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Climate Change Profile: Rasht Valley Tajikistan

This profile provides an overview of projected climate parameters and related impacts on the agricultural sector in the Rasht Valley, Tajikistan, under different **greenhouse gas (GHG) emissions** scenarios (called Representative Concentration Pathways, RCPs**, with its lower emission scenario RCP2.6, its intermediate emission scenario RCP6.0, and higher emission scenario RCP8.5**). By using easy-to-read graphs and texts intended for non-experts, this climate change profile builds on the latest climate data and state-of-the-art modelling.

Climate Projections

Compared to the 1986-2005 level, the **annual mean temperature** is projected to rise between **1.1°C and 6.1°C by 2080,** depending on the future GHG emissions scenario. Under the high emissions scenario, RCP8.5, annual temperatures will increase by approximately **1.7°C in 2030, 2.9°C in 2050, and 5.3°C in 2080**.

Winter precipitation will increase while spring precipitation depicts no trend. However, based on the same model ensemble, **heavy rainfall events (>20mm) will further increase during the spring months.**

As a consequence of increasing temperatures, **fewer frost days will occur.** Under the high emissions scenario, RCP8.5, frost days will decrease to approximately: **202 days in 2030, 190 days in 2050, and 163 days in 2080**.

The **Growing Season Length (GSL) is expected to increase**. Under the high emissions scenario, RCP8.5, GSL will be approximately: **175 days in 2030, 190 days in 2050, and 212 days in 2080.**

Despite an increasing GSL, the **agricultural productivity** during the growing season **is at risk** due to **increased temperatures**, **more frequent and intense heatwaves,** as well as **decreased irrigation water availability** caused by greater evaporation and glacier retreat (especially in late summer).

Rapid and intense climate-induced changes in temperatures and precipitation patterns are **causing biodiversity loss**. This is **especially the case in mountainous areas** where the potential for species migration is limited, and the vulnerable ecosystems are particularly well-adapted to their current environment.

Executive Summary

Rasht Valley is located in the upper central part of Tajikistan and is part of its Region of Republican Subordination. The Rasht Valley is comprised of seven districts that are all connected by a mostly paved, main road located along the Vakhsh River: **Faizobod, Rogun, Nurobod, Tavildara, Rasht, Tojikobod, and Laksh**. Laksh (formerly Jirgetal) is a border district with its border crossing to Kyrgyzstan. (The border, however, is currently only open for Tajik and Kyrgyz nationals.) The Rasht valley has over **514 600 inhabitants** - **roughly 5.6% of Tajikistan's population** – who live in a primarily rural and agricultural setting [1].

The wide slopes of the Rasht valley offer fertile soil for agricultural activities and livestock herding. **66% of the total land area is arable land** of which **21% is agricultural** and **45% is pasture land [1]**. Meat and dairy production make up a substantial share of the local food system [2]. **Most of the agricultural land depends on irrigation systems** which were constructed during the Soviet period. 74% of this land is irrigated by gravity which is inefficient and causes water scarcity in the summer months [3]. Most agricultural land is cultivated by **small-scale, private farms called dekhan farms**. In the seven districts that comprise the Rasht valley, 11 077 dekhan farms are active [1]. Since **access to financial and agricultural extension services** is especially difficult for people who live in the higher areas of the Rasht valley, **many households depend on remittances** sent back home from relatives working in the capital or abroad (mainly in Russia) **[4, 5]**.

The main crops grown in the Rasht valley are **potatoes, vegetables, fruits, grains, pulses, and wheat** [1]. Most produce is sold in the district's central markets; a smaller share is sold in Dushanbe [2]. Being situated close to Dushanbe and having access to its markets have decreased prices for agricultural products sold locally – especially in the lower-situated districts. While food prices have decreased, prices for agricultural inputs and machinery remain high; therefore farming is less profitable [2].

Rasht Valley is especially famous for its many **varieties of apples and other fruit tree species**. Over 50 different apple species are currently cultivated in the valley.

Altogether, the rural setting, the agriculture-dominated livelihoods, the limited access to social services (such as healthcare), and the lack of food necessary for a well-balanced diet cause the population of the Rasht valley to be **highly vulnerable to further negative impacts of climate change**.

Key Figures for Rasht Valley

Demographics

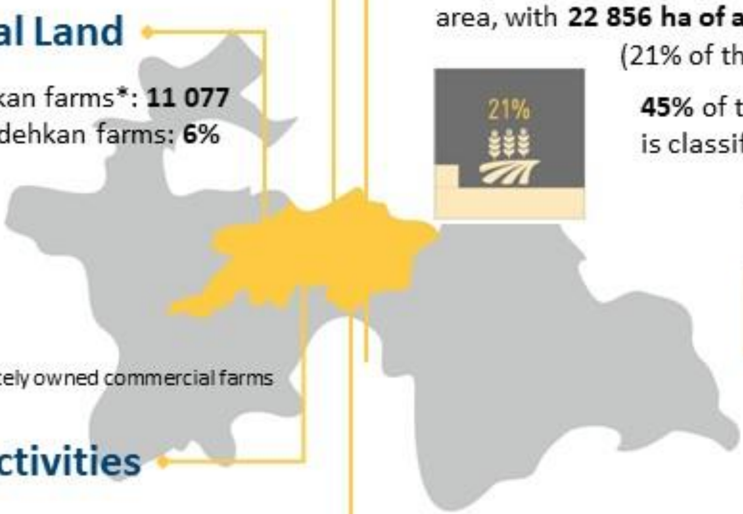
Total population of Rasht Valley is **514 600 people** (**5.6%** of Tajikistan's total population)

Urban 4%
Rural 96%

Agricultural Land

Number of dehkan farms*: **11 077**
Female-owned dehkan farms: **6%**

*dehkan farm: privately owned commercial farms



Farming Activities

Most important agricultural produce
(based on tonnage of production)

Potatoes	178 829 t
Vegetables	35 922 t
Fruit	34 370 t
Grains & Pulses *(excluding wheat)*	29 494 t
Wheat	23 962 t

Topography & Farming

Altitude range of district centers:

1 834 m.a.sl.

