



RISKS FROM CLIMATE CHANGE FOR WATER & AGRICULTURE IN TURKMENISTAN

ASSESSMENT REPORT ON CLIMATE RISK, VULNERABILITY, GENDER AND VULNERABLE GROUPS

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List of Acronyms

CEDAW	Convention on the Elimination of All Forms of Discrimination against Women
CMIP6	Coupled Model Intercomparison Project Phase 6
CRVA	Climate Risk and Vulnerability Assessment
CSO	Civil Society Organization
FAO	Food and Agriculture Organization of the United Nations
GCF	Green Climate Fund
GONGO	Governmental NGO
IFAS	International Fund for Saving the Aral Sea
ILO	International Labor Organization
IPCC AR5	Intergovernmental Panel on Climate Change Assessment Report 5
IPCC	Intergovernmental Panel on Climate Change
IWRM	Integrated Water Resources Management
NAP	National Adaptation Plan
NAPGE	National Action Plan for Gender Equality 2021-2025
NDC	Updated Nationally Determined Contribution
NEX	NASA Earth Exchange
NGO	Non-Governmental Organization
PMT	Project Management Team
RCP	Representative Concentration Pathway
SDG	Sustainable Development Goal
SEP	Stakeholder Engagement Plan
SPI	Standardized Precipitation Index
SSP	Shared Socio-economic Pathway
TMHC	Tuyamuyun Hydro-Complex
UN	United Nations Organization
USAID	United States Agency for International Development
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
UNGA	UN General Assembly

1. INTRODUCTION

1.1 BACKGROUND TO THE ASSIGNMENT

The largest area share of Turkmenistan is classified as cold desert climate zone¹. For water supply it is highly dependent on water from outside the country – over 97% of water resources used originate from outside of Turkmenistan (cf. Figure 2)². Accordingly, its agricultural activity is exclusively bound to artificially irrigated land and water availability in general is a major concern. Under these circumstances a good preparation for changing climate conditions is crucial.

Turkmenistan's susceptibility to climate change stems from the continuous rise in temperatures and the growing scarcity of water. The effects of the changing climate are being felt across the economy, with the strong impact on the water sector. To address this issue, the Government of Turkmenistan aims to enhance its ability to adapt and build resilience to climate change by integrating measures to address climate risks and adaptation into its planning and budgeting processes. This will be accomplished through the development of a National Adaptation Planning process (NAP).

The aim of the UNDP NAP-Project is to tackle the current obstacles to mid- and long-term planning and funding for climate adaptation in Turkmenistan. It is intended to assist the Government of Turkmenistan in enhancing its capacity for climate change adaptation planning at the national and sectoral levels, analyzing climate risks in various sectors, integrating climate change adaptation into national planning and budgeting, and taking measures to improve investment in adaptation efforts. The water sector, which is highly susceptible to climate change, is given particular attention.

This assignment conducts climate risk and vulnerability (CRVA) assessments in order to create an evidence base for strengthening adaptation planning in the water sector while, at the same time, including a thorough analysis of vulnerability of different groups (women, children, youth, people with chronic diseases). Concretely, this assignment comprises climate risks assessments with prioritization of climate risks for adaptation actions on sub-national level in two pilot areas (Figure 1):

1. In Ashgabat: climate risk and vulnerability assessments on water resources with involvement of key stakeholders (Ashgabat city municipality-Public Utilities Department, etc.)
2. In Dashoguz province: climate risk and vulnerability assessments on water resources and irrigated agriculture with involvement of key stakeholders (Dashoguz province municipality, Ministry of Agriculture, the Ministry of Environmental Protection, State Committee on Water Management, Union of Industrialists and Entrepreneurs, farmers, community leaders, etc.)

This report presents the results of the climate risk and vulnerability assessments separately for both areas. While the rest of this section gives further background and scoping information, section 2 presents the overall methodology relevant for both regions. Section 3 presents the overarching review of Gender issues and vulnerable groups. The overall results for Dashoguz Province are given in section 4 and those for Ashgabat City in section 5. Section 6 finally gives a summarizing view of the social aspects identified.

¹ The World Bank Group and the Asian Development Bank, "Climate Risk Country Profile: Turkmenistan."

² The World Bank Group and the Asian Development Bank.



Figure 1: Map of the two focus areas - Ashgabat City and Dashoguz Province - along with the major water flows in the scope of this report - the Amu Darya River and the Karakum Canal.



Figure 2: Water resource formation and use in Central Asia³.

³ Zoi Environment Network, *The Climate-Cryosphere-Water Nexus in Central Asia*.

1.2 WATER RESOURCES IN TURKMENISTAN

Surface waters of Turkmenistan are almost completely (97%) formed outside Turkmenistan. The amount of flow and water quality in Turkmenistan is determined next to natural factors, also to a large extent by economic activities in neighboring countries. Turkmenistan primarily relies on the Amu Darya as its main water source. The majority of this river's water is utilized by Turkmenistan and Uzbekistan along the shared border of the two countries – however, in the upstream area increasingly Tajikistan and Afghanistan take water from the river's affluent streams. Turkmenistan diverts over 30 percent of the Amu Darya's total flow to meet its own needs, primarily achieved through the utilization of the Karakum Canal⁴.

In general, according to the average multi-year assessment, the annual volume of water resources of Turkmenistan is 25 km³, and at 90% availability, 23.9 km³. At the same time, in the last four years (2019-2023) there is a clear deficit of water resources⁵.

	2012	2015	2016	2017	2018	2019	2020
Water intake from natural sources (in mln m ³)	27763.7	29487.6	28117.7	28856.2	26880	27708.1	26244.7
Underground water	354	344.1	347.2	348.2	242.2	249.6	214.1

Source: Statistical yearbook of Turkmenistan (2020)

The total annual volume of surface water resources according to the actual flow to Turkmenistan is 23,414 million m³. The Amu Darya River, the main water artery of the country, accounts for most of the surface water (94%). The Murghab River, the second in terms of water availability, provides another 4.4% of the surface water structure. Other rivers of Turkmenistan account for the remaining 1.6%. However, for the project areas (Ashgabat and Dashoguz province), the Amu Darya River is practically the only source of water supply.

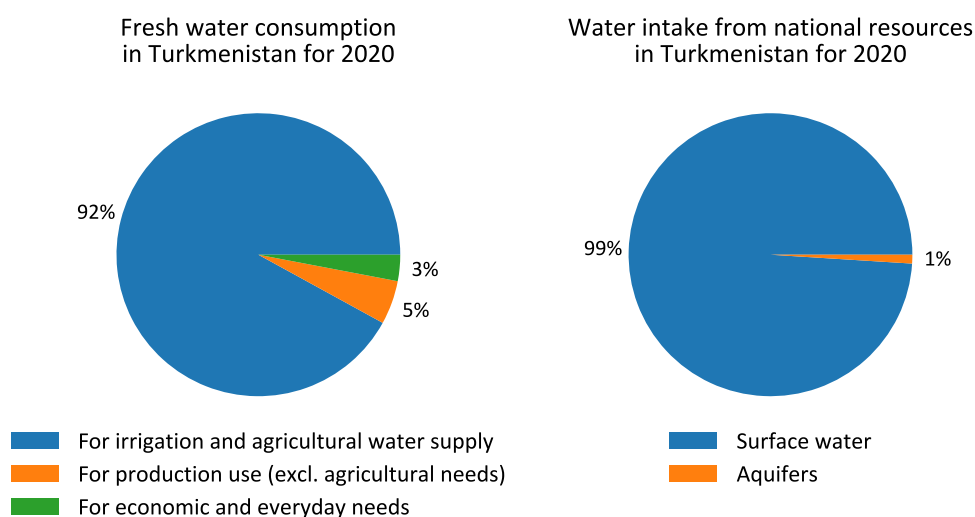


Figure 3: Shares of main water consumption and resources in Turkmenistan⁶.

⁴ Lerman et al., "Turkmenistan Agricultural Sector Review."

⁵ Stanchin, "Water Resources and Water Use in Turkmenistan: History, Current Status and Development Prospects."

⁶ Source: "национальный эксперт к.т.н. доц. Куртовезов Г.Д."

1.3 OVERALL SCOPE

1.3.1 Objective

This assignment is embedded in the National Adaptation Planning process (NAP) of Turkmenistan. In that, the UNDP Project Management Team intends to achieve the following outcomes:

- Outcome 1: An institutional framework to implement the Paris Agreement established
- Outcome 2: The evidence base for adaptation planning in the water sector strengthened
- Outcome 3: The capacity for adaptation planning strengthened

The focus of this assignment thereby is Outcome 2 aiming to create an evidence base for strengthening adaptation planning in the water sector. Specifically, the objective of the assignment is to conduct a climate change risk assessment on the water resources on sub-national level, on the water-agriculture nexus in Dashoguz Province and on water supply in the city of Ashgabat. As a further result, gender-specific climate risks resulting from the interplay of climate hazards, vulnerabilities, and exposed elements are assessed, prioritized, and gender-specific adaptation options for risk mitigation are identified.

1.3.2 Detailed scope

The scope of the assignment are assessments following selected assessment questions inside defined system boundaries. Here, for each focus area, the scope is slightly different. Whereas agriculture only plays a minor role in Ashgabat City, it is of primary focus in Dashoguz Province. The scope of this Climate Resilience Vulnerability Assessment (CRVA) is visually depicted in Figure 16 and Figure 39 for Dashoguz Province and Ashgabat City, respectively, outlining the boundaries of the respective system under examination.

1.3.3 Assessment guiding questions

With the water sector in the foreground for both areas, there is a strong overlap in the questions that guide each assessment. Of these, there are five for each project area ranging from analytical assessment, over adaptation options and particular focus groups to action-related advice including prioritization as well as guidance for action.

Question 1: What risks does climate change pose ...

... to the water-agriculture nexus in Dashoguz Province?

... for water supply in Ashgabat City?

This question aims to identify and analyze the potential risks that climate change poses to the water resources and, in the case of Dashoguz, also the agricultural sector overall (though this is directly linked to water-related issues). The purpose, here, is to examine the impact of changing weather patterns, future extreme events, and other climate-related factors affecting these sectors. This assessment is approached using the method of climate impact chains (cf. section 2.1) using quantification based on climate projections relevant for the water sector (cf. section 2.2).

Question 2: What are options for adaptation to mitigate those climate risks?

This question relates to the various adaptation options that can be employed to mitigate the climate risks identified in Question 1. Its aim is analyzing and recommending strategies, technologies, and policies that can increase the resilience of the water sector in both focus areas as well as the agricultural sector in Dashoguz to the impacts of climate change and promote sustainable water supply, use, and agriculture practices (cf. section 2.3).

Question 3: What groups are most vulnerable to climate risks and which adaptation options are gender-sensitive?

As an important part of the assessment, groups vulnerable to the risks identified in Question 1 are to be identified. Hence, this question regards such groups, but also includes the gender-dimension in the measures developed in Question 2. Here, aspects related to vulnerable groups or gender that have to be considered to prevent additional hardships.

Question 4: Which climate risks need action the most?

This question aims at the prioritization of the risks in terms of their overall danger and potential effects. Here, adaptation must be guided to use limited resources appropriately and tackling the most pressing issues, as to identified, first.

Question 5: How can decision making for adaptation be guided?

This question targets the decision process behind the adaptation action. Here, strategies are to be developed to guide the respective decision making and to build capacities for adaptation. This way, effective adaptation action can be facilitated, and maladaptation be avoided.

1.3.4 Validation workshop

The results from the first version of this document, including climate impact chains, climate analysis, and adaptation options, has been thoroughly discussed on a validation workshop with local experts – many of whom had also been interview participants. The results shown here have been adjusted based on the feedback received on the workshop.

Overall, the experts very much confirmed the analyses; discussions were mostly in consensus. They appreciated that risks have been identified and communicated on several dimensions – physical, social, and financial/economical. The experts additionally highlighted the importance of trans-boundary cooperation and a comprehensive water management program as overarching adaptation options. It also turned out that risks are barely confined to a particular scope and often follow-on risks in other sectors were mentioned – such as health, energy sector, or waste management. The links to other sectors have hence been included as hints to further complexes in the impact chain diagrams, where they were close in the analyses' scope. The potential for conflict over water was also added as suggested by the workshop participants.

2 METHODOLOGY

This section gives an overview of the main methodology used in this report to derive a thorough Climate Risk and Vulnerability Assessment. As a systematic qualitative approach, climate impact chains have been developed. The risk and vulnerability pathways identified in these lay the basis for quantitative climate analyses to estimate changes in these risks. All of these have been developed in close collaboration with local experts and stakeholders to ensure the relevance of the results for the local context.

2.1 CLIMATE IMPACT CHAINS

In order to grasp the complex interactions between potential climate hazards and the system components, climate impact chains have been developed for both focus areas. Climate impact chains represent a systemic approach to assess climate risks and derive solutions. Complex interactions of the various influencing factors are assessed qualitatively through a systemic approach. They thereby illustrate cause-and-effect relationships between climatic influences and their associated potential biophysical and socioeconomic impacts. This approach is based on the climate risk framework of the International Panel on Climate Change (IPCC), which was introduced in the IPCC's 5th Assessment Report (Figure 4)⁷.

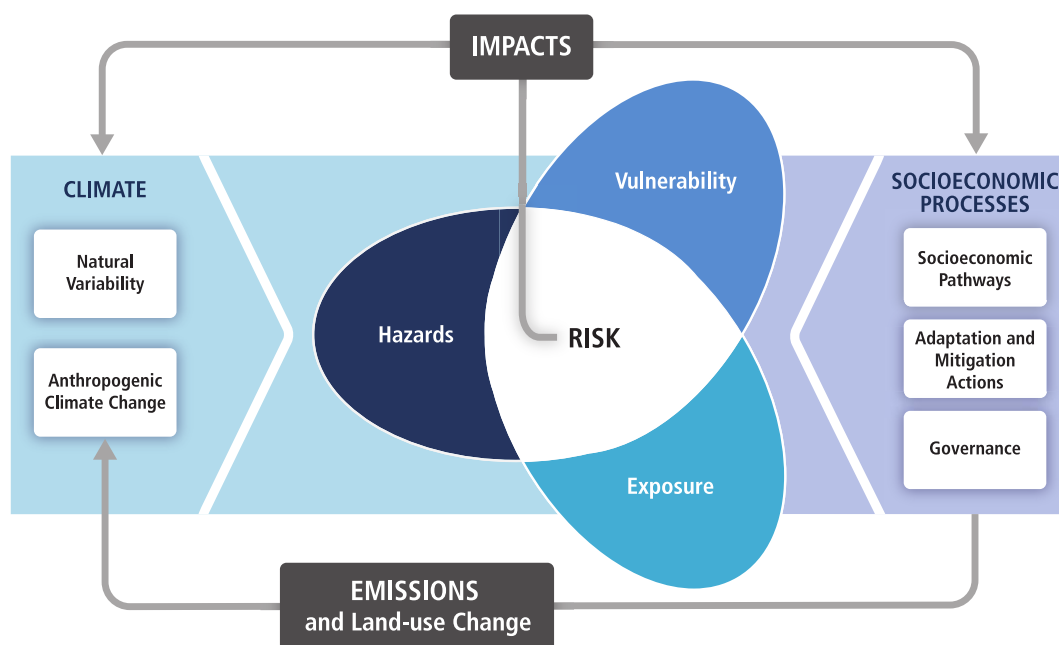


Figure 4: Climate Risk Assessment Framework of IPCC Assessment Report 5⁸

Climate impact chains are in line with the international standard for climate change adaptation ISO 14091:20219. In addition, climate impact chains have been used for national adaptation planning processes in Germany and internationally. For instance, the EU Commission's technical guideline on climate proofing of infrastructure projects recommends the use of climate impact chains to identify adaptation needs in terms of risk prevention and mitigation.

Adverse climate risks arise from the complex interplay of climatic influences (hazard), the spatial occurrence of exposed systems (exposure), and their predisposition with respect to the climate risks under consideration (sensitivity/vulnerability). As a result, cascading impacts cause cascading climate impacts that result into

⁷ IPCC, *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*.

⁸ IPCC.

climate risks (Figure 5). These are captured in the climate impact chains to be developed, thereby identifying the vulnerabilities of the respective system components.

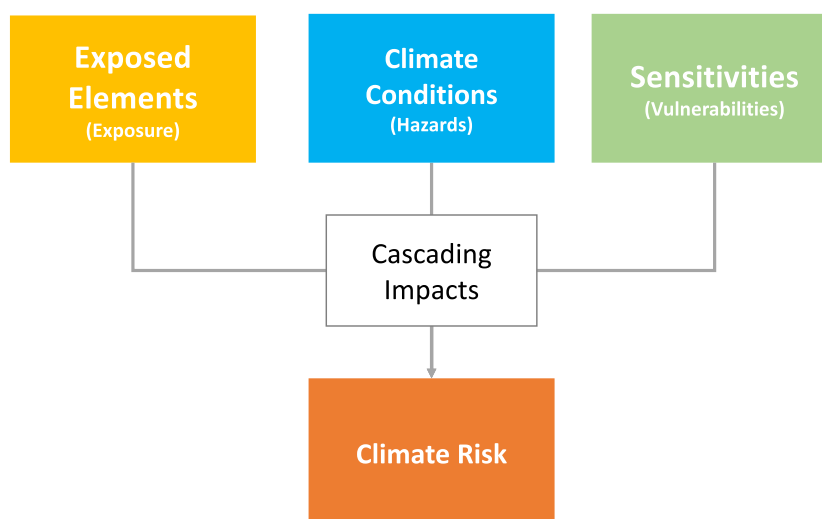


Figure 5: Complex interplay of the risk factors Exposure, Climate Hazards, and Sensitivities

The starting point for consideration thereby is the changing climatic influence (hazards), which can include heat, drought, or heavy rainfall events. This includes the type, extent, and speed of a climate change and variability, as well as related physical events or trends. The complex causes of effects that lead to adverse impacts will be determined with input from project experts, stakeholders, and a further literature review. For that, existing risk assessments will be reviewed alongside existing data on relevant weather patterns and additional data collected and participatory scoping undertaken during a field visit. As a qualitative they lay the basis for further assessments such as the development of adaptation options and, crucially, the expert judgment on the importance of the arising risks leading to a prioritization of issues in need of action.

2.2 CLIMATE ANALYSIS

Under progressing anthropogenic climate change, changes in various weather conditions are to be expected. Whereas some changes are already being experienced, future changes highly depend on global climate action now and in the future. Hence, standardized scenarios are used to capture possible pathways of greenhouse gas (GHG) emissions depending on potential action measures. Here, two of these are used, one scenario with global climate actions to mitigate GHG emissions and one business-as-usual scenario on the higher end of possible emission scenarios. With a certain degree of climate change already locked in due to past emissions, both, including even the more optimistic scenario, already shows strong changes as given in the respective sections below.



Figure 6: Map of areas selected for the climate analysis - Ashgabat City, Dashoguz Province, Amu Darya River (upstream of Dashoguz/Tuyamuyun Hydro Complex), Karakum Canal (upstream of Ashgabat), and the mountainous catchment area of the Amu Darya River. Over the sketched topography, gray shaded areas give the actual areas of the climate model output data grid cells used in the analysis for the respective region.

Both focus areas have a strong dependence on water supply from outside the area. Hence, in both cases, the upstream areas are assessed with regards to their projected climate conditions - in the catchment area as well as along the flat and arid area through which water is transported to the respective region. These areas are shown in Figure 6. In the case of Dashoguz these are, besides Dashoguz itself, the mountainous catchment area of the Amu Darya River and the river area between the catchment and Dashoguz Province. In the case of Ashgabat, these are the Karakum Canal, the river area between the canal and Ashgabat City, and Ashgabat itself. For each of these areas, changes in a selection of climate variables are estimated - temperature, precipitation, and wind - as well as derived quantities such as heat days, heavy rain, and tropical nights.

The estimation of changes in these variables is based on an ensemble of downscaled climate modeling results from the Coupled Model Intercomparison Project Phase 6 (CMIP6)⁹. It thereby uses results from a total of 29 climate models¹⁰, whose simulation runs have been standardized in the CMIP6 project, and hence can estimate uncertainties in the form of differing results between different models. These have been bias-corrected and downscaled to improve estimates on a local scale as provided by the NASA Earth Exchange (NEX) in its Global Daily Downscaled Projections (NEX-GDDP-CMIP6) dataset¹¹. For the use in this analyses, the geographic grid with a resolution of 0.25 degrees (about 25km) has been mapped to the respective areas (cf. gray shaded areas in Figure 6). Overall, for each model the respective climate variable has been estimated

⁹ Eyring et al., "Overview of the Coupled Model Intercomparison Project Phase 6 (CMIP6) Experimental Design and Organization." <https://gmd.copernicus.org/articles/9/1937/2016/>.

¹⁰ ACCESS-CM2, ACCESS-ESM1-5, BCC-CSM2-MR, CMCC-ESM2, CNRM-CM6-1, CNRM-ESM2-1, CanESM5, EC-Earth3, EC-Earth3-Veg-LR, FGOALS-g3, GFDL-CM4, GFDL-CM4_{gr2}, GFDL-ESM4, GISS-E2-1-G, HadGEM3-GC31-LL, INM-CM4-8, INM-CM5-0, IPSL-CM6A-LR, KACE-1-0-G, KIOST-ESM, MIROC-ES2L, MIROC6, MPI-ESM1-2-HR, MPI-ESM1-2-LR, MRI-ESM2-0, NESM3, NorESM2-LM, NorESM2-MM, UKESM1-0-LL

¹¹ NASA Earth Exchange (NEX), "Global Daily Downscaled Projections (NEX-GDDP-CMIP6)." <https://www.nasa.gov/nex/gddp>.

as a time series of the daily averages over the grid boxes covering the respective area (or maximum where stated otherwise)¹².

Temperature, precipitation, and wind are shown as annual time series for each season's average - Winter (December, January, February), Spring (March, April, May), Summer (June, July, August), Autumn (September, October, November) for the period of 1990 to 2100. As climate projections highly depend on global greenhouse gas emissions, these are shown for two different scenarios. The optimistic, strong global climate action/low emissions scenario ("Global Climate Action Scenario" in the figures) thereby is given by the standard SSP245 scenario (comparable to the RCP4.5 scenario in earlier phases of CMIP), whereas the "Business-as-usual", pessimistic scenario is represented in the SSP585 scenario (comparable to the former RCP8.5 scenario)¹³. Additionally, changes in the variables are estimated between two 20-year periods: a reference period spanning 1991-2010 as the "normal" or "commonly used to" state, and a future period covering the years 2041-2060 capturing climatic changes in the mid-term. These changes are calculated per model (i.e. estimating the changes between the two periods for each model first) and then presented as percentiles across the model ensemble in the figures and tables.

The derived quantities include the number of days with heat (with maximum temperature above 30°C), extreme heat (with maximum temperature above 45°C), tropical nights (with minimum - i.e. night - temperature above 25°C), and heavy rain (with total daily precipitation above 10mm). These numbers of days are counted per year per model and are shown as annual time series for each year from 1990 to 2100 for the two climate change scenarios. Additionally, changes in these quantities are estimated between the reference period (1991-2010) and the future period (2041-2060) and presented as percentiles across the model ensemble in the figures and tables.

Where statistics over the model are shown, these are given as percentiles over the ensemble of the output of 29 climate models - 5th, 25th, median (i.e. 50th), 75th, and 95th percentile. Assuming that the model results span all possible futures, values between the 5th and 95th percentile will occur with a probability of 90%, and with a probability of 50% the values will be in the 25th to 75th percentile range. In general, the *n*-th percentile will be undercut only with a probability of *n*% and exceeded with a probability of 100-*n*%. Hence, the median gives a good orientation of the expected value being equally likely to be exceeded or undercut. Where absolute and relative values for percentiles are given (in the case of precipitation and number of extreme days), these statistics are calculated separately, i.e., the relative values are taken relative to the mean reference baseline of each model and for each model first, then statistics are taken over the ensemble of relative values.

2.3 ADAPTATION OPTIONS

The climate risks that arise will have to be addressed by appropriate adaptation measures. Taking such measures early on in anticipation of increasing risks can thereby be a highly valuable investment paying off in case of future hazards. Here, options for such adaptation have been identified based on the identified impact chains and vulnerabilities in light of the projected changes to come under a changing climate. While climate conditions (hazards) can only be influenced by global efforts to reduce greenhouse gas emissions, vulnerabilities, along with exposure, are the main entry point for action to reduce climate risks. In that, the respective stakeholder and expert consultations conducted in the scope of this report have been of high value to identify the most pressing vulnerabilities and to discuss potential adaptation options.

2.4 VULNERABILITY ANALYSIS FOR DIFFERENT GROUPS

Water and climate change are inter-related issues. Water is the medium/agent through which the population experiences in climate change; it is the cause and result of most of the impacts of climate change. Climate change is negatively impacting on the availability, quality and quantity of water needed to meet basic human

¹² GIS-Data from HydroRIVERS (<https://www.hydrosheds.org/products/hydrorivers>) and GADM (<https://gadm.org>).

¹³ van Vuuren et al., "The Representative Concentration Pathways: An Overview."

needs. This is why the efficient water management is an integral part of addressing climate change. Climate change may lead to reduced water supply and increased demand for water, as well as deterioration of water quality and increased risks of pollution (and even contamination) of water resources and flooding. Climate change is a global problem and threat for all categories of population, but socially vulnerable categories are more affected by this factor: they are more dependent on environmental conditions and adapt less well to climate change due to limited social and financial resources. These and other social inequalities between men and women (including gender inequality) are further exacerbated by global climate change.

Climate change stress often manifests itself as water shortages or excesses, including extreme weather events, floods, droughts and sea level changes. The water sector plays a central role in managing these climate stresses, working to mitigate the threats of climate change through resilience, adaptation and mitigation of greenhouse gas emissions. According to the UN, climate change affects everyone, but the poorest and most vulnerable people, especially women and girls, elderly people and youth, bear the brunt of the environmental, economic and social upheavals.

Women play an important role in water management in agriculture, as they are often involved in supply, harvesting, storing and processing food. However, they face unequal access to resources, services and decision-making, which limits their opportunities and potential. While women's role in water management has been recognized, gender issues become even more relevant in the context of climate change, when the competition for resources becomes higher. Gender analysis of water resources identifies and addresses the specific needs, interests and contributions of women and men, and promotes gender equality and sustainable development. Raising awareness and building the capacity of female and youth audience is key to meeting this challenge

The purpose of this study is to determine the impact of climate change on women, children, youth, people with chronic diseases¹⁴ (based on information on the management of water resources and water-related natural disasters). According to the investigation some recommendations on possible interventions are given to overcome barriers women are facing (agricultural producers among them) to benefit from innovations on adaptation to climate change. The study also identifies how climate change-related natural disasters (floods, sandstorms) as well as progressive events (drought being the main concern) affect the target group.

A gender analysis¹⁵ tool has been used during the development of this report. The study was conducted using a combination of quantitative¹⁶ and qualitative data using the several research tools (questionnaire survey, focus group discussions). An original questionnaire was also used to explore the current beliefs and practices by men and women on a wide range of important issues related to gender equality. Climate change and its consequences affect various groups of the population, especially women and men¹⁷, differently. For that, the available gender-disaggregated data provided by the State Committee on Statistics of Turkmenistan were analyzed.

The main emphasis thereby is on the analysis of indicators disaggregated by gender, age, level of education and income, as well as place of residence of women and men.

The gender analysis of the situation of women and vulnerable groups in Dashoguz Province and the City of Ashgabat was built at the sub-national level in urban and rural areas. Gender analysis was used to examine

¹⁴ Among them are many elderly people and people of low income.

¹⁵ Gender analysis is the process of assessing the different impact on women and men by existing or proposed programs, legislation, government policies in all spheres of society and the state. Gender analysis provides a clear view and comparability: how and why the measures of the analyzed policies affect women and men differently from a gender perspective.

¹⁶ Statistical data by the State Committee of Turkmenistan on Statistics available for the city of Ashgabat and Dashoguz Province.

¹⁷ It depends on the percentage of the poor population; also, it depends on type of energy used for heating, lighting, cooking; also, it depends on the way of waste disposal and how this affects the preservation of ecosystems.

the capabilities and resources of women and men in accessing resources, assessing the impact of climate change on their economic status and forms of employment, the ability to use innovations on adaptation of living conditions change, and sharing the burden of unpaid domestic work and the responsibilities of childcare, upbringing and education.

In some cases, group interviews and observation were used. Communication activities were carried out to inform and receive feedback from key interest groups. A “snowball” strategy was also used - people met indicated who else should be talked to and what needs attention. The collection of statistical data was carried out through desk research. This method was used to review policy frameworks reflected in international and national policy documents, legislation, as well as secondary data such as statistics and other studies on water resources and climate change from a gender perspective. Despite their importance and relevance, most of the official indicators approved at the global and national levels on climate change and assessing its impact on women and men do not have gender-sensitive indicators. All gender-sensitive data available were analyzed. The main emphasis is on the analysis of indicators by gender, age, level of education and income, as well as place of residence of women and men.

The following documents have been reviewed and analyzed during the development of this review:

- International legal documents in the field of gender equality, as well as on climate change issues, to which Turkmenistan is a party. International documents were analyzed to identify norms and measures to ensure gender equality in climate change policy.
- National development strategies (short and long-term ones), as well as country strategies and programs in the field of gender and climate change policy. The analysis was focused on identifying measures and indicators across NAP sectors that are directly or indirectly related to gender and climate change aspects. At the same time, focal gender and climate strategic documents were considered from the point of view of reflecting climate change issues in gender policy and vice versa, reflecting gender aspects within the framework of climate change adaptation policy.
- Sectoral strategies, plans, development programs for NAP sectors to take into account gender and climate change issues. Particular emphasis was placed on identifying the gender, climate and water NEXUS.
- Local development programs for Ashgabat City and Dashoguz Province to take into account the commitments and measures of gender and climate change policies mentioned within these documents.

The following questions were asked for focus group discussion:

- How does climate change affect water resources in your region or country?
- How do women and men use and manage water resources in agriculture?
- What gender differences and inequalities exist in terms of access, control and influence over water resources?
- How does climate change affect women and men in agriculture, their living conditions, health, income and food security?
- What gender needs, interests, and contributions have been identified in the context of water and climate change?
- What gender goals and strategies are proposed to improve water management and adaptation to climate change?

3 GENDER AND VULNERABLE GROUPS – REVIEW

3.1 WATER RESOURCES AND WATER-RELATED CHALLENGES: SITUATION ANALYSIS

As stated above, Turkmenistan is located in Central Asia, between the Caspian Sea in the west, Iran and Afghanistan in the south, Uzbekistan and Kazakhstan in the north. In comparison, Turkmenistan is the second largest country in Central Asia with a total area of 491,200 sq. km. The length of the Turkmenistan border is 5,504 km (3,420 miles), of which almost a third is the coastline of the Caspian Sea.¹⁸

Turkmenistan's water resources are distributed extremely unevenly. Another characteristic feature of them is the fact that 95% of surface water is formed outside of Turkmenistan and, accordingly, the volume of water entering Turkmenistan is determined not only by the water content of the rivers, but also by the needs of the economies of neighboring countries. With some of these there are bilateral agreements (such as with Uzbekistan and Iran) however, for others such as Afghanistan there are none.

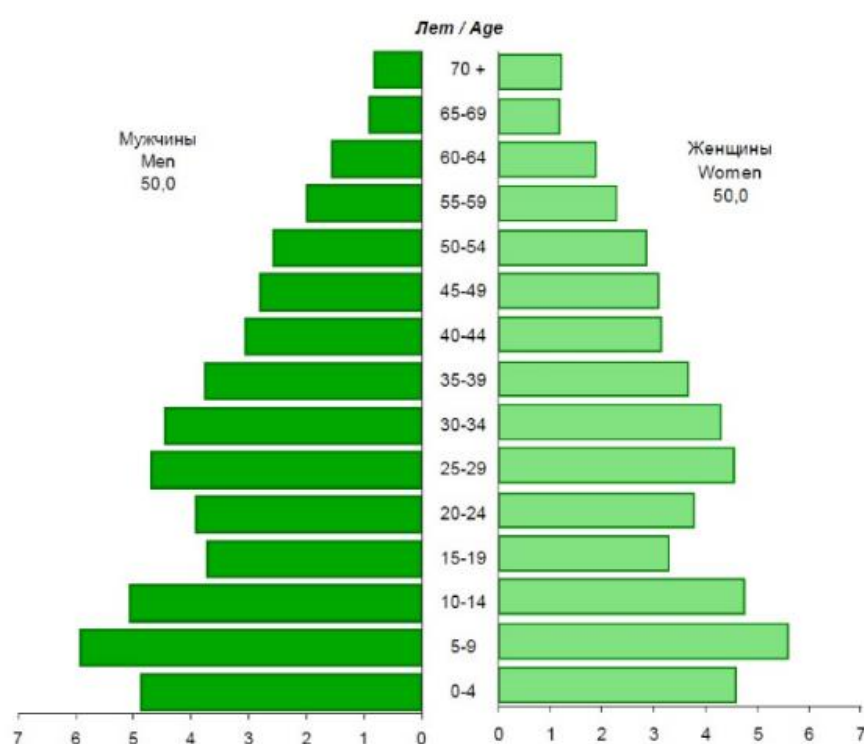


Figure 7: Sex and age structure of the population of Turkmenistan as of January 1, 2023.

Source: Yearbook 2022 by the State Committee of Turkmenistan on Statistics

nature/ecosystems. In addition, climate change causes an increase in the frequency and amplitude of extreme weather/temperature events, shifting seasons, and changing wind patterns, which also have a negative impact not only on living organisms, but also on infrastructure.

The population growth puts a significant pressure on water resources. As per World Bank data, the population of Turkmenistan increased three times during the period from 1960 to 2020, and now as per

The Amudarya River is the main waterway, which provides more than 23 million cubic meters per year (i.e. 94% of Turkmenistan's water intake) for the needs of the national economic complex of Turkmenistan. For Ashgabat and Dashoguz, Amu Darya is the single water source.

Among the main threats that climate change poses to the water resources of Turkmenistan are:

- a reduction in water availability,
- a shift in water availability peaks and
- a deterioration in water quality.

These factors are unfavorable for both humans and

¹⁸ Country Risk Profile | Turkmenistan, / Development of a mechanism for disaster risk transfer in the countries of Central Asian Regional Economic Cooperation 2022 - p.8.

official data by State Committee on Statistics, the population of the country in 2022 numbered 7,060.9 thousand people (including in Ashgabat – 1 030.400 people, in Dashoguz Province - 1,550.900 people).

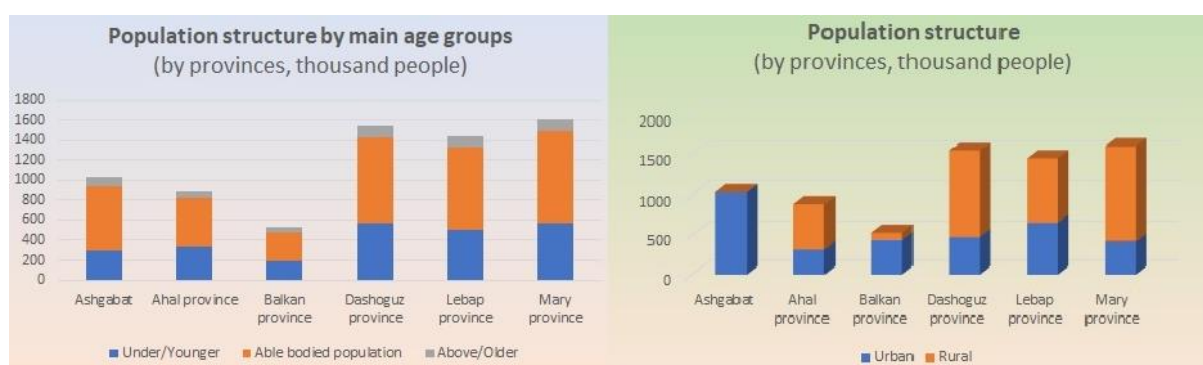


Figure 8: Population structure of Turkmenistan.

Source: Yearbook 2022 by the State Committee of Turkmenistan on Statistics

According to the State Committee of Turkmenistan on Statistics (cf. Figure 8), the gender structure of the population as of January 1, 2023 is presented as: men - 50.0% (3,527.9 thousand people) and women - 50.0% (3,533.0 thousand people). The structure of the population employed in agriculture is 43.3% (including 37.4% tenants and farmers

Along with population growth and economic development in Turkmenistan, the need for water is also growing - not only for drinking and for domestic needs, but also to meet the needs of industry and irrigated agriculture. The dynamics of growth in fresh water consumption by region (million cubic meters) is presented in Figure 9. Water supplies are being impacted by climate change, which is leading to rising temperatures, disrupted rainfall patterns and melting glaciers, all of which can reduce water supplies or the time it is available. Storms, droughts and other extreme weather events can both change water supplies and increase demand for water resources.

Climate change and environmental degradation threaten children's well-being and quality of life, particularly as water resources are reduced and water and air quality are deteriorating, which is likely to have a profound impact on children.

