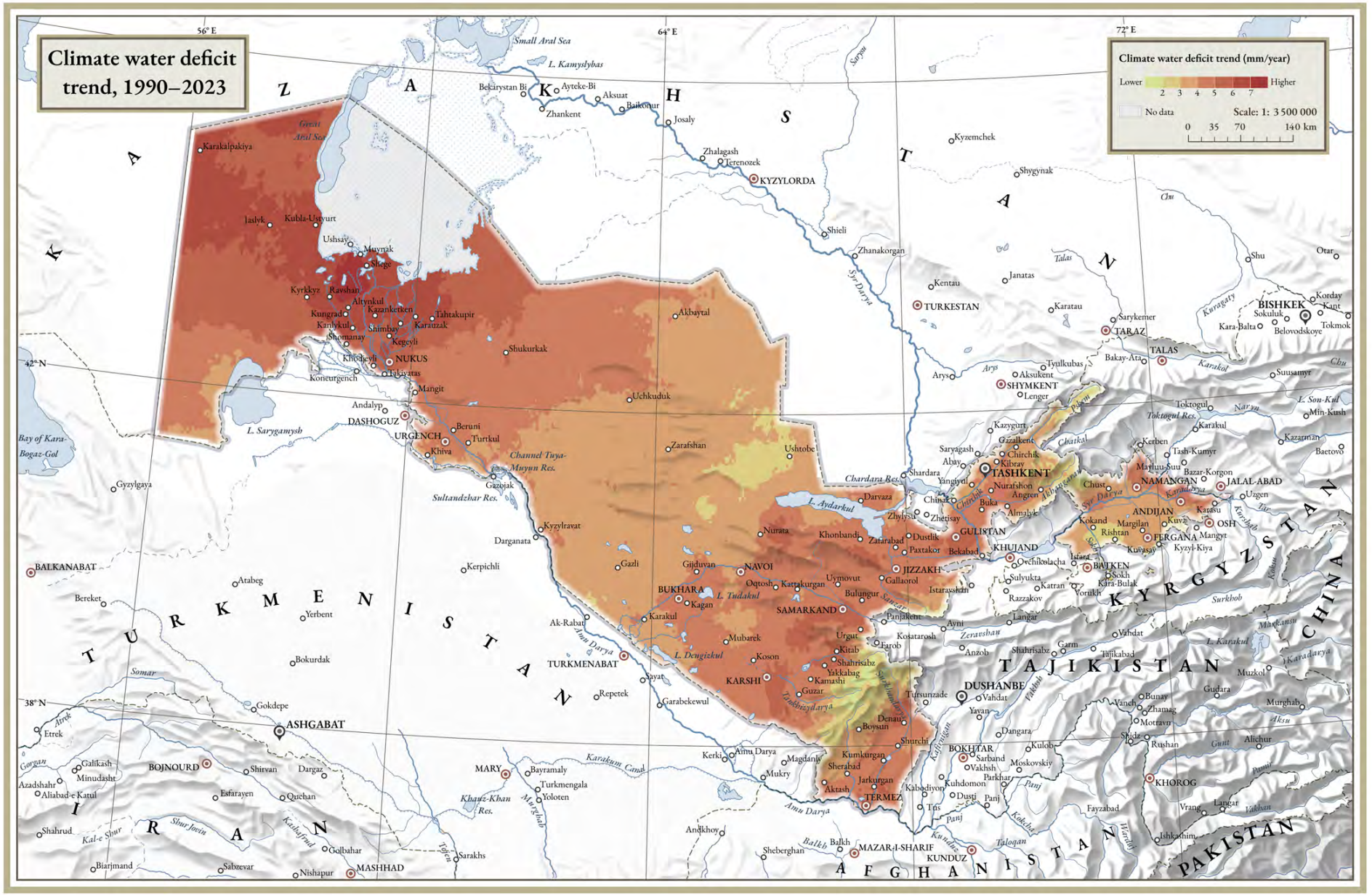
Climatic water deficit is the difference between the amount of water that can evaporate from the soil and vegetation surface under given climatic conditions (taking into account average daily temperature, wind speed, and the underlying surface) and the amount of precipitation in that area. According to TerraClimate (see the notes for the map 'Maximum Temperature Trend, 1960–2023').

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



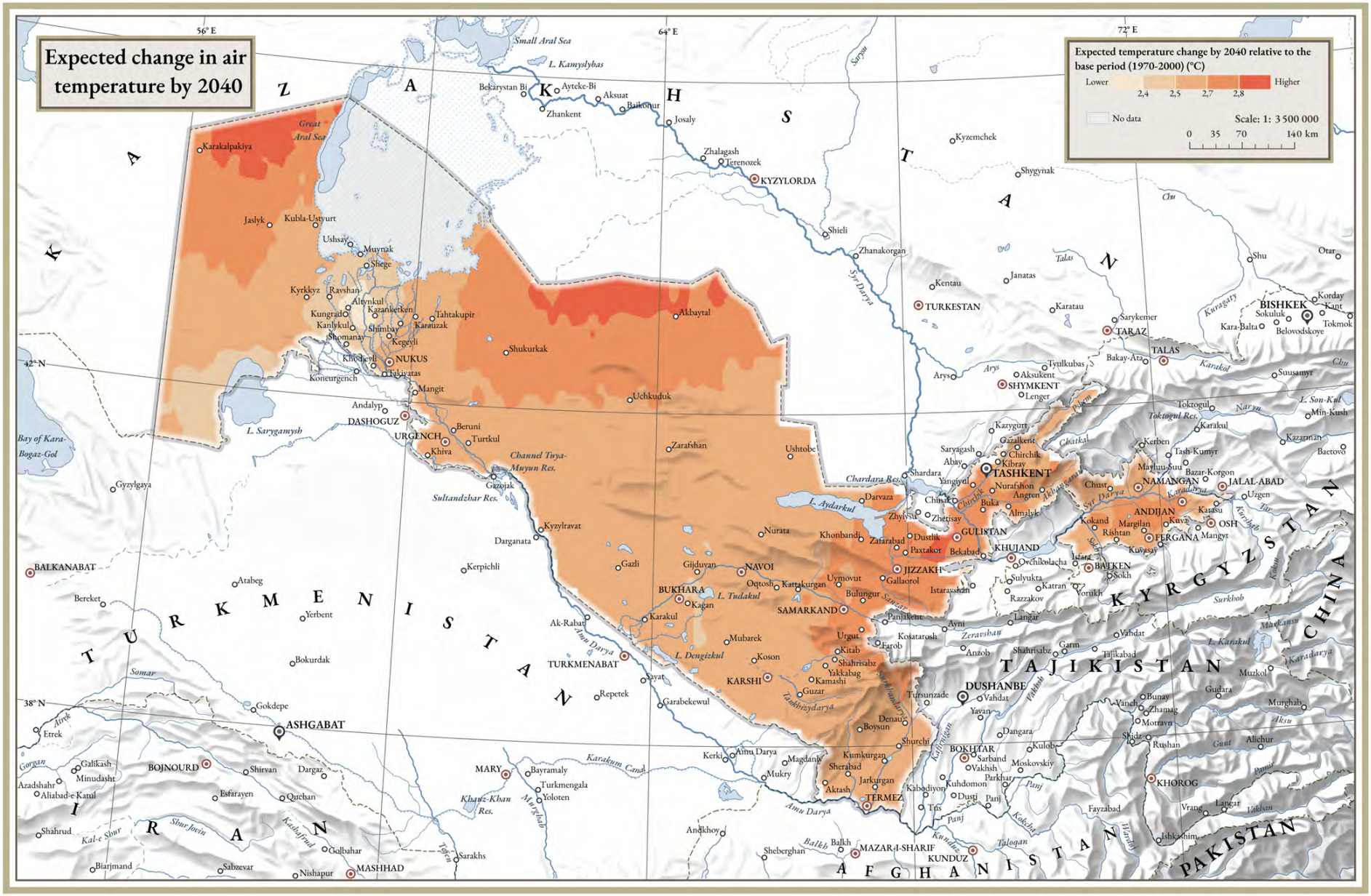
According to TerraClimate (see the notes for the map 'Maximum Temperature Trend, 1960–2023'). Trends are determined using the Sens method.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



According to TerraClimate (see the notes for the map 'Maximum Temperature Trend, 1960–2023'). Trends are determined using the Sens method.

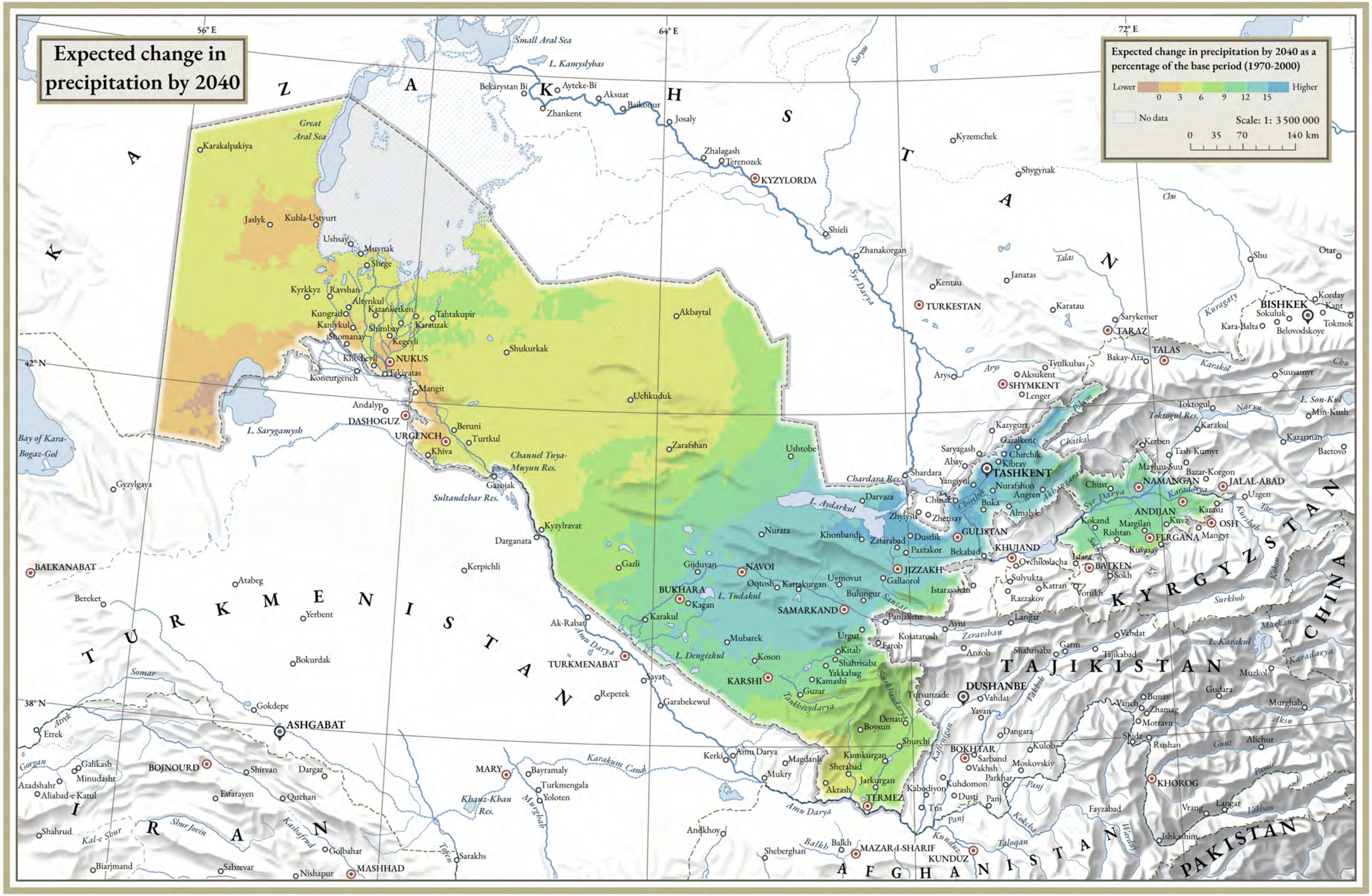
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Based on the results of the HadGEM3-GC31-LL18 model under the SSP126 scenario.[15] Spatial resolution is 100 km, temporal coverage is from 2000 to 2100.

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

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Based on the results of the HadGEM3-GC31-LL model (see the notes to the map ‘Expected temperature change by 2040’).

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.

Table 3. Dynamics of population size and gender composition in the Republic of Uzbekistan, 2000–2020 [1]

Indicator	2000	2005	2010	2015	2020	2010–2020, per cent
Total population, thousand	24,813.1	26,312.7	29,123.4	31,575.3	34,558.9	118.7
Female	12,428.9	13,167.6	14,555.0	15,736.4	17,180.4	118.0
Male	12,384.2	13,145.1	14,568.4	15,838.9	17,378.5	119.3
Urban	9,225.3	9,495.1	14,897.4	15,963.9	17,510.4	117.5
Female	4,668.9	4,787.8	7,487.3	7,987.8	8,761.5	117.0
Male	4,556.4	4,707.3	7,410.1	7,976.1	8,748.9	118.1
Rural	15,587.8	16,817.6	14,226.0	15,611.4	17,048.5	119.8
Female	7,760.0	8,379.8	7,067.7	7,748.6	8,418.9	119.1
Male	7,827.8	8,437.8	7,158.3	7,862.8	8,629.6	120.6

Table 4. Population density by region of Uzbekistan (persons/km²) and sown area per capita (ha/person)[2]

Region	Density 2000	Density 2023	Change 2000–2023 (%)	Sown area 2023 (ha/person)
Republic of Uzbekistan	54.6	80.2	46.9	0.44
Republic of Karakalpakstan	9.0	11.9	32.2	1.09
Andijan	520.5	772.7	48.5	0.07
Bukhara	35.2	50.0	42.0	1.30
Jizzakh	46.0	69.6	51.3	0.83
Kashkadarya	75.8	121.9	60.8	0.57
Navoi	7.1	9.5	33.8	1.00
Namangan	260.0	402.9	55.0	0.09
Samarkand	158.9	245.6	54.6	0.30
Surkhandarya	86.4	139.6	61.6	0.35
Syr Darya	149.3	209.5	40.3	0.27
Tashkent Region	153.6	197.7	28.7	0.19
Fergana	397.7	588.2	47.9	0.08
Khorezm	217.0	323.7	49.2	0.11
Tashkent City	6,472.2	6,599.1	2.0	0.002

1 Arabov et al. (2021) An Analysis of the Demographic Data of Population of the Republic of Uzbekistan. Global Research Network LL 2, 10: 15 - 20.

2 Data Collection Survey on Agriculture Sector in Republic of Uzbekistan (2017) Final Report. Japan International Cooperation Agency (JICA). Hokkaido Intellect Tank NTC International Co. Ltd. 207 P. The data collection survey on agriculture sector in Republic of Uzbekistan : final report [electronic resource]. -

2.2. Population and infrastructure

Since 2000, Uzbekistan's population has grown by 11.5 million people, or 47 per cent, exceeding 36 million in 2023. This upward trend has been largely steady since the 1950s. In the 2000s there was a temporary slowdown, however, after 2010, growth returned to a high rate of about two per cent per year. The main drivers of this rapid increase, averaging approximately 500,000 people annually, are high fertility rates, declining mortality rates due to improved access to medical services, rising living standards as well as cultural and religious factors. The population is very young, with roughly one-third being under 14 years old. According to official projections, Uzbekistan's population will reach 41 million by 2030 and 50 million by 2050[16].



Workers' costume (Samarkand region)

At present, the rural population accounts for 49.4 per cent (18.48 million) of the total. A key feature of Uzbekistan's current demographic development is that over the past 20 years its rural population has been growing faster than its urban population *(see Table 3)*. World Bank data show that the share of population living in rural areas fell from 59 per cent to 49 per cent during from 1990 to 2010 because rural growth in this period was modest (some 95,000 people per year). This slowdown was driven by the transition to a market economy, which reduced agricultural employment and prompted people to seek other income opportunities by moving to urban areas

16 Demographic Growth and Development Strategy in Uzbekistan: A Comprehensive Analysis of Population Trends and Future Projections - EMBASSY OF UZBEKISTAN IN THE UNITED STATES

Table 5. Dynamics of the number of settlements

Region	Number of settlements in 1970	Number of newly appeared settlements	Number of disappeared settlements	Share of newly appeared settlements (per cent)	Share of disappeared settlements (per cent)
Andijan Region	852	419	1	49.18	0.12
Bukhara Region	1,393	571	22	40.99	1.58
Fergana Region	1,081	823	2	76.13	0.19
Jizzakh Region	537	1,046	46	194.79	8.57
Namangan Region	533	729	3	136.77	0.56
Navoi Region	925	1,086	33	117.41	3.57
Republic of Karakalpakstan	1,021	1,077	112	105.48	10.97
Kashkadarya Region	1,089	882	12	80.99	1.10
Samarkand Region	1,560	667	15	42.76	0.96
Syr Darya Region	267	521	6	195.13	2.25
Surkhandarya Region	739	686	27	92.83	3.65
Tashkent (city) and Tashkent Region	840	729	13	86.79	1.55
Khorezm Region	484	643	19	132.85	3.93
Uzbekistan	**11,321**	**9,879**	**311**	**87.26**	**2.75**

or abroad[17]. Faster rural growth (some 273,000 people per year) resumed only after 2010, likely reflecting the stabilization of the agricultural sector in the country[18]. It should also be noted here that a contributing factor to the sharp increase in the urban population and the simultaneous decline in the rural population between 2005 and 2010 was linked to the 2009 reclassification of 966 villages as urban settlements *(see Table 3)*.

The most populous regions of Uzbekistan are Samarkand and Fergana (approximately four million each), together they account for over 22 per cent of the country's inhabitants. The least populous regions are Syr Darya and Navoi (about one million each).

Regional growth rates also differ substantially. The fastest-growing regions since 2000 are Surkhandarya (+61.60 per cent), Kashkadarya (+60.71 per cent) and Namangan (+55.77 per cent); slower growth is observed in the Republic of Karakalpakstan (+31.48 per cent), Navoi (+34.75 per cent) and Tashkent Region (+27.37 per cent). These contrasts are expected to persist in the medium term[19].

Accordingly, population density in Uzbekistan and its regions increased markedly between 2000 and 2023. Nationally, density rose by 46.95 per cent to 80.2 persons/km², compared with a Central Asian average of 17.43 persons/km². Uzbekistan's total area is 44.74 million hectares (ha), with much of it being flat, having limited water resources that constrains agriculture, meaning agricultural and irrigated land comprise only 9.6 per cent and 7.5 per cent of the total area, respectively. Settlements cluster near the most valuable resource, water, and regional settlement systems differ little across the republic *(see map. 'Share of built-up area to river basin area')*. While the figures vary widely by region *(see Table 4)*, Uzbekistan's population growth is occurring against a backdrop of limited productive land, nevertheless, it is better endowed with arable land, some 0.44 ha per person, than the Kyrgyz Republic (0.30 ha/person) and Tajikistan (0.08 ha/person).

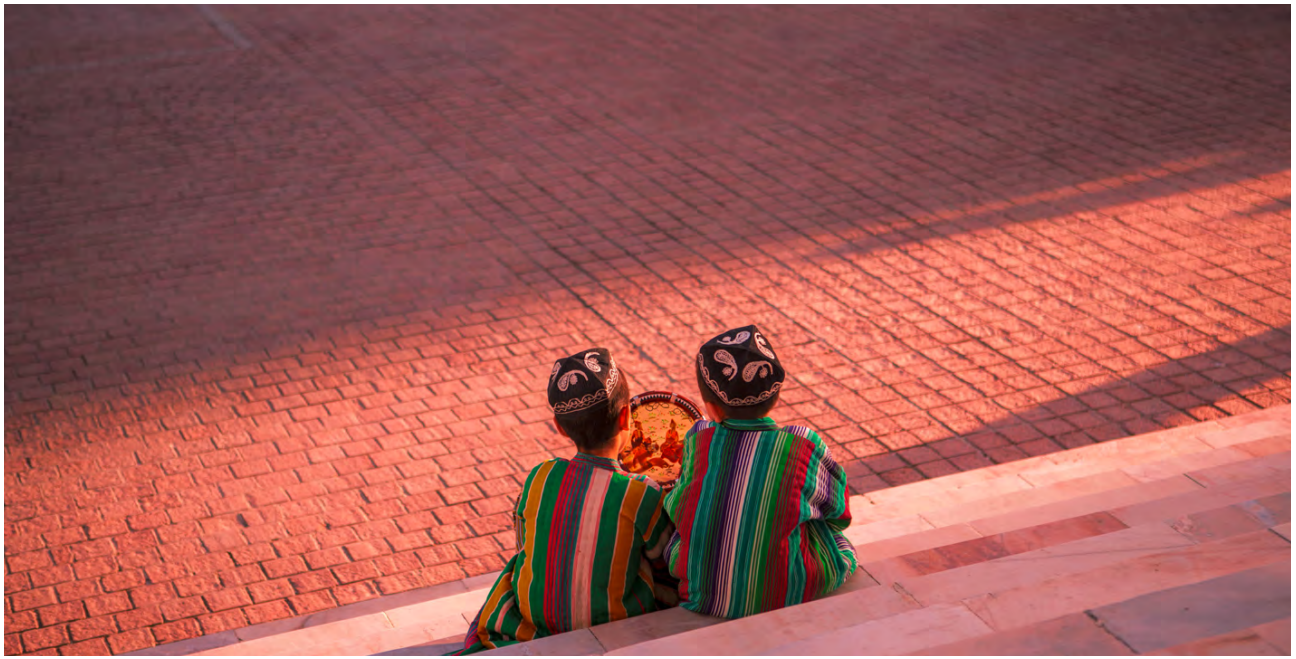


Young girl's costume, Samarkand region (left); summer costume of a rural woman, Samarkand region (right)

One region with a low population density (11.2 persons/km²) and relatively low annual population growth (1.4 per cent) is the Republic of Karakalpakstan, a lowland desert gradually transitioning into the former Aral Sea bed. Karakalpakstan accounts for 37 per cent of Uzbekistan's territory by area. The Navoi Region has similarly low population density and relatively modest growth (1.46 per cent per year). In both these regions, per-capita sown and irrigated land is relatively high (about one ha/person) with the average inter-village distance of 12.8 and 13.4 km, respectively, being more than twice the national mean (6.4 km)[20].

Regions with medium population density (50 to 200 persons/km²) include Bukhara, Jizzakh, Kashkadarya and Surkhandarya. Bukhara is experiencing medium population growth (1.8 per cent per year) and has relatively good cropland endowment, whereas Jizzakh and Kashkadarya are experiencing high growth (2.2 to 2.6 per cent) with the per-capita arable land above the national average. Inter-village

17 Tojiyeva et al. (2024) Regional Characteristics in the Dynamic and Location of the Rural Population of the Republic of Uzbekistan. E3S Web of Conferences. 491, 04004.
18 Rural population (per cent of total population) - Uzbekistan | Data
19 Arabov et al., 2021.
20 Tojiyeva et al., 2024.



Children in Registan Square in traditional clothes with doira

distances in these regions are 5.2 to 6.4 km, close to the national mean.

Regions with a population density above 200 persons/km² include Samarkand and Syr Darya. All of these regions show growth rates around the national average and cropland endowment of about 0.3 ha/person, which is close to global averages but may be considered indicative of unsustainable land use. Khorezm, another region with high population density, also falls into the zone of unsustainable land use: cropland endowment is only 0.11 ha/person and falling given the region's population growth exceeds 2.1 per cent per year. Khorezm, where the average inter-village distance is about four km, also has the greatest extent of moderately and strongly saline soils.

The Andijan and Namangan region, as well as the Fergana Valley, have Uzbekistan's highest population densities (over 400 persons/km²), elevated growth rates (exceeding two per cent per year) and extremely low per capita cropland endowment at only 0.07 to 0.09 ha/person *(see Table 4)*. Among these three, the Fergana Valley can be considered the country's most potentially problematic area, as it is characterized by the densest network of rural settlements, the average inter-village distance is only 2.5 km, and where nearly half of the population lives in rural areas directly tied to agriculture.

The capital, Tashkent, although in the high population density category, has relatively low population growth (under 33 per cent), although a distinctive feature of the entire Tashkent Region is the existence of a combination of medium population density with little growth in this indicator since 2000.

There are 120 cities in Uzbekistan, 1,058 urban-type settlements and 10,990 rural settlements in Uzbekistan. The number of rural settlements has declined by 1,737 since 1989, almost exclusively due to their reclassification as urban-type settlements or even cities because of either population growth or the spatial coalescence of small settlements. While the cities of Namangan and Samarkand have populations of more than 500,000, Tashkent is the only city with over one million residents and only 24 of the other cities have populations exceeding 100,000.



The bride's costume, Kashkadarya region

Uzbekistan's settlement system has undergone substantial transformation since 1970s. Nationwide, the number of settlements has been increasing since at least 1970, with the total number of settlements increasing since then by more than 9,800, or 85 per cent *(see Table 5)*. A comparison of recent satellite imagery with late-Soviet cartographic materials shows that since 1970 the total built-up area has increased by 10,800 km², or 125 per cent. Some 93 per cent of this process occurred through the expansion of existing settlements *(see map. 'Dynamics built-up areas, 1970–2020')*, with new settlements accounting for only 5.2

per cent of the increase in built-up area. At the same time, 311 small (on average about 0.3 km²) individual settlements shown on 1970s maps were abandoned, although these only had a combined area of about 100 km² *(see map. 'Disappeared settlements since 1970s')*. In their place, 419 larger (on average 2.4 km²) settlements have appeared, with a total area of 1,003 km² *(see Table 6)*. No significant region-level differences can be observed throughout Uzbekistan in settlement dynamics: 90 to 98 per cent of built-up growth is due to the expansion of existing settlements, two to nine per cent to the appearance of new settlements, while 0.1 to 2.8 per cent of the 1970s built-up areas have disappeared from the country's map. Even within the most densely populated and cropland-poor Fergana Valley, differences among the three administrative regions (Andijan, Namangan, and Fergana) fall within the above national ranges. For example, Namangan Region exceeds the national average in the share of newly appeared settlements since 1970, while Fergana and Andijan Regions are among the lowest values of such. The Republic of Karakalpakstan stands out for its somewhat higher share of disappeared settlements by both number (11 per cent) and area (2.8 per cent). Figure here may be tied to the fact that it is the most environmentally challenged region due to the Aral Sea catastrophe, nevertheless, the number of new settlements compared to existing settlements (106 per cent) and the increase in built-up area (89 per cent) are consistent with the rest of the country.

Infrastructure. Uzbekistan has over 6,100 km of railways, about 43,000 km of paved roads as well as significant pipeline infrastructure, with trunk pipelines extending for some 13,900 km. While the lengths of railways and trunk pipelines have remained stable over time, the length of paved roads has decreased by 41 per cent since 2000.

Uzbekistan's roads not only connect regions within the republic but also provide transit routes between neighboring countries *(see map 'Road density')*, as seen with the important highway that runs through Nukus, Termez, Bukhara and Karshi to link the republic with the Russian Federation.

According to Uzbekistan's transport strategy up to the year 2035, a key priority is the development of the 'Middle Corridor', which will connect by high quality roads China and the European Union through Central Asia via high-quality roads. In this context, particular the Uzbek Government is giving much attention to cooperation with Kazakhstan, a partnership that brings several geographic and economic advantages. Several other 'corridors' to Europe are planned, including a route that runs via the Kyrgyz Republic to Uzbekistan, Kazakhstan, Russia (Belarus) and then into the EU, as well as another that runs via the Kyrgyz Republic to Uzbekistan and Kazakhstan before turning toward the Caspian Sea and on to Azerbaijan and Georgia.

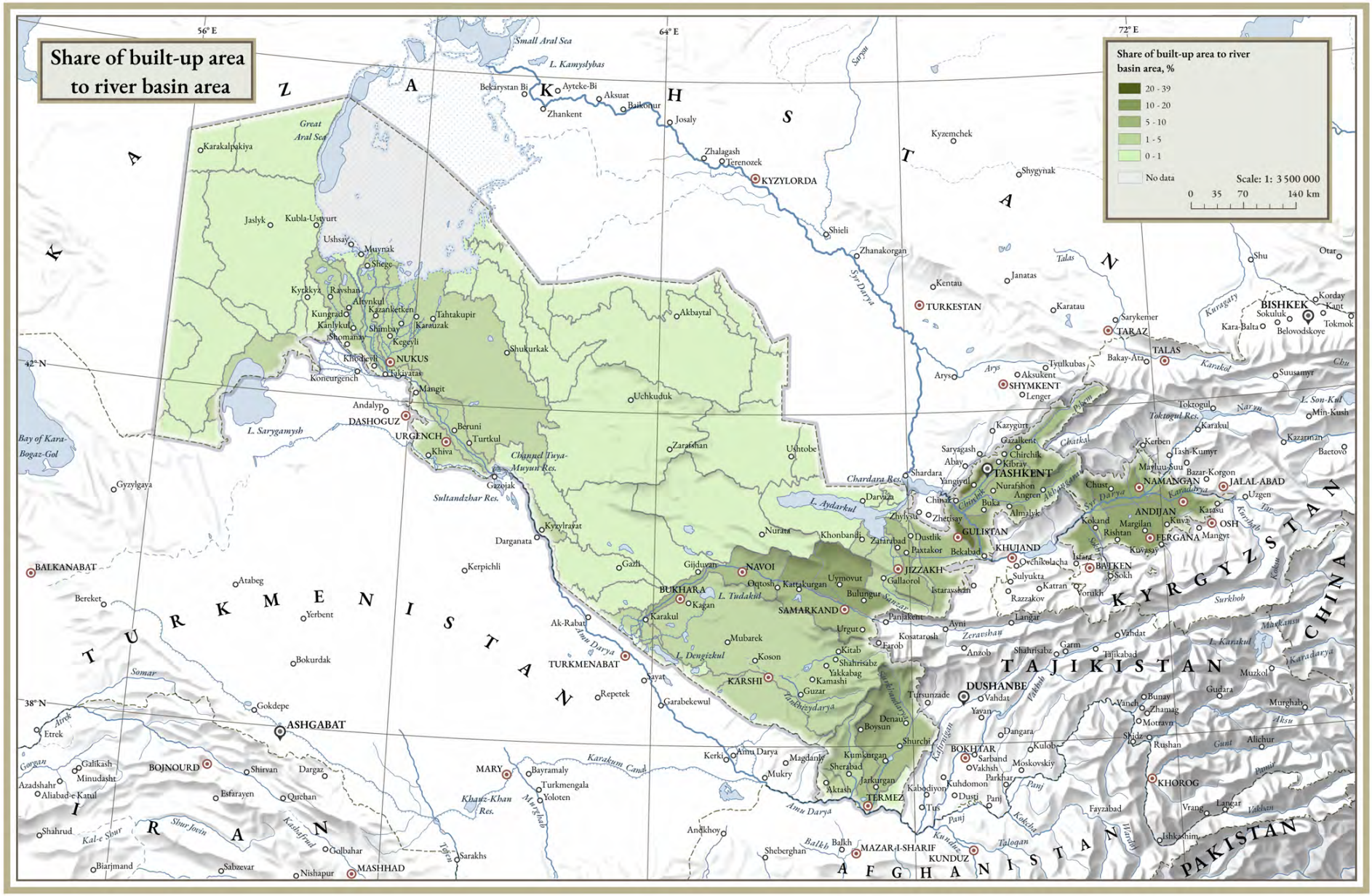
A recent study suggested that the throughput capacity of Uzbekistan's road infrastructure must increase by 486 per cent by 2030 and by 1,365 per cent by 2050 to meet the expected freight volumes transiting Uzbekistan[21].

In terms of railway infrastructure, the current flagship project is the construction of the China–Kyrgyz Republic–Uzbekistan line, although an additional line, the Trans-Afghan railway that runs to Pakistan via Afghanistan, is also being laid.

Table 6. Dynamics of built-up areas

Region	Built-up area in the 1970s (km²)	Built-up area in 2023 (km²)	Increase in built-up area (%)	Stable settlements (km²)	New settlements (km²)	Disappeared settlements (km²)	Expanded settlements (km²)
Andijan Region	630	2,119	236	8	37	0	2,074
Bukhara Region	546	1,432	162	8	43	3	1,381
Fergana Region	770	1,150	49	4	104	1	1,042
Jizzakh Region	386	1,285	228	18	101	21	1,167
Namangan Region	539	1,159	115	13	66	0	1,081
Navoi Region	430	1,123	159	16	101	10	1,006
Republic of Karakalpakstan	828	1,623	91	67	112	46	1,444
Kashkadarya Region	931	2,176	134	40	116	2	2,020
Samarkand Region	891	2,023	127	22	64	2	1,936
Syr Darya Region	297	631	111	18	50	4	562
Surkhandarya Region	680	1,745	156	15	80	2	1,650
Tashkent and Tashkent Region	1,120	1,948	73	42	82	4	1,825
Khorezm Region	597	1,012	69	43	47	6	923
Uzbekistan	**8,646**	**19,426**	**125**	**313**	**1,003**	**100**	**18,110**

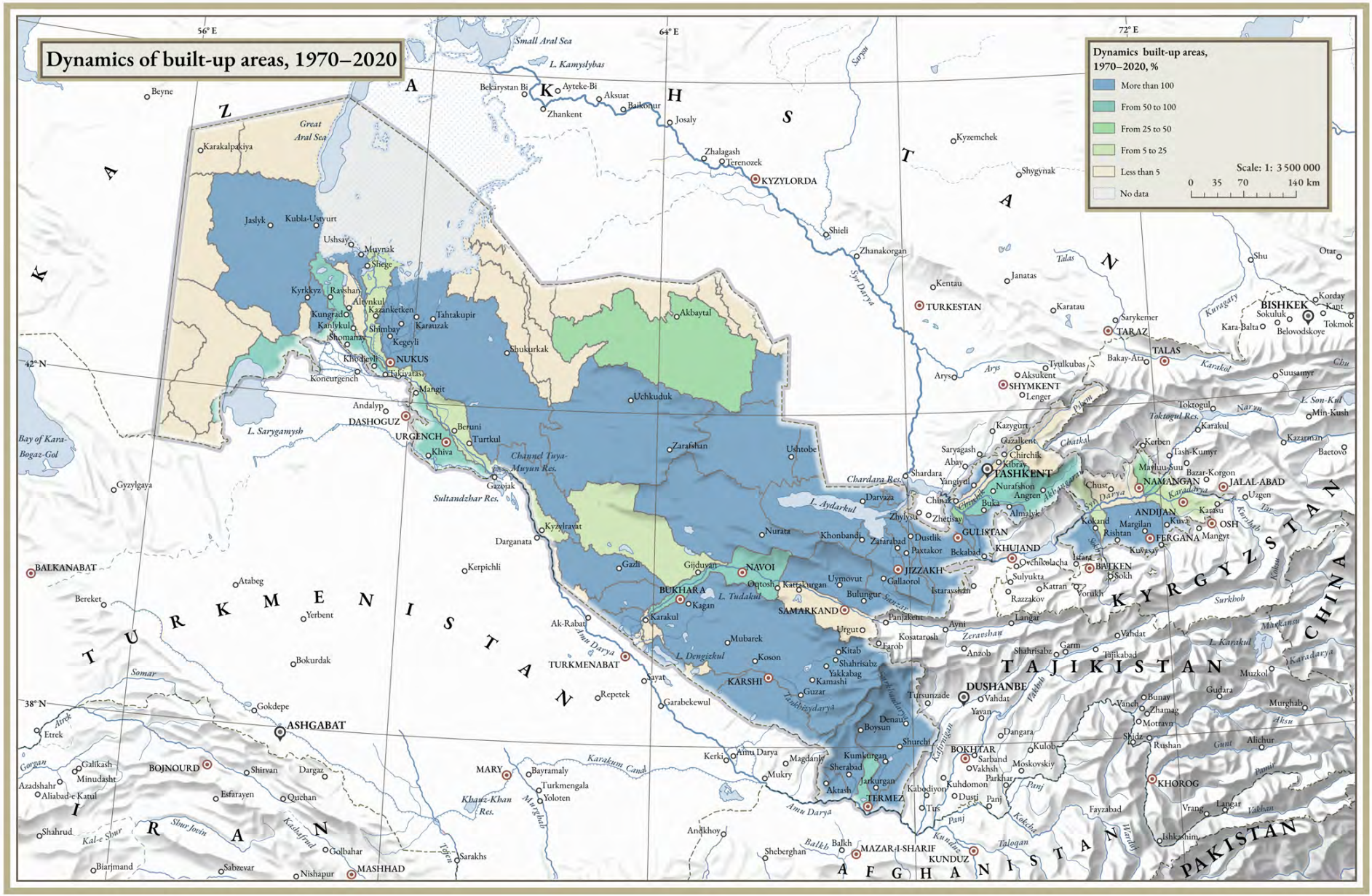
21 ITF (2019) Enhancing Connectivity and Freight in Central Asia,. International Transport Forum. Paris. http://www.itf-oecd.org.



Based on DLR World Settlement Footprint[22] data, obtained by classifying Sentinel 1 radar and Sentinel 2 optical and Landsat images. Spatial resolution is 10 m, temporal coverage is 1985–2020, depending on the version, and river basin boundaries are at level 6 detail, in accordance with HydroSHED data.

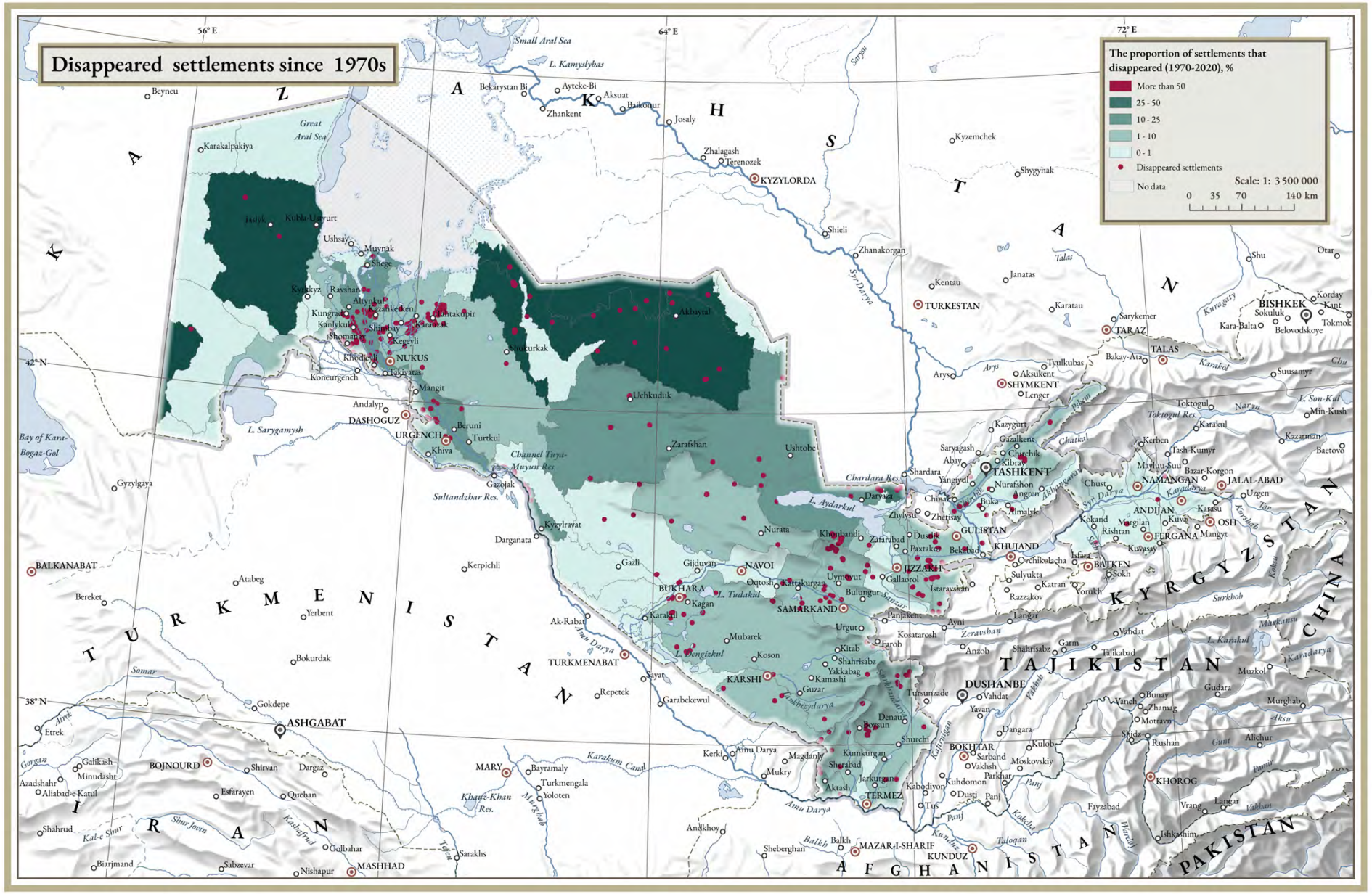
22 Marconcini et al. (2020) World Settlement Footprint (WSF) 2015.figshare. Dataset. https://doi.org/10.6084/m9.figshare.10048412.v1

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



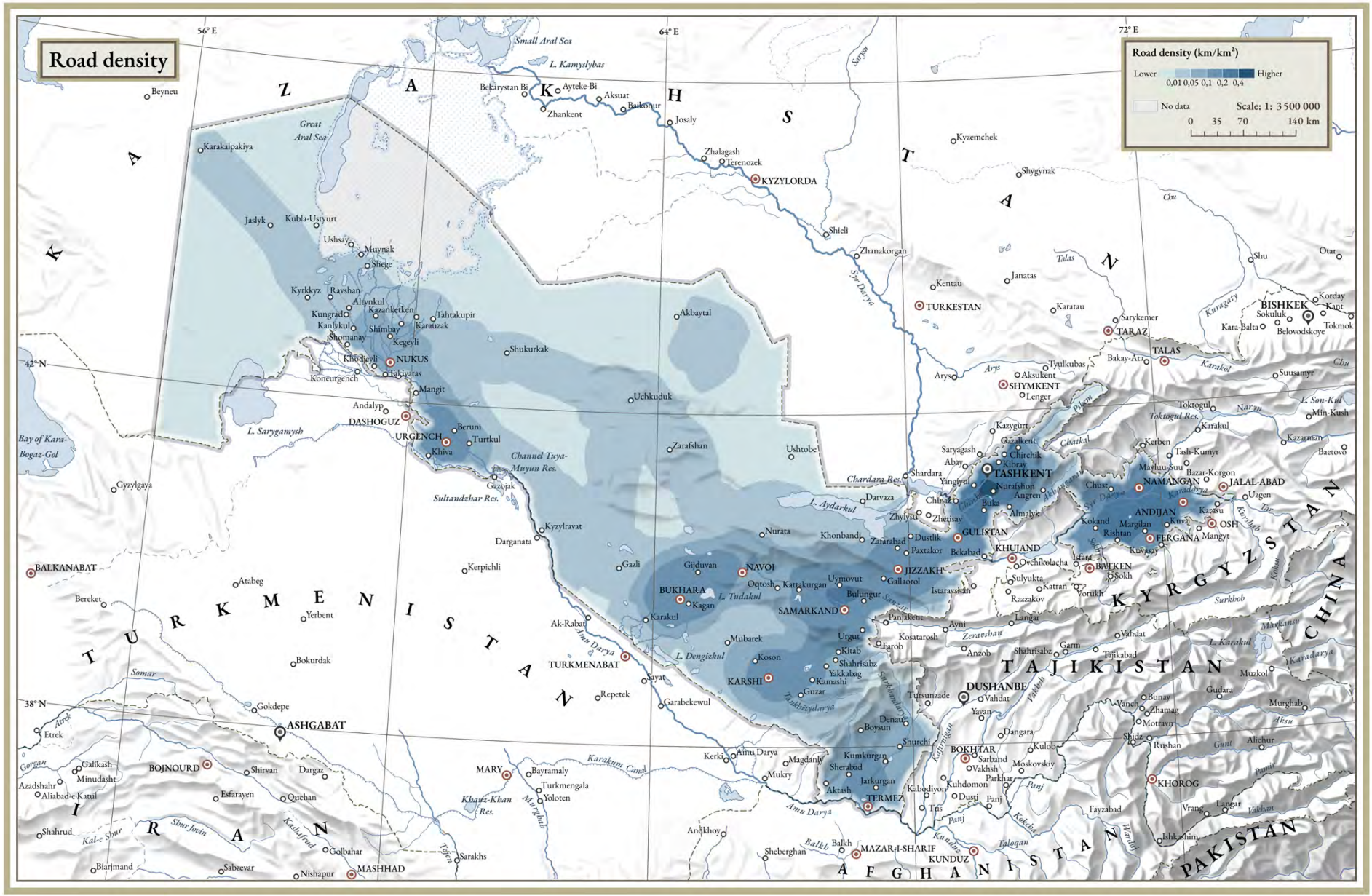
Current built-up area boundaries are based on the DLR World Settlement Footprint. Buit-up area boundaries from 1970 are based on maps of the USSR General Staff. Development dynamics were determined using GIS analysis. River basin boundaries are defined based on detailed Level 6 maps from HydroSHED.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



See the explanations for the map ‘Dynamics built-up areas, 1970–2020’.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



According to OpenStreetMap[23]

23 OpenStreetMap

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.

Water Resources



© Institute of Geography RAS, © PJSC RSC Energia



3.1. Key Aspects

- Increased withdrawals of water for agricultural purposes from the Amu Darya and Syr Darya basins do not guarantee the minimum ecologically required flow to support the Aral Sea basin.
- Despite climate change, the discharge dynamics of Uzbekistan's main rivers still fall within the bounds of natural variability.
- Uzbekistan's groundwater plays a major role in meeting domestic water needs, however, is transboundary in nature and has limits on the volume that can be sustainably abstracted.
- In terms of water-supply safety, the most problematic region is the Republic of Karakalpakstan where, according to chemical analyses, more than one-third of drinking-water samples do not meet sanitary standards.

3.2. Overview

For many arid territories and regions around the globe, their hydrographic networks are extremely sparse, for Central Asia, this network equates to about two metres per km². Under pronounced precipitation deficits, Central Asia's great transboundary rivers, the Amu Darya and Syr Darya, originating in high, glacierized mountains, are vital for the region due to its strong dependence on irrigated agriculture.

One of Central Asia's most serious environmental problems is the condition of the Aral Sea, which now contains less than 15 per cent of its historically recorded maximum water volume. The sea's level has fallen markedly since the 1960s, exposing the original seabed which now fuels dust storms that carry salt and sand over long distances. These changes affect not only the immediate local climate and environmental conditions but also soils, vegetation, water bodies and glaciers in more distant parts of the region.

For these reasons, Central Asia is recognized as experiencing an acute water crisis. Paradoxically, there should be no physical water scarcity here. According to international criteria, a water crisis arises if 2,000 or more people jointly use one million m³ of water per year[24]. In Uzbekistan, it takes only 192 people to use one million m³ of water per year[25]. This underscores the decisive role of water-resources management (and its inefficiencies) in the emergence of the current Aral crisis.

The shares of surface runoff formation in the Aral basin from the three target Central Asian countries detailed in this Atlas are: the Kyrgyzstan —25.4 per cent, Tajikistan—55.4 per cent and Uzbekistan—7.6 per cent *(see Table 7)*. Together, these three account for 88.4 per cent of total runoff, with the remainder coming from Kazakhstan, Turkmenistan and Afghanistan[26].

Under the 1987 Soviet-era quotas, which all Central Asian countries agreed to maintain after 1991, Uzbekistan is entitled to the largest share of water withdrawal for irrigation, namely 47.8 per cent (40.08 km³), this is followed by Turkmenistan with 26.1 per cent (22 km³) and Kazakhstan 11.9 per cent (10.1 km³) *(see Table 8)*[27]. Within this arrangement, total water consumption derived from the Aral Sea basin was to be 84.9

24 Wegerich K. (2003) Water: The Difficult Path to a Sustainable Future for Central Asia. In: Spoor M. (ed.). Transition, Institutions and the Rural Sector. London: Routledge: 247–259.
25 Smith D.R. (1995) Environmental Scarcity and Shared Water Resources in Post - Soviet Central Asia. Post - Soviet Geography. 36: 351-370.
26 UNECE (2004) Strengthening cooperation for rational and efficient use of water and energy resources in Central Asia. UN: New York. 110 P. effuse_en.pdf (unece.org).
27 Ibid.

km³, notably less than the combined Amu Darya and Syr Darya runoff flowing into the basin which was typically 115.60 km³. This excess flow guaranteed an "ecological influx" into the Aral Sea of about nine cubic kilometers during the growing season, when water demand peaks. In the late 1980s, the Soviet government envisaged gradually increasing the Amu Darya's 'ecological flow' from 6.4 to 8.7 km³ by 1990 and to 20 km³ by 2005, however, these plans were never realized. In the first decade of this century, the average 'ecological flow' of the Amu Darya and Syr Darya was 7.4 km³ [28] which did not halt the Aral Sea's shrinkage nor the formation of the resultant Aralkum Desert on the desiccated seabed[29]. International experts estimate that at least 23 km³ per year would have been required to prevent the sea's retreat[30], and no less than 55 km³ to gradually restore it to its former extent (over ~six decades)[31].

Soviet-era basin quotas were apparently determined by the availability of land potentially suitable for irrigation and the principle of equal water provision per irrigated hectare. The Aral Sea basin covers 1.5 million km², of which only 100,000 km² (6.5 per cent) are croplands. Uzbekistan has the largest share of this cropland in the basin, 51 per cent (52,100 km²), hence it having the largest share for water withdrawal *(see map 'Water management')*. For some of the other countries, Tajikistan's croplands constitute 8.6 per cent (8,700 km²) of croplands in the basin. The Kyrgyz Republic has the smallest area of arable land in the basin – 2.3 thousand km² (2.3%), and the majority of the country's cultivated areas (60%) are located outside the basin[32]. Also of note here is the fact that the entirety of Uzbekistan's and Tajikistan's croplands lie within the Aral Sea basin.

Water resources are simultaneously among the most important and vulnerable components of the natural environment, changing rapidly under the influence of human activities and climate change. As previously noted, Uzbekistan's water resources are almost entirely transboundary in nature. The principal transboundary rivers are the Amu Darya, Syr Darya and Zaravshan (formerly a tributary of the Amu Darya). All of the republic's irrigation areas (oases) lie within these basins *(see maps 'Share of irrigated land in basins'; 'Irrigated and drained lands')* as they historically always have *(see map 'Historical irrigation areas')*.

Table 7. Formation of surface runoff flowing into the Aral Sea basin

Country	Amu Darya (km³)	Amu Darya (per cent)	Syr Darya (km³)	Syr Darya (per cent)	Total (km³)	Total (per cent)
Uzbekistan	4.70	5.99	4.14	11.15	8.84	7.65
Tajikistan	62.90	80.17	1.10	2.96	64.00	55.36
Kyrgyzstan	1.90	2.42	27.40	73.77	29.30	25.35
Turkmenistan	2.78	3.54	–	–	2.78	2.40
Kazakhstan	–	–	4.50	12.12	4.50	3.89
Afghanistan	6.18	7.88	–	–	6.18	5.35
Total	**78.46**	**100**	**37.14**	**100**	**115.60**	**100**

Table 8. Agreed limits on surface-water abstractions among Central Asian countries (excluding return flows)

Country	Amu Darya (km³)	Amu Darya (per cent)	Syr Darya (km³)	Syr Darya (per cent)	Total (km³)	Total (per cent)
Uzbekistan	29.60	48.20	10.48	46.19	40.08	47.6
Tajikistan	9.50	15.40	1.81	7.98	11.31	13.4
Kyrgyzstan	0.40	0.60	0.39	1.72	0.79	0.9
Turkmenistan	22.00	35.80	–	–	22.00	26.1
Kazakhstan	–	–	10.01	44.12	10.01	11.9
Total	**61.50**	**100**	**22.69**	**100**	**84.19**	**100**

The Amu Darya's mean annual discharge is 78.46 km³, a figure derived from its typical range of 58.6 to 109.9 km³ *(see map 'Annual runoff')*. Of this, 62.8 km³ (80 per cent) is generated in Tajikistan and only 4.7 km³ (6 per cent) in Uzbekistan, even though 81.5 per cent of Uzbekistan's territory (and all its major irrigation areas) lies within the Amu Darya basin.

The Amu Darya's flow is regulated by a total of 51 Soviet-era reservoirs with a combined volume of 34.6 km³ *(see map 'Dams and reservoirs')*. In Turkmenistan, there are 21 relatively small reservoirs in the Amu Darya basin totaling 8.4 km³ while Tajikistan has only six reservoirs, but their volume exceeds 11 km³. Uzbekistan has 25 reservoirs in the basin and these have a modest combined volume of 14.9 km³. The largest of Uzbekistan's reservoirs is the Tuyamuyn Hydrosystem (commissioned in 1979), a complex of four reservoirs totaling 7.8 km³ located in Khorezm Region and jointly used with Turkmenistan. This reservoir complex is crucial for regulating irrigation water allocation in both republics. Smaller Uzbek reservoirs are embedded in complex irrigation-canal systems and regulate seasonal flows *(see map 'Volume of lakes and reservoirs in basins')*. The Amu Darya ranks among the world's muddiest rivers, creating siltation problems in reservoirs—including Tuyamuyn—which reduces effective storage.

Water withdrawals in the Amu Darya basin are coordinated by the Basin Water Organization 'Amu Darya', which is tasked with synchronizing withdrawals from canals in the Uzbek and Turkmen parts of the basin with releases from the Nurek Reservoir on the Vakhsh River in Tajikistan[33]. With an agreed quota of 40.4 km³, the Interstate Commission for Water Coordination (ICWC) allocated Uzbekistan an average annual limit of about 23.6 km³ during the period from 1992 to 2021, of which about 15 to 17 km³ were used in the growing season. This level of abstraction does not guarantee the desired average 'ecological flow' set by the ICWC of 4.6 km³ for the lower Amu Darya. As a result, some 50 large lakes in the river's delta in the Priaralye have disappeared. To help counter this, Uzbekistan is taking measures to establish water-protection zones and improve ecological conditions in the lower Amu Darya through large-scale afforestation.

28 Lutz et al. (2012) Climate change impact and adaptation on the water resources in the Amu Darya and Syr Darya River basins. FutureWater Report. 31. 116 P.

29 Klemm W., Shobair S.S (2010) Impact of Irrigation in Northern Afghanistan on Water Use in the Amu Darya Basin. FAO Rome. 13 P. Microsoft Word - Draft_FAO_Paper_08OCT2010_-WK final.docx.

30 Wegerich K. (2005) Institutional Change in Water Management at Local and Provincial Level in Uzbekistan. Frankfurt am Main: Peter Lang. 256 P.

31 Miklin V. (2005) Water and the future of the Aral Sea Basin. Aridnye Ekosistemy (Arid Ecosystems). 11 (26–27): 8–23. (In Russian)

32 UNECE, 2004.

33 UNECE (2011) Second Assessment of Transboundary Rivers, Lakes and Groundwaters. Tashkent. 448 P. (In Russian)

The maximum sustainable abstraction of groundwater resources in the Amu Darya basin is estimated at 7.1 km³ per year, with average withdrawals currently around 4.8 km³. This groundwater, which is also transboundary *(see map 'Depth of underground water')*, is used to supply settlements with drinking water. The large Karatag (Tajikistan)–Northern Surkhandarya (Uzbekistan) aquifer, which covers approximately 7,000 km² and is up to ~100 m thick, is associated with clastic deposits in Tajikistan and flows toward Uzbekistan, where it is associated with gravel deposits. Another smaller (343 km²) transboundary aquifer located in Uzbekistan, the Kafirnigan, was formed under similar geological circumstances. In both aquifers, instances of contamination by agricultural return flows have been recorded *(see map 'Underground water pollution')*[34].

Uzbekistan's important irrigation areas also lie within the basin of Central Asia's second-largest river, the Syr Darya *(see map 'Density of irrigation canals')*. The Syr Darya basin covers only 13.5 per cent of Uzbekistan's area but provides 37 per cent of the country's irrigation-water needs. Mean annual discharge is 37.2 km³ (typical range is 23.6 to 51.1 km³). Within the Syr Darya basin, surface runoff generated in the Kyrgyz Republic is 27.6 km³; in Uzbekistan 6.2 km³; in Tajikistan 1.0 km³; and in Kazakhstan 2.4 km³. The ICWC has set the growing-season withdrawal from the Syr Darya at 11.9 km³. Uzbekistan's annual quota from the Syr Darya is 8.8 km³, the vast majority of which is used for irrigation (93.8 per cent). Summer-season withdrawal limits are 0.27 km³ for the Kyrgyz Republic, 1.9 km³ for Tajikistan, and 0.8 km³ for Kazakhstan. The 'ecological flow' for the Syr Darya basin is 4.5 km³, including 1.78 km³ to maintain wetland ecological conditions and 2.7 km³ per year to support what remains of the Aral Sea.

A distinctive feature of the Syr Darya is its highly regulated regime, with the largest regulators located outside Uzbekistan. The largest reservoir, the Toktogul which holds 19 km³, is on the Naryn River in the Kyrgyz Republic. The repurposing of the Toktogul reservoir from purely irrigation to providing hydropower in the 2000s substantially affected the stability of water deliveries to the Fergana Valley during the growing season. The Syr Darya's flow is also regulated in Tajikistan by the Kairakkum Reservoir, which is also known as the 'Tajik Sea' and holds 3.4 km³ of water. Significant siltation in this, the oldest reservoir in the basin (built in 1950), has raised concerns that seasonal regulation could become infeasible, leaving it only with transport and/or hydropower functions[35]. The Shardara Reservoir (5.2 km³) in Kazakhstan is not a direct regulator for the Syr Darya in Uzbekistan's sector, however, it determines the water balance of Uzbekistan's Aydar–Arnasay lake system. Construction of the Koksaray counter-regulator in Kazakhstan (~three km³, completed in 2011) prevented winter floods in southern Kazakhstan, particularly those caused by winter releases from the Toktogul reservoir, but it has also reduced inflows to this Ramsar-designated lake system. In Uzbekistan's portion of the Syr Darya basin, there are 10 reservoirs with a combined volume of only 5.6 km³, the largest being the Andijan (1.75 km³) and Charvak (2.0 km³) reservoirs *(see Box 1)*.

Fourteen transboundary groundwater aquifers have been identified in the Syr Darya basin. The largest of these, the Syr Darya-1 (area 189,000 km²; maximum depth ~3,000 m), is weakly connected to surface waters and only some 0.067 km³ were abstracted from it in 2009, primarily for Uzbekistan's domestic needs.

34 UNECE, 2011.

35 Abdushukurov et al. (2016) The state of the Kayrakkum reservoir. Vestnik Tadzhikskogo Natsionalnogo Universiteta. Seriya Estestvennykh Nauk. 1 (192): 218–223. (In Russian)

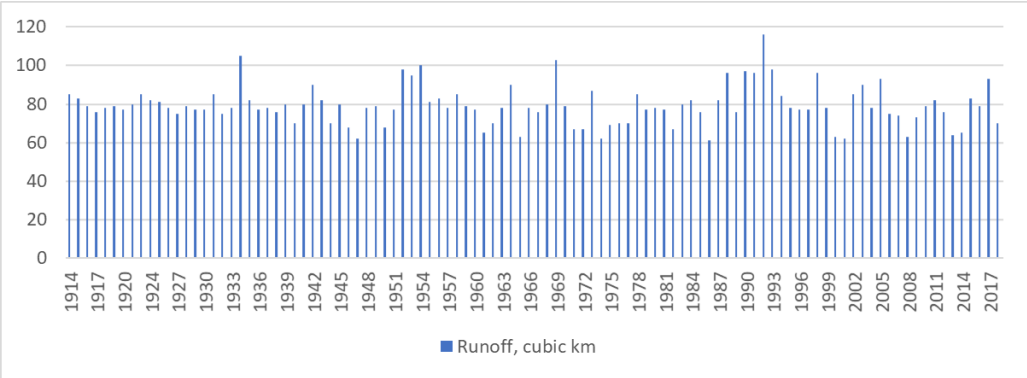


Fig. 2. Volume of flow of the Amu Darya, km³, 1914–2017[1].

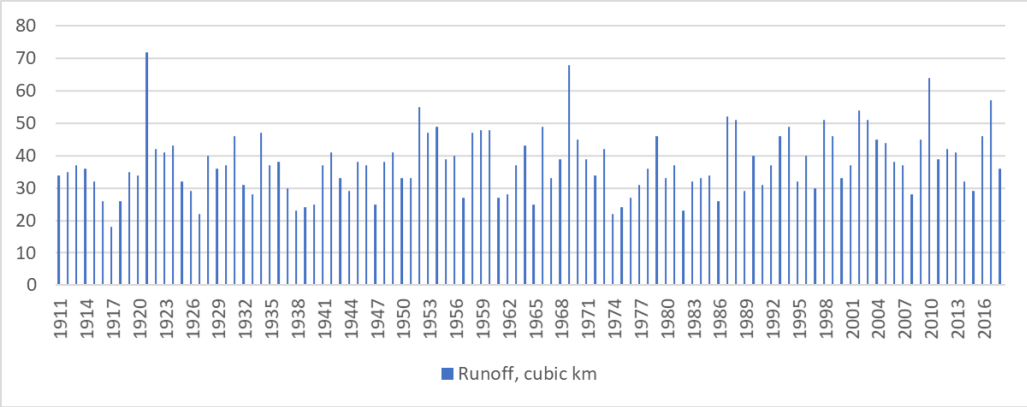


Fig. 3. Volume of flow of the Syr Darya, km³, 1914–2017[2].

1 Handbook..., 2019.
2 Ibid.

The Amu Darya and Syr Darya basins are separated by the Zaravshan River Valley, which spans Tajikistan's Sughd Region and Uzbekistan's Samarkand, Jizzakh, Navoi and Bukhara regions. The Zaravshan river originates from the Zaravshan Glacier in Tajikistan, however, by the time it flows into Uzbekistan it has taken on a lowland character, splitting into branches and forming islands. The river's present length is 870 km and its basin area is roughly 40,600 km². The main irrigation canal network in the Zaravshan Oasis is 3,140 km long; 40 per cent of which is lined with concrete and 60 per cent is strengthened. From this main network, water is distributed through small on-farm canals totaling 17,400 km, just over 10 per cent of which are lined *(see map 'Agriculture land served by irrigation canals')*. It is estimated that up to half of the water diverted into this network for irrigation is lost through infiltration and evaporation[36]. Until 1957, the Zaravshan River discharged into the Amu Darya, however, the expansion of cropland in its lower reaches has since led to the complete abstraction of its water for irrigation. The Zaravshan's mean annual runoff is 5.3 km³, generated almost entirely in Tajikistan. The volume currently used to irrigate the 559,000 ha of cropland the river supports is 6.6 km³, creating a 1.3 km³ deficit, which is being covered by reuse and return flows from drainage canals.

Hydrographs of the Amu Darya and Syr Darya show no definite trends over from 1914 to 2017 that could be linked to climate change, even though the latter has accelerated over the last 30 years *(Figs. 2 and 3)*. Instead, local experts note pronounced cyclicity in the discharge of these rivers, which are understood to be 12 years for the Syr Darya and 19 years for the Amu Darya. Climate models do not predict significant changes in Amu Darya and Syr Darya discharge in the near term[37], largely because both rivers have large snowmelt contributions, 35.2 and 26.9 per cent respectively, and snow cover responds rapidly to warming. Regression-based climate models indicate a decrease in the snow-covered area as mean annual temperatures rise across all basins, with the fastest reductions in basins occupying lower topographic positions. As a result, a reduction in runoff is possible into the basins of smaller rivers even in the near term.

Glaciers are the next most important source of river discharge in the region after atmospheric precipitation. In recent years (between 2000 and 2012), ice reserves declined relative to the 1961 to 1981 period by 21 per cent in the Syr Darya basin and by 17 per cent in the Amu Darya basin. Nevertheless, models suggest that even in the medium term, the reduction of growing-season discharges of the region's two main rivers will likely remain within the bounds of their historical natural variability. In the long term, a decrease in discharge of individual rivers is possible, with estimates ranging between five and 42 per cent for the Syr Darya basin and seven to 22 per cent for the Amu Darya basin *(see Box 1)*. In this context, the more intense glacier retreat will result in spring runoff remaining high, while late-summer runoff will decline sharply. This will increase the risk of floods in spring and droughts during the growing season.

The Zaravshan River can serve as a model basin for studying the dependence of runoff volume on climate warming. The river is formed by the confluence of the Matcha and Fondarya rivers in the Gissar–Alai Mountains in Tajikistan. Their contribution to the Zaravshan's total discharge is 57 per cent and 43 per cent respectively. The Matcha River originates from the Zarafshan Glacier, whose tongue lies 2,810 m above sea level. Analysis of discharge data at the outlet of the mountain valley and air temperatures in the headwaters between 1929 and 1995 revealed a mixed picture. A positive relationship between these two parameters (the higher/lower the air temperature, the greater/less the runoff) was observed in 58.7 per cent of years. However, in 23.8 per cent of years, increases in air temperature were accompanied by decreases in runoff and, in 17.5 per cent of years, decreases in air temperature led to increases in runoff[38]. Thus, the magnitude of the river's discharge is also partially determined by the precipitation regime in the upper basin. According to available data[39], the average annual rate of glacier degradation in the basin of the Zarafshan Glacier from 1980 to 2017 (0.24 per cent per year) was almost twice as low as it was between 1957 and 1980 (0.42 per cent per year). Thus, a clear discharge trend under accelerated climate change is not yet evident and the interannual variability of the Zaravshan's runoff remains within its historical natural variability, as was observed for the Amu Darya and Syr Darya.

Within Uzbekistan proper, glaciers are located in three river basins: the Kashkadarya and Surkhandarya (in their respective eponymous regions) and the Pskem, in the Tashkent Region *(see map 'Ice volume in glaciers' in Section 7.2)*. A comparison of the 1960 and 1980 glacier catalogues for Uzbekistan, combined with the results of processing 2010 satellite imagery, shows glacial reductions in all three basins: those glaciers in the Kashkadarya basin lost nearly half their area (from 10.3 to 20.3 km²), those in Surkhandarya lost up to 40 per cent (from 31.5 to 52.1 km²) and those in the Pskem basin 23 per cent (from 93.6 to 121.2 km²). The mean rate of glacier shrinkage is 0.1 m per year. This has not noticeably affected the runoff of these three small rivers.

The rates of glacier-area reduction in Uzbekistan have somewhat slowed since 1980 and are currently around 1.1 per cent per year for the glaciers of the Kashkadarya basin and 0.4 per cent per year for the Pskem and Surkhandarya basins. Compared to 1980, the mean firn-line elevation has risen by 17 m on glaciers of the Pskem basin and by 40 m in the Gissar–Alai basins (Kashkadarya and Surkhandarya). The uneven retreat of glaciers across these three basins is linked to local climatic conditions. On average, between 1970 and 2010, the summer air temperatures from June to August in the Kashkadarya basin (as measured by the Minchukur station) were 6.1°C higher than in the Pskem basin (as measured at the Oygaing station) at the same elevation (2,120 m). Different rates of glacier-area reduction in the south-western mountain regions are explained by the fact that the southern slope of the Gissar–Alai, where the Surkhandarya basin is located, receives more precipitation than the western slopes of the Gissar Range, where the Kashkadarya basin is located[40].

At present, interannual runoff variability may be a more pressing risk than climate change. Rivers in Central Asia are characterized by high discharge variability as these are largely driven by the climatic situation in any given year. For example, in extremely hot and dry years, basin runoff volume can decrease by 25 to 50 per cent, sharply exacerbating existing water deficits. River-water quality also depends on these discharges; in low-flow years and seasons, mineralization exceeds maximum permissible concentrations (MPC) *(see Box 2)* and this elevated mineralization of river water causes secondary salinization of irrigated soils. This situation is exacerbated by the deposition of salts with dust from the desiccated seabed of the Aral Sea which, while it is a contributing factor in soil salinization in the middle and lower Amu Darya, it is an order of magnitude smaller than salt inputs from irrigation waters: the figures here being 1.0 to 3.0 and 13 to 25 t/ha, respectively[41].

Uzbekistan, as the largest water user in Central Asia,

36 Groll et al. (2013) Water quality, potential conflicts and solutions—an upstream–downstream analysis of the transnational Zarafshan River (Tajikistan, Uzbekistan). Berlin: Springer-Verlag Berlin Heidelberg. 21 P.

37 Third National Communication of the Republic of Uzbekistan to the UN Framework Convention on Climate Change (2016) UzHydromet: Tashkent. 221 P.

38 Groll et al., 2013.

39 Karandaev S.V., Karandaeva L.M (2021) Assessment of Modern Glaciation of the Zaravshan Basin. Central
Asian Journal of Geographical Research. 3–4: 75–86. (in Russian)

40 Semakova E.R., Semakov D.G. (2017) On a possibility to use the remote sensing techniques for glaciological analysis in mountain regions of Uzbekistan. Led i Sneg [Ice and Snow]. 57 (2): 185–199. (In Russian)

41 Eshchanov O.I (2021) Analysis and assessment of the water quality of the Amu Darya
River. Scientific and Information Center ICWC. Tashkent. 59 P. (in Russian)

bears substantial responsibility for the rational use of water resources in the Aral Sea basin since, as previously noted, it consumes almost 48 per cent of the total Amu Darya and Syr Darya runoff country *(see Table 8)*. The principal water use in Uzbekistan is irrigated agriculture and increased withdrawals for this purpose, combined with the low efficiency and wastage of its irrigation systems, at times reduce these key rivers' discharges to below the required ecologically-sound levels.

Box 1. Change in the Surface Area of Central Asian Reservoirs as an Indicator of Climate Change

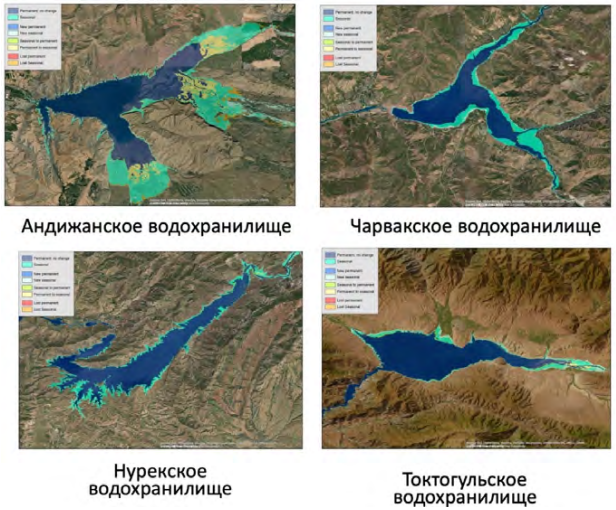


Fig. 4. Dynamics of inundation zones in large reservoirs in the target countries[42].

Reservoirs in the upper reaches of rivers differ hydrologically from those located downstream. Downstream of reservoirs, river regimes depart markedly from natural conditions because they depend entirely on releases from the headwater pool. Upstream of reservoirs, anthropogenic influence in this sense is limited. Thus, the upstream area can be treated as a near-natural system without direct human intervention on its flows and changes in its hydrological regime may serve as an indicator of broader environmental change across the relevant catchment area[43].

42 Freshwater Ecosystems Explorer SDG 6.6.1

43 Immerzeel et al. (2012) Climate Change Impacts on the Upstream Water Resources of the Amu and Syr Darya River Basins. FutureWater Report. 107.103 P.

Table 9. Sources of inflow to major Central Asian reservoirs and projected reductions due to climate change

Reservoir	Source contributions (%) – Glaciers	Snow	Rain	Groundwater	Mean discharge (m^3/s)	Projected maximum change (%) 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	–34.0

Reductions in inflows to reservoirs may reflect climate-driven shifts in a basin, such as declining precipitation, an upward migration of the snow line and glacier retreat. With the exception of baseflow, the contribution of each factor cannot be measured directly and must be modelled under explicit assumptions.

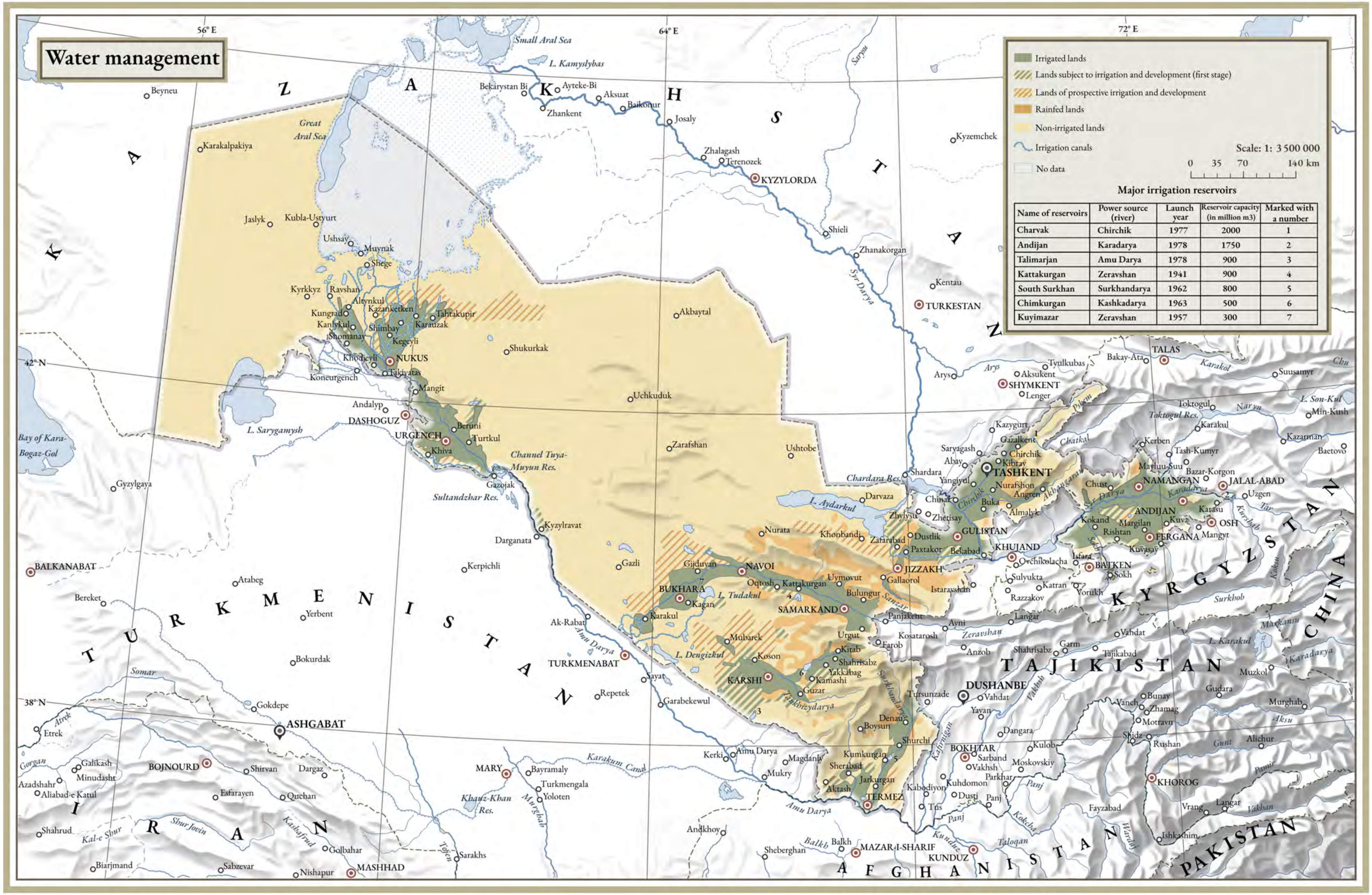
The Nurek (Tajikistan; Amu Darya basin) and Toktogul (Kyrgyzstan; Syr Darya basin) reservoirs, located in the upper reaches of their river basins, have very large catchments with observed peak inflows up to ~2,200 and ~1,800 m^3/s, respectively. The Andijan and Charvak reservoirs (both in Uzbekistan; Syr Darya basin), also located in the basin's upper reaches, have smaller catchments and peak inflows of between ~700 and 800 m^3/s. The observed contraction of the inundation zone of the Andijan Reservoir may indicate changing conditions for snow accumulation and retention in the Syr Darya basin. The Charvak Reservoir, which shows no clear signs of drawdown, lies in the Chirchiq River valley and one of the Chirchiq's tributaries (the Pskem River) originates in the small Sredniy Barkrak Glacier (0.087 km^3), which has been retreating since the 1960s[44]. For the Syr Darya as a whole, glacier and snowmelt contributions are ~10.7 per cent and 35.2 per cent, respectively *(see Table 9)*, whereas for the Amu Darya, glacier contributions are ~38 per cent and snowmelt ~26.9 per cent.

Overall changes in water inflow are likely to be negative for these reservoirs over the next 30 years. In general, glaciers in the high mountains of Central Asia exhibit a negative mass balance. Glacial melt plays a much larger role in the total inflows of the Nurek Reservoir than for the Toktogul Reservoir. As the glacier-melt contribution decreases sharply by 2050, inflows to Nurek are expected to decline substantially. For the Toktogul Reservoir, this effect will be much smaller, although the glacial-melt share will fall to zero as the glaciers in that basin disappear. A comparison of the Charvak and Andijan Reservoirs yields a similar conclusion: Charvak is expected to be more sensitive to climate change in the medium term= because glacial melt accounts for a higher share of its water balance.

44 Hoelzle et al. (2017) Re - establishing glacier monitoring in Kyrgyzstan and Uzbekistan, Central Asia. Geoscientific Instrumentation, Methods and Data Systems. 6: 397 - 418.



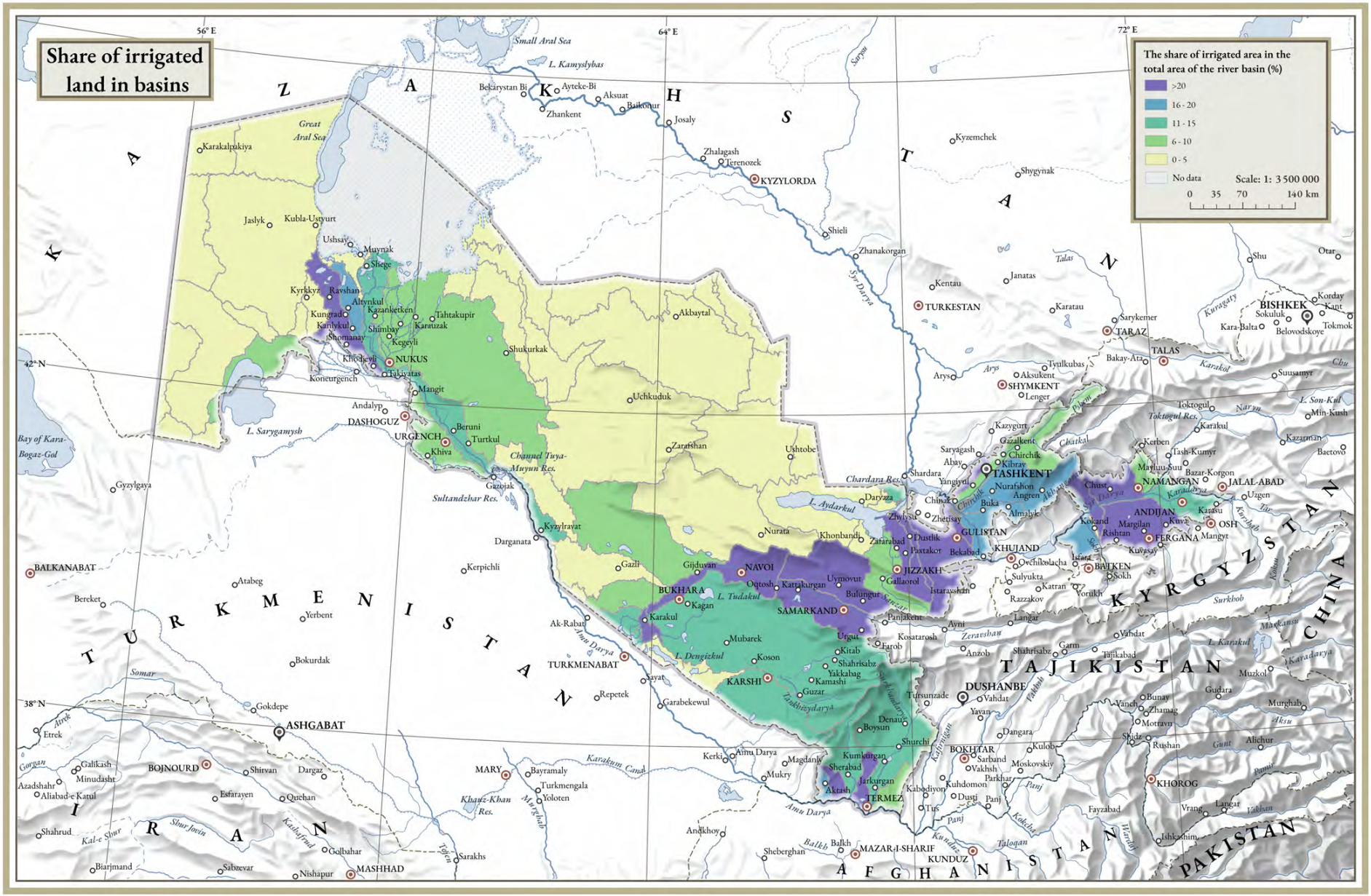
Winter view of the Charvak Reservoir



Name of reservoirs	Power source (river)	Launch year	Reservoir capacity (in million m3)	Marked with a number
Charvak	Chirchik	1977	2000	1
Andijan	Karadarya	1978	1750	2
Talimarjan	Amu Darya	1978	900	3
Kattakurgan	Zeravshan	1941	900	4
South Surkhan	Surkhandarya	1962	800	5
Chimkurgan	Kashkadarya	1963	500	6
Kuyimazar	Zeravshan	1957	300	7

Atlas of the Uzbek SSR. –M.: GUGK, 1981.

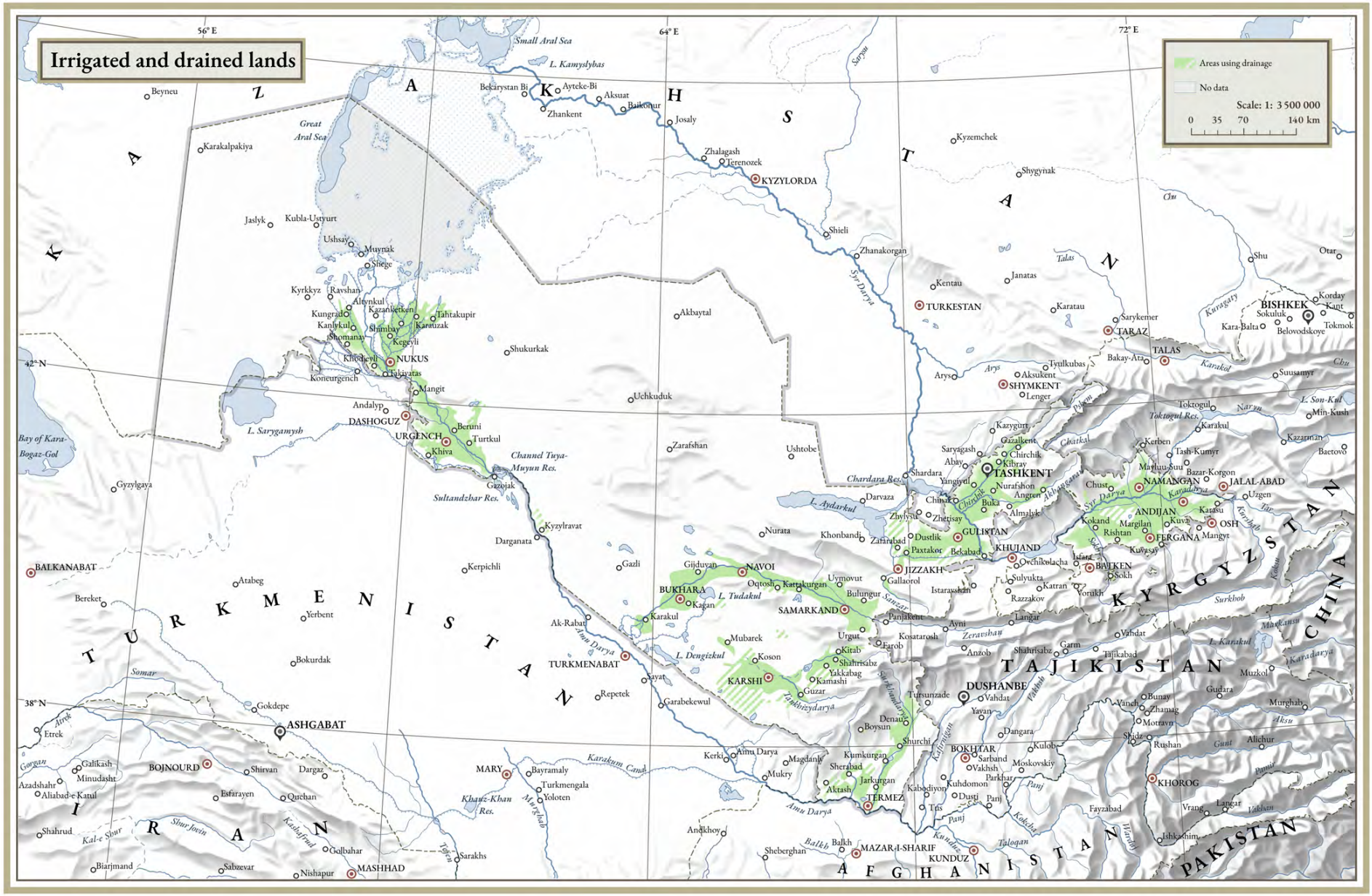
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Based on FAO Global Map of Irrigated Areas[45] modeling, taking into account remote sensing data, landcover classifications, and statistical data on irrigated areas available to FAO, broken down by country and its regions. The spatial resolution of the source is 5 arc minutes.

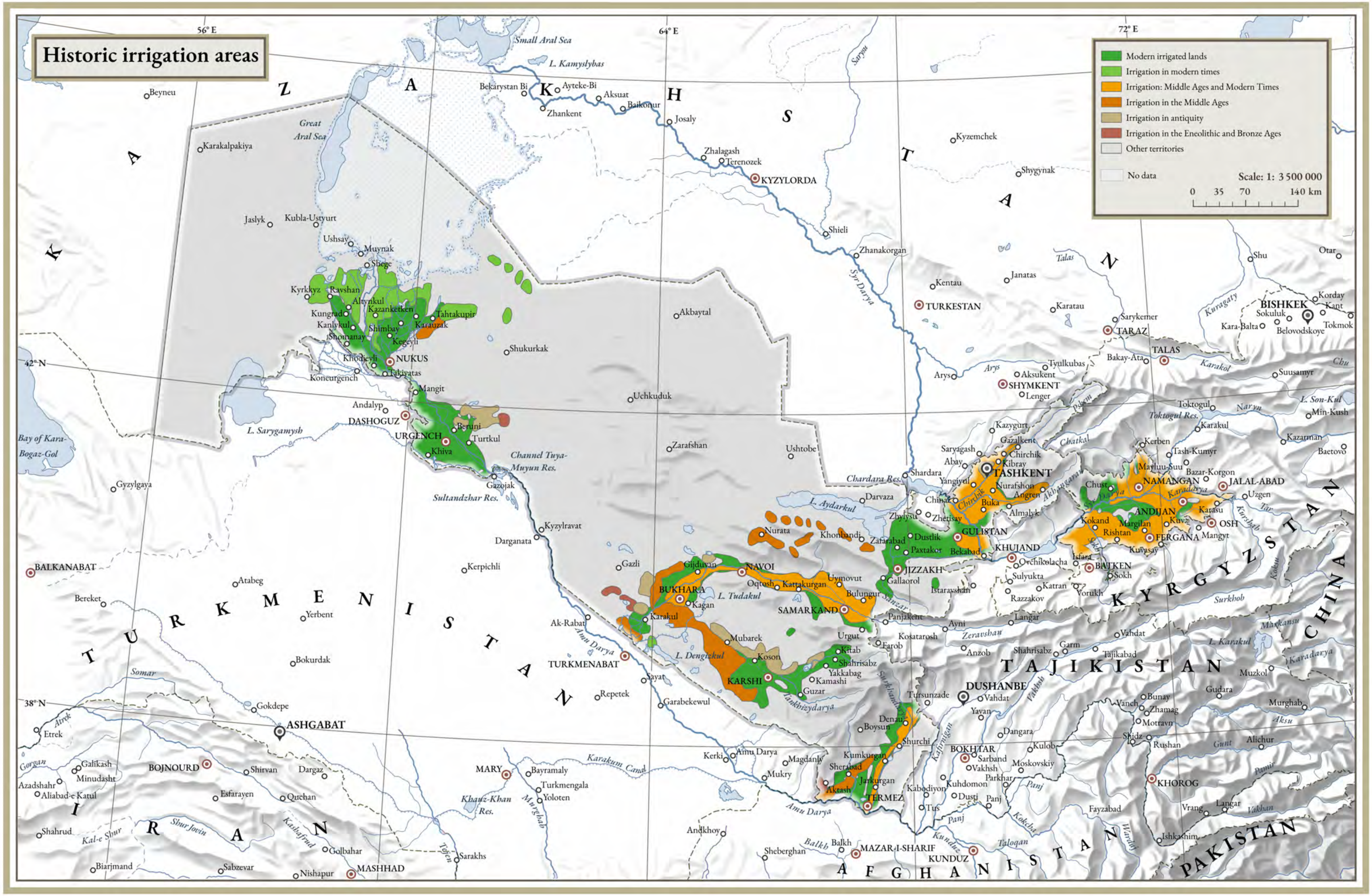
45 AQUASTAT - FAO's Global Information System on Water and Agriculture. fao.org/aquastat/en/geospatial-information/global-maps-irrigated-areas/

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



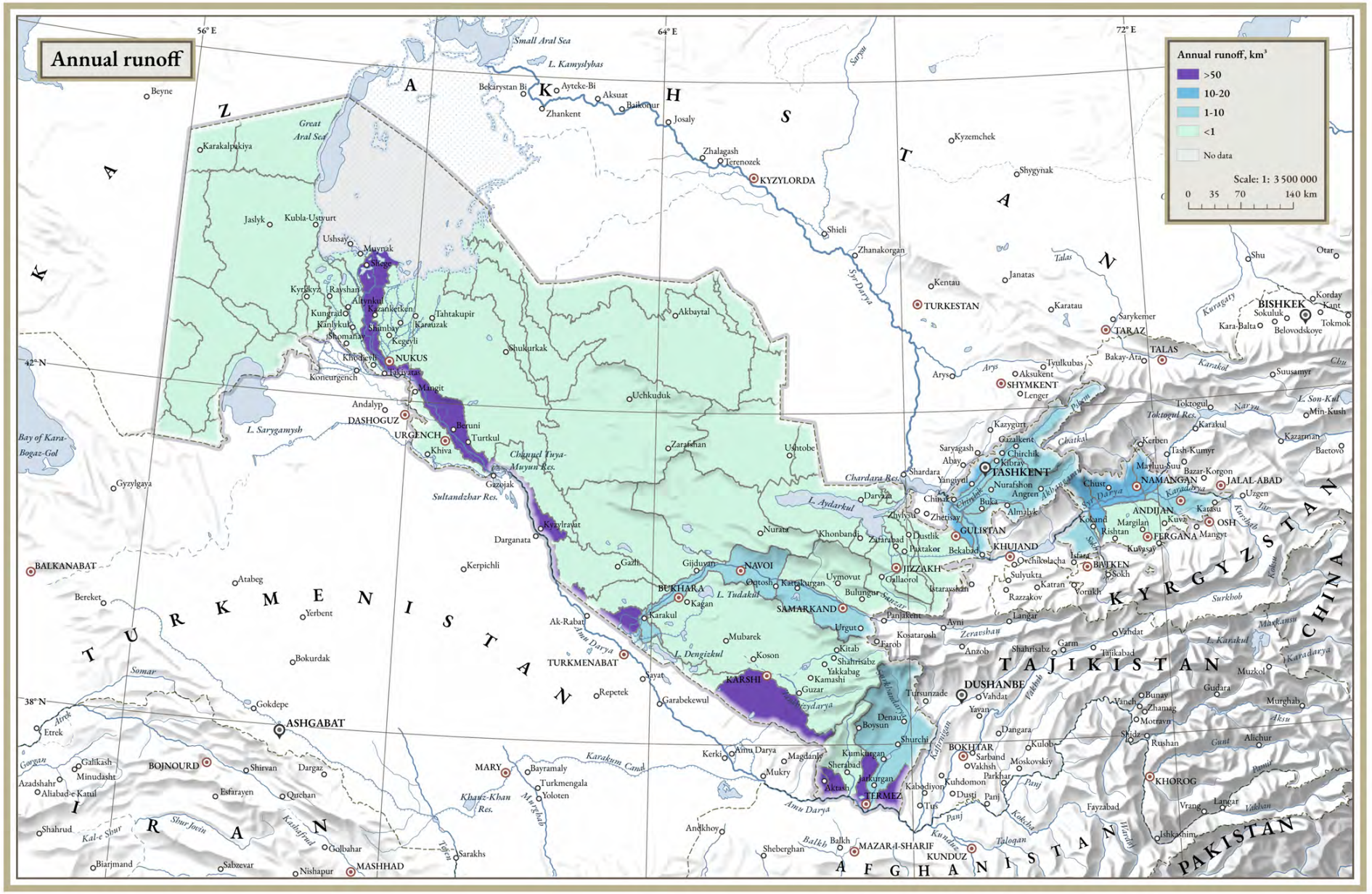
National Atlas of Uzbekistan: in two volumes / Cadastre Agency under the State Tax Committee of the Republic of Uzbekistan. Tashkent: Cartography, 2020. ISBN 978-9943-15-856-6.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



National Atlas of Uzbekistan: in two volumes / Cadastre Agency under the State Tax Committee of the Republic of Uzbekistan. Tashkent: Cartography, 2020. ISBN 978-9943-15-856-6.

