Kyrgyz Republic - Climate Change and Disaster Risk Profile

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Author: Olga Chepelianskaia, Climate Change Consultant to ESCAP

1. The Kyrgyz Republic – country overview

The Kyrgyz Republic is a land-locked, lower-middle-income country with a population of approximately 6.5 million (World Food Program, 2020). Bishkek (the capital) and Osh are the major cities of the country. According to the National Statistics Committee, nearly 66% of the country's population lives in rural areas and almost 1/4 of the population live below the poverty line. In 2019, worker remittances contributed to 28% of the country's GDP and the single gold mine of Kumtor accounted for 8% of it. A widespread of small-scale family-based farms coupled with land degradation makes the agricultural sector rather inefficient (International Trade Administration, 2020). As a result, the country faces moderate to severe food insecurity touching nearly 24% of the total population and a high dependence on imports of basic food items (World Food Program, 2020).

Nearly 94% of the country is located at over 1,000 meters above the sea level and 40% of it is above 3,000 meters. The Kyrgyz Republic is highly susceptible to natural hazards such as mudslides, landslides, avalanches and earthquakes. Damages and losses from climate - related natural disasters cost the country nearly USD 6.7 million per year between 2000 and 2011 (UNDP, 2013). The World Bank assessment estimates that natural disasters and climate change stressors will impact environmental, social and economic sectors and cause an annual GDP loss of 0.5% to 1.3% (World Bank, 2019).

Figure 1: Map of the Kyrgyz Republic
Source: https://geology.com/

2. Present and future climate change trends

Overview

GermanWatch's annual Climate Risk Index ranks the Kyrgyz Republic as 52nd in terms of climate change impact and vulnerability (Eckstein, 2018) and UNDP rates the country as the 3rd most vulnerable to climate change impacts in Central Asia (UNDP, 2013). A steady increase in air temperature leads to the **country's glacier melt** which, in turn, generates an increase in river runoff in near future and is likely to produce a water availability decline in the long run, which may heavily impact the agricultural sector and hydroelectric generation (OECD, 2019).

The Kyrgyz Republic is located in the high-altitude mountainous region. As highlighted in the Third National Communication, the country lies across 4 major physical and climatic zones by altitude above the sea level:

- **Plain and Submontane Belt** (valleys and foothills) - up to 1,200 m above sea level –hot summers and very low precipitation throughout the year;
- **Medium Altitude Belt** (midland) - from 1,200 to 2,200 m above sea level - a mainly arid climate with warm summers and cold winters;
- **High Mountain Belt** (alpine) - from 2,200 to 3,500 m above sea level - cooler summers and cold snowy winters;
- **Nival Belt** (permanent snow) - higher than 3,500 m above sea level – a harsh polar climate with snowfields and glaciers.

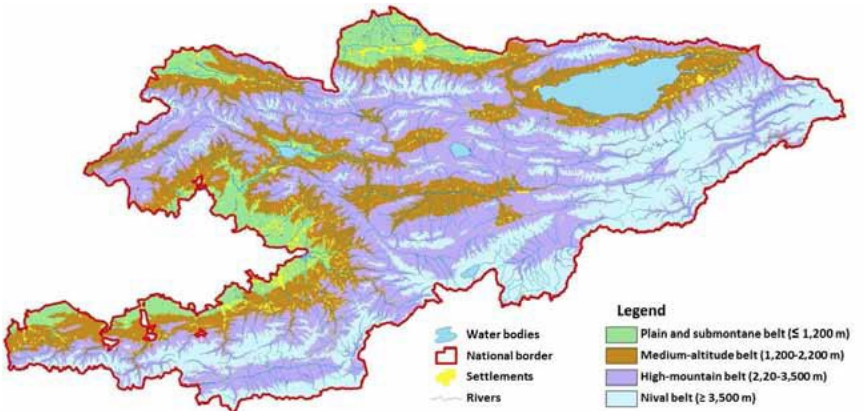

Figure 2: The Kyrgyz Republic physical and climatic zones by altitude above sea level
Source: Third National Communication of the Kyrgyz Republic, 2017

The country experiences a sharp continental climate with cold winters and hot summers. While its high altitude areas, particularly above 2,000 meters**, receive heavy rainfall**, its Central and Eastern regions are **highly drought-prone**. The country also experiences sandstorms due to the strong desert winds from neighbouring countries such as Kazakhstan and Uzbekistan (ADB, 2016). These climatic conditions make the Kyrgyz Republic highly vulnerable to shocks associated with climate change, which include both rapid onset (such as landslides, mudslides and mudflows) and slow onset (such as reduced glacial melt) events.

Historical climate trends

Historical climate observations for the climatological normal period of 1961 - 1990 show an increase in the near-surface annual average temperature trend of 0.18°C per decade. Over a more recent historical climate period of 1991 - 2016, this increase has reached 0.45°C per decade

(Harris, 2020). Such an **acceleration in the temperature increase produces impactful negative consequences for the country.** For example, as per a UNDP assessment, this increase caused 1/3 of the glacial area across the Central Asian region to disappear between 1930 and 2000.

The total annual precipitation in the country shows a slight increase of 4.6mm per decade for the climatological normal period of 1961 - 1990, and 9.3mm per decade for a more recent climate period of 1991 - 2016 (Harris, 2020).

Future climate trends

Summary

Under the median range of simulations for RCP 4.5 and RCP 8.5, future climate projections demonstrate:

- A warming trend across the country with an **annual average temperature rise of 2.0 - 2.5°C** by mid-century in comparison with a reference period of 1986 - 2005. This increases the risks of heatwaves, glacial melting and drought in the country;
- A **1.6 – 2.6mm increase in monthly precipitation** by 2040 - 2059, mainly in winter and spring. This *increases the risks of floods, landslides, mudslides and mudflows, especially in the mountainous regions*. A projected decrease in precipitation during the summer season, on the other hand, may lead to droughts.

Methodology

Climate Change Knowledge Portal (CCKP) data

The analysis utilises climate anomalies data from the World Bank's Climate Change Knowledge Portal (CCKP) unless otherwise indicated. Climate change projected anomaly in selected climate variables and indicators for an **intermediate future period from 2040 to 2059** in comparison with a reference period of **1986 to 2005** has been selected as optimal for this analysis because it provides a remote enough perspective while remaining within a reasonable policy planning timeframe. CCKP's projections were developed utilising an ensemble of 16 to 27 General Circulation Models (GCMs)[1], constituted under the Coupled Model Intercomparison Project, Phase 5 (CMIP5), in accordance with the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5).

