

---

# **Armenia**

## **General Water Security Assessment**

# Table of Contents

<b>Acknowledgements .....</b>	<b>Error! Bookmark not defined.</b>
<b>Disclaimer.....</b>	<b>Error! Bookmark not defined.</b>
<b>Executive Summary .....</b>	<b>3</b>
<b>1 Background and Project Introduction.....</b>	<b>7</b>
1.1 Scope and Objectives of the Water Security Report of Armenia .....	7
1.2 The Water Security Diagnostic Framework .....	7
1.3 The One-Water Methodology.....	8
1.4 Setting the scene: Armenia main physical, socio-economic and governance features .....	9
<b>2 Country Diagnosis .....</b>	<b>14</b>
2.1 Endowment.....	14
2.1.1 Supply .....	14
2.1.2 Demand .....	16
2.2 Architecture.....	18
2.2.1 Regulatory framework and institutions .....	18
2.2.2 Infrastructure .....	20
2.3 Performance.....	21
2.3.1 Water Resources Management .....	22
2.3.2 Management of Water Risks .....	22
2.3.2 Service delivery .....	24
2.4 Outcomes .....	25
2.4.1 Social outcomes.....	25
2.4.2 Environmental outcomes .....	26
2.4.3 Economic outcomes .....	26
<b>3 Future Trajectories .....</b>	<b>28</b>
3.1 Future climate and socioeconomic scenarios.....	28
3.2 Projections of some water security indicators .....	28
3.2.1 Water availability, water demand, and water stress .....	28
3.2.2 Flood risk .....	30
3.2.3 Drought risk .....	31
<b>4 Country Narrative and priority actions to increase water security.....</b>	<b>33</b>
<b>5 References.....</b>	<b>38</b>
<b>6 Annexes I: List of indicators used in the O-WM.....</b>	<b>40</b>
<b>7 Annex II: Results of Core indicator assessment.....</b>	<b>44</b>

## Executive Summary

Water Security is more than coping with resource scarcity	<b>Water security is defined</b> as “The availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies” (Grey and Sadoff, 2007). Water security is critical to attaining development goals by delivering benefits for people, the economy, and the environment, and mitigating water risks amplified by climate change.
Water Security Diagnostic Initiative	Against this background, the World Bank’s Water Global Practice initiated a <b>Water Security Diagnostic Initiative</b> <sup>1</sup> in 2017. The initiative seeks to make the best use of the World Bank’s technical experience, instruments, and financial resources to produce studies that influence senior policymakers beyond line ministries.
Vision	The initiative contributes to attaining the World Bank’s vision of achieving a “ <b>Water-Secure World for All</b> ” by sustaining water resources, delivering services, and building resilience.
Conceptual framework	<p>The World Bank’s conceptual <b>Water Security Diagnostic Framework (WSDF)</b> recognizes that not all water-related challenges are equally significant in their impacts on people, ecosystems, and economies. A consistent approach is important to identify the most severe risks and significant opportunities.</p> <p>The concept determines water security <b>outcomes</b> from how water is managed and used. These are results of water <b>sector performance</b>, resource management, service delivery, and risk management. The performance, in turn, depends on water <b>sector architecture</b>, institutions and infrastructure and all areas are conditioned by water <b>endowment</b>. Therefore, the framework includes four main topical areas or dimensions: (i) water outcomes, (ii) water sector performance, (iii) water sector architecture, and (iv) water endowment.</p>
One-Water Methodology	The <b>One-Water Methodology (O-WM)</b> aims to establish a consistent and systematic approach to diagnosing water security at country and regional levels without being overly prescriptive. It contributes to operationalizing the WSDF, identifying and benchmarking critical current and future challenges around water security in Europe and Central Asia (ECA) countries and proposing follow-up activities at the country level to improve water security.
Armenia water security report	This report assesses Armenia’s current water security and future change drivers, aiming to spotlight issues for enhanced water security. It compiles knowledge, offering an overview of challenges, risks, and opportunities. The focus is on identifying key areas for immediate and future improvements in water security.
Diagnostic of Armenia’s water security and proposed priority actions for enhancing water	The results of the diagnostic indicate that Armenia could significantly enhance the economic, social, and environmental outcomes from using its water resources, including improving safely managed drinking water and sanitation coverage, reducing pressure on water bodies, and maximizing economic water productivity. To do so, the following major challenges spanning over the different water security dimensions need to be addressed and prioritized:

<sup>1</sup> <https://www.worldbank.org/en/topic/water/publication/water-security-diagnostic-initiative>

security in  
Armenia

- **Endowment** – Armenia's water resources are significantly influenced by transboundary waters, which face mounting pressures due to human activities. Armenia's climate is characterized by relatively low annual precipitation and a dry summer season. During the dry summer months water resources become scarcer. The agricultural sector has the greatest demand for water with about 70%. The efficient use of water in agriculture has been a priority for the Armenian government due to water scarcity concerns. Nevertheless, precision farming and drip irrigation techniques cover only a very small percentage of irrigation practices. The current state of the irrigation systems in the country is a major concern. Increasing water use efficiency especially in the irrigation sector should be a priority in Armenia.
- **Architecture** – the main legal framework for Armenia's water sector is the water code. It was amended several times after it came into force, the last time in 2022. Two Ministries are responsible for water sector at the national level, but the coordination between them is insufficient and capacities are lacking. There is an independent regulator. It will be important in the future to strengthen this regulatory body and carry out a tariff reform. Improving the regulatory framework in Armenia's water sector is essential for ensuring fair and transparent regulation, protecting consumer interests, promoting investment, and fostering sustainable water resource management.
- **Performance** – Armenia needs to scale up its investment in water supply and sanitation (WSS) infrastructure to improve WSS coverage, especially in rural areas. Monitoring water losses (75% NRW) and supporting the development of staff capacities to detect, manage and address water losses, and identify projects for the rehabilitation and replacement of water supply networks would be needed. Moreover, a review of the water tariffs for improved cost recovery would be necessary to ensure operation, maintenance, and continued investments in WSS and irrigation infrastructure. Irrigation infrastructure in Armenia is not very efficient and often outdated. The agricultural sector requires investments to modernize existing irrigation schemes to introduce more efficient irrigation technologies. Lastly, Armenia is vulnerable to floods and droughts, requiring developing and implementing flood and drought management plans.
- **Outcomes** – Armenia has a good coverage of WSS services but quite often and in particular in rural areas only for basic services. The proportion of safely managed WSS services need to be increased. Armenia's water bodies face pressures due to growing water abstractions but also water pollution, requiring implementing effective water quality monitoring systems, improved wastewater treatment, and strengthening regulations and enforcement related to water pollution. The overall economic water productivity in Armenia is well below its potential. Improving the institutional capacity and promoting the adoption of modern technologies (e.g., precision farming techniques, drip irrigation) could help leveraging the untapped economic potential.

## Abbreviations

ADB	Asian Development Bank
AQUASTAT	FAO global information system on water resources and agricultural water management
ASHMS	Armenian State Hydrometeorological and Monitoring Service
BMOs	Basin management organizations
CMIP5	Coupled Model Intercomparison Project - Phase 5
EBRD	European Bank for Reconstruction and Development
ECA	Europe and Central Asia
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross domestic product
IBNET	International Benchmarking Network for Water and Sanitation Utilities
IPCC	Intergovernmental Panel on Climate Change
IWRM	Integrated Water Resources Management
JMP	Joint Monitoring Programme
NRW	Non-Revenue Water
OECD	Organization for Economic Cooperation and Development
O-WM	One-Water Methodology
RCP	Representative Concentration Pathways
SPEI	Standardized Precipitation Evapotranspiration Index
SDG	Sustainable Development Goal
SSP	Shared Socioeconomic Pathways
WASH	Water, Sanitation and Hygiene
WB	World Bank
WFD	Water Framework Directive
WHO	World Health Organization
WRI	World Resources Institute
WSDF	Water Security Diagnostics Framework
WSS	Water supply and sanitation
WUAs	Water User Associations

## List of tables

Table 1. Population of the Republic of Armenia as of 2022. Source: Statistical Committee of the Republic of Armenia <a href="https://armstat.am/en/">https://armstat.am/en/</a> .....	11
---	----

## List of figures

Figure 1: The Water Security Diagnostic Framework (WSDF) and its different dimensions. Source: World Bank (2019) .....	8
Figure 2: The 10-Steps-Process of the country One-Water-Methodology.....	9
Figure 3: topographic map of Armenia. Source: Philippe Rekacewicz, Emmanuelle Bournay, UNEP/GRID-Arendal .....	9
Figure 4: Annual mean air temperature (left) and yearly sum of precipitation (right) in Armenia during the reference period of 1961–1990. (Data Source: ASHMS, 2011c; Gevorgyan, 2014 (for air temperature), modified) .....	10
Figure 5: Administrative regions of Armenia. Source: <a href="http://www.gov.am">www.gov.am</a> .....	11
Figure 6: Results of indicator assessment regarding the water endowment in Armenia.....	14
Figure 7: Spatial variation of seasonal variability of water availability across states in Armenia. Source: Gassert et al. (2014). .....	16
Figure 8: Water withdrawal per capita in Armenia at the county level. Source: Gassert et al., (2014).....	17
Figure 9: Status of the water sector architecture in Armenia .....	18
Figure 10: Sector institutions at national, regional, and local level in the Republic of Armenia .....	19
Figure 11 Results of indicator assessment regarding Armenia’s water sector performance. ....	21
Figure 12: Riverine flood risk measured as damage experienced as a percentage of GDP in an average year in Armenia. Source: Hofste et al. (2019) .....	23
Figure 13: Riverine flood risk measured as percentage of population affected in Armenia. Source: Hofste et al. (2019) .....	23
Figure 14: Drought risk in Armenia. Source: Hofste et al. (2019) .....	24
Figure 15: Results of indicator assessment regarding Armenia’s water sector outcomes .....	25
Figure 16: Annual water availability for historical and three future scenarios.....	29
Figure 17: Sectoral demands for historical and future scenarios. Source: Burek et al. (2020) .....	30
Figure 18: Annual water stress for historical and future scenarios. Source: Burek et al. (2020) .....	30
Figure 19: Flood risk in terms of relative change to baseline GDP for the year 2050 based on the Pessimistic scenario. Source: Hofste et al. (2019) .....	31
Figure 20: CMIP5 ensemble projected change in monthly precipitation (mm) relative to the 1986–2005 baseline under RCP8.5. (Source: World Bank, 2023) .....	32
Figure 21: CMIP5 ensemble historical (1986 –2005) and projected drought risk (based on the SPE index) by 2100 under RCP8.5. ....	32