Turkmenistan's economy is concentrated in the industrial sector and remains heavily dependent on gas extraction. The country's share of industrial value added, equal to 57% of GDP, is the highest among CAREC countries¹⁹. Meanwhile, value added and the share of employment in agriculture are among the lowest in the region²⁰.

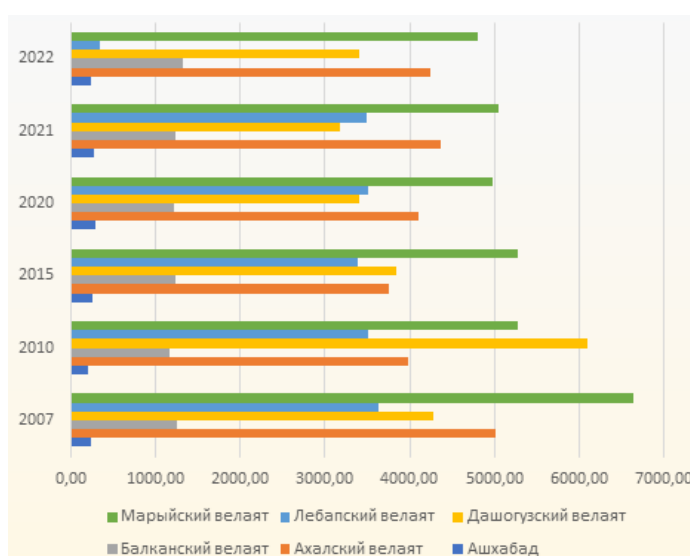


Figure 9: Fresh water consumption by regions/Velayats (million cubic meters).

Source: Yearbook 2022 by the State Committee of Turkmenistan on Statistics

¹⁹ Here: The CAREC partnership includes Afghanistan, Azerbaijan, PRC, Georgia, Kazakhstan, Kyrgyz Republic, Mongolia, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan

²⁰ World Bank (2021). World Bank Open Data. Employment in agriculture (% of total employment) (ILO modeled estimate). Access in April 2021 via: <https://data.worldbank.org/indicator/EN.POP.DNST>.

Table 1: Indicators of socio-economic vulnerability²¹.

Poverty rate at national poverty line (% of population)	N/A
Human capital indicator	N/A
Indicator GINI	40.8 (1998)
Gender Inequality Indicator	N/A
Household size	N/A
Dependent person ratio (% of working age population)	55 (2019)
Unemployment rate	4.1 (2020)
Gross general government debt (% of GDP)	31.366 (2018)
Child mortality under five years of age (per 1,000 live births)	42 (2019)
Life expectancy at birth (women)	72 (2019)
Life expectancy at birth (men)	65 (2018)
% of population using at least basic sanitation services	99 (2017)
% of population using at least basic drinking water services	99 (2017)

Source: Country Risk Profile | Turkmenistan (TA-9878 REG: Development of a mechanism for disaster risk transfer in the countries of Central Asian Regional Economic Cooperation; Publication by CAREC – 2022).

Rural residents and those whose income depends on agriculture and livestock are particularly vulnerable to negative impacts during drought. The productivity of desert oases and steppe pastures is highly dependent on precipitation, evaporation of water into the atmosphere and soil moisture.

In the majority of scientific publications, vulnerable groups of the population include the following categories of citizens:

- elderly pensioners;
- people with disabilities;
- pregnant women, infants and children;
- female-headed households and/or single mothers raising minor children;
- large families with low incomes;
- unemployed;
- children from orphanages, people living in nursing homes;
- stateless persons and refugees.

In relation to vulnerable categories in relation to “climate change” in Turkmenistan, a more general clustering is used:

- Women
- Children and youth

²¹ Country Risk Profile | Turkmenistan / Development of a mechanism for disaster risk transfer in the countries of Central Asian Regional Economic Cooperation 2022 - p.40.

- Persons with chronic diseases.

3.2 ANALYSIS OF REGULATORY DOCUMENTS AND PARTICIPATION IN DECISION MAKING

This section provides information on the current regulatory framework in the field of water resources management, in the field of gender equality, as well as in the field of ensuring participation in decision-making and implementation of activities. Considering the fact that Turkmenistan is a unitary state, laws adopted at the country level are valid and binding at the Velayat (province) level.

Water resources and their rational use are the main (although not the only) factor in the economic, social, and environmental well-being of the population of Turkmenistan. That is why, within the framework of this report, an analysis was carried out not only of the legal framework on gender equality issues, but also national programs, strategies and legislation, that promotes an integrated water management approach, were analyzed. The main National (long-term) program, that is related to SDG-30 is the program adopted at the beginning of 2022 and titled as “Revival of a new era of a powerful state: National Program for the Socio-Economic Development of Turkmenistan in 2022–2052”. Shorter and more focused versions of this program are presented as the “National Program of the President of Turkmenistan for the transformation of social and living conditions of villages, towns, cities, etrap and etrap centers for the period until 2028” and the “Program of the President of Turkmenistan for the socio-economic development of the country in 2022–2028” (both adopted in 2022).

The key development trends for water sector are presented also in the “National Strategy of Turkmenistan on Climate Change until 2030” (second edition has been adopted in 2019). Turkmenistan pays special attention to creating conditions for the involvement of small and medium-sized businesses in the industrial sector, the development of effective organizational and legal forms: the country has a “State Program to Support Small and Medium-Sized Enterprises in Turkmenistan for 2018–2024”.

Key policy and strategy documents that regulates the water management issues at the national level are:

- Concept for the development of the region of the Turkmen Lake “Altyn Asyr” in the period 2019–2025 and the Action Plan for its implementation;
- National program of Turkmenistan for the Aral Sea for 2021–2025,
- National strategy for the development of renewable energy in Turkmenistan (up to 2030);
- State program of Turkmenistan on energy saving for 2018–2024;
- National Forestry Program of Turkmenistan for 2021–2025;
- State program for the development of the digital economy of Turkmenistan (2021–2025);
- Concept for the development of the digital economy of Turkmenistan (2019–2025);
- National strategy for the management and reform of enterprises with state participation for 2021–2025;
- State program to support small and medium-sized businesses in Turkmenistan 2018–2024;
- National program “New Village” (until 2028);
- Civil Defense Program (Emergency);

An updated version of the State Program of the President of Turkmenistan titled as “Health” and the Plan for its implementation for 2021–2025 (adopted in 2021).

Turkmenistan has developed a National Action Plan to strengthen the SDG reporting in Turkmenistan. This document presents a medium-term strategic vision for the implementation of the SDGs in Turkmenistan, that built on the previously achieved results of integrating the SDGs into national policies, and presents further priority measures for implementation. In 2023, Turkmenistan has developed the second “Voluntary National Review on the implementation of the global sustainable development agenda”, which reflects progress towards achieving SDG 6 “Clean water and sanitation” for the period 2015–2022, as well as

identifying further steps to achieve targets under SDG 6. In 2022, the NDC²² report was submitted to the Secretariat of the UN Framework Convention on Climate Change. In 2020, while preparation of the Fourth National Communication and the first biennial report on climate change began.

The GLAAS Country Survey (2021-2022) was launched for the first time providing information on management, human resource monitoring and financing in a field of water, sanitation and hygiene sectors.

In 2020, Turkmenistan joined the UNECE's international program "Trees in Cities Challenge".

The water diplomacy concept by the President of Turkmenistan is set out in the Agricultural Complex Development Program for 2019-2025 and it covers the issues of cooperation between riparian countries. The priorities and objectives for the development of water economy in Turkmenistan are also reflected in the joint statements by the Heads of states that founded the IFAS and in the decisions by the members of the IFAS Board.

The "Action Program to Improve the Environmental and Socio-Economic Situation in the Aral Sea Basin" (ASBP-4) was developed and adopted in 2021 (June 29). This concept also covers part of the IWRM issues and sets goals and objectives of a technical, social, economic and financial nature.

In the near future, the further implementation of the Action Plan developed within the Concept for the development of the region of the Turkmen Lake "Altyn Asyr" in the period 2019–2025 will be continued at the national level to ensure the efficient use of the country's natural resources. In addition, the creation of this Lake will prevent the flooding of lowlands over an area of 4060 km²; also, it will make it possible to extract salts from water during its purification and desalination; it will create a favorable conditions for the development of fishery as well as it will make possible to return pastures flooded by drainage waters into circulation and to improve the quality of irrigated lands.

In order to increase the efficiency of the implementation of the National Program of Turkmenistan for the Aral Sea for 2021–2025, a regular monitoring of its implementation is planned, which will be carried out by the Intersectoral Commission for the development of the Aral National Program of Turkmenistan for 2021–2025.

It seems logical to bring together the existing disparate national strategies and concepts into one document (tentatively called "IWRM Implementation Roadmap"), which should be expanded with the following sections:

- Assessing the needs for the revision and/or development of regulatory legal and technical documents that are necessary for the implementation of IWRM. Expected results: lists of documents with justification of relevance.
- Assessing the needs for optimizing the institutional structure for IWRM implementation. Expected results: recommendations for improvement.
- Mechanisms/procedures that guarantee the participation of civil society organizations (including those representing the interests of vulnerable groups of the population) and private business. Expected results: procedural paper on the involvement of CSOs in the process of implementing IWRM.
- Mechanisms/procedures for co-financing projects/measures for the implementation of IWRM. Expected results: provision for the involvement of the private sector in the process of IWRM implementation.
- Assess the training and professional development needs in the field of IWRM both for the specialists of water sector and for ones who work with other institutions/IWRM stakeholders.

This work should be carried out in accordance with the IWRM principle on "Wide involvement of all stakeholders", using the format of "working groups" to draft each particular section of the "National IWRM Implementation Strategy". In case of efficient partnership between National institution duly supported by

²² Nationally Determined Contribution under the Paris Agreement.

international consultancy is settled for a “road map” development, then there is a high probability of upgrading of this document to the status of a “National IWRM Implementation Strategy” formally approved.

In March 2018, the President of Turkmenistan proposed to develop a “Central Asian Water Strategy”, since the relevance of this initiative has only increased since then, the discussions on the possibility of developing this document continue within the framework of IFAS. Also, Turkmenistan is an initiator of the development of the “UN Special Program for the Aral Sea Basin”.

The implementation of ASBP-4 continues in four areas:

- integrated use of water resources;
- environmental sector;
- socio-economic sector;
- improving institutional and legal mechanisms.

Gender issues are reflected in laws/plans including ones that are related to water management issues. Considering the current state and progress achieved during last 5-7 years, it should be noted that ensuring gender equality and empowering all women and girls is a cross-cutting subject within the national policy. Turkmenistan is pursuing an active gender-oriented national policy aimed to implement the principle of equal rights and opportunities for women and men while their participation in all spheres of social and political life.

The constitutional principle of equality of rights and freedoms for women and men is the basis of the country's legislative and regulatory framework. According to the Constitution of Turkmenistan, state guarantees have been established to ensure gender equality in all spheres of state and public life.

The National Law “On state guarantees of equal rights and equal opportunities for women and men” contains the relevant provisions of international conventions in the field of gender equality. The law establishes state guarantees for ensuring equal rights and equal opportunities for women and men in all spheres of state and public life, including healthcare, education, science, culture, employment and social protection, as well as other areas.

The application of the principles of the ILO²³ Convention regarding the “equal payment to women and men for work of equal value” is guaranteed in the Labor Code of Turkmenistan.

Monitoring of women's rights to participate in policy formation, planning and implementation of activities in the field of water resources is carried out by the Office of the Ombudsman, which operates on the basis of the Law of Turkmenistan “On the Ombudsman”.

When planning and designing the internal water supply and sanitation systems (including sanitary equipment) for residential and public buildings, the special needs of women are taken into account through the special requirements of the “Construction standards/norms and rules/regulations of Turkmenistan” and the “Sanitary Standards & Rules of Turkmenistan”.

National Reports on the implementation of the CEDAW Convention (CEDAW) is submitted to the UN Committee on the Elimination of All Forms of Discrimination against Women on a regular basis (every four years). The information on key legislative, institutional, administrative and other practical measures taken during the reporting period are presented in this report. In 2022, the sixth periodic report of Turkmenistan was prepared and submitted to the UN Committee. In 2023, Turkmenistan presented its second Voluntary National Review on eleven SDGs (including SDG 5 and SDG 6). According to the materials of this review, the country is implementing the “National Action Plan for Gender Equality in Turkmenistan for 2021–2025,” which is aimed to improve the conditions/environment for further expanding the participation of women in all spheres of life of the state and society. Within this period, work in the following areas (in connection with the SDGs) is planned:

²³ International Labor Organization

- Strengthening inclusiveness of institutions and the rule of law will improve gender equality in the country - SDG 16.3; 16.6; 16.7; 16.10; 16.a; 16.b
- Economic empowerment of women and girls - SDG 1.4; 2.3; 5.1; 5.4; 8.3; 8.10
- Increased participation of women at all levels, including in the political and public spheres - SDG 5.5; 5.8
- Countering gender-based violence against women and girls - SDG 5.2; 16.1; 16.3
- Creation of decent jobs for women. Maintain parity of opportunity in all spheres of life - SDG 1.1; 5.5; 8.3; 8.5; 8.6; 10.1; 10.2
- Reducing maternal and child mortality, caused by infectious and non-communicable diseases - SDG 3.1; 3.4
- Strengthening the institutional mechanisms to support gender equality - SDG 5.1; 8.8

Incorporating gender perspectives into water and land management is an approach that was adopted by Central Asian countries in the early 2000s. The active gender-oriented national policy, based on constitutional principles, is being pursued in Turkmenistan to achieve sustainable development goals.

Legislative and organizational measures are being taken to ensure equal rights and opportunities for men and women. To ensure guarantees of gender equality, the Law of Turkmenistan “On State Guarantees of Equal Rights and Equal Opportunities for Women and Men” was adopted in 2015.

In 2020, a MICS-6 Survey²⁴ “The health and status of women in the family in Turkmenistan” was conducted as part of the implementation of the National Action Plan for Gender Equality in Turkmenistan for 2015-2020. The work was attended by the Ministry of Health and Medical Industry of Turkmenistan, the State Committee of Turkmenistan on Statistics, the Ministry of Internal Affairs of Turkmenistan, the Ministry of Labor and Social Protection of the Population of Turkmenistan, the Institute of State, Law and Democracy of Turkmenistan, the Women's Union of Turkmenistan and the United Nations Population Fund (UNFPA). Survey data and results were used for reporting on SDG 5 (indicators 5.2.1. and 5.2.2).

In November 2022, a roadmap for the implementation of the recommendations of the «National Sample Survey on the health and status of women in the family in Turkmenistan for 2022-2025» was developed. It includes four main areas:

1. Improving legislation for the development and adoption of a law on the prevention of domestic violence;
2. Building a coordinated system of services to support and protect women victims of violence;
3. Implementation of measures to prevent violence against women and all forms of gender discrimination;
4. Collection and analysis of data on the frequency, prevalence, and characteristics of gender-based violence within and outside the family.

Almost the entire population of Turkmenistan has access to basic sanitation services. The State Sanitary and Epidemiological Service (SSES) of the Ministry of Health and Medical Industry of Turkmenistan provides a regular monitoring of water quality at the places where water is used by the population. On regular basis the water quality analyses are performed in the certified laboratories of State Sanitary & Epidemiology Service (located in all velayats and etraps): water is sampled at the places of water intake by population; drinking water samples are examined as prescribed by the requirements of the state standard on “Drinking Water”.

²⁴ MICS-6 Survey results are available at: https://mics-surveys-prod.s3.amazonaws.com/MICS6/Europe%20and%20Central%20Asia/Turkmenistan/2019/Survey%20findings/Turkmenistan%202019%20MICS%20SFR_Russian.pdf.

According to the results of the MICS-6 cluster survey, the proportion of the population using water supply services organized in compliance with safety requirements has increased significantly.

Significant efforts are being made to ensure the provision of Turkmenistan population with access to centralized systems of drinking water supply water and ensure an adequate level of sanitation. To support these activities the sectoral, territorial and thematic programs and strategies are periodically updated and successfully implemented, including:

- “Health” (2021-2025) – State program of Turkmenistan;
- “Village” - National program;
- National Strategy on Climate Change of Turkmenistan;
- National action plan for adaptation of the health of the population of Turkmenistan to climate change and its negative consequences for 2020-2025;
- Program of the President of Turkmenistan for the socio-economic development of the country for 2022-2028;
- Program for the development of the agricultural complex of Turkmenistan for 2019-2025;
- National Action Plan for Gender Equality in Turkmenistan for 2021-2025.

The state pays duly attention to areas with high levels of water consumption and water pollution. In November 2022 a complex of mudflow drainage structures has started operations. Being allocated in the Ashgabat region, it was designed and constructed to trap strong mudflows resulting from heavy rains, and further to use accumulated water for drip irrigation.

The country is implementing the “General Program for Clean Drinking Water supply for Turkmenistan settlements” (01/10/2011). As part of the program, water treatment/purification plants and desalination plants are being built in all velayats; existing water treatment facilities and water supply systems are being reconstructed; modern water saving technologies are being introduced to improve the availability and accumulation of water resources.

Women make a worthy contribution to the sustainable socio-economic development of the country and to the activation of civil society; the increase of females among employees is an evidence of it (40.1% of the women employed within the large and medium-sized enterprises in 2015 against the 42.5% of total number of employees in 2021)

Currently, the participation of women in all spheres of the socio-political life of the state is steadily increasing; on equal rights with men, Turkmenistan women are working in the representative, executive and legal governmental institutions on all levels.

Women are widely represented in all three political parties formally registered by government bodies; women are also working in local executive and representative bodies, local government bodies and the Mejlis of Turkmenistan (Parliament). Thus, in 2022, 25.7% of Parliament members were women (indicator 5.5.1); 21.7% of Halk Maslahaty (Supreme Council) members were female as well as almost 22.4% of top managers (indicator 5.5.2).

Thanks to the development of digitalization, more and more people, including women, are acquiring information and communication skills; the majority of them has a mobile phone and Internet access. Schools are introducing more robotics classes and encouraging initiatives to get girls into tech fields. Thus, according to the MICS-6 cluster survey (2019), almost 91.1% of women aged 15–49 years have their own mobile phone.

The legal regulation tools combined with organizational, economic, environmental, and technological measures are significantly important for optimization of water use.

The UNESCO Chair “Environmental Education for Sustainable Development” was opened at the Turkmen State Pedagogical Institute named after S. Seydi in February 2023.

The UNESCO club titled as “An Environmental protection is an important concept of sustainable development” was established at the Turkmen Agricultural Institute in Dashoguz in 2023.

As it has been formally reported (Country Report on Assessment of SDG 6.5.1 progress), over the past three to five years the significant progress was achieved in the field of gender perspectives in laws and plans regulating water issues (in 2023 it was estimated at forty points out of 100, which corresponds to the description: “Mechanisms and practices for gender mainstreaming in water resources management are being developed”).

According to official data²⁵, the participation of vulnerable groups in the regulation of water management issues remains low (ten points out of 100) that is textually determined as: “Participation of vulnerable groups not explicitly addressed in laws, policies, or plans.”

Further improvement in the field of gender-oriented policy in Turkmenistan is expected in the form of expanded participation of women in all spheres of social and political life. The state will continue to stimulate the development of market relations in the agricultural sector, providing equal rights and opportunities to both men and women. Activities aimed to increase a share of women entrepreneurs will be continued (this trend is confirmed by data provided by the State Statistics Committee of Turkmenistan: 23.1%, of female entrepreneurs in 2015 was increased up to 32.5% in 2022. In 2021, 1,039 land plots were allocated for agricultural production, of which 54 were allocated to women, and 901 plots out of 4,616 ones were allocated to women in 2022.

National water policy specialists understand that the main barrier for the effective participation of women in water resources management is their insufficient capacity in the field of integrated water resources management. Therefore, a lot of work remains to train the representatives of women's communities in the theory and best world practices of IWRM. This will make it possible in the future to create sustainable mechanisms/procedures for improvement the information access and participation in the IWRM decision-making process. The legal procedures of registration of such mechanisms is needed to be developed and put into practice. In addition, there is an understanding that more digitalization results more involvement of women, so it is logical to use IT tools within the capacity building programs.

It is also planned to continue educational, research, and information programs in the field of gender aspects of water resources management under climate change.

Characterizing the current situation in the field of participation of vulnerable groups in policy formation, planning and implementation of activities in the field of water resources, it can be stated that such participation is feasible as per Water Code of Turkmenistan both at the national and subnational levels. Discussions are currently underway on the possibility of developing by-laws that would clearly outline procedures and mechanisms for participation, sources of funding and measures to develop the human resources of government officials to involve vulnerable groups in water resource planning activities.

²⁵ Country review on assessment of progress towards SDG 6.5.1 achieved up to 2023.

4 WATER-AGRICULTURE NEXUS IN DASHOGUZ PROVINCE

4.1 OVERVIEW

Dashoguz province covers an area of 73.4 thousand square kilometers with an estimated total population of 1,550,324 (as per statistical data 2022). The urban population is estimated by 30% and rural population 70%. Food industry constitutes up to 61% of overall industrial production in Dashoguz Province (Statistical Yearbook 2020).

Table 2: Industry production in Dashoguz Province

District name	Production (mln Manat)	volume	Unit weight in terms of total volume (percentage)
Dashoguz city	865.5	1.3	
Kunyaurgench city	117.2	0.3	
Boldumsaz district (including data for former Gubadag district)	689.8	1.0	
Kunyaurgench district	355.1	0.5	
Akdepe district (including data for former District named after Gurbansoltan-eje)	960.9	1.4	
Saparmurat Turkmenbashi district	495.2	0.8	
Gerogly district	453.9	0.7	
District named after Niyazov	644.1	1	
Rukhubilent district	355.1	0.1	
Total for Dashoguz province	4633.9	7.1	

Water resources of Dashoguz province

The Amu Darya River is the main water source and provides water to nine districts through a system of canals and reservoirs. Water supply for agriculture, drinking water supply and industrial use depends in all districts on services of the Tuyamuyun Hydro Complex (THC) and its reservoirs, which also provide water to Uzbekistan (roughly 1/3 to Turkmenistan and 2/3 to Uzbekistan) (Figure 10).

Table 3: Fresh water consumption by regions (Ashgabat and Dashoguz province only) in 2020 (mln m³)

Territory	Total consumption	Including:		
		For irrigation & agriculture water supply	For production use (excluding of agricultural production needs)	For economic and everyday needs
Turkmenistan	17 504.1	16 119.6	931.0	453.5
Ashgabat city	299.0	17.2	38.1	243.7
Dashoguz province	3 403.8	3 380.6	2.0	21.2
Dashoguz city	18.3	6.7	0.8	10.8
Kunyaurgench city	1.2	0.4	0.1	1.0
Boldumsaz district (including data of former Gubadag district)	500	497.8	0.1	2.1
Kunyaurgench district	380.9	379.7	0.2	1.0

Akdepe district (including data of former District named after Gurbansoltan-eje)	731.8	727.8	0.3	2.7
Saparmurat Turkmenbashi district	879.5	876.2	0.1	1.2
Gorogly district	349.9	348.9	0	1.0
District named after Niyazov	414.4	413.0	0.3	1.1
Rukhubilent district	128.5	128.1	0.1	0.3

Water is supplied to these districts through the Turkmendarya system.

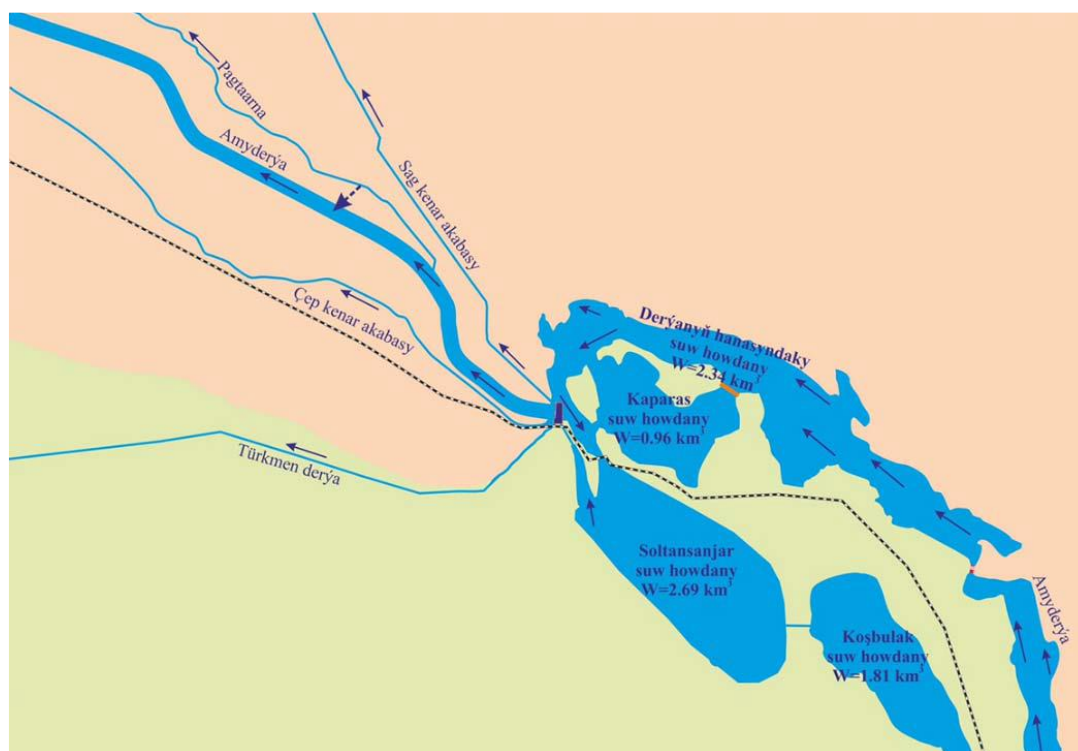


Figure 10: Schema of the Tuyamuyun Hydro Complex on the Amu Darya River (see also Figure 17) including its reservoirs and the channel systems fed by it.

At present, the lands of Dashoguz province are irrigated mainly from two large irrigation systems:

- northern part of the districts from the Khanab system with water intake directly from the Amu Darya downstream of THC and
- southern part from Turkmendarya with water intake from the Tuyamuyun Hydro Complex.

From the Tuyamuyun Hydro Complex, water flows to the Turkmendarya, which supplies water to the lands of five of the existing nine districts of Dashoguz province. At present, water coming from the Turkmendarya is used for irrigation of lands of Akdepe, S. A. Nyyazov, Gorogly, Gurbansoltan Eje, and Rukhybelent districts. The volume of water withdrawn from the Tuyamuyun Hydro Complex for the needs of Dashoguz province is about 47.8 % of the total water intake in the province. The throughput capacity of the I stage of the Turkmendarya (Tuyumuyun canal) was 210- 220 m³/s²⁶. With maximum water used for cotton crop rotation

²⁶ Volynov A.M., Zabelin V.A., Kiyatkin A.K., Lunezheva M.S. Land irrigation in Central Asia and Kazakhstan. - M.: Kolos, 1980 - 239 p. 2. Litvinov Y.P., Matafonov E. Results of research on the degree of influence of the Tashauz branch canal on the adjacent lands of Khorezm and Tashauz provinces. -Sb. of scientific works: Issues of land reclamation and water problems in Turkmenistan. - A.: Ylym, 1992, p. 118-126).

equal to 0.9 l/s per 1 ha of irrigated area, Turkmenyarya (I turn) can irrigate about 221 - 232 thousand ha of land. The table above presents information on irrigated areas for some key crops cultivated in Dashoguz.

According to statistical data in Dashoguz province, there is a reduction of sown areas, while significant efforts are made to reconstruct irrigation systems (cleaning and rearrangement of irrigation systems) to combat siltation. In order to solve the issues of guaranteed water supply, certain works are carried out to search for alternative water sources (use of collector-drainage water, exploration and operation of wells for groundwater extraction).

Agricultural production in Dashoguz province is traditional. Cotton is mainly grown in the region in rotation with wheat. The region is one of the main producers of rice, fruits and berries (41.8%), potatoes (14.8%) and melons (30.1%) in the country. Of the oilseed crops, sesame is grown.

One of the main branches of agriculture is cattle breeding. Dashoguz province is the first in the country in terms of cattle population 45.0%, milk production (41%), and small cattle population (29,4%).

The total crop area of the farms in Dashoguz province is 349.5 thousand hectares.

Table 4: Crop area and gross gathering of some agricultural crops in Dashoguz province in 2020

Crop	Crop area (thousand ha)	Gross harvest (kt)
Cereals and legumes	162.3	331.0
Cotton	155.8	281.5
Vegetables	8.4	216.9
Cucurbit crops (melons, cucumber, ...)	6.6	140.4
Potato	8.401	155
Fruit & Berries		92
Grape		22.4

Table 5: Animal breeding: Livestock and poultry (thousand heads) (as of January 2021)

Category	All farms out of total for whole Turkmenistan	Agricultural enterprises
Cattle	1,081.7 out of 2,489.6	10.5
Of which Cow	515.4 out of 1258.0	2.6
Sheep and goats	3700.8 out of 18744.9	85.9
Camel	16.8 out of 140.3	14.2
Houses	8.9 out of 27.7	0.3
Poultry	4758.8 out of 20606.2	10.0

Fishery is widely practicing in Dashoguz province. It is carried out on lakes formed by collector-drainage waters with a mineralization of 3–5 g/l, which is discharged from irrigated lands. The main share of fish catch comes from Sarykamysh and other lakes. Currently, fishing in Turkmenistan is carried out by the private sector - the Union of Industrialists and Entrepreneurs of Turkmenistan.

Dashoguz province is located in the downstream area of Amu Darya River and therefore it is obvious that the region is equally acute for water quantity and quality issues. One of the ways to solve water availability in Dashoguz province is transition to water-saving dialogs. There are small areas of both drip irrigation and sprinkling in Dashoguz province. For example, one can cite the farmer association named after S. Rozmetov. S. Rozmetov or new cattle-breeding complex located on the road of airport and Dashoguz city, where wide-catchment circular sprinkling machines are used for growing fodder crops.

The problem of water quality is being addressed in the course of implementation of the National Program to improve the population's access to drinking water. There are drinking water plants in Dashoguz province, one of which takes water from the Turkmendarya canal with water intake from the THC. The plant or treatment facility intended for water supply of Dashoguz city purifies water to drinking quality (TDS-2874-82 Drinking Water. Hygienic requirements and quality control or GOST 2874-82. Drinking water). The drinking water plant belongs to the administration of Dashoguz city.



Figure 11: State-managed channel (left) and drainage collector (right) in Dashoguz Province.

Focus here is the interrelation of water and agricultural sector. For the latter, water supply is organized by large state-managed channels (Figure 11) which feed a network of smaller privately owned channels leading directly to farms (Figure 12), some which even have small capacities for storing some of the water to manage their water supply more flexibly (Figure 12). In a similar manner, drainage water is collected from fields and transferred to larger state-managed collectors (Figure 11), which eventually take the drainage water to the Turkmen Lake “Altyn Asyr” in the west of Dashoguz Province.



Figure 12: A larger privately managed channel (Yarmas Canal with a capacity of 10m³/s; left), a water pump at the farm border providing water for the farm from the public channel (middle), a farm-owned water tower used as small reservoir (right)

The predominant form of irrigation of crop fields in Dashoguz is flood irrigation for which fields are flattened accordingly (Figure 13). Still, especially with high temperatures, this form of irrigation is prone to high evaporation losses. Additionally, the almost total dependence on irrigation water (in contrast to rain-fed water supply) leads to salinization of the soil. Here, leaching, i.e. “washing”, of soil is required to keep salt

levels appropriate for crops. Hence, there is a typical water use time evolution in a typical year (as shown in Figure 14) – with high irrigation water use in spring and later summer/autumn for leaching and first irrigation in the beginning of the year, and low irrigation needs during winter months.



Figure 13: Crop field in Dashoguz Province with drainage collector in front and soil barriers for flood irrigation.

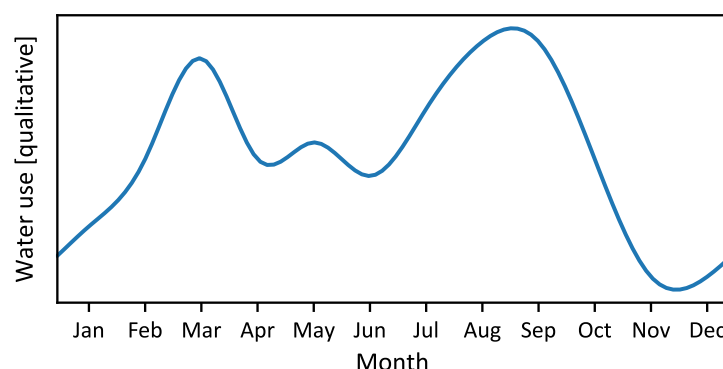


Figure 14: Typical water use in the course of one year (qualitative).

Besides crop growing, animal husbandry is the second pillar of agriculture in Dashoguz Province. Whereas some species and breeds are primarily kept on pasture land, others are kept directly on-farm (Figure 15 upper part). Mostly, farms provide the animal fodder themselves, either on close-by pasture lands, using farm-produced crops, or more specialized fodder produced on premises (Figure 15 middle part). Especially in hot summer months, animals kept on the farm, and in particular breeds not used to local hot conditions, need to be cooled. This constitutes an additional water demand – either for spraying the animals directly or providing bathing as cooling (Figure 15 lower part).



Figure 15: Cows at outside trough (upper left), cows in inside summer hall (upper right), seeds and seedlings for cattle fodder (middle), channel end lake used for cattle cooling in summer (bottom)

4.2 DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS

Dashoguz velayat is an administrative unit in the north of Turkmenistan. The administrative center of the region is Dashoguz. Table 6 provides the following data for Dashoguz Province according to the Statistical Yearbook as of January 1, 2023.

Table 6: Key facts Dashoguz Province.

Population, thsd people	Territory, thsd sq. km	Etraps	Cities	Settlements	Gengeshliks	Rural
1550,9	73,43	7 ²⁷	9 ²⁸	7	120	594

Dashoguz Province population structure as of January 1, 2023 is presented in Table 7.

Table 7: Dashoguz Province population structure as of January 1, 2023.

Dashoguz population structure by gender	thsd people	%
Male	775,2	50
Female	775,7	50
Dashoguz population structure by age	thsd people	
Younger than able-bodied population	568,1	37
Able-bodied population	859,2	55
Older than able bodied population	123,6	8
Dashoguz velayat population structure	thsd people	
Urban	474,1	31
Rural	1076,8	69
TOTAL population in Dashoguz velayat	1550,9	100

Source: Statistical Yearbook - 2022

The average population density is 21 people per 1 sq.km. Key sectors of the economy in Dashoguz Province are agriculture, light, and food industries. Agriculture is dominated by cotton growing and livestock. Rice, barley, corn, and sesame are also produced on a large scale. Vegetable crops (including potatoes) and perennial grasses are also grown in Dashoguz Province. Silk production and horticulture are developed (apricots, apple trees, peaches, quinces, pears), and there are vineyards. The cultivation of agricultural crops has been carried out for several centuries on relatively fertile lands, for irrigation of which river water is supplied to the fields through large irrigation systems²⁹. Using the collectors to drain fertile lands, salt water (from the vicinity of the old channel of the Amu Darya) is discharged into the Sarykamysh Lake.

Statistical yearbooks of 2015, 2016, 2017, 2018 and 2019 provided information on the growth of income of the population of Dashoguz velayat in national currency (see Table 8):

²⁷ Seven Etraps (districts): Akdepe Etrap (formerly Leninsky); Boldumsaz Etrap (formerly Kalininsky); Gorogly Etrap (formerly Takhtinsky); Kone-Urgench Etrap (formerly Kunya-Urgench); Shabat Etrap (formerly Dashoguz; named after S.A. Niyazov); Ruhubelent Etrap; Etrap named after Saparmurat Turkmenbashi (formerly Oktyabrsky).

²⁸ 9 cities: Akdepe; Boldumsaz; Gorogly; Gubadag; Andalyp; Koneurgench (formerly Kunya-Urgench); Shabbat; named after Saparmurat Turkmenbashi; Dashoguz

²⁹ Namely Tashsoka, Kylychniyozboy, Jumabaisoka, Kypchakbozsuv; names of old canals are: Shavat and Gazavat

Table 8: Income time development

2014	2015	2016	2017	2018	Average
604,7	662,1	672,2	706,3	779,5	685,0

The main problems in the field of water resource management in Dashoguz Province are determined by its location: Dashoguz Province is a downstream area of the Amu Darya River, and therefore the population of this region faces not only the problem of lack of water (which is significantly aggravated in dry years), but also problems of its quality (up to today drainage waters from the territory of Uzbekistan are still discharged into the Amu Darya³⁰).

In order to solve the problem of water shortage, agricultural producers of Dashoguz Province are actively studying the prospects for switching to water-saving technologies (there are already small areas of both drip irrigation and sprinkling, for example, in the S. Rozmetov peasant association or in the new livestock complex located along the road to the airport in Dashoguz, where wide-spread circular irrigation machines are used to grow 10 fodder crops).