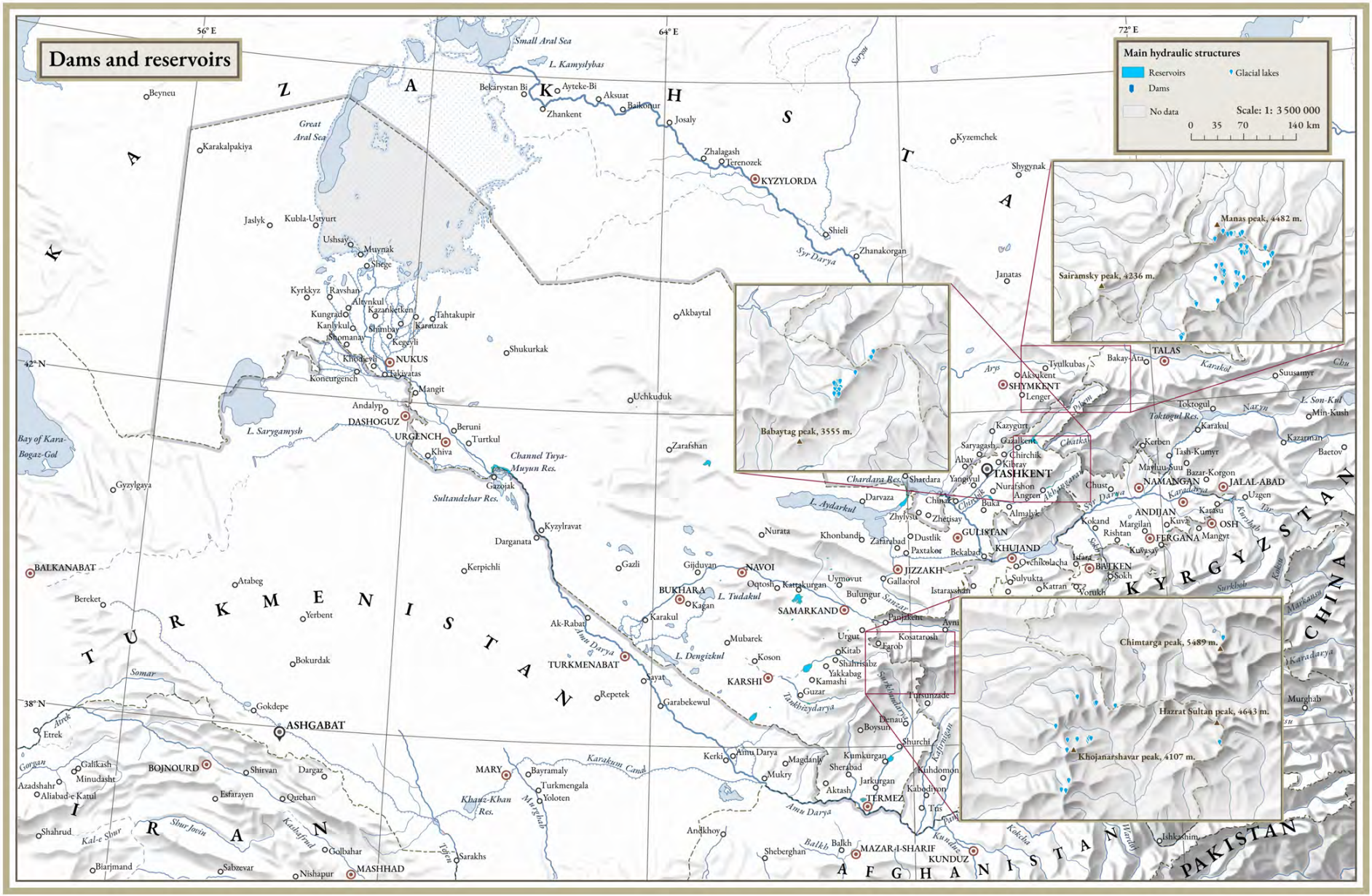
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Based on HydroSHED calculations using the WaterGAP 2.2[46] model and taking into account climate variables, features of the underlying surface, the nature of water use, the presence of artificial reservoirs and reservoirs.

46 http://www.watergap.de/

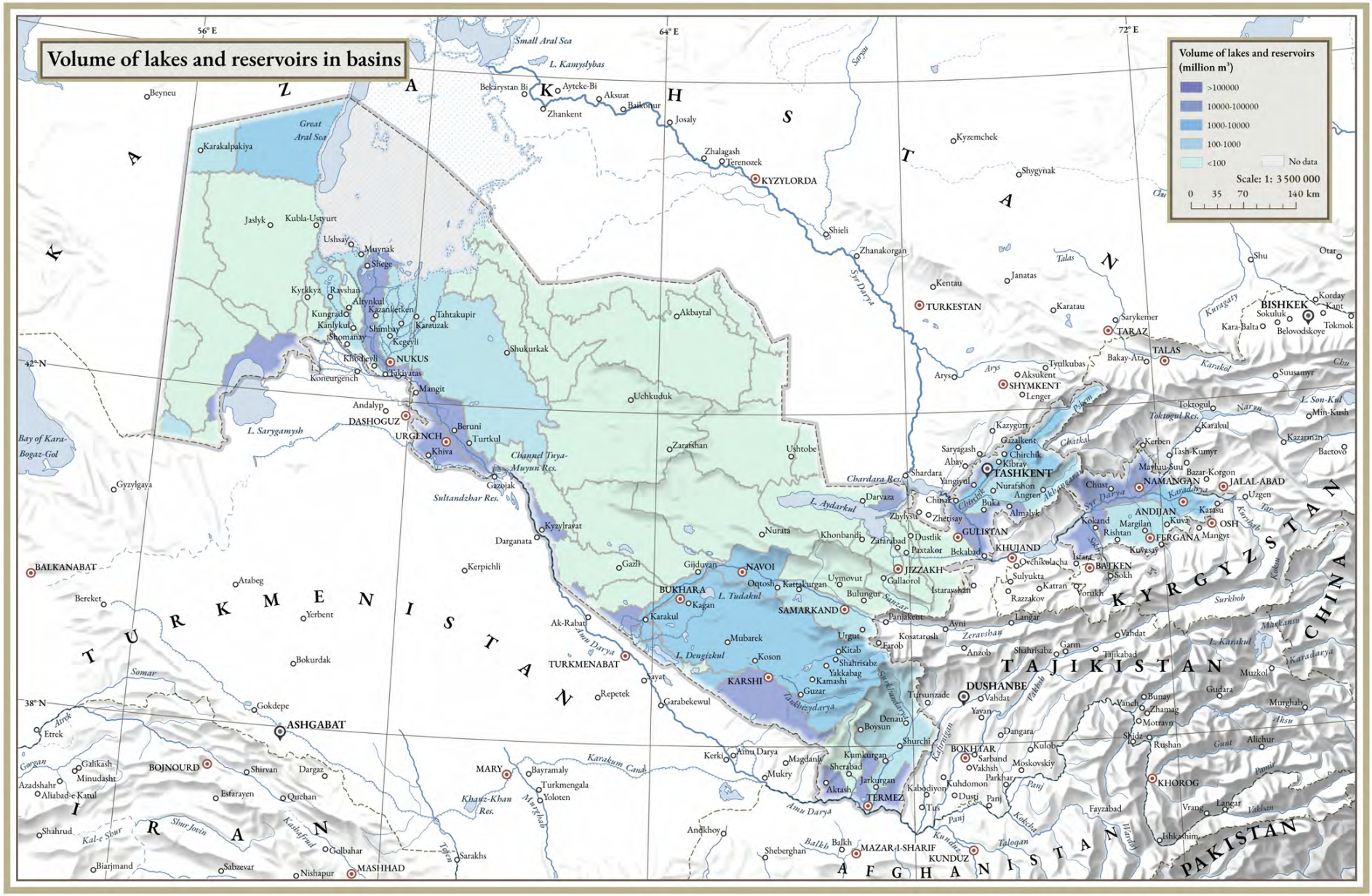
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Based on the global GDW database20[47], which includes over 38,000 dams, it was developed by digitizing visible dams using Google Earth satellite imagery.

47 GlobalDamWatch.org - GOODD

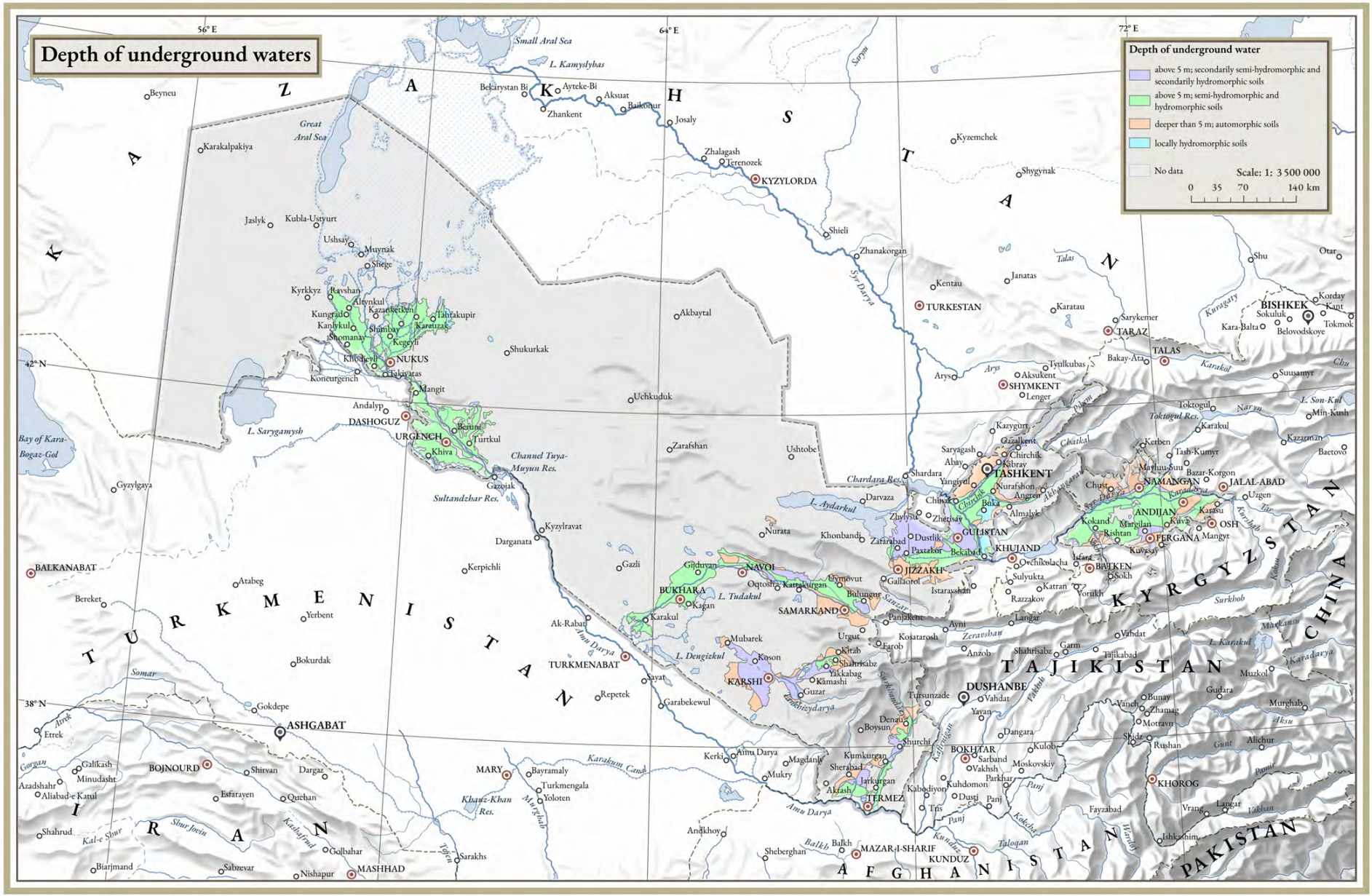
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Based on HydroSHED calculations using a geostatistical model, taking into account lake size, terrain features within a 100-meter radius, and available bathymetric data. Reservoir capacity is based on GRanD data collected from national sources and remote sensing data.[48]

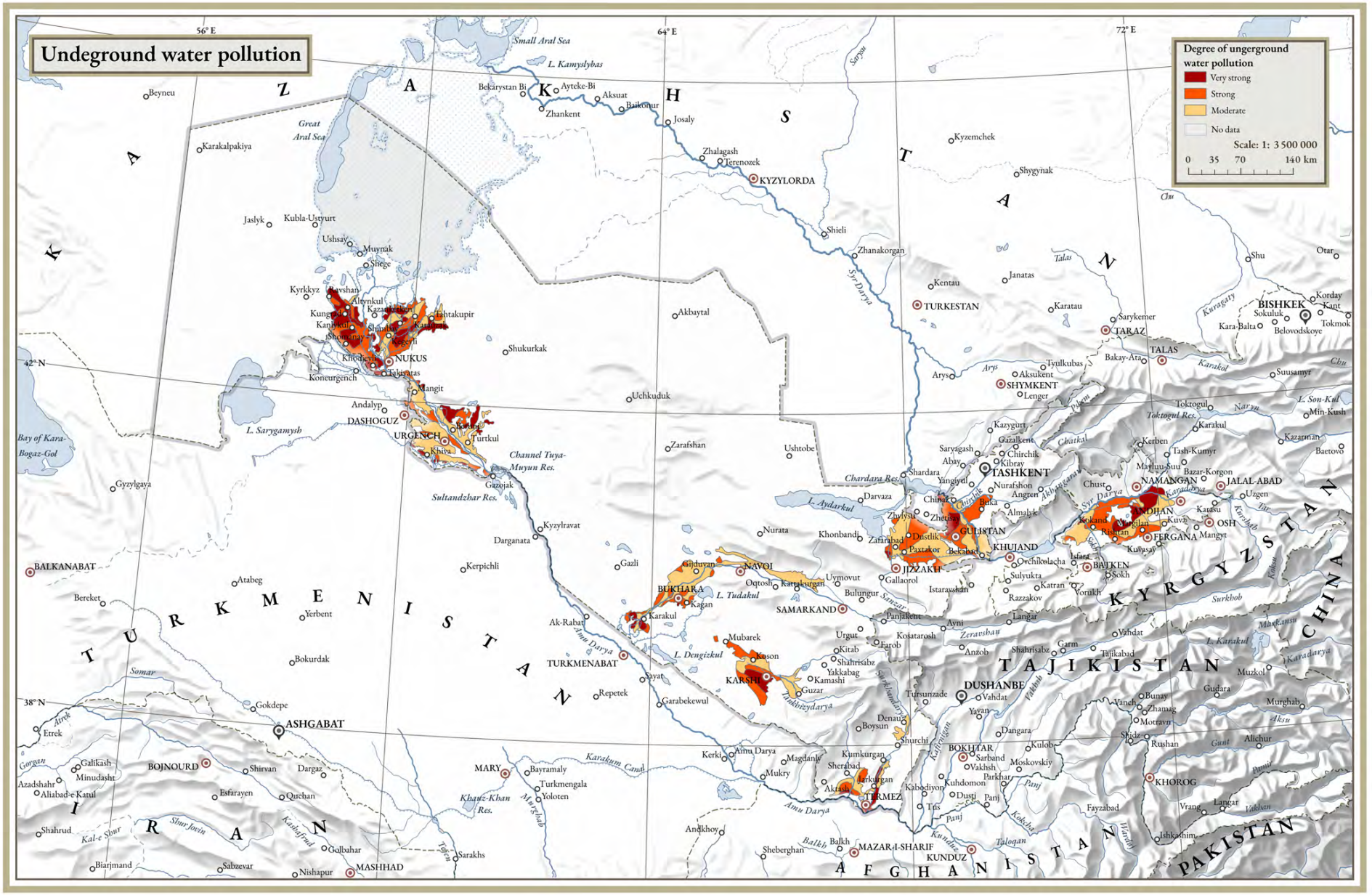
48 https://www.nature.com/articles/ncomms13603

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



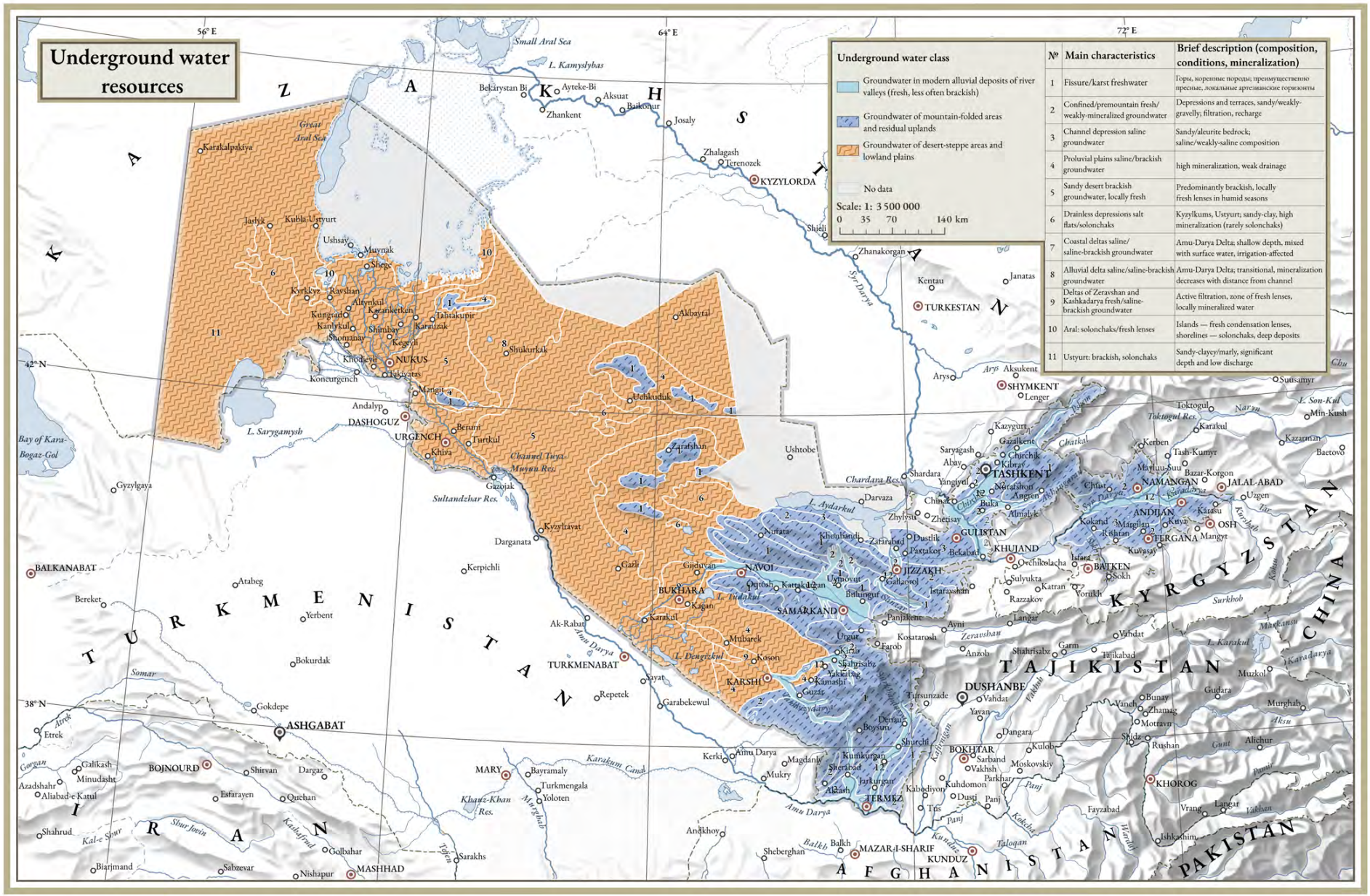
National Atlas of Uzbekistan: in two volumes / Cadastre Agency under the State Tax Committee of the Republic of Uzbekistan. Tashkent: Cartography, 2020. ISBN 978-9943-15-856-6.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



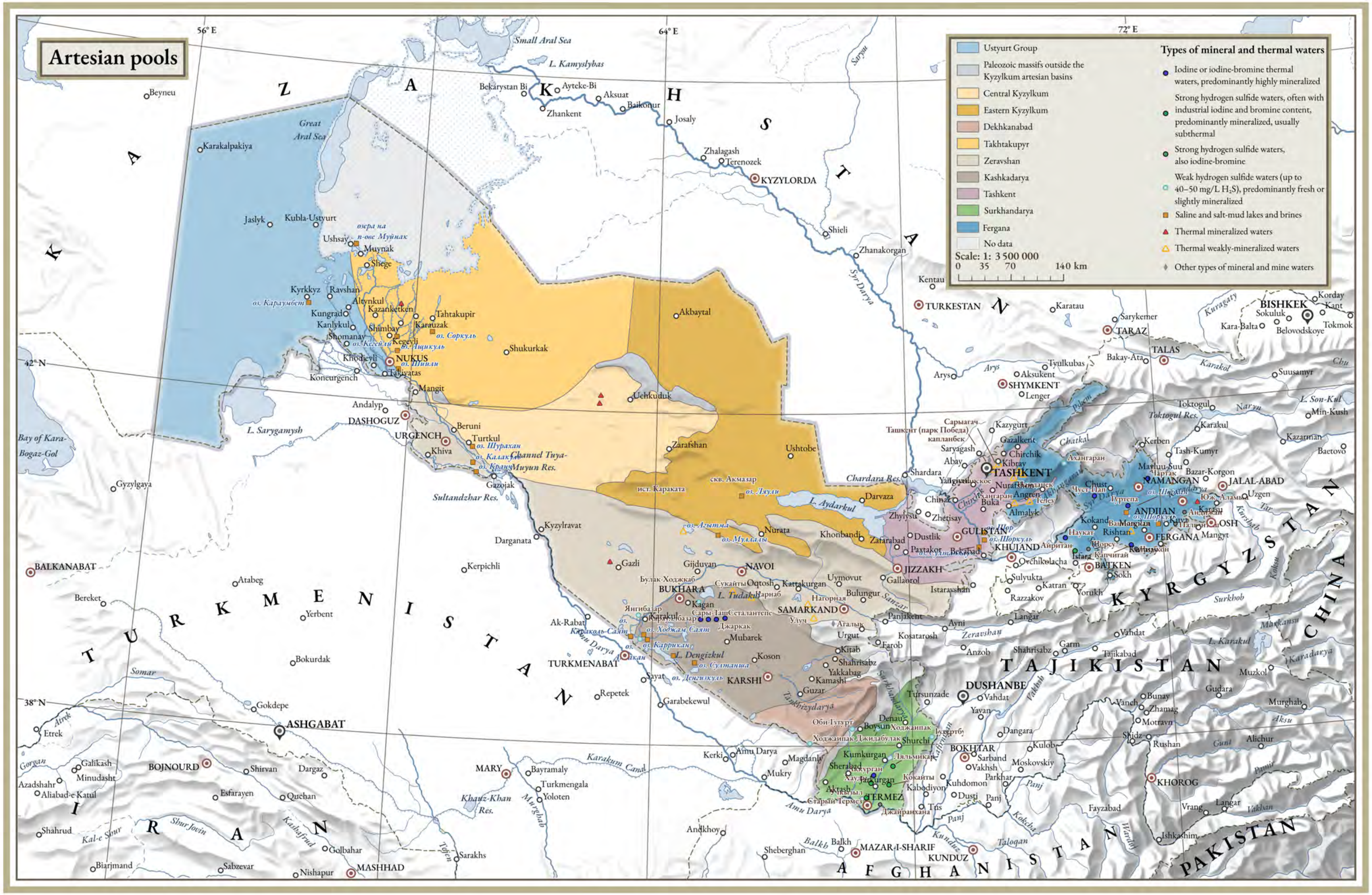
National Atlas of Uzbekistan: in two volumes / Cadastre Agency under the State Tax Committee of the Republic of Uzbekistan. Tashkent: Cartography, 2020. ISBN 978-9943-15-856-6.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



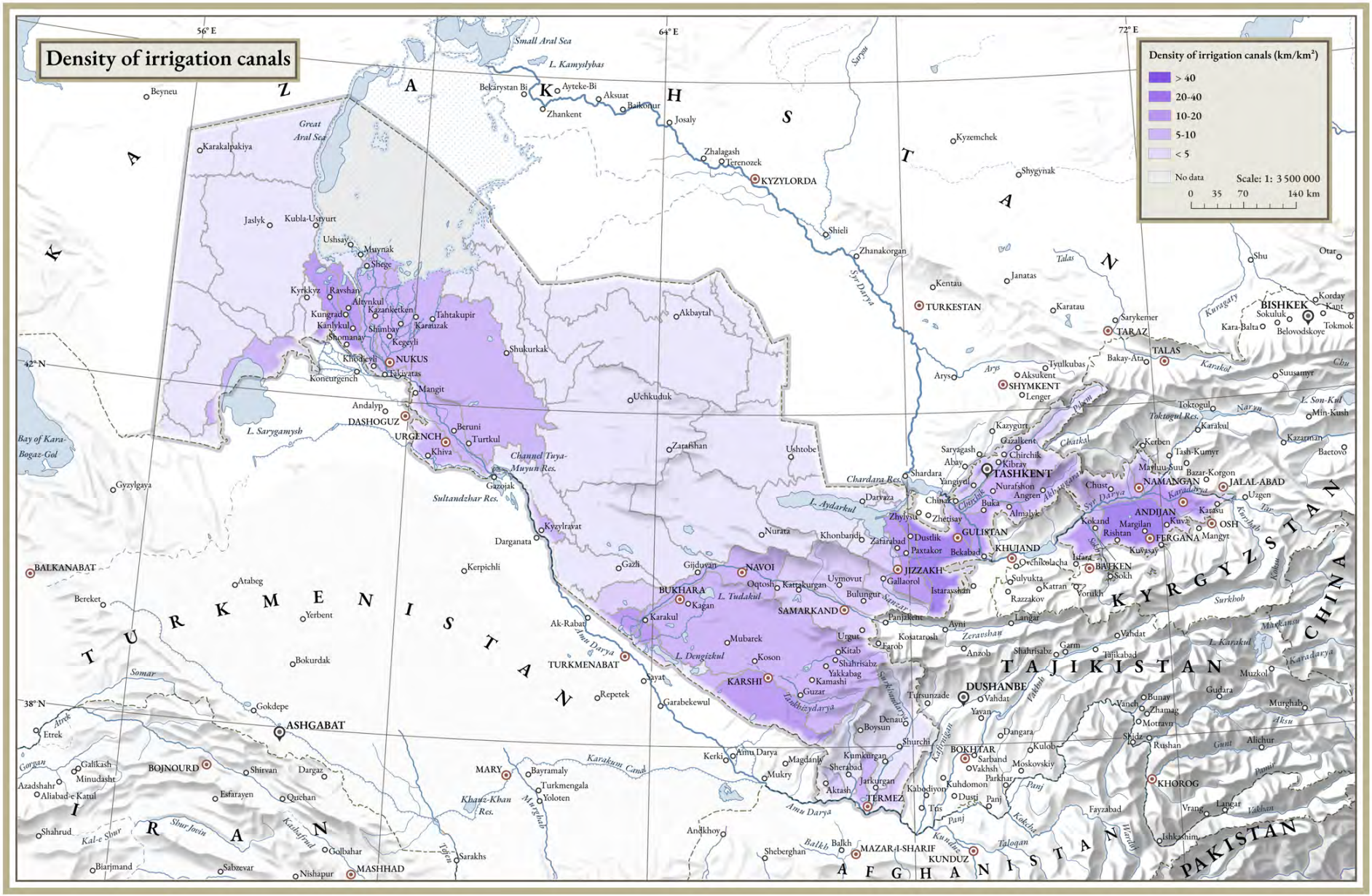
Atlas of the Uzbek Soviet Socialist Republic. – Tashkent-Moscow: Academy of Sciences of the Uzbek SSR; GUGK, 1963.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Atlas of the Uzbek Soviet Socialist Republic. – Tashkent-Moscow: Academy of Sciences of the Uzbek SSR; GUGK, 1963.

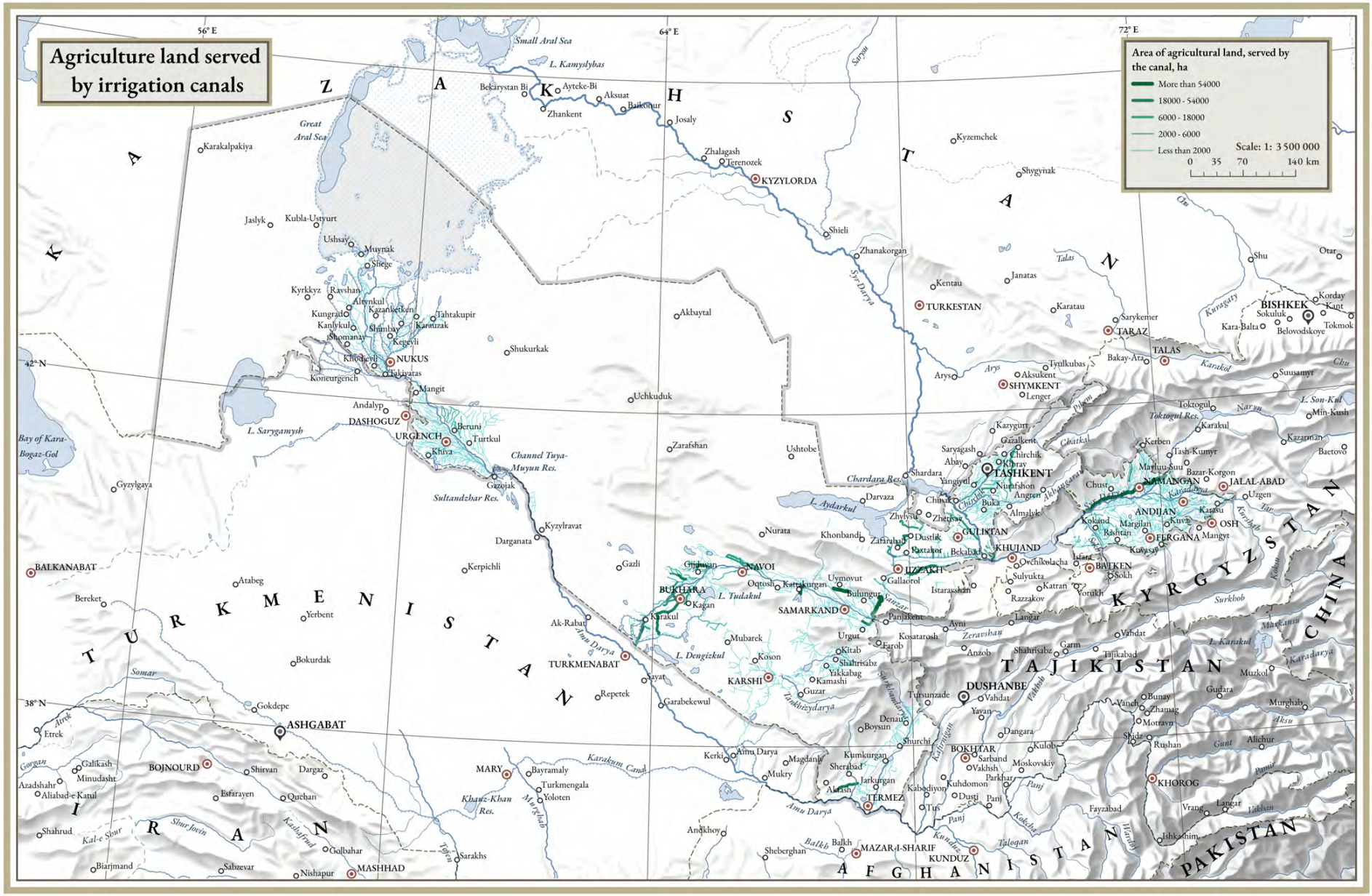
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Based on OSM[49] data, supplemented by visual interpretation.

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

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



According to national coordinators.

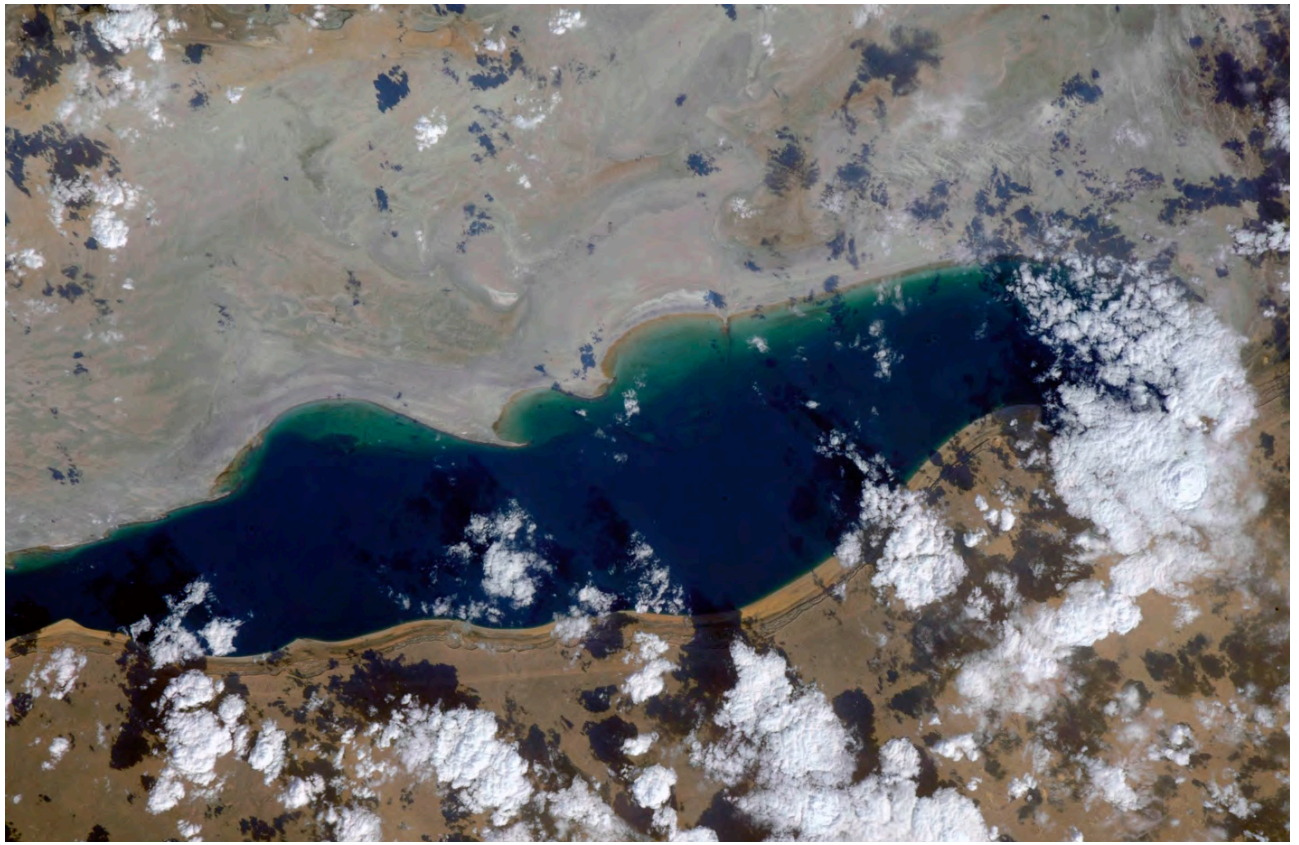
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.

3.3. Towards Achieving the SDGs

Water resources are priority objects for national and international policy in the Republic of Uzbekistan. The international legal framework for water resources management is based on the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (1992). This Convention provides a basis for joint management of shared water resources and for addressing environmental issues related to transboundary waters. Among Central Asian countries, the Convention has been ratified only by the downstream States of the Syr Darya and Amu Darya, namely Uzbekistan (in September 2007), Kazakhstan (in January 2000) and Turkmenistan (in August 2012). However, several regional agreements have been signed by all the States sharing the Aral Sea basin. Since 1992, core regional water policy has been based on the "Agreement on Cooperation in the Field of Joint Management, Use and Protection of Water Resources of Interstate Sources." Under this agreement, the ICWC was established and given the key task to determine annual water-use limits for each republic and for the region as a whole, which requires coordinating operating schedules for all major reservoirs in the Amu Darya and Syr Darya basins (Article 8). Other important regional water-management agreements include the Agreement on Joint Actions to Address the Problems of the Aral Sea and the Aral Sea Region (1993), the Aral Sea Basin Programme (1994), the Nukus Declaration (1995) on the management of the Aral Sea basin and the revised mandate of the International Fund for Saving the Aral Sea (1999).

There are also bilateral agreements on shared water resources that have been concluded by Uzbekistan with its neighbours. For example, transboundary water-management issues are handled operationally between Uzbekistan and Tajikistan through annual joint commissions. In September 2025, Uzbekistan, Kazakhstan and the Kyrgyzstan concluded an agreement on joint actions for managing water and energy resources. Under this agreement, Kyrgyzstan will release most of the water from the Toktogul Reservoir to Kazakhstan and Uzbekistan during the growing season. In return, Kyrgyzstan will receive electricity from both countries. The term of this agreement is currently limited to the spring of 2026, however, if extended, it could resolve one of the region's key post-Soviet challenges known among international experts as the 'water–energy nexus'.

Uzbekistan's domestic water policy is currently being adapted to the SDG framework.



Аральское море, снимок с МКС

In this context, SDG 6.5 provides for the implementation of IWRM at all levels, including in the sphere of transboundary cooperation. The IWRM concept is interpreted in Uzbekistan's official documents fully in line with the definition accepted by the international community. According to this internationally universally used definition, IWRM is "a process that promotes the coordinated development and management of water, land, and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems". This wording serves to elucidate a general principle that can be filled with specific content depending on regional and/or national needs. For Central Asian countries, the most important IWRM tasks are: full 'hydrographization' of territorial water-allocation systems at all administrative levels to reduce the risk of water conflicts; routine application of improved irrigation-norm calculation methods; and development of self-governance at the level of individual farms and their associations, key among the latter are Water Users Associations (WUAs). Experience from two pilot projects, the 'IWRM and Water Saving Plan for the Zaravshan River Basin' (2002) and the 'IWRM–Fergana' (2008), showed that many existing issues can be addressed within a sound IWRM framework[50].

50 GWP (2014) Integrated water resources management in Central Asia. IWRM - Central – Asia - TFP v15 (gwp.org). (in Russian)



Озеро Чарвак

In 2003, a system as put in place that officially established ten Basin Administrations of Irrigation Systems (BAIS) along with fifty Irrigation System Administrations (ISAs). In 2017, this system was adjusted to better align these administrative entities with hydrographic boundaries. As a result, instead 10, six BAIS were organized: Lower Syr Darya, Syr Darya–Zaravshan, Lower Amu Darya, Left-Bank Amu Darya, Zaravshan, and Lower Zaravshan. This division was also revised somewhat later. At present, the Ministry of Water Resources oversees 12 BAIS and the Ministry of Water Resources of the Republic of Karakalpakstan. They both supervise 100 ISAs, which interact directly with WUAs. Despite this reorganization, all 12 BAIS remain constrained to operating within their regional administrative boundaries rather than one BAIS managing an entire basin's needs[51].

There are two indicators related to SDG 6.5: the degree of IWRM implementation and the proportion of transboundary basin area covered by an operational arrangement for water cooperation.

Indicator 6.5.1, focused on the degree of IWRM implementation, was nationalized by Uzbekistan without any changes. This indicator is scored by experts from 0 to 100 across various aspects of water-resources governance. In 2017, Uzbekistan's mean score was 45 based on the following three aspects: enabling environment (38.3), institutions and management instruments (70) as well as financing (34). Uzbekistan received high scores (70) for the following aspects of water-resources governance: "National monitoring of available water supply (including surface and/or groundwater)", which is part of the 'Management Instruments' category; "Institutional framework for transboundary water management for the most important basins/aquifers", part of the 'Institutions and Participation' category; and "Agreements on transboundary water management in the most important basins/aquifers", in the 'Enabling Environment' category). These is relatively strong endorsement of key elements of Uzbekistan's IWRM policy. The lowest scores (30) were for "National water-resources legislation (laws)" and "Subnational water-resources strategies and basin/aquifer-level management plans based on IWRM", both listed in the 'Enabling Environment' category. Expert assessments related to financing were also low and a score of 20 was given for "Revenue collected from relevant fees from water users at basin, aquifer, or subnational level." Overall, this has led to IWRM implementation in Uzbekistan being assessed as in the "low–medium" (30–49.9 points) bracket[52].

51 UNECE (2020a) Uzbekistan. Environmental Performance Review. The Third Review. Tashkent. 502 P.

52 IWRM Data Portal IWRM Data Portal - Home (unepdhi.org)

Uzbekistan has not nationalized Indicator 6.5.2, which deals with the share of transboundary basin area with an operational mechanism for water cooperation, since data on its transboundary aquifers are lacking and make presenting a national value for the indicator impossible. Efforts surrounding this indicator are further complicated by the fact that any Uzbekistan has not entered into any interstate arrangements on transboundary groundwater. Possible actions to advance Target 6.5 in Uzbekistan could include conducting (in cooperation with neighbouring countries) a comprehensive cadastre of transboundary groundwater to identify needs best met through cooperation agreements. Within Uzbekistan's territory there are 97 deposits of fresh groundwater, including 19 associated with protected areas. Of these 19 protected areas, 11 are considered of national significance and eight of regional significance. According to the report[53], the absence of Indicator 6.5.2 among Uzbekistan's national indicators is a significant shortcoming of State water policy.

SDG 6.4: By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity. This goal is measured by two indicators: 6.4.1 (Water use per unit of GDP, m³/US$1,000) and 6.4.2 (Level of water stress: freshwater withdrawal as a proportion of available freshwater resources). In the UN SDG Country Profile for 2022, water-use efficiency (WUE) was US$2.6 per m³, which is twice that of Tajikistan (US$1.2) and the Kyrgyz Republic (US$0.9), but three times lower than in Kazakhstan (US$7.95)[54]. The agricultural sector is of particular importance for this indicator due to high water losses in irrigation.

Almost the entire territory of the Republic of Uzbekistan is characterized by a high level of water stress *(map "Water stress")*. In the UN's SDG Country Profile for Uzbekistan in 2022, it stated that the proportion of water consumed to the available stock of freshwater is 121.8 per cent, which implies there is widespread forced reuse of drainage and wastewater in agriculture[55].

In connection with warming, the required increase in irrigation norms for most crops will be 5.8 to 7.3 per cent by 2030, rising to between 9.7 and 15.0 per cent by 2050. In the foothills, this increase will be within two to five per cent for both horizons. The expected increase in irrigation norms will occur against a backdrop of declining precipitation, including solid precipitation, unstable river discharges and ongoing high population growth. Yield losses of cotton may reach four to five per cent by 2030 and six to 10 per cent by 2050 while losses to winter wheat are estimated to be seven to nine per cent and 14 to 17 per cent for the same respective horizons[56]. The risks of droughts accompanied by extreme low water-flow conditions will rise significantly, threatening not only an acute shortage of irrigation water but also increased groundwater mineralization.

The above is particularly concerning as most regions of the country are already characterized by a strained water balance, although these are not necessarily the driest areas *(see map 'Water balance')*. A detailed analysis (with elements of modelling) of water consumption by economic sector and by season in the Amu Darya and Syr Darya basins shows there were already chronic crisis-level water shortages in average years during the 2000 to 2010 period. These shortages existed not only in irrigation but also for municipal and household needs in Uzbekistan as a whole[57]. In the Syr Darya basin, an acute irrigation-water deficit routinely occurs in the second half of summer. As a rule, reservoir storage is exhausted by July, coinciding with the peak in irrigation demand for water, which is estimated at up to 8.6 km³ per month. The average national water deficit in July is 0.85 km³, which translate to about 24 per cent. In this same month, the Fergana Valley, which encompasses the densely populated Andijan, Fergana and Namangan regions (together with two Kyrgyz regions), requires about 3.5 km³ for irrigation, with a deficit estimated at 0.85 km³ (24 per cent). The Tashkent, Jizzakh and Syr Darya regions collectively exhibit roughly the same high demand and deficit in July, which persist through August and September *(see Figure 5)*.

The average monthly demand from the industrial and municipal sectors in the Syr Darya basin is constant throughout the year, at about 0.11 km³ per month. Despite this relatively small non-agricultural demand, it is also unmet in summer due to increased agricultural withdrawals and in winter due to low river discharges. By way of specifics here, the overall annual water deficit (including the agricultural sector) in the Syr Darya basin is estimated at eight per cent.

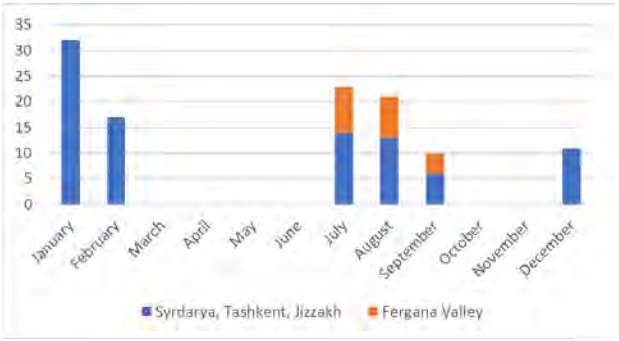


Fig. 5. Assessment of water deficit in the Syr Darya basin, million m³.

In the Amu Darya basin, the peak irrigation water demand falls in June–July, dropping to 13 km³ per month. Unlike the Syr Darya basin, the irrigation water deficit here is observable throughout the entire growing season from April to October. The maximum deficit occurs in July, reaching about 4.7 km³, or 36 per cent of the water required for irrigation. The two most problematic irrigation districts in the basin are the Zaravshan and Kashkadarya oases, where the July deficit soars to 70 per cent *(see map 'Water stress')*. The Zaravshan River and its ancient tributary, the Kashkadarya, which are both fully abstracted for irrigation, serve as the main water sources for these two oases *(see Figure 6)*.

Industrial and municipal water demand in the Amu Darya basin is 0.12 km³ per month and remains constant throughout the year. Unmet demand from these sectors is observable throughout the warm season but peaks in July at 0.045 km³, or 37 per cent. The most problematic areas in this respect are the Zaravshan and Surkhandarya regions. The overall water deficit in an average year in the Amu Darya basin is estimated at 24.8 per cent.

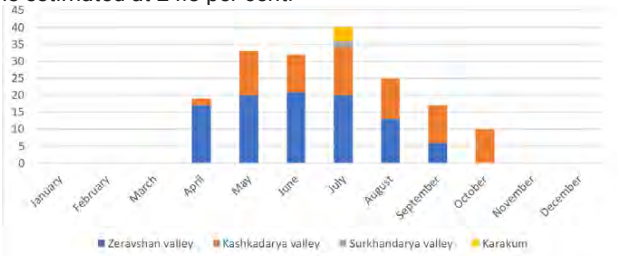


Fig. 6. Assessment of water deficit in the Amu Darya basin, million m³

53 UNECE, 2020a.
54 SDG Country Profiles.
55 Ibid.
56 Third National..., 2016.
57 Lutz et al., 2012.

Target 6.1 envisages "achieving universal and equitable access to safe and affordable drinking water for all by 2030." The corresponding Indicator 6.1.1 is measured by the share of the population using either (a) a centralized water supply, or (b) alternative water sources. Official sources contain contradictory data on the portion of the population covered by centralized water-supply systems. Uzbekistan's reporting on global Indicator 6.1.1 states that, in 2015, some 86.5 per cent of the urban population had access to safe drinking water from a centralized source, however, data for rural areas are absent[58]. According to the State Committee on Statistics, access to centralized drinking water averages 76 per cent nationwide and 63 per cent in rural areas. In contrast, the Ministry of Housing and Communal Services notes that only about 63.5 per cent of the population has access to a centralized water supply, 25 per cent rely on wells, springs, rivers and other sources, while 10 per cent depend on delivered (trucked in) water *(see map 'Population access to safe water sources')*. Residents without access to a centralized water system can spend six hours per day obtaining water from other sources, including its transport, storage and treatment[59].

As formulated, the national indicator does not account for the availability of a connection to a water source or the quality of existing connection to safe water supplies, which should be addressed in the future. Moreover, national data largely leave the 'safety' aspect unaddressed in assessments by assuming that any source classed as 'centralized' is safe, which is not always the case. Official data show that, nationwide, the average annual noncompliance of piped drinking-water samples with sanitary norms between 2012 and 2017 was 10 to 15 per cent due to chemical pollution and five to 10 per cent for microbiological contamination. The Republic of Karakalpakstan is the most problematic region in this respect as noncompliance was 32.3 per cent due to chemical pollution and 4.6 per cent for microbiological contamination. This indicates difficulties exist in the proper management of Uzbekistan's centralized drinking-water networks.

The Programme for the Integrated Development and Modernization of Drinking Water Supply and Sewerage Systems for 2017–2021 (implemented under Presidential Decree No. 2910, 2017) is the first document of its kind specifically targeting the country's water supply and sewerage. It identifies several areas where safe-water supply issues are particularly acute, such as the Bukhara, Jizzakh, Kashkadarya, Surkhandarya, Syr Darya and Khorezm regions as well as the Republic of Karakalpakstan.

Women and children are particularly vulnerable in this regard, as they spend more time at home and in schools. Home hygiene is crucial for maintaining the health of children and mothers *(see Box 2)*. According to official estimates, approximately 35–40% of infectious diseases in the country are associated with poor hygiene, which is also largely dependent on access to safe water and sanitation. On May 6, 2025, the Cabinet of Ministers of Uzbekistan approved the "Clean Hands" program, which is intended to cover all educational and healthcare institutions. The program's launch is part of the State Program for the Implementation of the "Uzbekistan 2030" Strategy until 2025. According to data for 2024, 29.5% of schools do not have water supply, and 70% of schools in Uzbekistan are not connected to sewerage systems. According to the Clean Hands program adopted in 2025, indoor toilets will be built in schools where toilets are currently located outside. As part of the Clean Hands program, all handwashing stations in educational and healthcare institutions will be provided with hygiene products, including soap and toilet paper. In communities without running water, infrastructure for the delivery and storage of drinking water will be created. More than 6,000 kindergartens will receive solar water heaters, and 4,295 social institutions will be equipped with water storage tanks and cisterns[60].

SDG 6.2 provides for "access to adequate and equitable sanitation and hygiene for all by 2030". This goal was nationalized by Uzbekistan as: "By 2030, ensure access to adequate and equitable sanitation and hygiene, with particular attention to the needs of vulnerable population groups". Unlike the global indicator, the nationalized indicator does not include a gender aspect. There are two indicators related to SDG 6.2: Indicator 6.2.1.1 focuses on the share of the population using safely managed sanitation services and having a handwashing facility with soap and water (analogous to global Indicator 6.2.1). In Uzbekistan in 2017, according to the State Committee on Statistics, only 35.8 per cent of the overall housing stock in the country had sanitation services, a figure that was only 10.8 per cent in rural areas. The second indicator, 6.2.1.2, deals with the share of the population covered by a centralized sewerage system. Although the entire population of Uzbekistan has access to basic sanitation, according to the Ministry of Housing and Communal Services, at the start of 2019, only about 15.6 per cent of households were connected to centralized wastewater systems *(see map 'Population access to sustainable sewerage systems')*.

SDG 6.3 provides for "improving water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials by 2030." When nationalizing SDG Target 6.3, Uzbekistan omitted the requirement to halve the "proportion of untreated wastewater," which forms part of the global target. Two national indicators were approved under Target 6.3, the first of which, Indicator 6.3.1, is centred on the share of safely treated wastewater (analogous to global Indicator 6.3.1). According to official Uzbek data from 2017, some 99.3 per cent of wastewater was treated. Uzbekistan's national Indicator 6.3.2, pertains to the Water Pollution Index (WPI), which differs to the global Indicator 6.3.2 that relates to the share of water bodies with good water quality. Irrespective of this, WPI is considered a well-established methodology and Uzbekistan intends to use its national system to track progress in improving water quality in its water bodies. Deriving a WPI class requires determining the arithmetic mean of six hydrochemical indicators, including biochemical oxygen demand (BOD), expressed as fractions of their maximum permissible concentrations (MPC)[61]. There are seven water-quality classes in the WPI regime, ranging from I (very clean) to VII (extremely polluted).

Uzbekistan's national statistics on surface and groundwater pollution are incomplete and do not allow a meaningful spatial picture of water quality across the republic. Data are available for individual gauging stations, which is problematic under conditions of diffuse pollution from irrigated lands. Compounding the above, statistical yearbooks do not provide data on discharges of industrial and municipal wastewater or the degree of their treatment[62].

Agriculture has the most detrimental effects on water quality *(see map 'Undeground water pollution')* as the large-scale use of fertilizers is a basic precondition for agricultural production on Uzbekistan's low-fertility soil. For comparison, in 2016, Uzbekistan used 233 kg of fertilizer per ha, this is five times higher than in most European countries and well above the global average of 141 kg per ha. A specific feature

58 https://unstats.un.org.

59 Sustainable Development Goals in the Republic of Uzbekistan (2023) Statistical Digest. Tashkent: Agency of Statistics under the President of the Republic of Uzbekistan. http://nsdg.stat.uz/ (in Russian)

60 Clean Hands program launched in Uzbekistan's educational and medical institutions – News from Uzbekistan – Gazeta

61 Water quality standards and norms in the Republic of Uzbekistan/National Report (2011) Project of the United Nations Economic Commission for Europe «Water Quality in Central Asia». Tashkent-Almaty. 72 P.

62 State Statistics Committee of the Republic of Uzbekistan (2021) Statistical Yearbook of the Republic of
Uzbekistan. Tashkent: Uzstat. 293 P. (in Russian)

of agriculture in Uzbekistan is the widespread application of organic fertilizers (mainly manure) to fields, figure here are up to 12 to15 tons per ha, which is 20 times the amount of mineral fertilizers applied. Due to the widespread practice of leaching (flushing) fields with water to reduce soil salinity, water pollution occurs because the flushing water is often returned to irrigation canals in order to cover water deficits. High contamination levels of food products with persistent organic pollutants (POPs) and heavy metals have been identified, creating high risks to the population *(see Box. 2)*.

The waters of the Syr Darya and Amu Darya are assessed as "moderately polluted" (Class III) according to the WPI classification, with pollution occurring mainly from return flows discharged from irrigated areas. More than 51 per cent of total drainage flows are discharged into rivers, with another 33 per cent going into endorheic basins. Due to pollution, only 16 per cent of return flows are reused for irrigation[63]. During dry periods, irrigation water deficits can be covered by drainage water with mineralization of between 1.0 and1.50 g/L, while at between 3.0 and 5.0 g/L, drainage water must be diluted with irrigation water to be usable[64]. One specific of note here is that the main water-quality problems in the lower Amu Darya are associated with pollution by organic matter, which leads to oxygen deficits.

At the Tuyamuyun gauging station, the long-term mean annual BOD concentration was 1.44 MPC (minimum 0.51, maximum 6.23 MPC) at an MPC of three mg/L, and chemical oxygen demand (COD) was 17.92 (minimum 4.4, maximum 54.4) MPC at an MPC of 30 mg/L. Both parameters characterize the overall sanitary situation as problematic in terms of the oxidation of organic matter (i.e., the amount of oxygen, microorganisms and chemical oxygen needed to oxidize organic matter in water). At the Kyzyljar gauging station, the long-term mean BOD value was comparable at 1.44 mg/L (minimum 0.008, maximum 2.50 mg/L) and COD 22.28 mg/L (minimum 5.6, maximum 51.53 mg/L).

Relatively high pollution of the Amu Darya River has been found for phenols and oil products, indicating pollution is also leeching in from municipal sources. The annual mean concentration of phenols ranged from 0.001 to 0.017 mg/L at an MPC of 0.001 mg/L, with oil products ranging from 0.01 to 0.17 mg/L at an MPC of 0.1 mg/L. As a positive, concentrations of other pollutants (notably ammonium, nitrites, nitrates, heavy metals, sulfate ions and chlorides) in the Amu Darya's water along its entire length did not exceed MPCs.

The water quality of the transboundary Zaravshan River, its tributaries, and the irrigation network was investigated (for the first time in the post-Soviet period) in 2010 under the auspices of a German-funded initiative project. The mean mineralization in drainage collectors was 2.24 g/L and the highest reading of 2.6 g/L (downstream of Navoi), was more than 2.5 times the national MPC (1.0 g/L). High contents of nitrates and phosphates in drainage water (maximums 175 mg/L and 250 mg/L, respectively) also indicate severe diffuse pollution. For comparative purposes, EU drinking-water norms are 40 mg/L for nitrates and five mg/L for phosphates. From this it is clear that rural Uzbek populations living along the republic's rivers and irrigation canals, who often use these rivers and canals as sources of drinking water, are subject to a practice that can increase health risks[65].

At present, the Zaravshan River is considered one of the most polluted in Central Asia, due in no small part to industrial discharges. High nitrate concentrations are found downstream of Navoi, where Navoiyazot, the country's largest producer of mineral fertilizers, is located. The presence of copper, phenols and oil products in the Zaravshan is associated with wastewater from large cities, namely Samarkand and Navoi[66].

To help combat the foregoing, SDG 6.b aims to support and expand the participation of local self-government bodies in improving water supply and sanitation management. In this regard, Indicator 6.b.1 is measured using the "share of local administrative units with established and operational policies and procedures for community participation in water and sanitation management". This global target and its indicator were nationalized by Uzbekistan without changes and, as of early 2019, some estimates were available for Uzbekistan in the global database[67], although they do not allow for a clear analysis.

In Uzbekistan, the first WUAs appeared in 2000. A feature of that historical moment was that their establishment became part of the broader land reform aimed at creating more efficient small and medium-sized farms to replace the large Soviet-era collective farms (kolkhozes). Thus, large collective farms were directly reorganized into WUAs that united the many newly-formed farm plots. The Khorezm Region served as a pilot area for this reform: the first WUAs (and associated farms) there were organized along hydrographic boundaries from the start of this process in 2000. By 2005, collective farms throughout most of the region had been reorganized into WUAs.

A governmental resolution on the reorganization of collective farms across all regions of the country was adopted in 2002, providing the legal basis for regional authorities to form WUAs[68]. However, a separate law on WUAs still does not exist, which is regarded as a major shortcoming of the water and agricultural reform. Nevertheless, as of 1 January 2018, Uzbekistan had 1,503 WUAs serving more than 59,000 farms and managing about four million ha, which is virtually the entire area of Uzbekistan's irrigated land. At present, it is premature to assess these WUAs' effectiveness in terms of economic performance or more rational water use, especially since the broader global experience with WUAs has thus far returned mixed results[69].

Problems in WUA functionality are openly discussed in Uzbekistan's national media and among experts where the key issues in the spotlight include: substituting the self-organization of water users with a top-down administrative management model; the lack of liquid funds among farmers to pay WUA fees; the inability of WUAs to cover fixed costs for operation, maintenance and repair of on-farm irrigation and drainage systems. Many of these concerns are well-founded, as evidenced by the widespread indebtedness among WUAs[70]. In practice, WUAs have not yet become autonomous entities that can make business decisions and, for example, re-elect their chairpersons, if an association is financially unviable. On the contrary, daily control over WUAs' production processes is exercised by local authorities and weekly[71] control by irrigation systems management (ISM), resulting in member alienation from decision-making and significant hampering the reform process' success.

In Uzbekistan, men dominate key aspects of agriculture, including membership within WUAs, despite the roughly equal male–female ratio in rural areas. Surveys in the Fergana Valley farms[72] show that most women indicated that they had never

63 UNECE, 2004.
64 Chembarisov E.I (1988) Hydrochemistry of irrigated areas (on the example of the Aral Sea basin). Tashkent:
FAN. 105 P. (in Russian)

65 Karimboev et al. (2021) Assessment of water quality in the downstream of the Amu Darya basin. E3S Web of Conferences. 264, 03049.
66 Groll et al. 2013.
67 https://unstats.un.org

68 Handbook ..., 2019.
69 Gilmartin D. (1999) The Irrigating Public: The State and Local Management of Irrigation in South Asia. In: Stig Toft Madsen (ed.). State, Society and the Environment in South Asia. Surrey: Curzon Press: 236–265.
70 Ibid.
71 Gert et al. (2013) Lost in transition? The introduction of water users associations in Uzbekistan. Water International. 38, 6: 758 – 773.
72 Abdullaev I., Yakubov M. (2004) Assessing the gender performance of the water users associations of Central Asia: case study from IWRM Ferghana Project. Paper presented at the ICWC 39th Annual Water Conference. Almaty, Kazakhstan. 19-21 May 2004. 11 P.

been WUA members and often did not know the distribution of powers or laws concerning WUAs' status as voluntary non-profit associations. Women traditionally perform what are considered locally as distinctly 'female' tasks in agriculture, namely things such as milking cows, weeding and cotton picking. They work in labour-intensive, low-paid and 'secondary' jobs, indicating a still entrenched gender bias in the division of labour. nevertheless, according to the survey, men acknowledge that women dominate household decision-making, including financial matters. Women rarely manage farms, only around 12.5 per cent (out of 180 randomly selected farms) were female run and broader female employment in productive agriculture is often a by-product of male migration to cities or abroad (for example, men make up about 85% of labor migrants to Russia). In rural areas, the number of wives abandoned by migrant workers (due to divorce or the cessation of remittances) is increasing. As such, rural Uzbek women shoulder a large burden of responsibility both in agricultural matter, such as crop planning and irrigation, purchasing equipment and fertilizers as well as harvesting then, beyond the fields, they must find time for household chores and child care. Furthermore, as noted above, WUAs generally suffer from member alienation in decision-making and for rural women, this situation is acute: only one woman has ever been elected to a WUA board, clearly highlighting ongoing gender inequality in water management reform processes.

Another global goal related to water is SDG 6.6: "By 2030, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes". This goal is measure using Indicator 6.6.1, which assumes that a reduction in the extent of water-related ecosystems reflects negative environmental change in a country *(see map 'Water ecosystems area in basins')*. In this regard, Uzbekistan, especially when compared to the more mountainous countries of the region (Tajikistan and Kyrgyzstan), is characterized by very high variability in the area of its permanent and seasonally inundated water bodies *(see maps 'Change in the area of permanently inundated ecosystems'; 'Change in the area of seasonally inundated ecosystems')*.

Indicator 6.6.1. is directly linked to the implementation of the Ramsar Convention, which was ratified by Uzbekistan in 2002. The country is one of three key partners in the Ramsar Regional Initiative for Central Asia (RRI-CA), a project organized to strengthen cooperation and synergy among RRI-CA members for the effective implementation of the Ramsar Convention and its Strategic Plan 2016–2024 at national and regional levels.

Five Uzbek water bodies have Ramsar status: the Aydar-Arnasay lake system, Lake Dengizkul, Lake Sudochye, the Tudakul Reservoir and Lake Jyltirbas. All are connected, one way or another, to irrigated agriculture. The Aydar-Arnasay system receives 2.1 km³ of drainage water annually via a canal coming from the irrigated Hunger Steppe. Lake Sudochye receives the discharges of two drainage canals providing 0.58 and 0.2 km³ of water annually. The large endorheic brackish Lake Dengizkul in the southwestern Kyzylkum Desert receives flows from the Dengizkul drainage collector. The Tudakul Reservoir receives water via the Amu-Bukhara Canal, which transfers irrigation water from the Amu Darya to an area no longer reached by the Zaravshan River. The Jyltirbas is a relict deltaic lake in the Aral Sea region[73].

Uzbekistan has 770 lakes occupying over 8,000 km², about 500 of these are in the Amu Darya basin and more than 200 in the Syr Darya basin. Most water bodies act as sinks for drainage water[74], which, due to this water's heavy pollution and salinity, is not suitable for reuse *(see map 'Drainage of irrigated areas')*. The country has a network or approximately 100,000 km of collector-drainage canals with a total drainage flow of up to 23.5 km³ per year *(see map 'Drainage canal runoff')*, within this network, there are 16 major drainage canals in the Amu Darya basin and 10 in the Syr Darya basin[75].

Lake Sarykamysh receives drainage discharges via a 150 km long canal draining the irrigated lands of the Khorezm oasis. The discharge volume is 2.3 km³ *(see map 'Drainage canal runoff')*. An estimated ~100 km³ of drainage water has accumulated in this artificial lake since the 1970s. The lake's salinity has reached 14 g/L, and it shows signs of gradual shoaling. The Aydar-Arnasay lake system, in the middle of the Syr Darya basin, is the largest artificial water body in Central Asia. Initially three natural depressions that began to fill in 1969 during an emergency flood release from the Syr Darya, by the 1980s this nascent lake system was already highly polluted, mainly from pesticides and fertilizers. In more recent years, releases from the Shardarinskoye Reservoir (Kazakhstan) into the Aydar-Arnasay have become largely unregulated, which does not ensure stability in the system's lake size. Recent data show high mineralization (4.2 MPC), elevated ammonium nitrate levels (3.7 MPC) and significant chlorine (2.9 MPC) in water samples from this lake system[76].

Most of Uzbekistan's 770 water bodies are small, occupying less than one km² each. Small lakes are widespread in the deltas of the Amu Darya and Syr Darya. These deltaic water bodies, such as Lake Jyltirbas, were particularly important for fisheries as they were major spawning grounds for commercial fish species. However, many delta lakes have been subjected to high levels of water abstraction for irrigation and often completely dry up during peak periods of irrigation demand. In the shallowing water bodies, water quickly became stagnant, rendering them unsuitable for fishing and their flora and fauna soon disappeared due to unstable water levels and salinity. Additional problems for such shallow water bodies include their strong dependence on air temperature, including deep freezing in winter. These lakes are not a reserve for irrigation due to heavy pollution and high mineralization.

Box 2. Water and Food Pollution in the Aral Sea-affected Region Pose the Highest Health Risks for Women and Children

A comprehensive review of publications on public-health issues in the Aral Sea-affected region shows that women and children are highly vulnerable to severe environmental pollution[77]. In the 1990 to 2010 period, the Uzbek Ministry of Health and Institute of Obstetrics and Gynecology, in partnership with UNICEF, conducted population surveys in the most environmentally disadvantaged regions, namely the Republic of Karakalpakstan and the Khorezm region, to assess the health status of local populations. Based on a representative sample of women and their children, researchers examined the rates of fertility, infant mortality, postnatal growth, anemia, asthma and diarrhea as well as child nutrition, among other indicators. Infant and under-five-year old mortality are measured by the probability of a child dying before reaching the ages of one and five, respectively. In Karakalpakstan and Khorezm, these mortality rates were 56 and 65 per thousand, respectively. Elsewhere in Uzbekistan, infant mortality ranged from 28 to 63 per thousand while under-five mortality rates were 31 to 76 per thousand. Furthermore, no significant differences were found between populations living in

73 Thorpe et al. (2011). Feasibility of restocking and culture - based fisheries in Central Asia. FAO Fisheries and Aquaculture Technical Paper. 565. FAO: Ankara. 106 P.
74 UNECE, 2020a.
75 Thorpe et al., 2011.
76 Akhmadjonova Y. T. (2022) Water Composition and Ecological Status of Aydar-Arnasay Lake System. Ekonomika i sotsium [Economy and Society]. 5 (96): 21-24.
77 Crighton E. J., Barwin L., Small I, Upshur R. (2010) What have we learned? A review of the literature on children's health and the environment in the Aral Sea area. International Journal of Public Health. 56 (2): 125-138.

the Aral Sea Region compared to those in other region in the percentage of low-birth-weight infants (< 2,500 g). Moreover, according to UNICEF[78], Karakalpakstan and Khorezm had the lowest share of infants under 2,500 g in the country, however, in the Aral Sea region, more than 26 per cent of children showed moderate or severe stunting in their postnatal growth. Although this figure is high by WHO standards, it was slightly below the national average of 31 per cent.

Several studies found diarrhea to be a significant cause of morbidity and mortality, especially among children. The two-week recall prevalence of diarrhea among children under the age of three was some eight per cent in Karakalpakstan and Khorezm, which was five per cent above the national average. A similar result was found in a 2000 UNICEF study. Susceptibility among children under two in Khorezm was notably above the low-income-country averages, with the main cause being contaminated drinking water and low domestic sanitation standards. A survey in Nukus showed that chlorination of domestic drinking water significantly reduces diarrhea risks while another finding noted that water disinfection and distribution infrastructure does not ensure water safety.

Multiple studies reported high concentrations of Persistent organic pollutants (POPs) across environmental media, local foods and within human tissues in the Aral Sea region. These pose major risks to children's reproductive, endocrine and immune systems, pre-/postnatal growth as well as their neurological development. These risks received widespread coverage in the national and local press and led to a reduction in the duration of breastfeeding due to mothers' concerns about chemical contamination. In the country, the average breastfeeding period had traditionally been up to 17 months (instead of the WHO-recommended six months).

Overall, research has confirmed these maternal concerns as breast-milk samples from the Kazakh part of the Aral Sea Region showed markedly elevated dioxin congeners, including the most toxic TCDD, at some of the highest levels ever recorded in women of reproductive age. Arsenic, sodium, mercury, bromine and nickel were also significantly elevated in children living near the Aral Sea. Tests of cord blood, pregnant women's blood and breast milk found β-HCH, DDT, DDE and TCDD at levels six times those found in Western Europe, making these readings among the highest returned worldwide. Studies of locally produced food in Karakalpakstan have found high levels of contamination with these chemicals in lipid-rich foods such as lamb, eggs, and cottonseed oil.

As already noted, the retreat of the Aral Sea has exposed the former seabed to strong winds, creating some of the highest airborne dust (PM10 and smaller) concentrations worldwide, which is seen as a potential risk factor for asthma and other respiratory diseases. Indeed, the two-week prevalence of ARI symptoms (coughing and rapid breathing) among children under three living in the Aral Sea Region was 3.8 per cent, compared to 1.2 per cent nationally. However, a summer study found the excess to be less than 1 percent. Another study found high asthma frequency in Karakalpakstan while other respiratory indicators were lower than elsewhere in Uzbekistan. A child-based survey across Karakalpakstan found large intra-republic differences in respiratory illnesses without establishing a clear link to dust concentrations, meaning that, overall, evidence that elevated dust in the Aral Sea Region affects child health remains inconclusive.

A geochemical feature of the region is the high salinity of soils, plants and dust as well as surface and groundwater. Salt intake via water, dust and food may cause increased rates of urinary-tract diseases, including hypercalciuria (high urinary calcium and sodium excretion) and crystalluria (urinary crystals as precursors of urolithiasis). Some 50 to 85 per cent of children living in the Aral sea region had crystalluria; for comparative purposes, a study in the Kazakh part of the Aral Sea Region found signs of crystalluria in almost 40 per cent of school-aged children, a rate that was only 13 per cent among a control group. Another possible cause of renal dysfunction is exposure to toxic chemicals (e.g., lead and cadmium), but this was not confirmed as a proven issue in the Aral Sea region.

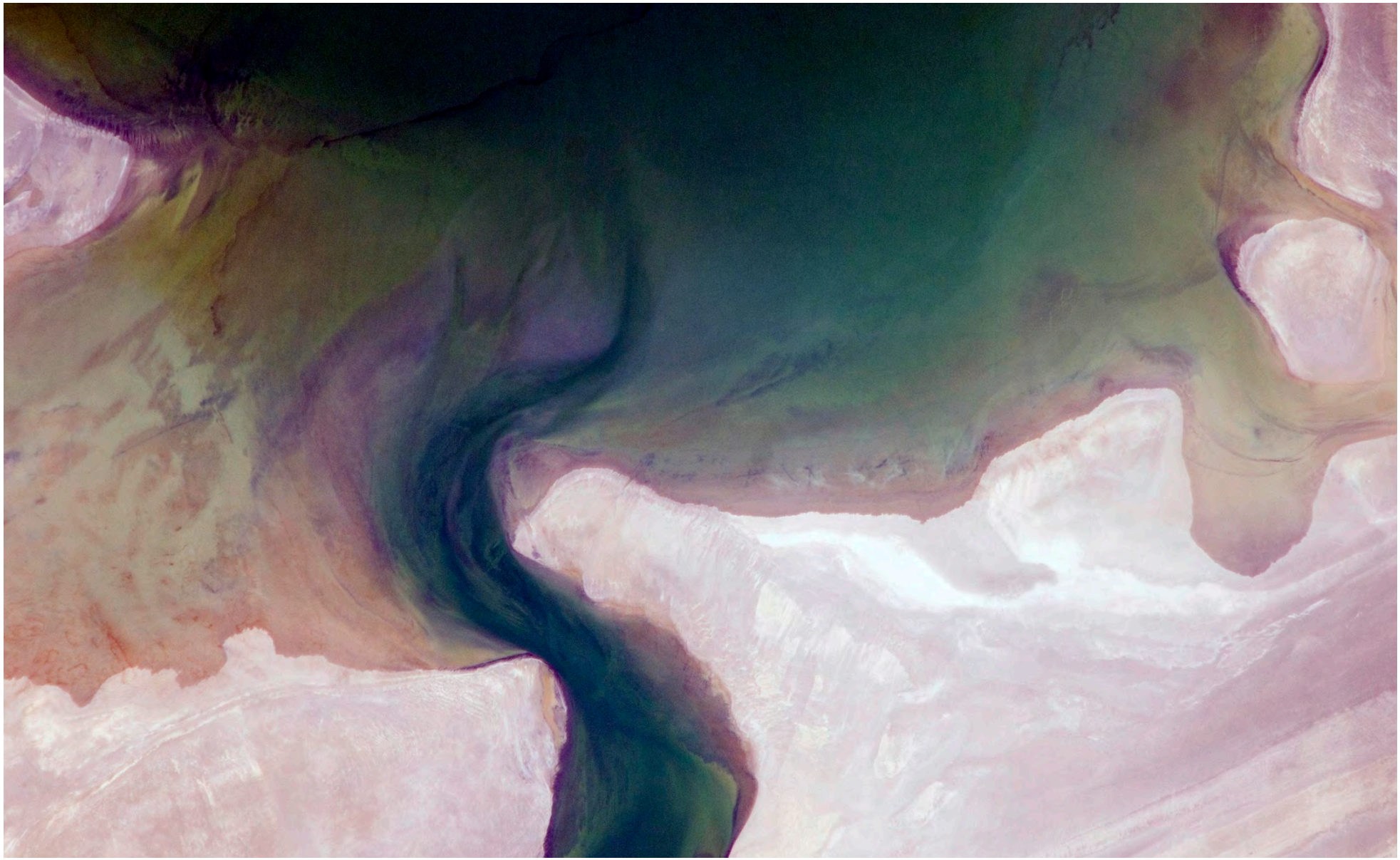
Child anemia is recognized as a significant and growing problem in the country, presumably linked to multiple factors, including iron deficiencies and exposure to detrimental environments. Data for children in Karakalpakstan and Khorezm showed that 70.4 per cent of children under five had nutritional anemia, which can stem from insufficient dietary iron. This figure is significantly higher than the national average. However, research in the Kazakh part of the Aral Sea Region found no direct link between anemia levels and blood iron in two-thirds of cases. As such, potential causes are believed to include a combination of micronutrient deficiencies, parasitic infections, hereditary diseases and environmental pollutants. The authors of the review concluded that iron fortification/supplementation alone will not solve the anemia problem in the Aral Sea region.

As a final point to this section, several other studies asked women in different regions across Uzbekistan to rate their under-five children's health from excellent to poor. In Karakalpakstan and Khorezm, only ~five per cent of mothers rated their children's health as "excellent–very good", versus 15 to 25 per cent elsewhere. At the other end of the scale, approximately 10 per cent mothers gave a "fair/poor" rating across all regions, including Karakalpakstan and Khorezm. A May 2008 self-assessment survey in Karakalpakstan found that 55 per cent of women reported their well-being as "fair/poor" well-being, 41 per cent expressed significant concern about the environment and 48 per cent considered themselves as emotionally distressed. These questions on environmental and health concerns were asked in the context of family well-being and, overall, the self-rated health of respondents in Karakalpakstan and Khorezm was low compared with the rest of Uzbekistan and much lower than in Western countries.

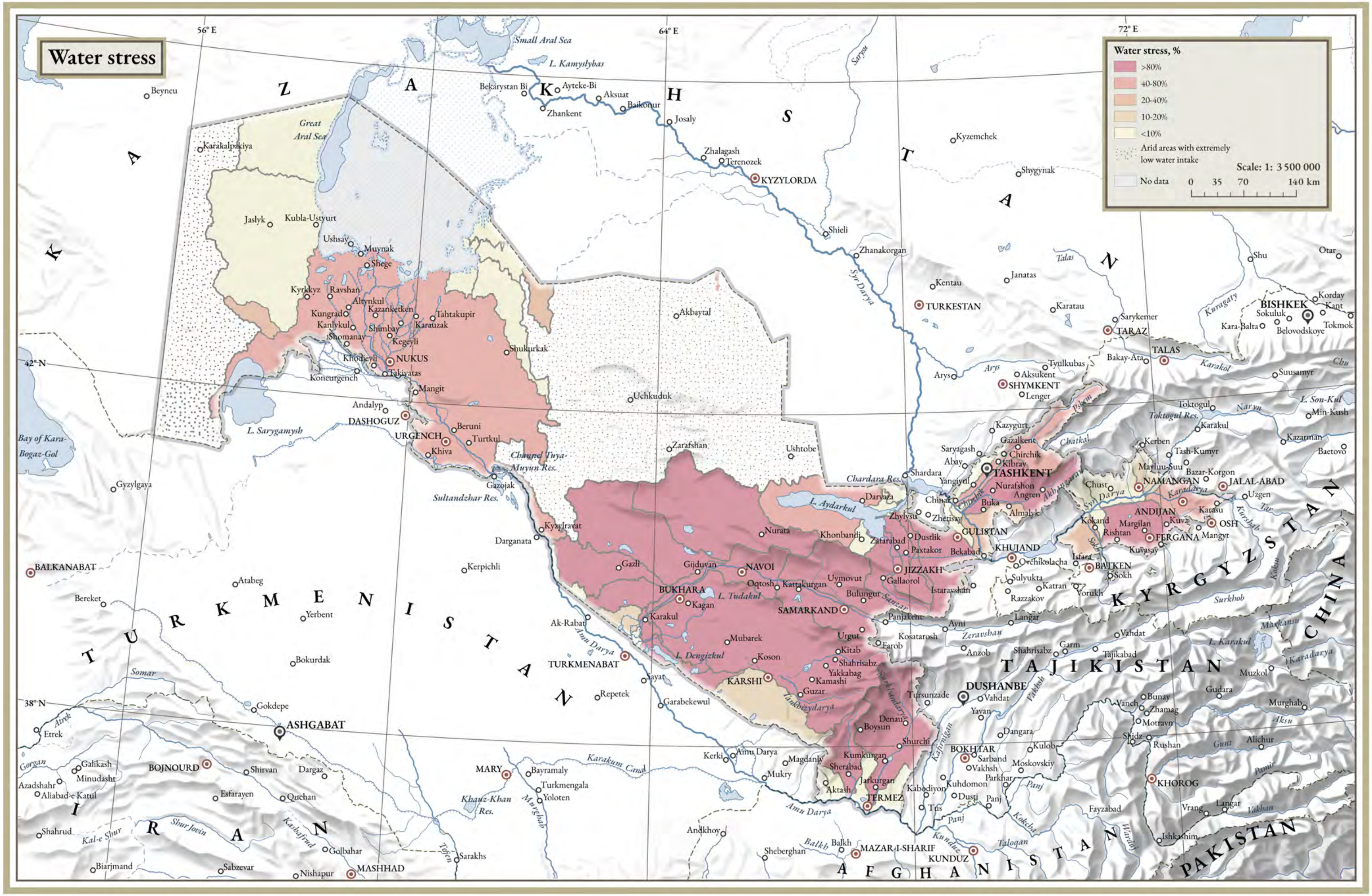
3.5. Response Measures

- Integrate targets for women and girls' access to safe sanitation and hygiene and ensure the collection of sex-disaggregated data to monitor progress in this area.
- Continuous nationwide monitoring of POPs in food and breast milk.
- Water-resource governance reform requires completing the transition from using administrative boundaries to river-basin-based water management.
- The first prerequisite to establishing the needed intergovernmental agreements on transboundary groundwater use is conducting a complete cadastre of such waters.

78 Multiple Indicator Cluster Survey – MICS (2006) State Department of Statistics (Uzbekistan) and the World Bank. Tashkent. Uzbekistan - Multiple Indicator Cluster Survey 2006 - Dataset - waterdata



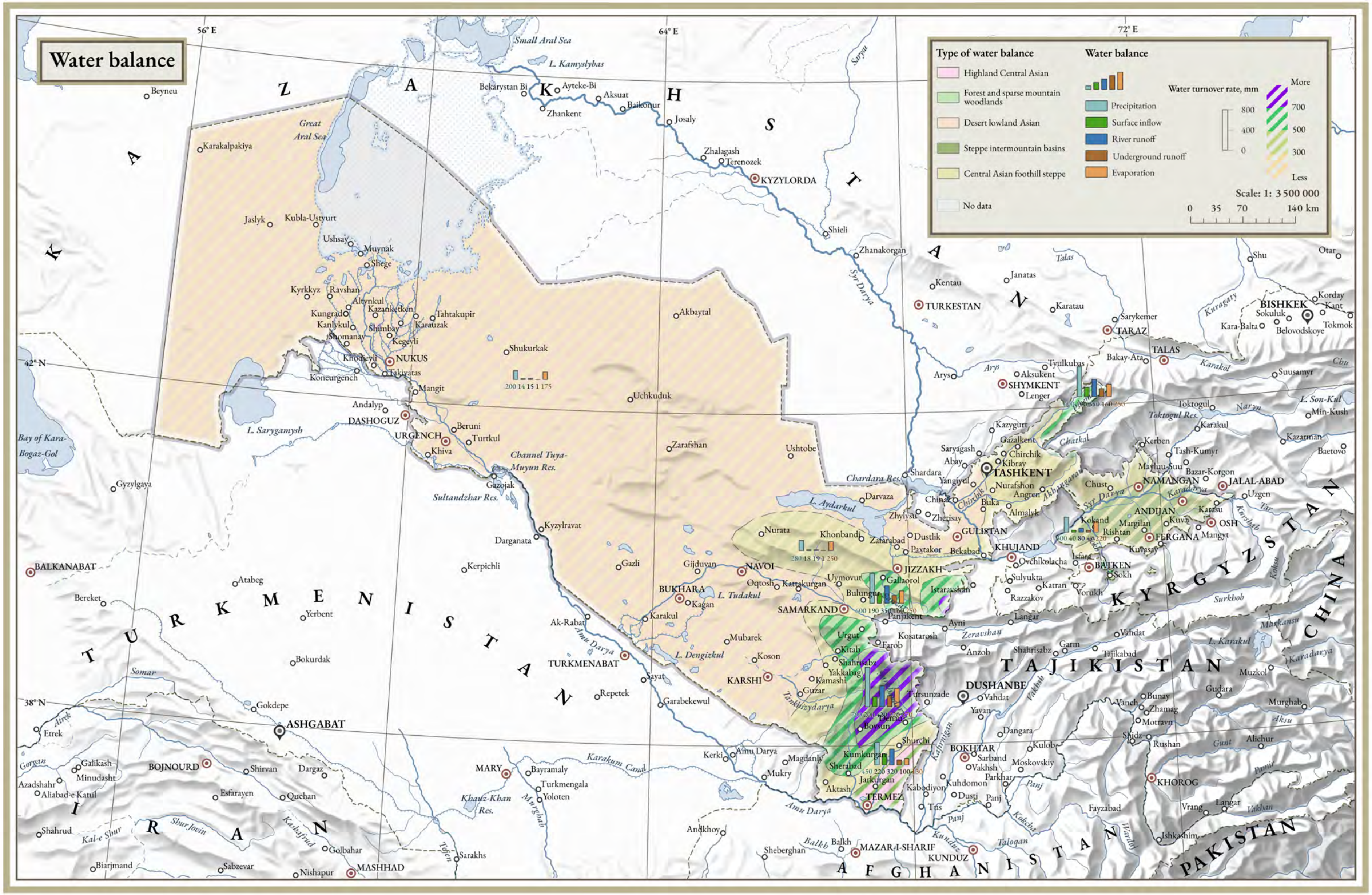
An image from the ISS



Based on calculations by Aqueduct,[79] using FAO Aquastat water use data, ERA5 climate data (see the notes for the «Trend in mean annual temperature, 1960–2023» map), and runoff modeling results using the WaterGAP model (see the notes for the «Annual runoff» map).

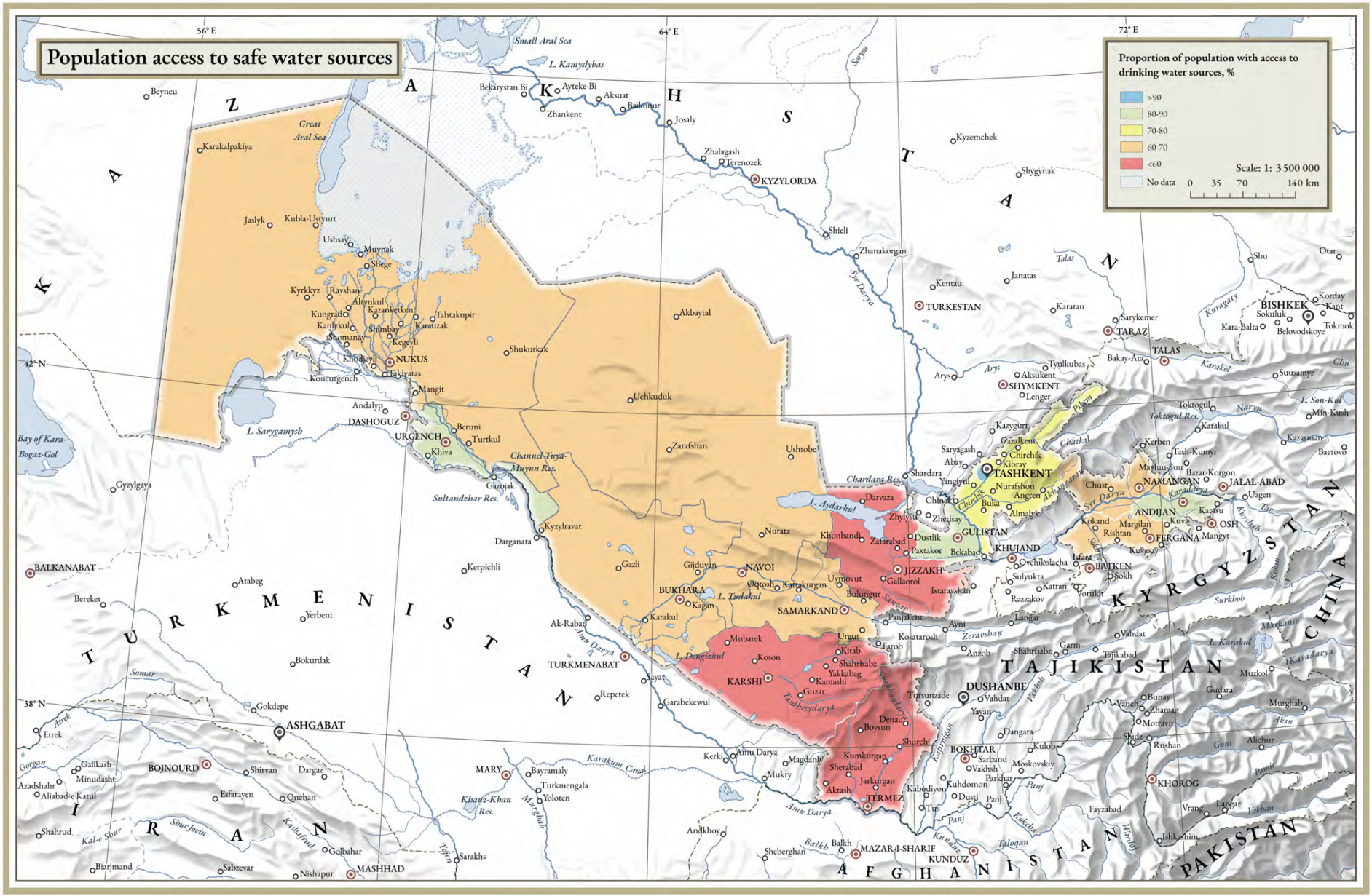
79 https://www.wri.org/research/aqueduct-40-updated-decision-relevant-global-water-risk-indicators

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Map of Water Balance Types of the USSR: [Maps]: for higher education institutions / compiled and prepared for publication by Faculty No. 10 of the Main Directorate of Geographical Sciences in 1985; ed. by I.S. Osadchuk; special content developed by Moscow State University staff: V.D. Bykov, Doctor of Geographical Sciences; T.G. Svatkova, Candidate of Geographical Sciences; performers: I.V. Sedelnikova, L.V. Titova

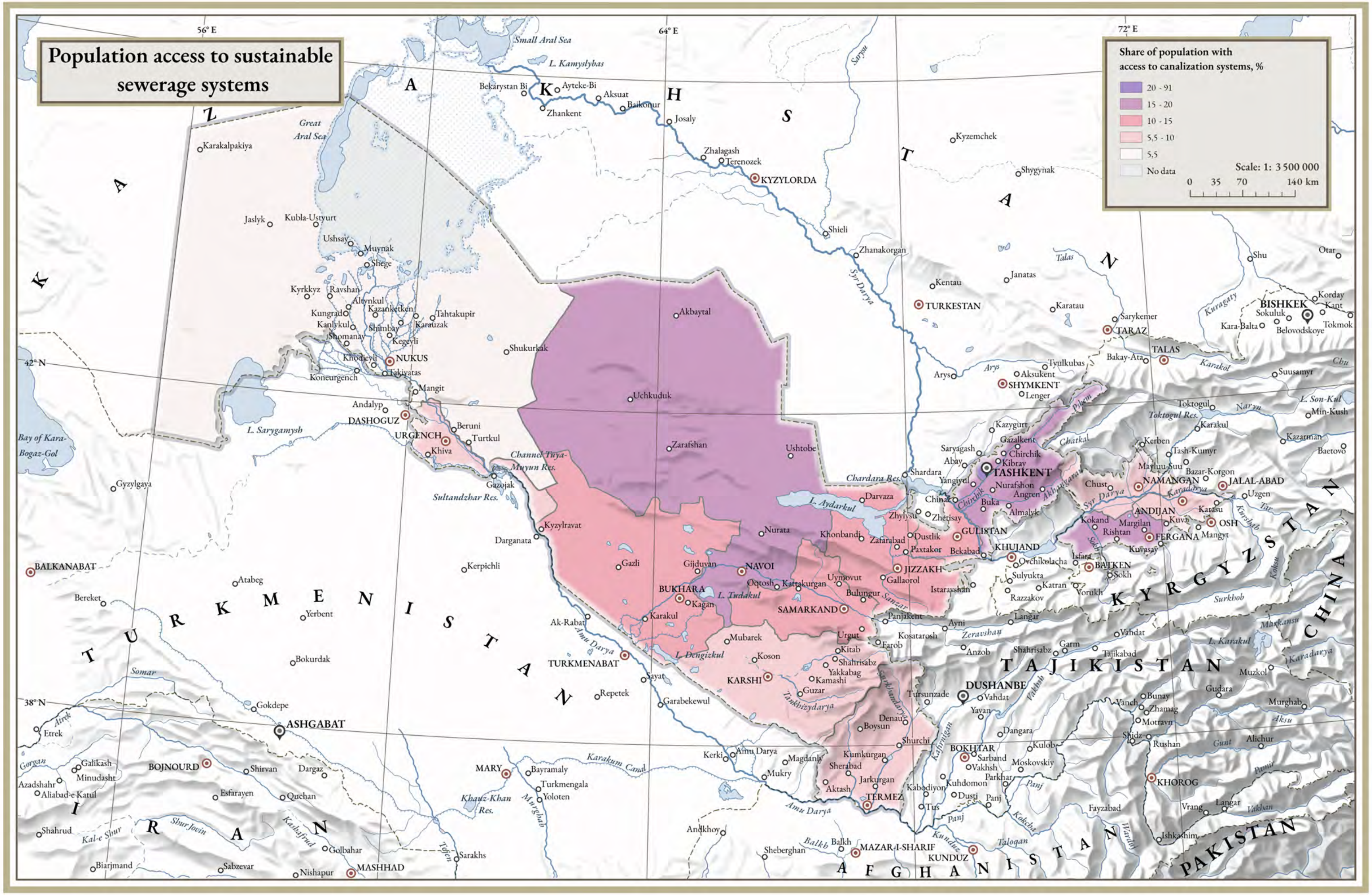
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



According to the National Statistics Committee of the Republic of Uzbekistan.[80]

80 https://nsdg.stat.uz/

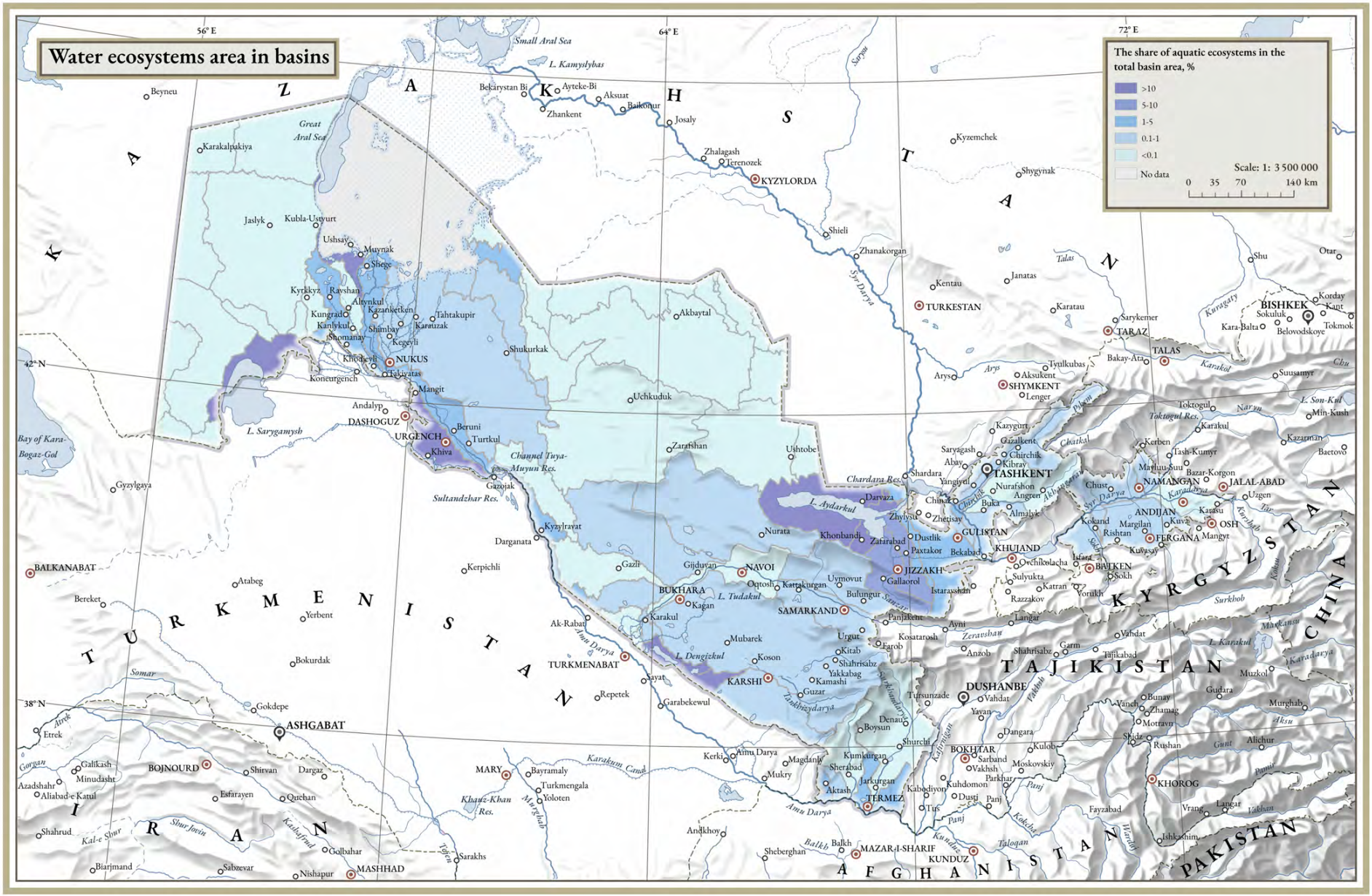
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



According to the National Statistics Committee of the Republic of Uzbekistan.[81]

81 https://nsdg.stat.uz/

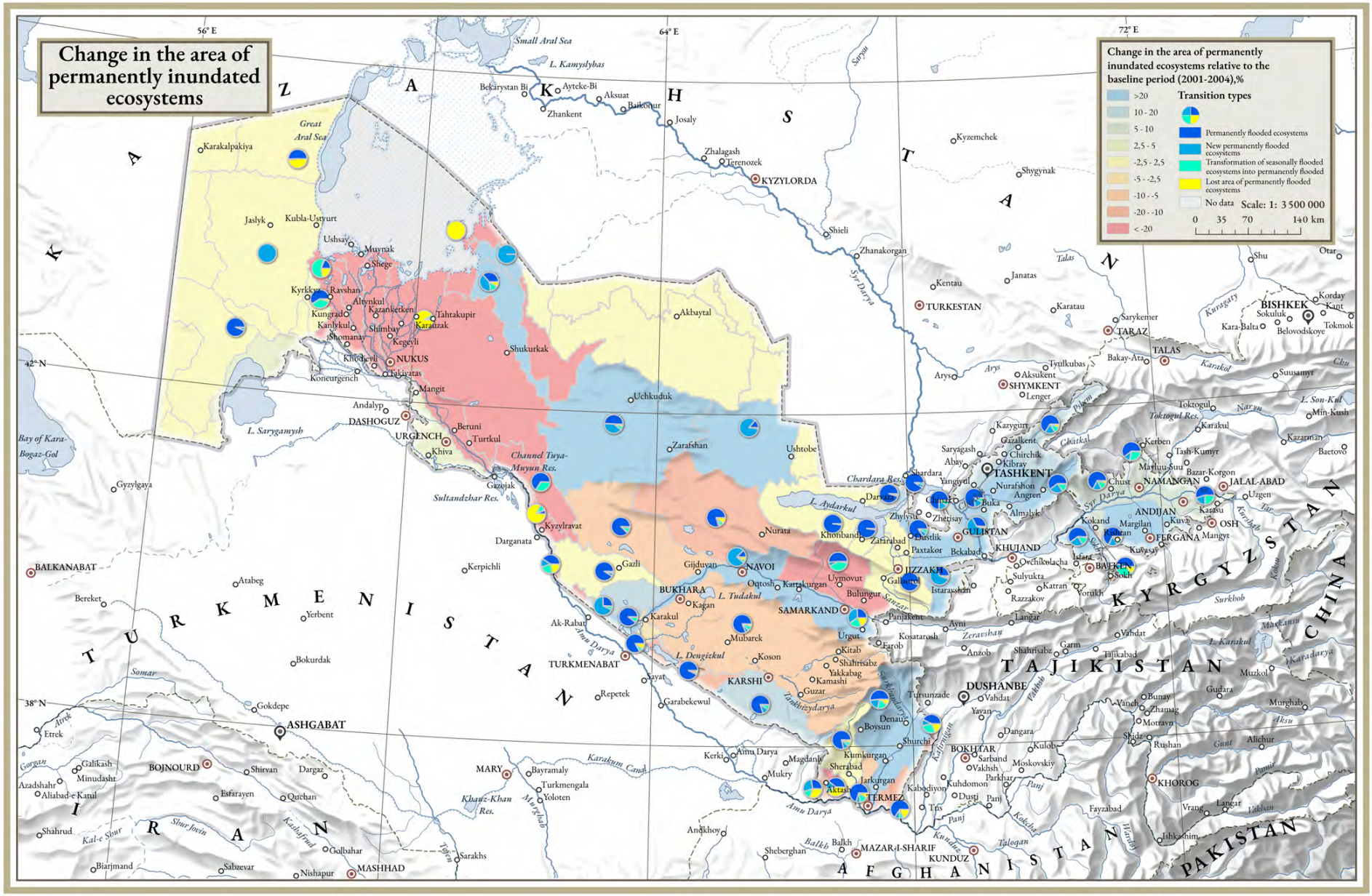
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Based on data from Freshwater Ecosystems Explorer,[82] obtained through automatic classification of Sentinel and Landsat MODIS satellite images.

