CLIMATE RISK COUNTRY PROFILE

ARMENIA

WORLD BANK GROUP

ADB ASIAN DEVELOPMENT BANK

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ACKNOWLEDGEMENTS

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

This profile was written by Alex Chapman (Consultant, ADB), William Davies (Consultant, ADB) and Ciaran Downey (Consultant). Technical review of the profiles was undertaken by Robert L. Wilby (Loughborough University). Additional support was provided by MacKenzie Dove (Senior Climate Change Consultant, WBG), Jason Johnston (Operations Analyst, WBG), Yunziyi Lang (Climate Change Analyst, WBG), Adele Casorla-Castillo (Consultant, ADB), and Charles Rodgers (Consultant, ADB). This profile also benefitted from inputs of WBG and ADB regional staff and country teams.

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

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FOREWORD

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

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

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

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

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

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

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

Bernice Van Bronkhorst
Global Director
Climate Change Group
The World Bank Group

Preety Bhandari
Chief of Climate Change and Disaster Risk Management Thematic Group
concurrently Director Climate Change and Disaster Risk Management Division
Sustainable Development and Climate Change Department
Asian Development Bank

KEY MESSAGES

- Projections suggest Armenia could experience warming at levels significantly above the global average, with potential warming of 4.7°C by the 2090s, above the 1986–2005 baseline, under the highest emissions pathway (RCP8.5).
- Expected rise in maximum and minimum temperatures are even more significant and represent major threats to human health, livelihoods, and ecosystems.
- Warming is projected to be strongly biased towards the summer months of July, August, and September.
- Increased drought risk is a particular threat to poorer rural communities dependent on subsistence agriculture. As the Caucasus Glaciers will largely disappear over the 21st century, the pressure and dependence on water management infrastructure is expected to also grow significantly.
- A warmer and more drought prone environment is likely to drive significant changes in ecosystems composition, notably driving dryland expansion, forest loss, and species range shifts.
- The increased risk of both flood and landslide hazards demand attention on disaster risk reduction, particularly in Armenia's poorer rural communities.
- A reduction in both the total arable land and the yield of staple crops threaten food production and efforts to eradicate undernourishment in Armenia.
- Without adaptation and disaster risk reduction, changes will exacerbate income and wealth inequalities and hinder attempts to reduce poverty rates.

COUNTRY OVERVIEW

Armenia is a land-locked country within the Caucasus region between Europe and Asia. The majority of the country is at high altitude (greater than 1,000 meters [m] above sea-level), including Lake Sevan, a freshwater lake, with a surface area of 1,279 kilometers (km^2) and the Seven River Basin with a surface area of 4,721 km^2, spans approximately one sixth of the nation's total land area. As of 2019, Armenia's population was estimated at 2.95 million people (2020) and its GDP at $13.6 billion.[1] Around one third of the nation's population lives in its capital city, Yerevan.[2]

Over the past decade, Armenia has transitioned from an industry-dominated to a service-dominated economy. As of 2016, the service sector constituted 48.8% of the labor force. Agriculture remains a major employer with a labor market share of 35.3% and there remains a relatively high rate of unemployment (18%) as well as net out-migration. GDP is distributed less evenly than employment, with around 55% originating in the service sector and only 17% in agriculture. Poverty persists, affecting around 29% of the population based on the national poverty line (**Table 1**).

In 2020 The Ministry of Environment delivered its Fourth National Communication on Climate Change (NC4) and its Second Biennial Report in 2018 under the United Nations Framework Convention on Climate Change (UNFCCC). Governance and management of climate change issues and projects is integrated across multiple

[1] World Bank (2020). DataBank – World Development Indicators. URL: https://databank.worldbank.org/source/world-development-indicators. [accessed September 23, 2020].
[2] Ministry of Environment (2020). Republic of Armenia – Fourth National Communication on Climate Change to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/NC4_Armenia_.pdf

agencies and relevant sectors of the Armenian government. International reporting responsibilities fall on the Ministry of Environment. Armenia signed and ratified the Paris Climate Agreement in 2017 and its First Nationally Determined Contribution (NDC) in 2015. Armenia has also ratified the Kigali Amendment to the Montreal Protocol on "Substances that Deplete the Ozone Layer" in 2019 and has committed to phase-out the use of HFCs from 2024 onwards, seeking a total reduction by 80%–85% by 2045. Armenia's NDC establishes the country's strong commitment to climate change adaptation measures and identifies its efforts in national greenhouse gas mitigation efforts. In Armenia, key sectors identified for adaptation action include: natural ecosystems, human health, water resources management, agriculture, forestry, and fisheries, energy, human settlements, infrastructure, and tourism.[3] Armenia formally joined the Nationally Determined Contributions Partnership in 2018. Through this partnership, Armenia will receive targeted and coordinated technical assistance, including the design of climate change national and sectoral development policy, implementation and monitoring of mitigation and adaptation projects, as well as access to financial support in bilateral and multilateral formats, to further support the country to meet its adaptation goals and climate change commitments.[4]

TABLE 1. Key indicators

Indicator	Value	Source
Population Undernourished[5]	2.6% (2017–2019)	FAO, 2020
National Poverty Rate[6]	23.5% (2018)	World Bank, 2019
Share of Income Held by Bottom 20%[7]	8.1% (2018)	World Bank, 2019
Net Annual Migration Rate[8]	–0.17% (2015–2020)	UNDESA, 2019
Infant Mortality Rate (Between Age 0 and 1)[9]	1.1% (2015–2020)	UNDESA, 2019
Average Annual Change in Urban Population[10]	0.22% (2015–2020)	UNDESA, 2018
Dependents per 100 Independent Adults[11]	48.4 (2020)	UNDESA, 2019
Urban Population as % of Total Population[12]	63.1% (2018)	CIA, 2018
External Debt Ratio to GNI[13]	87.5% (2018)	ADB, 2020b
Government Expenditure Ratio to GDP[14]	25.4% (2019)	ADB, 2020b

3 Republic of Armenia (2015). Nationally Determined Contributions to the UNFCCC. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Armenia%20First/INDC-Armenia.pdf

4 NDC Partnership (2021). Greening a Country – Armenia's Path Forward in an Uncertain Climate. Country Brief – February 2021. URL: https://ndcpartnership.org/sites/default/files/Country_Brief-Greening_a_Country_Armenias_Path_Forward_in_an_Uncertain_Climate-February_2021.pdf

5 FAO, IFAD, UNICEF, WFP, WHO (2020). The state of food security and nutrition in the world. Transforming food systems for affordable healthy diets. FAO. Rome. URL: http://www.fao.org/documents/card/en/c/ca9692en/

6 World Bank (2019). Poverty headcount ratio at national poverty lines (% of population). URL: https://data.worldbank.org/ [accessed 17/12/20]

7 World Bank (2019). Poverty headcount ratio at national poverty lines (% of population). URL: https://data.worldbank.org/ [accessed 17/12/20]

8 UNDESA (2019). World Population Prospects 2019: MIGR/1. URL: https://population.un.org/wpp/Download/Standard/Population/ [accessed 17/12/20]

9 UNDESA (2019). World Population Prospects 2019: MORT/1-1. URL: https://population.un.org/wpp/Download/Standard/Population/ [accessed 17/12/20]

10 UNDESA (2019). World Urbanization Prospects 2018: File 6. URL: https://population.un.org/wup/Download/ [accessed 17/12/20]

11 UNDESA (2019). World Population Prospects 2019: POP/11-A. URL: https://population.un.org/wpp/Download/Standard/Population/ [accessed 17/12/20]

12 CIA (2018) The World Factbook. Central Intelligence Agency. Washington DC. URL: https://www.cia.gov/the-world-factbook/

