CLIMATE RISK COUNTRY PROFILE

KYRGYZ REPUBLIC

WORLD BANK GROUP

ADB ASIAN DEVELOPMENT BANK

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ACKNOWLEDGEMENTS

This profile is part of a series of Climate Risk Country Profiles that are jointly developed by the World Bank Group (WBG) and the Asian Development Bank (ADB). These profiles synthesize the most relevant data and information on climate change, disaster risk reduction, and adaptation actions and policies at the country level. The profile is designed as a quick reference source for development practitioners to better integrate climate resilience in development planning and policy making. This effort is co-led by Veronique Morin (Senior Climate Change Specialist, WBG), Ana E. Bucher (Senior Climate Change Specialist, WBG) and Arghya Sinha Roy (Senior Climate Change Specialist, ADB).

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Climate and climate-related information is largely drawn from the Climate Change Knowledge Portal (CCKP), a WBG online platform with available global climate data and analysis based on the latest Intergovernmental Panel on Climate Change (IPCC) reports and datasets. The team is grateful for all comments and suggestions received from the sector, regional, and country development specialists, as well as climate research scientists and institutions for their advice and guidance on use of climate related datasets.

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FOREWORD

Climate change is a major risk to good development outcomes, and the World Bank Group is committed to playing an important role in helping countries integrate climate action into their core development agendas. The World Bank Group (WBG) and the Asian Development Bank (ADB) are committed to supporting client countries to invest in and build a low-carbon, climate-resilient future, helping them to be better prepared to adapt to current and future climate impacts.

Both institutions are investing in incorporating and systematically managing climate risks in development operations through their individual corporate commitments.

For the World Bank Group: a key aspect of the World Bank Group's Action Plan on Adaptation and Resilience (2019) is to help countries shift from addressing adaptation as an incremental cost and isolated investment to systematically incorporating climate risks and opportunities at every phase of policy planning, investment design, implementation and evaluation of development outcomes. For all International Development Association and International Bank for Reconstruction and Development operations, climate and disaster risk screening is one of the mandatory corporate climate commitments. This is supported by the World Bank Group's Climate and Disaster Risk Screening Tool which enables all Bank staff to assess short- and long-term climate and disaster risks in operations and national or sectoral planning processes. This screening tool draws up-to-date and relevant information from the World Bank's Climate Change Knowledge Portal, a comprehensive online 'one-stop shop' for global, regional, and country data related to climate change and development.

For the Asian Development Bank (ADB): its Strategy 2030 identified "tackling climate change, building climate and disaster resilience, and enhancing environmental sustainability" as one of its seven operational priorities. Its Climate Change Operational Framework 2017–2030 identified mainstreaming climate considerations into corporate strategies and policies, sector and thematic operational plans, country programming, and project design, implementation, monitoring, and evaluation of climate change considerations as the foremost institutional measure to deliver its commitments under Strategy 2030. ADB's climate risk management framework requires all projects to undergo climate risk screening at the concept stage and full climate risk and adaptation assessments for projects with medium to high risk.

Recognizing the value of consistent, easy-to-use technical resources for our common client countries as well as to support respective internal climate risk assessment and adaptation planning processes, the World Bank Group's Climate Change Group and ADB's Sustainable Development and Climate Change Department have worked together to develop this content. Standardizing and pooling expertise facilitates each institution in conducting initial assessments of climate risks and opportunities across sectors within a country, within institutional portfolios across regions, and acts as a global resource for development practitioners.

For common client countries, these profiles are intended to serve as public goods to facilitate upstream country diagnostics, policy dialogue, and strategic planning by providing comprehensive overviews of trends and projected changes in key climate parameters, sector-specific implications, relevant policies and programs, adaptation priorities and opportunities for further actions.

We hope that this combined effort from our institutions will spur deepening of long-term risk management in our client countries and support further cooperation at the operational level.

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KEY MESSAGES

- The Kyrgyz Republic is projected to experience temperature rises significantly above the global average. Warming over the 1986–2005 baseline period could reach 5.3°C by the 2090s, under the highest emissions pathway, RCP8.5.
- Warming is projected to be even stronger in maximum and minimum temperatures and this is likely to amplify pressure on human lives, livelihoods and ecosystems.
- Heat stress may represent a serious risk to human life during peak summer temperatures, with a high likelihood that temperatures will more regularly exceed 40°C, particularly in lowland regions such as the Fergana Valley.
- Heat could combine with increased drought incidence to expand arid land cover. Without effective adaptation agricultural yields are likely to suffer. Ecosystems may shift their geographic ranges and at higher altitudes species are likely to see a significant reduction in viable habitat.
- Over the long term, the water sector is projected to experience a regime shift. The loss of mountain glaciers may reduce the regularity of flows and result in the drying of some watersheds.
- Flooding issues and associated hazards such as landslide are expected to intensify, potentially costing lives and livelihoods. Landslide exposure is widespread, and multiple hazardous glacial lakes also demand disaster risk reduction efforts.
- Multidimensional poverty and undernourishment are prevalent in the Kyrgyz Republic. The projected impacts of climate changes are likely to slow progress in addressing these issues as they disproportionately affect the poorest and most marginalized groups.

COUNTRY OVERVIEW

The Kyrgyz Republic (Kyrgyzstan) is a landlocked country located in Central Asia between two major mountain systems, the Tien Shan and the Pamirs. The Kyrgyz Republic is bordered by Kazakhstan to the north, Uzbekistan to the west, Tajikistan to the southwest, and China to the east. Approximately 94% of the country is above 1,000 meters (m) elevation, and 40% is above 3,000 m. Over 80% of the country is within the Tian Shan mountain chain and 4% is permanently under ice and snow. The Kyrgyz Republic had a population of 6.5 million in 2019.[1] Most of this population live in the foothills of the mountains, and is centered around two urban conurbations, the capital Bishkek in the north, and between Osh and Jalal-Abad in the west.

The socio-economic context in the Kyrgyz Republic is complex. In terms of GDP per capita (PPP) the Kyrgyz Republic ranks among the poorest countries in the world. This position is reflected in the high national poverty rate of 25.4% but less so in the rate of undernourishment (6.4%) where the country performs comparatively better (**Table 1**). A recent feature of Kyrgyz society has been the high rate of outmigration, with an estimated 0.5% of the population leaving the country every year between 2010–2015. Linked to this has been the rise in household reliance on remittances for income, with remittance income estimated to be equivalent to 28.5% of GDP in 2019.[1]

[1] World Bank Group (2021). Data Bank. Country indicators. URL: https://databank.worldbank.org/source/world-development-indicators

The Kyrgyz Republic's national economy has rapidly transitioned away from agriculture, constituting 14.6% of GDP in 2017 compared with 54.2% from the service sector. However, a large proportion of the population remain dependent on agriculture for subsistence and this remains a major employer.

A wide variety of natural hazards also affect the Kyrgyz Republic. Earthquakes are common and have led to loss of life and significant damage to infrastructure and livelihoods, typically occurring every 5–10 years. Climate-related hazards are also common and diverse. These include drought, land and mudslides, flash floods, and glacier lake outburst floods (GLOFs), all of which contribute to significant levels of disaster risk. In the context of high social vulnerability and hazard exposure the emerging impacts of climate change are of potential significance. The Kyrgyz Republic has identified climate change impacts as a significant challenge to its development goals and has identified its commitment to climate change adaptation through its First Nationally Determined Contribution (2016) and Updated Nationally Determined Contribution (2020). In 2016 the Republic released its Third National Communication to the UNFCCC (NC3), directed by the State Agency for Environment Protection and Forestry under the Government of the Kyrgyz Republic. The country has identified its water, energy, agriculture and infrastructure sectors as the most vulnerable to climate change.[2]

TABLE 1. Key indicators

Indicator	Value	Source
Population Undernourished[3]	6.4% (2017–2019)	FAO, 2020
National Poverty Rate[4]	22.4% (2018)	ADB, 2019
Share of Income Held by Bottom 20%[5]	9.9% (2018)	World Bank, 2019
Net Annual Migration Rate[6]	–0.06% (2015–2020)	UNDESA, 2019
Infant Mortality Rate (Between Age 0 and 1)[7]	1.6% (2015–2020)	UNDESA, 2019
Average Annual Change in Urban Population[8]	2.03% (2015–2020)	UNDESA, 2018
Dependents per 100 Independent Adults[9]	59.7 (2020)	UNDESA, 2019
Urban Population as % of Total Population[10]	36.4% (2018)	CIA, 2018
External Debt Ratio to GNI[11]	103% (2018)	ADB, 2020
Government Expenditure Ratio to GDP[12]	28.4% (2019)	ADB, 2020

[2] Kyrgyz Republic (2016). Third National Communication to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/NC3_Kyrgyzstan_English_24Jan2017_0.pdf
[3] FAO, IFAD, UNICEF, WFP, WHO (2020). The state of food security and nutrition in the world. Transforming food systems for affordable healthy diets. FAO. Rome. URL: http://www.fao.org/3/a-i7695e.pdf
[4] ADB (2019). Poverty data: Kyrgyz Republic. URL: https://www.adb.org/countries/kyrgyz-republic/poverty [accessed 17/12/20]
[5] World Bank (2019). Poverty report – Kyrgyz Republic Living Conditions Survey.URL: https://data.worldbank.org/country/KG
[6] UNDESA (2019). World Population Prospects 2019: MIGR/1. URL: https://population.un.org/wpp/Download/Standard/Population/ [accessed 17/12/20]
[7] UNDESA (2019). World Population Prospects 2019: MORT/1-1. URL: https://population.un.org/wpp/Download/Standard/Population/ [accessed 17/12/20]
[8] UNDESA (2019). World Urbanization Prospects 2018: File 6. URL: https://population.un.org/wup/Download/ [accessed 17/12/20]
[9] UNDESA (2019). World Population Prospects 2019: POP/11-A. Available at: https://population.un.org/wpp/Download/Standard/Population/ [accessed 17/12/20]
[10] CIA (2018). The World Factbook. Central Intelligence Agency. Washington DC. URL: https://www.cia.gov/library/publications/the-world-factbook/geos/ch.html
[11] ADB (2020). Key Indicators for Asia and the Pacific 2020. Asian Development Bank. URL: https://www.adb.org/sites/default/files/publication/443671/ki2018.pdf
[12] ADB (2020) Key Indicators for Asia and the Pacific 2020. Asian Development Bank. URL: https://www.adb.org/sites/default/files/publication/443671/ki2018.pdf