Problems of drinking water quality are solved by expanding the capacity of water treatment facilities. In Dashoguz Province there is a drinking water plant that takes water from the Turkmendarya canal with water intake from Tuyamuyun hydroelectric complex (THMC) - The volume of water taken from TMHC for the needs of Dashoguz Province is about 47.8% of the total water intake in the velayat. A plant or treatment facility intended for water supply for Dashoguz purifies water to the level of drinking quality (TDS-2874-82 Drinking water. Hygienic requirements and quality control or GOST 2874-82. Drinking water). The drinking water plant belongs to the Khyakimlik of Dashoguz. Payment for the purification and delivery of drinking quality water through the pipeline system is carried out according to established tariffs and the volume of water used. The volume of water used is measured by meters installed on pipelines in outlets to households.

The region has sufficient land resources, but water resources are limited. The main industries dependent on the Tuyamuyun Hydro Complex include agriculture and water management, public utilities, energy³¹, and processing industries. The population receives income mainly through agriculture, crop production and livestock breeding and is interested in the normal operation of TMHC.

The water resources of this region are also important for fisheries, which is an important factor for replenishing the fish diet of the local population of the region. It should be noted that the main share of fish catch in Dashoguz Province falls on SarykamyshLake and other lakes, into which collector-drainage waters with a mineralization of 3-5 g/l are discharged. Collector waters drained from the irrigated fields are formed during surface irrigation, leaching of saline lands, and filtration from irrigation network canals in earth beds. Part of the water taken from the TMHC replenishes the collector-drainage waters and thereby indirectly participates in the reproduction of fish stocks. Currently, in Dashoguz Province the fishery was transferred to the private sector/entrepreneurs who are members of the Union of Industrialists and Entrepreneurs of Turkmenistan. Fish products produced in Dashoguz are used mainly for the domestic market with export to other regions of the country.

The development of greenhouse farming can be considered as an adaptation measure in the Dashoguz region. In Dashoguz there are industrial-scale greenhouses of both state and private ownership. The Turkmen Agricultural Institute provides a bachelor program on greenhouse farming on a budgetary and paid basis. This specialty is very attractive (and equally accessible) for both men and women. The products of greenhouse farms in Dashoguz Province serve domestic markets as well as the country's exports.

³⁰ http://cawater-info.net/library/rus/sic-icwc_proceedings_12_2021.pdf

³¹ Citizens of Dashoguz Province are not using the energy produced by Tuyamuyun Hydro Complex.

4.3 SCOPE

For Dashoguz Province the agricultural sector is in particular focus due to its strong entanglement with the water sector of the area (Figure 16). For water system elements here is a strong emphasis on the irrigation network used for agricultural water use. Additionally, agriculture elements are in focus. These include soil (with regard to its use and quality, e.g. affected by salinization), crops, and livestock. The area's water supply is exclusively sourced from the nearby Amu Darya River, hence, the climate conditions along this water source are part of the assessment along local conditions.

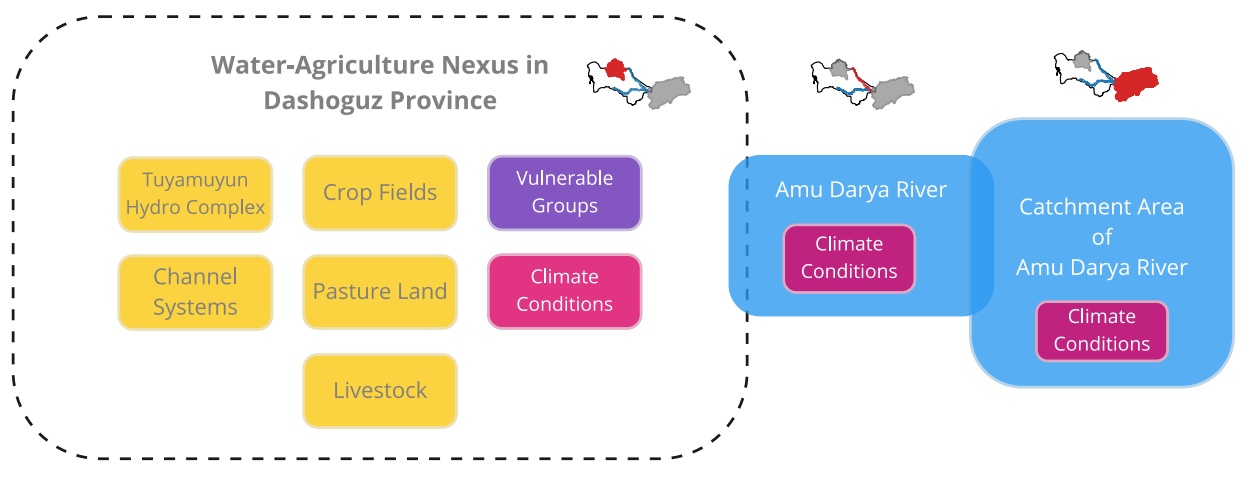


Figure 16: Scope of Climate Risk and Vulnerability Assessment in Dashoguz Province.

An overview of these – the mountainous catchment area of Amu Darya River, the river itself between the catchment and the Tuyamuyun Hydro Complex, which supplies Dashoguz Province with water, and Dashoguz Province itself is given in Figure 17.



Figure 17: Map of areas selected for the climate analysis for the water-agriculture nexus in Dashoguz Province - Dashoguz Province, Amu Darya River (upstream of Dashoguz/Tuyamuyun Hydro Complex), and the mountainous catchment area of the Amu Darya River.

4.4 CLIMATE IMPACT CHAIN

Climate Impact Chain — Water-Agriculture Nexus in Dashoguz Province

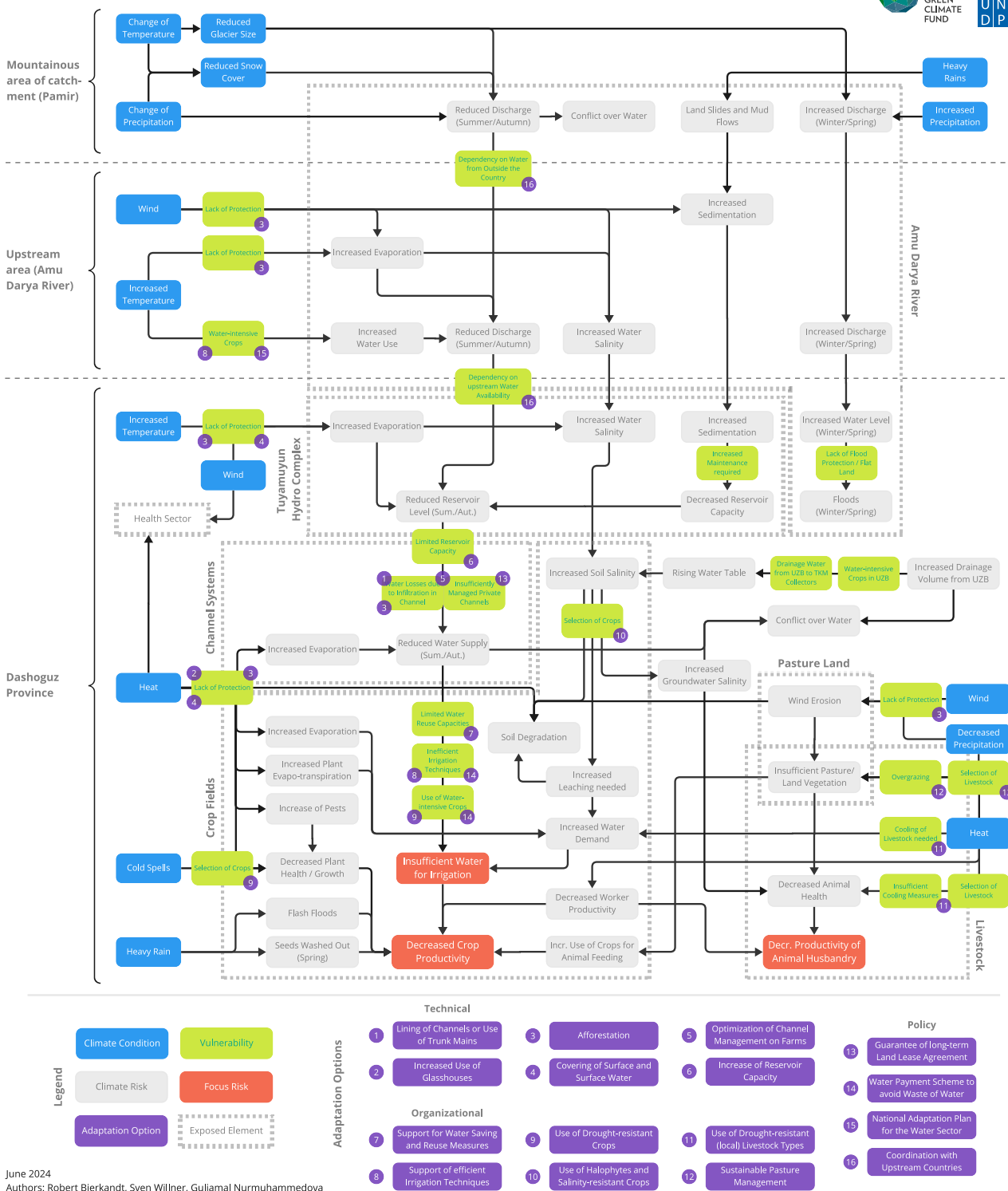


Figure 18: Climate Impact Chain for Dashoguz Province visualizing the interrelations between climate conditions (blue), vulnerabilities (green), exposed elements (within dotted lines) and arising risks (gray and red). Adaptation options to tackle specific vulnerabilities are provided as numbers (purple) referencing adaptation options given on the right.

Figure 18 illustrates the major impact channels that affect the water-agriculture nexus in Dashoguz Province with a focus on the water sector. It thereby differentiates between climate conditions and impacts outside the region and those inside. As virtually all water sources are from outside the region, conditions in the

upstream area of the Amu Darya River as the major water source play a particular role. These have been divided into the mountainous catchment area of the river outside of Turkmenistan (upper part of the figure) and the river area between the catchment and Dashoguz Province (middle part) – also see Figure 6 for a geographical overview. The lower part of the figure shows the part of the impact chain in Dashoguz Province itself.

The catchment area of the Amu Darya River is characterized by its mountains in which rain, glaciers, and snow melt constitute the major sources of the river. Here, changes in temperature and precipitation can lead to changes in river discharge – highly depending on the season. For instance, increasing temperatures would lead to retreating snow lines, more glacier melt and earlier snow melt in spring – moving overall discharge to earlier months. Thus, discharge in spring would increase whereas it would decrease in summer and autumn, even with the same amount of overall precipitation. With several territories depending on these waters on different heights of the river, this can spark or aggravate further conflict of the water provided by the river. Heavy rains, on the other hand, could lead to land slides and mud flows in the vicinity.

Once the Amu Darya River reaches the flat low lands, its additional water intake there is negligible to upstream sources (Figure 2). Here, the main potentially climatic influences are temperature increases and wind leading to water losses due to additional evaporation as well as increased sediment intake from sandy surroundings by strong winds. With strong agricultural activity around the river withdrawing water, potentially reduced discharge can be worsened when increasing temperatures require additional water use. Additionally, with potential shifts of large river discharge to earlier in the year, there is a risk of floods along its river bed also in the east of Dashoguz Province.

As described above, the water supply in Dashoguz is mainly derived from the Tuyamuyun Hydro Complex, a system of reservoirs fed by the Amu Darya River. This high dependency on upstream water availability for Dashoguz constitutes a major factor in managing reservoir levels according to discharge changes during the year. Additionally, increased temperature and wind would lead to water losses due to evaporation and increase of salt concentration in the water. With high sedimentary intake by the Amu Darya River, reservoirs also function as settling basins requiring maintenance efforts to keep high reservoir capacity.

The supply of fresh water to farms for irrigation is organized through a vast network of channel systems - the six major systems of Khan-yab, Klychbay, Jumabaysaka, Turkmenderya, Kypchakbossu. While the upstream parts of these systems, between the reservoirs and the farm land, are government-managed, smaller channels downstream are privately managed by farmers. Hence, there is a big difference in the quality of channel construction and management with high risks of water losses, e.g. due to infiltration. Additionally, evaporation constitutes another source of water loss as most of the systems are in the open.

As the climate in Dashoguz Province is very arid, crop agriculture there fully depends on water supplied by the channels for irrigation. Hence, reduced water availability along the supply chain – the channels, the upstream reservoirs, and Amu Darya River – constitutes a major risk of insufficient water for irrigation and consequent decrease in crop output. An increase in heat in local climate conditions would further increase this risk by increasing the evaporation of irrigation water on the field as well as evapo-transpiration of the planted crops. These factors increase the dependence on water bearing the potential for conflicts between different water users. Additionally, extreme temperature changes constitute a risk for plant health and growth in general, directly, as well as indirectly by increasing the potential for new and more dangerous pests. On the other hand, heavy rains during the planting season have been reported to increase the danger of washed-out seeds.

Such a strong irrigation scheme naturally leads to the accumulation of salt in the soil due to changes in the water table as well as evaporation and evapo-transpiration of the water leaving its original salt content behind. In order to reduce soil salinity to a level suitable for the designated crops, fields are leached – i.e. salt is washed out of the soil – requiring additional water. Here, increased salinity of supplied water (e.g. due to evaporation or intake of salty sediments by wind upstream) increases risk of soil salinity. Overall, soil degradation is aggravated by salt intake, as well as heat and wind erosion. Additionally, drainage water from irrigated fields is collected in designated channels, “collectors”, and transported to the Sarygamysh Lake in the west of Dashoguz Province. This also includes drainage water from agricultural activity in Uzbekistan, east and north of Dashoguz- in typical years with about twice the drainage volume of that from Dashoguz

Province. With the use of water-intensive crops there, high volumes of drainage water from Uzbekistan increase the risk of rising water table alongside increased soil salinity in Dashoguz Province.

Regarding animal husbandry two systems are to be considered. For one, livestock is kept and fed on pasture land which is at risk of wind erosion, overgrazing, and consequent decrease in vegetation useful for livestock feeding. This situation can be worsened by decreased precipitation, heat, or general drought conditions. On the other hand, livestock kept on farms are often in need of cooling during high temperatures - especially for imported breeds not used to local conditions. As this mostly involves spraying or bathing, such measures further increase water demand on farm land overall.

4.5 CHANGING CLIMATE CONDITIONS

As depicted in Figure 18, the high dependency of water intake from upstream sources for Dashoguz Province requires the analysis of changing climate conditions not only locally but also upstream. This section shows the analysis results for each of these areas and each climate variable identified:

- Seasonal mean temperature and total precipitation for the mountainous catchment area of the Amu Darya River,
- Seasonal mean temperature and wind along the Amu Darya River upstream of the Tuyamuyun Hydro Complex,
- Seasonal mean temperature, total precipitation, wind, heat, and heavy rain events in Dashoguz Province itself.

Results are shown as time series from 1990 to 2100 for absolute values and as a box plot for changes from 1991-2010 to 2041-2060.

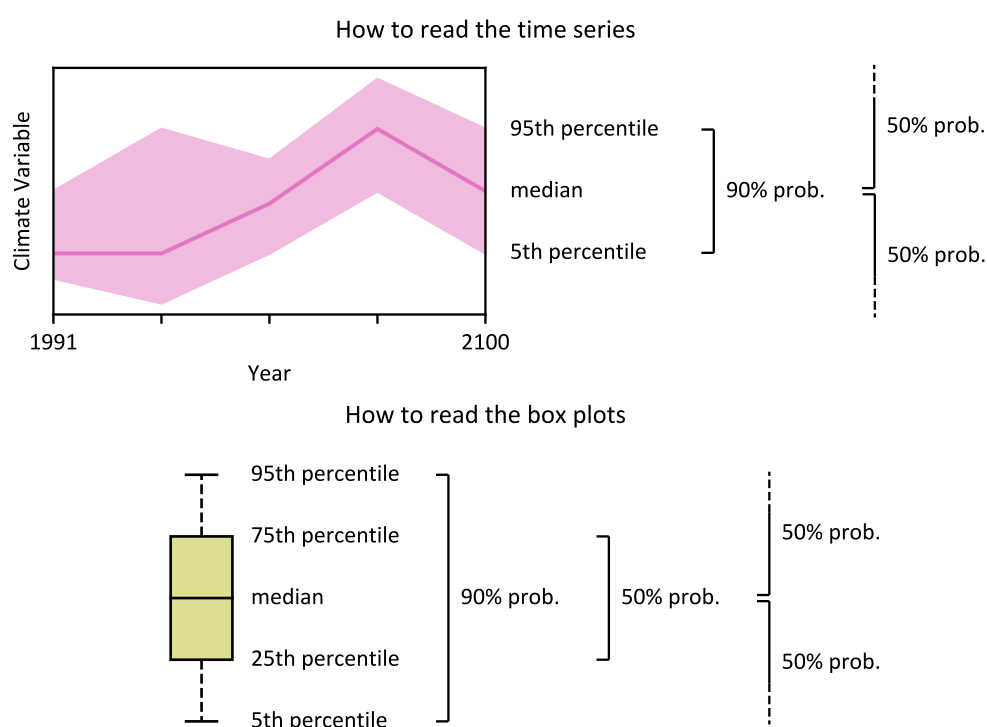


Figure 19: Legend for time series (upper half) and box plots (lower half) as shown for results of the climate analysis. The given range within the time series represents 90% of all possible futures under a given emission scenario, which is based on the ensemble of the output of 29 climate models. Box plots represent the change for the value from today's climate (1991-2010) to mid-century climate (2041-2060). Additionally, a short explanation is given for how to interpret the percentile: Assuming that the model results span all possible futures, values between the 5th and 95th percentile will occur with a probability of 90%, those above or below the median with a probability of 50% each.

4.5.1 In the mountainous catchment area of the Amu Darya River

Seasonal mean temperature and total precipitation are analyzed for the mountainous catchment area of the Amu Darya River.

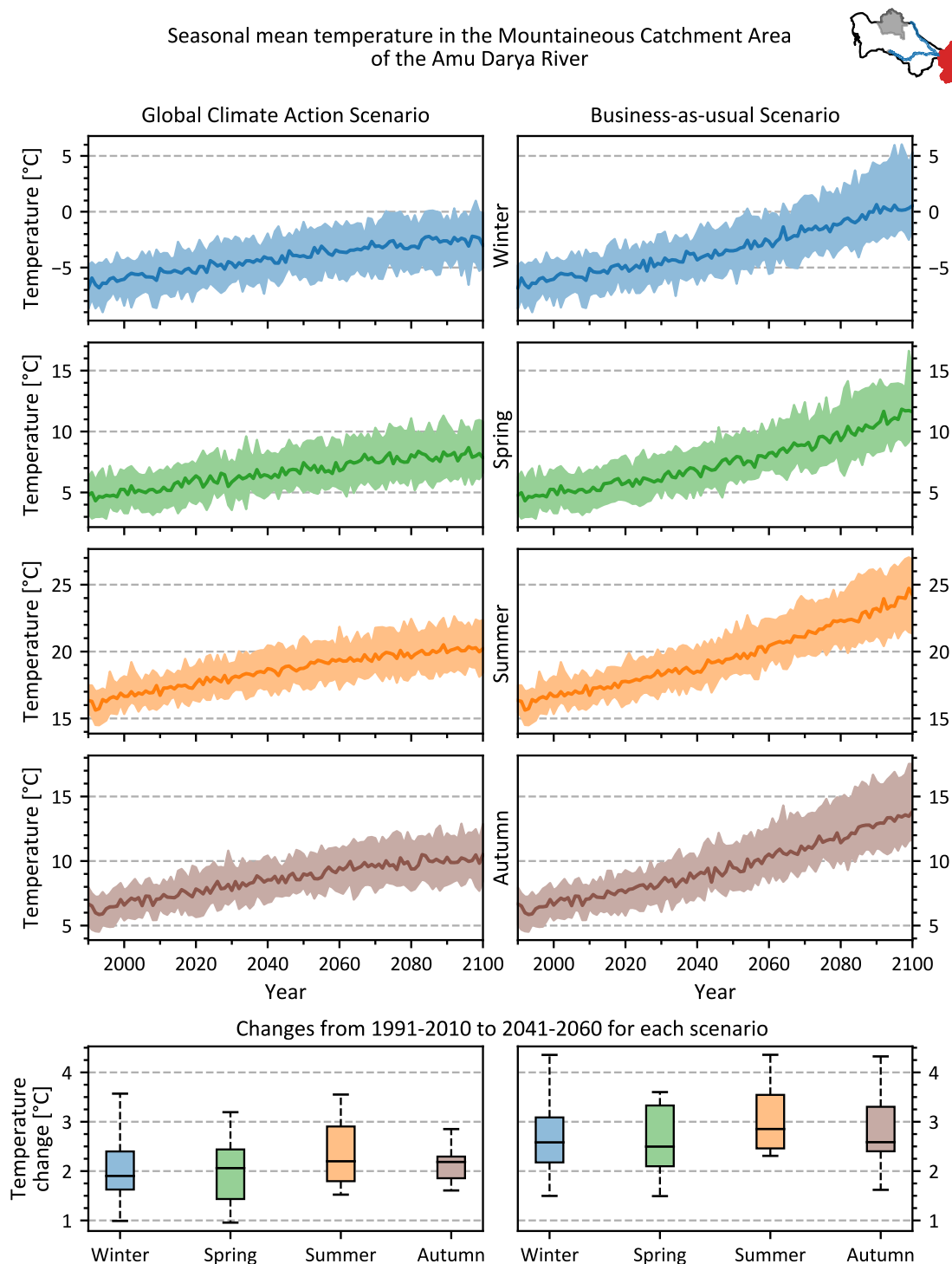


Figure 20: Seasonal mean temperature in the upper catchment area of Amu Darya River (mean over the whole area). Time series from 1990 to 2099 are given per season (upper four rows) and per climate change scenario (columns). Colored areas represent 90% of possible futures in the given emission scenario, based on 29 climate models, solid lines give the ensemble median. Temperature changes between the reference period (1991-2010) and the future period (2041-2060) are presented at the bottom as box plot with 5th and 95th percentile of the model ensemble as whiskers, 25th and 75th percentile as box boundaries, and the median as middle line. For details see Section 2.2.

Table 9: Changes in seasonal mean temperature in the upper catchment area of Amu Darya River (mean over the whole area) between the reference period (1991-2010) and the future period (2041-2060) for each season and climate change scenario (columns). For details see Section 2.2.

Scenario/Season	5th percentile (95% prob. to be exceeded)	25th percentile (75% prob. to be exceeded)	Median (50% prob. to be exceeded)	75th percentile (25% prob. to be exceeded)	95th percentile (5% prob. to be exceeded)
Global climate action					
Winter	1.0°C	1.6°C	1.9°C	2.4°C	3.6°C
Spring	1.0°C	1.4°C	2.1°C	2.4°C	3.2°C
Summer	1.5°C	1.8°C	2.2°C	2.9°C	3.6°C
Autumn	1.6°C	1.9°C	2.2°C	2.3°C	2.9°C
Business-as- usual					
Winter	1.5°C	2.2°C	2.6°C	3.1°C	4.4°C
Spring	1.5°C	2.1°C	2.5°C	3.3°C	3.6°C
Summer	2.3°C	2.5°C	2.9°C	3.5°C	4.4°C
Autumn	1.6°C	2.4°C	2.6°C	3.3°C	4.3°C

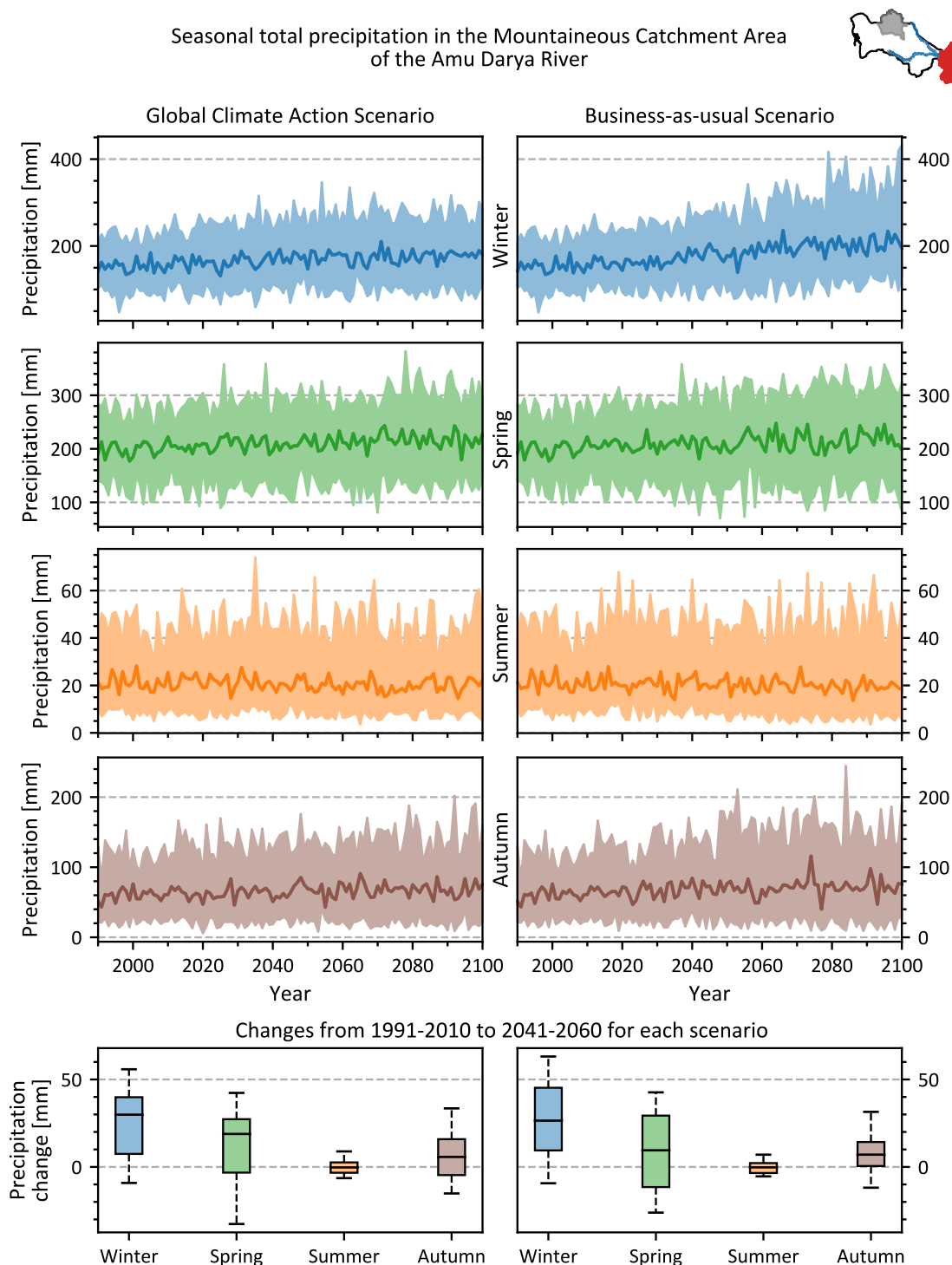


Figure 21: Seasonal total precipitation in the upper catchment area of Amu Darya River (mean over the whole area). Time series from 1990 to 2099 are given per season (upper four rows) and per climate change scenario (columns). Colored areas represent 90% of possible futures in the given emission scenario, based on 29 climate models, solid lines give the ensemble median. Precipitation changes between the reference period (1991-2010) and the future period (2041-2060) are presented at the bottom as box plot with 5th and 95th percentile of the model ensemble as whiskers, 25th and 75th percentile as box boundaries, and the median as middle line. For details see Section 2.2.

Table 10: Changes in seasonal total precipitation in the upper catchment area of Amu Darya River (mean over the whole area) between the reference period (1991-2010) and the future period (2041-2060) for each season and climate change scenario (columns). For details see Section 2.2.

Scenario/Season	5th percentile (95% prob. to be exceeded)	25th percentile (75% prob. to be exceeded)	Median (50% prob. to be exceeded)	75th percentile (25% prob. to be exceeded)	95th percentile (5% prob. to be exceeded)
Global climate action					
Winter	-9.2mm (-5.7%)	7.4mm (+4.3%)	29.9mm (+19.9%)	39.9mm (+27.8%)	55.8mm (+35.0%)
Spring	-32.6mm (- 16.1%)	-3.3mm (-1.7%)	18.9mm (+9.5%)	27.3mm (+13.4%)	42.3mm (+21.7%)
Summer	-6.4mm	-3.3mm	-0.3mm	2.6mm	8.9mm
Autumn	-15.2mm (- 23.2%)	-4.7mm (-7.6%)	5.7mm (+10.1%)	15.9mm (+30.6%)	33.5mm (+58.3%)
Business-as- usual					
Winter	-9.3mm (-5.7%)	9.4mm (+6.0%)	26.4mm (+17.4%)	45.3mm (+28.7%)	63.1mm (+45.1%)
Spring	-26.1mm (- 12.3%)	-11.5mm (-5.9%)	9.5mm (+4.6%)	29.3mm (+14.6%)	42.6mm (+25.4%)
Summer	-5.4mm	-3.5mm	-0.2mm	2.2mm	7.0mm
Autumn	-11.9mm (- 20.1%)	0.5mm (+1.0%)	7.0mm (+9.6%)	14.2mm (+26.0%)	31.5mm (+57.6%)

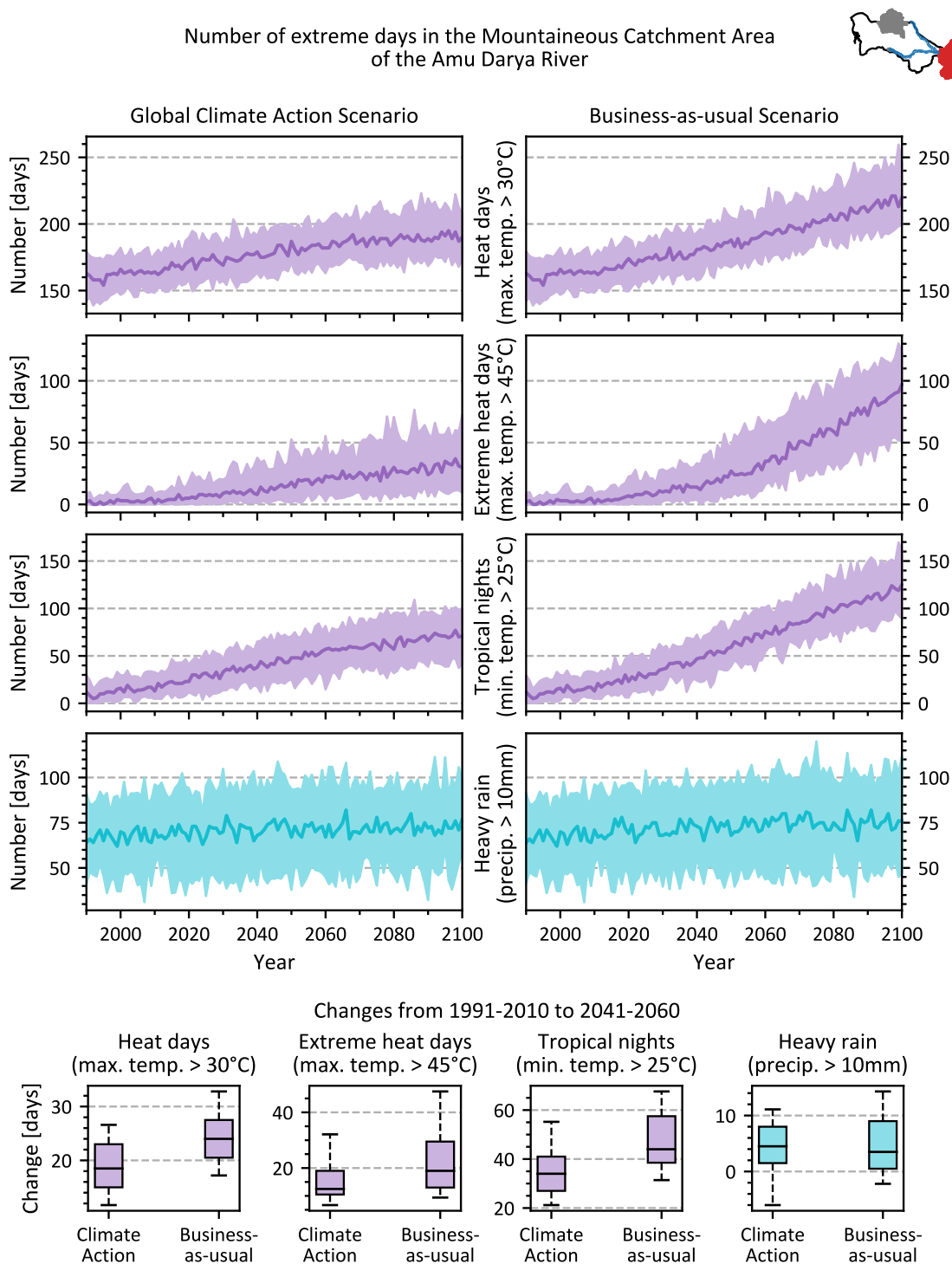


Figure 22: Number of days in the upper catchment area of Amu Darya River with heat (with maximum temperature above 30°C), extreme heat (with maximum temperature above 45°C), tropical nights (with minimum - i.e. night - temperature above 25°C), and heavy rain (with total daily precipitation above 10mm). Colored areas represent 90% of possible futures in the given emission scenario, based on 29 climate models, solid lines give the ensemble median. Changes between the reference period (1991-2010) and the future period (2041-2060) are presented at the bottom as box plot with 5th and 95th percentile of the model ensemble as whiskers, 25th and 75th percentile as box boundaries, and the median as middle line. For details see Section 2.2.

Table 11: Changes in the number of days in the upper catchment area of Amu Darya River with heat, extreme heat, tropical nights, and heavy rain between the reference period (1991-2010) and the future period (2041-2060) for each season and climate change scenario (columns). For details see Section 2.2.

Variable/Scenario	5th percentile (95% prob. to be exceeded)	25th percentile (75% prob. to be exceeded)	Median (50% prob. to be exceeded)	75th percentile (25% prob. to be exceeded)	95th percentile (5% prob. to be exceeded)
Heat days (>30°C)					
Global climate action	11.7 (+7.4%)	15.0 (+9.3%)	18.5 (+11.3%)	23.0 (+14.1%)	26.6 (+16.1%)
Business-as-usual	17.2 (+10.7%)	20.5 (+12.4%)	24.0 (+14.9%)	27.5 (+17.0%)	32.8 (+20.1%)
Extreme heat days (>45°C)					
Global climate action	6.7	10.5	12.5	19.0	32.1
Business-as-usual	9.4	13.0	19.0	29.5	47.5
Tropical nights (>25°C)					
Global climate action	21.2 (+149.7%)	27.0 (+209.5%)	34.0 (+256.2%)	41.0 (+365.0%)	55.2 (+535.3%)
Business-as-usual	31.4 (+221.3%)	38.5 (+296.3%)	44.0 (+357.1%)	57.5 (+525.0%)	67.6 (+680.0%)
Heavy rain (>10mm)					
Global climate action	-6.0 (-9.6%)	1.5 (+3.1%)	4.5 (+5.8%)	8.0 (+11.5%)	11.1 (+19.3%)
Business-as-usual	-2.2 (-3.6%)	0.5 (+0.8%)	3.5 (+4.6%)	9.0 (+13.3%)	14.3 (+21.4%)

4.5.2 Along the Amu Darya River upstream of the Tuyamuyun Hydro Complex

Seasonal mean temperature and wind is analyzed along the Amu Darya River upstream of the Tuyamuyun Hydro Complex.