13 ADB (2020b). Key Indicators for Asia and the Pacific 2020. Asian Development Bank. URL: https://www.adb.org/publications/key-indicators-asia-and-pacific-2020

14 ADB (2020b). Key Indicators for Asia and the Pacific 2020. Asian Development Bank. URL: https://www.adb.org/publications/key-indicators-asia-and-pacific-2020

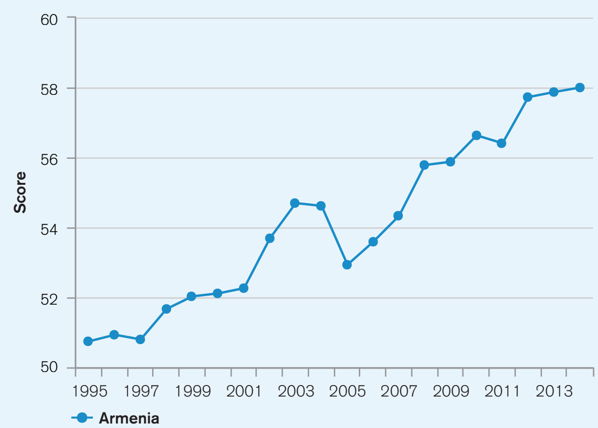
Green, Inclusive and Resilient Recovery

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

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

Due to a combination of political, geographic, and social factors, Armenia is recognized as vulnerable to climate change impacts, ranked 57th out of 181 countries in the 2020 ND-GAIN Index.[15] The ND-GAIN Index ranks 181 countries using a score which calculates a country's vulnerability to climate change and other global challenges as well as their readiness to improve resilience. The more vulnerable a country is the lower its score, while the more ready a country is to improve its resilience the higher it will be. Norway has the highest score and is ranked 1st. **Figure 1** is a time-series plot of the ND-GAIN Index showing Armenia's progress

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



[15] University of Notre Dame (2019). Notre Dame Global Adaptation Initiative. URL: https://gain.nd.edu/our-work/country-index/

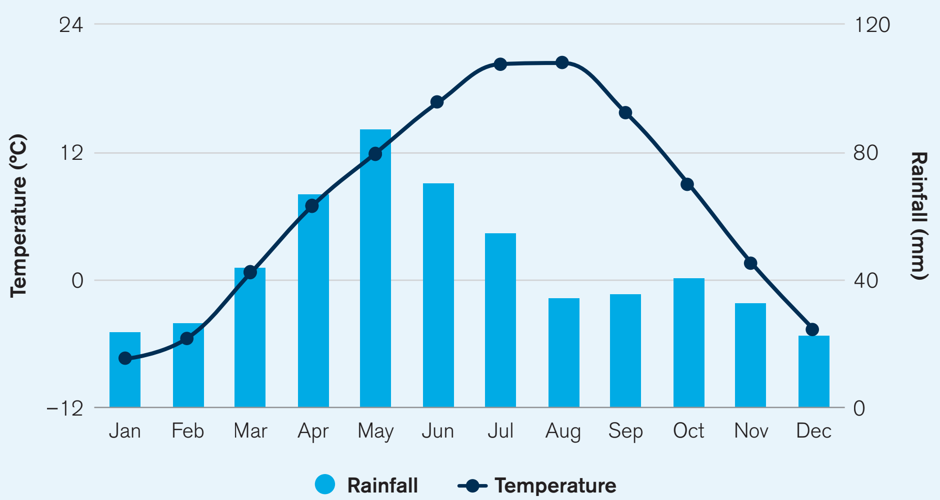
Climate Baseline

Overview

Armenia's climate can be described as highland continental, with large variation between summer highs (June to August) and winter lows (December to February) (**Figure 2**). The country also experiences large climatic contrasts because of its intricate terrain, and the climates range from arid to sub-tropical and to cold, high mountains. Summer highs in Armenia's capital Yerevan average around 30°C—33°C while the average in winter is 1°C—3°C. The more mountainous regions experience lower average temperatures and prolonged periods of snow cover. The average annual precipitation is low at 526 millimeters (mm). Precipitation intensity is greater in Armenia's high-altitude regions with May and June the wettest months.[16] For Armenia, altitude is the strongest controlling factor determining the spatial distribution of temperatures and precipitation in Armenia. Sub-zero average temperatures are common in Armenia's mountain ranges while its highest average temperatures are experienced in the relatively low-lying western plains. Similarly, Armenia's highest peaks may receive up to 1,000 mm of annual precipitation while precipitation can be as low as 200 mm in the western plains (**Figure 3**).

Annual Cycle

FIGURE 2. Average monthly temperature and rainfall in Armenia (1991–2019)[17]

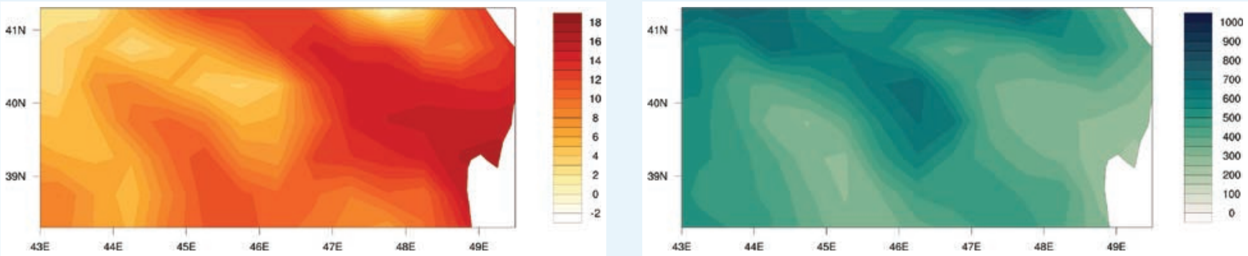


[16] Ministry of Environment (2020). Republic of Armenia – Fourth National Communication on Climate Change to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/NC4_Armenia_.pdf

[17] WBG Climate Change Knowledge Portal (CCKP, 2020). Climate Data: Historical. URL: https://climateknowledgeportal.worldbank.org/country/armenia/climate-data-historical

Spatial Variation

FIGURE 3. Annual mean temperature (°C) (left), and annual mean rainfall (mm) (right) in Armenia over the period 1901–2019.[18] Maps present the coordinates of Armenia: latitude 38°49′53″N–41°18′26″N and 43°26′22″E–46°38′33″E.



Key Trends

Temperature

Armenia's NC4 reports that it experienced an average temperature rise of 1.23°C between 1929–2016. This historical rise in temperatures has resulted in the rapid shrinking of the glaciers in Armenia's mountain regions, with spatial extents retreating at around 8 m per year.[19] Trends suggest climate variability is increasing and in 2018, Yerevan experienced a new record July temperature, reaching 42°C.

Precipitation

Armenia's NC4 reported a 10% reduction in average annual precipitation volume was documented over the period 1935–2012 (**Figure 3**). The spatial distribution of precipitation changes is irregular: the northeast and central regions have become more arid. However, precipitation has increased in the southern and northwestern regions and in the western region of the Lake Sevan Basin. Additionally, the number of days with heavy rainfall and hailstorms has increased.[20]

A Precautionary Approach

Studies published since the last iteration of the IPCC's report (AR5), such as Gasser et al. (2018), have presented evidence which suggests a greater probability that earth will experience medium and high-end warming scenarios than previously estimated.[21] Climate change projections associated with the highest emissions pathway (RCP8.5) are presented here to facilitate decision making which is robust and attuned to these risks.