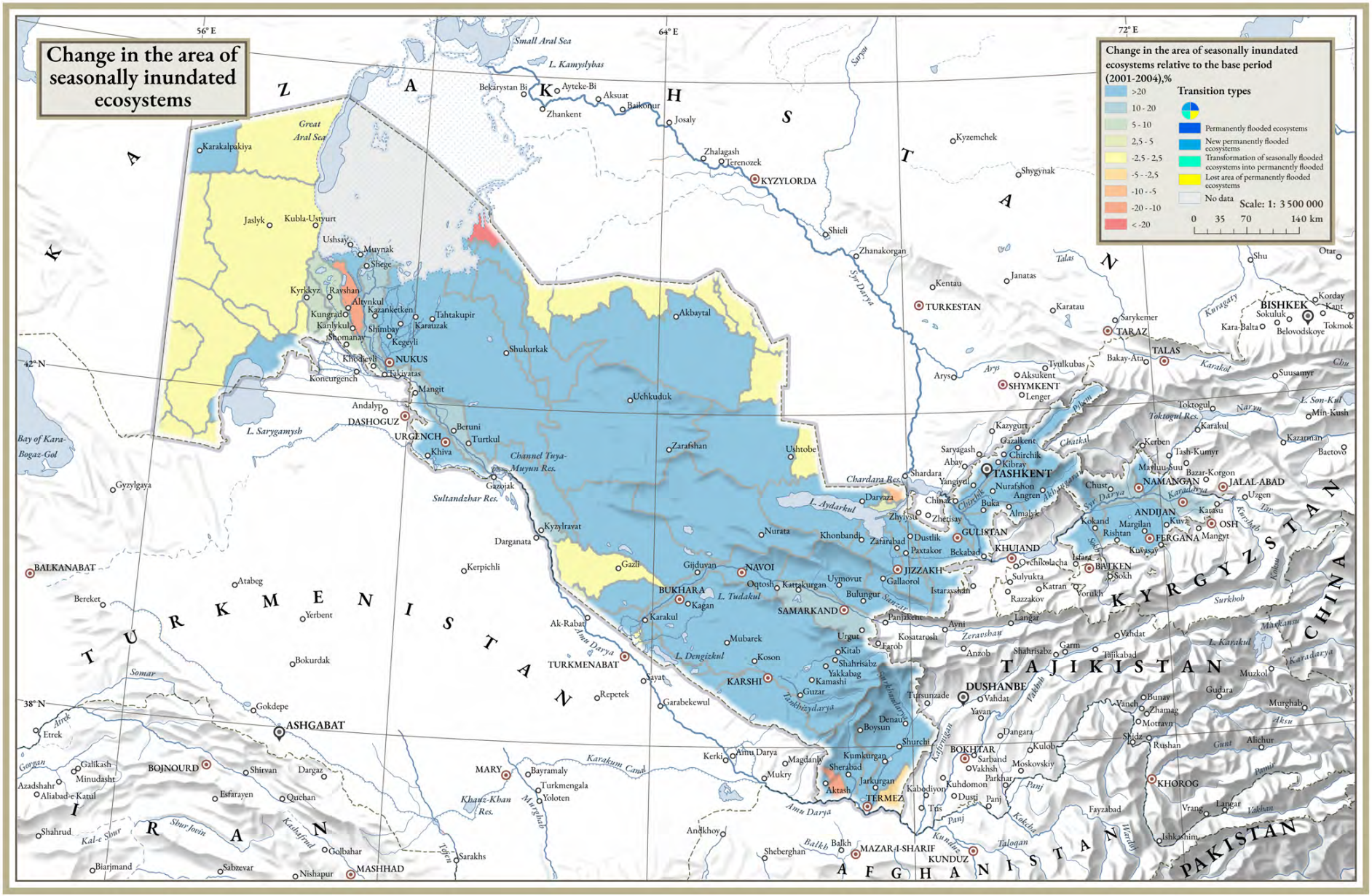
82 https://map.sdg661.app/

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



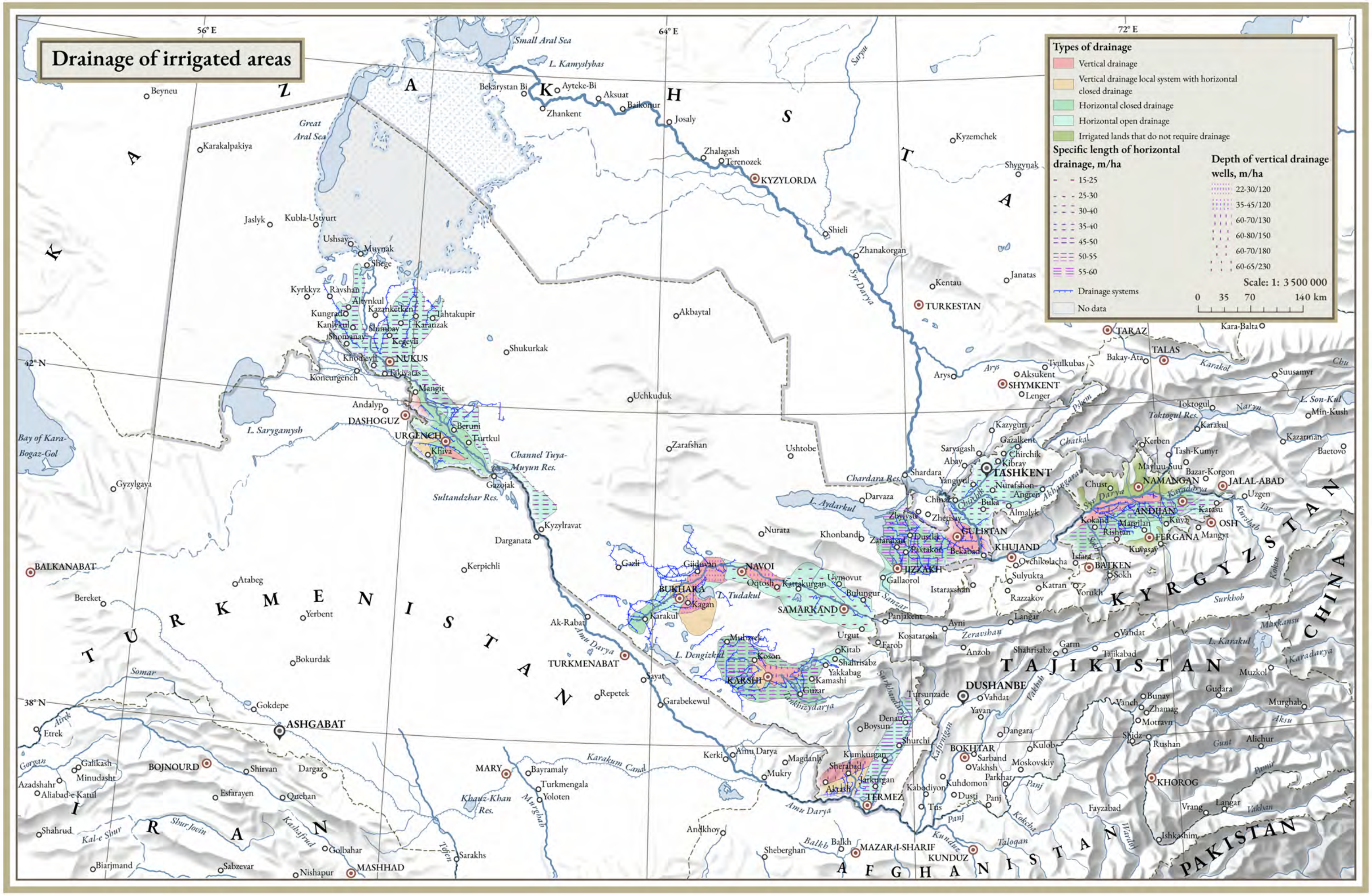
According to Freshwater Ecosystems Explorer (see notes on the map «Area of Aquatic Ecosystems»).

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.

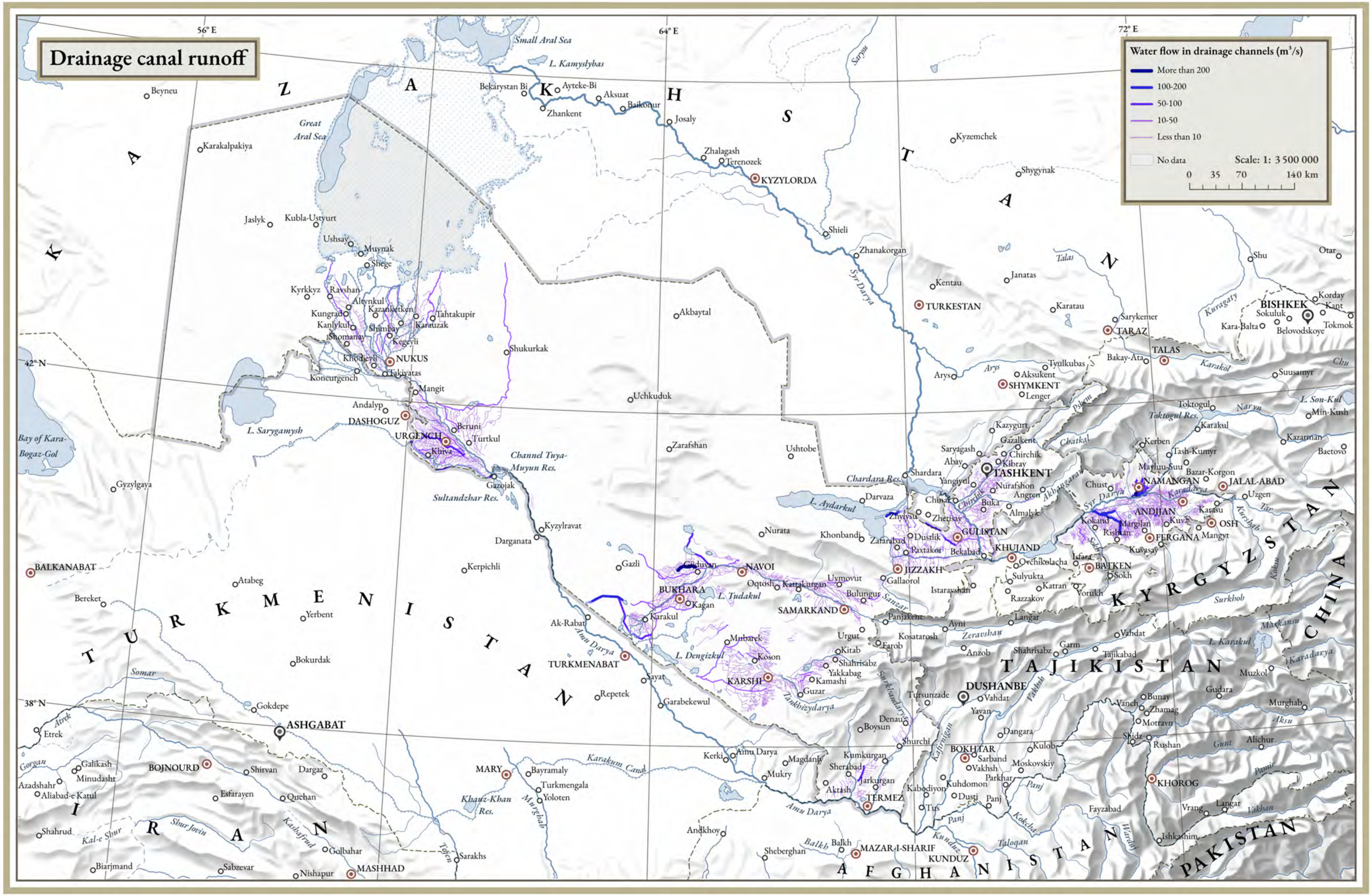


According to Freshwater Ecosystems Explorer (see notes on the map «Area of Aquatic Ecosystems»).

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



National Atlas of Uzbekistan: in two volumes / Cadastre Agency under the State Tax Committee of the Republic of Uzbekistan. Tashkent: Cartography, 2020. ISBN 978-9943-15-856-6.



According to national coordinators.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.

Land Resources



© Institute of Geography RAS, © PJSC RSC Energia



4.1. Key Aspects

- Agriculture continues to have increasingly high social and economic importance in Uzbekistan because the rural population, most of which is employed in the agricultural sector, is growing faster than the urban population.
- Produce from irrigated lands accounts for 95 per cent of the republic's gross agricultural output, however, most climate-change scenarios predict increasing water deficits nationwide.
- Over 60 per cent of irrigated agricultural lands in Uzbekistan, and over 90 per cent in the Republic of Karakalpakstan, are classified as affected by salinization due to the poor technical condition of irrigation and drainage infrastructure.
- Nearly all livestock are not stall-kept, which leads to unregulated grazing and loss of productivity on natural rangelands.

4.2. Overview

The total land area of the Republic of Uzbekistan is 44 million ha, of which an estimated 21 million ha (47 per cent) are used as natural pastures and hayfields; irrigated cropland occupies 4.3 million ha (9.8 per cent) and rainfed cropland totals 0.75 million ha (1.7 per cent) *(see map 'Land cover in 2021')*[83]. Irrigated cropland has formed the backbone of Central Asia's entire economy throughout the region's historical development. According to estimates, the maximum possible irrigated area in the Aral Sea Basin within present-day Uzbekistan was 3.8 million ha in antiquity, however, at the start of the 19th century, irrigated lands only covered about two million ha, by the early 20th century this figure ~three million ha and peaked in late Soviet period at just over four million ha[84].

In terms of its land resources, Uzbekistan can be divided into plain, foothill and mountain zones. The plain component comprises irrigated lands and the development of Karakul sheep husbandry; the foothill zone is dominated by rainfed (bogar) farming while the mountain zone is dominated by pastoral husbandry.

More than 80 per cent of the country is covered by plains, much of which are gypsum deserts, the most widespread desert type in Uzbekistan that totals 13 million ha in Kyzylkum and on the Ustyurt Plateau. Here, the most extreme aridity coincides with predominantly loamy gypsum soils unsuitable for crop farming but serves as an important natural forage base for domesticated Karakul sheep. Overall, these desert pastures occupy 17.4 million ha, with the Republic of Karakalpakstan having 5.2 million ha of such pasture while the Navoi Region has 8.8 million ha. The challenges of using desert pastures are linked to the low productivity of their plant communities (1.5 to 3.0 quintal per ha), which also fluctuates sharply from year to year, with every third year being extremely dry[85]. As was previously noted is the case for all other aspects of Uzbekistan's sustainable development, the key resource for livestock is the availability of water resources.

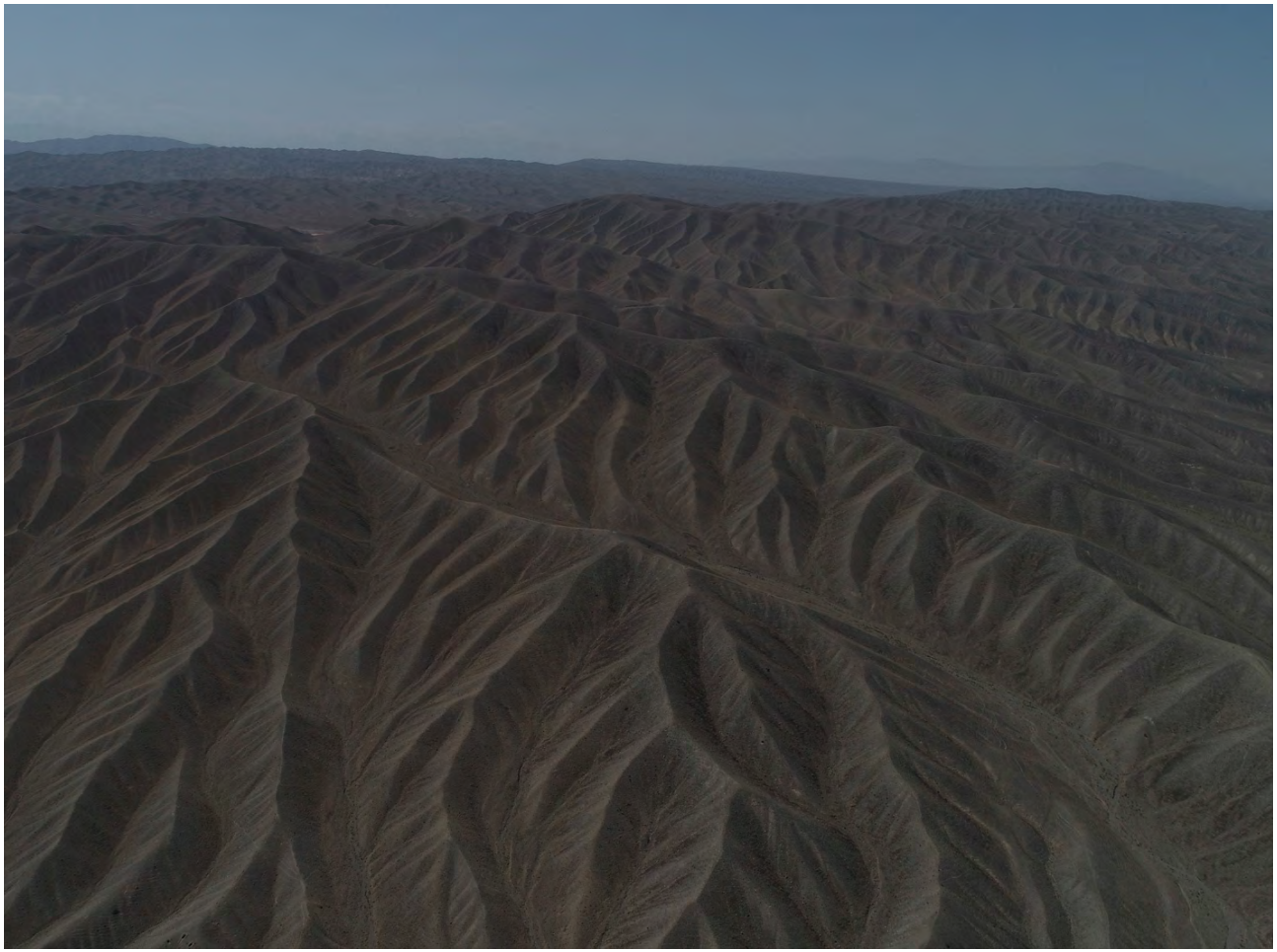
The desert plain belt is the zone of irrigated agriculture with annual precipitation of 100 to 250 mm. Most cultivated land is clustered around oases, where it is either naturally

83 Ruzmetov et al. (2021) Status quo of pastures in Uzbekistan. IOP Conference Series: Earth and Environmental Science. 938, 032069.
84 Micklin P. (2000) Managing Water in Central Asia. London: Royal Institute of International Affairs. 55 P.
85 Shaumarov M., Birner R. (2013) Dryland Pastoral Systems in Transition: What are the Options for Institutional Change in Uzbekistan? Paper presented at the 53rd Annual Conference of the German Society of Economic and Social Sciences in Agriculture (GEWISOLA). Berlin, 25–27 September 2013. RePEc:ags:gewi13:156133.

and artificially drained and where soil fertility is relatively high under irrigation. Irrigated agricultural lands in this zone total about 4.3 million ha, of which 3.3 million ha are used for annual crops, mainly cotton and wheat. On 2.2 million ha (51 per cent) of this cropland, irrigation water is supplied by pumping stations. The drainage area, i.e. the area equipped with a drainage network to drain polluted water into depressions in the relief or to return part of the water to the irrigation system, is 3.05 million hectares[86].

Aside from water, the main resource for farming in the desert zone is its soil. The soil cover of Uzbekistan's desert landscapes is somewhat uniform as light serozems (grey desert soils) predominate, albeit in combination with brown semi-desert and light chestnut soils *(see map 'Soil types')*. These soil types differ in fertility and moisture but are well-suited to the low rainfall and high evaporation environment. Two main latitudinal soil types dominate, namely grey-brown desert soils in the north and serozem desert soils in the south. The total area of desert soils is 65 per cent of the republic's total area (i.e., 29.2 million ha), including 11.2 million ha of grey-brown soils, 5.2 million ha of light serozems, 1.6 million ha of takyr intrazonal soils and 11.9 million ha of sandy and desert sandy soils. Light serozems are the most suitable for irrigated farming. These soils, with solonetzic properties, form under dry, hot climates prone to intense evaporation but where ephemeral and wormwood–grass vegetation exists. They have a weakly developed humus horizon (~one to 2.3 per cent humus) and high contents of both carbonates and salts. Their natural fertility is not high, however, under irrigation and with fertilization they can yield good crops of cotton and cereals. In river floodplains and key-moisture sites solonchaks occur, as well as meadow and meadow-bog soils developed on cobble–gravel and sand–gravel deposits. Outside irrigated oases, large areas are occupied by bare or sparsely sodded deposits of various textures *(see map 'Unturfed surface')*.

The foothill and low-mountain belt, which occurs at altitudes between 450 and 700 m above sea level, is rainfed land where normal annual precipitation does not exceed 400 mm. This belt accounts for 18.3 per cent of all cropland in the republic, totaling 757,300 ha. In some places, this rainfed cropland forms relatively narrow foothill strips, whiles elsewhere, extensive leveled or gently sloping surfaces are used *(see map 'Agricultural lands')*. Dark serozems dominate rainfed soils; they have good natural fertility thanks to their water-holding capacity (when left fallow these soils can store 720 to 800 m³ water/ha), relatively high humus and promote high biological activity[87]. These soils produce decent grain yields, typically eight to 10 quintal per ha in favourable years and three to five quintal per ha in dry years and are also suitable for both orchards and vineyards. At their upper limits, dark serozems occur at altitudes up to 1,200 to 1,500 m, where they transition to brown forest, brown and dark-colored soils. Mountain brown soils have markedly higher humus than dark serozems and support diverse land uses, including rainfed farming, orcharding, viticulture and, to a lesser extent, pastoralism. The potential to extend Uzbekistan's rainfed farming area is estimated at more than 2.1 million ha[88]. Foothill (adyr-type) pastures are mainly used seasonally, namely in autumn and spring when cattle graze there, but are grazed year-round by sheep and goats.



Canyon in the Shorsu Mountains in the Ferghana Valley near the city of Kokand in Uzbekistan

86 UNECE, 2020a.

87 Sodikova et al. (2025) GIS-based analysis of abandoned irrigated mountain lands in Uzbekistan. BIO Web of Conferences. 173: 03024.

88 Ibid.

Uzbekistan's main mountain belt, which exists between 800 and 2000 m above sea level, includes the slopes of the Chatkal, Kuramin, Piskom and Ugam ranges (all parts of the Tian Shan Mountains) as well as the Turkestan, Zaravshan and Gissar ranges (parts of the Alay Mountains). Here mountain brown soils have formed under various steppe and shrub vegetation, creating conditions conducive for organic-matter accumulation. These soils have brown to dark-brown colours, medium to high humus and low to medium carbonate and salt levels. They are of medium to high fertility and suitable for non-irrigated agriculture, however, in this zone slopes with gradients of 20° to more than 25° are prevalent, making them highly prone to erosion. In this belt, permanent meadows and pastures cover over half the area. Mountain pastures are mainly used in summer and suitable for all types of domestic animals while natural rangelands here are estimated to total ~one million ha *(see map 'Agro-landscapes')*.

As previously stated, agriculture is the primary sector in Uzbekistan's economy, accounting for 23 per cent of GDP. Nearly half of the population (49 per cent) lives in rural areas and depends on agricultural produce from their plots. Poverty levels among this rural population and the share of the workforce engaged in agriculture are very high compared, for example, to Kazakhstan.

Cotton production has always been of paramount importance to Uzbekistan's economy as the country has always produced the largest amount of cotton of all Central Asian countries. In 1992, Uzbekistan ranked second worldwide, after the USA, in cotton exports with the republic's exports of cotton fibre accounting for 41 per cent of export revenues at the end of the Soviet period. Cotton was dubbed 'white gold' in the Soviet press, while metallic gold was the next most lucrative export item, bringing in four times less revenue (~nine per cent of GDP). Uzbekistan produced about 4.5 million tons of seed cotton annually in the early 1990s, however, in the post-Soviet period, cotton output declined, mainly due to reductions in the sown area. In the 2010s, 3.6 million tons of seed cotton and ~one to 1.2 million tons of cotton fibre were produced, of which 0.7 to 0.8 million tons went to the world market, constituting ~20 per cent of Uzbekistan's export revenues. During the 1990s transition, Uzbekistan dropped to fifth place among global cotton exporters[89]. In 2016, cotton exports entered an era of notable decline, reaching an absolute minimum in 2021 which, according to national media, was linked to a policy decision to fully process cotton domestically in Uzbekistan's textile industry to provide jobs.

89 NCC (2012) Ranking from National Cotton Council of America http://www.cotton.org/econ/cropinfo/cropdata/rankings.cfm

In 1992, Uzbekistan's 1.7 million ha under cotton was the largest in Central Asia, a figure that shrank to 1.43 million ha by 2008 (a 16 per cent reduction) and to 1.05 million ha (a 38 per cent reduction from 1992) by 2020. The reduction in the cotton-sown area was driven by environmental and economic factors. Given the prevailing arid conditions, cotton production is entirely dependent on irrigation *(see map 'Cotton yields and growing areas')*. The Soviet policy of maximizing cotton production in the Amu Darya and Syr Darya basins played an extremely negative role in the desiccation and pollution of the Aral Sea due to very high levels of water withdrawal and the extensive use of agrochemicals. Heavy pollution of drainage waters resulted in their irretrievable diversion to endorheic depressions. The monoculture of cotton exhausted the soils and led to serious plant diseases that still adversely affect cotton yields[90].

The contraction of Uzbekistan's cotton growing area should have had a positive effect on yield dynamics, since the first lands to be withdrawn from cultivation should logically have been the least productive. However, according to data from the U.S. Department of Agriculture , Uzbek cotton yields have shown a clear negative trend in the post-Soviet period *(see Figure 7)*. Experts believe this negative trend is caused by inefficient resource use as, for example, from 1995 to 2005 the seed cotton produced per kilogram of fertilizer used decreased by 2.2 kg while cotton produced per kilogram of fuel used dropped by 1.2 kg. The root cause of inefficiency in the cotton sector lies in the protracted and inconsistent transition from a centralized economy to a market model, which entailed the removal of subsidies in agriculture and price liberalization for outputs. Overall, such policies have increased input prices and reduced output prices across Uzbekistan's agricultural sector, including for cotton and grain[91].

Food security is another national priority. In the 1990s, Uzbekistan imported over 82 per cent of all grain consumed, 50 per cent of meat and meat products, 60 per cent of dairy products, 50 per cent of potatoes and 100 per cent of sugar, milk powder and baby food[92]. The situation today is remarkably improved as Uzbekistan has achieved near self-sufficiency in virtually all staple foods thanks to rapid growth in domestic production (with the exception of sugar). However, food imports are still increasing as both its population and incomes rise. The Government, therefore, aims to further diversify cropping by expanding the areas available to wheat and vegetables as well as fruit plantations. Indeed, the Government actively encourages residents to continue sowing and growing produce on their household plots. This is one factor contributing to the fact that small local households play a major role in Uzbekistan's agricultural output, producing 84 per cent of the republic's potatoes, 67 per cent of its vegetables, 52 per cent the fruit and nearly all the country's meat and milk[93].

Following the gradual introduction of agricultural reforms, Uzbekistan rapidly increased grain production during the transition period. The irrigated wheat area grew from 0.48 million ha in 1991 to about 1.4 million ha in 2015, coming mainly at the expense of the cotton growing area. This raised total wheat output from 0.6 million tons in 1991 to 7.2 million tons in 2015, figures that were fuelled by wheat yields increasing from 1.2 t/ha in 1991 to 4.8 t/ha by the mid-2000s[94]. This yield growth was achieved primarily through intensification, varietal improvement and modern agronomic technologies, despite the unfavorable growing conditions the republic experienced from 1999 to 200951. Nevertheless, wheat yields have stagnated since the mid-2000s and remain low by European standards, not even exceeding the grain yields obtained on rainfed lands in Uzbekistan *(see Figure 8)*.

As a result of structural transformations, agricultural production became a dual system with two producer types—private dehkan (household) farms and private commercial farms. There are about 4.7 million dehkan farms, which hold only 15 per cent of cropland; their plots average 0.35 to 0.5 ha. Commercial (farmer) farms number about 63,000 and controlled 1.2 million ha in 2002, with an average field size of 20 ha. The average size of irrigated land on dehkan farms is close to traditional pre-Soviet allotments, and experts note that smaller fields ensure more uniform water supply, limiting non-productive runoff[96]. Commercial farms mostly grow wheat and cotton, while dehkan farms focus on livestock, fruits and vegetables. This crop split reflects the system of State orders and procurement that commercial farms must follow. State procurement prices for wheat and cotton have consistently been significantly below market prices, with the resultant

90 Djanibekov et al. (2021) Cotton sector reforms in Central Asia. IAMO Annual 2020: 46-54. Cotton sector reforms in Central Asia (iamo.de).

91 Swinnen J., Vranken L. (2010) Reforms and agricultural productivity in Central and Eastern Europe and Former Soviet Republics: 1989 – 2005. Journal of Productivity Analysis. 33: 241 - 258.

92 Kim K.R., Hasanov S. (2013) Development of agriculture and marketing structure in Uzbekistan for agro- processing of fruits and vegetables. Journal of Agricultural, Life and Environmental Sciences. 25, 2: 1–9.

93 Ibid.

94 Uzbekistan Wheat Yield by Year (MT/HA).

95 Sherzod et al. (2018) Agricultural transition and technical efficiency: an empirical analysis of wheat-cultivating farms in Samarkand region, Uzbekistan. Sustainability. 10, 3232.

96 Micklin P. (1991) The Water Management Crisis in Soviet Central Asia. The Carl Beck Papers in Russian & East European Studies. 905. Pittsburgh: University of Pittsburgh. 131 P.

losses being only partially offset by indirect subsidies (tax breaks, cheap credit) for seeds, fertilizers, chemicals and fuel. Farmers were allowed to sell any surplus at market prices only after fulfilling their State quotas. Where high-value crops (e.g., potatoes, watermelons and onions, commonly grown in the Zaravshan Valley) would be more profitable, the State orders force farmers to grow only cotton and wheat, this leads to substantial losses for both farmers and the Government, since the State partly compensates for those losses[97]. Despite having larger landholdings, guaranteed input and output channels, and, crucially, priority access to irrigation water, commercial farms may be less efficient than dehkan farms, which can choose crops freely based on market prices *(see Box. 3)*.

Over the last decade, agricultural reform in Uzbekistan has become more consistent and, since 2022, a decision has granted commercial farms greater freedom regarding crops grown and channels through which to sell them.

Presidential Decree No. 2460 (2015), entitled 'On measures for further reform and development of agriculture in 2016–2020', established the legal basis for diversifying crop patterns by reallocating 170,000 ha of cotton and 50,000 ha of grain (wheat) to other valuable crops in the years from 2016 to 2020. Presidential Decree No. 4239 (2019) aims to promote agricultural cooperatives in the fruit-and-vegetable sector, notably granting co-ops freedom to choose and/or change which crops they grow. Implementing these decisions may lead to the emergence of specialized cooperative structures alongside dehkan and commercial farms.

Gardening and crop diversification can provide a source of income for rural households, as well as contribute to dietary diversity and improved food security. Reforms in this area have a distinct gender dimension, providing rural women with new employment opportunities while simultaneously highlighting persistent traditional discrimination in the labor market. Women farmers complain about the difficulties they face in gardening, such as the poor quality of available seeds, which negatively impacts yields. Women play a predominant role in tending vegetable gardens, which account for over 80% of agricultural production (excluding crops such as cotton, wheat, and rice). However, the often informal nature of women's participation in this area means that rural advisory services and other programs targeting farmers often fail to target women. Agricultural processing is an area with the potential



Fig. 7. Dynamics of cotton yield, kg/ha, 1987–2024[1]

1 Uzbekistan Cotton Yield by Year (KG/HA)



Fig. 8. Dynamics of wheat yield, t/ha, 1987–2024[1]

1 Uzbekistan Cotton Yield by Year (KG/HA)

97 Hasanov et al. (2011) Agricultural efficiency and productivity growth in Uzbekistan: A case study. Business and Economic Horizons. 4 (1): 81–87.

to create jobs for rural women and redress the disparities in their representation in Uzbekistan's agriculture sector[98].

Uzbekistan's agricultural policy now focuses on reallocating land among existing producers, not on rezoning land for agricultural purposes. The country has limited scope to expand its cropland, with the main limiting factor being an unstable water supply plagued by existing chronic shortages to key irrigated regions even in average-flow years.

Livestock development also faces challenges tied to the incomplete market transition *(see map 'Livestock farming')* while livestock management indicators show unsatisfactory trends. Meat and milk production is concentrated in small dehkan farms, which lack their own pastures and hayfields. Productivity in such semi-subsistence systems is very low as is seen, for example, by the fact that the average daily milk yield per cow is three litres in dehkan farms, versus 20 litres in agro-enterprises[99]. As such, developing more efficient, larger operations is an urgent task.

The gender division of labor in livestock farming means that men bear sole responsibility for selling, slaughtering, and breeding livestock, while women care for the livestock, feed them, milk them, and prepare dairy products. Surplus produce (such as milk and eggs) can be sold informally to neighbors. They manage these funds themselves, while the proceeds from livestock sales are managed by the head of the household. It is important to facilitate access to markets for women who produce and sell agricultural products (both livestock and other) and develop their income-earning potential to strengthen their position in the family and community[100].

Unorganized grazing remains the predominant feeding system employed by Uzbek herders, even though forage crops are among the crops the Government seeks to promote in its diversification agenda *(see map 'Forage lands')*. Livestock accounts for about 40 per cent of total agricultural output across all of Uzbekistan's regions, although this notably varies by region depending on natural conditions. Sheep husbandry is based on semi-arid and arid rangelands, so typically in foothill and mountain arid zones, where both fat-tailed sheep and goats are raised. In the early 1990s, barley made up an important part (0.72 kg/head) of the daily feed of small-ruminant, However, since then barley production has fallen three-fold due to reduced area being sown and lower yields, largely because barley has been relegated onto poorer soils and drier sites by expanded wheat production[101]. Over the same period, the small-ruminant herd has grown by 260 per cent, sharply increasing grazing pressure on the unorganized desert and semi-desert rangelands used[102].

In irrigated zones, meat-and-dairy cattle, fat-tailed sheep and poultry are predominant; although horses and camels are also raised. The cattle herd is about 13.9 million head, up from eight million in 1992. As of early 2022, the number of sheep and goats exceeded 23 million head[103]. Most of these millions of animals freely graze on State-owned natural lowland and mountain pastures, although a 2019 law introduced procedures for long-term leasing of pasture plots to individuals and legal entities[104]. In the Soviet Union period, most cattle were stall-kept, however, today nearly all this stock is dispersed across rural settlements and adjacent pastures. Extensive overgrazing has led to the loss of herb cover and undergrowth, a problem that is particularly salient in pastures near settlements, while remote pastures become shrub-encroached due to underuse.

Box 3. The profitability of irrigation water use is higher among dehkan than commercial farmers in Uzbekistan

A fairly recent study was conducted in the agrarian and poor Khorezm region[105], revealing that over 70 per cent of its 1.7 million people live in rural areas and are primarily involved in growing crops, with about 28 per cent living below the poverty line. A survey of members of three WUAs analysed factors affecting irrigation efficiency (water productivity) by farm type (dehkan vs. farmer). The WUAs differed from each other in the location of the irrigated areas relative to the main canals (at the head, middle or "tail"), i.e. depending on the distance from the place where the canals branched off from the Amu Darya. In total, the managers of 120 agricultural enterprises were interviewed: 86 dehkan and 34 farmers.

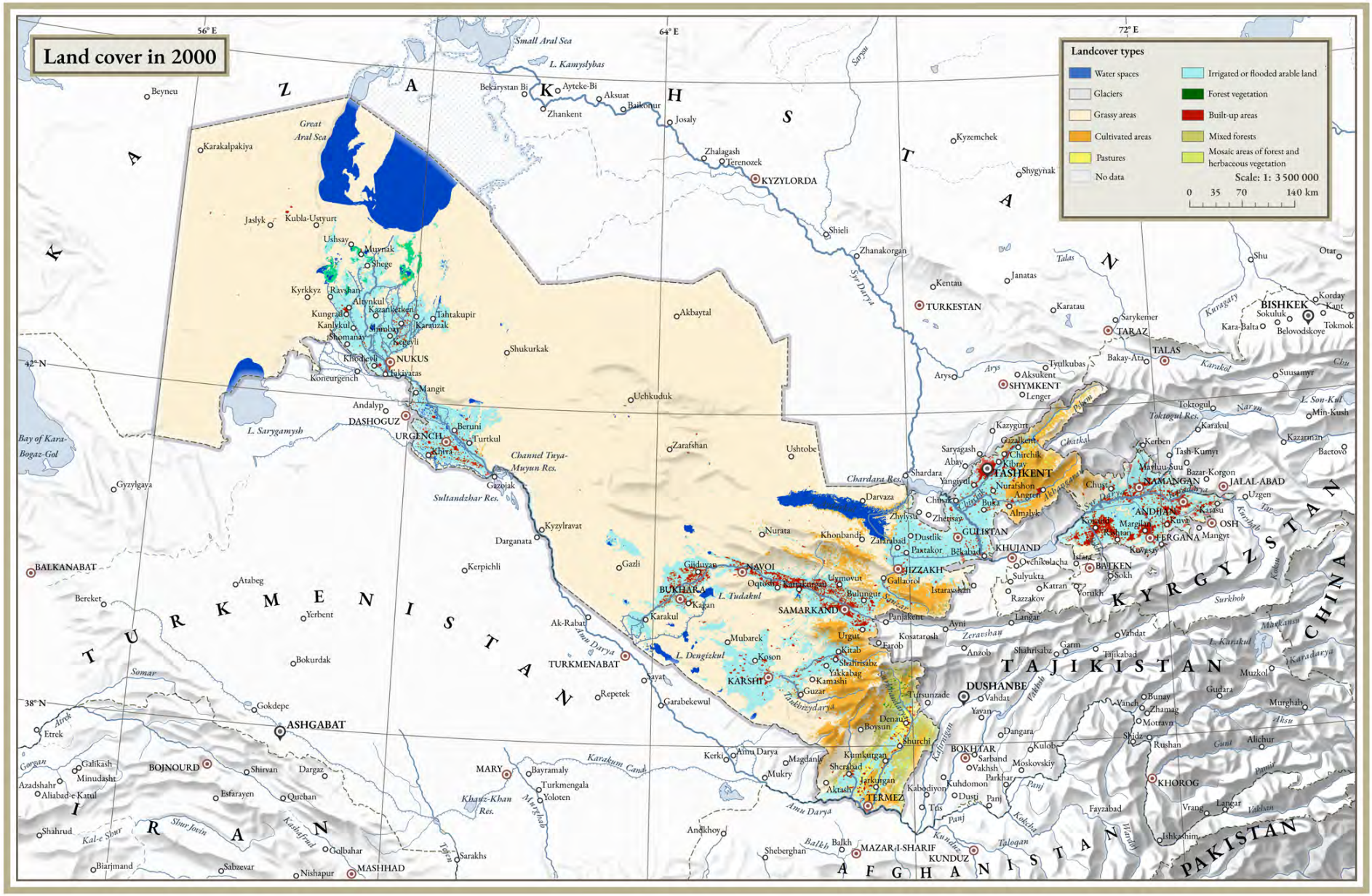
The results showed that in Khorezm the probability of achieving 'good' returns from irrigation among dehkan farms was 58 per cent, 'medium' returns were 27 per cent and 'low' returns some 15 per cent. The strongest drivers of water productivity were having access to both irrigation sources and professional experience as well as output prices when their produce was brought to market. The regression model shows that higher farm income subsequently increases the share of «good» profitability from 58 to 68 percent, driven mainly by income from rice, corn, and vegetables/fruits.

Commercial farmers rated irrigation profitability much lower, with only eight per cent rating it as 'good', 39 per cent 'medium', and 53 per cent as 'low'.

The study also found dehkan farm results were not dependent on their position along the main canal as the share rating their returns as 'good' was roughly equal across all three WUAs. Among farmers, satisfaction with water productivity was highest (21 per cent rated it as 'good') in the WUA closest to the Amu Darya, while none rated it 'good' in the tail-reaches WUA.

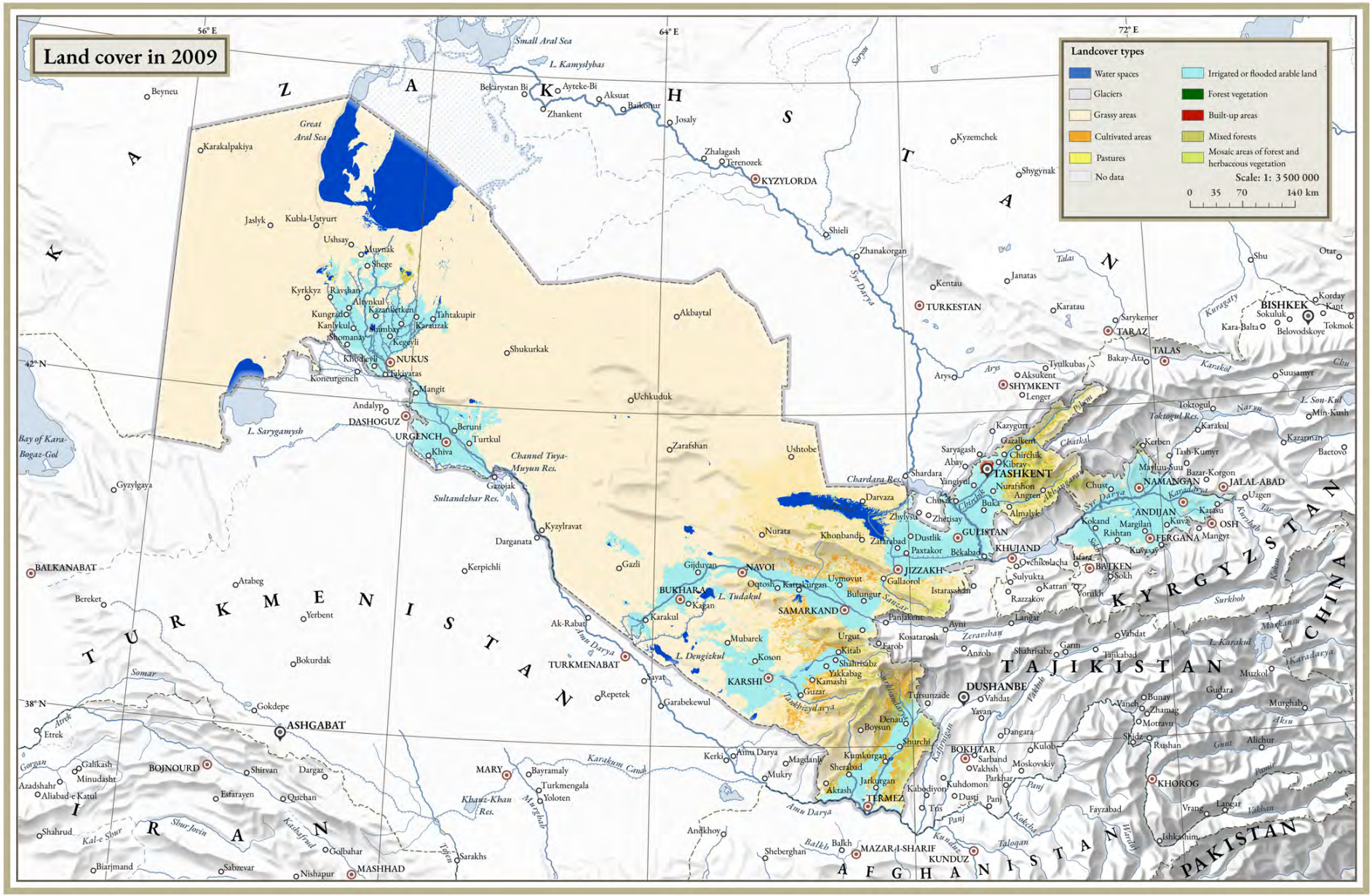
Two reasons explain these differences. First, dehkans plan and grow primarily for self-provision, whereas commercial farmers are, as previously mentioned, obliged to grow cotton and wheat for the State. Dehkans thus enjoy much greater autonomy and can choose crops according to household needs and market opportunities. Second, although both groups draw from the same irrigation infrastructure, dehkans receive residual water: water is first allocated to commercial farmers and, once their needs are satisfied, water is made available to dehkans. As a result, dehkans have been forced to adapt, finding ways to use water more efficiently and, in some cases, mitigating their water dependence by installing their own pumps to lift groundwater, enabling more profitable crops to be grown and resulting in higher water productivity. For commercial farms, using groundwater is not a practical option to solve water deficits (e.g., in drought years) due to their large field sizes.

98 Gender, agriculture and rural development in Uzbekistan (2018) Country Gender Assessment Series. FAO: Budapest. 92 P.
99 World Bank to Help Uzbekistan Develop a Productive, Sustainable, and Market-Oriented Livestock Sector
100 Gender..., 2018.
101 Uzbekistan Barley Production by Year (1000 MT).
102 Gintzburger et al. (2003) Rangelands of the Arid and Semi-Arid Zones in Uzbekistan. Montpellier/Aleppo: CIRAD & ICARDA. 426 P.
103 Uzbekistan's pastures are close to irreversible degradation – CACIP Central Asia Climate Information Portal
104 ЗРУ-538-сон 20.05.2019. О пастбищах.
105 Saravanan et al. (2014) Irrigation water management in Uzbekistan: analyzing the capacity of households to improve water use profitability. In: Vlek, et. Al. (eds.): Restructuring Land Allocation, Water Use and Agricultural Value Chains: Technologies, Policies and Practices for the Lower Amudarya Region. ZEF: 253–274.



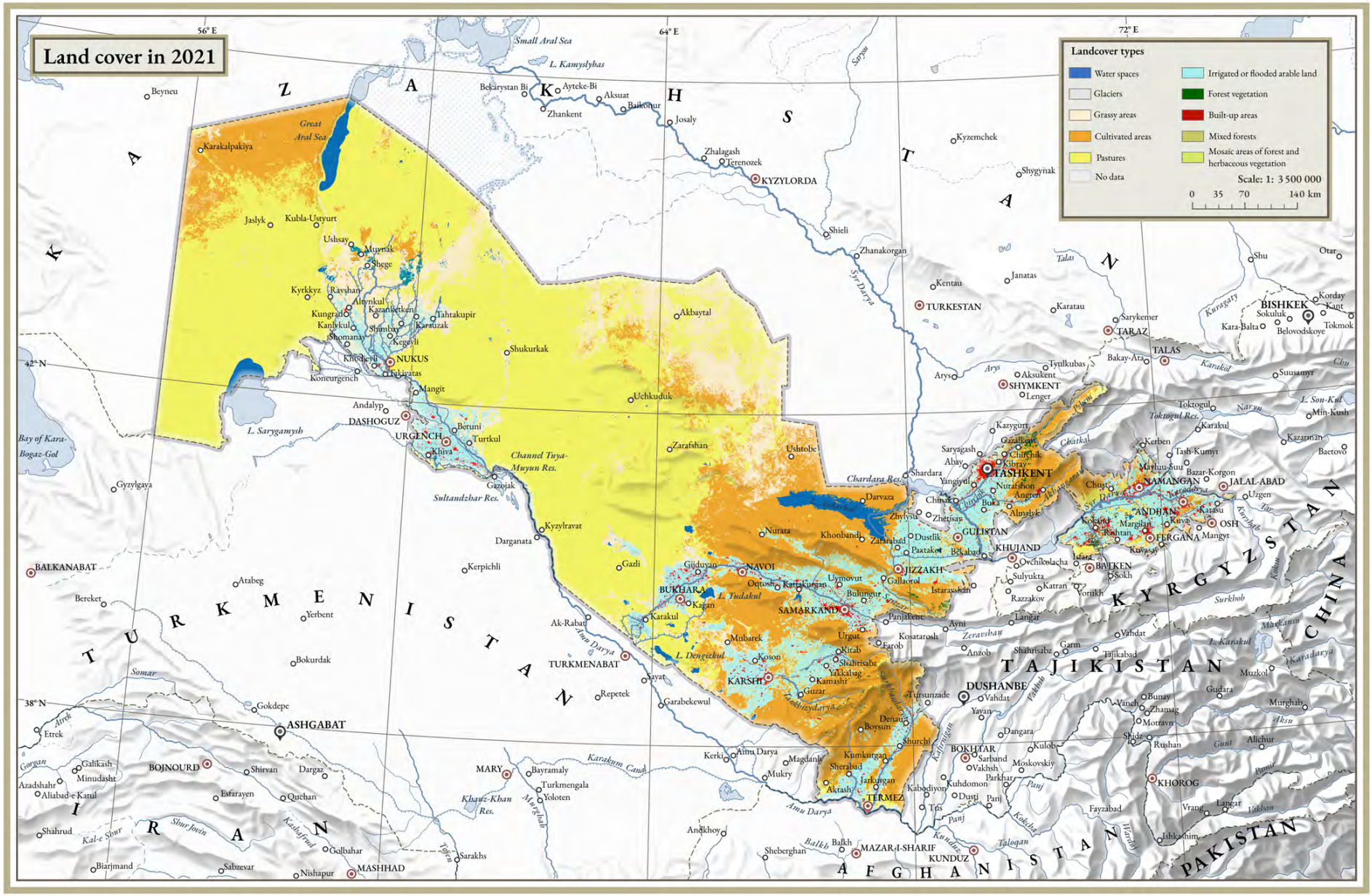
ESA. Land Cover CCI Product User Guide Version 2. Tech. Rep. (2017). Available at: maps.elie.ucl.ac.be/CCI/viewer/download/ESACCI-LC-Ph2-PUGv2_2.0.pdf

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



The GlobCover products have been processed by ESA and by the Université Catholique de Louvain. © ESA 2010 and UCLouvain. Accompanied by a link to our ESA DUE GlobCover website: http://due.esrin.esa.int/page_globcover.php

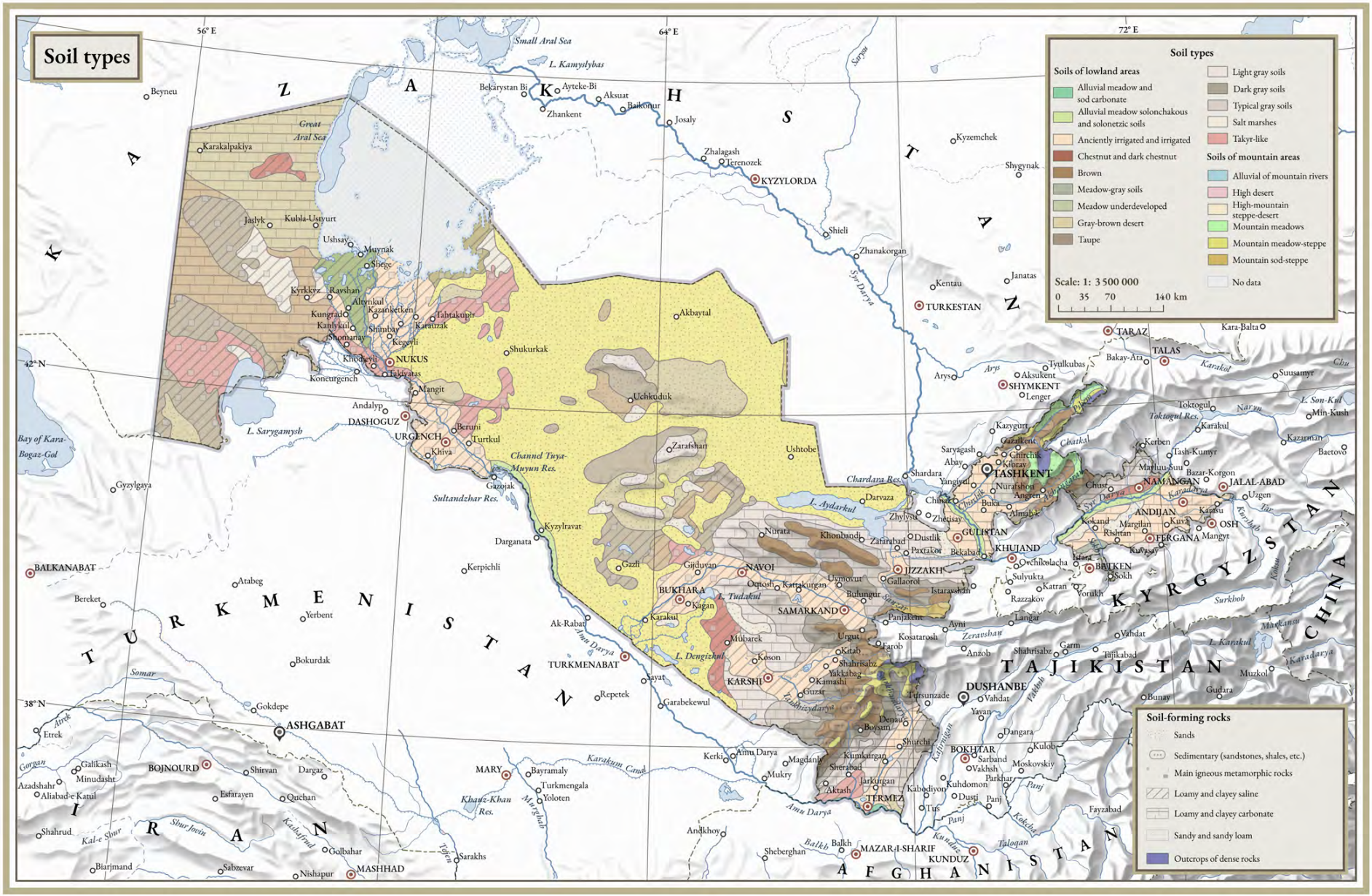
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Based on ESA WorldCover 2021 data[106], obtained from the automatic classification of Sentinel 1 and 2 satellite images. Spatial resolution is 10 m.

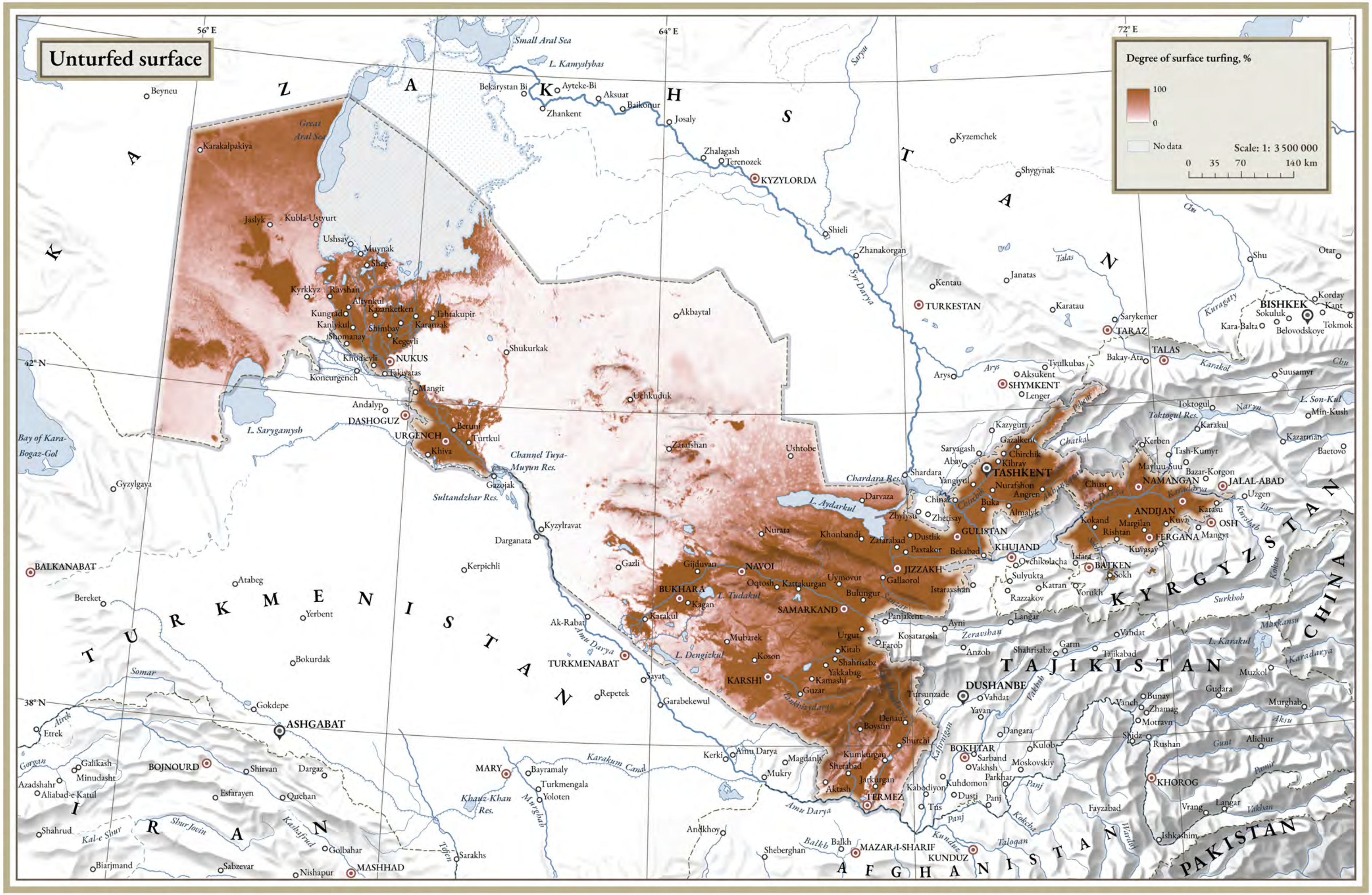
106 https://doi.org/10.5281/zenodo.5571936%C2%A0

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Atlas of the Uzbek Soviet Socialist Republic. – Tashkent-M.: Academy of Sciences of the Uzbek SSR; GUGK, 1963.

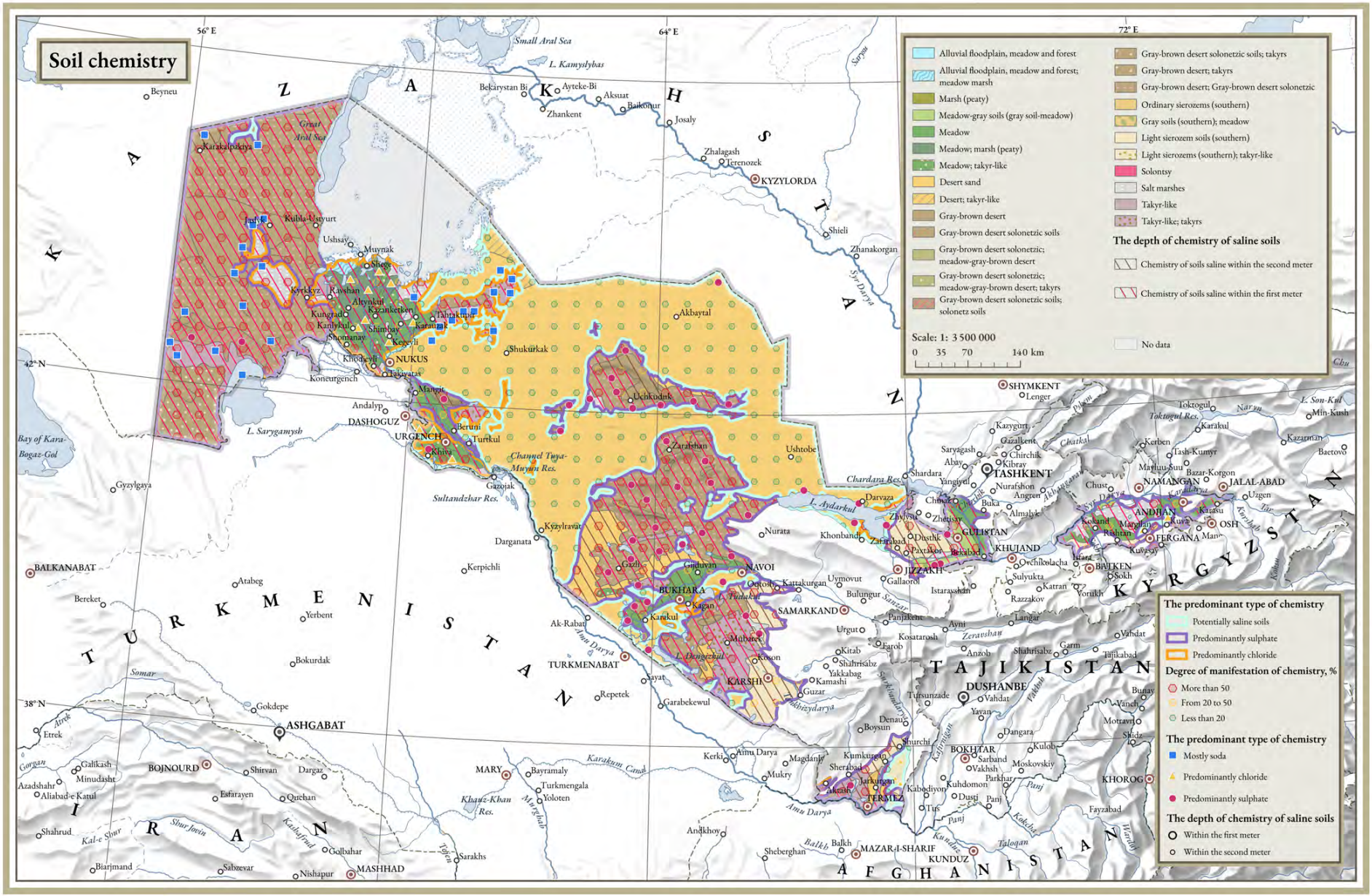
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Based on Global 2010 Bare Ground data[107], obtained using Landsat 7 satellite images and regression tree models. Spatial resolution is 30 m, temporal coverage is 2010.

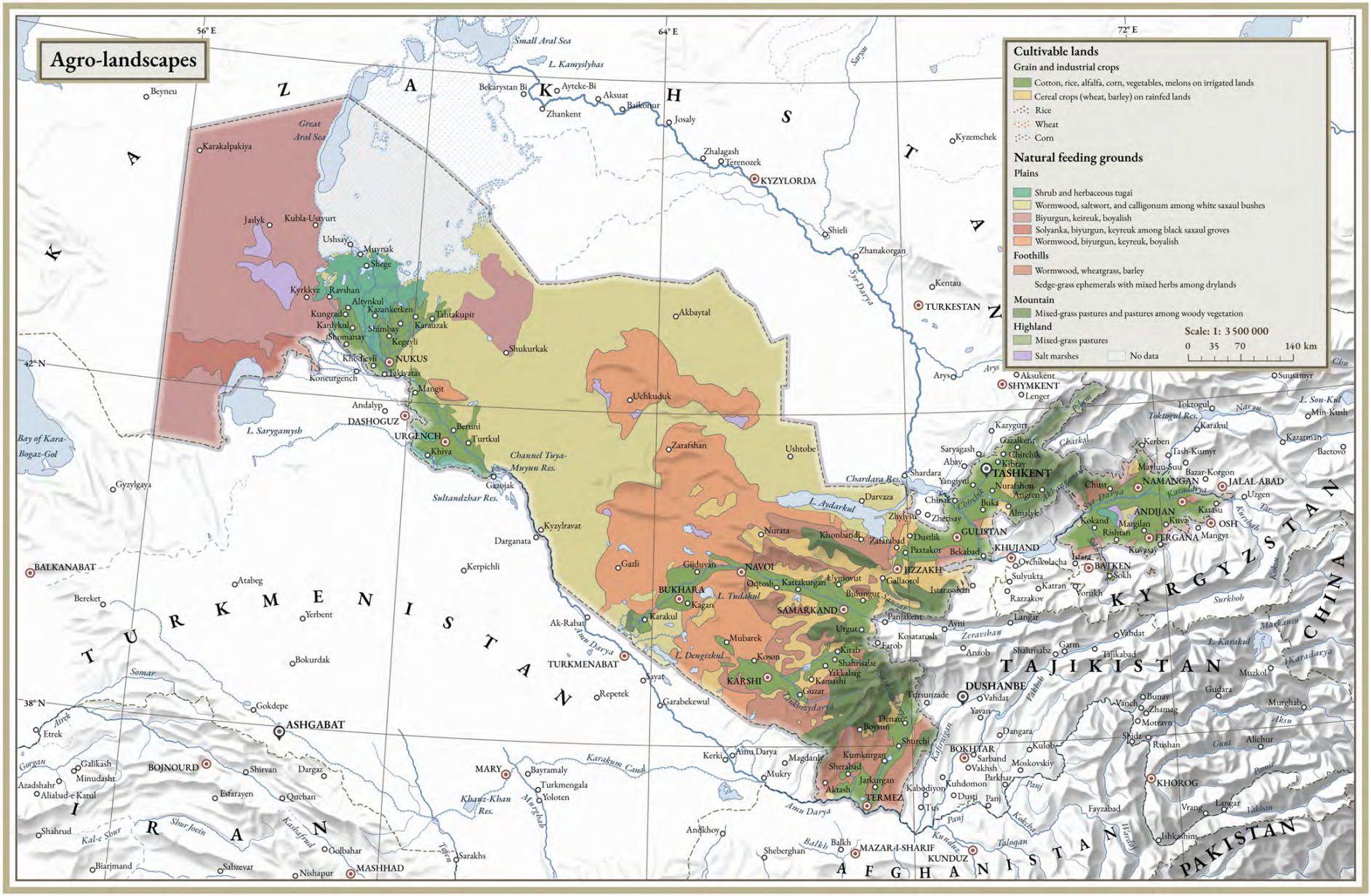
107 Dematte et al. (2020) Bare earth's Surface Spectra as a proxy for Soil Resource Monitoring. Scientific reports. 10,1: 1-11.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



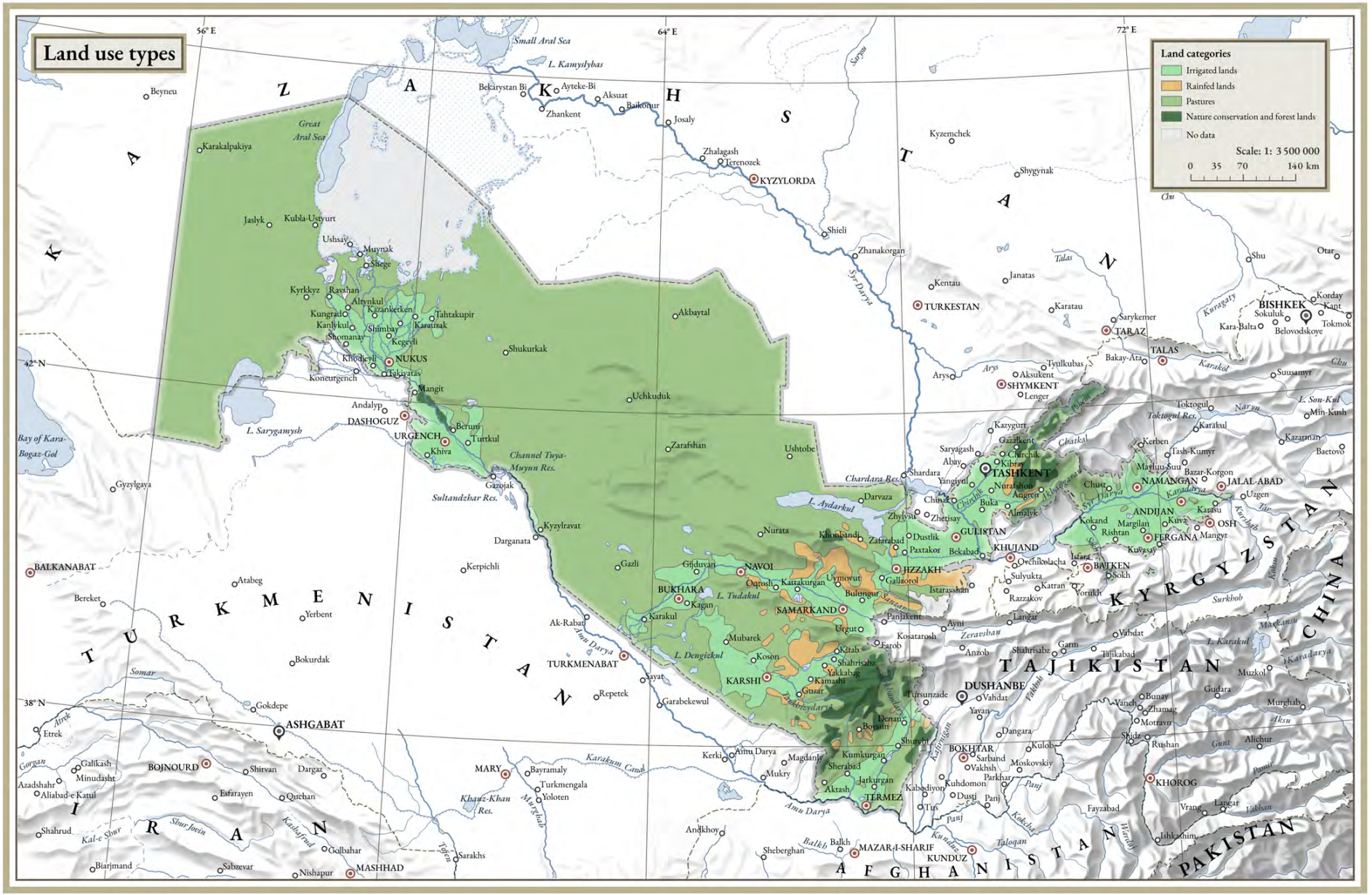
Map of soil salinity types in the USSR. 1:2,500,000. On 6 sheets. – Moscow: GUGK, 1976.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



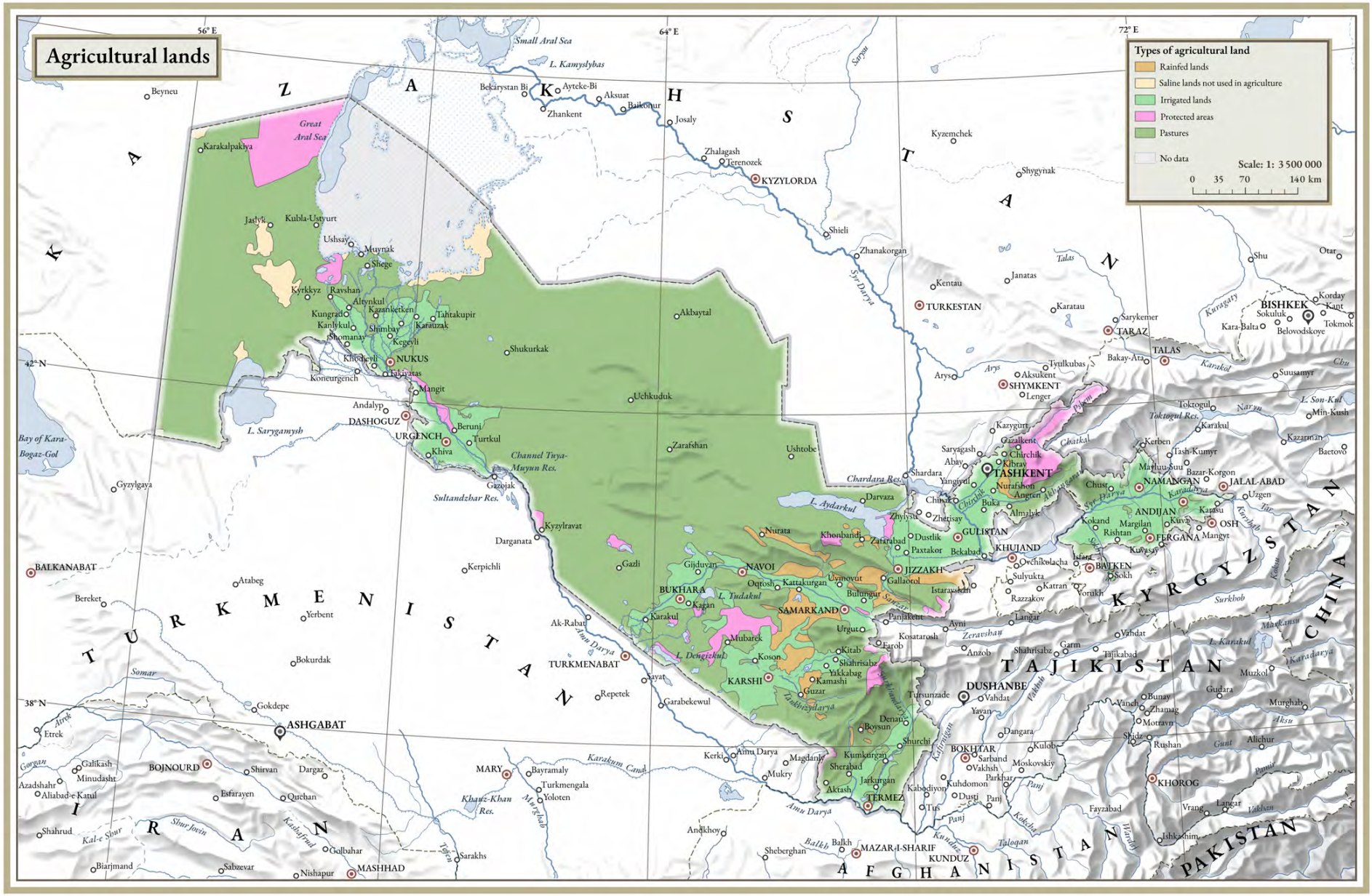
National Atlas of Uzbekistan: in two volumes / Cadastre Agency under the State Tax Committee of the Republic of Uzbekistan. Tashkent: Cartography, 2020. ISBN 978-9943-15-856-6. / Cadastre Agency under the State Tax Committee of the Republic of Uzbekistan. Tashkent: Cartography, 2020. ISBN 978-9943-15-856-6.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



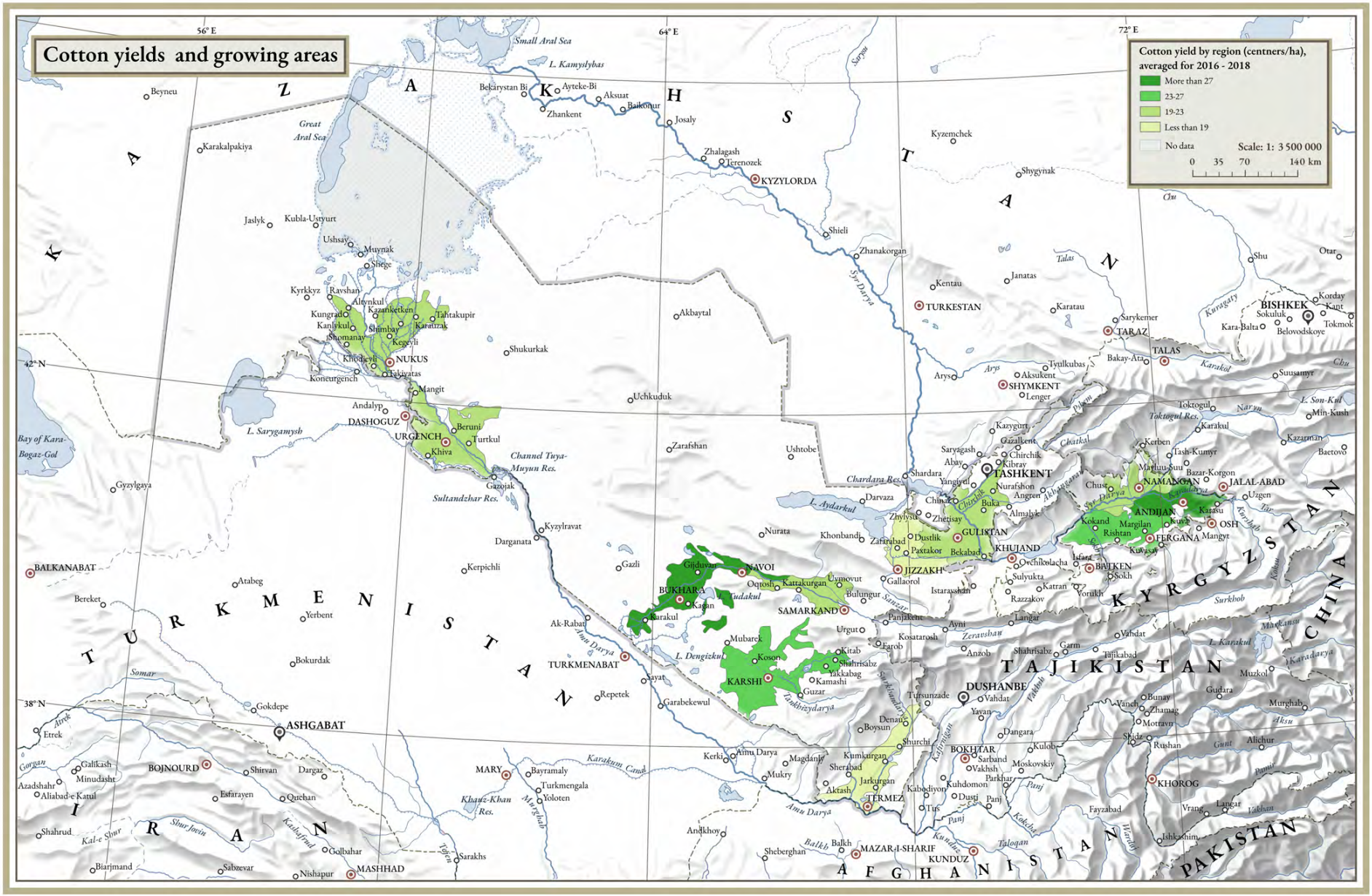
National Atlas of Uzbekistan: in two volumes / Cadastre Agency under the State Tax Committee of the Republic of Uzbekistan. Tashkent: Cartography, 2020. ISBN 978-9943-15-856-6.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



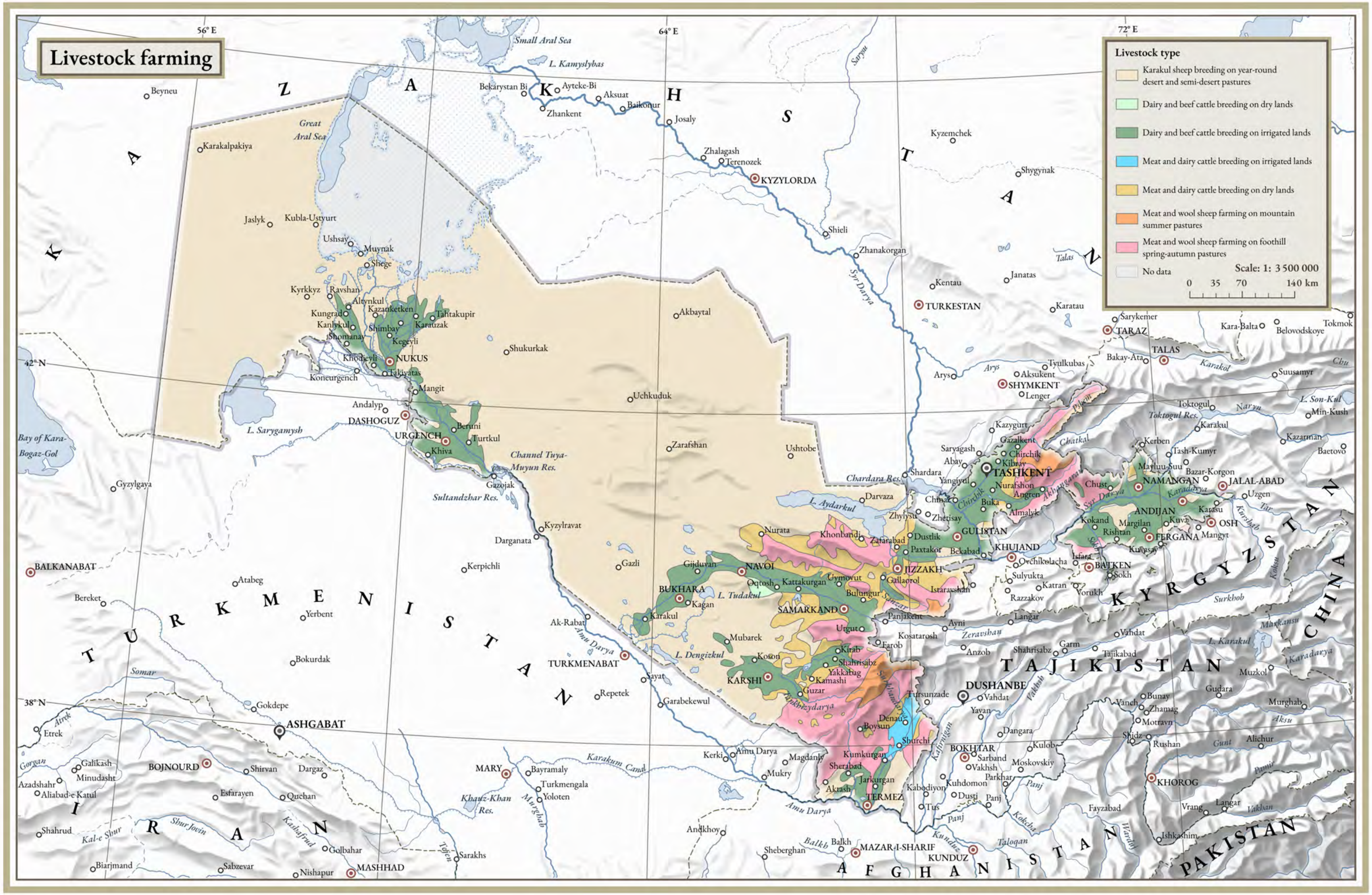
National Atlas of Uzbekistan: in two volumes / Cadastre Agency under the State Tax Committee of the Republic of Uzbekistan. Tashkent: Cartography, 2020. ISBN 978-9943-15-856-6.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



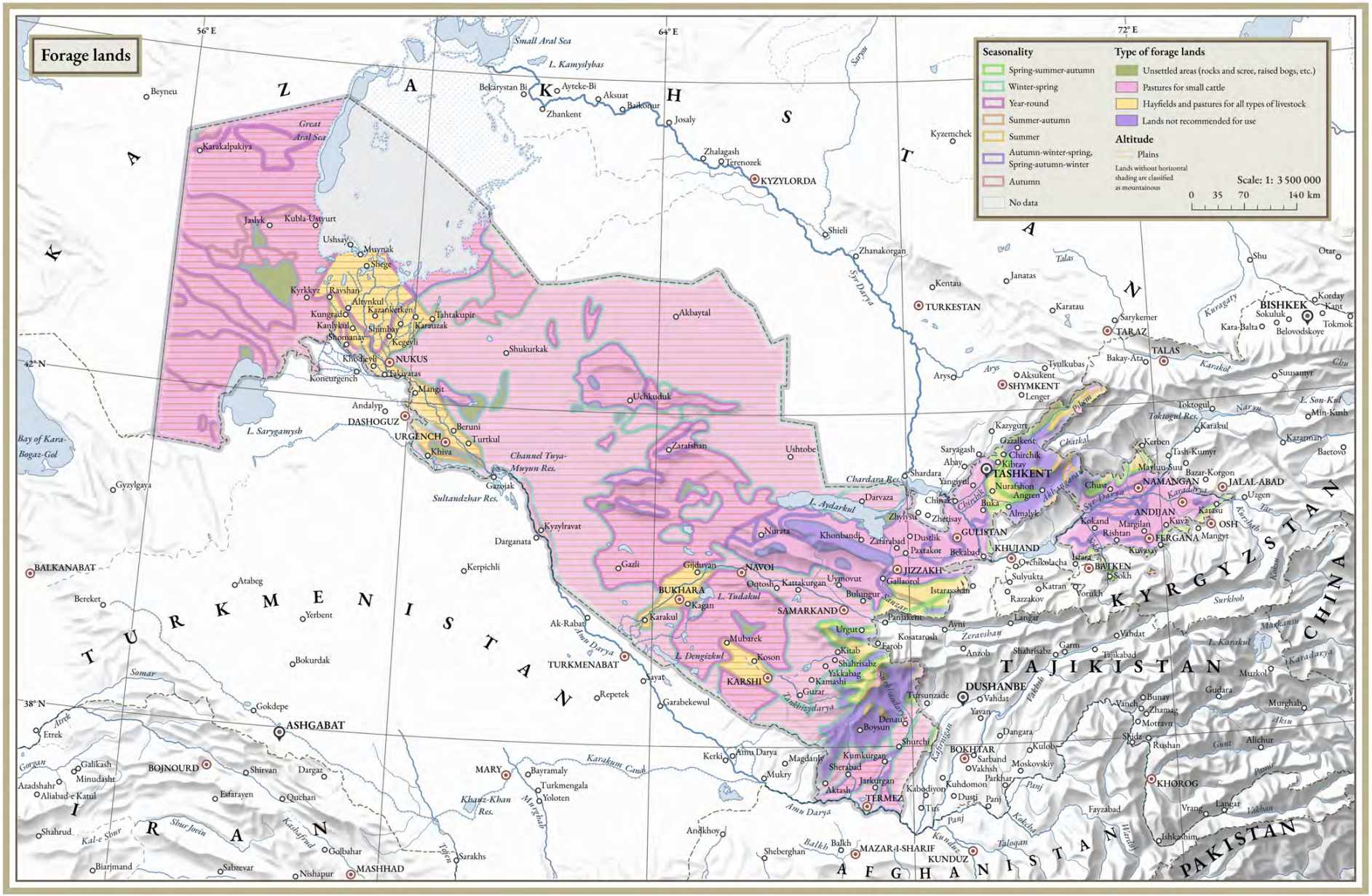
National Atlas of Uzbekistan: in two volumes / Cadastre Agency under the State Tax Committee of the Republic of Uzbekistan. Tashkent: Cartography, 2020. ISBN 978-9943-15-856-6.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Atlas of the Uzbek SSR. –M.: GUGK, 1981.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Natural Forage Lands of the Russian Federation and Adjacent States Maps: For Higher Education Institutions / Compiled and prepared for publication by the Omsk Cartographic Faculty in 1994; scientific and methodological guidance of the Research Lab of the Integrated Cartographic Faculty of Moscow State University; authors L. V. Shvergunova et al.; editor T. V. Kotova. — Corrected in 2001 — Moscow: Roskartografiya, 2001. — 1 book (4 sheets): color: 86x116 cm.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.

Table 10. Condition of soils in the irrigated districts of the Republic of Uzbekistan[108]

Region	Share of irrigated land in agriculture, %	Non-saline, %	Slightly saline, %	Moderately saline, %	Strongly saline, %
Republic of Karakalpakstan	22.5	22.7	28.9	38.9	9.5
Khorezm	96.1	0.0	54.1	33.1	12.9
Bukhara	8.9	13.4	59.8	23.5	3.4
Navoi	3.0	12.7	71.2	14.0	2.1
Samarkand	25.2	98.5	1.4	0.1	0.0
Kashkadarya	23.1	52.9	35.3	9.3	2.3
Surkhandarya	26.8	68.4	21.7	9.6	0.3
Jizzakh	23.4	21.1	52.4	24.4	2.0
Syr Darya	93.3	1.6	80.7	16.4	1.3
Tashkent	58.4	97.7	1.9	0.4	0.0
Fergana	95.1	52.2	36.0	10.7	1.1
Namangan	82.6	90.9	6.2	2.5	0.3
Andijan	91.7	95.6	2.3	2.0	0.0
Republic of Uzbekistan	**23.8**	**51.0**	**31.6**	**14.5**	**2.9**

108 Ibid.

4.3. Towards Achieving the SDGs

Land resources are at the centre of national environmental policy in the Republic of Uzbekistan. Uzbekistan was the first country in Central Asia and the CIS to ratify the UNCCD. The country is also an active participant in international projects on the rational use of land resources in Central Asia. As early as 2003, Central Asian States agreed upon and adopted a Sub-regional Action Programme to combat desertification under the UNCCD. This platform later enabled the launch of the Central Asian Countries Initiative for Land Management (CACILM) in 2006. Within the UNCCD framework in Central Asia, a standing interregional group of Convention participants was established to promote cooperation on the objectives of the UNCCD 2018–2030 Strategic Framework, and Uzbekistan is one of its members. Another pilot programme, the 'Regional Approaches to Sand and Dust Storms and Drought Management' (launched 2018), includes Uzbekistan as one of the countries facing land degradation and desertification processes; it aims to develop a regional drought-risk strategy, map vulnerable areas in Central Asia and devise measures to prevent sandstorms. A further example of regional cooperation is the analytical project 'The Economics of Land Degradation in Central Asian Countries (2014–2016)', also implemented under the UNCCD with participation from the main development agency of Germany (GIZ), the International Center for Agricultural Research in the Dry Areas (ICARDA), national governments, and the Central Asia Regional Economic Cooperation Program (CAREC), to raise stakeholder awareness of the economic value of productive land using both market and ecosystem approaches.