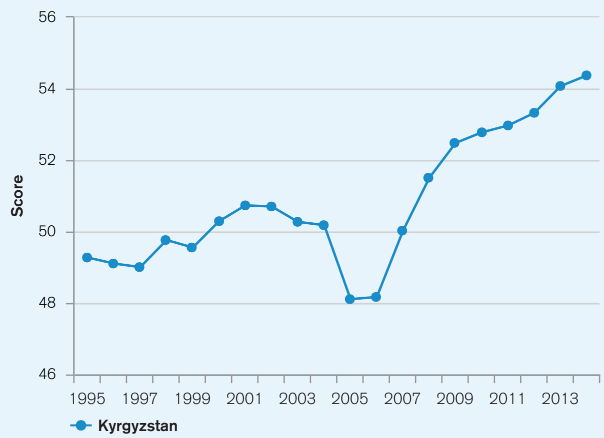
Green, Inclusive and Resilient Recovery

The coronavirus disease (COVID-19) pandemic has led to unprecedented adverse social and economic impacts. Further, the pandemic has demonstrated the compounding impacts of adding yet another shock on top of the multiple challenges that vulnerable populations already face in day-to-day life, with the potential to create devastating health, social, economic and environmental crises that can leave a deep, long-lasting mark. However, as governments take urgent action and lay the foundations for their financial, economic, and social recovery, they have a unique opportunity to create economies that are more sustainable, inclusive and resilient. Short and long-term recovery efforts should prioritize investments that boost jobs and economic activity; have positive impacts on human, social and natural capital; protect biodiversity and ecosystems services; boost resilience; and advance the decarbonization of economies.

This document aims to succinctly summarize the climate risks faced by PNG. This includes rapid onset and long-term changes in key climate parameters, as well as impacts of these changes on communities, livelihoods and economies, many of which are already underway. This is a high-level synthesis of existing research and analyses, focusing on the geographic domain of PNG, therefore potentially excluding some international influences and localized impacts. The core data presented is sourced from the database sitting behind the World Bank Group's Climate Change Knowledge Portal (CCKP), incorporating climate projections from the Coupled Model Inter-comparison Project Phase 5 (CMIP5). This document is primarily meant for WBG and ADB staff to inform their climate actions. The document also aims to direct the reader to many useful sources of secondary data and research.

Due to a combination of political, geographic, and social factors, the Kyrgyz Republic is recognized as vulnerable to climate change impacts, ranked 75th out of 181 countries in the 2020 ND-GAIN Index[13] The ND-GAIN Index ranks 181 countries using a score which calculates a country's vulnerability to climate change and other global challenges as well as their readiness to improve resilience. The more vulnerable a country is the lower their score, while the more ready a country is to improve its resilience the higher it will be. Norway has the highest score and is ranked 1st. **Figure 1** is a time-series plot of the ND-GAIN Index showing Kyrgyz Republic progress.

FIGURE 1. The ND-GAIN Index summarizes a country's vulnerability to climate change and other global challenges in combination with its readiness to improve resilience. It aims to help businesses and the public sector better prioritize investments for a more efficient response to the immediate global challenges ahead.



[13] University of Notre Dame (2020). Notre Dame Global Adaptation Initiative. URL: https://gain.nd.edu/our-work/country-index/

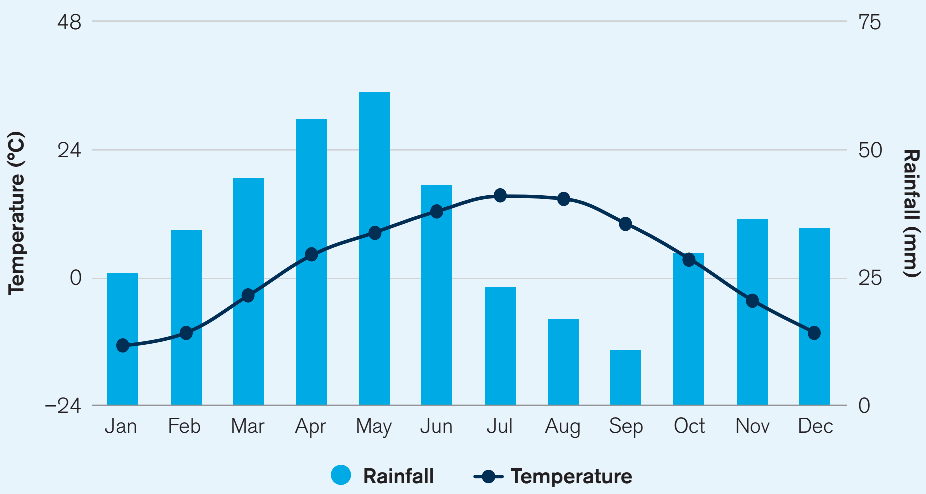
Climate Baseline

Overview

The Kyrgyz Republic is considered to have an extreme continental climate. The majority of the country is arid, with increased cloudiness and precipitation due to the alpine relief. The country's climate is determined by its location in the Northern Hemisphere, in the center of the Eurasian continent, the remoteness from major water bodies, and the close proximity of deserts. Temperature trends tend to be higher in the Northern hemisphere than temperatures in the Southern hemisphere. The climate of Kyrgyz Republic is characterized relatively high inter-annual and spatial variability. Average annual temperatures vary from less than –10°C in high altitude regions of the Tien Shan mountains to over 12°C in the northern and western lowlands. In the lowland regions around Bishkek and Osh temperatures regularly exceed 30°C between June and August, while falling below –5°C between December and February (**Figure 2**), which shows the latest climatology (1991–2020). Mean annual precipitation for the latest climatology was 378.3 millimeters (mm), however precipitation varies by region, typically between 100 mm to 1,000 mm and is highest in the region surrounding Jalal-Abad. Approximately, 24% of the country's surface area has an altitude above 3,500 meter (m) and these areas have historically been under permanent snow cover.[14] **Figure 3** shows the spatial differences of observed historical temperature and rainfall in Kyrgyz Republic.

Annual Cycle

FIGURE 2. Average monthly temperature and rainfall in the Kyrgyz Republic, 1991–2020[15]

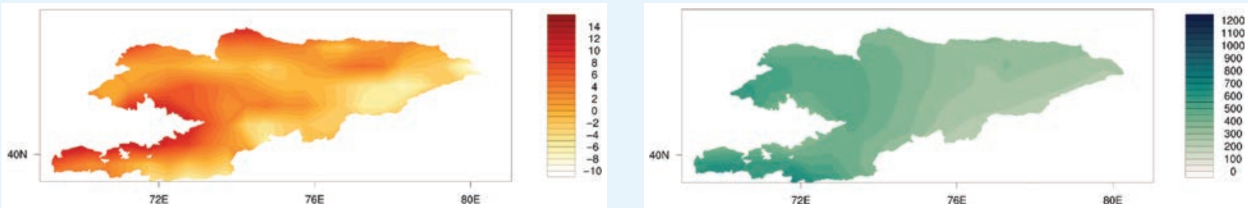


[14] Kyrgyz Republic (2016). Third National Communication to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/NC3_Kyrgyzstan_English_24Jan2017_0.pdf

[15] WBG Climate Change Knowledge Portal (CCKP, 2021). Climate Data: Historical. URL: https://climateknowledgeportal.worldbank.org/country/kyrgyzstan/climate-data-historical

Spatial Variation

FIGURE 3. (Left) Annual Mean Temperature (°C), and (Right) Annual Mean Rainfall (mm) in the Kyrgyz Republic over the period 1991–2020[16]



Key Trends

Temperature

Average annual temperatures in the Kyrgyz Republic have risen approximately 1.1°C between 1960–2010. The rate of warming has accelerated over the period 1990–2010. Warming trends were reported across all of the Kyrgyz Republic's different regions, and at all altitudes.[17] Warming has been most pronounced in winter (November–March) minimum temperatures. Inter-annual variation in temperature is weakly correlated with large scale climate circulation phenomena, El Niño Southern Oscillation (ENSO) and North Atlantic Oscillation (NAO).[18]

Precipitation

The Kyrgyz Republic's TNC suggests there has been little change in average annual precipitation on a national level between 1920–2010. Some sub-national changes have been reported, including small increases in precipitation in the central and northwestern parts of the country and small decreases in the east, but there is little evidence distinguishing these trends from typical natural variability in the region.[19,20] Inter-annual variations in winter precipitation are correlated with ENSO. Under El Nino conditions there tends to be more winter precipitation.[9]

A Precautionary Approach

Studies published since the last iteration of the IPCC's report (AR5), such as Gasser et al. (2018), have presented evidence which suggests a greater probability that earth will experience medium and high-end warming scenarios than previously estimated.[1] Climate change projections associated with the highest emissions pathway (RCP8.5) are presented here to facilitate decision making which is robust to these risks.