# 1 Background and Project Introduction

## 1.1 Scope and Objectives of the Water Security Report of Armenia

**This report provides a high-level assessment of Armenia's water security status across different water security dimensions (endowment, sector architecture, performance and outcomes) with the aim of highlighting where efforts should be focused to increase the resilience of the water sector now and in the future.** The assessment focuses on identifying the key water security challenges, risks, and opportunities, following the *One-Water Methodology*. It responds to key questions such as: why does water security matter for Armenia? What risks threaten its water security currently and in the light of future climate change? How is its performance constrained or enabled? What areas require special attention to overcome existing gaps and enhance water security in Armenia? The findings in this report provide a high-level picture of Armenia's water security but also offers a general set of recommendations for action, including water security areas where comprehensive analysis is required to identify leverage points, and sector investment plans.

This report is meant for policy and decision makers working in the space of water security for which water is a critical input, as well as non-state water institutions working on water security.

The report is organized as follows. The remainder of Chapter 1 provides a short overview of the Water Security Diagnostic Framework, the *One-Water Methodology*, and a general overview of key physical, and socio-institutional features of Armenia. Chapter 2 provides a diagnosis of current water security status of Armenia across its four main dimensions (endowment, sector architecture, performance and outcomes). Chapter 3 describes Armenia's future trajectories imposed by global climate and socio-economic scenarios, and drivers related to ongoing and foreseen development plans. Chapter 4 elaborates a preliminary country narrative and related policy recommendations based on the main water security challenges, risks, and opportunities that Armenia is and is likely to face in the near future.

## 1.2 The Water Security Diagnostic Framework

Water security is a complex, multi-dimensional and multi-sectoral concept. It concerns the building of a water secure future for the people, the economy, and the environment in the face of local and global challenges. Achieving water security is therefore the overarching goal of water management and includes leveraging productive aspects of water for human well-being, livelihoods, environment and socio-economic development, and the management of the destructive impacts of water such as floods, droughts, and pollution to protect societies, economies, and the environment. Water insecurity is typically driven by a combination of environmental, socio-economic, technological, and governance factors. The most water insecure countries combine challenging hydrological environments with weak institutions and chronic under-investment in water infrastructure. Even when water is abundant, and the hydrologic regime is benign, mismanagement (for example, poor pollution regulation) or inadequate infrastructure investments can lead to water insecurity.

Water security cannot be adequately assessed by any single integrative index. In addition, water security often intersects with other security concerns, including energy, food, climate change and overall national security. As an alternative to establishing a strict methodology for measuring water security, the Water Global Practice of The World Bank has developed a **Water Security Diagnostic Framework (WSDF)** (Figure 1). The WSDF focuses on establishing a consistent and structured conceptual approach to diagnosing water security without being overly prescriptive. This approach is important to identify the most severe risks and significant opportunities, facilitate global comparisons, and benchmark countries. Moreover, seeks to make explicit the relationship between a country's **water endowment** (given and subject to change due to climate change) and its linkage to **social, economic and environmental outcomes**. This is done by examining the role of **water sector architecture**, encompassing infrastructure and institutions, in the **performance** of the water sector in managing **water resources**, delivering **water services**, and mitigating **water-related risks**.

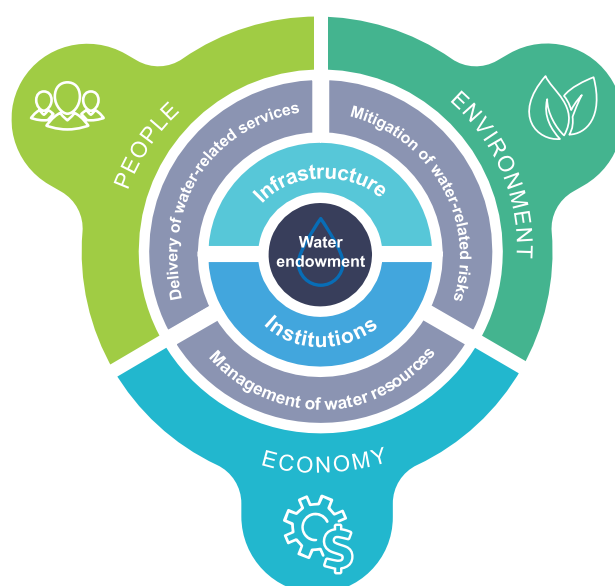


Figure 1: The Water Security Diagnostic Framework (WSDF) and its different dimensions. Source: World Bank (2019)

### 1.3 The One-Water Methodology

The **One-Water Methodology (O-WM)** has been developed to **operationalize the WSDF** using an innovative method which maximizes the use of available country data and stakeholder knowledge to establish a **rapid, consistent, and systematic diagnosis of the water sector** across the different dimensions as defined in the WSDF. Through an innovative set of qualitative and quantitative indicators structured in the form of a *performance* matrix, the O-WM allows countries to map where are they standing; but also provides the basis to **identify high-impact actions** to incrementally improve the performance of the water sector and put the country on the right track to water security. The O-WM promotes a dynamic learning cycle i.e. *learning by doing* that continuously strengthens the methodology and accelerates the systematic identification of new gaps and new opportunities.

The O-WM for country analysis and strategy comprises three phases and each phase includes several steps as shown in Figure 2:

Phase A: Preparatory and Diagnosis Phase: This phase defines the current water security status of a country using a set of quantitative and qualitative indicators which help describing the different water security dimensions of the WSDF. Such indicator-based assessment is combined with desktop review and several stakeholder interactions, including scoping interviews and one workshop with key water-related actors. The main output of this phase is a detailed narrative of a country's water security status along the four water security dimensions of the WSDF, along with an identification of the main risks and opportunities of existing and future climate and socio-economic scenarios. The list of quantitative and qualitative indicators used to assess a country's water security is provided in the [Annex I](#).

Phase B: Action Planning and Decision Phase: Based on the diagnosis, this phase supports countries in the identification of pathways to enhance their water security through the identification and prioritization of actions through a participatory multi-criteria analysis. The main output of this phase is a roadmap that includes a set of priority actions that should ideally feed into a strategic action plan that builds on the momentum to accelerate policy reforms and investments to achieve a long-term water security vision.

Phase C: Learning phase and preparation for next cycle: Accumulation and analysis of experiences and lessons learned during the implementation of the O-WM and preparation for the next One-Water cycle.



Figure 2: The 10-Steps-Process of the country One-Water-Methodology.

In this report, only the Phase A of the **O-WM** is implemented to provide a preliminary assessment of water security in Armenia. The country narrative serves as the basis to identify strategic areas of concern of the countries' water security, and where further efforts should be placed for action planning and implementation.

#### 1.4 Setting the scene: Armenia main physical, socio-economic and governance features

**Geography.** Armenia is a landlocked country located in the South Caucasus region of Eurasia. It shares borders with Turkey to the west, Georgia to the north, Azerbaijan to the east, and Iran to the south. Armenia is characterized by a diverse terrain that includes mountains, valleys, and highlands. The Armenian Plateau, which extends from the Caucasus Mountains, covers a significant portion of the country. The Caucasus Mountains run along the northern border of Armenia. The highest peak in the country and the entire Caucasus region is Mount Aragats, which stands at an elevation of 4,090 meters. Armenia is located in a seismically active region due to the convergence of the Arabian, Eurasian, and Anatolian tectonic plates. This has led to the occurrence of earthquakes in the past.