1 234 m.a.sl.

Rasht Valley covers **14 060 km²** and comprises **9.8%** of Tajikistan's total surface area, with **22 856 ha of agricultural land** (21% of the total land)

21%

45% of the agricultural land is classified as **pastureland**

45%

Food Security

68% of the average **household income** is spent on food

24% of all children *(aged between 6 months to 5 years)* are **stunted**

The overall **poverty rate** is **33.2%***

** Includes all Districts of the Republican Subordination*

Sources:
Agency for statistics of the Republic of Tajikistan, 2018 / 2019
World Bank 2015 / 2016

Topography and environment

The altitude in the Rasht valley ranges from 1 000 to 7 600 meters above sea level (m.a.sl.). Most inhabitants live between **1 000 and 2 800 m.a.sl.** [4], however, permanent communities have settled at higher altitudes. Most villages are located along the main river, Vakhsh. The Vakhsh River leads into the highest dam in the world - the Rogun Dam - before continuing into the Khatlon province and eventually beyond Tajikistan`s borders to the Aral Sea. In the mountainous hills of the valley, a multitude of **summer pastures** are situated. In April, herds are brought to the summer pastures from lower areas (including Khatlon province) and they remain there until the last days of September. Due to the large area of pastures available in the Rasht Valley and the proximity to Dushanbe, much livestock is brought there from outside the valley in big herds for grazing. Nevertheless, the Rasht valley **lacks sufficiently mapped pasture corridors and pasture-use rights and is additionally missing clear legal-use rights.** These issues have led to overuse, land degradation and the need for the fencing of most of the agricultural plots along the pasture corridors.

The climate in the Rasht valley depends on the altitude of the individual location. The difference altitude creates a valley that is rich in biological diversity with several agro-ecological zones. Since the beginning of the 20th century, **a steady increase in the mean temperature by 0.07°C has been recorded** and **precipitation patterns are shifting**. Rainfall in winter has steadily increased, whereas spring average rainfall has remained stable. While the overall amount of rainfall recorded during spring has stayed the same in the past 100 years, an **increase in heavy rainfall events** has been documented. These heavy rain events cause land degradation by eroding the topsoil and important nutrients and, additionaly, harm the fruit crop-development during the blooming season. **These changes in climate have strong, negative impacts on the yield and quality of the local harvest** [2].

In addition, different parts of the main road are annually washed away and need to be repaired at high costs to ensure mobility and continued access to markets, healthcare, and other services. Overall increases in temperatures and reduced frost days in winter caused by climate change have brought **new pests and insects** to the valley. Further, the combination of heavy rainfall, late frost, and strong winds has caused **more frequent mudflows and floods** [2]. Greater climate change and its impacts are threatening the unique ecosystems found in the Rasht valley. These impacts emphasize the need for adaptation measures to protect the valley`s rich biodiversity and maintain its valuable ecosystem services.

Climate trends from 1900 to 2016

Present climate

Land-locked Tajikistan has an arid climate with high seasonal variability; it features different local climates based on different altitudes. Average annual temperatures range from -6°C in the Pamirs to +17°C in the southern regions which border Afghanistan. The lowest temperatures measured in Tajikistan can reach -63°C, while the highest temperatures can reach beyond 50°C [6]. The average annual precipitation ranges from 70 to 160 mm per year [6]. In mountain areas, such as the Rasht valley, **summer temperatures reach up to 17,3°C, and winters can be as low as -13.7°C, on average, while Precipitation is especially strong in spring time and causes the river to change is flowing path every year [7].**

Climate Trends over the last century

Figures 1 and 2 (shown below) illustrate existing trends for annual mean temperature and precipitation as observed over the last century[1]. Here, precise values for temperatures and precipitation for specific locations cannot be applied because precise values – especially for temperature - vary strongly with elevation (approx. 0.6°C per 100 meters). The observed annual mean temperatures for the Rasht valley show an increasing trend over the 20th century. Winter precipitation in Rasht Valley shows an equally increasing trend, whereas spring precipitation either shows no trend or an insignificant decreasing trend depending on the emissions scenario used (see Figures 1 and 2).