[18] WBG Climate Change Knowledge Portal (CCKP, 2020). Climate Data: Historical. URL: https://climateknowledgeportal.worldbank.org/country/armenia/climate-data-historical

[19] Shahgedanova, M., Hagg, W., Hassell, D., R. Stokes, C., & Popovnin, V. (2009). Climate Change, Glacier Retreat, and Water Availability in the Caucasus Region. In J. Anthony, A. Jones, T. Vardanian, & C. Hakopian (Eds.), Threats to Global Water Security (pp. 131–143). URL: https://link.springer.com/chapter/10.1007/978-90-481-2344-5_15

[20] Ministry of Environment (2020). Republic of Armenia – Fourth National Communication on Climate Change to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/NC4_Armenia_.pdf

[21] Gasser, T., Kechiar, M., Ciais, P., Burke, E. J., Kleinen, T., Zhu, D., . . . Obersteiner, M. (2018). Path-dependent reductions in CO_2 emission budgets caused by permafrost carbon release. Nature Geoscience. URL: http://pure.iiasa.ac.at/id/eprint/15453/

Climate Future

Overview

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

For Armenia, these models show a trend of consistent warming across all seasons. However, precipitation for Armenia continues to be highly variable. Projections indicate an increase in average annual precipitation by mid-century; yet, a decrease in precipitation is expected across summer months. This indicates increased incidence of heavy precipitation events. Eastern and southern areas are expected to receive the least amount of precipitation. **Tables 2** and **3** below, provide information on temperature projections and anomalies for the four RCPs over two distinct time horizons, presented against the reference period of 1986–2005.

TABLE 2. Projected anomaly (changes °C) for maximum, minimum, and average daily temperatures in Armenia for 2040–2059 and 2080–2099, from the reference period of 1986–2005 for all RCPs. The table is showing the median of the CCKP model ensemble and the 10–90th percentiles in brackets.[22]

	Average Daily Maximum Temperature		Average Daily Temperature		Average Daily Minimum Temperature	
Scenario	**2040–2059**	**2080–2099**	**2040–2059**	**2080–2099**	**2040–2059**	**2080–2099**
RCP2.6	1.6 (–0.7, 4.0)	1.6 (–0.7, 3.9)	1.4 (–0.3, 3.2)	1.4 (–0.4, 3.2)	1.2 (–0.4, 2.9)	1.2 (–0.5, 2.9)
RCP4.5	2.1 (–0.2, 4.1)	2.9 (0.7, 5.0)	1.7 (0.0, 3.5)	2.5 (0.9, 4.4)	1.6 (0.0, 3.3)	2.3 (0.6, 4.2)
RCP6.0	1.8 (0.2, 3.8)	3.7 (1.5, 5.9)	1.6 (0.3, 3.2)	3.2 (1.6, 5.0)	1.6 (0.0, 2.9)	2.9 (1.1, 4.5)
RCP8.5	2.8 (0.6, 4.8)	5.8 (3.2, 8.0)	2.5 (0.8, 4.1)	5.1 (3.2, 7.2)	2.3 (0.6, 3.9)	4.8 (2.7, 6.8)

[22] WBG Climate Change Knowledge Portal (CCKP, 2019). Climate Data: Historical. URL: https://climateknowledgeportal.worldbank.org/country/armenia/climate-data-historical.

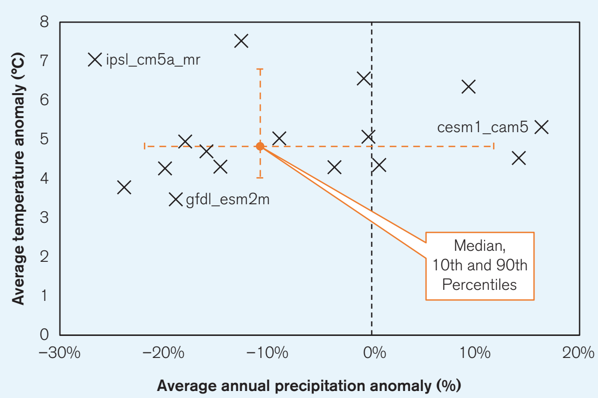
TABLE 3. Projections of average temperature anomaly (°C) in Armenia for different seasons (3-monthly time slices) over different time horizons and emissions pathways, showing the median estimates of the full CCKP model ensemble and the 10th and 90th percentiles in brackets.[21]

Scenario	2040–2059 Jun–Aug	2040–2059 Dec–Feb	2080–2099 Jun–Aug	2080–2099 Dec–Feb
RCP2.6	1.9 (–0.3, 4.5)	1.4 (–0.2, 2.7)	1.8 (–0.8, 4.4)	1.5 (–0.1, 2.7)
RCP4.5	2.4 (0.0, 4.9)	1.7 (0.0, 2.9)	3.2 (1.0, 5.8)	2.2 (1.0, 3.6)
RCP6.0	2.1 (0.5, 3.8)	1.7 (0.4, 3.1)	4.1 (1.8, 6.1)	3.0 (1.6, 4.3)
RCP8.5	3.3 (1.1, 5.3)	2.1 (0.3, 3.4)	6.4 (4.0, 9.1)	4.4 (2.8, 6.0)

Model Ensemble

Climate projections presented in this document are derived from datasets available through the CCKP, unless otherwise stated. These datasets are processed outputs of simulations performed by multiple General Circulation Models (GCM) (for further information see Flato et al., 2013).[23] Collectively, these different GCM simulations are referred to as the 'model ensemble'. Due to the differences in the way GCMs represent the key physical processes and interactions within the climate system, projections of future climate conditions can vary widely between different GCMs, this is particularly the case for rainfall related variables and at national and local scales. The range of projections from 16 GCMs for annual average temperature change and annual precipitation change in Armenia under RCP8.5 is shown in **Figure 4**. Spatial variation of future projections of annual temperature and precipitation for mid and late century under RCP8.5 are presented in **Figure 5**.

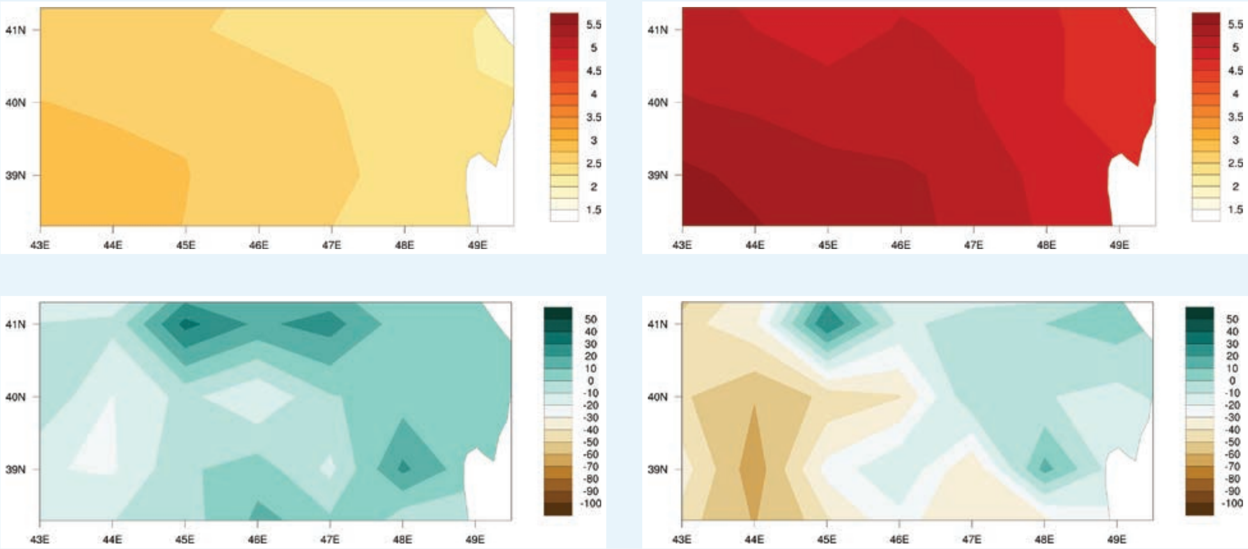
FIGURE 4. 'Projected average temperature anomaly' and 'projected annual rainfall anomaly' in Armenia. Outputs of 16 models within the ensemble simulating RCP8.5 over the period 2080–2099. Models shown represent the subset of models within the ensemble which provide projections across all RCPs and therefore are most robust for comparison.[21] Three models are labelled.