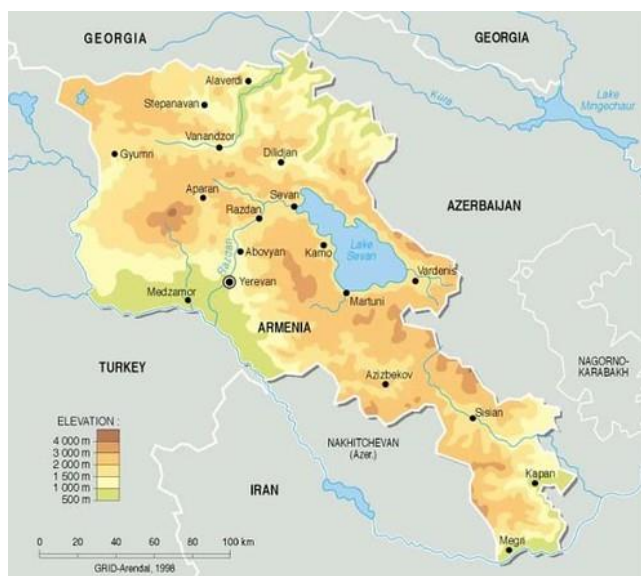


Figure 3: topographic map of Armenia. Source: Philippe Rekacewicz, Emmanuelle Bournay, UNEP/GRID-Arendal

**Climate.** Armenia experiences a diverse range of climates due to its varying elevations and geographical features. The country's climate is influenced by its location in the South Caucasus region and its proximity to several major geographical features, such as mountains, plateaus, and lakes. Summers in Armenia, especially in the lowland areas, can be quite hot. Temperatures often exceed 30°C and can even reach 40°C during heatwaves. The sun is intense, and the air can be dry, leading to high evaporation rates. Winters in Armenia are cold and snowy, especially in the mountainous regions. Temperatures can drop well below freezing, and heavy snowfall is common in higher elevations. In the capital city, Yerevan, winter temperatures can range from -5°C to -10°C. Precipitation patterns in Armenia vary by region and elevation. The western parts of the country, closer to the border with Turkey, receive more precipitation compared to the east. Rainfall is more common in the lowlands, while higher elevations receive snowfall.

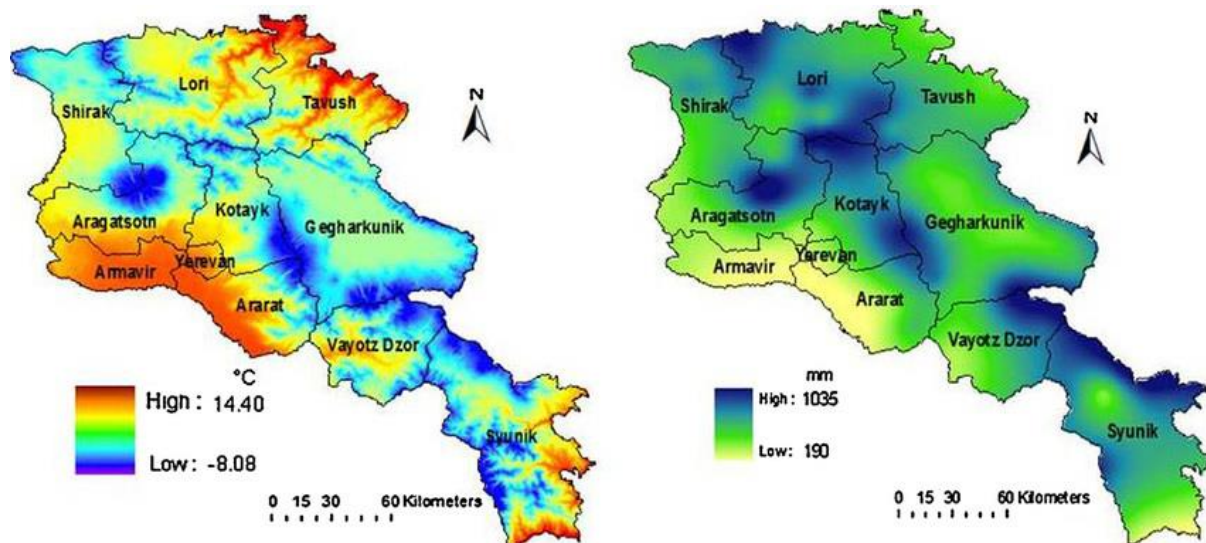


Figure 4: Annual mean air temperature (left) and yearly sum of precipitation (right) in Armenia during the reference period of 1961–1990. (Data Source: ASHMS, 2011c; Gevorgyan, 2014 (for air temperature), modified)

**Administration.** The territory of the Republic of Armenia is composed of ten marzes (regions) and Yerevan city which is governed by the law on local self-government in the city of Yerevan. Public administration in the marzes is governed by RA President's decree "On public administration in the marzes of the Republic of Armenia" and other legal acts.

Marz governors implement the regional policy of the government. They coordinate the activities of local branches of the executive authority, except as otherwise specified by law.

Within the bounds of the authority they are vested with by law, marz governors carry on the government's regional policy in their respective marzes in the following areas: finance, urban development, housing and utilities, transport and road construction, agriculture and land use, education, healthcare, social security, culture and sports, nature and environmental protection, commerce, public catering, and services. Regional policy in the foregoing sectors is carried on by means of marz administrations, as well as through subordinate organizations.



Figure 5: Administrative regions of Armenia. Source: [www.gov.am](http://www.gov.am)

**Population.** Armenia is a country with a population of 2,9 million people, situated in the South Caucasus region. The population density in Armenia is relatively moderate, with an average of around 104 persons/km<sup>2</sup>. This density is somewhat akin to that of neighboring countries like Georgia (58 persons/km<sup>2</sup>).

The ethnic makeup of Armenia is primarily composed of ethnic Armenians, accounting for a significant majority of the population. Other minority groups include Yazidis, Russians, Assyrians, Greeks, and Kurds. This diversity reflects the country's historical and geographical position as a crossroads of various civilizations.

Armenia's population features a median age of approximately 32 years, showcasing a relatively youthful populace. The country experiences a stable birth rate, which is tempered by emigration trends. Armenia has historically faced emigration challenges due to economic factors and political circumstances, leading to a significant diaspora population spread across the world.

The urbanization rate in Armenia is notable, with over two-thirds of the population (around 65%) residing in urban areas, while the remaining population lives in rural regions. The capital city, Yerevan, is the most densely populated and accounts for a substantial portion of the total population, representing approximately 30% of the country's inhabitants (Table 1).

Table 1: Population of the Republic of Armenia as of 2022. Source: Statistical Committee of the Republic of Armenia <https://armstat.am/en/>

	Total population 2022	Urban population	Rural population	% Urban
<b>Republic of Armenia</b>	2,961,367	1,892,147	1,069,220	64
City Yerevan	1,092,778	1,092,778	-	100
Aragatsotn Marz	124,646	26,545	98,101	21
Ararat marz	256,615	71,969	184,646	28
Armavir Marz	264,383	82,522	181,861	31

	Total population 2022	Urban population	Rural population	% Urban
Gegarkunik Marz	227,778	65,916	161,862	29
Lori Marz	211,677	124,470	87,207	59
Kotayk Marz	251,076	136,960	114,116	55
Shirak Marz	230,340	134,074	96,266	58
Syunik marz	134,731	90,695	4,4036	67
Vayots Dzor Marz	47,584	16,291	3,1293	34
Tavush Marz	119,759	49,927	6,9832	42

**Economy.** Armenia's economy is characterized by a combination of agriculture, services, and manufacturing sectors. Agriculture has traditionally been important, with products like fruits, vegetables, dairy, and livestock playing a significant role in the rural economy. The services sector, including industries like tourism, information technology (IT) services, and financial services, has been growing steadily and has become a key driver of the economy. Armenia has developed a small but growing manufacturing sector, producing goods like textiles, processed foods, machinery, and electronics.

Economic performance in 2022 was unexpectedly strong, with real GDP growth reaching 12.6 percent. Robust 18 percent growth in services (mainly driven by the finance, IT, transport, and hospitality services) contributed to approximately three quarters of total growth. On the demand side, growth was driven largely by private consumption fuelled by exceptionally high inflows of people and funds from Russia, and by a 10 percent increase in real wages. The unemployment rate fell to 11.6 percent in Q3 2022, down from 15.5 percent at end-2021, and this is expected to drive a substantial reduction in the UMIC poverty line (USD 6.85/day, 2017 PPP) from 51.7 percent in 2021 to 41.8 percent in 2022.

**Agriculture.** According to the World Bank, Armenia's total agricultural land amounts to 16,768 sq. km, which comprises 59% of the total land area. Armenia's total arable land is around 446,400 hectares (4,464 sq. km), comprising some 15.7% of Armenia's land area. At present, the agricultural sector remains essential for the economy of the country. Agriculture is the main source of economic activity in rural areas and significant contributor to GDP. It produces 12.0 % of GDP (as of 2022) and employs about 21.8 % (2022) of the working population.

**Energy.** Armenia's energy sector has historically faced challenges due to its limited domestic energy resources. The country heavily relies on imports of energy resources, including natural gas, oil, and electricity. Natural gas dominates the energy mix (59.6% of total energy supply in 2020). Although Armenia's energy demand averages more than 3 Mtoe (3.59 Mtoe in 2020) and the country does not produce any fossil fuels, it manages to cover 27% of energy demand with domestic energy production. This production (0.96 Mtoe in 2020) comes mostly from nuclear and hydro resources.

**Electricity.** In 2021, Armenia produced 7.7 TWh of electricity, of which natural gas covered 44% (3.4 TWh), hydro and other renewables 30% (2.3 TWh) and nuclear 26% (2.0 TWh). In the Caucasus region, Armenia is the only country producing nuclear energy.

**Water resources.** Water resources play a significant role in Armenia's economy, agriculture, and overall development due to its predominantly mountainous terrain and relatively small size. Armenia is home to several rivers and lakes, many of which are important water sources for the country. The two major rivers are the Araks and the Hrazdan. Lake Sevan, located at an elevation of about 1,900 meters above sea level, is the largest freshwater lake in the South Caucasus and a crucial water reservoir for the country. Lake Sevan is of paramount importance to Armenia's water resources. It covers an area of about 940 square kilometers and holds approximately 34 cubic kilometers of water. It serves as a critical source of freshwater for drinking water, irrigation, and hydropower generation. Armenia also

has considerable groundwater resources, which play an important role in the overall water balance. About 96 percent of the water used for drinking purposes and about 40 percent of water abstracted in the country comes from groundwater (ADB 2011).