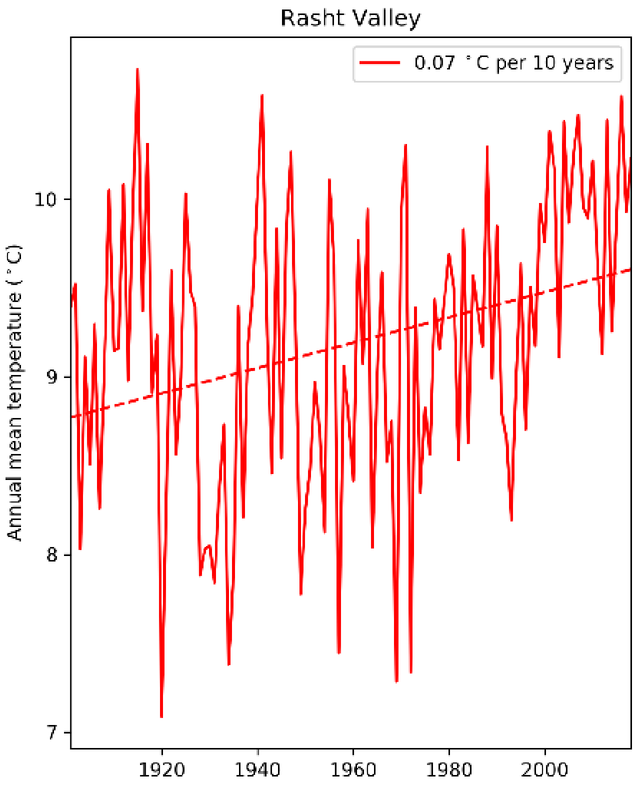


Figure 1: Past climatic trends for annual mean temperature from 1900 to 2016. Dotted lines represent the linear trend over time. The significant change per 10 years is noted in the upper right corner.

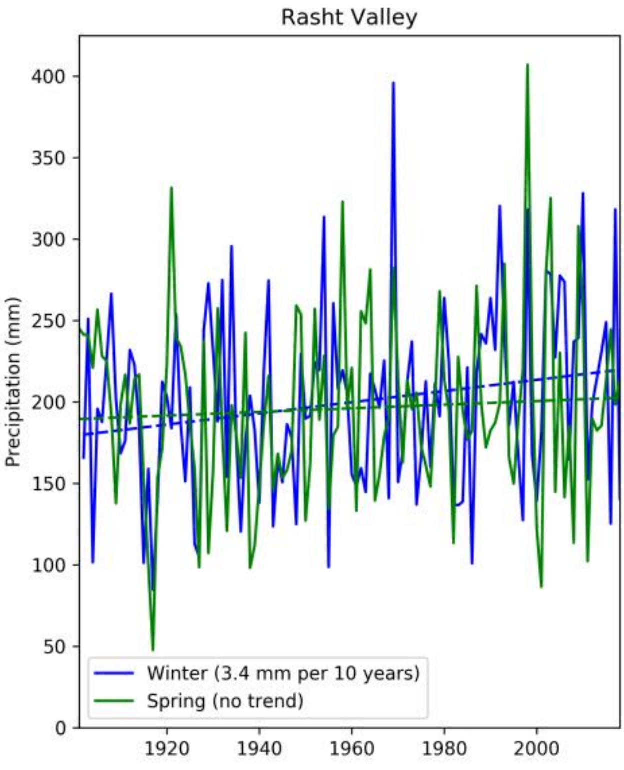


Figure 2: Past climatic trends for precipitation from 1900 to 2016. Dotted lines represent the linear trend over time. The significant change per 10 years is noted in the lower-left corner.

[1] *The time series for past annual mean temperatures and precipitation are based on the dataset of the University of East Anglia's Climatic Research Unit (CRU), which has combined data of local stations, which are part of the World Meteorological Organization (WMO) station network, into a grid data format of half degree resolution (https://crudata.uea.ac.uk/cru/data/hrg/cru_ts_4.03/)*

Climate Change impacts on Biodiversity and Agriculture

Central Asia's wealth of biodiversity and its broad range of habitats result in a **unique species composition** as well as a multitude of endemic plants and animal species. Particularly, the **mountain ecosystems provide habitats for many endemic species.** Tajikistan has signed the **Convention on Biological Diversity (CBD)** and has additionally committed to the **Cartagena Protocol and** the **Nagoya Protocol**. Together, with the **Aichi Targets 2020** and the **Agenda 2030 for Sustainable Development**, these global commitments strengthen Tajikistan in its efforts to conserve its biological wealth. Biodiversity is more than mere species conservation, together with other ecosystem services, it is essential for agricultural production which **ensures food security and economic well-being, particularly for the most vulnerable communities.**

Biodiversity provides a multitude of ecosystem services that are vital for environmental sustainability and human well-being. These ecosystem services are increasingly under threat due to overuse, mismanagement, as well as climate change. The natural capital of agricultural landscapes serves as a source of food, fibre, firewood, and fodder, etc. and provides additional ecosystem services such as nutrient-cycling, soil fertilization, water conservation, and pollination. **The richness of genetic diversity in the agricultural landscapes guarantees better adaptation to climate change** and consequent severe weather events such as floods and droughts, as well as more general changes in the precipitation patterns and their potential impact on future water availability.

Biodiversity and climate change are strongly linked [8]. A changing climate negatively impacts biodiversity since certain species may not survive changed climatic conditions; species extinction can further aggravate the effects of climate change. Conjointly, a high level of biodiversity contributes likewise to higher adaptation potential and the possibility to mitigate climate change impacts [9]. Consequently, a policy dialogue linking biodiversity, agriculture, and climate change is essential [8].

Adaptation to climate change is gaining urgency globally. The conservation of biodiversity and ecosystem services in agricultural landscapes plays a key role in achieving a more resilient agricultural production, and therefore, safeguarding food security and improved livelihoods.