[23] Flato, G., Marotzke, J., Abiodun, B., Braconnot, P., Chou, S. C., Collins, W., . . . Rummukainen, M. (2013). Evaluation of Climate Models. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, 741–866. URL: http://www.climatechange2013.org/images/report/WG1AR5_ALL_FINAL.pdf

Spatial Variation

FIGURE 5. CMIP5 ensemble projected change (32 GCMs) in annual temperature (top) and precipitation (bottom) by 2040–2059 (left) and by 2080–2090 (right) relative to 1986–2005 baseline under RCP8.5.[24] Maps present the coordinates of Armenia: latitude 38°49′53″N–41°18′26″N and 43°26′22″E–46°38′33″E.



Temperature

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

The model ensemble's estimate of average warming in Armenia under the highest emission pathway (RCP8.5) is an average temperature increase of 2.8°C by the 2050s and 5.8°C by the 2090s. Ensemble estimates of warming under the lowest emission pathway (RCP2.6) also presents an average temperature increase of 1.2°C by the 2050s and maintain through the end of the century. Both of these temperature increases represent greater rates of increase than the global average. By the 2090s, temperatures are projected to have increased around 35% to 40% higher than the global average. Under all scenarios, except for the lowest emission pathway (RCP 2.6), the number of summer days is expected to increase and the number of frost and ice days are expected to fall dramatically by the end of the century.

[24] WBG Climate Change Knowledge Portal (CCKP 2020). Armenia. Climate Data. Projections. URL: https://climateknowledgeportal.worldbank.org/country/armenia/climate-data-projections

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

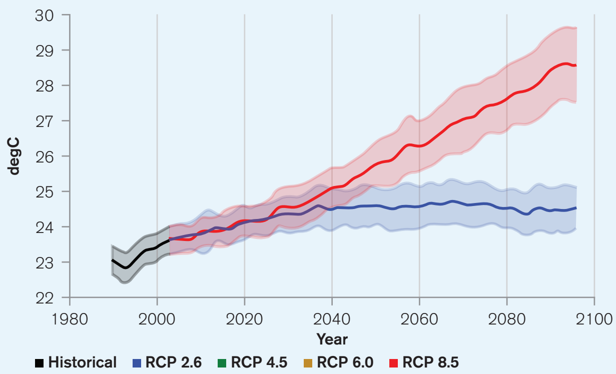
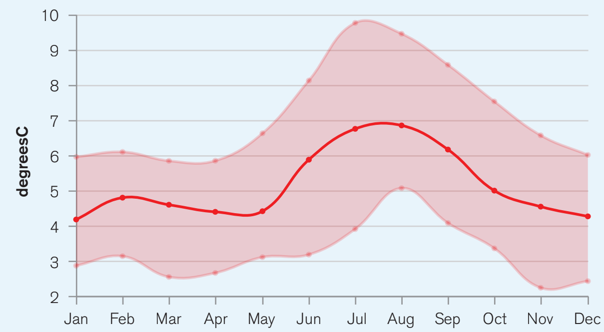


FIGURE 7. Projected change (anomaly) in monthly temperature, shown by month, for Armenia for the period 2080–2099 under RCP8.5. The value shown represents the median of the model ensemble with the shaded areas showing the 10th–90th percentiles.[24]



In the case of Armenia, the rate of warming in maximum temperatures, as shown in **Table 2,** is 5.8°C by the 2090s under RCP8.5, which is notably faster than the warming in monthly average temperature. This points towards an increase in the intensity of temperature extremes, and is among the some of the largest margins of warming projected anywhere on Earth. The seasonality of future temperature changes holds some uncertainty on lower emissions pathways. However, as shown most clearly in RCP8.5 (**Figure 7**), projected warming is strongest in the summer months from June to September. The months of July, August, and September are projected to see around 50% faster warming than the winter months from November to April under the highest emissions pathway (RCP8.5).

Precipitation

While considerable uncertainty surrounds long-term projections in regional precipitation trends, global trends are evident. The intensity of sub-daily extreme rainfall events appears to be increasing with temperature, a finding supported by evidence from different regions of Asia.[26] However, as this phenomenon is highly dependent on local geographical contexts further research is required to constrain its impact in Armenia.

For Armenia, additional uncertainty remains around future changes in average annual precipitation as well as for changes in seasons. Model ensemble estimates are not statistically significant (i.e. less than one standard deviation from zero) across all emissions pathways. However, the trend indicated, which is consistent with historical climate behavior and most models (see **Figure 4**), is towards a decline in average monthly precipitation. Under all

[25] WBG Climate Change Knowledge Portal (CCKP 2020). Armenia Interactive Climate Indicator Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=ARM&period=2080-2099

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

emissions pathways, an increase in the precipitation associated with a maximum 5-day rainfall event is expected more predominantly in the northern and eastern areas of Armenia. Under all emissions pathways, precipitation reductions are projected in the western regions, and under lower emissions pathways reductions are also expected in the arid northern regions. These changes match global trends, which suggests the intensity of sub-daily extreme rainfall will increase as temperatures increase, a finding supported by evidence from different regions of Asia.[27]

CLIMATE RELATED NATURAL HAZARDS

Armenia faces significant disaster risk levels and is ranked 101 out of 191 countries by the 2019 Inform Risk Index[28] (**Table 4**). This ranking is driven strongly by the exposure component of risk. Armenia has high exposure to natural hazards, including, riverine, flash, and coastal, and very high exposure to tropical cyclones and their associated risks. Drought exposure is also significant. Disaster risk in Armenia is elevated due to its moderate levels of social vulnerability and the country's decent coping capacity. The section that follows analyses climate change influences on the exposure component of risk in Armenia. As seen in **Figure 1**, the ND-GAIN Index presents an overall picture of a country's vulnerability and capacity to improve its resilience. In contrast, the Inform Risk Index identifies specific risks across a country to support decisions on prevention, preparedness, response and a country's overall risk management.

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

Natural Disasters (0–10)	Hazards & Exposures (0–10)	Institutional Strength (0–10)	Socio-Economic Vulnerability (0–10)	Lack of Coping Capacity (0–10)	Overall Inform Risk Level (0–10)	Rank (1–191)
4.3	3.7	6.7	2.1	4.8	3.6	101

The most serious disasters in Armenia's history have primarily been earthquakes, notably the 1988 Spitak quake, which killed over 25,000 people. However, high poverty rates have persisted in Armenia and are increasing vulnerability to climate hazards. Armenia is vulnerable to mudflow and landslides with around 4.1% of the country's area exposed to landslide risk, resulting in approximately one third of its communities. Large areas face drought risk, and some areas, particularly the Ararat and Shirak valleys, also face flood risk. Around 40,000 people are affected by flooding each year, with estimates of the annual cost to national GDP ranging between $20 to $100 million.[29]

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

28 European Commission (2019). INFORM Index for Risk Management. Armenia. URL: https://drmkc.jrc.ec.europa.eu/inform-index

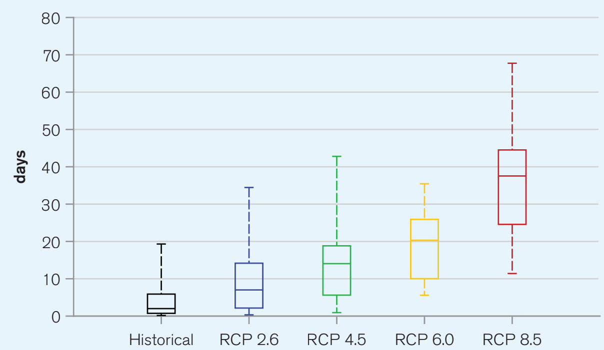
29 UNISDR (2014). PreventionWeb: Basic country statistics and indicators. URL: https://www.preventionweb.net/countries [accessed 14/08/2018]

The risks of disasters resulting from these drivers are likely to increase as the severity and frequency of extreme climate event increases. In recent decades the annual number of events designated as hazardous hydro-meteorological phenomena (such as hurricanes, snow storms, heat waves) has increased.