Representative concentration pathways **RCP 4.5 (moderate scenario) and RCP 8.5 (business as usual scenario)** have been selected to present a range of possible variations likely to affect the country depending on how future international climate change mitigation efforts could evolve.

The **50th percentile**, or the middle - temperature value in the range of all projected temperatures in the GCMs' ensemble, is used for the analysis to present a moderate and a most likely (as per the climate models) future scenario. However, the projected climate data table (Table 1) includes the 90th percentile data, or the GCM ensemble extremes, to showcase the maximum possible extremes anticipated for the country.

While projections from the CCKP source help identify most likely climate change trends, they also present **a number of limitations**:

- The reference period used by the CCKP data source is 1986 to 2005, which means that, as of today, the anomaly could be slightly lower;
- Model biases reveal particularly strong for mountainous countries. The country analysis hence does not indicate absolute values but presents only variations of selected climate change variables and indices;
- The low resolution of GCMs (1 degree or about 100 km) produces uncertainties in precipitation due to the country's complex topography;
- CCKP does not segregate data by regions. The USAID Climate Smart Agriculture Profile (2018) was identified as the most recent source of regional climate projections and is quoted here for a basic understanding of regional climate vulnerabilities.

Comparison with CMIP 6 data

It is of high interest to compare the results of CMIP5 climate models with the most recent Phase 6 generation of GCMs: the **CMIP6**. The latter utilises Shared Socioeconomic Pathways (SSP) instead of RCP, which includes socio-economic factors such as population, education, urbanization, economic growth and the rate of technological development.

- Scenario **SSP126** (optimistic) presupposes success in limiting global warming to below 2°C by 2100 compared to the pre-industrial levels;
- Scenario **SSP245** (median) is associated with the population growth stabilization by the end of the century and reduced energy intensity;
- Finally, **SSP585** (pessimistic) is characterized by a rapid growth of the global economy and an increased use of fossil fuels, while significant investments are made into health, education, social and human capital, technological progress as a part to the sustainable development, and management of local environmental issues (Riahi K, 2017).

Considering the availability of a very recent report Assessment of Climate Change in the Kyrgyz Republic prepared in the frame of an IFAD project (Kretova, 2020), a few key variations from a GCM ensemble of 10 climate models under CMIP6 have been indicated for the near future period of **2021 - 2050** compared to the reference period of **1981 – 2010**.

Regional data: Climate Smart Agriculture profile (World Bank, 2018)

Climate data from CCKP analyses climate at the national scale. It is however of high importance to consider the climate data and future changes in temperature and precipitation at a regional scale. Basic regional changes are hence reflected based on the Climate Smart Agriculture profile (World Bank, 2018). In this profile, GCMs climate projections were analysed by 2050 based on a reference period of 1960 - 2010.

Selected climate variables and indices

The following climate variables and indices have been considered as most relevant for the three infrastructure sectors considered under the present profile:

- Annual average temperature (Tas);
- Average annual maximum of daily maximum temperature (TXx);
- Average annual minimum of daily minimum temperature (TNn);
- Number of summer days (Tmax > 25°C);
- Number of hot days (Tmax > 35°C);
- Annual average precipitation (Pr);
- A number of days with rainfall > 20mm.

High variations of these variables and indices may negatively affect the energy, ICT and transport infrastructure and increase the frequency and intensity of natural hazards such as landslides, mudflows, glacial melting or heatwaves, which may further affect these sectors.

Climate variables and indices	RCP 4.5	RCP 4.5	RCP 8.5	RCP 8.5
	50th percentile	90th percentile	50th percentile	90th percentile
Temperature (°C)				
Tas annual anomaly	2	3.3	2.5	4.1
TXx annual anomaly	2.4	5.5	2.8	6.5
TNn annual anomaly	2	6.7	2.9	7.2
Number of Summer Days (Tmax > 25°C)	17	35	22	43
Number of Hot Days (Tmax > 35°C)	2	7	3	10
Precipitation (mm)				
Average monthly precipitation	1.6	14.2	2.6	16.2
Number of Days with Rainfall > 20mm	0	2	0	2

Table 1: Change in climate variables and indices for the period 2040 - 2059
Source: World Bank Climate Change Knowledge Portal (2021)

Analysis of climate variables and indices

Average annual temperature (Tas)

Under the 50th percentile, the CMIP5 climate projections from CCKP for the selected intermediate future period of 2040-2059 (reference period of 1986 - 2005) anticipate a Tas increase of 2°C under a moderate RCP 4.5 emissions scenario and an up to 2.5°C increase under a business-as-usual scenario RCP 8.5. Under the 90th percentile, this increase goes further up to 3.3°C (RCP 4.5) and to 4.1 (RCP 8.5).

The CMIP6 GCM ensemble's projections for the period of 2021 - 2050 indicate an increase by 1.5 - 1.9°C (SSP126 – SSP585) based on the reference period 1981 - 2010. The maximum increase is expected in summer by 1.7 to 2.2°C (Kretova, 2020). While these projections cannot be directly compared to the CCKP projections due to the difference in the future and reference periods, the **CMIP6 anomaly confirms the increasing trend and indicates that the average annual temperature hides an increased peak over the summer period**, which can lead to a stronger negative impact on the infrastructure.

Finally, the World Bank's Climate Smart Agriculture profile (2018) anticipates the **daily maximum and minimum fluctuations likely to be more severe than the annual average values**. On the other hand, the projected **Tas increase does not showcase a significant regional difference**: anticipated variations range from 2.6°C in the Issyk-Kul region to 2.9°C in the Batken region.

