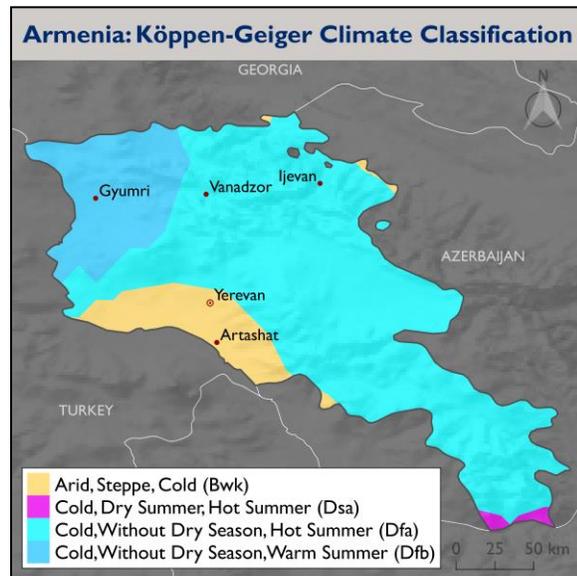




CLIMATE RISK PROFILE ARMENIA

COUNTRY OVERVIEW

Armenia is a small landlocked country with complex topography. It has a history of drought, significant land degradation and active desertification processes. Frequent landslides, mudflows, floods and other natural hazards negatively impact infrastructure, agriculture and water resources, increasing the country's vulnerability to climate variability and change. Between 1998 and 2010, weather-related hazards caused losses of \$2.8 billion, averaging \$450 million per year. Unemployment remains high at 17 percent, while 30 percent of the population lives in poverty. Agriculture is vital to the economy, accounting for 19 percent of GDP and employing 39 percent of the country's population of 3 million. Agricultural production is vulnerable to increasing temperatures and reduced precipitation, particularly in areas requiring irrigation. River flows are projected to decline with rising temperatures and declining precipitation, reducing freshwater supply. Forests, which cover 11 percent of the country, are at risk due to increased aridity, which reduces growth rates and regeneration, making trees more susceptible to pests, diseases and forest fires. More frequent and longer heatwaves pose health risks, especially to vulnerable populations. (Citations: 1, 13, 14, 17)



CLIMATE PROJECTIONS



1.6 - 2.2° C increase in temperatures by 2050



Uncertain changes in average annual precipitation; 7 - 10 percent decrease in June-September precipitation by 2050



22 - 32 percent increase in extreme rainfall events by 2050

KEY CLIMATE IMPACTS

Infrastructure

Destruction of roads and highways
Damage to human settlements

Agriculture

Reduced crop yields
Damage to crops and livestock
Soil erosion

Human Health

Increased incidence of heat stroke
Increased incidence of malaria

Ecosystems

Loss of biodiversity
Reduced forest productivity

Water Resources

Reduced water supply
Decline in water quality
Reduced hydropower potential

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CLIMATE SUMMARY

Armenia’s climate is influenced by the Caucasus Mountains, and ranges from dry sub-tropical to cold alpine. The average annual temperature (1960-2015) is 7.6°C, varying from -8°C in the high mountains to 12 to 14°C in low valleys. The coldest temperatures occur December to February (ranging from -3 to -7°C), and warmest temperatures occur in July and August (averaging about 20°C); though, in low-land areas temperatures can reach 24 to 26°C in July and August, and in high alpine regions temperatures typically do not exceed 10°C. Armenia’s average annual precipitation is 524 mm (1960-2015), over 40 percent occurring April through June; with average annual precipitation of 200 to 250 mm in low-land areas, and 800 to 1,000 mm at higher altitudes. (1, 2, 5, 6, 9,12,19)

HISTORICAL CLIMATE

Observations since 1960 include:

- Between 1960 and 2015, average annual temperature increased by 0.20°C per decade.
- Between 1960 and 2003, the average number of “hot”¹ summer days increased by 10.6 percent; “cold”² summer days per month decreased by 6 percent.
- There was no significant trend in average annual rainfall between 1960 and 2015.

FUTURE CLIMATE

Projected changes by 2050³ include:

- An increase in average annual temperature of 1.6° to 2.2°C.
- An increase in the number of “hot” days and nights; a decrease in the number of “cold” days and nights.
- Inconsistent changes in average annual precipitation, but likely reductions of -7 to -10 percent in monthly average precipitation June to September.
- An increase in the number of consecutive dry days⁴ by 7 to 11 percent.
- An increase in extreme rainfall days⁵ by 22 to 32 percent.