Heatwaves

Armenia regularly experiences high maximum temperatures, with an average monthly maximum of around 13.2°C and an average August maximum of 27.5°C. The current annual probability of a heat wave (defined as a period of 3 or more days where the daily temperature is above the long-term 95th percentile of daily mean temperature) is around 3%. The model ensemble projects that the annual probability of a heatwave could increase to 5% under RCP2.6 and, more significantly, to 18% under RCP8.5 by the end of the century. The country is also projected to experience a significant increase in the number of very hot days (Tmax > 35°C) (**Figure 8**). However, these increases primarily reflect the continual rise in temperatures against the model baseline period of 1986–2005. Further research is required to understand the implications of climate change for temperature volatility in Armenia.

FIGURE 8. Box plots showing historical (1986–2005) and projected (2080–2099) average annual frequency of very hot days >35°C.[30]



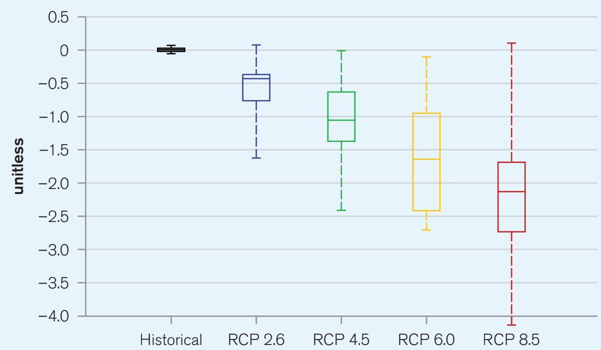
Drought

Two primary types of drought may affect Armenia, meteorological (usually associated with a precipitation deficit) and hydrological (usually associated with a deficit in surface and subsurface water flow, potentially originating in the region's wider river basins). When low hydrological flows also coincide with imperfect crop choices and land management practices agricultural drought can also result. At present, Armenia faces a significant annual probability of severe meteorological drought, as defined by a standardized precipitation evaporation index (SPEI) of less than –2.

[30] WBG Climate Change Knowledge Portal (CCKP 2019). Armenia. Climate Data. Projections. URL: https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=ARM&period=2080-2099

The 2001 drought highlighted the vulnerability of the rural poor to drought. Agencies working in the region reported more than 25,000 poor households affected, the majority of whom were dependent on local food production which was severely damaged by the drought. The model ensemble projects a dramatic increase in the annual probability of drought increasing to 20% under RCP2.6 to over 80% under RCP8.5 by the 2090s (**Figure 9**). Naumann et al. provide a global overview of changes in drought conditions under different warming scenarios. Their analysis supports these extreme projections, suggesting that the West Asia region could experience a considerable increase in the frequency of extreme drought.[31] Under 1.5°C of warming what is currently a 1-in-100-year event may return every 20 years, and under 2°C of warming such an event may recur every 10 years or less.

FIGURE 9. Boxplots showing the annual probability of experiencing a 'severe drought' in Armenia (–2 SPEI index) in 2080–2099 under four emissions pathways.[24]



Extreme Precipitation, Flood, and Landslide

Heavy rainfall events are known to trigger landslides and floods in rural areas of Armenia, often affecting poorer and more isolated rural communities. River levels in Armenia are particularly variable, and high flows often hit communities without forewarning, resulting in flood disasters. Flooding can result in damage to subsistence agriculture and increase the incidence of poverty and health issues. Floods also represent a risk to national economic productivity particularly when affecting the capital city, Yerevan.

While most climate models project a small increase in the intensity of extreme precipitation events, uncertainty remains in precipitation projections and model ensemble estimates. The general shift in the seasonality of precipitation away from the summer months, combined with the projected loss of many of Armenia's glaciers will likely intensify extreme events and highlight a need for disaster risk reduction measures. However, research and development in the climate modelling arena is needed to support decision makers and planning efforts, specifically more reliable downscaled modelling and additional work will be needed in order to better understand and map rural exposure and vulnerability.

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

Natural Resources

Water

Uncertainty remains around the precise trajectory of future change in the availability of water resources in Armenia and river flows are expected to reduce dramatically. While vulnerability for basin and watersheds vary, under a 'worst-case scenario', average decrease in river flow is estimated at 39% by the end of the century.[32] These changes would have a significant impact on the levels of Armenia's lakes and reservoirs, with implication for society potentially coming from the resulting damage to fish stocks and decline in water levels and water quality. However, caution should be applied as these projections are derived from a single climate scenario; other scenarios provide less consistent trends. More recent analysis of runoff from Caucasus Glaciers suggest a significant increase in the short-term (up to 2022) as melting intensifies, but near total loss of glaciers and glacial meltwater towards the end of the 21st century.[33]

A likely impact of the loss of Armenia's mountain glaciers is an increase in variability of water flows as glaciers typically act to smooth runoff over the year.[34] Water scarcity towards the end of summer (August, September) is likely to increase. Armenia has already experienced declines in annual precipitation and desertification has been documented around the nation, including in the Ararat Valley, an important agricultural production area.[35] More information is needed to understand the potential threat of a broader restructuring of the nation's ecosystems, particularly whether tipping points threaten the viability of current agricultural operations. The complexity of regional hydrological systems may mean climate change leads to unforeseen negative outcomes. For example, research suggests potential declines in water quality and safety for human consumption as a result of ongoing changes.[36]

Soil and Land Cover

A key route through which climate change may lead to soil and land degradation is through its impact on soil moisture.[37] With very large increases in the frequency and intensity of drought projected over Armenia, the potential for declines in soil quality are significant. The Caucasus region is among many regions where an expansion of the arid and semi-arid area is projected, with the affected area growing rapidly over the 21st century under higher emissions pathways[38]. Such changes will reduce ecosystem productivity resulting in species range shifts, and potential loss of biodiversity.