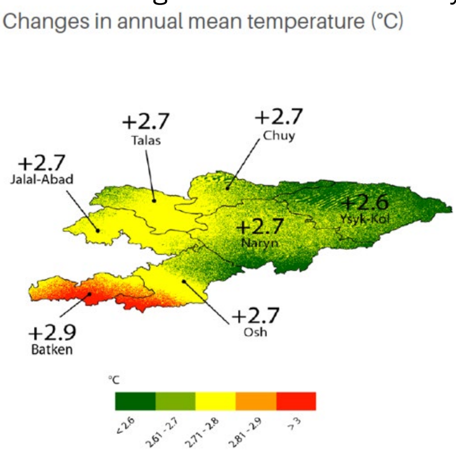

Figure 3: Projected changes in annual mean temperature of the Kyrgyz Republic by 2050
Source: World Bank, Climate Smart Agriculture profile, 2018

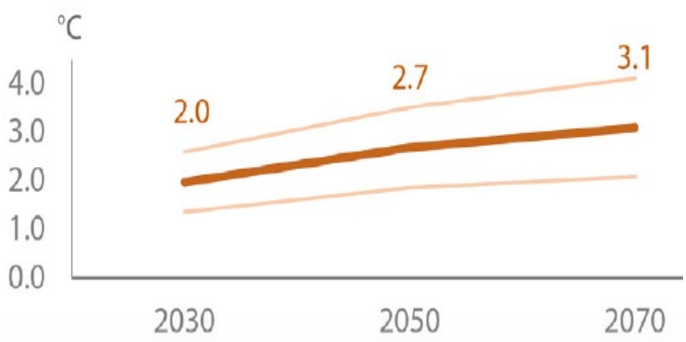

Figure 4: Projected average temperature change in the country
Source: World Bank, Climate Smart Agriculture profile, 2018

The above Tas trends may affect the energy sector (e.g. availability of water resources for hydroelectricity generation) and ICT sector (e.g. reduces signal range and quality of wireless transmissions).

Average annual maximum of daily maximum temperature (TXx)

Physical infrastructure sectors are most vulnerable to high temperature peaks and variations over a short time span. TXx is hence an important indicator. In the Kyrgyz Republic, TXx mostly occurs in July. Climate projections based on the annual TXx projections by 27 GCMs for the period 2040 – 2059 show an increase of 2.4°C (50th percentile) to 5.5°C (90th percentile) under RCP 4.5 and 2.8°C (50th percentile) to 6.5°C (90th percentile) under RCP 8.5. **This increase in TXx, especially for the 90th percentile, will most likely affect the three considered sectors.**

An increase in TXx may affect the energy sector (e.g. rapid loss of glacial ice increases the long-term risk of water availability for hydropower generation), the ICT (e.g. high temperatures decrease performance and conductivity of underground cables) and the transport sectors (e.g. high temperatures contribute to thermal expansion of bridge joints and of the pavement surface).

Average annual minimum of daily minimum temperature (TNn)

The average annual minimum of daily minimum temperature (TNn) represents the minimum temperature extreme. Climate projections based on the 27 GCMs simulations for the period 2040 – 2059 for annual TNn show an increase of 2.0°C (50th percentile) to 6.7°C (90th percentile) under RCP 4.5 and 2.9°C (50th percentile) to 7.2°C (90th percentile) under RCP 8.5. **An increase in the minimum temperature extreme is even more pronounced than for the average and maximum temperatures.**

An increase in minimum temperature may influence the transport sector in temperature in very cold areas since it can cause road subsidence and weaken bridge support due to permafrost thawing.

Number of summer days

The number of summer days is the temperature index that indicates the annual number of days with a minimum temperature of over 25°C. The 27 GCMs ensemble shows an increase in summer days of 17 days (50th percentile) to 35 days (90th percentile) under RCP4.5 and of 22 days (50th percentile) to 43 days (90th percentile) under RCP8.5. **Such an increase in summer days is significant, especially for the Southern regions with a semi - arid and arid climates.**

Coming to seasonal anomalies, July and August would see a 6 to 7 days increase while June and September would see a 3 to 4 days increase under the 50th percentile. Under the 90th percentile, July and August would reach 12 to 13 additional days a month whereas June and September about 8 additional days (World Bank Climate Change Knowledge Portal, 2021).

An increase in summer days is likely to affect the energy sector through a reduced water availability for hydropower generation in summer.

Number of hot days

The number of hot days is the temperature index that indicates the annual number of days with a maximum temperature of over 35°C. The 27 GCMs ensemble assessment anticipates an increase of 2 days (50th percentile) to 7 days (90th percentile) under RCP 4.5 and of 3 days (50th percentile) to 10 days (90th percentile) under RCP8.5.

Under RCP 4.5, the 50th percentile shows a 0.5 to 1-day increase in July and August, and the 90th percentile shows 3 additional days a month in July and August. Under RCP 8.5 the 50th percentile shows one additional day in July and August, and the 90th percentile shows 3.5 to 4 additional days in July and August (World Bank Climate Change Knowledge Portal, 2021).

An increase in the number of hot days is a major cause of natural hazards such as droughts or heatwaves. The anticipated anomaly is particularly significant for the Southern part of the country (e.g. the Batken and Osh regions). It may affect the energy (e.g. influence the generation capacity of a hydroelectric dam), ICT (e.g. overheating of mobile towers) and transport (e.g. rapid deterioration of road asphalt due to prolonged exposure to heat; expansion of railway track joints) sectors.

Average monthly precipitation (Pr)

The 16 GCMs ensemble shows an increase in average monthly precipitation (Pr) in the future period of 2040 – 2059 in comparison with the reference period of 1986 – 2005 by 1.6mm (50th percentile) to 14.2mm (90th percentile) under RCP 4.5 and by 2.6mm (50th percentile) to 16.2mm (90th percentile). In general, the GCMs show a precipitation increase in winter and spring and a decrease in summer.

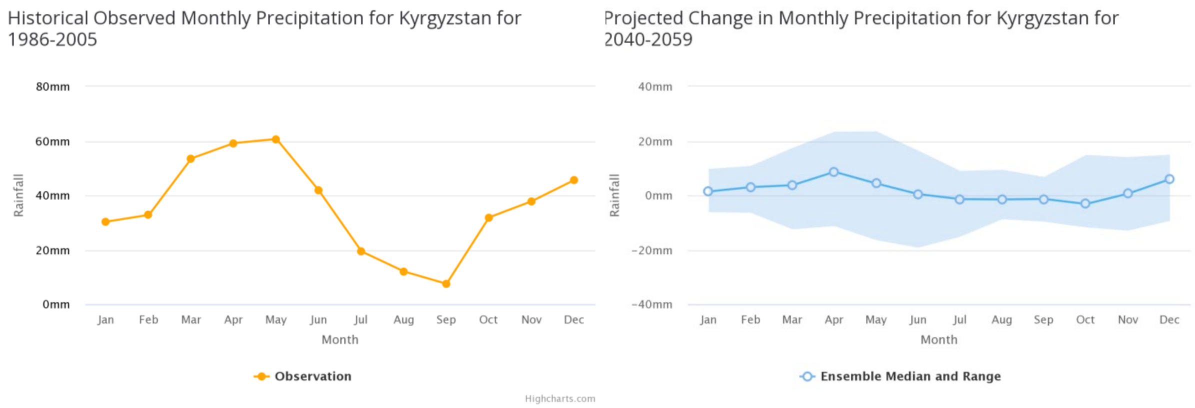

Figure 5: Historical monthly precipitation (left) for the Kyrgyz Republic and precipitation change (right) for the period 2040 – 2059 under RCP 4.5
Source: World Bank Climate Change Knowledge Portal, 2021