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16 WBG Climate Change Knowledge Portal (CCKP, 2021). Climate Data: Historical. URL: https://climateknowledgeportal.worldbank.org/country/kyrgyzstan/climate-data-historical

17 Kyrgyz Republic (2016). Third National Communication to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/NC3_Kyrgyzstan_English_24Jan2017_0.pdf

18 Dixon, S.G. and Wilby, R.L. (2019). A seasonal forecasting procedure for reservoir inflows in Central Asia. Rivers Research and Applications – Special Issue, doi:10.1002/rra.3506. URL: https://onlinelibrary.wiley.com/doi/abs/10.1002/rra.3506

19 Xu, L., Zhou, H., Du, L., Yao, H. and Wang, H., 2015. Precipitation trends and variability from 1950 to 2000 in arid lands of Central Asia. Journal of Arid Land, 7(4), pp.514–526. URL: https://link.springer.com/article/10.1007/s40333-015-0045-9

20 Chen, F., Huang, W., Jin, L., Chen, J. and Wang, J., 2011. Spatiotemporal precipitation variations in the arid Central Asia in the context of global warming. Science China Earth Sciences, 54(12), pp.1812–1821. URL: https://link.springer.com/article/10.1007/s11430-011-4333-8

Climate Future

Overview

The main data source for the World Banks' Climate Change Knowledge Portal (CCKP) is the Coupled Model Inter-comparison Project Phase 5 (CMIP5) models, which are utilized within the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), providing estimates of future temperature and precipitation. Four Representative Concentration Pathways (i.e. RCP2.6, RCP4.5, RCP6.0, and RCP8.5) were selected and defined by their total radiative forcing (cumulative measure of GHG emissions from all sources) pathway and level by 2100. In this analysis RCP2.6 and RCP8.5, the extremes of low and high emissions pathways, are the primary focus RCP2.6 represents a very strong mitigation scenario, whereas RCP8.5 assumes business-as-usual scenario. For more information, please refer to the RCP Database.

For the Kyrgyz Republic, these models show a trend of consistent warming that varies by emissions scenario. However, the projections in rainfall are less certain for the Kyrgyz Republic. It is anticipated that the country will experience an increase in intensity for extreme rainfall events. **Tables 2** and **3** below, provide information on projected temperature anomalies for the four RCPs over two distinct time horizons; presented against the reference period of 1986–2005.

TABLE 2. Projected anomaly (changes °C) for maximum, minimum, and average daily temperatures in the Kyrgyz Republic for 2040–2059 and 2080–2099, from the reference period of 1986–2005 for all RCPs. The table is showing the median of the CCKP model ensemble and the 10–90th percentiles in brackets.[21]

	Average Daily Maximum Temperature		Average Daily Temperature		Average Daily Minimum Temperature	
Scenario	**2040–2059**	**2080–2099**	**2040–2059**	**2080–2099**	**2040–2059**	**2080–2099**
RCP2.6	1.5 (–0.6, 3.8)	1.4 (–0.8, 3.8)	1.5 (–0.2, 3.5)	1.4 (–0.5, 3.5)	1.6 (–0.4, 3.6)	1.5 (–0.5, 3.5)
RCP4.5	2.0 (–0.1, 4.1)	2.7 (0.5, 5.0)	1.9 (0.1, 3.8)	2.7 (0.7, 4.7)	2.0 (0.0, 4.0)	2.8 (0.5, 4.8)
RCP6.0	1.7 (0.0, 3.5)	3.5 (1.6, 5.8)	1.7 (0.1, 3.4)	3.4 (1.7, 5.4)	1.8 (0.0, 3.5)	3.5 (1.4, 5.4)
RCP8.5	2.6 (0.4, 4.8)	5.6 (3.3, 8.2)	2.6 (0.8, 4.5)	5.6 (3.6, 7.8)	2.7 (0.7, 4.6)	5.7 (3.3, 7.9)

[21] WBG Climate Change Knowledge Portal (CCKP, 2021). Climate Data: Projections. URL: https://climateknowledgeportal.worldbank.org/country/kyrgyzstan/climate-data-projections

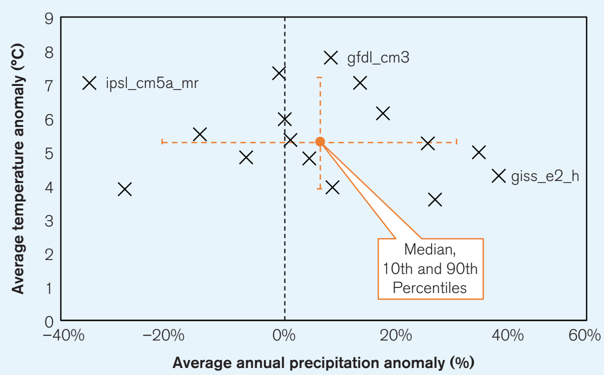
TABLE 3. Projections of average temperature anomaly (°C) in the Kyrgyz Republic for different seasons (3-monthly time slices) over different time horizons and emissions pathways, showing the median estimates of the full CCKP model ensemble and the 10th and 90th percentiles in brackets.[13]

	2040–2059		2080–2099	
Scenario	**Jun–Aug**	**Dec–Feb**	**Jun–Aug**	**Dec–Feb**
RCP2.6	1.8 (–0.4, 3.8)	1.5 (–0.5, 3.9)	1.6 (–0.9, 4.1)	1.5 (–0.5, 3.8)
RCP4.5	2.1 (0.0, 4.0)	1.9 (0.0, 4.1)	3.0 (0.5, 3.2)	2.8 (0.9, 4.8)
RCP6.0	1.8 (0.4, 3.3)	1.9 (–0.2, 3.7)	3.7 (1.9, 5.7)	3.5 (1.7, 5.7)
RCP8.5	2.8 (0.8, 4.8)	2.4 (0.5, 4.7)	5.9 (3.7, 8.3)	5.5 (3.8, 8.0)

Model Ensemble

Climate projections presented in this document are derived from the CCKP, unless otherwise stated. These datasets are processed outputs of simulations performed by multiple General Circulation Models (GCM) developed by climate research centers around the world and evaluated by the IPCC for quality assurance in the CMIP5 iteration of models (for further information see Flato et al., 2013).[22] Collectively, these different GCM simulations are referred to as the 'model ensemble'. Due to the differences in the way GCMs represent the key physical processes and interactions within the climate system, projections of future climate conditions can vary widely between different GCMs. This is particularly the case for rainfall related variables and at national and local scales. Exploring the spread of climate model outputs can assist in understanding uncertainties associated with climate models. The range of projections from 16 GCMs on the indicators of average temperature anomaly and annual precipitation anomaly for the Kyrgyz Republic under RCP8.5 is shown in **Figure 4.** It should be noted that concerns have been raised about the realism of some of the more extreme outlier models labelled in **Figure 5.**[23]

FIGURE 4. 'Projected average temperature anomaly' and 'projected annual rainfall anomaly' in the Kyrgyz Republic. Outputs of 16 models within the ensemble simulating RCP8.5 over the period 2080–2099. Models shown represent the subset of models within the ensemble which provide projections across all RCPs and therefore are most robust for comparison. Three models are labelled.

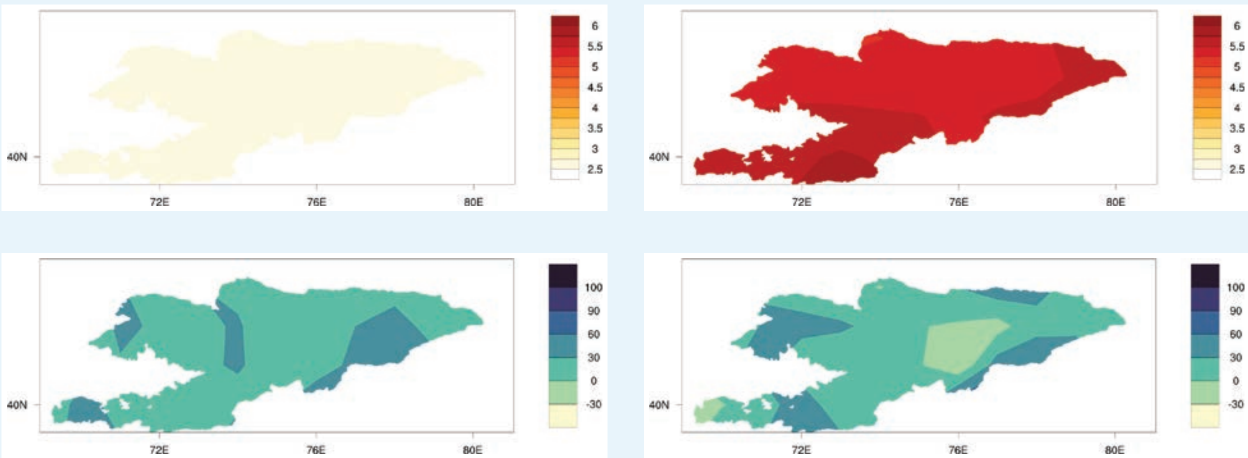


[22] Flato, G., Marotzke, J., Abiodun, B., Braconnot, P., Chou, S. C., Collins, W., . . . Rummukainen, M. (2013). Evaluation of Climate Models. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, 741–866. URL: https://sealevel.nasa.gov/publications/4408/evaluation-of-climate-models-in-climate-change-2013-the-physical-science-basis-contribution-of-workin/

[23] McSweeney, C.F., Jones, R.G., Lee, R.W. and Rowell, D.P., 2015. Selecting CMIP5 GCMs for downscaling over multiple regions. Climate Dynamics, 44(11–12), pp.3237–3260. URL: https://link.springer.com/article/10.1007/s00382-014-2418-8

Spatial Variation

FIGURE 5. CMIP5 ensemble projected change (32 GCMs) in annual temperature (top) and precipitation (bottom) by 2040–2059 (left) and by 2080–2090 (right) relative to 1986–2005 baseline under RCP8.5.[24]



Temperature

Projections of future temperature change are presented in three primary formats. Shown in **Table 2** are the changes (anomalies) in maximum and minimum temperatures over the given time period, as well as changes in the average temperature. **Figures 6** and **7** display the annual and monthly average temperature projections. While similar, these three indicators can provide slightly different information. Monthly/annual average temperatures are most commonly used for general estimation of climate change, but the daily maximum and minimum can explain more about how daily life might change in a region, affecting key variables such as the viability of ecosystems, health impacts, productivity of labor, and the yield of crops, which are often disproportionately influenced by temperature extremes.