In Tajikistan, agriculture is a priority for livelihood security and economic development. In 2018, the agricultural sector accounted for 19% of the GDP and provided for 51% of the national employment [10]. Despite the existing efforts in conserving biodiversity in protected areas, **the importance of fostering biodiversity for the benefit of agricultural landscapes has not yet been fully recognized**.

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Ativities by the Deutsche Gesellschaft für internationale Zusammenarbeit (GIZ) in the Rasht valley

Biodiversity enhancing land use practices

The objective of the ***Global Project on Biodiversity and Ecosystem Services in Agrarian Landscapes*** – commissioned by the **International Climate Initiative (IKI) of the Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU)** – is to strengthen the knowledge and the capacities of land-users, technical experts, and decision-makers on the importance of biodiversity to the agricultural sector. The project evaluated existing biodiversity-enhancing land-use practices in agriculture and implements them pilot-wise in the Rasht valley.

Inclusive value chain development

The **inclusive value chain development (IVCD) approach** aims at improving the resilience of smallholder farmers. The key strategy here is to strengthen the economic orientation of support structures at the meso level across districts. The risks faced due to climate change can be minimized through diversification and the use of local, climate-resilient species. The project, commissioned by the **German Federal Ministry for Economic Development (BMZ)**, supports farmers by, for example, helping them access relevant information on market prices. This enables the farmers to achieve a higher sale price during negotiations. Further, the project supports agricultural advisory services on sustainable farming practices and post-harvest processes.

Documentation of climate-resilient apple tree species

Local apple tree species in Rasht valley are being documented via a small-scale project on **assessing climate change impacts of the technical cooperation provided by the GIZ** and funded by the **German Federal Ministry for Economic Development (BMZ)**. This documentation takes stock of the biological wealth of the Rasht valley (like the more than 50 apple species native to the valley). Further, the documentation provides information on the species in all four seasons and contains information on species composition, growth, and the expected harvests. The documentation also indicates how to further process the harvest and its respective market potential. This facilitates a preference for local and mostly-climate-resilient varieties instead of the current commercialization of the mostly non-native species.

Further possible options for actions

The Rasht Valley is home to a wide range of diverse species and provides an important stock of land areas suitable for farming and livestock herding. At the same time, the impacts of climate change - especially in the form of extreme weather events - are already felt in the valley. There is a great need for soil restoration and the protection of local, climate-resilient species to allow local adaptation to climate change. The (export) market value for local produce is not yet assessed and could increase the economic potential for the valley`s population while allowing the protection of its unique ecosystems.

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Climate Change Impacts on the Apple Value Chain in Rasht Valley

Apples	Provision of seedlings and other inputs	Cultivation of apples	Harvesting, Storage, Processing	Transport and Marketing
Increased annual mean temperatures	Increased costs of production due to lower seedling survival rate; the need for purchasing of pesticides	Increased labour and costs due to increased irrigation need; increased risk of pests and diseases	Decreased quantity and quality of harvest	Lower market value of apples due to lower quality; economic losses
Magnitude of impact	Minor	Severe	Major	Major
Farmers current strategies to cope	Farmers aligning in groups and cooperatives to obtain agricultural inputs at subsidized costs	Joint construction of irrigation infrastructure; joint procurement of pheromone traps and pesticides	Processing of fruits into juice or dried apples	Sell to the market when prices are higher
Other potential options to increase adaptive capacity	Propagate local heat resilient species; the exchange between nurseries to increase genetic diversity	Replace current conventional high yield but highly vulnerable variety of trees with local resilient species; diversification of orchards with different apple varieties	Introduce farmer field schools to encourage peer-learning on high-quality processing methods	Provide accurate and timely information on market prices to farmers
Increased heavy rainfall events	Affects the availability of seeds and planting material as they cannot be transported; too much rain affects grafting	Increased risk for erosion of topsoil, damaged flowers and fruit buds	Damage to storage or processing facilities, damage to stored fruits/spoiling of processed fruits	Washed away roads blocked transportation routes
Magnitude of impact	Minor	Major	Major	Severe
Framers current strategies to cope		Farmers construct gullies	Annually recurring need and effort to rebuild storage facilities	Transport routes are reconstructed annually at high costs
Other potential options to increase adaptive capacity	Modernize seed storage facilities at district or community level	Strengthen farmers knowledge of and capacity to apply agricultural practices that avoid or reduce erosion	Facilitated access to financial means, e.g. a micro-loan to invest in more resistant storage and processing facilities	Strengthening capacities to process and select storable apples, allowing apples/ apple produce to be sold during the off-season at higher prices