**Water management.** Water resources management in Armenia is executed by the Ministry of Environment, through the Water Resources Management Agency (WSS) and six basin management organizations (BMOs). Since 2002, a number of reforms have been made in Armenia aimed at sustainable and adequate management of water resources. Armenia has substantially undertaken structural revision of the water management agencies, made a number of legal reforms and implemented new management tools such as Water Use Permits.

**Water and Sanitation.** About 96% of drinking water is groundwater drawn through boreholes, wells, and springs. Most raw water is of good quality and requires only disinfection. The typical drinking water infrastructure includes water intakes, transmission mains, pumping stations, and distribution networks.

Armenia's sanitation services are not adequate, especially in rural areas. While in urban areas 96% have access to improved sanitation facilities, half of the rural population use unimproved facilities, causing direct damage to the environment and exposing inhabitants to health risks.

## 2 Country Diagnosis

The country diagnosis of the water security situation of Armenia is performed for the four dimensions of water security (endowment, architecture, performance, and outcomes) following the methodological approach provided in the O-WM. The overall assessment of each dimension is provided using radar charts that summarize the ranking of different indicators on a range band from 0 to 5 as defined in the O-WM<sup>2</sup>. A rating of 1 indicates Low performance (i.e., the country is at a very unfavourable status or performing poorly for a particular indicator), 2 rating is a Low-Medium (i.e., the country is underperforming although some progress has been made), 3 is Medium (i.e., the country is performing at an average level compared to other countries), 4 is Medium-High (i.e., the country is performing above average and showing good progress towards the desired outcome), and 5 is High (i.e., the country is at a high favourable status, outperforming and can be considered as best practice). The raw values of the indicators used to describe the different dimensions are described in Annex II.

### 2.1 Endowment

Water endowment refers to the total available water resources in quantity and quality. Available water resources include renewables (surface runoff and groundwater recharge), non-renewable (fossil groundwater) and non-conventional sources of water, including reused wastewater. In Armenia, the availability and quality of water resources are graded at a moderate level when viewed in a global context. Armenia's water landscape is also marked by pronounced seasonal variations, where the availability of water resources can significantly differ between wet and dry periods. Additionally, the country experiences a moderate level of interannual variability, indicating fluctuations in water availability from year to year.

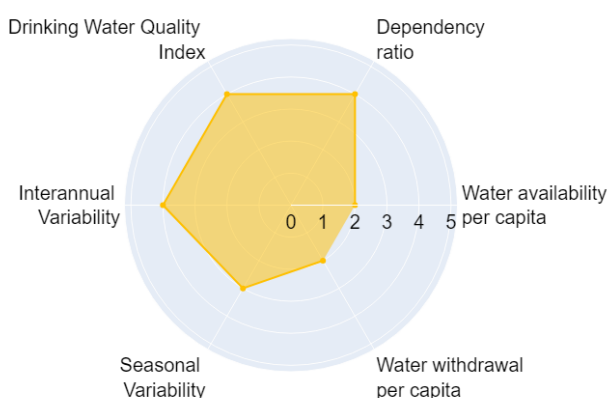


Figure 6: Results of indicator assessment regarding the water endowment in Armenia.

#### 2.1.1 Supply

##### *Water availability*

**Armenia's water endowment is relatively modest but still exceeds the regional average for the South Caucasus.** The country has an average water availability of approximately 2,632 m<sup>3</sup>/capita/year, equivalent to around 8.5 billion cubic meters annually. This places Armenia's water resources above the regional average for South Caucasus countries, which is approximately 2,000 m<sup>3</sup>/capita/year (FAO, 2022).

<sup>2</sup> A score of 0 is equivalent to No Data

Renewable surface waters in Armenia encompass both locally generated runoff and, potentially, contributions from neighbouring regions. However, the precise distribution between these sources can be intricate and may change over time.

### *Dependency ratio*

**Armenia's water resources are significantly influenced by transboundary waters, which face mounting pressures due to human activities.** A substantial portion, around 30-35%, of Armenia's surface water flows originate from neighbouring countries (FAO, 2022; Armenian Water Resources Report, 2019). This proportion can vary depending on the specific river basins, with some experiencing a more significant dependence on transboundary flows. Over time, both local and transboundary water flows in Armenia have seen reductions, potentially due to regional climate changes and intensified human activities in upstream countries (Armenian Water Resources Report, 2019).

**The country's largest rivers are transboundary water bodies with high regional importance for agriculture and the energy sector.** One illustrative example is the Aras River, which flows along Armenia's western border before entering Azerbaijan and further into the Caspian Sea. The Aras River plays a crucial role in supporting agriculture, industry, and communities in Armenia, Azerbaijan, and Iran. However, it is subject to variations in flow due to activities upstream in Turkey and Iran, including dam construction and water diversion for irrigation and hydropower generation. These actions have the potential to impact Armenia's water availability, agricultural practices, and overall water security.

Similarly, the Vorotan River, originating in the Vayots Dzor Province of Armenia, flows through Azerbaijan and then into Iran. It is a critical water source for both Armenia and its neighbouring countries. The construction of dams and reservoirs upstream, especially in Azerbaijan, has the potential to affect water availability downstream in Armenia, which relies on the Vorotan River for agricultural irrigation and electricity generation.

### *Interannual and seasonal water variability*

**Armenia experiences moderate interannual variability along with a notable seasonal variability in its water availability.** Despite its diverse topography and distinct regional climate characteristics, Armenia's climate tends to be relatively warm and dry during the summers, and cold and even drier throughout the winters, typically spanning from December to February. During this winter period, the precipitation received is often less than 60% of the annual average (World Bank, 2023). This significant difference in precipitation between seasons contributes to a substantial level of seasonal variability.

Moreover, the extent of this seasonal variability tends to rise as one moves from the southern to the northern regions of Armenia. In the northern areas, the coefficients of variation—representing the distinction between months with the highest and lowest water availability—are particularly elevated (as illustrated in Figure 10). This demonstrates that the variance in water availability between the wettest and driest periods is most prominent in the northern parts of the country.

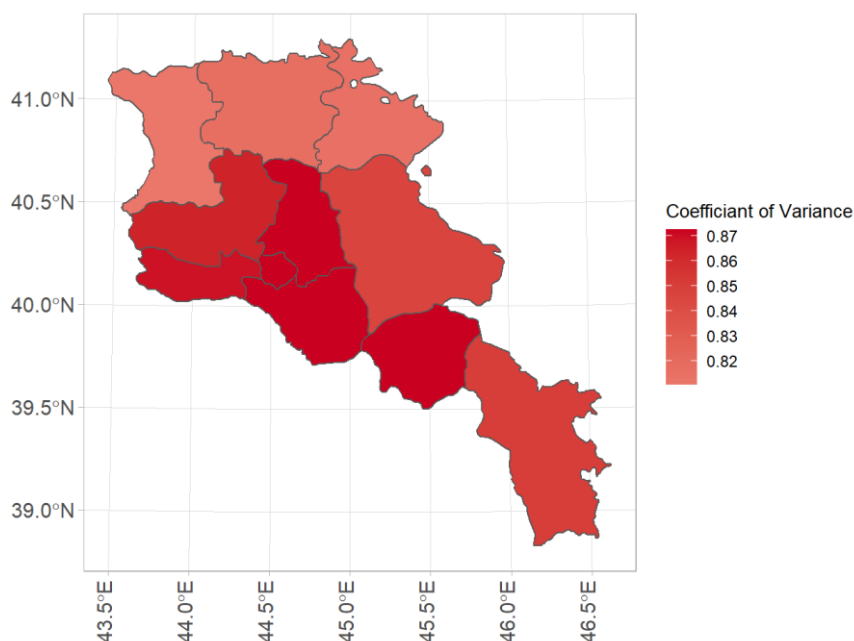


Figure 7: Spatial variation of seasonal variability of water availability across states in Armenia. Source: Gassert et al. (2014).

### Water quality

#### **Water quality in Armenia is generally moderate and comparable to the regional average.**

When assessing water quality in Armenia, it is essential to consider both drinking water and ambient water quality. Regarding drinking water quality, it is typically evaluated by measuring the number of age-standardized disability-adjusted life-years lost per 100,000 individuals (DALY rate) due to exposure to unsafe drinking water. A score of 100 indicates that a country has one of the lowest DALY rates globally ( $\leq 5$ th-percentile), while a score of 0 suggests that a country falls among the highest DALY rates ( $\geq 95$ th-percentile). Armenia falls within the medium range with a score of, for instance, 58.3, which is akin to the regional average (Environmental Performance Index 2022). Ambient water quality in Armenia is assessed using the SDG indicator 6.3.2, which measures the proportion of water bodies with good ambient water quality. This indicator's scale ranges from 0 to 100, with Armenia achieving a score of 66%. This means that approximately 66% of the country's water bodies, which encompass rivers, lakes, and aquifers, exhibit a favourable status according to national and/or subnational water quality standards, as determined through measurements of global water quality parameters.

**Pollution of water bodies is a major environmental problem in Armenia.** Due to the lack of wastewater treatment plants and appropriate solid waste management, agricultural practises, and pollution from toxic chemicals, many water bodies are contaminated. The poor state of the water supply networks and insufficient water treatment increases the risk of potable water contamination. In addition, it is common practice to use grey water for irrigation.

### 2.1.2 Demand

#### *Water withdrawals per source of water*

**Armenia's water withdrawal is high and unevenly distributed across the country.** Armenia's current water withdrawals of 919 m<sup>3</sup>/capita/year. The total water withdrawal is approximately 2.72 billion m<sup>3</sup>/year.