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32 Ministry of Environment (2020). Republic of Armenia – Fourth National Communication on Climate Change to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/NC4_Armenia_.pdf

33 Bliss, A., Hock, R., & Radić, V. (2014). Global response of glacier runoff to twenty-first century climate change. Journal of Geophysical Research: Earth Surface, 119(4), 717–730. URL: https://agupubs.onlinelibrary.wiley.com/doi/10.1002/2013JF002931

34 Barnett, T. P., Adam, J. C., & Lettenmaier, D. P. (2005). Potential impacts of a warming climate on water availability in snow-dominated regions. Nature, 438(7066), 303–309. URL: https://www.nature.com/articles/nature04141

35 Ministry of Environment (2020). Republic of Armenia – Fourth National Communication on Climate Change to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/NC4_Armenia_.pdf

36 Margaryan, L.A. (2017). Assessment of the Climate Change Impact on the Quality and Quantity of Drinking Water Sources in Armenia. Russian Journal of General Chemistry, 87(13), pp. 3160–3165. URL: https://link.springer.com/article/10.1134/S1070363217130096

37 FAO (2015). Status of the world's soil resources. Food and Agriculture Organization of the United Nations. URL: http://www.fao.org/3/i5199e/i5199e.pdf

38 Huang, J., Yu, H., Guan, X., Wang, G., Guo, R. (2015). Accelerated dryland expansion under climate change. Nature Climate Change: 6: 166–171. URL: https://www.nature.com/articles/nclimate2837

Linked to issues of land degradation and drought are potential changes to Armenia's forest cover. Armenia's NC4 estimates a potential loss of 14,000–17,500 ha (around 3%–4%) by 2030 as a result of changes to ecosystems and growing conditions, as well as increased frequency of forest fire, pest and disease outbreaks, and invasive species. Armenia has already begun to enact adaptation and restoration plans to reduce deforestation through its National Forest Policy and Strategy, improved wildfire management policies and specific area action plans such as the City of Yerevan 5-Year Plan (2019–2023) to restore the city's buffer forest layer by 40 hectares.[39] A general trend of species range shifts towards higher altitudes is expected and conversion of lower altitude land cover to arid forest types, steppe, and semi-desert. Armenia's National Strategy and Action Program to Combat Desertification was ratified in 2015 to increasing the effectiveness of land management, raising public awareness on desertification issues and their solutions, as well as international cooperation.[40]

Economic Sectors

Agriculture

Climate change in Armenia is likely to influence food production via direct and indirect effects on crop growth processes. Direct effects include alterations to carbon dioxide availability, precipitation, and temperatures. Indirect effects include through impacts on water resource availability and seasonality, soil organic matter transformation, soil erosion, changes in pest and disease profiles, the arrival of invasive species, and decline in arable areas due to desertification. On an international level, these impacts are expected to damage key staple crop yields, even on lower emissions pathways. Tebaldi and Lobell (2018) estimate 5% and 6% declines in global wheat and maize yields respectively even if the Paris Climate Agreement is met and warming is limited to 1.5°C.[41] Shifts in the optimal and viable spatial ranges of certain crops are also inevitable, though the extent and speed of those shifts remains dependent on the emissions pathway.

In some cases, changing temperature and rainfall patterns may be favorable for crop production. Under all scenarios of future climate change, the agricultural growing season could extend by 10–40 days in Armenia. However, this may also present challenges due to uncertainty and potential declines in future water resources. Armenia is already struggling with land degradation on most agricultural land; climate change could accelerate this degradation as temperatures rise and extreme weather events increase in frequency and severity. Temperature extremes are likely to result in sub-optimal growing conditions for many of Armenia's highest grossing crops, typically grains and vegetables. The increase in the number of very hot days (>35°C) shown in **Figure 10**, even in the order of 5 days as projected for the low emissions pathway (RCP2.6), is likely to damage yields for almost all crops grown in lowland areas of Armenia as well as for a majority of crops grown in intermediate and upland areas.[42] Studies have

[39] ArmenPress (2018). Yerevan City Council approves five-year action plan. [25 December, 2018]. URL: https://armenpress.am/eng/news/959347.html

[40] Republic of Armenia (2015). National Strategy and Action Program to Combat Desertification in the Republic of Armenia. URL: http://www.mnp.am/uploads/1/1551885091anapat_eng-1.pdf

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

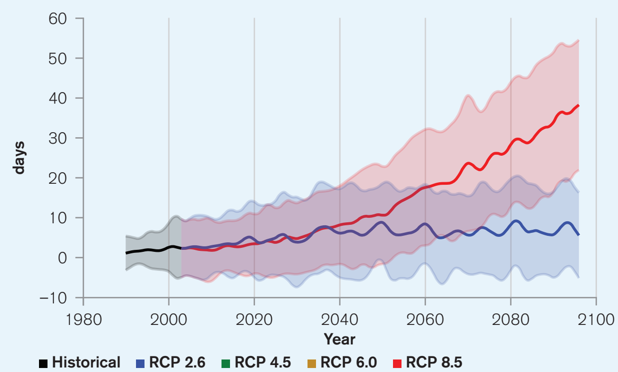
[42] Ahouissoussi, N., Neumann, J., and Srivastava, J. (2014). Building resilience to climate change in South Caucasus agriculture. World Bank. URL: http://documents.worldbank.org/curated/en/193691468012673593/pdf/Building-resilience-to-climate-change-in-South-Caucasus-agriculture.pdf

suggested pressure will be amplified by a potential doubling of the average water requirement of Armenia's crops as temperatures rise.[43] As the glacier supply depletes, and its regulating effect on flows reduces, effective water storage and management infrastructure will grow in importance.

Armenia implemented sustainable agricultural development strategies to increase the unused arable land in rotation by approximately 10,000 hectares per annum in an effort to combat projected yield reductions.[44] Projections show that by the 2070s, potato crop yields will decrease by 21%, with the highest level of reduction expected in Shirak and Syunik marzes. The largest decline in the grape yields will be recorded in the Ararat Valley – by 20%.[45] At the same time the area of high productivity land is projected to shrink, with a 17% increase in less productive desert and meadow-steppe land. Agriculture, Forestry and Fisheries make up Armenia's lowest paid sector yet continue to employ over 30% of the population. These high levels of vulnerability, and risks in both slow and rapid onset hazards emphasize the serious risks climate change represents in Armenia, particularly under higher emissions pathways.

A further, and perhaps lesser appreciated influence of climate change on agricultural production is through its impact on the health and productivity of the labor force. Dunne et al. (2013) show that labor productivity during peak months has already dropped by 10% as a result of warming, and that a decline of up to 20% might be expected by the 2050s under the highest emissions pathway (RCP8.5).[46] In combination, it is highly likely that the above processes will have a considerable impact on national food consumption patterns both through direct impacts on internal agricultural operations, and through impacts on the global supply chain. Without adaptation, the economic environment for smallholder agricultural operations is likely to become increasingly hostile.[47]

FIGURE 10. Model ensemble estimate of the annual number of very hot (Tmax >35°C) days in 2080–2099 under four emissions pathways in Armenia.[48]



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[43] Melkonyan, A. (2015). Climate change impact on water resources and crop production in Armenia. Agricultural Water Management, 161, 86–101. URL: https://www.sciencedirect.com/science/article/abs/pii/S0378377415300500

[44] Republic of Armenia (2020). Strategy of the Main Directions Ensuring Economic Development in Agricultural Sector of the Republic of Armenia for 2020–2030. URL: https://mineconomy.am/media/10032/MijocarumneriTsragir_Angleren.pdf

[45] Ministry of Environment (2020). Republic of Armenia – Fourth National Communication on Climate Change to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/NC4_Armenia_.pdf

[46] Dunne, J. P., Stouffer, R. J., & John, J. G. (2013). Reductions in labor capacity from heat stress under climate warming. Nature Climate Change, 3(6), 563–566. URL: http://www.precaution.org/lib/noaa_reductions_in_labour_capacity_2013.pdf

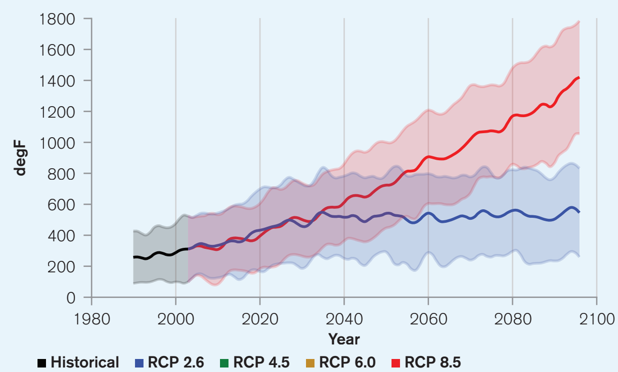
[47] Melkonyan, A. (2014). Environmental and socio-economic vulnerability of agricultural sector in Armenia. Science of The Total Environment, 488–489, 333–342. URL: https://www.sciencedirect.com/science/article/abs/pii/S0378377415300500