Apples

	Provision of seedlings and other inputs	Cultivation of apples	Harvesting, Storage, Processing	Transport and Marketing
Decrease in annual frost days	Increase of incidences of pests (i.e. harmful insects) require more inputs of pesticides	Increased risk of pests and diseases / late frost harms the blossom	Less harvest with potentially less quality	Lower market value of produce
Magnitude of impact	Major	Major	Major	Minor
Farmers current strategies to cope	Purchase of cheap chemical pesticides	Purchase of cheap chemical pesticides		
Other potential options to increase adaptive capacity	Ensure to plant local, climate-resilient tree species; training on integrative pest management methods	Ensure to plant local, climate-resilient tree species; training on integrative pest management methods	Processing of lower quality fruits to juice and dried apples	Development of marketing strategy for local apple species
Increased growing season length (GSL)*	Seedlings from lower altitudes become suitable for higher altitudes; heatwaves and dry spells lower seedling survival rate	Potential to grow apple species that are suitable for warmer climates; dry spells and heat waves impact growth and quality of apples	Less harvest with potentially lower quality	Lower market value of produce; new market opportunities with early and late apples
Magnitude of impact	Moderate	Moderate	Moderate	Minor
Farmers current strategies to adapt	Limited exchange of seeds across districts	Continued planting of conventional species; flood irrigation during heat waves	Processing of lower quality fruits into juice and dried apples	Marketing of apple juice or dried apples from lower quality apples
Other potential options to increase adaptive capacity	Research on apple species grown in lower altitudes that have or had a similar growing season length; provisioning of shading for seedlings during heat waves and dry spells	Piloting of different species that are more suitable to the longer growing season and the herewith higher temperatures; cultivation of heat and drought-resilient species	Training on post-harvest management for different, new species	Explore new market opportunities for apples and apple products

** Despite the opportunities of an increasing GSL, the productivity during the growing season is under threat from more frequent and intense heatwaves and the risk of less irrigation water availability due to higher evaporation and glacier retreat.*

Climate change

How to read the climate projections as time series:
All figures and analyses of projected climate change presented in this document are based on climate model outputs produced in phase 5 of the Coupled Model Intercomparison Project (CMIP5) in 2014. A multi-model ensemble of global climate models that took part in the CMIP5 have been used (colour shaded area in diagrams). Data sources are the Climate Explorer of the Royal Netherlands Meteorological Institute[2] (KNMI), the Climate Change Knowledge Portal[3] of the World Bank, and the WorldClim dataset.
All global climate models of CMIP5 used to base their simulations on different **Representative Concentration Pathways (RCPs)**. RCPs are **comprehensive future greenhouse gas concentration pathway scenarios** adopted by the IPCC. The term pathway emphasizes not only the long-term concentration levels of interest, but also the trajectory taken over time to reach that outcome. Projections are presented for **RCP2.6** (corresponds to the emissions target of the Paris agreement), **RCP6.0** (business as usual), and a high emission **scenario, RCP8.5**. The number at the end of every RCP identifier represents the strength of the radiative effect of all greenhouse gas (GHG) emissions emitted under the respective emissions scenario by the year 2100. The higher this number, the stronger the associated global warming.
For each scenario, a multi-model ensemble is considered where each model provides a result. This leads to a multi-model range for each scenario. The upper and lower estimates are defined by the use of the 25th to 75th percentile. In other words, the multi-model range for each scenario was reduced in the following way: the lowest 25% and the upper 25% of the model results are dismissed. These highest and lowest results were regarded as outliers. The colour shaded areas in the diagrams show the range of the multi-model ensemble between the 25th and 75th percentile.

Historic average Temperatures (1961 – 1990)

The present annual avarage maximal temperatures are depicted in the map below and shall serve as a comparisson for the following presented temperature change projections. The observed annual mean temperatures for Tajikistan show an increasing trend over the 20th century.

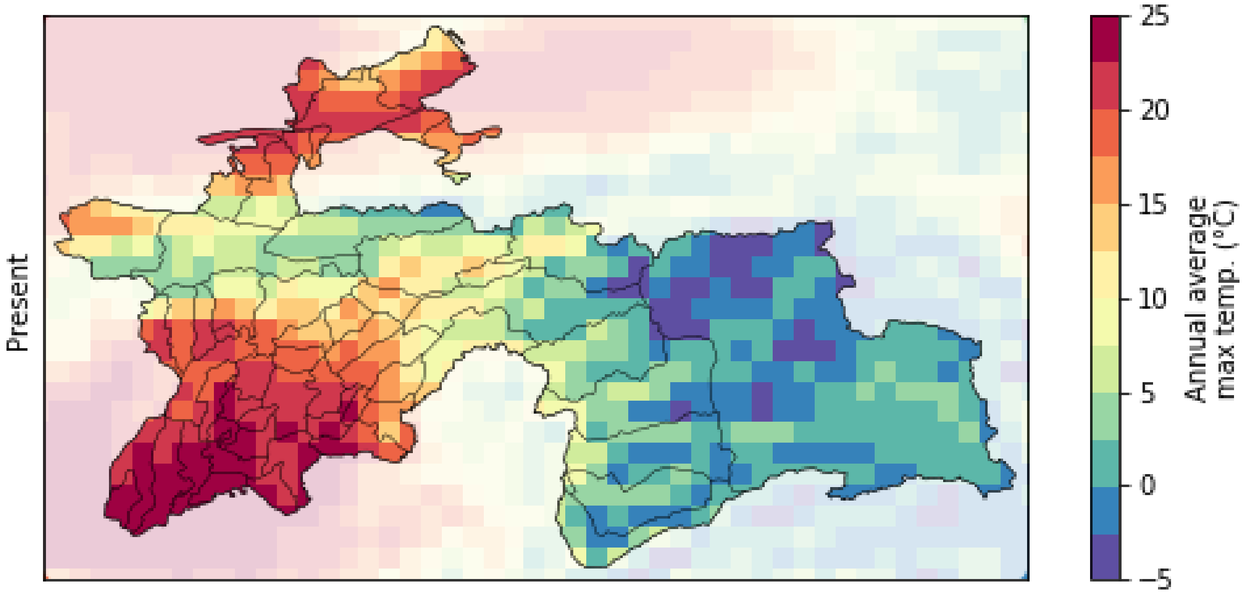

Figure 3: Baseline for mean temperatures (1961-1990) in Tajikistan.