There is good agreement among model projections that the Kyrgyz Republic will experience rates of warming considerably above the global average. By the 2090s the ensemble projects 5.6°C of warming under the highest emissions pathway (RCP8.5) compared to a global average rise of 3.7°C. The warming projected in maximum and minimum temperatures is typically around 10% higher than the rise in average temperature. Under the lowest emissions pathway (RCP2.6) warming peaks in the 2050s period at around 1.6°C above the 1986–2005 baseline and then begins to decline. This highlights the very significant influence potential global emissions reductions could have over warming trends in the Kyrgyz Republic.

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[24] WBG Climate Change Knowledge Portal (CCKP 2021). Kyrgyzstan. Climate Data. Projections. URL: https://climateknowledgeportal.worldbank.org/country/kyrgyzstan/climate-data-projections

FIGURE 6. Historic and projected average annual temperature in the Kyrgyz Republic under RCP2.6 (blue) and RCP8.5 (red) estimated by the model ensemble. Shading represents the standard deviation of the model ensemble.[25]

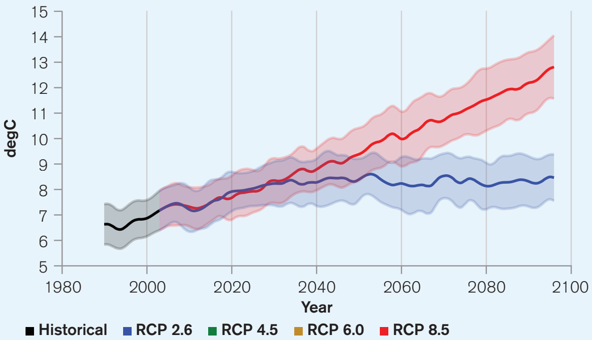
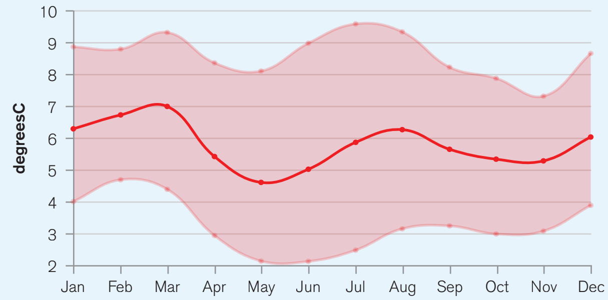


FIGURE 7. Projected change (anomaly) in monthly temperature, shown by month, for the Kyrgyz Republic for the period 2080–2099 under RCP8.5. The value shown represents the median of the model ensemble with the shaded areas showing the 10th–90th percentiles.[17]

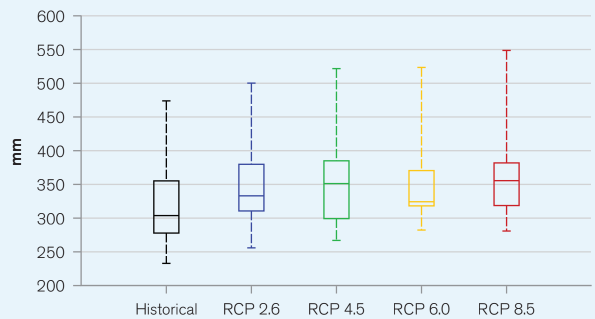


The seasonality of future temperature rises is somewhat uncertain, but under higher emissions pathways (**Figure 7**) warming projections from the CCKP model ensemble tend to be stronger in the summer months of July, August and September.

Precipitation

Very little information can be taken from examination of the CCKP ensemble projections of annual precipitation change (**Figure 8**). As shown in **Figure 4** models do not agree on the direction nor magnitude of change. While considerable uncertainty surrounds projections of local long-term future precipitation trends, some global trends are evident. The intensity of sub-daily extreme rainfall events appears to be increasing with temperature, a finding supported by evidence from different regions of Asia.[26] Although great uncertainty surrounds projections, most models in the CCKP ensemble project increases in the quantity of rainfall deposited during extreme precipitation events, with rises in the range of 5–15% by the 2050s. As this phenomenon is highly dependent on local geographical contexts further research is required to constrain its impact in the Kyrgyz Republic.

FIGURE 8. Projected average annual precipitation for the Kyrgyz Republic in the period 2080–2099.[17]



[25] WBG Climate Change Knowledge Portal (CCKP 2021). Kyrgyzstan. Climate Data. Projections. URL: https://climateknowledgeportal.worldbank.org/country/kyrgyzstan/climate-data-projections

[26] Westra, S., Fowler, H. J., Evans, J. P., Alexander, L. V., Berg, P., Johnson, F., Kendon, E. J., Lenderink, G., Roberts, N. (2014). Future changes to the intensity and frequency of short-duration extreme rainfall. Reviews of Geophysics, 52, 522–555. URL: https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2014RG000464

The Kyrgyz Republic faces varied natural hazards and experiences moderately high levels of disaster risk. While the Kyrgyz Republic performs well in the INFORM 2019 Index[27] in terms of the vulnerability of its population, and achieves an average ranking for coping capacity, the nation faces significant risk from floods (including river and flash flooding) as well as landslides and particularly drought (**Table 4**).

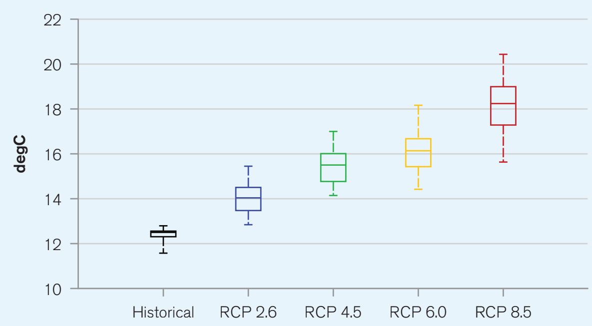
TABLE 4. Selected indicators from the INFORM 2019 Index for Risk Management for the Kyrgyz Republic. For the sub-categories of risk (e.g. "Flood") higher scores represent greater risks. Conversely the most at-risk country is ranked 1st. Global averages are shown in brackets.

Flood (0–10)	Tropical Cyclone (0–10)	Drought (0–10)	Vulnerability (0–10)	Lack of Coping Capacity (0–10)	Overall Inform Risk Level (0–10)	Rank (1–191)
5.6 [4.5]	0.0 [1.7]	6.7 [3.2]	2.6 [3.6]	4.5 [4.5]	3.9 [3.8]	91

Heatwaves

The Kyrgyz Republic experiences an average monthly maximum temperature of around 8.4°C. However, considerably higher temperatures occur during summer months in lowland regions such as the Fergana Valley. As shown in **Figure 9** the historical (1986–2005) maximum of daily maximum temperatures is around 30°C when averaging across the country. Maximum temperatures in the Fergana Valley regularly surpass 35°C in summer. Under all emissions pathways this value is projected to increase significantly, potentially reaching a national average of 36°C by the 2090s under the highest emissions pathway, RCP8.5. This highlights the potential for extreme temperatures, potentially over 40°C, to become a more regular occurrence in the low-lying and most densely populated areas.

FIGURE 9. Historical (1986–2005) and projected (2080–2099) annual maximum of daily maximum temperature in the Kyrgyz Republic.[25]



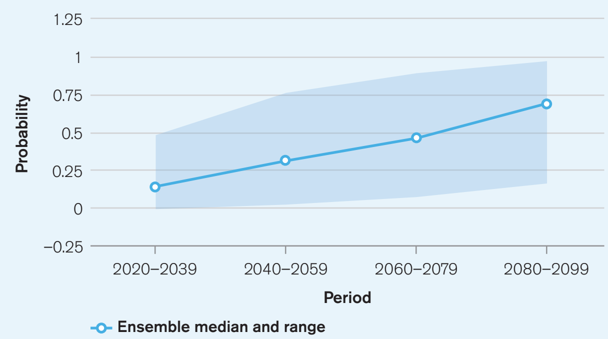
[27] European Commission (2019). INFORM Index for Risk Management. Country Profile. URL: https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk

Drought

Two primary types of drought may affect the Kyrgyz Republic, meteorological (usually associated with a precipitation deficit) and hydrological (usually associated with a deficit in surface and subsurface water flow, potentially originating in the region's wider river basins). In addition, crop choices and land management practices can combine with climatic conditions to produce agricultural drought. For a 256 reconstruction of historical drought conditions see Zhang et al. (2019).[28]

Naumann et al. (2018) provide a global overview of changes in meteorological drought conditions under different warming scenarios.[29] The work suggests the Central Asian region will be among the most significantly affected by climate change influences on drought probability. What would previously have been a 1 in 100-year drought event is projected to occur around once every 15 years under 2°C of global warming, a threshold which is likely to be surpassed under both RCP6.0 and RCP8.5. The CCKP model ensemble projections support these findings, suggesting very high future probability of severe drought conditions under higher emissions pathways (**Figure 10**).