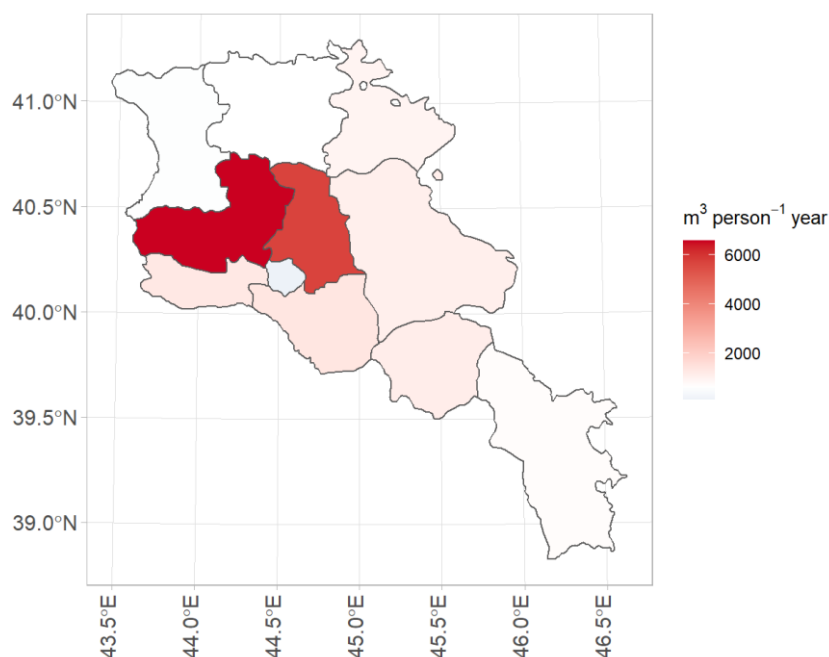


Figure 8: Water withdrawal per capita in Armenia at the county level. Source: Gassert et al., (2014)

**Groundwater plays a crucial role in Armenia's water supply systems.** It serves primarily for drinking purposes but is also utilized in various industrial processes. Despite its significance, Armenia has not fully harnessed the potential of its groundwater resources. According to a report by the OECD (2016), Armenia possesses a total of 437 aquifers suitable for drinking purposes, yet only 295 of them are actively utilized for commercial purposes. This underutilization of groundwater resources is notable, as it affects the country's overall water supply. The data from the same report indicates that Armenia's average daily groundwater extraction stands at approximately 1.5 million cubic meters, accounting for only 28% of the available groundwater reserves. This implies that a significant portion of Armenia's groundwater remains untapped, highlighting the need for more efficient utilization and management of this vital resource. Moreover, the distribution of groundwater availability and demand within Armenia is uneven. In some regions, particularly in the southern and eastern parts of the country, groundwater extraction rates remain considerably below their sustainable levels, except in the Ararat Valley, where groundwater overextraction is a serious problem with consequences for the overall groundwater availability. In the northern, western, and central regions, there is a growing concern about groundwater shortages due to higher demand and overextraction. Efforts to address these disparities and promote sustainable groundwater management are essential for ensuring a stable and reliable water supply across Armenia. It is crucial for policymakers and water resource authorities to prioritize the responsible and equitable utilization of groundwater to meet the diverse needs of the country while safeguarding this invaluable resource for future generations.

### **Sectoral water withdrawals**

**Agriculture:** Agriculture is the largest consumer of water resources in Armenia, accounting for a significant portion of water withdrawals. This includes irrigation for crops, orchards, and vineyards, as well as watering livestock. The efficient use of water in agriculture has been a priority for the Armenian government due to water scarcity concerns.

**Municipal and Domestic Use:** Water withdrawals for municipal and domestic purposes, including drinking water supply and household use, are also significant. Urban and rural areas depend on these water sources for their daily needs.

**Industry:** The industrial sector in Armenia also relies on water for various processes, such as manufacturing, energy production, and mining. Industrial water use can vary depending on economic activity and industrial development in different regions.

**Hydropower Generation:** Armenia has a substantial hydropower generation capacity, and water withdrawals for energy production through hydropower are essential. Hydropower is one of the key sources of electricity in the country.

## 2.2 Architecture

The architecture of the water sector in Armenia is assessed by looking at the institutional set up and regulatory framework and the availability and status of the infrastructure for key uses (water supply and sanitation and irrigation). Figure 9 displays the results of the indicators used for assessing the status of the water infrastructure. The institutional and regulatory framework will be assessed qualitatively but not benchmarked. As described in Section 2.1, the higher the score, the better is the country performing against the specific indicator.

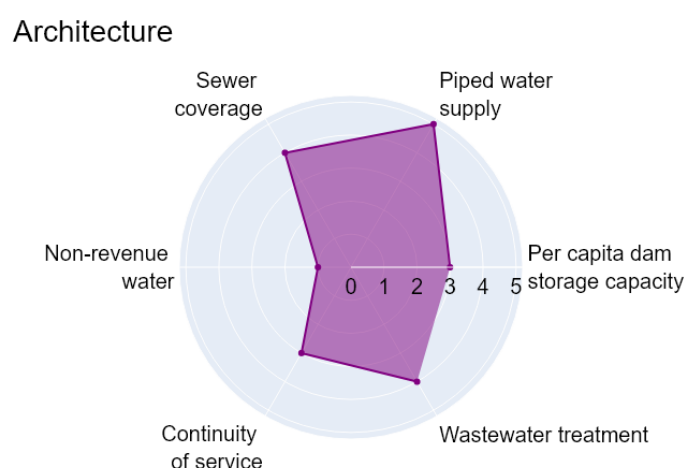


Figure 9: Status of the water sector architecture in Armenia

### 2.2.1 Regulatory framework and institutions

#### *Institutional arrangement, roles, and responsibilities*

**The institutional set-up in the water sector is relatively clear and not as fragmented as in other countries in the ECA region with four main institutions on the national level.** Nevertheless, there are ongoing discussions on how different challenges in the water sector can be improved, especially with regard to improved efficiency in service delivery and sustainability. The **Ministry of Environment** and the **Ministry of Territorial Administration and Infrastructure** are the two ministries responsible for the water sector in Armenia. The Ministry of Environment of Armenia is primarily responsible for environmental policies and regulations, including those related to water resource management, water quality, and environmental protection. The Ministry of Territorial Administration and Infrastructure has a role in overseeing and managing the country's infrastructure, which includes water supply and sanitation, as well as irrigation infrastructure and hydropower plants. It is also involved in planning and implementing water-related projects. Under this ministry the **State Committee of Water Resources** in Armenia operates as government agency responsible for the management and regulation of water infrastructure in the country.

**The Public Services Regulatory Commission (PSRC) of Armenia, under the jurisdiction of the Government of Armenia, operates independently as a regulatory authority.** PSRC is responsible for regulating various public services in Armenia, including energy, water supply, and sanitation services, among others. It sets tariffs, monitors service quality, and ensures compliance with regulations in these sectors. **The institution responsible for water quality in Armenia is the Environmental Protection and Mining Inspection Body.** This body is responsible for monitoring and enforcing environmental regulations, including those related to water quality and pollution control. This body operates independently as a regulatory authority overseeing environmental matters. To resolve disputes related to water use permits Armenia established a **Dispute Resolution Commission.**

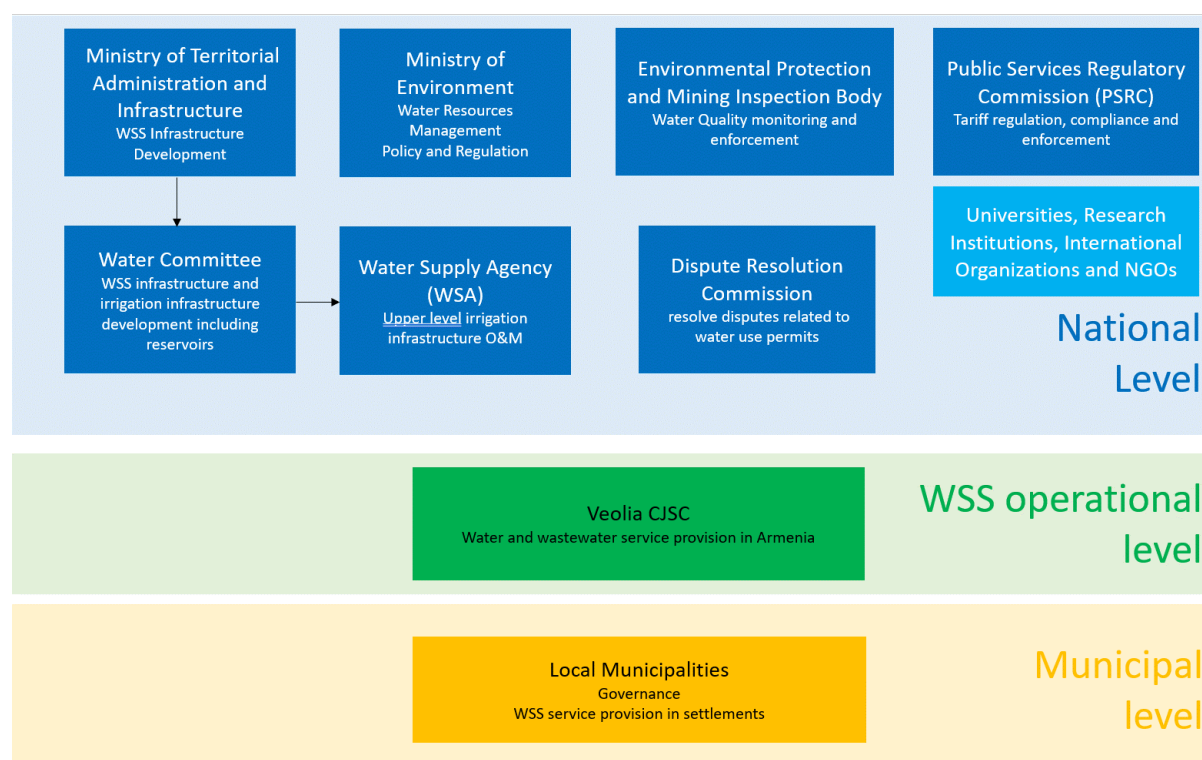


Figure 10: Sector institutions at national, regional, and local level in the Republic of Armenia

**Veolia CJSC is Armenia's water supply and wastewater service provider.** Under the management contract, the company manages drinking water production and distribution and the country's wastewater treatment facilities including the capital city Yerevan. Veolia's contract specifies that it shall develop and improve the efficiency of the country's water supply network. The goal is to provide quality and ongoing service for around 73% of the population of Armenia by Veolia Group. The remaining settlements of the country are served by local municipalities.