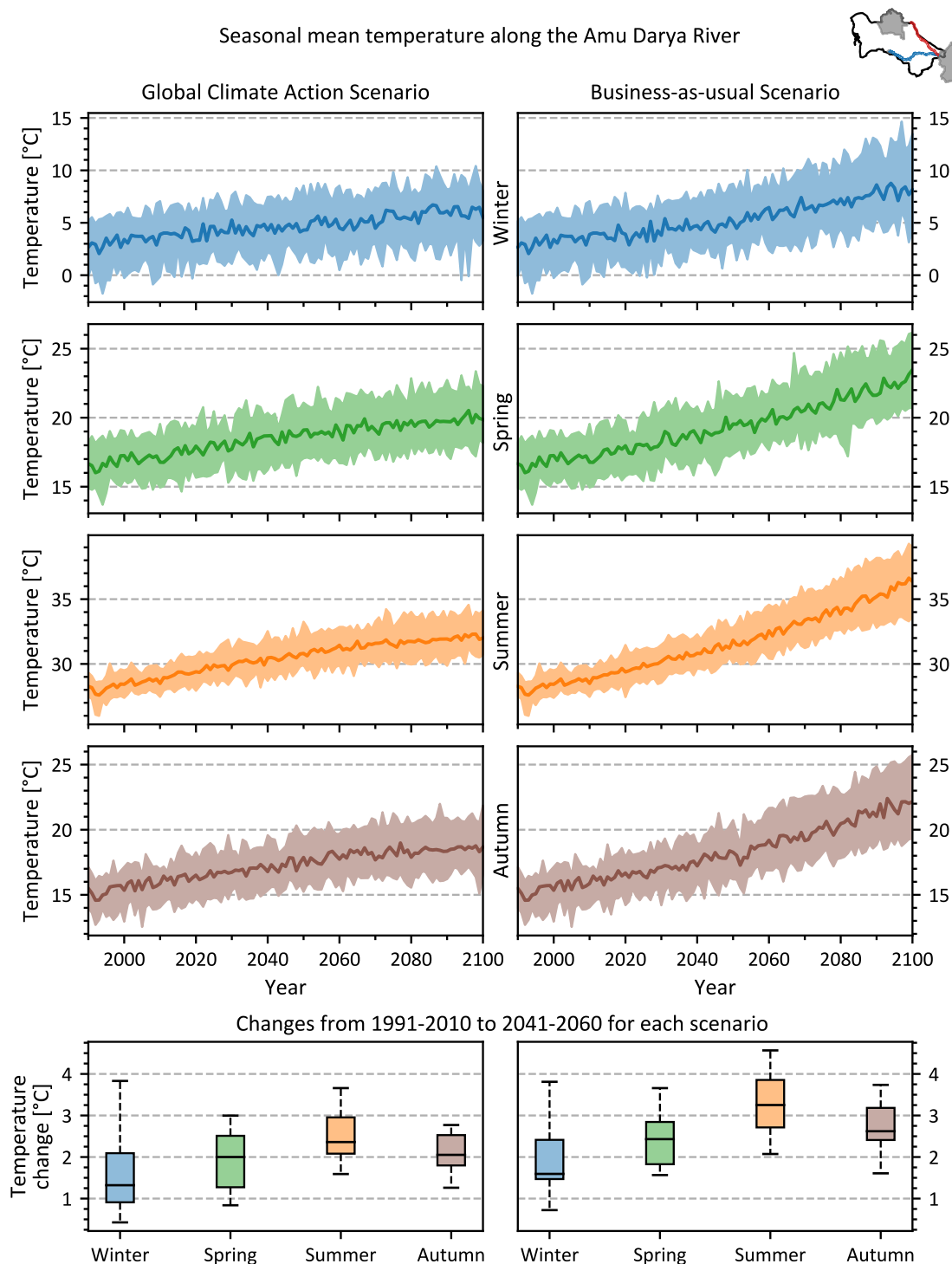


Figure 23: Seasonal mean temperature along Amu Darya River (upstream of Dashoguz/Tuyamuyun Hydro Complex; mean over the whole area). Time series from 1990 to 2099 are given per season (upper four rows) and per climate change scenario (columns). Colored areas represent 90% of possible futures in the given emission scenario, based on 29 climate models, solid lines give the ensemble median. Temperature changes between the reference period (1991-2010) and the future period (2041-2060) are presented at the bottom as box plot with 5th and 95th percentile of the model ensemble as whiskers, 25th and 75th percentile as box boundaries, and the median as middle line. For details see Section 2.2.

Table 12: Changes in seasonal mean temperature along Amu Darya River (upstream of Dashoguz/Tuyamuyun Hydro Complex; mean over the whole area) between the reference period (1991-2010) and the future period (2041-2060) for each season and climate change scenario (columns). For details see Section 2.2.

Scenario/Season	5th percentile (95% prob. to be exceeded)	25th percentile (75% prob. to be exceeded)	Median (50% prob. to be exceeded)	75th percentile (25% prob. to be exceeded)	95th percentile (5% prob. to be exceeded)
Global climate action					
Winter	0.4°C	0.9°C	1.3°C	2.1°C	3.8°C
Spring	0.8°C	1.3°C	2.0°C	2.5°C	3.0°C
Summer	1.6°C	2.1°C	2.4°C	3.0°C	3.7°C
Autumn	1.3°C	1.8°C	2.1°C	2.5°C	2.8°C
Business-as-usual					
Winter	0.7°C	1.5°C	1.6°C	2.4°C	3.8°C
Spring	1.6°C	1.8°C	2.4°C	2.8°C	3.7°C
Summer	2.1°C	2.7°C	3.3°C	3.9°C	4.6°C
Autumn	1.6°C	2.4°C	2.6°C	3.2°C	3.7°C

Just as Turkmenistan has been shown to likely expect warming climate conditions larger than the global average, so is its northern border, here, the Amu Darya River. Overall, the temperature increase is projected to occur for every season, but with a tendency of stronger increase the warmer the season already is. Here, only a quarter of all models projects an increase in winter by less than 1°C, but also a quarter projects an increase in summer for over 3°C till the mid of this century (for the climate action scenario) - with much stronger increases for the business-as-usual scenario.

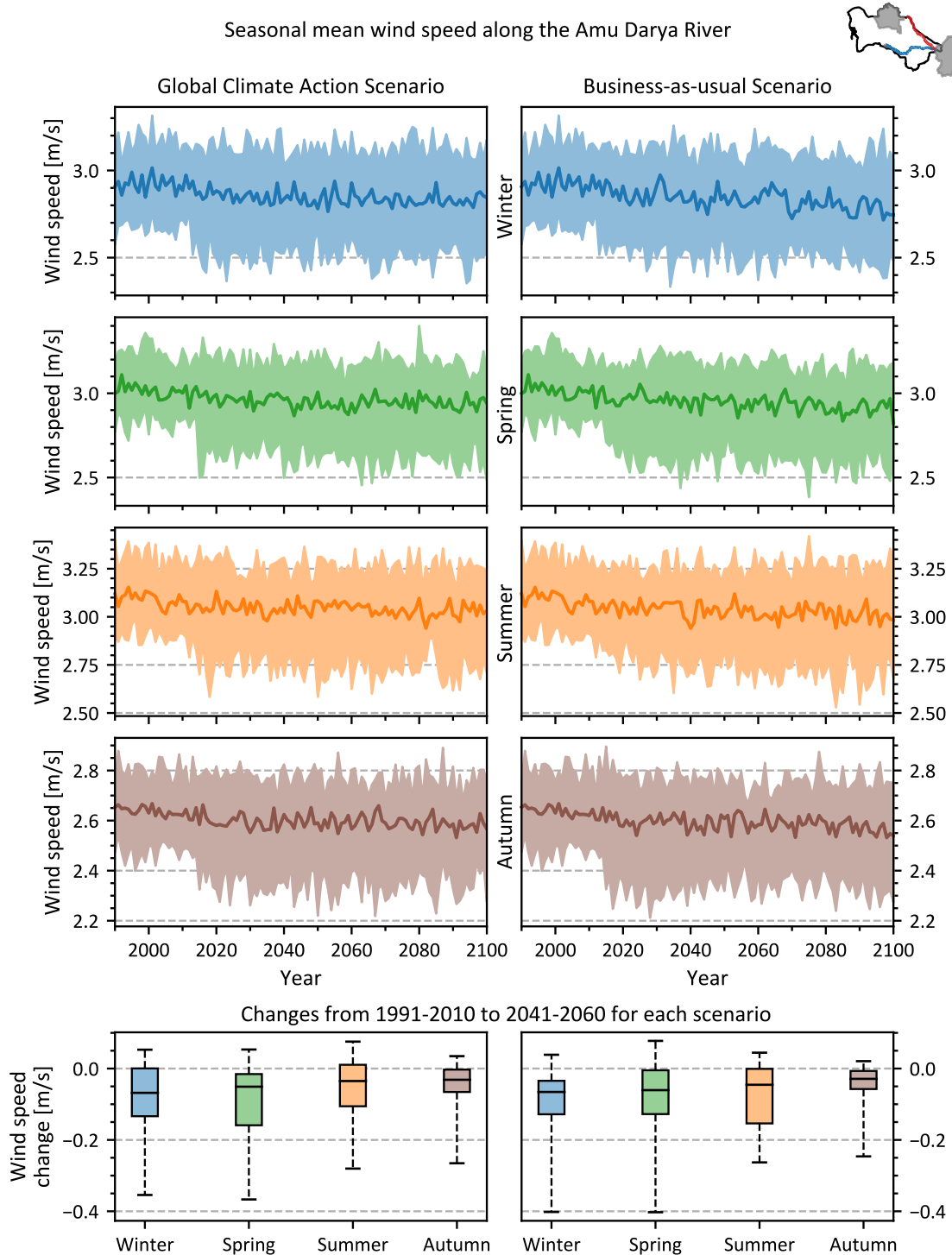


Figure 24: Seasonal mean near-surface wind speed along Amu Darya River (upstream of Dashoguz/Tuyamuyun Hydro Complex; mean over the whole area). Time series from 1990 to 2099 are given per season (upper four rows) and per climate change scenario (columns). Colored areas represent 90% of possible futures in the given emission scenario, based on 29 climate models, solid lines give the ensemble median. Wind speed changes between the reference period (1991-2010) and the future period (2041-2060) are presented at the bottom as box plot with 5th and 95th percentile of the model ensemble as whiskers, 25th and 75th percentile as box boundaries, and the median as middle line. For details see Section 2.2.

Table 13: Changes in seasonal mean near-surface wind speed along Amu Darya River (upstream of Dashoguz/Tuyamuyun Hydro Complex; mean over the whole area) between the reference period (1991-2010) and the future period (2041-2060) for each season and climate change scenario (columns). For details see Section 2.2.

Scenario/Season	5th percentile (95% prob. to be exceeded)	25th percentile (75% prob. to be exceeded)	Median (50% prob. to be exceeded)	75th percentile (25% prob. to be exceeded)	95th percentile (5% prob. to be exceeded)
Global climate action					
Winter	-0.4m/s	-0.1m/s	-0.1m/s	0.0m/s	0.1m/s
Spring	-0.4m/s	-0.2m/s	-0.1m/s	-0.0m/s	0.1m/s
Summer	-0.3m/s	-0.1m/s	-0.0m/s	0.0m/s	0.1m/s
Autumn	-0.3m/s	-0.1m/s	-0.0m/s	-0.0m/s	0.0m/s
Business-as-usual					
Winter	-0.4m/s	-0.1m/s	-0.1m/s	-0.0m/s	0.0m/s
Spring	-0.4m/s	-0.1m/s	-0.1m/s	-0.0m/s	0.1m/s
Summer	-0.3m/s	-0.2m/s	-0.0m/s	-0.0m/s	0.0m/s
Autumn	-0.2m/s	-0.1m/s	-0.0m/s	-0.0m/s	0.0m/s

Though temperatures are expected to rise significantly, wind speeds, at least in their daily mean, are projected to change little with a slight tendency to increase in their variability and a tendency to lower (Figure 24). Still risks of higher wind speeds remain (around 25% of the overall ensemble for both scenarios and all seasons) and a statement on strong wind gusts cannot be made at this stage. Hence, the risks arising through wind in the area should be considered in at least a similar amount as today.

4.5.3 In Dashoguz Province

Seasonal mean temperature, total precipitation, wind, heat, and heavy rain events are analyzed for Dashoguz Province.

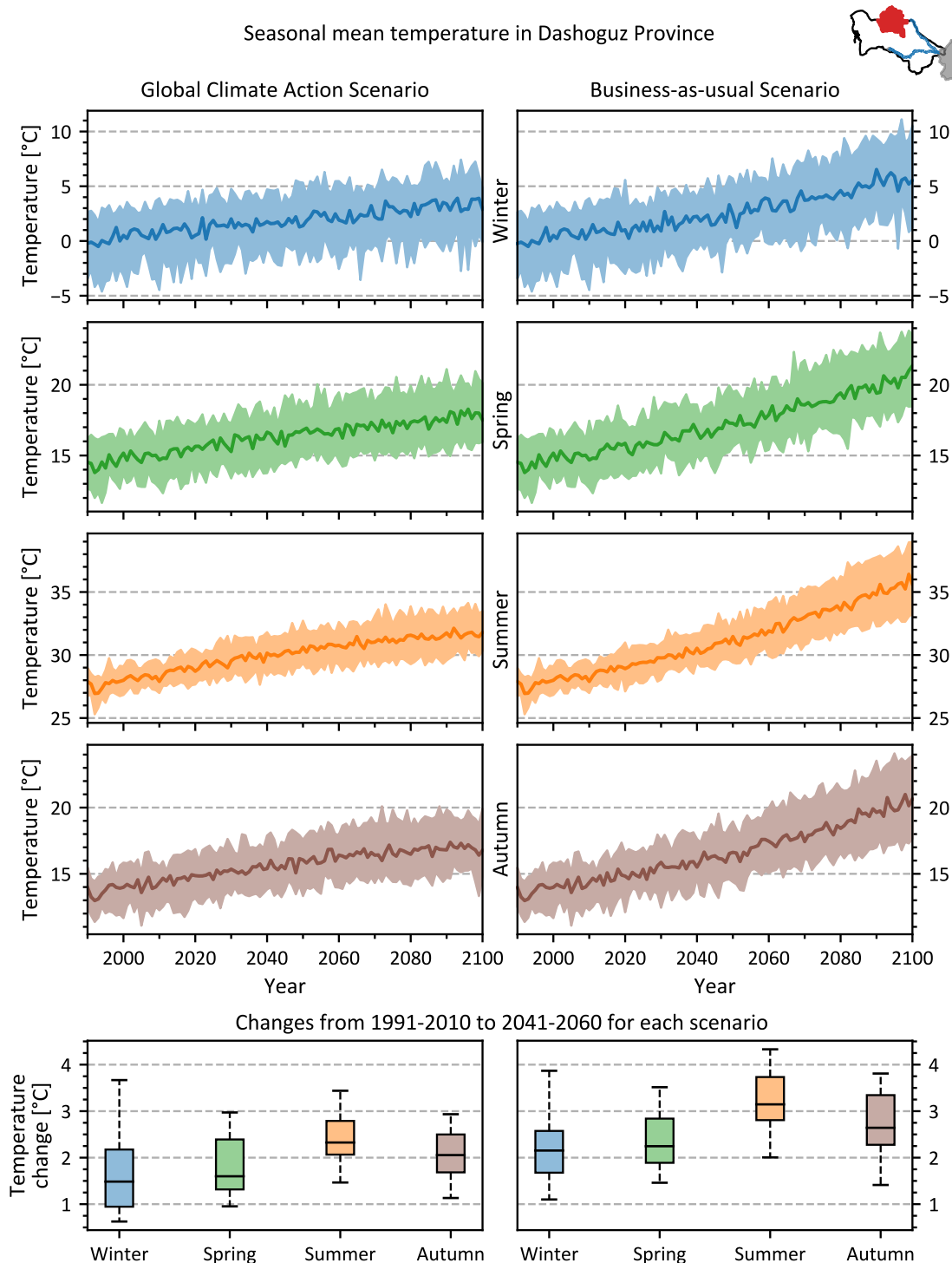


Figure 25: Seasonal mean temperature in Dashoguz Province (mean over the whole area). Time series from 1990 to 2099 are given per season (upper four rows) and per climate change scenario (columns). Colored areas represent 90% of possible futures in the given emission scenario, based on 29 climate models, solid lines give the ensemble median. Temperature changes between the reference period (1991-2010) and the future period (2041-2060) are presented at the bottom as box plot with 5th and 95th percentile of the model ensemble as whiskers, 25th and 75th percentile as box boundaries, and the median as middle line. For details see Section 2.2.

Table 14: Changes in seasonal mean temperature in Dashoguz Province (mean over the whole area) between the reference period (1991-2010) and the future period (2041-2060) for each season and climate change scenario (columns). For details see Section 2.2.

Scenario/Season	5th percentile (95% prob. to be exceeded)	25th percentile (75% prob. to be exceeded)	Median (50% prob. to be exceeded)	75th percentile (25% prob. to be exceeded)	95th percentile (5% prob. to be exceeded)
Global climate action					
Winter	0.6°C	0.9°C	1.5°C	2.2°C	3.7°C
Spring	1.0°C	1.3°C	1.6°C	2.4°C	3.0°C
Summer	1.5°C	2.1°C	2.3°C	2.8°C	3.4°C
Autumn	1.1°C	1.7°C	2.1°C	2.5°C	2.9°C
Business-as- usual					
Winter	1.1°C	1.7°C	2.2°C	2.6°C	3.9°C
Spring	1.5°C	1.9°C	2.2°C	2.8°C	3.5°C
Summer	2.0°C	2.8°C	3.1°C	3.7°C	4.3°C
Autumn	1.4°C	2.3°C	2.6°C	3.3°C	3.8°C

As depicted in Figure 25, temperatures in Dashoguz Province are expected to increase substantially. While the spread between models is quite large for winter months, the trend of temperature increase is pronounced for all seasons and for both climate scenarios. For winter, this means a mean winter temperature above 0°C and for summer those beyond 30°C. In particular the already warm to hot summers are expected to experience higher temperatures with a median increase of 2.2°C for the climate action scenario and 3.2°C for the business-as-usual scenario around the mid of the century - still, mean temperatures are likely to further increase well beyond that and at least till the end of the century for the scenario with little to no climate action.

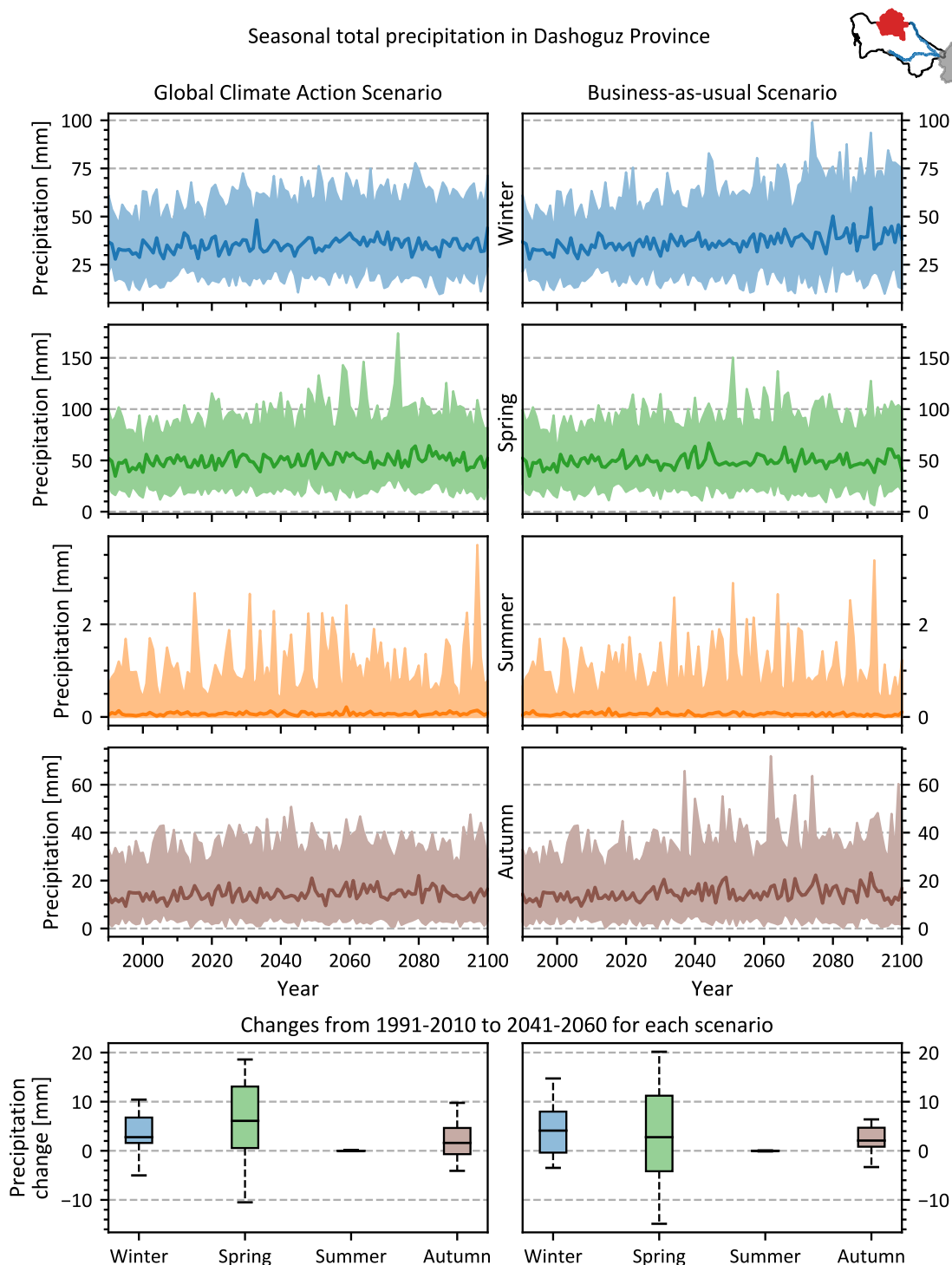


Figure 26: Seasonal total precipitation in Dashoguz Province (mean over the whole area). Time series from 1990 to 2099 are given per season (upper four rows) and per climate change scenario (columns). Colored areas represent 90% of possible futures in the given emission scenario, based on 29 climate models, solid lines give the ensemble median. Precipitation changes between the reference period (1991-2010) and the future period (2041-2060) are presented at the bottom as box plot with 5th and 95th percentile of the model ensemble as whiskers, 25th and 75th percentile as box boundaries, and the median as middle line. For details see Section 2.2.

Table 15: Changes in seasonal total precipitation in Dashoguz Province (mean over the whole area) between the reference period (1991-2010) and the future period (2041-2060) for each season and climate change scenario (columns). For details see Section 2.2.

Scenario/Season	5th percentile (95% prob. to be exceeded)	25th percentile (75% prob. to be exceeded)	Median (50% prob. to be exceeded)	75th percentile (25% prob. to be exceeded)	95th percentile (5% prob. to be exceeded)
Global climate action					
Winter	-5.0mm (-14.8%)	1.6mm (+4.7%)	2.8mm (+8.7%)	6.8mm (+23.2%)	10.4mm (+31.4%)
Spring	-10.5mm (- 19.5%)	0.6mm (+1.4%)	6.1mm (+11.8%)	13.1mm (+26.1%)	18.6mm (+43.8%)
Summer	-0.1mm	-0.0mm	-0.0mm	0.0mm	0.2mm
Autumn	-4.1mm (-28.6%)	-0.7mm (-4.7%)	1.6mm (+17.2%)	4.6mm (+35.0%)	9.8mm (+84.8%)
Business-as- usual					
Winter	-3.5mm (-10.8%)	-0.4mm (-1.0%)	4.1mm (+12.1%)	8.0mm (+25.3%)	14.7mm (+50.4%)
Spring	-14.9mm (- 33.0%)	-4.2mm (-8.4%)	2.8mm (+5.6%)	11.2mm (+25.6%)	20.2mm (+44.6%)
Summer	-0.1mm	-0.0mm	-0.0mm	0.0mm	0.1mm
Autumn	-3.3mm (-24.1%)	0.8mm (+7.9%)	2.1mm (+16.8%)	4.7mm (+36.9%)	6.4mm (+74.2%)

While precipitation will basically remain absent in summer in Dashoguz Province, there is a tendency of precipitation to increase slightly in the other seasons (Figure 26). Still, a risk of 25% of lower precipitation remains for the "Climate Action" scenario and even slightly more for the "Business-as-usual" scenario. Overall, the variability in precipitation is projected to increase in winter especially for the stronger climate scenario.

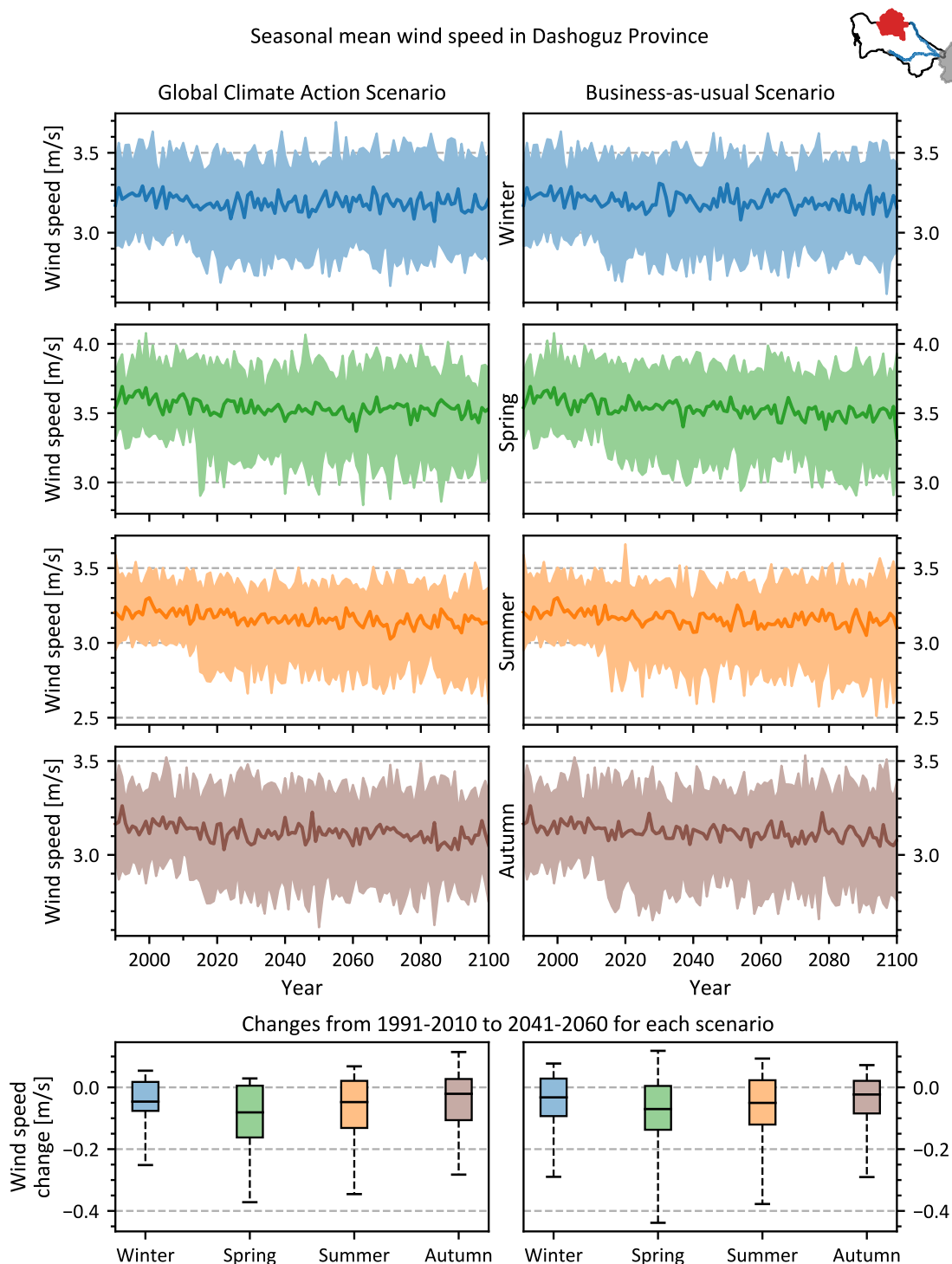


Figure 27: Seasonal mean near-surface wind speed in Dashoguz Province (mean over the whole area). Time series from 1990 to 2099 are given per season (upper four rows) and per climate change scenario (columns). Colored areas represent 90% of possible futures in the given emission scenario, based on 29 climate models, solid lines give the ensemble median. Wind speed changes between the reference period (1991-2010) and the future period (2041-2060) are presented at the bottom as box plot with 5th and 95th percentile of the model ensemble as whiskers, 25th and 75th percentile as box boundaries, and the median as middle line. For details see Section 2.2.

Table 16: Changes in seasonal mean of near-surface wind speed in Dashoguz Province (mean over the whole area) between the reference period (1991-2010) and the future period (2041-2060) for each season and climate change scenario (columns). For details see Section 2.2.

Scenario/Season	5th percentile (95% prob. to be exceeded)	25th percentile (75% prob. to be exceeded)	Median (50% prob. to be exceeded)	75th percentile (25% prob. to be exceeded)	95th percentile (5% prob. to be exceeded)
Global climate action					
Winter	-0.3m/s	-0.1m/s	-0.0m/s	0.0m/s	0.1m/s
Spring	-0.4m/s	-0.2m/s	-0.1m/s	0.0m/s	0.0m/s
Summer	-0.3m/s	-0.1m/s	-0.0m/s	0.0m/s	0.1m/s
Autumn	-0.3m/s	-0.1m/s	-0.0m/s	0.0m/s	0.1m/s
Business-as- usual					
Winter	-0.3m/s	-0.1m/s	-0.0m/s	0.0m/s	0.1m/s
Spring	-0.4m/s	-0.1m/s	-0.1m/s	0.0m/s	0.1m/s
Summer	-0.4m/s	-0.1m/s	-0.1m/s	0.0m/s	0.1m/s
Autumn	-0.3m/s	-0.1m/s	-0.0m/s	0.0m/s	0.1m/s

Though temperatures are expected to rise significantly, wind speeds, at least in their seasonal mean, are projected to change little with a slight tendency to increase in their variability and a tendency to lower (Figure 27). Still risks of higher wind speeds remain (around 25% of the overall ensemble for both scenarios and all seasons) and a statement on strong wind gusts cannot be made at this stage. Hence, the risks arising through wind in the area should be considered in at least a similar amount as today.

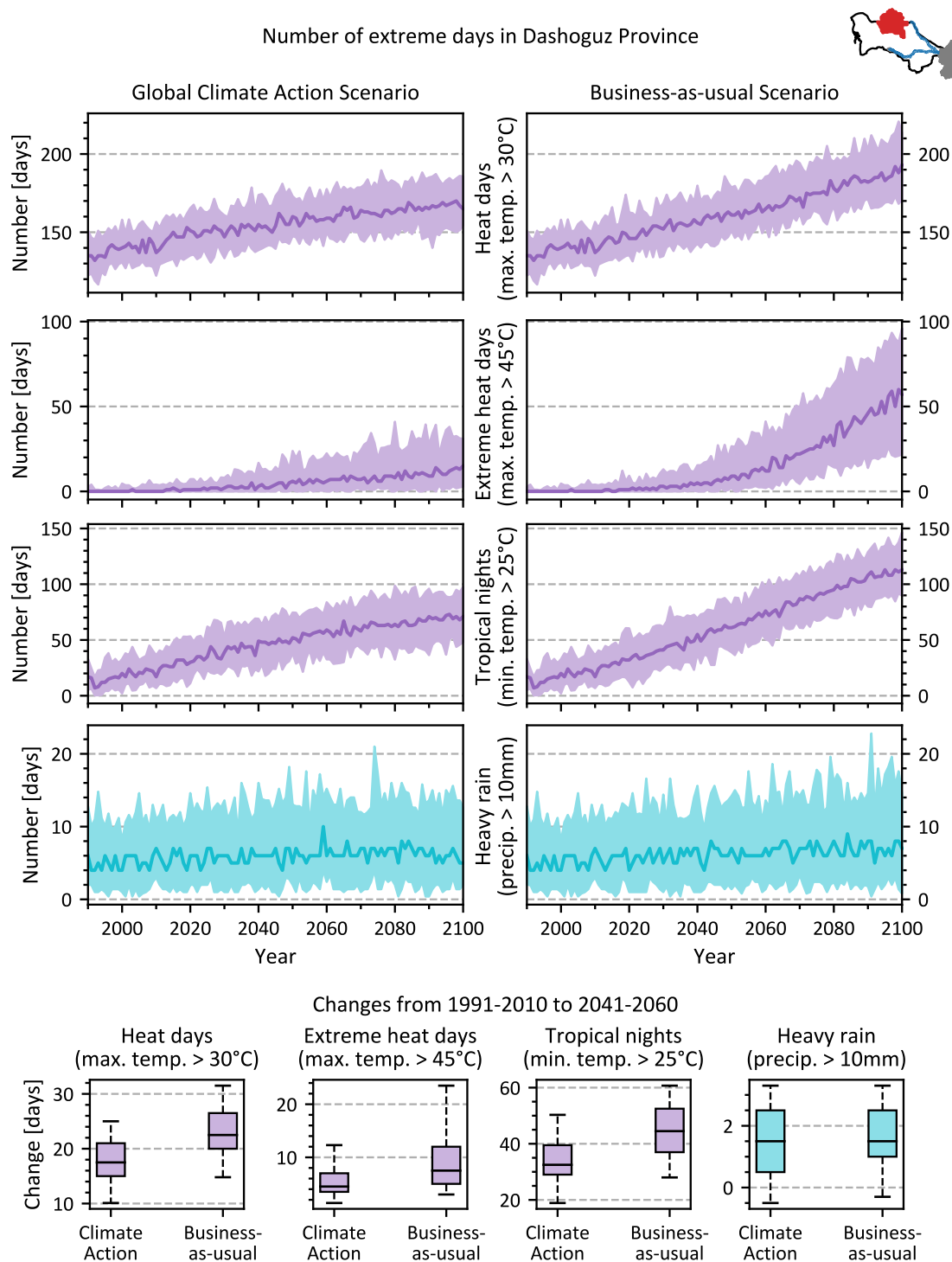


Figure 28: Number of days in Dashoguz Province with heat (with maximum temperature above 30°C), extreme heat (with maximum temperature above 45°C), tropical nights (with minimum - i.e. night - temperature above 25°C), and heavy rain (with total daily precipitation above 10mm). Time series of these for each year from 1990 to 2099 are given per climate change scenario (columns). Colored areas represent 90% of possible futures in the given emission scenario, based on 29 climate models, solid lines give the ensemble median. Changes between the reference period (1991-2010) and the future period (2041-2060) are presented at the bottom as box plot with 5th and 95th percentile of the model ensemble as whiskers, 25th and 75th percentile as box boundaries, and the median as middle line. For details see Section 2.2.

Table 17: Changes in the number of days in Dashoguz Province with heat, extreme heat, tropical nights, and heavy rain between the reference period (1991-2010) and the future period (2041-2060) for each season and climate change scenario (columns). For details see Section 2.2.

Variable/Scenario	5th percentile (95% prob. to be exceeded)	25th percentile (75% prob. to be exceeded)	Median (50% prob. to be exceeded)	75th percentile (25% prob. to be exceeded)	95th percentile (5% prob. to be exceeded)
Heat days (>30°C)					
Global climate action	10.1 (+7.2%)	15.0 (+10.9%)	17.5 (+12.2%)	21.0 (+15.6%)	25.0 (+18.3%)
Business-as-usual	14.8 (+10.5%)	20.0 (+13.9%)	22.5 (+16.3%)	26.5 (+19.4%)	31.5 (+22.6%)
Extreme heat days (>45°C)					
Global climate action	1.4	3.5	4.5	7.0	12.3
Business-as-usual	3.0	5.0	7.5	12.0	23.5
Tropical nights >25°C)					
Global climate action	18.9 (+98.0%)	29.0 (+134.9%)	32.5 (+184.2%)	39.5 (+240.0%)	50.3 (+444.2%)
Business-as-usual	28.0 (+127.6%)	37.0 (+202.9%)	44.5 (+274.2%)	52.5 (+318.2%)	60.7 (+522.8%)
Heavy rain (>10mm)					
Global climate action	-0.5 (-10.6%)	0.5 (+10.0%)	1.5 (+30.0%)	2.5 (+50.0%)	3.3 (+83.4%)
Business-as-usual	-0.3 (-6.7%)	1.0 (+16.7%)	1.5 (+33.3%)	2.5 (+50.0%)	3.3 (+69.5%)

Extremes of temperature as well as of heavy rain are expected to rise significantly in Dashoguz Province under changing climate (Figure 28). Here, the number of heat days per year with temperatures exceeding 30°C is projected to increase by 18 to 22 days (from historically experienced 140 in the median depending on the climate change scenario, but by at least 10 days). Similar for days with even more extreme heat - beyond 45°C - which are to increase vastly for the Business-as-usual scenario towards the end of the century. Also the number of tropical nights with temperatures not falling below 25°C - a major health risk for vulnerable groups - is to increase significantly by at least 20 days and around 40 days in the median - though these have been comparably rare in the past with around 20 days of such conditions per year.

The number of heavy rain events is also highly likely to increase (more than 90% chance) in the future period (2041-2060). Here, in the median of one to two additional days of heavy rain are to be expected - an increase of about 50%.

4.6 RISKS AND VULNERABILITIES

Risks in the climate impact chain as shown in Figure 18 can be grouped together into several exposed elements - the Amu Darya River upstream and in Dashoguz, the Tuyamuyun Hydro Complex as the major reservoir and controlling element for water supply in Dashoguz, as well as the channel systems, crop fields, livestock, and pasture land in Dashoguz itself.

Amu Darya River

Along the Amu Darya River, the greatest risks are related to runoff in the river - at both extremes. Regarding high discharge, the projected increase in precipitation in the mountainous catchment area (especially in winter and spring) comes with the risk of increased river discharge. During winter and spring, precipitation may increase until mid century with a probability of approximately 75 % in at least one emission scenario (box plot in Figure 21). Under a global Business-as-usual emission scenario, there is a 25% probability that precipitation increases by 29% (+45mm) or more for winter and 15% (+29mm) or more for spring until mid century (Table 10).