[2] https://climexp.knmi.nl/plot_atlas_form.py?id=someone@somewhere
[3] https://climateknowledgeportal.worldbank.org

Projected climate changes

Temperatures

Compared to the 1986-2005 level, the annual mean temperature is projected to rise between 1.1°C and 6.1°C by 2080, depending on the future GHG emissions scenario. Under the high emissions scenario, RCP8.5 (red), its multi-model mean **temperature** (coloured line) **will increase approximately by 1.7°C in 2030, 2.9°C in 2050, and 5.3°C in 2080.** Due to the high variance of temperatures for different altitudes, the projected change in temperatures is denoted.

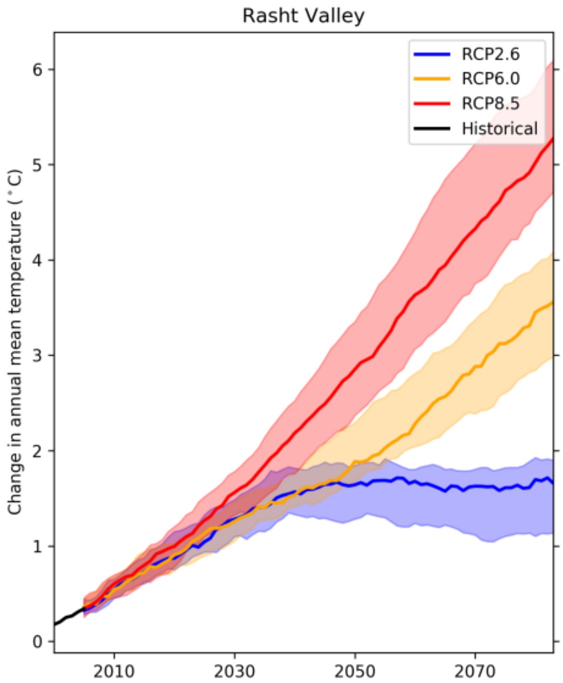

Figure 4: Temperature change projections for different GHG emissions scenarios (colour) and historical values (black). Each coloured line represents the 30-year running mean of the model ensemble under a given emissions scenario. Shaded areas represent the range of the model ensemble.

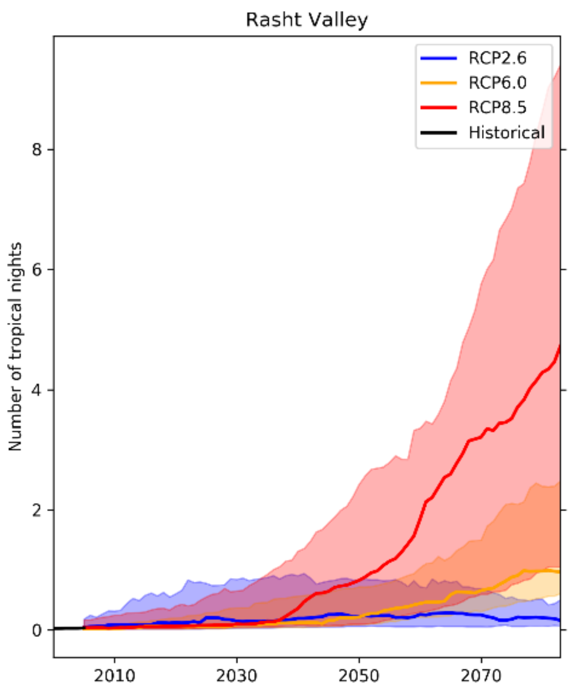

Figure 5: Number of tropical nights change projections for different GHG emissions scenarios (colour) and historical values (black). Each coloured line represents the 30-year running mean of the model ensemble under a given emissions scenario. Shaded areas represent the range of the model ensemble.

Tropical nights

During a tropical night, the temperature does not fall below 20°C. **An increase of tropical nights directly influences human well-being.** The increase in health threats can be monitored through the frequency of tropical nights. The energy sector is affected by a higher electricity demand during summer due to the increased use of air conditioning. Under RCP8.5, the multi-model mean for **tropical nights increases to a value of almost 5 nights by 2080.**

It needs to be noted that these numbers are geographic averages over the respective indicated region. Tropical nights are highly sensitive to elevations and can vary from location to location within the region if the elevation differs.

Precipitation

In contrast to projected temperature, **future trends for precipitation are more uncertain. This is because of the large, natural variability on multi-decadal time scales and considerable modelling uncertainty.**

Projected ranges (coloured shades for multi-model range) for changes in winter and spring precipitation allow an increase and decrease of precipitation under each scenario. Under RCP8.5, the multi-model range covers **a range of -2% to +30% for winter and -7% to +8% for spring by 2080.** However, the mean of the model ensemble (coloured lines) of all emissions scenarios shows a positive trend in winter. The multi-model mean for the RCP8.5 emissions scenario projects the highest mean **increase in winter precipitation reaching +12% by 2080**. **During spring, all emission scenarios except RCP8.5 show no trend.** The multi-model mean of the high emissions scenario, RCP8.5 shows a negative trend of up to -5% in spring precipitation to be reached by the second half of this century.