SECTOR IMPACTS AND VULNERABILITIES

INFRASTRUCTURE

In avalanche-prone areas, abrupt terrain, steep slopes and arid land exposed to heavy rainfall events can result in landslides, flash floods and mudslides. A significant number of settlements and roads, bridges, reservoirs and other infrastructure are in landslide-prone zones where heavy rains can oversaturate unstable ground, resulting in major landslides which have destroyed hundreds of buildings and vital infrastructure, including residential areas, roads, highways and railways. In 2004, landslides caused \$43 million in damages. Between 2004 and 2007, mudflows damaged 200 settlements and 600 sites on main transportation routes. In 2009, there were damages of \$11.5 to

Climate Stressors and Climate Risks INFRASTRUCTURE	
Stressors	Risks
Rising temperatures	Increased flood and mudslide damage to homes, buildings, communication networks and other infrastructure.
Increased storminess	Increased damage to transportation routes, including roads, highways and railways.

\$13 million from landslides and \$5.7 to \$7.1 million from mudslides. (1, 7, 13, 14)

¹ “Hot” day or night is defined by the temperature exceeded on 10% of days or nights in current climate of that region and season.

² “Cold” day or night is defined by the temperature below which 10% of days or night are recorded in current climate of that region or season.

³ Relative to the data from 1986-2015

⁴ Maximum number of consecutive days per year with less than 1 mm of precipitation.

⁵ Annual total precipitation when daily precipitation exceeds the 99th percentile of wet day (calculated from days when it precipitated at least 1 mm).

AGRICULTURE

Agriculture accounts for 62 percent of total land use, while 80 percent of crops require irrigation, due in part to desertification. Projected declines in summer precipitation and increases in temperature will increase the need for irrigation and contribute to increasing water scarcity. In recent decades, extreme weather events (e.g., drought, hot dry winds, hail and spring frosts) have become more frequent and extended, reducing crop yields and damaging livestock. From 2000 through 2005, Armenia suffered \$107 million in economic losses to the agricultural sector due to drought, frost and floods, threatening rural livelihoods and food security. The Ararat Valley, an important region for agriculture, is also one of the hottest and driest in summer. Wheat, a key cereal crop, is projected to decline in this region by 6 to 8 percent in 2040 to 2050 due to rising temperatures and water stress.

HUMAN HEALTH

A malaria epidemic peaked in the Ararat Valley in 1998 with over 1,000 cases. While Armenia has been malaria-free since 2011, research suggests that malaria may increase in the future as climate conditions change, specifically in the country's warm temperate forests and dry semiarid and dry tropical climate zones. Over the last thirty years, the duration of heatwaves has significantly increased, most prominently at lower elevations. In the capital, Yerevan, average heatwave duration increased by about 40 days from 1981-2013. Heat stress can have a greater impact on the elderly and those with cardiovascular diseases and other chronic illnesses;

ECOSYSTEMS

Due to variation in elevations and climatic zones, Armenia's ecosystems support rich biodiversity, with most species endemic or rare. Plant and animal species are likely to shift upwards in elevation due to climatic changes, altering both ecosystem structure, habitat biodiversity and ecosystem services. More than 15 percent of Armenia's higher plant species are in danger of extinction due to projected climate change. Semi-desert and desert areas are projected to expand by 30 percent, which will accelerate desertification. More frequent summer droughts and water stress will reduce the growth rate of trees and increase susceptibility to pests and diseases; this will also create conditions conducive to more frequent and intense wildfires, leading to an

Climate Stressors and Climate Risks AGRICULTURE	
Stressors	Risks
Rising temperatures	Increased pests and disease
Changes in seasonality of precipitation	Soil erosion and loss of soil fertility
	Reduced crop yields (alfalfa, apricot, grape, potato)
More droughts	Increased need for irrigation to maintain yields
Increased storminess	Damage to crops and livestock

These conditions will also promote livestock and crop pests and diseases. Yields of alfalfa, apricot, grape and potato are projected to decline in all agricultural regions in 2040 to 2050. (1, 3, 7, 20, 21)

Climate Stressors and Climate Risks HUMAN HEALTH	
Stressors	Risks
Rising temperatures	Increased incidence of heat stroke, particularly among the elderly and chronically ill
Reduced rainfall and increased drought	Increased incidence of malaria
	Increased risk of injury/death from mudflows and landslides
Increased storms	Increased risk of injury/death from mudflows and landslides

it can also disproportionately harm the poor, who frequently lack air conditioning. (4, 7, 11, 14, 18)

Climate Stressors and Climate Risks ECOSYSTEMS	
Stressors	Risks
Rising temperatures	Changes in species' abundance and distribution
	Reduced tree growth and reproduction
Reduced rainfall	Forest degradation from increased pests/disease
	Increased intensity and frequency of forest fires

estimated 14,000 to 17,000 ha of forest loss by 2030. (1, 7, 15)

