Sustainable Management of Water Resources in Rural Areas in Uzbekistan

Diagnostic Atlas

Shakhrikhansai River Basin

Zafar Gafurov, Shovkat Khodjaev, Bekzod Akramov, Sarvarbek Eltazarov, Oyture Anarbekov, Kakhramon Djumaboev and Makhliyo Nasirova

germaniya hamkorligi
DEUTSCHE ZUSAMMENARBEIT
Implemented by: giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
IWMI International Water Management Institute

The Diagnostic Atlas is based on data and information collected for the assessment and development of basin planning under the program "Sustainable Management of Water Resources in Rural Areas in Uzbekistan" in cooperation with a group of regional, national and local partners. The data and information in the atlas were collected and analyzed by the authors and do not imply endorsement by the EU, GIZ, IWMI or other relevant stakeholders.

The designations employed and the presentation of material in this atlas do not imply the expression of any opinion whatsoever on the part of the Shakhrikhansai Basin Irrigation System Authority concerning the delineation of its frontiers or boundaries.

Data Accuracy and Reliability

The atlas was created using open source GIS, Remote Sensing and local analogue information, some of which has been published by world renowned organizations and used in public projects and scientific research certified by international agencies.

Availability and Accessibility

The atlas can be obtained in digital form for use by external parties with the approval of the International Water Management Institute. The use of the atlas should give credit to the authors and the institution.

Software Employed

This atlas and the associated maps were created on a computer machine running Windows 10 Professional and using ArcGIS 10.5, QGIS, Google Earth Engine. End users should download the package that is most appropriate for the version of ArcGIS software that they are using. It is important to note that ArcGIS is not required to make use of the map package and the associated geodatabase.

Diagnostic
Atlas

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/ GIS / remote sensing / river basins / digital technology / maps / simulation models / satellite imagery / urban population / urban areas / rural population / rural areas / population density / irrigation systems / irrigation water / water resources / water storage / water use efficiency / canals / drainage systems / pumps / lakes / reservoir storage / watersheds / streams / transportation / groundwater / soil types / vegetation / ecosystems / climate change / infrastructure / Uzbekistan /

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Foreword

„Buy an atlas and keep it by the bed - remember you can go anywhere", said British actress Joanna Lumley. I can only recommend to keeping this atlas – not only at your bedside - and studying it carefully – you will find many interesting and amazing things.

Making decisions based on geography is basic to human thinking. By understanding geography and people's relationship to location, we can reach informed decisions about the way we live on our planet. "GIS (Geographic Information System), in its digital manifestation of geography, goes beyond just the science. It provides us a framework and a process for applying geography. It brings together observational science and measurement and integrates it with modeling and prediction, analysis, and interpretation so that we can understand things" (Jack Dangermond, founder of ESRI company, the industry leader in GIS technology).

GIS technology is very important in many fields and among them in water management. Within the frame of the EU-financed programme "Sustainable management of water resources in rural areas in Uzbekistan – component 1" GIS formed the basis of the National Water Cadastre and it was used in our efforts in working on river basin management. It allows for better viewing, and understanding the physical features and relationships that influence critical environmental and social conditions in a basin. Factors, such as steepness of slopes, aspects and vegetation, can be viewed and overlaid to determine various environmental parameters – and are an important element for strategic environment analysis.

This diagnostic atlas was prepared for the Shakhrikhansai river basin to provide users with valuable information for effective and sustainable management of the basin.

The diagnostic atlas consists of seven parts and each part covers one theme based on data availability. You will find information on the territory of the river basin and its boundaries, the population and different social issues, on physical landforms and transport infrastructure, on monitoring stations, on water resources, crops and droughts as well as on details of climate characteristics and future projection scenarios.

The maps in this atlas present an overall picture of the basin and do not claim to cover all details. I would like to thank my colleagues and project partners of the International Water Management Institute (IWMI) for their work and dedication to our programme and for their input to this atlas; without them, this work would not have been possible. We hope that this atlas will be useful to a wide range of stakeholders in the decision-making process and give interesting information to all its users.

Dr. Caroline Milow
Programme Manager,
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Maps have become an important tool for sharing vast amounts of different types of information. Today, map creation is made easy with geographic information systems (GIS). GIS helps us to combine different categories of data such as environmental, social and economic conditions related to a specific geographical area, and to create new maps with useful information for those locations and areas. Further, digital maps created using GIS provide an opportunity to overlay and analyze various processes taking place, and to extract information from various combinations of data in support of decision-making.

This diagnostic atlas presents social, physical and climate information of the Shakhrikhansai river basin, which is located in Kashkadarya province of Uzbekistan. The data used to create these maps were collected from water management organizations, global data sources and from personal interviews conducted with local experts. The data are processed and validated by scientists at the International Water Management Institute (IWMI).

We hope that the Atlas will be useful to those who are directly or indirectly involved in water resources management in Uzbekistan.

Dr. Herath Manthrithilake
Head, Sri Lanka Development Initiative, IWMI

The European Union (EU) program

European Union (EU) Programme on "Sustainable Management of Water Resources in rural areas in Uzbekistan" works within the framework of the EU Multi-annual Indicative Programme for the period from 2014 to 2020 and helps Uzbekistan to implement best European practices based on the EU Water Framework Directive. The programme has the overall objective of promoting sustainable and inclusive growth in the rural sector in Uzbekistan in a changing climate. The objective of the Programme is to improve water supply and water management efficiency at the national, basin and farm levels.

The Program consists of three interrelated components:

- Component 1 is presented by the "National policy framework for water governance and integrated water recourses management" project implemented by the Deutsche Gesellschaft fur Internationale Zusammenarbait (GIZ) GmbH.
- Component 2 on "Technical Capacity Building" is implemented by UNDP.
- Component 3 on "Awareness Raising and partnership for sustainable water and environment development in Uzbekistan" is implemented by the Regional Environmental Center for Central Asia (CAREC).

This Atlas is prepared under Component 1. The goal of the component is to contribute to the further development of the national water management strategy by strengthening legal, institutional, organizational and financial mechanisms, as well as regulatory tools and bringing them in line with international standards.

International Water Management Institute (IWMI)

The International Water Management Institute (IWMI) is a non-profit, research-for-development organization that works with governments, civil society and the private sector to solve water problems in developing countries and scale up solutions. Through partnership, IWMI combines research on the sustainable use of water and land resources, knowledge services and products with capacity strengthening, dialogue and policy analysis to support implementation of water management solutions for agriculture, ecosystems, climate change and inclusive economic growth. Headquartered in Colombo, Sri Lanka, IWMI is a CGIAR Research Center and leads the CGIAR Research Program on Water, Land and Ecosystems (WLE).

The International Water Management Institute's (IWMI's) official presence in Central Asia started in 2001 with the opening of a subregional office in Tashkent, Uzbekistan, to oversee its research activities. Since then, IWMI's research has concentrated on addressing some of the key water management issues facing the region. While carrying out its work, IWMI collaborates closely with the ministries, local water management authorities, farmers, nongovernmental organizations (NGOs), other CGIAR centers and donor-funded projects.

Acknowledgments

The Diagnostic Atlas: Shakhrikhansai River Basin is based on data and information generated and collected data within the framework of EU Programme on "Sustainable Management of Water Resources in Rural Areas in Uzbekistan". Data and information were also obtained from published and grey literature as well as spatial analyses carried out using publicly available sources. The authors would like to thank national and local project partners in Uzbekistan for their input and feedback to the content of the atlas.

The diagnostic atlas was generated within the framework of the activities carried out in Component 1 (titled "National Policy Framework for Water Governance and Integrated Water Resources Management (IWRM)") under the EU Programme on "Sustainable Management of Water Resources in Rural Areas in Uzbekistan" being implemented by the International Water Management Institute (IWMI) in collaboration with Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ), Environment Agency Austria (Umweltbundesamt – UBA), and CREA. Since 2016, the Programme has been focusing on water efficiency with special emphasis on water use in agriculture.

For further details about the project, visit:

Donor

This project is funded by the following:

The EU program "Sustainable Management of Water Resources in Rural Areas in Uzbekistan" is in line with the wider framework of the EU bilateral MIP 2014-2020 for Uzbekistan and promotes best European practice based on the EU Water Framework Directive.

CONTENTS

Introduction

Atlas overview

A strong and permanent element of the the EU Programme on “Sustainable Management of Water Resources in Rural Areas in Uzbekistan” is data generation in water-related state aspects, with a view to specifically developing a basin planning atlas using open source data. The atlas consists of various input data, which were obtained from open domains of several government and non-government organizations, and present the data through visually appealing maps and other visually informative forms (i.e., charts, infographics, etc.) to show the spatial and temporal distribution of water and land resources and the way they are used.

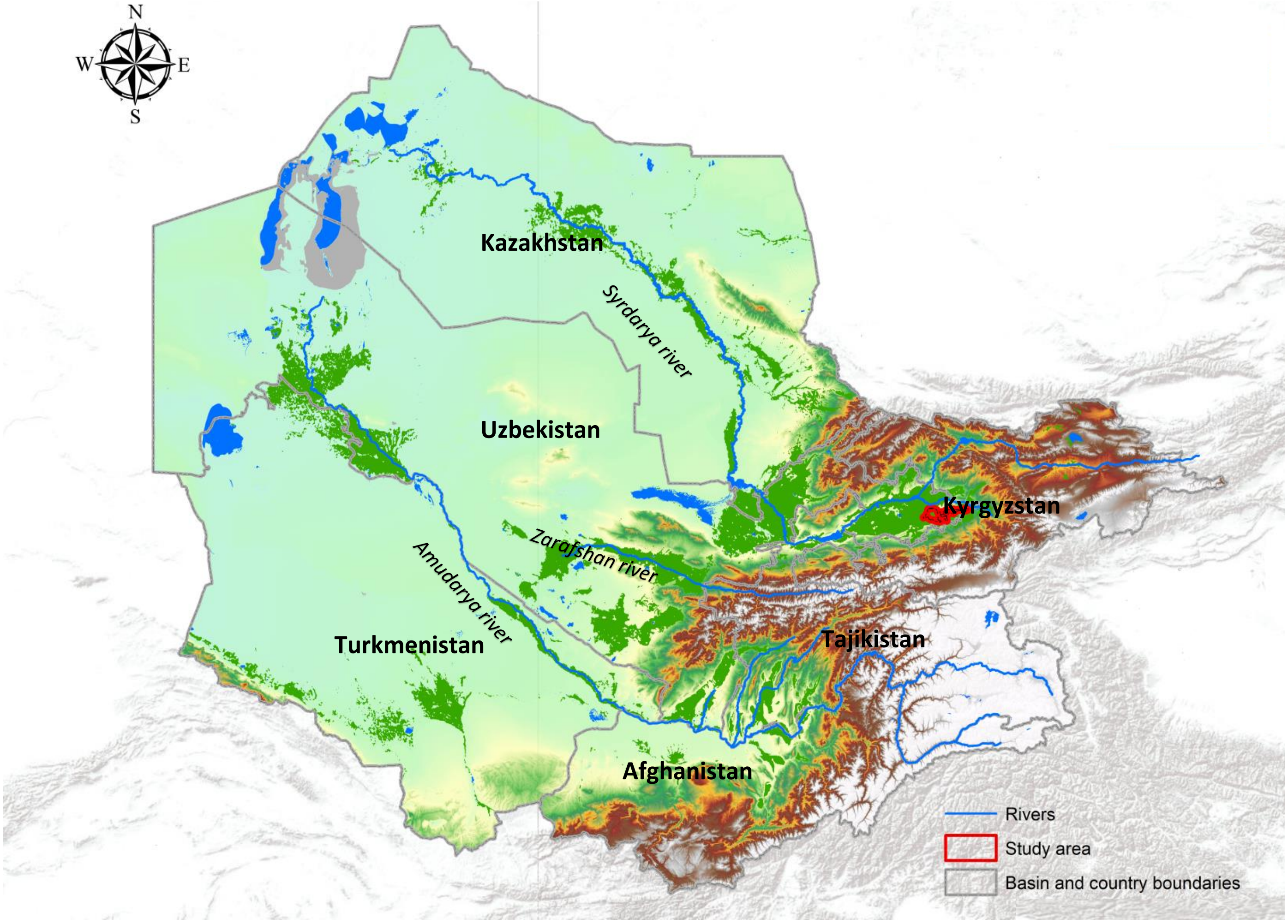
This atlas serves as a resource for people interested in what the future may hold for the Shakhrikhansai river basin in Andijan province of Uzbekistan. The objective is to provide scientific data and analyses that help both policymakers and local citizens make better decisions about land and water use in the area. While the atlas deals specifically with the Shakhrikhansai river basin, the approaches employed here can serve as a model for similar decision support efforts in other regions.

The atlas starts with a map and a brief overview of the larger Aral Sea basin covering most of Central Asia. Chapter 2 provides general information about Shakhrihansai river basin, including its administrative boundaries, catchments and Shakhrihansai canal. Chapter 3 focuses on the social characteristics of the basin area. Chapter 4 examines the physical landforms and transport infrastructure that shapes the basin region. The last three chapters explore water resources, crops, droughts, monitoring stations, and other relevant factors.

Data and information presented in this atlas provides an essential foundation for projecting future change in the Shakhrikhansai river basin. The atlas presents projections for some weather parameters through the year 2050. It can help decisionmakers evaluate the likely effects of these predicted scenarios on important natural resources, including water availability, crop production and other agricultural activities. The data and analyses in the atlas can help relevant stakeholders make informed decisions about future land and water use, and they can also be used to prioritize and design future strategies focusing on the Shakhrihansai river.

It is noted that, this is not a finished product, but a first step which relies on currently available information, which is limited. We expect that monitoring in the region will improve and that the atlas will be able to incorporate more data over time, improving its effectiveness and usefulness as a diagnostic and decision support tool.

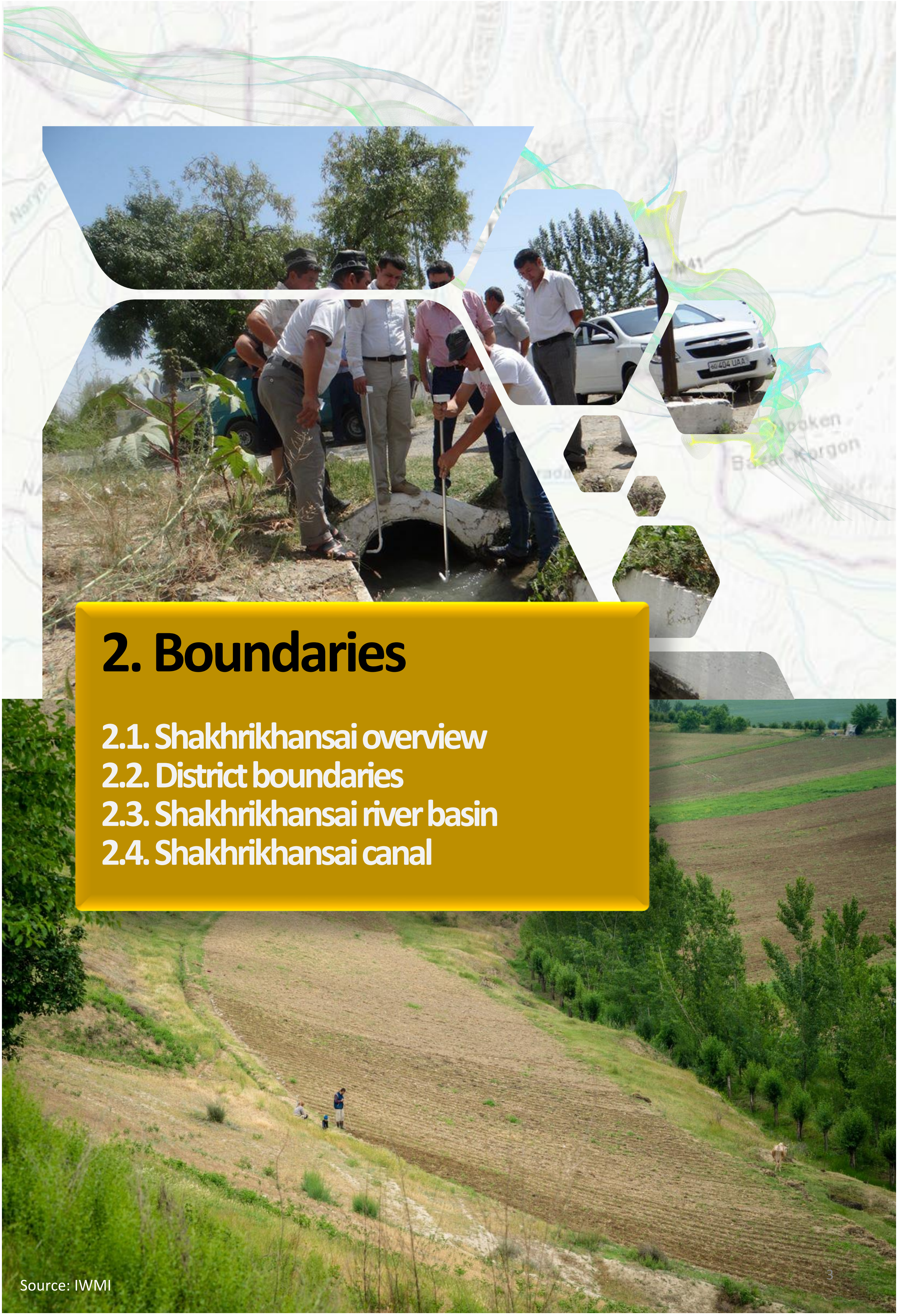
1. Aral Sea Basin Overview



The Aral Sea is a former inland drainage lake in Central Asia, located on the border of Kazakhstan and Uzbekistan. It was the fourth largest lake in the world until 1960s. The area of the Aral Sea basin is about 1.8 million km². Its area is 67,499 km², volume - 1,089 km³.

The Aral Sea is formed by the waters of two large Central Asian rivers - the Amu Darya and Syr Darya. The Amu Darya flowed into the southern part of the sea, the Syr Darya - into the northeast. Both rivers originate in mountainous areas, where the whole stream is formed due to the melting of snow and glaciers. At present time most of the flow of the Amu Darya and Syr Darya is used for various agricultural purposes, in particular, for irrigation.

Source:www.researchgate.net/publication/293333621_Bioraznoobrazie_Aralskogo_mora_i_vozmoznye_puti_reabilitacii_i_sohranenia_ego_ostatocnyh_vodoemov



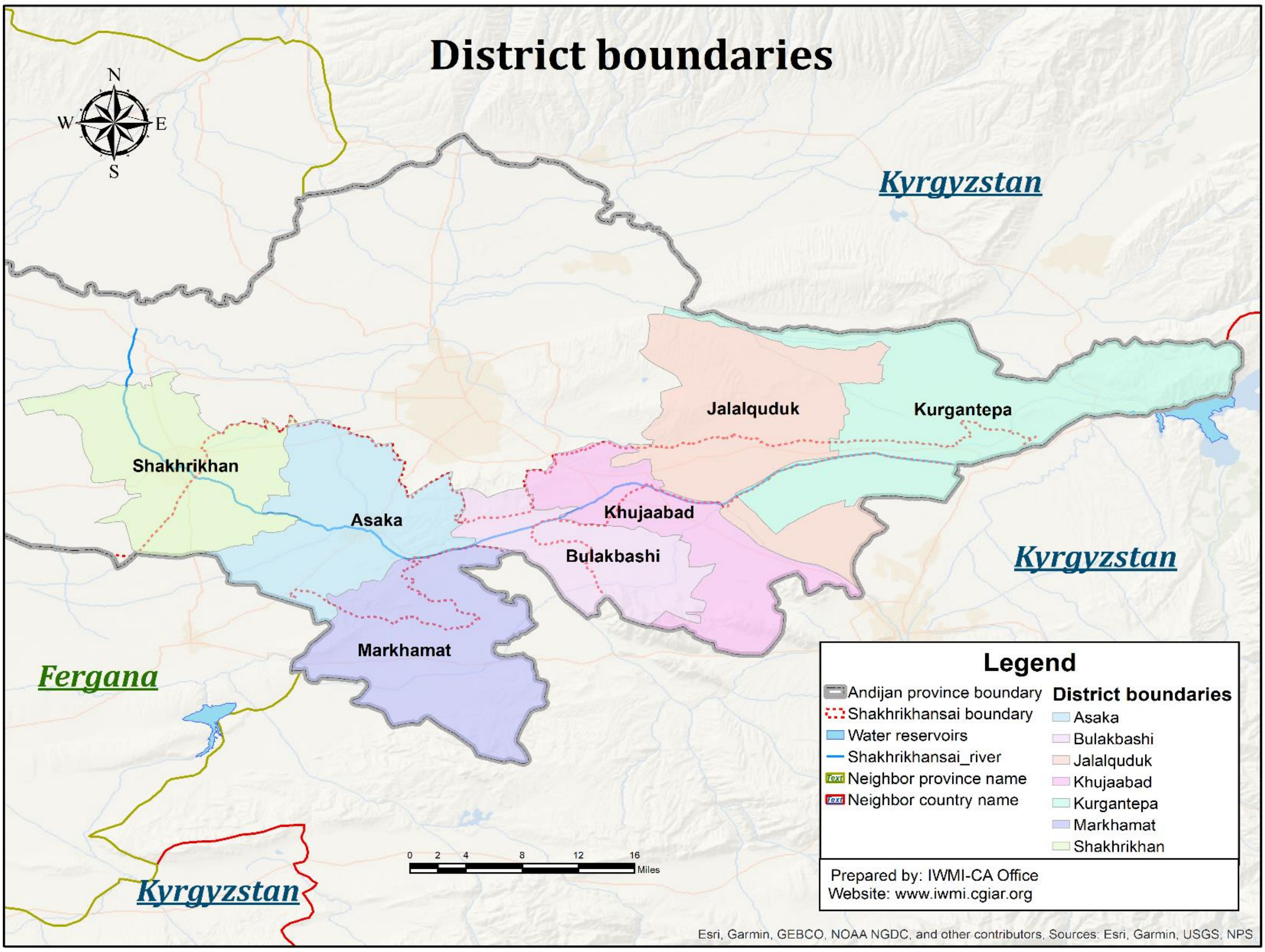
2. Boundaries

Source: IWMI

General information. The Fergana Valley irrigation is a holistic irrigation system, ringed by the main canals feeding each other -the Big Fergana Canal (BFC), the Big Andijan Canal (BAC) and the Southern Fergana Canal (SFC), which are conventionally called the Fergana Irrigation System (FIS).

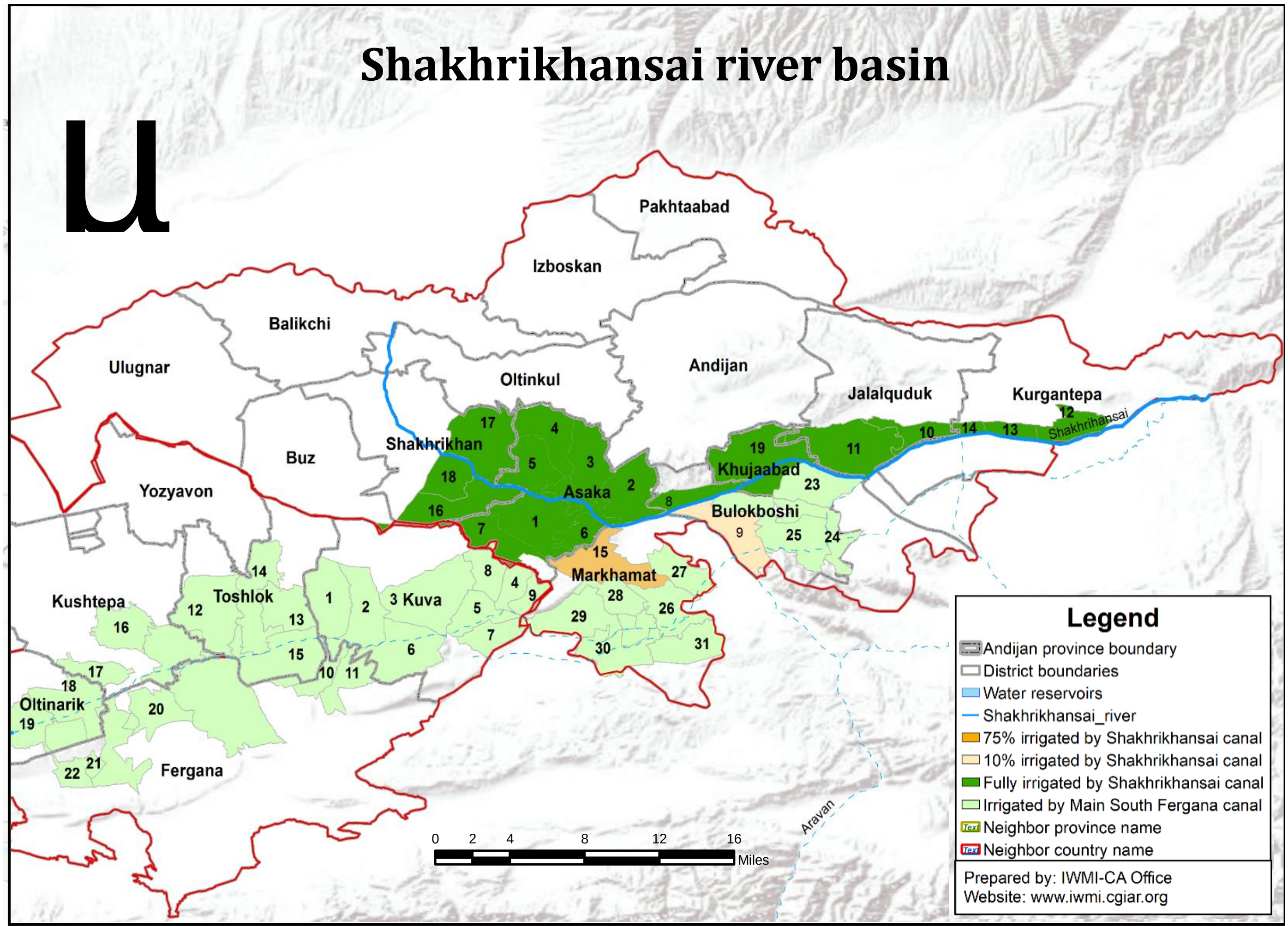
Shakhrikhansai basin considered one of the subsystems of FIS. Shakhrikhansai Irrigation system originates from the Andijan Water Reservoir and delivers water to 59,487 ha of irrigated land in Kurgantepa, Jalalkuduk, Khodjaabad, Bulakbashi, Asaka, Shakhrikhan and Markhamat districts of Andijan region, and 55,544 ha of irrigated land in Kuvasay city, Kuva, Altyaryk, Kushtepa, Tashlak and Fergana districts of Fergana region.