Additionally, rising temperatures in the mountains, on the one hand, lead to increased melting of glaciers leading to additional discharge during all but winter times. Mean temperature is expected to increase for all seasons and under all emission scenarios (Figure 20). Under a global Business-as-usual emission scenario, there is a 25% probability that the mean winter temperature in the catchment area increases by 3.1°C or more until mid century (Table 9). On the other hand, they lead to snow melt earlier in the year as well as more precipitation in the form of rain rather than snow. Hence, especially in spring, discharge is expected to occur earlier and faster increasing the risk of floods along river beds early in the year. In cases of heavy rains, which are expected to occur more frequently (Figure 22), the risk of land slides and mud flows is increasing leading to further sediments transported downstream by the river.

On the flip side, earlier and stronger snow melt (due to temperature increase) likely lead to lower discharge in later times of the year - particularly in summer and autumn. Here, water that had been stored in the mountains in the form of glaciers or snow before has already been discharged through the river earlier in the year. Increasing temperatures along the low land river flow (Figure 23) would further increase water losses due to evaporation. With the river fully exposed, evaporation is aggravated by wind, which additionally increases intake of sediments from the dry and sandy surroundings (potentially with high salt amount). While temperatures are projected to increase - especially when already high in summer - wind shows small to no projected changes (Figure 24). Considering the time development of discharge, this risk of increased evaporation would further aggravate risk of low to very low discharge. Overall, the impact of changing climate conditions is expected to increase the already strong variability of Amu Darya's discharge in its annual evolution - higher discharge in spring, lower in summer and autumn.

Though not related to changes in climatic conditions, upstream water use is in direct competition with downstream demand, and hence, risk of low water is aggravated by upstream activities such as a new off-branching channel, the Kusch-Tepa Canal, upstream for water use in Afghanistan – increasing the potential for conflict over water in the region.

Tuyamuyun Hydro Complex

At the Tuyamuyun Hydro Complex between Dashoguz Province and the Amu Darya River, the main risk is that of reduced reservoir level, especially in summer and autumn, when water intake from Amu Darya River is low as described above. The major vulnerability thereby is the full dependency on upstream water availability for reservoir levels as other water intake, e.g. due to precipitation, is negligibly low in comparison. This risk is expected to be worsened by additional evaporation due to increased temperatures (Figure 25) along the openly exposed reservoirs. Again, with little to no changes in wind to be expected in the area additional evaporation would be driven by higher temperatures especially in summer, when additional water intake from Amu Darya is already low. Mean temperature is expected to increase in Dashoguz Province for all seasons and under all emission scenarios (Figure 25). Under a global Business-as-usual emission scenario, there is a 25% probability that the mean summer temperature in Dashoguz province increases by 3.7°C or more until mid century (Table 14).

As the reservoirs also function as settling basins, permanent maintenance is required to keep high reservoir capacity. Here, the risk of additional sedimentary inflow, e.g. due to upstream mud flows, can be expected to increase. With more elaborate reservoir management to bridge low discharge times required this poses additional challenges.

Channel Systems

The capacity of reservoirs between Amu Darya River and channels that transport the water to end-users, i.e. farmers, is naturally limited. Hence, the risk of low reservoir levels directly relates to the risk of reduced water supply via the channel systems. This risk is further aggravated by additional water losses along the channels. On the one hand, water is lost via infiltration as most of the channels are not lined but lead through sandy soil. On the other hand, open exposure of the channels implies evaporation losses, especially considering increasing temperatures (Figure 25) and more heat days (Figure 28). The number of annual heat days (above 30°C) is expected to increase in Dashoguz Province under all emission scenarios (Figure 28). Under a global Business-as-usual emission scenario, there is a 25% probability that the mean annual number of heat days (above 30°C) in Dashoguz province increases by 27 days (+20%) or more until mid century (Table 17). As the downstream channels are mostly managed by farmers themselves, there is the challenge of limited know-how and other limited capacities for optimal channel management.

Crop Fields

One of the focus risks of this report is the risk of decreased crop output in Dashoguz Province, which arises through various factors. On a minor note, those are direct impacts of local climate conditions on the fields or the crops. Here, heavy rains during planting season, which are expected to occur more frequently (Figure 28), pose the risk of damages to or loss of the seeds as these are washed from the soil. But also changes in temperature affect plant health and growth. As temperatures are projected to increase (Figure 25), also in the upper extreme (Figure 28), crops can be negatively impacted, depending on the selection of crop types and their optimal growth temperatures. The mean number of annual extreme heat days (above 45°C) is expected to increase in Dashoguz Province under all emission scenarios (Figure 28). Under a global Business-as-usual emission scenario, there is a 25% probability that the mean annual number of extreme heat days (above 45°C) in Dashoguz Province increases by 12 days or more until mid century (Table 17). These conditions naturally also pose risks in the health sector, but can also increase the occurrence of new or more dangerous agricultural pests. Lower temperatures or cold spells are, on the other hand, less likely to occur – though, of course, some risks remain here. If commonly used livestock fodder, such as from pasture lands, is low in supply (e.g. due to impacts on pasture land), some of the crop harvest would need to be used for livestock and are lost to the markets.

The major source of risk for decreased crop productivity, however, is that of insufficient water for irrigation, which, due to local arid conditions, is a necessary requirement for effective agricultural activity in Dashoguz Province. Here, a change in risk can arise through the risk of lower water supply and/or that of higher water demand – potentially leading to conflict between different water users. The former is a strong focus in this report and has been given detailed attention in following the full water supply chain as described above. Here, crop irrigation in Dashoguz Province is particularly vulnerable to the risk of reduced water supply via local channels. This is due to i) limited capacities for water reuse, ii) inefficient irrigation techniques – almost the whole area is most water-intensely irrigated via flood irrigation -, and iii) use of water-intensive crops – in particular, cotton, grown for economic reasons. Regarding water demand, the risk of increased evaporation and plant evapo-transpiration due to increased temperatures (Figure 25) and heat (Figure 28) must be considered. Especially with open irrigation on unprotected fields, these can be an additional reason for water losses. Furthermore, should the salinity of upstream waters already increase (e.g. due to evaporation or other factors as described above), additional leaching might be required – additional water demand for the whole area. Alongside heat and wind erosions, additional salt intake and concentration would lead to further soil degradation.

Livestock and Pasture Land

As drinking water use for livestock is small in comparison to irrigation water, reduced water supply might not be such a large risk here. Still, a focus risk of this report is that of decreased productivity in animal husbandry - the major agricultural output besides crop harvest. Here, climate conditions, in particular increase in heat (Figure 28), pose risks for animal health. With many breeds being vulnerable to high temperatures, cooling

measures are required, which are mostly water-based, thus increasing water demand of a farm overall. For livestock being kept on pasture lands - most of Dashoguz area is pasture land - insufficient vegetation as fodder constitutes the main risk. This, on the one hand, is due to erosion by strong winds on the plain land, which mostly is only covered by very low vegetation. Near-surface wind in the future is expected to be similar to that currently experienced, and so is the risk of wind erosion. On the other hand, drought conditions such as heat and decreased precipitation in combination with overgrazing are strong factors for vegetation decline. Whereas temperatures, in particular heat, are projected to increase (Figure 25 and Figure 28), overall precipitation is projected to increase. Still, the almost absent precipitation during hot summer months experienced so far is likely not to improve (Figure 26). Hence, the risk of increased desertification of pasture lands is substantial.

Apart from the mentioned exposed elements, it is important to note that, of course, also the quality of drinking water is a crucial aspect. Especially in rural areas such as Dashoguz Province, problems here lead to high child mortality rate, in particular due to drug-resistant tuberculosis, Hepatitis E, kidney problems, and contaminated groundwater.

4.7 ADAPTATION OPTIONS IN DASHOGUZ PROVINCE

Given the risks and vulnerabilities as described above this section gives a list of potential adaptation options to reduce the vulnerabilities and tackle the risks accordingly. While this list is naturally not exhaustive, it constitutes the most effective options as viewed by the authors of this report after conducting expert interviews.

All of the options aim to increase technical as well as organization capacities of the overall water supply and agricultural system in Dashoguz Province. The proposed measures, shown as purple numbers and boxes tackling the respective vulnerabilities in Figure 18, can hence be grouped into technical, organizational, and policy measures.

On a technical level, water losses can be avoided by increasing the protection of open water or fields. Here, **lining of channels or use of main trunks (1)** would help to prevent infiltration losses or even exposure to evaporation. Especially at the end of water supply chains where lower quantities are transported, the increased use of pipes would significantly contribute to reducing water losses.

On farms themselves, the **increased use of glasshouses (2)** can help keep water used for irrigation but not yet absorbed by crops in the supply cycle rather than losing it to the immediate environment. Though such measures are naturally limited by the required capital and is not suitable for all kinds of crops, they are being used even on very large scales in arid areas such as southern Spain.

As a further technical measure already partially undertaken, **afforestation (3)** increases the protection of exposed fields and channels in various ways. For reservoirs and channels, targeted planting systems such as vetiver system³² help not only to stabilize the surrounding soil, and ideally deep roots help to keep soil moisture and protect from sun radiation as well as wind above the surface. Around fields afforestation can also lead to further produce, e.g. additional income from silk caterpillars on Mulberry trees, as is being practiced in some farmers' associations already. Together with the soil barriers between fields already being in place (which are mostly needed for flood irrigation), plants around fields additionally reduce runoff of rain water in rainy seasons. Also on pasture land, afforestation constitutes a major measure of protection against wind erosion. Using mulch from plants, such as vetiver, on fields would further protect soil moisture from evaporation. Further measures **covering of surface and surface water (4)** incl. reservoirs include covering fields (as already been practised during drought conditions in Soviet times). Here, the technique of using floating balls as practised in the USA provides an excellent example.

There is a large potential for **optimising of channel management on farms (5)**. While larger upstream channels closer to the reservoirs are government-managed, smaller inter-farm channel systems are privately managed. The latter management is often far less effective and efficient as the former one and mostly

³² <https://www.vetiver.org/>

requires vast optimization. Here, the possibility of extending the government management to this channels also bears large potential. In particular the large number of smaller channels should be reduced and an overall optimization of the systems as a whole should be undertaken. This can be accompanied by an improvement of canal digging techniques on the smaller private channels with the help of expertise on organizations working on the government managed channels.

As water supply is very likely to show higher variability over the year, managing reservoir levels becomes increasingly important. An **increase in reservoir capacity (6)** and underground reservoirs would give greater flexibility for water management and some leeway in cases where forecasts have been overly optimistic. Thermal mixing with compressed air has demonstrated success in suppressing evaporation in deep reservoirs (greater than +18 m), but it requires the installation of compressors and pumps, leading to high energy usage.

While water saving already is generally encouraged, **support for water saving and reuse measures (7)** can be taken further. For instance, low-interest credits for adaptation measures beyond water-saving would also be needed. In general, such support should not only focus on water saving but also tap into the large potential of water reuse and give support also for systemic measures when thinking of a whole toolbox of adaptation options for farms in the long run. The collection and reuse of all wastewater (pre-treated) for irrigation purpose would not only save a great quantity of surface water, but would also allow a reduction in industrial fertilisers.

Here, in particular the **support of efficient irrigation techniques (8)** plays a crucial role. Combining water-reuse with drip irrigation has been proven to have a large potential for reduction of water use. The mostly used technique of flood irrigation leads to high water evaporation rates and soil salination. With current irrigation measures - mostly flood irrigation - already being optimized, e.g. by leveling of fields, more efficient irrigation measures still have no wide adoption. In particular, farms require targeted support to switch to drip irrigation on a large scale. Additionally, support can be given in the form of knowledge exchange regarding efficient rotating schemes on fields or the use of suspended mixtures to prevent evaporation of irrigated fields.

Still, the risk of insufficient water for irrigation and the expected larger watering challenges for local agriculture requires a structural adaptation in particular in the **use of drought-resistant crops (9)**. While in particular the growing of cotton is encouraged on a large scale for economic reasons, the growth of such water-intensive crops needs to be reconsidered in light of future challenges - not only locally in Dashoguz Province but also at water users upstream. Fortunately, several projects are experimenting with such crops as well as arid regions experienced in optimizing their crops accordingly. In a similar vein, as soil salinity is a permanent challenge, the need for improved water management in light of the potential increase in water scarcity implies a need for managing soil salinity. Here, **use of halophytes³³ and salinity-resistant crops (10)** can, on the one hand, reduce water demand by reducing need of soil leaching as such crops can deal with higher soil salinity. On the other hand, some of these crops can also absorb salinity reducing salt content in soil - ideally in a rotating scheme with other crops. Support for such crops can be given through knowledge exchange, targeted credits, and, crucially, the development of a market for such crops.

Analogously, livestock management should incorporate local circumstances such as climate conditions. Here, the **use of drought-resistant (local) livestock types (11)** is of major importance, in particular, where livestock is exposed to the outside or needs additional cooling measures in summer. While this has to be weighed against economic factors - e.g. imported cattle bred for maximum milk giving - targeted breeding can be incorporated into long-term planning. For livestock keeping, **sustainable pasture management (12)** is an additional factor to consider. While there exists excellent shepherd knowledge about schemes of pasture land rotation this must be disseminated to farms to improve their pasture land management. In particular, overgrazing must be avoided to keep good pasture conditions. The aforementioned afforestation constitutes an additional major puzzle piece in this context.

The third category of potential adaptation options is that of higher-level policy measures. In particular adaptation undertaken by farmers requires long-term planning security. Here, a **guarantee of long-term land**

³³ Halophytes are especially salt-tolerant or even salt-preferring plants.

lease agreement (13) is a major prerequisite. While farmers are often reluctant to invest in adaptation measures due to the uncertainty in ownership structure, such long-term agreement would provide the necessary incentive and reliability for the farmer. This is especially true for measures that require large investments such as the use of drip irrigation. For instance, such agreements could be linked to the credits provided to ensure their sustainability. Further incentives must be created to save water and to improve overall water management on a longer time scale. This can be done by introducing an appropriate **water payment scheme to avoid waste of water (14)**. A prerequisite here is the full implementation of the by-laws for the already-in-place Water Code. An overarching framework is essential as overall water management is likely to be an increasing challenge. A **National Adaptation Plan (NAP) that incorporates the water sector (15)** would constitute such a long-term strategy for the water sector in Turkmenistan providing the necessary guidance for adaptation measures. It should, in particular, incorporate strategies on intensified knowledge exchange and improving forecast dissemination for farmers. Ground water as the strategic water resource would further need to be accounted for in such long-term planning. Here, the Integrated Water Resources Management (IWRM)³⁴ approach would provide the necessary framework as a guiding example. Such measures would be complemented by increasing **coordination with upstream countries (16)** to ensure sustainable water management in the whole Amu Darya River basin under looming increased challenges.

Overall, several adaptation options have been identified that can help to reduce the risks and vulnerabilities in the water and agricultural sector in Dashoguz Province. These are to tackle the specific vulnerabilities as identified in the climate impact chain in Figure 18. While some of these options are already being implemented, others are not yet. In particular, underlying central vulnerabilities remain to be tackled. While local knowledge is available, it is not yet sufficiently disseminated, for instance, concerning channel management. Furthermore, often materials for technical measures are not available or not affordable. Hence, additional support in this regard and for the implementation of the crucial adaptation options is required.

4.8 VULNERABILITY ANALYSIS FOR DIFFERENT GROUPS

This chapter addresses the vulnerability of rural residents living in Dashoguz Province - women, children, youth and people with chronic diseases³⁵ - regarding:

- Food security and access to land and water resources
- Healthcare (including reproductive health)
- Livelihoods and decent work
- Mobility

4.8.1 Vulnerability and adaptation of rural groups (women, children, youth, people with chronic diseases) in the terms of food security and access to land and water resources.

Food security is becoming more pressing in the context of climate change, with evident negative impacts on food availability, accessibility, consumption, and production. If we consider small-scale production in Turkmenistan, the main workforce is women. Income from small-scale production is the main source of livelihood and nutrition. The particular impact of climate change-related food insecurity on women relates to their nutritional needs during pregnancy, breastfeeding and childbirth.

Malnutrition is one of the factors in the prevalence of anemia among women, the indicators of which in women of reproductive age are mandatory during the examination of pregnant women in Turkmenistan. Experts also talk about “discriminatory distribution of food in families and its impact on women’s nutrition,

³⁴ <https://www.un.org/waterforlifedecade/iwrn.shtml>

³⁵ Including old people and people of low-income

since in difficult times it is women that are the first to restrict themselves in food or reduce their diet”³⁶. If food prices rise, all of the categories discussed in this section are likely to suffer.

Land tenure tends to be governed by male-dominated structures, making it difficult for women to access fertile land and agricultural extension services, limiting their ability to engage in climate-smart agriculture and increasing their vulnerability to climate change. Traditional unequal distribution of household and care work may also hinder women's ability to adapt to the negative impacts of climate change by leaving less time for other activities. As practice shows, it is not enough to provide a legal framework; it is also necessary to teach women how to use these rights. These concerns not only issues of land ownership or lease, but also issues of easy access to finance, extension services, inputs, tools, seeds, technology, fertilizers, information and water. According to FAO, if women had the same access to productive resources as men, they could increase their farm yields by 20–30%. To date, there are no extension service centers in the Dashoguz region that provide women with this kind of advice, although the reasonability and efficiency of the creation of such centers have been proved during several pilot projects funded by international agencies. In the context of climate change, when competition for resources will become even more intense, the creation of advisory centers for women would contribute to the achievement of gender equality in practice.

4.8.2 Vulnerability and adaptation of rural groups (women, children, youth, people with chronic diseases) in the field of health care (including reproductive health)

Climate change may have disproportionate impacts on women's physical and mental health. Women are more likely than men to die during extreme weather events, and those women who survive have lower life expectancy. Climate change is reducing the quantity and quality of available water, which can lead to numerous health risks for women.

The Aral disaster (the disappearance of the Aral Sea as a result of irrational human use of water resources) and its consequences (including salt storms) have a significant impact on air quality, which also affects the health of people living in the Aral Sea basin area. Women, children and people with chronic diseases are the most vulnerable from this point of view.

Since Dashoguz Province is located in downstream part of Amu Darya River, key problems faced are the water quality and quantity. Problems of drinking water quality are successfully solved thanks to the construction of drinking water plants and a centralized drinking water supply system. Thus, thanks to technical solutions, it is possible to avoid most of the risks to women's health associated with water supply issues at the household level.

As discussed above, climate change may also contribute to the spread of vector-borne diseases, which particularly affect women. This situation is also very relevant for Dashoguz Province.

It is known from global practice that climate change can limit women's access to sexual and reproductive health services. For example, access to these services may be limited due to reduction in mobility associated with climate change. Extreme weather events, the frequency and severity of which are increasing due to climate change, can destroy critical infrastructure or otherwise reduce the quality, availability, and accessibility of sexual and reproductive health services. In such circumstances, additional barriers may arise that exacerbate pre-existing forms of gender-based discrimination. Lack of access to contraception can lead to unplanned pregnancies; and, if women are denied safe abortions, they are forced to resort to potentially life-threatening methods of abortion, which in turn leads to maternal mortality and morbidity. Unsafe water use and limited mobility can also impact sexual and reproductive health rights. Climate change may also directly affect pregnancy, increasing the risks of maternal mortality and morbidity and threatening women's rights to health and life. Adverse effects on pregnancy and maternal health, such as decreased birth weight, may result from exposure to extreme temperatures. Poor air quality (as caused by the Aral Sea catastrophe) can negatively impact the health of mothers and babies, causing intrauterine growth restriction and birth

³⁶ Global Gender and Climate Alliance, Gender and Climate Change: A Closer Look at Existing Evidence (2016); <http://wedo.org/wp-content/uploads/2016/11/GGCA-RP-FINAL.pdf>

defects. Salinity of drinking water sources may lead to a higher risk of adverse health effects, including preterm birth and maternal and perinatal mortality.

That is why, in Dashoguz region, issues of protecting the health of mothers and children are resolved comprehensively, using the latest achievements of national medicine.

4.8.3 Vulnerability and adaptation of rural groups (women, children, youth, people with chronic diseases) in the field of livelihoods and decent work

The harmful effects of climate change can deplete resources and destroy infrastructure, increase unemployment and increase gender inequality in the world of work, where women already face significant barriers. Climate action that excludes women may exacerbate these challenges. Various forms of discrimination based on tribal or ethnic identity, migrant status, or disability may exacerbate the socioeconomic vulnerability of some women, especially where adequate social protection systems are lacking. Climate change may exacerbate these vulnerabilities by depriving women of sufficient time to participate in economic activities or access to resources, including information and training, needed for better adaptation.

Climate change directly and indirectly affects women's employment opportunities in a number of sectors. Very often, women are employed in low-paid or unpaid, labor-intensive and time-intensive agricultural work.



Figure 29: Breeding Holstein (left) and Swiss cows (right) in Dashoguz Province.



Figure 30: Livestock farm in Dashoguz, engaged in acclimatization and breeding of Romanov breed sheep.

Declining incomes and deteriorating working conditions in agriculture and related sectors due to climate change can have a particularly negative impact on women. That is why women are actively searching for alternative sources of replenishing the family budget, promoting a more rational use of available resources. Alternative sources of income that are actively in demand by women of Dashoguz Province include the

production of wool products (carpet weaving and felting), sewing and embroidery, greenhouse farming, livestock farming (including breeding), and beekeeping.

Recently, the format of “gender symbiosis” for the successful promotion of entrepreneurial activity has become increasingly popular. A successful example of such entrepreneurship in Dashoguz Province is a livestock breeding farm, where meat and dairy products are also processed. In this farm, the head/owner is a man who provides access to resources (land, financial, technological, etc.), and the woman actually plays the role of manager, ensuring the sustainability of the farm.



Figure 31: Artificial pond on a livestock farm for bathing cows in the hot season.

In the absence of “extension services”, through trial and error, Turkmen farmers (including female farmers) are doing their best in acclimatization and breeding of large and small ruminants that are most promising ones (Figure 29 and Figure 30). Additional infrastructure like covered premises and small ponds for swimming as protection from overheating in hot weather (Figure 31) and greenhouses for forage production to enrich/diversify the diet with hydroponically sprouted oats (Figure 32) are built to support the adaptation and acclimatization of the breeding livestock during the very cold winters and very hot and long summers.

The trials to acclimatize and breed new breeds of domestic animals in Turkmenistan can also be considered as an adaptation measure that allows farmers to increase production profitability

in the face of declining profits from agricultural activities due to climate change.

Female farmers are actively exploring the possibility of generating additional income through more efficient use of local raw materials. (Figure 33).

The wool of Romanov breed sheep started recently to be produced in Dashoguz recently is suitable for the nuno-felting for outerwear, interior items, souvenirs, and this circumstance opens up new prospects for the development of new creative industry creation of modern industries, so, there is a good chance for women entrepreneurship, employment for the development of Dashoguz region.



Figure 32: Female farmers in Dashoguz Province germinate oat grains using water-saving technologies (hydroponics) to supplement the feed of breeding cows.



Figure 33: Information workshop on modern wool crafting techniques (Dashoguz, October 2023)

4.8.4 Vulnerability and adaptation of rural groups (women, children, youth, people with chronic diseases) in matters of mobility

While many women can empower themselves or take leadership, roles in climate action through migration and human mobility pose particular risks for women. Among these risks are human trafficking and an increase in the number of early and forced marriages.

Both sudden and slow-onset negative impacts of climate change can stimulate human mobility and make buildings, lands, and areas uninhabitable. In areas affected by climate change, gender greatly influences how much of the population leaves and what part stays, how decisions are made, the personal circumstances surrounding departure, and the outcomes of relocation. Displacement can affect gender dynamics by

reinforcing traditional gender roles and existing inequalities or by challenging and changing them. For example, male migration, at least partly driven by climate change, may lead to an increased role and empowerment of women in decision-making in agriculture. However, if income from agriculture lags behind that earned in other sectors, the growing role of women in the agricultural sector may exacerbate gender inequality.

4.9 NEEDS, PROBLEMS AND RECOMMENDATIONS IDENTIFIED BY INTERVIEWED STAKEHOLDERS

Gender inequality analysis in terms of access, use and management of water resources, analysis of vulnerability and adaptation to climate change of various population groups, especially women, children, older and low-income people, needs, problems identification as well as the development of recommendations for improving the water resource situation and for mitigation the consequences of climate change for Dashoguz velayat have been performed on the basis of results of focus group discussions and interviews with representatives of government institutions, business companies and CSOs listed below:

1. State Sanitary and Epidemiological Service under the Ministry of Health and Medical Industry of Turkmenistan;;
2. State Insurance Organization of Turkmenistan company;
3. Dashoguz Production Association “Agyzsuv”;
4. Dashoguz Department of Environmental Protection;
5. “Women's Union of Turkmenistan”;
6. Dashoguz branch of the State Committee for Water Management - “Dashoguzsuvkhodzhalik”;
7. “Union of Industrialists and Entrepreneurs”;
8. “Ecodurmush” NGO (Dashoguz).

To understand better to what extent women and men are equal in the opportunities to contribute to economic development of communities and to the improvement of adaptive capacity to climate change, it is important to identify whether there are differences in men's and women's access to the principal resources - land, water, finance, technology training, and knowledge on climate change adaption etc. Yet, this research is at the very beginning: in 2021 the “Guidelines for the collection, processing, analysis, use and storage of gender-disaggregated data to integrate a gender perspective into climate change adaptation and resilience activities” has been developed within the framework of the joint project of the Ministry of Agriculture and Environmental Protection of Turkmenistan and the UN Development Program “Supporting climate-sustainable economic activities of agricultural communities in the arid regions of Turkmenistan” under the financial support of the USAID program “Promoting the improvement of public administration in Turkmenistan”.

In the press available there is no information on application of this methodology and results of research (if so) by state institutions of Turkmenistan. Meanwhile, the Ministry of Agriculture and/or the Ministry of Finance and Economy, and/or the Institute of State, Law and Democracy of Turkmenistan (as the agency authorized to implement activities and prepare country reporting on SDG 5) are considered the most interested stakeholders/customers for this study. The executors could be the State Committee on Statistics of Turkmenistan and/or the Union of Industrialists and Entrepreneurs and/or an analytical agency that is experienced in this type of survey.

Since to date such a study has not been conducted, and also given the fact that there is no high-quality statistical data on the difference in social behavioral norms and values of men and women in all spheres of life (e.g. choice of profession, division of labor, participation in the transfer of knowledge, participation in decision-making within a family or work team), the gender analysis presented in this report was carried out on the basis of interviews with representatives of institutions listed above and results of focus group discussions.

All participants of focus group discussions noted that in Turkmenistan in general and in Dashoguz Province, in particular, women and men have equal rights by law and there are no formal obstacles to the implementation of these rights.

Survey participants repeatedly emphasized that farming is usually a family business, and despite the fact that quite often it is registered in the name of a man (as the formal head of the family), women (as informal leaders) take part in planning and decision-making on farm activities and budget.

In addition to existing stereotypes, there are many other reasons why a “business” is registered in the name of a man, among which are:

- Lack of any specific financial (and non-financial) benefits for women-led businesses.
- Men are more mobile, since caring for the home and family members (children, old parents) remains “on the shoulders” of women; (mobility is an important factor in conditions of competition for resources).
- Men find it easier to discuss production issues (and reach agreements) with partners and supervisory authorities, who are also (in the vast majority) men

At the same time, there are certain areas of business that are preferably entirely governed by females (beauty salons, tailoring studios, wedding salons, etc.). Also, as a rule, an “operatorship” is registered in the wife’s name, but not property, i.e. the wife can be the “director” of the company, but not always the “owner”.

None of the interviewed participants spoke about single women, single mothers, or mothers with many children who are engaged in entrepreneurship. One can guess how easy or difficult it is for them to access resources (credit, good land, timely watering) as there is no official data.

The Union of Industrialists and Entrepreneurs has some gender statistics on female entrepreneurs (it concerns only the formal percentage of women engaged in entrepreneurship, but says nothing on the degree of women’s involvement in decision-making processes and on the effectiveness of their involvement).

During a focus group discussion on vulnerability to climate change, as well as gender aspects in water management, participants noted that:

- Men and women in Turkmenistan have the opportunity to fully realize their economic and environmental rights and to contribute to the formation of adaptation policies. For women, these opportunities can sometimes be realized through the formal status of a tenant or owner, and sometimes in an informal way (as the wife/mother of the owner of a family business)
- Women and men have equal opportunities to realize themselves in work and in case of the excellent work they are equal to receive financial and moral awards (e.g. in the “Hall of Fame” in the museum of the daykhan association named by Sadulla Rozmetov presenting the revered “production leaders” - both men and women)
- At the operational level: both women and men are involved in water quality management (as the middle engineering staff of water quality laboratories and water inspections), predominantly men are involved in water quantity management (whether at the field or basin level, it is men who are the decision makers³⁷).
- At the household level, “management” of water resources is in most cases the responsibility of women. Irrigation is mainly done with drinking water; there are water meters everywhere.
- In the context of climate change and declining incomes, both women and men are equally interested in finding alternative sources of income. The search for such sources is carried out first of all in one’s

³⁷ Management of water resources in arid climates, when water resources are distributed unevenly throughout the country, is associated with certain conditions (remoteness of objects, the need for constant monitoring). Women, due to being busier at home than men, cannot gain sufficient experience to achieve high positions in water resources management.

own region, secondly - earnings in the capital, and lastly - labor migration abroad (as a rule, both spouses travel together, leaving children in the care of their closest relatives)

- In the context of climate change and a decrease in the flow of rivers and the availability of water resources, women, including single mothers (as well as mothers of large families) are in a more vulnerable position
- Older people that usually have chronic diseases or even a disabled ones (including women) are among those most affected by the harms associated with climate change, for example due to the increasing prevalence of vector-borne diseases, heat stress and the increased frequency and severity of sudden and slow-onset disasters that can impact their physical and mental health and well-being
- In case of emergency situations (rapidly developing natural disasters), all categories of the population considered in this review are recognized as vulnerable
- At the same time, older people have greater knowledge, experience and resilience, making their participation, inclusion and leadership as a key to rights-based global efforts to adapt to and mitigate the adverse impacts of climate change.

Participants also emphasized that the state guarantees equal access to water resources both at the level of agricultural producers and at the household level. It was noted that the allocation of the required amount of water from the canal, rivers and reservoirs for agricultural producers is strictly centralized. The need and effectiveness of centralized management and control over the distribution of water resources is especially obvious in dry years and during periods of drought, and today, as interview participants noted, drought is the main problem for agricultural producers.

During an interview with Dashoguz representatives of the Union of Industrialists and Entrepreneurs, it was noted that farmers (and farmer associations) are very interested in introducing water-saving technologies and would be happy to take advantage of preferential loans allocated by states for these purposes. The only thing that keeps some farmers of Dashoguz Province from the full-scale implementation of water-saving technologies is the lack of guarantees that the same land plot will be leased for at least a 10-year period with the right to extend.

Advanced farmer associations and individual farmers (who have a good material and technical base) actively use preferential loans to introduce water-saving technologies (as an example: the farmer's association named after Sadulla Rozmetov uses drip and sprinkler irrigation technologies and has a large greenhouse farm). Both women and men work fruitfully in this association, the museum of which houses a large portrait gallery of production leaders, many of whom are women. This approach allows us to further motivate the initiative of rural women in moving up the social ladder.

Migration processes also occur in Turkmenistan (both internal and external migrations are noted). As a rule, young rural people go to study "to the city" (mainly Ashgabat and Dashoguz) and abroad. Turkmenistan managed to avoid a significant outflow of the labor force due to restrictive regulations that go along with programs for rural development, business support and support for young families. There are examples of labor migration, which is typical mainly for middle-aged people and for young people who have completed their studies abroad. Although, today, the main reasons for labor migration are called economic reasons, it is already clear today that to some extent economic reasons are a consequence of climate change. Turkmenistan is a "country of origin" of "labor" migration, therefore, effective measures to create favorable economic conditions within Turkmenistan for its residents are an important component of curbing labor migration, during which there is a high risk of destruction of the institution of marriage and family.

“Medical³⁸” and “sports³⁹” tourism is also in-demand because of climate change. Obviously, this trend will only steadily increase in the next 50-100 years for arid countries. Unfortunately, for the time being, there is no scientifically based research on this issue in Turkmenistan.

Considering the fact that climate change also has a negative impact on the older generation and people with chronic diseases, it is imperative that adequate level of medical care should be organized for residents of rural areas, as well as the access to the medical services/assistance (including paid medical service) within large medical centers of the velayat and the capital of Turkmenistan should be ensured as well.

Women, children, population with low income, national minorities, and refugees belong to the vulnerable categories. Although people of these categories are not always successful in terms of exercising their rights to vocational education, nevertheless they have their own experience, knowledge, and innovations that could shared in case of having the opportunity to participate in the discussion and planning of climate change adaptation activities.

³⁸ Travel abroad for the summer, to a different climate zone, according to doctors' indications

³⁹ Training athletes during summer period in foreign sports camps to improve the body's capabilities for successful performance in competitions.

5 WATER SUPPLY IN ASHGABAT CITY

5.1 OVERVIEW

Ashgabat is the capital and the largest city of Turkmenistan. It lies between the Karakum Desert and the Kopetdag mountain range, near the Iran-Turkmenistan border. The Soviet-era Karakum Canal runs through the city, carrying waters from the Amu Darya from east to west. The total territory of Ashgabat city is 0.9 thousand square kilometers within which four districts are divided. The population structure is 49.6% male, 50.4% female; with 100% urban population.

Industry production:

Territory name	Industry production volume (million TMT)	Weight of production in terms of total volume (percentage)
Ashgabat	8 571.6	13.2

Surface Water for Ashgabat. The main source of surface water is Amu Darya water, which is delivered along the Karakum Canal (Figure 34). With its long way through the desert along hundreds of kilometers, this means high water losses due to evaporation and especially infiltration into the sandy soil. Close to the city, however, parts of the canal are lined with concreted – though additionally planned in a wider riverbed than used today. Additionally, within the current borders of Ashgabat (the territory of which was significantly increased in 2013) is the Golden Lake (Turkm. *Altyn Köl*; former name – Kurtli Reservoir)⁴⁰.

Small water sources of Turkmenistan are located in the north-eastern and western mountainous and foothill areas of Kopetdag and bring only 0.3% of the total water resources to the water balance of Turkmenistan, which is about 70 million m³; at the same time, they are almost completely disassembled for the needs of the local population.

In Ashgabat, the capital of Turkmenistan, 100% of the population has access to centralized water supply and sewerage systems.

⁴⁰ The Kurtli reservoir was created in 1962 (a settling basin for the waters of the Karakum canal); In the first years of its existence and until the early 80s, the reservoir became a popular place of beach recreation for Ashgabat residents - a city beach, a boat station, departmental recreation centers and summer houses were established here. In May 2020, the President of Turkmenistan instructed to create a modern recreation area near the lake. On June 15, 2020, Kurtli Lake was officially renamed into Golden Lake (Turkm. *Altyn köl*); on June 15, 2020, the first complex of leisure infrastructure facilities was inaugurated on the shores of the lake. In February 2021, the President of Turkmenistan signed a Decree, according to which a new modern recreation zone will be built on the shore of the Golden Lake in 2021-2024.



Figure 34: Karakum Canal in the north of Ashgabat

Groundwater. The predicted reserves of fresh groundwater in Turkmenistan are less than 8 million cubic meters per day, and the approved exploitation reserves are about 3.5 million cubic meters per day. At present, part of them is consumed for drinking water supply (both through central water supply systems and in bottled form), the rest is kept untouched.

There are also mineralized groundwaters within Ashgabat, which are consumed depending on their quality/composition:

- for irrigation of green areas (mainly through drip irrigation systems);
- for balneological purposes (Medical Center in the south of Ashgabat).

Use of Water Resources. In Ashgabat water resources are used for the following purposes:

- Drinking and domestic water supply;
- Health care;
- Industry and energy;
- Park management;
- Forestry;
- Recreation;
- Construction;
- Fire safety;

While drinking water has the highest priority in the management of water supply, a large share of the water is used for irrigation. Here, the focus of irrigation is on plants in parks as well as on the trees in the Green Belt – a ring of afforested trees around the city for protection and overall improvement of city climate (Figure 35). For both types drip irrigation is the most prominent type of irrigation. In times of drought, however, this huge afforestation project is in danger of losing some of the carefully grown trees to the dry conditions.



Figure 35: Afforestation in the Green Belt of the city

5.2 DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS

Ashgabat is the capital of Turkmenistan, that has the status of a velayat and includes four “etraps in cities”, namely Byuzmein, Berkararlyk, Bagtyyarlyk, Kopetdag. According to the statistical yearbook as of January 1, 2023 for Ashgabat, Administrative-territorial divisions of Ashgabat as per 01.01.2023 are presented below:

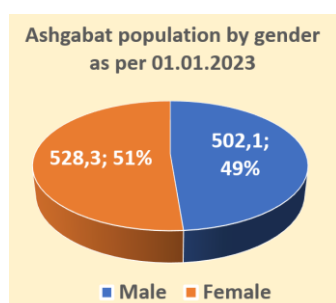


Figure 36: Ashgabat population distribution.