In September 2015, the Government of Uzbekistan adopted national indicators for the SDGs under the auspices of the Cabinet of Ministers decree entitled 'On measures to implement national SDGs and targets to 2030'. This decision formalized national goals, targets and indicators through to the year 2030, including Target 15.3 on achieving Land Degradation Neutrality (LDN)[109].

As a part of preparing the final report on LDN Target-setting in Uzbekistan (2019), the CACILM session hosted a round-table that carried out the first national assessment of Uzbekistan's exposure to desertification and drought[110]. Using a suite of global and national indicators (wind erosion, soil salinity bonitation, aridity index, the Standardized Precipitation Index and the Normalized Difference Vegetation Index (NVDI)), the preliminary assessment found that 26 to 28 per cent of the country's area experienced degradation in the period from 2000 to 2013. The principal hotspots were the irrigated and rainfed zones of the Aral Sea Region within the Republic of Karakalpakstan and the Khorezm oasis. Such composite assessments (mixing indicators of different metrics and 'weights') are not always straightforward to interpret. The estimate cited here is likely conservative because two of the most important high-weight indicators in Uzbekistan, namely salinized agricultural soils and degraded rangelands, stand at 49 per cent and 36.8 per cent, respectively.

SDG 15.3 calls for protecting, restoring and promoting the sustainable use of terrestrial ecosystems, including SFM, combating desertification as well as halting and reversing both land degradation and biodiversity loss. In this regard, the republic's LDN goal for 2030 has been incorporated into SDG 15.3. Uzbekistan's voluntary LDN target states: "By 2030, combat desertification, restore degraded land and soil—including land affected by desertification, drought, and floods—and strive for a world where land degradation is neutral". The primary indicator here (15.3.1) is the share of degraded land area (irrigated and non-irrigated) relative to total land area. In line with international practice, this composite indicator comprises three sub-indicators: land cover/land-use change, land productivity/net primary productivity and, finally, carbon stocks in biomass and soils. Following the 'one-out-all-out' principle, an area is deemed degraded if any sub-indicator shows a clear negative trend. However, currently available data for Uzbekistan are insufficient to determine trends for all three sub-indicators.

Land-cover dynamics can be an important indicator of regional environmental change linked to the Aral Sea crisis and climate driven transformations *(see map 'Dynamics of arable land, 2003–2019')*. National statistics, however, show relative stability in the size of irrigated and sown areas since the mid-1990s. The sown area in both 1995 and 2012 was ~3.63 million ha[111], a figure that dipped only slightly to 3.39 million ha in 2020, although that was likely due to that year's difficult climatic conditions[112]. On average, Uzbekistan's sown area has hovered around 3.5 million ha over the last 30 years. However, large shifts can be seen in crop structure, primarily driven by policies to enhance food security and diversify in the

109 Summary Report on the LDN Target Setting Programme in the Republic of Uzbekistan (2019) Global Mechanism of the UNCCD. 14 P.
110 Ibid.
111 State Statistics..., 1991.
112 State Statistics..., 2021.

agricultural sector. Local agriculture continues its transition away from the cotton monoculture that dominated the Soviet era toward other market crops. Grain cultivation has expanded slightly (2.4 per cent increase since 2011), while the cotton-growing area has shrunk by ~20 per cent since 2011, freeing irrigated land for crops of vegetables and melons[113].

Modern remote sensing is a useful tool to validate national statistics. One of the first such studies[114] focused on the Kashkadarya irrigation district, which experiences chronic irrigation water deficits[115]. Analyses of five single years within the 1973 to 2009 period showed systematic over-reporting of irrigated area in national statistics for the Kashkadarya oasis. This over-reporting was significant, on average by 20 per cent over the whole period and up to 42 per cent in the extremely dry year of 1998. According to the authors of the publication, national statistics reflect planned sown area rather than the area actually sown and successfully emerged irrigated area.
At the same time, the Kashkadarya study confirms there was growth in its sown and irrigated area despite rising water scarcity. From 1998 to 2009, remote-sensing evidence shows gradual expansion of cropping beyond the most suitable light serozem soils into solonetz, solonchak and takyr soils that require additional amelioration.

A significant post-1991 shift in crop structure is also clear as evidenced, for example, by the area under wheat doubling from 102,500 ha in 1987 to 201,800 ha in 1998. In Soviet times, wheat appeared as relatively large, compact blocks, whereas in the post-Soviet period, its distribution became 'fine-grained' on satellite images, reflecting the rise of numerous small dehkan farms replacing the large Soviet collectives. An NDVI analysis distinguished three cropping patterns: predominantly winter wheat (single peak in May to June); predominantly cotton (single peak in late August through to early September); and winter wheat plus various summer crops (cotton, rice, maize, sorghum—which had two peaks – in May and August). Such diversification has enabled intensification by increasing the areas under both winter and summer crops within a given season. A downside to this development is that expanding winter crops has disrupted the autumn leaching of saline soils, which normally happens before the cold weather reduces salt solubility.

Stability or some expansion of the irrigated and sown areas is a characteristic visible in all oases, regardless of their



Stone blocks of volcanic rock on the slopes of the foothills of the Nuratinsky mountains. Jizzakh region of Uzbekistan

specific environmental challenges *(see map 'Dynamics of land cover, 1985-2020')*. The key driver of this more extensive land use is demographic pressure as, in the Khorezm oasis for example, the population grew 60 per cent between 1991 and 2017. While the built-up area increased ~400 per cent, about 70 per cent of the region's 1.5 million residents are still engaged in some form of agriculture. Agricultural land area rose from 3,098.54 km² to 3,661.08 km² (an 18 per cent increase) in this same period between 1991 and 2017, largely by incorporating peripheral hills and wastelands. This coincided with an increase in the area of saline lands from 50.78 to 599.17 km²,[116] a 13.4 per cent reduction in water surface area, greater bare-soil extent and reduced Amu Darya discharge in its lower reaches[117].

The second sub-indicator is land productivity dynamics. Nationally, 'land productivity' is assessed using the inherited Soviet soil bonitation expert system, an index of soil quality divided into classes relative to the most potentially fertile soil (class I = 100 points). The national mean is 55 points, with Karakalpakstan having the lowest (44) and Namangan the highest (59)[118]. Overall, due to the relative uniformity of the desert plain soils present in irrigated regions, most of Uzbekistan has moderate quality (40–60 points, III class) 'land productivity'. Within irrigation districts, however, plots with low bonitation (<40, class IV) are typically abandoned first during times of extraordinary water stress.

113 Ibid.
114 Edlinger et al. (2012) Reconstructing the spatio-temporal development of irrigation systems in Uzbekistan using Landsat time series. Remote Sensing. 4 (12): 3972–3994.
115 Lutz et al., 2012.
116 Rakhmonov et al. (2021) Land Use and Land Cover Change in Khorezm, Uzbekistan. E3S Web of Conferences. 227, 01002. *Land Use and Land Cover Change in Khorezm, Uzbekistan.
117 Boymurodov et al. (2024) Monitoring land use and land cover (LULC) in the Khorezm oasis using the Esri Sentinel-2 Land Cover Explorer database. E3S Web of Conferences. 590, 04001. Monitoring land use and land cover (LULC) in the Khorezm oasis using the Esri Sentinel-2 Land Cover Explorer database.
118 UNECE (2010) Environmental Performance Reviews: Uzbekistan. Second Review. Geneva. 227 P.
*UNECE Environmental Performance Reviews_Uzbekistan 2010 (2nd cycle).pdf.

Secondary salinization, both a cause and a consequence of water scarcity, is a major threat to agriculture and has likely contributed to the decline in cotton yields and the stagnation of grain yields (see Figures 7 and 8). A degree of salinization is natural in intermontane, alluvial and proluvial areas of the arid zone *(see map 'Degree of soil salinization')*. However, it is exacerbated by anthropogenic factors: waterlogging from non-drained irrigation, seepage losses (especially from canals without proper lining), over-irrigation and reuse of mineralized drainage water for irrigation. The recently adopted practice of expanding winter wheat followed by planting cotton as a second crop can also increase salinity because leaching is normally done in autumn, precisely when winter crops are planted. Data indicate active salinization in the recent years *(see map 'Irrigated soil salinization')*. In national statistics, irrigated areas are classified by salinity into four types: 1—non-saline; 2—slightly saline; 3—moderately saline; 4—strongly saline. The classification is based on salt content in the upper soil horizon, which harms crops when salt levels are elevated. In type three and four areas, periodic leaching is practiced to reduce salt content, however, this requires roughly 15 per cent of the already scarce irrigation water to be used for this purpose[119].

Table 11. EVI trend of land-cover classes, 2000–2014

Region	Tree cover	Shrubland	Grassland	Cropland	Built-up areas	Bare surface	Water bodies	Wetlands
Republic of Karakalpakstan	0.000579	-0.00013	-0.00027	0.000931	0.000496	-0.0003	0.000184	0.000466
Khorezm Region	0.001491	0.001216	0.001158	0.001528	0.000408	0.000216	0.000387	0.002224
Navoiy Region	0.000804	3.16E-05	-4.7E-05	0.000847	0.000144	-0.00026	0.000209	0.002655
Bukhara Region	0.000795	0.000295	-0.00023	0.000949	0.000196	-4.5E-05	0.00045	-0.00096
Samarkand Region	0.001384	0.000195	0.001008	0.000523	0.000346	-0.00016	0.000133	0
Kashkadarya Region	0.000516	-0.00054	0.000538	0.000895	0.000143	-0.00028	0.000152	-0.00285
Surkhandarya Region	0.000603	0.000511	-0.00038	0.00146	0.000474	-0.00027	-0.00028	0
Jizzakh Region	0.000516	3.5E-05	0.00023	0.000533	-6.3E-05	-0.00019	0.000323	0.000277
Syr Darya Region	0.000656	0	0.000333	0.000707	0.000634	-0.00084	-0.00384	0
Tashkent Region	0.000173	0	0.00029	-0.00012	-0.00084	0.000193	-0.00079	0
Andijan Region	0.000363	0	-0.00044	0.001003	-0.00056	-0.00039	-0.001	0
Namangan Region	0.00094	0	8.43E-05	0.001075	-0.00063	-0.00043	-0.00025	0
Fergana Region	0.001976	0	0.000612	0.000836	0.000297	-4.1E-05	-0.00193	-0.00051
Republic of Uzbekistan	**0.000646**	**-2.4E-05**	**-0.00016**	**0.000916**	**0.000175**	**-5.1E-05**	**0.000252**	**0.000375**

According to literature cited here *(see Table 10)*, 49 per cent of cultivated soils in Uzbekistan are salinized to some degree: 14.5 per cent moderately and 2.9 per cent heavily salinized. Other national and international sources return similar results: 50 to 53 per cent of irrigated lands salinized, of which 14 to 16 per cent are moderately salinized and 3.9 to five per cent heavily salinized[120].

Having noted the above, regional variation is large *(see map 'Soil salinization dynamics')*. Nationally, the share of irrigated area with moderate to strong salinity is 17.4 per cent. However, in the Republic of Karakalpakstan and the Khorezm Region, 48.4 per cent and 46.0 per cent of their respective irrigated lands fall into these categories *(see Table 10)*. The Bukhara and Jizzakh regions are also problematic, with ~26 per cent of their irrigated lands being moderately or heavily salinized, while the Namangan, Andijan, Tashkent and Samarkand regions have 90 to 98 per cent non-saline soils. Adding to these mixed results, the Fergana Valley, which is densely populated and demographically fast-growing, appears to be increasingly problematic with 11.8 per cent of its irrigated lands suffering from moderate or heavy salinity.

Assessments of trends in irrigated soil salinity are contradictory. According to the State Committee on Land Resources, Geodesy, Cartography and State Cadastre, ongoing soil-quality mapping indicates a positive tendency or stabilization from 2002 to 2008 and, in many regions, some improvement in land quality was observed[121]. In a number of studies[122], the use of remote methods showed a decrease in the area of saline land, for example, in parts of the Fergana Valley after 2011. However, the use of remote methods in other oases showed negative salinity trends over the last decade, with the most negative tendencies revealed, unsurprisingly, in the Aral Sea Region. Also of concern here is the fact that the area of saline soils in the Khorezm Region increased eleven-fold between 1991 and 2017[123]. Remote studies in Chimbay District of the Republic of Karakalpakstan revealed an increase

119 UNECE, 2020a.
120 UNECE, 2010.
121 UNECE, 2010.
122 Khamraliev et al. (2023) Soil Salinity Monitoring in Irrigated Areas of Rishtan District of Ferghana Valley, Uzbekistan. E3S Web of Conferences. 386, 01010. Soil Salinity Monitoring in Irrigated Areas of Rishtan District of Ferghana Valley, Uzbekistan.
123 Rakhmonov et al., 2021.

Table 12. Assessment of trends in the dynamics of primary production on croplands in the regions of Uzbekistan, 2001–2020

Region	Cropland area, ha	Cropland area by degree of degradation, ha		
		Weak	Moderate	Strong
Republic of Karakalpakstan	271,662	75,625	119,223	76,813
Khorezm	233,302	56,357	92,258	84,687
Bukhara	262,048	100,297	115,858	45,893
Navoiy	109,584	44,099	46,518	18,967
Samarkand	429,333	201,111	176,962	51,260
Kashkadarya	483,002	197,789	189,876	95,337
Surkhandarya	315,188	139,601	136,931	38,656
Jizzakh	418,246	159,057	169,216	89,972
Syr Darya	202,411	84,014	78,857	39,540
Tashkent	349,778	205,625	101,944	42,209
Andijan	241,626	177,199	47,040	17,387
Fergana	314,043	169,487	89,632	54,925
Namangan	230,336	122,511	75,301	32,524
Uzbekistan	**3,860,559**	**1,732,771**	**1,439,617**	**688,171**

in the saline-soil area from 46.5 per cent to 48.9 per cent between 2015 and 2022[124].

Uzbekistan is a leader in Central Asia in applying remote sensing methods to assess land condition, having produced 75 per cent of the region's publications on this matter[125]. However, assessing soil salinity by remote sensing means is challenging as salinization occurs mainly beneath the surface and is highly dynamic in the vertical dimension of the soil profile, making it largely invisible to remote sensors. Furthermore, heterogeneous vegetation cover blurs remote-sensing signals, distorting the external characteristics of saline soils[126].

The recommended remotely sensed indicator for measuring salinization is the dynamics of primary productivity[127]. The methodology for using vegetation indices is well established across many regions around the globe where the NDVI and Enhanced Vegetation Index (EVI) indices are used as indicators. Their values make it possible to compare vegetation conditions across different landscape settings in a given year or period *(see map 'Average maximum NDVI values, 2004–2024')*. A positive trend in the indices indicates an improvement in land condition, while a negative trend indicates a deterioration *(see maps 'Dynamics of Normalized Vegetation Index '; 'Dynamics of Enhanced Vegetation Index')*. The NDVI and EVI indices resented here show large differences in Uzbekistan's green biomass dynamics among land-cover classes *(see Table 11)*. Shrub communities of deserts and semi-deserts are in a depressed state while grassland communities (rangelands) show a distinct negative trend, unlike croplands. Other vegetation indices yield similar results *(see maps 'Dynamics of Leaf Area Index'; 'Dynamics of land productivity')*.

According to data provided by the UNCCD, an analysis of Uzbekistan's land primary-productivity trends between 2000 and 2013 showed that 80 per cent of the land area is stable, 15 per cent is degrading and five per cent is improving[128]. In another study conducted by World Bank experts, medium-resolution Moderate Resolution Imaging Spectroradiometer data were used to compute trends in primary-production dynamics for different land-cover classes (ESA WorldCover 2021) between 2001 and 2020[129]. According to the results, only 45 per cent of the land area was stable, 37 per cent show some negative trend and 17 per cent a significant negative trend *(see Tables 12 and 13)*. The discrepant results returned from the two cited sources is related to differing time periods for computing cropland-productivity trends and the use of global resources to identify croplands and other land categories.

Within the World Bank study, hotspots of agricultural-land degradation were identified by substantial declines in vegetation productivity over the 20-year study period. These hotspots correspond well to the areas of declining primary productivity identified in this Atlas *(see map 'Dynamic of land productivity')*, namely the Fergana Valley, the Gulistan–Jizzakh corridor, the areas north of Nukus and Namangan as well as the area around Tashkent. Interestingly, these results coincide with the assessment presented here of cropland-use intensity *(see map 'Intensity of arable land use')*. These five "foci of degradation" (to use World Bank report's terminology) likely have different causes for their unsatisfactory conditions. Agricultural lands in the densely populated Fergana Valley and the Gulistan-Jizzakh corridor are likely to have suffered from a combination of water scarcity and soil degradation or salinization. The decline in biomass productivity around Tashkent, Namangan and Fergana may be associated with withdrawals of cropland from active use due to the expansion of residential areas and associated infrastructure. The 'browning' of the Aral Sea region is explained by deteriorating local climatic conditions, for example, more intense dust storms.

The two most problematic regions of Uzbekistan, where the relative share of degraded cropland is more than three times the national average, are the Republic of Karakalpakstan and the Khorezm Oasis. In-depth studies based on vegetation indices in these regions broadly confirm this assessment. Seasonal-sum NDVI (250 m) across the entire Khorezm Oasis shows that a negative trend in biomass productivity between 2000 and 2020 is observable on 35.3 per cent of the territory, with maximum values 42.9 per cent in Yangiarik District and the minimum of 25.3 per cent in the Bagat District)[130], estimates that were field-verified to have 78 per cent accuracy. A regression model showed that the most significant factors for the distribution of plots with moderate and strong negative trends are groundwater level, fallow land, slope and groundwater salinity; the least significant are bonitation classes (except the lowest Class IV), density of canals and collectors as well as distance to collectors, pumps and water bodies. For example,

124 Jumaniyazov et al. (2024) Assessment of Agricultural Land Cadaster Indicators of Shimbay Irrigated Areas (Republic of Karakalpakstan). E3S Web of Conferences. 590, 01007.
125 Conrad et al. (2020) Remote sensing-based assessments of land use, soil and vegetation status, crop production and water use in irrigation systems of the Aral Sea Basin. A review. Water Security. 11, 100078.
126 Ibid.
127 Summary Report..., 2019.
128 Ibid.
129 Agostini et al. (2024) Climate Adaptation in Uzbekistan: Landscape Restoration Opportunities. The World Bank Group. 92 P.
130 Dubovyk et al. (2013) Spatio-temporal analyses of cropland degradation in the irrigated lowlands of Uzbekistan using remote-sensing and logistic regression modeling. Environmental Monitoring and Assessment. 185: 4775–4790.

a one g/L increase in groundwater mineralization increases the probability of degradation by 25.96 per cent. The strongest negative trends are found on abandoned peripheral plots that are part of the surrounding deserts or the latter's margins that have deeper groundwater tables. However, this may be an effect, not a cause, of abandonment under water scarcity within the oasis.

The condition of the republic's rangelands is a major concern among both national and international experts due to very high grazing pressure amid the reduction in forage-crop area. The area of natural pastures is 21.0 million ha, most of which exists as desert lowland pastures in the northwest of the country that requires watering points for year-round small-ruminant grazing *(see map 'Types of pasture vegetation')*. Three regions account for over 79 per cent of the national pasture fund: the Navoiy Region (42 per cent), the Republic of Karakalpakstan (25 per cent) and the Bukhara Region (12.1 per cent), which together form the main centre of Karakul sheep husbandry. In the east, desert lowland pastures gradually transition to foothill pastures going up to 1,200 m above sea level and mainly used seasonally for cattle. High-mountain pastures are located at 2,500 m above sea level on the ridges of the Western Tien Shan, these summer pastures can support all livestock types.

According to national assessments, 78 per cent of the country's pastures are affected by overgrazing, evidenced by a more than 20 per cent reduction in their (and hayfields) plant abundance and species composition coupled with a twofold decline in productivity[131]. According to a remote-sensing study by World Bank experts, a significant negative trend in biomass primary production is found on 34 per cent of pasture area and a moderate negative trend on 27 per cent *(see Tables 14 and 15)*[132]. Thus, about 60 per cent of pastures show declining productivity, with limited regional differences. For example, the Republic of Karakalpakstan as well as the Samarkand and Tashkent regions each suffer from more than 68 per cent of their respective pasture area experiencing declining productivity.

Field geobotanical surveys of pastures are the most reliable source for assessing their ecological condition and Uzbekistan inherited a strong geobotanical tradition from Soviet times. According to such geobotanical surveys, the most degraded pastures are in the Navoi Region[133], where the

131 Rakhmonov et al., 2021.
132 Agostini et al., 2024.
133 Mamatov et al. (2021) Characteristics of the pastures of the Navoi region and their use. Nat. Volatiles & Essent. Oils. 8 (5): 9302–9311.

Table 13. Assessment of trends in the dynamics of primary production on croplands in the regions of Uzbekistan, 2001–2020

Region	Share of cropland by degree of degradation, %		
	Weak	Moderate	Strong
Republic of Karakalpakstan	27.8	43.9	28.3
Khorezm	24.2	39.5	36.3
Bukhara	38.3	44.2	17.5
Navoiy	40.2	42.4	17.3
Samarkand	46.8	41.2	11.9
Kashkadarya	40.9	39.3	19.7
Surkhandarya	44.3	43.4	12.3
Jizzakh	38.0	40.5	21.5
Syr Darya	41.5	39.0	19.5
Tashkent	58.8	29.1	12.1
Andijan	73.3	19.5	7.2
Fergana	54.0	28.5	17.5
Namangan	53.2	32.7	14.1
Uzbekistan	**44.9**	**37.3**	**17.8**

Table 14. Assessment of trends in the dynamics of primary production on pasturelands in the regions of Uzbekistan, 2001–2020

Region	Pasture area, thousands ha	Pasture area by degree of degradation, thousand ha		
		Weak	Moderate	Strong
Republic of Karakalpakstan	5,175.6	1,726,278	1,333,942	2,197,081
Khorezm	109.3	51,774	34,516	23,011
Bukhara	2,558.1	1,341,954	629,041	587,105
Navoiy	8,762.3	3,473,945	2,501,241	2,918,114
Samarkand	797.1	249,000	199,200	348,600
Kashkadarya	1,406.8	650,907	356,949	398,943
Surkhandarya	826.5	271,645	293,376	260,779
Jizzakh	726.7	392,008	166,306	178,185
Syr Darya	20.5	6,041	7,463	6,396
Tashkent	437.6	145,865	121,555	178,280
Andijan	21.1	8,242	6,923	5,934
Fergana	23.4	12,852	6,242	4,406
Namangan	150.8	57,769	55,458	36,972
Uzbekistan	**21,015.8**	**8,388,280**	**5,712,212**	**7,143,807**

main pastures are located in the Kyzylkum Desert, a sharply continental climate zone with high interannual variability of climatic indicators. The desert's soil cover is comprised of aeolian sands with poor structure and low humus content but good water permeability, which reduces the evaporative loss of atmospheric precipitation. Sandy loam and gravelly–crusted gray-brown soils also occur in combination with gravelly-gypsiferous and solonchak (saline) soils in this area. Plant communities are composed mainly of a few edificator shrub and semi-shrub species. In 2020, only 36 species of perennial and annual plants were recorded on the surveyed pastures, however, in the dry year of 2016 this figure dropped to 28 while in the more favorable years it rose to 44. For this type of sandy desert, about 100 species are typical, and the low species diversity can be explained by degradation caused by excessive grazing pressure. A second indicator of ecological condition is the decline in productivity. Under normal conditions, pastures in the Navoi Region have relatively good productivity for desert landscapes, yielding 0.35 to 0.45 t/ha, however, in a degraded state productivity drops to 0.25 to 0.35 t/ha. The share of degraded pastures in the Navoi Region is estimated at 46.7 per cent, with productivity reduced by 26.5 per cent. According to field surveys, on average across Uzbekistan, 36.8 per cent of pastures are degraded and the average decline in productivity of desert plant associations is 25.6 per cent *(see Table 16)*. While nationwide means coincide, there are substantial discrepancies in regional estimates. For example, field results indicate the share of degraded pastures in the Samarkand Region is 14.7 per cent, not the 43.7 per cent indicated by remote-sensing studies *(see Table 15)*. Remote-sensing methods, particularly those providing vegetation indices, have limitations in deserts and semi-deserts due to the very sparse vegetation cover and this vegetation's dynamism, a phenomenon driven by the large role of ephemerals and ephemroids. Another challenge for such studies is the uncertainty of pasture boundaries due to unorganized (open-range) grazing of livestock. Nevertheless, one can conclude that Uzbekistan's pasturelands are more degraded than its croplands.

How degraded pastures are depends primarily on stocking rates exceeding the established norms which are, in turn, determined by the productivity of dominant vegetation types and water availability *(see map 'Grazing norms on pastures')*. Widespread exceedance of normative loads explains the predominance of low pasture productivity, except in mountain areas *(see map 'Pasture productivity')*. At the same time, trend assessments across different pasture types show that vegetation types respond differently to loading as, for example, white saxaul *(Haloxylon persicum)* pastures are the least resilient, unlike black saxaul *(Haloxylon aphyllum)*, even though both belong to desert complexes. Overall, desert and semi-desert pastures on saline soils (saltwort and wormwood communities) show negative trends, whereas foothill, mountain and floodplain pastures show positive tendencies *(see Table 17)*.

The third sub-indicator for assessing land resources is the dynamics of soil organic carbon (SOC) in the upper 30 cm of the soil horizon.

Under the UNCCD's Land Degradation Neutrality Target Setting Programme (LDN TSP)[136], a preliminary analysis of land condition by the 'soil carbon' indicator was carried out based on global data (GSOC map) benchmarked against Uzbekistan's national data. Monitoring of humus content in agricultural soils has been conducted at 260 sites across

Table 15. Assessment of trends in the dynamics of primary production on pasturelands in the regions of Uzbekistan, 2001–2020

Region	Share of pastures with a negative trend in biomass primary production, %		
	Weak	Moderate	Strong
Republic of Karakalpakstan	33.4	25.8	42.5
Khorezm	47.4	31.6	21.1
Bukhara	52.5	24.6	23.0
Navoiy	39.6	28.5	33.3
Samarkand	31.2	25.0	43.7
Kashkadarya	46.3	25.4	28.4
Surkhandarya	32.9	35.5	31.6
Jizzakh	53.9	22.9	24.5
Syr Darya	29.5	36.4	31.2
Tashkent	33.3	27.8	40.7
Andijan	39.1	32.8	28.1
Fergana	54.9	26.7	18.8
Namangan	38.3	36.8	24.5
Uzbekistan	**39.9**	**27.2**	**34.0**

Table 16. Area and productivity of degraded pastures in the regions of Uzbekistan [134]

Region	Pasture area, thousands ha [135]	Area of degraded pastures, thousands ha	Share of degraded pastures, %	Reduction in productivity, %
Republic of Karakalpakstan	5,175.6	1,566.3	30.2	27.0
Navoi	8,762.3	4,093.6	46.7	26.5
Bukhara	2,558.1	1,019.0	39.8	18.5
Jizzakh	726.7	168.4	23.1	10.9
Kashkadarya	1,406.8	185.7	23.1	6.2
Samarkand	797.1	117.3	14.7	10.9
Surkhandarya	826.5	205.7	24.9	17.4
Total	**20,253.0**	**7,456.0**	**36.8**	**23.5**

134 Ibid.
135 Ibragimova R.A., Ibraimova A.A. (2022) Pastures of Uzbekistan and some issues of their use. Economy and society. 6 (97): 567-570. (In Russian) .www.iupr.ru

136 Summary Report..., 2019.

different landscape zones over the last 60 years using a standard certified methodology. For three regions, Samarkand, Bukhara and Navoi, the correspondence between national SOC monitoring and the global database was analysed. Preliminary estimates indicate good agreement in 70 per cent of cases, allowing the conclusion that global databases can be used to assess SOC trends nationwide. Global data show that from 2000 to 2015, some 98 per cent of the country's lands were in a stable condition, about one per cent were degrading and one per cent improving. Thus, in terms of the LDN concept and the SOC indicator, Uzbekistan tends toward a neutral land-degradation balance.

However, changes in SOC occur very slowly, therefore, trend assessments must rely on observations over a longer period. Compared even with other Central Asian countries, Uzbekistan is characterized by extremely low SOC contents, and the prevailing intensive agricultural model inevitably leads to ongoing SOC losses and higher greenhouse gas (GHG) emissions to the atmosphere.

The total stock of carbon in Uzbekistan's soils, namely the upper 30 cm with a bulk density of 1,250 kg/m³, is estimated at 622.5 million tons, with 34.7 million tons stored in above-ground biomass and 59.5 million tons in below-ground biomass[137]. The predominance of below-ground biomass is typical for arid territories. All of this translates to the mean SOC content in Uzbekistan's soils being only 13.9 t/ha, or 0.37 per cent, well below the commonly recommended two per cent threshold for soil productivity and atmospheric carbon sequestration potential. For comparison, average SOC for two of Uzbekistan's neighbours is 1.9 per cent in Kyrgyzstan and 1.3 per cent in Tajikistan.

This low average SOC in Uzbekistan is driven by natural causes, since more than half of the country is covered by sandy and gypsiferous deserts *(see map 'Organic carbon in soils')*. The dominant gray-brown soils in the lowlands are the main reserve for irrigated agriculture, but their natural SOC content does not exceed 0.43 to 0.45 per cent, although applying organic amendments to such soils can raise this SOC to 0.52 to 0.57 per cent. Intrazonal takyr soils of the dry steppes have somewhat better natural fertility and, under irrigation, SOC can reach 0.54 to 0.59 per cent. Elsewhere in the republic, serosem soils of the dry steppes in plains and foothills have a mean SOC not exceeding 0.45 per cent while the more fertile brown forest, chestnut and dark-colored soils of the mid-mountains have relatively high SOC. However, mid-mountain soil SOC depends strongly on its erosion status: 2.02 to 2.61 per cent on uneroded soils, 1.7 to 2.1 per cent on slightly eroded and 1.4 to 1.7 per cent on moderately eroded[138].

Unsustainable agricultural practices are the main cause of SOC decline on cultivated lands. Long-term observations of serosem soils between 1930 and 1976 showed that cotton monoculture, undertaken without mineral fertilizers, reduced SOC in the top 30 cm layer of soil by almost 35 per cent, whereas with mineral fertilizers the SOC reduction was 20 per cent. In contrast, cotton monoculture with organic fertilizers (manure) did not reduce SOC. The difference in contemporary SOC between typical virgin serosem and irrigated lands is 35 per cent, a figure that goes up to 55 per cent when comparing between virgin and rain-fed lands[139].

Uzbekistan's GHG emissions totaled around 189.2 million tons CO2 equivalent in 2018, with the energy sector

Table 17. Trends in the EVI indices for different pasture vegetation types

Pasture vegetation type	EVI trend (per year)
Wormwood communities (Artemisia)	-0.00028
Harmal communities (Peganum harmala)	-0.00020
Saltwort–ephemeral communities on gravel	-0.00018
Saltwort–forb communities	-0.00017
Short-grass–graminoid–forb communities	-0.00014
White saxaul communities	-0.00007
Forb–Stipa communities among juniper woodlands	-0.00005
Tall-forb–ephemeral communities	-0.00004
Forb–graminoid communities among juniper stands	-0.00002
Reed communities (Phragmites)	0.00000
Krascheninnikovia ceratoides (boyalysh) communities	0.00000
Forb communities	0.00002
Forb–shuvak communities of the adyr (foothill) zone (local name)	0.00002
Forb communities in pistachio open woodlands	0.00002
Forb communities among shrub thickets	0.00006
'Singren' communities (local name; species to be clarified)	0.00008
Wormwood–forb communities	0.00009
Anabasis communities ('keyreuk', local name)	0.00015
Salsola arbuscula ('cherkez') and related species	0.00015
Calligonum (camelthorn/'djuzgun') communities	0.00018
Forb–ephemeral communities with almond	0.00018
Wheatgrass communities (Agropyron/Elymus)	0.00019
Tamarisk communities (Tamarix)	0.00024
Communities dominated by 'partak' (local desert dwarf shrub; species to be clarified)	0.00024
Brome–forb communities (Bromus)	0.00044
Black saxaul communities	0.00056
Forb communities in tugai (riparian) forests	0.00073

137 Aichi Biodiversity Target 11 Country Dossier: UZEBEKISTAN (cbd.int).

138 Raupova N.B., Abdullaev S.A. (2019) Composition and properties of humus in soils of vertical zonality of the Western Tien Shan and their eroded differences. Scientific review. Biological sciences. 2: 63-68. (in Russian).

139 Lal R. et al. (2007) Climate Change and Terrestrial Carbon Sequestration in Central Asia. Carbon Management and Sequestration Center, the Ohio State University. 12 P.

being the largest contributor (around 76%), primarily from natural gas use, followed by agriculture. The livestock sector accounts for approximately 12%, or 22.5 million tons of CO2 equivalent. The contribution of agricultural soils (3.3 million hectares of irrigated and 0.75 million hectares of non-irrigated land) to national GHG emissions in CO2 equivalent is estimated at 5.6%. This amounts to less than 3 tons per hectare and a total of 10.7 million tons per year[140]. These figures are mainly due to the use of mineral fertilizers on irrigated lands, especially when growing cotton. Increasing SOC in croplands is possible by shifting toward conservation tillage (no-till/min-till), abandoning summer fallows, growing cover forage crops and using mulching and organic amendments. This can significantly reduce soil-carbon losses and even raise SOC, thereby ensuring a positive soil–atmosphere carbon balance[141].

SDG 2.4 requires the adoption of sustainable, high-productivity agricultural practices that help maintain ecosystems and increase resilience to climate change, extreme weather, droughts, floods and other disasters. Here, Uzbekistan's Indicator 2.4.1 mirrors the global indicator by focusing on the "proportion of agricultural area under productive and sustainable agriculture". Two sub-indicators are proposed for SDG 2.4: the share of land under drip irrigation and the share of land under organic agriculture.

140 Uzbekistan: Updated nationally determined contribution | PreventionWeb

141 Lal R. (2004) Carbon sequestration in soils of Central Asia. Land Degradation & Development. 15 (6): 563–572.



Kamchik mountain pass in the Fergana Valley in Uzbekistan in summer

In Uzbekistan, "productive and sustainable agriculture" practices remain at very low levels.

Over the past decade, drip irrigation has expanded but clearly remains insufficient despite the fact that the Government began subsidizing water-saving methods, particularly drip irrigation *(see Box 4)*. In 2019, drip irrigation covered only 9.6 per cent of the republic's irrigated land (326,400 ha), although this is the highest absolute figure of all Central Asian countries. Other sustainable practices, such as organic farming, are even less visible and are mainly confined to a few pilot projects. Only about 5,600 ha have been certified as engaged in organic production by foreign organizations and, currently, there is no national legal framework for organic agriculture, so the country does not issue organic certificates. As a final point of note, the amounts of fertilizers and pesticides applied on croplands are important for tracking progress toward sustainable agriculture and fertilizer use in Uzbekistan is 60 to 70 per cent higher than the global average *(see Section 3.3)*.

Box 4. A new study[142] confirms earlier findings: with improved irrigation methods, Uzbekistan can achieve substantial water savings

Despite unstable transboundary inflows and unfavourable climate-change projections for water regimes, Uzbek farmers still use traditional furrow irrigation for staple crops such as cotton and wheat. The Karshi Steppe, home to the country's largest irrigation system, is characterized by very high evaporation levels: over 1,240 mm with mean annual precipitation around 245 mm, leading to significant water deficits. One recent study compared three irrigation methods: (1) furrow irrigation with traditional scheduling; (2) closed-pipe irrigation with perforated polyethylene gates; and (3) drip irrigation. Soil moisture on test plots was monitored by tensiometers at different depths and the dates and volumes of each irrigation event were recorded. Irrigation was resumed when soil moisture dropped below a set threshold.

The number of irrigation events for the three systems was five, five and 18, respectively; the total seasonal irrigation water applied was 6,837, 5,543 and 3,247 m³/ha. The difference is explained by the fact that the amount of water applied during the first irrigation under traditional and closed-pipe methods significantly exceeded the soil's water-holding capacity. In terms of output from these test plots, cotton yields were 3.5 t/ha under traditional furrows, 4.1 t/ha under closed-pipe irrigation and 4.6 t/ha under drip irrigation. Accordingly, water productivity was 0.46, 0.59 and 1.20 kg/m³. These results corroborate many other studies showing the potential that drip irrigation has to substantially reduce irrigation-water use in Uzbekistan.

142 Djumaboev et al. (2019) Growing cotton in Karshi Steppe, Uzbekistan: water productivity differences with three different methods of irrigation. Indian National Committee on Surface Water (INCSW) - CWC. Proceedings of 9th International Micro Irrigation Conference (9IMIC), Aurangabad, India, 16-18 January 2019. Bangalore, India: IvyLeague: 391-397.



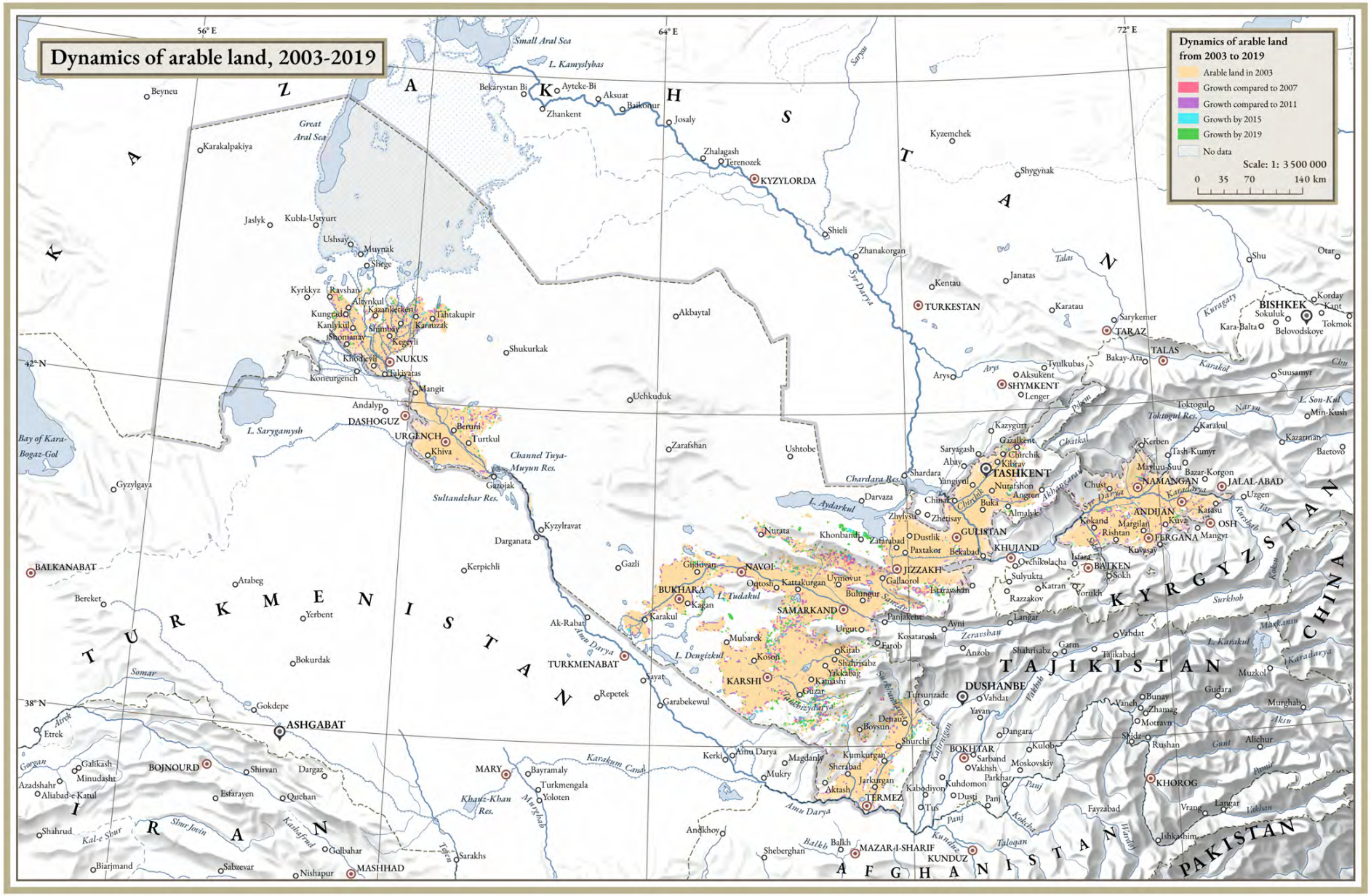
Chingishan canyon in Shorsu mountains

4.4. Response Measures

- To scientifically assess and monitor land resources and trends, large-scale studies are needed to validate and verify global information resources.
- Shifting to higher-value crops reduces water consumption per unit of output, but the effect of such a policy largely depends on the technical condition of irrigation infrastructure.
- Ensuring women's access to land, secure land tenure, extension services and credit schemes.
- Organic agriculture can be an important factor in reducing mineral-fertilizer use on irrigated lands, given appropriate legal and economic support.



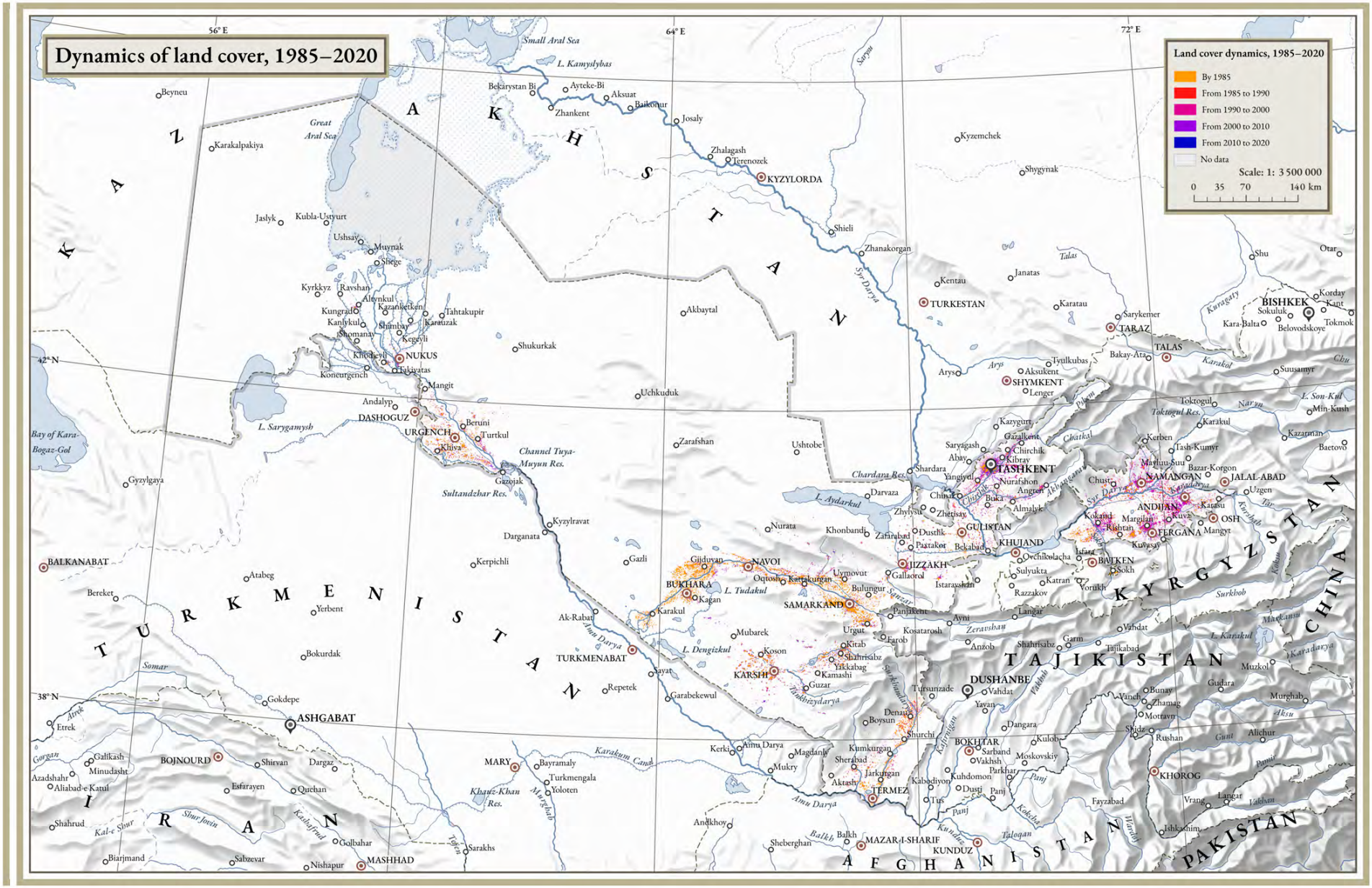
An image from the ISS



According to Potapov et al.,[143] who present an analysis of global changes in arable land area over the first two decades of the 21st century, obtained on the basis of the Landsat satellite data archive with a spatial resolution of 30 m.

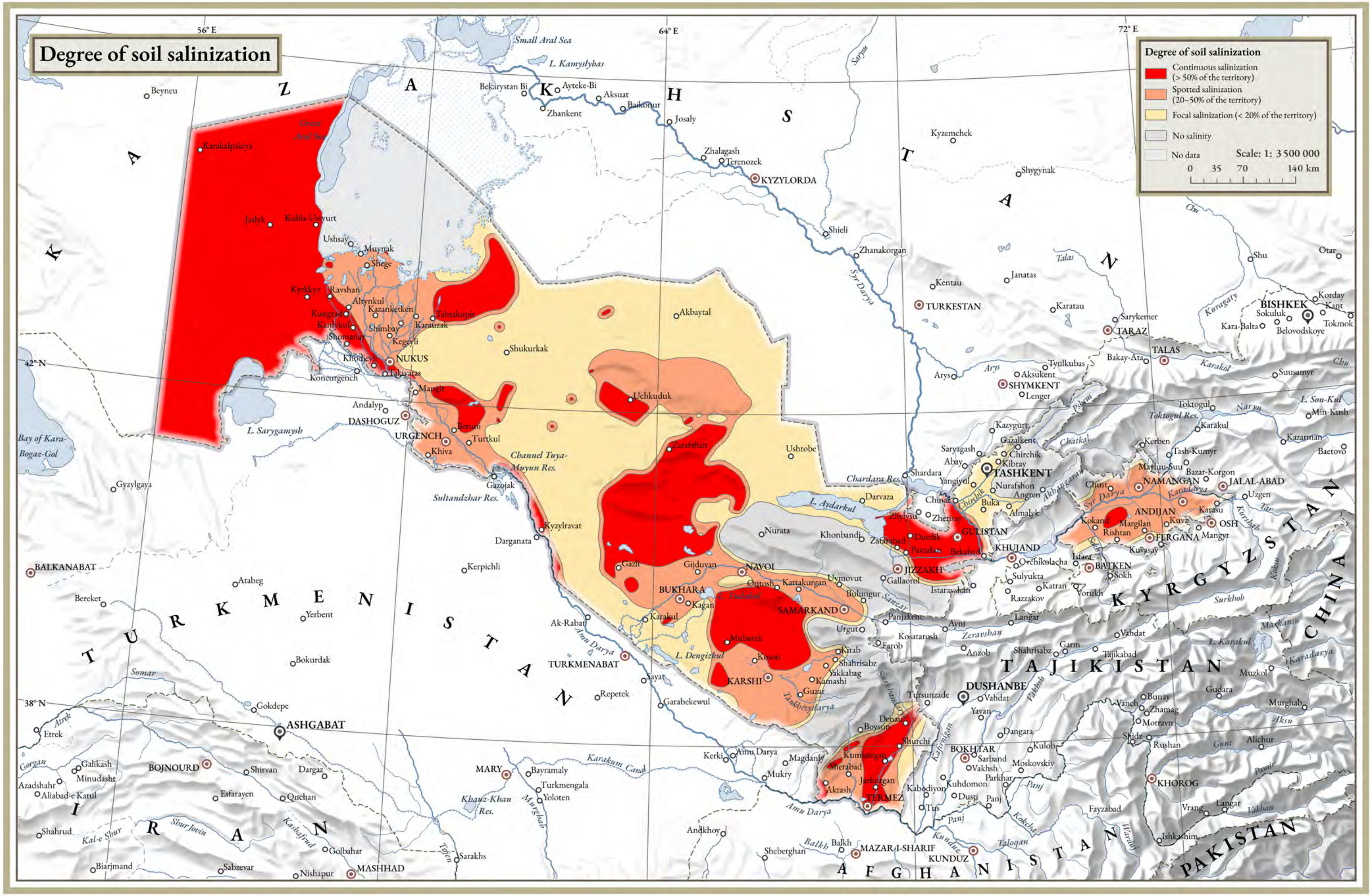
143 Potapov et al. (2021) Global maps of cropland extent and change show accelerated cropland expansion in the twenty-first century. Nature Food. 3 (1):19-28.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



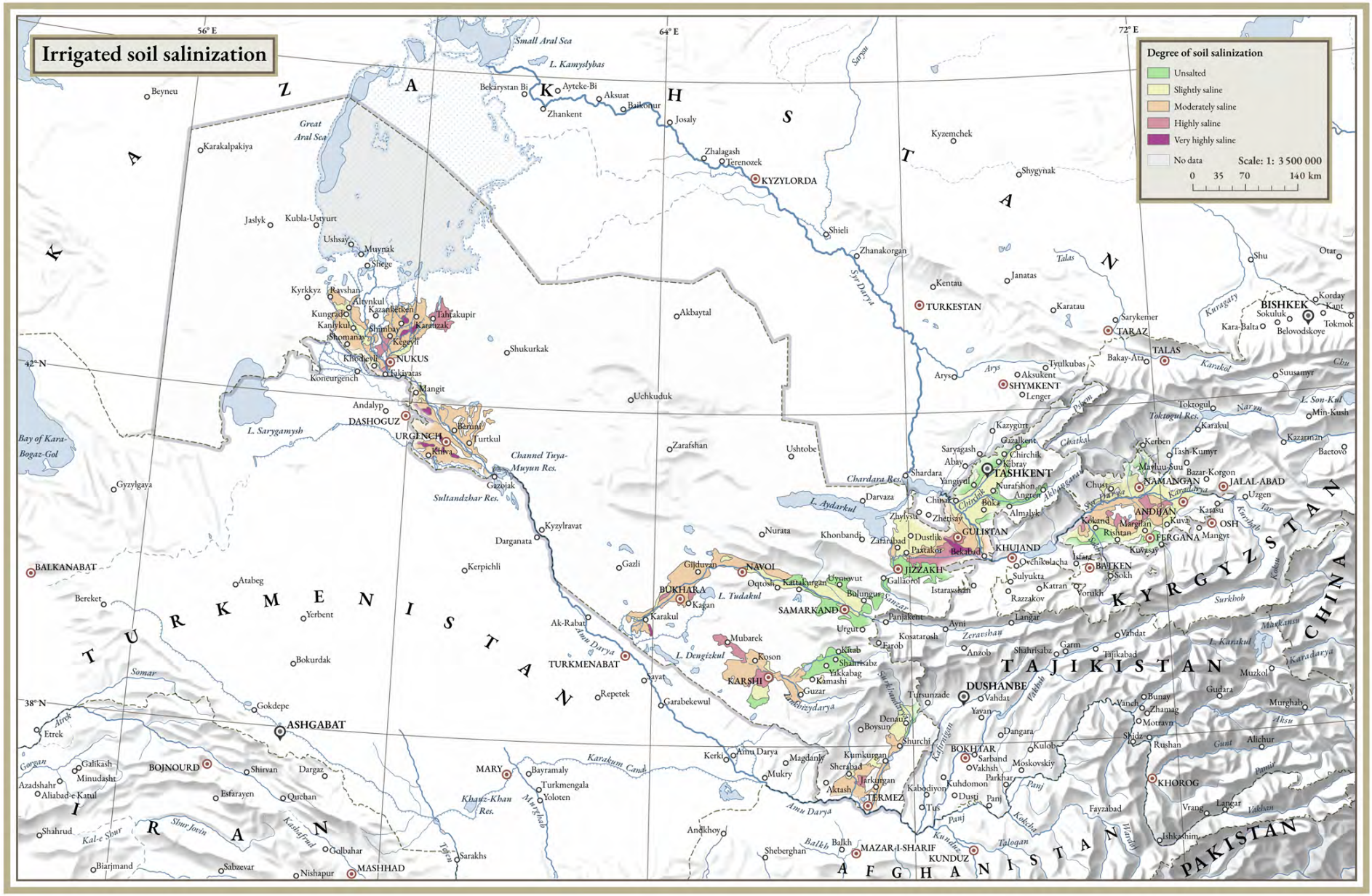
Based on ESA CCI69 Land Cover data (2000 to 2010). CCI Landcover was obtained by classifying ENVISAT and Proba-V satellite images. Spatial resolution is 300 m.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Schematic map of the distribution of saline soils in irrigated areas of Central Asia. [1:2 500 000]. Compiled based on space photography from 1975 to 1982. Specialized department of Soyuzgiprovodkhoz, USSR Ministry of Water Resources, and the V.V. Dokuchaev Soil Science Institute

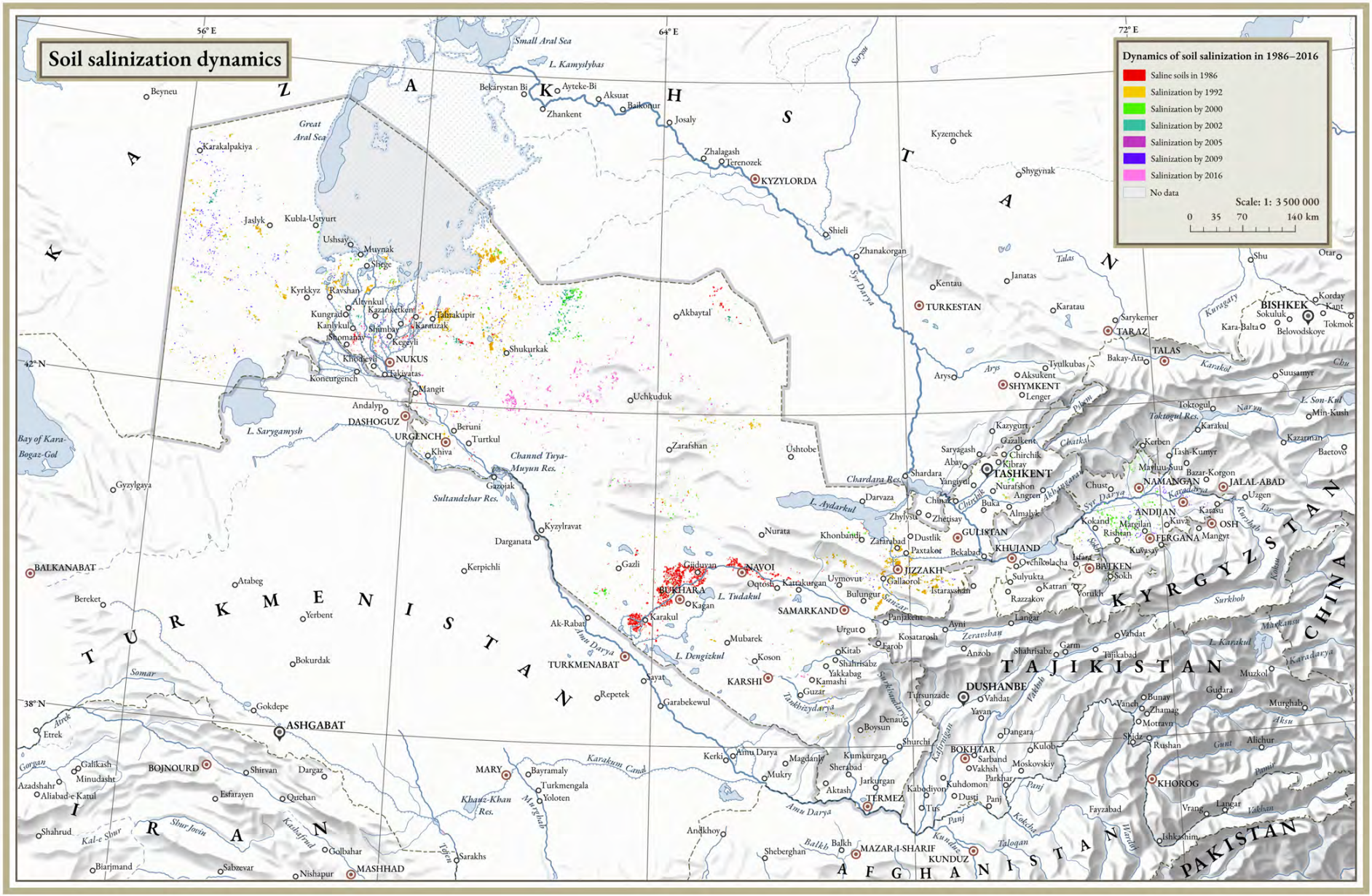
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



According to field observations.[144]

144 Kuziev R.K., Sektimenko V.E. (2009) Soils of Uzbekistan. Tashkent: Extremum Press. 351 P. (in Russian)

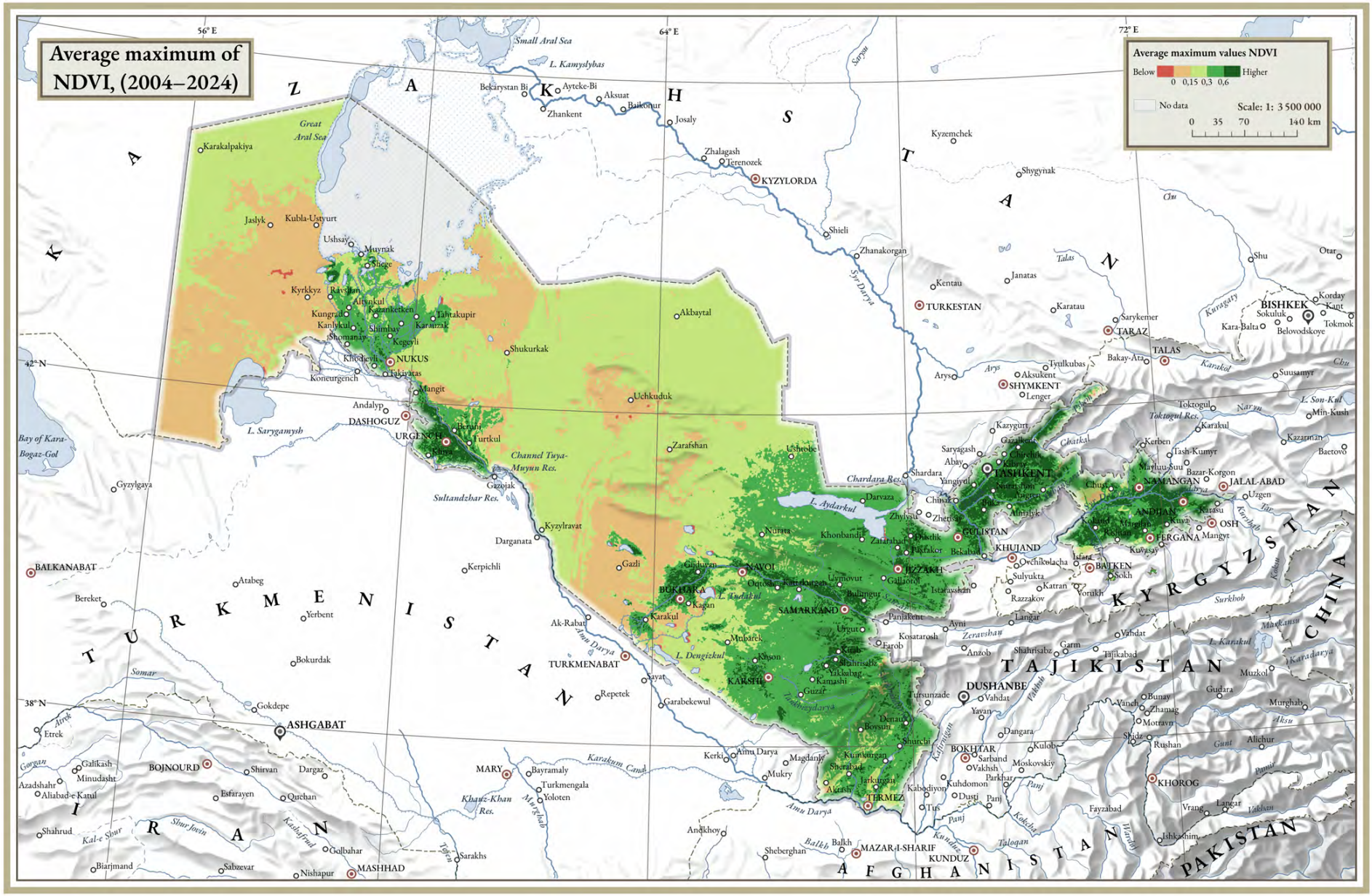
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Based on the Google Earth Engine computing environment, using soil property maps, thermal infrared images, and ECe point data from the WoSIS database for 1998-2016. The accuracy of the resulting maps is 67–70%.[145]

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

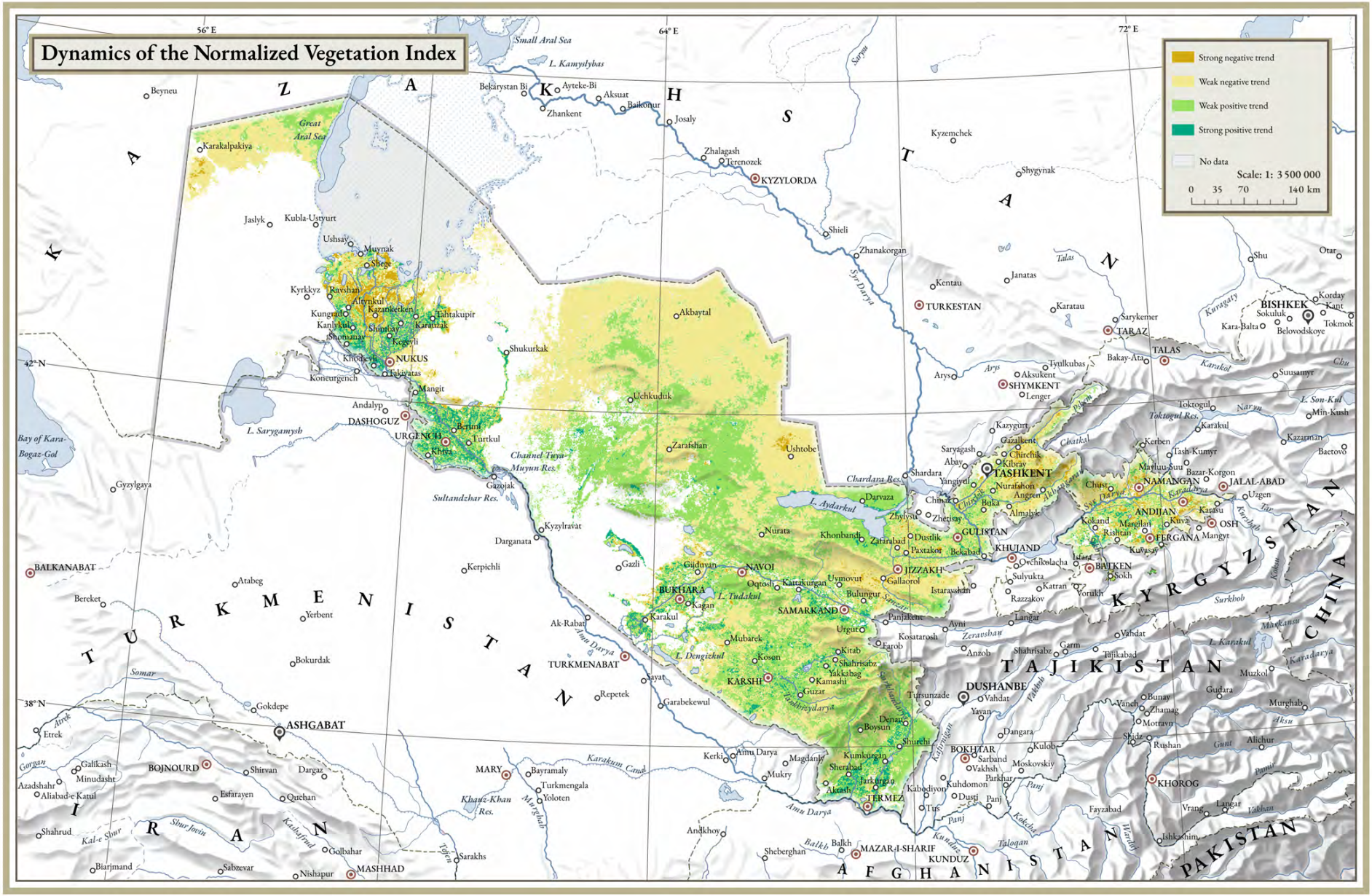
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



The Normalized Vegetation Index (NDVI) indicates the amount of green biomass produced at a given location.[146]

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

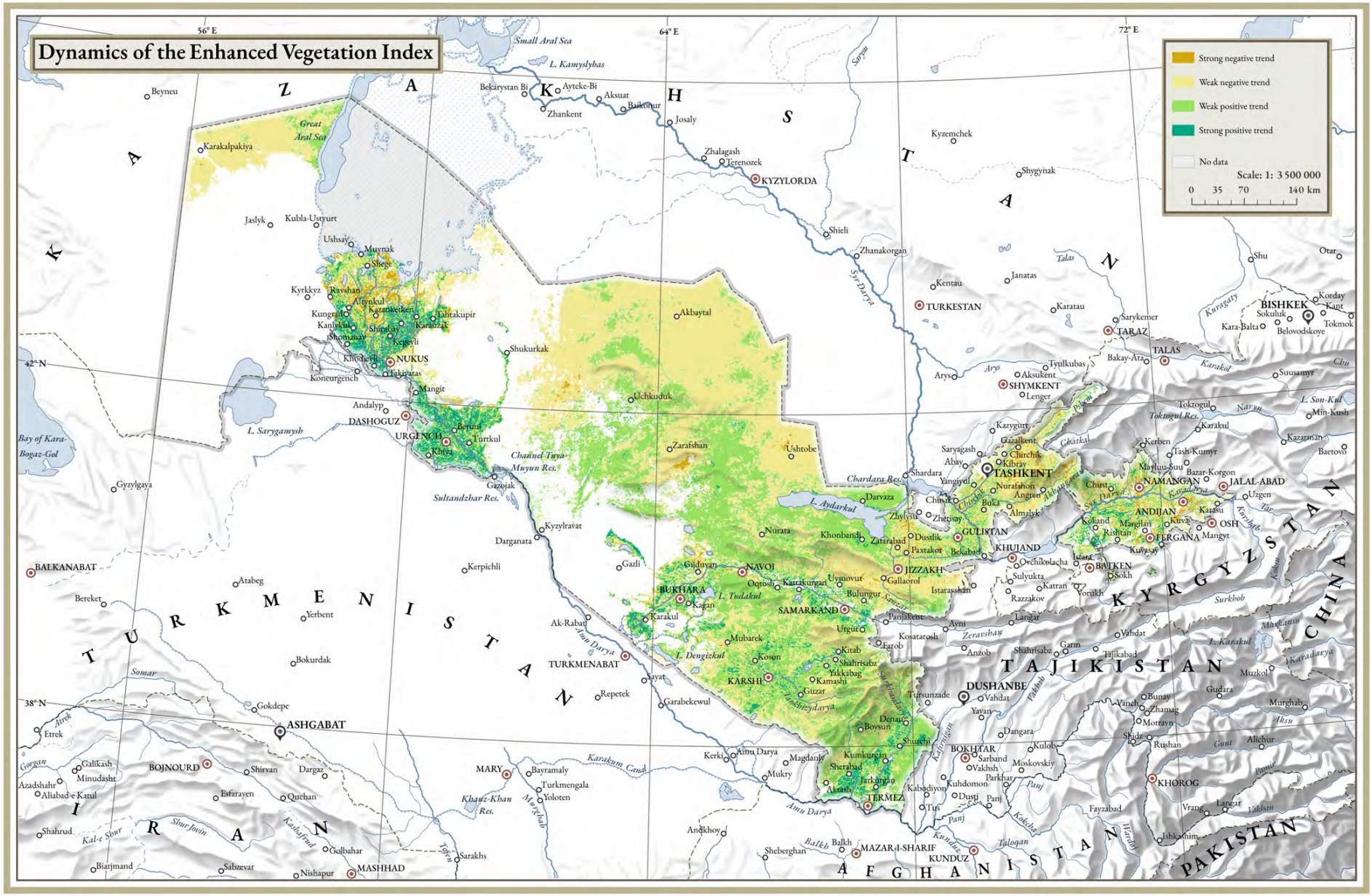
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



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[147], obtained by processing SPOT Vegetation and MODIS data, the dynamics of the NDVI index is given for the period 1999–2013.

147 Cui, Li, 2022.

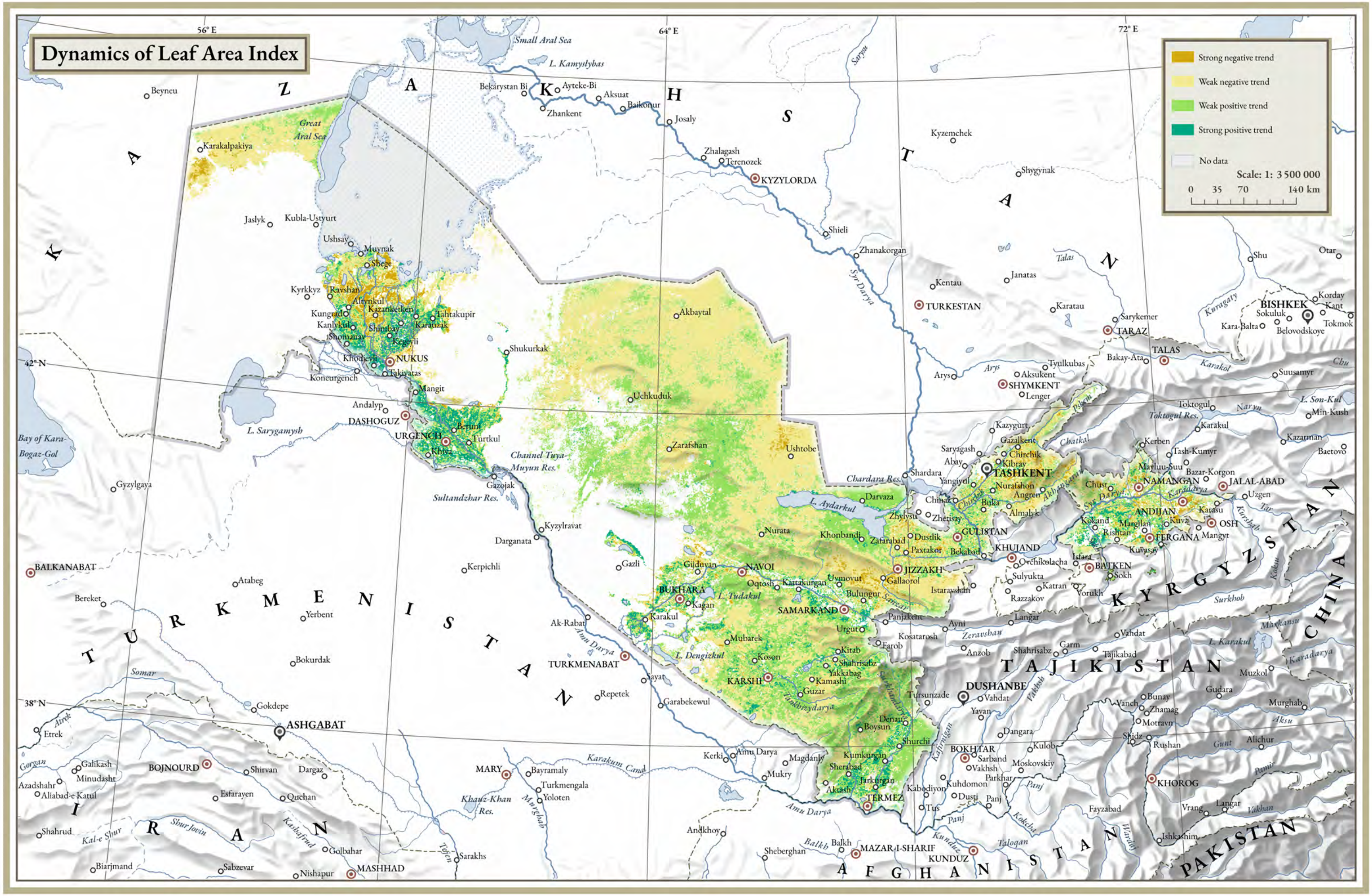
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



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[148] obtained by processing SPOT Vegetation and MODIS data. The dynamics of the NDVI index is given for the period 1999–2013.

148 Cui, Li, 2022.

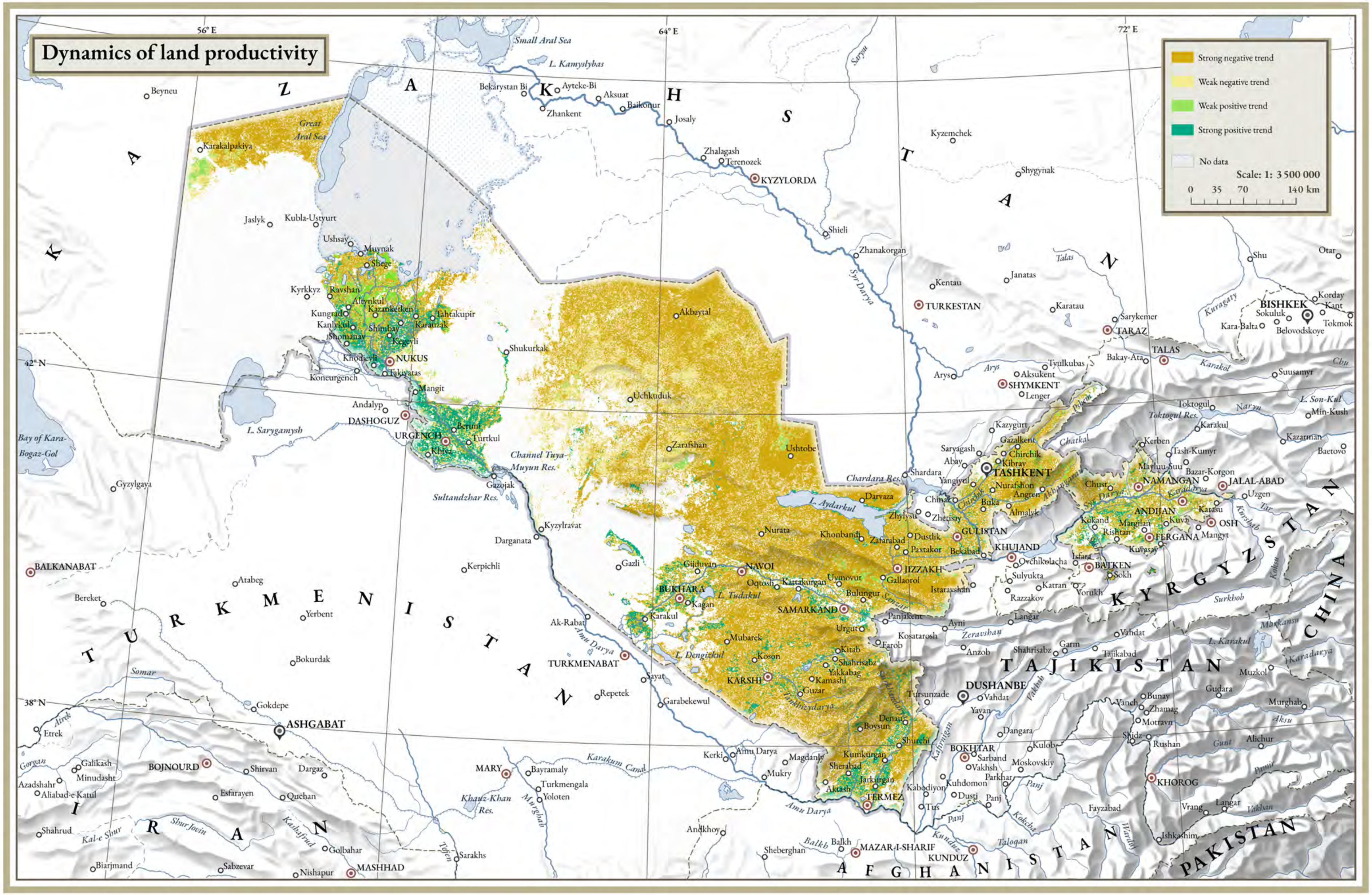
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



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[149]. The above map was created according to the Global Land Productivity Dynamic Dataset[150], obtained by processing SPOT Vegetation and MODIS data. The dynamics of the NDVI index is given for the period 1999–2013.

149 Copernicus Land Monitoring Service. land.copernicus.eu
150 Cui, Li, 2022.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.

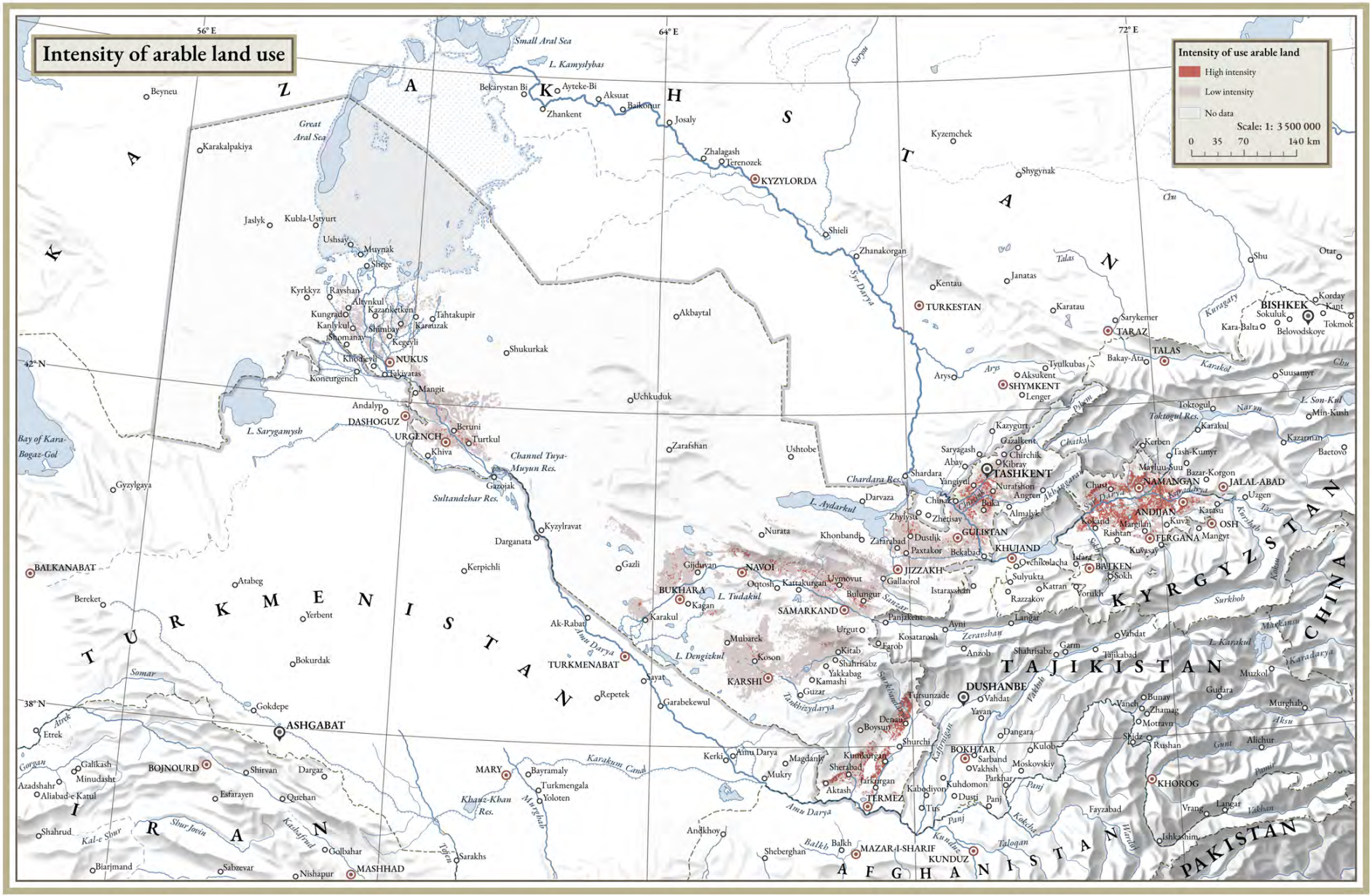


Land Productivity Dynamics (LPD) is estimated by integrating information on the dynamics of four biophysical indices: EVI, LAI, NDVI, NPP. (compared to the average indicators in this zone). The above map was created according to the Global Land Productivity Dynamic Dataset[151], obtained by processing SPOT Vegetation and MODIS data. The dynamics of the NDVI index is given for the period 1999–2013[152].

151 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

152 Cui, Li, 2022.

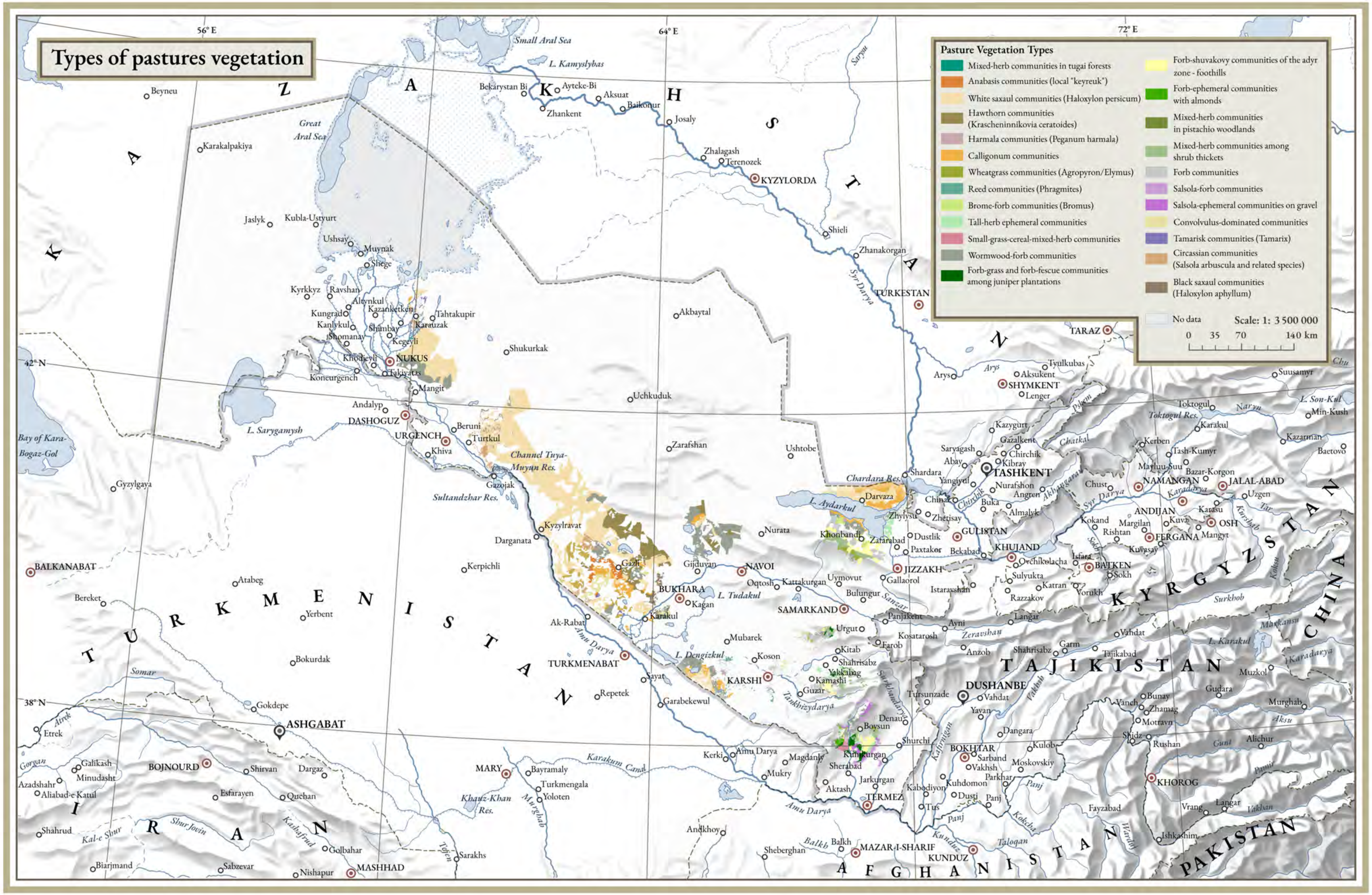
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



According to the study by Zhang et al.,[153] who used data from multiple satellites to develop a global, spatially continuous CI map dataset with 30 m resolution, allowing the delineation of areas with monocrop (low-intensity) and multicrop (high-intensity) agriculture.

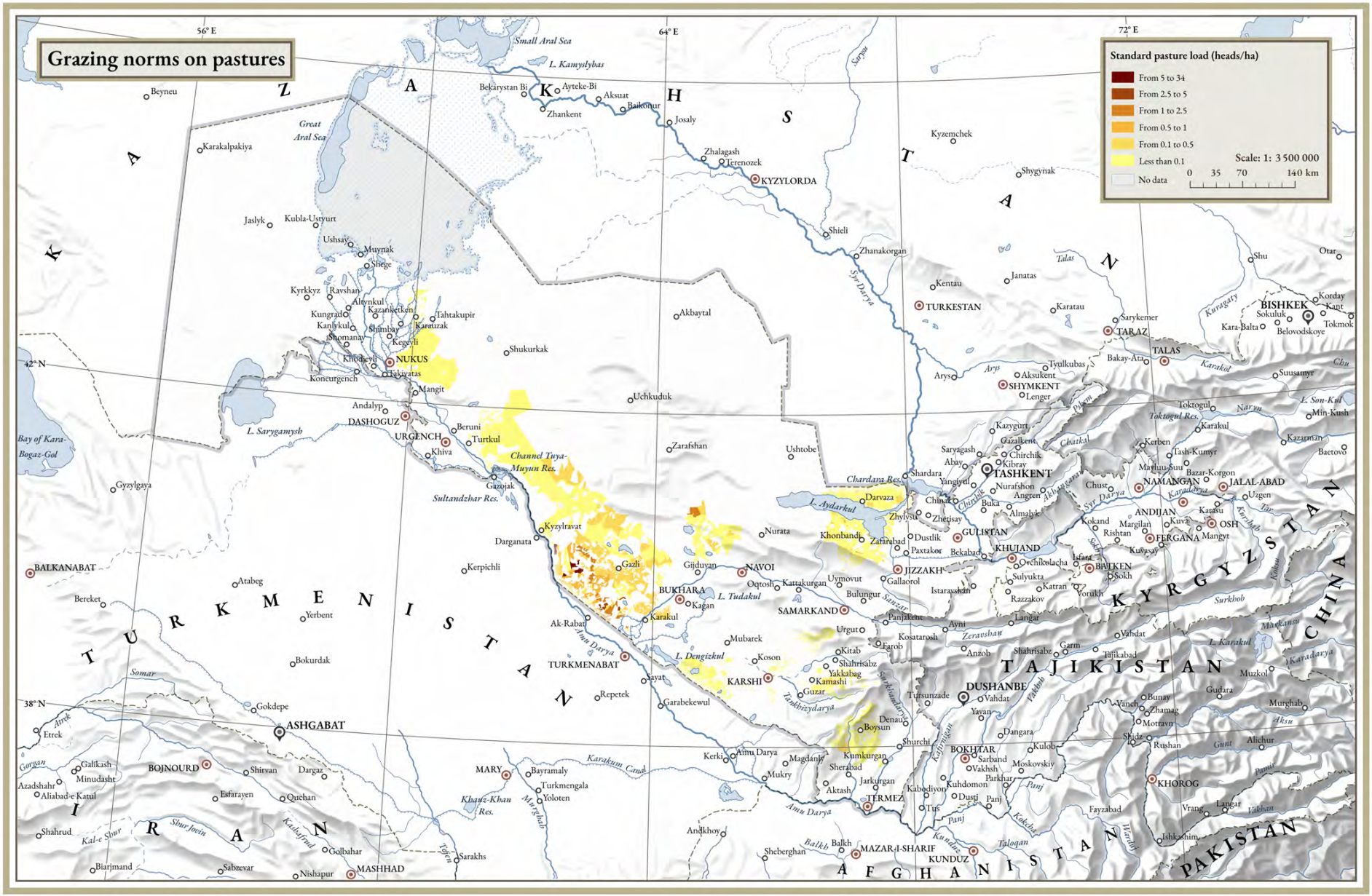
153 Zhang et al. (2021) GCI30: a global dataset of 30-m cropping intensity using multisource remote sensing imagery. Earth System Science Data. 13(10): 4799–4813.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



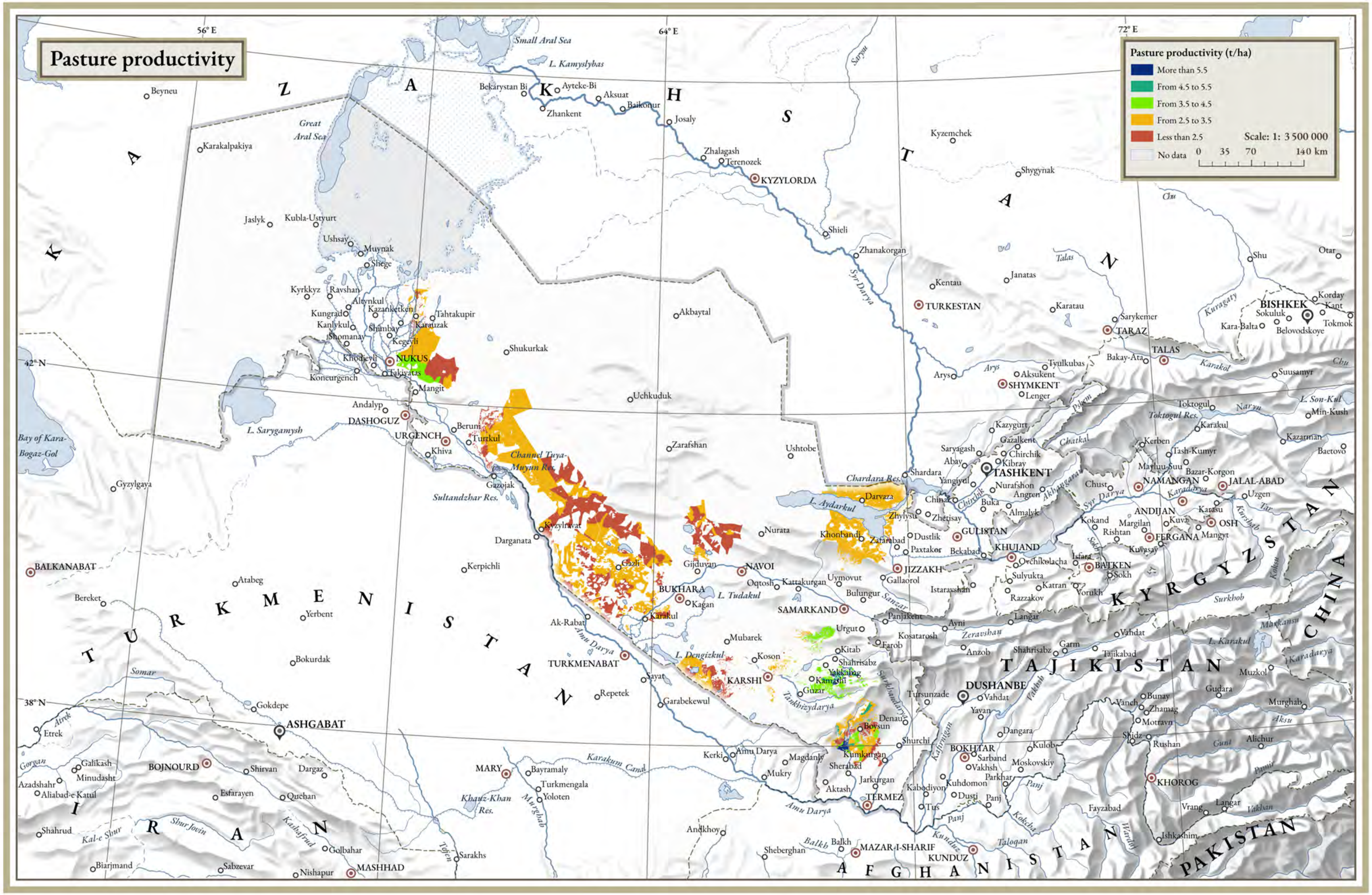
According to national coordinators.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



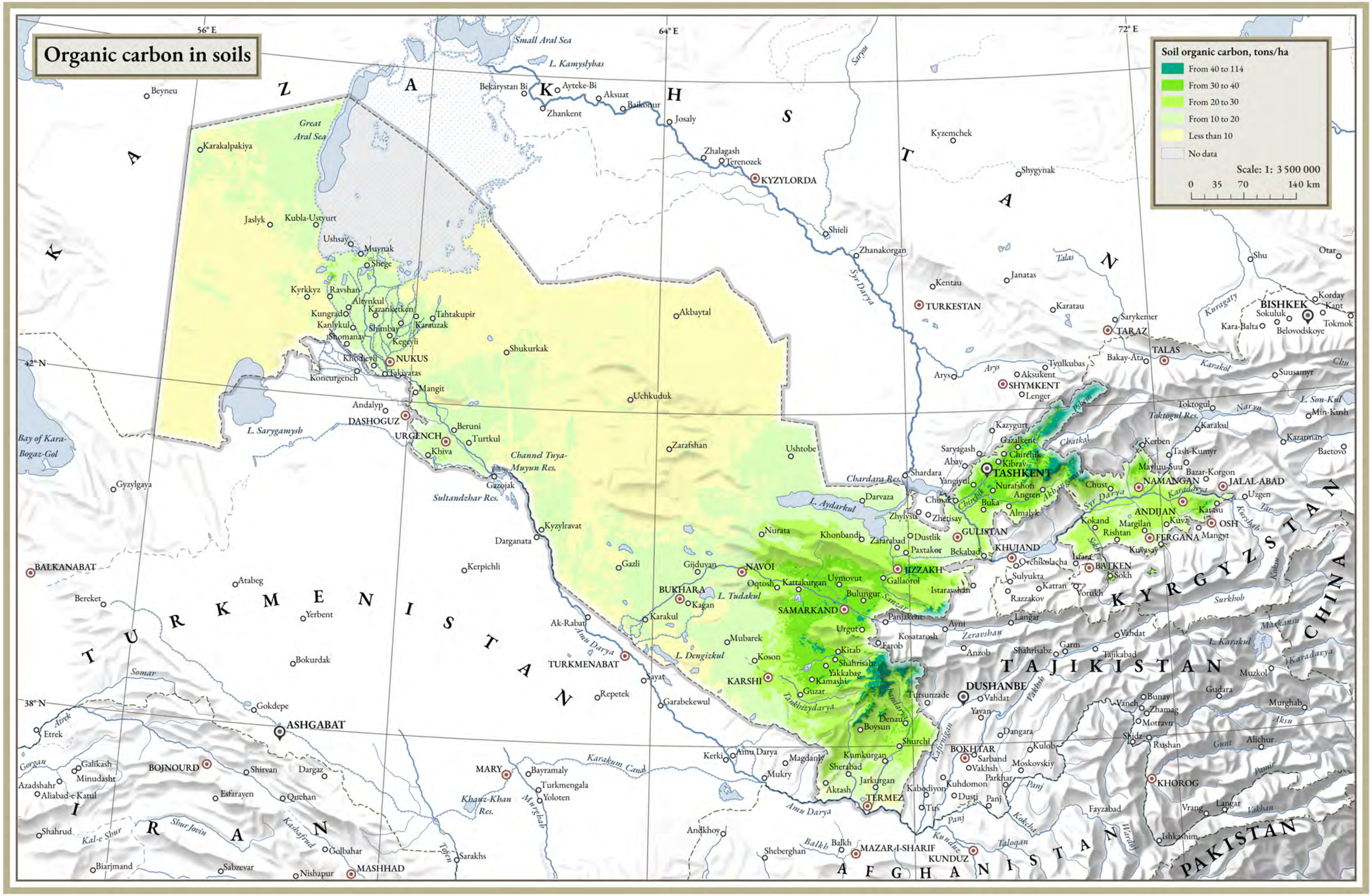
According to national coordinators.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



According to national coordinators.