Source: IWMI



District boundaries source: BISA

The district boundaries shown in this map were based on discussions with the representatives of local district irrigation authorities in the basin and information provide by the Shakhrihansai Basin Irrigation System Authority. Shakhrihansai canal provides water fully and seasonally to different irrigation system authorities in five districts along the river. Considering water flow and its supply fully and partially in the territory of the districts, the maps were developed for entire districts showing their boundaries on the maps.

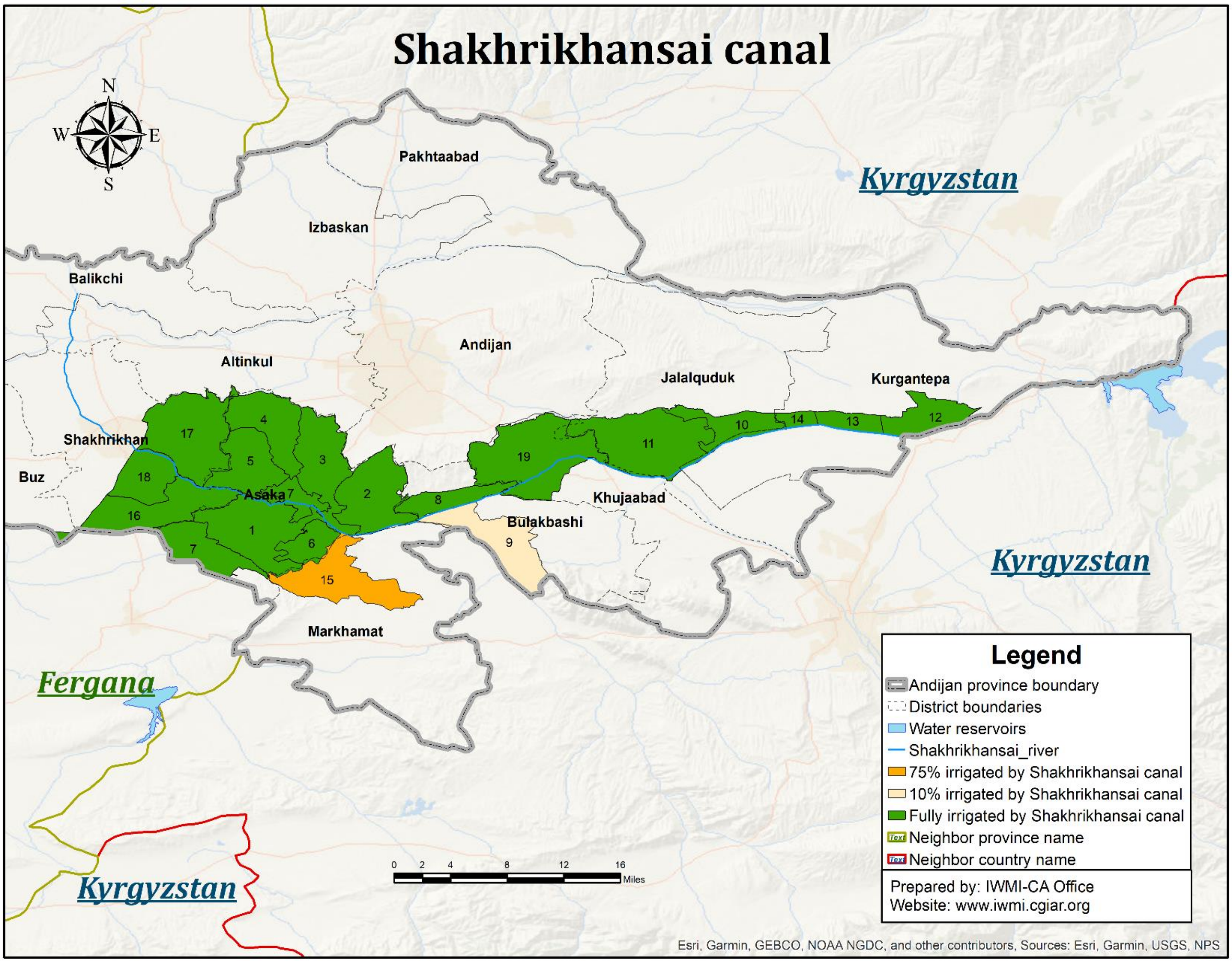


List of WCAs supply by Main South Fergana Canal

№	Name of WCA	District	Irrigation ares of WCA
1	Akbarabad	Kuva	3389
2	Musajon Ismailov	Kuva	2151
3	Kodirjon Azamjon	Kuva	3645
4	Buston Bahor Polvontosh	Kuva	1110
5	Dadakhon Abror Asror	Kuva	1250
6	Kuldashali Ismonaliyev	Kuva	3332
7	Kuva Urta Buz Anori	Kuva	1476
8	Mashrabjon Mamataliev	Kuva	2341
9	Karimov U.	Kuva	887
10	Arsif obihayot	Kuvasai	1476
11	Kalacha Y. Salohiddinov	Kuvasai	1353
12	K.Umarov mirob	Toshlok	3957
13	Yakkatut Obrivan	Toshlok	3173
14	Zarmirob Turgunboy	Toshlok	3096
15	Honobod Honarik	Toshlok	4882
16	Gishtmon obihayot	Kushtepa	2695
17	Oktepa Zilol Chashma	Oltalrik	2217
18	Faizabod Shokhimardon	Oltalrik	2217
19	Povulgon Abdusalom	Oltalrik	1499
20	Humonu Aziz	Fargana	2970
21	Mindon Turop Sattorov	Fargana	2244
22	Najmiddinov	Fargana	2686
23	Hujaobkash	Khujaibod	1590
24	Jurapolvon	Bulokboshi	1025
25	S.Kosimov	Bulokboshi	1224
26	Tojiboev-1	Markhamat	1641.7
27	Tomchi Kuli	Markhamat	3209.5
28	Pakhtakor	Markhamat	1205.7
29	Mashal	Markhamat	3055.8
30	T. Mirzaev	Markhamat	2567.5
31	Markhmat Nosir	Markhamat	820.8

List of WCAs supply by Shakhrihansai canal

№	Name of WCA	District	Irrigation ares of WCA
1	Zokirjon Sobirov	Asaka	2990.8
2	Sohibkor Akbarjon	Asaka	1275
3	Madamipolvon Davomchilari	Asaka	2425.1
4	Kadimlik Mirishkar	Asaka	2402.3
5	Azimjon Karabaev	Asaka	2555.6
6	Lutfulla Bakhromov	Asaka	235
7	Karafpalik Israil	Asaka	2362.3
8	Ulugbek	Bulakboshi	1933
9	B.Rejapov	Bulakboshi	2476.8
10	A. Temur	Jalakuduk	1556.1
11	Jalukud suv bulogi	Jalakuduk	3831
12	Sobirjonov suv bulogi	Kurgantepa	895.5
13	Khamrabaev sakbovati	Kurgantepa	481.7
14	Mashrabboy sakbovati	Kurgantepa	559.4
15	Istiklol	Markhamat	1890.1
16	Yangi Naynavo Mrishkori	Shakhrihan	3762.1
17	Segaza orzular sari	Shakhrihan	3742.2
18	Abdusamat irrigatsiya	Shakhrihan	1129.4
19	Zavrak	Khujabad	2273



The "Shakhrikhansai" Irrigation System is located in Andijan region. The length of the canal is 120 km. The main source of water for the “Shakhrikhansai” Basin Irrigation System is the glacial- snow-fed Karadarya River. Minimum costs are observed from December to March, more often in February. During the flood period, up to 70-75% of the annual flow for the low-flow period (November-February) is 25-30% of the annual flow.

The maximum observed flow rate in May is 1110 m^3/s, the minimum observed in January is 25 m^3/s. The average annual flow of the Karadarya River is 3.783 million m^3. The average annual flow of the Karadarya River is 3.783 million m^3.

3. Social Characteristics

3.1. Population density

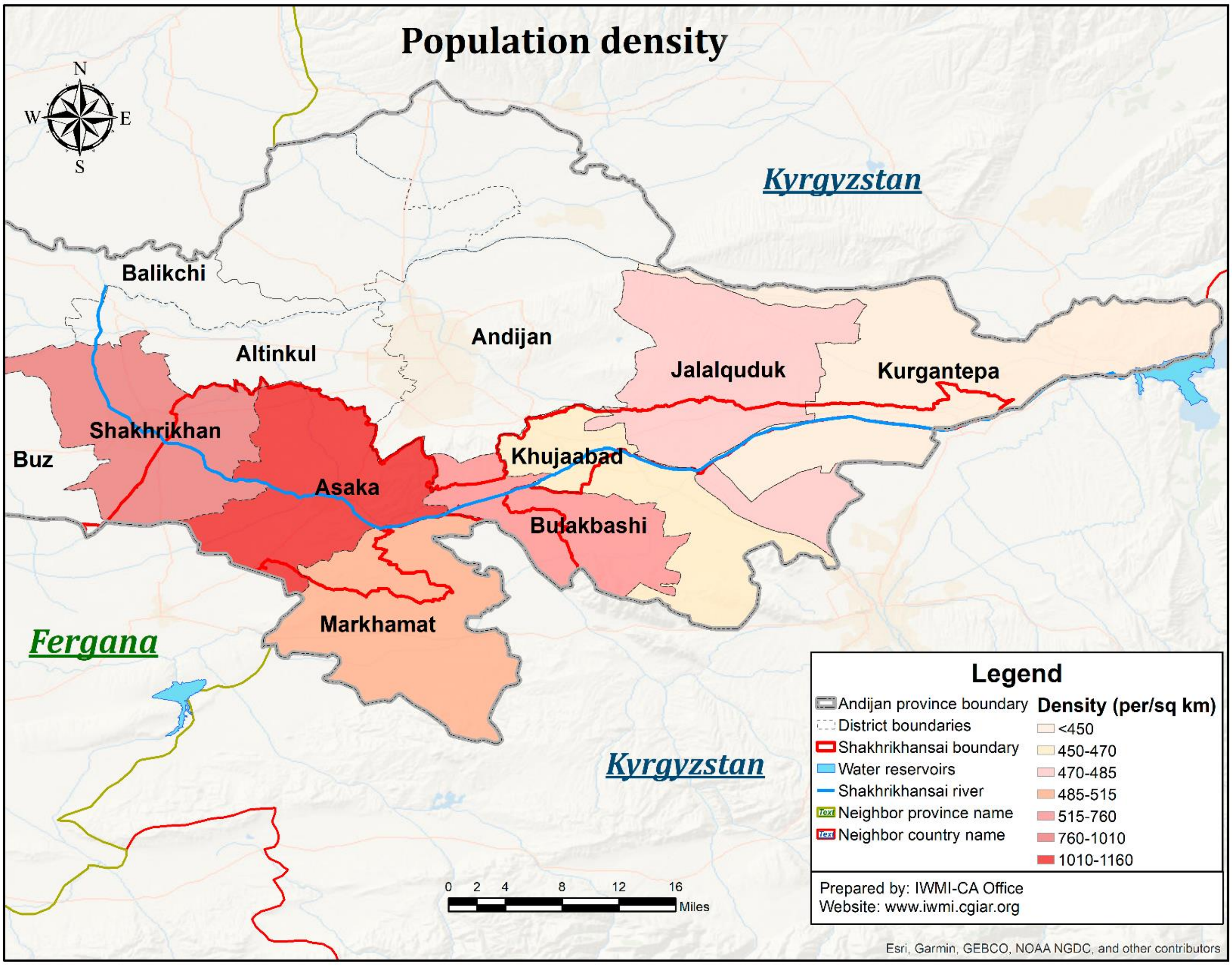
3.2. Population growth

3.3. Urban population

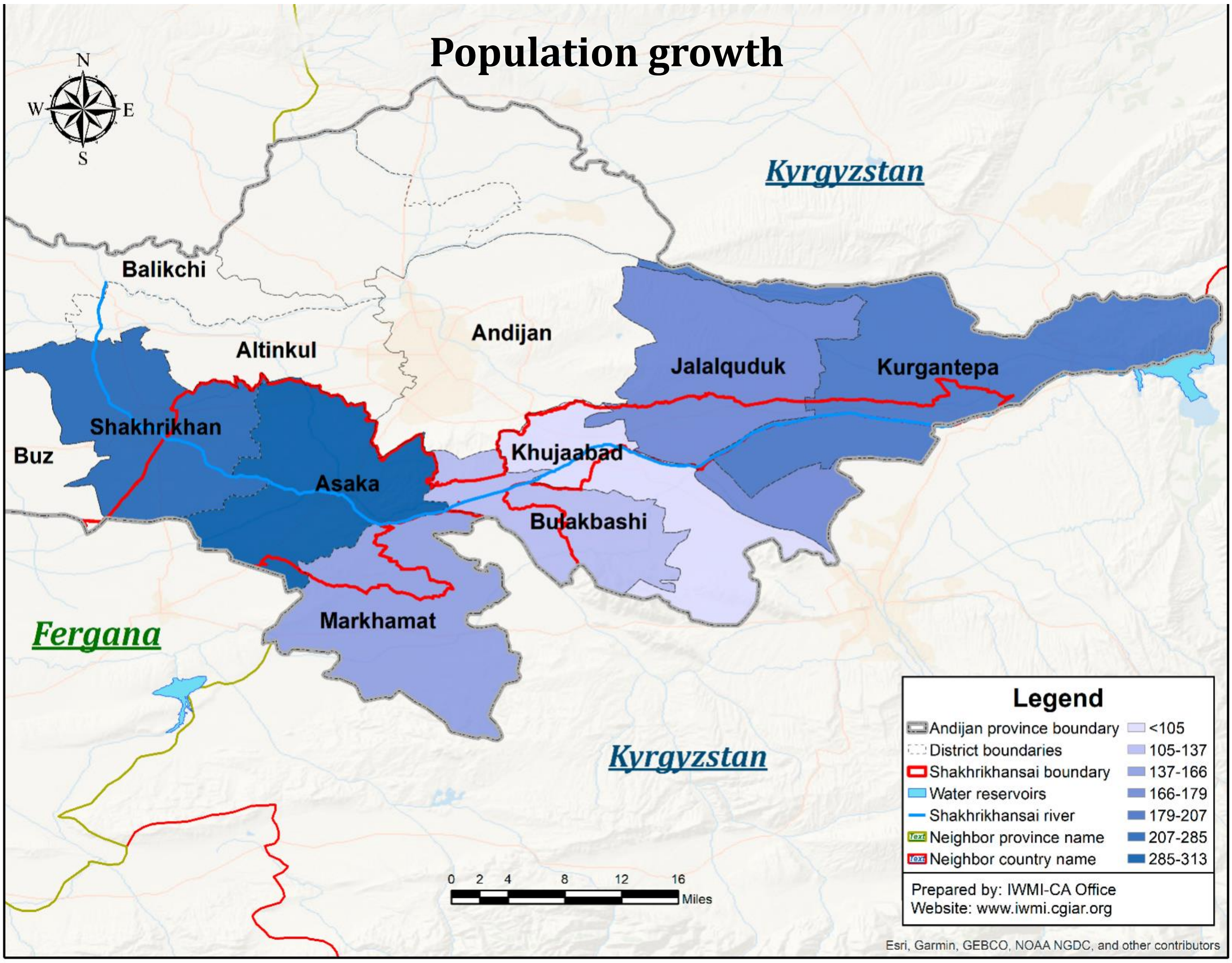
3.4. Rural population

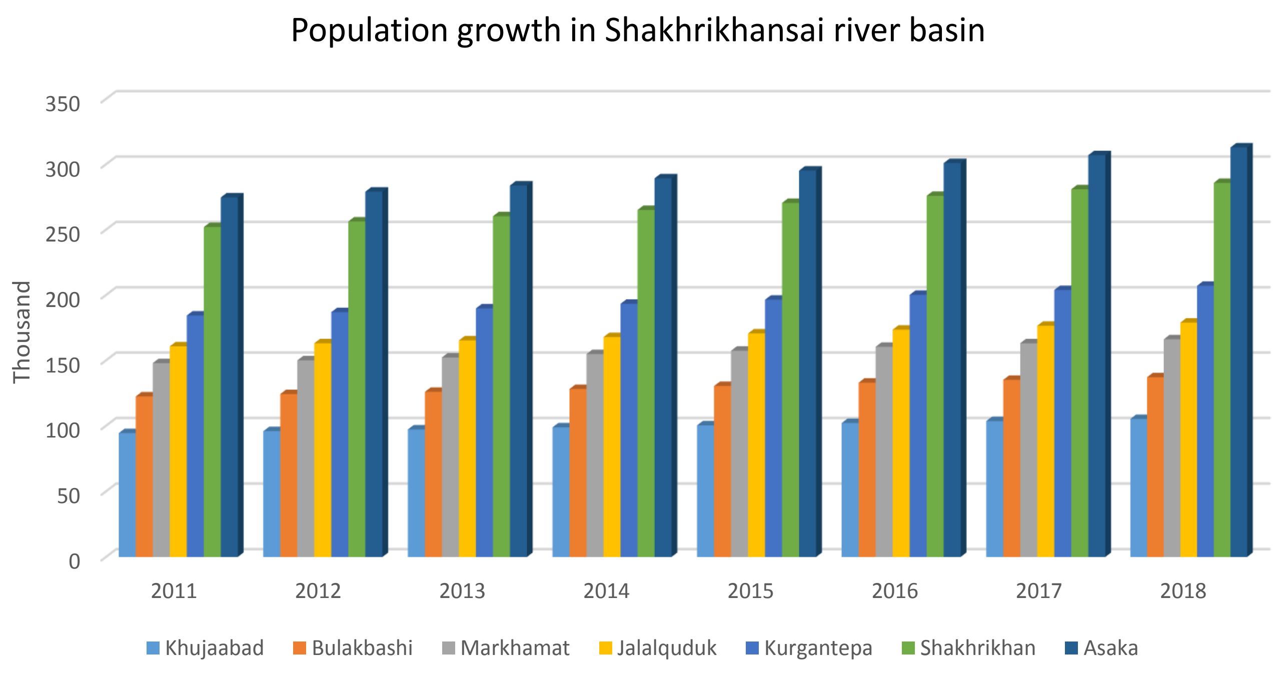
3.5. Gender ratio

3.6. Primary school enrollment

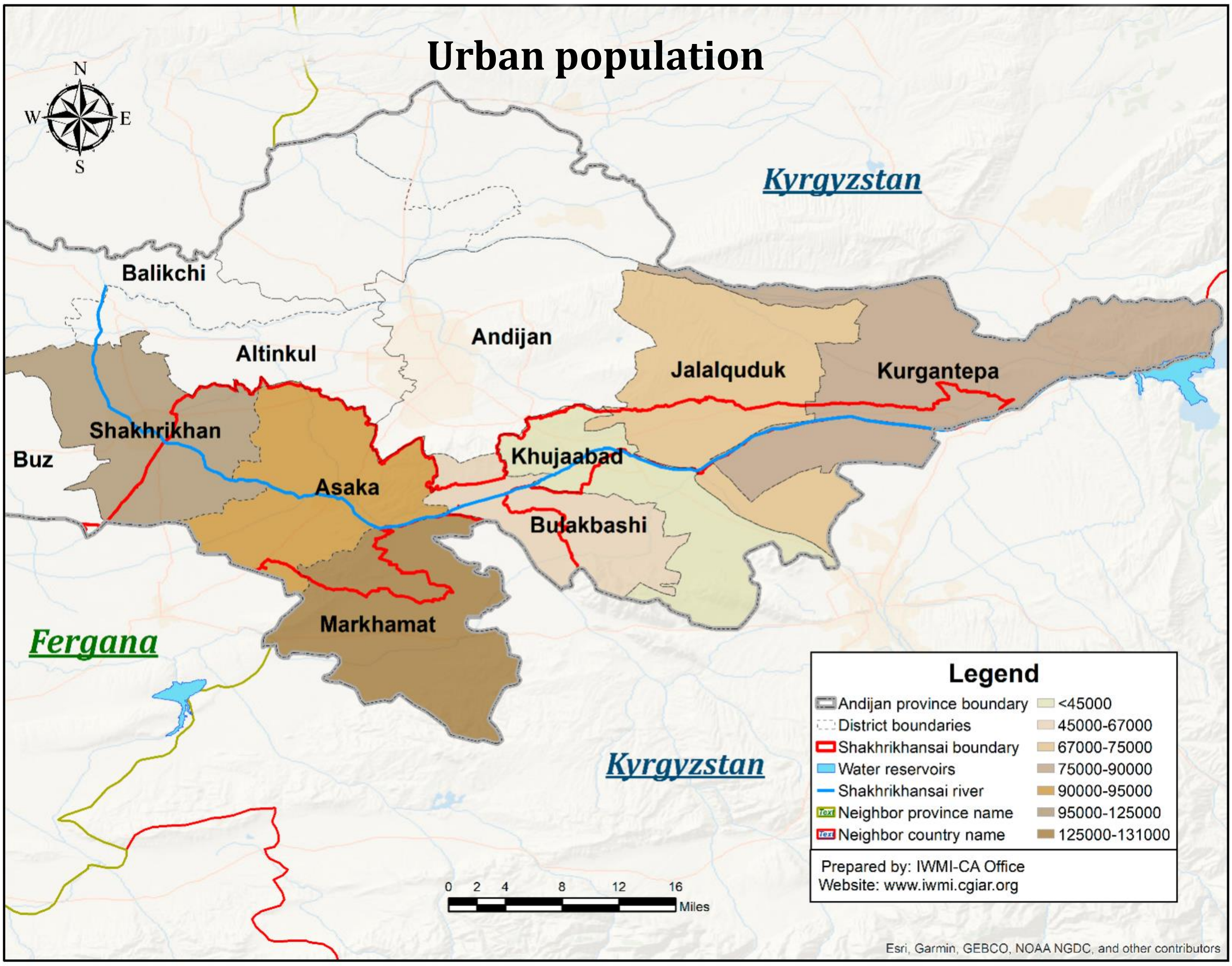


As illustrated in the map, population density varies across the five districts. Asaka has the highest population density which falls into 1010--1160 people/km2 range, while Khujaabad has the lowest population density with less than 450 people/ km2. Shakhrikhan is second with 760-1010 people/ km2, followed by Bulakbashi which has a population density between 515 and 760 people/km2.