Source: Statistical yearbook– 2022 by State Committee of Turkmenistan on Statistics

Table 18: Administrative-territorial divisions of Ashgabat as per 01.01.2023

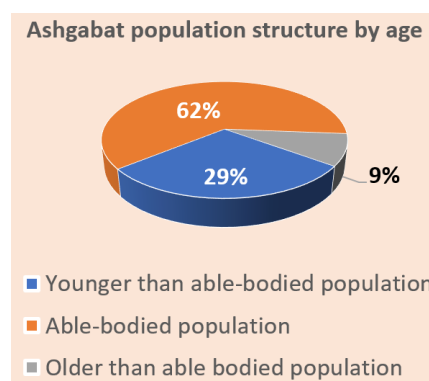
Population, thsd people	Territory, thsd sq. km	Etraps	Cities	Settlements	Gengeshliks	Rural
1030,4	0,9	4	1	-	-	-

Gender structure of the population of Ashgabat as per January 1, 2023: male - 48.7% (502.1 thousand people); female - 51.3%. (528.3 thousand people). (see Diagram 4 and Table 3)

Table 19: Ashgabat population structure

Ashgabat population structure by gender		thsd. people
Men		502,1
Women		528,3
Ashgabat population structure by age		thsd. people
Younger than able-bodied population ⁴¹		300,8
Able-bodied population		639,4
Older than able-bodied population		90,2

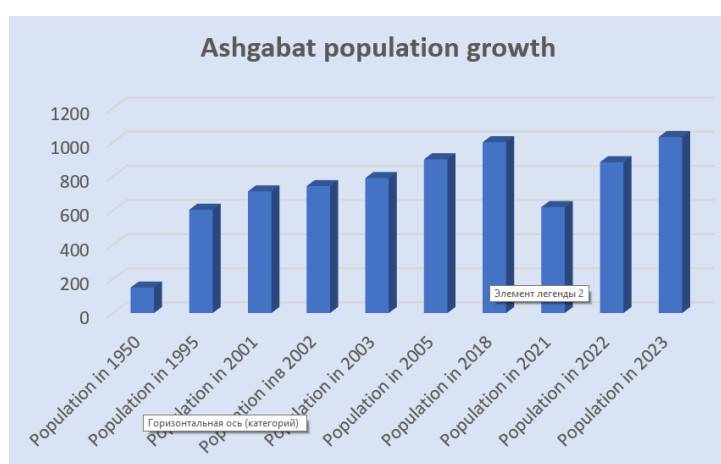
Source: Statistical yearbook – 2022 by State Committee of Turkmenistan on Statistics


Figure 37: Ashgabat population structure by age

Over the past half century, urbanization in Ashgabat has manifested itself most clearly in all three areas:

- significant population growth;
- significant increase in territory;
- significant introduction of “green technologies”.

In 1948 the territory of Ashgabat was about 3 thousand hectares, while in 1969 it was increased to up to 7.5 thousand hectares. During the period 1949 – 1959 the construction tried to keep the historical style and character. The significant urban development boom was started in the mid-80s, a trend was set for the consolidation of neighborhoods, the expansion of streets, the creation of residential areas (like Cantons) and green recreation areas. The architectural transformation of Ashgabat began actively in the late 90s and today the housing stock of Ashgabat amounts to more than 23.5 million square meters (on average, there are 22.9 square meters per resident in the city of Ashgabat).


Figure 38: Ashgabat population growth.

Source: Statistical yearbook – 2022 State Committee of Turkmenistan on Statistics

Dynamics of Ashgabat population growth is presented in Figure 38, which shows the significant population growth recorded over the past three years. This population growth has lead to the creation of several newly developed areas, implementation of great construction projects (public and residential development ones) with the associated infrastructure. One example of these construction projects is “Arkadag - smart city⁴²” -, which is located 30 km outside Ashgabat. This city is constructed using green technologies, including those aiming to reduce a greenhouse gas emission. At the same time, both women and men of different ages are equally benefiting from these technologies.

⁴¹ Under 18 years old

⁴² Today, the city of Arkadag is a city of national importance (the city of Ashgabat has the same status)

5.3 SCOPE

The assessment in the focus area of Ashgabat City (Figure 39) includes the water sector with its three components of the relevant transport and distribution of water (via channels and the pipes network), the in-between storage in reservoirs, and the actual use of water in households, local industry, and in public use (e.g., drinking water supply, parks). With almost all of the relevant water supply in Ashgabat is via the Karakum Canal, the assessment includes the relevant conditions along the supply flow, and, most importantly, the Amu Darya River catchment – an overview of these areas is given in Figure 40.

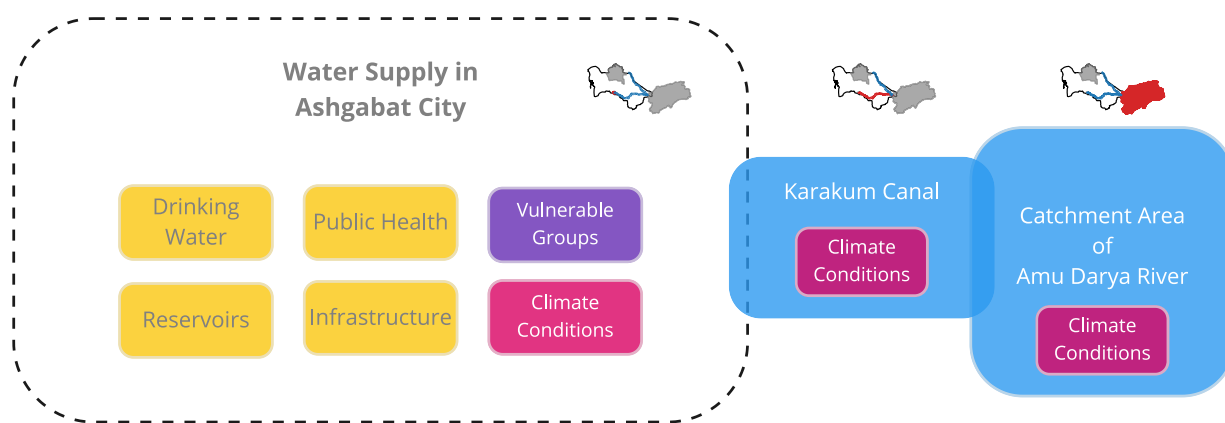


Figure 39: Scope of Climate Risk and Vulnerability Assessment in Ashgabat City.



Figure 40: Map of areas selected for the climate analysis for water supply in Ashgabat City - Ashgabat City, the Karakum Canal (upstream of Ashgabat), and the mountainous catchment area of the Amu Darya River.

5.4 CLIMATE IMPACT CHAIN

Climate Impact Chain — Water Supply in Ashgabat City

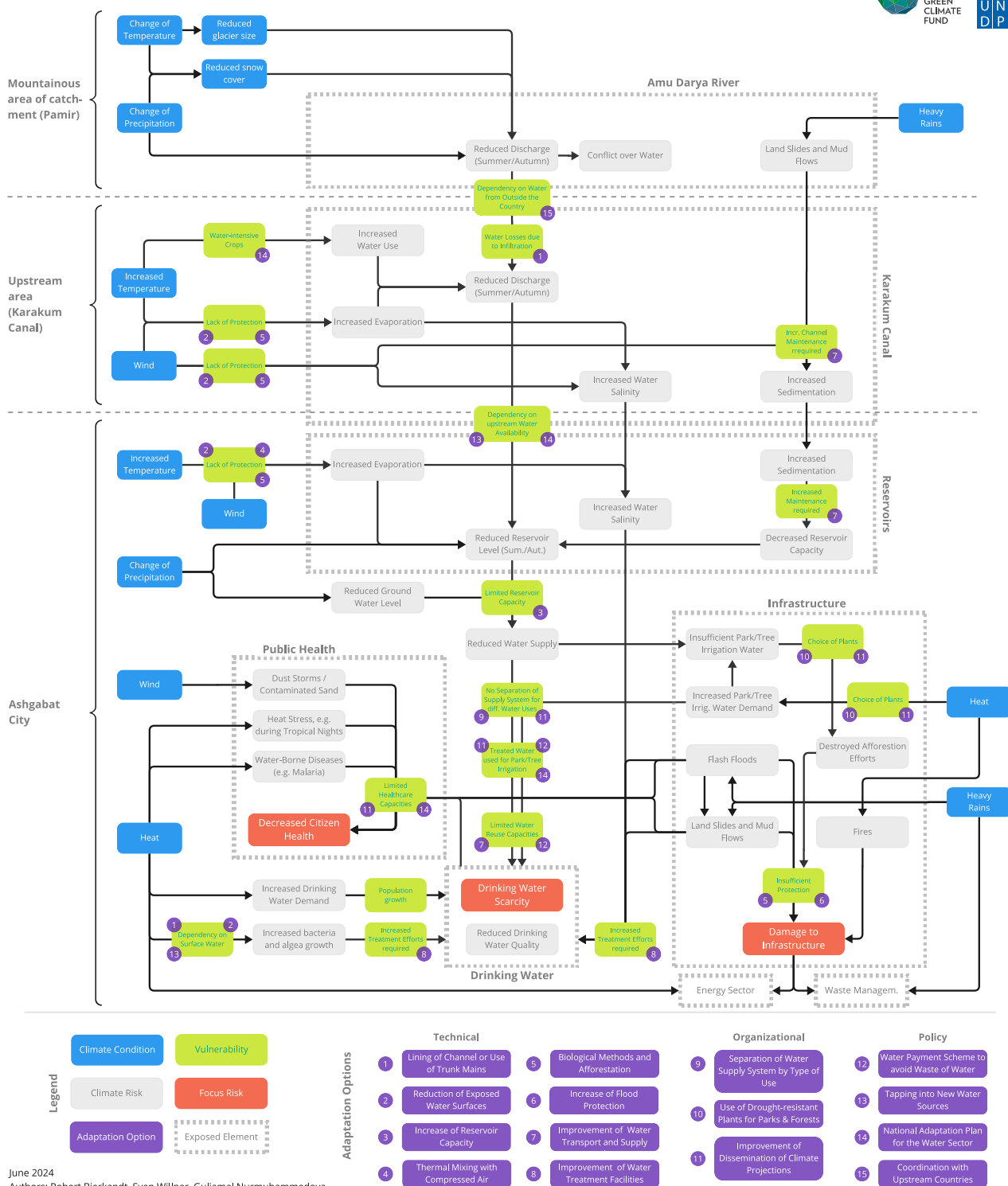


Figure 41: Climate Impact Chain for Ashgabat City visualizing the interrelations between climate conditions (blue), vulnerabilities (green), exposed elements (within dotted lines) and arising risks (gray and red). Adaptation options to tackle specific vulnerabilities are provided as numbers (purple) referencing adaptation options given on the right.

Figure 41 illustrates the major impact channels that affect the water supply in Ashgabat City with a focus on the water sector. As stated above, the city is fully dependent on water supply via the Karakum Canal, which in turn receives water from Amu Darya River, originating in the Pamir Mountains outside of Turkmenistan.

Hence, the climate impact chain for Ashgabat City consists of three parts, taking into account risks and climate conditions in the mountainous catchment area of the Amu Darya River (upper part), along the Karakum Canal upstream of the city (middle part) as well as local conditions in Ashgabat City itself (lower part). A geographical overview of these areas is given in Figure 6.

The catchment area of Amu Darya River is characterized by its mountains in which rain, glaciers, and snow melt constitute the major sources of Amu Darya River. Here, changes in temperature and precipitation can lead to changes in river discharge - highly depending on the season. For instance, increasing temperatures would lead to more glacier melt and earlier snow melt in spring - moving overall discharge to earlier months. Thus, discharge in spring would increase whereas it would decrease in summer and autumn, even with the same amount of overall precipitation. With several territories depending on these waters on different heights of the river, this can spark or aggravate further conflict of the water provided by the river. Heavy rains, on the other hand, could lead to land slides and mud flows in the vicinity.

Where Amu Darya River enters Turkmenistan close to the Afghan border, the Karakum Canal starts and receives water from the river with the Zeid reservoir as a controlling element. Here, the main potentially climatic influences are temperature increases and wind leading to water losses due to additional evaporation as well as increased sediment intake from sandy surroundings by strong winds. More importantly, along the hundreds of kilometres from its river source to Ashgabat City the Karakum Canal suffers substantial water losses due to infiltration.

In the northern part of Ashgabat City, the canal passes the city and feeds three major water reservoirs, which constitute the main fresh water source for the city. These reservoirs further function as settling bases for the water with its high sediment content. From there, the water is treated and distributed to the city. Overall, with the city being located in an arid area, the water supply is highly dependent on the Karakum Canal and its upstream sources. All changes in their water supply accordingly mean additional challenges for reservoir management.

Inside the city, the water is used for irrigation of parks and green areas, industrial use, recreational purposes, and, crucially, drinking water. There is no systemic and physical separation of the supply system for these different water uses. Hence, prioritization and distribution among these water users is currently an important task for water management - which might become difficult in situations of water shortages.. Though drinking water is of the highest priority - while it only constitutes a smaller share of overall water demand - the full dependency on reservoir water constitutes a major vulnerability. In particular, under temperature changes and in light of Ashgabat's population growth, additional demand for drinking water can be expected. A particular focus for drinking water is naturally its quality, which again is impacted by climate conditions locally as well as upstream.

In competition with drinking water supply, a large amount of water is used to irrigate parks and green areas. In addition to townscape design, this encompasses the irrigation of afforestation around the city - the Green Belt. Beyond improving the overall town climate, its purpose is protecting the city from wind and sand storms as well as from flooding. Still, these efforts are highly dependent on the water intake and can suffer in times of low water supply, constituting risks for the city's infrastructure.

In addition to risks of low water, heavy rains can and have led to flash floods. As Ashgabat City is located directly to the foothills of the Kopet Dag Mountains, heavy rains in the mountains can lead to further land slides and mud flows. Here, the city's infrastructure - including water supply - is at risk of damage and the population is at risk of injuries or even death. While the city has implemented measures against such events, the risk of such events can increase with changing climate conditions. Heat and dry conditions additionally aggravate the risk of fires. Though not in focus here, it is important to note the connection to other sectors such as the energy sector or waste management which are affected directly by changing climate conditions as well as indirectly by the impacts discussed here.

Not only such extreme events as flash floods and droughts accompanied by drinking water scarcity put citizens' health at risk. Also further changes in climate conditions such as in heat and in wind have a potential impacts. Winds bear the risk of dust storms and can bring sand from the surrounding into the city that is potentially contaminated with pesticides or salt leading to respiratory issues. Heat, on the other hand, can lead to extreme day temperatures as well as tropical nights (those beyond 25°C). Here, the elderly and children are particularly vulnerable. Additionally, with changing climate conditions, the risk of water-borne

diseases so far uncommon in the area has to be taken into account. Overall, these risks pose new challenges to the current healthcare system.

5.5 CHANGING CLIMATE CONDITIONS

As depicted in Figure 41, the high dependency of water intake from upstream sources for Ashgabat City requires the analysis of changing climate conditions not only locally but also upstream. This section shows the analysis results for each of these areas and each climate variable identified:

- Seasonal mean temperature and total precipitation for the mountainous catchment area of the Amu Darya River,
- Seasonal mean temperature and wind along the Karakum Canal upstream of Ashgabat City,
- Seasonal mean temperature, total precipitation and wind, heat, and heavy rain events in Ashgabat City itself.

Results are shown as time series from 1990 to 2100 for absolute values and as a box plot for changes from 1991-2010 to 2041-2060.

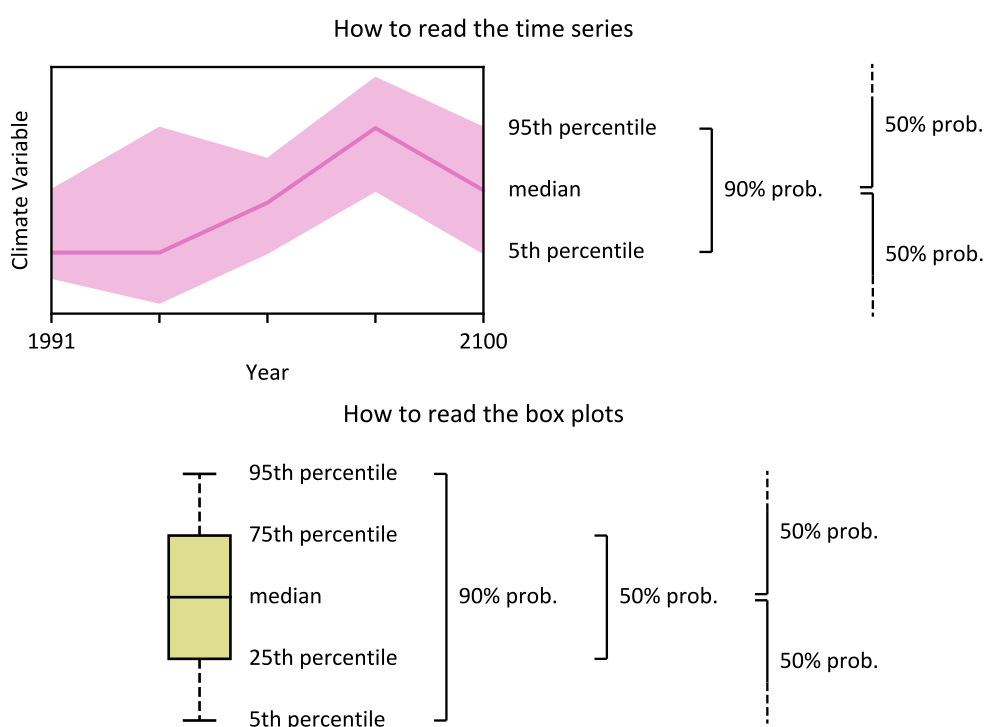


Figure 42: Legend for time series (upper half) and box plots (lower half) as shown for results of the climate analysis. The given range within the time series represents 90% of all possible futures under a given emission scenario, which is based on the ensemble of the output of 29 climate models. Box plots in other figures represent the change for the value from today's climate (1991-2010) to mid-century climate (2041-2060). Additionally, a short explanation is given for how to interpret the percentile: Assuming that the model results span all possible futures, values between the 5th and 95th percentile will occur with a probability of 90%, those above or below the median with a probability of 50% each.

5.5.1 In the mountainous catchment area of the Amu Darya River

Seasonal mean temperature and total precipitation are analyzed for the mountainous catchment area of the Amu Darya River.

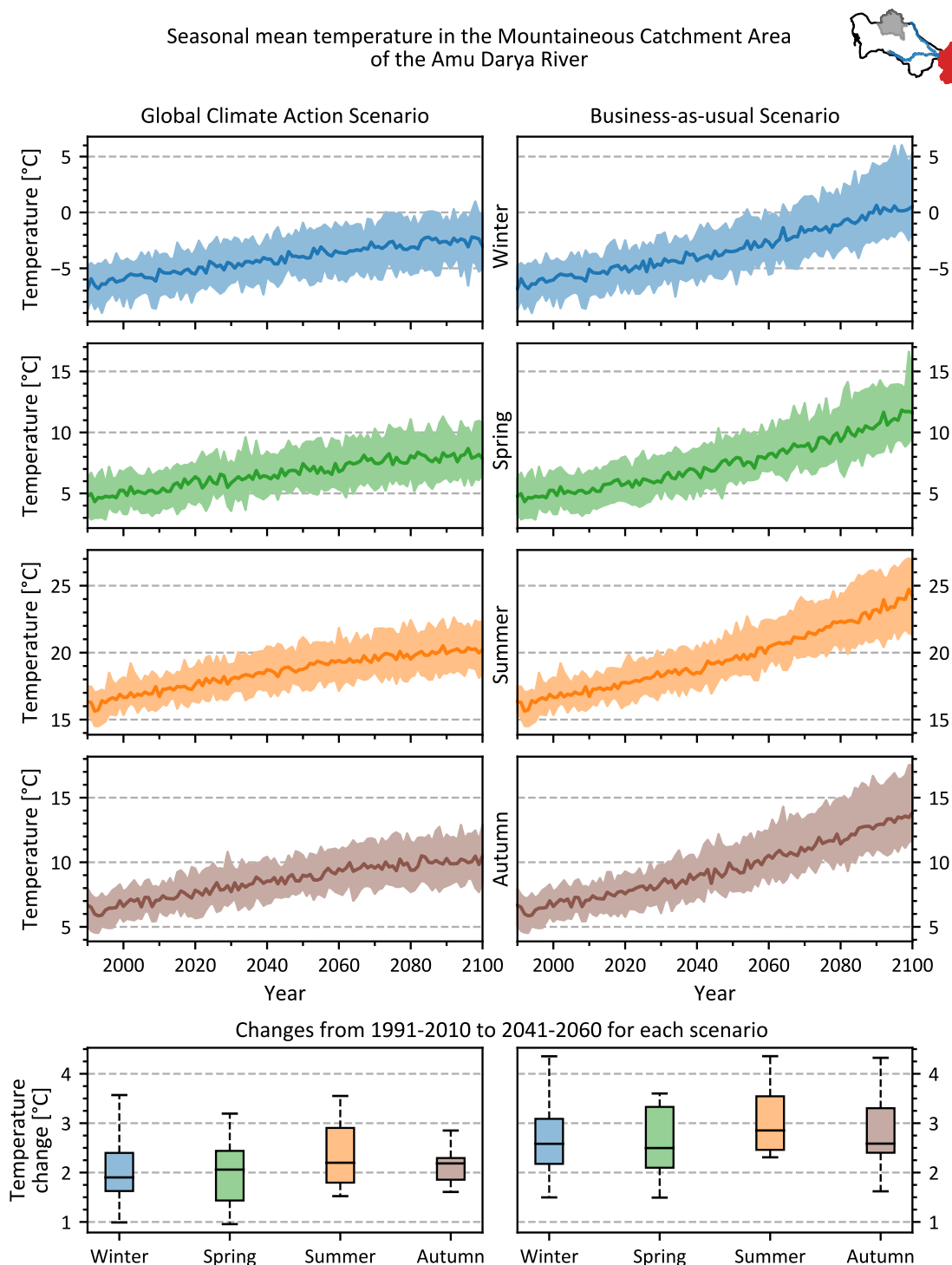


Figure 43: Seasonal mean temperature in the upper catchment area of Amu Darya River (mean over the whole area). Time series from 1990 to 2099 are given per season (upper four rows) and per climate change scenario (columns). Colored areas represent 90% of possible futures in the given emission scenario, based on 29 climate models, solid lines give the ensemble median. Temperature changes between the reference period (1991-2010) and the future period (2041-2060) are presented at the bottom as box plot with 5th and 95th percentile of the model ensemble as whiskers, 25th and 75th percentile as box boundaries, and the median as middle line. For details see Section 2.2.

Table 20: Changes in seasonal mean temperature in the upper catchment area of Amu Darya River (mean over the whole area) between the reference period (1991-2010) and the future period (2041-2060) for each season and climate change scenario (columns). For details see Section 2.2.

Scenario/Season	5 th percentile (95% prob. to be exceeded)	25 th percentile (75% prob. to be exceeded)	Median (50% prob. to be exceeded)	75 th percentile (25% prob. to be exceeded)	95 th percentile (5% prob. to be exceeded)
Global climate action					
Winter	1.0°C	1.6°C	1.9°C	2.4°C	3.6°C
Spring	1.0°C	1.4°C	2.1°C	2.4°C	3.2°C
Summer	1.5°C	1.8°C	2.2°C	2.9°C	3.6°C
Autumn	1.6°C	1.9°C	2.2°C	2.3°C	2.9°C
Business-as-usual					
Winter	1.5°C	2.2°C	2.6°C	3.1°C	4.4°C
Spring	1.5°C	2.1°C	2.5°C	3.3°C	3.6°C
Summer	2.3°C	2.5°C	2.9°C	3.5°C	4.4°C
Autumn	1.6°C	2.4°C	2.6°C	3.3°C	4.3°C

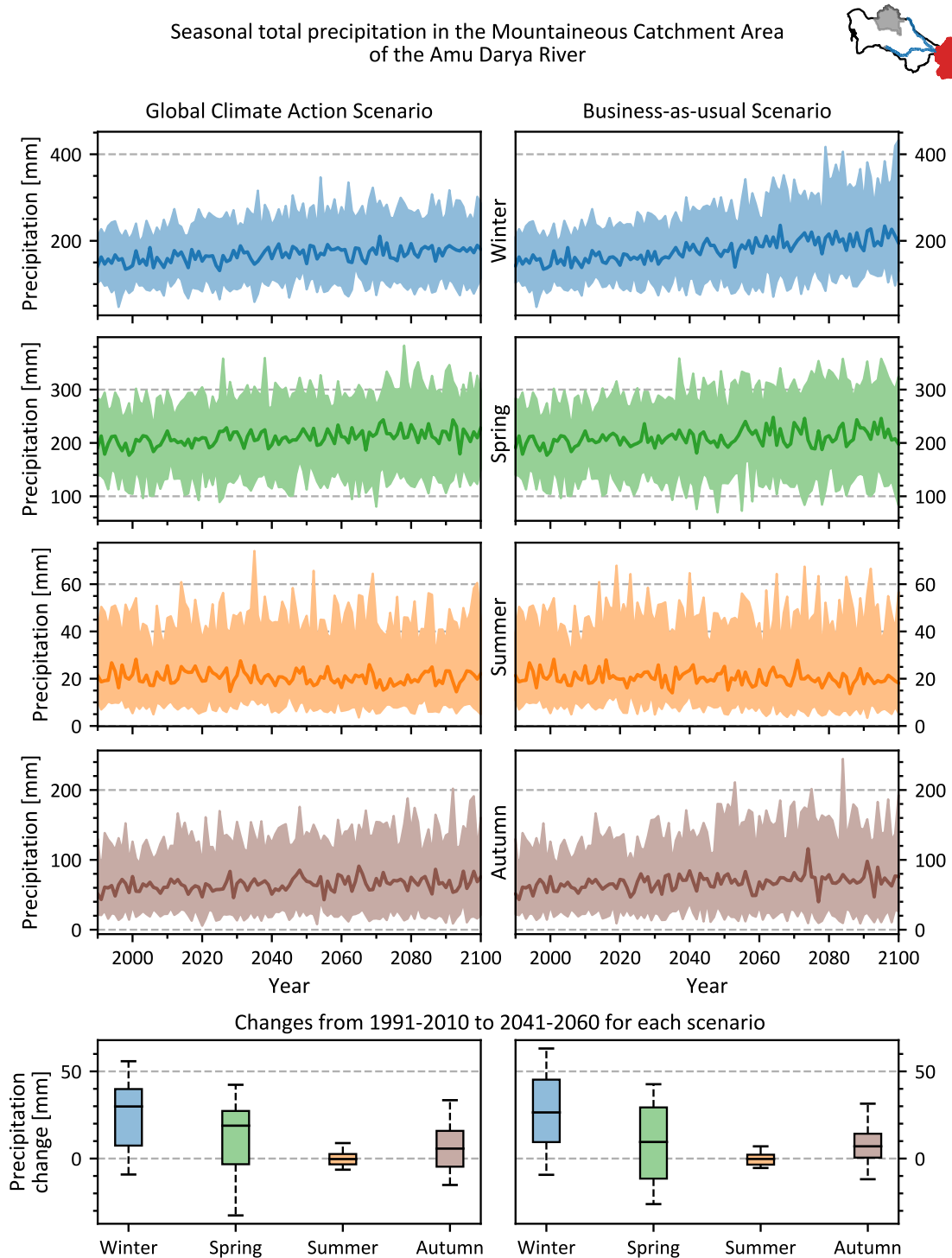


Figure 44: Seasonal total precipitation in the upper catchment area of Amu Darya River (mean over the whole area). Time series from 1990 to 2099 are given per season (upper four rows) and per climate change scenario (columns). Colored areas represent 90% of possible futures in the given emission scenario, based on 29 climate models, solid lines give the ensemble median. Precipitation changes between the reference period (1991-2010) and the future period (2041-2060) are presented at the bottom as box plot with 5th and 95th percentile of the model ensemble as whiskers, 25th and 75th percentile as box boundaries, and the median as middle line. For details see Section 2.2.

Table 21: Changes in total precipitation in the upper catchment area of Amu Darya River (mean over the whole area) between the reference period (1991-2010) and the future period (2041-2060) for each season and climate change scenario (columns). For details see Section 2.2.

Scenario/Season	5th percentile (95% prob. to be exceeded)	25th percentile (75% prob. to be exceeded)	Median (50% prob. to be exceeded)	75th percentile (25% prob. to be exceeded)	95th percentile (5% prob. to be exceeded)
Global climate action					
Winter	-9.2mm (-5.7%)	7.4mm (+4.3%)	29.9mm (+19.9%)	39.9mm (+27.8%)	55.8mm (+35.0%)
Spring	-32.6mm (- 16.1%)	-3.3mm (-1.7%)	18.9mm (+9.5%)	27.3mm (+13.4%)	42.3mm (+21.7%)
Summer	-6.4mm	-3.3mm	-0.3mm	2.6mm	8.9mm
Autumn	-15.2mm (- 23.2%)	-4.7mm (-7.6%)	5.7mm (+10.1%)	15.9mm (+30.6%)	33.5mm (+58.3%)
Business-as- usual					
Winter	-9.3mm (-5.7%)	9.4mm (+6.0%)	26.4mm (+17.4%)	45.3mm (+28.7%)	63.1mm (+45.1%)
Spring	-26.1mm (- 12.3%)	-11.5mm (-5.9%)	9.5mm (+4.6%)	29.3mm (+14.6%)	42.6mm (+25.4%)
Summer	-5.4mm	-3.5mm	-0.2mm	2.2mm	7.0mm
Autumn	-11.9mm (- 20.1%)	0.5mm (+1.0%)	7.0mm (+9.6%)	14.2mm (+26.0%)	31.5mm (+57.6%)

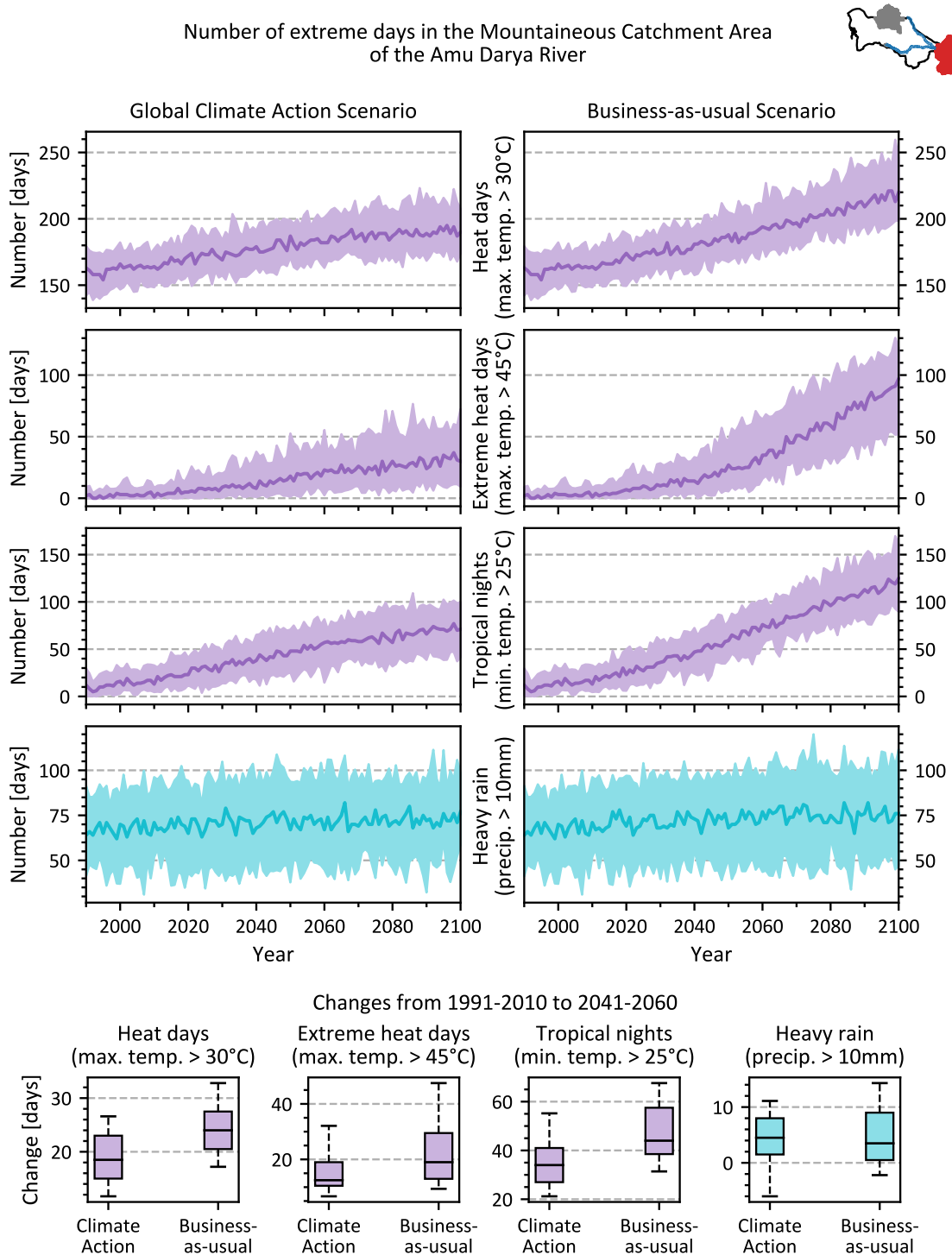


Figure 45: Number of days in the upper catchment area of Amu Darya River with heat (with maximum temperature above 30°C), extreme heat (with maximum temperature above 45°C), tropical nights (with minimum - i.e. night - temperature above 25°C), and heavy rain (with total daily precipitation above 10mm). Colored areas represent 90% of possible futures in the given emission scenario, based on 29 climate models, solid lines give the ensemble median. Changes between the reference period (1991-2010) and the future period (2041-2060) are presented at the bottom as box plot with 5th and 95th percentile of the model ensemble as whiskers, 25th and 75th percentile as box boundaries, and the median as middle line. For details see Section 2.2.

Table 22: Changes in the number of days in the upper catchment area of Amu Darya River with heat, extreme heat, tropical nights, and heavy rain between the reference period (1991-2010) and the future period (2041-2060) for each season and climate change scenario (columns). For details see Section 2.2.

Variable/Scenario	5th percentile (95% prob. to be exceeded)	25th percentile (75% prob. to be exceeded)	Median (50% prob. to be exceeded)	75th percentile (25% prob. to be exceeded)	95th percentile (5% prob. to be exceeded)
Heat days (>30°C)					
Global climate action	11.7 (+7.4%)	15.0 (+9.3%)	18.5 (+11.3%)	23.0 (+14.1%)	26.6 (+16.1%)
Business-as-usual	17.2 (+10.7%)	20.5 (+12.4%)	24.0 (+14.9%)	27.5 (+17.0%)	32.8 (+20.1%)
Extreme heat days (>45°C)					
Global climate action	6.7	10.5	12.5	19.0	32.1
Business-as-usual	9.4	13.0	19.0	29.5	47.5
Tropical nights (>25°C)					
Global climate action	21.2 (+149.7%)	27.0 (+209.5%)	34.0 (+256.2%)	41.0 (+365.0%)	55.2 (+535.3%)
Business-as-usual	31.4 (+221.3%)	38.5 (+296.3%)	44.0 (+357.1%)	57.5 (+525.0%)	67.6 (+680.0%)
Heavy rain (>25°C)					
Global climate action	-6.0 (-9.6%)	1.5 (+3.1%)	4.5 (+5.8%)	8.0 (+11.5%)	11.1 (+19.3%)
Business-as-usual	-2.2 (-3.6%)	0.5 (+0.8%)	3.5 (+4.6%)	9.0 (+13.3%)	14.3 (+21.4%)

5.5.2 Along the Karakum Canal upstream of Ashgabat

Seasonal mean temperature and wind is analyzed along the Karakum Canal upstream of Ashgabat City.