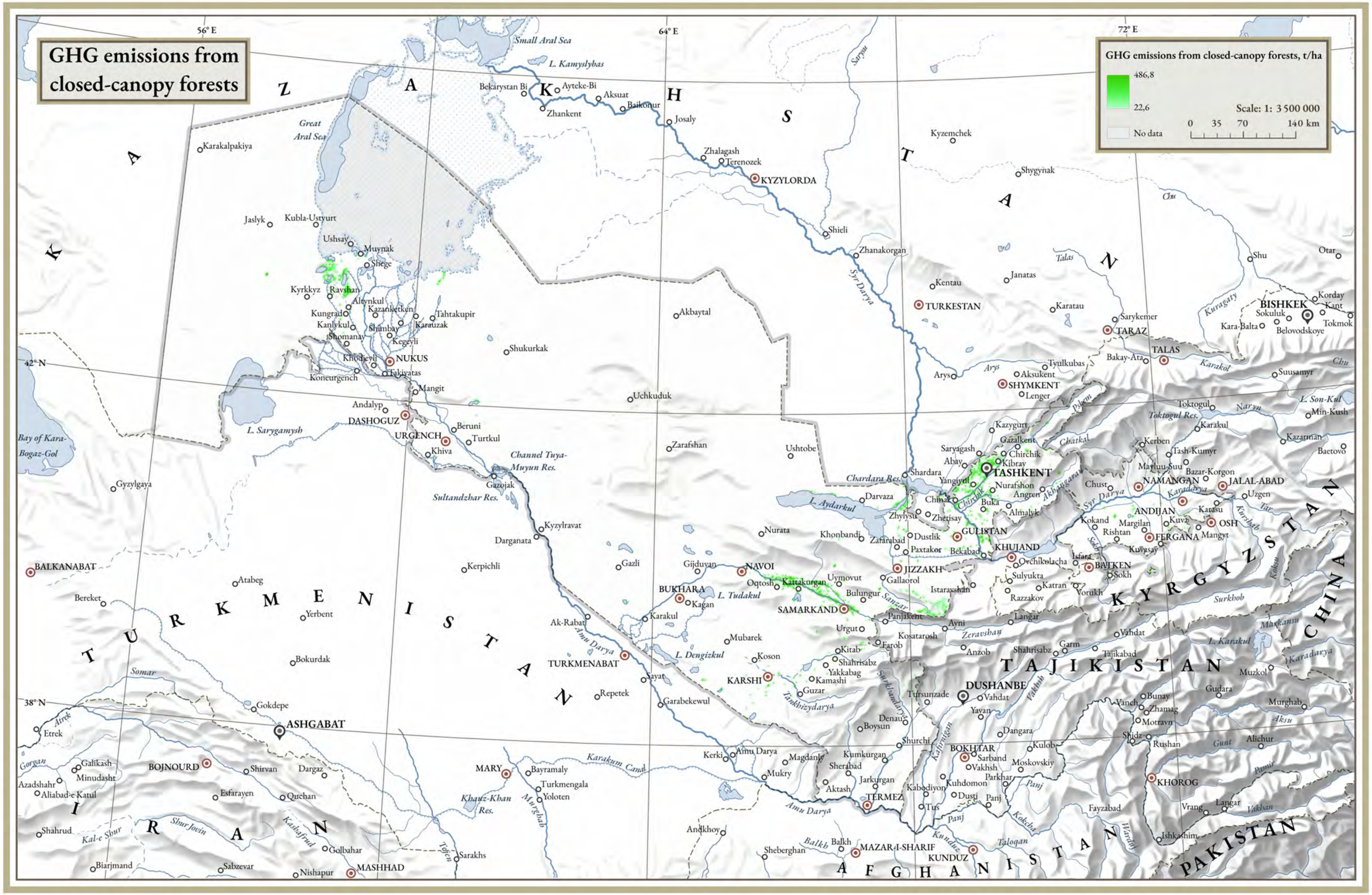
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Based on the Global Soil Organic Production Map (GSOCv1.5.0) developed by the Global Soil Partnership (GSP)[154].

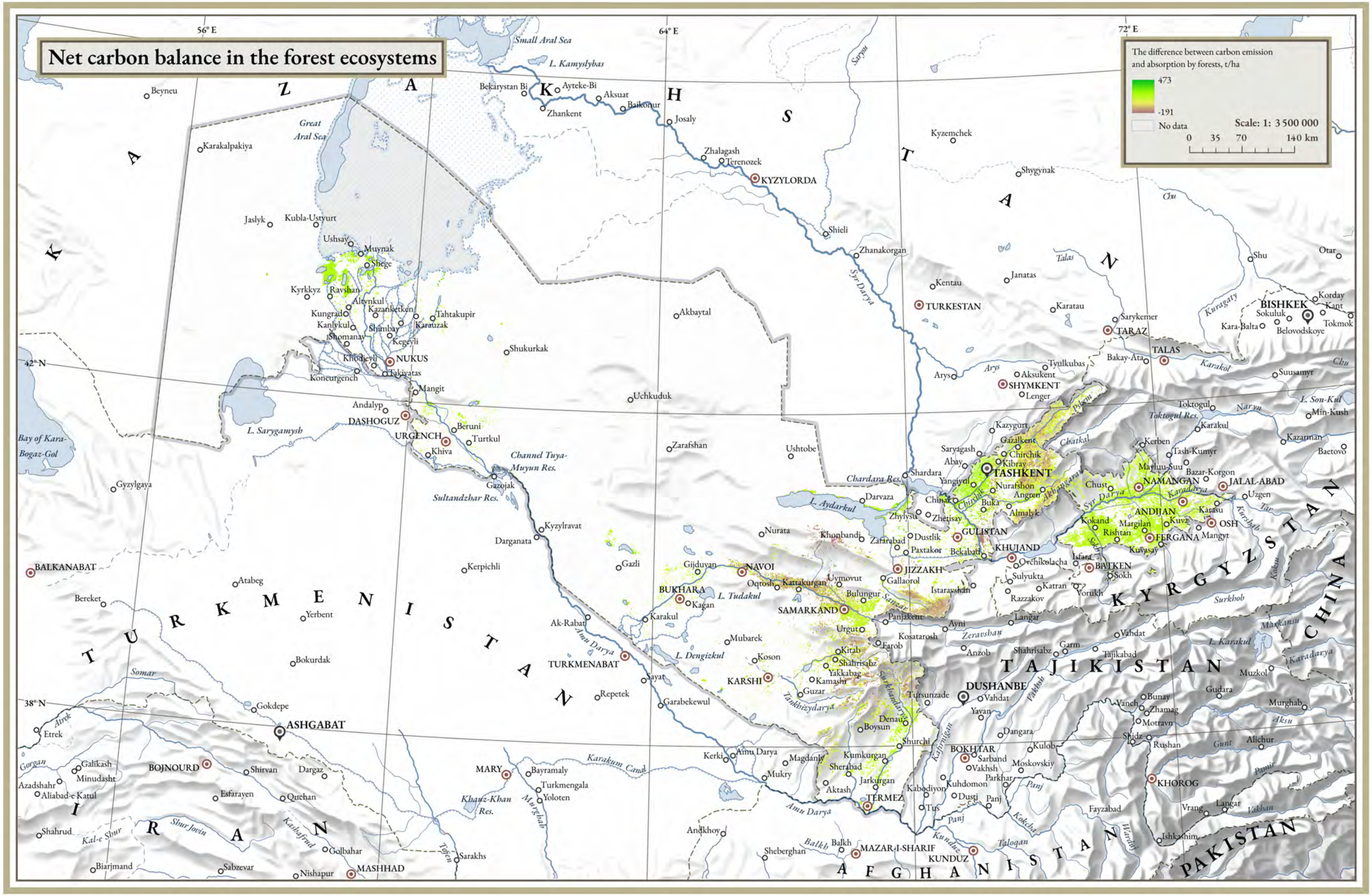
154 FAO and ITPS (2020) Global Soil Organic Carbon Map V1.5: Technical report. Rome, FAO.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Harris, N.L., Gibbs, D.A., Baccini, A. et al. Global maps of twenty-first century forest carbon fluxes. Nat. Clim. Chang. 11, 234–240 (2021). https://doi.org/10.1038/s41558-020-00976-6

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Harris, N.L., Gibbs, D.A., Baccini, A. et al. Global maps of twenty-first century forest carbon fluxes. Nat. Clim. Chang. 11, 234–240 (2021). https://doi.org/10.1038/s41558-020-00976-6

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.

Forest Resources



© Institute of Geography RAS, © PJSC RSC Energia



5.1. Key Aspects

- Global databases indicate extremely low forest cover in Uzbekistan (from 0.01 to 0.29 per cent of total land area), unlike national statistics, because the latter include vast areas of saxaul thickets as well as other desert woody and shrub species as forest areas.
- Despite the low forest cover, there is great diversity of forest types in the mountains, where more than 100 species of trees and shrubs can be found.
- The condition of tugai (riparian) forests in the floodplains of Uzbekistan's major rivers is unsatisfactory and requires maintaining specific ecological conditions, such as a high groundwater table, periodic floods combined with a hot dry climate and low air humidity.
- All forests perform ecological functions, as demonstrated by the large-scale afforestation programme on the desiccated former seabed of the Aral Sea which, in this particular case, helps prevent salt and dust erosion and to stabilize otherwise mobile sands.

5.2. Overview

Uzbekistan can clearly be classed as a country that has very limited forest resources, nevertheless, the State Forest Fund (SFF) of Uzbekistan, Administered by the State Committee on Forestry, occupies 11.17 million ha, or 26.5 per cent of the country's territory (2019). These SFF lands include not only areas covered by stands of trees but also lands designated for afforestation, as well as non-forest lands where afforestation will first require additional reclamation measures to prepare sites. Forests in strict nature reserves and other PAs are also part of the SFF. The SFF does not include shelterbelts, woody and shrub plantings on agricultural lands, protective plantings along roads, water bodies and other hydraulic features, urban tree plantings or trees and shrubs on either household or garden plots.

According to national data, Uzbekistan's forest area was 3.0 million ha in 1990, increased to 3.3 million ha by 2005, mainly due to plantations, then decreased somewhat to 3.28 million ha in 2010 because of the severe drought from 2005 to 2008[155]. From 2015 to 2020, the forest area grew from 3.2 to 3.68 million ha thanks to the active establishment of saxaul plantations in the Aral Sea Region Accurately assessing the actual distribution of forests in Uzbekistan is difficult because of mismatches between the definitions used in national forest statistics and those adopted by the FAO and other international organizations *(see maps 'Tree cover in 2005'; 'Closed forest cover')*. This complicates comparative assessments of the republic's forest resources with other countries, both in the region and worldwide[156].

National forest statistics distinguish between three forest types: desert, mountain and valley–tugai (floodplain) forests, which corresponds to the country's general morphostructural zonation. These forest types represent 85 per cent, 13.5 per cent and 1.5 per cent of the forested area, respectively *(see map 'Forest types')*.

Some 3,030 ha of 'forest' lands in deserts and semi-deserts are shrub thickets of saxaul occupying semi-arid and arid habitats: stony deserts (hamadas), dry channels of ephemeral streams (sais), sandy deserts and takyrs. Soils in these habitats can be highly saline and gypsiferous while tree height ranges from 0.7 to 2.8 m, with canopy cover ranging from one to 38 per cent. Extensive areas are also occupied

155 Global Forest Resources Assessment (2015) Country Report. FAO. 253 P. FRA 2015 Country Reports | Global Forest Resources Assessment | Food and Agriculture Organization of the United Nations

156 Worbes et al. (2006) Scope and constraints for tree planting in the irrigated landscapes of the Aral Sea Basin: case studies in Khorezm Region, Uzbekistan. ZEF Discussion Papers On Development Policy. 112. 49 P.

by thickets of Salsola richteri (and *S. paletzkiana*), Calligonum (candyme), and Tamarix. Most of these desert plantings are of low density (0.3 to 0.4) and have low timber stocks: only three to four m³/ha.

In Uzbekistan, saxaul forests are 80 per cent white saxaul and 20 per cent black saxaul communities *(see map 'Saxaul habitat')*. White saxaul, named for its whitish or light-gray bark, is a shrub averaging two to three m high and rarely reaching five to six m. Its root system typically goes down two to three m in depth and does not depend on groundwater levels. Its habitat is dune slopes, low hills and, in some cases, interdune depressions. White saxaul is considered a fast-growing plant and is extremely drought-tolerant, able to survive at relative humidities as low as one per cent. Black saxaul is one of the largest desert plants, reaching up to 12 m in some cases, and appears as either a tree or shrub with a characteristically crooked, knotty trunk and dark bark that stands out against whitish or reddish desert sands. It is drought-tolerant, undemanding of soils and can grow on highly saline sites thanks to a very well-developed root system that can tap groundwater deeper than 10 to 12 m. Black saxaul typically occupies small areas in valleys and between sand dunes[157].

The area occupied by saxaul stands throughout the region may shrink due to climate aridization in Central Asia and rising anthropogenic pressure. Nevertheless, assessing the real condition of naturally occurring saxaul stands is difficult. Various national and international reports provide only very general estimates of significant degradation of desert forests caused by the overgrazing of small ruminants and widespread household use of saxaul wood, which has high calorific value. One positive for saxauls is that Uzbekistan has amassed extensive experience with artificial saxaul plantings, enabling not only compensation for losses of naturally occurring communities but also expansion of the total area of woody plantings in the republic's desert and semi-desert zones *(see map 'Natural and planted forests')*.

The notion of "desert forest" bears little resemblance to classical forestry concepts of forest ecosystems[158]. However, the ecosystem role of woody vegetation in arid zones appears exceptional. Uzbekistan is making enormous efforts to restore the landscapes of the Aral Sea region, and the only option is to rapidly implement large-scale plantings of saxaul on the dried-up seabed. The exposed seabed can naturally develop

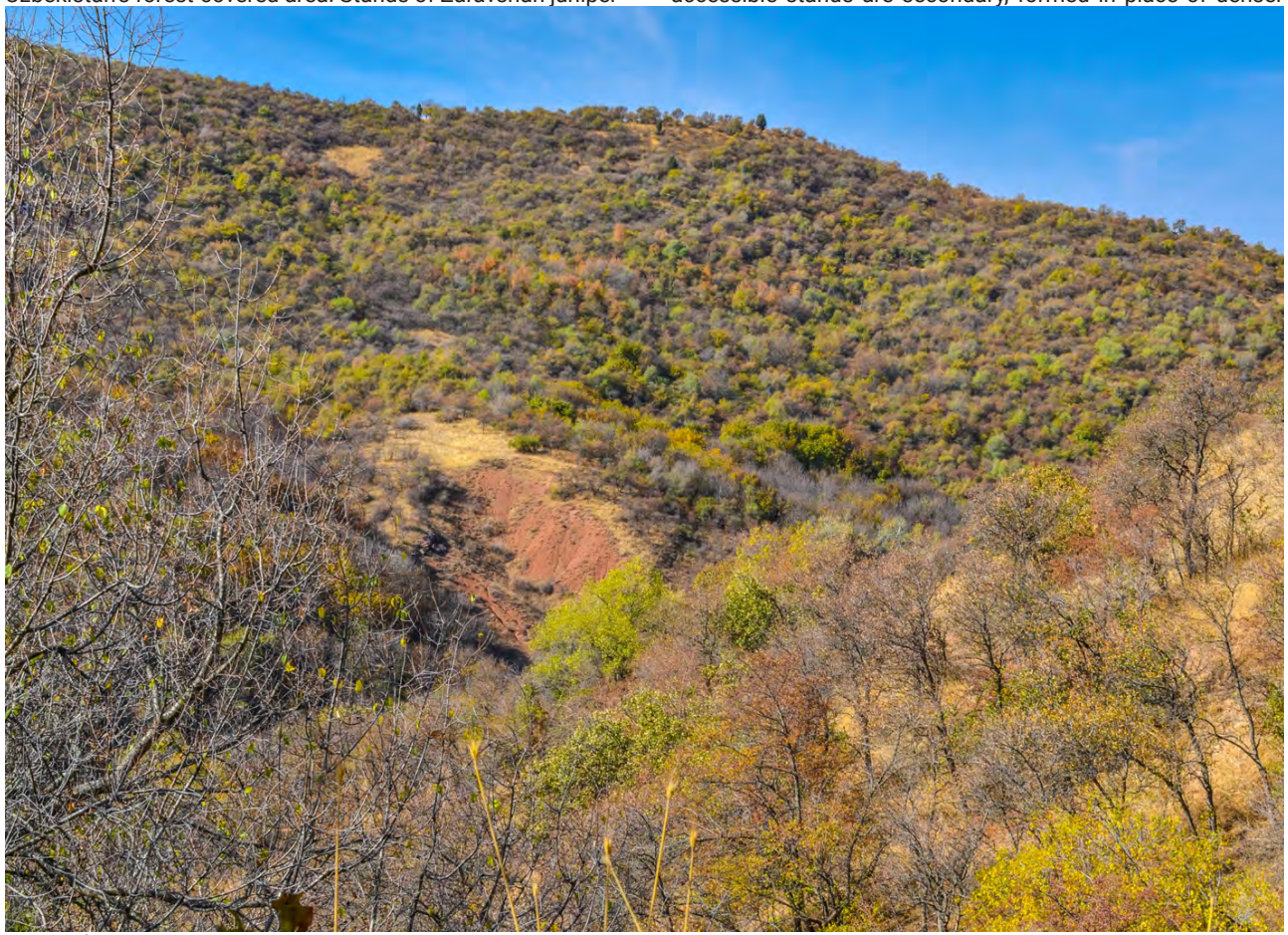
157 Aminqulovich F. U., Gulom qizi M. L. (2025) Development of saxaul cultivation in Uzbekistan. American Journal of Biology and Natural Sciences. 2 (1): 104 - 108.
158 Ibid.



An image from the ISS

a specific vegetation cover through primary succession with native plant species, primarily scattered grasses, occupying suitable habitats. The potential for vegetation development depends largely on the availability of seed material and its supply (for example, through wind transport), as well as the physicochemical state of the soil and salinity. However, such land cover change occurs slowly (over at least 20 years), is spontaneous, and does little to mitigate erosion.

Mountain forests occupy 420,000 ha, or 13.5 per cent of Uzbekistan's forest-covered area. Stands of Zaravshan juniper *(Juniperus seravschanica)*, the second most widespread tree in the republic, account for only 3.8 per cent (123,000 ha) of forest lands. They are typical high-mountain forests growing above 1,500 m where, for example, small patches of these conifer forests occur on the slopes of the Western Tien Shan Mountains and the western spurs of the Turkestan and Gissar ranges. Despite their relatively small area, Uzbekistan's mountain forests are comparatively species-rich: more than 100 tree and shrub species can be found within them. These accessible stands are secondary, formed in place of denser old juniper forests logged in the past, some of which exceed 50 years of age. Old-growth forests persist in remote areas but have also been heavily affected by livestock grazing.



Walnut forest and rocks on the hills near Karankul

Besides juniper, the mountain forests include various types such as pistachio, almond, walnut *(Juglans regia)*, apple, hawthorn forests combined with shrubs (mainly *Crataegus pontica*, a tree, and *C. turkestanica*, a shrub). Pistachio stands occupy second place in area after junipers and are concentrated mainly on the ridges of the Babatag Mountains. Their total area in Uzbekistan is 39,322 ha. These long-lived trees, with some specimens reaching 300 years old, form highly drought-resistant forests of open stands and an annual increment of 2.54 m³/ha. Natural regeneration of pistachio forests is poor, partly due to intensive nut collection and their heavy use as grazing pasture.

Stands of walnut are small, usually occupying under one ha, and are typically artificial plantings near settlements, although some old-growth stands do exist, for example, in protected areas and these are likely natural. Walnut forests are associated with north-facing slopes on the lower parts of divides, with pure walnut forest most often found in valley bottoms and on gentle north-facing slopes of the Fergana and Chatkal ranges.

Turkestan maple *(Acer turkestanicum)* typically covers shady steep, mostly concave slopes, ravines and screes where generally rocky soils with better moisture regimes and available nutrients exists. These stands are usually not old, rarely exceeding 50 to 70 years, likely due to intensive fuelwood harvesting and are often mixed with elm, plum, hawthorn and other woody species. Hawthorn occupies both low (at around 800 m above sea level) and high mountain (over 2,000 m above sea level) habitats. Mixed maple–walnut and apple–walnut forests form open stands of short trees with a canopy cover typically being 0.3 to 0.4. The average timber stock of mature walnut stands reaches only 60 m³/ha.

Commercial logging in the republic's natural forests is prohibited, with only sanitary cuts being allowed, and the total annual volume of timber harvested, coming from poplar plantations and private holdings, is under 50,000 m³. This volume does not meet current local industrial and domestic demand, to overcome this shortfall, merchantable timber is imported into Uzbekistan, mainly from Russia. However, this scarcity creates inflated prices which, in turn, encourages illegal felling, chiefly of poplar and juniper trees that provide timber suitable for construction.

In river floodplains and valleys, there are woody–shrub

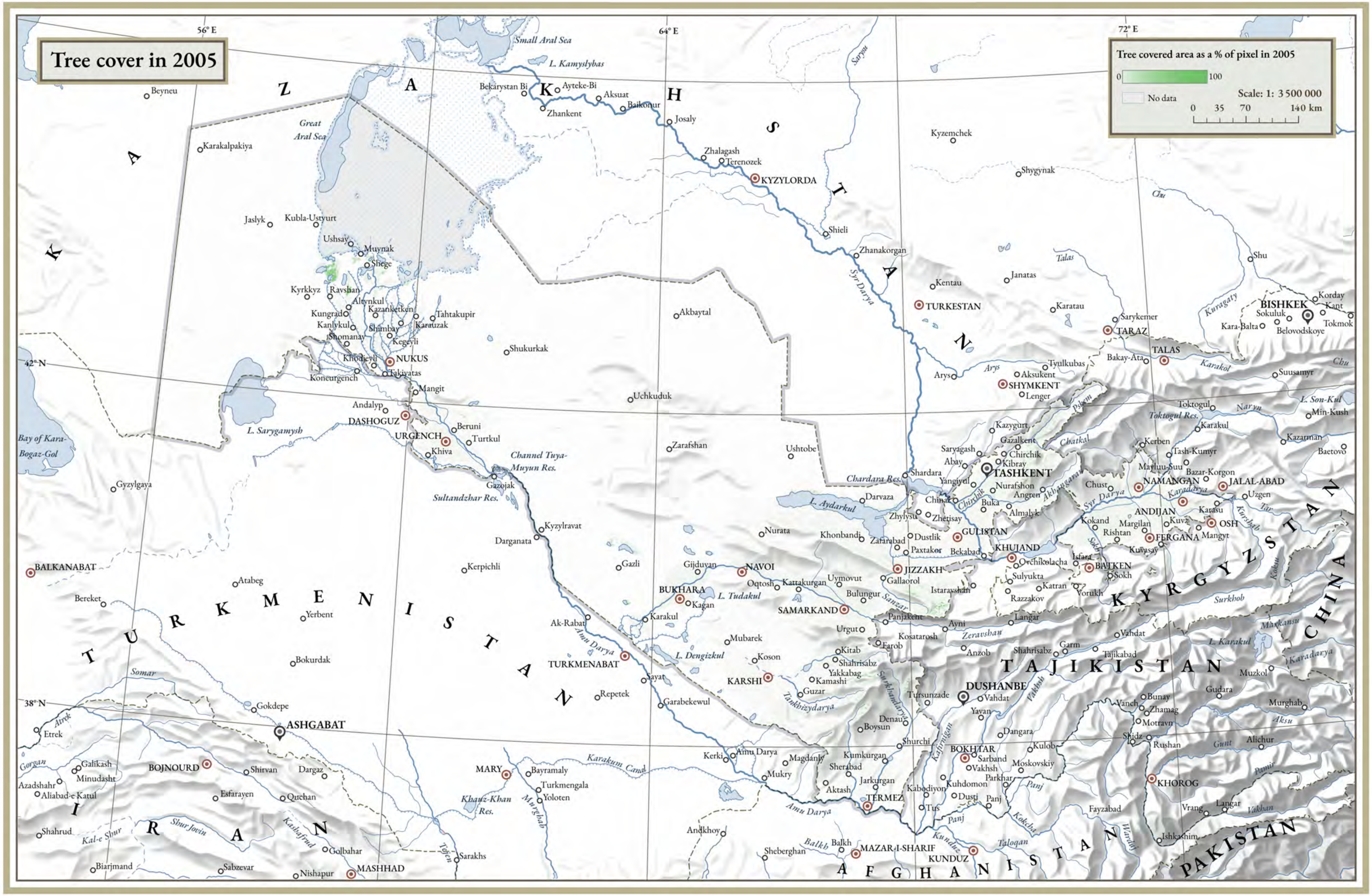
and herbaceous plant communities, these for the so-called tugai that are located mainly on islands and sandbars along river channels. The main forest-forming species of tugai are poplar, blue poplar *(Populus diversifolia, P. pruinosa)*, narrow-leaved oleaster *(Elaeagnus angustifolia L)*, Djungarian willow *(Salix songarica Anderss.)*, and tamarisk. Their total area in the country is estimated at 103,3 00 ha, with the largest concentrations being in the Amu Darya delta in the Republic of Karakalpakstan, the Syr Darya floodplain in the Fergana Valley, the lower reaches of the Chirchik River near Samarkand and the along the Zaravshan River. Although tugai vegetation can withstand the absence of summer precipitation, it requires specific ecological conditions to persist, such as high groundwater, periodic flooding combined with a hot dry climate and low air humidity. Contemporary tugai forests have low productivity, with yields typically being 46 to 64 m³/ha. However, there are exceptions: in the Khorezm Region and Karakalpakstan, tugai timber stocks can provide up to 200 m³/ha.

A critical task for maintaining the productivity of irrigated lands in arid zones is the creation of shelterbelts that stabilize this fragile and vulnerable human-modified landscape by improving local microclimates, controlling soil erosion, providing biodrainage and delivering recreational, aesthetic and other functions. From a climate change perspective, tree plantings on irrigated lands have higher productivity and thus greater carbon-sequestration capacity. In the mid-1980s, Uzbekistan had about 40,000 ha of such plantings, however, by 2006 only about 25,000 ha remained. New protective plantings are rarely established on croplands, while existing naturally-occurring belts are over-mature and being cut.

In Uzbekistan, all forests, both existing and newly created, are considered protective (for soils, waters, etc.). In terms of the total sowing and planting area of afforestation projects, more than 80 per cent is in the desert zone of the Aral Sea region and on the desiccated seabed. In these areas, large-scale reforestation efforts are carried out annually using key sand-tolerant tree species such as saxaul, saltwort, and firebush. The main goal of these activities is to prevent or reduce salt and dust erosion from the soil surface and to stabilize mobile sands. However, there are limits as the desiccated seabed consists of light and heavy soils, with afforestation currently only possible on the lighter soil types.



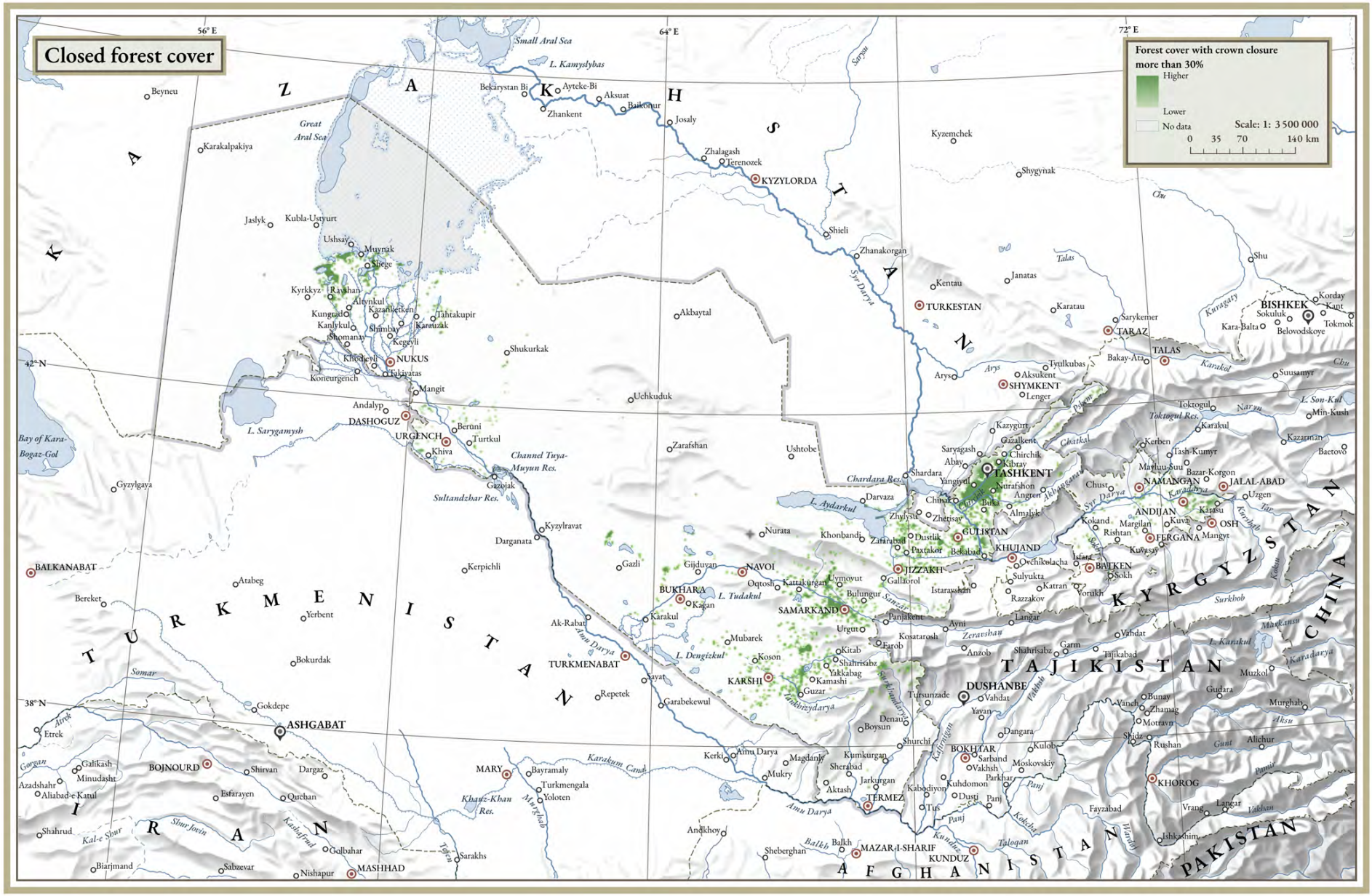
Charvak reservoir



According to Sexton et al.[159] areas are considered ‘forested’ if they have ≥30% tree cover, rather than having a categorical ‘forest’/‘non-forest’.

159 Sexton et al. (2013) Global, 30-m resolution continuous fields of tree cover: Landsat-based rescaling of MODIS Vegetation Continuous Fields with lidar-based estimates of error. International Journal of Digital Earth. 130321031236007.

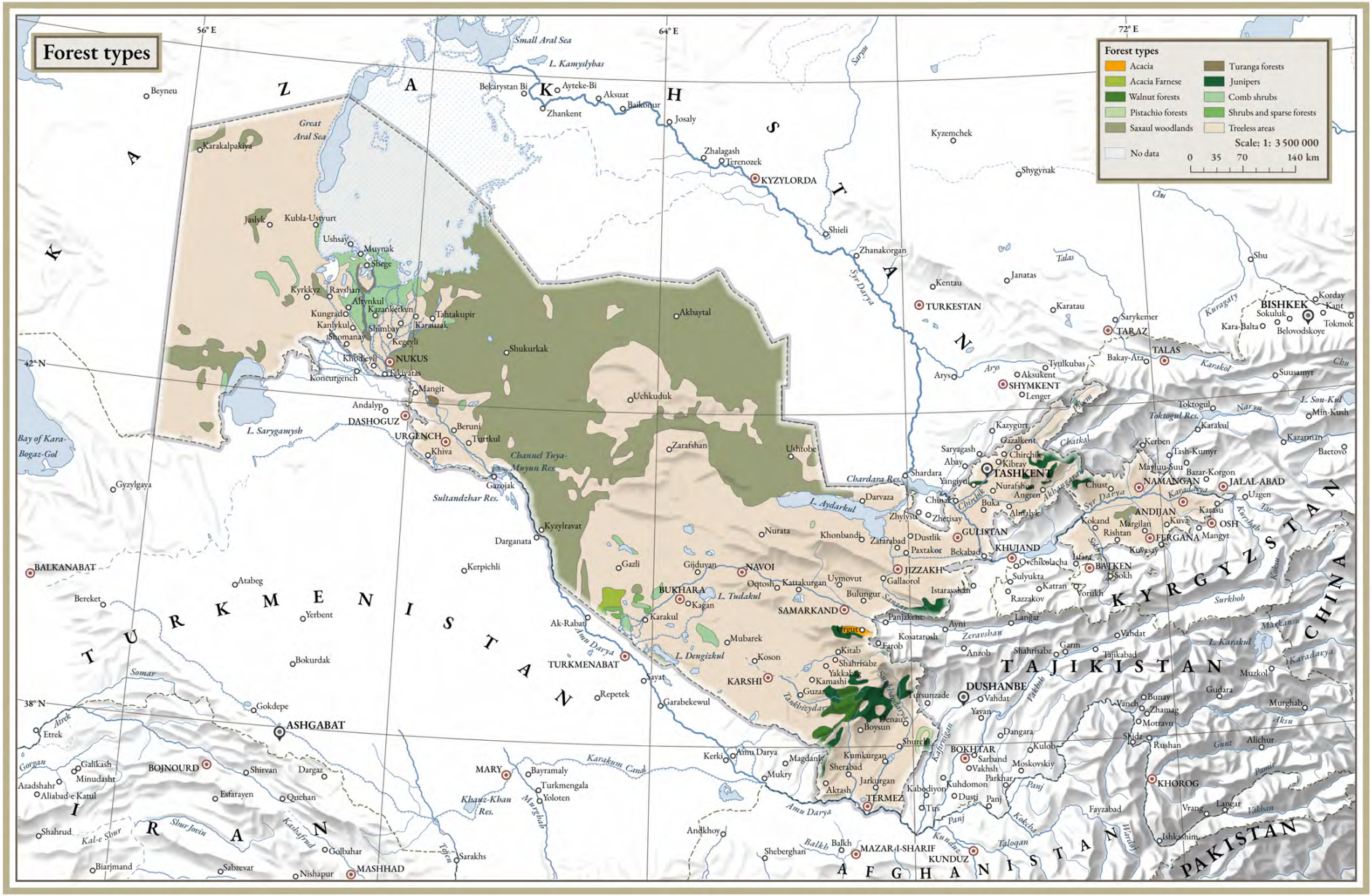
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



According to Hansen et al.[160], forest definition was based on tree height >5 m and canopy density of 10% or more.

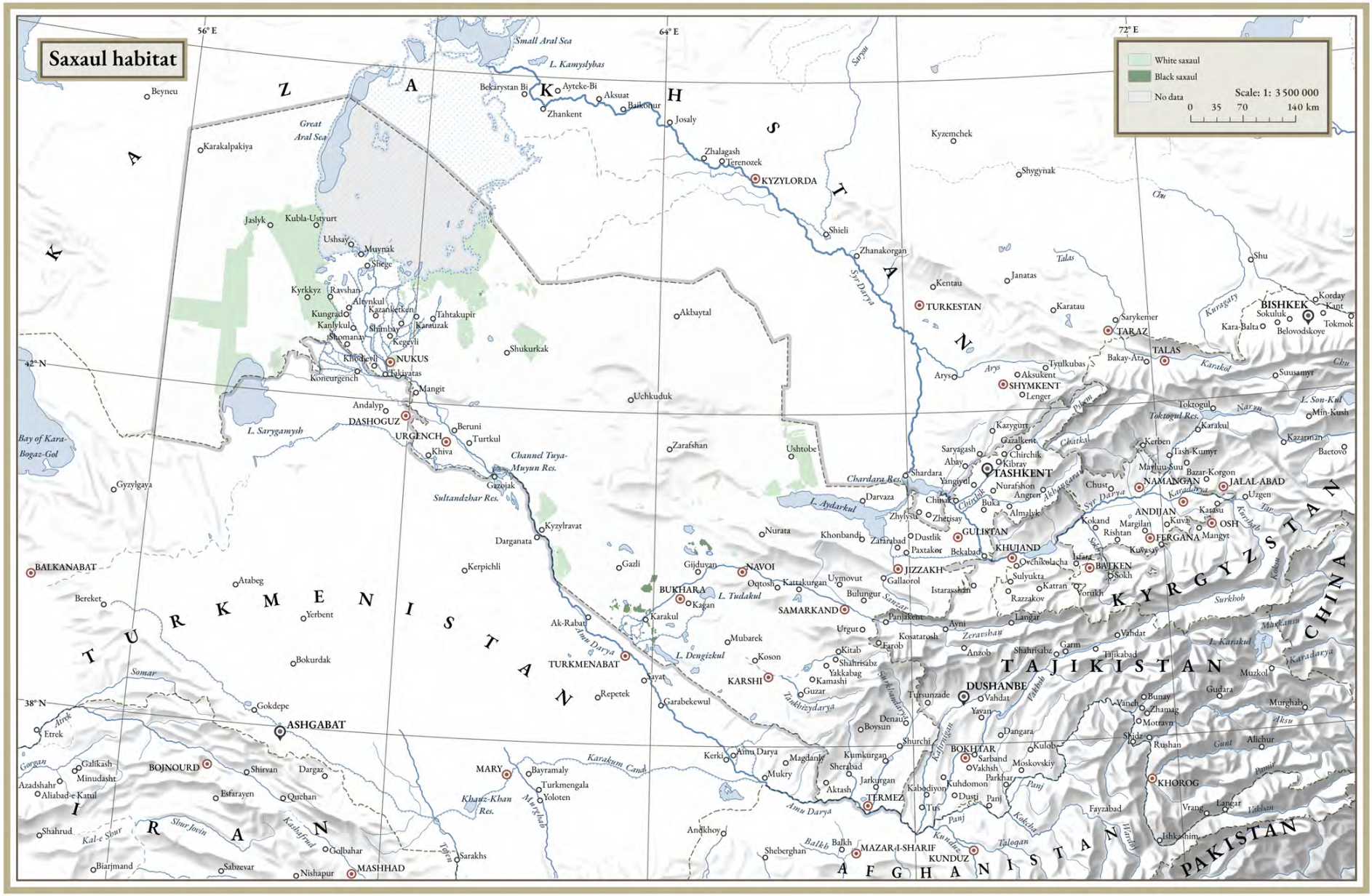
160 Hansen et al. (2013) High-Resolution Global Maps of 21st- Century Forest Cover Change: Science. 342. 6160: 850-853.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



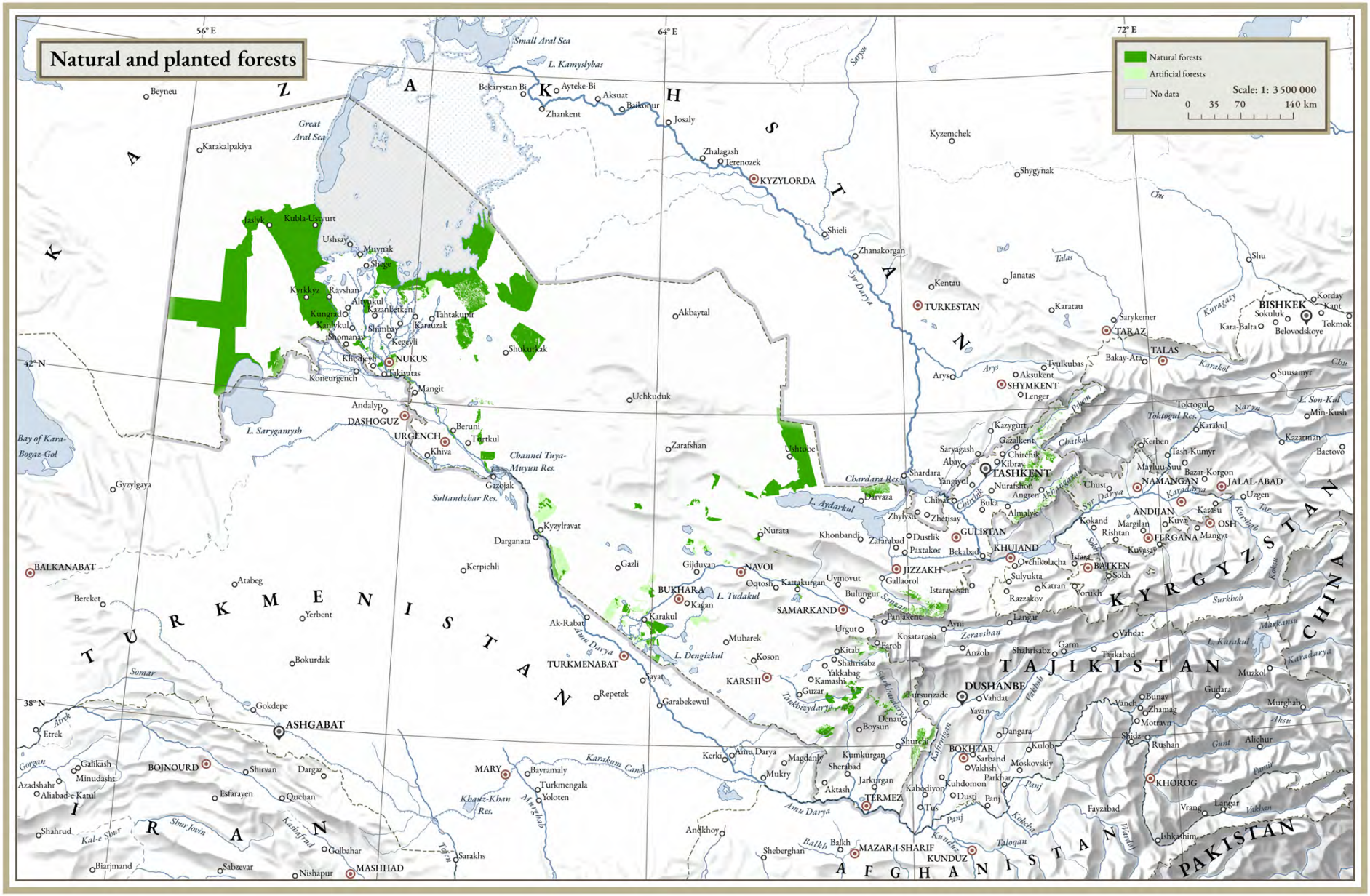
Atlas of the Uzbek Soviet Socialist Republic. – Tashkent-M.: Academy of Sciences of the Uzbek SSR; GUGK, 1963.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



According to national coordinators.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



According to national coordinators.

The original scale of the map is 1:3 500 000. The map image has been modified for page

5.3. Towards Achieving the SDGs

Adopted in 2015, the Bonn Challenge calls on all countries to restore 350 million ha of forest landscapes by 2030. In 2018, within a regional initiative (the 'Astana Resolution'), the countries of the Caucasus Mountains and Central Asia made voluntary commitments to restore three million ha of forests by 2030. In 2018, in support of the Bonn initiatives, Uzbekistan pledged to restore 500,000 ha of degraded land by 2030. This is an extremely ambitious task given the country's very arid climate. For comparison, Tajikistan's commitment was to restore 66,000 ha from 2018 onward, while the Kyrgyzstan, which has the most favorable conditions to establish/re-establish forests among these countries, set a national target of 323,200 ha.

Critics of the Bonn Challenge point to time frames that are too short to judge end results in any given country. The original concept envisioned restoring 150 million ha of degraded landscapes globally by 2020. However, since measuring significant positive changes over such a short period proved impossible, the wording shifted to assessing reforested areas as 'under restoration'. Ultimately, the challenge's deadlines were extended by 10 years, to 2030. Nevertheless, the problem of objectively evaluating implementation and outcomes remains. Extreme climate events and shifts in both climate and land use are serious medium-term challenges for newly created forest ecosystems[161]. Accordingly, experts highlight that the key performance indicator for reforestation and afforestation programmes should not be the area planted but the persistence of plantings under changing environmental conditions. Only then can restored forests be said to have delivered ecosystem services.

Successful historic experience in restoring forest ecosystems has been linked to a simple and low-cost measure: withdrawing degraded agricultural land from use and allowing natural woody vegetation to recover. In semi-arid and arid regions, it is far more costly, in terms of the financial, technological and social and time resources required, to create resilient forest ecosystems. For example, when irrigated lands in Uzbekistan are abandoned, saxaul should be planted promptly before soil salinization sets in and, as experience has shown, engaging local people in restoration plans is often decisive for their success. In 2020, Uzbekistan adopted the Forest Sector Development Strategy to 2030, which places particular emphasis on developing market mechanisms in the forest sector, more specifically, leasing non-forest plots to individuals and legal entities for 49 years for forest restoration purposes[162]. To successfully deliver on this strategy, the root causes of forest cover degradation must be clearly understood; these can include, but are not necessarily limited to, unclear land-user6 poverty, market failures and a lack of policy coordination across economic sectors. Access to land and guaranteed rights to planted forests remain crucial elements for large-scale restoration projects in transitioning countries, where such issues are still unresolved and may take decades to settle[163]. Similar concerns apply to restoration programmes within Uzbekistan *(see Box 5)*, despite the fact that international forest restoration initiatives have received strong domestic political backing. Since 2018, the country has also run an intensive reforestation and afforestation campaigns where, for example the 2019 one-year moratorium on logging valuable tree species was introduced and then extended indefinitely. Under the Bonn Challenge, Uzbekistan's afforestation strategy calls for planting hardy native and adapted shrub and tree species on the former Aral Sea bed. By 2020, the State Forestry Committee had planted 500,000 ha of saxaul, kick-starting large-scale afforestation in the Aral Sea region. In 2021, the President launched the national 'Yashil Makon' ('Green Land') project, aiming to plant one billion trees and shrubs across the country over five years and increasing urban green space from the current 7.6 per cent to 30 per cent. These plans envisage expanding the forest fund to 14 million ha by 2030 (32 per cent of the country), of which areas covered by woody vegetation would total six million ha.

The 'Yashil Makon' project provides for broad public participation and calls for the planting 200 million seedlings annually. According to the Presidential press service, by the end of 2021, 85 million seedlings had already been planted, with a further 125 million planted in the spring of 2022, meaning that by 2024, some 226.6 million trees were planted under the project. However, the impressive pace has not been matched by a comprehensive concept for post-planting care and management, leaving the fate and viability of both the trees and the initiative an unknown quantity[164]. The success of such initiatives require more than just a plant-and-forget approach but the provision of sustained care over the first 10 to 12 years for seedlings to reach maturity. Accordingly, comprehensive monitoring of plantings, coupled with the creation of nurseries to grow, for example, the saxaul seedlings needed for the Aral Sea's desiccated seabed, are essential.

Nevertheless, despite the foregoing intent and effort, Uzbekistan has limited potential for natural forest regeneration. This, to a certain extent, justifies the question of whether the reforestation projects implemented in Uzbekistan (and Kazakhstan) fully comply with the Bonn Challenge concept, since the main goal of the imitative is the restoration of natural forest landscapes[165].

The global **SDG 15.1** has been nationalized by Uzbekistan as "to ensure the conservation, restoration, and sustainable use of terrestrial and inland freshwater ecosystems and their services—particularly forests, wetlands, mountains, and drylands—in line with international commitments by 2020". Subsequent to this, Indicator 15.1.1 measures forest area as a percentage of total land area.

Uzbekistan recognizes three main forest types: drought- and salt-affected forests in desert areas; mountain forests; and tugai (floodplain) forests. The latter two types have relatively closed tree canopies, allowing them to be considered as forests under international practice *(see map 'Tree canopy closure')*. According to the Sixth National Report on the conservation of biological diversity (2018)[166], as of January 2018, the overwhelming majority of the State Forest Fund (9.53 million ha, 84.6 per cent of the total) was located in sandy deserts, with much smaller areas in mountains (1.12 million ha, 9.95 per cent), valleys (0.26 million ha, 2.31 per cent) and floodplains (0.11 million ha, 0.98 per cent). The State Forest Fund includes not only forested lands but also areas designated for planting *(see section 5.2)*. Official data show Uzbekistan's forested area has grown, especially over the last 20 years, but almost exclusively due to extensive saxaul plantations in the Aral Sea Region *(see map 'Forest age')*. At the same time, the condition of mountain and floodplain forests remains unclear in official sources.

Unreliable forestry statistics are a region-wide problem in Central Asia[167], as data provided by countries to FAO is mostly

161 Stanturf et al. (2019) Implementing forest landscape restoration under the Bonn Challenge: a systematic approach. Annals of Forest Science. 76. 10.1007/s13595-019-0833-z. Implementing forest landscape restoration under the Bonn Challenge: a systematic approach | Annals of Forest Science | Full Text.

162 Resolution of the President of the Republic of Uzbekistan «On approval of the concept of development of the forestry system of the Republic of Uzbekistan until 2030» ПП-4850-сон 06.10.2020. Об утверждении Концепции развития системы лесного хозяйства Республики Узбекистан до 2030 года. (in Russian)

163 Stanturf et al., 2019.

164 Ensuring a green future for Uzbekistan through 1 billion trees | UNDP Climate Promise.

165 Forest landscape restoration: transforming landscapes and livelihoods in the Caucasus and Central Asia (2018) IUCN. FORESTBRIEF. 23. 8 P.

166 Sixth National Report of the Republic of Uzbekistan on the conservation of biological diversity (2018) ed. by B.T. Kuchkarov. Tashkent. 214 P.

167 Yin et al. (2017) Forest cover mapping in post-Soviet Central Asia using multi-resolution remote sensing imagery. Sci Rep. 7, 1375.

outdated or missing[168]. There are substantial discrepancies among datasets from different sources, leaving no accepted estimate of total forest area in Central Asia. To date, only Kyrgyzstan has conducted a robust national forest inventory using modern tools, equipment and software with FAO support and participation. The outcome resulted in a revision of national data concerning forest cover, forest vegetation classes (including a new category of 'shrubby forest'), above-ground biomass stocks, carbon content and other parameters. The explanatory note to this inventory stresses that these data are not comparable with any previously published figures because methodologies differed significantly.

Uzbekistan last conducted a forest inventory in 1987. Accordingly, a UNECE review noted that a proper assessment of the current status of its forests and trends in forestry is impossible due to the lack of complete, reliable and publicly available forest-resource statistics. Together with the FAO, the Government has developed a project proposal for a national forest inventory, however, it has yet to be implemented. This would be an invaluable undertaking as carrying out an inventory in line with international standards could lead to a substantial revision of national forest statistics[169].

In the absence of a modern inventory, satellite data are recognized as the only reliable and independent source for estimating forest-type areas at regional and national scales. Remote-sensing methods can identify main land-cover classes with acceptable accuracy, distinguish mixed (deciduous) and coniferous forests as well as separate them from grasslands and wetlands. For Central Asian countries, such data return large differences between national statistics and processed satellite imagery, especially in countries dominated by deserts and semi-deserts, such as Uzbekistan *(see map 'Forest landscape integrity')*.

Discrepancies between national and global forest-area estimates reflect different definitions of 'forest'. A 2018 revision of Uzbekistan's 1999 Law On Forests retained a Soviet-era definition of a forest as "trees, shrubs and other natural objects on lands of the forest fund". This definition sets no explicit thresholds for areas that may or may not be recognized as 'forest'. In contrast, the FAO defines forest as "land over 0.5 ha with trees higher than five m and canopy cover of more than 10 percent, or trees able to reach these thresholds in situ". This latter definition is also used in other environmental conventions, such as the UNFCCC, which results in lands with a canopy cover that drops below 10 per cent in carbon-sequestration projects being classified as 'deforested'[170].

Communities such as saxaul stands do not meet the FAO's definition of a forest and can be labelled as such only conditionally, since these desert stands (in fact, shrub communities) do not align well with classical forestry or botanical concepts of forest ecosystems[171]. On the one hand, saxaul stands are edificators, playing a key role in structuring desert ecosystems and delivering ecological functions (wind-erosion control, soil formation, biodiversity support). On the other hand, forest is not only an ecological but also an economic (resource) category. Average timber stock in saxaul stands is 2.5–3.3 m³/ha for mature trees, making timber production economically infeasible[172].

In many relatively close arid countries, such as Kazakhstan, Turkmenistan, Mongolia and China, saxaul stands are nevertheless treated as a separate forest category rather than shrub vegetation. In Mongolia, for example, saxaul occupies roughly the same area (about two million ha) as in Uzbekistan. To classify them as a distinct forest type, the following thresholds have been proposed by Mongolia: minimum stand height of one m and with a minimum canopy cover 4.65 per cent[173]. Below this canopy threshold, Mongolia would classify the area as shrubbed desert.

According to Global Forest Watch (GFW), applying FAO canopy thresholds (i.e., over 10 per cent) reduces Uzbekistan's 'forest' area from the nationally reported 3.284 million ha to 0.123 million ha, , or from the official figure of 7.6% to just 0.28 per cent of the country[174]. A detailed study using multi-temporal Landsat and Sentinel-2 imagery likewise puts the republic's forest cover at 0.29 per cent of the country's total area[175]. Regional forest cover in 2010 ranged from 0.03 per cent in the Navoi Region to 2.29 per cent in the Tashkent Region, reflecting broad climatic and orographic differences *(see Table 18)*. Comparing remote-sensing results for 2000 and 2010 (and over longer periods) shows a 50 per cent reduction in what the FAO definition classes as closed forests. Tugai forests in the desert zone were likely the most affected forest type. The authors of the study attribute the shrinkage not to long-term trends but to several extremely dry years in the late 2000s, underscoring the extreme vulnerability of

168 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. at The 2nd National Forest Inventory in Kyrgyzstan is being completed – CACIP Central Asia Climate Information Portal

169 UNECE, 2020a.

170 Government of Mongolia (2018) Mongolia's Forest Reference Level submission to the United Nations Framework Convention on Climate Change. UN-REDD Mongolia National Programme, Ministry of Environment and Tourism, Ulaanbaatar. 62 P.

171 Ibid.

172 Worbes et al., 2006.

173 Ibid.

174 Worbes et al., 2006.

175 Yin et al., 2017.

Table 18. Area of closed forests (>10 per cent canopy) in regions of Uzbekistan in 2000 and 2010[1]

Region	Region area, ha	Closed forest area in 2000, ha	Closed forest area in 2010, ha	Forest cover in 2000, %	Forest cover in 2010, %
Republic of Karakalpakstan	16,483,460	41,564	19,132	0.25	0.12
Khorezm	729,174	1,822	42	0.25	0.01
Bukhara	4,042,815	11,697	365	0.29	0.01
Navoi	11,217,881	10,517	3,828	0.09	0.03
Samarkand	1,433,767	25,815	4,515	0.67	0.31
Kashkadarya	2,812,535	25,815	5,791	0.92	0.21
Surkhandarya	1,989,878	23,213	4,437	1.17	0.22
Jizzakh	2,137,425	47,081	37,570	2.20	1.76
Syr Darya	489,707	5,804	9,236	1.19	1.89
Tashkent	1,511,444	71,856	34,647	4.75	2.29
Andijan	449,605	1,670	2,037	0.37	0.45
Fergana	670,177	888	700	0.13	0.10
Namangan	754,712	2,732	1,194	0.36	0.16
Uzbekistan	**44,722,580**	**270,474**	**123,494**	**0.60**	**0.28**

1 Global Forest Change.

Table 19. Trends in Primary Productivity on Forest Lands in Regions of Uzbekistan, 2001–2020

Region	Forest and shrub area, ha	Weak, %	Moderate, %	Strong, %
Republic of Karakalpakstan	1,072,807	32.00	52.00	16.0
Khorezm	53,700	47.00	44.00	9.0
Bukhara	334,645	52.00	42.00	6.0
Navoi	1,270,900	36.00	48.00	16.0
Samarkand	13,000	60.00	34.00	6.0
Kashkadarya	164,200	48.00	43.00	9.0
Surkhandarya	233,400	51.00	44.00	5.0
Jizzakh	163,800	49.00	45.00	6.0
Syr Darya	4,200	49.00	44.00	7.0
Tashkent	81,602	67.00	28.00	5.0
Andijan	3,900	88.00	10.00	2.0
Fergana	14,600	68.00	25.00	7.0
Namangan	23,900	58.00	32.00	10.0
Uzbekistan	**3,434,654**	**39.89**	**47.16**	**13.0**

Table 20. EVI Trends for Forest Types in Uzbekistan, 2000–2024

Forest type	Mean EVI trend (per year)
Saxaul stands	-0.000035
Shrub communities	-0.000027
Shrub-like communities	-0.000185
Salt-affected treeless lands within the State Forest Fund	-0.000112
Coniferous forests	0.000217
Mixed forests	0.000408
Fruit trees	0.000268
Walnut forests	0.000057
Deciduous forests (tugai)	0.000078

forest ecosystems to climate variability in the region and, by extension, to projected climate change *(see map 'Dynamics of forest areas, 1982–2016')*.

According to GFW[176], between 2001 and 2024, Uzbekistan's forests emitted 0.012 million tons of CO2-equivalent per year and absorbed – 0.410 million tons per year *(see maps "GHG emissions from closed-canopy forests"; "Carbon sequestration in closed-canopy forests")*. This represents a net carbon uptake of only 0.390 million tons per year, or 3.2 tons per hectare in CO2-equivalent *(see map 'Net carbon balance in the forest ecosystems")*. By comparison, total greenhouse gas emissions from cultivated land are estimated at 10.7 million tons per year, largely reflecting the large difference in the area of forest and cultivated land. Thus, restoring deforested lands can only marginally improve a country's carbon balance *(see map "Carbon sequestration potential through reforestation")*. Uzbekistan is relying more on millions of hectares of saxaul plantations planned in the country's desert landscapes to help fulfill the new revised in 2021 country's Paris Agreement commitment to cut greenhouse-gas emissions per unit of GDP by 35 per cent by 2030 when compared to 2010 levels[177].

The global SDG 15.2 has been nationalized by Uzbekistan in its efforts "to promote sustainable management of all types of forests, halt deforestation, restore degraded forests, and substantially increase reforestation afforestation worldwide by 2020". The corresponding indicator is 15.2.1, which states that progress toward SFM is measured by sub-indicators such as changes in forest areas; above-ground biomass stocks in forests; the share of forest areas within legally established protected areas; the share of forest areas under long-term forest-management plans; and the area certified under an independently verified forest-certification system.

Below, Table 19 presents results on trends in Uzbekistan's forest areas (or more precisely, its forest and shrub areas) in terms of primary productivity as published in the World Bank report[178]. Calculating biomass dynamics, especially for sparse desert stands, requires verification and should be treated as preliminary. Overall, the estimates indicate rather moderate degradation of forests and shrubs in Uzbekistan in 2001–2020. Elevated degradation of woody vegetation is found in Karakalpakstan and Navoi, where about 70 per cent of the country's desert forests occur.

According to the national report[179] deforestation is most intense in the foothill and mountain areas of the Tashkent, Surkhandarya, Samarkand and Fergana regions. Degradation of tugai forest ecosystems, primarily driven by unsustainable use (notably overgrazing), is further exacerbated by unfavourable changes in hydrological regimes caused by agricultural water withdrawals and climate change. However, remote sensing data, on the contrary, show rather positive trends in green biomass in valley, foothill and mountain forests. Negative trends are seen in desert woody communities, e.g., saxaul stands (see Table 20), however, these negative trends may be associated with the succession of abnormally dry years between 2019 and 2024.

Another SFM sub-indicator is the trend in above-ground biomass stock in forests. Changes in this biomass indicate the balance between growth (stock increase) and losses from timber extraction and natural disturbances. At the national scale and over a longer period, SFM requires stable or increasing biomass per hectare, while long-term declines point to either unsustainable management with gradual degradation or unexpected large-scale losses from things such as fire, wind, pests or disease events.

Overall, Uzbekistan's forests are low-productivity, except for the tugai forests. According to the FAO, as of 2018,

176 Uzbekistan Deforestation Rates & Statistics | GFW

177 Ensuring a green future for Uzbekistan through 1 billion trees | UNDP Climate Promise.

178 Agostini et al. 2024.

179 Sixth National..., 2018.

Uzbekistan's total forest growing stock was 26 million m³ (19 million m³ broadleaved, seven million m³ coniferous), however, these figures cannot be verified without an updated national forest cadastre. Data on trends in total and per-hectare growing stock, average annual increments and stand age structure are currently unavailable. Nationwide harvests of wild fruit are also small (e.g., wild apple less than 200 tons, nuts around 100 tons, cherry-plum and apricot between 100 and 150 tons) and the incomes derived from this gathering are modest[180].

As previously mentioned, Uzbekistan's self-sufficiency in forest-industry products is only 2.6 per cent, with the deficit covered by imports, primarily from the Russian Federation, which accounts for over 75 per cent of the republic's imported sawnwood, plywood and other timber products[181]. Currently, the most valuable domestic timber resource is sourced from artificial plantations of fast-growing poplar.

There are no complete statistics on the annual production of commercial timber and firewood in publicly available official statistics. According to the State Forestry Committee, recent average annual harvests were 25,278 m³ (including 3,654 m³ from sanitary fellings). Data on illegal logging volumes and household fuelwood collection are also absent.

Changes in forest areas within PAs is an indicator of trends in conserving forest biodiversity as well as the preservation of cultural and spiritual values and, as such, is a clear sign of the political will to protect and increase forests *(see section 6.3)*. This is linked to Aichi Target 11 on the conservation of biological diversity, calling on countries to protect at least 17 per cent of their terrestrial (and inland water) ecosystems. All forests in Uzbekistan are officially recognized as protected. According to the FAO's Global Forest Resources Assessment (2015)[182], about 83 per cent of forests in Uzbekistan are designated for combating desertification and another 12 per cent for biodiversity protection. In support of these goals, commercial timber harvesting has not been allowed since the 1960s, except for sanitary cuts, Uzbekistan has reported that it has successfully halted deforestation and implemented intensive reforestation/afforestation programmes.

The fourth sub-indicator of SDG 15.2.1 concerns the share of forested land managed under a long-term forest-management plan. Having a documented plan is fundamental for long-term sustainable management for multiple objectives: wood and non-wood products, soil and water protection, biodiversity conservation, social and cultural uses and/or combinations thereof. Growth in such areas indicates progress in SFM. Uzbekistan participated in the joint UNECE/FAO project 'Accountability Systems for SFM in the Caucasus and Central Asia (2016–2019)', which helps the relevant countries develop national criteria, indicators and reporting systems for SFM under the SDGs. Under this project, participating countries are to develop a national set of criteria and indicators for SFM aligned with international experience. Somewhat related to this, Uzbekistan also participated in preparing the 'State of Forests in the Caucasus and Central Asia' report.

During the period between 2016 and 2019, Uzbekistan made some progress in drafting an SFM plan with criteria, indicators and elements of a new forest-reporting system under the joint UNECE–FAO project in cooperation with the State Forestry Committee. However, to date, the resultant SFM plan has not been approved[183].

The fifth sub-indicator is the area certified under an independent forest-certification system. Such systems apply standards generally higher than national regulations and are verified by an accredited independent body. Expansion of certified area is additional evidence of progress in SFM. Certification data are reported annually to FAO by the systems' headquarters and include the area certified under any internationally recognized schemes, such as the Forest Stewardship Council (FSC), the Programme for the Endorsement of Forest Certification (PEFC) or the Sustainable Biomass Program (SBP), including multi-certified areas. As of today, no forest certification exists in Uzbekistan[184].

Nomination of forestry enterprises for an internationally recognized voluntary forest certification scheme is a prerequisite for the sustainable development of this economic sector. Furthermore, forestry certification has an important social impact, promoting women's employment and requiring equal opportunities, non-discrimination, and fair wages. Certification systems such as PEFC and FSC oblige certified organizations to provide equal employment, training, and contracting opportunities for both men and women, as well as fair wages that meet or exceed legal minimum requirements, regardless of gender. They also provide platforms for women to participate in decision-making processes related to sustainable forest management.

In Uzbekistan, women are virtually underrepresented in forestry and forest management-related employment. Forestry is considered a «male» field, reflected in the fact that women constitute only 4% of the total workforce in state forestry agencies (usually as the lowest-paid technical workers in offices). Despite their lack of formal roles, women participate in forest management in other ways, such as collecting non-timber forest products (medicinal herbs, seedlings, and some fruits), which they process. Men are typically responsible for selling these products. Men also constitute the majority of forest license holders, which regulate the use of forest lands, and women rarely engage in formal negotiations with forestry enterprises. Proactive measures are needed to ensure that women who use forest resources also have a voice in forest management[185].

The global **SDG 15.4** focuses on conserving mountain ecosystems, including their biodiversity, to strengthen their capacity to provide benefits essential for sustainable development. The main indicator here is the Mountain Green Cover Index (MGCI), designed to measure changes in mountain green vegetation, such as forests, shrubs, trees, pasture and cropland, as a means to monitor progress toward this target. Declines are generally associated with overgrazing, urbanization, forest exploitation, illegal logging, fuelwood collection and fires; increases may reflect vegetation growth tied to land restoration, reforestation or afforestation. The indicator is based on Collect Earth, which provides very-high-resolution multi-temporal imagery used in Google Earth and Bing Maps, as well as Landsat 7/8 via the Google Earth Engine. The indicator has 99 per cent global accuracy, though at a national scale, especially in smaller countries, this value may be significantly lower. The value of Indicator 15.4.2 for Uzbekistan in 2017 was 54.81 per cent, which was below the 64 per cent average for Central and South Asia. However, it should also be noted that many mountain forests in Uzbekistan, especially juniper, are too sparse to be included in the MGCI calculation[186].

Box 5. Uncertainty in Land Tenure Hinders Afforestation of Degraded Lands

180 CBD Sixth National Report - Uzbekistan (English version).
181 UNECE (2020b) Overview of the State of Forests and Forest Management in Uzbekistan. Geneva. 31 P.
182 Global Forest ..., 2015.
183 UNECE, 2020a.
184 UNECE, 2020b.
185 Gender, agriculture.., 2018.
186 Sustainable Management of Forests in Mountain and Valley Areas | GEF

Ongoing monoculture for cotton production in the lower reaches of the Amu Darya has led to the degradation of 23 per cent of this area's arable land. Improving degraded cropland through afforestation can be one option for sustainable development. Experimental studies identified the tree species *Elaeagnus angustifolia L., Populus euphratica Olive and Ulmuspumila* as the most suitable for such lands. The wood can be used as fuel and the protein-rich leaves can be added to livestock feed, increasing its nutritional value while reducing feed costs. However, local farmers do not see this as a full-fledged alternative.

A survey conducted between 2010 and 2011 of 60 farms growing cotton in the lower Amu Darya identified key factors constraining these farmers from adopting tree-planting practices[187]. The study area covered parts of the Khorezm Region and the southern districts of the Autonomous Republic of Karakalpakstan. The survey showed that 52 per cent of respondents were not interested in growing trees on such land, preferring instead to leave their low-productivity land fallow or terminate their lease contracts with the State.

The surveyed farmers indicated that the absence of a long-term planning horizon for land use is the main reason for refusing to convert degraded cropland into tree plantations. The problem is that a farmer's legal status often changes and a land-lease contract can be annulled during new agrarian reforms or after failures to meet State production quotas. Frequent reforms aimed at reorganizing farms (in terms of their size and number) have created uncertainty over land tenure, hence farmers fear that the State may simply terminate their land leases. This, in turn, reduces incentives to secure the long-term investments needed for sustainable land use. Given that tree growing is a long-term undertaking, the frequently changes to land-use policies force farmers to make short-term conservative and pragmatic decisions that do not favour sustainable land management. Land is then used intensively to obtain short-term profits, as evidenced by one surveyed farmer who identified the barriers to change very clearly:

"I have a land plot of about 15 ha with very low yields. I usually plant cotton there; I do this because I am a cotton-growing farmer and I must produce cotton. I also have some other land plots that I have left abandoned due to their poor quality—they are not suitable for cotton. [On these fields] the soil is sandy, and the water I receive is too little. If someone starts planting trees so I can see what those trees are worth, and if I have permission and a government guarantee of long-term land use, I will allocate part of my poor lands for trees."

Experts contend that the inability to secure long-term benefits is the main obstacle to sustainable land management in the country. Only in 2020 did the Government abolish quotas for cotton production and sales, giving farmers on leased State land the option to grow other, more profitable crops. The few farmers who would be ready to undertake tree planting on their low-productivity lands cited potential profits from timber, fuelwood and fruit as would-be motivators. However, none of the respondents were familiar with the wider range of ecosystem services provided by such land uses, such as carbon sequestration for climate-change mitigation, land restoration, and so on.

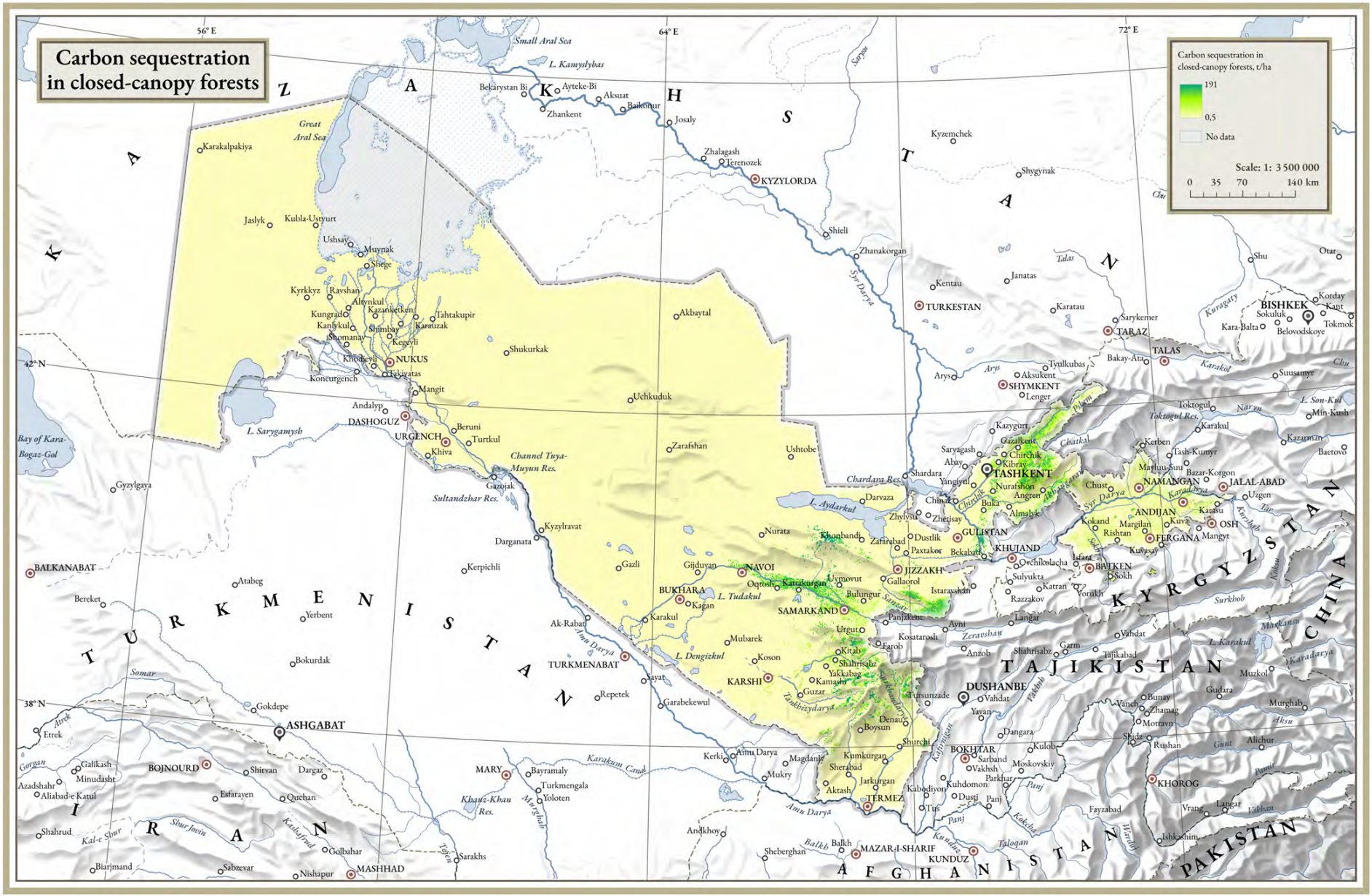
5.4. Response Measures

- To accurately assess and monitor Uzbekistan's forests, national legislation and statistics must be harmonized with data coming from global information resources, including the latter's terminology, concepts and definitions .
- Forest policy should focus equally on afforestation of the dried Aral Sea bed and on protecting forests in foothill and mountain areas that provide biodiversity and other ecosystem services.
- Forest certification under any internationally recognized scheme (FSC, PEFC, SBP) can be an important step towards harmonizing international and national forest management practices, including ensuring women's participation in forest policy.
- Afforestation on low-productivity and degraded lands can be a viable economic alternative to growing traditional crops, provided long-term land-use rights are guaranteed.



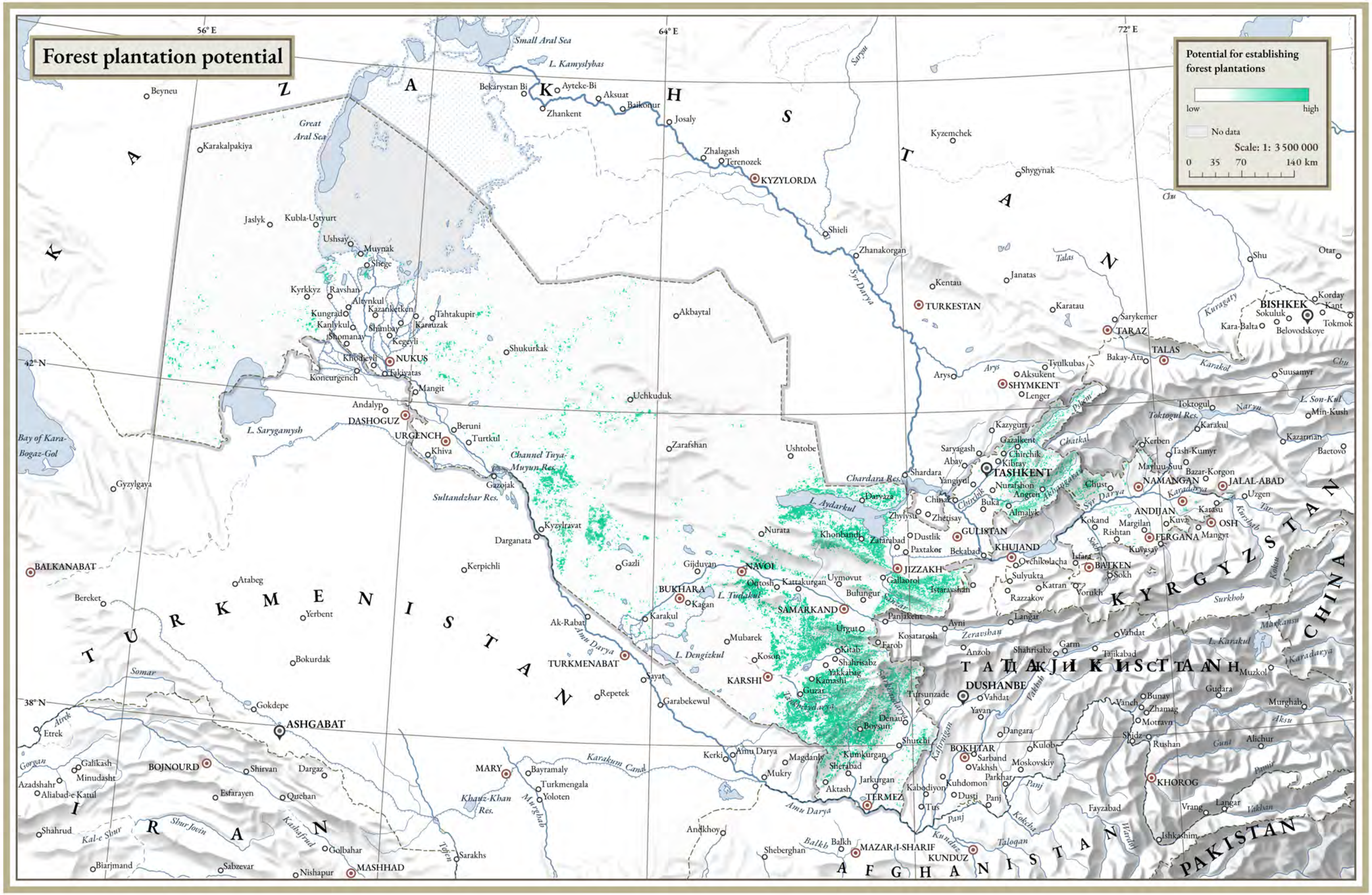
Mountains covered with grass and trees in Zaamin reserve

187 Djanibekov U. (2015) A Co-evolutionary Perspective on the Adoption of Sustainable Land Use Practices: The Case of the Amu Darya River Lowlands, Uzbekistan. 10.1007/978-3-319-12274-8_16.



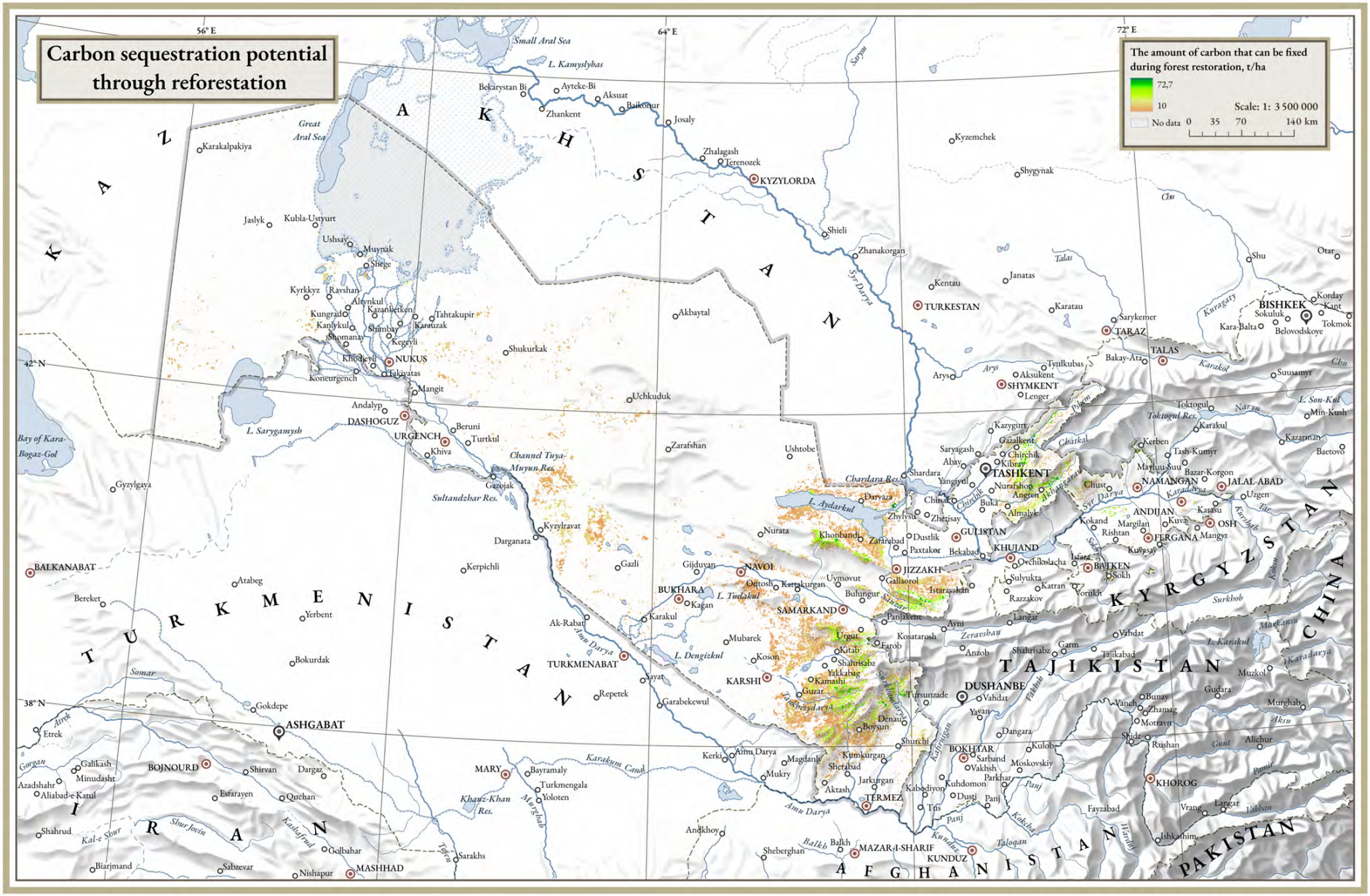
See note to the map ‘GHG emissions from closed-canopy forests’.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



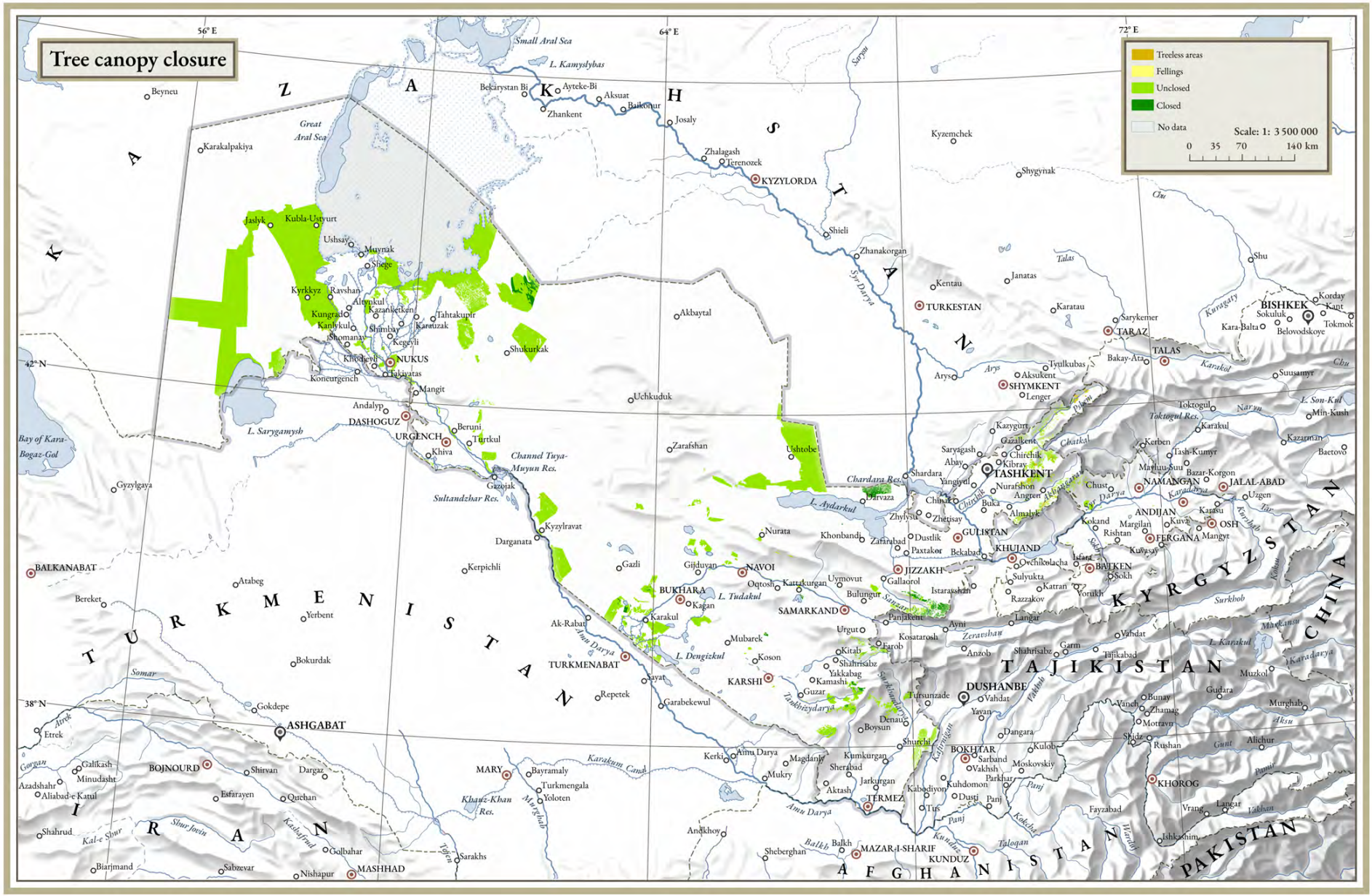
See note to the map ‘GHG emissions from closed-canopy forests’.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



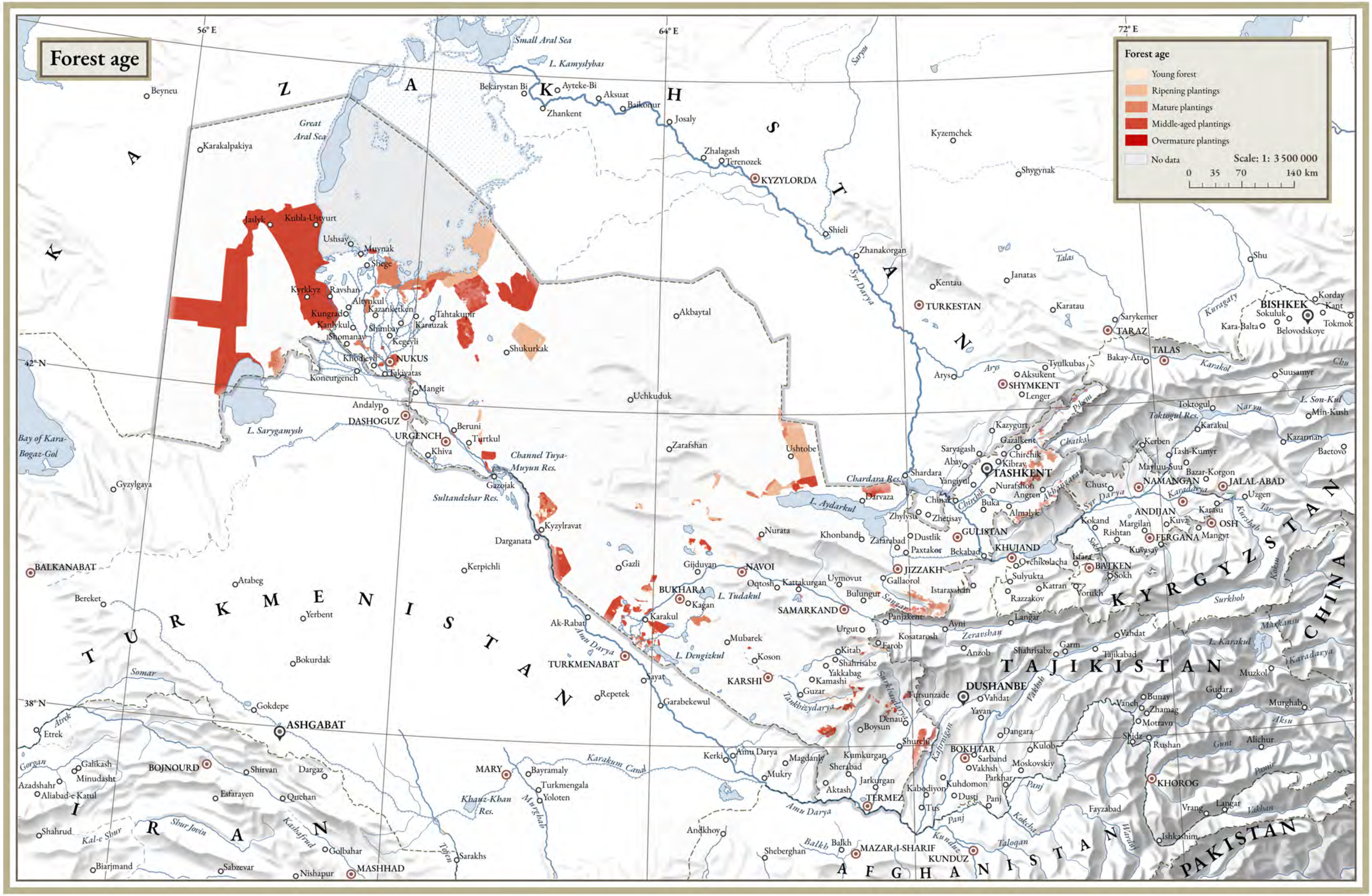
Harris, N.L., Gibbs, D.A., Baccini, A. et al. Global maps of twenty-first century forest carbon fluxes. Nat. Clim. Chang. 11, 234–240 (2021). https://doi.org/10.1038/s41558-020-00976-6

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



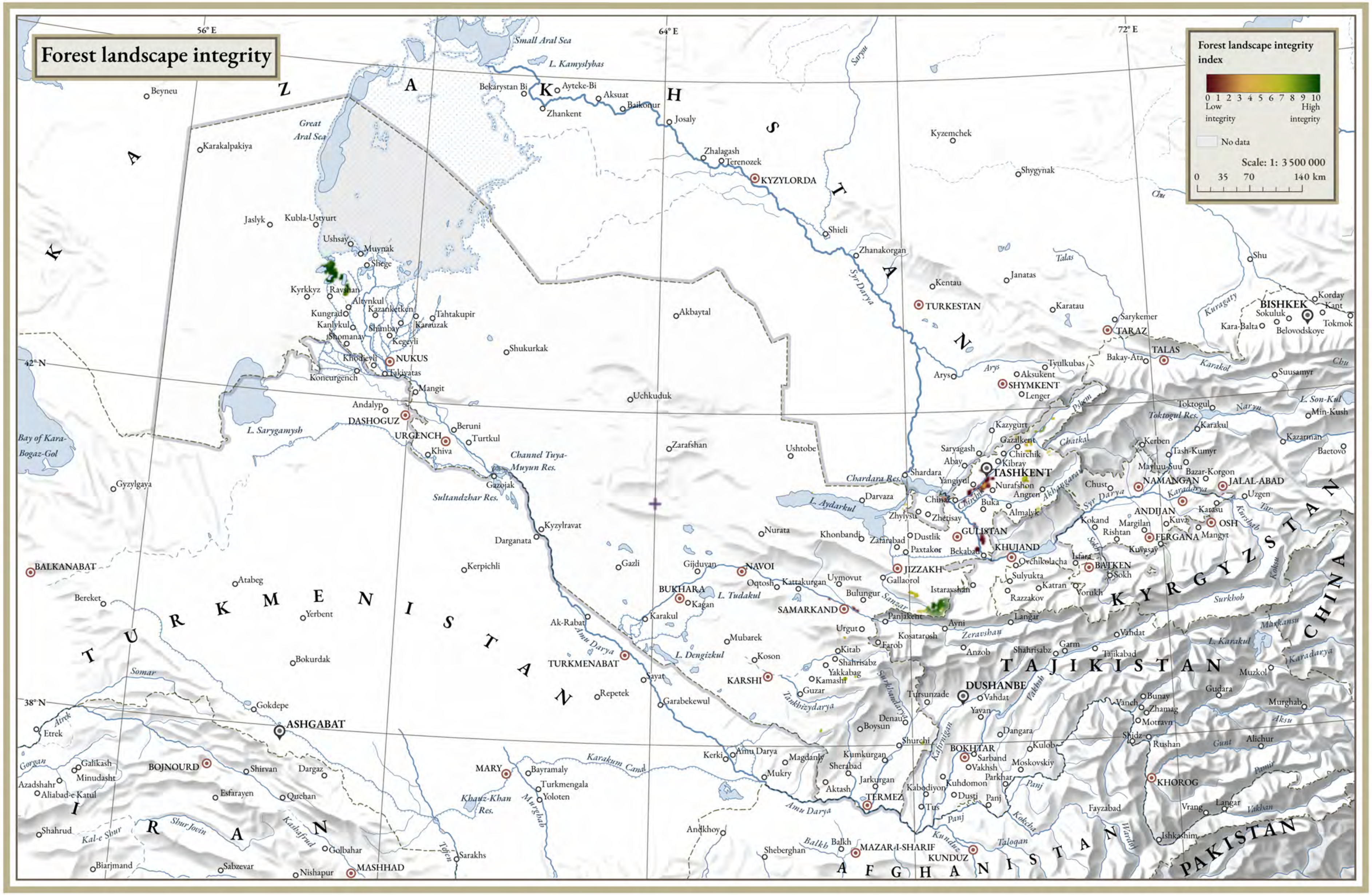
According to national coordinators.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



According to national coordinators.