[48] WBG Climate Change Knowledge Portal (CCKP 2020). Armenia. Climate Data. Projections. URL: https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=ARM&period=2080-2099

Urban and Energy

Research has established a reasonably well constrained relationship between heat stress and labor productivity, household consumption patterns, and (by proxy) household living standards.[49] In general terms, the impact of an increase in temperature on these indicators depends on whether the temperature rise moves the ambient temperature closer to, or further away from, the optimum temperature range. The optimum range can vary depending on local conditions and adaptations. In Armenia, a general decline in productivity is expected due to high temperatures that are offset by a reduction in the frequency of extreme low temperatures. This trend can be measured in the change to the annual heating and cooling degree days. The full model ensemble projects an increase in the annual cooling requirement of around 1,000°C (degree days) (**Figure 11**), versus a decline in the heating requirement of around 2,000°C (degree days). This points towards a potential net energy saving. Armenia's energy policy is focused on ensuring independence and increased security of the energy sector and promotion of the sustainable development of the energy sector based on efficient use of local primary (renewable) energy resources, further development of the nuclear energy sector, diversification of energy supply sources and introduction of energy efficient and advanced technologies. In the medium term, meeting increases in electricity demand, energy system reliability, and affordability of electricity services are important challenge to be addressed.[50] The country has begun to increasingly invest in the development of renewable energy sources and, more specifically, in recent years, electricity generation at photovoltaic (PV) solar plants,[51] with a longer-term interest in further development of wind and nuclear energy.[52]

FIGURE 11. Historic and projected annual cooling degree days in Armenia (cumulative degrees above 65°F) under RCP2.6 (blue) and RCP8.5 (red). The values shown represent the median of 30+ GCM model ensemble with the shaded areas showing the 10–90th percentiles.[24]



[49] Mani, M., Bandyopadhyay, S., Chonabayashi, S., Markandya, A., Mosier, T. (2018). South Asia's Hotspots: The Impact of Temperature and Precipitation changes on living standards. South Asian Development Matters. World Bank, Washington DC. URL: http://documents.worldbank.org/curated/en/201031531468051189/pdf/128323-PUB-PUBLIC-DOC-DATE-7-9-18.pdf

[50] World Bank (2016). Armenia Power Sector Policy Note. URL: https://www.worldbank.org/en/country/armenia/publication/power-sector-policy-note

[51] Republic of Armenia (2014). Scaling up Renewable Energy Program – Investment Plan for Armenia. URL: https://dhinfrastructure.com/wp-content/uploads/2015/04/Armenia-SREP-Investment-Plan_final.pdf

[52] IAEA (2020). Country Nuclear Power Profiles - Armenia. URL: https://cnpp.iaea.org/countryprofiles/Armenia/Armenia.htm

The effects of temperature rise and heat stress in urban areas are increasingly compounded by the phenomenon of the Urban Heat Island (UHI) effect. Dark surfaces, residential and industrial sources of heat, an absence of vegetation, and air pollution[53] can push temperatures higher than those of the rural surroundings, commonly anywhere in the range of 0.1°C–3°C in global mega-cities.[54] As well as impacting on human health (see Communities) the temperature peaks that will result from combined UHI and climate change, as well as future urban expansion, are likely to damage the productivity of the service sector economy, both through direct impacts on labor productivity, but also through the additional costs of adaptation. The Armenian economy has great dependence on activity in its capital city, Yerevan, where around half of the nation's industrial production takes place. While the economy of the city is strong, and poverty rates comparatively low, the health risks of high temperatures require consideration. The 2018 heatwave, during which a new temperature record was set in Yerevan of 42°C, illustrated the strain that extreme climate events can place on the energy system, with technical faults and high demand putting strain on the energy system. Research suggests that on average, a one degree increase in ambient temperature can result in a 0.5%–8.5% increase in electricity demand.[55] Notably, this strains business and residential air-cooling systems.[56]

Heating requirements continue to be an important part of Armenian energy needs. Individual heat boilers are primarily used for heating, of which 50% use natural gas. Natural gas is followed by wood use for heating, with an estimated 35% of Armenian households using wood for heating. This is primarily driven by affordability.[57] As the country's deforestation rates are likely to continue, the use of biomass for heating is likely to continue to the trend, which is expected to adversely affect the poorest households due to a decline in firewood availability and price increase.

Further research is required to constrain the other potential risks in urban environments in Armenia. Some Armenian settlements, located around landslide-prone sites, mainly in mountainous areas and on the foot of the mountains, where given the force of gravity on the slopes, rock sliding occurs have exposure to land and mudslides. Uncertainty around future precipitation trends makes estimation of climate change's implications for future landslide trends difficult but the global trend, involving increases in the frequency and intensity of these extreme precipitation events, raises the importance of disaster risk reduction activities.[58]

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

54 Keggenhoff, I., Elizbarashvili, M. and King, L. (2015). Heat wave events over Georgia since 1961: Climatology, changes and severity. Climate, 3(2), pp. 308–328. URL: https://www.mdpi.com/2225-1154/3/2/308/htm

55 Santamouris, M., Cartalis, C., Synnefa, A., & Kolokotsa, D. (2015). On the impact of urban heat island and global warming on the power demand and electricity consumption of buildings—A review. Energy and Buildings, 98, 119–124. URL: https://pdfs.semanticscholar.org/17f8/6e9c161542a7a5acd0ad500f5da9f45a2871.pdf

56 ADB (2017). Climate Change Profile of Pakistan. Asian Development Bank. URL: ADB (2017). Climate Change Profile of Pakistan. Asian Development Bank.

57 Economic Development Research Center (2015). Residential Energy consumption Survey. Analytic Report, UNDP, Residential Energy Consumption Survey. Yerevan, October 2015. URL: http://www.edrc.am/images/Publications/Statistical_Surveys/undp_recs_2015_eng.pdf

58 Ministry of Environment (2020). Republic of Armenia – Fourth National Communication on Climate Change to the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/NC4_Armenia_.pdf

Communities

Poverty and Inequality

High poverty rates prevail in Armenia. These are in part linked to high unemployment rates, but also to the poor productivity of the agricultural sector which employs around 35% of the working population. According to the Armenian Statistical Committee wages in the agriculture, fisheries, and forestry sector are the lowest of all the primary sectors. Many households are dependent on remittances received from migrant workers. Disruption of remittance flows is possible as a result of climate change, but is an issue which is poorly understood. Due to potential high impacts of climate change on the agricultural sector in Armenia, alongside the increased risk of climate-related disasters, the country faces major challenges from climate change, particularly under higher emissions pathways.

Many of the climatic changes projected are likely to disproportionately affect the poorest groups in society. For instance, heavy manual labor jobs are common among the lowest paid whilst also being most at risk of productivity losses due to heat stress.[59] Poorer businesses are least able to afford air conditioning, an increasing need given the projected increase in cooling days. Poorer farmers and communities are least able to afford local water storage, irrigation infrastructure, and technologies for adaptation. According to the FAO, most agricultural holdings remain small, with an average size of 1.4 ha, many farming households are poor and many already rely on remittances sent from household members who migrate for work during fallow periods on the farm.[60] Climate changes, such as changes to growing seasons, extreme weather events and species range shifts (potentially resulting in new invasive species) further threatens to expose a lack of adaptability and resilience in the population dependent on the agricultural sector. The majority of agricultural small-holders are not covered by any insurance system, resulting in reduced resilience to disaster events.