Source: Andijan province statistics committee (www.andstat.uz)

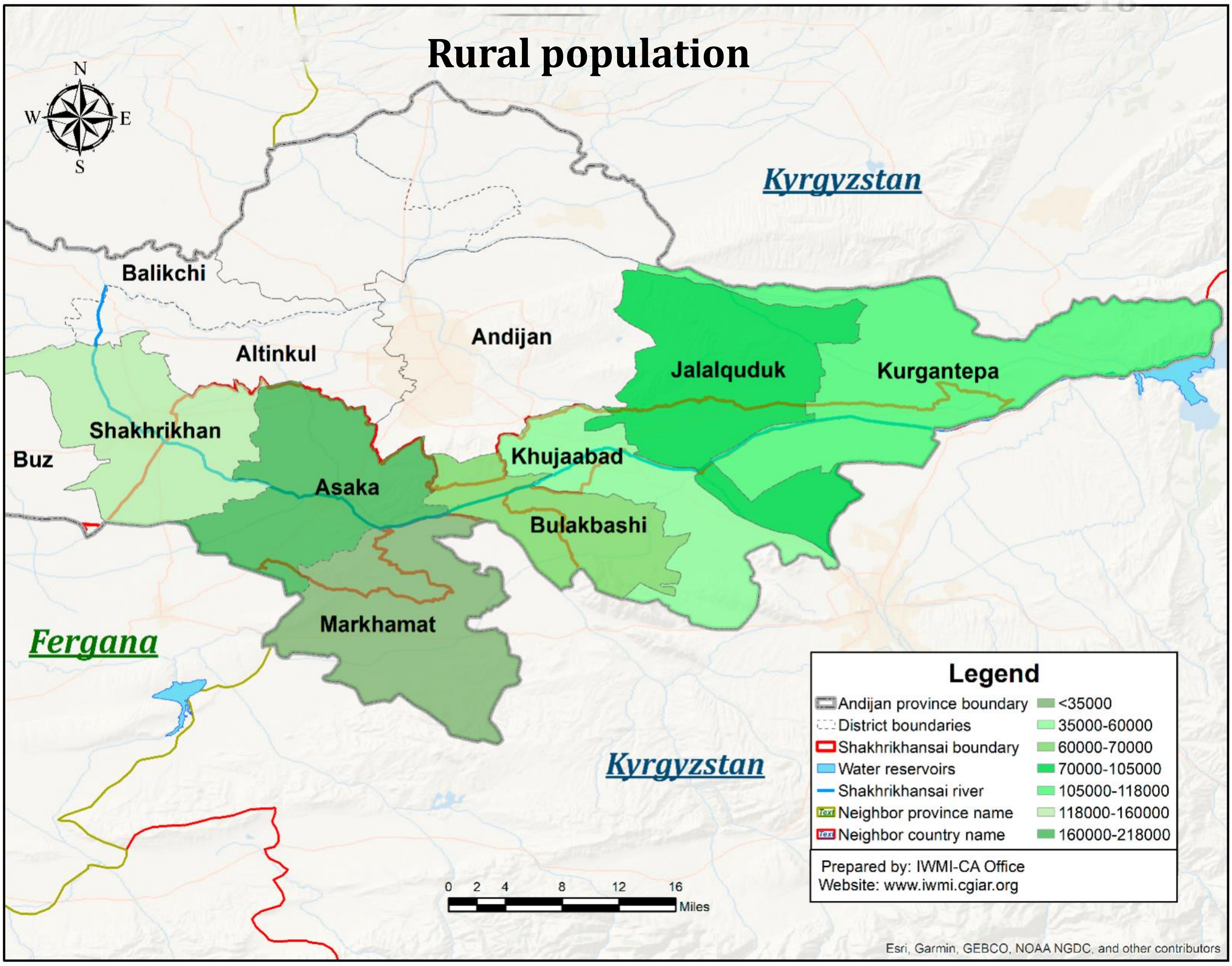


District	Urban population (thousand)	Total population (thousand)	%
Kurgantepa	89.2	207.1	43.07
Jalalquduk	74.7	178.9	41.76
Khujaabad	44.3	105.2	42.11
Bulakbashi	66.9	137.1	48.80
Markhamat	131.04	166.1	78.89
Shakhrikhan	125.8	285.8	44.02
Asaka	95.3	312.9	30.46

Source: Andijan province statistics committee (www.andstat.uz)


Source: IWMI


Source: IWMI

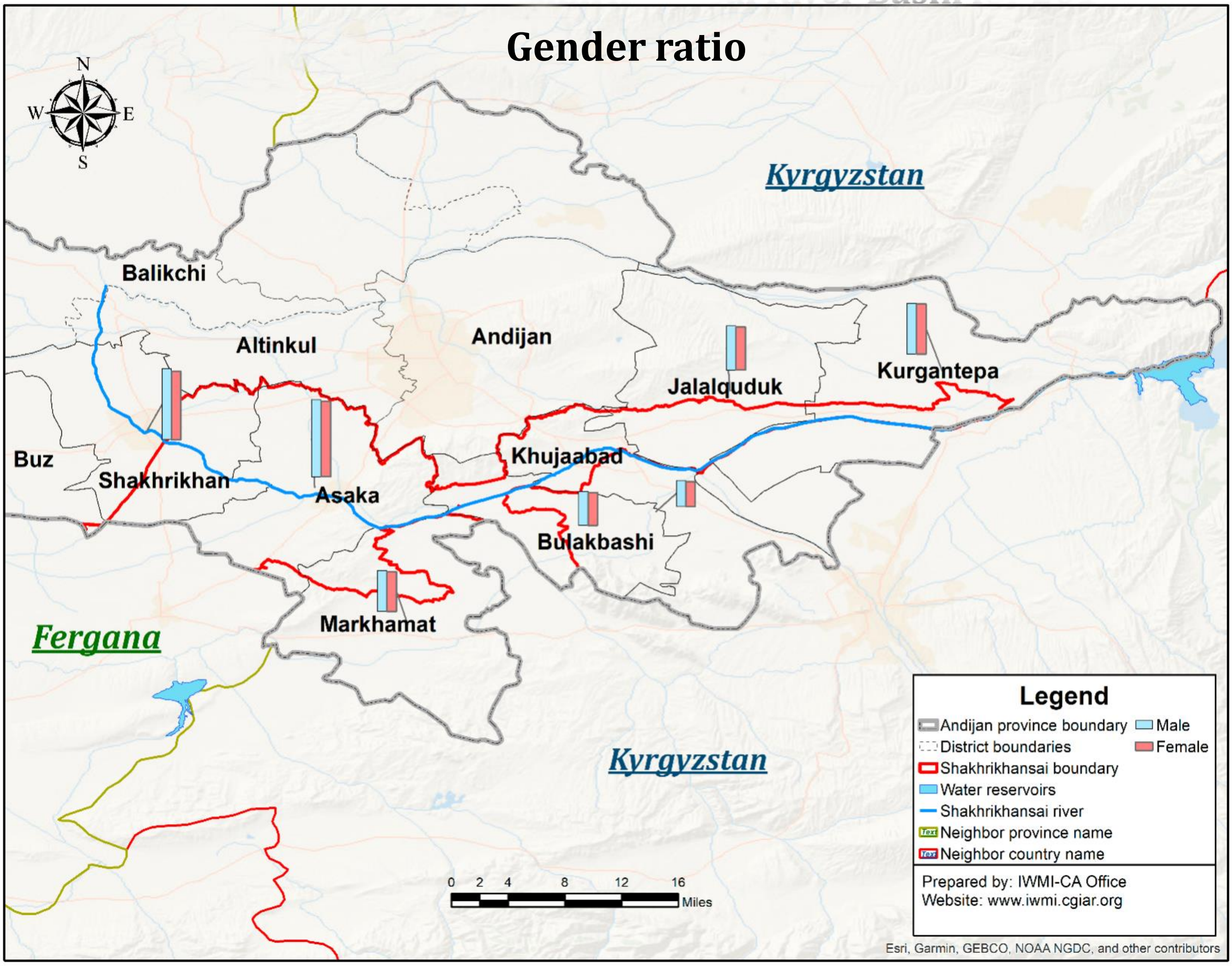


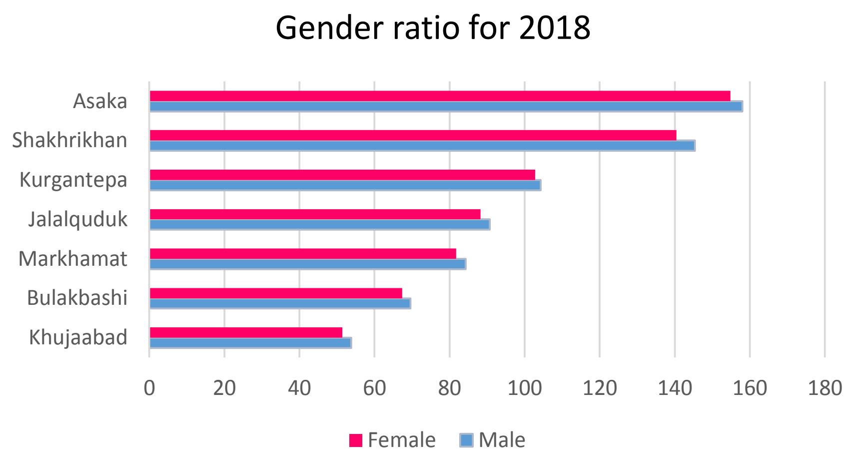
District	Rural population (thousand)	Total population (thousand)	%
Kurgantepa	117.9	207.1	56.93
Jalalquduk	104.2	178.9	58.24
Khujaabad	60.99	105.2	57.98
Bulakbashi	70.168	137.1	51.18
Markhamat	35.024	166.1	21.09
Shakhrikhan	160	285.8	55.98
Asaka	217.7	312.9	69.57

Source: Andijan province statistics committee (www.andstat.uz)


Source: IWMI


Source: IWMI

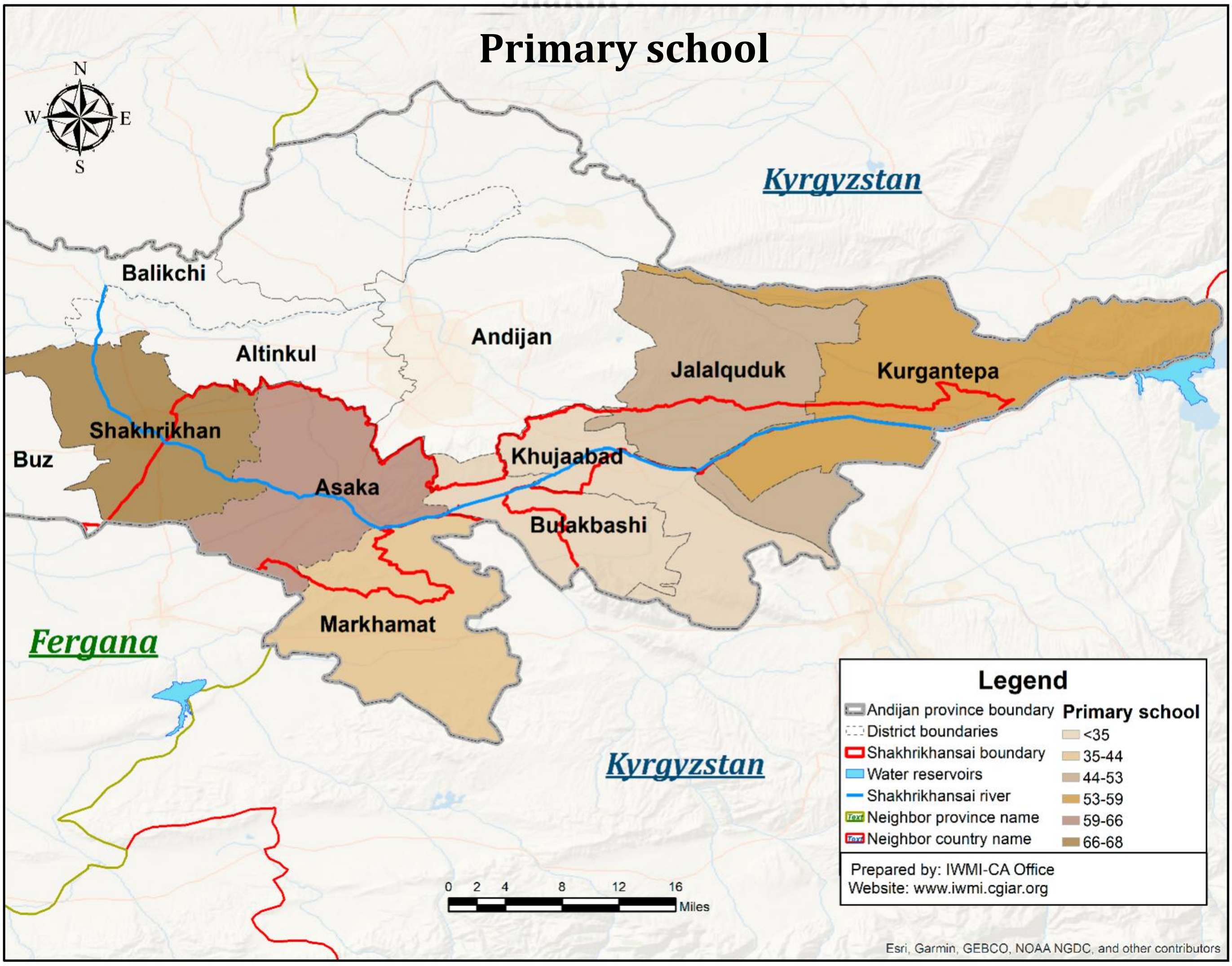




District	Female population (thousand)	Total population (thousand)	%
Kurgantepa	102.82	207.1	49.65
Jalalquduk	88.25	178.9	49.33
Khujaabad	51.38	105.2	48.84
Bulakbashi	67.4	137.1	49.16
Markhamat	81.78	166.1	49.24
Shakhrikhan	140.45	285.8	49.14
Asaka	154.86	312.9	49.49

District	Male population (thousand)	Total population (thousand)	%
Kurgantepa	104.25	207.1	50.34
Jalalquduk	90.69	178.9	50.69
Khujaabad	53.77	105.2	51.11
Bulakbashi	69.6	137.1	50.77
Markhamat	84.27	166.1	50.73
Shakhrikhan	145.35	285.8	50.86
Asaka	158.05	312.9	50.51

Source: Andijan province statistics committee (www.andstat.uz)

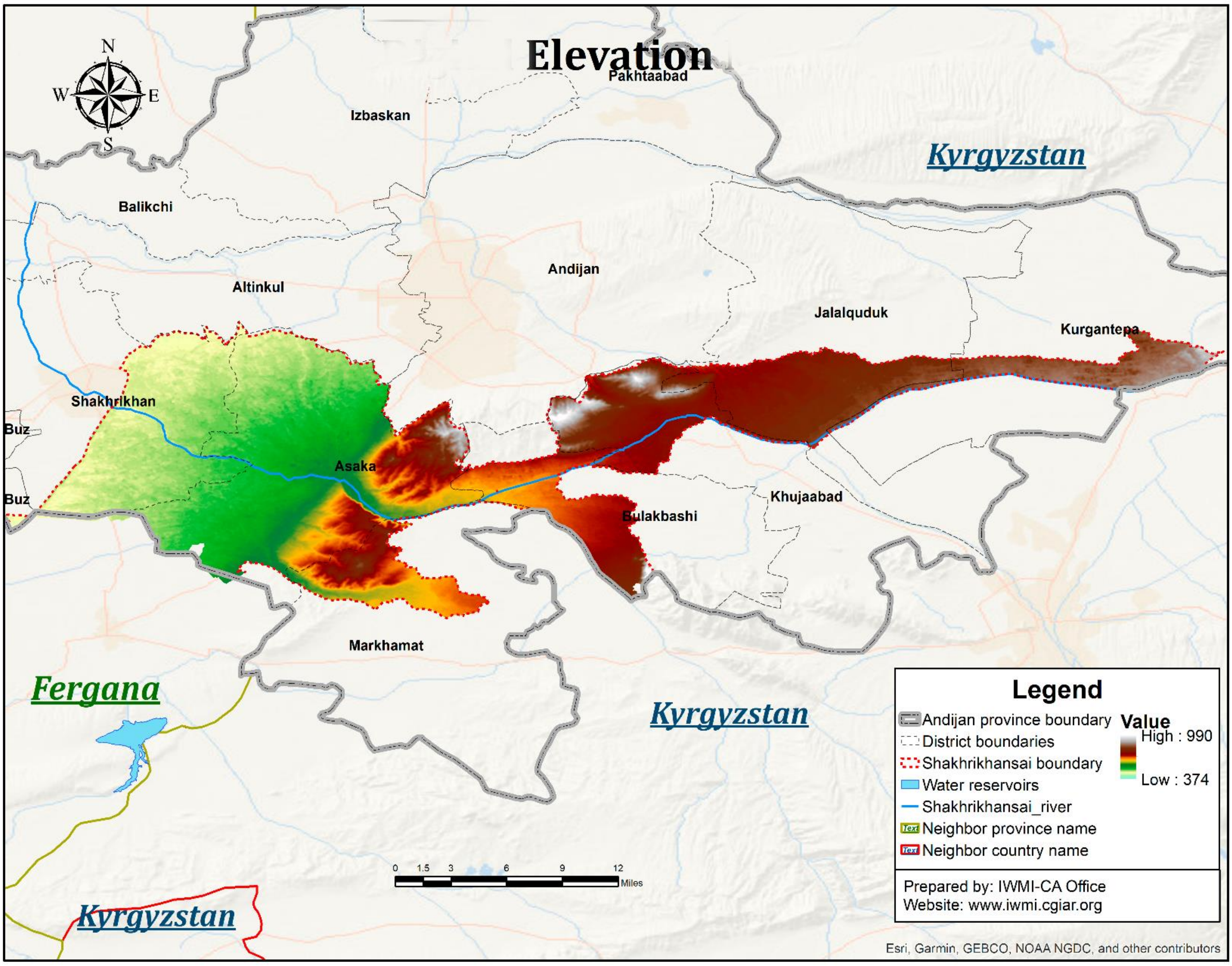


Primary school enrollment refers to the proportion of children of primary school age who are enrolled in primary school. This map depicts the primary school enrollment rate across the districts in the Shakhrihansai river basin. The map shows that primary school enrollment is generally high in each district, which means that nearly all children in the basin are attending primary school. Data are from statistical agencies at the provincial and district levels.

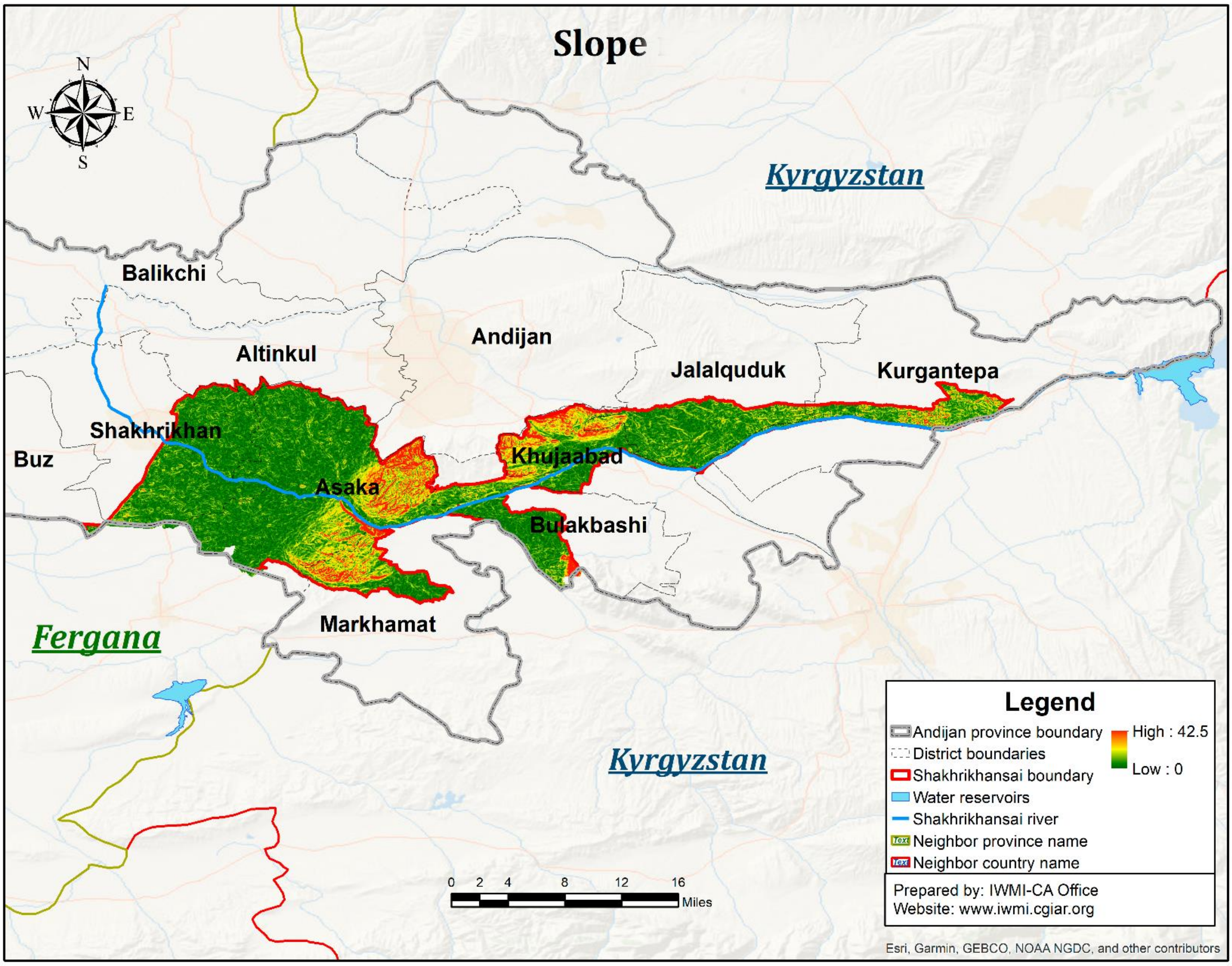
Source: Andijan province statistics committee (www.andstat.uz)

4. Physical Landforms and Transport Infrastructure

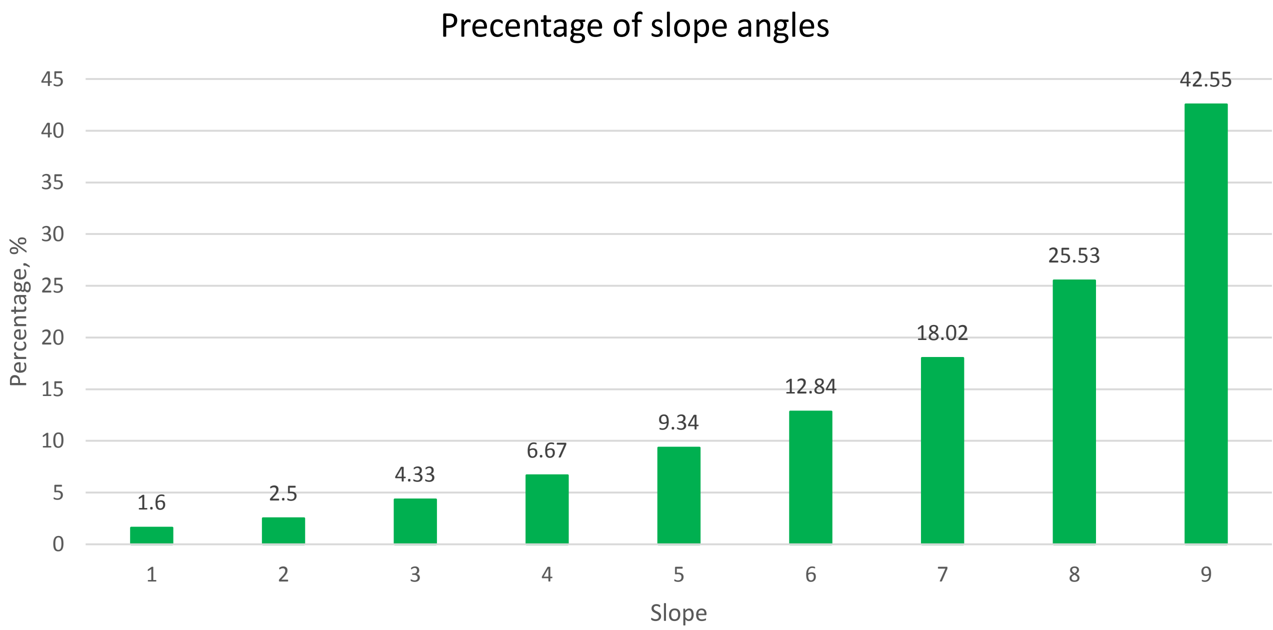
Source: IWMI

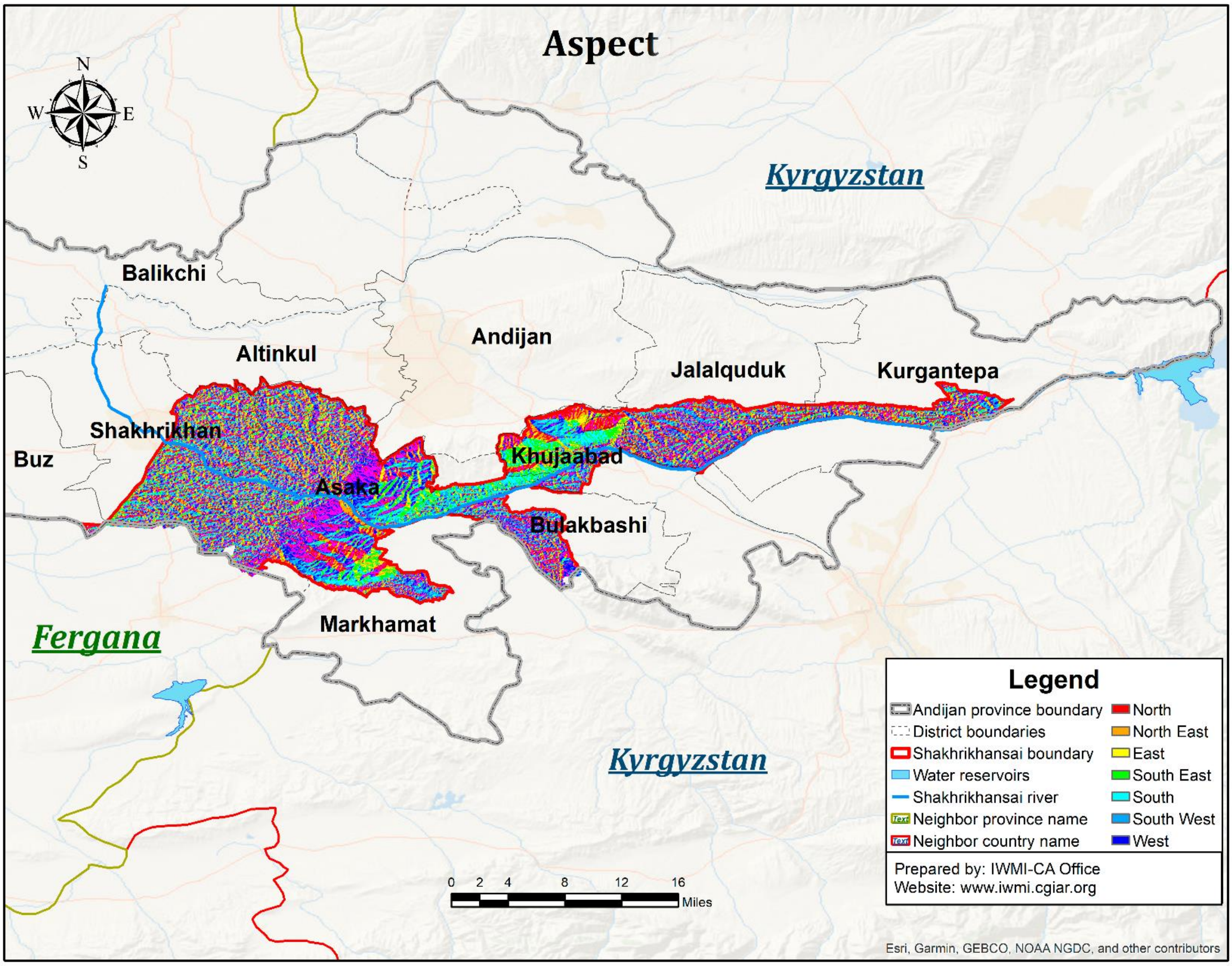


The elevation of Shakhrikhansai river basin varies from 374 to 990 m. Annual rainfall within the considered meteorological stations varies from 350 to 650 mm.