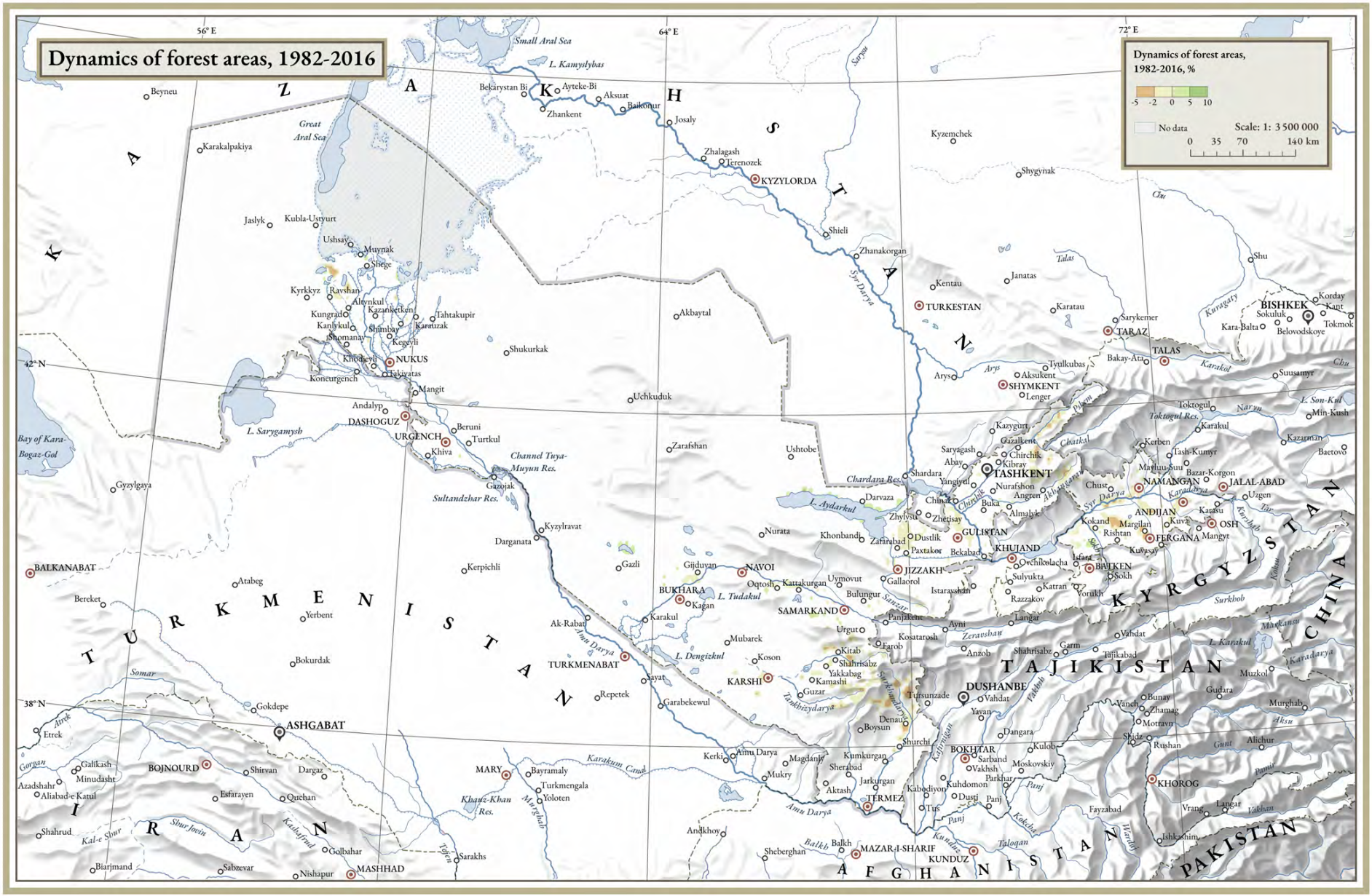
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



According to the Forest Landscape Integrity Index,[188] calculated using a combination of satellite data (such as global forest cover and loss maps), observed and predicted human impacts, as well as changes in forest connectivity. The index is calculated at a 300-meter resolution and covers the year 2019.

188 Grantham et al. (2020) Anthropogenic modification of forests means only 40% of remaining forests have high ecosystem integrity. Nat Commun. 11, 5978. 3

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.

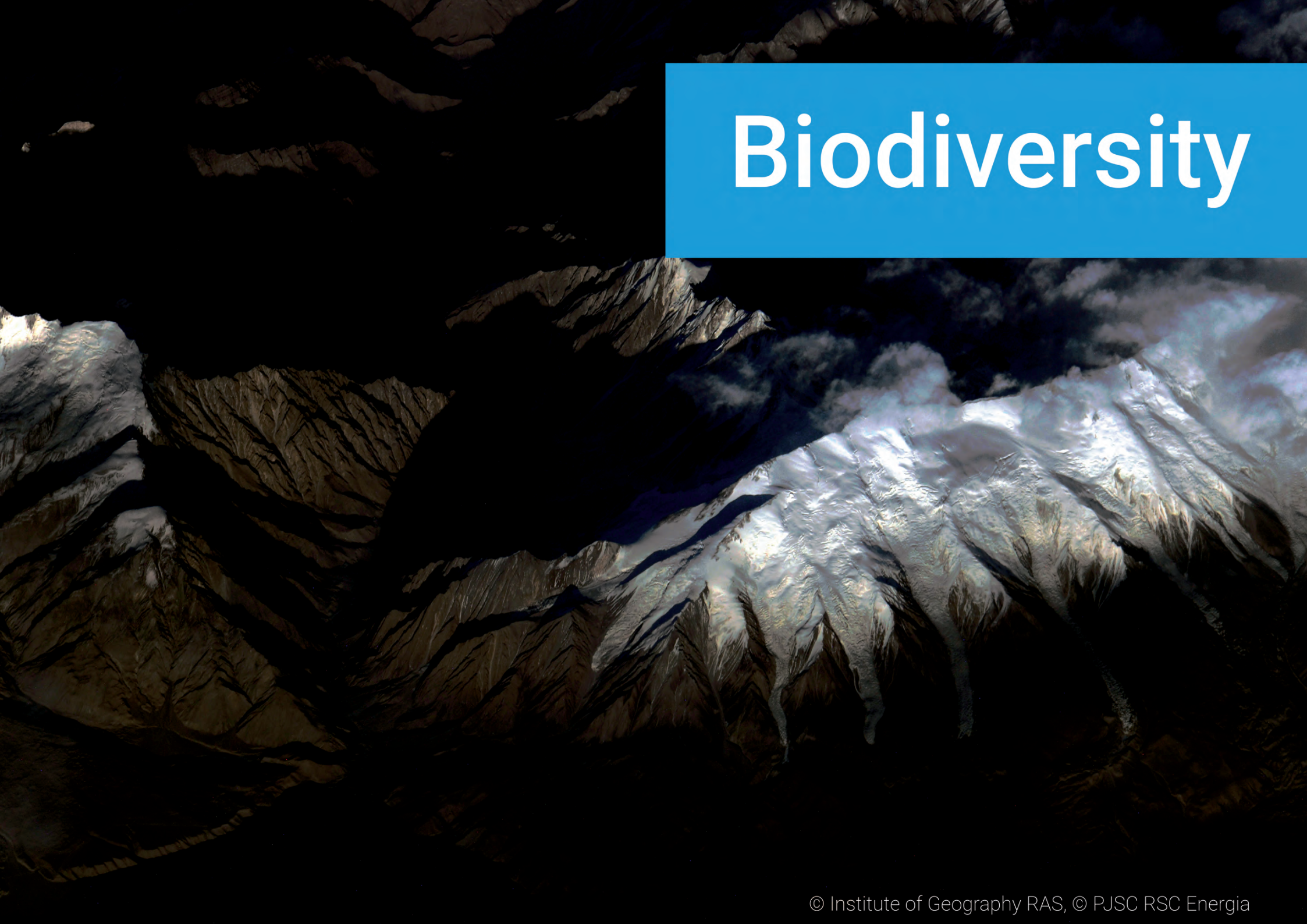


According to a study by Song et al.,[189] who used satellite images to produce a comprehensive record of global landscape change dynamics (at 300 m resolution) over the period 1982–2016.

189 Song et al.(2018) Global land change from 1982 to 2016. Nature. 560: 639–643.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.

Biodiversity



© Institute of Geography RAS, © PJSC RSC Energia



6.1. Key aspects

- Lands in conservation categories I to V occupied 9.5% per cent of the country's territory, which is below UNCBD Target 11.
- Of the 54 KBAs, only five fall entirely within the boundaries of protected areas of various categories
- Some 48.9 per cent of higher plant species listed in the Red Book of Uzbekistan, and 37.4 per cent of all national endemics, are safeguarded within the PAs of the highest categories (I-II).
- The IBA network in Uzbekistan includes all landscape types of the country (i.e., desert ecosystems, wetlands, desert-lake complexes, mountainous areas, desert lowlands and tugai forests) and is part of the global IBA network.

6.2. Overview

The vegetation and landscape of Central Asia are generally characterized by diversity conditioned by the arid climate, where changes in the hydrothermal regime due to the complex topography plays a significant role in species distribution. The region is home to thermophilic floras of the Paleogene and Neogene periods, as well as subtropical plants. Central Asia has two main ecological and geobotanical provinces, namely Turan and Kazakhstan, that differ in their climatic and hydrological conditions. The Turan province is similar to the Irano-Arabian region, with its characteristic subtropical features, while the Kazakhstan province is associated with a temperate climate zone.

According to the WWF Global classification, the Central Asian deserts are internationally recognized as one of the 200 most threatened ecoregions on the planet[190]. With its southern mountain spurs, Uzbekistan also belongs to the Central Asian Mountain System, which is included in the International Union for Conservation of Nature (IUCN) list of 36 global 'biodiversity hotspots'. This mountain system was included in the IUCN list in 2011 during its revision as they are experiencing significant anthropogenic impacts and contain a significant number of endemic species of higher plants (27 per cent), amphibians (44 per cent) and freshwater fish (19 per cent)[191].

Uzbekistan boasts a wide range of ecosystem types, from sandy deserts to coniferous forests *(see map 'Physical - geographical regions')*. Approximately 85 per cent of the country's area is lowland desert ecosystems that support psammophytes, including saxaul, on these lowland's sandy soils (Kyzylkum), ephemeral-wormwood communities grow on clay soils, such as is found on the Ustyurt Plateau, while halophytes can be found on solonchak soils of the Aralkum Desert. To the south of the country, the lowlands transition to foothill and low-mountain forb-grass shrub steppes with loess and loess-clay soils. In the mid- and highlands, mountain steppes and mountain meadows, there are common, albeit sparse, juniper and maple woodlands as well as coniferous forests, the latter being found on western spurs of the Tien Shan Mountains. Finally, there are tugai forests that are common in river valleys *(see map 'Landscape types')*. Thus, in a predominantly arid climate, the presence of altitudinal layers that redistribute precipitation creates a rather diverse, and in places even contrasting, landscape structure *(see map 'Landscape zonation')*.

In the flat, extra-arid zone, which receives approximately 100 mm of precipitation per annum, solonchaks, sandy and gypsum deserts as well as riparian vegetation in river valleys predominate.

Each ecosystem type in the lowland arid zone has a unique flora, consisting of species with a very broad ecological range or, conversely, highly specialized in their habitats. In Kyzylkum, plants such as calligonum, saxaul, tumbleweed and sand acacia (all highly specialized) are common and can be found colonizing desert sandy soils and even dune sands. Other arid zones, such as the Ustyurt deserts, are also characterized by sparse vegetation, dominated by barnyard grass and wormwood on loamy, gypsum-rich and/or saline soils *(see maps 'Vegetation formations'; 'Vegetation types')*.

190 Olson D. M., Dinerstein E. (2002) The Global 200: Priority ecoregions for global conservation. Annals of the Missouri Botanical Garden. 89 (2): 199 –224.
191 Mittermeier R.A. et al. (2004) Hotspots Revisited. Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions. Cemex. 200 P.

While Sarsazan conicalis and glasswort have colonized the salt marshes, the Golodnaya and Karshi steppes, formed on alluvial and loess-like deposits, are populated by semi-desert wormwood-saltwort communities on light gray soils. Uzbekistan's river valleys are, as noted above, home to tugai communities that grow on marsh and meadow-takyr soils creating ecosystems characterized by dense tree-shrub and herbaceous vegetation, including poplars, willows and narrow-leaved oleaster. The tugai of the Aral Sea Region, despite its small area compared to other landscape types within the republic, play a significant role in maintaining the diversity of mammals and are home to individual populations, for example, the main Central Asian population of Bukhara deer are located here, therefore, these tugai are classified as a separate zoogeographic region *(see map 'Zoogeographical regions')*.

The foothills, which receive 300 to 400 mm of precipitation annually, serve as a transition zone between the vegetation of the plains and the mountainous areas. Herbaceous plants and subshrubs predominate these foothills, with virtually no trees present. Two altitudinal tiers can be distinguished in the foothills: the lower adyr, with elevations between 600 and 900 metres above sea level, and the upper adyr, with elevations ranging from 900 to 1,200 metres above sea level. The lower adyr has a more gentle topography, covered with steppe vegetation dominated by ephemeretums *(Phlomis, Cousinia, Ferula, Katran, and Eremurus)* and ephemerals *(Artemisia annua)* growing on gravelly serozem soils. These plant communities likely formed in place of the sparse pistachio woodlands that previously grew there but which remain now only in small patches in hard-to-reach areas.

The upper adyr is a dry, mixed-grass steppe on dark serozem soils and is characterized by a more rugged topography. This zone is also characterized by ephemeral plants, including grasses such as couch grass *(Elymus repens)*, bulbous barley *(Hordeum bulbosum)* and dactylus, as well as dicotyledonous herbs such as elecampane and marshmallow. Upland xerophytes are common in the upper Adyr, including acantholimon and milk vetch, as well as numerous essential oil and medicinal plants, such as perovskia, larkspur, St. John's wort, oregano and creeping thyme. Shrubs grow on the rocky slopes, even those devoid of soil cover, including some species of almond, rose hips and curly grass. Other highly specialized representatives of the Lamiaceae and Astriales have colonized fissures in the rocks[192].

192 Sixth National...,2018.



In the cotton field

In the lowlands, which exist between 1200 and 1800 m above sea level, various ephemeral species, forb and subshrub formations grow on serozem soils. This zone is distinguished by a combination of typical dry-steppe communities, which include a variety of herbaceous species (sage, ziziphora, St. John's wort, rhubarb and sorrel), with sparse fruit- and nut-bearing forests of juniper (archa), almond, pistachio, apple, cherry and cherry plum. It is believed that the highlands of the Tashkent, Kashkadarya and Surkhandarya regions were the origin of many modern-day cultivated fruit plants. Subtropical species, such as pomegranate, fig and persimmon can also be found in these lowlands.. Other tree species common to the temperate zone occupy wetter habitats: birch, poplar, hawthorn, and willow. Shrub species include rose hips, honeysuckle, and barberry.

The immediately obvious characteristics of the landscape cover of the mid-mountain areas, found between 1800 to 2500 m above sea level, is the absence of ephemeral plants, the predominance of shrub and woody vegetation as well as the transition from serozem soils to brown forest soils. Among the shrubs, rose hips and ephedraria predominate, while the woody species are different junipers. Open rocky surfaces are colonized by mountain xerophytes, including acantholimon, oxytropa, gypsophila and ephedra. Mountain steppes form a belt at altitudes of 2000 and 2500 meters.

Existing at altitudes above 2500 metres, the highlands are comprised of alpine and subalpine meadows and steppes. Here, mixed-grass meadows with perennial low-growing formations and upland cushion xerophytes predominate. In the upper dzhailau (summer pastures), sparse steppe vegetation has taken hold, dominated by Wallisian fescue and alpine xerophytes. Dwarf juniper (Turkestan juniper) and low-growing shrubs are common, as are mixed-grass meadows with essential oil and medicinal plants.

A general pattern in Uzbekistan is the gradual increase in biodiversity as one transitions from desert to mountain landscapes. This is clearly demonstrated by the distribution of bird and mammal species across the country *(see maps 'Bird species diversity'; 'Mammal species diversity')*, a pattern that reflects the gradual increase in habitat diversity *(see map 'Biodiversity Habitat Index')*.

Plants and animals have always served as important resources for local populations, who gathered useful plants and hunted birds and animals *(see map 'Useful plants')* to meet their daily needs. The spatial distribution of these biological resources has its own characteristics and, for example, the habitats of commercially important bird and mammal species gravitate toward the desert landscapes of the Aral Sea region and its wetlands *(see map of 'Game birds')*. In the Aral Sea Region, tugai forests occupy no more than 69,000 hectares

(hundredths of a percentage of the Republic's territory), however, they are home to 200 bird species, more than 62 per cent of the region's total avifauna (319 species), including 25 game bird species out of the regional total of 50.

Many mammal and bird species in Uzbekistan are listed in the Red Book due to their high commercial and domestic use value[193]. Ungulates are still traditionally hunted and the Red Book's 'game and commercial' category includes, for example, the endangered markhor, Siberian ibex and Kyzylkum sheep *(see map 'Game and commercial animals')*. Hunting in Uzbekistan often requires a licence and both the cost thereof and the species covered can, at times, come to the fore. The most recent iteration of the hunting law (2006) added the ibex to the list of huntable species and a story on permitting the hunting of the endangered markhor in 2024, where the cost of a hunting licence was US $100,000, was widely discussed in the Uzbek media[194]. Interestingly, the Convention on International Trade in Endangered Species, which Uzbekistan became the first country in the region to sign in 1997, lists the markhor in Appendix I, meaning it is an endangered species and trade in it is strictly prohibited. As an aside, and while perhaps unrelated to this incident, the UN General Assembly decided to declare May 24 as Markhor Day in 2024. For the other ungulates in the country, they are also subject to poaching, however, the exact extent of issue is unknown.

Another factor threatening biodiversity in the country is the fragmentation and loss of natural habitats. Approximately 20 per cent of Uzbekistan's territory has experienced significant anthropogenic impacts, leading to a significant reduction in the ranges and abundance of many native plant and animal species *(see map 'Biodiversity Intactness Index')*.

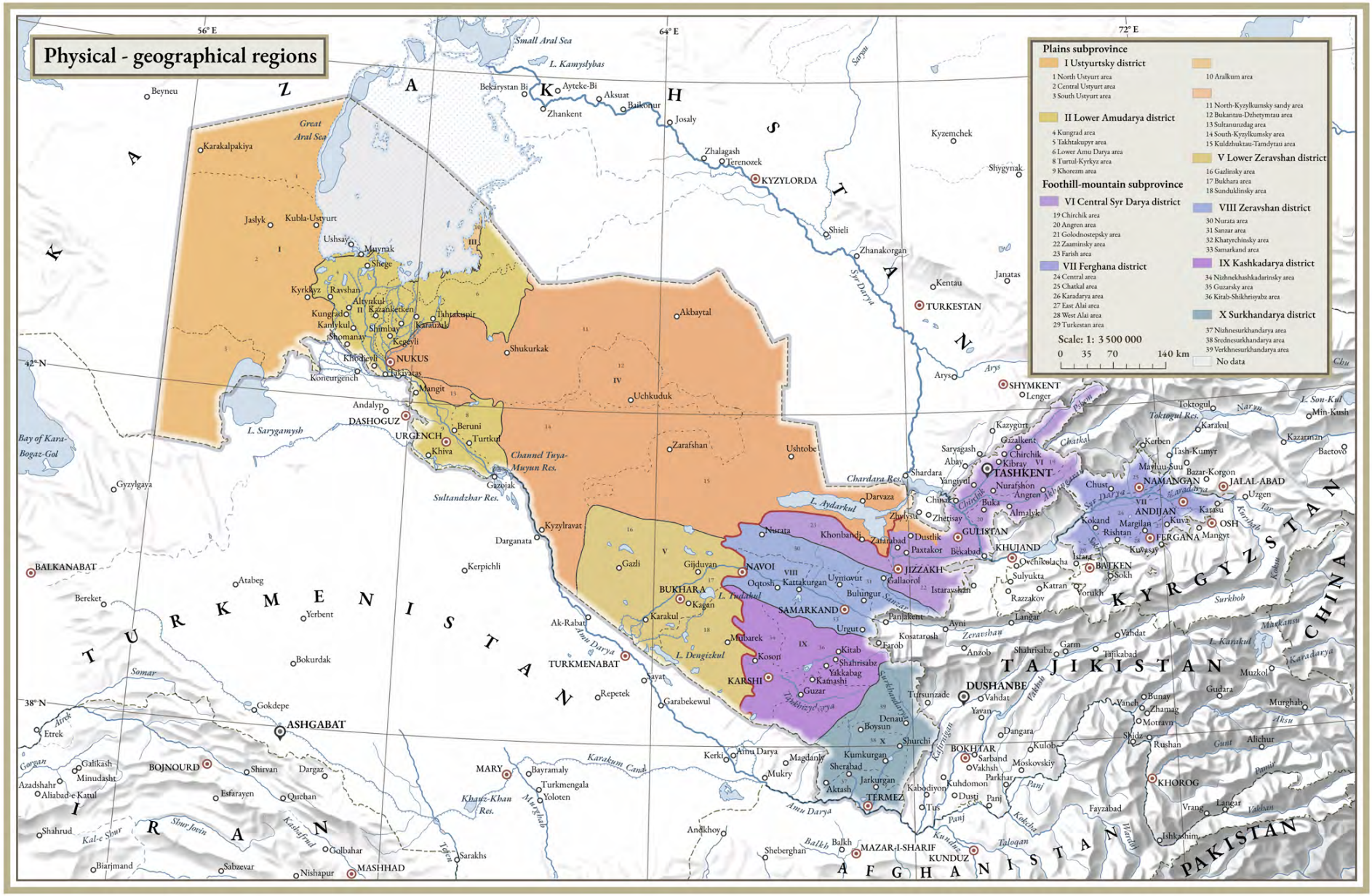
Accordingly, the greatest environmental impact can be achieved by focusing environmental policy on the most transformed areas that are under ongoing anthropogenic impact *(see map 'Conservation Value Index')*. The most problematic regions include the Fergana Valley as well as the Zaravshan, Kashkadarya and Surkhandarya river valleys. However, the anthropogenic impacts in these regions cannot compare to the dire transformation of natural ecosystems that has occurred in the Aral Sea Region due to excessive water use drying the Aral Sea. In this region, unsurprisingly, it is the biodiversity of the Aral Sea itself that has undergone the most dramatic changes.

193 Bykova et al. (2020) Brief overview of the status of rare ungulates in Uzbekistan. Ecosystems of Central Asia: research, conservation, rational use: Proceedings of the XV Ubsunur International Symposium (Kyzyl, July 5-8, 2020). ed. by Ch. N. Sambyl. - Krasnoyarsk: Offset Publishing House: 199-205. (in Russian)

194 Трофейная охота на краснокнижных животных | uzbloknot.com

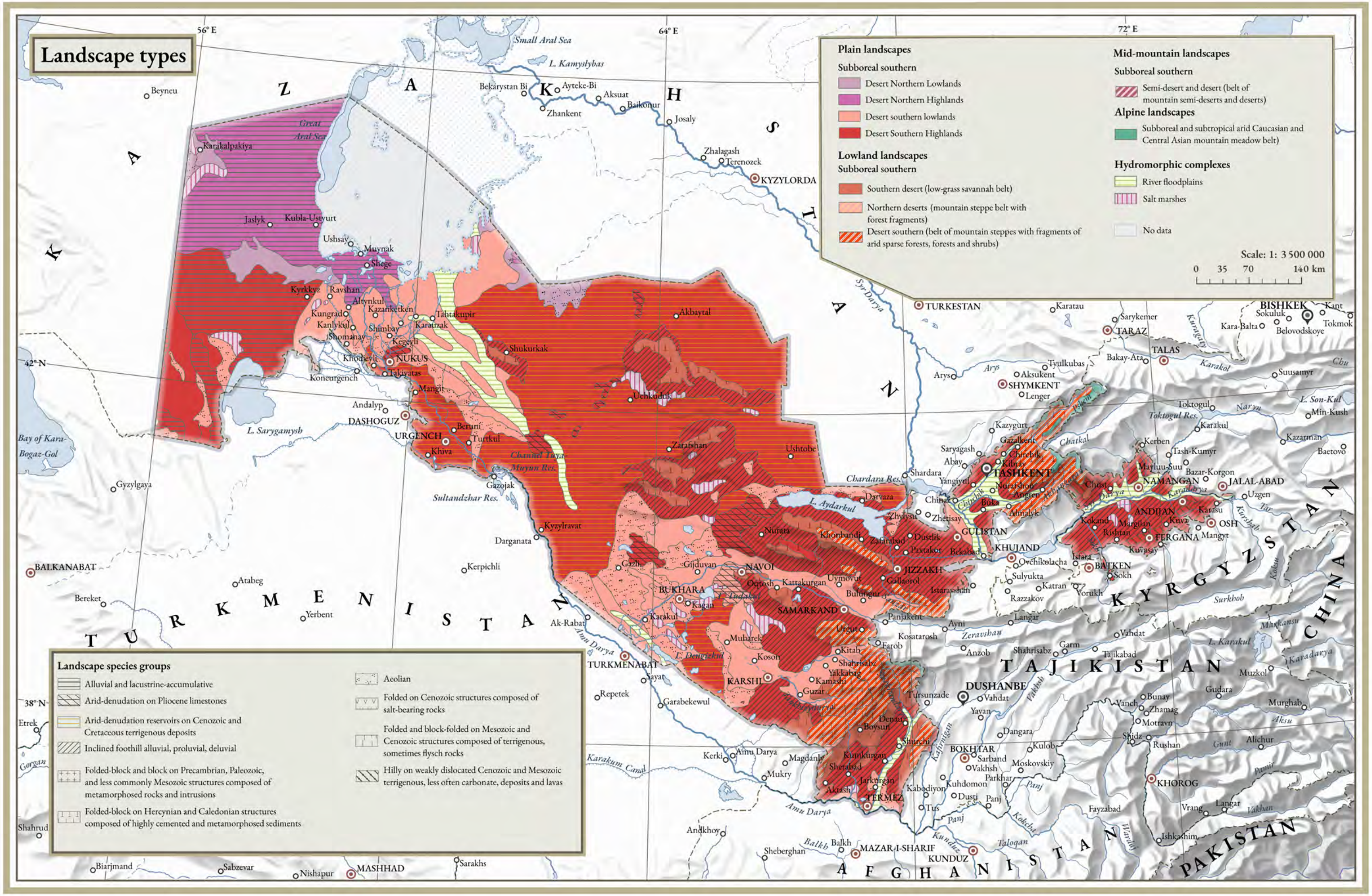


An image from the ISS



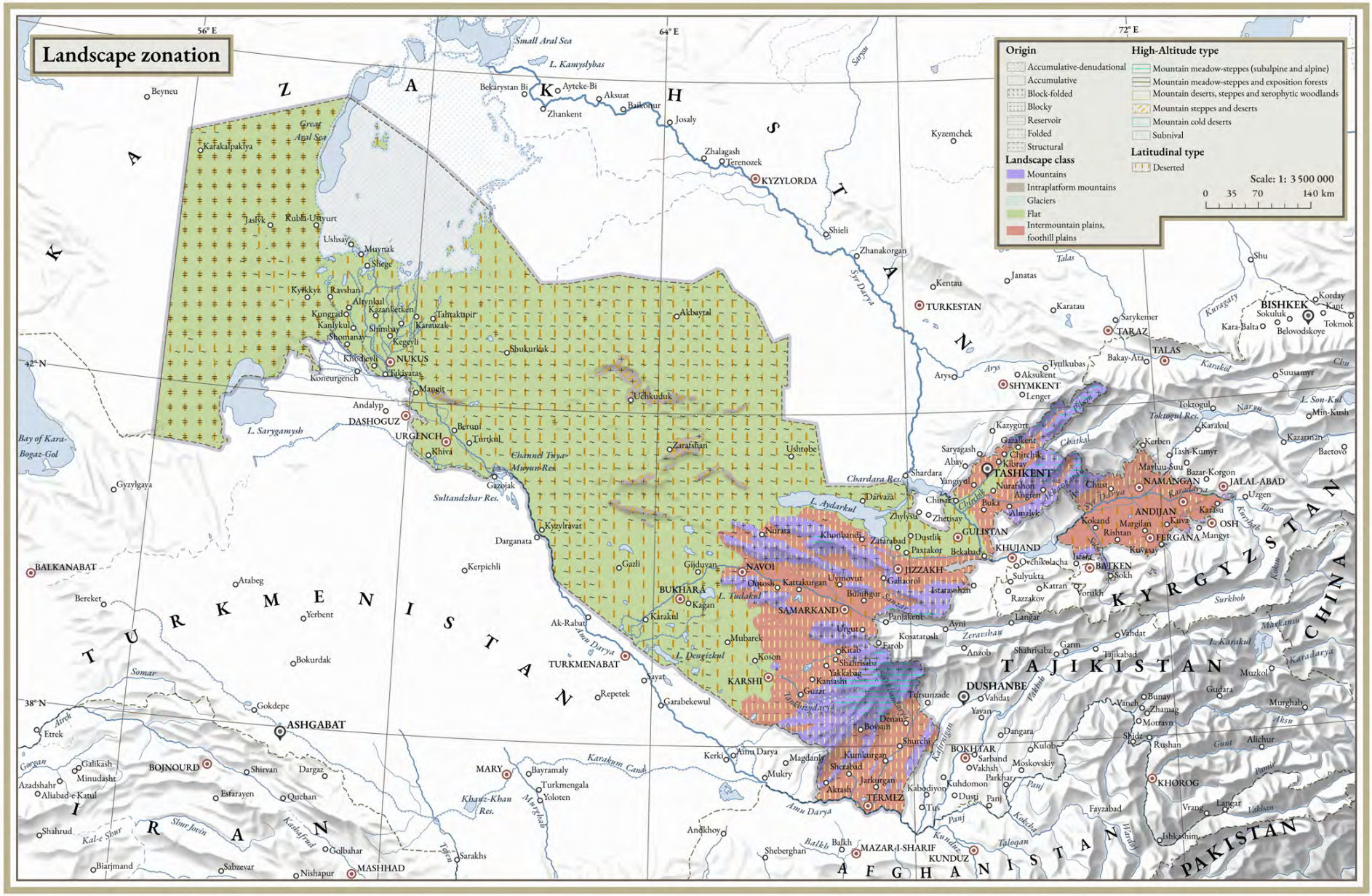
Atlas of the Uzbek Soviet Socialist Republic (1963) Tashkent-M.: Academy of Sciences of the Uzbek SSR, GUGK.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



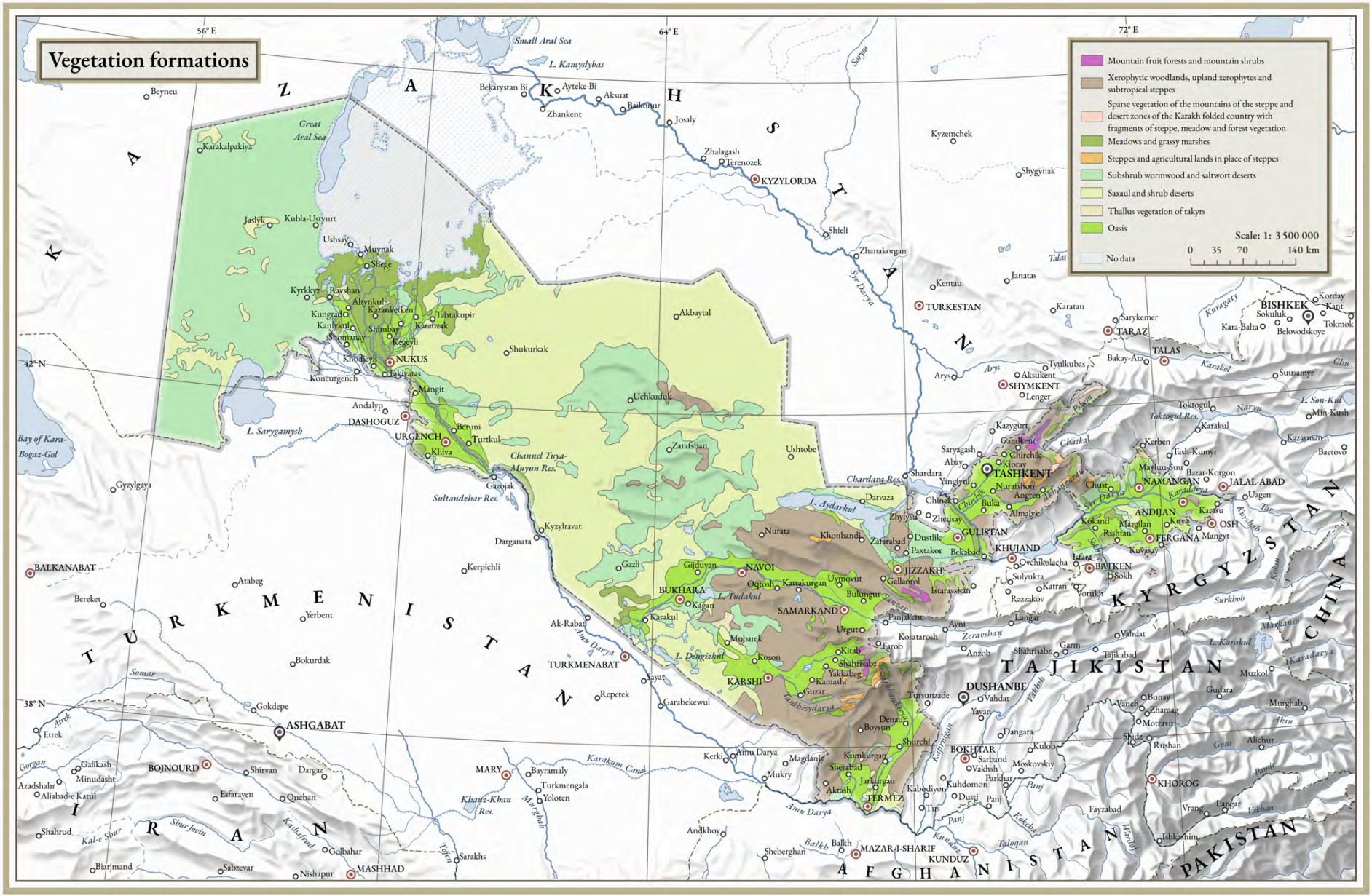
Landscape map of the USSR: for higher education institutions / compiled and prepared for publication by Faculty No. 10 in 1988; ed. B. N. Kostyuk; special content developed by staff of the Research Institute of Geography of Leningrad State University: A. G. Isachenko, Doctor of Geographical Sciences [and others]; responsible ed. A. F. Voronina. - 1:4,000,000.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



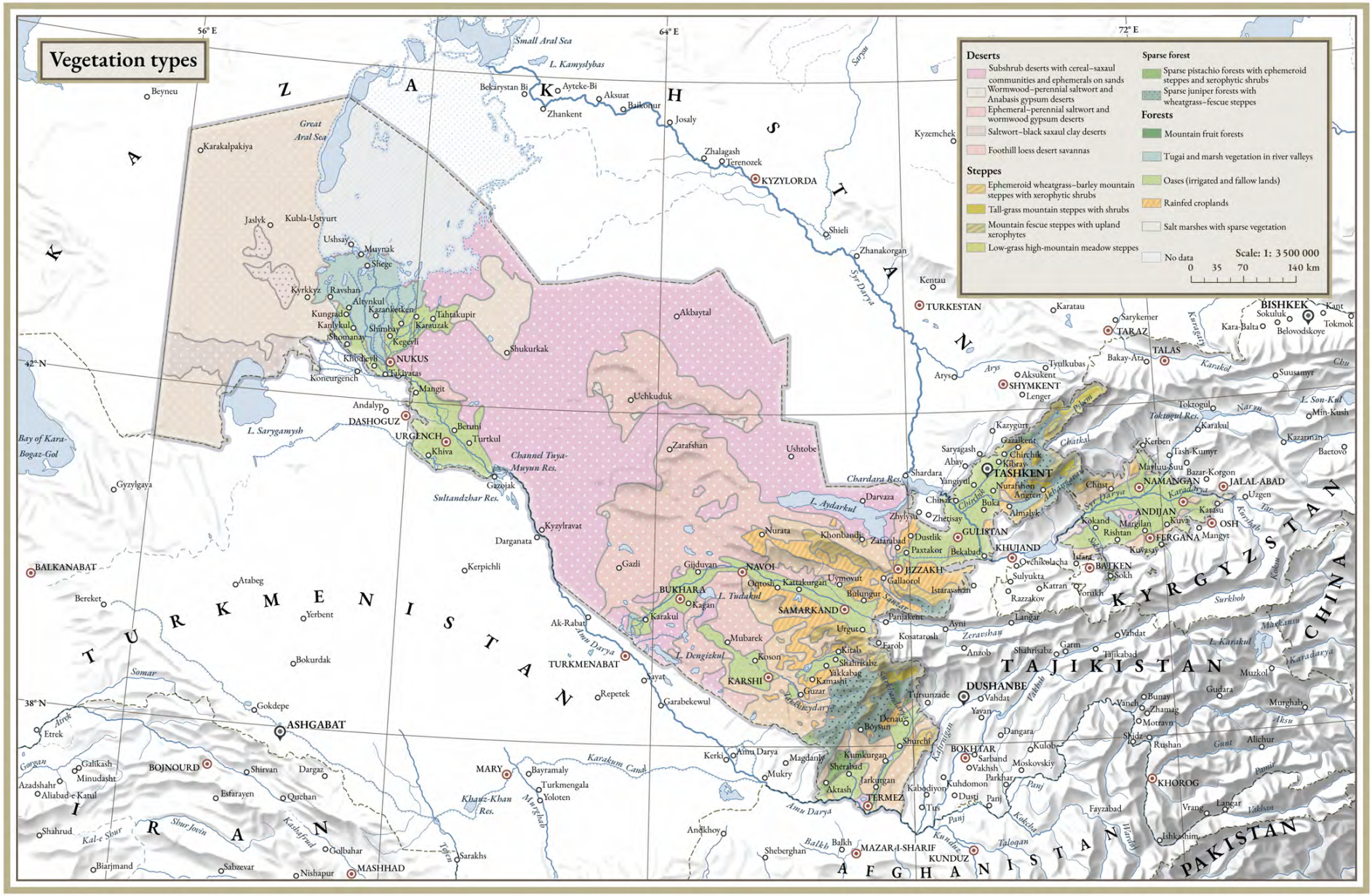
Landscape map of the USSR: 1980 / compiled by PGO Gidrospetsgeologiya; editor-in-chief I. S. Gudilin; editorial team: K. F. Belyakova, N. A. Bogolyubskaya, A. E. Gavrilyuk [et al.]; compiled by: M. S. Anuchin, I. S. Balmusova, S. V. Beletskaya; designed and printed at the Leningrad cartographic faculty of VSEGEI; cartographer V. A. Kalinin; hydrogeologist I. D. Chikina. - 1:2 500 000

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



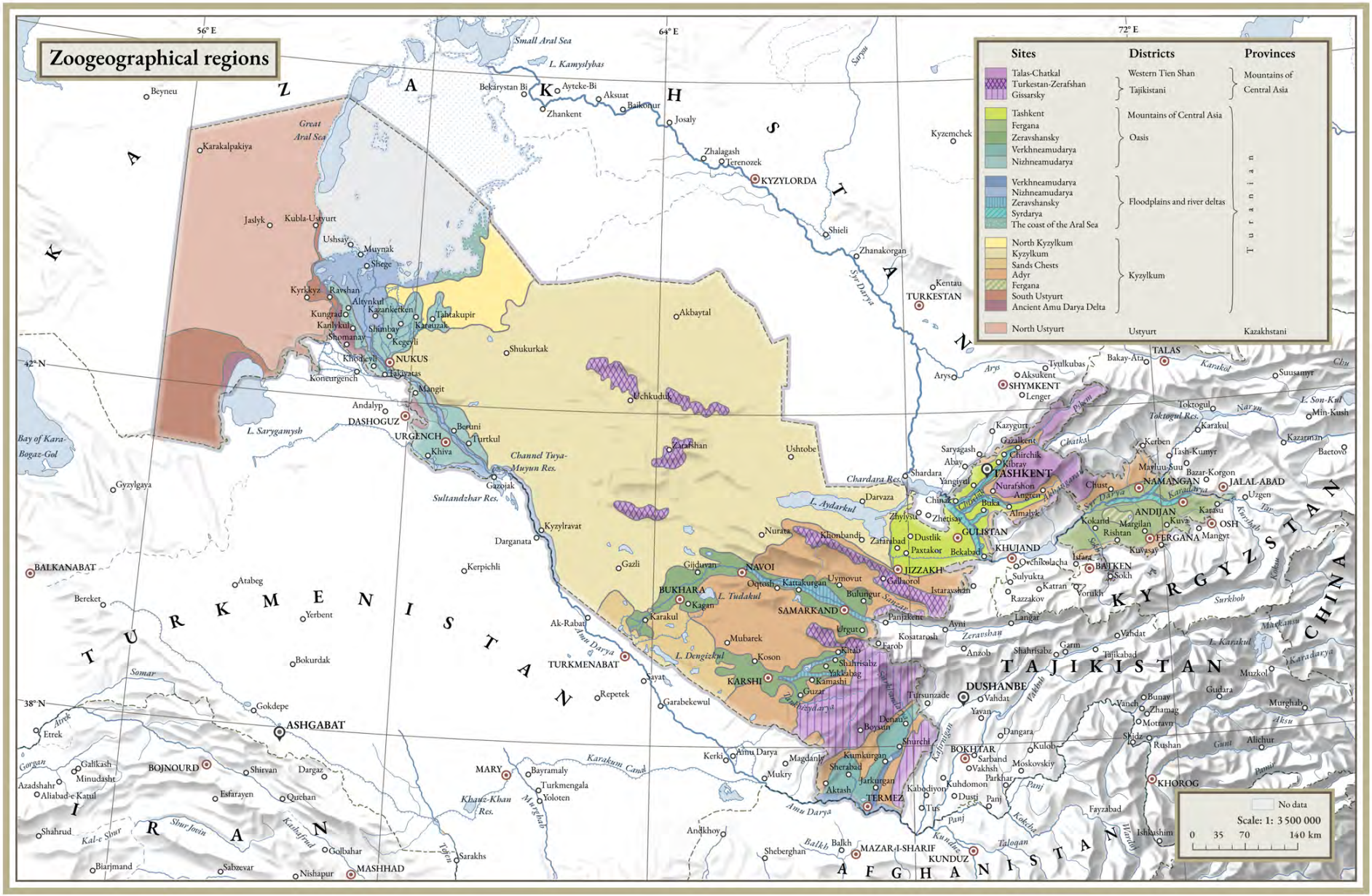
Geobotanical map of the USSR / comp. in 1954 B.N. Gorodkov, T.I. Isachenko [and others]; under the leadership and ed. E. M. Lavrenko and V. B. Sochavy. - 1:4 million

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



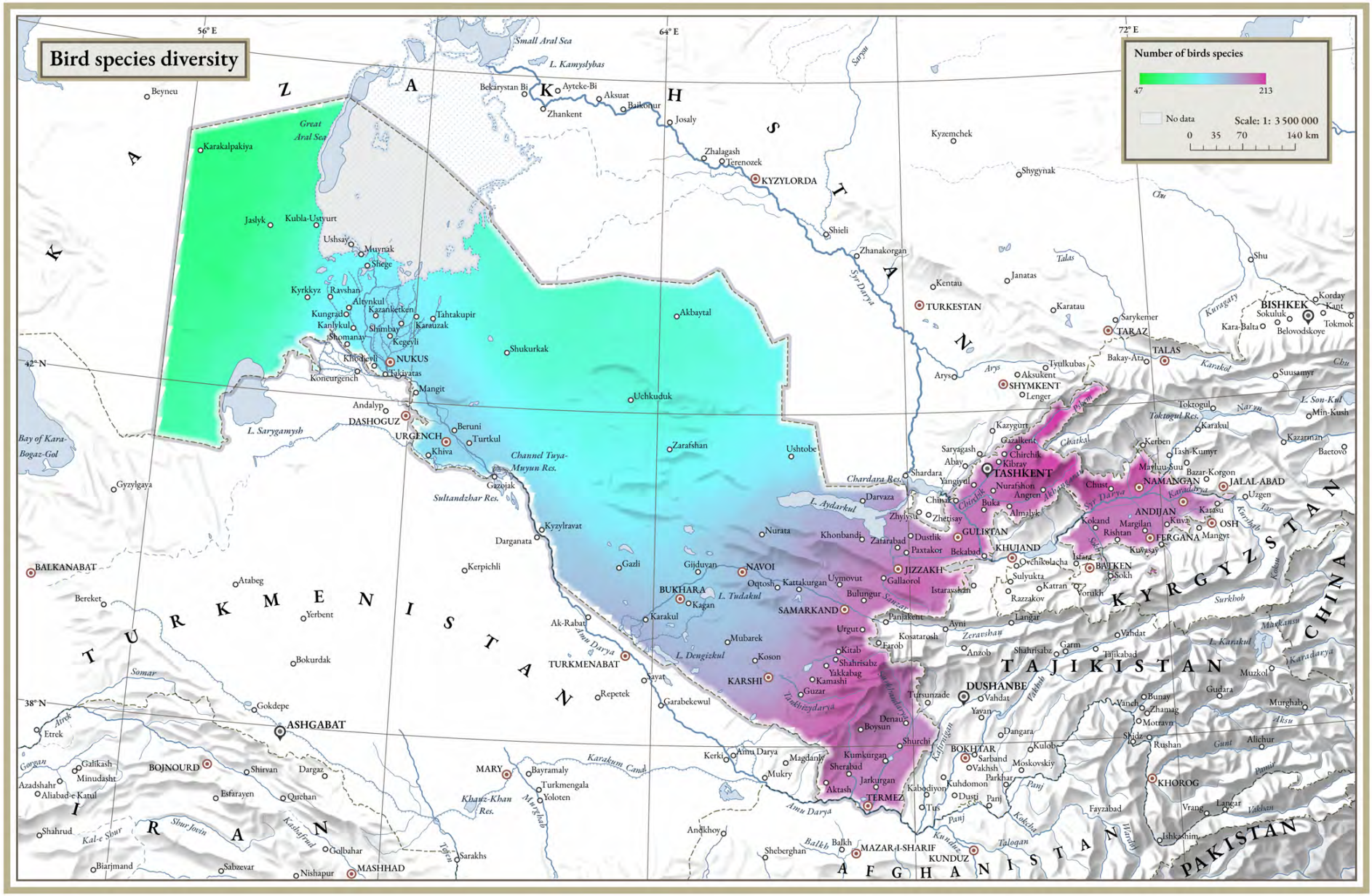
Atlas of the Uzbek Soviet Socialist Republic (1963) Tashkent-M.: Academy of Sciences of the Uzbek SSR, GUGK.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



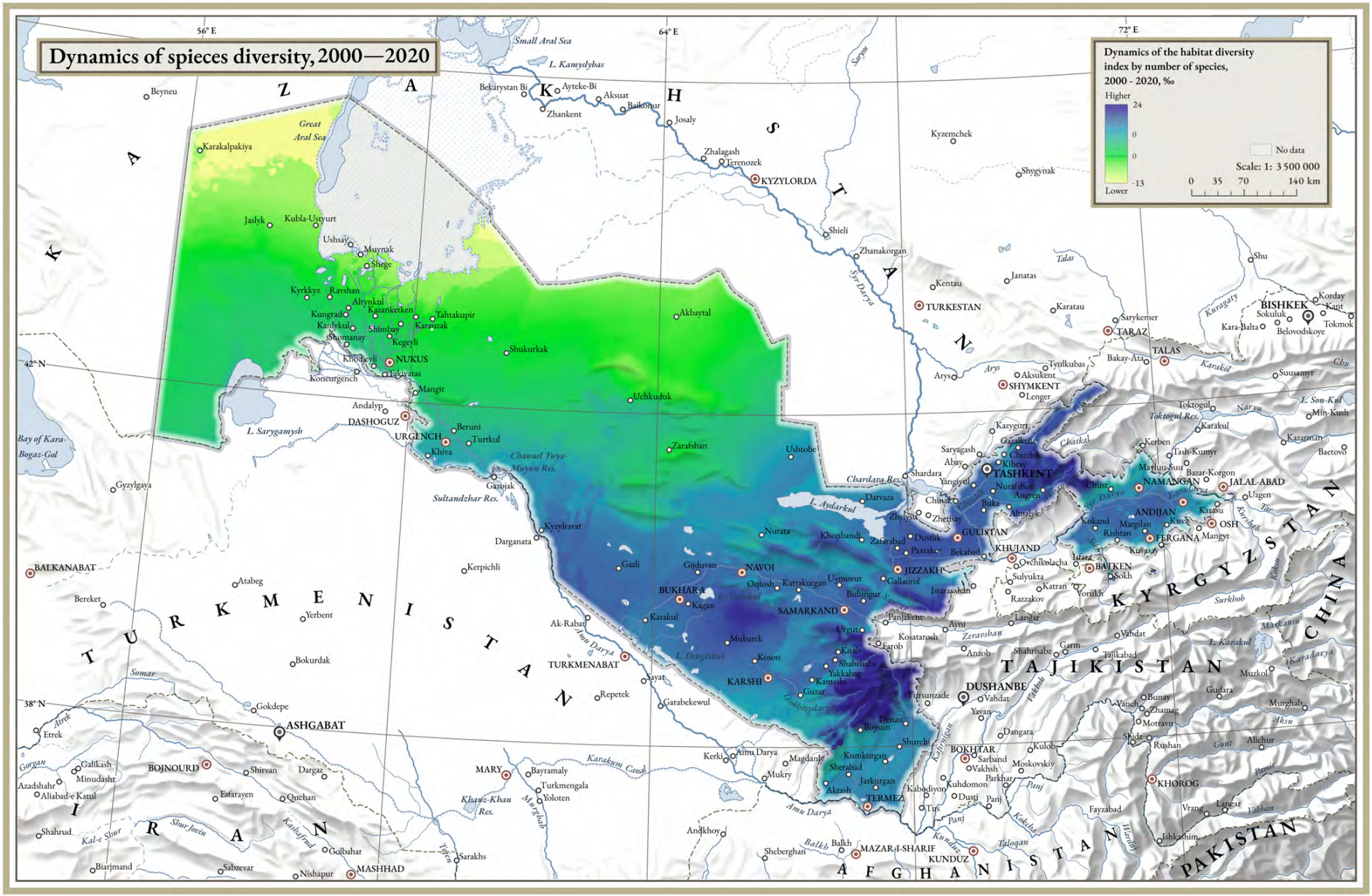
Atlas of the Uzbek Soviet Socialist Republic (1963) Tashkent-M.: Academy of Sciences of the Uzbek SSR, GUGK.

The original scale of the map is 1:3 500 000. The map image has been modified for page



Based on data from BiodiversityMapping.org (based on IUCN/BirdLife/NatureServe habitats). The data acquisition technology is the integration of binary rasters of species presence in an equal-area 10x10 km grid, excluding extinct, introduced, and «random» records. Resolution is 10x10 km; temporal extent is the current state (2017–2018).

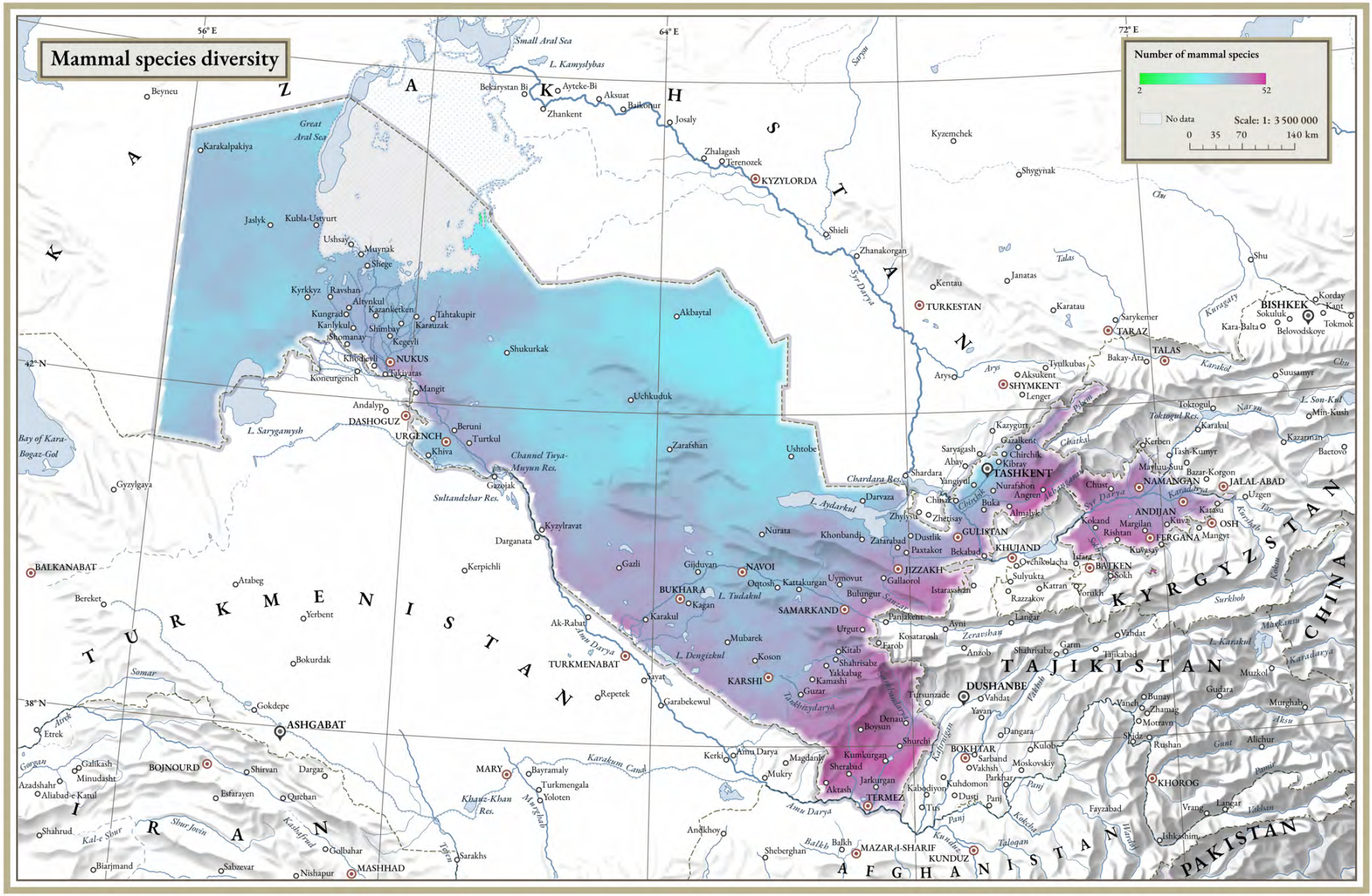
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Based on BHI v2 data, Proportion of Species Maps[195] is a global product with a resolution of up to 30 arc seconds (approximately 1 km), covering the period from 2000 to 2020 (in 5-year increments). The model estimates the Biodiversity Habitat Index o based on the number of species present in ecosystems (landscapes), taking into account their area, connectivity and integrity.

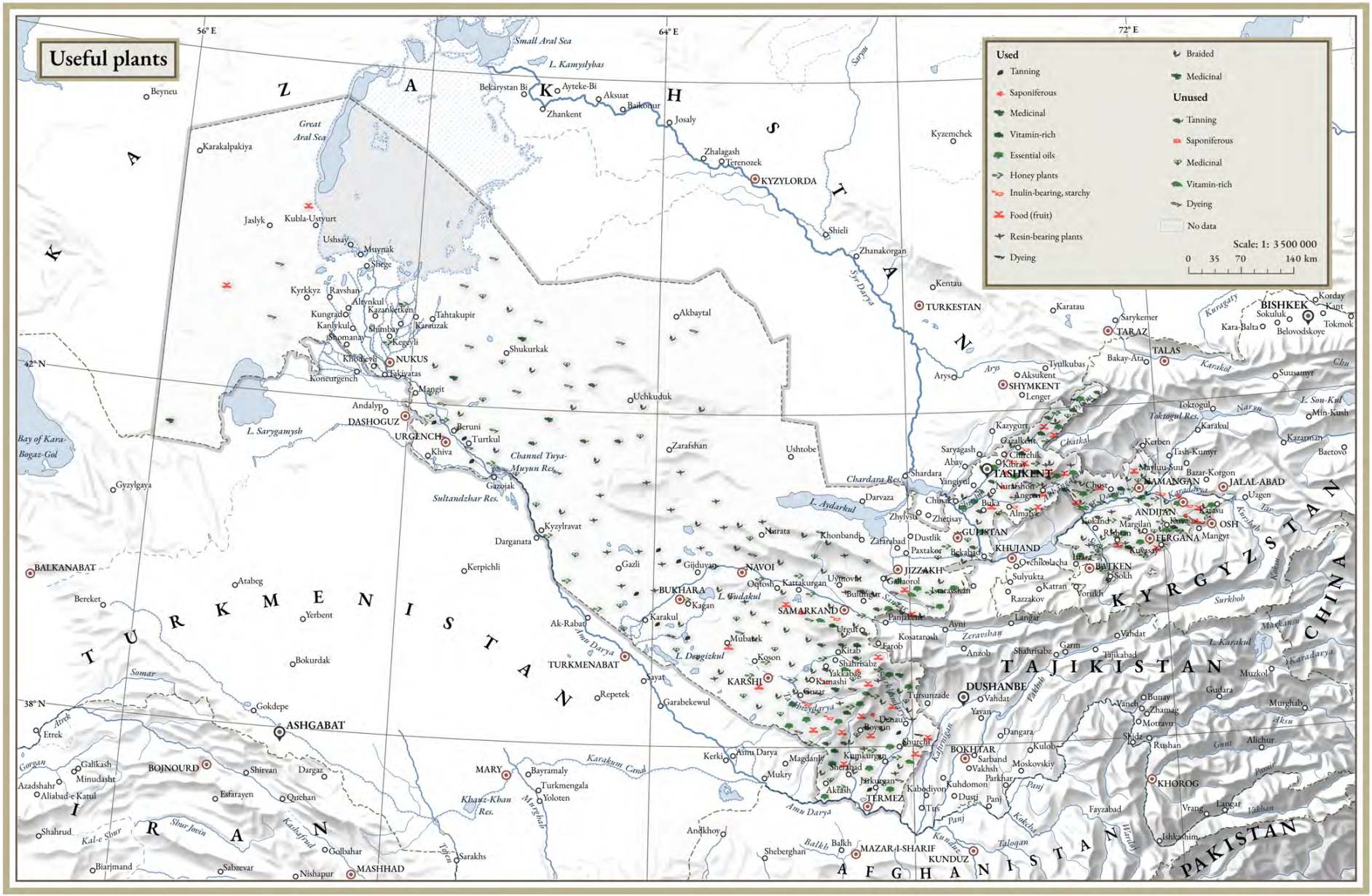
195 Harwood et al. (2022) BHI v2: Biodiversity Habitat Index: 30s global time series. v1. CSIRO. Data Collection. https://doi.org/10.25919/3j75-f539

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



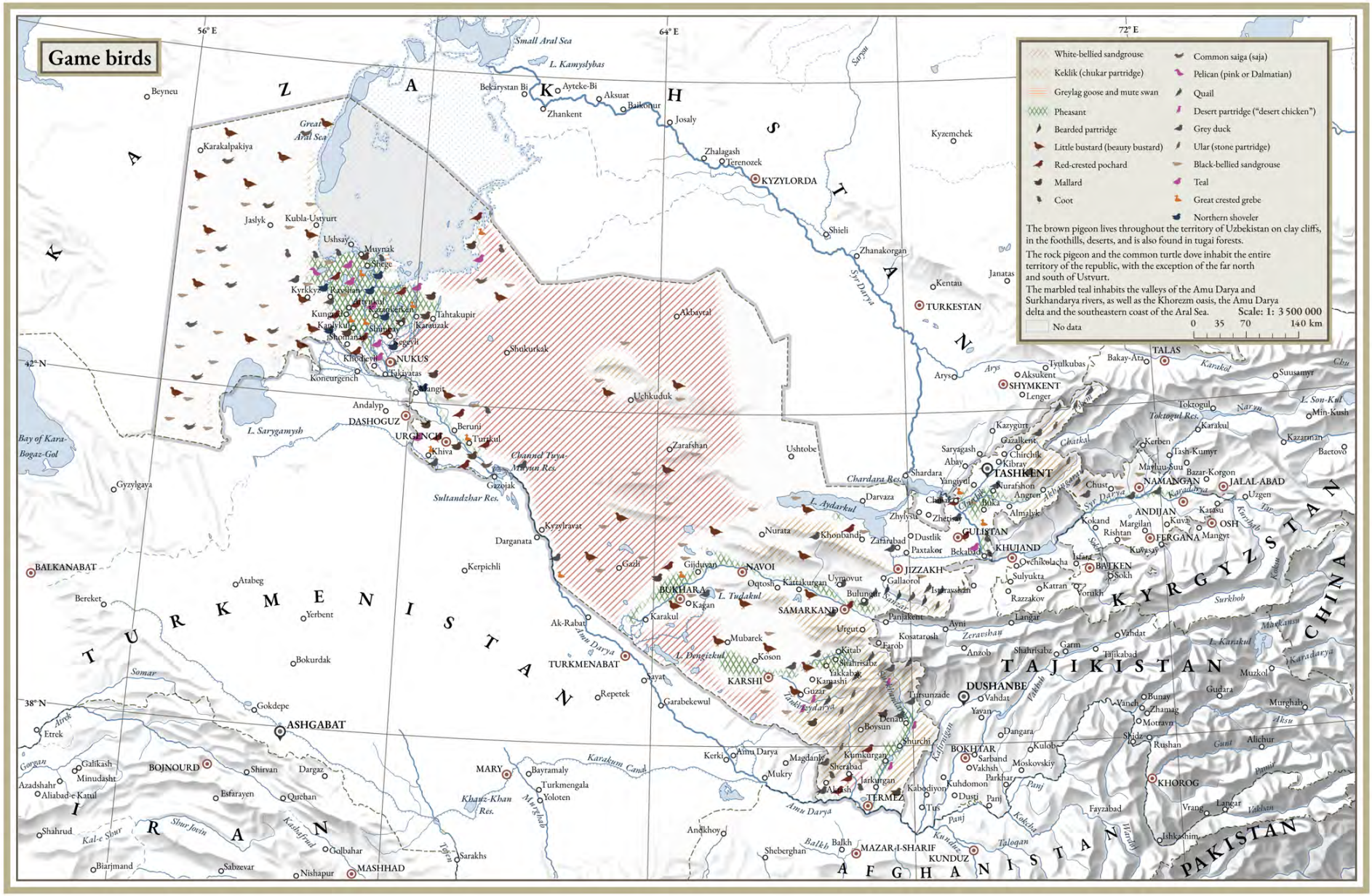
Based on data from BiodiversityMapping.org (based on IUCN/BirdLife/NatureServe habitats). The data acquisition technology is the integration of binary rasters of species presence in an equal-area 10x10 km grid, excluding extinct, introduced, and «random» records. Resolution is 10x10 km; temporal extent is the current state (2017–2018).

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



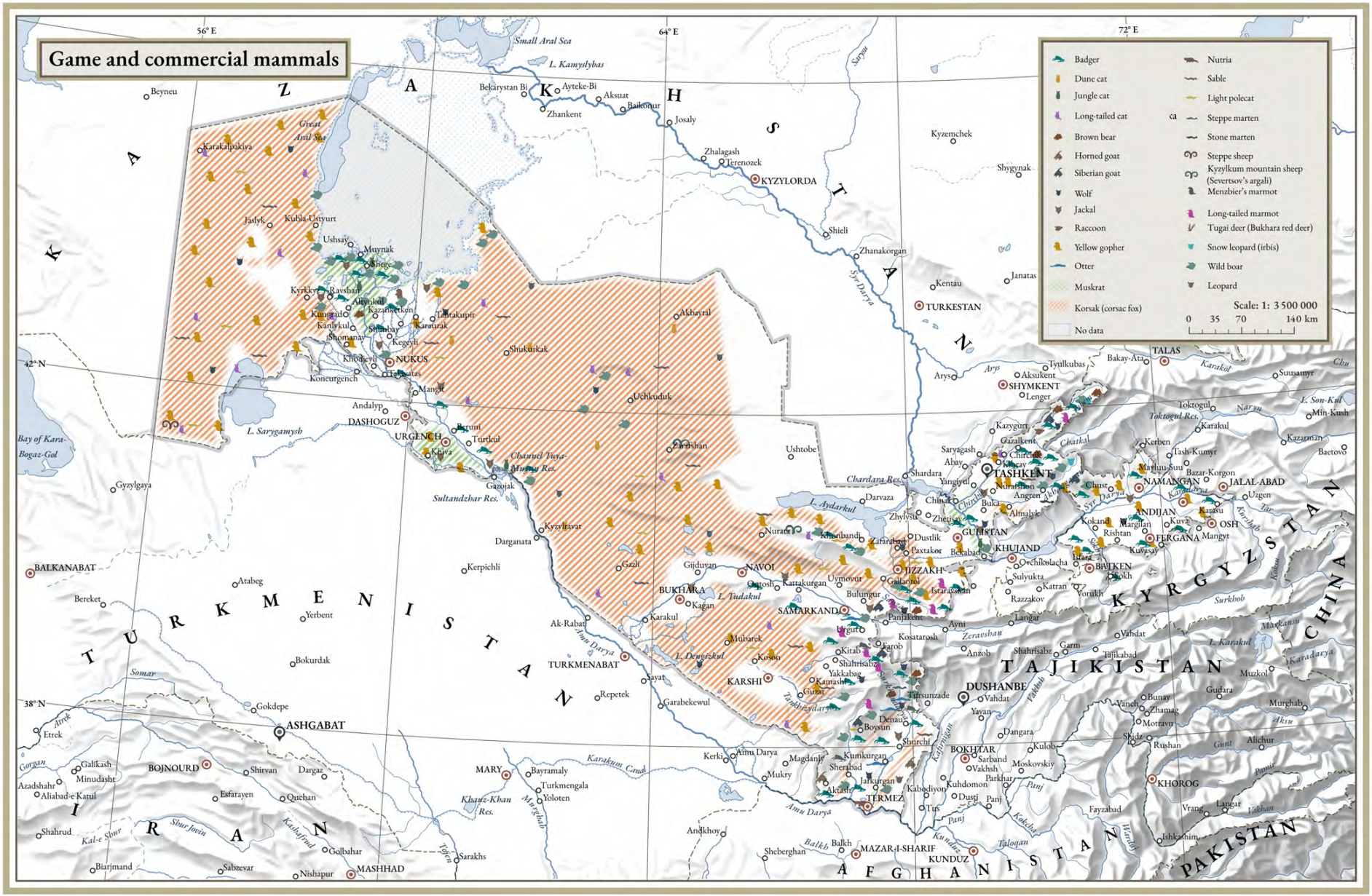
Atlas of the Uzbek Soviet Socialist Republic (1963) Tashkent-M.: Academy of Sciences of the Uzbek SSR, GUGK

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



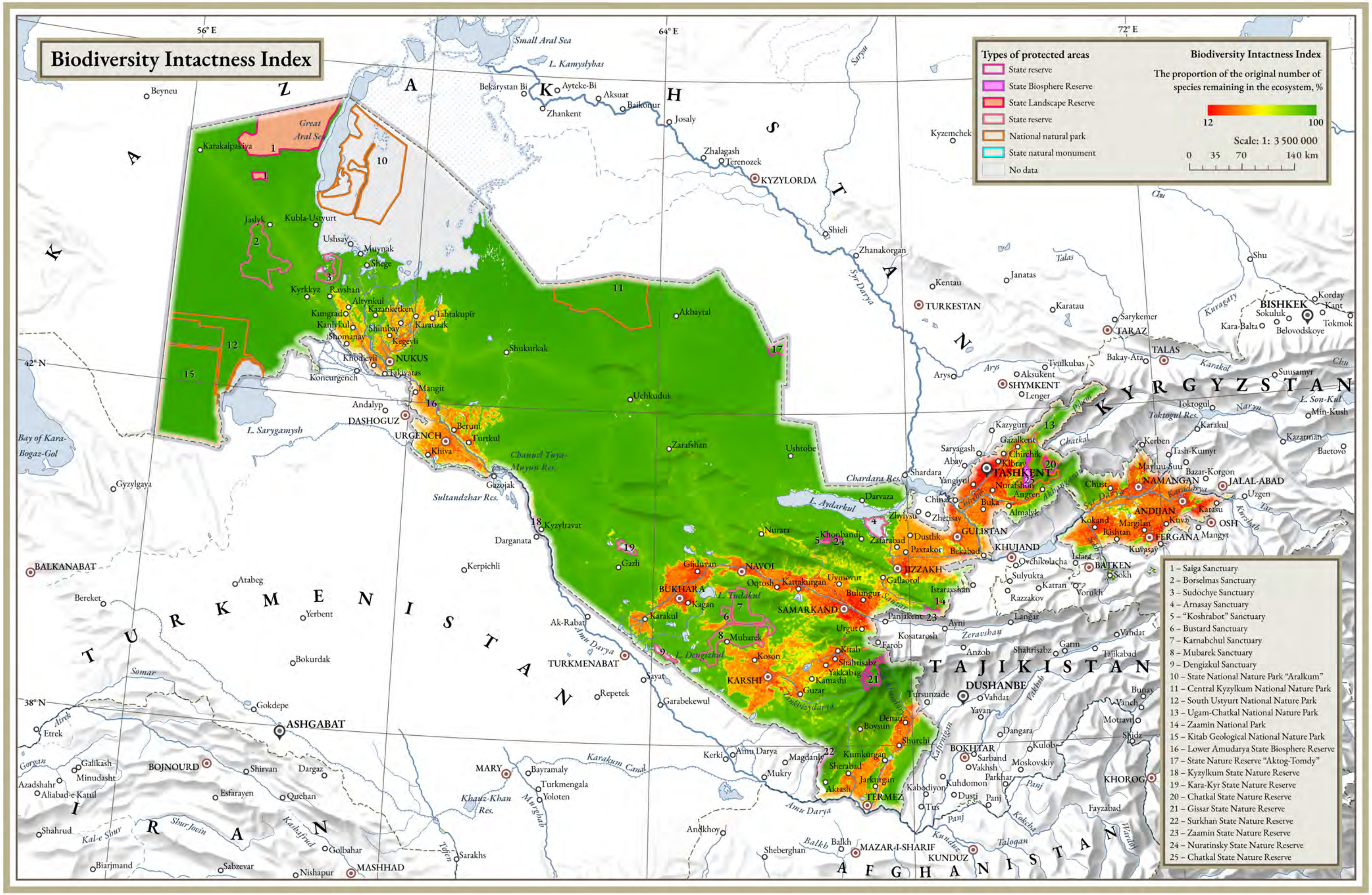
Atlas of the Uzbek Soviet Socialist Republic (1963) Tashkent-M.: Academy of Sciences of the Uzbek SSR, GUGK.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



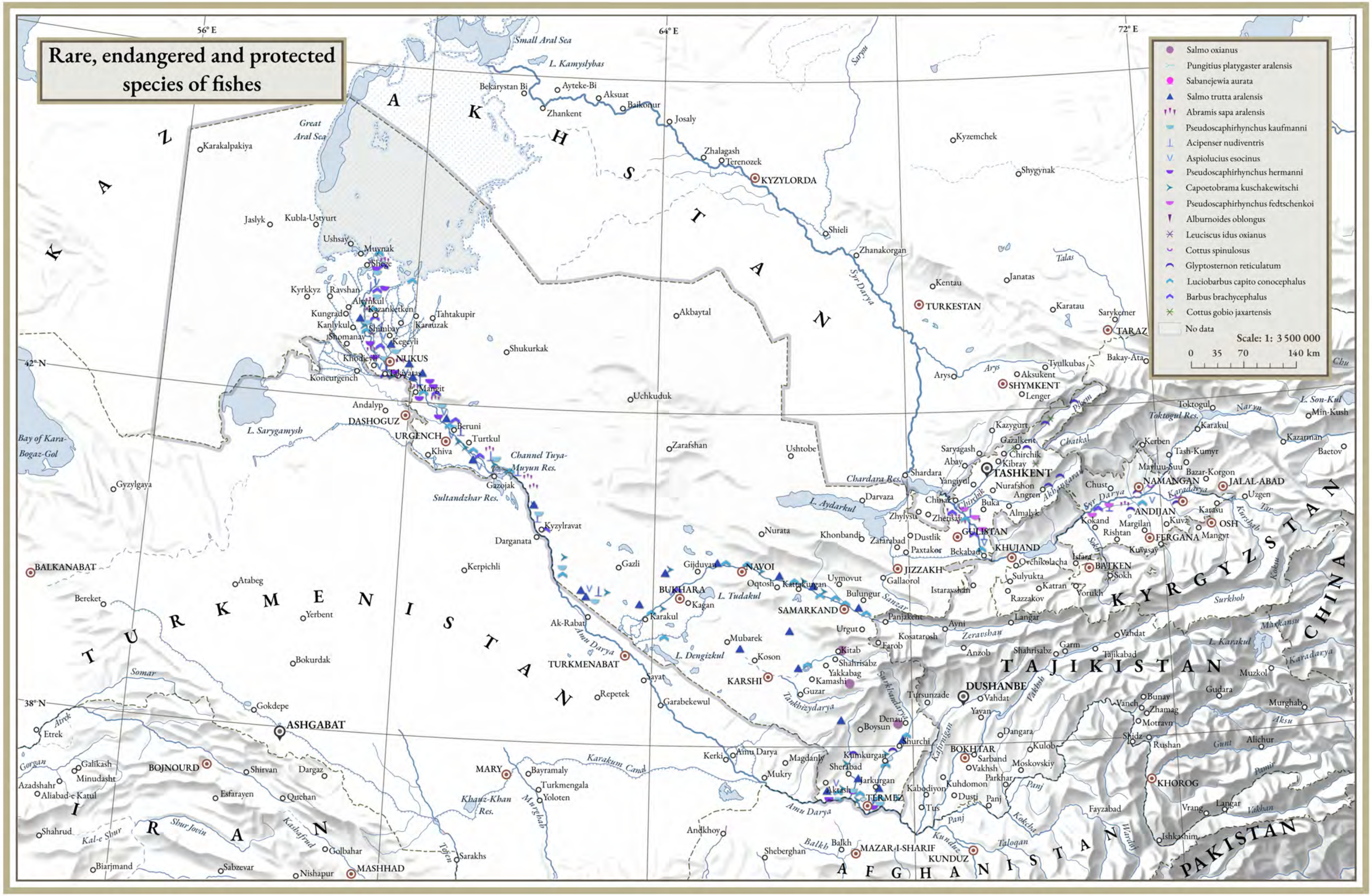
Atlas of the Uzbek Soviet Socialist Republic (1963) Tashkent-M.: Academy of Sciences of the Uzbek SSR, GUGK.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



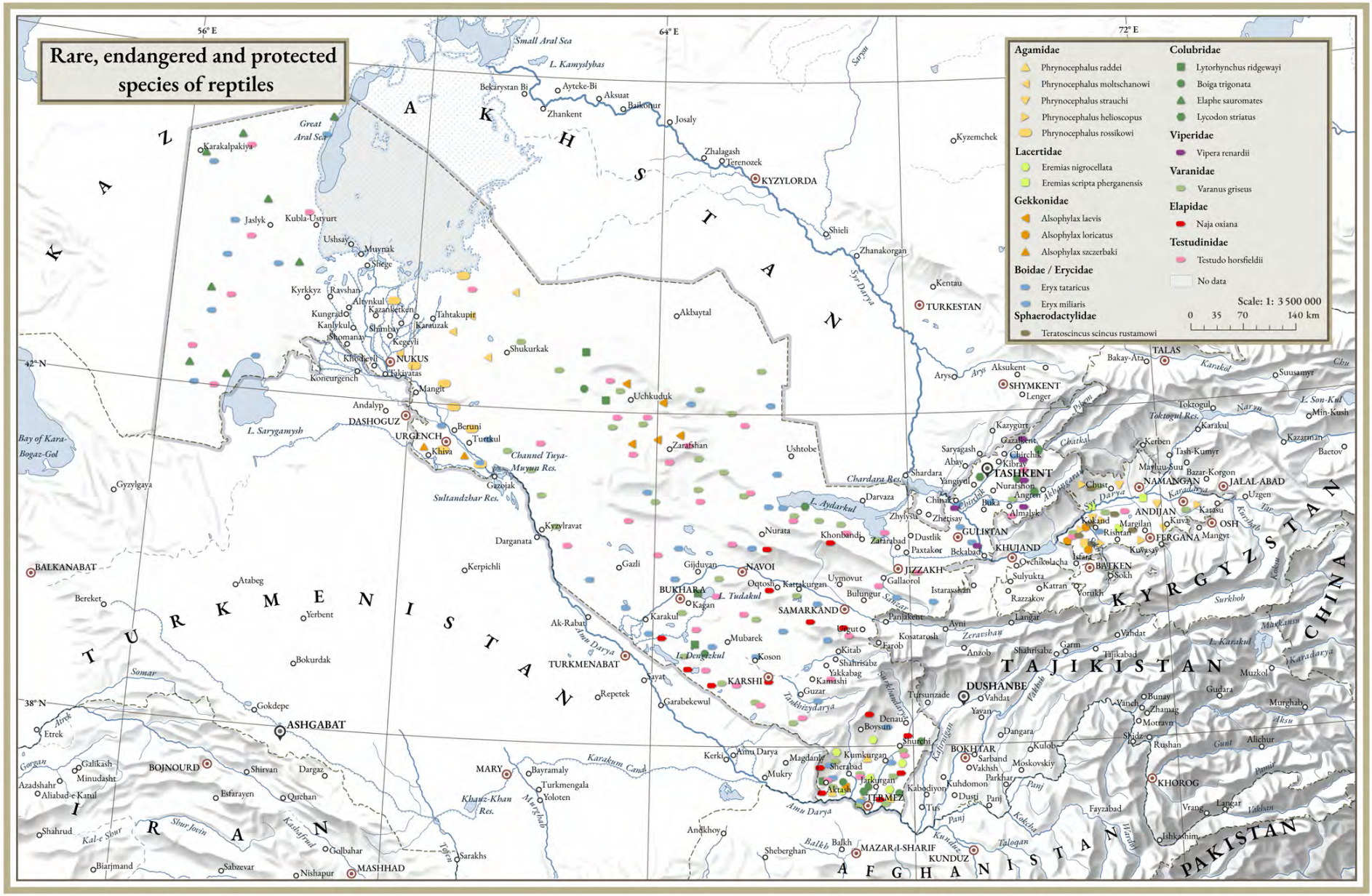
Based on Impact Observatory data (based on PREDICTS, 2017–2020, 100 m resolution). The Biodiversity Intactness Index (BII) is calculated as the product of relative species abundance and the similarity of species composition to reference undisturbed sites. Models were trained using the global PREDICTS observational database and extrapolated based on land use maps, population density, illumination, proximity to roads, and other predictors of anthropogenic pressure. The result reflects the proportion of original biodiversity preserved under modern human impact.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



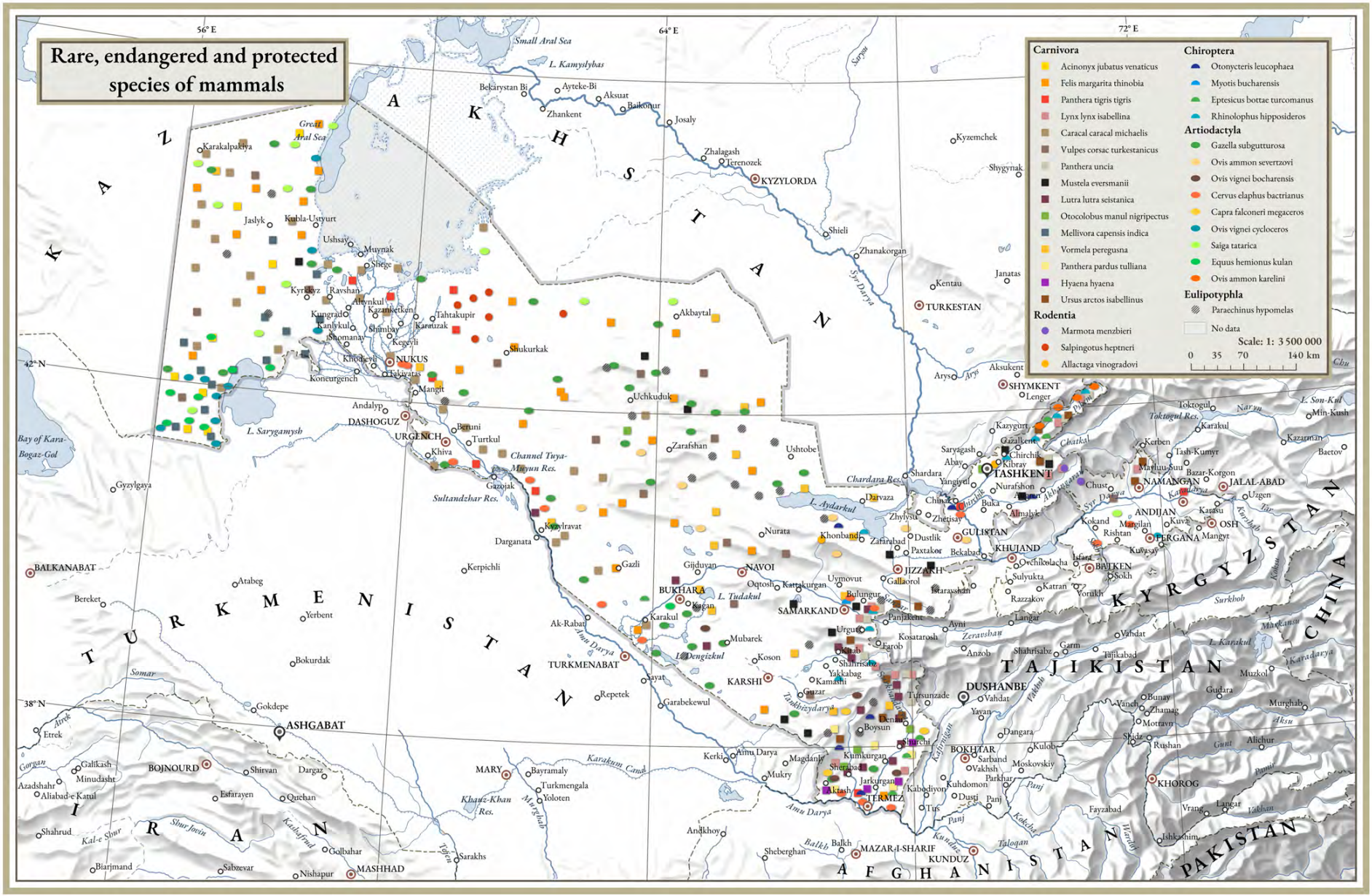
Red Book of the Republic of Uzbekistan (2019). Tashkent.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



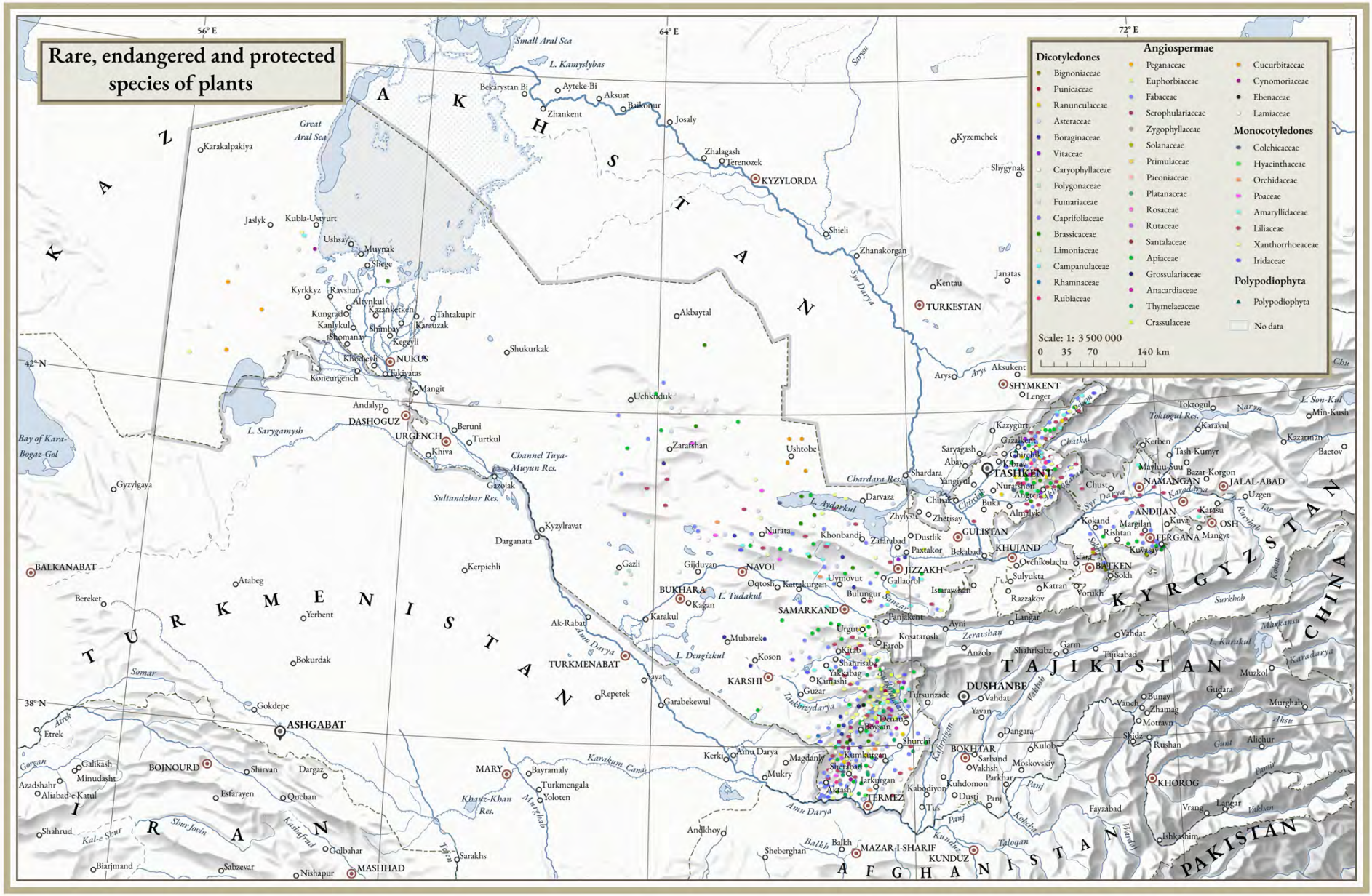
Red Book of the Republic of Uzbekistan (2019). Tashkent.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



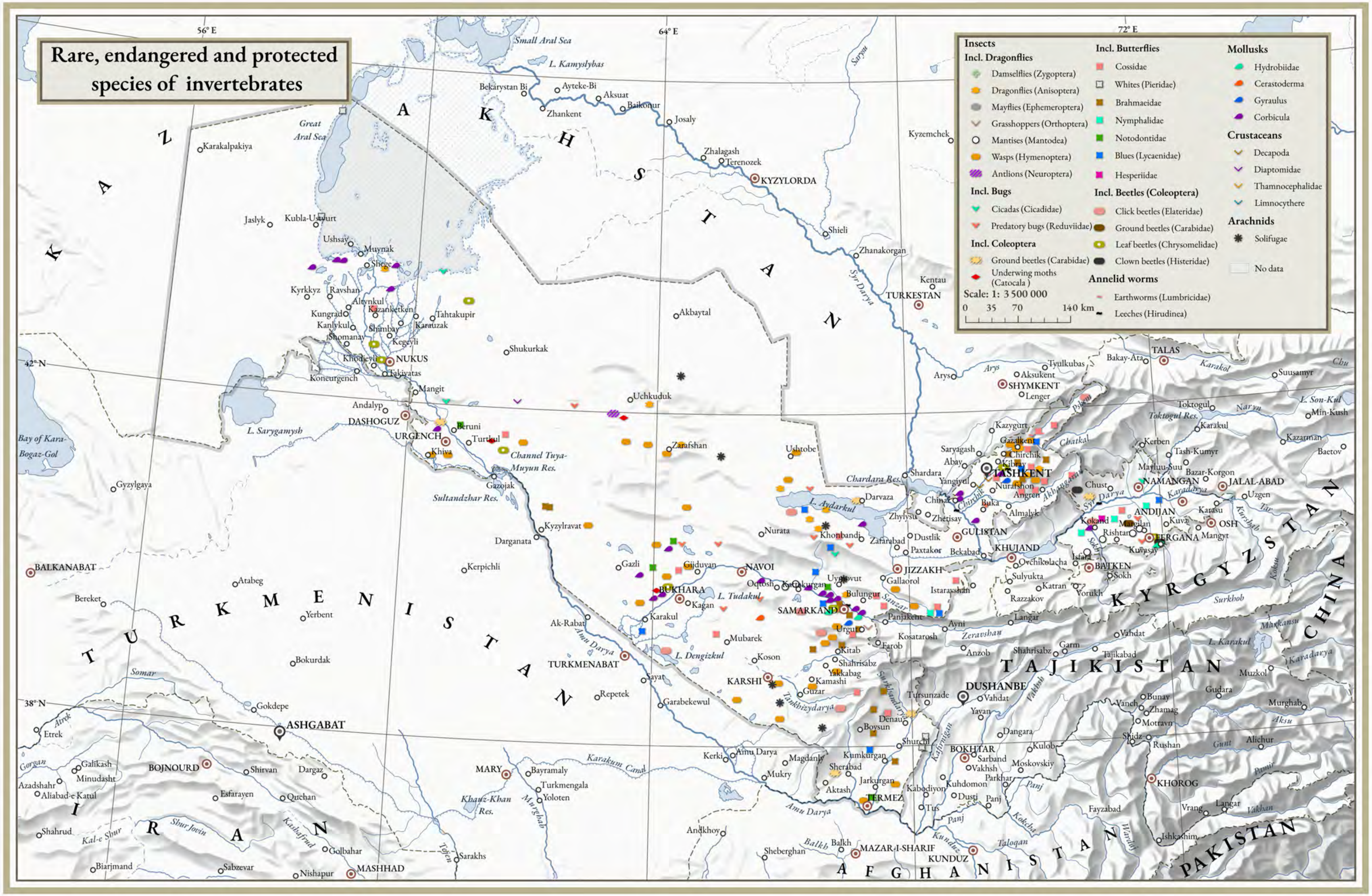
Red Book of the Republic of Uzbekistan (2019). Tashkent.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



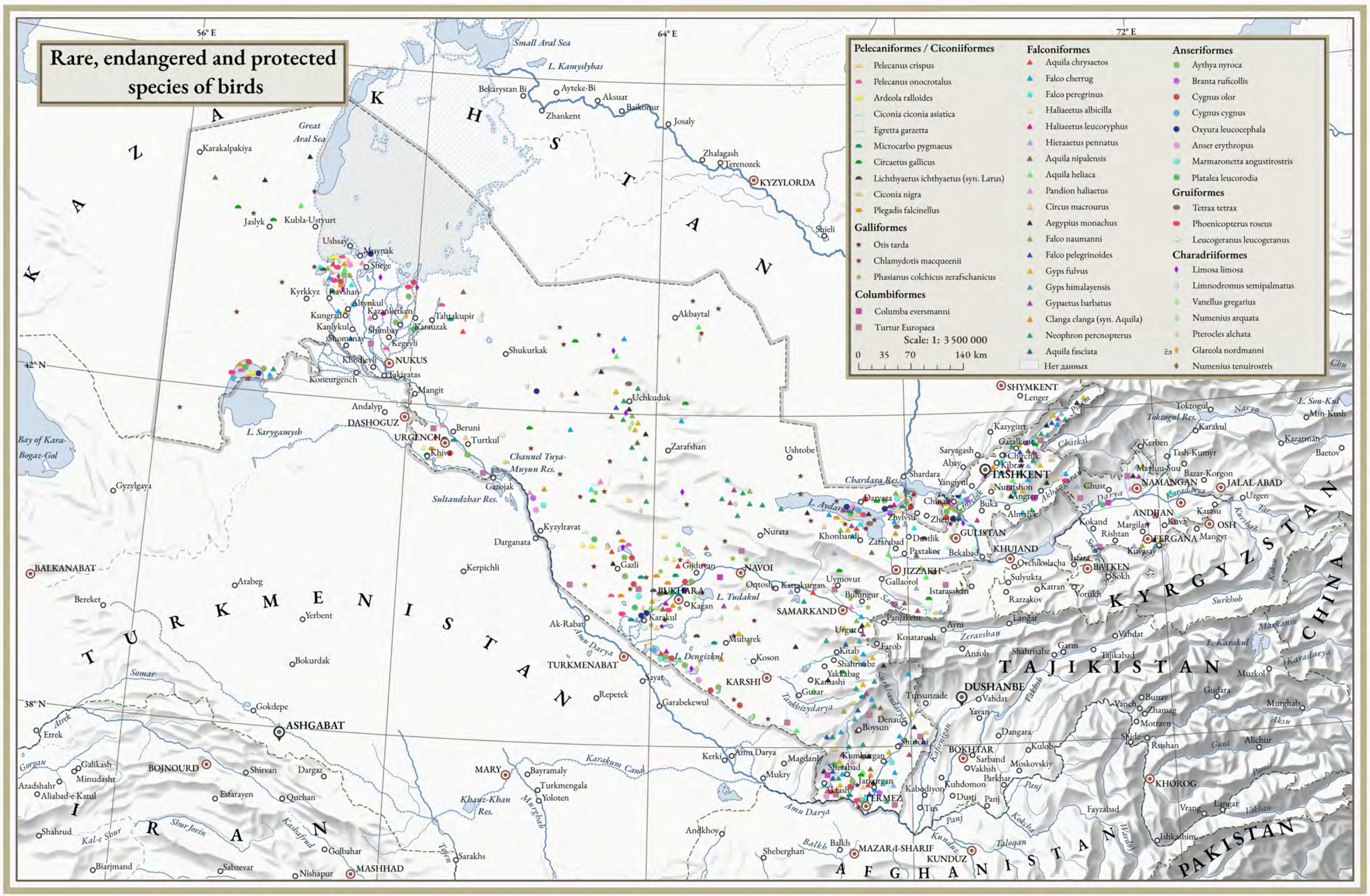
Red Book of the Republic of Uzbekistan (2019). Tashkent.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Red Book of the Republic of Uzbekistan (2019). Tashkent.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Red Book of the Republic of Uzbekistan (2019). Tashkent.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.