FIGURE 10. Projected annual probability of experiencing at least 'severe drought' conditions (–2 SPEI index) under the RCP8.5 emissions pathway in the Kyrgyz Republic.[25]



Flood and Landslide

UNISDR suggests that flood damages have made a significant contribution to average annual losses in the Kyrgyz Republic – estimated to be $36 million, or 0.5% of GDP, in 2014.[30] However, the reporting mechanisms behind this value are known to neglect smaller-scale hazard events and the actual losses may be higher. The World Resources Institute's AQUEDUCT Global Flood Analyzer can be used to establish a baseline level of river flood exposure. As of 2010, assuming protection for up to a 1 in 25-year event, the population annually affected by flooding in the Kyrgyz Republic is estimated to be 17,000 people with an expected annual impact on GDP of $38 million.[31] Adding the impact of flash flooding to this total would likely push it higher than the UNISDR estimate.

The Kyrgyz Republic is unusual in that most globally focused models do not project increases in the intensity of river flooding. For example, modelling by Willner et al. (2018), shows average increases in the population affected by river flooding of 0–2% by 2035–2044 (**Table 5**).[32] Work by Paltan et al. (2018) which demonstrates that even

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[28] Zhang, T., Lu, B., Zhang, R., Diushen, M., Rysbek, S., Bakytbek, E., Chen, F., Yu, S., Jiang, S. and Zhang, H. (2019). A 256-year-long precipitation reconstruction for northern Kyrgyzstan based on tree-ring width. International Journal of Climatology. URL: https://rmets.onlinelibrary.wiley.com/doi/10.1002/joc.6280

[29] Naumann, G., Alfieri, L., Wyser, K., Mentaschi, L., Betts, R. A., Carrao, H., . . . Feyen, L. (2018). Global Changes in Drought Conditions Under Different Levels of Warming. Geophysical Research Letters, 45(7), 3285–3296. URL: https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2017GL076521

[30] UNISDR (2014). PreventionWeb: Basic country statistics and indicators. URL: https://www.preventionweb.net/countries

[31] WRI (2018). AQUEDUCT Global Flood Analyzer. URL: https://floods.wri.org/# [Accessed: 22/11/2018]

[32] Willner, S., Levermann, A., Zhao, F., Frieler, K. (2018) Adaptation required to preserve future high-end river flood risk at present levels. Science Advances: 4:1. URL: https://advances.sciencemag.org/content/4/1/eaao1914

under lower emissions pathways coherent with the Paris Climate Agreement almost all Asian countries face an increase in the frequency of extreme river flows, gives inconclusive projections for the Kyrgyz Republic.[33] The AQUEDUCT Global Flood Analyzer also projects no climate-induced increase in the annual population affected by river flooding, nor in its economic impact.[22]

TABLE 5. Estimated number of people in Kyrgyz Republic affected by an extreme river flood (extreme flood is defined as being in the 90th percentile in terms of numbers of people affected) in the historic period 1971–2004 and the future period 2035–2044. Figures represent an average of all four RCPs and assume present day population distributions.[23]

Estimate	Population Exposed to Extreme Flood (1971–2004)	Population Exposed to Extreme Flood (2035–2044)	Increase in Affected Population
16.7 Percentile	194,000	196,672	2,672
Median	207,181	208,572	1,391
83.3 Percentile	232,905	237,592	4,687

Climate change impacts on flash flooding, mudslide and landslide are less studied and hard to accurately project due to their localized nature. Nonetheless, it is important to consider such risks in the Central Asian region where landslides have a proportionately large impact.[34] The Kyrgyz Republic is particularly vulnerable, as one of the region's most mountainous nations. Notably, the region of the Kyrgyz Republic encompassing the eastern part of the Fergana Valley experiences frequent landslides, killing an estimated 30 people per year according to one study.[35] Heavy and prolonged rainfalls are known to be a key risk factor triggering mudslides. More intense rainfall under climate change could increase the threat. While further research is required to better understand and map the climate-induced risk, past work has identified that significant areas of population and infrastructure lie in potentially exposed areas.[36] Recent work has considerably improved our understanding of landslide susceptibility across the majority of the Kyrgyz Republic, and highlights its great extent.[37] Studies have also suggested that the number and size of unstable slopes in the Kyrgyz Republic increased from 162 in 1962 to 208 in 2007.[38]

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33 Paltan, H., Allen, M., Haustein, K., Fuldauer, L., & Dadson, S. (2018). Global implications of 1.5°C and 2°C warmer worlds on extreme river flows Global implications of 1.5°C and 2°C warmer worlds on extreme river flows. Environmental Research Letters, 13. URL: https://iopscience.iop.org/article/10.1088/1748-9326/aad985/meta

34 Reyer, C. P. O., Otto, I. M., Adams, S., Albrecht, T., Baarsch, F., Cartsburg, M., . . . Serdeczny, O. (2017). Climate change impacts in Central Asia and their implications for development. Regional Environmental Change, 17(6), 1639–1650. URL: https://research.vu.nl/en/publications/climate-change-impacts-in-central-asia-and-their-implications-for

35 Danneels, G., Bourdeau, C., Torgoev, I., & Havenith, H.-B. (2008). Geophysical investigation and dynamic modelling of unstable slopes: case-study of Kainama (Kyrgyzstan). Geophysical Journal International, 175(1), 17–34. URL: https://academic.oup.com/gji/article/175/1/17/716950

36 Havenith, H. B., Torgoev, I., Meleshko, A., Alioshin, Y., Torgoev, A., & Danneels, G. (2006). Landslides in the Mailuu-Suu Valley, Kyrgyzstan—Hazards and Impacts. Landslides, 3(2), 137–147. URL: https://www.infona.pl/resource/bwmeta1.element.springer-9e756bb9-63cd-351f-a5d5-caf8acba3d2e

37 Havenith, H. B., Torgoev, A., Schlögel, R., Braun, A., Torgoev, I., & Ischuk, A. (2015). Tien Shan Geohazards Database: Landslide susceptibility analysis. Geomorphology, 249, 32–43. URL: https://www.sciencedirect.com/science/article/abs/pii/S0169555X15001609

38 Schlögel, R., Torgoev, I., De Marneffe, C., & Havenith, H.-B. (2011). Evidence of a changing size–frequency distribution of landslides in zz Tien Shan, Central Asia. Earth Surface Processes and Landforms, 36(12), 1658–1669. URL: https://onlinelibrary.wiley.com/doi/abs/10.1002/esp.2184

Also contributing to disaster risk in the Kyrgyz Republic are glacial lake outburst floods (GLOFs) and debris flows. These occur when a moraine dam holding back high-altitude meltwater bursts, either as a result of geological disturbance or due to high lake levels. The Tien Shan mountain range which encompasses much of the Kyrgyz Republic is a known hotspot of high altitude lakes which present a potential risk given the rapid melting of glaciers in the region.[39] Historic events have resulted in deaths and significant livelihood damage.[40] For a time series of historic GLOF activity in the region see Zaginaev et al. (2019).[41] As warming accelerates the importance of monitoring and making disaster risk reduction preparations for major GLOFs increases.[42]

CLIMATE CHANGE IMPACTS

Natural Resources

Water

Water resources in the Kyrgyz Republic are under pressure, with declines in stored water volumes recorded between 2003–2013.[43] While climatic factors have played a role, particularly occurrence of drought and increased rates of evaporation, other human development pressures, such as expansion of irrigation, are often the strongest drivers of water stress.[34] Nonetheless climate changes are having significant impacts on water resources in the Kyrgyz Republic. Glaciers in The Tien Shan and Pamir mountains have been shrinking rapidly.[44] In the short to medium-term the runoff from the Tien Shan mountain range is likely to increase, potentially peaking around 2040, as a result of glacier melt.[45] Up to this point other human influences on water availability are likely to control the sector's success. Beyond this point, runoff is likely to decrease considerably as glaciers deplete, with potential for severe water shortages before the end of the century.