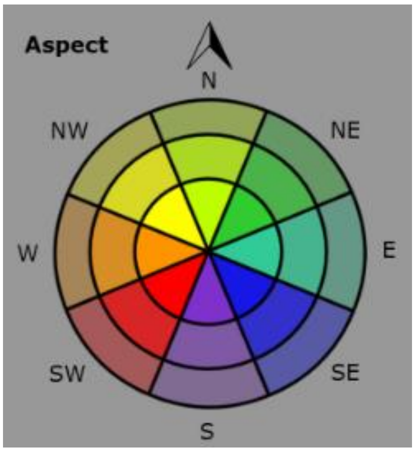


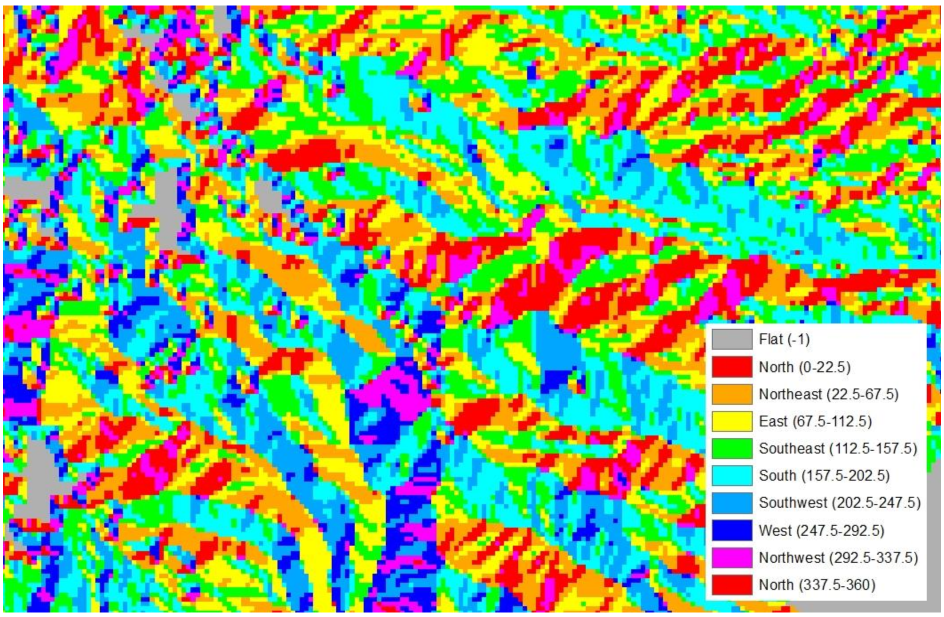
This colorized slope is appropriate for visualizing the steepness of the terrain at all map scales. This layer can be added to applications or maps to enhance contextual understanding. Below graph shows percentage of slope angles.

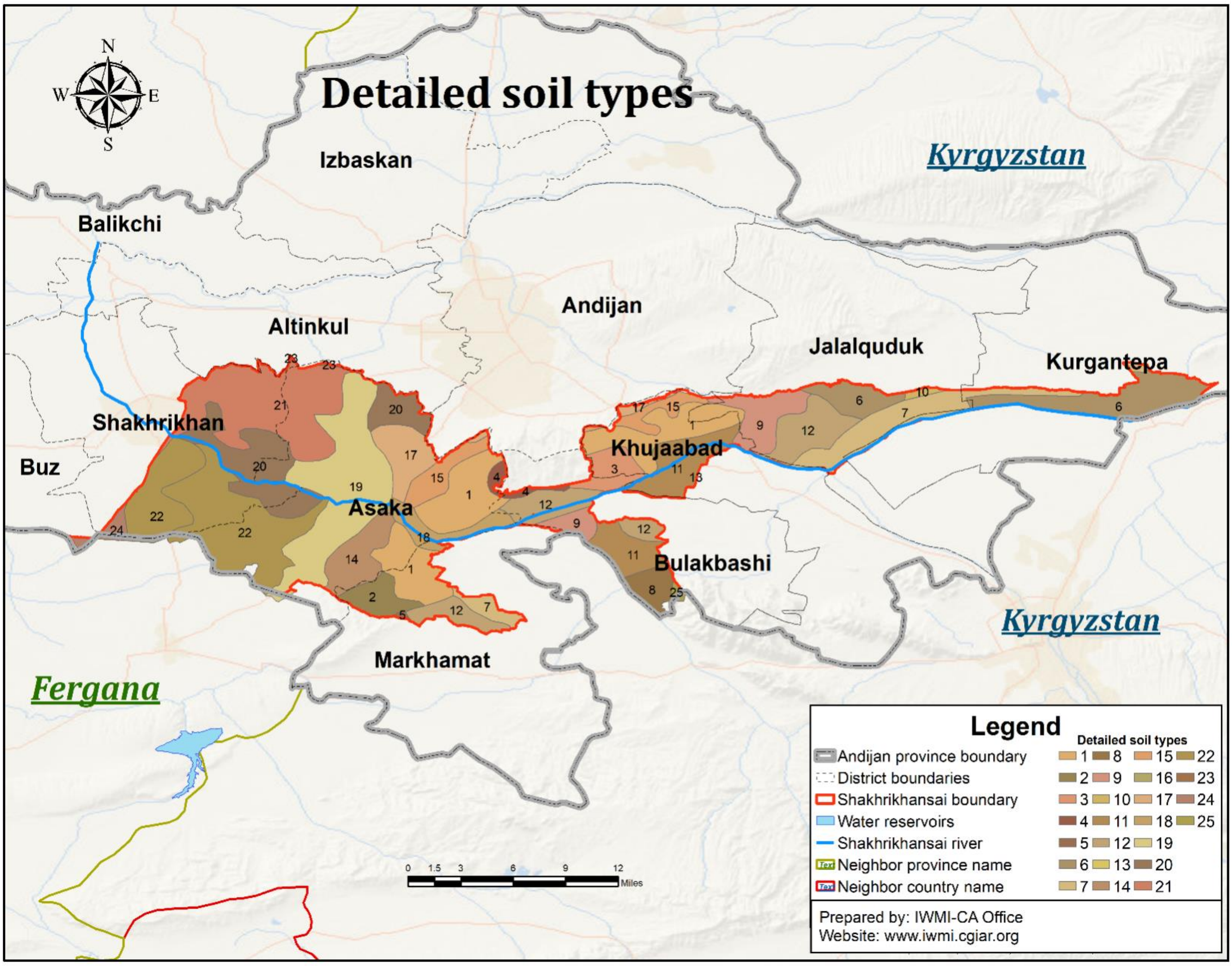




Aspect values illustrate the directions of the faces of physical slope. Aspect is done through classification directions based on slope angles.

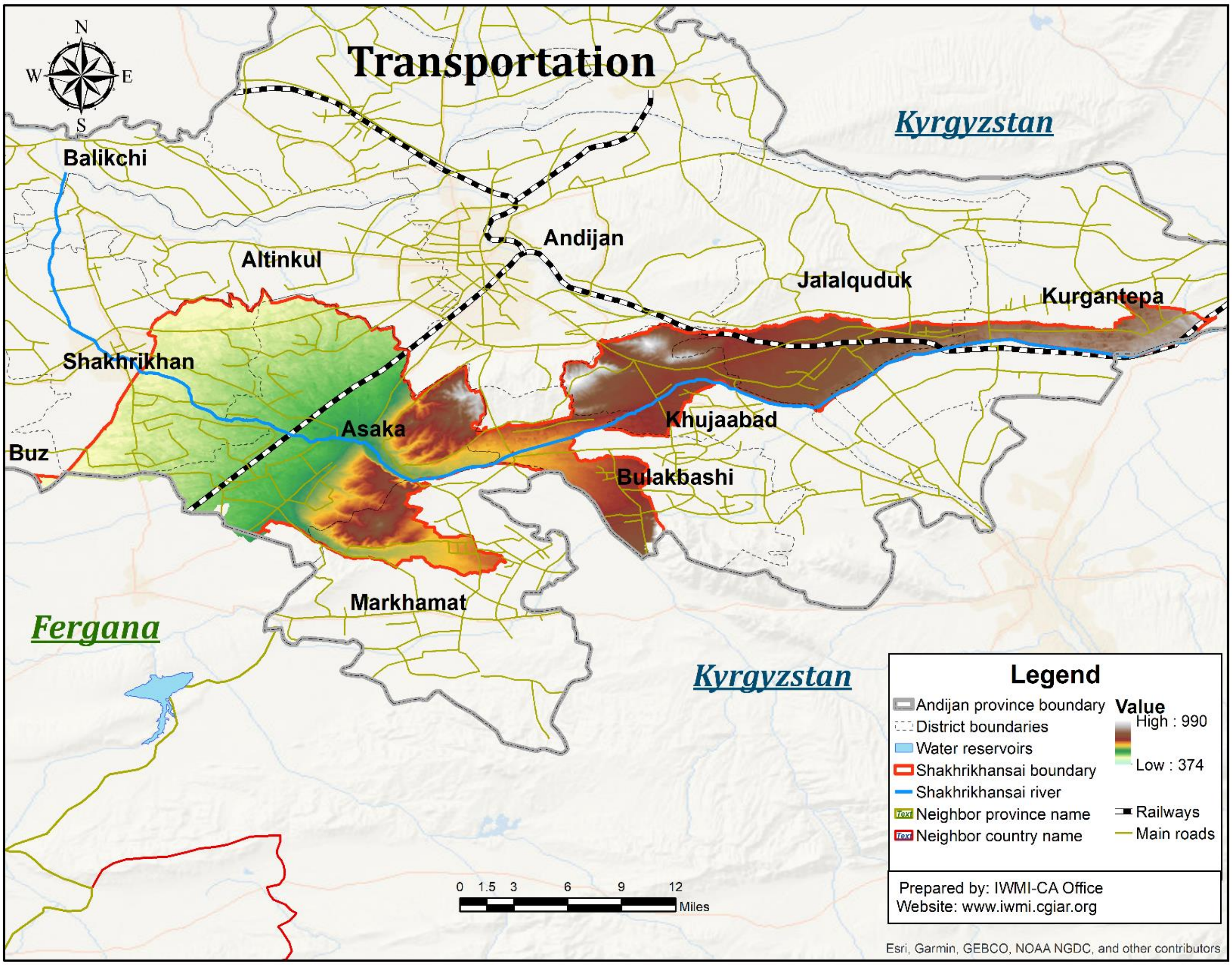






№	Detail soil type
1	New irrigated chernozems typical medium-loamy, weakly skeletal and sometimes with lightly, sometimes to a depth of 0.5-1 m - gravel
2	New irrigated chernozems typical medium-loamy, with lightly, sparsely populated places, sometimes with 0.5-1 m - gravel
3	Chernozem typical (of virgin-fallow with small plots of rainfed and irrigated conventionally) medium loam, with heavy loam and clay, sometimes skeletal, medium - and heavily eroded
4	Chernozem typical (of virgin-fallow) musculo-skeletal fine earth and rough in places with outcrops of bedrock, medium and strongly eroded
5	Old irrigated chernozems typical medium-loamy, sometimes with 0.5-1 m - gravel
6	Irrigated chernozem-meadow and meadow-chernozem soils loamy, sometimes sparsely populated and lightly washed
7	Staro irrigated chernozem-meadow and meadow-chernozem soil medium loamy
8	New irrigated chernozem-meadow and meadow-chernozem soil medium loamy, slightly salted, sometimes with lightly, sometimes with 0.5-1 m - gravel
9	Staro irrigated meadow saz loamy soil, sometimes slightly skeletal, uninhabited, sometimes slightly saline
10	Staro Irrigated meadow saz soil medium loamy, weakly, moderately saline sites, sometimes omer gelevannye
11	New irrigated meadow saz loamy soil, sparsely populated places
13	New irrigated meadow saz loamy soil, medium and strongly saline, places arzyk
14	Irrigated chernozem-meadow and meadow-chernozem soils loamy, sometimes sparsely populated and lightly washed
15	New Irrigated meadow saz soil medium loamy, weakly, moderately saline sites
16	Novo mastered sierozems srednesuglinistye bright, sparsely populated, places lightly washed, gypsum-bearing, sometimes with a 0.5 m - gravel
17	Staro irrigated loamy black soil light, sparsely populated places and with lightly, sometimes with 0.5-1 m - gravel
18	New light black soil irrigated secondary clay, uninhabited, sometimes with lightly, often 0.5-1 m lies pebbles
19	Staro irrigated chernozem-meadow and meadow-chernozem soils srednesuglinistye, sometimes with 0.5-1 m - gravel
20	Staro irrigated meadow saz soils loamy, slightly salted, sometimes washed
21	Staro irrigated meadow saz soil medium loamy, slightly salted, sometimes washed, sometimes with 0.3-0.5 m - gravel
22	New irrigated meadow saz loamy soil medium, sometimes easy loamy, weakly, sometimes moderately saline and gypsum-bearing
23	Staro irrigated meadow alluvial soils loamy, sometimes shokh
24	New irrigated meadow saz-alluvial soils easily loamy and sandy loam, medium salinity, places with 0.5 m - Schoch and gravel
25	Rocks, debris, rock outcrops

Source: Uzgipromeliovodkhoz institute (www.uzgip.uz)



Country roads

Main roads

Field roads

Railroads

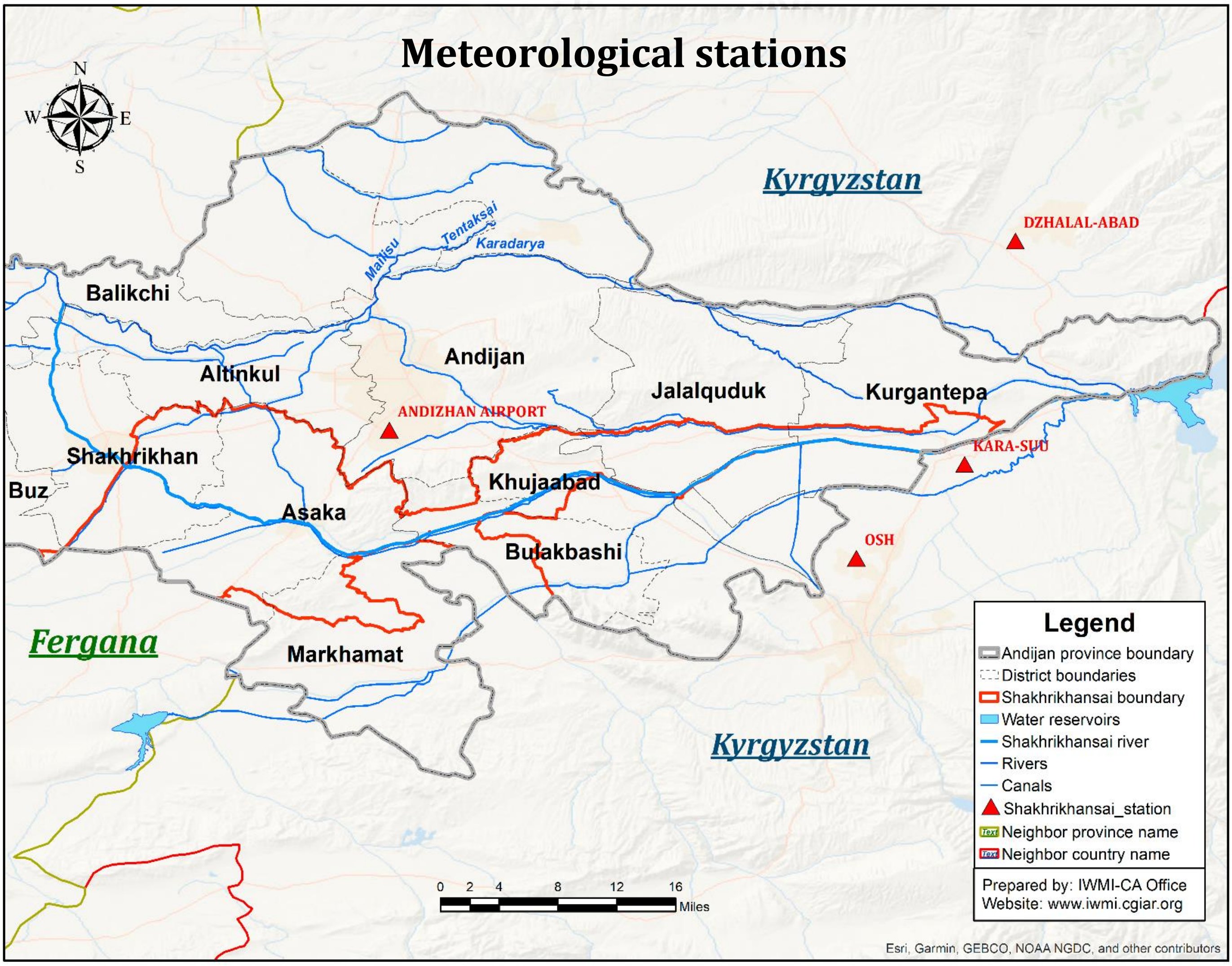
The transportation infrastructure in Andijan province is adequate, as there are a good amount of country roads, main roads and field roads. There is also a railroad that passes through the region, connecting the local populations to other cities and provinces in the country. However, it should be noted that there are certain parts of the basin that have not been settled yet and have limited or no form of transportation access.

5. Monitoring Stations

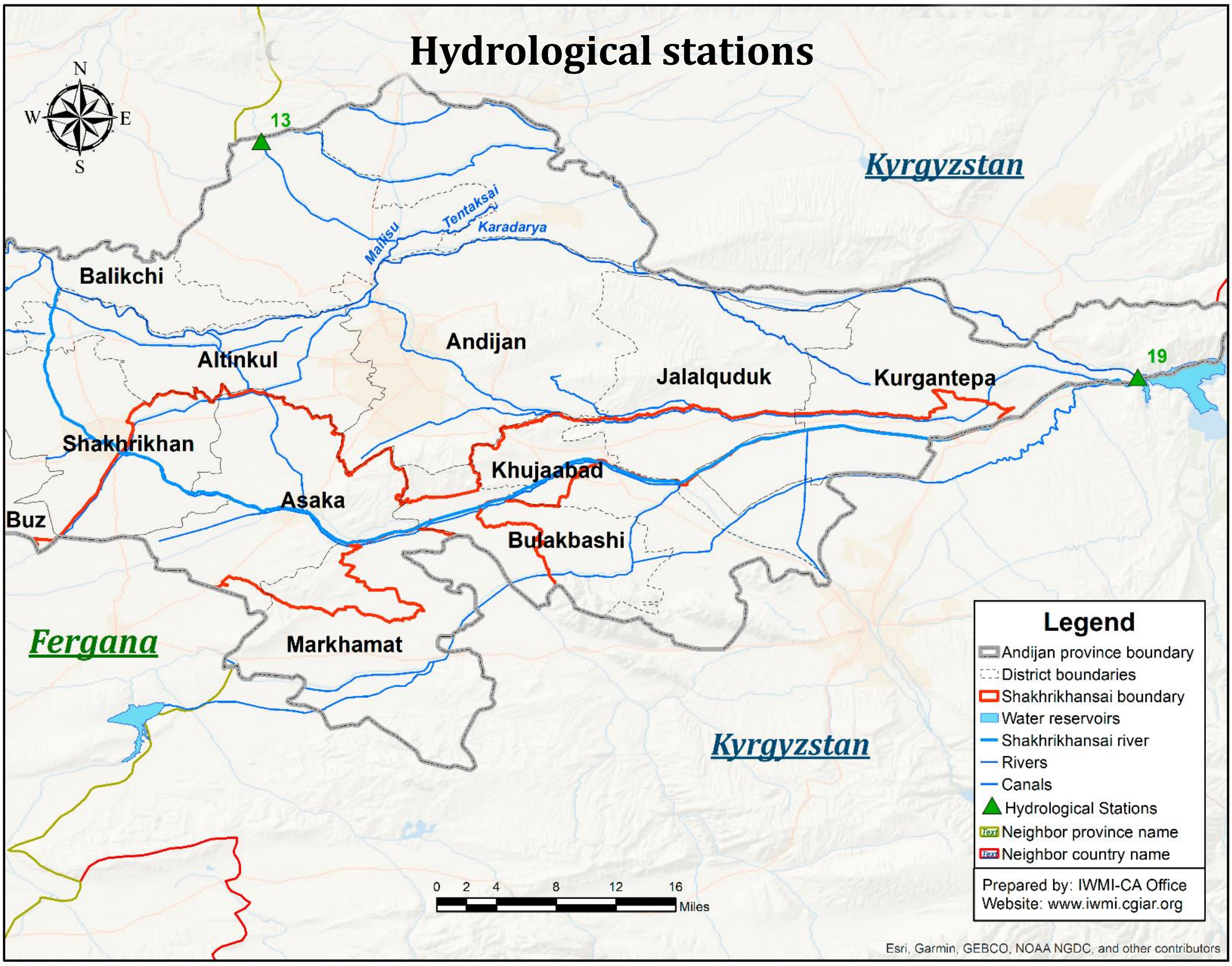
5.1. Meteorological stations

5.2. Hydrological stations

Source: IWMI


Meteorological stations
N
S
W
E
Kyrgyzstan
DZHALAL-ABAD
Tentaksai
Karadarya
Maiilsu
Balikchi
Andijan
Altinkul
Jalalquduk
Kurgantepa
ANDIZHAN AIRPORT
KARA-SUU
Shakhrikhan
Khujaabad
Buz
Asaka
OSH
Bulakbashi
Fergana
Markhamat
Kyrgyzstan
Legend
Andijan province boundary
District boundaries
Shakhrikhansai boundary
Water reservoirs
Shakhrikhansai river
Rivers
Canals
Shakhrikhansai_station
Neighbor province name
Neighbor country name
Prepared by: IWMI-CA Office
Website: www.iwmi.cgiar.org
0 2 4 8 12 16
Miles
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors


Source: IWMI



This map displays the geographical locations of eight hydrological stations located either within or close the boundary of the Shakhrikhansai river basin. Hydrological stations provide important data and information on hydrological conditions, including water level and temperature, speed of the current, turbidity, and ice phenomena. Analysis and understanding of hydrological conditions are also vital to effective management of water resources.