6.3. Towards Achieving the SDGs

Uzbekistan has been a Party to the UNCBD since 1995 and has submitted six national reports to the Convention's Secretariat. However, challenges related to the implementation of the Convention remain due to insufficient administrative capacity and significant gaps in critical information for biodiversity management. As such, the lack of access to reliable and up-to-date biodiversity information is an obstacle to progress on numerous biodiversity-related SDG targets.

Indicator **15.1.2** focuses on the proportion of important terrestrial and freshwater biodiversity areas covered by protected areas, by ecosystem type, relevant to the country's environmental policy.

Protected areas have always played a key role in biodiversity conservation policy in Uzbekistan. National legislation established seven categories of PAs: (I) State reserves; (II) nature sanctuaries; (III) national parks; (IV) natural monuments; (V) areas designated for the reproduction of useful populations (nurseries, fishery zones); (VI) protected recreational and resource-saving zones (resort areas, etc.); (VII) areas created for natural resource management (forest lands and hunting grounds) *(see map 'Protected areas')*.

The total area of the republic's 36 PAs is 13.2 million hectares, or 29.4 per cent of the country's territory, which is significantly higher than the Aichi Target for 2020 which requires only 17 per cent or more. Moreover, more than 83 per cent of the total protected area falls under Category VII, i.e., Sate Forest Fund lands (approximately 11 million hectares), of which only a third is covered by forests, while the remaining 70 per cent is land potentially suitable for afforestation but currently used for various other purposes, for example, as pasture or wasteland. As such, these areas have no real significance for the protection of Uzbekistan's biodiversity. Lands in categories I to V, which best meet the objectives of territorial nature conservation, occupied less than 2.1 million hectares in 2018, some 4.63 per cent of the country's territory. The strictest conservation regime has been established in seven nature reserves and two biosphere reserves, covering a total area of 721,000 hectares, or 1.79 per cent of the country's land area[196]. The country plans to expand the area of protected areas of categories I to V to be 12 per cent of the republic's total area by 2030. According to the World Bank, the relative area of protected areas increased from 4.63% in 2018 to 9.5% in 2024, mainly due to the creation of the South Ustyurt and Central Kyzylkum national parks[197].

196 Sixth National…„ 2018.

197 Uzbekistan - Terrestrial And Marine Protected Areas (% Of Total Territorial Area) - 2025 Data 2026 Forecast 1990-2024 Historical

Almost all the PAs with a high conservation regime are located in the southeastern part of Uzbekistan, with the exception of the Lower Amu Darya Biosphere Reserve in the Republic of Karakalpakstan, which was only included in the UNESCO Biosphere Reserve System in 2022. The state of the ecosystems in Uzbekistan's PAs can be assessed based on trends in vegetation indices *(see Table 21)*. Of the 57 assessed individual territories (including various functional zones of the protected area), 19 (33%) are characterized by negative trends. The Republic of Karakalpakstan stands out in this regard – 9 out of 14 protected areas show negative trends, thus confirming this region's status as the most problematic. The Navoi Region also has a predominance of protected areas with negative vegetation indices for the period between 2000 and 2024. The strongest negative trends were identified in the Chust Nature Monument (Jizzakh Region) and the Kara-Kir State Nature Reserve (Bukhara Region). These natural monuments have very low conservation status, however, information on their dynamics is insufficient to confirm or explain the negative vegetation cover trends within these areas.

The optimality of a PA system is assessed based on its connectivity and representativeness relative to the main types of natural complexes, key biodiversity areas (both KBAs and IBAs) and the geographic distribution of Red Book species. The connectivity of Uzbekistan's protected area system is estimated at 0.37 (on a scale of zero to one, where one is the highest connectivity), indicating that the protected area system is rather fragmented spatially[198].

The degree of conservation status of the main types of natural complexes can be assessed according to the Aichi Biodiversity Targets which, as noted above, require at least 17 per cent of the PAs in question to be protected. The UNCBD Secretariat identifies eight main types of ecoregions within Uzbekistan. The representation of these ecoregions in the PA system is extremely uneven *(see map 'Ecoregions')*. The Tien Shan mountain steppes and meadows, occupying a relatively small area of 694.2 km2, have a protected status on 59.3% of their territory. The Gissar-Alai open forests ecoregion is optimally provided with protected areas, where protected areas occupy 17.6% of its area while PAs in the Badghyz and Karabil semi-deserts account for only 1.3 per cent of their area. The Central Asian floodplain forests and the Central Asian southern deserts are also under served by PAs, having only 2.3 per cent and three per cent of their respective areas thus classified. This is of notable concern as, for example, the valuable ecosystems of the mountain residual massifs in the central part of the Kyzylkum Desert are virtually unprotected. The situation in the Alay-western steppes and the Central Asian northern deserts is not much better as they have PAs covering 8.1 per cent and 6.4 per cent of their areas, respectively, and the Pamir alpine deserts and tundra ecoregion (with a very small area of only 85.4 km²) has no PA at all.

198 Aichi Biodiversity Target 11 Country Dossier: UZBEKISTAN (2021) Aichi Biodiversity Target 11 Country Dossier: UZEBEKISTAN (cbd.int)

There are 54 KBAs designated in Uzbekistan *(see map 'Key Biodiversity Areas')*. The designation criterion is the regular presence of globally threatened species or narrowly endemic species with a very small distribution range limited to a given habitat. Their average representation in protected areas is 20.6 per cent, however, the main problem is the extreme unevenness of these KBAs' conservation coverage. Only five KBAs fall entirely within the boundaries of PAs of various categories. These include the Aydar–Arnasay Lake system in the southern border zone with Kazakhstan, Lake Tuzgan at the southernmost end of the Aydar–Arnasay Lake system, the small karst plateau of Pulatkhan in the northwestern spurs of the Chatkal Range, the Oygaing mountain river valley and Lake Sudochie in the Amu Darya delta. Another 13 KBAs only partially overlap with existing protected areas, among them is the Jeyran Ecocenter, where goitered gazelles *(Gazella subgutturosa subgutturosa)*, wild ass *(Equus hemionus Pallas)* and Przewalski's horses *(Equus przewalskii)* are bred and maintained in a semi-enclosure setting. Another important site of this kind is the Dengizkul salt lake, which serves as a wintering ground for several globally threatened bird species *(Dalmatian pelican, marbled teal, ferruginous duck and white-headed duck)*. However, 36 IBAs do not yet have any protected status in Uzbekistan[199].

Between 2008 and 2009, BirdLife identified and detailed 52 IBAs in Uzbekistan. Unlike the PA system, the IBA network in Uzbekistan covers all ecoregions and landscape types relatively evenly: desert ecosystems (9 IBAs), wetlands proper (15), desert-lake (9), mountainous areas (12), desert lowlands (3) and tugai forests (4). The BirdLife Secretariat has officially recognized these sites as IBAs and they are now part of the global IBA network of more than 10,000 PAs listed in the World Biodiversity Database. However, only 17 of Uzbekistan's 52 IBAs partially or fully overlap with existing PAs of any category and the remaining 35 do not enjoy any legal protection in Uzbekistan. According to BirdLife, bird populations are regularly observed in only nine IBAs.

Uzbekistan's network of existing PAs is currently

199 Aichi…, 2021.

Table 21. Trends in the vegetation index (EVI) in protected areas, 2000–2024

Region	Protected area	Average increase of EVI per decade
Republic of Karakalpakstan	Aral Sea Region National Nature Park	0.01705
	Lower Amu Darya State Biosphere Reserve, Protected Zone (formerly Badai-Tugai Nature Reserve)	0.00782
	Aralkum National Nature Park	0.00733
	Lower Amu Darya State Biosphere Reserve, Transition Zone	0.00638
	Protected Zone of the Akpetki State Nature Reserve	0.00475
	Barsakelmes State Nature Reserve	0.00160
	Southern Ustyurt National Nature Park, Economic Zone	-0.00068
	Southern Ustyurt National Nature Park, Recreational Zone	-0.00087
	Akpetki State Nature Reserve	-0.00151
	Lower Amu Darya State Biosphere Reserve	-0.00174
	Protected Zone of the Saigachiy Nature Reserve	-0.00212
	Saigachiy Complex Landscape Reserve	-0.00248
	Sudochye State Nature Reserve	-0.00373
	Protected Zone of the Sudochie State Nature Reserve	-0.00523
Khorezm	National Nature Khorezm Park, recreational area	-0.00776
	Khorezm National Nature Park, economic zone	0.00236
	Khorezm National Nature Park, protected area	0.00029
Navoi	Oktog-Tomdi State Nature Reserve	-0.00077
	Central Kyzylkum National Nature Park, economic zone	0.00168
	Aktau State Nature Reserve	0.00064
	Central Kyzylkum National Nature Park	0.00050
	Central Kyzylkum National Nature Park, recreational area	-0.00005
	Nurabad State Nature Reserve	-0.00086
	Karnabchul State Nature Reserve	-0.00762
Bukhara	Vardonze Historical Monument	0.01833
	Khadicha State Nature Reserve	0.01321
	Kyzylkum State Nature Reserve	0.00725
	Varakhsha Historical Monument	0.00475
	Dengizkul Ornithological Reserve	0.00387
	Protected Zone of the Kyzylkum State Nature Reserve	0.00386
	Bukhara Specialized Nursery Jeyran	0.00182
	Kumsultan State Nature Reserve	-0.00153
	Mubarek State Nature Reserve	-0.00676
	Kara-Kir State Nature Reserve	-0.01676
Samarkand	Zarafshan National Nature Park	0.01129
Kashkadarya	Gissar State Nature Reserve	0.00224
Surkhandarya	Surkhan State Nature Reserve	0.00484
Jizzakh	Arnasay State Ornithological Reserve	0.00630
	Zaamin State Nature Reserve	0.00464
	Nurata State Nature Reserve	0.00377
	Zaamin National Nature Park	0.00305
	Kushrabot State Nature Reserve	0.00225
	Nurata State Nature Reserve Protected Zone	0.00122
	Zaamin State Nature Reserve Protected Zone	0.00061
	Gissar State Nature Reserve Protected Zone	0.00185
	Kitab Geological National Nature Park	0.00038
	Surkhan State Nature Reserve Protected Zone	0.00000
	Pap National Nature Park	0.00284
	Ugam-Chatkal National Nature Park	0.00053
	Mingbulaksky Natural Monument	-0.00547
	Chustsky Natural Monument	-0.01664
	Amankutan National Nature Park	0.00207
	Babatag National Nature Park	0.00267
	Yukori Tupalang National Nature Park	-0.00002
Tashkent	Ugam-Chatkal State Biosphere Reserve	0.00071
Namangan	Chatkal State Biosphere Reserve	0.00495
Fergana	Yozyovan Desert Natural Monument	0.00373

insufficient to effectively protect its Red Book species. Protected areas of high categories (I and II) monitor the status of 49 per cent of the republic's Red Book plant species, 56 per cent of its mammal species and 38.5 per cent of its bird species. Some rare and endangered species, particularly reptiles and birds, which are only found within PAs with low protection regimes. The status of Red Book plant and animal species in such PAs is difficult to assess as no fieldwork to inventory flora and fauna has been conducted. Many areas known for their rich species diversity are not provided with PA status, such as the Baysun Mountains, the Tupalang River Valley, the Sangardak River Basin and the Shakhimardan Enclave. This translates to the existing network of territorial nature conservation areas being unable to ensure the protection of migratory animal species throughout their entire life cycle due to the small size of the PAs (average area of 32,000 hectares) and their weak connectivity *(see Box 6)*. At the same time, implementing a robust conservation regime may make it is necessary to consider the existence of other forms of territorial protection that have historically developed in various economic sectors. For example, in agriculture, approaches to protecting soils from degradation were developed, while measures to protect fisheries were taken in the water sector *(see map 'Nature conservation')*.

The Government of Uzbekistan, with the participation of international organizations, developed a Roadmap for the Development of the Protected Natural Area System for the period from 2019 to 2022. Based on an analysis of various landscape, botanical and zoological data, coupled with GIS methods, 29 promising areas were identified for the establishment of new or the expansion of existing PAs. In actioning these results, five new PAs are expected to be established in the Republic of Karakalpakstan alone. In 2020, the country's largest national natural park, the 'Southern Ustyurt', was established, covering over 1.4 million hectares. This park has the potential to become part of the largest transnational conservation areas, as it adjoins the Kaplankyr Nature Reserve in Turkmenistan (established in 1979) and the Ustyurt State Nature Reserve in Kazakhstan (established in 1984).

In support of aspects of the foregoing, Indicator **6.6.1**, which focuses on changes in aquatic ecosystems over time, is particularly relevant in Uzbekistan due to the catastrophic desiccation of the Aral Sea.

Until the early 1960s, the Aral Sea's key parameters, its area (67,499 km²), water volume (1,089 km³) and salinity (10 g/L), had remained virtually unchanged since the 19th century. Before the 1920s, the lake was home to 160 species, including 12 fish species and 148 free-living invertebrate species. In the 1920s, the intentional and/or accidental introduction of alien species resulted in the presence of 21 new fish species and 16 invertebrate species, most of which originated from the Caspian and Azov Seas. This brought the Aral Sea's fauna species count to 187. The impact of 16 of these new species on the Aral Sea's biodiversity was assessed as positive (for example, in terms of improving the prey base of commercial species), nine species were assessed as negative, and the remaining 12 invasive species had neutral or poorly studied impacts on the lake's ecosystems. Overall, the introduction of these species were considered a success.

The first signs of a depressed state of the sea's ichthyofauna became noticeable in the mid-1970s as water salinity increased to 14 g/L. Commercial fishing ceased in the Aral Sea when salinity reached 18 g/L, which occurred in the early 1980s. During this decade, the lake's shallowing also sharply increased and salinity rapidly rose to 30 g/L. Of the 187 species present since the 1920s, only 10 fish species and 15 invertebrate species survived under these conditions. Further shallowing led to the sea's division into three separate bodies of water, accompanied by a catastrophic increase in salinity in two of them: up to 100 g/L in the Western Large Aral and up to 150 to 160 g/L in the Eastern Large Aral. Fish survival became impossible and only a few invertebrate species persisted.

After being isolated from the Greater Aral Sea, the Small Aral Sea soon regained conditions conducive for the survival of ichthyofauna and 12 fish species and 15 invertebrate species were again present by 2000[200]. Currently, the salinity of the Small Aral Sea has dropped to five g/L and the number of commercial fish species has reached 22 (pike, bream, carp, silver carp, flounder, and others) due to their natural reintroduction with river runoff. Fishing is still a fraction of its former size and requires improving the food supply for commercial fish species by introducing more diverse invertebrate fauna. Before the catastrophic shallowing of the Aral Sea, such invertebrate fauna was endemic and its natural reintroduction is now unlikely[201]. However, the introduction of alien invertebrate species (mollusks, crustaceans, etc.) can have a positive effect, as was the case in the last century.

Indicator 6.6.1. is also directly related to the implementation of the Convention on Wetlands of International Importance, ratified by Uzbekistan on 8 February 2002. However, Uzbekistan is not part of the Ramsar Regional Initiative for Central Asia, although it has participated in meetings within its framework. This initiative provided support to countries in the region in the implementation of the Ramsar Convention and its Strategic Plan for the period from 2016 to 2024. More than 400 bird species have been recorded in Uzbekistan, 200 of which are wetland inhabitants. Of these, 52 species are included in the national Red Book and 43 species are included in the Red Lists of the IUCN. However, Uzbekistan has only three Ramsar sites. The first is Lake Dengizkul, nominated in 2001, which is the largest saline closed lake in the southwestern Kyzylkum Desert, with typical ecological conditions for natural lakes found in the deserts of Central Asia. In 2008, the Aydar-Arnasay lake system was added as the second Ramsar site. It is Uzbekistan's largest reservoir and consists of freshwater lakes located in the middle reaches of the Syr Darya River and in the irrigated areas of both the Hunger Steppe and Kyzylkum Desert. Neither of these sites currently has a management plan. With support from Sweden, a proposal was developed (and implemented) to nominate a third Ramsar site: the Tudakul and Kuymazar reservoirs are complexes in the arid biogeographic region that is the southwestern Kyzylkum Desert, located 23 km east of Bukhara. In 2023, the Sudochie lake system, which once formed the largest body of water in the Amu Darya delta, was designated a Ramsar Wetland of International Importance. The former Amu Darya delta also contains the drying lake Zhyltyrbas, an important stopover site for many migratory birds and, therefore, was also included in the Ramsar Convention list in 2024.

Uzbekistan replaced global indicator 15.4.1, entitled 'Protection of mountain areas important for biodiversity by protected areas', with the national indicator entitled 'Proportion of protected mountain ecosystems in their total area', which somewhat changes the meaning and focus of the indicator. The nationalized indicator only assesses the relative area of PAs in the republic's mountains while the global indicator requires identifying mountain ecosystems with enhanced biodiversity. Formally, mountain ecosystems are the most protected ecosystem types in Uzbekistan as they are included in the higher categories (I to III) of PAs. The only exception is the mountain remnant massifs of the Kyzylkum Desert, which are poorly provided with PAs. However, existing PAs in the Western

200 Aladin et al. (2008) Biodiversity Of The Aral Sea And Its Importance To The Possible Ways Of Rehabilitating And Conserving Its Remnant Water Bodies In book: Environmental Problems of Central Asia and their Economic, Social and Security Impacts, NATO Security through Science Series C: Environmental Security: 73–98.

201 Plotnikov et al. (2016) Modern state of the Small (Northern) Aral Sea fauna. Lakes & Reservoirs Research & Management. 21 (4): 315–328.

Tien Shan Mountains cover only 12 of its 36 identified KBAs. Thus, there is a need for further expansion of the PA system in mountainous regions, and this is justified by the results of two United Nations Development Programme (UNDP) and SCEEP projects, as well as by the work done by the Critical Ecosystem Partnership Fund and the Zoï Environmental Network between 2012 and 2017, which aimed to identify key areas for the protection of biological diversity in Uzbekistan.

SDG 15.5 stipulates: "Urgent and significant action is needed to reduce the degradation of natural habitats, halt biodiversity loss, and, by 2020, protect threatened species and prevent their extinction". The indicator to help measure this SDG is 15.5.1, which uses IUCN Red List data to calculate an index that aggregates changes in extinction risks across species groups. The index ranges from zero to one, where one means all species are classified as 'Not a Concern', and zero means all the relevant species are classified as 'Extinct'. Uzbekistan has a relatively high index of 0.97, ranking 17th among all countries globally for its Red List species. For comparison, Tajikistan is in 4th place with a score of 0.99 and Kyrgyzstan is in 39th place with a score of 0.89[202].

According to IUCN global assessments, 46 animal species (out of 206 listed in the Red Book) and 16 plant species (out of 313 listed in the Red Book) found in Uzbekistan are globally threatened with extinction, clearly highlighting the priorities for the national biodiversity conservation strategy. However, Uzbekistan has changed the global indicator here to «the number of species listed in the national Red Book", an alteration that is justified locally due to the significant discrepancies between the IUCN Red Book list and that of Uzbekistan's Red Book.

Uzbekistan's biodiversity boasts over 27,000 species, including 14,900 invertebrate species and 11,000 plant, fungal, and algal species. Of the 715 vertebrate species (77 fish, 3 amphibians, 61 reptiles, 467 birds, and 107 mammals), 206 (29%) are included in the latest edition of the Red Data Book of the Republic of Uzbekistan, and of the 4,300 higher wild plant species, 313 (7%) are included.

Uzbekistan is distinguished by high endemism of fish (about 50 per cent) and reptiles (60 per cent), many species of which originated in the interfluve of the Amu Darya and Syr Darya *(see maps 'Rare, endangered and protected species of fishes'; 'Rare, endangered and protected species of reptiles')*.

202 Red List Index - Sustainable Development Goals - United Nations Economic Commission for Europe.



Camels in Kyzyl-Kum

Among the republic's terrestrial vertebrates, endemics make up 9.5 per cent, including 15 per cent of mammals but only 1.7 per cent of birds *(see map 'Rare, endangered and protected species of mammals'; map 'Rare, endangered and protected species of birds')*. In contrast, Uzbekistan is not characterized by a high level of endemism among its higher plants; the proportion of endemic species, primarily growing in the mountains, is eight to nine per cent *(see map 'Rare, endangered and protected species of plants')*. However, Central Asia is recognized by modern science as the global point of origin for many cultivated fruit trees (such as apricot, cherry, apple and pear) and nut trees (pistachio, almond and walnut). There are 202 wild-relative species of cultivated plants, belonging to 102 genera and 24 families, that have been discovered in Uzbekistan[203]. This represents more than 65 per cent of the species identified in the Central Asian region as the ancestors of modern cultivated plants. The least studied group in terms of endemism is invertebrates *(see map 'Rare, endangered and protected species of invertebrates')*.

The republic's Red Book uses the IUCN classification system so all species fall into either the 'Least Concern' (LC) group, the 'Near Threatened' (NT) group or the 'Globally Threatened' group, where the latter has three subcategories: Vulnerable (VU), endangered (EN) and critically endangered (CR)[204].

Revisions of the national Red Book show an increase in the number of rare and threatened vascular plant species: going from 163 in 1984 to 313 vascular plant species and three fungal species in 2019. However, a number of species were removed from the republic's list of globally vulnerable (VU), endangered (EN) and critically endangered (CR) species based on their widespread distribution in neighboring Central Asian countries and Russia. Some these previously listed species have been found to exist in significant numbers within Uzbekistan itself. By way of another positive, the number of species previously classified as probably extinct (EW) has decreased from 19 to 10, although 15 new rare and endemic species have been added to the national Red Book. As new scientific findings have been obtained, 157 Red Book species have changed their status.

The IUCN Red Book list for Uzbekistan includes 62 species, including 16 higher plants, 10 mammals, 19 birds, seven reptiles and seven fish, including species listed in the three categories of VU, EN and CR.

Of the 10 mammal species listed, seven are ungulates.

203 Abduraimov et al. (2023) Floristic diversity and economic importance of cultivated plants in Uzbekistan. BIODIVERSITAS. 24, 3: 1668–1675.

204 IUCN Red List version 2020-21.

There are discrepancies between the national and international status assessments of many of these species. By way of a few examples of this, the Bukhara deer *(Cervus hanglu)* is recognized as EN on the national list but as LC on the international list. The markhor *(Capra falconeri)* is listed in the Red Book of Uzbekistan as CR, but in the IUCN list as NT, i.e. a species not listed as endangered. The Ustyurt mountain sheep *(Ovis orientalis)* is listed as vulnerable (VU) by the IUCN and CR in the Red Data Book. The only overlap is the status of the Ustyurt mountain sheep—both systems recognize the species as CR.

Of the 19 bird species Red Book listed, only one, the sociable lapwing *(Vanellus gregarious)*,is considered CR by the IUCN in Uzbekistan (as well as in Tajikistan). However, the steppe lapwing is not listed in the Red Book of Uzbekistan, as this species only migrates through its territory (the main population of the steppe lapwing is located in Kazakhstan, in the Ili River basin).

Of the higher plants listed, three species are assessed by the IUCN as CR: the calcareous calligonum *(Calligonum calcareum)*, the Korshinsky pear *(Pyrus korshinskyi)* and the malvifolium currant *(Ribes malvifolium)*. Two species—calcareous calligon and malvolifolia currant—are listed as endangered in the Red Data Book of Uzbekistan. Korzhinsky pear *(Pyrus korshinskyi)* is a common wild species in the Central Asian region and is not listed as endangered in Uzbekistan.

Such discrepancy between the national and international Red Book lists of threatened species is considered typical for Central Asian countries[205]. The overestimation of the number and level of threats to species populations may be due to their limited distribution in a given area, while populations may be quite healthy within the macroregion or in neighboring countries. A second, more serious factor is the lack of reliable national-level data on population decline rates (criterion A in the IUCN methodology), which again requires broad spatial and temporal coverage for a valid global assessment of species' statuses. However, some researchers working in the region believe that discrepancies between national and global assessments lies more with the international expert community[206].

Regarding indicator **15.7.1**, which uses the metric involving the share of detected illegal trade in total trade in wildlife flora and fauna and their products, it is difficult to estimate the true scale of poaching and illegal trafficking of Uzbekistan's protected species as data on current wildlife population sizes are lacking. Furthermore, data for calculating the national indicator related to SDG 15.7 are virtually nonexistent.

National indicator **15.8.1** assumes the adoption of appropriate national legislation to prevent the spread of invasive species, however, unlike the global indicator, the national version does not guarantee the allocation of dedicated resources to combat such species. In 2018, Uzbekistan compiled its first list of the 228 alien plant species, including both introduced and invasive, that have naturalized in the country. Regarding fauna, most alien species now present were introduced intentionally for commercial purposes, this applies in particular to fish (which already account for approximately 50 per cent of the ichthyofauna). Alien fauna also includes two synanthropic bird species: the common myna *(Acridotheres tristis)* and the Eurasian collared dove *(Streptopelia decaocto)*, as well as five mammal species. The threat posed by alien birds, typically as carriers of parasites and viruses, is considered insignificant. Uzbekistan has not yet adopted relevant national legislation related to indicator 15.8.1., this must be done in partnership with implementing State monitoring and research programmes on invasive alien species as the necessary next steps towards achieving target 15.8.

Uzbekistan replaced the original indicator 15.9.1 (integration of biodiversity into national accounting and reporting systems) with a nationally developed indicator entitled the 'Number of national, sectoral and regional strategies and programmes that consider the value and security of biodiversity and ecosystems'. However, as of 2019, no positive examples of such integration of ecosystems and biodiversity values were identified.



Landscape panorama with poppies in the mountains of Uzbekistan

Box 6. Challenges of conserving dynamic wildlife

205 Milner-Gulland et al. (2006) Application of IUCN red listing criteria at the regional and national levels: A case study from Central Asia. Biodiversity and Conservation. 15: 1873–1886. 10.1007/s10531-005-4304-5.

206 Nowak et al. (2020) Red List of vascular plants of Tajikistan – the core area of the Mountains of central Asia global biodiversity hotspot. Scientific Reports. 10 P. https://doi.org/10.1038/s41598-020-63333-9.

Traditional conservation practices involve tried and tested tools, such as the establishment of PAs, which have fixed spatial boundaries. When the protected species are migratory, this traditional and geographically anchored approach may be insufficient to protect them. The protection of rare animals is of limited value if the species can be lost outside of PAs. The examples of saigas *(Saiga tatarica)*, snow leopards *(Panthera uncia)* and caracals *(Caracal caracal)* illustrate the key challenges of a geographically fixed approach to protecting migratory species. The migratory saiga is listed as EN in the UICN Red Book and, since the collapse of the Soviet Union, the saiga population has declined by 95 per cent. According to aerial surveys, the Ustyurt saiga population in 2015 was only 1,270 individuals. The animals spend the winter in Uzbekistan and migrate north in the summer and when saigas enter areas without effective protection, poachers shoot them for their horns. Habitats extending beyond PAs can also pose numerous potential threats due to industrial development. With the expansion of natural gas production in Uzbekistan, anthropogenic disturbances in the Ustyurt region have increased. Intensive infrastructure development, including the construction of new roads and fences on the Kazakh side of the border, is also impacting saiga habitat.

A similar situation can be observed with snow leopards[207]. In Uzbekistan, this cat is protected in three nature reserves, Chatkal, Gissar and Zaamin, as well as in two national parks: Ugam-Chatkal and Zaamin. However, approximately 35 per cent of the snow leopard's habitat remains outside of these PAs, where poaching rates are thought to be high.

The caracal, or steppe lynx, although not a migratory species, travels long distances (up to 90 km) in search of food and mating grounds[208]. Between 2011 and 2017, a group of experts conducted a study of the caracal population in the Kyzylkum Desert and the Ustyurt Plateau (that portion within the Republic of Uzbekistan). As a part of that study, information obtained from interviews with local residents indicates that at least 11 of the 27 recorded individuals of this species were deliberately shot and one was hit by a car. The local population's negative attitude toward mammalian predators can be explained by a lack of knowledge about how to properly protect their livestock. Furthermore, not all the respondents, with the exception of local authorities, knew that the caracal is listed in the Red Book of Uzbekistan as a protected species.

One option for protecting such mobile species could be the creation of mobile protected areas that would monitor the most vulnerable parts of the endangered animal's life cycle (such as calving grounds of saigas)[209]. However, this notion remains purely conceptual and its implementation has not yet been tested in practice.

6.4. Response Measures

- Expanding the PA system in Uzbekistan using landscape, botanical and zoological criteria as well as GIS methods to increase its representativeness.
- Developing regional contacts in biodiversity conservation through the creation of transboundary PAs and participation in regional agreements, such as the Ramsar Regional Initiative for Central Asia.
- Further harmonizing the national system of terms and concepts with the international biodiversity conservation framework. Ensuring women's participation in decision-making on environmental conservation and biodiversity benefit sharing.
- Establishing a system for recording the population sizes of threatened wildlife, particularly the commercial valuable ones, to conserve their numbers and understand the true scale of poaching and illegal trafficking of such protected species.

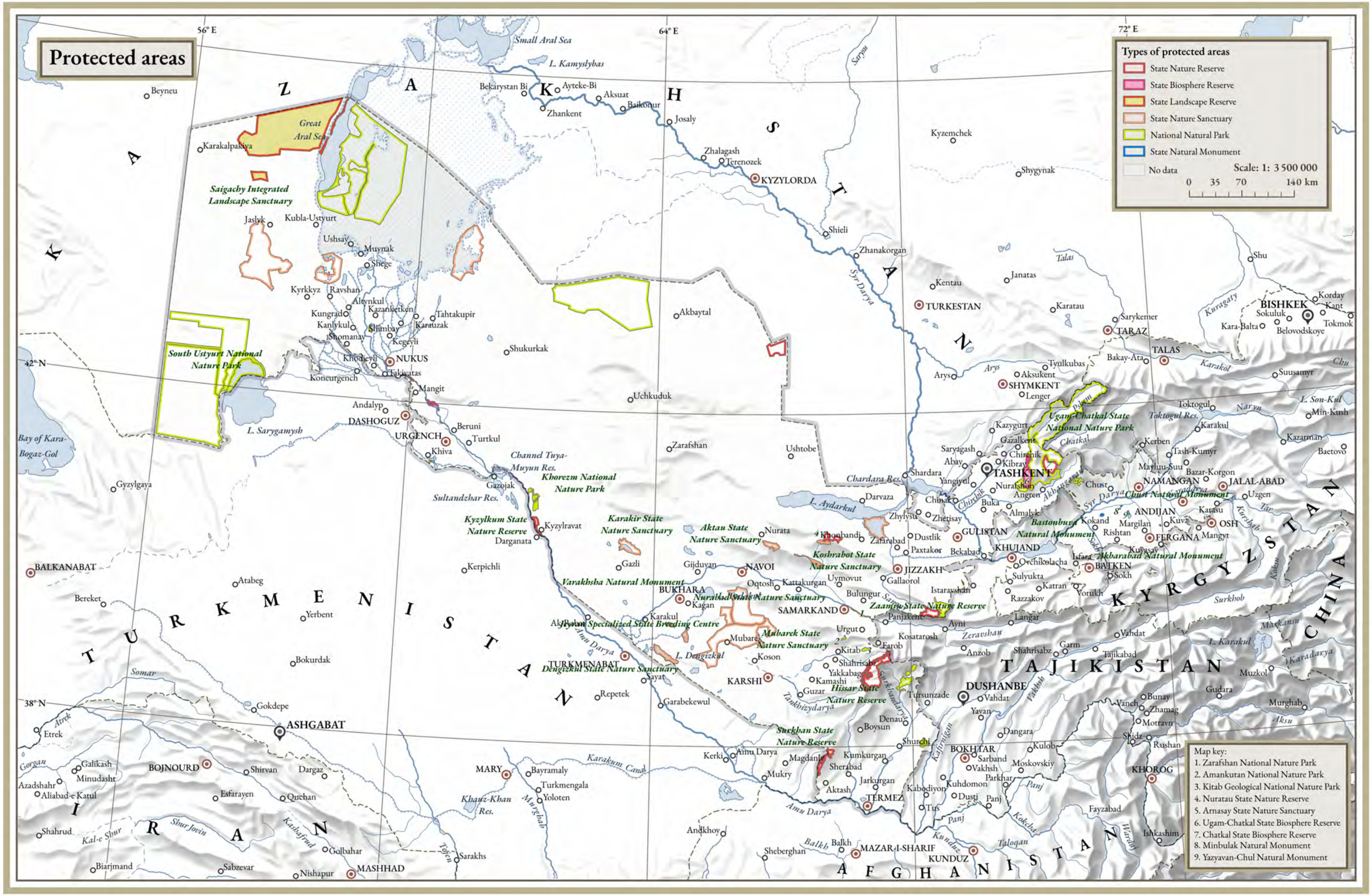
207 Esipov et al. (2016) Central Asia: Uzbekistan. In: McCarthy T., Mallon D. (Eds.), SNOW LEOPARDS, Biodiversity of the World: Conservation from Genes to Landscapes. Academic Press, United Kingdom: 439–448 https://doi.org/10.1016/B978-0-12-802213-9.00034-1/

208 Gritsina M.A.(2019) The Caracal Caracal caracal Schreber, 1776 (Mammalia: Carnivora: Felidae) in Uzbekistan. Journal of Threatened Taxa. 11 (4): 13470–13477.

209 Bull et al. (2013) When is biodiversity offsetting appropriate? Frontiers in Ecology and the Environment. 11 (9): 492–501. https://doi.org/10.1890/120066.

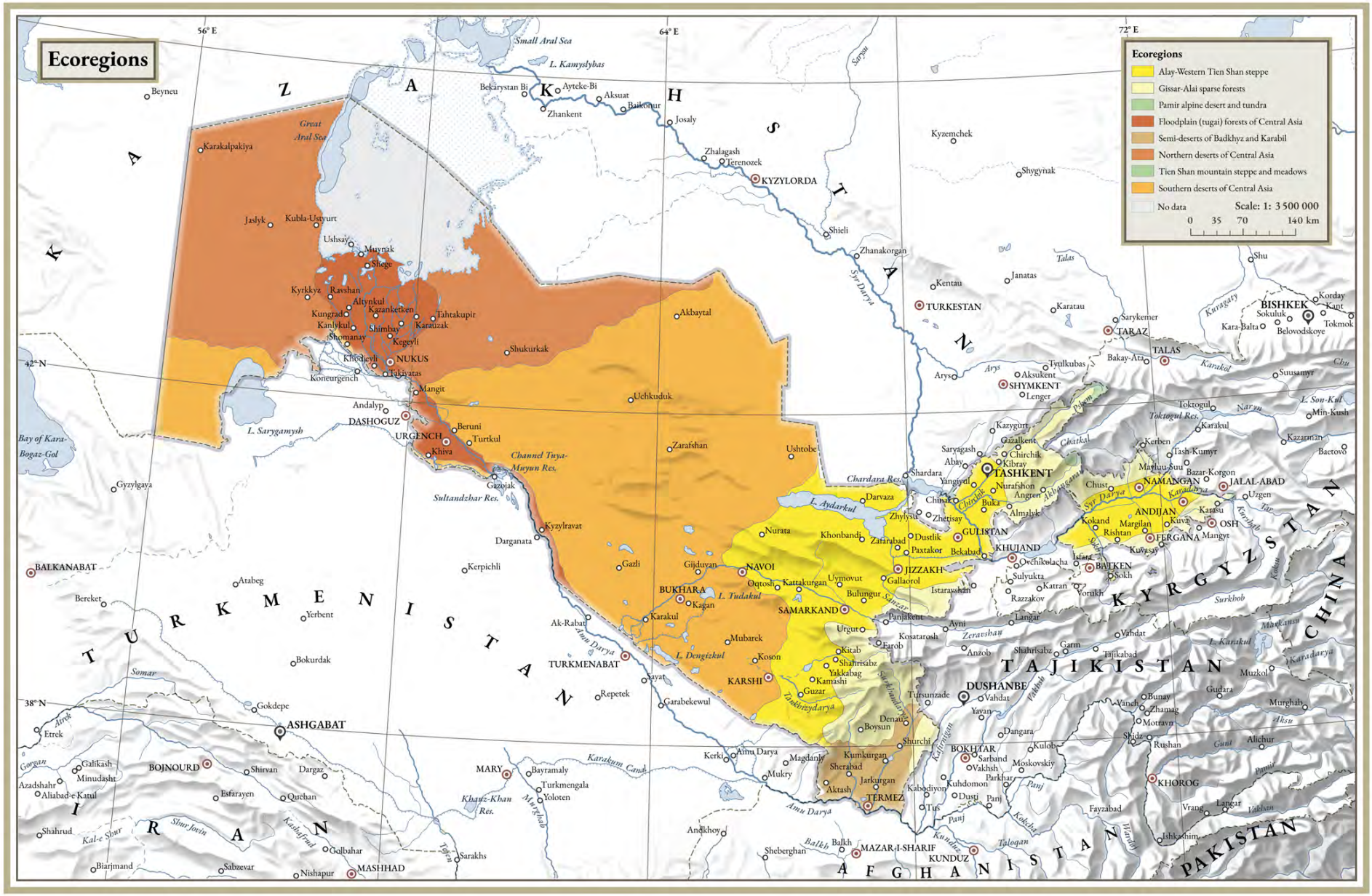


Natural landscape in Uzbekistan



According to the World Database on Protected Areas (WDPA) and national coordinators.

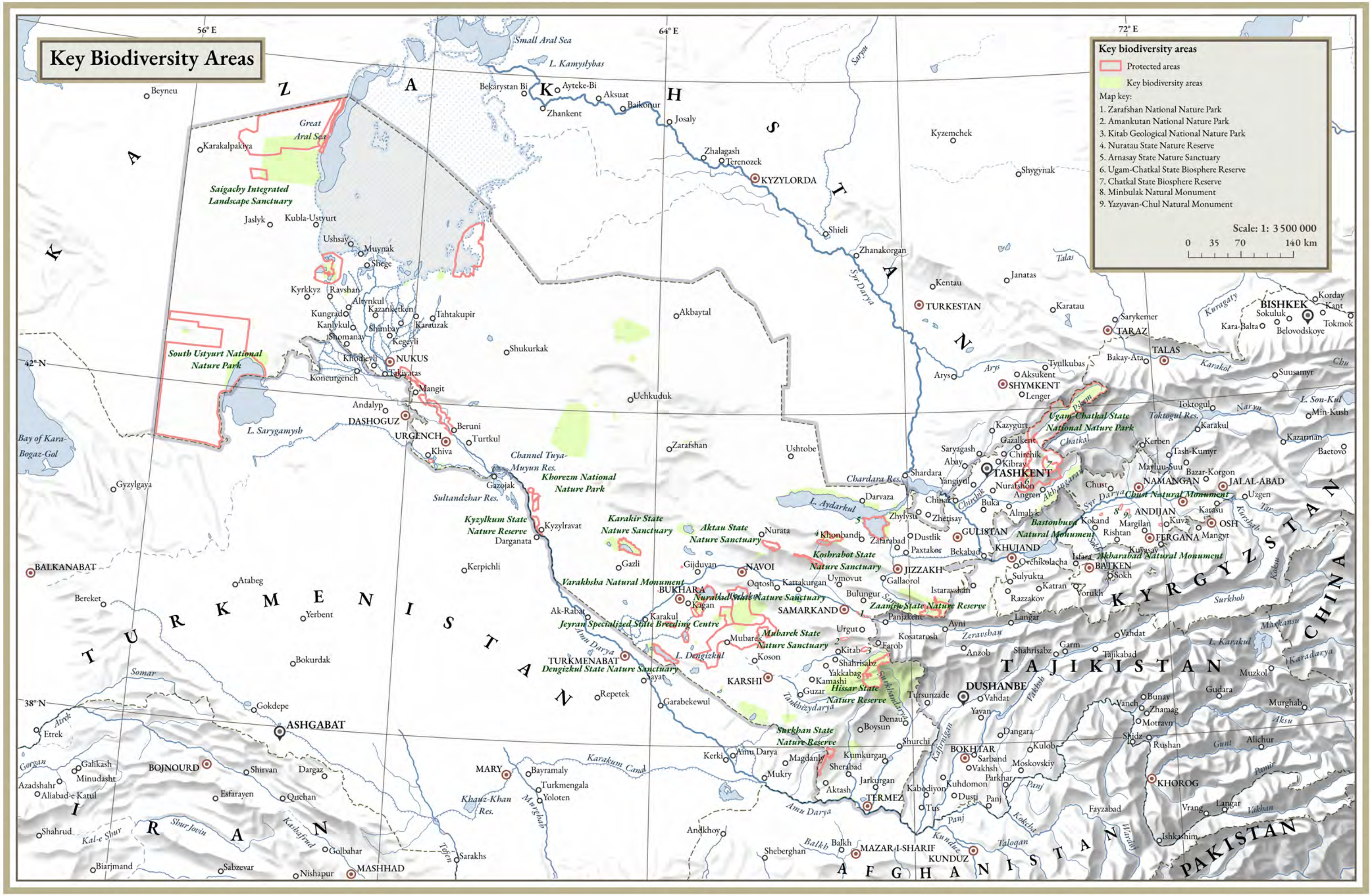
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Ecoregions[210] are relatively large areas of land or water that are important for the conservation of global biodiversity because they contain distinctly different sets of habitats and species.

210 Terrestrial Ecoregions of the World | Publications | WWF

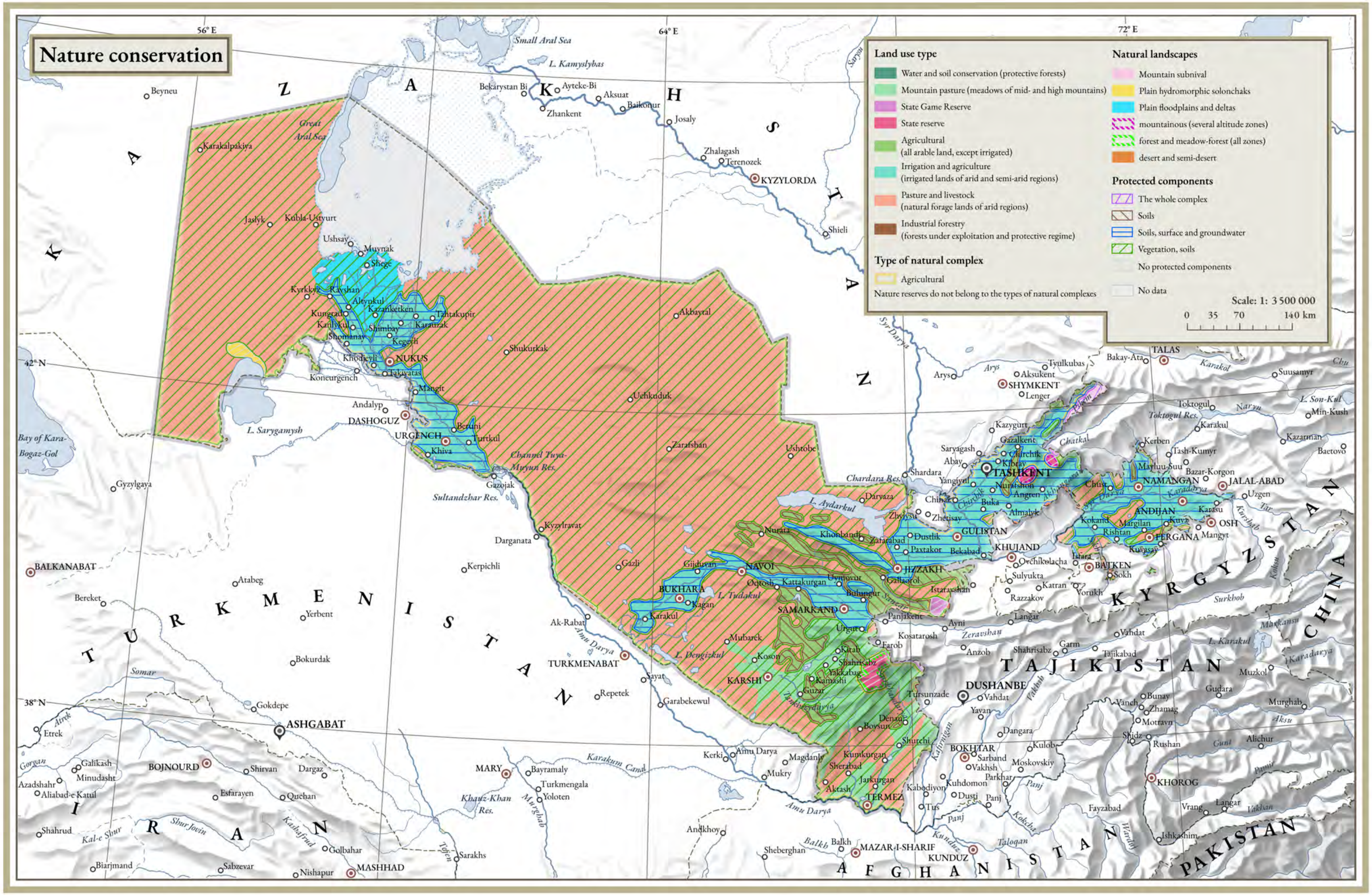
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Key biodiversity areas (KBAs) are territories or water areas with a high proportion of endemic species in different taxonomic groups (excluding microorganisms), which determines their special value for the protection of biodiversity on a regional and global scale.[211]

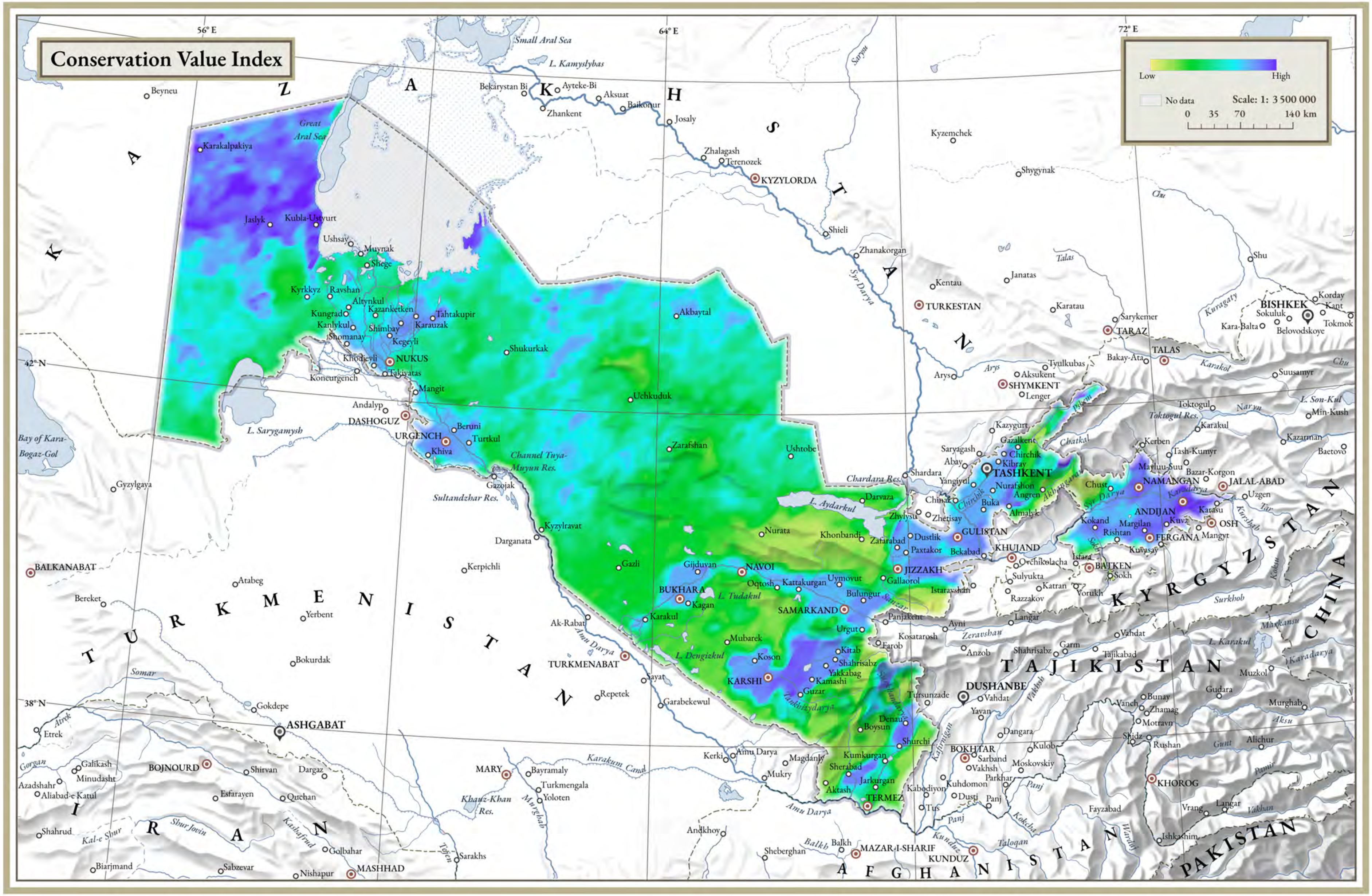
211 BirdLife International (2024) Important Bird and Biodiversity Area (IBA) digital boundaries: September 2024 version. BirdLife International, Cambridge, UK. http://datazone.birdlife.org/site/requestgis.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Map «Nature Conservation of the USSR». 1:4,000,000, GUGK (1989) Guidelines for maps for higher education institutions. Nature Conservation of the USSR [M. 1:4,000,000 / Section written by S.E. Salnikov et al.]. 66 p.

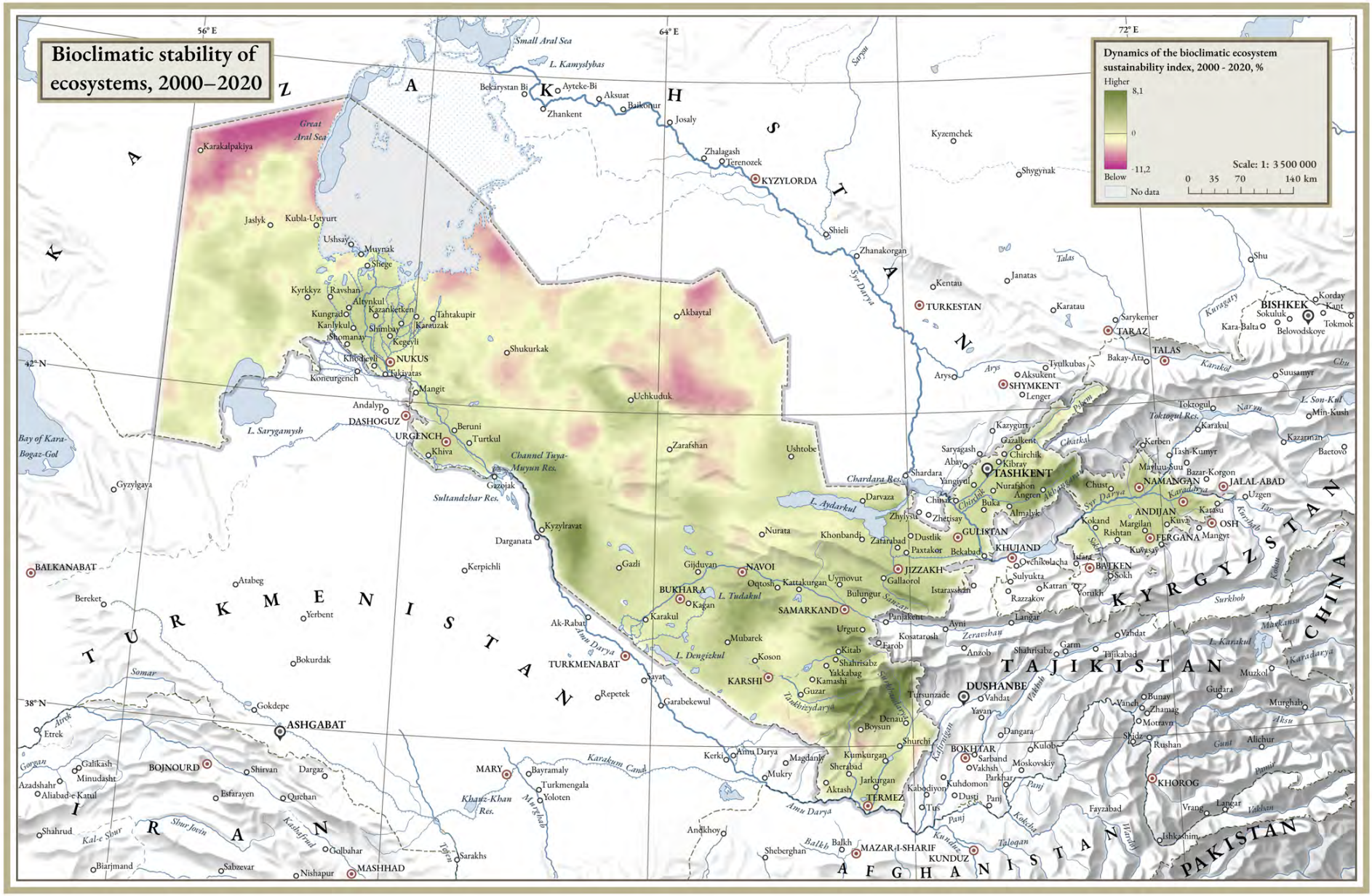
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



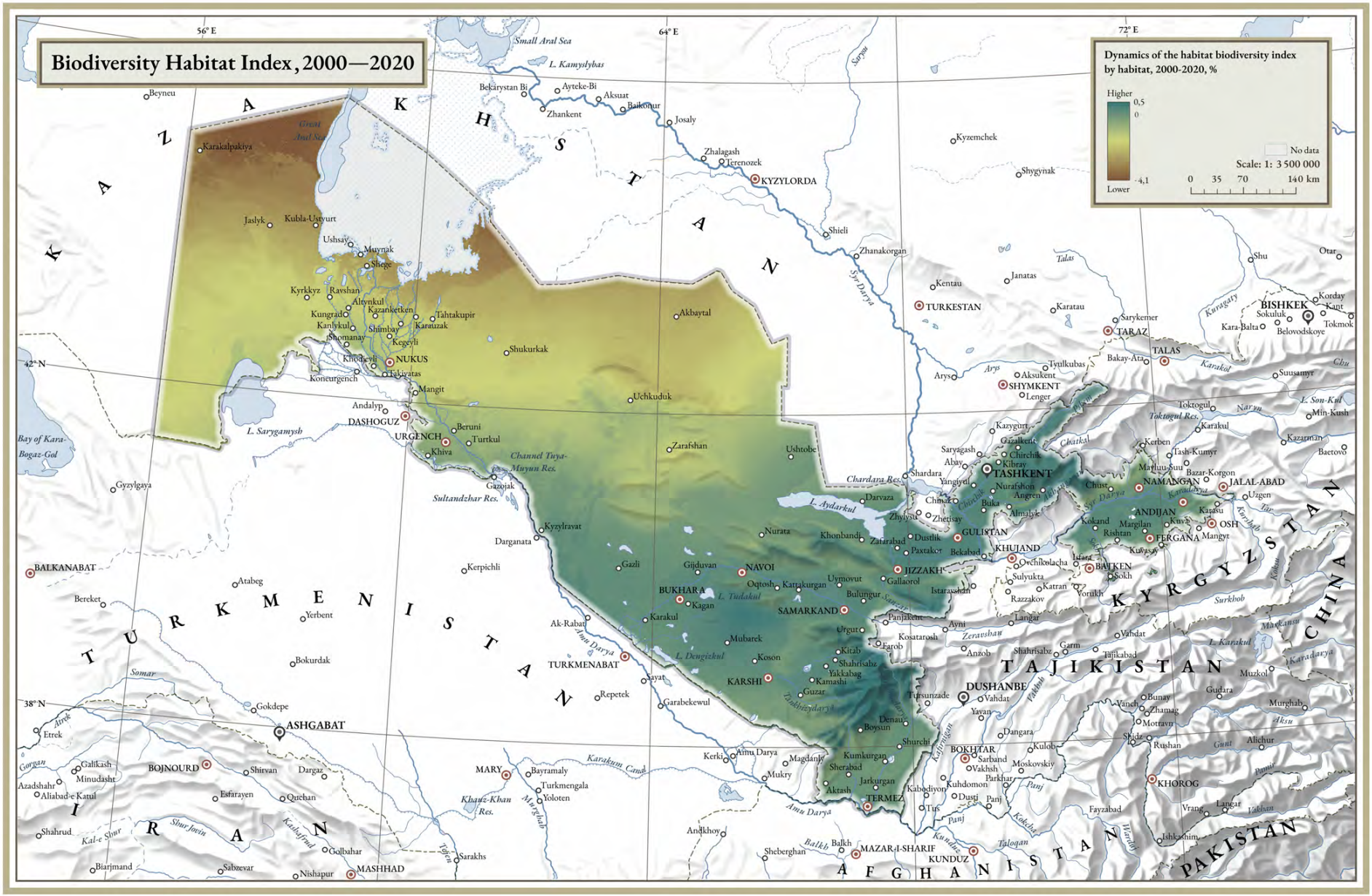
Based on NatureMap/IIASA[212] data, 10 km resolution; time span ≈ 2015–2019). The priority of sites was determined using spatial optimization: based on a regular grid, rank estimates of the contribution of each cell to achieving biodiversity conservation goals, carbon stocks vulnerable to land-use conversion, and freshwater resource management were calculated for a given proportion of the considered area; stratification by biomes and the existing network of protected areas (WDPA-2019) were taken into account. The layer values are rank classes (1–100) of the proportion of area with the highest expected conservation effect.

212 NatureMap Priority maps to Areas of global importance for conserving terrestrial biodiversity, carbon, and water

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.

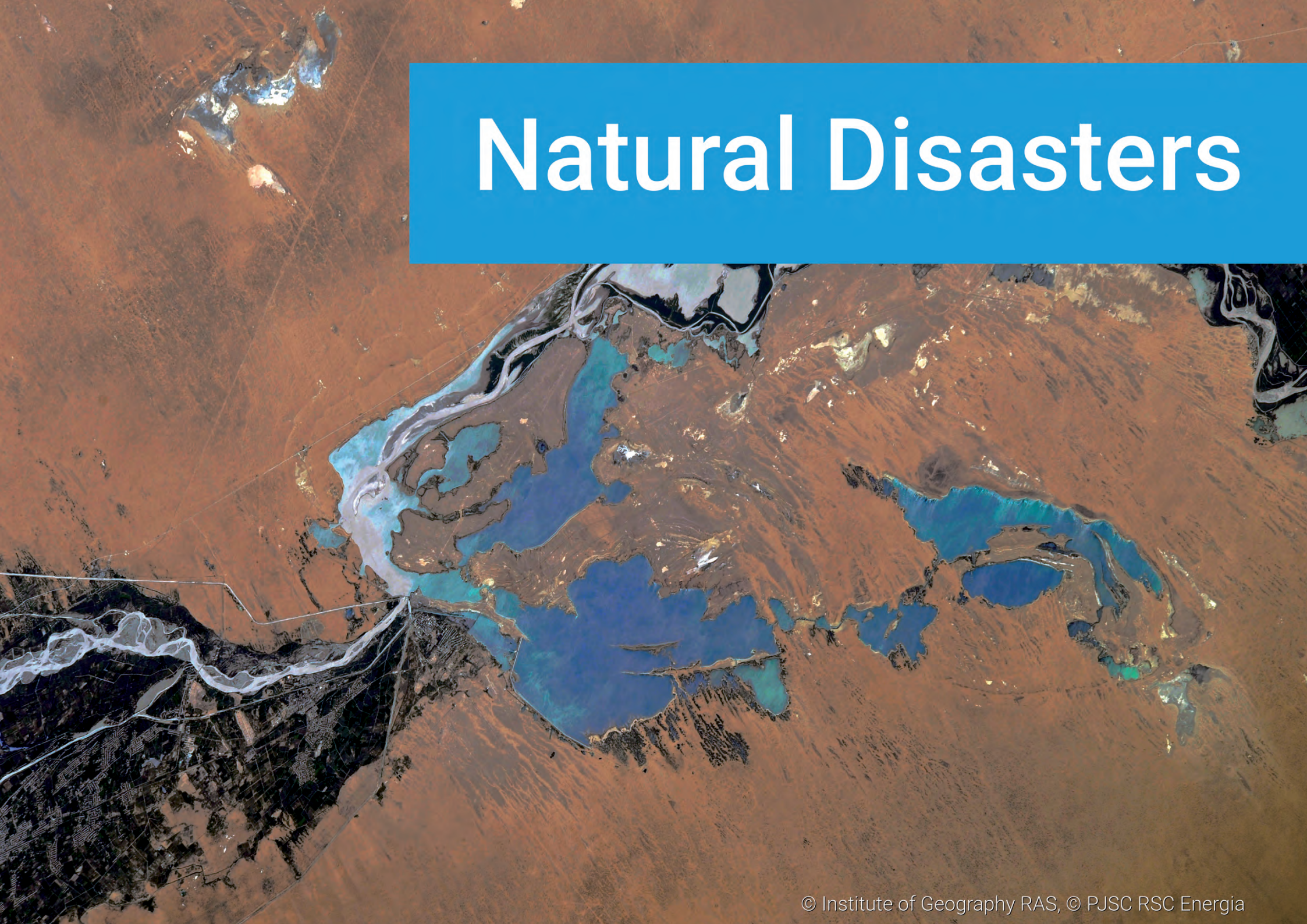


The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



The original scale of the map is 1:3 500 000. The map image has been modified for page layout.

Natural Disasters



© Institute of Geography RAS, © PJSC RSC Energia



7.1. Key aspects

- Compared to other Central Asian countries, the frequency of adverse and dangerous natural disasters in Uzbekistan is relatively low.
- Mudflows in the mountainous and foothill regions of southeastern Uzbekistan pose a significant and growing threat to the population due to climate change.
- In lowland areas, floods are one of the most common and dangerous natural disasters, especially as a result of transboundary floods in mountain river valleys of neighboring countries.

7.2. Overview

Compared to other Central Asian countries, the frequency of severe and dangerous natural disasters in Uzbekistan is relatively low. According to the Centre for Research on the Epidemiology and Disasters, 184 major natural disasters occurred in Central Asia from 1999 to 2022. The majority of the resultant damage from nine events occurred in Tajikistan (71.4 per cent), followed by Kazakhstan (10.2 per cent), with Uzbekistan accounting for much less (5 per cent)[213]. According to the same database, Uzbekistan is close to the global median for natural disaster risk, ranking 112th out of 191 countries. The highest risks within the republic are associated with seismic events, where the country ranks second in the world for this metric. The country is also among the top 20 countries in the world for drought susceptibility while flood hazard is above average. The country's statistics on natural disasters for the period from 1980 to 2024, available in international databases, appear to be very incomplete. For this period, EM-DAT data provide information on only 10 natural disasters that had serious consequences, i.e., resulted in material damage and casualties[214].

According to more comprehensive national data, 80 hazardous meteorological and geophysical events have been recorded in Uzbekistan over the past 10 years: approximately 64 per cent of these were associated with mudflows, 33 per cent with landslides and the remainder with avalanches. However, these statistics do not include hydrological phenomena such as floods, which are the most common of the republic's natural disasters and are closely linked to climate change. The flood and mudflow season in the region is gradually shifting from the traditional June to July period to between April and June. Heavy precipitation and rising temperatures in mountainous regions in March and April have also lead to the increasing severity of snow avalanches, threatening both lives and livelihoods.

Populations and infrastructure in affected areas are vulnerable to natural disaster risks, including earthquakes, landslides, avalanches, droughts, mudflows, and floods, which have a significant impact on the country annually. Key factors contributing to this vulnerability include poor safety regulations and standards, poor land-use planning, deteriorating infrastructure, worn-out production equipment and land degradation, all of which increases the vulnerability of people and property subjected to a disaster.

213 Centre for Research on the Epidemiology of Disasters (CRED) | PreventionWeb.
214 Uzbekistan UZB - Historical Natural Disasters | Climate Change Knowledge Portal

Due to climate change, an increase in the frequency and intensity of natural disasters is expected in Central Asia. The first group of climate risks, associated primarily with increased droughts, includes areas located in the lower reaches of Uzbekistan's main rivers. In addition to droughts, this risk group also includes other hazardous hydrometeorological phenomena, such as dry winds, low water levels, water shortages and extreme heat. The most vulnerable regions in this context are the Republic of Karakalpakstan and the Khorezm region. Most areas located in the middle reaches of the republic's rivers fall into the medium-risk group. Among these are areas that rely on small rivers for irrigation as they will be more vulnerable to the impacts of climate change. The Andijan, Fergana and Tashkent regions are considered the least vulnerable to droughts due to their geographic location.

The second group of climate risks is associated with area of mountainous terrain *(see Hypsometric map; map 'Geomorphological map'; map 'Potential exodynamic hazards of the territory')*. The impact of climate change on the frequency and intensity of other natural hydrometeorological phenomena, such as mudflows, depends on changes in the nature and regime of precipitation. Currently, the most dangerous season is spring, when snowmelt can coincide with heavy rainfall. While no clear trends toward increasing mudflow activity have been identified, the calendar extension of the mudflow-prone period, along with the increased proportion of liquid precipitation in February and March, could lead to more frequent mudflows in the foothill and mountainous regions of Uzbekistan. These mudflow-prone areas are characterized by high settlement density as the valleys are home to the majority of irrigated land. Potential outburst lakes, which form in the marginal zones of retreating glaciers, also pose serious and difficult-to-predict risks due to climate change warming the mountainous regions. In Uzbekistan, 242 such lakes that require constant monitoring have been identified, 40 per cent of which are assessed as having a high risk of outburst[215]. However, modelling suggests that climate change should not lead to increased risks of avalanches as higher temperatures tend to strengthen the integrity of snow cover on slopes.

215 Petrov M. et al. (2017) Glacial lake inventory and lake outburst potential in Uzbekistan. The Science of The Total Environment. 592: 228-242.

Droughts. In Uzbekistan, droughts are most often caused by stationary anticyclones covering a large area resulting in lingering low cloud cover, abundant sunshine, low precipitation and the persistence of dry air. Atmospheric drought increases plant transpiration and soil desiccation, leading to these dry soils providing reduced crop yields. These issues are compounded by reduced river flows and a shortage of irrigation water, leading to agricultural drought. Accordingly, different types of droughts are distinguishable, namely atmospheric, hydrological and agricultural, and indices have been developed and used for each type to assess their severity.

The country has a fairly dense network of 79 meteorological stations and 130 hydrological posts, whose observations allow for rapid assessments of precipitation patterns and water flow dynamics in rivers, canals and reservoirs across the republic. At 61 meteorological stations and 30 hydrological posts, agrometeorological observations are conducted every two days to monitor soil temperature and



Dry coast, the problem of the Aral Sea

moisture in the root zone as well as freeze-thaw dynamics, crop damage and overall crop health.

According to Uzhydromet, in the lowland part of the country, severe droughts occur every 10 years, and droughts with precipitation deficits of more than 20 per cent occur every five years. In many areas, precipitation deficits (atmospheric droughts) are almost constant. An analysis of atmospheric drought monitoring data from 1961 to 2020 at 34 meteorological stations located across the country revealed that the highest number of days with atmospheric drought in Uzbekistan were observed in Surkhandarya (65 days), Navoi (56 days), Kashkadarya (55 days) and Bukhara (50 days)[216].

Over the past decade, droughts have been increasing in frequency, becoming more frequent in the summer and autumn, especially in the lower reaches of the Amu Darya. In the 1980s and 1990s, droughts occurred on average twice every ten years. Between 2000 and 2012, extreme meteorological droughts were recorded four times, namely in 2000, 2001, 2008 and 2011. The severe droughts of 2000 to 2001, which was particularly dangerous in terms of its scale and impact on agriculture and water management, prompted the Government to take emergency measures in the most affected regions and to conduct an analysis and assessment of the country's vulnerability to drought[217]. However, a few years after this series, six consecutive dry years followed from 2019 to 2024 *(see map 'Palmer Drought Index, 2000-2004')*.

The recent drought is comparable in severity to the catastrophic two-year drought of 2000–2001. The drought severity estimates presented here are based on the Palmer Soil Severity Index, a balance equation that includes evapotranspiration, soil moisture recharge, surface runoff and soil surface moisture loss as key elements. Accordingly, the index is calculated using data on average monthly air temperature, monthly precipitation totals, normal air temperature and minimum field moisture capacity. The latter depends on soil particle size distribution, structure, humus content, alkalinity and salinity. Only natural factors are considered in calculating the index, whereas the actual situation can change significantly, for better or worse, depending on anthropogenic (management) factors, such as irrigation regimes, reservoir levels and technical availability of groundwater.

The effects of the 2000–2001 drought were most severe in the Republic of Karakalpakstan and the Khorezm Region, where not only crop yields fell, but also reservoirs covering a total of 160,000 hectares disappeared and groundwater levels dropped to between 10 to 15 metres. Local authorities called the drought the most severe in the last 100 years and the Government was forced to take emergency measures to temporarily relocate children and pensioners outside the affected region[218]. Furthermore, farmers received a one-year land tax exemption, were granted livestock loans and received increased cash benefits to help cope with the aftermeth[219]. The centre of the massive drought was located in the middle reaches of the Amu Darya River. A rapid analysis by UNDP experts revealed that these consequences were largely the result of inadequate planning, forecasting and monitoring of water resources at the regional, national and local levels, leading to a 20 to 30 per cent reduction in water availability in Karakalpakstan and a 35 to 80 per cent reduction in the Khorezm Region, compared to approved limits[220].

The impact of droughts in the early 2020s was exacerbated by the fact that the water volume in the Tuyamuyun Dam reservoirs fell below the 'dead volume', rendering the Dam unable to regulate flows in the lower reaches of the Amu Darya[221]. The dam is a key facility for not only controlling these flows but also distributing water and energy resources between Uzbekistan and Turkmenistan. The persisting problem here, which involved a series of four reservoirs, is the sharp reduction in their usable capacity, up to 60 per cent, due to the large amount of sediment that has accumulated on the reservoirs' bottoms over their 65 years of operation.

Earthquakes. Turning the focus to earthquakes, Uzbekistan, particularly its eastern part, is located in a seismically active zone *(see map 'Geography and intensity of earthquakes in Uzbekistan')*. The eastern part belongs to the neotectonic epiplatform orogen of the Western Tien Shan, whose development is associated with the formation of deep fault networks, while the western part belongs to the quieter epi-Hercynian Turanian platform. Earthquakes with magnitudes M≥7 and epicentral intensities of eight to nine on the Moscow Standard Scale (MSK-64) scale have occurred in Uzbekistan and adjacent regions, both historically and in modern times.

The country has a well-established statistical database recording seismic events and a strong scientific school of study. Instrumental seismology in Uzbekistan began in 1892, when 14 seismoscopes of the Russian Geographical Society were installed in Tashkent, with regular seismic observations being made from 1901 onwards. Following the devastating Tashkent earthquake of 26 April 1966, the Institute of Seismology of the Academy of Sciences of Uzbekistan was established. The most comprehensive data catalogue available for Uzbekistan's earthquakes covers the period from 1955 to 2000. During these 45 years, 8,630 earthquakes with a magnitude greater than 2.5 were recorded. Of these, 60 had magnitudes of five to 5.5, 14 had magnitudes of 5.5 to 6.5, four had magnitudes

216 Tolipov H., Sokolov V. (2022) Uzbekistan country survey report. Draft concept for revision the National Action Program to combat drought and land degradation in Republic of Uzbekistan. GWP-CACENA. Tashkent. 48 P.
217 Ibid.
218 Uzbekistan - Drought OCHA Situation Report No. 2 | OCHA
219 Ibid.
220 UNDP (2003) Impact Assessment of the 2000-2001 Drought in Karakalpakstan and Khorezm.
221 Уровень воды в водохранилищах Туямуюнского гидроузла опустился ниже «мёртвого объёма» – Новости Узбекистана – Gazeta

Table 22. Intensity (MSK-64 scale) and recurrence period of earthquakes for major cities of Uzbekistan[1]

City	Intensity and recurrence period of earthquakes (years)			
	7	8	9	10
Alamyk	50	-	-	-
Bukhara	50	-	-	-
Fergana	50	100	-	-
Kokand	50	200	-	-
Muruntau	1000	-	-	-
Navou	100	-	-	-
Samarkand	150	500	1000	-
Shargun	50	200	1000	> 1000
Tashkent	25	100	-	-
Termez	100	-	-	-

1 Ibid.

of 6.5 to seven and three had a magnitude of seven or more[222].

Thus, the country regularly experiences earthquakes of varying intensity: an average of 190 tremors per year with a magnitude greater than 2.5, of which, two have magnitudes greater than 5. For example, in 2021, an earthquake with a magnitude of 4.9 was recorded in the Bukhara Region and another registering as 5.0 occurred in the Namangan Region. These two earthquakes occurred at relatively shallow depths (from one to 10 km), which is typical for the region. It is important to note that earthquakes can be felt at significant distances from their epicentres and in Uzbekistan's case, tremors with epicentres in Afghanistan and Tajikistan are regularly felt in Tashkent.

Seismic statistics were used by construction and other government agencies to assess the how often destructive earthquakes of various magnitudes were likely to occur in 333 settlements in Uzbekistan. Below, Table 22 provides an overview of this assessment for the country's major cities.

While an earthquake measuring four is considered 'noticeable', those measuring five on the MSK-64 scale are formally considered 'emergencies'. Having said that, if building codes are followed, the consequences of such earthquakes may include the swaying of furniture and cracks in plaster, but little more of any great consequence. However, even the most common earthquakes, measuring two to three, can pose a danger to local residents of many settlements as these are often comprised of low-rise, improvised buildings. Such structures are unstable due to the use of locally available, fragile building materials (such as adobe), poor mortar adhesion to bricks, shallow foundations, asymmetrical room layouts, built-in niches, flimsy outbuildings adjacent to the main house and so forth. Such buildings do not meet construction standards suitable for high-seismicity zones and, as such, represent a danger to their inhabitants.

The Tashkent earthquake of April 26, 1966 was a dramatic event. Throughout its long history, Tashkent has been subject to numerous earthquakes. For example, from 1868 to 2002, 11 earthquakes with an intensity exceeding 6.0 on the MSK-64 were recorded, resulting in the destruction of buildings and loss of life. However, the 1966 earthquake caused particularly widespread destruction in Tashkent and, in the aftermath, the city's residential area shrank from 7.2 million m2 to 2.8 million m2 as over 300,000 of the city's 1.2 million residents lost their homes. The scale of the destruction was due to the poor quality of construction of the city's private adobe houses, virtually all of which were destroyed even although it was only a 5.3 magnitude earthquake. This earthquake intensity could be increased by approximately 1 on the Richter scale due to the prevalence of soft soil in the city. However, no collapses of more modern buildings have been recorded, further highlighting the critical importance of quality construction in seismically active zones.

In many Uzbek cities, such as Tashkent (population 2.3 million), Samarkand (0.58 million), Bukhara (0.29 million) and others, seismic events with magnitudes of seven or eight on the MSK-64 are considered highly likely, the only question is when. In 1995, Uzbekistan implemented stricter design standards for buildings and structures, requiring a radical renovation of the housing stock to meet these new standards. Currently, approximately 40 per cent of all the country's city residents still live in buildings that were not properly designed for seismic resistance[223].

Mudflows are characterized by high flow velocities and a high concentration of solid material, a combination that makes them highly destructive. They are highly erosive, causing channels and banks to deform and can even change the courses of rivers. By transporting enormous quantities of solid material, they create characteristic mudflow deposits, alluvial fans and proluvii, that form physical barriers and can either bury or destroy residential areas, agricultural lands and a wide variety of infrastructure.

The total area potentially susceptible to mudflow activity in Uzbekistan is 53,770 km2, or 76 per cent of the country's mountainous region *(see map 'Mudflow zones')*. Mudflows pose a significant risk to commercial and residential properties, particularly in the foothill regions of the eastern part of the country. Damage typically includes human casualties, material losses and disruptions to the ecological balance. Approximately 61 per cent of mudflows in the country cause material and community damage, with fatalities occurring in 17 per cent of cases. The magnitude of damage that occurs, or potential damage should a mudflow strike a particular location, is largely determined by the density of commercial and residential properties. This is particularly salient in the foothills at the outlets of mountain valleys. According to the Uzhydromet network, there are 709 mudflow-prone streams in the country, and 858 residential and commercial properties



View over the winding roads and mountains between Tashkent

are located within some of their potential impact zones[224].

As is the case with earthquakes, the country has an extensive mudflow statistical database which allows national experts to conduct in-depth spatial and temporal analyses of this type of natural disaster. Systematic mudflow studies in Uzbekistan were first organized in 1928, focused on the southwestern spurs of the Gissar Range, and throughout the Soviet period this work was expanded to identify mudflow-prone areas and mudflow centres throughout Uzbekistan. At the end of the 20th century, the Scientific Research Hydrometeorological Institute systematized data on mudflows and their consequences for the republic[225].

In Uzbekistan, almost all the rivers, including temporary streams that appear in the foothills and mountains, are prone to mudflows. The advent of catastrophic, highly destructive mudflows in any given basin has a recurrence period that averages several decades, although this does not exclude the possibility that such mudflows may occur more frequently[226].

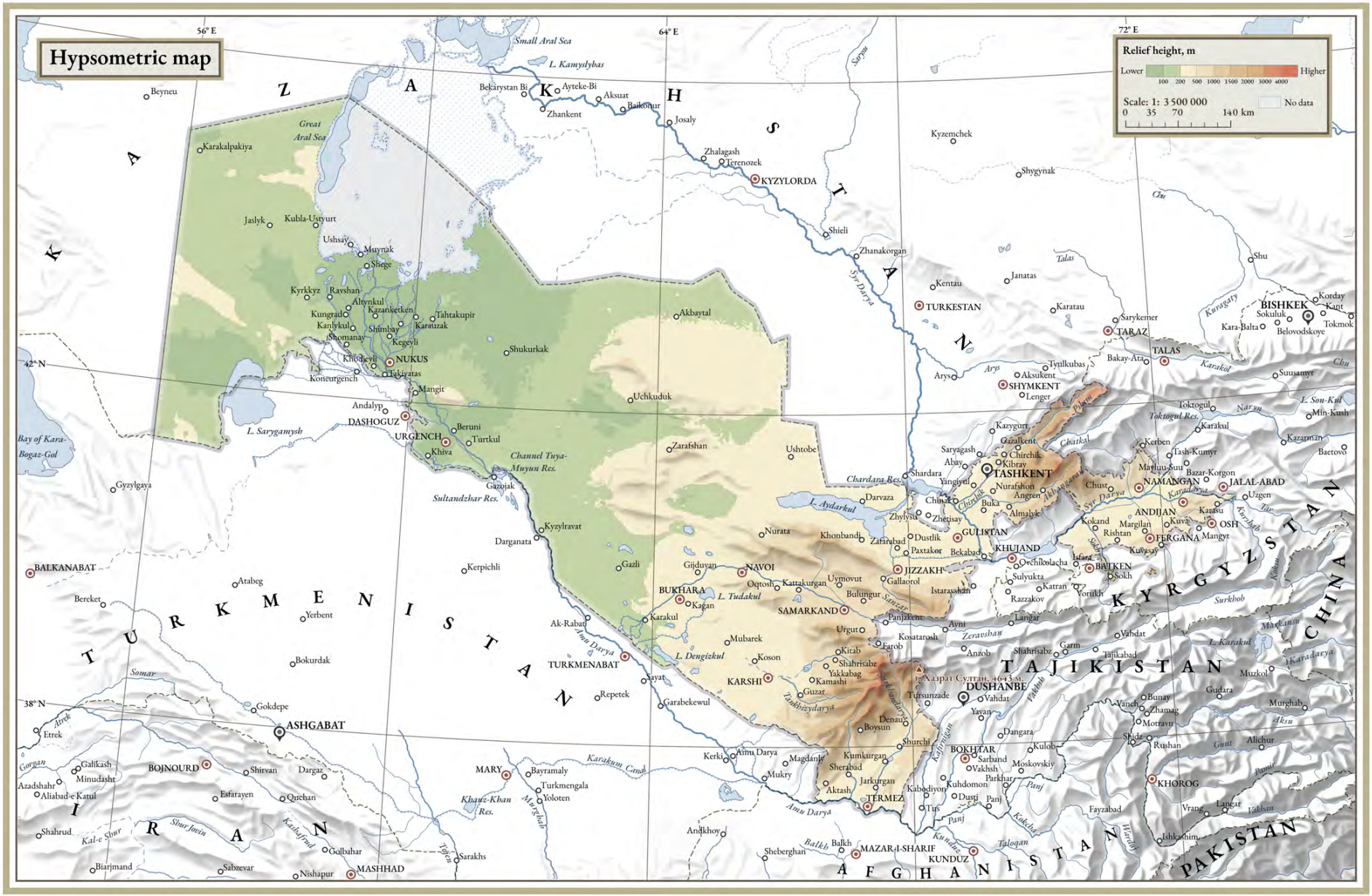
222 Mavlyanova et al. (2004) Seismic code of Uzbekistan. 13th World Conference on Earthquake Engineering Vancouver, B.C., Canada August 1-6, 2004. Paper 1611. 8 P.

223 Mavlyanova et al., 2004.

224 Dergacheva I.V. (2017) Problems of Forecasting and Preventing Transboundary Floods in Mountainous and Foothill Regions of Uzbekistan. NIGMI, Uzhydromet, (in Russian)

225 Dergacheva et al. (2021) Mudflow hazard in the foothill and mountainous regions of Uzbekistan. E3S Web of Conferences. 263, 02019.

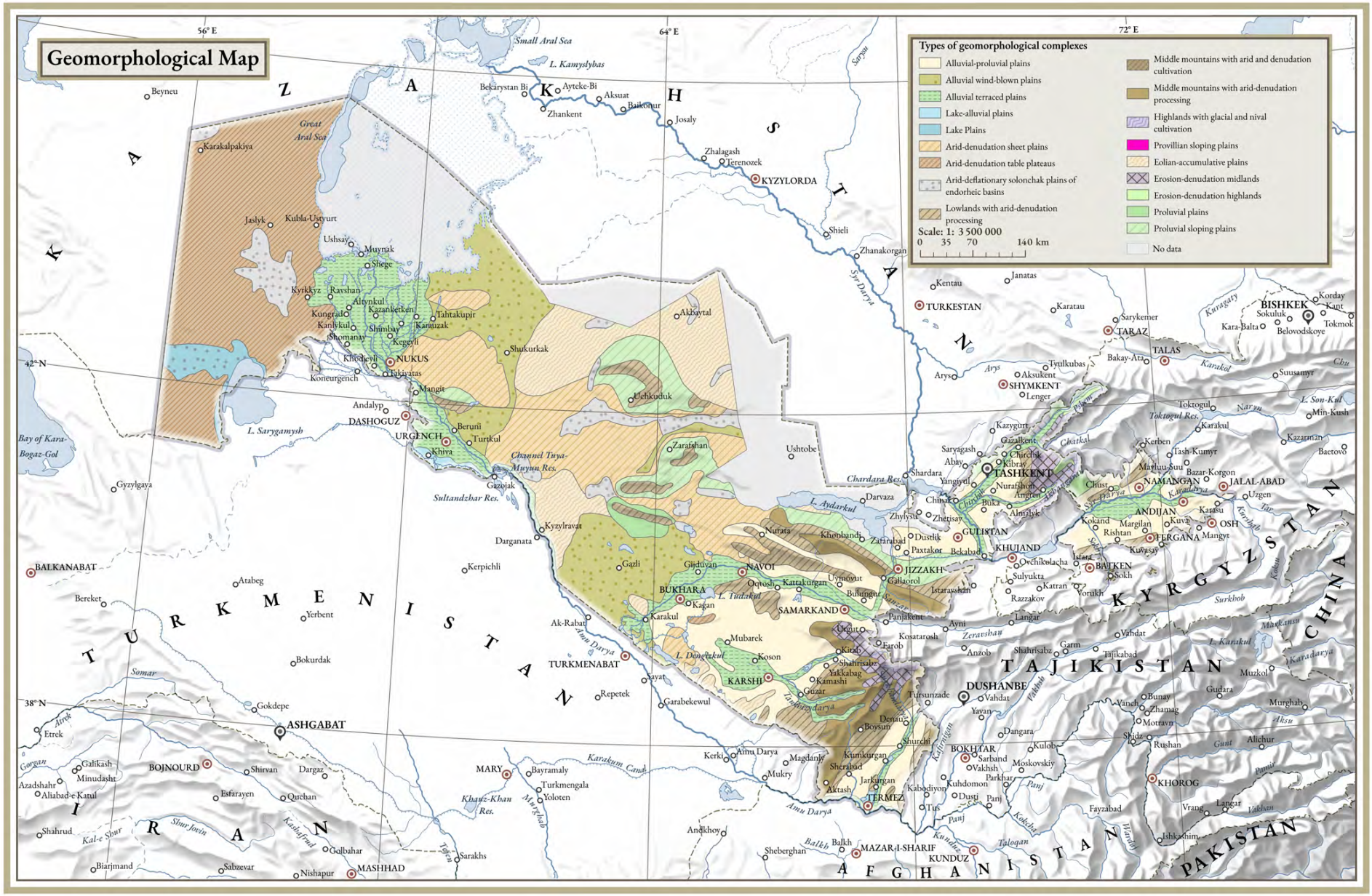
226 Salimova B.D., Dergacheva I.V. (2022) Study of mudflow activity in mountainous and foothill regions of the Republic of Uzbekistan. Problems of modern science and education. 9 (178): 48–52. (in Russian)



Terrain based on NASA Shuttle Radar Topography Mission (SRTM) (2013).[227]

227 https://doi.org/10.5069/G9445JDF

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Atlas of the Uzbek Soviet Socialist Republic (1963) Tashkent-M.: Academy of Sciences of the Uzbek SSR, GUGK.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.

In 90 per cent of cases, heavy rainfall is the direct cause of mudflows. Only four per cent of mudflows are associated with intense snowmelt and six per cent are due to other causes, including glacial lake outburst floods.

Between 1950 and 1986, there were 662 mudflow days recorded in the foothills and mountains of Uzbekistan, 50 per cent of which caused notable economic damage and 25 per cent were catastrophic[228]. In the year from 1987 to 2020, some 515 mudflow days have been recorded in Uzbekistan, with a slight decrease in the number of mudflows observed in almost all regions of the country. In the 1950 to1986 period, 180 mudflows days were recorded in the Namangan Region, whereas from 1987 to 2020, this figure was 101. In the Fergana Valley these figures are 119 and 73; in the Andijan Region, 73 and 35; in the Surkhandarya Region, 116 and 57; in the Kashkadarya Region, 74 and 60; in the Tashkent Region, 55 and 61 (an increase); in the Samarkand Region, 115 and 57; in the Jizzakh Region, 63 and 36; and, finally, in the Navoi Region, 16 days in both periods. These statistics do not indicate a decrease in the intensity of mudflow activity in Uzbekistan but are associated with more active anti-mudflow measures in the country, which include the construction of anti-mudflow structures and mudflow storage facilities to intercept and discharge slope runoff[229]. The foregoing is not universally embraced as some experts cite their own statistics on natural disasters to argue that mudflow activity has increased in recent years[230]. Whatever the case may be, all agree that the risk of mudflows remains very high in the susceptible parts of the country.

The Fergana, Namangan and Andijan regions account for 41 per cent of all mudflow days in the country in modern times, with the Fergana Valley being the most prone area. Indeed, this valley is considered the most problematic area for mudflows throughout the entire Central Asian Region. Almost all permanent and temporary streams flowing into the Fergana Valley are mudflow-prone to varying degrees, however, the southeastern slopes of the Chatkal Range (which generate 40 per cent of all mudflows in the Fergana Valley), the northern slope of the Alay Range (30 per cent) and the northern slope of the Turkestan Range (25 per cent) are particularly prone to mudflows. The second most mudflow-prone areas in Uzbekistan are the slopes of the Gissar Range, the southern slopes of the western part of Zarafshan, and the western slopes of the Baysuntau Mountains (Surkhandarya and Kashkadarya regions), where 22.6 per cent of all mudflow days were recorded from 1987 to 2020.

In Uzbekistan as a whole, the highest number of mudflows occurs in May, the peak month for mudflow activity in the Fergana Valley. In the Surkhandarya and Kashkadarya River basins, as well as in the Samarkand and Tashkent regions, the mudflow peak occurs in April, coinciding with intense snowmelt and heavy rainfall. There is a direct correlation between climate change and the annual mudflow pattern due to a calendar shift in rainfall activity. In recent decades, this shift has pushed much mudflow activity from April to May, which correlates with increased precipitation and rising temperatures[231], both of which increase the risk of extremely destructive mudflows.

Research into mudflow factors allows researchers to develop predictive empirical models for each mudflow-prone zone in the republic. As such, given that slope moisture is known a contributing factor, in the Fergana Valley, mudflow formation becomes probable with precipitation exceeding 15 mm per day; at 20 mm, the probability reaches 45 per cent; and 30 mm can lead to catastrophic mudflows in mountain stream beds. For the Zaravshan Valley, Kashkadarya and Surkhandarya basins, the required daily rainfall for mudflow formation is 20 to 22 mm, while catastrophic mudflows require more than 30 to 40 mm. Mudflow formation in the Chirchik and Akhangaran river basins in the Tashkent region requires more than 32 mm of precipitation per day with slope moisture of 15 mm. Daily rainfall of 20 mm has only a 20 per cent chance of causing a mudflow, while catastrophic mudflows can form with precipitation exceeding 50 mm, as the foothills here are heavily forested there. More complex integrated models have also been developed that make it possible to make more accurate short-term forecasts to prevent or mitigate the would-be catastrophic consequences of mudflows[232].

Floods in Uzbekistan, particularly in lowland areas, are one of the most common and dangerous natural disasters that befall the republic. The gentle slopes of the plains result in low river flow rates, preventing large volumes of water from passing through their channels during floods. As a result, rivers overflow their banks, inundating vast areas of the surrounding lowlands. Floods on lowland rivers are caused by intense spring snowmelt and/or prolonged precipitation in the form of rain and heavy rainfall. Rain-driven floods in temperate climates occur either in the spring, coinciding with snowmelt, or in the summer-fall period.

Floods in Uzbekistan can be caused by a number of natural factors, not the least of which is that Uzbekistan is characterized by significant fluctuations in annual precipitation. Major rivers, such as the Syr Darya and Amu Darya, can overflow their banks as a result of rapid snowmelt and intense rainfall *(see map 'Flood risk')*. In regions with annual precipitation of 100 mm or less, such as the Ustyurt Plateau, the lower Amu Darya and the Kyzylkum Desert, the risk of flooding is negligible compared to the country's mountainous and foothill areas, where precipitation can be 300 to 550 mm per year *(see map 'Density of floods')*. In mountainous areas, snow can lie on the ground for up to 90 or 100 days per year, with snow cover thickness reaching 1.2 to two metres. These conditions contribute to increased runoff during the spring snowmelt. Furthermore, Uzbekistan frequently suffers from strong winds, which can cause surface water movement and contribute to both erosion and flooding.

The most devastating floods in Uzbekistan have resulted from a combination of factors acting in concert. For example, on 26 March 1987, a 5.3 magnitute earthquake occurred in the Tashkent region triggered mudflows that impeded the flow of local river, then, in April and May, heavy rainfall and avalanches resulted in further mudflows. This series of events caused a sharp rise in the region's river levels and resulted in populated areas in several districts and cities being flooded. Across the Tashkent region, 254 homes were completely destroyed, while 12 schools, five kindergartens, two hospitals, six first-aid stations, numerous retail and social facilities were damaged along with much infrastructure. In terms of the latter, this amounted to 505 km of roads, 85 bridges, 464.7 km of power lines, 187 km of communication lines being destroyed while many water and sewer networks and electrical substations were damaged. Livestock farms, warehouses, field camps, hydraulic structures, cotton gins and other facilities were also inundated. At the same time, in the Namangan Region, a dam on the Karadarya River also failed to withstand the pressure created by the rising water level, inundating large areas of cropland, including cotton fields. Uzbekistan's more than 55 reservoirs, most of which are earth-fill dams, also impact the country's hydrological security as failures at these structures pose a risk of flooding should they fail failure[233].

228 Lyakhovskaya I.V., Salikhova G.B. (1989) Forecasting mudflows in the mountains of Uzbekistan. In: 'Chelovek i Stikhiya–89' (Man and Nature–89), Book of Abstracts, Leningrad State University: 63–64. (In Russian)
229 Salimova, Dergacheva, , 2022.
230 Ibid.
231 Salimova, Dergacheva, 2022.
232 Akhmedov, Salyamova, 2018.
233 Ibid.