**Water User Associations (WUAs) are local organizations established to facilitate community participation in and irrigation.** The fifteen existing associations facilitate the participation of water users, including farmers and landowners, in the management and distribution of irrigation water and play a significant role in the efficient use of water resources at the local level. WUAs can be responsible for allocating water resources among their member users, operation and maintenance of irrigation infrastructure, collection of water service fees, and conflict resolution among others. WUAs are an essential component of Armenia's efforts to improve water resource management.

and promote sustainable agriculture practices while involving water users in the decision-making process.

### *Legal framework*

**The Water Code of the Republic of Armenia is the primary legal framework governing water management in the country.** The purpose of the Water Code is the protection of the national water reserve, usable water resources meeting the demands of citizens and the economy through effective and comprehensive management, ensuring the ecological stability of the environment, as well as provide the legal basis to achieve the objectives of this Code. The Law consists of 17 Chapters composed of 121 articles and was amended in July 2022. The main principles of this legal document are:

1. Satisfaction of the basic vital needs of the present and future generations;
2. Maintenance and increase of volumes of the national water reserve;
3. Protection of aquatic and related ecosystems and their biological diversity as well as recognition of integrated and interconnected relations of land, air, water and biological diversity;
4. Water use shall be regulated through water use permits.

Under the Law on Making Amendments and Supplements to the RA Water Code, legal relationships in the sanitation sector are fully regulated, as well as the types of wastewater and drainage systems and the requirements for wastewater discharge, treatment and monitoring are defined. This law is in force since January 2020.

**The Law on Water Users Associations and Federations of Water Users Associations defines their operational basis.** The establishment and termination of irrigation systems, as well as the principles for relations with state bodies, are aimed at increasing the operational efficiency of the irrigation systems of the Republic of Armenia. The Association and Federation are non-profit legal entities that operate in the public interest to carry out the operation and maintenance of irrigation systems.

**The Law on Fundamental Provisions of the National Water Policy is a long-term development concept for the strategic use and maintenance of water resources and water systems.** The purpose of this law is to ensure the availability and accessibility of water resources necessary for human well-being, for the development of the country's socioeconomic system and satisfaction of the economic and ecological needs in the present and future.

**There are several other legal documents such as Ministerial Decrees or Government Decisions completing the legal framework of Armenia's water sector.**

## **2.2.2 Infrastructure**

### *Water supply and sanitation*

**Armenia's water supply and wastewater treatment systems are still outdated and require substantial investments.** The high level of non-revenue water of approx. 75% can be considered a major issue within the water supply sector. According to the Joint Monitoring Program of the WHO the total water supply coverage by improved facilities is with 99% very high. On the other hand the coverage of sanitation services by improved facilities especially in rural areas are significantly lower than for drinking water supply. While in urban areas 96% have access to improved sanitation facilities, half of the rural population use unimproved facilities. This results in a total sanitation coverage by sewer facilities of 71%. The connection rate of sewer systems to treatment plants is with 52% medium high. In total, 571 rural settlements do not have regular access to water supply and sanitation services.

**Armenia had received financial support and assistance from various international organizations and donors to support the rehabilitation and improvement of water supply infrastructure.** Some of the organizations that are or have been involved in recent years in providing

financial support and assistance to Armenia's water sector include The World Bank, the European Bank for Reconstruction and Development (EBRD) the European Union (EU), the Asian Development Bank (ADB), Kreditanstalt für Wiederaufbau (KfW) and bilateral aid agencies.

### *Irrigation, reservoir storage and hydropower*

#### **Armenia's irrigation infrastructure is aging and in need of maintenance and modernization.**

The country has a network of irrigation infrastructure, including canals, pipelines, and reservoirs, designed to support agricultural activities, but water efficiency and distribution is a challenge. On the other hand, efforts are underway to improve irrigation practices and infrastructure to increase water use efficiency and promote sustainable agriculture. According to FAO's AQUASTAT (2020) the share of cultivated land under irrigation is 19,3%. More than 90% of the Country's irrigation systems is flood irrigation and less than 1% drip irrigation. But Armenia makes efforts to increase drip irrigation.

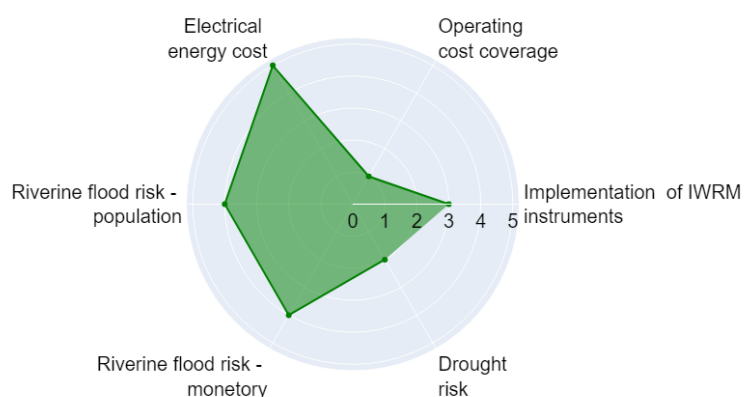
#### **Armenia has 87 reservoirs and dams, which serve various purposes, including irrigation, water supply, and hydropower generation.**

The most significant reservoir in Armenia is Lake Sevan, which is the largest freshwater lake in the South Caucasus. It serves multiple purposes, including water supply, fisheries, and recreation. Reservoirs are crucial for regulating water supply, especially in arid and semi-arid regions, and for mitigating the impacts of droughts and floods. According to FAO's AQUASTAT (2020) the storage capacity per inhabitant is 470 m<sup>3</sup>. Other countries in the Caucasus region have a significant higher dam storage capacity per capita (Georgia 850 m<sup>3</sup>, Azerbaijan 2,190 m<sup>3</sup>) than Armenia. In Central Asian countries such as Kazakhstan, Kyrgyzstan and Tajikistan, the per capita storage capacity is even higher at 3,000 to more than 4,000 m<sup>3</sup>.

**Armenia has developed a substantial hydropower sector due to its mountainous terrain and abundant water resources.** Hydropower plants (HPPs) of various sizes exist throughout the country, generating a significant portion of Armenia's electricity. The hydropower sector has been a focus of renewable energy development, contributing to Armenia's energy mix and reducing its reliance on fossil fuels.

## **2.3 Performance**

The performance of the water sector in Armenia is assessed under three categories: water resources management, management of water risk, and service delivery. The results of the indicator assessment for water sector performance are provided in Figure 11.



*Figure 11: Results of indicator assessment regarding Armenia's water sector performance.*

### 2.3.1 Water Resources Management

#### *Strategic Planning*

**In the last two decades, Armenia has achieved significant legislative and institutional reforms in terms of water resources management and protection.** These measures establish the principles and mechanisms needed to implement integrated water resources management (IWRM) in the country. In general, these laws are comprehensive in scope and serve as a strong foundation for planning and management in the water sector (see also section 2.2.1.). The National Water Programme was the main instrument for the development of water resources, but it expired in 2020. Currently, the country Armenia has no overarching water resources management strategy, no irrigation strategy and no WSS strategy. With the absence of these documents, the guidance of future areas of development and analysis is missing in the country.

#### *Operational Planning*

**Armenia has established river basin management plans for its major river basins.** Under the EU and Armenia Comprehensive and Enhanced Partnership Agreement, delineating the river basin districts and developing the river basin management plans is one of the key activities in Armenia to ensure the integrated water resources management as approximation towards the EU WFD practices and implementation. Armenia holds two major river basins; Kura and Araks (Aras) discharging to Caspian Sea via Kura and Araks (Aras) rivers crossing Turkey, Georgia, Azerbaijan, and Iran. The country holds Sevan Lake as endoreic basin. Armenia manages its water resources within six management areas, namely Akhuryan, Ararat, Hrazdan, Northern, Sevan and Hrazdan basins. The river basin management plans for Ararat, Akhuryan and Southern basins were already adopted by the Government of Armenia. The Sevan and Hrazdan basin management plans are in the stage of development.

**Historically, the management of water resources in the South Caucasus region, has been a complex and sensitive issue, primarily due to political conflicts and disputes over shared rivers and water resources.** The most significant shared water resource between Armenia and Azerbaijan is the Aras River, which forms part of their international border. The status of cooperation in the water sector between Armenia and Azerbaijan has been influenced by the Nagorno-Karabakh conflict and the broader political tensions in the region. There are limited formal mechanisms for water resource management cooperation between the two countries due to these political challenges. However, there have been efforts by international organizations, to facilitate dialogue and cooperation on water-related issues in the region. These efforts aimed to promote the peaceful and equitable management of shared water resources and mitigate potential conflicts over water use.