WATER RESOURCES

Glacial volume declined by 50 percent since the early 1900s. Higher temperatures will increase evaporation rates and reduce winter snowpack, reducing spring runoff and Armenia's already limited water resources. Aggregate river flow is projected to decrease by 11.9 percent by 2030 and 37.8 percent by 2100 compared to the 1961-1990 baseline period due to the combined effects of higher temperatures and reduced rainfall. Inflow to Lake Sevan, the largest freshwater lake in Armenia, is projected to decrease by more than 50 million m³ in 2030, by more than 110 million m³ in 2070 and by 190 million m³ in 2100 compared to the current baseline. As a result, the lake's surface level is expected to recede by 16 cm annually, threatening irrigated agriculture, municipal water supply and hydropower production. Warmer temperatures could lead to shifts in seasonal fish migration, including spawning and

Climate Stressors and Climate Risks WATER RESOURCES	
Stressors	Risks
Rising temperatures	Reduced snow cover and surface water from snowmelt
Reduced summer rainfall	Increased water stress for households, agriculture and hydropower production
Increased drought	Decreased runoff with declines in rainfall, reducing freshwater supply from both surface and groundwater sources
Increased storms	Reduced water quality
	Increased flooding

feeding areas for the lake's whitefish. (1, 7, 11, 20)

POLICY CONTEXT

INSTITUTIONAL FRAMEWORK

The Ministry of Nature Protection formulates and implements policies in environmental protection and sustainable use of natural resources, and is the UNFCCC focal point. Armenia ratified the UNFCCC in 1993 and signed the Paris Agreement in 2016. The country has submitted three national communications, an INDC and first Biennial Update Report. Armenia's INDC outlines adaptation activities for natural ecosystems; human health; water resource management; agriculture; energy; human settlements and infrastructure; and tourism. (7,8)

NATIONAL STRATEGIES AND PLANS

- [First Biennial Update Report of the Republic of Armenia under UNFCCC](#) (2016)
- [Third National Communication to the UNFCCC](#) (2015)
- [Intended Nationally Determined Contributions](#) (2015)
- [Development Strategy for 2014-2025](#) (2014)
- [Second National Communication to the UNFCCC](#) (2010)
- [Initial National Communication to the UNFCCC](#) (1998)

KEY RESOURCES

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Map resource. Map source: Adapted from [Koppen-Geiger Classification information](#)

SELECTED ONGOING EXPERIENCES

Selected Program	Amount	Donor	Year	Implementer
Development of Armenia's Fourth National Communication to the UNFCCC and Second Biennial Report	\$1.4 million	GEF	2016-2020	Ministry of Nature Protection
Advanced Science and Partnerships for Integrated Resource Development Project (ASPIRED)	\$4.99 million	USAID	2016-2020	Mendez England & Associates, Inc. for the Ministry of Nature Protection
Participatory Utilization and Resource Efficiency of Water (PURE-Water)	\$1.04 million	USAID	2017-2020	The Urban Foundation for Sustainable Development
Mainstreaming Sustainable Land and Forest Management in Mountain Landscapes of North-Eastern Armenia	\$17 million	GEF/UNDP	2016-2020	Ministry of Nature Protection, Hayantar State Non-Commercial Organization under the Ministry of Agriculture
De-risking and scaling-up investment in energy efficient building retrofits in Armenia	\$29.8 million	Green Climate Fund, Government of Armenia, UNDP	2016-2036	Ministry of Nature Protection
Second Community Agriculture Resource Management and Competitiveness Project	\$42.7 million	World Bank	2014-2020	Agriculture Projects Implementation Unit State Agency of the Ministry of Agriculture
Climate Forum East (CFE) II (Regional Project)	\$1.3 million	EU, Austrian Development Agency, Austrian Red Cross Society	2015-2017	Armenian Red Cross Society
Integrated biodiversity management, South Caucasus (Regional project)	\$16 million	German Federal Ministry for Economic Cooperation & Development, Austrian Development Cooperation	2015-2019	Ministry of Territorial Administration and Emergency Situations (Armenia); Ministry of Ecology and Natural Resources (Azerbaijan); Ministry of Environment Protection (Georgia)
Irrigation System Enhancement Project	\$37.5 million	World Bank	2013-2018	Water Sector Development Unit
Geothermal Exploratory Drilling Project	\$10.7 million	World Bank	2015-2019	Armenia Renewable Resources and Energy Efficiency Fund
Sustainable Management of pastures and forest in Armenia to demonstrate climate change mitigation and adaptation benefits and dividends for local communities	\$1.2 million	EU/UNDP	2013-2017	Ministries of Nature Protection and Agriculture, Gegharkunik Regional Administration