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39 Bolch, T., Peters, J., Yegorov, A., Pradhan, B., Buchroithner, M., & Blagoveshchensky, V. (2011). Identification of potentially dangerous glacial lakes in the northern Tien Shan. Natural Hazards, 59(3), 1691–1714. URL: https://link.springer.com/article/10.1007/s11069-011-9860-2

40 Narama, C., Duishonakunov, M., Kääb, A., Daiyrov, M., & Abdrakhmatov, K. (2010). The 24 July 2008 outburst flood at the western Zyndan glacier lake and recent regional changes in glacier lakes of the Teskey Ala-Too range, Tien Shan, Kyrgyzstan. Nat. Hazards Earth Syst. Sci., 10(4), 647–659. URL: https://nhess.copernicus.org/articles/10/647/2010/

41 Zaginaev, V., Petrakov, D., Erokhin, S., Meleshko, A., Stoffel, M. and Ballesteros-Cánovas, J.A. (2019). Geomorphic control on regional glacier lake outburst flood and debris flow activity over northern Tien Shan. Global and planetary change, 176, pp.50–59. URL: https://www.sciencedirect.com/science/article/abs/pii/S0921818118306635

42 Xie, Z., ShangGuan, D., Zhang, S., Ding, Y., & Liu, S. (2013). Index for hazard of Glacier Lake Outburst flood of Lake Merzbacher by satellite-based monitoring of lake area and ice cover. Global and Planetary Change, 107, 229–237. URL: https://ui.adsabs.harvard.edu/abs/2013GPC...107..229X/abstract

43 Deng, H., & Chen, Y. (2017). Influences of recent climate change and human activities on water storage variations in Central Asia. Journal of Hydrology, 544, 46–57. URL: http://www.egi.ac.cn/xwzx/kydt/201612/W020161229657217542234.pdf

44 Barandun, M., Huss, M., Usubaliev, R., Azisov, E., Berthier, E., Kääb, A., Bolch, T. and Hoelzle, M. (2018). Multi-decadal mass balance series of three Kyrgyz glaciers inferred from modelling constrained with repeated snow line observations. Cryosphere, 12, 1899–1919. URL: https://tc.copernicus.org/articles/12/1899/2018/

45 Gan, R., Luo, Y., Zuo, Q., & Sun, L. (2015). Effects of projected climate change on the glacier and runoff generation in the Naryn River Basin, Central Asia. Journal of Hydrology, 523, 240–251. URL: https://www.semanticscholar.org/paper/Effects-of-projected-climate-change-on-the-glacier-Gan-Luo/88ab7ebc7f765f096d79db8516db4627c5eb62dc

In addition to changes in net runoff, shifts in the intra-annual runoff regime are projected. Notably, a potential advance in the annual peak runoff by up to a month is projected, increasing spring flows but significantly reducing summer flows.[36] The combined influences of climate change are projected to dramatically increase the probability of drought conditions. Given the importance of changes to glacier mass in local mountain ranges to local health, biodiversity and economies, there have been recent concerted efforts to improve local monitoring and data collection.[46] The condition and sustainability of water resources in the Kyrgyz Republic is not only important to the country's residents, but also to societies across central Asia, with the majority of the region's fresh water originating from the mountains of the Kyrgyz Republic and Tajikistan.[47]

Pressures on water supply caused by climate change are of significance both to the national economic outlook of the Kyrgyz Republic and its neighboring countries, but also to vulnerable communities. Poorer rural areas often have deteriorating water infrastructure and lack the resources to invest privately.[48] The importance of effective and inclusive adaptation is therefore great. The Kyrgyz Republic also has a strategically important geographic position, controlling the upper basin of river networks of great significance to neighboring nations. Under increasing water stress and a changing runoff regime, careful and co-operative management of key dams, such as Toktogul reservoir, will be essential to minimize health impacts, loss and damage on communities across the region.[49]

An important water resource in the Kyrgyz Republic is Lake Issyk-Kul, the tenth largest lake in the world by water volume. Issyk-Kul is home to endemic fish species and has historically underpinned significant economic activity, including tourism. Study largely points to human development pressures as the most important controls on water levels, and water quality of Issyk-Kul,[50,51] and particularly to the lake's biodiversity.[52] However, research and monitoring will be required to understand the potential impact of climate changes on the lake's health.

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46 Hoelzle, M., Azisov, E., Barandun, M., Huss, M., Farinotti, D., Gafurov, A., Hagg, W., Kenzhebaev, R., Kronenberg, M., Machguth, H. and Merkushkin, A. (2017). Re-establishing glacier monitoring in Kyrgyzstan and Uzbekistan, Central Asia. Geoscientific Instrumentation, Methods and Data Systems, 6(2), pp.397–418. URL: https://gi.copernicus.org/articles/6/397/2017/

47 ADB (2014) Climate change and sustainable water management in Central Asia. Asian Development Bank, Central and West Asia Working Paper Series No.5. URL: https://www.adb.org/sites/default/files/publication/42416/cwa-wp-005.pdf

48 Rost, K. T., Ratfelder, G., & Topbaev, O. (2015). Problems of rural drinking water supply management in Central Kyrgyzstan: a case study from Kara-Suu village, Naryn Oblast. Environmental Earth Sciences, 73(2), 863–872. URL: https://link.springer.com/article/10.1007/s12665-014-3299-1?shared-article-renderer

49 Sorg, A., Mosello, B., Shalpykova, G., Allan, A., Clarvis, M.H. and Stoffel, M. (2014). Coping with changing water resources: the case of the Syr Darya river basin in Central Asia. Environmental Science & Policy, 43, pp.68–77. URL: https://discovery.dundee.ac.uk/en/publications/coping-with-changing-water-resources-the-case-of-the-syr-darya-ri

50 Alifujiang, Y., Abuduwaili, J., Ma, L., Samat, A. and Groll, M. (2017). System Dynamics Modeling of Water Level Variations of Lake Issyk-Kul, Kyrgyzstan. Water, 9(12), p.989. URL: https://www.mdpi.com/2073-4441/9/12/989

51 Alymkulova, B., Abuduwaili, J., Issanova, G. and Nahayo, L. (2016). Consideration of water uses for its sustainable management, the case of Issyk-Kul Lake, Kyrgyzstan. Water, 8(7), p.298. URL: https://www.mdpi.com/2073-4441/8/7/298

52 Alamanov, A. and Mikkola, H. (2011). Is biodiversity friendly fisheries management possible on Issyk-Kul Lake in the Kyrgyz Republic?. Ambio, 40(5), p.479. URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3357812/

Land, Soil, and Ecosystems

Historical warming has already had an impact on largescale vegetation health across Central Asia and locally in the Kyrgyz Republic. Over the period 1992–2011 rising temperatures were associated with significant loss of 'greenness' in lowland and cropland regions.[53] These losses have been linked to increased water deficits driven primarily by greater evapotranspiration which can result in stunted plant growth and desiccation. The Kyrgyz Republic's lowlands are also among the areas already being affected by increased aridity.[54] Persistent drought periods degrade grassland areas causing transition to sparsely vegetated lands and shrubs. Forested areas, and tree species such as Juniper, have also been documented struggling with increasing aridity.[55] Indeed, over the Central Asian region an estimated 8% of grasslands and 10% of forest land converted to shrubland between 2000–2013.[56] However, the interplay between climate change and direct human pressures is complex; in general, direct human influences remain the most significant driver of ecosystem degradation locally.[57]

The Central Asia region is identified as a hotspot of potential dryland expansion under future climate change.[58] In some cases desertification may also be at risk but evidence from 2017 suggested Kyrgyz Republic contained the majority of the land immediately vulnerable to desertification.[59] The future of land and soil health in the Kyrgyz Republic will depend strongly on local land management and development practices, such as biomass burning and soil conservation,[60] but sustainability challenges are likely to be exacerbated by climate change. These changes, in combination with issues such as glacial melt and drought will likely result in significant shifts in species' viable ranges. Modelling is increasingly reinforcing the likely 'upslope' (movement to higher altitudes) and northwards shifts ranges and the resulting declines in viable ranges this will bring for many species in Central Asia.[61]

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[53] Zhou, Y., Zhang, L., Fensholt, R., Wang, K., Vitkovskaya, I., & Tian, F. (2015). Climate Contributions to Vegetation Variations in Central Asian Drylands. Remote Sensing, 7(3), 2449–2470. URL: https://www.mdpi.com/2072-4292/7/3/2449

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[61] Ashraf, U., Peterson, A. T., Chaudhry, M. N., Ashraf, I., Saqib, Z., Rashid Ahmad, S., & Ali, H. (2017). Ecological niche model comparison under different climate scenarios: a case study of Olea spp. in Asia. Ecosphere, 8(5), e01825. URL: https://kuscholarworks.ku.edu/bitstream/handle/1808/27356/Ashraf_2017.pdf?sequence=1&isAllowed=y

Economic Sectors

Agriculture

Despite its falling contribution to GDP the agricultural sector remains vital to community livelihoods and subsistence in the Kyrgyz Republic. According to the TNC, agriculture employs 60% of the rural population. Key crops include wheat, corn, barley, potatoes and cotton. The document also emphasizes aspects of the nation's food security. Notably, the Kyrgyz Republic has relied significantly on food imports since the turn of the 21st century, operating an annual food trade deficit of around $150 million between 2008–2013. In addition, the food and agriculture sector has suffered from significant damage from natural hazards. The Kyrgyz Republic's Third National Communication highlights at least $14 million in average annual agricultural losses to hazards between 1991–2011. These are almost entirely attributable to drought and water shortages, focused particularly on wheat.

Climate change will influence food production via direct and indirect effects on crop growth processes. Direct effects include alterations to carbon dioxide availability, precipitation and temperatures. Indirect effects include through impacts on water resource availability and seasonality, soil organic matter transformation, soil erosion, changes in pest and disease profiles, the arrival of invasive species, and decline in arable areas due to desertification. On an international level, these impacts are expected to damage key staple crop yields, even on lower emissions pathways. Tebaldi and Lobell (2018)[62] estimate 5% and 6% declines in global wheat and maize yields respectively even if the Paris Climate Agreement is met and warming is limited to 1.5°C. Shifts in the optimal and viable spatial ranges of certain crops are also inevitable, though the extent and speed of those shifts remains dependent on the emissions pathway. In the context of the Kyrgyz Republic's dependence on food imports these international trends are likely to present challenges to food security.