### 2.3.2 Management of Water Risks

#### *Flood Risk*

**Around 40,000 people are affected by flooding each year costing around \$100 million<sup>3</sup>.** Looking at the average annual hazard occurrence in Armenia in the last four decades, almost a quarter of all natural disasters (earthquakes, storms, droughts, landslides, floods etc.) have been flood events. This places the country at global level on a moderate level of risks to floods. Armenia's mountainous terrain can exacerbate flood risks. Rainfall or snowmelt in higher elevations can lead to the rapid accumulation of water downstream, causing flash floods and landslides. Around 4.1% of the country's area is exposed to landslide risk, and almost one third of its communities.

---

<sup>3</sup> According to the global dataset of AQUEDUCT (Hofste et al., 2019), annually an average of 0.98% of population in Armenia are affected by floods, while losses over a 100-year return period are equivalent to 0.98% of GDP.

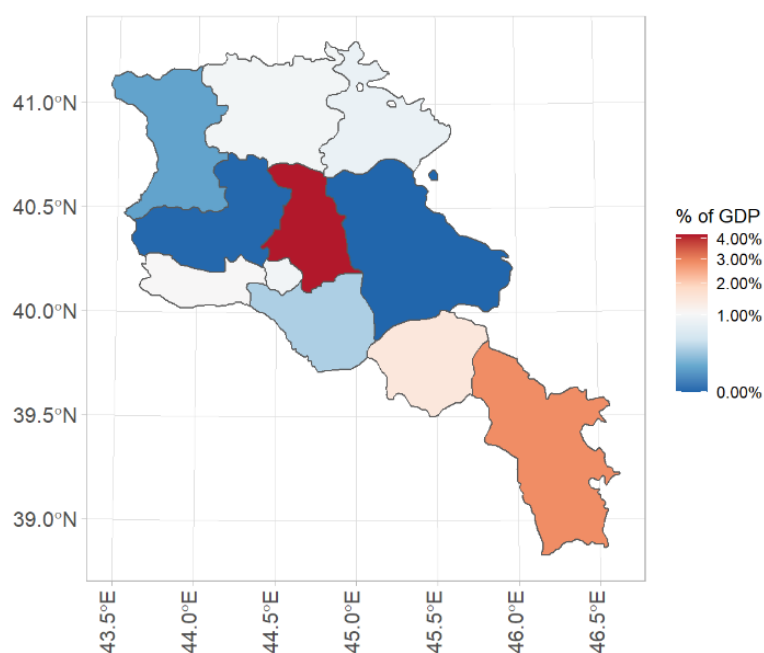


Figure 12: Riverine flood risk measured as damage experienced as a percentage of GDP in an average year in Armenia. Source: Hofste et al. (2019)

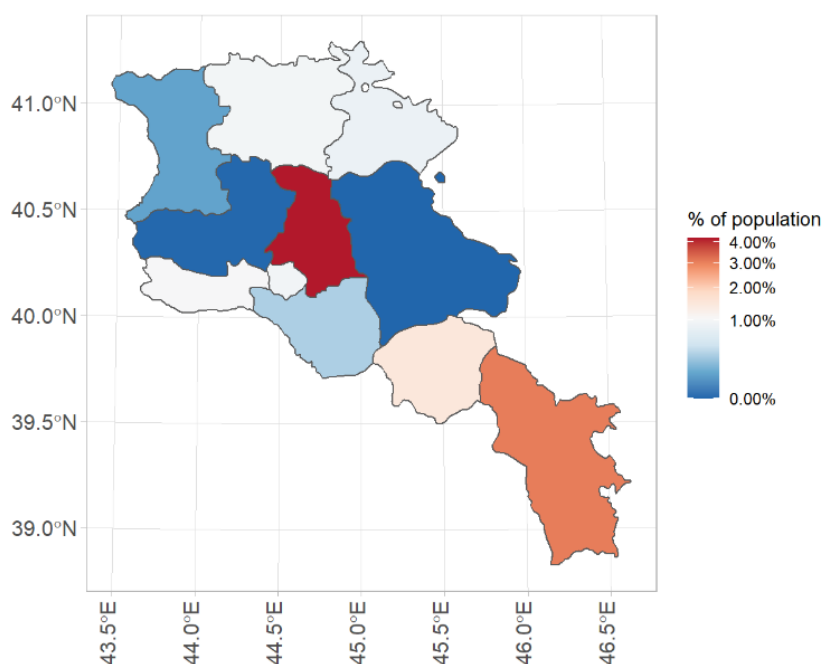


Figure 13: Riverine flood risk measured as percentage of population affected in Armenia. Source: Hofste et al. (2019)

### Drought Risk

**The average drought risk in Armenia is rated “Low-Medium”, but large areas of Armenia face drought risk.** Armenia's climate is characterized by dry summers and relatively low annual

precipitation. This makes the country inherently vulnerable to drought, particularly during the warm and dry summer months. Drought can have severe consequences for agriculture, which is a vital sector of Armenia's economy. Insufficient rainfall and soil moisture deficits can lead to reduced crop yields, livestock water shortages, and food security concerns. To address drought risk, Armenia has implemented various measures, including improved water management practices, the development of drought monitoring and early warning systems, and efforts to enhance water use efficiency in agriculture.

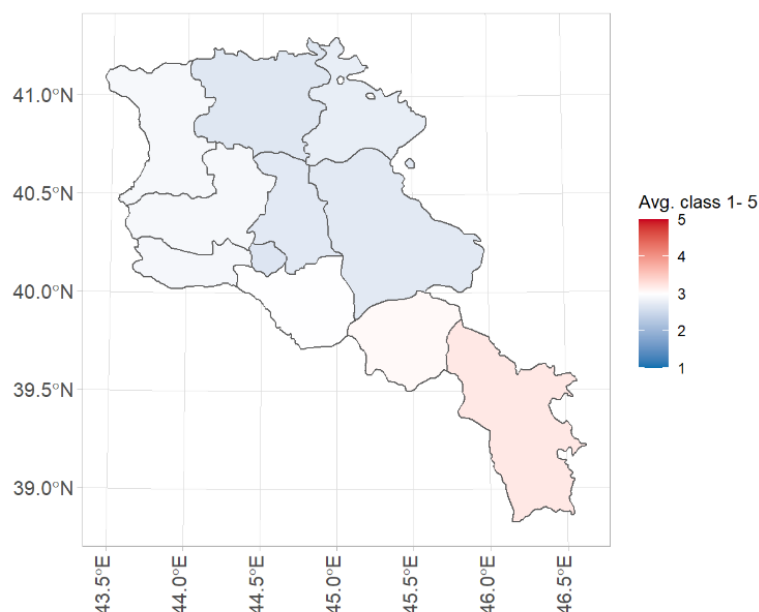


Figure 14: Drought risk in Armenia. Source: Hofste et al. (2019)

### 2.3.2 Service delivery

**Armenia's water sector faces challenges related to aging infrastructure, efficiency, and equitable access, with ongoing efforts to improve sustainability and quality.** Armenia's water supply infrastructure, particularly in some older urban areas, includes deteriorating infrastructural assets. The condition of the water supply and sanitation infrastructure can vary widely, but many systems are in need of rehabilitation and modernization. The maintenance and investment in water supply infrastructure have been ongoing challenges. Adequate funding for maintenance and infrastructure improvements is lacking, leading to high water losses through leaks and inefficient distribution (NRW >70%). The average continuity of service of drinking water is 22 hours per day nationally. In reality there are frequent occurrences of interrupted supplies in some specific rural areas, especially during periods of high demand or infrastructure issues. This accounts for much of the 2 hour average interruptions noted. In urban areas, water supply infrastructure is generally better developed and maintained compared to rural areas, where access to safe and reliable water supply services can be limited, and infrastructure may be less robust. Efforts to involve local communities in the management of water supply systems have been made to improve infrastructure maintenance and service quality at the local level.

**On average water tariffs are not sufficient to support costs recovery.** According to IBNET, operational costs, on average, are not covered by the tariff (operating cost coverage ratio with 0.71% rated "low"). The electrical energy costs make a relatively small proportion of the total operational costs (8% and thus rated "high"). These figures are based on the utility reports of the few utilities in the frame of IBNET. The above figures are hence only partially representative. To ensure equity in service provision, clear investment priorities and a strategy to ensure quality of service provision for all systems,

be it utility-managed or not, is needed. Irrigation tariffs should also be adjusted to ensure sustainable operation and adequate maintenance of the infrastructure. The low tariffs are a significant factor for the deterioration of Armenia's irrigation systems. Considering the electricity costs for irrigation systems, these can account for up to 70 % of the total operating costs.

## 2.4 Outcomes

This section summarizes the analysis of the benefits derived from water and its use in Armenia. Benefits are measures in terms of social, economic and environmental outcomes. As with other dimensions, the higher the score, the better is the country performing on that particular aspect or indicator. Figure 15 describes the indicator performance across the different outcomes.