6. Water Resources, Drought and Crop Maps

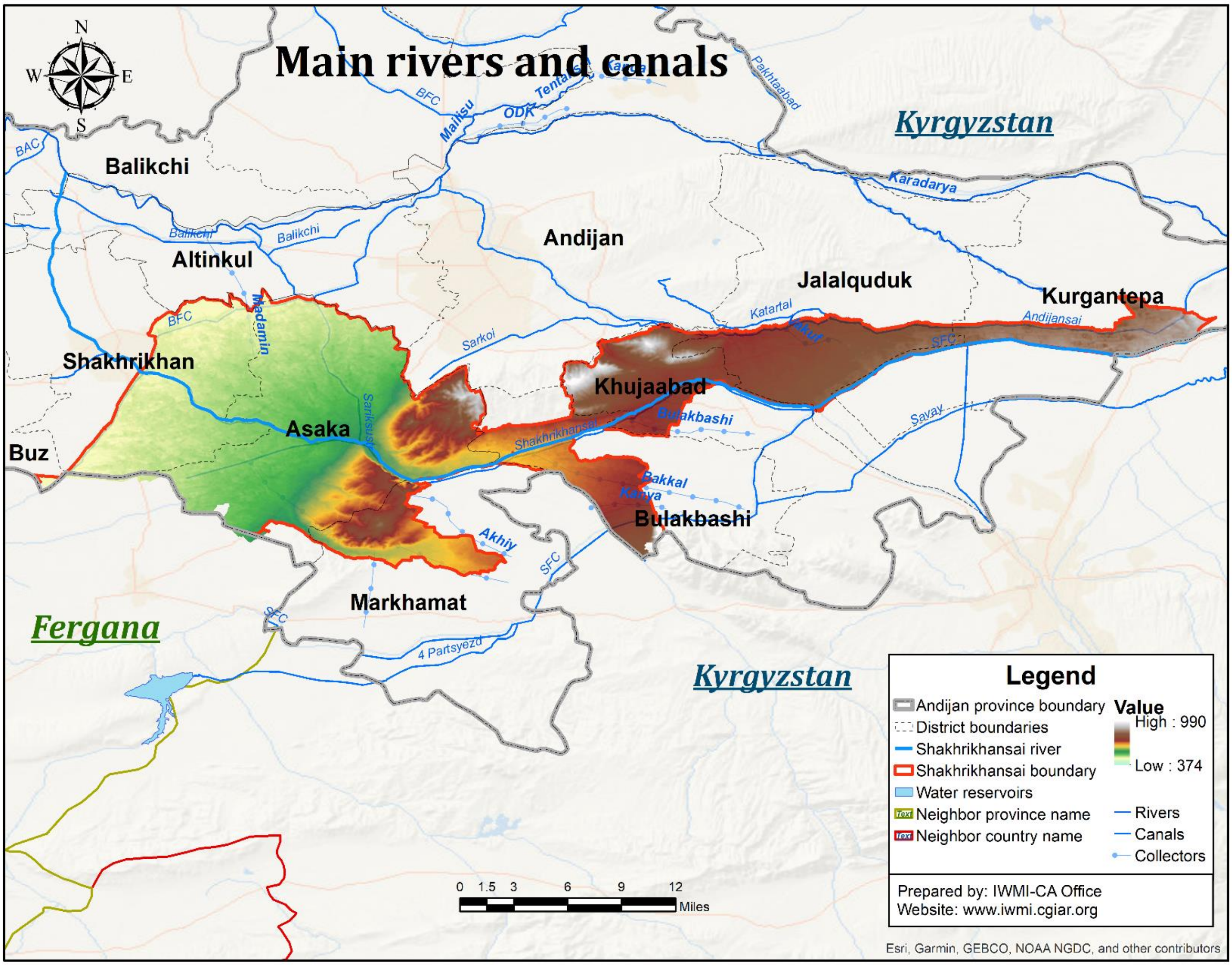
6.1. Rivers

6.2. Pump stations

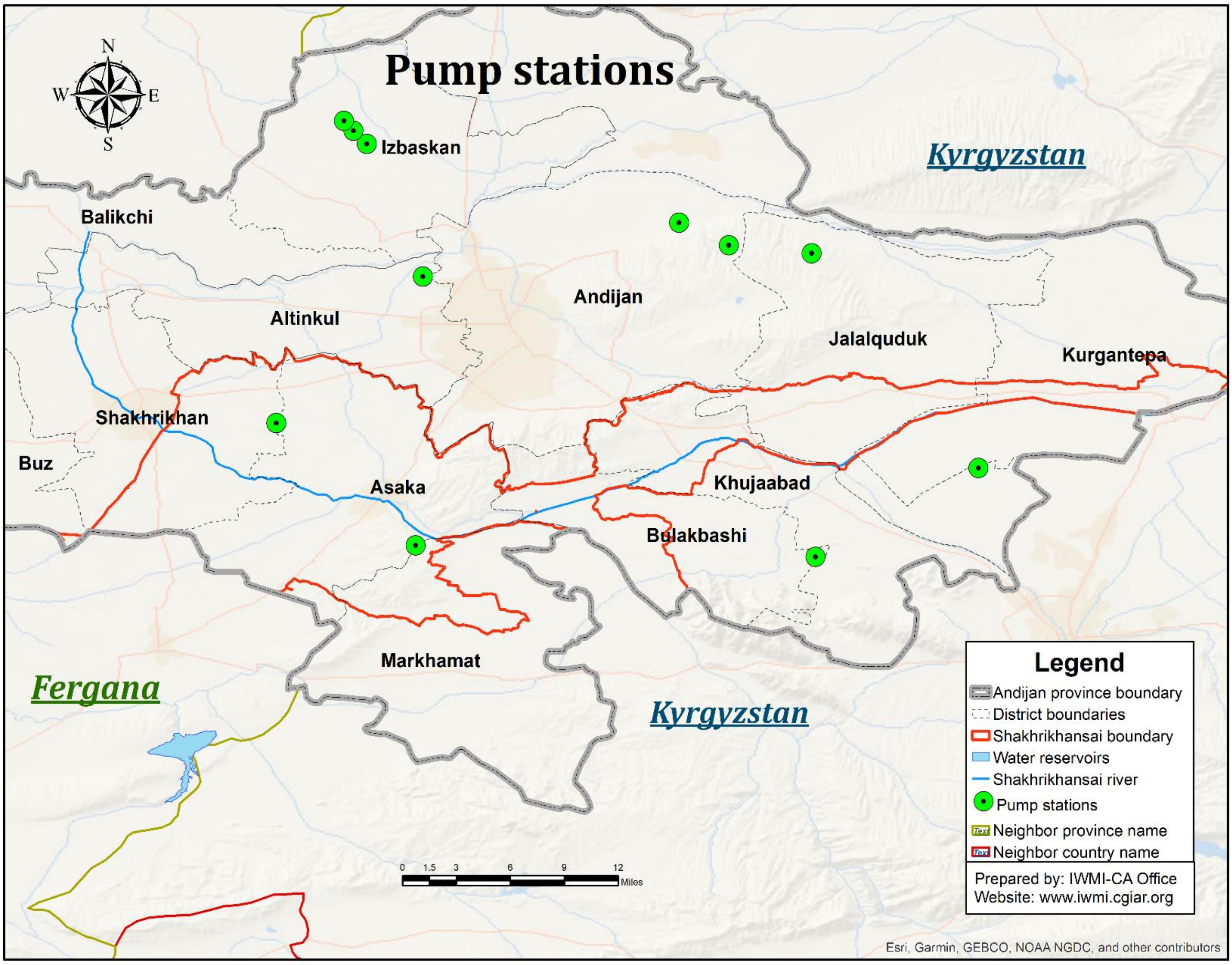
6.3. Crop classification

6.4. Drought mapping and analyses

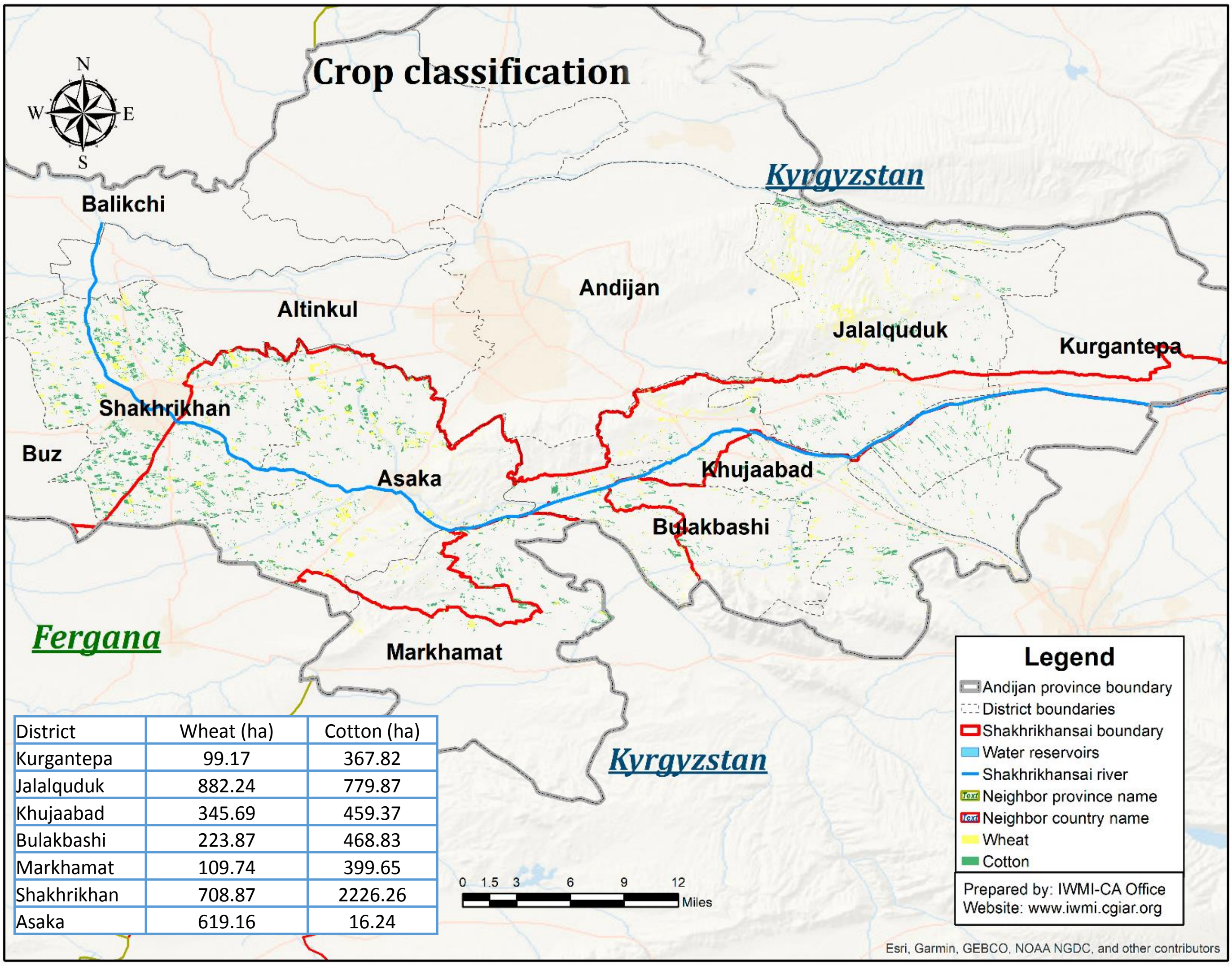
Source: IWMI



The Karadarya river flow is regulated by the Andijan Reservoir of long-term regulation with a volume of 1.9 million m^3. The Akbrasay and Aravansay rivers flow into the Shakhrikhansai, the largest annual flow is in July - September period (40-60% of the annual flow). At this time, the rivers are fed mainly as a result of melting snow and glaciers. From March to June, these rivers receive a minimum flow – 20-30% of the annual flow, but not more than 40%.



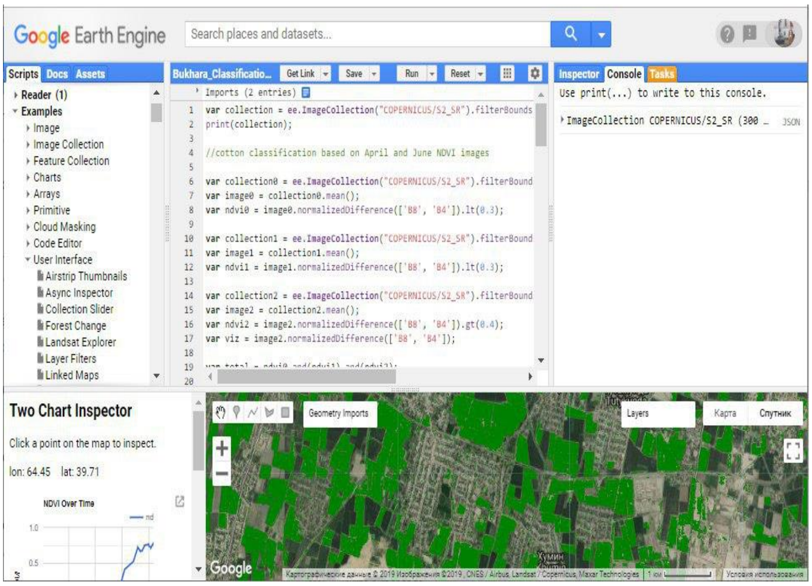
There are more than 11 pumping stations located across the five districts covering the areas in and around the Shakhrikansai river basin.



District	Wheat (ha)	Cotton (ha)
Kurgantepa	99.17	367.82
Jalalquduk	882.24	779.87
Khujaabad	345.69	459.37
Bulakbashi	223.87	468.83
Markhamat	109.74	399.65
Shakhrikhan	708.87	2226.26
Asaka	619.16	16.24

Google Earth Engine tool used to classify crops in 2018

Cotton and wheat are the predominant crops in the five districts. Google Earth Engine combines a multi-petabyte catalog of publicly available satellite imagery. The public data archive includes more than thirty years of historical imagery and scientific datasets, updated and expanded daily. It contains over twenty petabytes of geospatial data instantly available for analysis.



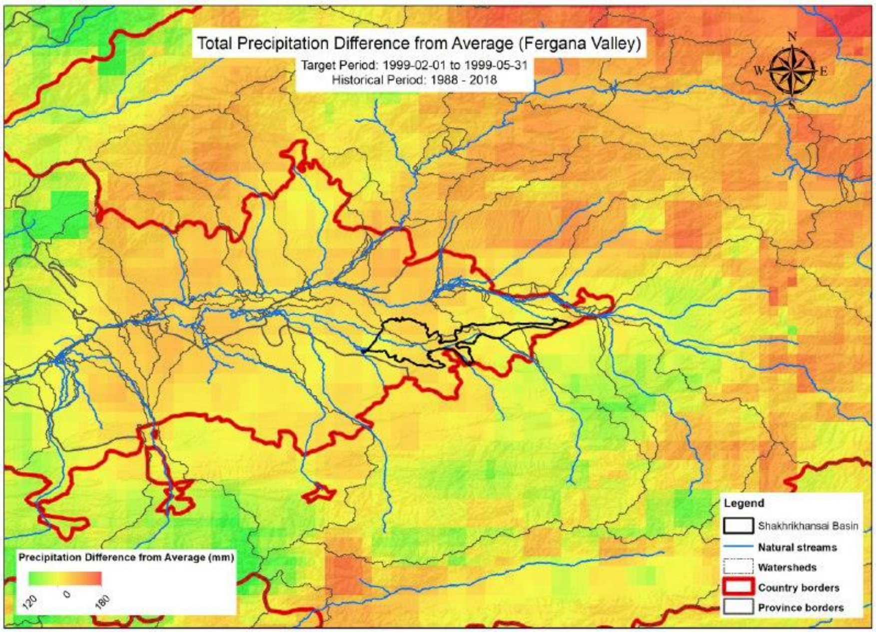
Drought Mapping and Analysis'

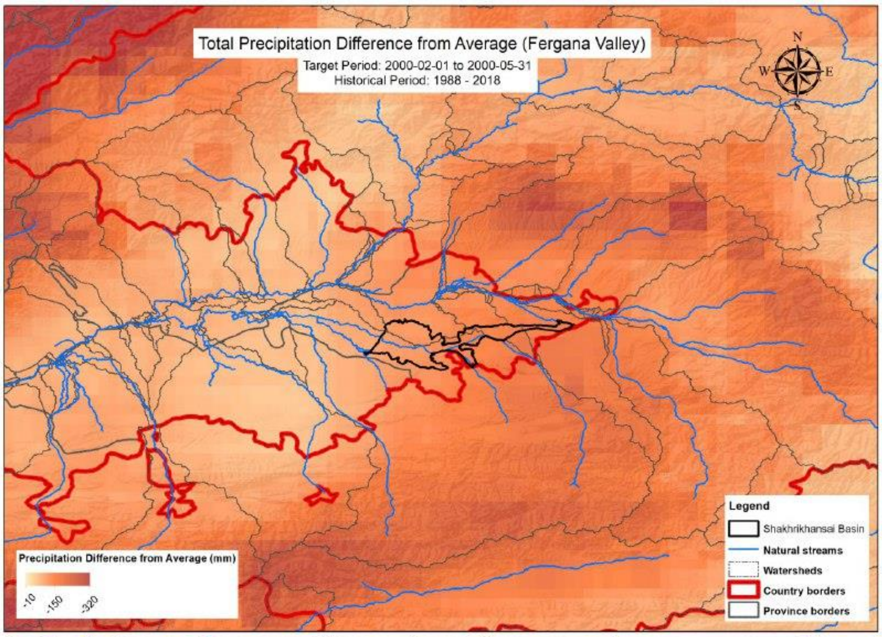
We have used the developed tool in Climate Engine platform and through scripting we analyzed Climate Hazards Group Infra Red Precipitation with Station data (CHIRPS) to explore droughts in selected study area over the past 18 years. For drought analysis, CHIRPS data were used where data comes directly from the Climate Hazards Center which provides pixel wise precipitation amount in selected years. Data is provided for each 0.05^0 grid sizes and produced as maps.

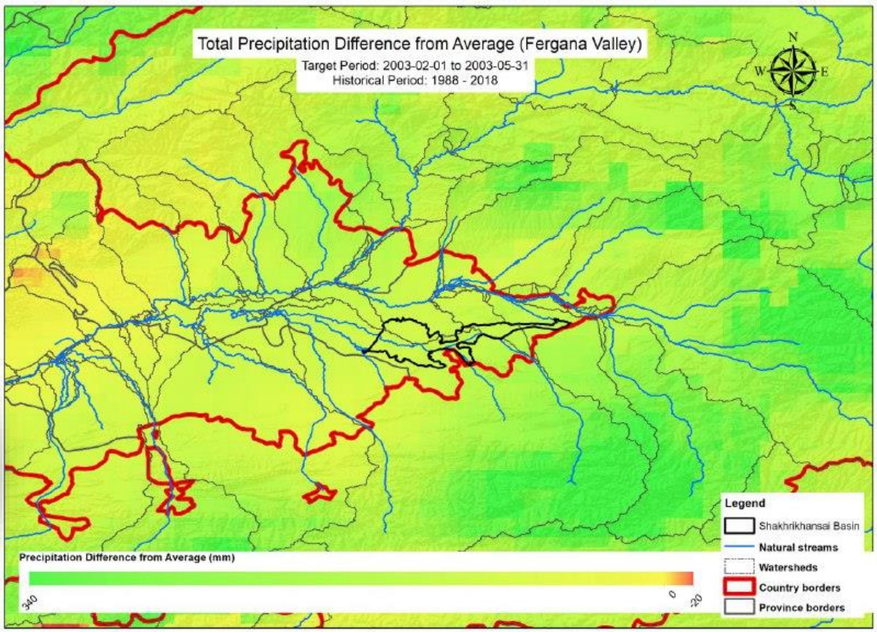
Spatial identification and visualization of drought period and areas experienced in Shakhrikhansai river basin is obtained by calculating precipitation difference from average for given period. Data comes directly from the Climate Hazards Center

Target period: February 01 to May 31 of last 20 years

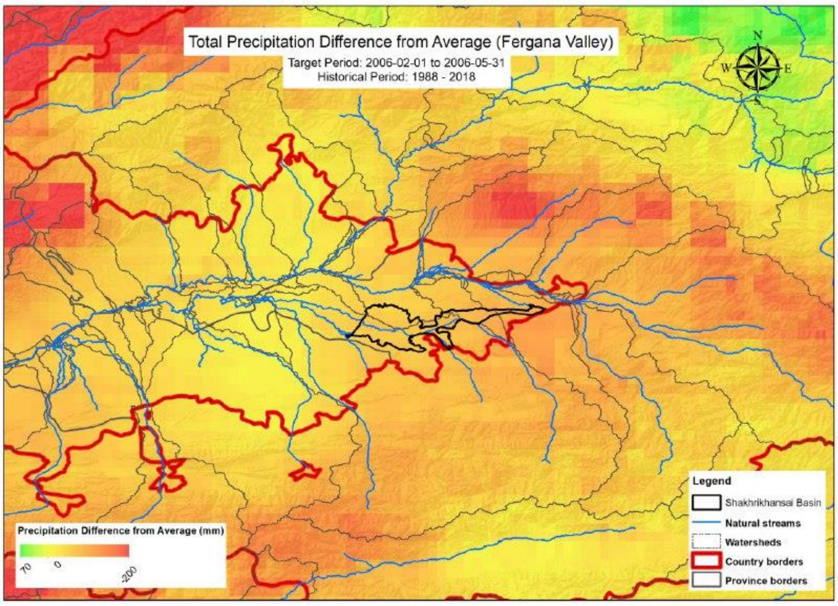
Historical period: 1988 – 2018

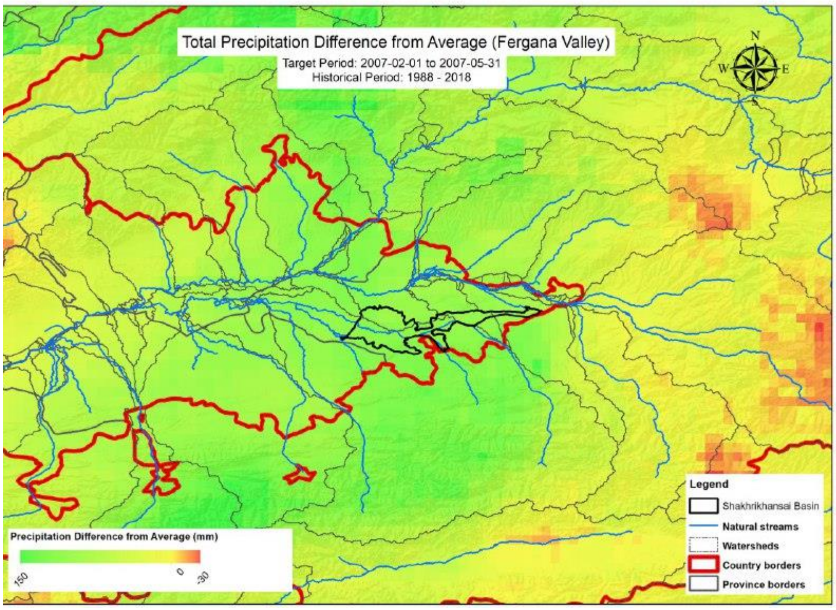


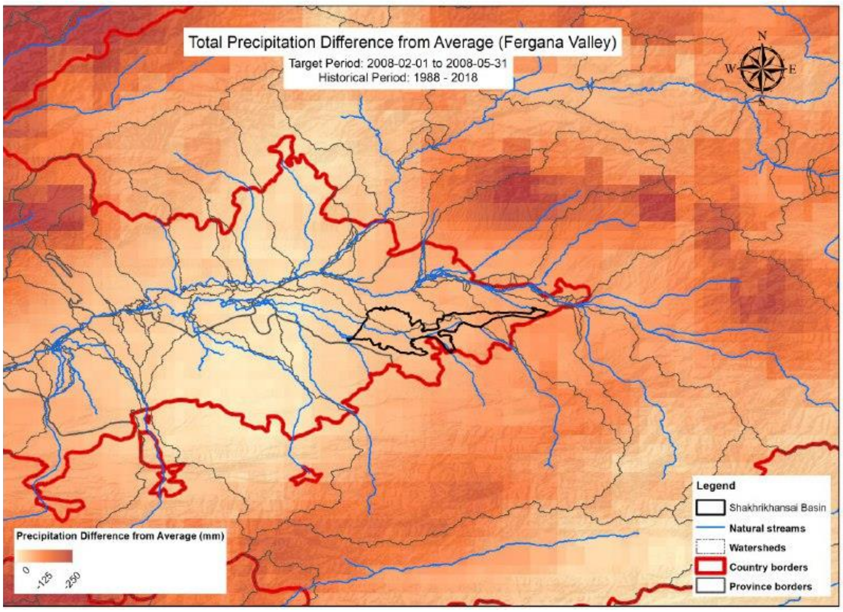




Drought Mapping and Analysis







CHIRPS is a 30+ year quasi-global rainfall dataset. Spanning 50°S-50°N (and all longitudes), starting in 1981 to near-present, CHIRPS incorporates 0.05° resolution satellite imagery with in-situ station data to create gridded rainfall time series for trend analysis and seasonal drought monitoring.

Calculated equation and generated maps provide spatial interpretation of precipitation difference from average for given period based on historical period. This maps help to understand cause and critical amount of precipitation in particular basin, which is causing water shortage and flood risks. Identification of critical amount may assist in short term forecasting on upcoming level of water availability in the beginning of the spring for summer irrigation period.