Uzbekistan also faces transboundary flood risks, such as the potential failure of the natural dam of Lake Sarez in Tajikistan. Rising water levels increase the risk of a dam failure and, as a result, could potentially lead to catastrophic flooding along the Bartang, Panj and Amu Darya rivers. If this scenario were to occur, the disaster could affect a vast area of approximately 69,000 km² in Tajikistan, Uzbekistan, Turkmenistan and Afghanistan. A breach of this natural dam could lead to the complete destruction of infrastructure such as hydroelectric power plants, bridges, roads, power lines, as well as industrial and civil buildings. This could lead to the decommissioning of significant areas of agricultural land.

Glacial lake outbursts in Uzbekistan are somewhat geographically contained as the relevant lakes are only located within three river basins: along the Kashkadarya and Surkhandarya rivers (in the regions of the same name) and the Tashkent Region's Pskem River *(see map 'Ice volume in glaciers')*. Research shows there was a reduction in glacier area in all three basins by an average of 30 per cent over 50 years, from 193.6 km² in 1960 to 135.4 km² in 2010. This glacial retreat has not yet affected the runoff of the related rivers but has led to the fragmentation of large glaciers (over one km²) and the formation of new glacial lakes[234]. These lakes contain large amounts of water and, should they suffer an outburst, would cause catastrophic flooding that could also trigger mudflows.

Proglacial lakes can be relatively small, however, even with moderate peak discharges, if they burst, they can trigger catastrophic mudflows, especially on the steep slopes that typically surround them. Such outbursts have previously occurred in the mountainous regions of Uzbekistan as, for example, happened on 7 July 1998. This event happened in the Shakhimardan River Basin in the Gissar-Alai region, a mudflow of 50,000 m³ was triggered by the outburst of a small proglacial lake, resulting in the deaths of more than 100 people in the Shakhimardan enclave[235].

There are very limited studies in the mountainous regions of Uzbekistan that have sought to provide an inventory of proglacial lakes and assess their potential for outbursts. The most comprehensive study in this regard was conducted in 2017 using very high-resolution satellite imagery (0.5 to two m) and was conducted in conjunction with a field survey of several mountain lakes[236]. Proglacial lakes were identified on satellite images for all mountain regions and then classified according to their position in the relief relative to melting glaciers into the following types: supraglacial (i.e., on the glacier's surface), proglacial (in front of the glacier and/or on its sides), periglacial (residual, after the glacier had retreated at least two km) and ,finally, extraglacial (distance to the glacier edge is more than two km, i.e., the lake dynamics are not determined by the glacier melt regime). These types were then classified according to the type of dam present (glacial, moraine, landslide and/or bedrock). For example, the largest lakes, namely Kurbankul and Kokkul, with respective areas of 0.08 and 0.1 km², belong to the extraglacial type of lakes with landslide dams. Additional parameters for assessing these lakes' hazard included freeboard height, drainage type (open or closed), dam width, width-to-height ratio and dam length. The outburst potential of each periglacial lake was assessed taking all these parameters into account and, as a result, 68 lakes were identified in the lower part of the Gissar-Alai Range (in the Surkhandarya Region), 35 of which (51.5 per cent) had high outburst potential. North of the Gissar-Alai Range (in the Kashkadarya Region), there were 39 lakes, 12 of which (31.6 per cent) had high outburst potential. In the Tashkent Region (the Pskem River basin, a tributary of the Chirchik River), 131 lakes were identified, 48 of which (36.6 per cent) had high outburst potential. In the Shakhimardan Basin, an enclave of Uzbekistan, there are four periglacial lakes, two of which



Rocks in the canyon of the Ustyurt plateau

234 Semakova, Semakov, 2017.

235 Chernomorets S. (2015) Mudflow hazard in the Shakhimardan River basin (Kyrgyzstan and Uzbekistan) - report at the conference | TRUTH – Intelligent System for thematic research of scientific data [WWW Document]. (in Russian)

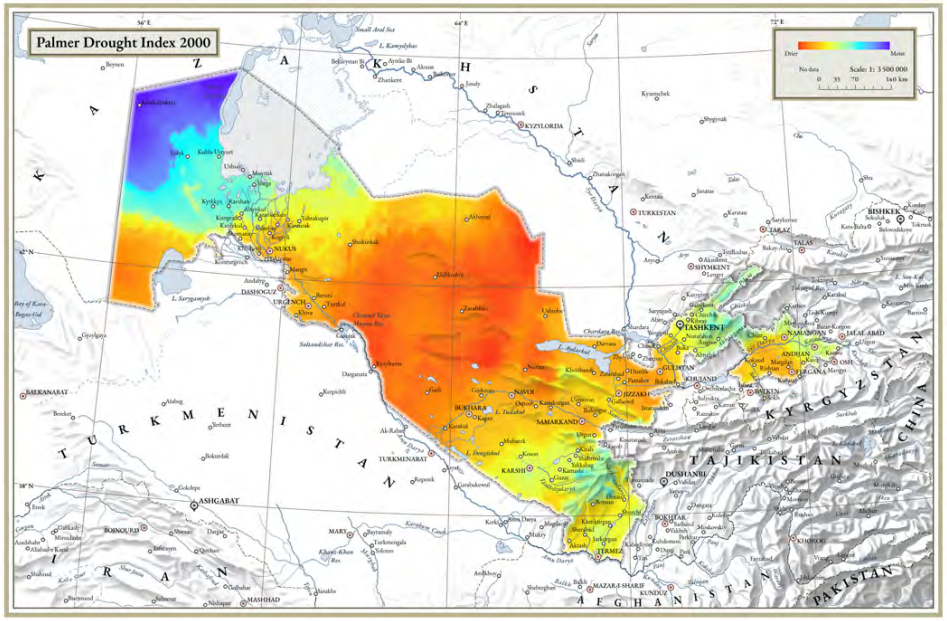
236 Petrov et al., 2017.

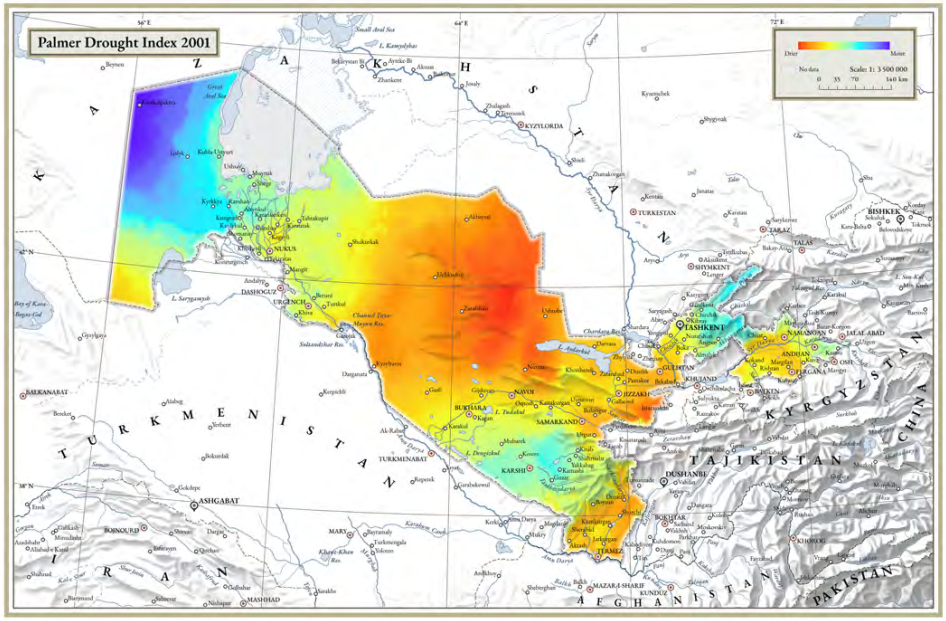
were deemed as having high outburst potential. Overall then, a total of 97 (40 per cent) of 242 periglacial lakes identified are considered to have high outburst potential. The largest number of lakes with high outburst potential are relatively small and often form part of a cascade with ice or ice-debris dams located on or near the glacier. However, these high-outburst-potential lakes are located at the highest elevations of the republic's relief, average approximately 3,400 m above sea level, being are typically located in the periglacial zone. In contrast, the largest periglacial lakes, while still being located at significant altitudes, generally fall into the low outburst potential category because they are usually located quite far from their source glaciers and their dams have relatively stable structures.

Snow avalanches are common in the eastern mountainous region of the Republic of Uzbekistan and the avalanche season typically lasts five to six months per year. Avalanches occurring in uninhabited high-mountain areas do not cause 'emergencies', as they pose no significant threat to people, property, infrastructure, crops or livestock due to their absence in these areas. Having said that, avalanches that descend onto mountain roads can, nevertheless, cause serious damage, blocking routes and sometimes even burying people and property as well as damaging or destroying local flora and fauna. In this context, almost every year, avalanches block some of Uzbekistan's strategically important roads, such as the road through the Kamchik Pass which connects Tashkent and Namangan regions of the Fergana Valley, bypassing neighboring Tajikistan. The thickness of avalanche debris which, for example, blocks a road, can vary from a few centimetres to tens of metres. There have been cases where the mass of a large avalanche does not melt during the summer season and remains an obstacle until the following year.

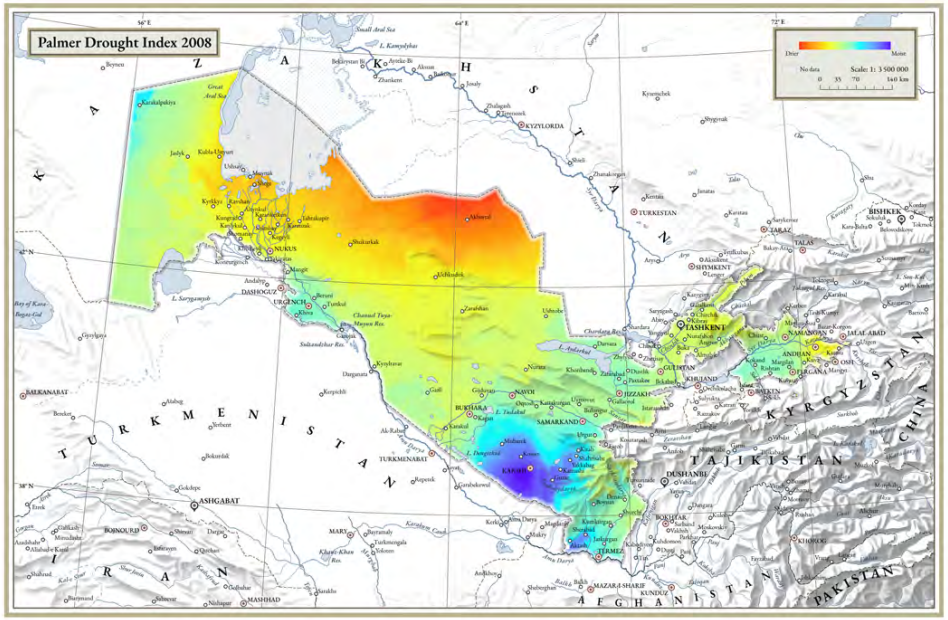
Heavy precipitation and rising temperatures in mountainous regions in March and April have heightened the risks of avalanches, threatening lives and livelihoods as well as disrupting economic activity, particularly in the Tashkent (Akhangaran, Bostanlyk and Parken districts), Namangan (Pap district), Kashkadarya and Surkhandarya regions. These areas are all high-risk avalanche zones where a large avalanche is likely to create an 'emergency' situation.

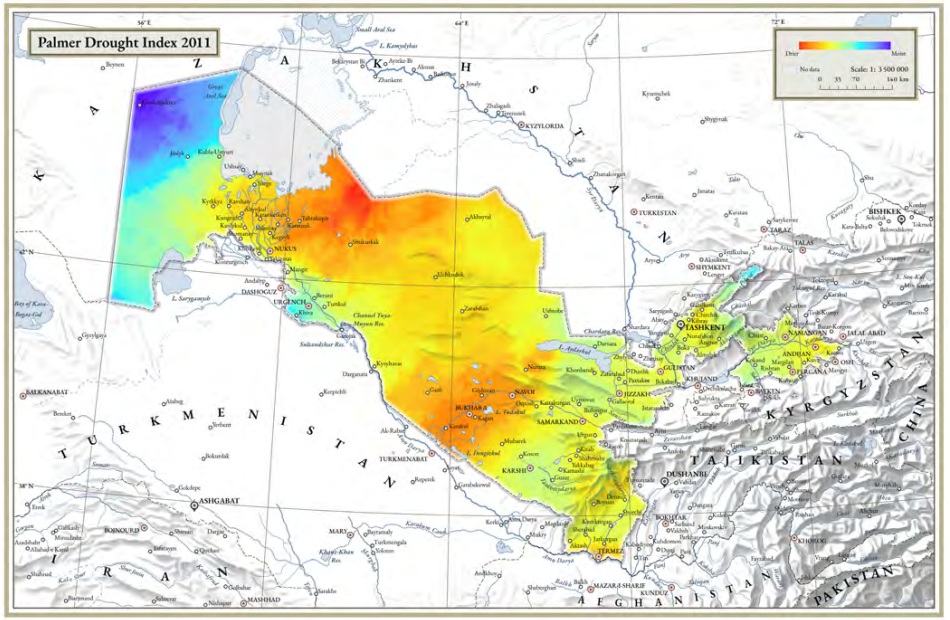
In addition to the direct damage they cause, avalanches can indirectly impact the environment by blocking river channels, creating reservoirs that subsequently burst, which can cause mudflows and/or flooding. As such, despite a general trend toward a decrease in avalanche frequency, the risks remain high for many parts of the republic during unusually snowy winters, particularly in the upper reaches of the Akhangara River.

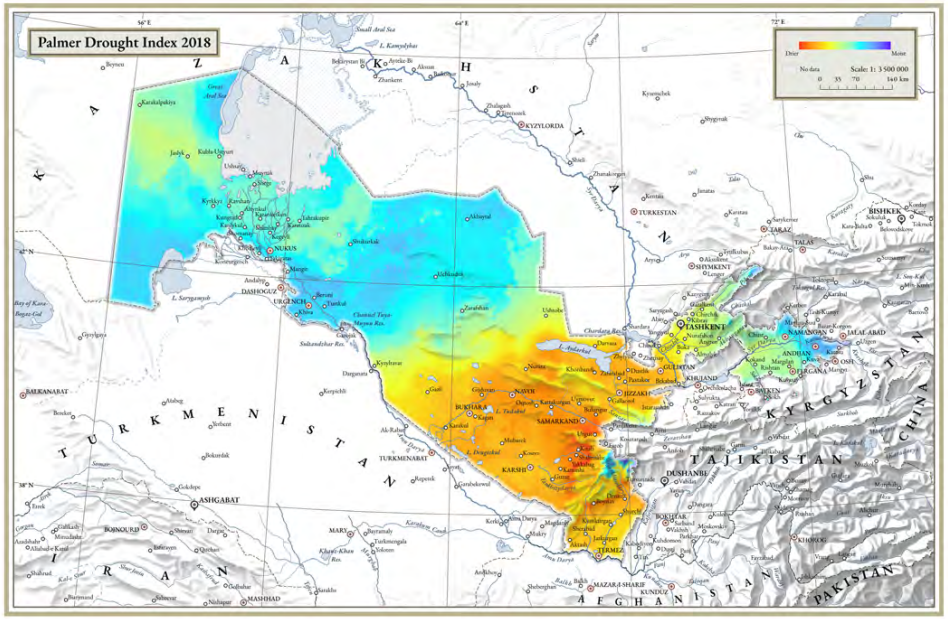


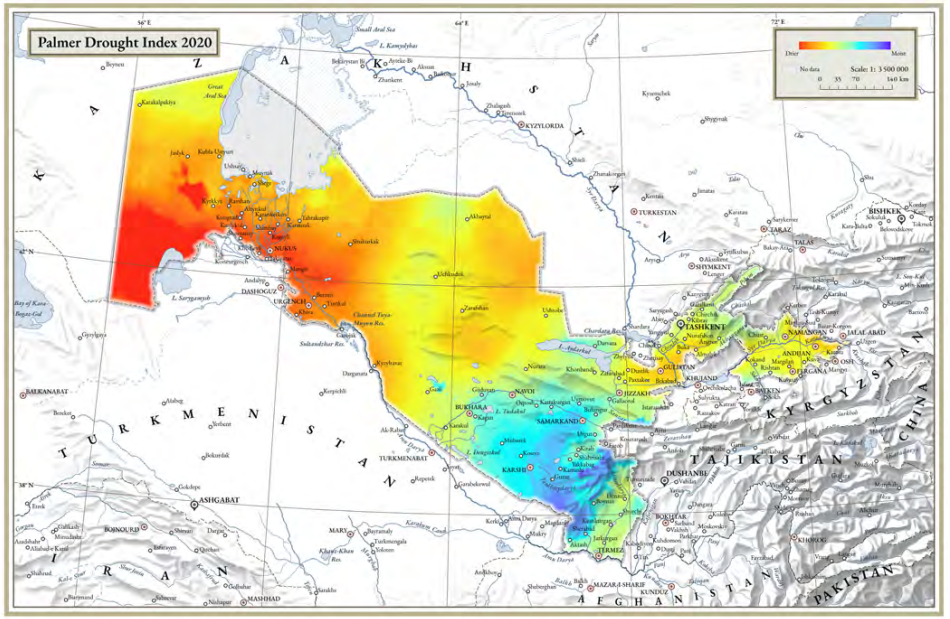


The original scale of the map is 1:3 500 000. The map image has been modified for page layout.

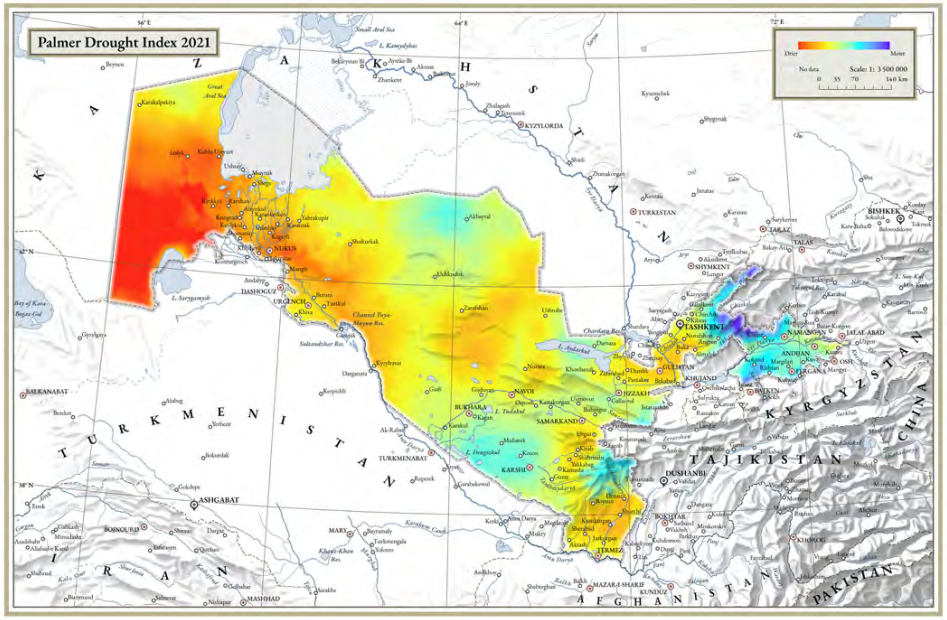


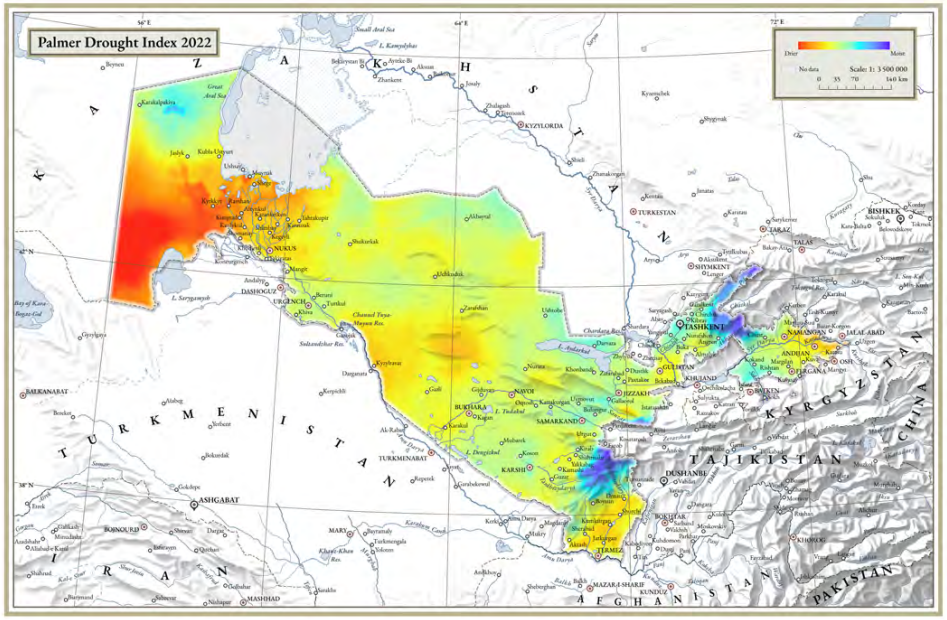


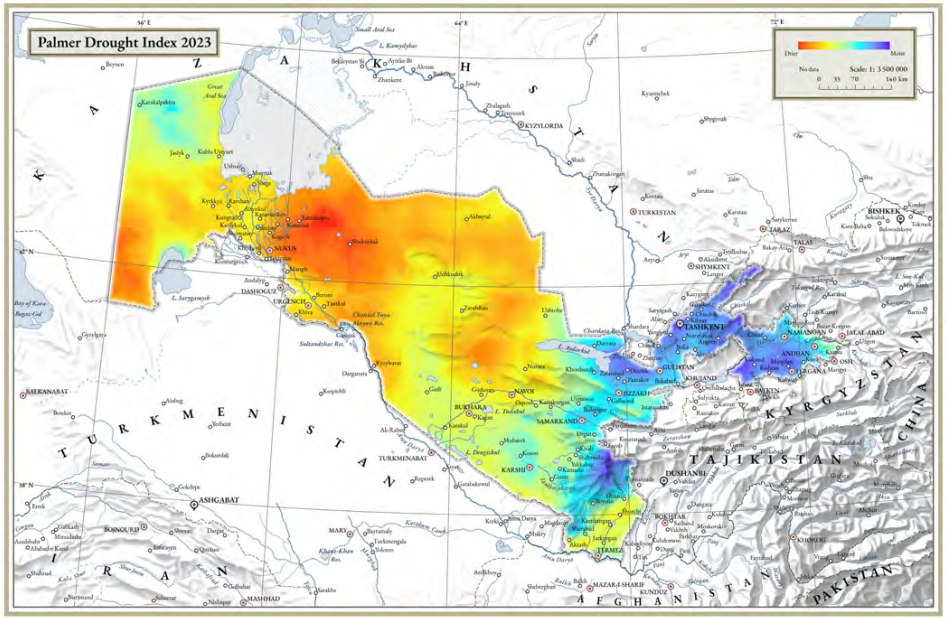


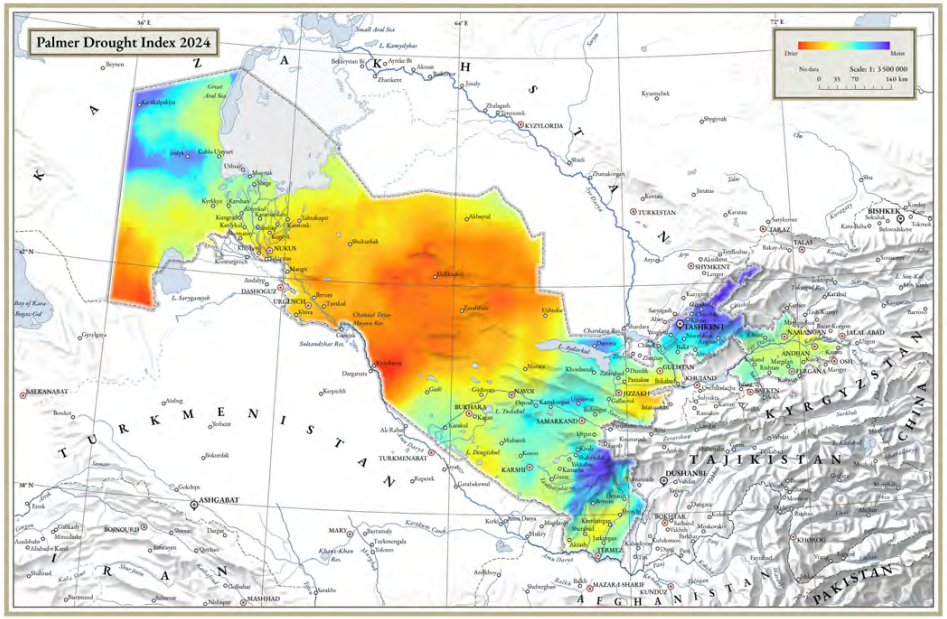


The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



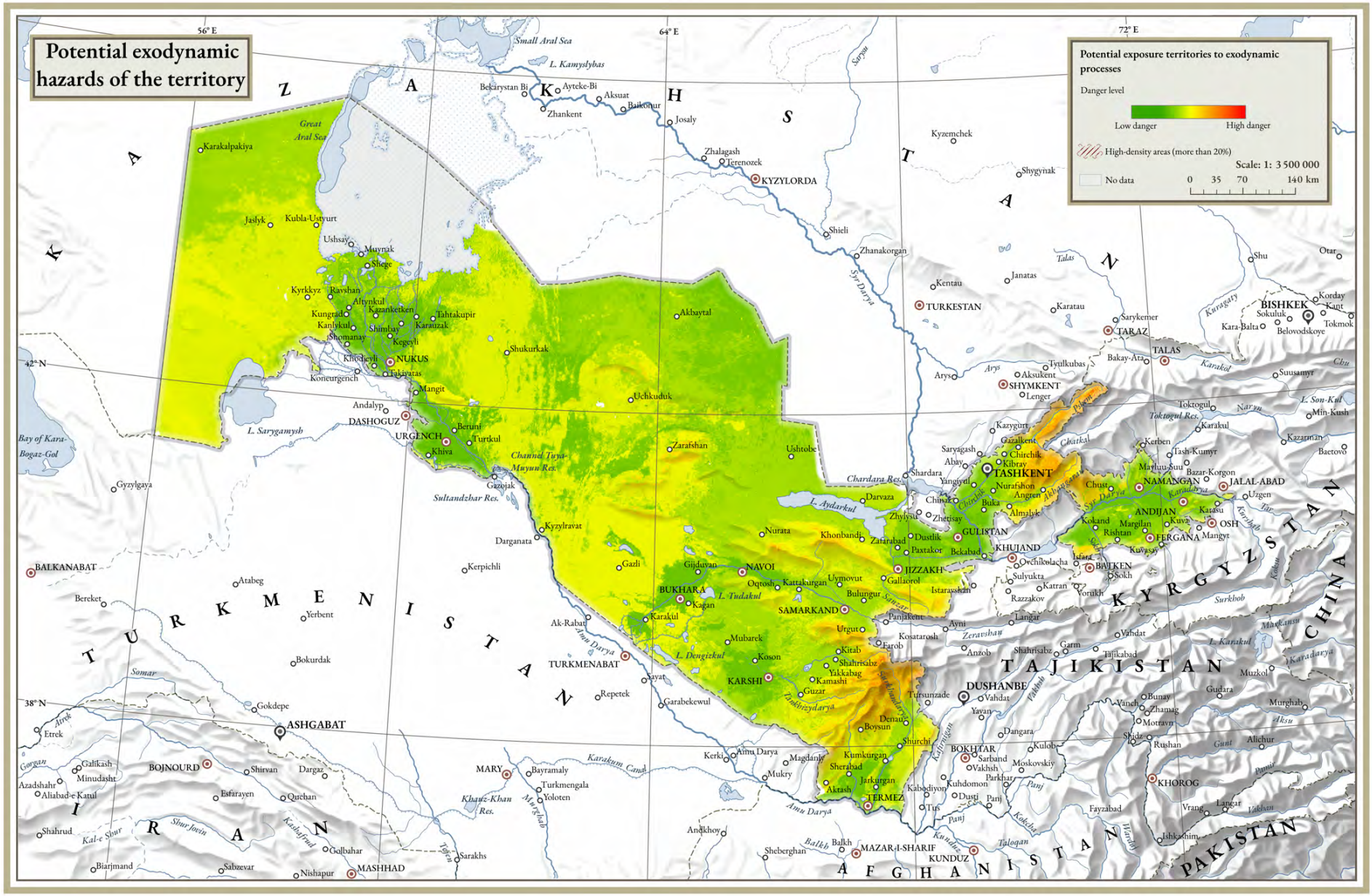






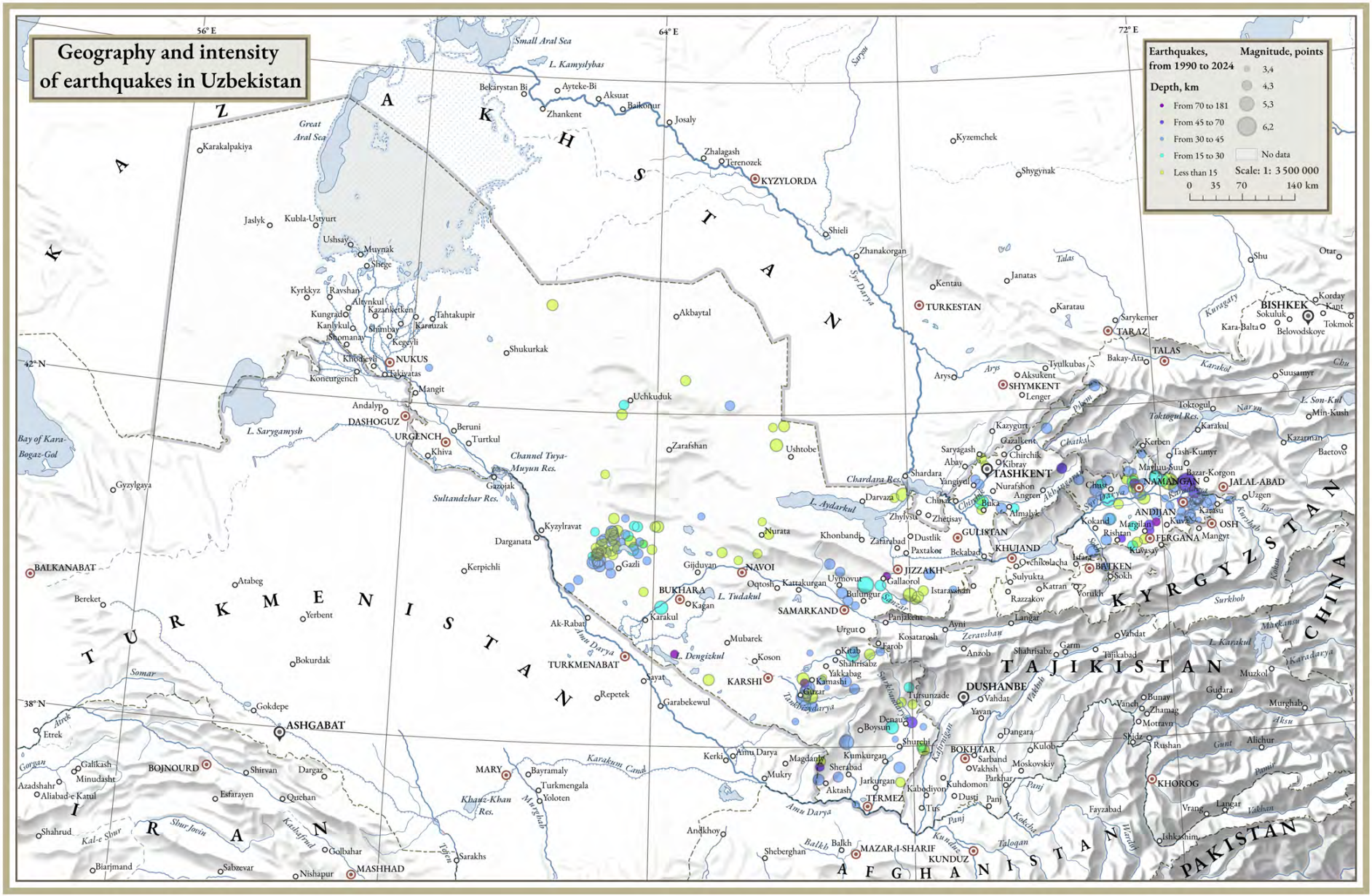
Based on TerraClimate data obtained through reanalysis of WorldClim, CRU Ts4.0, and JRA55 data, TerraClimate demonstrates a high degree of agreement with a range of observations at weather stations from various networks, including SNOTEL and RAWS. The spatial resolution is 4 km; the temporal coverage is from 1958 to the present, with a temporal resolution of 1 month.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



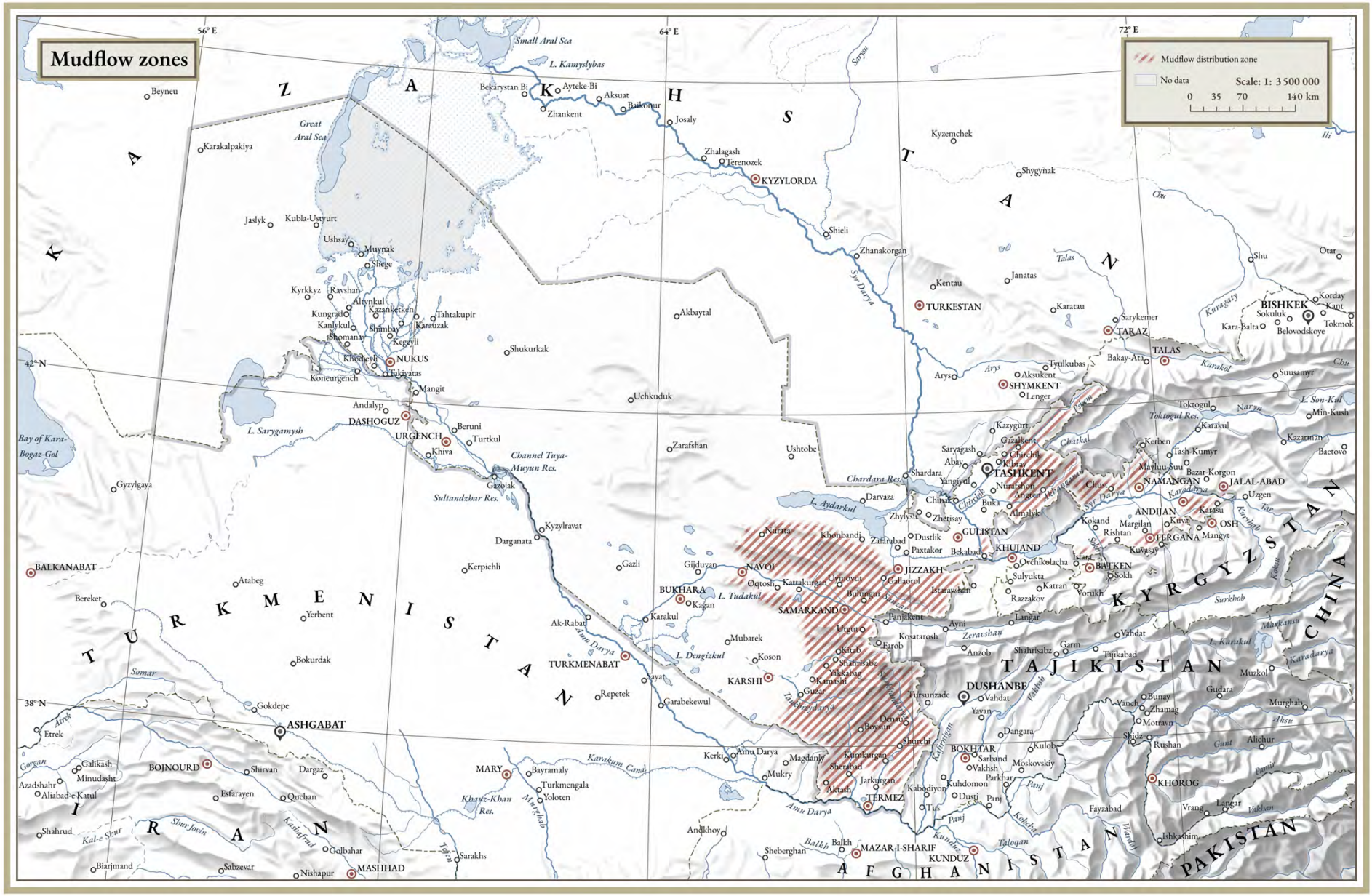
Based on the results of the integration of geomorphological indices calculated on the basis of DEM SRTM.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



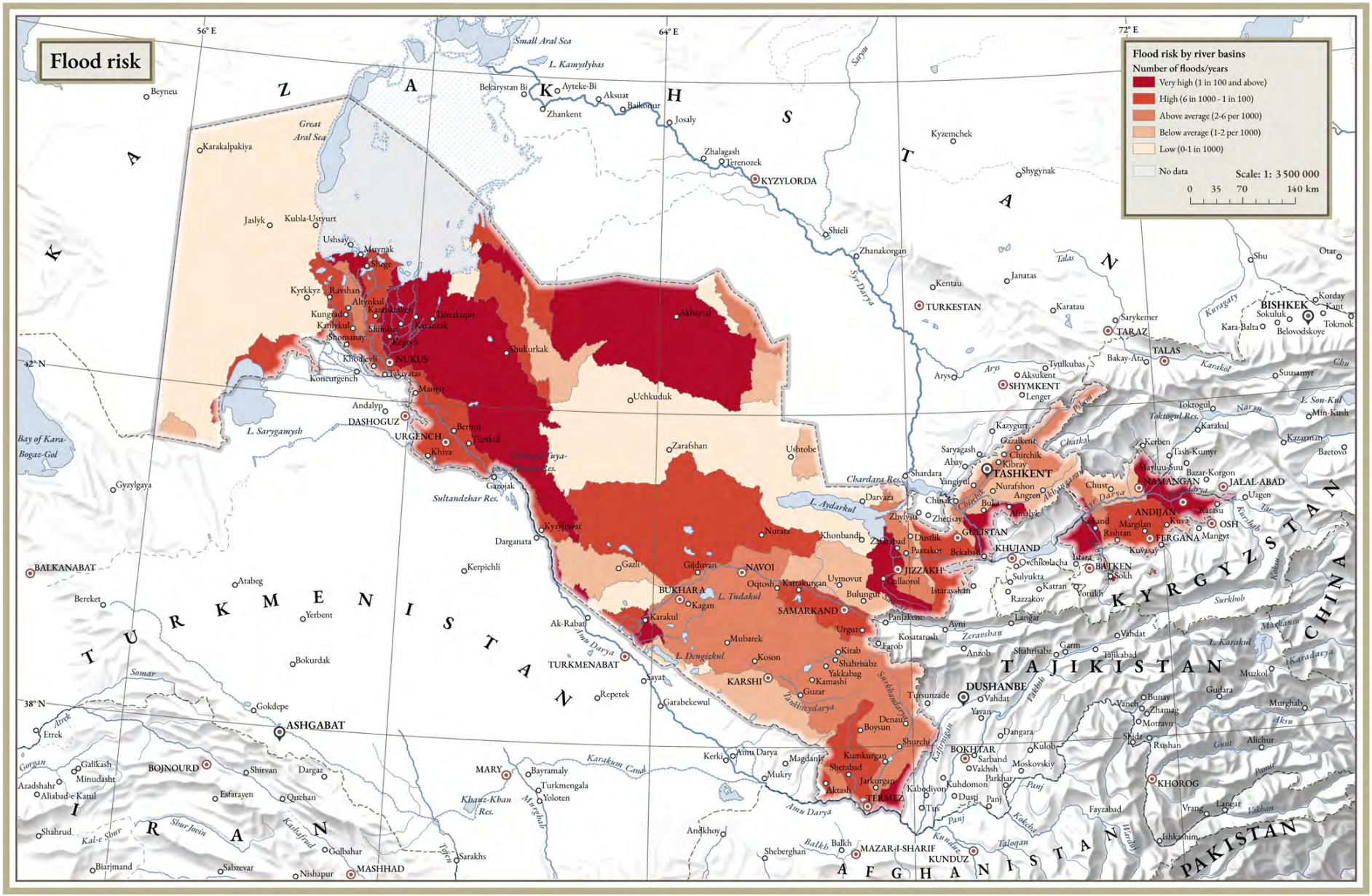
According to the U.S. Geological Survey.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



According to the project's national coordinators.

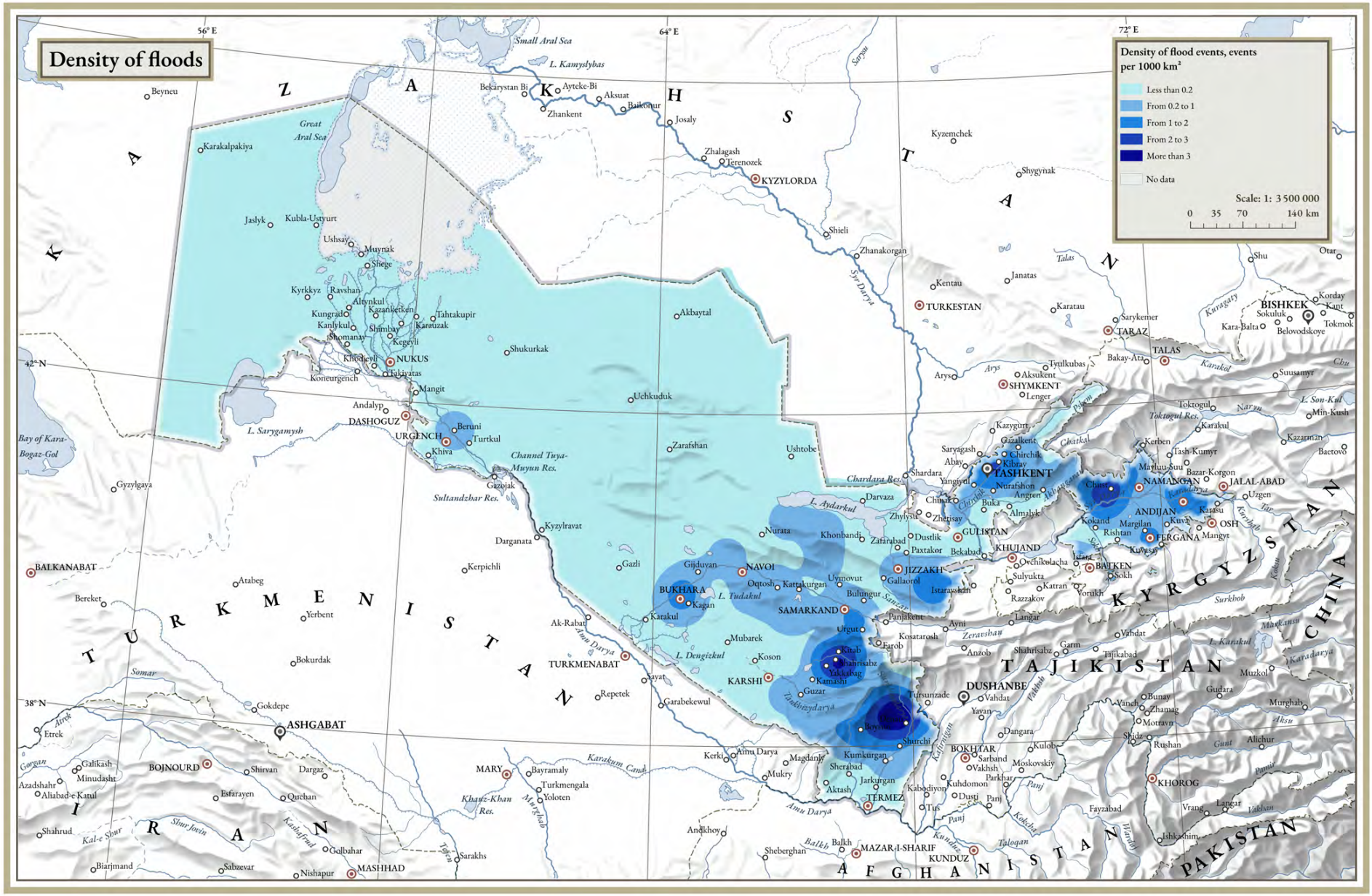
The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



According to the WRI Aqueduct Water Risk Atlas.[237]

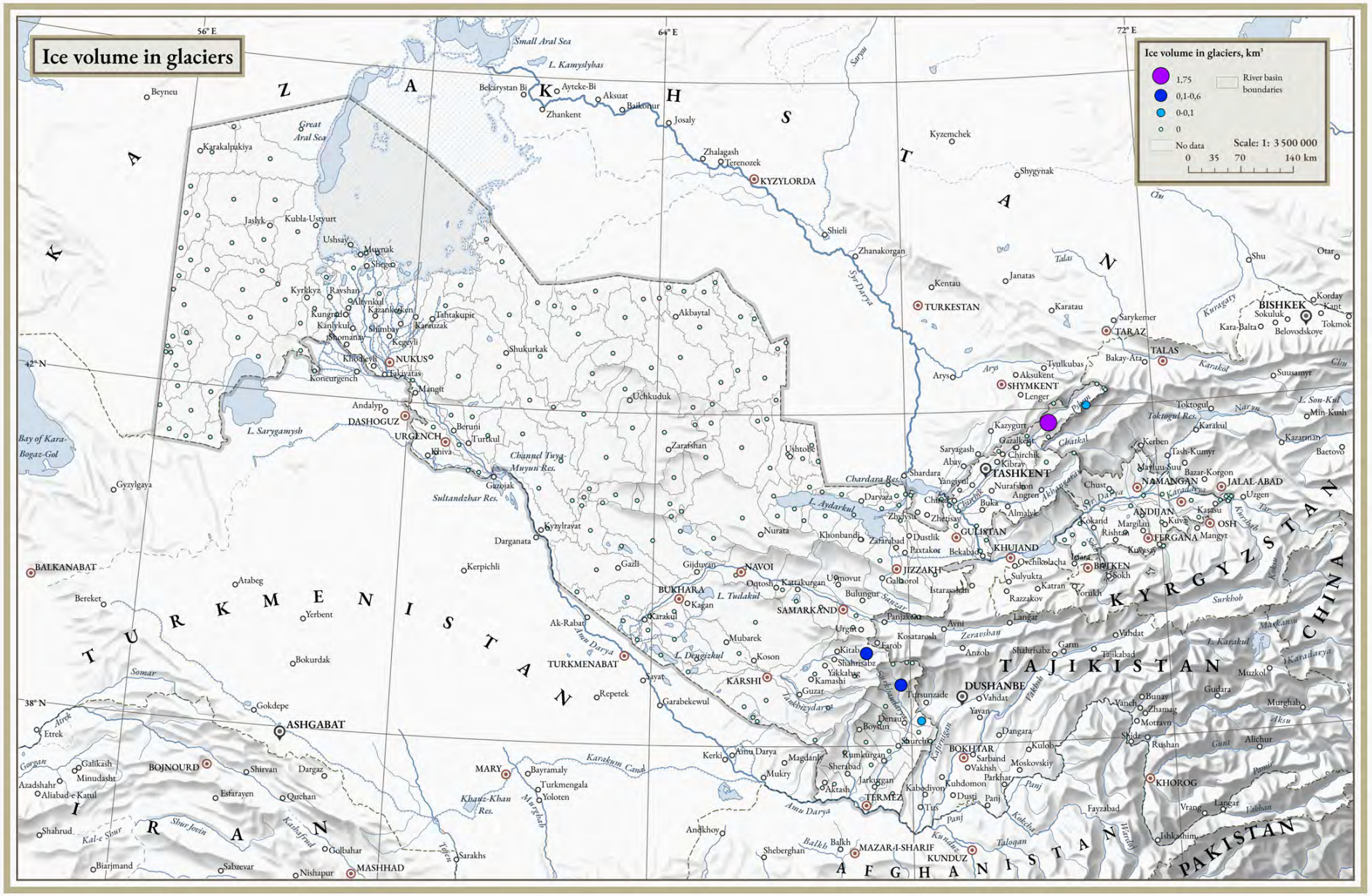
237 https://www.wri.org/applications/aqueduct/water-risk-atlas

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



Based on the results of processing the database of the Ministry of Emergency Situations of the Republic of Uzbekistan.

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



According to the global ice management information system (GLIMS),[238] the GLIMS155 database is suitable for estimating ice volume at the basin level, which is useful for assessing the risk of hazardous natural events such as floods and mudflows.

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

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.

7.3. Towards Achieving the SDGs

The Government of Uzbekistan recognizes climate change as the primary cause of more frequent and intense natural disasters in the country. A trend toward greater vulnerability of the economy and population to these emergencies has also been observed. Two major global agreements can serve as guidance for creating an effective national early warning system and adaptation to the increasing risks of hydrometeorological disasters in Uzbekistan. The country is prioritizing climate change adaptation in its Paris Agreement implementation strategy, in particular, the need to establish an Early Warning System for Natural Hazards is seen as crucial. The second global agreement is the Sendai Framework for Disaster Risk Reduction 2015–2030, adopted by UN Member States in March 2015 as a global policy for disaster risk reduction. One of the goals of the strategy is: «By 2020, substantially increase the number of countries with national and local disaster risk reduction strategies.» According to the Sendai Framework, disaster risk reduction strategies and policies should incorporate and integrate disaster risk reduction across and among all sectors of an economy, across multiple timescales and with targeted indicators.

These strategies should aim to prevent the creation of disaster risks, reduce existing risks and strengthen the economic, social, health and environmental resilience of a country and its regions, objectives that are reflected in the SDGs.

In the context of climate change, women are recognized as one of the most vulnerable groups whose needs require special attention, as well as the importance of their empowerment and inclusion in decision-making processes. At the international level, women from Central Asian countries are well represented at UNFCCC meetings. In this regard, Uzbekistan stood out in particular, with women representing 90% of its delegation in 2009 and 77% in 2016. Despite widespread recognition and emphasis on the positive role of women in helping combat climate change, at the country and regional levels, men completely dominate in climate-sensitive economic sectors such as agriculture, energy, and water resources. Ignoring the differences between men and women in adaptation needs can not only exacerbate gender inequality but also reduce women's potential as agents of change in climate-sensitive economic sectors[239].

Against this backdrop, **SDG 11.5.1** includes as an indicator the «number of dead, missing, and directly affected persons affected by natural disasters per 100,000 population". The indicator is directly linked to the Sendai Framework, whose Target A aims to significantly reduce the «global mortality rate from natural disasters between 2020 and 2030 compared with the 2005–2015 baseline". Similarly, Target B aims to significantly reduce the «number of affected people globally between 2020 and 2030 compared with the 2005–2015 baseline". Indicator 1.5.2 also proposes assessing «direct economic losses attributable to natural disasters relative to global gross domestic product (GDP).»



Travelling throug wild nature on the road to Kokand

There is no comprehensive information available on the number of victims and value of economic losses in regions of Uzbekistan related to natural disasters[240]. Long-term observations show that areas most frequently affected by flash floods and mudflows are in the lower parts of valley slopes (river channels, plains and terraces), as well as foothills and low-altitude areas *(see maps 'Economic losses from floods and earthquakes'; 'Number of deaths from floods and earthquakes')*. Data provided by Uzhydromet show an average of 30 mudflows occurred each year from 2014 to 2018, with an increase in their frequency over this time. Most mudflows occur in the Fergana Valley, where the hazard is at least partially transboundary generated. Floods originating in the mountainous river regions of Kyrgyzstan and Tajikistan threaten the foothills and lowland areas of Uzbekistan, particularly the cities of the Fergana and Andijan regions, as well as rural areas in the northeast and southeast of the valley. According to Uzhydromet, the Navoi Region accounts for more than 50 per cent of all households located in mudflow-hazard zones, followed by Fergana Region, although to a significantly lesser extent (approximately 10 per cent of households). Four significant settlements are located in mudflow-hazard zones in Tashkent region, and the largest share (approximately 50 per cent) of infrastructure is also concentrated in these areas. However, available data are limited to the distribution of households and infrastructure by administrative district. Adequate spatial resolution for demographic estimates and characteristics of the population at risk, along with flood hazard (by category) and flood risk mapping, are unavailable to conduct more precise vulnerability assessments[241].

The global **SDG target 13.1** aims to develop legal

239 Kovaleva et al. (2023) Central Asia: Exploring Insights on Gender Considerations in Climate Change. Sustainability. 15(16), 12667.

240 UNECE, 2020.

241 Ibid.

and policy frameworks and mainstream climate change and disaster risk reduction at the local level. In measuring progress toward this SDG, indicator 13.1.2 refers to the requirement that «local authorities adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies". However, local disaster risk reduction strategies are absent from the Strategy for the Implementation of the Sendai Framework for Disaster Risk Reduction 2015–2030 in the Republic of Uzbekistan.

In Uzbekistan, the increasing risks associated with natural disasters have been analysed primarily at the national level. The Ministry of Emergency Situations is responsible for the prevention of natural and man-made emergencies and civil defence. An intergovernmental task force, comprising the Ministry of Emergency Situations, the Ministry of Ecology, Environmental Protection and Climate Change, the Ministry of Water Resources and the State Committee on Geology and Mineral Resources, is tasked with protecting the population from floods and landslides and annually surveying mountainous areas considered at risk from natural disasters. Recommendations from this annual review may, in exceptional cases, lead to a temporary evacuation of a population if the risk of flooding in the upcoming season is seen as high and preparedness levels are deemed insufficient. A population may be permanently relocated if the risk is considered persistent and cannot be mitigated. Another body, the State Flood Control Commission, was established in 2017 and one of its members, the Ministry of Emergency Situations, submits data and recommendations to the Cabinet of Ministers for consideration.

Uzbekistan is participating in the project 'Dam Safety in Central Asia: Building Capacity for Regional Cooperation', implemented by the UNECE and the Economic and Social Commission for Asia and the Pacific in cooperation with EC-IFAS within the framework of the UN Special Programme for the Economies of Central Asia. The project promotes regional cooperation in the exchange of information and notification in the event of accidents or emergencies involving the region's dams. Uzbekistan is a recognized leader in the Central Asian region in dam safety, and its specialists actively participate in various technical assignments and training duties within the project's programme. Uzbekistan has already benefited from the development of technical documentation related to dam safety within the project. For example, since 2017, Uzbekistan has been developing direct cooperation with Tajikistan and Kyrgyzstan on the safety and management of specific hydraulic structures. The following year, in March 2018, an intergovernmental agreement on cooperation to ensure the operation of the Farhad Dam was signed between Tajikistan and Uzbekistan. This agreement recognizes the Farhad hydroelectric power station as being within Tajikistan's territory, while the hydroelectric facility is considered the property of Uzbekistan. Tajikistan has committed to ensuring the facility's security, and Uzbekistan is to provide maintenance.

Box 7. Natural Disaster Insurance

The consequences of natural disasters also result in significant economic losses for Uzbekistan. On average, Uzbekistan suffers economic losses of around US$92 million annually, or 0.2 per cent of GDP[242].

Currently, the Republic of Uzbekistan uses a post-disaster financing model to compensate for damage caused by natural disasters and protect affected individuals. Losses are reimbursed after a catastrophic event using funds from the State reserve fund, however, given the relatively limited financial resources available, disaster relief funds can only compensate for a small portion of the total losses incurred by people. Overall, in Central Asian countries, the amount of such compensation ranges from a few hundred dollars (in Uzbekistan, Kyrgyzstan, Turkmenistan and Tajikistan) to approximately US$1,000 in Kazakhstan[243]. Risk transfer instruments do not meaningfully improve this situation as the insurance industry in the country remains small and underdeveloped. According to Axco (an insurance information services), only about 10 per cent of all residential buildings were covered by natural disaster insurance in 2019. In terms of insurance providing protection for property, policies are primarily taken out by mortgage borrowers at the request of commercial lenders. Experts attribute this low insurance coverage to a lack of public confidence in insurers' ability to pay compensation for damages in the event of a major catastrophic event, and indeed, the country's insurance products do seem to have a number of significant shortcomings.

In Uzbekistan, insurers do not assess natural disaster risks by disaster type, that is, companies offer homeowners policies that cover property damage to private homes from all hazards without exception (e.g., fires, lightning strikes, explosions, aircraft crashes). This package also covers all natural disaster types (earthquakes, floods, mudflows, avalanches, and so forth). Due to low policy uptake rates, local insurance companies rarely earn sufficient premiums and are, therefore, forced to bear almost all the financial risks. Given the country's vulnerability to natural disasters, companies rapidly accumulate a high-risk portfolio of clients, which may make it impossible for them to provide adequate compensation to policyholders even in the event of a disaster of limited scope. In the event of large-scale or widespread natural disaster, the insurance industry will simply not be able to promptly meet its financial obligations, with the only option then being that the Government steps in to cover the resultant losses.

242 World Bank (2020) Disaster Property Insurance in Uzbekistan. World Bank Publications – Reports 33885, The World Bank Group. 33 P.

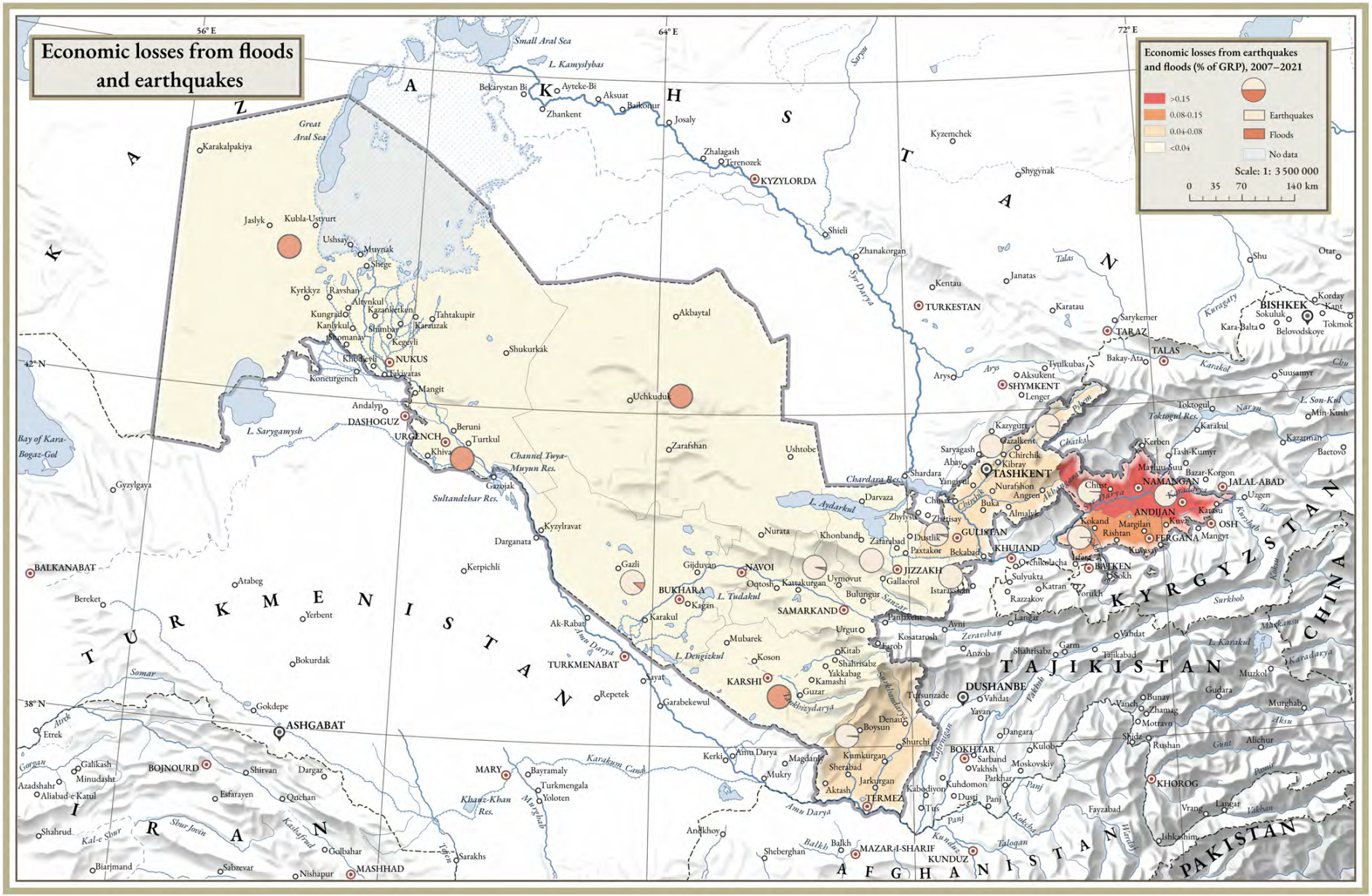
243 World Bank (2009) Mitigating the Adverse Financial Effects of Natural Hazards on the Economies of Central Asia. A Study of Catastrophe Risk Financing Options. http://www.unisdr.org/preventionweb/files/11742_MitigatingtheAdverseFinancialEffect.pdf.

7.4. Response Measures

- Conduct accurate vulnerability assessments of settlements to natural hazards with appropriate spatial resolution for demographic assessments and population characteristics. This should be done in partnership with disaster risk mapping.
- Further develop cooperation with Tajikistan and Kyrgyzstan on the safety and management of specific hydraulic structures, as well as early warning measures for transboundary floods and mudflows.
- Develop locally based, gender-responsive disaster risk reduction strategies, recognizing women's role in preparedness and recovery, and collect sex-disaggregated data on the impacts of disasters.
- Develop an insurance system that allows for mass public and private household cover against natural disasters based on scientific risk assessments of natural events rather than the currently unsustainable generic pricing model for premiums.

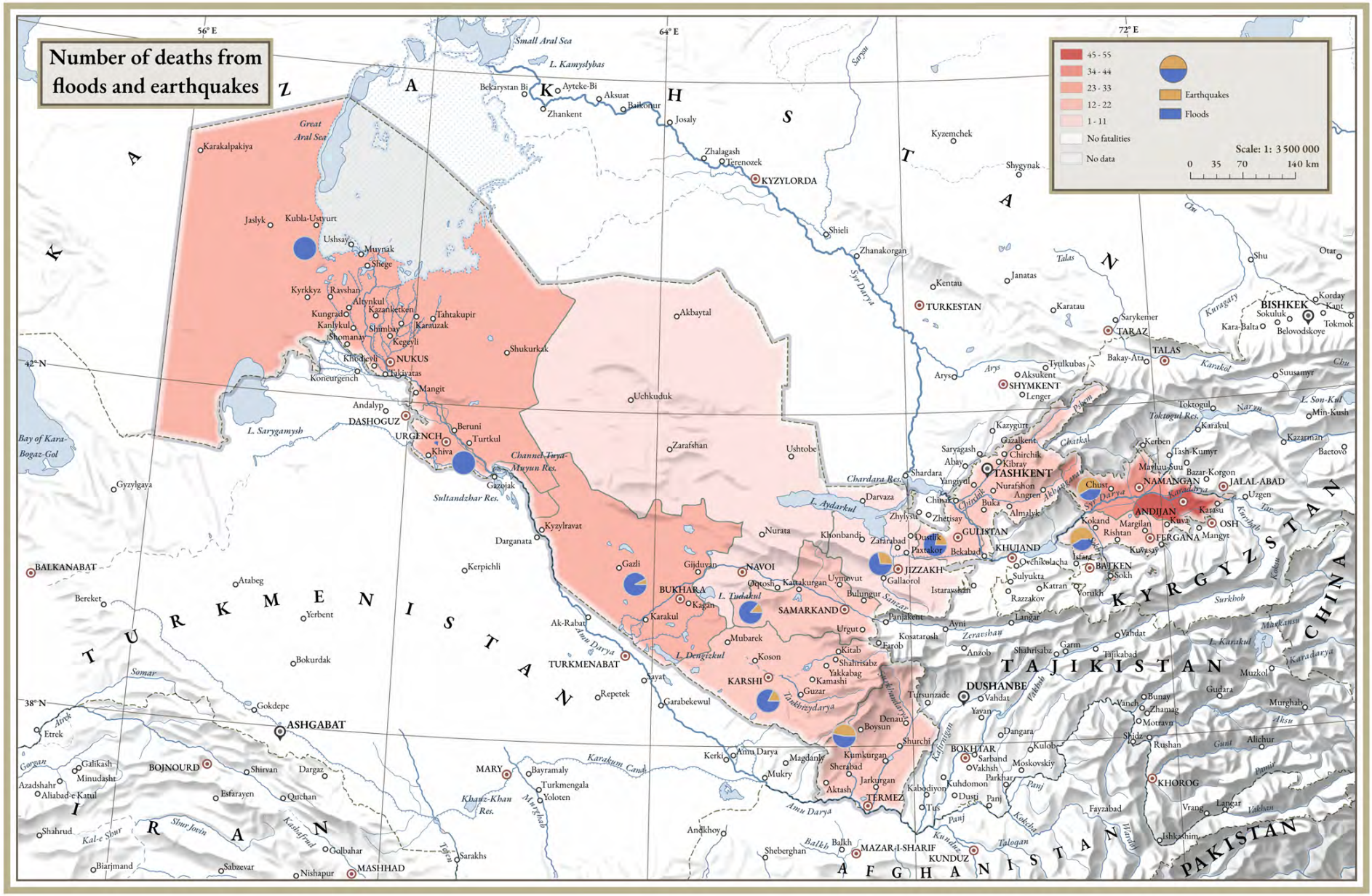


An image from the ISS



According to the National Statistics Committee of the Republic of Uzbekistan

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.



According to the National Statistics Committee of the Republic of Uzbekistan

The original scale of the map is 1:3 500 000. The map image has been modified for page layout.

Literature

1. Abdullaev I., Yakubov M. (2004) Assessing the gender performance of the water users associations of Central Asia: case study from IWRM Ferghana Project. Paper presented at the ICWC 39th Annual Water Conference. Almaty, Kazakhstan. 19–21 May 2004. 11 P.
2. Abduraimov O.S., Maxmudov A.V., Kovalenko I., Allamurotov A.L. et al. (2023) Floristic Diversity and Economic Importance of Wild Relatives of Cultivated Plants in Uzbekistan (Central Asia). Biodiversitas. 24: 1668 – 1675. https://doi.org/10.13057/biodiv/d240340.
3. Abdushukurov A.A., Azimov A.R., Dzhuraev A.G., Petukhov V.N. (2016) The state of the Kayrakkum reservoir. Vestnik Tadzhikskogo Natsionalnogo Universiteta. Seriya Estestvennykh Nauk. 1 (192): 218–223. (In Russian)
4. Agostini P., Golub E.S., Piabuo S.M (2024) Climate Adaptation in Uzbekistan: Landscape Restoration Opportunities. The World Bank Group. 92 P.
5. Aichi Biodiversity Target 11 Country Dossier: UZBEKISTAN (2021) Aichi Biodiversity Target 11 Country Dossier: UZEBEKISTAN (cbd.int).
6. Akhmadjonova Y. T (2022) Water Composition and Ecological Status of Aydar-Arnasay Lake System. Ekonomika i sotsium [Economy and Society], 5 (96): 21–24.
7. Aladin N., Micklin Ph., Plotnikov I. (2008) Biodiversity Of The Aral Sea And Its Importance To The Possible Ways Of Rehabilitating And Conserving Its Remnant Water Bodies In book: Environmental Problems of Central Asia and their Economic, Social and Security Impacts. NATO Security through Science Series C: Environmental Security: 73 – 98.
8. Aminqulovich F. U., Gulom qizi M. L. (2025) Development of saxaul cultivation in Uzbekistan. American Journal of Biology and Natural Sciences. 2 (1): 104 – 108.
9. Arabov N.U., Nasimov D.A., Artikov Z.S (2021) An Analysis of the Demographic Data of Population of the Republic of Uzbekistan. Global Research Network LL 2, 10: 15 –20.
10. Assessment of drought challenges and drought monitoring models in Central Asian region (2020) Center for Emergency Situations and Disaster Risk Reduction. ESCAP. 55 P.
11. Beck H. E., McVicar T. R, Vergopolan N., Berg A., Lutsko N. J., Dufour A., Zeng Z., Jiang X., van Dijk A. I. J. M., Miralles D. G (2023) High - resolution (1 km) Köppen - Geiger maps for 1901 – 2099 based on constrained CMIP6 projections. Sci Data. 10, 724.
12. Beck H., Zimmermann N., McVicar T. et al. (2018) Present and future Köppen-Geiger climate classification maps at 1-km resolution. Sci Data. 5, 180214.
13. Boymurodov R., Matchanov M., Tajiyev Q., Amandurdiyev D., Mangit R., Udashev S., Kadyrov A. (2024) Monitoring land use and land cover changes in the Khorezm oasis using the Esri Sentinel-2 Land Cover Explorer database. E3S Web of Conferences. 590, 04001.
14. Bull J. W., Suttle K. B., Singh N. J., Milner-Gulland E. J. (2013) When is biodiversity offsetting appropriate? Frontiers in Ecology and the Environment. 11 (9): 492–501. https://doi.org/10.1890/120066
15. Bykova E.A., Marmazinskaya N.V., Esipov A.V., Gritsyna M.A. (2020) Brief overview of the status of rare ungulates in Uzbekistan. Ecosystems of Central Asia: research, conservation, rational use: Proceedings of the XV Ubsunur International Symposium (Kyzyl, July 5-8, 2020). ed. by Ch. N. Sambyl. - Krasnoyarsk: Offset Publishing House: 199–205. (in Russian)
16. Chembarisov E.I (1988) Hydrochemistry of irrigated areas (on the example of the Aral Sea basin). Tashkent: FAN. 105 P. (in Russian)
17. Chernomorets S. (2015) Mudflow hazard in the Shakhimardan River basin (Kyrgyzstan and Uzbekistan) - report at the conference | TRUTH - Intelligent System for Thematic Research of Scientometric Data [WWW Document]. (in Russian)
18. Conrad Ch., Usman M., Morper-Busch L, Schönbrodt-Stitt S. (2020) Remote sensing-based assessments of land use, soil and vegetation status, crop production and water use in irrigation systems of the Aral Sea Basin. A review. Water Security. 11: 100078.
19. Crighton EJ, Barwin L, Small I, Upshur R. (2010) What have we learned? A review of the literature on children's health and the environment in the Aral Sea area. International Journal of Public Health. 56 (2): 125-138.
20. Cui Y., Li X. (2022) Global Land Productivity Dynamic Dataset Product. V1. Science Data Bank. https://cstr.cn/31253.11.sciencedb.j00076.00084.
21. Data Collection Survey on Agriculture Sector in Republic of Uzbekistan (2017) Final Report. Japan International Cooperation Agency (JICA). Hokkaido Intellect Tank NTC International Co. Ltd. 207 P. The data collection survey on agriculture sector in Republic of Uzbekistan : final report [electronic resource]. -
22. Demattê J.A.M., Safanelli J.L., Poppiel R.R. et al. (2020) Bare earth's Surface Spectra as a proxy for Soil Resource Monitoring. Scientific reports. 10,1: 1-11.
23. Dergacheva I., Klimov S., Khamdamova G., Raximov Q., Apakhujayeva T. (2021) Mudflow hazard in the foothill and mountainous regions of Uzbekistan. E3S Web of Conferences. 263, 02019.
24. Dergacheva I.V. (2017) Problems of Forecasting and Prevention of Catastrophic Floods in Transboundary Rivers (on the example of the Amu Darya Basin). Tashkent: UzHydromet (NIGMI). (In Russian)
25. Djanibekov U. (2015) A Co-evolutionary Perspective on the Adoption of Sustainable Land Use Practices: The Case of the Amu Darya River Lowlands, Uzbekistan. 10.1007/978-3-319-12274-8_16.
26. Djanibekov N., Charyyeva S., Sanaev G. (2021) Cotton sector reforms in Central Asia. IAMO Annual 2020: 46–54 (iamo.de).
27. Djumaboev K., Manthrithilake H, Ayars J., Yuldashev T., Akramov B., Karshev R., Eshmuratov D. (2019) Growing cotton in Karshi Steppe, Uzbekistan: water productivity differences with three different methods of irrigation. In Indian National Committee on Surface Water (INCSW) - CWC. Proceedings of 9th International Micro Irrigation Conference (9IMIC), Aurangabad, India, 16-18 January 2019. Bangalore, India: IvyLeague. 391–397.
28. Dubovyk O., Menz G., Conrad C., Kan E., Machwitz M., Khamzina A., Mammadov B. (2013) Spatio-temporal analyses of cropland degradation in the irrigated lowlands of Uzbekistan using remote-sensing and logistic regression modeling. Environmental Monitoring and Assessment. 185: 4775–4790.
29. Edlinger J., Conrad C., Lamers J.P.A., Khasankhanova G., Koellner T. (2012) Reconstructing the spatio-temporal development of irrigation systems in Uzbekistan using Landsat time series. Remote Sensing. 4(12): 3972–3994.
30. Eshchanov O.I. (2021) Analysis and assessment of the water quality of the Amu Darya River. Scientific and Information Center ICWC. Tashkent. 59 P. (in Russian)
31. Esipov A., Bykova E., Protas Y., Aromov B. (2016) Central Asia: Uzbekistan. In: McCarthy T., Mallon D. (Eds.), SNOW LEOPARDS, Biodiversity of the World: Conservation from Genes to Landscapes. Academic Press, United Kingdom: 439 – 448. https://doi.org/10.1016/B978 - 0 - 12 - 802213 - 9.00034 - 1/.
32. FAO and ITPS (2020) Global Soil Organic Carbon Map V1.5: Technical report. Rome, FAO.
33. Forest landscape restoration: transforming landscapes and livelihoods in the Caucasus and Central Asia (2018) IUCN. FORESTBRIEF. 23. 8 P.
34. Fourth National Communication of the Republic of Uzbekistan to the UN Framework Convention on Climate Change (2024) UzHydromet: Tashkent, Uzbekistan. 582 P.
35. Gender, agriculture and rural development in Uzbekistan (2018) Country Gender Assessment Series. FAO: Budapest. 92 P.
36. Gert J., Veldwisch A., Mollinga P.P (2013) Lost in transition? The introduction of water users associations in Uzbekistan. Water International. 38, 6: 758 – 773.
37. Gilmartin D. (1999) The Irrigating Public: The State and Local Management of Irrigation in South Asia. In: Stig Toft Madsen (ed.). State, Society and the Environment in South Asia. Surrey: Curzon Press: 236–265.
38. Gintzburger G., Toderich K.N., Mardonov B.K., Mahmudov M.M. (2003) Rangelands of the Arid and Semi-Arid Zones in Uzbekistan. Montpellier/Aleppo: CIRAD & ICARDA. 426 P.
39. Global Forest Resources Assessment (2015) Country Report. FAO. 253 P. FRA 2015 Country Reports | Global Forest Resources Assessment | Food and Agriculture Organization of the United Nations
40. Government of Mongolia (2018) Mongolia's Forest Reference Level submission to the United Nations Framework Convention on Climate Change. UN - REDD Mongolia National Programme, Ministry of Environment and Tourism, Ulaanbaatar. 62 P.

41. Grantham H.S., Duncan A., Evans T.D. 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.
42. Gritsina M.A (2019) The Caracal Caracal caracal Schreber, 1776 (Mammalia: Carnivora: Felidae) in Uzbekistan. Journal of Threatened Taxa. 11 (4): 13470 - 13477.
43. Groll M., Opp C., Kulmatov R (2013) Water quality, potential conflicts and solutions - an upstream - downstream analysis of the transnational Zarafshan River (Tajikistan, Uzbekistan). Berlin: Springer - Verlag Berlin Heidelberg. 21 P.
44. GWP (2014) Integrated water resources management in Central Asia. IWRM - Central - Asia - TFP v15 (gwp.org). (in Russian)
45. Handbook on water resources management in Uzbekistan (2019) ed. by V. Sokolov. Tashkent. 325 P. handbook_wrm_uzb_ru.pdf (in Russian)
46. Hansen M.C., Potapov P.V., Moore R. et al. (2013) High-Resolution Global Maps of 21st- Century Forest Cover Change. Science. 342. 6160: 850-853.
47. Harris N.L., Gibbs D.A., Baccini A. et al. (2021) Global maps of twenty-first century forest carbon fluxes. Nat. Clim. Chang. 11: 234–240. https://doi.org/10.1038/s41558-020-00976-6
48. Harwood T., Ware Ch., Hoskins A., Ferrier S. et al. (2022) BHI v2: Biodiversity Habitat Index: 30s global time series. v1. CSIRO. Data Collection. https://doi.org/10.25919/tt2t-h452
49. Hasanov S., Ahmed M., Nomman A.M. (2011) Agricultural efficiency and productivity growth in Uzbekistan: A case study. Business and Economic Horizons. 4(1): 81–87.
50. Hoelzle M, Azisov E., Barandun M., Huss M., Farinotti D., Gafurov A., Hagg W., Kenzhebaev R., Kronenberg M., Machguth H., Merkushkin A., Moldobekov B., Petrov M., Saks T., Salzmann N., Schöne T., Tarasov Y., Usubaliev R., Vorogushyn S., Zemp M (2017) Re - establishing glacier monitoring in Kyrgyzstan and Uzbekistan, Central Asia. Geoscientific Instrumentation, Methods and Data Systems. 6: 397 – 418.
51. Ibragimova R.A. Ibraimova A.A. (2022) Pastures of Uzbekistan and some issues of their use. Economy and society. 6 (97): 567–570. (In Russian)
52. Immerzeel W.W., Lutz A.F., Droogers P (2012) Climate Change Impacts on the Upstream Water Resources of the Amu and Syr Darya River Basins. FutureWater Report. 107. 103 P.
53. ITF (2019) Enhancing Connectivity and Freight in Central Asia. International Transport Forum. Paris. http://www.itf-oecd.org.'
54. Ivushkin K., Bartholomeus H., Bregt A.K., Pulatov A., Kempen B., De Sousa L. (2019) Global mapping of soil salinity change. Remote sensing of environment. 231, 111260.
55. JICA (2013) The Data Collection Survey on Agriculture Sector of the Republic of Uzbekistan. Tokyo: Japan International Cooperation Agency. (Open JICA Report No. 1000032445).
56. Jumaniyazov I., Juliev M., Khudaybergenov Y., Jaksibaev A. (2024) Assessment of Agricultural Land Cadaster Indicators of Shimbay Irrigated Areas (Republic of Karakalpakstan). E3S Web of Conferences. 590, 01007.
57. Karandaev S.V., Karandaeva L.M (2021) Assessment of Modern Glaciation of the Zaravshan Basin. Central Asian Journal of Geographical Research. 3–4: 75–86. (in Russian)
58. Karimboev F., Gulomov D., Tillayeva Z. (2021) Assessment of water quality in the downstream of the Amu Darya basin. E3S Web of Conferences. 264, 03049.
59. Khamraliev A., Mamatkulov Z., Musaev I., Saipova B., Oymatov R., Mirjalolov N. (2023) Soil Salinity Monitoring in Irrigated Areas of Rishtan District of Ferghana Valley, Uzbekistan. E3S Web of Conferences. 386, 01010. Soil Salinity Monitoring in Irrigated Areas of Rishtan District of Ferghana Valley, Uzbekistan
60. Kholmatjanov B.M., Petrov Y.V., Khujanazarov T., Sulaymonova N.N., Abdikulov F.I., Kenji Tanaka K (2020) Analysis of Temperature Change in Uzbekistan and the Regional Atmospheric Circulation of Middle Asia during 1961– 2016. Climate. 8, 101.
61. Kim K.R., Hasanov S. (2013) Development of agriculture and marketing structure in Uzbekistan for agro- processing of fruits and vegetables. Journal of Agricultural, Life and Environmental Sciences. 25, 2: 1–9.
62. Klemm W., Shobair S.S (2010) Impact of Irrigation in Northern Afghanistan on Water Use in the Amu Darya Basin. FAO Rome. 13 P. Microsoft Word - Draft_FAO_Paper_08OCT2010_ - WK final.docx.
63. Kovaleva M., Leal Filho W., Borgemeister C., Komagaeva J. (2023) Central Asia: Exploring Insights on Gender Considerations in Climate Change. Sustainability. 15(16), 12667.
64. Kuziev R.K., Sektimenko V.E. (2009) Soils of Uzbekistan. Tashkent: Extremum Press. 351 P. (in Russian)
65. Lal R., Suleimenov M., Stewart B.A., Hansen D.O. (2007) Climate Change and Terrestrial Carbon Sequestration in Central Asia. Carbon Management and Sequestration Center, the Ohio State University. 12 P.
66. Lal R. (2004) Carbon sequestration in soils of Central Asia. Land Degradation & Development. 15 (6): 563–572.
67. Lutz A.F., Droogers P., Immerzeel W.W (2012) Climate change impact and adaptation on the water resources in the Amu Darya and Syr Darya River basins. FutureWater Report. 31. 116 P.
68. Lyakhovskaya I.V., Salikhova G.B. (1989) Forecasting mudflows in the mountains of Uzbekistan. In: 'Chelovek i Stikhiya–89' (Man and Nature–89), Book of Abstracts, Leningrad State University: 63–64. (In Russian)
69. Mamatov Q.M., Bekchanov M.B., Mukimov T. (2021) Sustainable management of agricultural resources in Uzbekistan: Challenges and solutions. Natural Volatiles & Essential Oils. 8 (4): 14164–14175.
70. Marconcini M., Metz - Marconcini A., Üreyen S., Palacios - Lopez D., Hanke W., Bachofer F., Zeidler J., Esch T., Stranoet E. (2020) World Settlement Footprint (WSF) 2015. figshare. Dataset. https://doi.org/10.6084/m9.figshare.10048412.v1
71. Mavlyanova N.Z., Inagamov R., Rakhmatullaev K., Tolipova N. (2004) Seismic Code of Uzbekistan. In: Proceedings of the 13th World Conference on Earthquake Engineering (WCEE), Vancouver, Canada. Paper 1611. 8 P.
72. Micklin P. (1991) The Water Management Crisis in Soviet Central Asia. The Carl Beck Papers in Russian & East European Studies. 905. Pittsburgh: University of Pittsburgh. 131 P.
73. Micklin P. (2000) Managing Water in Central Asia. London: Royal Institute of International Affairs. 55 P.
74. Miklin V. (2005) Water and the future of the Aral Sea Basin. Aridnye Ekosistemy (Arid Ecosystems). 11(26–27): 8–23. (In Russian).
75. Milner-Gulland E., Kreuzberg E., Grebot B., Ling S. et al. (2006) Application of IUCN red listing criteria at the regional and national levels: A case study from Central Asia. Biodiversity and Conservation. 15: 1873–1886.
76. Mittermeier R.A. Gill P.R., Hoffmann M. et al. (2004) Hotspots Revisited. Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions. Cemex. 200 P.
77. Multiple Indicator Cluster Survey – MICS (2006) State Department of Statistics (Uzbekistan) and the World Bank. Tashkent. Uzbekistan - Multiple Indicator Cluster Survey 2006 - Dataset - waterdata
78. NCC (2012) Ranking from National Cotton Council of America http://www.cotton.org/econ/cropinfo/cropdata/rankings.cfm
79. Nowak A., Świerszcz S., Nowak S., Hisorev H., Klichowska E. et al. (2020) Red List of vascular plants of Tajikistan – the core area of the Mountains of central Asia global biodiversity hotspot. Scientific Reports. 10 P. https://doi.org/10.1038/s41598-020-63333-9.
80. Olson, D.M.; Dinerstein, E. (2002) The Global 200: Priority ecoregions for global conservation. Annals of the Missouri Botanical Garden. 89(2): 199–224. https://doi.org/10.2307/3298564
81. Petrov M.A., Sabitov T.Y., Tomashevskaya I.G. et al. (2017) Glacial lake inventory and lake outburst potential in Uzbekistan. Science of The Total Environment. 592: 228 - 242.
82. Plotnikov I., Aladin N., Micklin Ph (2016) Modern state of the Small (Northern) Aral Sea fauna. Lakes & Reservoirs Research & Management. 21(4): 315–328.
83. Potapov P., Turubanova S., Hansen M.C. , Tyukavina A., Zalles V., Khan A., Song X.-P., Pickens A., Shen Q., Cortez J. (2021) Global maps of cropland extent and change show accelerated cropland expansion in the twenty-first century. Nature Food. 3 (1) :19–28.
84. Rakhmatova N., Nishonov B.E., Kholmatjanov B.M., Rakhmatova V., Toderich K.N., Khasankhanova G.M., Shardakova L., Khujanazarov T., Ungalov A.N., Belikov D.A. (2024) Assessing the Potential Impacts of Climate Change on Drought in Uzbekistan: Findings from RCP and SSP Scenarios. Atmosphere. 15, 866.
85. Rakhmonov S., Umurzakov U., Rakhmonov K., Bozarov I., Karamatov O. (2021) Land use and land cover change in Khorezm, Uzbekistan. E3S Web of Conferences. 227, 01002.

86. Raupova N.B., Abdullaev S.A (2019) Composition and properties of humus in soils of vertical zonality of the Western Tien Shan and their eroded differences. Scientific review. Biological sciences. 2: 63–68. (in Russian)
87. Ruzmetov I., Musayev S., Shomurodov O., Zakirov A., Sherov K. (2021) Status quo of pastures in Uzbekistan. IOP Conference Series: Earth and Environmental Science. 938, 032069.
88. Salimova B.D., Dergacheva I.V. (2022) Study of mudflow activity in mountainous and foothill regions of the Republic of Uzbekistan. Problems of modern science and education. 9 (178): 48–52. (in Russian)
89. Santoro M., Beaudoin A., Beer C., Cartus O., Fransson J. E. S., Hall R. J., Pathe C., Schepaschenko D., Schmullius C., Shvidenko A., Thurner M., Wegmüller U. (2015) Forest growing stock volume of the Northern Hemisphere: Spatially explicit estimates for 2010 derived from Envisat ASAR data. Remote Sens. Environ. 168: 316–334.
90. Saravanan V.S., Muhammad H., Schraven B. (2014) Irrigation water management in Uzbekistan: analyzing the capacity of households to improve water use profitability. In: Vlek, et. Al. (eds.): Restructuring Land Allocation, Water Use and Agricultural Value Chains: Technologies, Policies and Practices for the Lower Amudarya Region. ZEF: 253–274.
91. 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. at The 2nd National Forest Inventory in Kyrgyzstan is being completed - CACIP Central Asia Climate Information Portal.
92. Semakova E.R., Semakov D.G. (2017) On the possibility of using remote sensing materials to study snow cover on the mountain rivers basins. Led i Sneg [Ice and Snow]. 57 (2): 185–199. (in Russian)
93. Sexton J. O., Song X.-P., Feng M., Noojipady P., Anand A., Huang C., Kim D.-H., Collins K.M., Channan S., DiMiceli C., Townshend J.R.G. (2013) Global, 30-m resolution continuous fields of tree cover: Landsat-based rescaling of MODIS Vegetation Continuous Fields with lidar-based estimates of error. International Journal of Digital Earth. 130321031236007.
94. Sharma, A., Huang, HP., Zavialov, P., Khan V (2018) Impact of Desiccation of Aral Sea on the Regional Climate of Central Asia Using WRF Model. Pure Appl. Geophys. 175: 465–478.
95. Shaumarov M., Birner R. (2013) Dryland Pastoral Systems in Transition: What are the Options for Institutional Change in Uzbekistan? Paper presented at the 53rd Annual Conference of the German Society of Economic and Social Sciences in Agriculture (GEWISOLA). Berlin, 25–27 September 2013. RePEc:ags:gewi13:156133.
96. Sherzod B., Kim K.-R., Lee S.H.(2018) Agricultural transition and technical efficiency: an empirical analysis of wheat-cultivating farms in Samarkand region, Uzbekistan. Sustainability. 10, 3232.
97. Sixth National Report of the Republic of Uzbekistan on the conservation of biological diversity (2018) ed. by B.T. Kuchkarov. Tashkent. 214 P.
98. Smith D.R. (1995) Environmental Scarcity and Shared Water Resources in Post - Soviet Central Asia. Post - Soviet Geography. 36: 351–370.
99. Sodikova M., Khamroev B., Alimkhanov M., Chorshanbijev A. (2025) GIS-based analysis of abandoned irrigated mountain lands in Uzbekistan. BIO Web of Conferences. 173: 03024.
100. Song XP., Hansen M.C., Stehman S.V. et al. (2018) Global land change from 1982 to 2016. Nature. 560: 639–643.
101. Stanturf J., Kleine M., Mansourian S., Parrotta J., Madsen P., Kant P., Burns J., Bolte A. (2019) Implementing forest landscape restoration under the Bonn Challenge: a systematic approach. Annals of Forest Science. 76. 10.1007/s13595-019-0833-z.
102. State Statistics Committee of the Republic of Uzbekistan (1991) National economy of the Uzbek SSR in 1990: Statistical yearbook. Tashkent: UzStat. 186 P. (in Russian)
103. State Statistics Committee of the Republic of Uzbekistan (2021) Statistical Yearbook of the Republic of Uzbekistan. Tashkent: UzStat. 293 P. (in Russian)
104. Stewart I.D., Oke T.R (2012) Local Climate Zones for Urban Temperature Studies. Bulletin of the American Meteorological Society. 93, 12. (ametsoc.org).
105. Summary Report on the LDN Target Setting Programme in the Republic of Uzbekistan (2019) Global Mechanism of the UNCCD. 14 P. Uzbekistan LDN TSP Country Report_0.pdf (unccd.int)
106. Sustainable Development Goals in the Republic of Uzbekistan (2023) Statistical Digest. Tashkent: Agency of Statistics under the President of the Republic of Uzbekistan. http://nsdg.stat.uz/ (in Russian)
107. Swinnen J., Vranken L. (2010) Reforms and agricultural productivity in Central and Eastern Europe and Former Soviet Republics: 1989–2005. Journal of Productivity Analysis. 33: 241–258.
108. Third National Communication of the Republic of Uzbekistan to the UN Framework Convention on Climate Change (2016) UzHydromet: Tashkent. 221 P.
109. Thorpe A., Whitmarsh D., Drakeford B., Reid C., Karimov B., Timirkhanov S., Satybekov K., Van Anrooy R. (2011) Feasibility of restocking and culture - based fisheries in Central Asia. FAO Fisheries and Aquaculture Technical Paper. 565. FAO: Ankara. 106 P.
110. Tier Classification for Global SDG Indicators (2019). UNSTATS Tier Classification of SDG Indicators_11 December 2019_web.xlsx (un.org).
111. Tojiyeva Z., Omanova K., Pardayev N., N Jaloliddinov N., Bekzod M., Sadriddin K. (2024) Regional Characteristics in the Dynamic and Location of the Rural Population of the Republic of Uzbekistan. E3S Web of Conferences. 491, 04004.
112. Tolipov H., Sokolov V. (2022) Uzbekistan country survey report. Draft concept for revision the National Action Program to combat drought and land degradation in Republic of Uzbekistan. GWP-CACENA. Tashkent. 48 P.
113. UNDP (2003) Impact Assessment of the 2000–2001 Drought in Karakalpakstan and Khorezm.
114. UNECE (2004) Strengthening cooperation for rational and efficient use of water and energy resources in Central Asia. UN: New York. 110 P.
115. UNECE (2010) Environmental Performance Reviews: Uzbekistan. Second Review. Geneva. 227 P.
116. UNECE (2011) Second Assessment of Transboundary Rivers, Lakes and Groundwaters. Tashkent. 448 P. (in Russian)
117. UNECE (2020a) Uzbekistan. Environmental Performance Review. The Third Review. Tashkent. 502 P.
118. UNECE (2020b) Overview of the State of Forests and Forest Management in Uzbekistan. Geneva: United Nations Economic Commission for Europe. 31 P.
119. Water quality standards and norms in the Republic of Uzbekistan/National Report (2011) Project of the United Nations Economic Commission for Europe «Water Quality in Central Asia». Tashkent-Almaty. 72 P.
120. Wegerich K. (2003) Water: The Difficult Path to a Sustainable Future for Central Asia. In: Spoor M. (ed.). Transition, Institutions and the Rural Sector. London: Routledge: 247–259.
121. Wegerich K. (2005) Institutional Change in Water Management at Local and Provincial Level in Uzbekistan. Frankfurt am Main: Peter Lang. 256 P.
122. Worbes M., Botman E., Khamzina A., Tupitsa A., Martius C., Lamers J.P.A (2006) Scope and constraints for tree planting in the irrigated landscapes of the Aral Sea Basin: case studies in Khorezm Region, Uzbekistan. ZEF Discussion Papers On Development Policy. 112. 49 P.
123. World Bank (2020) Analytical Note on Disaster Insurance in Uzbekistan. Washington, DC: World Bank. 33 P.
124. World Bank (2009) A Study of Catastrophe Risk Financing Options, Mitigating the Adverse Financial Effects of Natural Hazards on the Economies of Central Asia, World Bank, UNISDR, CAREC. http://www.unisdr.org/preventionweb/files/11742_MitigatingtheAdverseFinancialEffect.pdf.
125. Yin H., Khamzina A., Pflugmacher D. et al. (2017) Forest cover mapping in post-Soviet Central Asia using multi-resolution remote sensing imagery. Sci Rep. 7, 1375.
126. Zhang M., Wu B., Zeng H., He G., Liu C., Tao S., Zhang Q., et al. (2021) GCI30: a global dataset of 30-m cropping intensity using multisource remote sensing imagery. Earth System Science Data. 13(10): 4799–4813.
127. Zhang X.X., Claiborn C., Lei J.Q., Vaughan J., Wu S.X., Li S.Y., Liu L.Y., Wang Z. - F., Wang Y.D., Huang S.Y., et al (2020) Aeolian Dust in Central Asia: Spatial Distribution and Temporal Variability. Atmos. Environ. 238, 117734.

Special thanks to UNEP's funding partners. For more than 50 years, UNEP has served as the leading global authority on the environment, mobilizing action through scientific evidence, raising awareness, building capacity and convening stakeholders. UNEP's core programme of work is made possible by flexible contributions from Member States and other partners to the Environment Fund and UNEP Planetary Funds. These funds enable agile, innovative solutions for climate change, nature and biodiversity loss, and pollution and waste.

Support UNEP. Invest in people and planet.
www.unep.org/funding

UN environment programme

www.unep.org
unep-communication-director@un.org