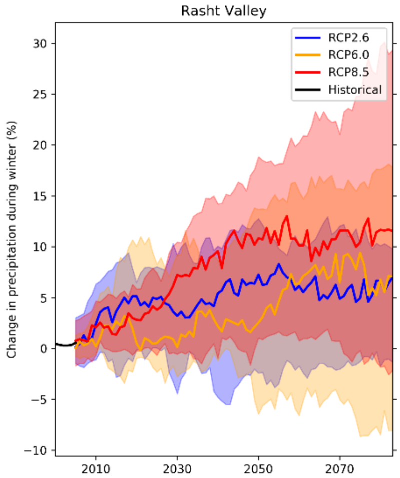

*Figure 6: **Winter precipitation** change projections for different GHG emissions scenarios (colour) and historical values (black). Each coloured line represents the 30-year running mean of the model ensemble under a given emissions scenario. Shaded areas represent the range of the model ensemble.*

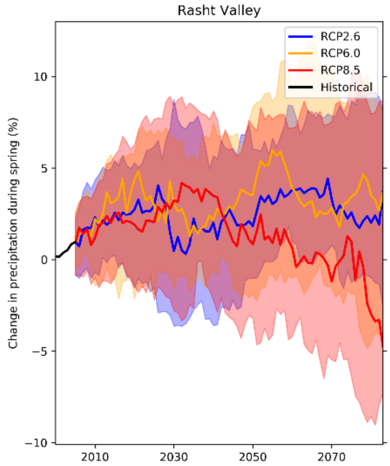

*Figure 7: **Spring precipitation** change projections for different GHG emissions scenarios (colour) and historical values (black). Each coloured line represents the 30-year running mean of the model ensemble under a given emissions scenario. Shaded areas represent the range of the model ensemble.*

Heavy precipitation events

Heavy precipitation events are expected to become more intense due to the increased water vapour holding capacity of a warmer atmosphere. Here, we defined extreme precipitation as a daily precipitation above 20mm. Projections show an increasing trend for extreme precipitation. Under RCP8.5, the multi-model mean for heavy precipitation days indicates an increase of approximately 1 day to reach a total value of up to 3.6 days by 2080.

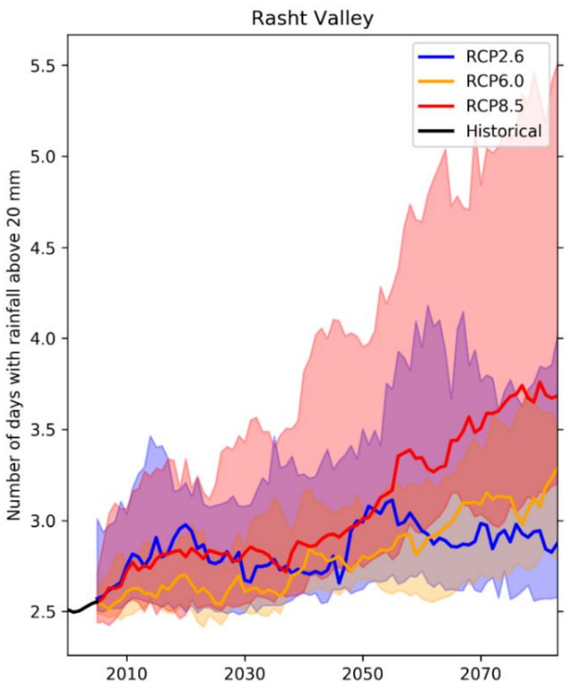

*Figure 8: **Heavy precipitation events** change projections for different GHG emissions scenarios (colour) and historical values (black). Each coloured line represents the 30-year running mean of the model ensemble under a given emissions scenario. Shaded areas represent the range of the model ensemble.*

Frost days and growing season length

As a consequence of increasing temperatures, **fewer frost days will occur and the growing season length (GSL) is expected to increase.** GSL is defined as the length of the period between the first spell of five consecutive days with mean temperature above 5°C and the last such spell of the year. Under the high emissions scenario, RCP8.5, **there will be approximately 202 frost days in 2030, 190 days in 2050, and 163 days in 2080.**

For the same scenario, the **GSL will approximately be 175 days in 2030, 190 days in 2050, and 212 days in 2080.** Despite an increasing GSL, the productivity during the growing season is at risk due to **more frequent and intense heatwaves and the risk of reduced irrigation water availability caused by higher evaporation and glacier retreat (especially in late summer).**

It needs to be noted that these numbers are geographic averages for the indicated region. Frost days and GSL are highly sensitive to elevations and can vary from location to location within the region based on elevation differences.

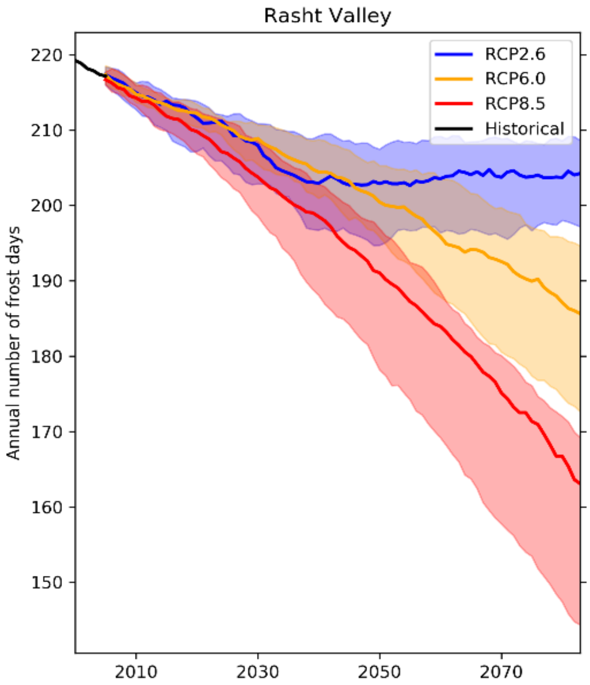

*Figure 9: **Number of frost days** change projections for different GHG emissions scenarios (colour) and historical values (black). Each coloured line represents the 30-year running mean of the model ensemble under a given emissions scenario. Shaded areas represent the range of the model ensemble.*