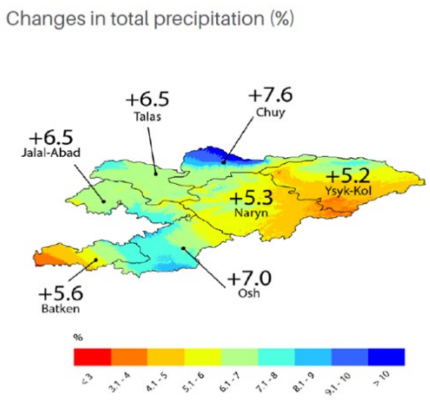

Figure 6: Projected change in precipitation in the Kyrgyz Republic by 2050
Source: World Bank profile for Climate Smart Agriculture for the Kyrgyz Republic, 2018

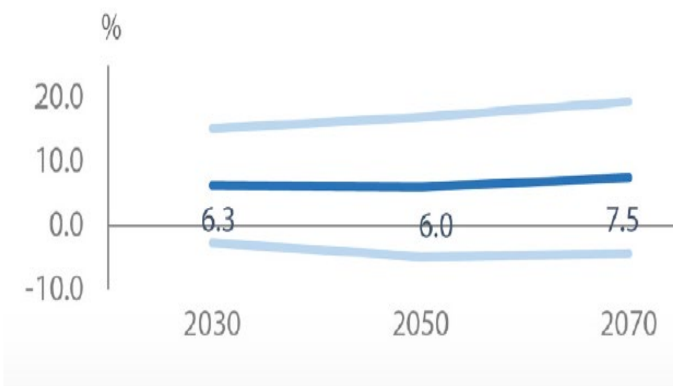

Figure 7: Projected average precipitation change in the count
Source: World Bank profile for Climate Smart Agriculture for the Kyrgyz Republic, 2018

The CMIP6 projections of the annual precipitation for the period of 2021 - 2050 indicate an increase of 5 - 5.7% (SSP126 - SSP585) based on the reference period 1981 - 2010. The **maximum**

increase is expected in winter (by 9.4 - 12.9%) and no significant change in summer (1.9 – 3.4%) (Kretova, 2020). These findings are consistent with projections obtained under CCKP.

Finally, the World Bank's Climate Smart Agriculture profile (2018) anticipates that the annual total precipitation over the Kyrgyz Republic is likely to increase across the country till the mid-century under the RCP 4.5 pathway and is likely to mostly impact the Chuy, Osh and Jalal-Abad regions (Figure 6).

A precipitation decrease in summer affects water availability, which is important for the energy sector in the Kyrgyz Republic. An increase in winter and spring, where the maximum of precipitation takes place during the historical period, is likely to affect transport and ICT sectors through floods, mudflows and landslides, especially in the Southern regions that are vulnerable to such hazards.

Number of very heavy precipitation days

The number of very heavy precipitation days is a climate index that indicates the annual number of days with a daily rainfall of over 20mm. The 27 GCMs ensemble does not show significant changes – 0.1 days (50th percentile) under RCP 4.5 and 0.2 days (50th percentile) under RCP 8.5. However, up to 2 additional consecutive days are projected under RCP 8.5 for the 90th percentile, which could contribute to creating flash floods, mudflows and landslides (World Bank Climate Change Knowledge Portal, 2021).

An increase in this index can impact the energy, ICT and transport sectors through mudflows and floods (i.e. extreme events may damage dams, turbines and generators; floods may submerge cables in tunnels and potentially cause cable damage).

3. Present and future vulnerability to climate change related natural hazards

Climate change impacts identified above are likely to trigger an increased frequency and intensity of natural hazards and exacerbate existing vulnerabilities across all socio-economic sectors in the Kyrgyz Republic. The risk of disasters such as landslides, mudflows and floods will increase the most as a result of rapid glacial melting resulting from a temperature rise as well as an increase in winter and spring precipitation. The increase in the number of hot days and heat waves will, on the other hand, increase the risk of droughts in the country with the water scarcity risk bein considered as medium by ThinkHazard.

Methodology

ThinkHazard is a tool providing an overview of natural hazards affecting a given location. It uses the best available datasets from published public reports as well as from private, academic and governmental institutions. Regional level data is used over global data when available. Natural disasters affecting the study area are classified as very low, low, medium and high based on assessed hazard intensity threshold, hazard frequency threshold, susceptibility (considering trigger factors of a hazard occasion) as well as considering which damages may occur as a result of the examined hazards. The portal also provides guidance on how to diminish the impact of these disasters, and where to find additional information (ThinkHazard, 2020).

In comparison, multi-hazard risk analysis based on the Average Annualised Loss (AAL) risk metric considers mainly social and economic risk (ESCAP, 2020).

The present report utilizes data from the ThinkHazard portal, unless otherwise indicated, in order to **take into consideration natural hazard intensity, frequency and susceptibility under climate change**, which are most likely to affect the energy, transport and ICT sectors in the country. In comparison, multi-hazard risk analysis based on the Average Annualised Loss (AAL) risk metric considers mainly social and economic risk (ESCAP, 2019). The present report utilizes data from the ThinkHazard portal, unless otherwise indicated, in order to **take into consideration natural hazard intensity, frequency and susceptibility under climate change**, which are most likely to affect the energy, transport and ICT sectors in the country.

Landslides

All regions across the country are highly susceptible to landslide risks. Intense rainstorms and snow melts destabilise mountain slopes, triggering landslides in mountainous regions. Nearly 5,000 potentially active landslide sites have been identified in the country, of which 3,500 sites are located in the Southern part of it. Over 10,000 homes are located in landslide-prone areas. Between 1991 and 2011, landslides caused the largest number of deaths in the country compared to other natural hazards. Landslides also cause damage to buildings, roads, power lines, water and heating supply, and sewerage system networks.

Projected climate change such as a 1.6 - 2.6mm increase in monthly precipitation and an increase in extreme events such as glacial lake outburst floods can further increase the frequency and intensity of landslides in the country.