Dataset Availability

1981-01-01T00:00:00 - Present

Dataset Provider

UCSB/CHG

Earth Engine Snippet

Climate Hazards Center
UC SANTA BARBARA

Source: https://chc.ucsb.edu/data/chirps

7. Global Climate Model

7.1. CMIP5 model ensemble

7.2. Downscaling CMIP5

7.3. Annual average wind speed in 2020

7.4. Annual average wind speed in 2030

7.5. Annual average wind speed in 2050

7.6. Annual average maximum temperature in 2020

7.7. Annual average maximum temperature in 2030

7.8. Annual average maximum temperature in 2050

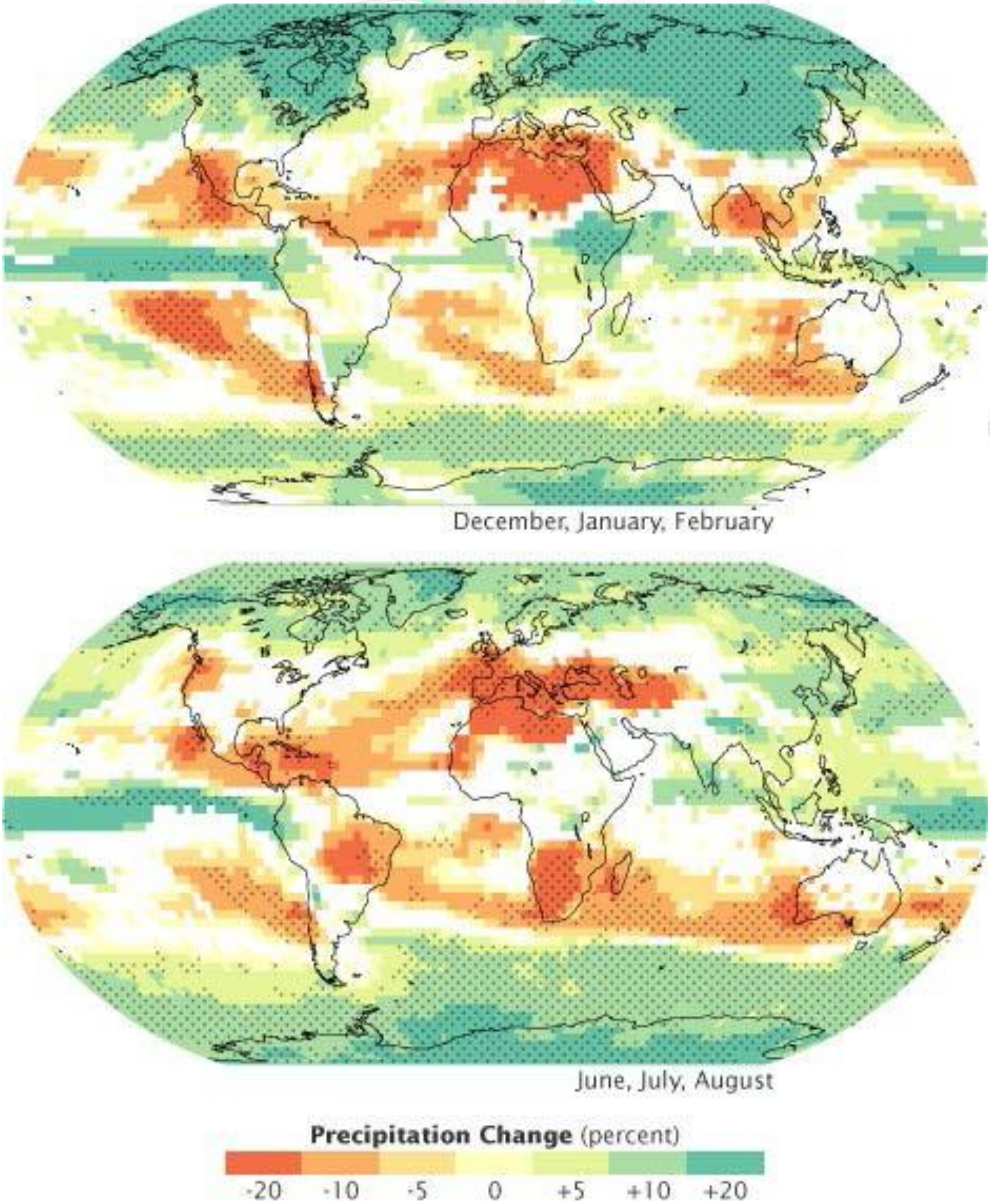
7.9. Annual average minimum temperature in 2020

7.10. Annual average minimum temperature in 2030

7.11. Annual average minimum temperature in 2050

Source: www.esgf-index1.ceda.ac.uk/projects/cmip5-ceda/

Global climate model

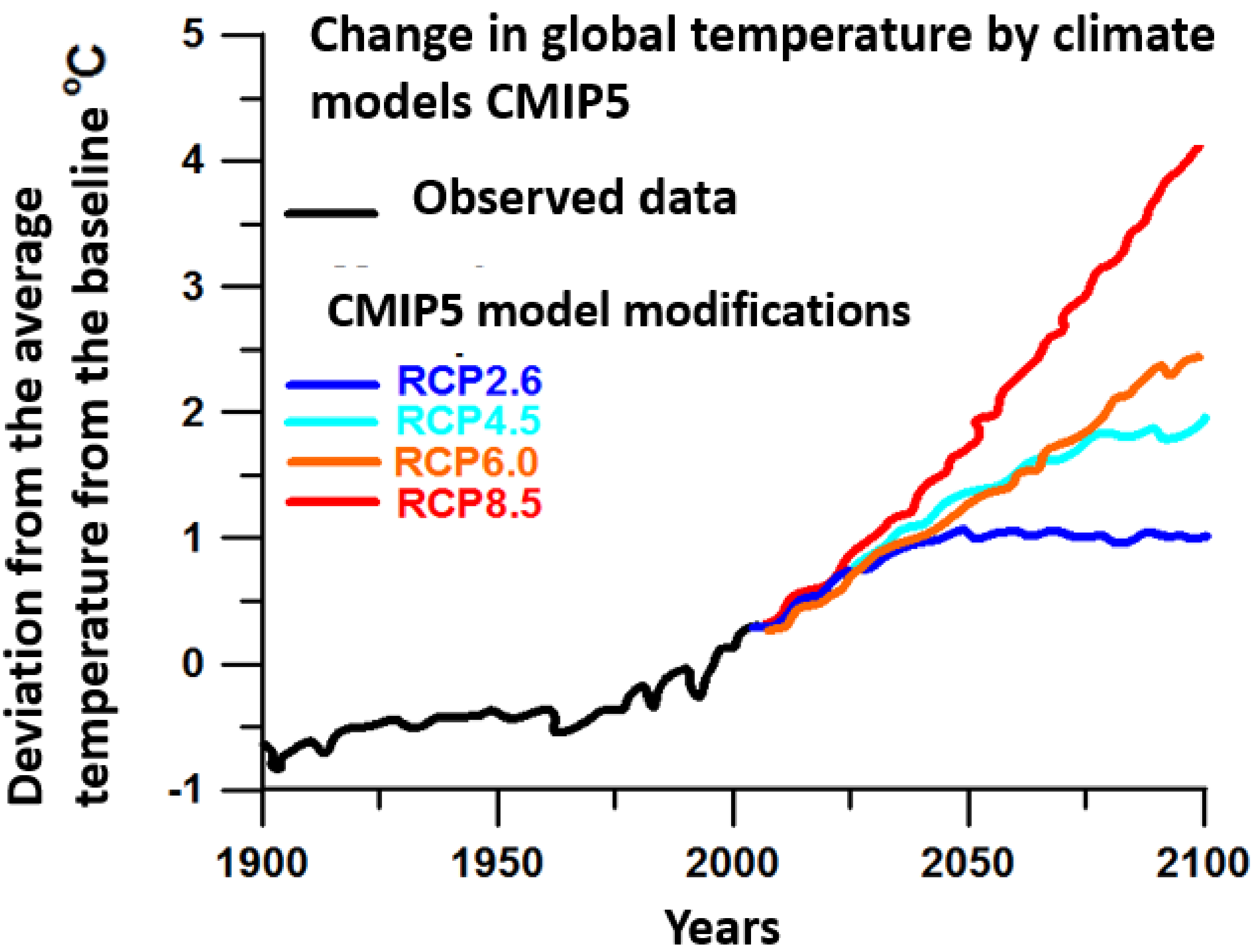


Source: https://earthobservatory.nasa.gov/features/GlobalWarming/page6.php

CMIP5 model ensemble

Climate model Coupled Model Intercomparison Project Phase Five (CMIP5) promotes a standard set of model simulations. This climate change data was derived through the new portal, the Earth System Grid - Center for Enabling Technologies. Model provides future projections under different scenarios. Scenarios used are RCP 2.6, 4.5 and 8.5.

Coordinated Regional Climate Downscaling Experiment (CORDEX) is providing global coordination of regional climate downscaling for improved regional climate change adaptation and impact assessment. The simulation covers the years from 1951 up to 2100 with daily data which are used in this study. Below is an example of different scenarios illustrating varied change trends.



Source: www.dkrz.de/communication/climate-simulations/cmip5-ipcc-ar5/ergebnisse/Mitteltemperatur-en

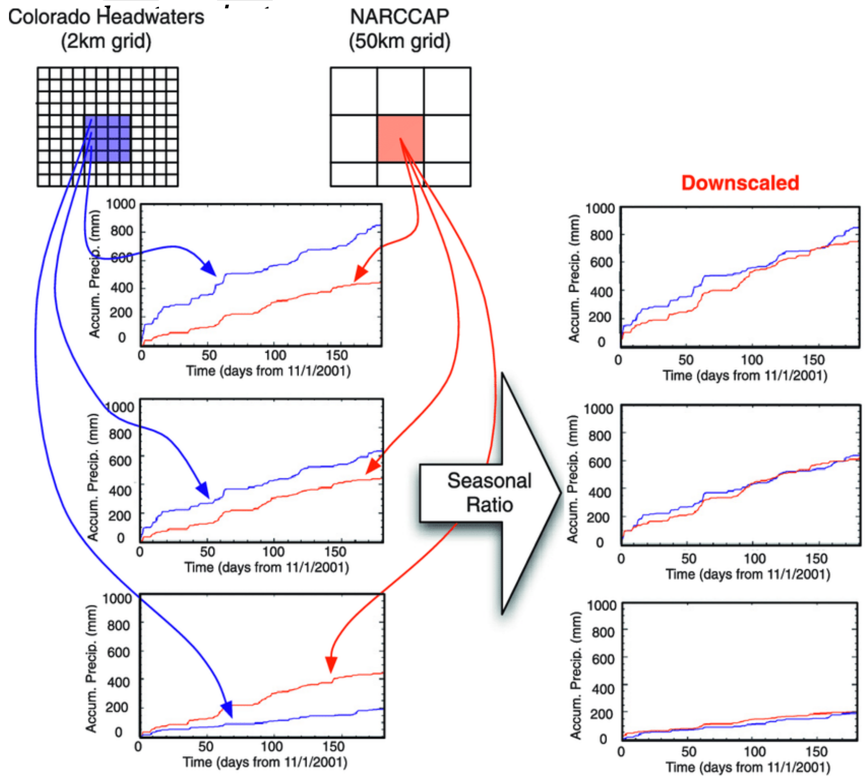
Downscaling CMIP5 model

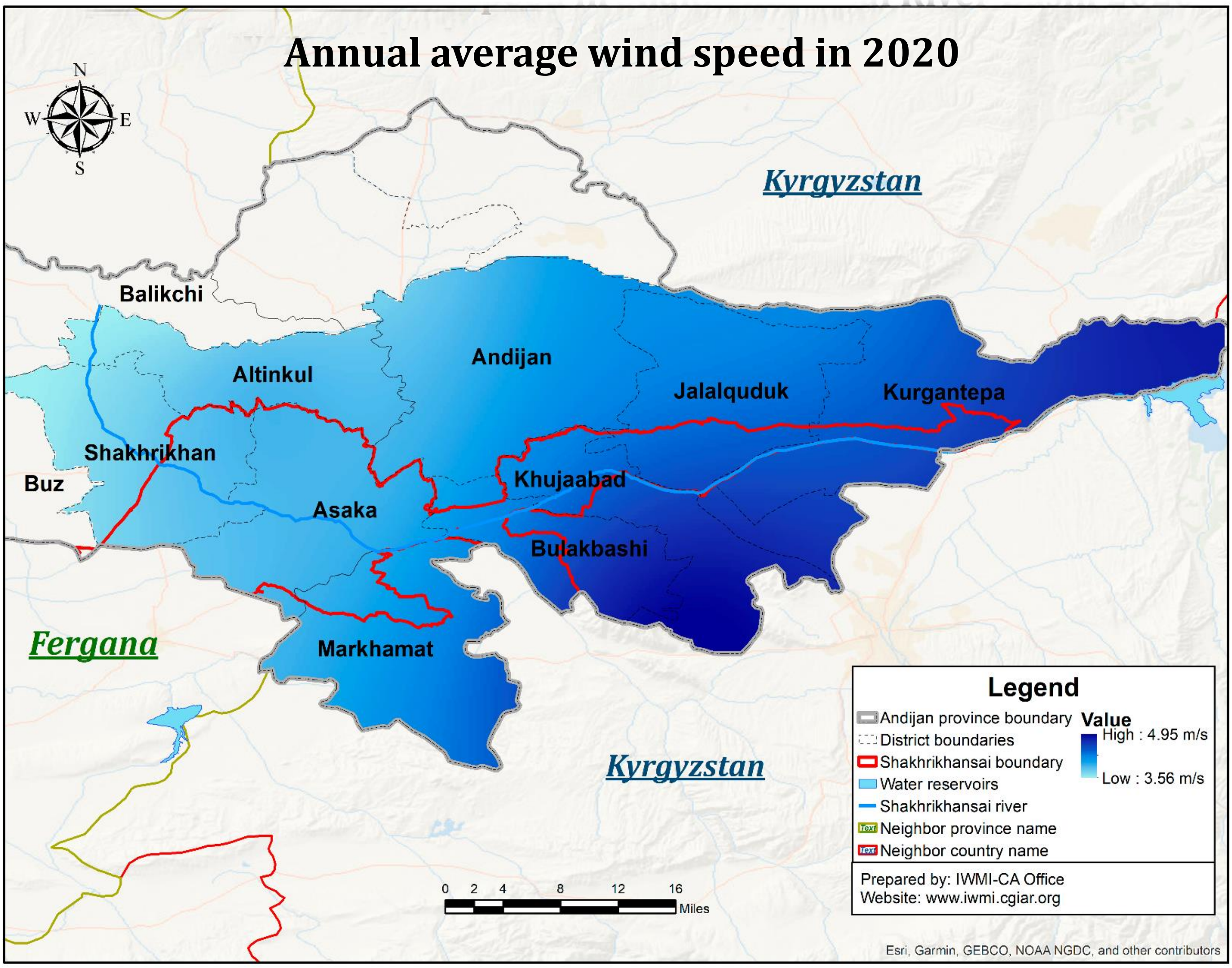
The task of climate change assessments and downscaling of Global Climate Models (CMIP5) for the region have undertaken taking into account historical observed data which was collected from local data sources. This way bias correction was done and the data result of downscaled data which then has been converted from digital number into spatial distributed maps to have clear pictures for decision makers.

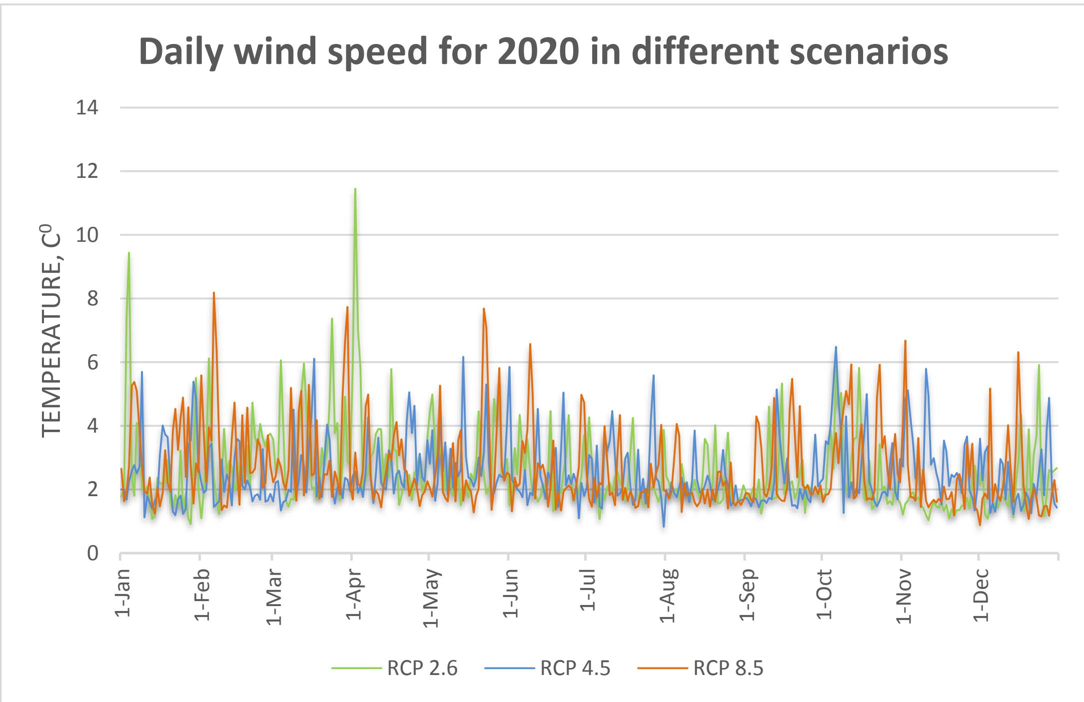
Bias correction method: In this method, initially long term means monthly statistics for the climate variables for the historic (his) and future (fu) period will be calculated. Similar long term mean statistics for the observed data is calculated for the present period. The daily climate data is scaled by the ratio (precipitation) or difference (temperature) between mean monthly values of observed and simulated climate variables.

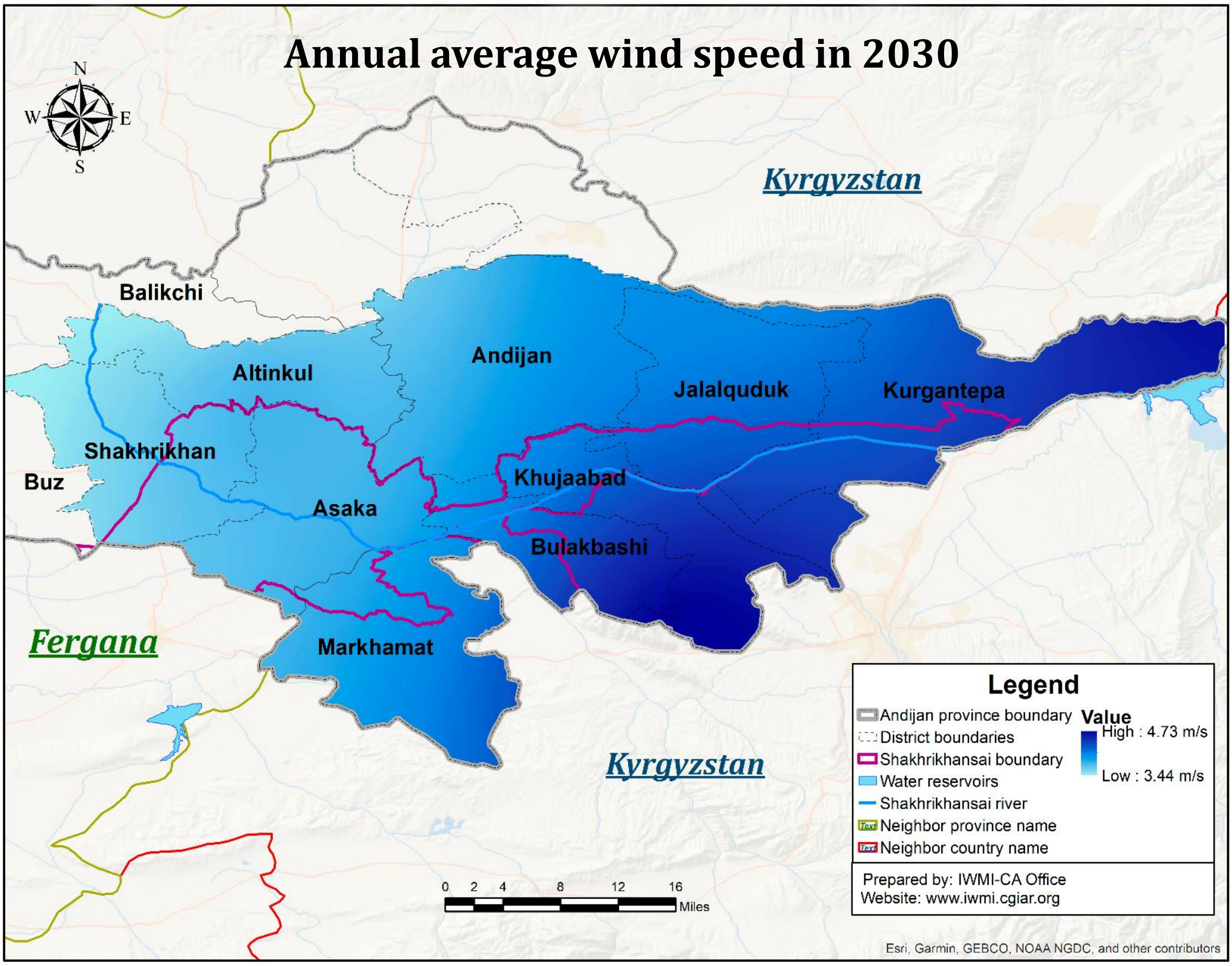
The forecasts for the climate model were corrected taking into account the discrepancies obtained as a result of the implementation of the optimal interpolation method in the nodes of the regular grid at the nearest meteorological stations and model results according to the formulas:

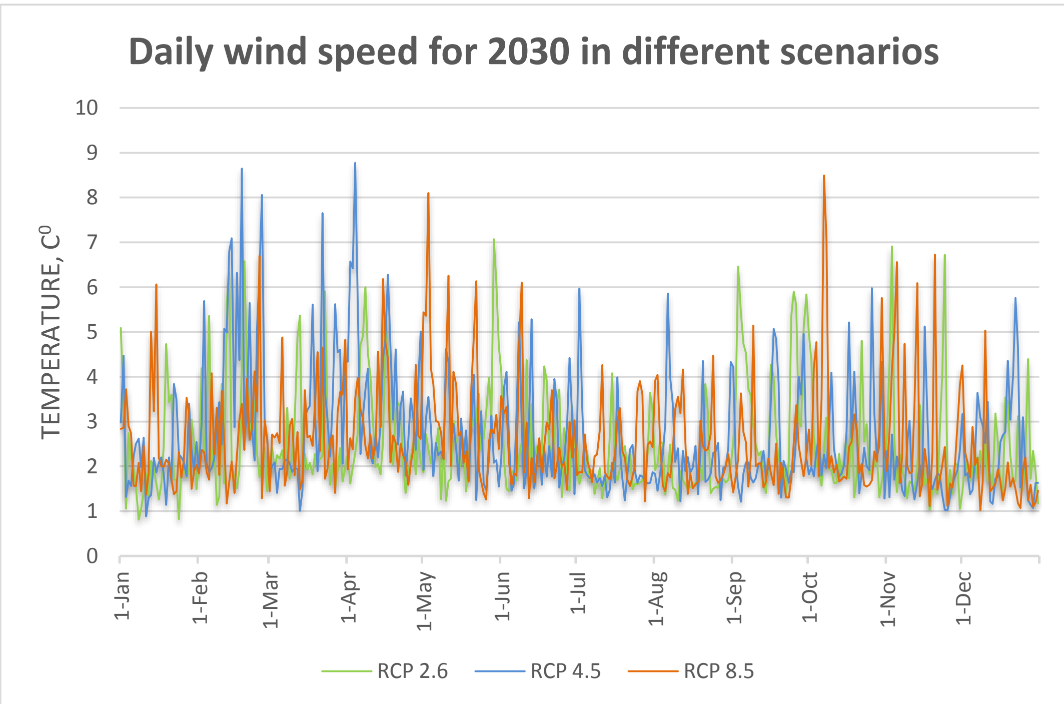
$$\bar{\Delta}_m = \frac{1}{L}\sum^{L}\frac{1}{N}\sum^{N}\left(f_{m_i}^{mod} - f_{m_i}^{int}\right)_k, \quad \hat{f}_m = f_m^{mod} + \bar{\Delta}_m$$