The overall outlook for crop production and agricultural livelihoods in the Kyrgyz Republic is mixed. Broadly, studies suggest a positive outlook in sub-humid environments (wetter areas), and a negative outlook in arid environments.[63] While higher carbon dioxide concentrations and warmer temperatures are expected to boost yields in key crops such as wheat, potential increases in the frequency of drought events and extreme heats could cancel out these gains.[64] One study has suggested that cotton yields could reduce towards the end of the 21st century, as well as becoming more volatile throughout.[65] Demand for irrigation is likely to grow significantly, potentially leading to water deficits,[66] for example for the production of cotton and winter wheat.[67]

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62 Tebaldi, C., & Lobell, D. (2018). Differences, or lack thereof, in wheat and maize yields under three low-warming scenarios. Environmental Research Letters: 13: 065001. URL: https://iopscience.iop.org/article/10.1088/1748-9326/aaba48

63 Bobojonov, I., & Aw-hassan, A. (2014). Impacts of climate change on farm income security in Central Asia: An integrated modeling approach. Agriculture, Ecosystems and Environment, 188, 245–255. URL: https://www.sciencedirect.com/science/article/pii/S0167880914001170

64 Sommer, R., Glazirina, M., Yuldashev, T., Otarov, A., Ibraeva, M., Martynova, L., . . . de Pauw, E. (2013). Impact of climate change on wheat productivity in Central Asia. Agriculture, Ecosystems & Environment, 178, 78–99. URL: https://www.sciencedirect.com/science/article/abs/pii/S0167880913002168

65 Bobojonov, I., & Aw-Hassan, A. (2014). Impacts of climate change on farm income security in Central Asia: An integrated modeling approach. Agriculture, Ecosystems & Environment, 188, 245–255. URL: https://www.sciencedirect.com/science/article/pii/S0167880914001170

66 Nikanorova, A.D., Milanova, E.V., Dronin, N.M. and Telnova, N.O. (2016). Estimation of Water Deficit under Climate Change and Irrigation Conditions in the Fergana Valley of Central Asia. Arid Ecosystems, 6(4), pp.260–267.URL: https://link.springer.com/article/10.1134/S2079096116040053

67 Tian, J., & Zhang, Y. (2020). Detecting changes in irrigation water requirement in Central Asia under CO2 fertilization and land use changes. Journal of Hydrology, 583, 124315. URL: https://www.sciencedirect.com/science/article/abs/pii/S0022169419310509

In order to maximize yields farmers will require 'climate-smart' infrastructure and technologies. Without intervention these resources are likely to be available only to wealthier farmers. Notably, access to credit and necessary agricultural inputs represent major barriers to adoption of adaptation technologies.[68] Reflecting the country's proportionately lower wealth levels, uptake of climate-smart technologies in the Kyrgyz Republic is currently believed to be very significantly lower than in other Central Asian nations.[56] Studies also suggest there remains a significant yield gap in the region.[69] This means that there may still be scope to increase agricultural production, or at least offset climate losses, through improvements in practices, technologies and crop choices.

As of 2016 an estimated 48% of value added in the agricultural sector derived from livestock farming[70] and the industry remains significant in its contribution to GDP, employment, and subsistence. The livestock industry can both be susceptible to climate risk, and drive climate risk and both of these processes are in need of further research.[71] Poorly managed pastoral land, where soils and ecosystems are allowed to degrade, can compound climate risks such as flooding, drought, and biodiversity loss. At the same time, climate changes can impact both on the net primary productivity (NPP) of the land which feeds livestock, and in some cases on the physical health of the animals themselves, particularly through hazards such as droughts, but also through second-order impacts such as increased prevalence of disease.[72]

A recent study looks at the NPP of the Kyrgyz Republic's grasslands.[73] This study shows that climate changes have been negatively impacting the NPP of grasslands across the majority (96%) of the country's land surface area. This is primarily linked to shifts in precipitation patterns and as a result, different trends have been seen in other parts of Central Asia and significant uncertainty about future changes remains.[74] In contrast, the impact of livestock grazing practices reduced over the assessment period (2000–2014) as a result of improved enforcement of environmental protection policies over most of the country — with the exception of the northwestern region where livestock grazing has compounded the negative climate impact on NPP. With both slow and rapid-onset climate risks threatening communities dependent on pastoral livelihoods attention has turned to adaptation options. Research has shown the benefits of supporting communities with knowledge building activities, access to technologies, diversified income streams, and devolving decision-making power in building adaptive capacity in remote communities.[75]

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[75] Ashley, L., Zhumanova, M., Isaeva, A., & Dear, C. (2016). Examining changes in local adaptive capacity resulting from climate change adaptation programming in rural Kyrgyzstan. Climate and Development, 8(3), 281–287. URL: https://www.tandfonline.com/doi/abs/10.1080/17565529.2015.1034230

Urban and Energy

Research has established a reasonably well constrained relationship between temperature stress and labor productivity, household consumption patterns, and (by proxy) household living standards.[76] In general terms, the impact of an increase in temperature on these indicators depends on whether the temperature rise moves the ambient temperature closer to, or further away from, the optimum temperature range. The optimum range can vary depending on local conditions and adaptations. Sub-optimal temperatures typically lead either to increased energy usage for heating and cooling, or to adverse health outcomes.

On a national level, the net optimality of temperatures for human life in the Kyrgyz Republic is projected to improve under all emissions pathways. This is expressed in heating and cooling 'degree days' (i.e. the cumulative number of degrees spent each day above or below the optimal temperature). On average the Kyrgyz Republic will see a large reduction in the number of days in which heating is required, and small increase in the number of days during which cooling is required. It is possible that this trend will reduce the pressure on energy systems typically seen during winters in the Kyrgyz Republic.[77] Energy systems in the Kyrgyz Republic are already under pressure, with energy consumption higher than its neighbors, and growing rapidly. Residential energy consumption grew by 58% between 2007–2016.[78]

Research suggests that on average a one degree increase in ambient temperature can result in a 0.5–8.5% change in electricity demand.[79] Notably this affects the strain on business and residential air heating and cooling systems. During hotter periods an increase in demand places strain on energy generation systems which can be compounded by the heat stress on the energy generation system itself. This can reduce system efficiency.[80]

Climate change may lead to other pressures on the energy generation systems in the Kyrgyz Republic. The majority of energy generated and supplied to the grid is sourced from hydropower. As a result of the likely long-term decline in water resources in the Kyrgyz Republic due to glacier melting, the productivity of hydropower may eventually decline.[81] In the immediate future Kyrgyz Republic faces increasing challenges balancing water demands from energy and irrigation, and from neighboring countries. These may be exacerbated by less consistent and/or more extreme runoff, and a better understanding of the regional hydrological system will be essential to ensure power generation needs are met,[9] but also to ensure that environmental flows and associated ecosystem services are not lost.

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[81] Reyer, C. P. O., Otto, I. M., Adams, S., Albrecht, T., Baarsch, F., Cartsburg, M., . . . Stagl, J. (2017). Climate change impacts in Central Asia and their implications for development. Regional Environmental Change, 17(6), 1639–1650. URL: https://research.vu.nl/en/publications/climate-change-impacts-in-central-asia-and-their-implications-for

National projections are strongly influenced by changes in conditions in the mountainous regions and may hide potential extreme temperature highs in lowland areas. Further study is required to understand the impact of temperature changes on productivity on a more localized scale and particularly in urban areas. The effects of temperature rise and heat stress in urban areas are increasingly compounded by the phenomenon of Urban Heat Island (UHI). Dark surfaces, residential and industrial sources of heat, an absence of vegetation, and air pollution[82] can push temperatures higher than those of the rural surroundings, commonly anywhere in the range of 0.1–3°C in global mega-cities.[83] While study of UHI in the Kyrgyz Republic is limited, recent research has documented the rapid expansion of impervious surfaces in urban areas in the country, with the impervious surface area expanding by 35%, 75%, and 15% in Bishkek, Osh, and Jalal-Abad respectively between 1993 and 2017.[84] Wider research closely connects impervious surface area to UHI effect[85] suggesting it is likely to grow in relevance in the Kyrgyz Republic over coming years, and particularly during climate-driven periods of extreme heat. As well as impacting on human health (see Communities) the temperature peaks that will result from combined UHI and climate change, as well as future urban expansion, may damage the productivity of the service sector economy, both through direct impacts on labor productivity, but also through the additional costs of adaptation. The poor energy performance of buildings in the Kyrgyz Republic has been identified as a vulnerability (and potential adaptation) which requires significant investment.[63] A challenge is likely to present in ensuring that the poorest households are able to overcome the significant capital investments which are often required to improve building standards. There is also a need to support and encourage households to switch to cleaner energy sources.[86]

Communities

Poverty, Inequality, and Vulnerability to Climate-Related Disaster

Many of the climate changes projected are likely to disproportionately affect the poorest groups in society. Poorer businesses are least able to afford space heating and cooling or building energy efficiency improvements. Poorer farmers and communities are least able to afford local water storage, irrigation infrastructure, and technologies for adaptation. In the Kyrgyz Republic there is evidence that women and poorer rural dwellers are most likely to be affected by flash flooding and landslide as they spend proportionately more time in exposed residential and a subsistence production area.[25] Historical evidence suggests a climate-driven increase in the impact of floods and landslides could contribute to rural-urban migration.[61]

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82 Cao, C., Lee, X., Liu, S., Schultz, N., Xiao, W., Zhang, M., & Zhao, L. (2016). Urban heat islands in China enhanced by haze pollution. Nature Communications, 7, 1–7. URL: https://www.nature.com/articles/ncomms12509

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84 Omurakunova, G., Bao, A., Xu, W., Duulatov, E., Jiang, L., Cai, P., Abdullaev, F., Nzabarinda, V., Durdiev, K., & Baiseitova, M. (2020). Expansion of Impervious Surfaces and Their Driving Forces in Highly Urbanized Cities in Kyrgyzstan. International Journal of Environmental Research and Public Health, 17(1). URL: https://www.mdpi.com/1660-4601/17/1/362/htm

85 Li, D., Liao, W., Rigden, A. J., Liu, X., Wang, D., Malyshev, S., & Shevliakova, E. (2019). Urban heat island: Aerodynamics or imperviousness? Science Advances, 5(4). URL: https://advances.sciencemag.org/content/5/4/eaau4299

86 Sabyrbekov, R. and Ukueva, N. (2019). Transitions from dirty to clean energy in low-income countries: insights from Kyrgyzstan. Central Asian Survey, 38(2), pp.255–274. URL: https://www.tandfonline.com/doi/abs/10.1080/02634937.2019.1605976?scroll=top&needAccess=true&journalCode=ccas20

Increases in the intensity and frequency of drought stand out as some of the most significant risks associated with climate change. There is strong evidence that these risks could disproportionately impact the poorest groups in the Kyrgyz Republic. At present, the poorest quintile is estimated to be more than twice as likely to be exposed to droughts in comparison with other groups.[87] This population group typically works in, or relies on, the rural agricultural sector for livelihood or subsistence, where drought impacts are projected to be severe.