Changing precipitation patterns are likely to alter the slope and bedrock stability. Based on historical observed data on rainfall and landslide events, empirical methods such as logical regression and quantile regression can determine what rainfall threshold conditions can result in slope failures (landslides). This analysis can be used to identify the most vulnerable regions, predict potential future occurrence of landslides in specific areas and develop early warning systems (Shuangshuang He, 2019)*. Hydromet could undertake this assessment and develop an early warning system for landslides in the country.*

Glacial melts

A temperature increase in higher altitudes has accelerated the rate of glacial melting. The country possesses over 8,500 glaciers covering an area of 8,000 sq kilometres or 4% of the total country's surface. The country has over 1,000 high mountain lakes of which 200 are identified as dangerous due to their proximity to human settlements and related risk of glacial lake outburst floods.

Between 1970 and 2000, the country lost nearly 20% of its glacier surface. Continued rapid glacial melting and increased evaporation due to increasing temperatures can lead to a greater uncertainty of water discharge patterns in rivers and glacial lake outburst floods. Glacial melting is particularly prominent in the Northern mountainous region of Issyk-Kul. In the Batken, Chuy, Jalal-

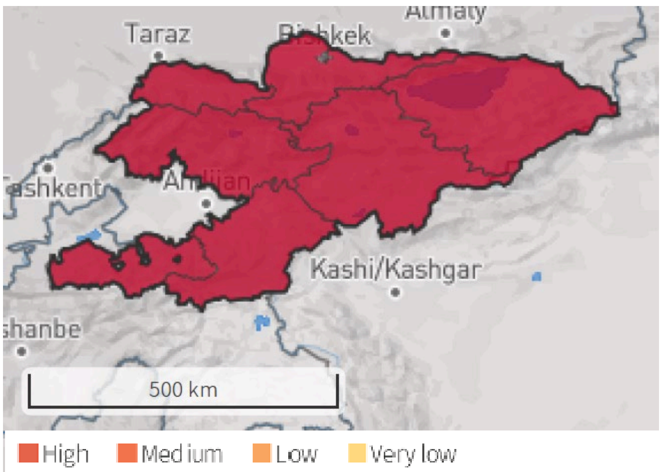

Figure 8: Landslide risk in the Kyrgyz Republic
Source: ThinkHazard (2020)

Abad, Osh and Talas regions, on the other hand, an accelerated glacier melting may increase a water scarcity risk in the future.

A resulting increased uncertainty over the availability of water resources may particularly impact hydropower generation and agricultural production. The country's hydropower largely depends on rivers fed by glacial melt and snowmelt. Decreasing volumes of glaciers and consequently shrinking lakes make hence the electricity sector very vulnerable and may in the long run create competition between the energy and the agricultural sectors over the water resource. Hydromet could undertake a more detailed assessment of glacial melts through hydrological models.

Floods, flash floods and mudflows

Floods and mudflows are frequent hazard risks for the Kyrgyz Republic. Most of the country's locations are floods and mudflows prone. The country counts over 3,000 mudflow rivers. Floods and mudflows essentially occur in spring, and 80% of floods are a consequence of a heavy rainfall. An increase in precipitation is likely to affect the frequency and intensity of floods (Third National Communication, 2016).

Floods and mudflows can cause damages to the infrastructure. Between 1990 and 2008, over 850 incidents of floods and mudslides were registered with a maximum economic loss of 113.8 million KGS per mudflow event and 18.1 million KGS per flood event (UNDP, 2013). The projected temperature rise is likely to accelerate the hydrological cycle, intensify the rate of glacier melting and increase the risk of intense flood events (Tabari, 2020).

While the entire country is prone to flood risks, the Osh and Batken regions are most vulnerable to them. In particular, the city of Osh is highly exposed to the risk of floods (ThinkHazard, 2020).

For a more detailed assessment, Hydromet could generate flood projections by using hydrological models and hydrographs (Third National Communication, 2016).

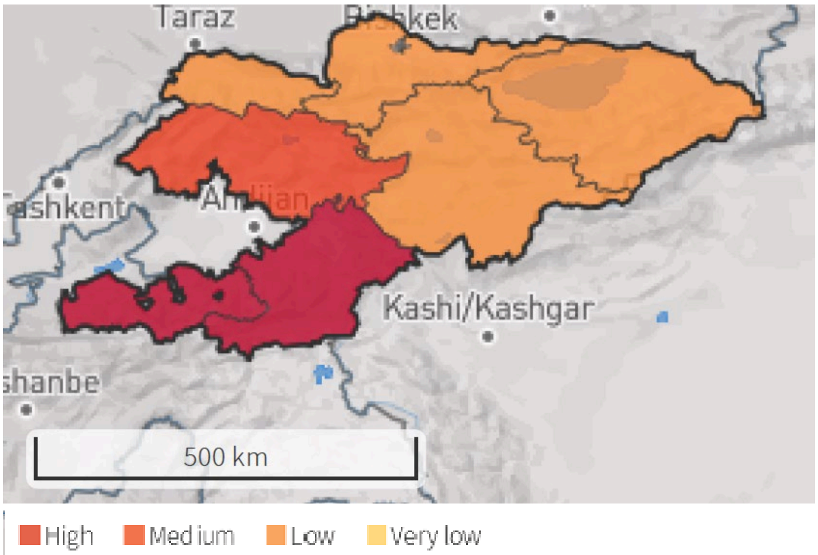

Figure 9: Urban flood risk in the Kyrgyz Republic
Source: ThinkHazard, 2020

Droughts

A decrease in precipitation during summer months combined with an increase in surface air temperature can have important implications for the country. For example, rapid depletion of soil moisture could lead to drought conditions.

The frequency and intensity of heat waves (dry days) across the country could increase by 19 to 23 days per year by 2050 under the RCP 8.5 pathway (ADB, 2018). The country faces a medium risk of water scarcity with a 20% chance of drought to occur within 10 years from 2020 (ThinkHazard, 2020). Climate change is likely to exacerbate the risks of water scarcity and land surface drying mainly in the Southern, North – Western, and Western regions of the Kyrgyz Republic (Figure 11). Rapidly melting glacial ice further increases this risk.