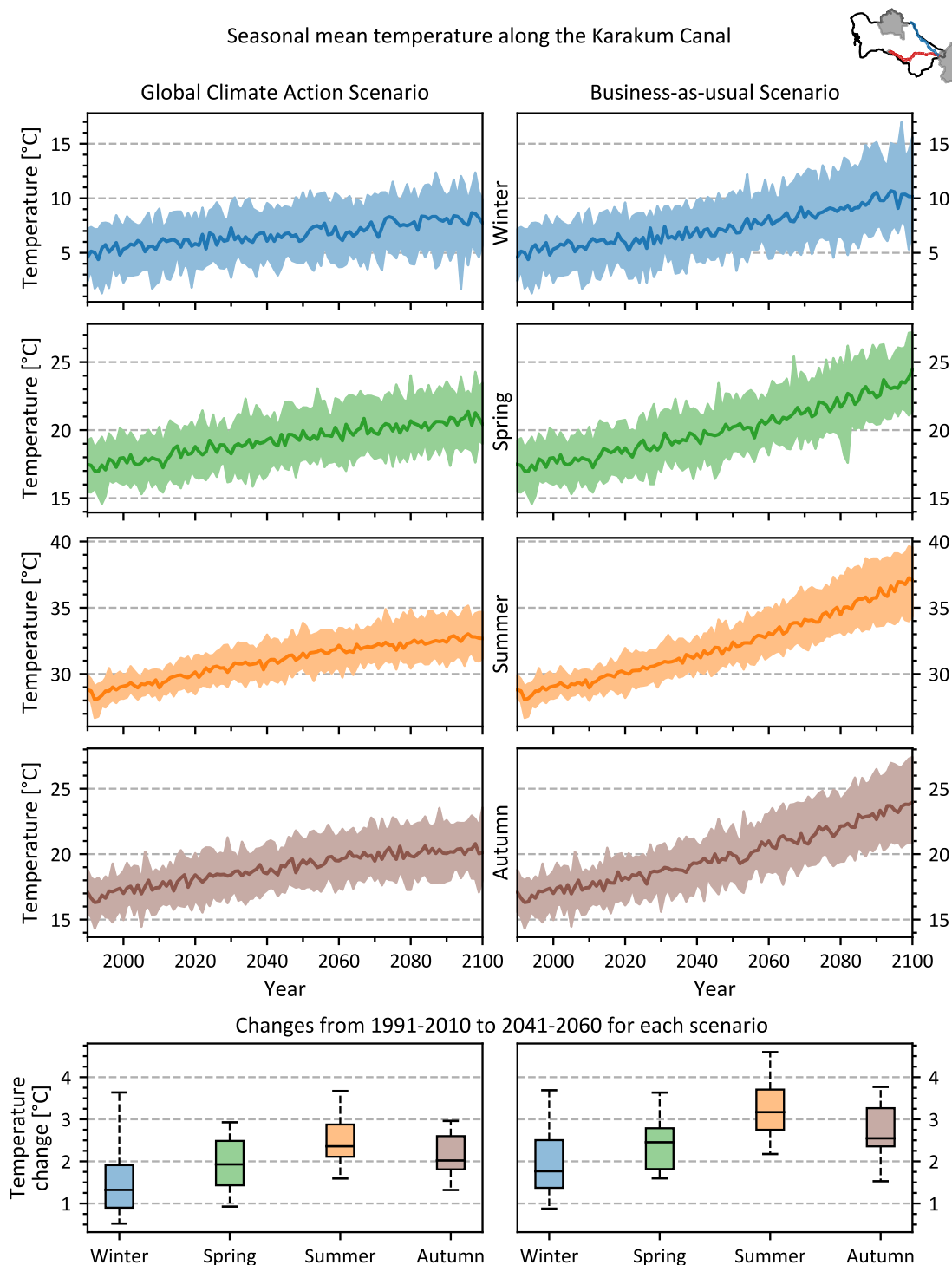


Figure 46: Seasonal mean temperature along Karakum Canal (upstream of Ashgabat; mean over the whole area). Time series from 1990 to 2099 are given per season (upper four rows) and per climate change scenario (columns). Colored areas represent 90% of possible futures in the given emission scenario, based on 29 climate models, solid lines give the ensemble median. Temperature changes between the reference period (1991-2010) and the future period (2041-2060) are presented at the bottom as box plot with 5th and 95th percentile of the model ensemble as whiskers, 25th and 75th percentile as box boundaries, and the median as middle line. For details see Section 2.2.

Table 23: Changes in seasonal mean temperature along Karakum Canal (upstream of Ashgabat; mean over the whole area) between the reference period (1991-2010) and the future period (2041-2060) for each season and climate change scenario (columns). For details see Section 2.2.

Scenario/Season	5 th percentile (95% prob. to be exceeded)	25 th percentile (75% prob. to be exceeded)	Median (50% prob. to be exceeded)	75 th percentile (25% prob. to be exceeded)	95 th percentile (5% prob. to be exceeded)
Global climate action					
Winter	0.5°C	0.9°C	1.3°C	1.9°C	3.6°C
Spring	0.9°C	1.4°C	1.9°C	2.5°C	2.9°C
Summer	1.6°C	2.1°C	2.4°C	2.9°C	3.7°C
Autumn	1.3°C	1.8°C	2.0°C	2.6°C	3.0°C
Business-as-usual					
Winter	0.9°C	1.4°C	1.8°C	2.5°C	3.7°C
Spring	1.6°C	1.8°C	2.5°C	2.8°C	3.6°C
Summer	2.2°C	2.7°C	3.2°C	3.7°C	4.6°C
Autumn	1.5°C	2.4°C	2.5°C	3.3°C	3.8°C

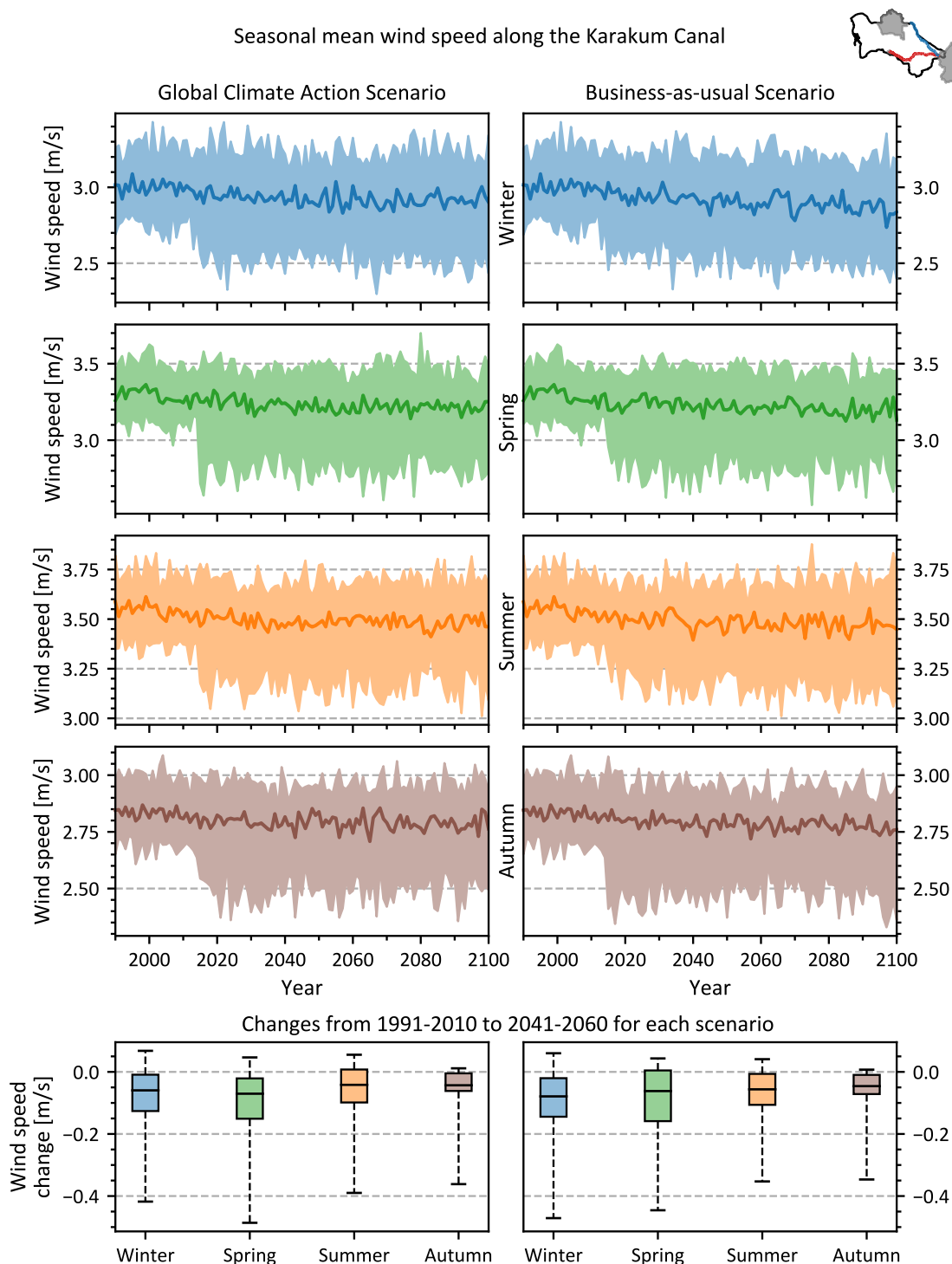


Figure 47: Seasonal mean near-surface wind speed along Karakum Canal (upstream of Ashgabat; mean over the whole area). Time series from 1990 to 2099 are given per season (upper four rows) and per climate change scenario (columns). Colored areas represent 90% of possible futures in the given emission scenario, based on 29 climate models, solid lines give the ensemble median. Wind speed changes between the reference period (1991-2010) and the future period (2041-2060) are presented at the bottom as box plot with 5th and 95th percentile of the model ensemble as whiskers, 25th and 75th percentile as box boundaries, and the median as middle line. For details see Section 2.2.

Table 24: Changes in seasonal mean near-surface wind speed along Karakum Canal (upstream of Ashgabat; mean over the whole area) between the reference period (1991-2010) and the future period (2041-2060) for each season and climate change scenario (columns). For details see Section 2.2.

Scenario/Season	5th percentile (95% prob. to be exceeded)	25th percentile (75% prob. to be exceeded)	Median (50% prob. to be exceeded)	75th percentile (25% prob. to be exceeded)	95th percentile (5% prob. to be exceeded)
Global climate action					
Winter	-0.4m/s	-0.1m/s	-0.1m/s	-0.0m/s	0.1m/s
Spring	-0.5m/s	-0.2m/s	-0.1m/s	-0.0m/s	0.0m/s
Summer	-0.4m/s	-0.1m/s	-0.0m/s	0.0m/s	0.1m/s
Autumn	-0.4m/s	-0.1m/s	-0.0m/s	-0.0m/s	0.0m/s
Business-as- usual					
Winter	-0.5m/s	-0.1m/s	-0.1m/s	-0.0m/s	0.1m/s
Spring	-0.4m/s	-0.2m/s	-0.1m/s	0.0m/s	0.0m/s
Summer	-0.4m/s	-0.1m/s	-0.1m/s	-0.0m/s	0.0m/s
Autumn	-0.3m/s	-0.1m/s	-0.0m/s	-0.0m/s	0.0m/s

5.5.3 In Ashgabat City

Seasonal mean temperature, total precipitation and wind, heat, and heavy rain events are analyzed for Ashgabat City itself.

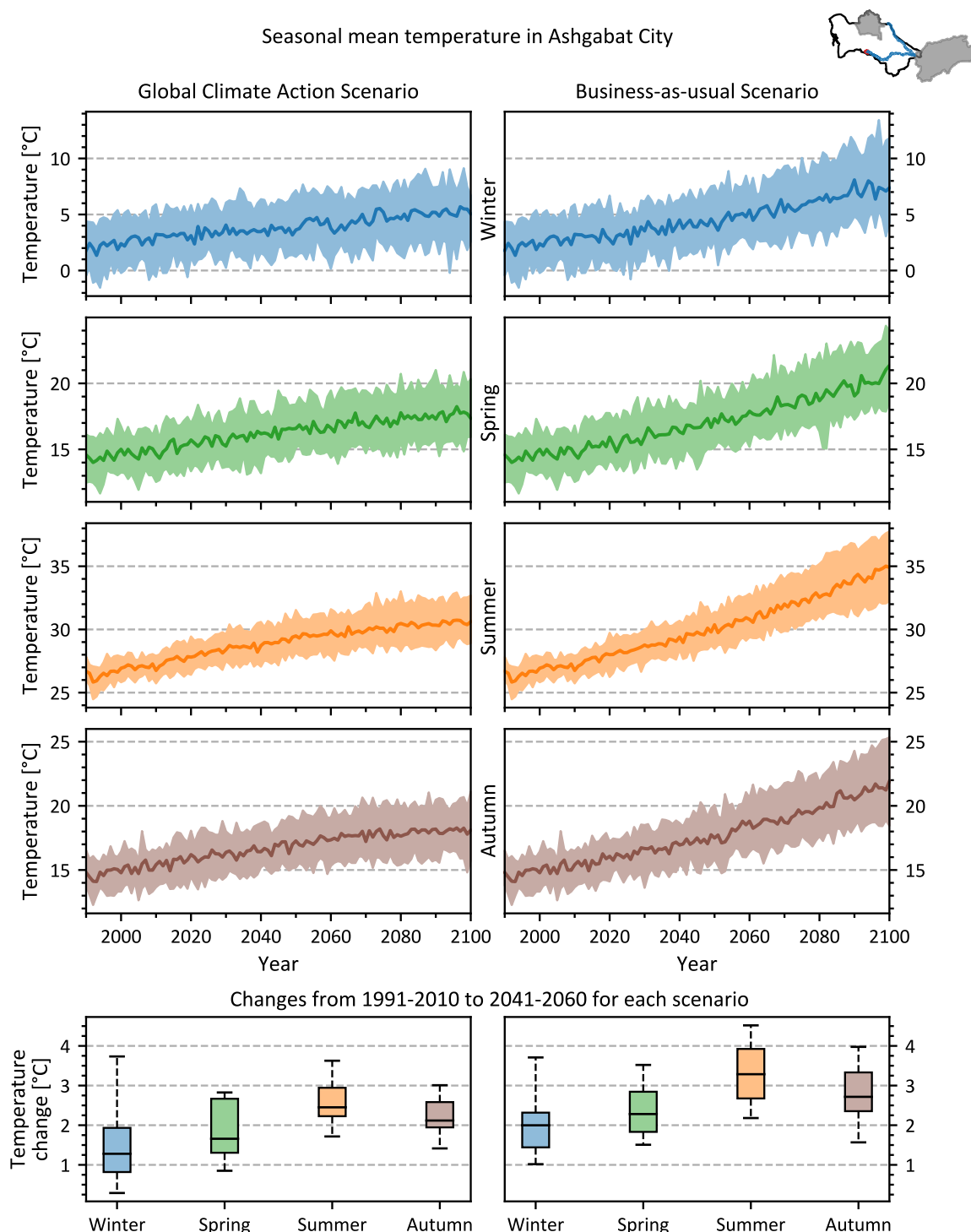


Figure 48: Seasonal mean temperature in Ashgabat city (mean over the whole area). Time series from 1990 to 2099 are given per season (upper four rows) and per climate change scenario (columns). Colored areas represent 90% of possible futures in the given emission scenario, based on 29 climate models, solid lines give the ensemble median. Temperature changes between the reference period (1991-2010) and the future period (2041-2060) are presented at the bottom as box plot with 5th and 95th percentile of the model ensemble as whiskers, 25th and 75th percentile as box boundaries, and the median as middle line. For details see Section 2.2.

Table 25: Changes in seasonal mean temperature in Ashgabat City (mean over the whole area) between the reference period (1991-2010) and the future period (2041-2060) for each season and climate change scenario (columns). For details see Section 2.2.

Scenario/Season	5th percentile (95% prob. to be exceeded)	25th percentile (75% prob. to be exceeded)	Median (50% prob. to be exceeded)	75th percentile (25% prob. to be exceeded)	95th percentile (5% prob. to be exceeded)
Global climate action					
Winter	0.3°C	0.8°C	1.3°C	1.9°C	3.7°C
Spring	0.9°C	1.3°C	1.7°C	2.7°C	2.8°C
Summer	1.7°C	2.2°C	2.5°C	2.9°C	3.6°C
Autumn	1.4°C	1.9°C	2.1°C	2.6°C	3.0°C
Business-as- usual					
Winter	1.0°C	1.4°C	2.0°C	2.3°C	3.7°C
Spring	1.5°C	1.8°C	2.3°C	2.8°C	3.5°C
Summer	2.2°C	2.7°C	3.3°C	3.9°C	4.5°C
Autumn	1.6°C	2.4°C	2.7°C	3.3°C	4.0°C

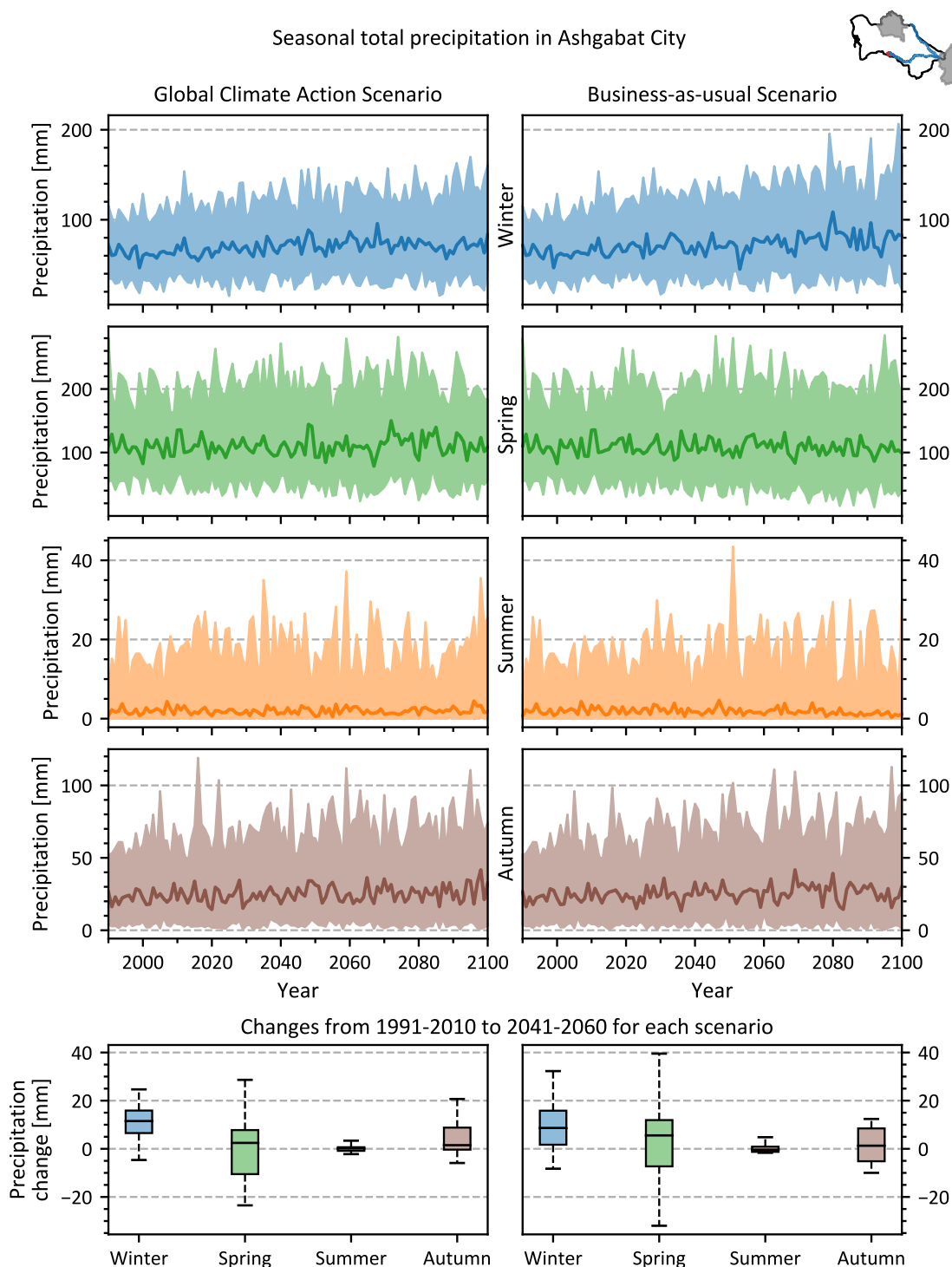


Figure 49: Seasonal total precipitation in Ashgabat City (mean over the whole area). Time series from 1990 to 2099 are given per season (upper four rows) and per climate change scenario (columns). Colored areas represent 90% of possible futures in the given emission scenario, based on 29 climate models, solid lines give the ensemble median. Precipitation changes between the reference period (1991-2010) and the future period (2041-2060) are presented at the bottom as box plot with 5th and 95th percentile of the model ensemble as whiskers, 25th and 75th percentile as box boundaries, and the median as middle line. For details see Section 2.2.

Table 26: Changes in seasonal total precipitation in Ashgabat City (mean over the whole area) between the reference period (1991-2010) and the future period (2041-2060) for each season and climate change scenario (columns). For details see Section 2.2.

Scenario/Season	5th percentile (95% prob. to be exceeded)	25th percentile (75% prob. to be exceeded)	Median (50% prob. to be exceeded)	75th percentile (25% prob. to be exceeded)	95th percentile (5% prob. to be exceeded)
Global climate action					
Winter	-4.6mm (-6.9%)	6.5mm (+10.9%)	11.5mm (+19.6%)	15.9mm (+26.7%)	24.7mm (+43.9%)
Spring	-23.5mm (- 19.7%)	-10.5mm (-9.5%)	2.5mm (+2.2%)	7.8mm (+7.5%)	28.6mm (+30.8%)
Summer	-2.2mm	-0.8mm	0.1mm	0.7mm	3.4mm
Autumn	-5.9mm (-23.4%)	-0.3mm (-1.4%)	1.5mm (+14.3%)	8.8mm (+39.7%)	20.7mm (+101.4%)
Business-as- usual					
Winter	-8.3mm (-13.1%)	1.7mm (+2.7%)	8.7mm (+12.1%)	15.8mm (+29.5%)	32.3mm (+56.4%)
Spring	-32.0mm (- 27.2%)	-7.3mm (-6.4%)	5.6mm (+5.4%)	11.9mm (+11.0%)	39.5mm (+43.5%)
Summer	-1.7mm	-1.3mm	-0.4mm	0.9mm	4.8mm
Autumn	-10.0mm (- 36.8%)	-5.2mm (-20.4%)	1.3mm (+4.6%)	8.5mm (+43.9%)	12.4mm (+77.5%)

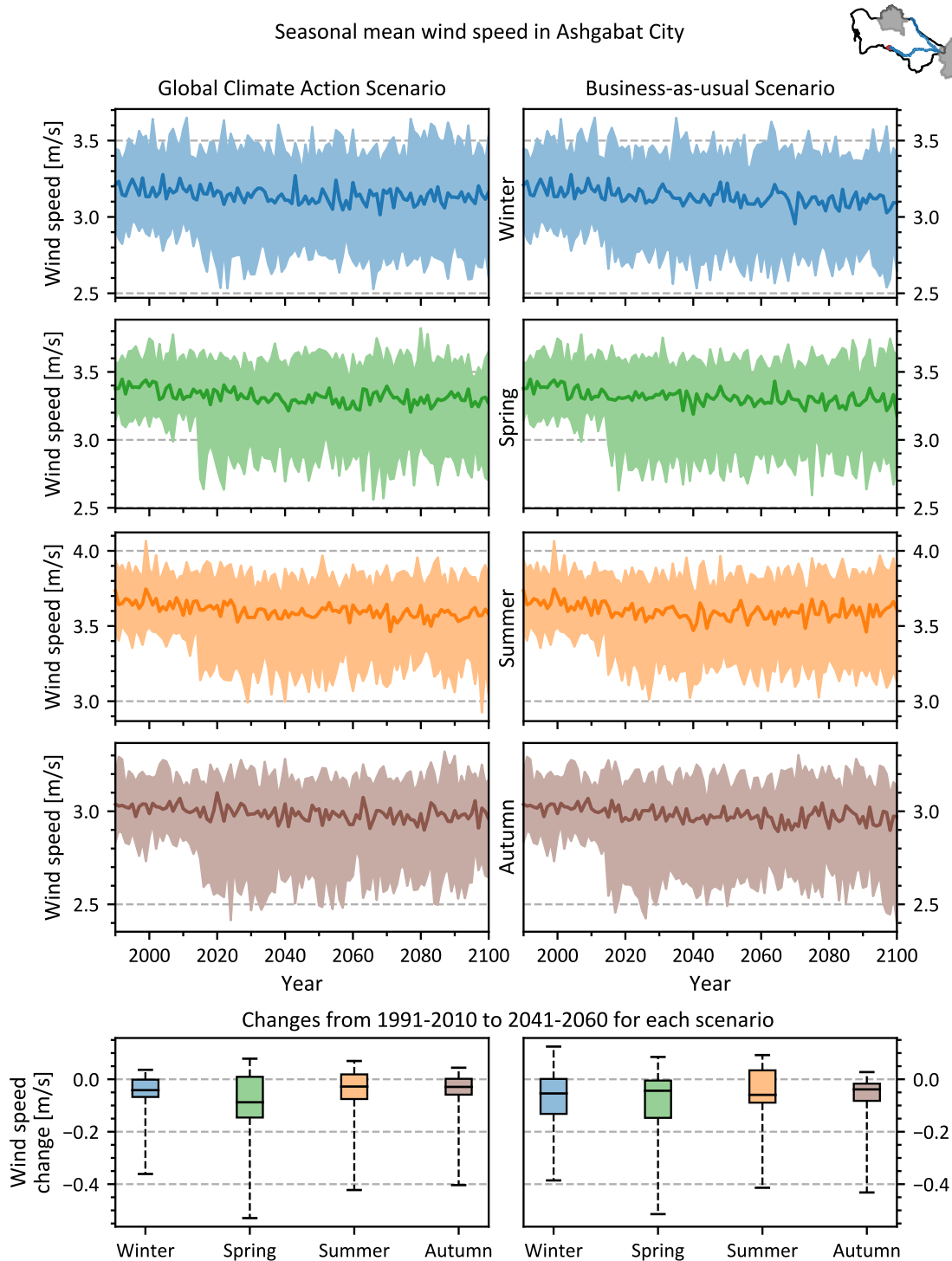


Figure 50: Seasonal mean near-surface wind speed in Ashgabat City (mean over the whole area). Time series from 1990 to 2099 are given per season (upper four rows) and per climate change scenario (columns). Colored areas represent 90% of possible futures in the given emission scenario, based on 29 climate models, solid lines give the ensemble median. Wind speed changes between the reference period (1991-2010) and the future period (2041-2060) are presented at the bottom as box plot with 5th and 95th percentile of the model ensemble as whiskers, 25th and 75th percentile as box boundaries, and the median as middle line. For details see Section 2.2.

Table 27: Changes in seasonal mean of mean near-surface wind speed in Ashgabat City (mean over the whole area) between the reference period (1991-2010) and the future period (2041-2060) for each season and climate change scenario (columns). For details see Section 2.2.

Scenario/Season	5th percentile (95% prob. to be exceeded)	25th percentile (75% prob. to be exceeded)	Median (50% prob. to be exceeded)	75th percentile (25% prob. to be exceeded)	95th percentile (5% prob. to be exceeded)
Global climate action					
Winter	-0.4m/s	-0.1m/s	-0.0m/s	-0.0m/s	0.0m/s
Spring	-0.5m/s	-0.1m/s	-0.1m/s	0.0m/s	0.1m/s
Summer	-0.4m/s	-0.1m/s	-0.0m/s	0.0m/s	0.1m/s
Autumn	-0.4m/s	-0.1m/s	-0.0m/s	0.0m/s	0.0m/s
Business-as- usual					
Winter	-0.4m/s	-0.1m/s	-0.1m/s	0.0m/s	0.1m/s
Spring	-0.5m/s	-0.1m/s	-0.0m/s	-0.0m/s	0.1m/s
Summer	-0.4m/s	-0.1m/s	-0.1m/s	0.0m/s	0.1m/s
Autumn	-0.4m/s	-0.1m/s	-0.0m/s	-0.0m/s	0.0m/s

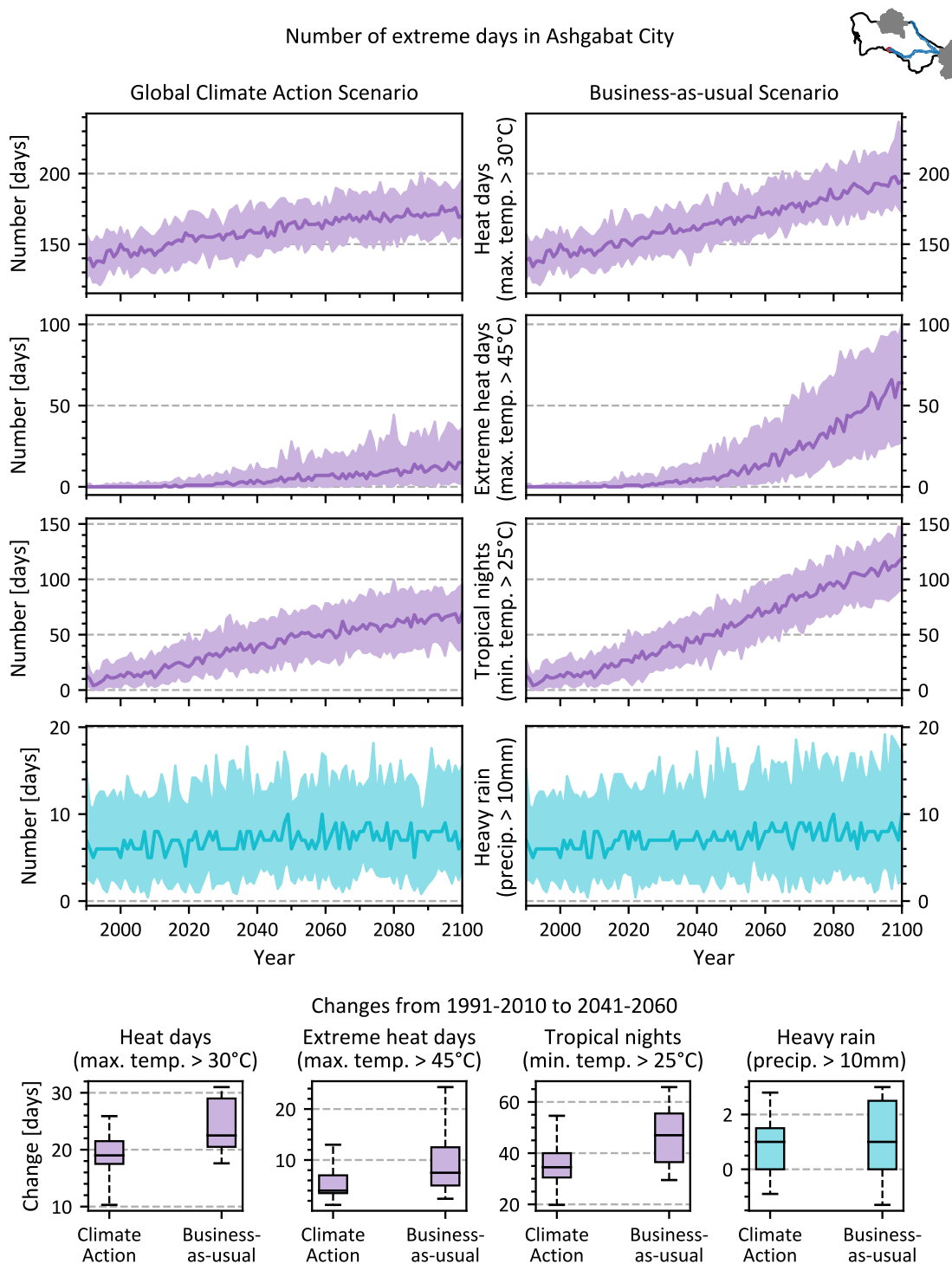


Figure 51: Number of days in Ashgabat City with heat (with maximum temperature above 30°C), extreme heat (with maximum temperature above 45°C), tropical nights (with minimum - i.e. night - temperature above 25°C), and heavy rain (with total daily precipitation above 10mm). Time series of these for each year from 1990 to 2099 are given per climate change scenario (columns). Colored areas represent 90% of possible futures in the given emission scenario, based on 29 climate models, solid lines give the ensemble median. Changes between the reference period (1991-2010) and the future period (2041-2060) are presented at the bottom as box plot with 5th and 95th percentile of the model ensemble as whiskers, 25th and 75th percentile as box boundaries, and the median as middle line. For details see Section 2.2.

Table 28: Changes in the number of days in Ashgabat City with heat, extreme heat, tropical nights, and heavy rain between the reference period (1991-2010) and the future period (2041-2060) for each season and climate change scenario (columns). For details see Section 2.2.

Variable/Scenario	5th percentile (95% prob. to be exceeded)	25th percentile (75% prob. to be exceeded)	Median (50% prob. to be exceeded)	75th percentile (25% prob. to be exceeded)	95th percentile (5% prob. to be exceeded)
Heat days (>30°C)					
Global climate action	10.3 (+7.1%)	17.5 (+12.3%)	19.0 (+13.3%)	21.5 (+15.2%)	25.9 (+18.3%)
Business-as-usual	17.6 (+12.3%)	20.5 (+14.4%)	22.5 (+15.5%)	29.0 (+20.1%)	31.0 (+21.5%)
Extreme heat days (>45°C)					
Global climate action	1.2	3.5	4.0	7.0	13.0
Business-as-usual	2.4	5.0	7.5	12.5	24.3
Tropical nights (>25°C)					
Global climate action	19.8 (+144.6%)	30.5 (+217.9%)	34.5 (+260.6%)	40.0 (+409.1%)	54.6 (+630.8%)
Business-as-usual	29.5 (+196.9%)	36.5 (+281.0%)	47.0 (+346.7%)	55.5 (+517.6%)	65.8 (+924.2%)
Heavy rain (>10mm)					
Global climate action	-0.9 (-13.8%)	0.0 (+0.0%)	1.0 (+16.7%)	1.5 (+27.3%)	2.8 (+50.0%)
Business-as-usual	-1.3 (-17.9%)	0.0 (+0.0%)	1.0 (+16.7%)	2.5 (+37.5%)	3.0 (+60.0%)

5.6 RISKS AND VULNERABILITIES

Risks in the climate impact chain as shown in Figure 41 are grouped together into several exposed elements - the Amu Darya River along its main catchment area, the Karakum Canal as the main water source for Ashgabat, as well as local reservoirs and other surface water, infrastructure in the city itself as well as drinking water and overall public health.

Amu Darya River

Along the Amu Darya River, the greatest risks are related to runoff in the river - at both extremes. Regarding high discharge, the projected increase in precipitation in the mountainous catchment area comes with the risk of increased river discharge. During winter and spring, precipitation may increase until mid century with a probability of approximately 75% in at least one emission scenario (box plot in Figure 21). Under a global Business-as-usual emission scenario, there is a 25% probability that precipitation increases by 29% (+45mm) or more for winter and 15% (+29mm) or more for spring until mid century (Table 21).

Additionally, rising temperatures in the mountains, on the one hand, lead to increased melting of glaciers leading to additional discharge during all but winter times. Under a global Business-as-usual emission scenario, there is a 25% probability that the mean winter temperature in the catchment area increases by 3.1°C or more until mid century (Table 20). On the other hand, they lead to snow melt earlier in the year as well as more precipitation in the form of rain rather than snow. Hence, especially in spring, discharge is expected to occur earlier and faster increasing the risk of floods along river beds early in the year. Since, Ashgabat is not situated at the Amu Darya directly, river flooding is not considered a risk here. In cases of heavy rains, which are expected to occur more frequently (Figure 45), the risk of land slides and mud flows is increasing leading to further sediments transported downstream by the river.

On the flip side, earlier and stronger snow melt (due to temperature increase) likely lead to lower discharge in later times of the year - particularly in summer and autumn. Here, water that had been stored in the mountains in the form of glaciers or snow before has already been discharged through the river earlier in the year. Though not related to changes in climatic conditions, upstream water use is in direct competition with downstream demand, and hence, risk of low water is aggravated by upstream activities such as a new off-branching channel, the Kusch-Tepa Canal, upstream for water use in Afghanistan – increasing the potential for conflict over water in the region.

Karakum Canal

As Amu Darya River is the single source of water for the Karakum Canal, the river's discharge almost directly determines the canal's - with some, but limited, leeway of control given reservoirs along the canal. Increasing temperatures along the pathway of the Karakum Canal (Figure 46) would further increase water losses due to evaporation. With the canal fully exposed, evaporation is aggravated by wind, which additionally increases intake of sediments from the dry and sandy surroundings (potentially with high salt amount). While temperatures are projected to increase - especially when already high in summer - wind shows little to no projected changes (Figure 47). Under a global Business-as-usual emission scenario, there is a 25% probability that the mean summer temperature along the Karakum Canal increases by 3,7°C or more until mid century (Table 23). With high infiltration losses along the long canal pathway already, this puts additional pressure on managing discharge from the reservoirs along the canal. As water-intensive crops are grown in the areas of Mary and Tejen, water from Karakum Canal is often used for irrigation water upstream of Ashgabat City. With increasing temperatures - accompanied by higher water demand upstream - and potentially decreasing discharge in the canal, the pressure to keep stable water intake for Ashgabat's reservoirs is likely to increase. With increased risk of sedimentary intake from the mountains, the need for regular channel cleaning is also expected to increase, requiring additional efforts and costs.

One should keep in mind that Karakum Canal not only supplies Ashgabat City with water, but also areas downstream. The large project of establishing the Altyn Asyr Lake additionally depends on fresh water intake from the south. Here, the risk of low canal discharge requires thorough planning and prioritization between all water users.