Gender

An increasing body of research has shown that climate-related disasters have impacted human populations in many areas including agricultural production, food security, water management and public health. The level of impacts and coping strategies of populations depends heavily on their socio-economic status, socio-cultural norms, access to resources, poverty as well as gender. Research has also provided more evidence that the effects are not gender neutral, as women and children are among the highest risk groups. Key factors that account for the differences between women's and men's vulnerability to climate change risks include: gender-based differences in time use; access to assets and credit, treatment by formal institutions, which can constrain women's opportunities, limited access to policy discussions and decision making, and a lack of sex-disaggregated data for policy change.[88]

Human Health

Nutrition

The World Food Programme (2015)[89] estimate that without adaptation the risk of hunger and child malnutrition on a global scale could increase by 20% respectively by 2050. Springmann et al. (2016) assessed the potential for excess, climate-related deaths associated with malnutrition. Two key risk factors are expected to be the primary drivers: a lack of fruit and vegetables in diets and health complications caused by increasing prevalence of people underweight. There could be approximately 50.1 climate-related deaths per million population linked to lack of food availability in the Kyrgyz Republic by the year 2050 under RCP8.5. The World Health Organization estimated future stunting of growth in children under five years of age attributable to climate change through loss of nutrition in the Central Asian Region (for detailed assumptions of the study follow reference).[90] The ensemble mean projection under the base case scenario was a 1.2% increase in moderate stunting and 0.8% in severe stunting by 2030.

Heat-Related Mortality

Research has placed a threshold of 35°C (wet bulb ambient air temperature) on the human body's ability to regulate temperature, beyond which even a very short period of exposure can present risk of serious ill-health and death.[91] Temperatures significantly lower than the 35°C threshold of 'survivability' can still represent a major threat to human health. Climate change could push global temperatures closer to this temperature 'danger zone' both through slow-onset warming and intensified heat waves.

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Honda et al. (2014) utilized the A1B emissions scenario from CMIP3 (most comparable to RCP6.0) to estimate that without adaptation, annual heat-related deaths in the Central Asian region, could increase by 139% by 2030 and by 301% by 2050.[92] The aforementioned study by the World Health Organization[69] also estimated future heat-related mortality attributable to climate change in the Central Asian Region. This study assumes population growth based on the UN's 2010 revised projections.[93] An ensemble mean estimate of 1,752 excess deaths was projected for the year 2030, and 4,886 for the year 2050 for the region. The potential reduction in heat-related deaths achievable by pursuing lower emissions pathways is significant, as demonstrated by Mitchell et al. (2018).[94]

Disease

The aforementioned study by the World Health Organization[69] explored changes in the incidence of a number of key diseases under future climate changes in the Central Asian Region. Notably, an 11% rise in the number of deaths due to diarrhoeal disease in children under 15 was projected by 2030 and attributed to climate change, and a 16% rise by 2050 in the region. Two known interactions are likely to drive transmission of diarrhoeal disease, increasing temperatures and increases in flooding frequency and extent.[95] One study, albeit based on outdated climate modelling, has suggested that climate change could also drive increased prevalence of circulatory diseases.[96] Further research is required to better understand the potential changes to disease incidence in the Kyrgyz Republic.

POLICIES AND PROGRAMS

National Adaptation Policies and Strategies

TABLE 6. Key national adaptation policies, plans and agreements

Policy/Strategy/Plan	Status	Document Access
National Communications to the UNFCCC	Three submitted	Latest: January, 2017
National Strategy for Comprehensive Safety of Population and Territories of the Kyrgyz Republic from Disasters and Emergencies: 2012–2020	Enacted	2011
National Strategy and Climate Change Adaptation Plan	In development	
Nationally Determined Contribution (NDC) to Paris Climate Agreement	Two Submitted	2020 (Russian) 2015

[92] Honda, Y., Kondo, M., McGregor, G., Kim, H., Guo, Y-L, Hijioka, Y., Yoshikawa, M., Oka, K., Takano, S., Hales, S., Sari Kovats, R. (2014). Heat-related mortality risk model for climate change impact projection. Environmental Health and Preventive Medicine 19: 56–63. URL: https://pubmed.ncbi.nlm.nih.gov/23928946/

[93] UN (2011). World Population Prospects: the 2010 revision. New York: United Nations. URL: https://www.un.org/en/development/desa/publications/world-population-prospects-the-2010-revision.html

[94] Mitchell, D., Heaviside, C., Schaller, N., Allen, M., Ebi, K. L., Fischer, E. M., . . . Vardoulakis, S. (2018). Extreme heat-related mortality avoided under Paris Agreement goals. Nature Climate Change, 8(7), 551–553. URL: https://doi.org/10.1038/s41558-018-0210-1

[95] Levy, K., Woster, A. P., Goldstein, R. S., & Carlton, E. J. (2016). Untangling the Impacts of Climate Change on Waterborne Diseases: a Systematic Review of Relationships between Diarrheal Diseases and Temperature, Rainfall, Flooding, and Drought. Environmental Science & Technology, 50(10), 4905–4922. URL: https://pubmed.ncbi.nlm.nih.gov/27058059/

[96] Sharshenova, A. and Arzygulova, K. (2009). Assessment of Morbidity of the Population of the Kyrgyz Republic Under Climate Change Scenarios. Epidemiology, 20(6), p.S52. URL: https://journals.lww.com/epidem/fulltext/2009/11001/Assessment_of_Morbidity_of_the_Population_of_the.123.aspx

Climate Change Priorities of ADB and the WBG

ADB – Country Partnership Strategy

ADB has agreed a Country Partnership Strategy (CPS) with the Kyrgyz Republic which spans the period 2018–2022. Climate change is a cross-cutting theme of the CPS but feature most prominently under the second of three engagement pillars 'Improve access to public and social services. Specifically, the CPS states that ADB assistance to the Kyrgyz Republic on climate change and disaster risk resilience will focus on water resources. Efforts will combine structural interventions with capacity development, incorporating a systems or basin approach that addresses (i) upstream sources of risks such as those arising from mudflows and landslides, and (ii) downstream outcomes on irrigation systems. The program will incorporate community-driven development approaches targeting vulnerable and poorer regions, and enhance the representation of women in water user associations. ADB will modernize flood control infrastructure in arable lands, improve agricultural productivity and land management practice, and enhance disaster-related data collection and analysis. Mainstreaming environmental principles in the national development agenda through green industry promotion, sustainable infrastructure development, and low-carbon development will be considered.[97]

WBG – Country Partnership Framework

The World Bank Group has agreed a Country Partnership Framework (CPF) with the Kyrgyz Republic for FY2019-FY2022. Climate change issues are a cross-cutting theme of the CPF but feature most prominently under the second focus area which aims to 'enhance economic opportunities and resilience'. The CPF places high priority on strengthening resilience by focusing on the twin action agenda: namely, promoting sustainable management and use of natural resources; and improving the management and mitigation of natural risks and disasters. Key, ongoing activities include the heat supply improvement project which is increasing the efficiency of heating services through support for the rehabilitation of district heating in Bishkek, and the modernization of its combined heat and power plant, installation of smart heat and hot water meters. Additionally, the ongoing Electricity Supply Accountability and Reliability Improvement Project will also contribute to this objective by reducing network losses. To support the Kyrgyz Republic's efforts to respond and reduce to disaster risk reduction, the CPF program will help authorities improve disaster risk information and promote risk-informed policy-making. This includes a systematic and programmatic implementation of disaster risk reduction initiatives in key sectors as well as enhancing disaster preparedness and response capacities. Early warning systems for disaster risk are also being strengthened, particularly for mountain hazards. A major focus will lie in increasing the capacity of the government to absorb fiscal, financial, and economic shocks.[98]

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[97] ADB (2018). Kyrgyz Republic, 2018–2022 – Supporting Sustainable Growth, Inclusion, and Regional Cooperation. URL: https://www.adb.org/sites/default/files/institutional-document/455921/cps-kgz-2018-2022.pdf

[98] WBG (2018). FY19-FY22 Country Partnership Framework for the Kyrgyz Republic. URL: http://documents1.worldbank.org/curated/en/358791542423680772/pdf/kyrgyz-cpf-fy19-22-oct102018-10122018-636780024730768882.pdf

CLIMATE RISK COUNTRY PROFILE

KYRGYZ REPUBLIC

WORLD BANK GROUP

ADB ASIAN DEVELOPMENT BANK