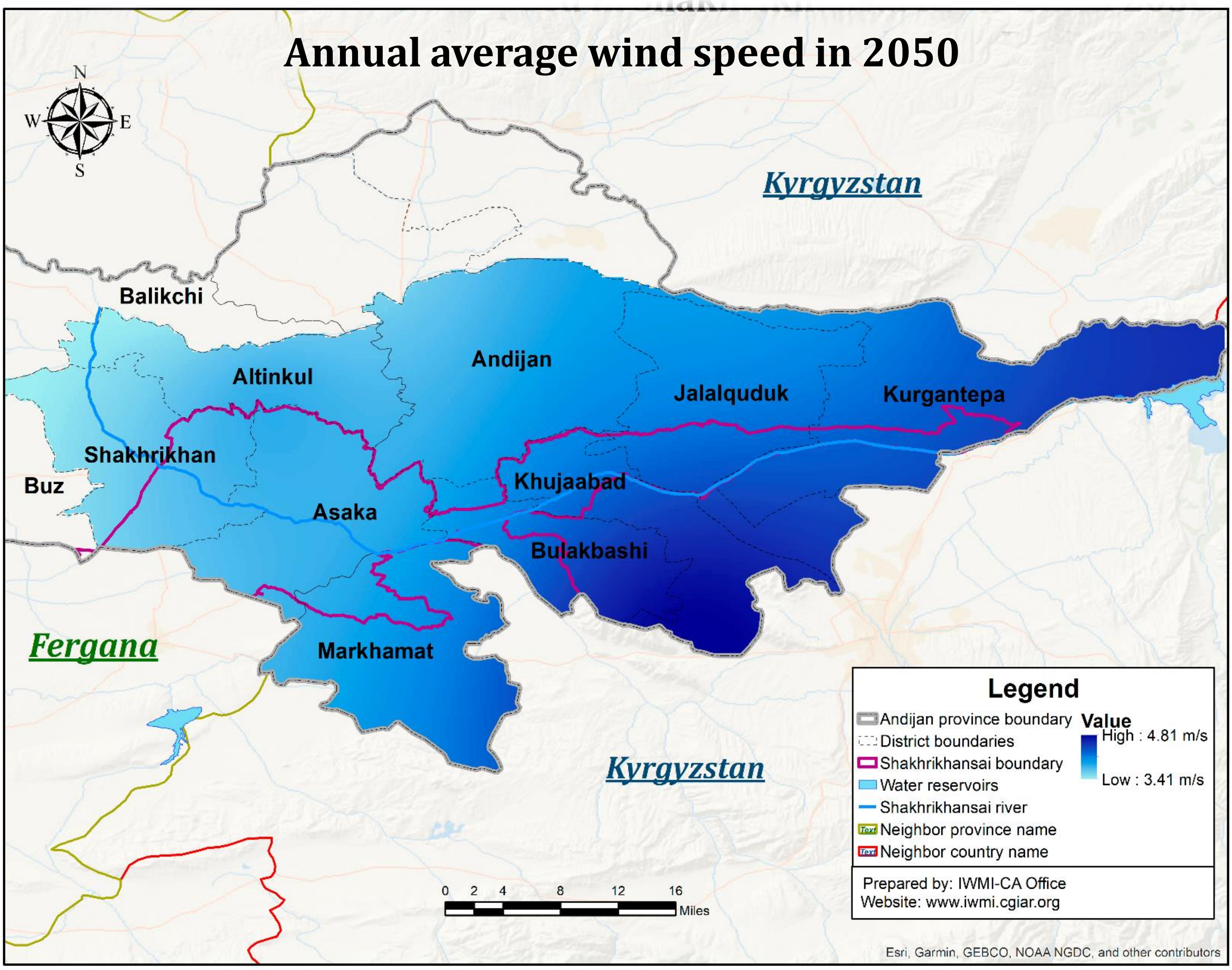



Annual average wind speed in 2020
N
W
E
S
Kyrgyzstan
Balikchi
Altinkul
Andijan
Jalalquduk
Kurgantepa
Shakhrikhan
Buz
Khujaabad
Asaka
Bulakbashi
Fergana
Markhamat
Kyrgyzstan
Legend
Andijan province boundary
District boundaries
Shakhrikhansai boundary
Water reservoirs
Shakhrikhansai river
Neighbor province name
Neighbor country name
Value
High : 4.95 m/s
Low : 3.56 m/s
Prepared by: IWMI-CA Office
Website: www.iwmi.cgiar.org
0 2 4 8 12 16
Miles
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

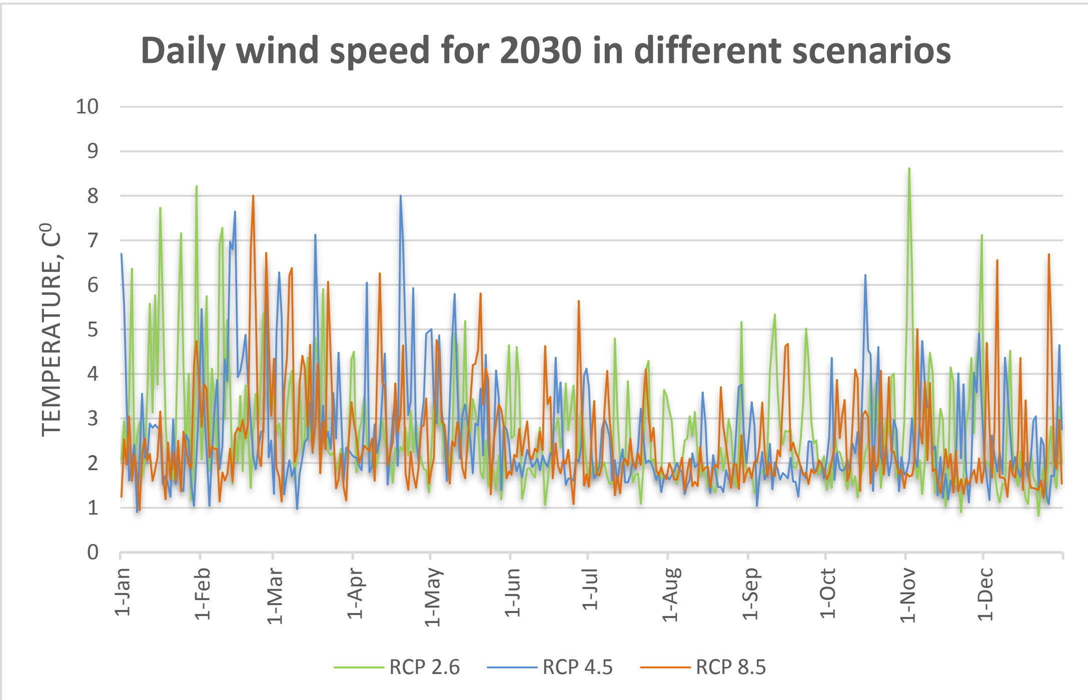

Daily wind speed for 2020 in different scenarios
TEMPERATURE, C0
14
12
10
8
6
4
2
0
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec
RCP 2.6
RCP 4.5
RCP 8.5


Annual average wind speed in 2030
N
W
E
S
Kyrgyzstan
Balikchi
Altinkul
Andijan
Jalalquduk
Kurgantepa
Shakhrikhan
Buz
Khujaabad
Asaka
Bulakbashi
Fergana
Markhamat
Kyrgyzstan
Legend
Andijan province boundary
District boundaries
Shakhrikhansai boundary
Water reservoirs
Shakhrikhansai river
Neighbor province name
Neighbor country name
Value
High : 4.73 m/s
Low : 3.44 m/s
0 2 4 8 12 16
Miles
Prepared by: IWMI-CA Office
Website: www.iwmi.cgiar.org
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

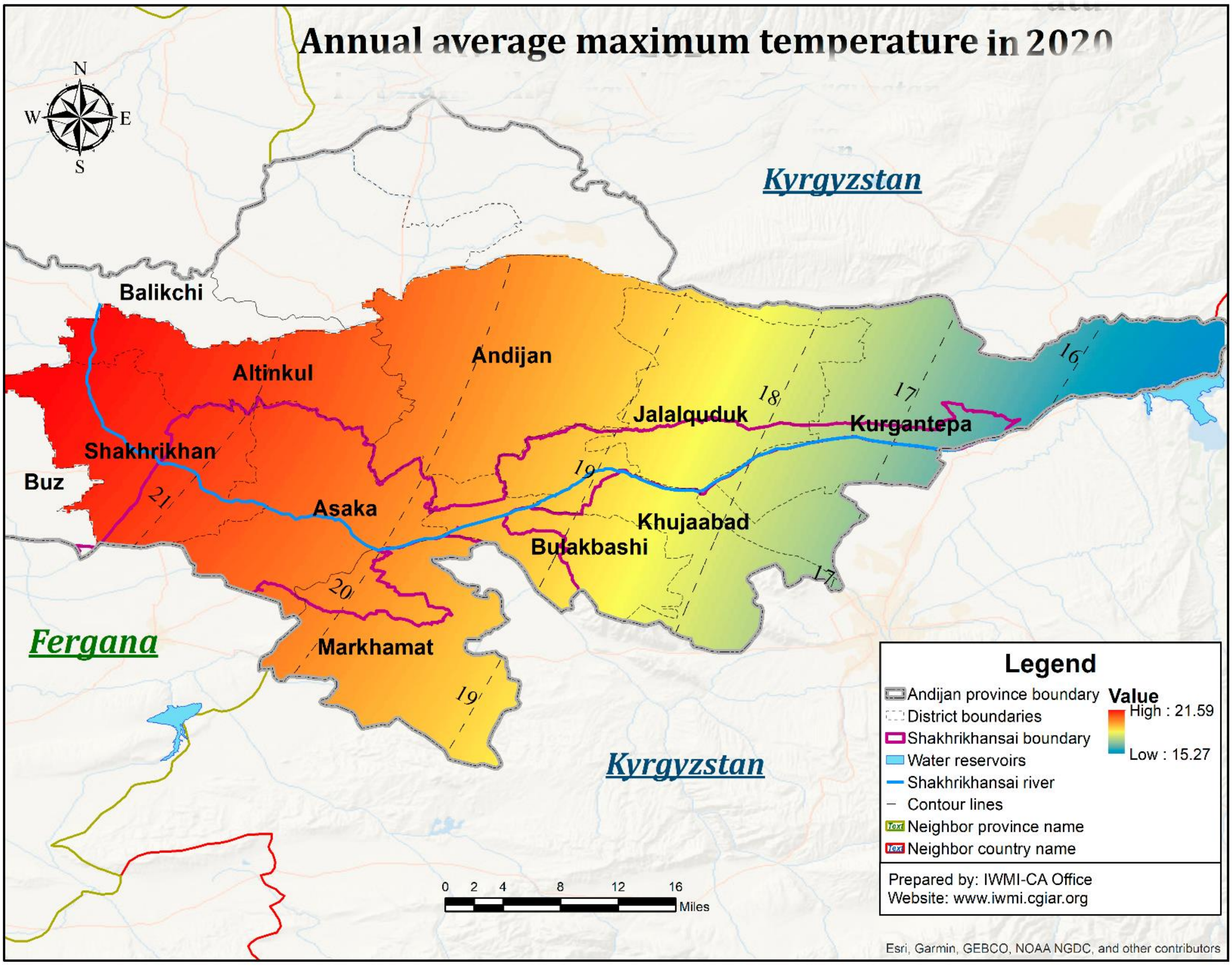

Daily wind speed for 2030 in different scenarios
TEMPERATURE, C0
10
9
8
7
6
5
4
3
2
1
0
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec
RCP 2.6
RCP 4.5
RCP 8.5

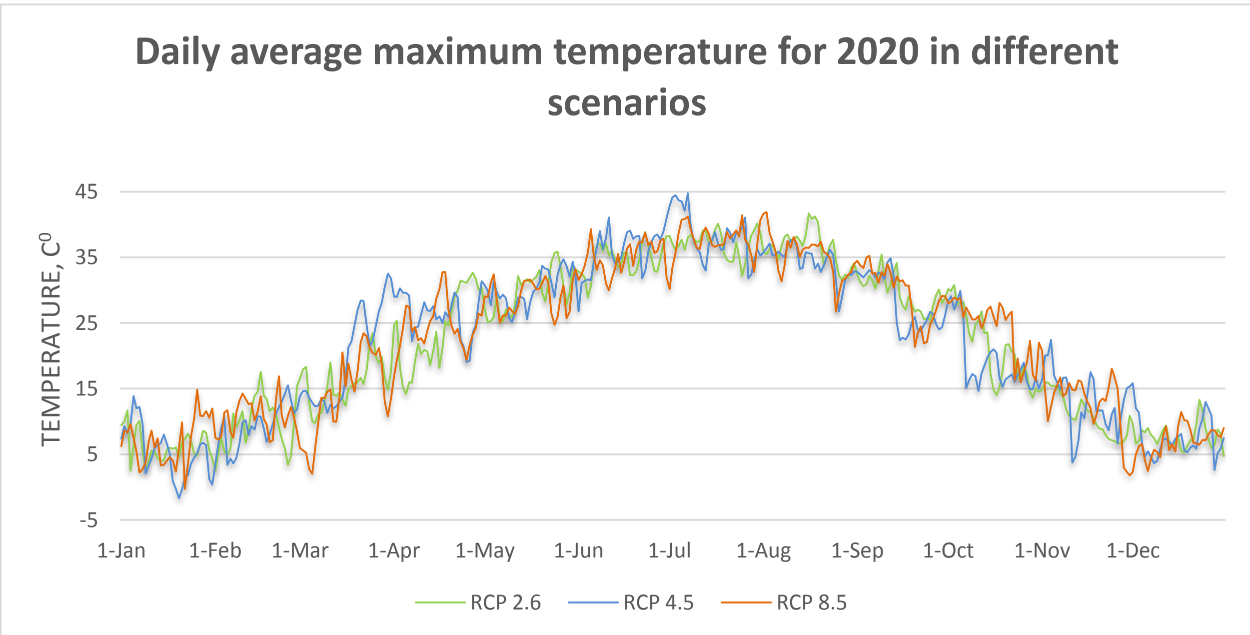


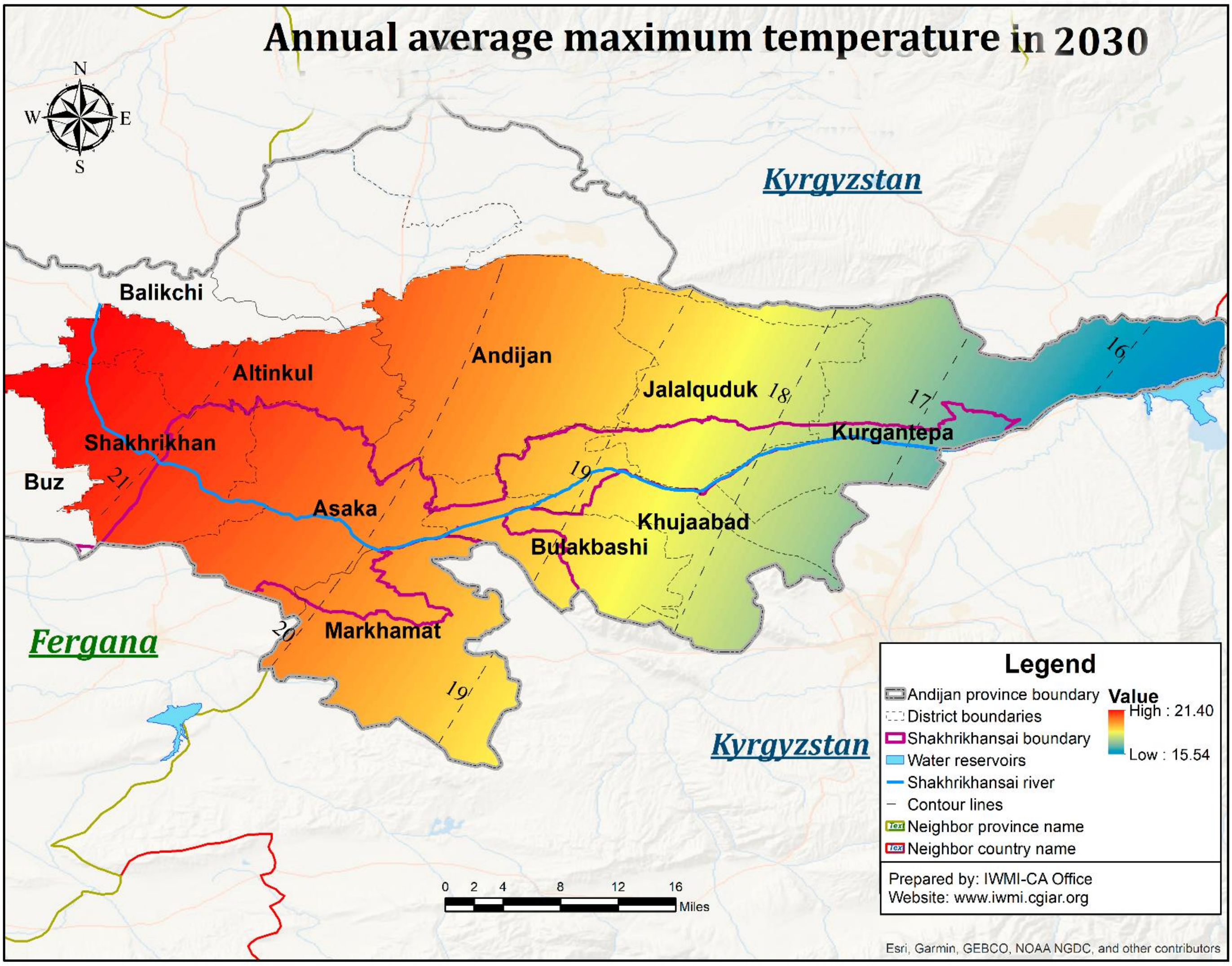
Annual average wind speed in 2050
N
W
E
S
Kyrgyzstan
Balikchi
Altinkul
Andijan
Jalalquduk
Kurgantepa
Shakhrikhan
Buz
Asaka
Khujaabad
Bulakbashi
Fergana
Markhamat
Kyrgyzstan
Legend
Andijan province boundary
District boundaries
Shakhrikhansai boundary
Water reservoirs
Shakhrikhansai river
Neighbor province name
Neighbor country name
Value
High : 4.81 m/s
Low : 3.41 m/s
0 2 4 8 12 16
Miles
Prepared by: IWMI-CA Office
Website: www.iwmi.cgiar.org
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

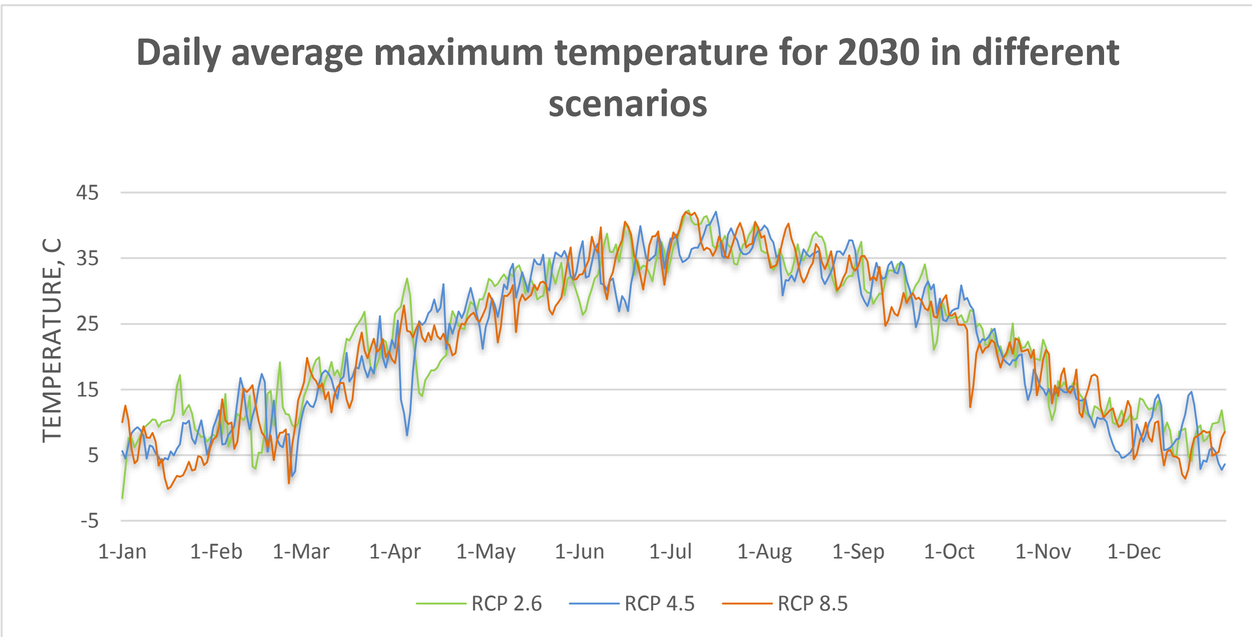


Daily wind speed for 2030 in different scenarios
TEMPERATURE, C0
10
9
8
7
6
5
4
3
2
1
0
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec
RCP 2.6
RCP 4.5
RCP 8.5


Annual average maximum temperature in 2020
N
W
E
S
Kyrgyzstan
Balikchi
Altinkul
Andijan
Jalalquduk
Kurgantepa
Shakhrikhan
Buz
Asaka
Khujaabad
Bulakbashi
Markhamat
Fergana
Kyrgyzstan
16
17
18
19
20
21
Legend
Andijan province boundary
District boundaries
Shakhrikhansai boundary
Water reservoirs
Shakhrikhansai river
Contour lines
Neighbor province name
Neighbor country name
Value
High : 21.59
Low : 15.27
Prepared by: IWMI-CA Office
Website: www.iwmi.cgiar.org
0 2 4 8 12 16
Miles
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors


Daily average maximum temperature for 2020 in different scenarios
TEMPERATURE, C0
45
35
25
15
5
-5
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec
RCP 2.6
RCP 4.5
RCP 8.5


Annual average maximum temperature in 2030
N
W
E
S
Kyrgyzstan
Balikchi
Altinkul
Andijan
Jalalquduk
Shakhrikhan
Buz
Asaka
Kurgantepa
Khujaabad
Bulakbashi
Markhamat
Fergana
Kyrgyzstan
16
17
18
19
20
21
Legend
Andijan province boundary
District boundaries
Shakhrikhansai boundary
Water reservoirs
Shakhrikhansai river
Contour lines
Neighbor province name
Neighbor country name
Value
High : 21.40
Low : 15.54
Prepared by: IWMI-CA Office
Website: www.iwmi.cgiar.org
0 2 4 8 12 16
Miles
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors


Daily average maximum temperature for 2030 in different scenarios
TEMPERATURE, C
45
35
25
15
5
-5
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
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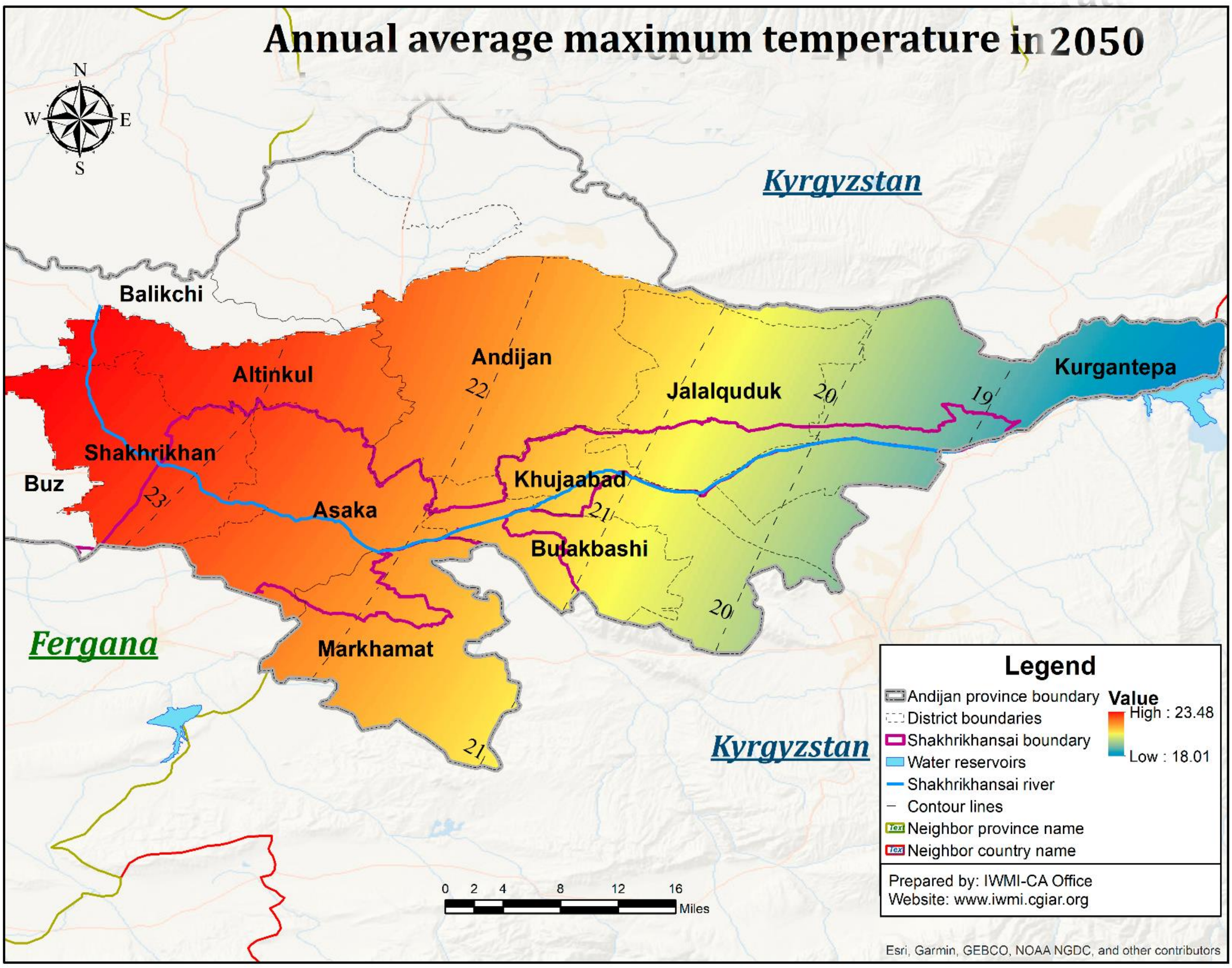
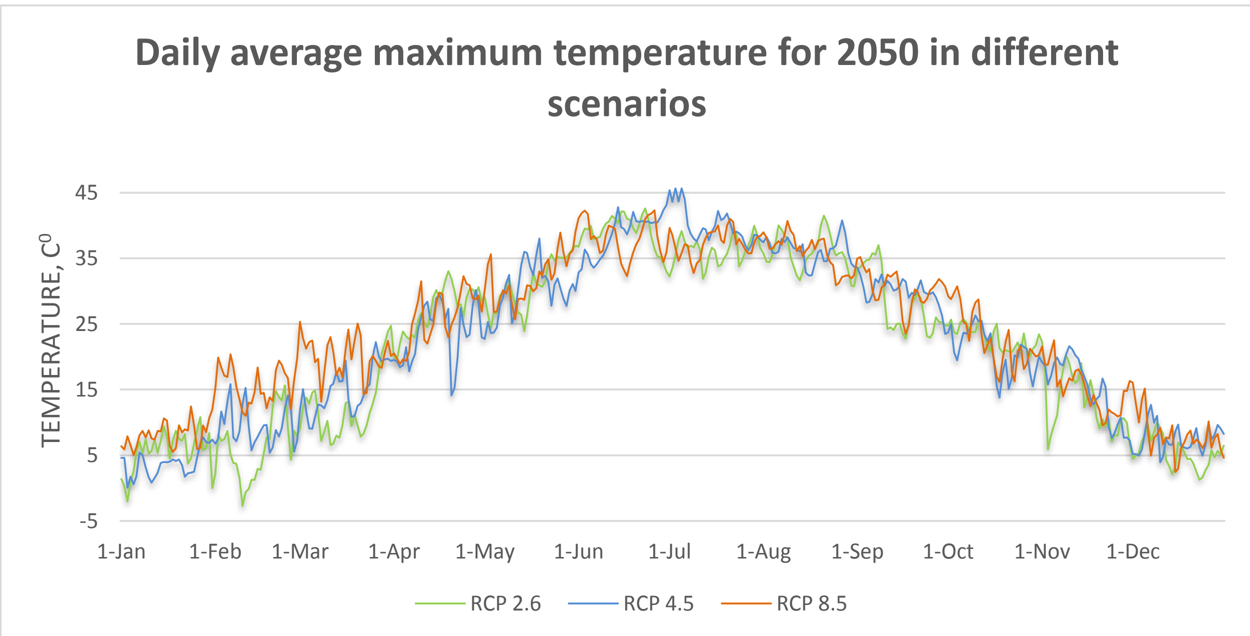
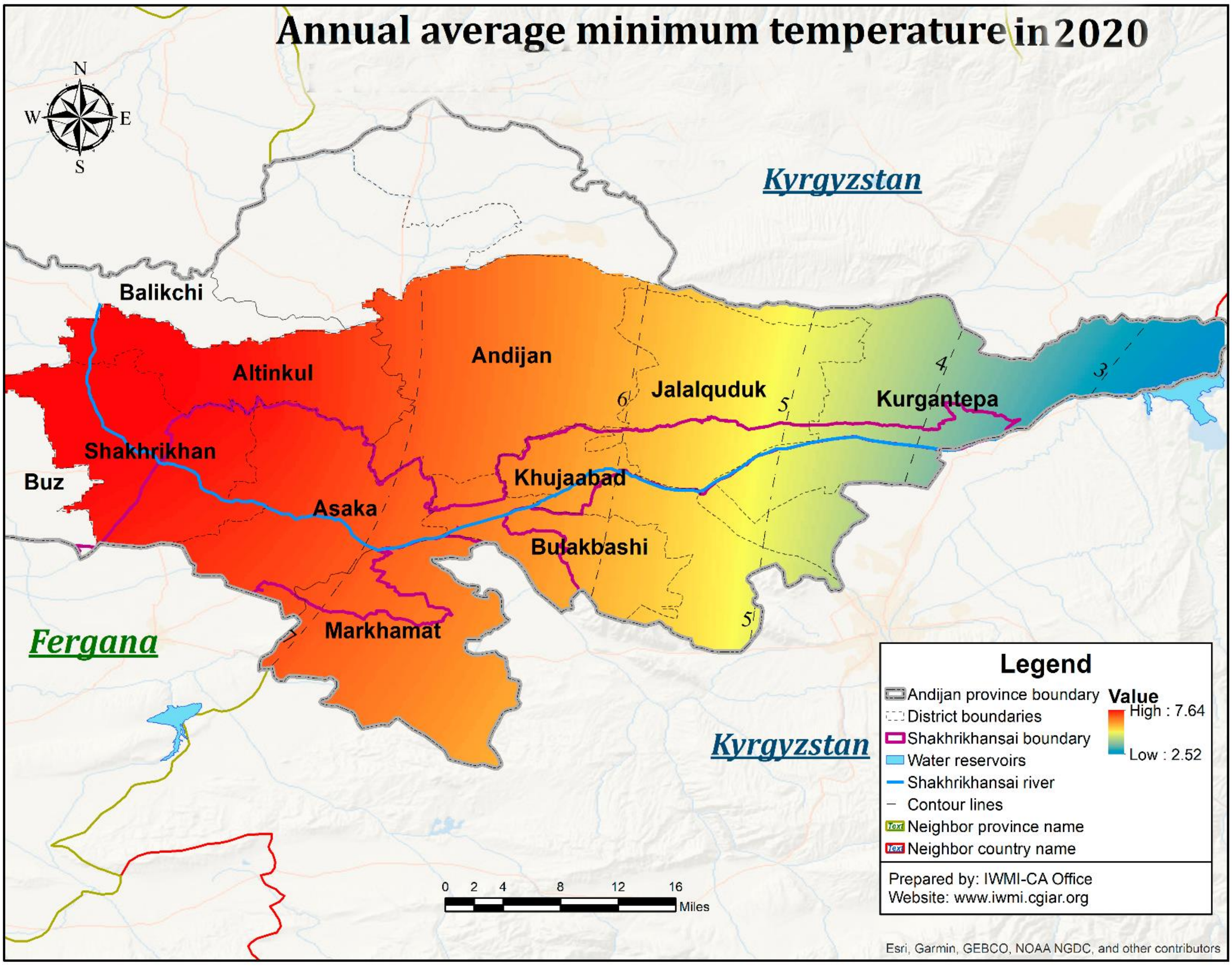
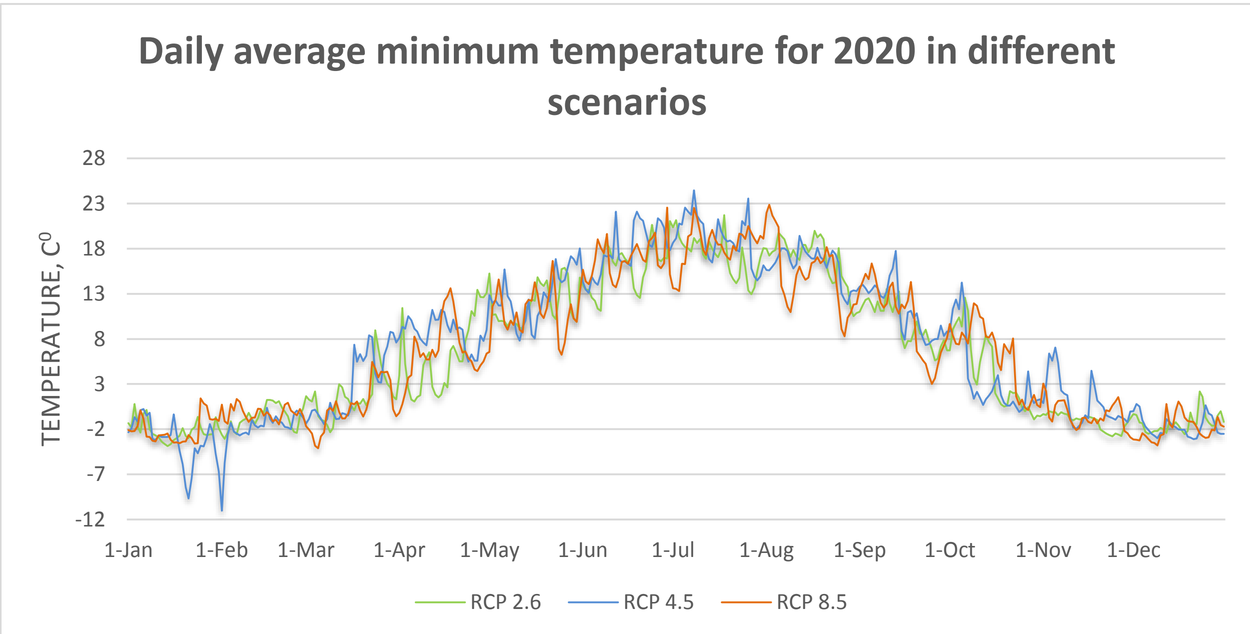
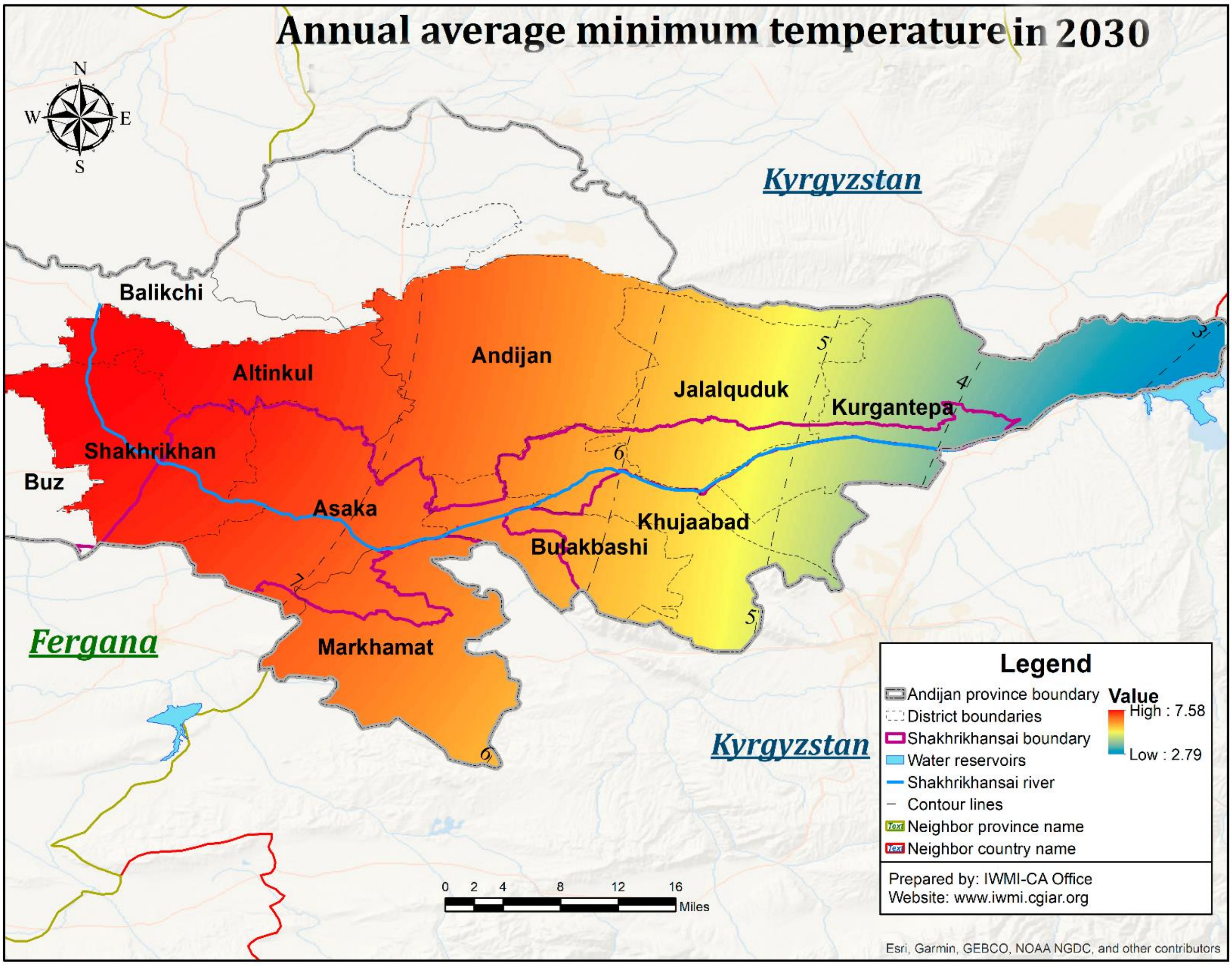
1-Dec
RCP 2.6
RCP 4.5
RCP 8.5

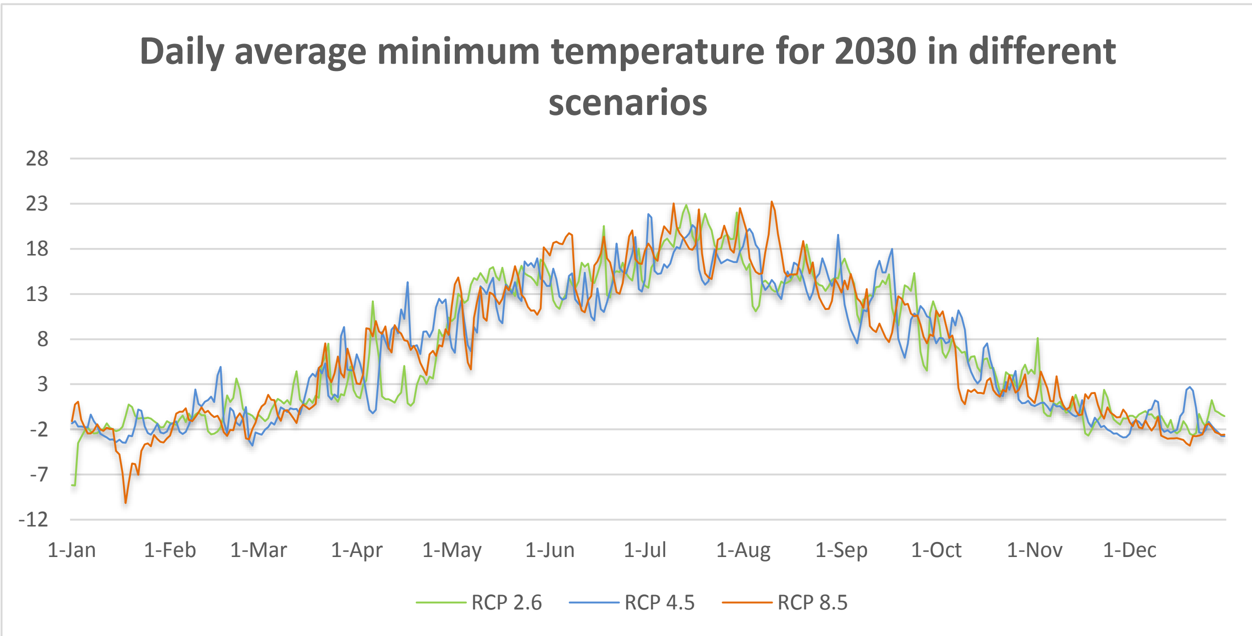

Annual average maximum temperature in 2050
N
W
E
S
Kyrgyzstan
Balikchi
Altinkul
Andijan
Jalalquduk
Kurgantepa
Shakhrikhan
Buz
Khujaabad
Asaka
Bulakbashi
Markhamat
Fergana
Kyrgyzstan
23
22
21
20
19
Legend
Andijan province boundary
District boundaries
Shakhrikhansai boundary
Water reservoirs
Shakhrikhansai river
Contour lines
Neighbor province name
Neighbor country name
Value
High : 23.48
Low : 18.01
Prepared by: IWMI-CA Office
Website: www.iwmi.cgiar.org
0 2 4 8 12 16
Miles
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

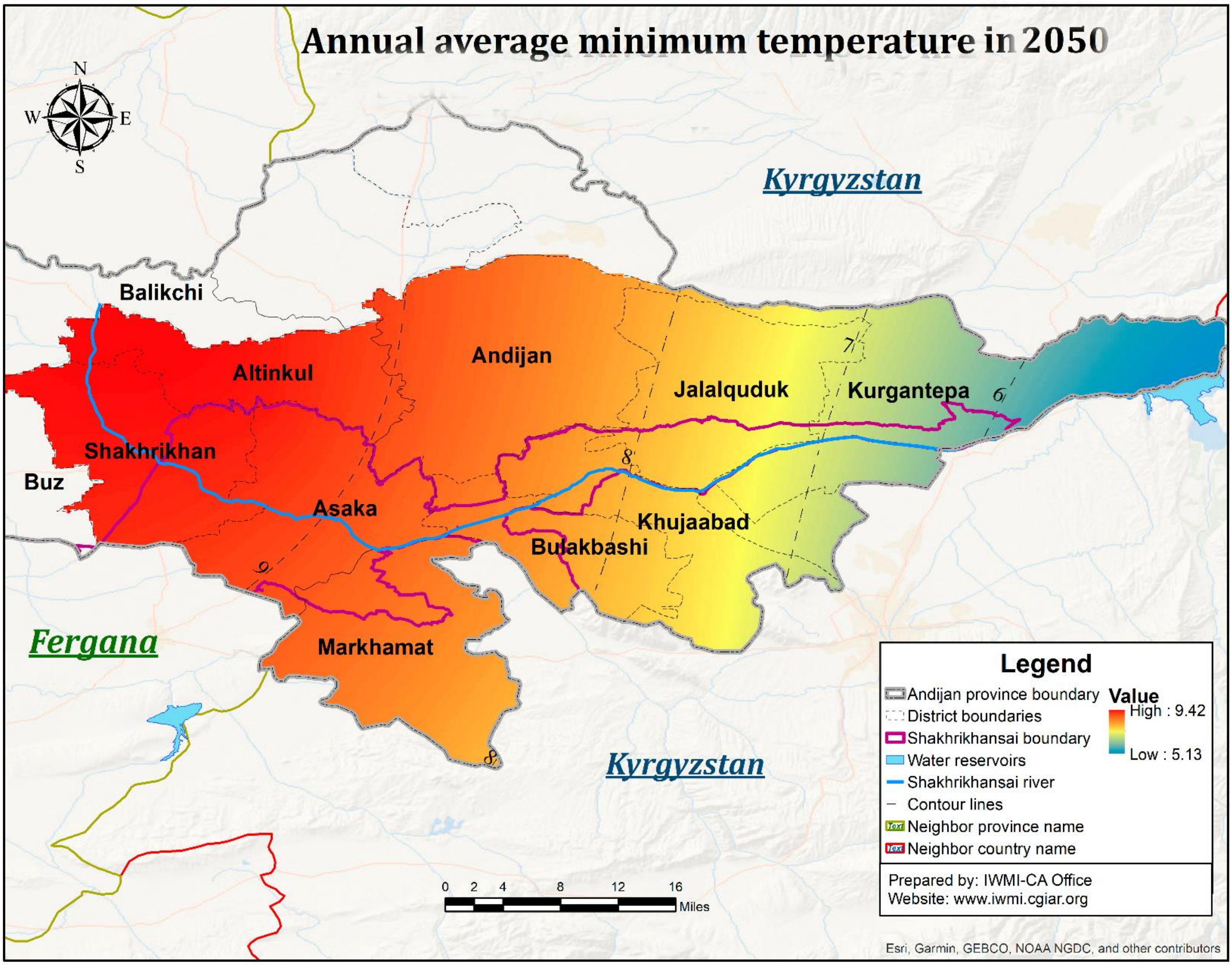

Daily average maximum temperature for 2050 in different scenarios
TEMPERATURE, C⁰
45
35
25
15
5
-5
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec
RCP 2.6
RCP 4.5
RCP 8.5


Annual average minimum temperature in 2020
N
S
W
E
Kyrgyzstan
Balikchi
Altinkul
Andijan
Jalalquduk
Kurgantepa
Shakhrikhan
Buz
Asaka
Khujaabad
Bulakbashi
Markhamat
Fergana
Kyrgyzstan
Legend
Andijan province boundary
District boundaries
Shakhrikhansai boundary
Water reservoirs
Shakhrikhansai river
Contour lines
Neighbor province name
Neighbor country name
Value
High : 7.64
Low : 2.52
Prepared by: IWMI-CA Office
Website: www.iwmi.cgiar.org
0 2 4 8 12 16
Miles
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors


Daily average minimum temperature for 2020 in different scenarios
TEMPERATURE, C0
28
23
18
13
8
3
-2
-7
-12
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec
RCP 2.6
RCP 4.5
RCP 8.5


Annual average minimum temperature in 2030
N
W
E
S
Kyrgyzstan
Balikchi
Altinkul
Andijan
Jalalquduk
Kurgantepa
Shakhrikhan
Buz
Asaka
Khujaabad
Bulakbashi
Fergana
Markhamat
Kyrgyzstan
Legend
Andijan province boundary
District boundaries
Shakhrikhansai boundary
Water reservoirs
Shakhrikhansai river
Contour lines
Neighbor province name
Neighbor country name
Value
High : 7.58
Low : 2.79
0 2 4 8 12 16
Miles
Prepared by: IWMI-CA Office
Website: www.iwmi.cgiar.org
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors


Daily average minimum temperature for 2030 in different scenarios
28
23
18
13
8
3
-2
-7
-12
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec
RCP 2.6
RCP 4.5
RCP 8.5


Annual average minimum temperature in 2050
N
W
E
S
Kyrgyzstan
Balikchi
Altinkul
Andijan
Jalalquduk
Kurgantepa
Shakhrikhan
Buz
Asaka
Khujaabad
Bulakbashi
Markhamat
Fergana
Kyrgyzstan
Legend
Andijan province boundary
District boundaries
Shakhrikhansai boundary
Water reservoirs
Shakhrikhansai river
Contour lines
Neighbor province name
Neighbor country name
Value
High : 9.42
Low : 5.13
0 2 4 8 12 16
Miles
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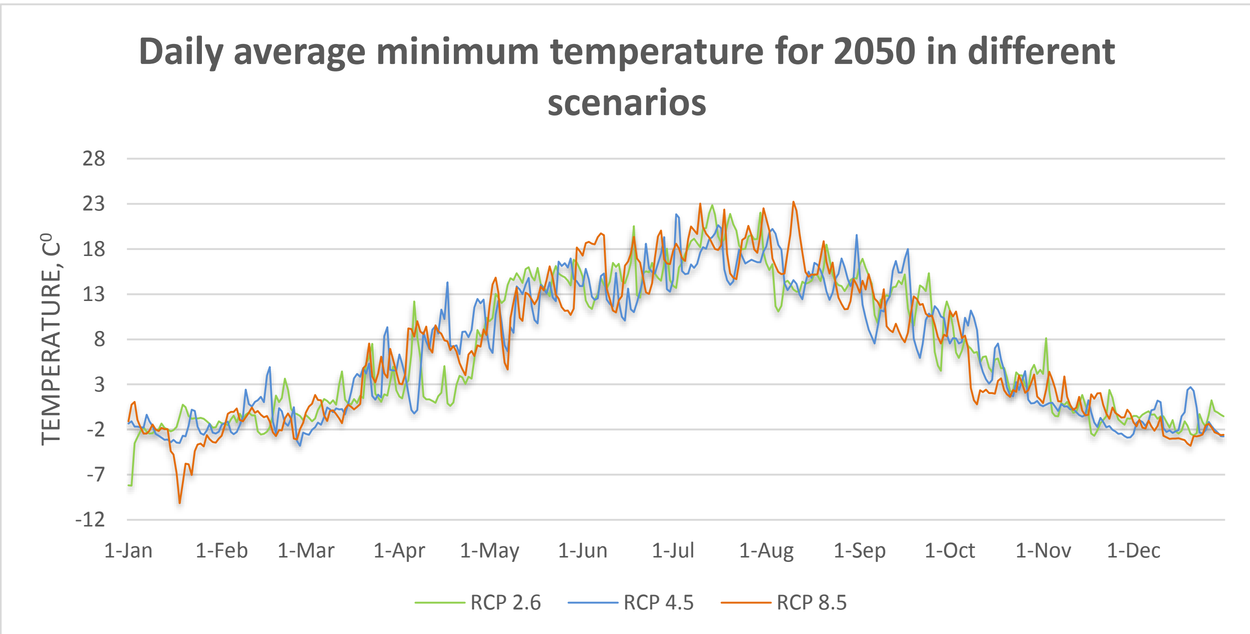
Daily average minimum temperature for 2050 in different scenarios
TEMPERATURE, C°
28
23
18
13
8
3
-2
-7
-12
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec
RCP 2.6
RCP 4.5
RCP 8.5

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