Reservoirs

Water supply of Ashgabat City from Karakum Canal is managed by several reservoirs. As the reservoirs' capacity is naturally limited, the risk of low water supply to Ashgabat City is increasing with overall lower water intake or changes in times of water availability - just as higher water intake is to be expected earlier in spring, but less than currently experienced later in the year. Additionally, the reservoir's capacity is limited by the amount of sediments it can hold. With increased sediment intake from the canal, the reservoirs' capacity is decreasing. Low water situations can further be aggravated by additional evaporation as temperatures are expected to increase (Figure 48) at basically unchanged wind (Figure 50). Under a global Business-as-usual emission scenario, there is a 25% probability that the mean summer temperature in Ashgabat increases by 3,9°C or more until mid century (Table 25).

Drinking water

Drinking water in the city is at risk in two regards - in quantity and in quality - with drinking water scarcity a focus risk in this report. In terms of quantity every low water in reservoirs puts availability of drinking water at risk as surface water is the only currently establish source of water. This risk is aggravated by the fact that all water users derive water from the same system and though drinking water is a priority especially in times of low water, property water distribution has to be managed carefully. Here, also treated water suitable for drinking is used for park and tree irrigation potentially wasting capacities important for water actually destined for drinking. Also, the capacities to reuse water from the city's sewage system are limited and not yet fully established. With increasing temperatures to be expected (Figure 48) and the city's population growing, demand for good drinking water is additionally increasing.

In terms of water quality, drinking water in Ashgabat City is affected by potentially increased salt intake from upstream. Though likely a minor factor due to additional evaporation only, the salinity of the water is expected to increase rather than decrease - a thorough investigation is needed here to grasp the gravity of this risk. With more certainty water quality is at risk of increased temperatures - in particular more extreme heat (Figure 51) - that increase likelihood of bacteria and algae growth, especially as surface water is the major source. Though these risks are manageable, likely here are additional treatment efforts required. The mean number of annual extreme heat days (above 45°C) is expected to increase in Ashgabat under all emission scenarios (Figure 51). Under a global Business-as-usual emission scenario, there is a 25% probability that the mean annual number of extreme heat days (above 45°C) in Ashgabat increases by 13 days or more until mid century (Table 27).

In cases of heavy rains, which are projected to slightly increase in frequency and severity (Figure 51), consequent flash floods as well as land slides and mud flows endanger water quality directly on the surface as well as water supply infrastructure as a whole. The mean number of annual heavy rain events (above 10mm) is expected to increase with a probability of 75% in Ashgabat under all emission scenarios (Figure 51). Under a global Business-as-usual emission scenario, there is a 25% probability that the mean annual number of heavy rain events (above 10mm) in Ashgabat increases by 3 days (approx. 40%) or more until mid century (Table 27).

Infrastructure

Such risks implied by this increase in heavy rains, of course, also puts all kinds of infrastructure at risk of damage - a further focus risk here. After major flash flood events, the city's flood protection measures have been greatly improved and remain untested to this day. Still, with changing climate conditions, the risk of such events is increasing and should be accounted for – similarly for the risk of fires that is increased by further dry and hot conditions. The Green Belt – a ring of afforestation around the city – is a major element in the city's overall protection. Here, the risk of insufficient water supply for irrigation of the trees and plants in the Green Belt implies a risk of destroyed afforestation efforts overall lowering protection. In general, the impacts of changing climate conditions on adaptation efforts themselves, such as afforestation, need to be accounted for in thorough planning.

Public health

The third focus risk here is that of decreased public health. A major factor here is the availability of drinking water of good quality - both at risk as described above. Especially in rural areas outside the city this leads to high child mortality rate, in particular due to drug-resistant tuberculosis, Hepatitis E, kidney problems, and contaminated groundwater. In a similar vein, extreme events such as flash floods and their consequences

have heavy impact on public health. Additionally, changing climate conditions mean additional challenges for the healthcare system. Respiratory issues due to dust storms and sand storms are expected not to change significantly as wind situations are projected to stay similar to those historically observed (Figure 50). However, as temperatures are expected to rise significantly, and in particular the number of extreme heat days as well as tropical nights, so are the risks to the health in particular of vulnerable citizens. Here, the elderly and people with chronic diseases are at risk of heat strokes and heat exhaustion. Additionally, the risk of water-borne diseases is increasing with changing climate conditions and remains in need of thorough monitoring. Overall, these risks pose new challenges to the current healthcare system.

5.7 ADAPTATION OPTIONS IN ASHGABAT CITY

This section gives a list of potential adaptation options to reduce the vulnerabilities and tackle the risks accordingly. Naturally, this list is not exhaustive. A more detailed prioritization including a guide for scaling such options will be given in a follow-up report. Here, the options are grouped into technical, organizational, and policy measures as shown in Figure 41 in the form of purple boxes and numbers.

On a technical level, the **lining of channel or use of trunk mains (1)** is a measure that can be applied to all channels and pipes in the water supply system. It would help to prevent infiltration losses or even exposure to evaporation. Especially at the end of water supply chains where lower quantities are transported, the increased use of pipes would significantly contribute to reduction of water losses.

Similarly, the **reduction of exposed water surfaces (2)** such as floating covers on the water surface would help to reduce evaporation losses, in particular, in the large open reservoirs close to the city; and it would reduce siltation. Here, the technique of using floating balls or lattice-like structures as practiced in the USA provides an excellent example.

As water supply is very likely to show higher variability over the year, the management of reservoir levels becomes ever so important. An **increase of reservoir capacity (3)** and an increase in underground reservoirs would give higher flexibility for water management and give some leeway in case where forecasts have been overly optimistic.

Thermal mixing with compressed air (4) demonstrated success for evaporation suppression of deep reservoirs (larger than 18m), but requires the instalment of compressors and pumps leading to high energy usage.

Biological methods (5) such as floating plants, wind breakers and palm fronds can provide a significant decrease in the volume of evaporation but they have some restrictions on their uses⁴³. While **afforestation (5)** as a technical measure is already undertaken in the Green Belt around the city, i.e. for wind protection, there is still potential in afforesting around reservoirs and the Karakum Canal, e.g. following the vetiver system⁴⁴, to stabilize the ground, but more importantly to keep soil moisture as well as protect from sun radiation and wind - hence reducing evaporation and sedimentary intake.

To reduce the risk accompanied by flash floods or even mud flows, there is likely a need to further **increase flood protection (6)** beyond afforestation. While such preparations have already been undertaken after major events, in light of future risk of more heavy rains, a thorough revision should be done.

To ensure good means of water supply management, **improving water transport and supply facilities (7)** is indispensable. Here, the potential for increased intake from sediments upstream is a risk to be tackled.

More essential is the **improvement of water treatment facilities (8)** in the city itself. Better capacities for water reuse especially allow for high flexibility in terms of low water usage. Such measures would further ensure high drinking water quality overall and thus take a burden from citizens' health that is most likely already under pressure from higher temperatures. Water treatment plans should thereby take the expected

⁴³ Yousseff & Khodzinskaya. *A Review of Evaporation Reduction Methods from Water Surfaces*

⁴⁴ <https://www.vetiver.org/>

temperature rise into account and could complement further water protective measures such as covering or pipe use. The collection and reuse of all wastewater (pre-treated) for irrigation purpose would not only save a great quantity of water, but would also allow a reduction in industrial fertilisers.

On an organizational level, a root downside of the current system is the competition of different water uses, especially in times of low water. While this issue is being regulated, a more robust system would require **separating the water supply system by type of use (9)**. This would additionally separate water by the different qualities as needed its respective use. In particular for irrigation, which constitutes a major share of water demand, lower water quality is needed in comparison to recreational or even drinking water.

Still, there is a water-saving potential with the **use of drought-resistant plants for parks and forests (10)**. Here, the local fauna and other plants adapted to arid conditions could place a central place if cityscape design would embrace it accordingly. Some of these plants, such as vetiver, with deep roots would further strengthen the soil protective function of afforested areas.

In general, changing climate conditions require planning and enablement on all organizational levels. Here, it would be essential to **improve the dissemination of climate projections (11)** to enable governmental agencies, particularly those dealing with water uses and water management, to plan ahead smartly. Additionally, integrating climate risks into public service training curricula and public planning constitutes a major factor. While there is a general awareness of climate change and its potential impacts, there is potential to increase the knowledge about the specific risks and vulnerabilities in the region. This applies to public service training curricula as well as for public planning. Here, the integration of climate risks into the curricula of public service training as well as into public planning would help to increase awareness and knowledge about the specific risks and vulnerabilities in the region. This would also help to increase the capacity of public service to deal with climate risks and to integrate adaptation measures into their planning.

In light of a more challenging water supply management, further incentives need to be created to save water and to improve overall water management on a longer time scale. This can be done by introducing an appropriate **water payment scheme to avoid waste of water (12)** and thereby also to increase the incentive for an improved water reuse scheme. A prerequisite here is the full implementation of the by-laws for the already-in-place water code.

This could be combined with **tapping new water sources (13)** such as the possibility to supply Ashgabat with desalinated water from the Caspian Sea. Turkmenistan has a high potential for electricity production by photovoltaic and gas-powered turbines, which can be used for large-scale desalination projects. Overall, the focus here should be on the reduction of dependence on surface water and diversifying sources of water through appropriate water resources management.

An overarching framework is essential, as overall water management is likely to be an increasing challenge. A **National Adaptation Plan (NAP) that incorporates the water sector (14)** would constitute such a long-term strategy for the water sector in Turkmenistan providing the necessary guidance for adaptation measures. It should, in particular, incorporate strategies for intensified knowledge exchange and improving forecast dissemination for farmers. Ground water as the strategic water resource would further need to be accounted for in such long-term planning. Here, the Integrated Water Resources Management (IWRM)⁴⁵ approach would provide the necessary framework as a guiding example.

Such measures would be complemented by an increase in the **coordination with upstream countries (15)**, especially with Uzbekistan and Afghanistan, to ensure a sustainable water management in the whole Amu Darya River basin under looming increased challenges.

5.8 VULNERABILITY ANALYSIS FOR DIFFERENT GROUPS

According to expert forecasts, the problem of climate change will become the central one for urban development in the near future, and by 2030, millions of people and multimillion-dollar financial assets will

⁴⁵ <https://www.un.org/waterforlifedecade/iwrm.shtml>

be at risk of climate disasters; it will be urban areas that produce 75% of global CO₂ emissions and that at the same time suffer because of consequences of greenhouse gases emissions.

Urban areas are exposed to serious risks originating from climate change (e.g. severe weather events, floods, droughts, heat and cold waves, and the emergence of new infections). Response measures to the climate change problem for urban areas, as a rule, deals with two type measures: reducing greenhouse gas emissions and adapting to climate change. In this case, the degree of vulnerability of various categories of the population to the effects of climate change must be taken into account.

Since, from a wide range of adaptation measures and activities to reduce and mitigate the effects of climate change, only the ones relating to water resource management are subject to be covered within the present review, this chapter provides an analysis of the vulnerability of various categories in the following fields:

- Drinking water supply
- Healthcare
- Resilience of infrastructure to negative impacts as a result of water related emergencies
- Resilience of urban ecosystems (such as green spaces, water bodies, soils) to maintain their climate-regulating capacity;

5.8.1 Vulnerability and adaptation of various groups (women, children, youth, people with chronic diseases) in the field of drinking water supply

The provision of clean and safe drinking water to the population is an issue of top importance. The country has a proper legal and regulatory framework (the Drinking Water Law and the General Program on Provision of the Clean Drinking Water to Settlements, a new edition of the Sanitary Code and the water quality standards). Institutional, operational and financial issues are also duly settled. The capital has a loop water supply system that is under the responsibility of the Ashgabatagyzsuv Association;. Water comes from drinking water plants and from wells and upon the purification it is duly distributed via the water supply network. Modern closed-cycle technologies are used; construction/reconstruction and maintenance of water supply facilities as well as the sewerage systems are carried on the regular basis. The water quality monitoring is duly performed, the innovative projects are being implemented. 100% of the population has access to safe drinking water through centralized water supply systems. Today, drinking water supply (and sewerage) is a subsidized industry. Water consumers and water users partially compensate the costs for water supply services according to approved tariffs based on water meter readings; all houses and industries are equipped with water meters. Despite the fact that since the beginning of 2024, tariffs for water supply services have doubled, the cost of water supply remains the lowest in Central Asia. All categories of the population in Ashgabat have equal access to centralized water supply and sewerage systems; they have the opportunity to pay these costs through a digital payment system using telephones/Internet and payment terminals.

5.8.2 Vulnerability and adaptation of various groups (women, children, youth, people with chronic diseases) in the field of health

It is agreed that the following climate change risks related to the human health are under the concern of Ashgabat specialists: an increase in average temperature, an increase in extreme temperatures, heat and cold waves, changes in water availability and deterioration of fresh/surface water quality, a raise of ground water table, an increase in the frequency and amplitude of extreme weather phenomena (drought, floods, landslides and mudflows, heavy rains, storms (including sandstorms), an increase in the number of sunny days, etc.).

So, for sure, all vulnerable categories considered in this review (including pregnant women and children) are at particular risk.

The impact of climate change on human health can be direct: for example, cases of frostbite occur during periods of extreme cold; road and household injuries (fractures and bruises) are sharply increasing because of icing. Complex chains of impacts are also possible: for example, when the temperature range changes in the environment, bacteria, viruses and microorganisms that were not previously common in the territory of Turkmenistan will result in the infection and illness of animals and humans introducing new diseases. It is known that climate change contributes to the spread of vector-borne diseases, which particularly affect women. Mosquitoes and midges are sensitive to climate change, and rising temperature can lead to the spread of malaria. Risks of invasive species are very likely in the border areas of Turkmenistan (including Ashgabat). Turkmenistan has made significant and successful efforts to combat malaria - since 2010, Turkmenistan got the status of a “malaria-free country” and is working hard to regularly confirm this status (Figure 52).



Figure 52: Practical exercises to improve the skills of SES employees. (Photo by A. Berdyev)

Given the fact that traditionally the majority of low- and mid-level personnel of health care sector are women, their health is at particular risk in the event of an epidemic (or pandemic) regarding diseases related to water and climate change. In the event of this type of epidemic (or pandemic), pregnant women, infants/children, and people with chronic diseases are particularly at risk.

Since climate change also often causes changes not only in water availability but in quality as well, the swimming in open water can also cause a health deterioration.

Other health risks include the possibility of the spread of diseases resulting from poor/insufficient nutrition in the event of crop failure and/or lack of sufficient food supplies. Health risks from climate change are greatest for young women, children, people with disabilities and/or chronic illnesses, and older people. The remaining categories have approximately the same degree of risk.

Combined with negative gender stereotypes, such as the unequal distribution of caregiving responsibilities between women and men, caring for sick family members can limit or even deny women other opportunities.

5.8.3 Vulnerability and adaptation of various groups (women, children, youth, people with chronic diseases) in the field of infrastructure resilience to negative impacts as a result of emergencies

The main consequences of climate change for housing and communal services in Ashgabat are: increased risk of disruption of utilities during extremely cold winters (premature destruction of road surfaces and reinforced concrete structures, defrosting of water, heat and gas supply and sewerage systems, breaks in overhead wires power transmission, etc.). Extreme weather events lead to an increase in injuries (including road traffic injuries due to decreased driver alertness during extreme temperatures in the summer and due to icy roads in the winter), morbidity and mortality, challenging health care systems.

At the same time, climate change will lead to higher wind loads and, therefore, roads and bridges need to be built or modernized in a way that makes them solid/stay fitted (Figure 53)



Figure 53: Destruction of infrastructure facilities due to extreme natural phenomena. (Photo by A. Berdyev)

Therefore, the existing construction norms and regulations are continuously revised and improved to ensure timely adjustments. Other important strategic documents aimed at improve the resilience for climate change are also subject of periodical adjustments. Traditionally these adjustments are performed by men, but all categories of population (men, wome,n and children) are benefiting equally.

In addition to increasing average annual temperatures, climate change entails the increased frequency and severity of anomalous natural phenomena (changes in precipitation patterns, stronger storms, heavy rainfall, floods, landslides, drought), changes in the water content of rivers, and changes in groundwater levels. In this case, it is necessary to pay duly attention to the creation and strengthening of early warning and awareness systems, improving the capacities of rescue services, as well as repeatedly practicing/training population on first aid skills to be used in case of disasters (Figure 54⁴⁶).



Figure 54: Training of first aid skills.

When development and delivery of first aid skills training programs, it should be always keep in mind that women, children and people with chronic diseases (including the elderly and people with disabilities) suffer disproportionately in the event of natural disasters (the highest mortality rate, and if they survive, life is often short-lived).

At the same time, according to statistics, women are the most vulnerable category of the population, which is particularly susceptible to the consequences of natural disasters. During extreme weather events, women are on duties on family member caring. This circumstance, coupled with the experience of emergency events, can also affect the mental health of women. Considering that, according to climate change scenarios, the frequency of extreme natural events related to water will increase, it is necessary to find a special

solution for these categories to meet this challenge.

⁴⁶ Simulation exercises on actions in case of emergency, organized by the Ministry of Defense of Turkmenistan together with the Ministry of Education with the support of UNICEF and the National Red Crescent Society in the Velayats (provinces) of the country. <https://arzuw.news/v-turkmenistane-proshli-uchenija-po-deistvijam-v-sluchae-chs>

5.8.4 Vulnerability and adaptation of various groups (women, children, youth, people with chronic diseases) in a field of resilience of urban ecosystems (such as green spaces, water bodies, soils) to maintain their climate-regulating capacity

There are scientific fundamental studies proving that climate change leads to a reduction in biodiversity and this process can seriously affect human health if ecosystem services no longer meet people's needs. As per research by World Health Organization experts, even today, the changing weather conditions are disrupting the innate reproductive systems of flora and fauna, leading to unpredictable consequences and degradation of biodiversity and aquatic ecosystems. It is known from reliable climate records dating back to 1880, and sometimes even earlier, that climate change processes have been altering the ecological balance of biodiversity and biosecurity in the world over the past two decades.

To date, there is no accurate information and open data about the biodiversity of the ecosystems of Ashgabat, but given the progress that has been achieved in the “green botany/park management in the capital, an impression of confident prosperity is created from the point of view of “biodiversity”.

The importance of preservation and development of urban ecosystems, via creation of large parks/walking areas, “green roofs” and “green walls”, within the boundaries of megacities is becoming obvious to many municipalities. For example, in cities of China, the concept of sponge cities is being developed - by greening buildings and increasing the area of water and marsh spaces in the city. It is expected that these natural methods of collecting, filtering, storing, and purifying water will help to regulate the water balance and to cope with floods, heat, air pollution, and drought.

The urban ecosystems deals with the provision of favorable climatic conditions (shade and coolness in hot weather), create conditions for improving health (clean air rich in oxygen), and delight the eye with aesthetic solutions to citizens. No doubts that a significant success was achieved by municipal services in terms of the aesthetics of urban eco-systems, but still a lot of improvements needs to succeed in terms of the other two indicators.

Considering that temperatures will increase due to climate change, in order to protect the population from the harmful effects of solar radiation and heat stroke, it would be advisable to revise the existing concept of landscaping and arrangement of walking areas towards planting deciduous trees, which presently are not so convenient for cleaning services,

but are undoubtedly much more beneficial for the environment, human health and infrastructure than coniferous plants. It would be optimal to use multi-level landscaping, combining deciduous, and coniferous plant species in plantings. It is possible that in this case more water will be required to water the plants. There is no information in the available literature on the norms for watering deciduous and coniferous crops in the urban area (Ashgabat), but in this case, water from alternative sources can be used for irrigation after processing (e.g. waster water after treatment, water accumulated in small reservoirs due to the interception and accumulation of runoff from small rivers and mudflow channels in mountain and foothill areas, Figure 55). At the same time, when choosing plants recommended for planting in gardening areas and in green areas along highways, it is necessary to take into account the risk of freezing of green spaces due to abnormally low temperatures, which are also a consequence of climate change.

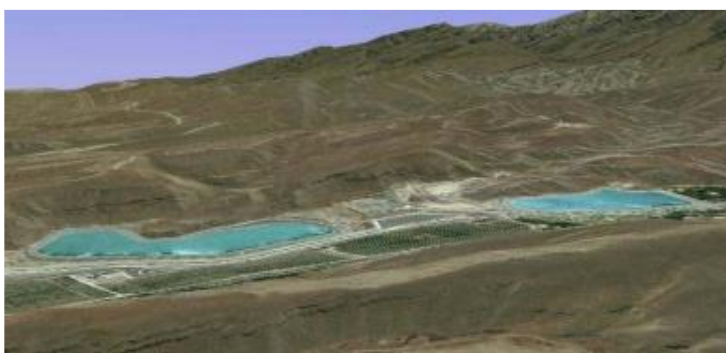


Figure 55: Small reservoir in the foothills of the Kopetdag for intercepting and accumulating the seasonal/temporal flows of small rivers and mudflows.

5.9 NEEDS, PROBLEMS, AND RECOMMENDATIONS IDENTIFIED BY INTERVIEWED STAKEHOLDERS

The research presented covers the issues listed below:

- Analysis of gender differences and inequalities in access, use and management of water resources,
- Analysis of vulnerability and adaptation to climate change of various population groups, especially women, children, older people and the poor,
- Identification of needs, problems and
- Preparation of recommendations for improving the water management to reduce the climate change impact

It was conducted based on focus group discussions and questionnaires among representatives of government departments, business organizations and public organizations , including:

1. State Sanitary and Epidemiological Service under the Ministry of Health and Medical Industry of Turkmenistan
2. Production Association “Agyzsuv” within the Public Utilities Department of Ashgabat Khyakimlik;
3. Ministry of Environmental Protection of Turkmenistan
4. State Hydrometeorological Service under the Ministry of Environmental Protection of Turkmenistan;
5. State Committee for Water Economy;
6. Research, Design and Production Institute “Turkmensuvlymytaslama” under the State Committee for Water Economy
7. Institute of State, Law and Democracy of Turkmenistan;
8. State Insurance Company
9. Turkmen State Agricultural University
10. Academy for State Officials under the President of Turkmenistan
11. Women’s Union of Turkmenistan;
12. Union of Industrialists and Entrepreneurs;
13. Society for Nature Conservation of Turkmenistan;
14. Grassroot CSOs that focused on the environmental issues (“Beik eyam” (Turkmenabat); “Yash Tebigatchi”; “Mashgala” (Mary); “Yashyl Shokhle”; “Ynanch-Vepa”; “Ynamly Kepil”; “Ecodurmush” (Dashoguz).

During the discussions, the opinion was expressed that gender problems in water resource management in connection with climate change in Ashgabat are related to the fact that:

- Traditionally, it is women that are responsible for providing household water and may experience deterioration in the availability and quality of water due to severe cold, droughts, floods, pollution, and other factors. This factor not only causes “inconvenience” at the everyday level, but also poses a threat to the health of women and her family members. At some stage, the problem of shortage or poor quality of water can lead to a deterioration in the sanitary and epidemiological situation.
- Women are poorly represented in water management decision-making at various levels (from local to national) and may therefore be excluded from the benefits of water management. Experts note that the predominance of men in decision-making water management bodies contributes to the marginalization of women.

Also, participants mentioned the below listed items as key factors for participation of women in water management decision making:

- lack of technical knowledge capacities (due to prevailing stereotypes the water resources management specialties are currently unattractive for women and girls);
- lack of necessary practical experience on water management needed to build a professional carrier (the period of accumulation of practical knowledge and work experience occurs at a time when the matrimonial tasks are a priority for women);

- exclusion from meetings and decision-making as a consequence of existing stereotypes in society; gender stereotypes persist and limit women participation in water negotiations.

5.9.1 Conclusions and recommendations

As the process of climate change is global in nature and in Central Asia it is happening twice as fast as anywhere else in the world, it is the Central Asia countries that will be the first to face a large “menu” of problematic consequences (including gender ones) that climate change brings. Taking into account that it is Turkmenistan is a downstream country of the Amu Darya transboundary river which covers almost 90% of the water needs for Turkmenistan economy where almost 90% is occupied by the Karakum desert, is the most vulnerable to climate change among the Central Asia countries. It is clear that for Turkmenistan (as well as for the entire Central Asian region), water resource management must be central to climate change action plans.

Given the pace of this process, very urgent action on evidence-based solutions needs to be taken now. In case of the mechanisms of the expert community consultations and gender approach will be introduced for planning and implementation of climate change adaption, then the effectiveness of the latter will certainly be higher. This work could be a start for consultations on the assessment of the current situation in matters of greening the city.

There is a practice when a lot of cities of the world are developing their own climate change adaptation and mitigation plans, containing both measures to reduce greenhouse gas emissions and adaptation strategies to climate change. As a rule, the second direction includes an analysis of the main climate risks (in particular, an analysis of which sectors of the urban economy fall under the main threats - the residential sector, transport, communications, public health), as well as recommendations for adapting urban infrastructure to the threats of the present and the future, including reform of norms and requirements for the construction and operation of new buildings and infrastructure.

It is obvious that in discussing issues of strengthening natural urban ecosystems it is necessary to ensure at least the participation of women as the most active representatives of the most vulnerable categories of the population. Their experience and knowledge, and most importantly, their direct interest in resolving issues of developing and maintaining “green infrastructure⁴⁷” in effective manner, could be useful in resolving issues of investing in natural infrastructure to improve the resiliency as recommended by World Resources Institute specialists (WRI).

Nowadays, Turkmenistan has institutions, mechanism,s and procedures that provide conditions for women’s participation in water resource management, discussion, and decision-making on climate change adaptation and mitigation. Representatives of these institutions are included in the working groups, but today there is still a need to increase the expert potential of women so improve the efficiency of their participation while taking a decision on planning and implementation of actions addressed to climate change challenges.

⁴⁷ Quality of soils, green spaces, surface waters, so that they can perform the natural functions of water purification, water balance regulation, flood control

6 SUMMARY ON VULNERABLE GROUPS

In general, if today the situation in water resources management in Turkmenistan can be called (relatively) prosperous due to the highly centralized management, strict discipline, mandatory execution and competent water management personnel, then apparently, in the nearest future, the competition for water will become intensified both between farmers and between sectors of the national economy, resulting to the worsening of living conditions. If no measures are taken, not only the amount of harvest and income will decrease, but the frequency and amplitude of abnormal natural phenomena will also increase; Solar radiation will become more intense, the percentage of cancer cases will increase, air temperature will raise, etc. Various climate change scenarios prescribed for Turkmenistan, as well as for many countries in the arid zone, clearly predict a worsening of the environmental situation. Perhaps this is why the scientific community is increasingly using the term “climate refugees”, which could become a serious challenge for Turkmenistan in the future⁴⁸.

Table 29: Assessment of SDG 6.5.1 progress achieved during the period 2020 - 2023 (IWRM)

Section	Average scores - 2020	Average scores - 2023
	Baseline survey	Progress assessment
Section 1: Enabling environment	64	69
Section 2: Institutions and participation	48	55
Section 3: Management instruments	63	66
Section 4: Financing	80	80
Total score for SDG 6.5.1 (IWRM) (0–100)⁴⁹	64	68

Source: Turkmenistan: Country report on Assessment of SDG 6.5.1 progress

As it is stated in the “SDG 6.5.1 Progress Assessment Report”, developed in 2023 during tri-partite (intersectoral) consultations with the involvement of representatives of state institutions, business companies and CSOs, Turkmenistan has made some progress in introducing an integrated approach to water resources management, one of the principles of which is the recognition of that **“Women play a central role in the provision, management and protection of water resources.”**

As can be seen from the table 6 on scoring for the SDG 6.5.1 indicator (IWRM) presented above, the greatest progress was achieved in the second section “Institutions and participation”.

Interviewed participants in these consultations mentioned that the main input in progressing is achieved within the components **2.2.b - “Public participation in water resources policy, planning and management at the local level”** (20 points) and component **2.2.d - “Gender mainstreaming in water resources management”** (40 points) ensured such progress.

At the same time, the scoring for indicator 2.2.b - “Public participation in water resources policy, planning and management at the local level” is doubled and today in textual terms this score means that *“Information on water resources, policy, planning and management is made available to the public at the local level.”* Further progressing (up to the next stage) will be formulated as *“Communication: Government authorities request information, experiences and opinions of the public”* (Scoring for this stage will be ranging from 30 to 50 points).

Indicator **2.2.d - “Gender mainstreaming in water resources management”** also saw a twofold increase in scores, and today in textual terms this score means that *“Gender mainstreaming mechanisms exist (but limited implementation, budget or monitoring).”* The next stage of progress is formulated as *“Gender*

⁴⁸ Turkmenistan has all the prerequisites to become both a country of origin of climate refugees and a destination country (for the “Arab countries”) and/or “transit” one Even all three statuses can be applicable simultaneously.

⁴⁹ All values are rounded to the nearest whole number

mainstreaming objectives partly achieved (activities implemented and partially monitored and funded)” and will be scored in the range of 60 to 70 points.

The lowest score (10 points) in this section was given by participants for indicator 2.2.c. “Participation of Vulnerable Populations in Water Resources Planning and Management.” This estimate remained unchanged since the baseline survey-2020. In textual terms, this assessment means that *“Participation of vulnerable groups not explicitly addressed in laws, policies, or plans.”* The next stage of progress is formulated as *“Vulnerable groups partially addressed, but no explicit procedures in place.”* At the same time, achieving this level will allow you to evaluate progress in the range from 20 to 30 points.

In 2023, Turkmenistan prepared a “Voluntary National Review on the Progress of the Global Agenda for Sustainable Development”, which reflects progress towards achieving SDG 6 and SDG 5 for the period 2015-2022, as well as identifying further steps to achieve targets for each of these goals.

It is known that the country is implementing the “National Action Plan for Gender Equality in Turkmenistan for 2021–2025,” that was designed in a references on SDGs and that is aimed to create the necessary conditions for further expanding the participation of women in all spheres of life of the state and society. Noting the importance of the main directions set out in the Action Plan on Gender Equality, we regret to note that for the time being, no links between the indexes of SDG 6 (Water and Sanitation) and SDG 5 (Gender Equality) are formally recognized by Turkmenistan authorities, while it is apparent that almost all indicators of SDG 6 are ideally combined/puzzled with priority areas for SDG 5 in which a lot of work is already underway. It seems reasonable to consider links between SDG 5 and SDG 6 on the issues specified below:

- Economic empowerment of women and girls
- Increasing women's participation at all levels, including political and public fields
- Creation of decent jobs for women. Maintaining parity of opportunities in all spheres of life

An analysis of current strategies, action plans and completed assessments indicates that in Turkmenistan there is an urgent need to clearly formulate and agree on the common position of officials and specialists who are working for state, business and civil society institutions on issues of gender equality in the management of water and land resources. It would be logical for this work to be coordinated by the Institute of State, Law and Human Democracy under the President of Turkmenistan, which is the main coordinating agency for SDG 5. A clear and coherent vision of the importance of gender considerations in policies, legislation, institutions, budgets and projects related to water resources management, as well as increased informed participation and inclusion of women in processes at all levels will improve the efficiency of implemented strategies and plans (this work can be based on refer to the “Guide to Gender Equality and Inclusion in Water Management” developed by the Global Water Partnership; in addition, various tools can be used for gender analysis and assessment in the field of water resources management, such as gender audit, gender budget, gender indicators and others). The experience of neighboring countries (e.g. Kyrgyzstan, where “gender approach” has been introduced in the “NDC Implementation Plan” (that is considered as a good example of the “successful practice on gender and climate reporting”) and/or the gender linked methodology on the development of indicators of the assessment of efficiency of public policy”) might be a subject of particular interest of Turkmenistan specialists.

In parallel with this work, it is necessary for government institutions to conduct/to order a study aimed to assess the impact of the gender factor in climate change adaptation and resilience using the “Guidelines⁵⁰”, as well as to provide a comprehensive (administrative and institutional) support to the efforts of Turkmen NGOs, particularly to those that are focused on the development of women’s entrepreneurship, with priority given to the agrobusiness. Financial support for these activities could be provided by international organizations, for example the EU and the USA/USAID, which have specialized programs aimed to support

⁵⁰ “Guidelines for the collection, processing, analysis, use and storage of gender-disaggregated data to integrate a gender perspective into climate change adaptation and resilience activities.”

female entrepreneurship⁵¹. The establishment/piloting of extension service centers for women is a top urgent action to be done to ensure the duly access of women to adaptation technologies, and lobbying of the introduction of gender quotas for preferential lending.

⁵¹ For example:

- In 2023, the European Bank for Reconstruction and Development launched the project “Mentor School for Women Entrepreneurs of Turkmenistan-2023” with the support of the EU;
- In 2023 – the US Embassy and USAID in Turkmenistan supported the projects “Vocational Training Center for Women”, “Information seminars on modern/innovative techniques for making wool products”; in 2024 - “Academy of Women Entrepreneurs” (AWE) - a free three-month program held in Ashgabat, Dashoguz, Mary and Turkmenabat in partnership with the Union of Economists of Turkmenistan

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8 ANNEX

8.1 SUMMARY OF MEETINGS WITH STAKEHOLDERS

Date	Stakeholders	Summary
27.11.2023	UNDP NAP project team	- Preparation for the series of meetings
	UNCCD Focal Point	- National commitments of Turkmenistan to UNCCD
28.11.2023	Ministry of Environmental Protection: - Department of Coordination of International Environmental Cooperation and Projects - Department of Environmental Protection - Forestry Department	- Measures of water protection - Rational water use - Environmental problems for agriculture
	Ministry of Agriculture: - Directorate for Construction of Agricultural and Water Management Facilities - Department of Livestock and Pasture Management	- Structure of agricultural sector in Dashoguz - Perceived problems and risks - Relation between local agriculture and water supply
	State Committee on Water Management: Turkmen State Water Management Research, Production and Design Institute "Turkmensuvlymtaslama"	- Structure of water supply in Ashgabat and Dashoguz - Perceived problems and risks with water supply
	State Hydrometeorology Service of the Ministry of Environmental Protection	- Climate simulations for TKM - Meteorological data - River gauge data - Observations of changing climate
29.11.2023	Hyakimlik of Dashoguz Province (Head of Agricultural Division)	- Organization and regulation of water and agricultural sector in Dashoguz Province - Strategic Goals in the water and agriculture sector - Perceived problems and risks wrt climate
	State Committee on Water Management: "Dashoguzsuwhojalyk" Production Association	- Structure of water supply in Dashoguz - Perceived problems and risks with water supply - Relation between local agriculture and water supply
30.11.2023	Union of Industrialists and Entrepreneurs (Dashoguz Province): Farmers' Association "Uly Ynam" (Kone-Urgench district).	- Local experiences with water supply, agriculture, and climate in general - Vulnerabilities to climate - Perceived climatic changes - Measures for preparation for climatic changes

Date	Stakeholders	Summary
01.12.2023	Union of Industrialists and Entrepreneurs (Dashoguz Province): Farmers' Association "Alai" on the territory of the Agricultural Joint-Stock Company named after S. Rozmetov (Shabat district)	- Local experiences with water supply, agriculture, and climate in general - Vulnerabilities to climate - Perceived climatic changes - Measures for preparation for climatic changes
	International Fund for Saving the Aral Sea (IFAS) Office Dashoguz	- Role of IFAS in Dashoguz Province - Perceived climate changes and challenges - New version of Aral Sea Basin Programme (ASBP)
	Basin Water Organization (BWO) "Amudarya"	- Role and work of BWO in Dashoguz Province - Management of water supply in Dashoguz Province by government bodies - Experienced problems w.r.t climate change
04.12.2023	Hyakimlik of Ashgabat: Public Utilities Department, Production and Operational Department of "Ashgabatagyzsuv" Association	- Organization and regulation of water sector in Ashgabat - Strategic Goals in the water sector - Perceived problems and risks wrt climate
	State Statistics Committee	- Meteorological data - River gauge data - Observations of changing climate
	Ministry of Finance and Economy: Department of Strategic and Sustainable Development	- Planned investments in water infrastructure and agriculture - Perceived problems and risks wrt climate - Making investments climate resilient for water infrastructure
5.12.2023	Academy of Public Service under the President of Turkmenistan	- Climate-related policy - Strategic Goals in the water and agriculture sector - Perceived problems and risks wrt climate - Organization and regulation of water and agricultural sector in Dashoguz Province - Measures for climatic problems such as floods or droughts - Anticipated changes or risks wrt water resources
	Ministry of Health and Medical Industry	- Vulnerable groups - Perceived problems and risks wrt climate
	Ministry of Education: • Turkmen State University • Turkmen State Agricultural University	- Climate-related policy - Strategic Goals in the water and agriculture sector - Perceived problems and risks wrt climate - Organization and regulation of water and agricultural sector - Measures for climatic problems such as floods or droughts
06.12.2023	State Insurance Organization	- Risks in the agriculture sector - Mitigation of risks via insurance - Flood protection measures - Water emergency measures (e.g., drinking water)

Date	Stakeholders	Summary
	- Dayhan Bank - Rysgal Bank	- Planned investments in water infrastructure and agriculture - Perceived problems and risks wrt climate - Making investments climate resilient for water infrastructure
	- Women's Union - Youth Union	- Vulnerable groups - Perceived problems and risks wrt climate





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