A more detailed drought risk assessment could be undertaken to predict the probability of drought occurrence by using soil moisture data and examining shifts in drought incidence across various GCM climate scenarios. Drought indices such as the Palmer Drought Severity Index (PDSI), Integrated Drought Index (IDI), Aridity Anomaly Index (AAI) and the Standardized Precipitation Index (SPI) are developed to quantify meteorological, agricultural and hydrological droughts (WMO, Global Water Partnership, 2018)*. These indices require multiple inputs for drought calculation such as humidity, precipitation, temperature, soil moisture under different GCM scenarios and give more realistic and accurate drought prediction* (Jehanzaib, 2020)*. Hydromet could calculate the drought index using local climate indicators and analyse the drought risk across different regions of the country.*

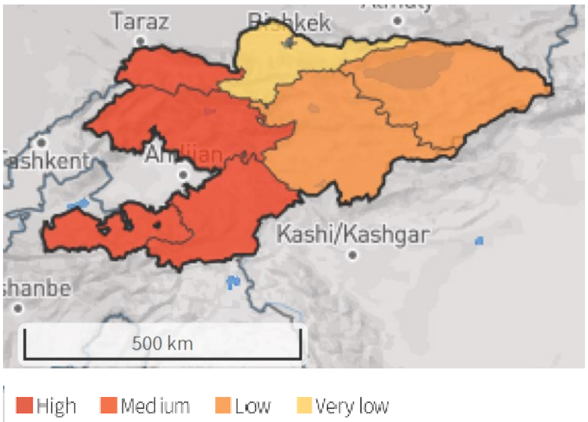

Figure 10: Water scarcity risk in the Kyrgyz Republic
Source: ThinkHazard, 2020

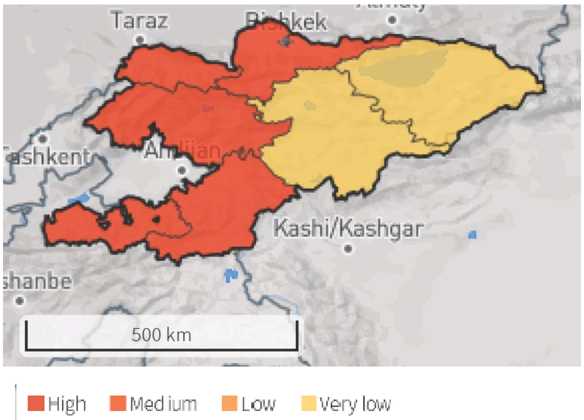

Figure 11: Extreme heat risks in the Kyrgyz Republic
Source: ThinkHazard, 2020

Regional vulnerabilities

UNEP identified the Southern and Western regions as most vulnerable to both climate change and related aggravated risks of natural hazards such as droughts, glacial melts, floods, mudflows and landslides. The country's 2nd most populated city Osh along with the cities of Jalal-Abad and Naryn are located in these most vulnerable region. In the North, the city of Karakol is highly exposed to rising temperatures and rapid glacial melting.

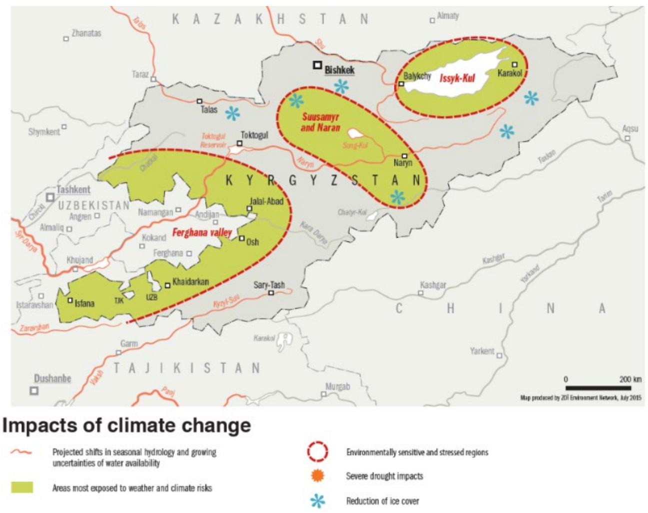

Figure 12: Impacts of climate change in the Kyrgyz Republic

4. Climate change impacts on the energy, ICT and transport sectors

Climate change may affect the energy, ICT and transport infrastructure in two ways: by gradual or incremental climate change patterns (such as gradually increasing average surface mean temperature) and by changing extreme weather events patterns (such as intensified and more frequent heat waves). Climate change may intensify some natural disaster risks (drought, floods) or have a less direct relationship to them (earthquakes).

Climate change vulnerability of the infrastructure sectors depends not only on climate change patterns themselves, but as much on the **specifics of each infrastructural asset.** Indeed, the asset's specific location, the asset's age, quality and maintenance, the assets safety parameters accounted influence the extent to which it may be affected by climate change. Understanding how exactly and to what extent infrastructural assets are likely to be affected by climate change hence requires a thorough engineering analysis of each specific asset. However, there are a number of **well identified cause-to-effect patterns** for each of the considered infrastructural sectors that can be taken into consideration when looking into climate proofing them. The present section aims to list them and highlight broad directions to further explore when devising climate proof policies and interventions for the energy, ICT and transport sectors.

The table below summarises these cause to effect patterns relevant for the specifics of the climate change and the energy, icT and transport sectors in the Kyrgyz Republic:

Climate change pattern	Potential impact on the energy sector in the Kyrgyz Republic
Increased average and extreme temperatures	▪ Decreased hydropower generation capacity ▪ Reduced efficiency of thermal power plants ▪ Damage to physical infrastructure such as transmission lines
Changes in precipitation patterns	▪ Reduced coal quality and thermal power generation capacity
Climate related natural disasters	
Droughts	▪ Water scarcity may affect hydro power generation capacity and impact thermal power cooling systems
Floods	▪ Damage to physical infrastructure
Landslides and mudslides	▪ Damage to physical infrastructure
Climate change pattern	**Potential impact on the ICT sector in the Kyrgyz Republic**
Increased average and extreme temperatures	▪ Decreased conductivity and performance of underground cables ▪ Reduced efficiency of wireless transmission ▪ Overheating of data centres ▪ Health risk to maintenance staff
Changes in precipitation patterns	▪ Heavy rainfall can weaken quality and reliability of wireless transmission signals
Climate related natural disasters	
Floods	▪ Damage to physical infrastructure
Landslides and mudslides	▪ Can damage physical infrastructure causing failure of network and loss of connectivity
Climate change pattern	**Potential impact on the transport sector in the Kyrgyz Republic**
Increased average and extreme temperatures	▪ Structural damage to the road surface ▪ Expansion of bridge joints and railway tracks
Changes in precipitation patterns	▪ Wash out of road surfaces

	▪ Increased seepage and infiltration into pavement and subgrade, reduced structural stability of roads and pavements
Climate related natural disasters	
Floods	▪ Water-logging due to overload on roadside drainage ▪ Damage to road infrastructure
Landslides and mudslides	▪ Damage to physical infrastructure ▪ Blocking road connectivity