Gender

An increasing body of research has shown that climate-related disasters have impacted human populations in many areas including agricultural production, food security, water management and public health. The level of impacts and coping strategies of populations depends heavily on their socio-economic status, socio-cultural norms, access to resources, poverty as well as gender. Research has also provided more evidence that the effects are not gender neutral, as women and children are among the highest risk groups. Key factors that account for the differences between women's and men's vulnerability to climate change risks include: gender-based differences in time use; access to assets and credit, treatment by formal institutions, which can constrain women's opportunities, limited access to policy discussions and decision making, and a lack of sex-disaggregated data for policy change.[61]

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59 Kjellstrom, T., Briggs, D., Freyberg, C., Lemke, B., Otto, M., Hyatt, O. (2016). Heat, human performance, and occupational health: A key issue for the assessment of global climate change impacts. Annual Review of Public Health: 37: 97–112. URL: https://www.ncbi.nlm.nih.gov/pubmed/26989826

60 FAO (2013). Assessment of the agriculture and rural development sectors in the Eastern Partnership countries: Armenia. Food and Agriculture Organization of the United Nations and European Union. URL: http://www.fao.org/3/aq670e/aq670e.pdf

61 World Bank Group (2016). Gender Equality, Poverty Reduction, and Inclusive Growth. URL: http://documents1.worldbank.org/curated/en/820851467992505410/pdf/102114-REVISED-PUBLIC-WBG-Gender-Strategy.pdf

Human Health

Risk to human health from climate-related hazards are expected to increase, particularly under higher emissions pathways. Risks include the increased probabilities of drought, exacerbated by the loss of mountain glaciers, and heat waves. Immediate risks include heat-related sicknesses and the increased vulnerability to malaria outbreaks. These impacts are likely to be followed by the risks to nutrition of associated agricultural losses and water shortages. Experience can be drawn from the 2001 drought, which necessitated emergency food distribution by the World Food Program to around 200,000 citizens in response to high levels of malnutrition.

Nutrition

The World Food Program estimate that without adaptation the risk of hunger and child malnutrition on a global scale could increase by 20% respectively by 2050.[62] Work by Springmann et al. (2016) has assessed the potential for excess, climate-related deaths associated with malnutrition.[63] The authors identify two key risk factors that are expected to be the primary drivers: a lack of fruit and vegetables in diets, and health complications caused by increasing prevalence of people underweight. The authors' projections suggest there could be approximately 81 climate-related deaths per million population linked to lack of food availability in Armenia by the 2050s under RCP8.5.

Heat-Related Mortality

Research has placed a threshold of 35°C (wet bulb ambient air temperature) on the human body's ability to regulate temperature, beyond which even a very short period of exposure can present risk of serious ill-health and death.[64] Temperatures significantly lower than the 35°C threshold of 'survivability' can still represent a major threat to human health. Climate change could push global temperatures closer to this temperature 'danger zone' both through slow-onset warming and intensified heat waves. Armenia has also been identified as a having particularly poor air quality in many of its urban and developed areas and associated issues may be amplified by increased incidence of extreme heat.[65] Honda et al. (2014)[66] utilized the A1B emissions scenario

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62 WFP (2015). Two minutes on climate change and hunger: A zero hunger world needs climate resilience. The World Food Program. URL: https://docs.wfp.org/api/documents/WFP-0000009143/download/

63 Springmann, M., Mason-D'Croz, D., Robinson, S., Garnett, T., Godfray, H. C. J., Gollin, D., . . . Scarborough, P. (2016). Global and regional health effects of future food production under climate change: a modelling study. The Lancet: 387: 1937–1946. URL: https://www.ncbi.nlm.nih.gov/pubmed/26947322

64 Im, E. S., Pal, J. S., & Eltahir, E. A. B. (2017). Deadly heat waves projected in the densely populated agricultural regions of South Asia. Science Advances, 3(8), 1–8. URL: https://advances.sciencemag.org/content/3/8/e1603322.full

65 Environmental Performance Index (2019). Armenia. URL: https://epi.envirocenter.yale.edu/epi-country-report/ARM [accessed 01/07/2019]

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

from CMIP3 (most comparable to RCP6.0) to estimate that without adaptation, annual heat-related deaths in the Central Asian region, could increase 139% by 2030 and 301% by 2050. The potential reduction in heat-related deaths achievable by pursuing lower emissions pathways is significant, as demonstrated by Mitchell et al. (2018).[67]

POLICIES AND PROGRAMS

National Adaptation Policies and Strategies

TABLE 5. Key national adaptation policies, plans and agreements

Policy/Strategy/Plan	Status	Document Access
The Disaster Risk Management National Strategy and the Action Plan	Enacted	April, 2017
Nationally Determined Contribution (NDC) to Paris Climate Agreement	Submitted	2015
Technology Needs Assessment Report	Completed	December, 2015
National Communications to the UNFCCC	Four submitted	Latest: May, 2020
National Platform for Disaster Risk Reduction	Enacted	2010
National Adaptation Plan (NAP) to Advance Medium and Long-Term Adaptation Planning in Armenia	In development phase	
National Forest Policy and Strategy	Enacted	January, 2015
Wildfire Action Management Plan	Enacted	May, 2013
EU-Armenia Comprehensive and Extended Partnership Agreement (CEPA) (2017).	Adopted	September, 2017
Eu-Armenia Cepa Roadmap	Adopted	2018
Green City – Yerevan Action Plan	Enacted	2017

[67] Mitchell, D., Heaviside, C., Schaller, N., Allen, M., Ebi, K. L., Fischer, E. M., . . . Vardoulakis, S. (2018). Extreme heat-related mortality avoided under Paris Agreement goals. Nature Climate Change, 8(7), 551–553. URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6181199/

Climate Change Priorities of ADB and the WBG

ADB Country Partnership Strategy

Armenia's most recent Country Partnership Strategy (2019–2023) reiterates Armenia's pledge to include climate change measures in infrastructure projects to increase the country's adaptation efforts and increase its resilience to climate change. ADB will continue to support adoption of environmental safeguard measures and institutional capacities for their enforcement.

WBG Country Partnership Framework

The WBG's Country Partnership Framework (2019–2023) with Armenia identified the risks climate change presents to poverty reduction and economic growth ambitions – notably the country's vulnerability to disasters and the impact climate change is expected to have on Armenia's agricultural sector. Targeted actions include support to climate-smart agriculture efforts and agricultural risk management. These efforts include improving farmer access to agronomic technology and information, investigating options for crop insurance, particularly during drought periods, improving the quality, capacity, and reach of extension services, both generally and for adapting to climate change, improving the capacity of hydro-meteorological institutions, and improving farmers' access to rural finance to enable them to access new technologies. The CPF also commits to supporting Armenia in developing catastrophe risk financing and weather risk hedging instruments, to reduce the financial vulnerability of the government, businesses, and households to the adverse impacts of geo-hazards and climate change, through market-based risk transfer mechanisms. Through the CPF, the WBG will also seek funding from external sources for climate change related efforts such as providing technical support to translate NDCs under international climate agreements into an actionable implementation strategy.[68]

[68] WBG (2019). Country Partnership Framework for The Republic of Armenia for the Period FY19-FY23. URL: http://documents.worldbank.org/curated/en/523501552357219076/pdf/armenia-cpf-fy19-fy23-february-27-final-update-3-4-19-03062019-636876792405788612.pdf

CLIMATE RISK COUNTRY PROFILE

ARMENIA

WORLD BANK GROUP

ADB ASIAN DEVELOPMENT BANK