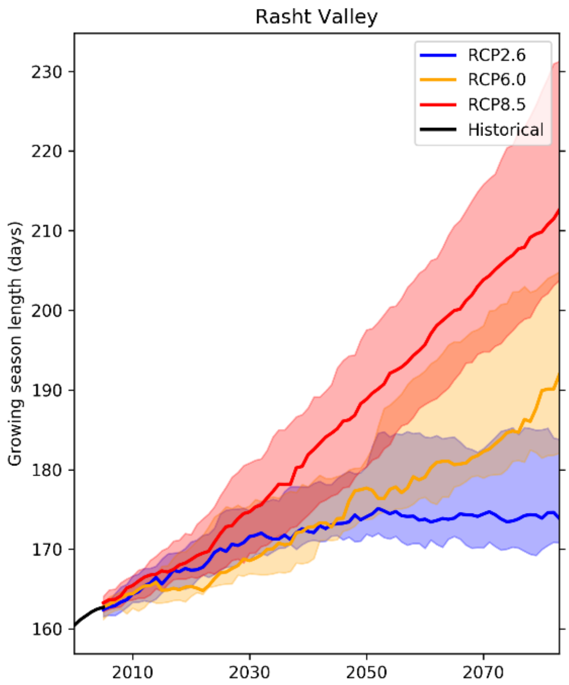

*Figure 10: **Growing season length (GSL)** change projections for different GHG emissions scenarios (colour) and historical values (black). GSL is defined as the length of the period between the first spell of five consecutive days with mean temperature above 5°C and the last such spell of the year. Each coloured line represents the 30-year running mean of the model ensemble under a given emissions scenario. Shaded areas represent the range of the model ensemble.*

Disclaimer

Like all projections, these climate projections have uncertainty embedded within them. Sources of uncertainty include data and modelling constraints, the random nature of some parts of the climate system, and the limited understanding of some physical processes. Uncertainty is addressed and visualized by using **state-of-the-art climate models, multiple scenarios of future greenhouse gas concentrations, and recent peer-reviewed literature.** Even so, the projections are not exact probabilities and the potential for error should be acknowledged.

References:

[1] Agency on statistics. (2018). *Гендерные показатели в производственной деятельности дехканских хозяйств.* Dushnabe: Agency for statistics.

[2] WFP (2016). *Market Environment Assessment.* TAJIKISTAN Rasht Valley, Khatlon & Faizobod, GBAO. Report accessed on https://www.wfp.org/publications/tajikistan-market-environment-assessment-rasht-valley-khatlon-faizobod-gbao-december-2016

[3] Asian Development Bank (ADB). (2013). *Republic of Tajikistan: Developing Water Resources Sector Strategies in Central and West Asia*

[4] Guenther, Robinson, Otambekov, Jumakhonova. (2006). *Moving out of poverty in rural Central Asia: long term economic development or high income volatility? A case study from Tajikistan.* 10.13140/RG.2.1.2929.2643.

[5] Robinson, S., & Guenther, T. (2007). *Rural Livelihoods in Three Mountainous Regions of Tajikistan. Post-Communist Economies*, *19*(3), 359–378. https://doi-org.ludwig.lub.lu.se/10.1080/14631370701312352

[6] World Bank Climate Change Knowledge Portal. (2019). Retrieved November 26, 2019, from https://climateknowledgeportal.worldbank.org/country/tajikistan.

[7] Aalto, J., Ka¨ma¨ra¨inen, M., Shodmonov, M., Rajabov, N., & Vena¨la¨inen, A. (2017). Features of Tajikistan's past and future climate. *International Journal of Climatology*, *37*(14), 4949–4961. https://doi-org.ludwig.lub.lu.se/DOI: 10.1002/joc.5135

[8] Convention on biological diversity (CBD). (2019). CBD/SBSTTA/23/INF/1. *Review of new scientific and technical information on biodiversity and climate change.* Published, 6th of November 2019. Retrieved from: https://www.cbd.int/meetings/SBSTTA-23

[9] Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). (2018). *Summary for policymakers of the regional assessment report on biodiversity and ecosystem services for Europe and Central Asia.* M. Fischer, M. Rounsevell, A. Torre-Marin Rando, A. Mader, A. Church, M. Elbakidze, V. Elias, T. Hahn, P.A. Harrison, J. Hauck, B. Martín-López, I. Ring, C. Sandström, I. Sousa Pinto, P. Visconti, N.E. Zimmermann and M. Christie (eds.). IPBES secretariat, Bonn, Germany. 48 pages.

[10] World Bank. (2019). Open Data Platform. Tajikistan Data Set. Retrieved from: https://data.worldbank.org/country/tajikistan

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