Table 2: Climate change impact on the energy, transport and ICT sectors

In addition, the following points will need to be incorporated at a more detailed infrastructural sectors' screening stage:

- To effectively mainstream climate change into infrastructural investments, **climate change projections need to be as viable as possible.** Indeed, climate proofing an infrastructural asset may often come to an additional adaptation cost. It is therefore important to correct mclimate models' biases and use high resolution climate models. This means that the CCKP's data used for the present assessment may be helpful to analyse general climate change trends at the national level, but may not be precise enough to take infrastrucruree investment decisions. For the latter, it is recommended to use an ensemble of Regional Climate Models (RCM);
- Climate proofing the infrastructure often comes to **climate proofing future investments**, in particular for the infrastructure sectors in which most of the assets are reaching the end of their lifecycle;
- When most of the future infrastructural assets are to be built for the considered climate change time period, it is of a critical importance to **align the spatial planning of the infrastructural assets with high resolution climate change projections** and associated natural disasters' maps in order to avoid locating future assets in most climate vulnerable areas.

Energy sector

Energy sector overview

The energy sector represents 4% of the GDP (IEA 2020) and is heavily dependent upon hydropower. Indeed, **hydropower represents about 90% of the electricity generation share.** River basins supplying water to large hydropower plants (HPP) depend upon glacial melt and snowmelt water. The country also produces a small amount of electricity from fossil fuels, particularly coal and natural gas. It has two large thermal power plants located the country's biggest cities: Bishkek and Osh. During winter, when hydropower generation is low, the country largely relies on oil and gas imports to meet its energy needs.

The energy sector requires large investments as the transmission network losses represent over 25% of the generated electricity (UNECE, 2018). Over 45% of the electricity generation capacity is beyond its lifecycle and 70% of steam and hot water networks are older than 25 years (Climate Investment Programme, 2018). The sector faces a major challenge with attracting required investments considering its largely subsidised energy tariffs.

Potential climate change impacts on the energy infrastructure

The energy sector of the country presents several major vulnerabilities to climate change and natural disasters:

1. Heavy dependence on hydropower;

2. Weak transmission and distribution networks;
3. A major challenge with attracting required investments to introduce the required sectoral improvements, which includes climate and disaster proofing the sector.

The energy sector is heavily dependent on hydropower which, in turn, depends on glacier and snowmelt that is affected by climate change. All the existing large hydro power plants in the country are dependent on the Naryn River for their water supply. The anticipated temperature rise will increase evaporation losses and accelerate glacial melting, reducing reliability and availability of water for hydropower. **Rapid glacial melt can contribute to increasing hydropower generation in the short term (next 5 to 10 years) and significant decreasing it afterwards** due to decreased water availability for generation in the long term (USAID, 2018). The likely future water stress may also affect the thermoelectric cooling of thermal power plants. These cover less than 10% of the country's electricity demand but are critical to heating in the two major cities of the country, Bishkek and Osh.

Figure 13: Toktogul hydroelectric power plant (HEPP) located on the Naryn River
Source: https://www.carecprogram.org

Climate change impacts such as **increased precipitation** may further exacerbates climate related disasters floods, glacial lake outburst floods, landslides and mudslides. Flood and mudslides can cause soil erosion and damage physical infrastructure such as coal storage facilities, thermal power plants, dams and power generating facilities. In particular, the regions of Jalal – Abad and Osh, most exposed to landslides, are likely to be the most vulnerable.

At present, the country is investing 3.3 billion USD (OECD, 2019) into hydropower anticipating aan increased water runoffs over the next two decades (by 2030s) (Third National Communication, 2016). It aims at selling the electricity to the neighbouring countries. However, considering its future climate vulnerabilities, the country needs to consider **investments into alternative sources of energy beyond this period.** However, domestic electricity tariffs are very low and are, at the same time, a highly sensitive social topic. The sector lacks transparency on the tariff formation, which makes it difficult to generate public support for a tariff increase. The sector is heavily fragilized by very low electricity tariffs, and this includes climate change adaptation of the sector, which will require invvestments much needed energy efficiency and renewable energy technologies.

ICT sector

ICT sector overview

Information communication and technology (ICT) is an important and a rapidly growing sector of the Kyrgyz economy. The cellular communication services have grown particularly fast. Access to internet services in the country is currently 34.5%, with only 4.2 subscribers per 100 inhabitants for broadband services. Market trends anticipate a 8% annual growth of internet services.

To meet this increasing demand, the ICT sector services and infrastructure are expected to grow in the coming years. According to an ESCAP assessment, a 10% increase in broadband access leads to a 1% increase in the GDP and doubling the average broadband speed can increase the country's GDP by 0.3% (ESCAP, 2019). The government aims to accelerate the digital transformation in the country and has adopted the Digital Transformation Concept of the Kyrgyz Republic 2019-2023, under the National Development Strategy of the Kyrgyz Republic 2018 to 2040 (State Committee for Information Technologies and Communications of the Kyrgyz Republic, 2019). The Digital Transformation Concept aaims to:

- Improve digital infrastructure and internet connectivity;
- Increase digital literacy and provide IT education to promote domestic employment opportunities;
- Develop e-government services and platforms;
- Promote economic growth through the digital transformation of the financial technology and banking sectors.

Potential climate change impacts on the ICT infrastructure

Physical infrastructure of the ICT sector comprises of underground fiber optic lines, cable ducts, mobile towers, power transmission pillars, telecommunication equipment and networks. With the rise in ambient temperature, the surface soil temperature increases **decreasing the conductivity and performance of underground cables**. It is estimated that for temperatures above 55°C the underground cable capacity is lost by 29%. A temperature rise also reduces signal range and affects the quality of wireless transmissions. The 2.0 - 2.5°C (the median range of temperatures under RCP 4.5 and RCP 8.5 accordingly) increase in average temperatures in the country for the period of 2040 - 2059 may cause rise in operating temperature of the telecommunication equipment, which may **affect stability of operations and result in hardware failure**. Increase in temperature and heat waves may cause overheating of data centres and increase health risks of outdoor maintenance staff (ITU, 2018).

Increase in intensity and frequency of extreme weather events such as floods is likely to increase the risk of natural disasters such as landslides and mudflows. Landslides may damage terrestrial cables, mobile towers, destroy underground ducts causing network failure and disrupting ICT broadband services (ITU, 2014).

Transport sector

Transport sector overview

Due to its strategic location, the Kyrgyz Republic positions itself as a potential transit hub for goods and passengers between Central Asian and European countries. The country's transport sector is mainly dominated by the **road transport**. Its road system consists in nearly 34,000 kilometres of paved roads. The rail system consists of 2 major rail lines (Northern line and Southern line) of a total length of 424.6 kilometres (ESCAP, 2019). The road transport caters to 96.6 % of the freight and 99.8 % of domestic passenger traffic.

Despite a heavy dependence of local and national economic growth on the transport infrastructure, nearly 33% of the country's roads are underdeveloped and nearly 70% of roads require major repairs and reconstruction (ADB, 2013). The national government formulated a Road Development Strategy until 2025 with the aim to ensure a safe and efficient operation of the transport infrastructure. The Ministry of Transport and Roads coordinates the implementation of the strategy. Ongoing public road improvement projects are:

- A 433km North-South alternative road project;
- A Bishkek-Osh International road Phase 4, repair and reconstruction of 130 km of the road;
- Reconstruction of the Issyk-Kul ring road.

Figure 14: Rehabilitation And Widening Of Bishkek-osh Road, Kyrgyzstan
Source: https://www.kayson-ir.com/

The ageing railway network of the country is less developed than the road network. Kyrgyz Railways currently operates passenger and freight traffic along the Northern and Southern lines. Railway infrastructure projects underway are:

- Electrification of 161 km Lugovaya – Bishkek railway section;
- Reconstruction of 324 km Balykchi – Chaldovar – Lugovaya railway section;
- Construction of interstate railway on the route Balykchy – Kochkor – Kara-Keche.

Overall, the OECD estimates that the country's transport sector must improve its capacity to 984% by 2050 (OECD, 2019).

Potential climate change impacts on the transport infrastructure

The changes in the pattern of temperature and precipitation may affect the transport infrastructure beyond its preparedness capacity. Rising extreme temperatures may deteriorate the asphalt road surface integrity and cause thermal expansion of bridge joints and paved surfaces. Fluctuation in temperatures can also cause cracks and expansion of joints in railway tracks.

Localised strongly changing precipitation patterns may severely impact selected sections of road and rail networks. An excess in rainfall runoff may increase seepage and infiltration into pavement and subgrade, reducing structural stability of roads and pavements. Change in rainfall patterns may also impact soil moisture levels, increase soil moisture levels and affect the structural integrity of roads, bridges and tunnels. Finally, extreme rainfall events and glacial melts increase the risks of slope failures, which may trigger landslides in mountainous regions. These, in turn, may block transportation connectivity, supply of goods and essential items, which will increase the country's economic vulnerability.

The most climate vulnerable infrastructure sector

Based on the analysis above, the energy and transport sectors appear as more sensitive to changes in temperature and precipitation. The **energy sector** appears to be he most vulnerable among the three sectors considering its heavy dependence on hydropower and is ageing energy infrastructure. A weak adaptation to future climate change patterns in this sector is likely to generate significant socio-economic vulnerabilities.

5. References

ADB. (2013). Country Partnership Strategy: Kyrgyz Republic, 2013–2017. Retrieved from https://www.adb.org/sites/default/files/linked-documents/cps-kgz-2013-2017-ssa-03.pdf

ADB. (2018). Retrieved from Climate Change and Disaster Resilient Water Resources Sector Project (RRP KGZ 51081-002)

Eckstein, D. H. (2018). Global climate risk index 2019: Who suffers most from extreme weather events? Weather-related loss events in 2017 and 1998 to 2017. Germanwatch Nord-Süd Initiative EV

ESCAP. (2019). In-depth national study on ICT infrastructure co-deployment with road transport and electricity infrastructure in Kyrgyzstan

ESCAP. (2020). Risk-informed Infrastructure Planning, Central Asia Pilot in Kazakhstan and Kyrgyz Republic

Harris, I. O. (2020). Version 4 of the CRU TS monthly high-resolution gridded multivariate climate dataset. . Scientific Data, 1-18

IEA. (2020). Kyrgyzstan energy profile. Retrieved from https://www.iea.org/reports/kyrgyzstan-energy-profile

International Trade Administration. (2020). Retrieved from https://www.trade.gov/country-commercial-guides/kyrgyz-republic

ITU. (2014). Resilient pathways - the adaptation of ICT sector to climate change

ITU. (2018). Framework of climate change risk assessment for telecommunication and electrical facilities

Jehanzaib, T.-W. K. (2020). Drought Risk Analysis, Forecasting and Assessment under Climate Change

Kretova, Z. (2020). Assessment of climate change in the Kyrgyz Republic. Bishkek: IFAD Project.
OECD. (2019). Strategic Infrastructure Planning for Sustainable Development in the Kyrgyz Republic

Riahi K, V. V. (2017). The shared socioeconomic pathways and their energy, land use, and greenhouse gas emissions implications: an overview. Global Environmental Change, 153-168

Shuangshuang He, J. W. (2019). Rainfall Event–Duration Thresholds for Landslide Occurrences in China

State Committee for Information Technologies and Communications of the Kyrgyz Republic. (2019). Retrieved from http://www.ict.gov.kg/index.php?r=site%2Fsanarip&cid=27

Tabari, H. (2020). The hydrological cycle is expected to intensify with global warming, which likely increases the intensity of extreme precipitation events and the risk of flooding
ThinkHazard. (2020). Kyrgyz Republic Report

Third National Communication. (2016). Third National Communication of Kyrgyz Republic under the UN Framework

UNDP. (2013). Climate profile of the Kyrgyz Republic

UNDP. (2013). Enabling Integrated Climate Risk Assessment for CCD planning in Central Asia . Almaty: The Climate and Development Knowledge Network

UNECE. (2018). Kyrgyz Republic energy sector overview

USAID. (2018). Climate Risk Profile Kyrgyz Republic

WMO, Global Water Partnership. (2018). Retrieved from https://www.droughtmanagement.info/indices/

World Bank Climate Change Knowledge Portal. (2021). Retrieved from https://climateknowledgeportal.worldbank.org/country/kyrgyzstan/climate-data-projections

World Bank. (2018). Climate-Resilient Agriculture in the Kyrgyz Republic. Retrieved from CSA Country Profiles for Asia Series

World Bank. (2019). Retrieved from https://reliefweb.int/report/world/wb-central-asian-states-mull-natural-disasters-exclusive

World Food Program. (2020). https://reliefweb.int/report/kyrgyzstan/wfp-kyrgyz-republic-country-brief-october-2020