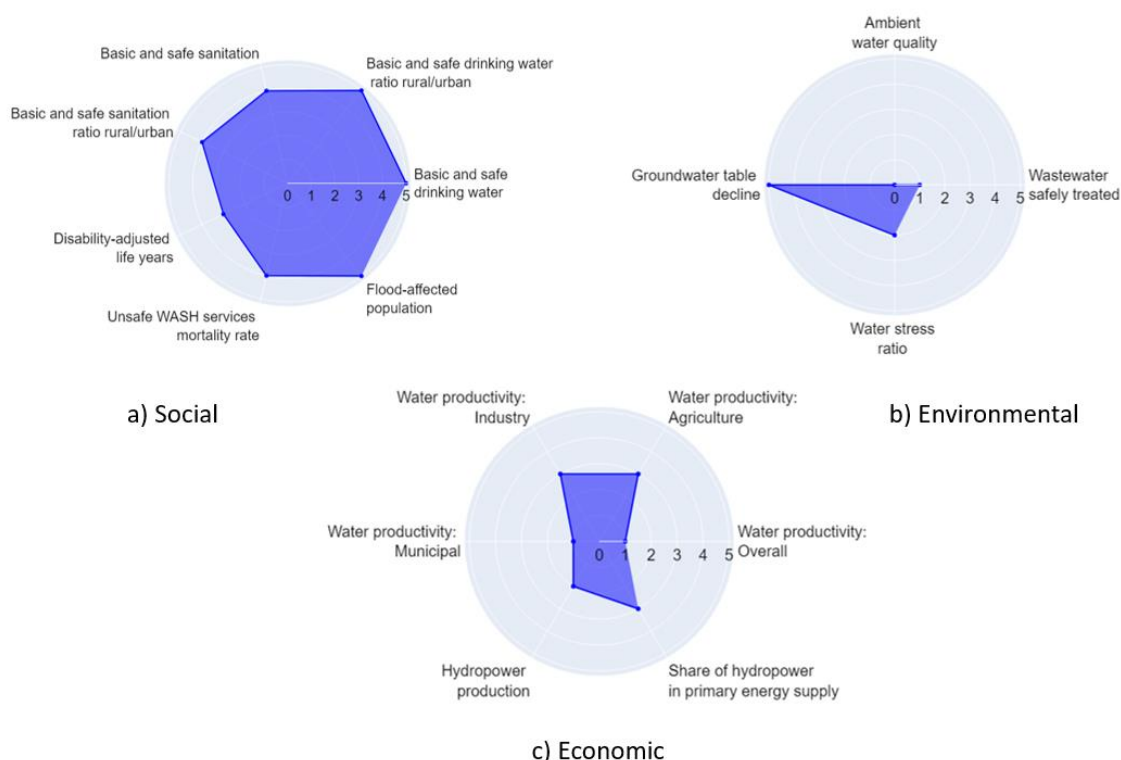


Figure 15: Results of indicator assessment regarding Armenia's water sector outcomes

### 2.4.1 Social outcomes

#### *Supply of drinking water and sanitation services*

**As of 2022, almost 100% of the population in Armenia had access to basic or safely managed drinking water sources.** Specifically, 82.4% has access to safely managed and 17.6% remain with basic service. But there is a slight trend in the last 15 years towards a lower proportion of safely managed services (-0.8% since 2008). Safely managed drinking water services are significantly lower in rural areas with 62.2%.

**As of 2022, 93% of the population in Armenia had access to at least basic sanitation services.** But only 10.75% has access to safely managed sanitation services highlighting the importance of prioritizing efforts in the rural areas. In rural areas, only 16% have unimproved or even limited sanitation facilities.

#### *Health and safety*

**Armenia performs relatively well in terms of health consequences of insufficient water supply and sanitation services.** The number of DALYs ("disability adjusted life years") due to unsafe water, sanitation and handwashing is with 128 DALYs/100,000 inhabitants, a value in range with the middle range for the ECA countries (medium ranges between 75-150 DALYs/100,000 inhabitants). The mortality rate attributable to unsafe WASH services is with 0.18 people/100,000 inhabitants, which is well below the middle range of ECA countries (0.5-1 people/100,000 inhabitants).

## 2.4.2 Environmental outcomes

The results of the indicator assessments for environmental outcomes are provided in Figure 15.

### *Water quality and ecological status*

**Armenia has not reported information about the proportion of water bodies with good ambient water quality for Armenia** (SDG indicator 6.3.2). Lake Sevan is the largest freshwater lake in the South Caucasus and a critical water resource for Armenia. Water quality in Lake Sevan has been a concern, with challenges related to eutrophication (excessive nutrient enrichment) and invasive species. But the country been made to address these issues, including water quality monitoring, habitat restoration, and the prevention of further deterioration. Only 40% of the wastewater is safely treated, due to the lack of wastewater treatment plants and a high percentage of basic sanitation services in rural areas without connection to a sewer system or adequate faecal sludge management.

### *Water stress*

**Armenia currently faces a high level of water stress overall.** The water stress ratio of withdrawals to supply is according to the global dataset of AQUEDUCT (Hofste et al., 2019) at 57.8%. Water stress might increase in future due to climate change. Agriculture is a significant water user in Armenia, and it accounts with 70% for a substantial portion of the country's water consumption. Ensuring a consistent and sufficient water supply for agricultural needs is crucial for food production. Armenia's climate is characterized by relatively low annual precipitation and a dry summer season. During the dry summer months water resources become scarcer.

## 2.4.3 Economic outcomes

**Armenia is considered as a upper-middle income<sup>4</sup> economy.** Armenia's economic growth is based on different sectors including information technology (IT) and high-tech industries, agriculture, tourism, mining and energy. The energy sector, including electricity generation and distribution, has been an important contributor to the economy. Armenia has hydropower resources and is developing renewable energy sources.

**The overall economic water productivity in Armenia is low.** "Economic water productivity" measures the efficiency with which water is used in the economy at national level and is shown in USD per m<sup>3</sup> of water extracted. Armenia's overall water productivity is about USD 3.2/m<sup>3</sup>, and below the average of other countries in the Caucasus Region ( $\approx$  USD 4-5/m<sup>3</sup>). Armenia should find ways to further leverage its sufficient water resources. The country's municipal water productivity is USD 9.7/m<sup>3</sup>, productivity of the industry sector is about USD 19.1/m<sup>3</sup> and for agriculture USD 0.22/m<sup>3</sup>. The agricultural sector has very low water productivity due to the cultivation of water intensive crops. High-value crops like fruits and vegetables often require more irrigation.

**The agricultural sector in Armenia is economically very important.** In 2022, the agricultural sector contributed almost 12% to GDP. Agriculture is a vital source of employment in Armenia,

---

<sup>4</sup> The classification of a country's income level is based on its Gross National Income (GNI) per capita, and Armenia falls within the lower-middle-income category according to World Bank criteria.

particularly in rural areas. It provides livelihoods for a substantial portion of the population, including farmers, agricultural laborers, and those involved in related industries such as food processing. Armenia has a rich agricultural heritage, with traditional practices in grape cultivation, wine production, and agriculture deeply ingrained in the country's culture and history.

**Hydropower is one of the primary sources of electricity generation in Armenia.** It contributes significantly to the country's energy supply, providing a substantial portion of the electricity consumed domestically. Armenia's hydropower infrastructure includes a mix of small, medium, and large hydropower plants (HPPs). Small and medium-sized HPPs are distributed throughout the country, while larger HPPs are situated on major rivers and reservoirs. Armenia's surplus hydropower capacity allows the country to export electricity to neighbouring countries, particularly to Georgia and Iran. These cross-border energy exports contribute to revenue generation.

#### *Water-related risks and economic costs*

**Armenia faces medium risk from riverine floods affecting a large number of inhabitants and causing significant economic losses.** The annual average population affected by flooding is about 1% of the total population. And the average annual affected GDP is about 100 million USD which is about 1% of the annual GDP.

**Currently, Armenia experiences an estimated 3% annual probability of severe meteorological drought.** Agriculture is highly vulnerable to drought, and crop yields can be significantly reduced during prolonged dry spells. Armenia relies on hydropower for electricity generation. Drought can lead to lower river flows, reducing the capacity of hydropower plants and necessitating increased reliance on more expensive energy sources. The economic costs of droughts can vary by region. Typically, the southern and southeastern regions of Armenia, which are more arid, are more susceptible to drought impacts.

## 3 Future Trajectories

This section provides quantitative projections for several indicators representing selected water security dimensions described earlier. The following indicators with future projections include renewable water availability, total water demand, water stress, and flood risk.

### 3.1 Future climate and socioeconomic scenarios

**The Intergovernmental Panel on Climate Change (IPCC), a United Nations organization tasked with advancing knowledge on climate change, uses a collection of climate and socio-economic projections for modelling and research.** The climate/emission scenarios, the Representative Concentration Pathways (RCPs), are four projections of how concentrations of greenhouse gases in the atmosphere will change due to human activities. The four RCPs (i.e., RCP2.6, RCP4.5, RCP6.0, and RCP8.5) range from low future concentrations (RCP2.6) to high (RCP8.5). In this assessment, three RCPs are considered, and for simplification, these are referred to as low (RCP2.6), medium (RCP4.5) and high (RCP8.5) emission scenarios. For each RCP, we used the projections of five climate models: GFDL-ESM4, IPSL-CM6A-LR, MPI-ESM1-2-HR, MRI-ESM2-0, and UKESM1-0-LL6F6F<sup>5</sup>. Climate models provide projections of climate conditions (e.g., temperature, precipitation) under the various RCP scenarios.

**The socioeconomic scenarios, the Shared Socioeconomic Pathways (SSPs), are five narratives of development, cooperation, and priorities.** For example, SSP1 is called the Sustainability Path and imagines a world acknowledging environmental boundaries, increasing equality and education, economic growth motivated by human well-being, and decreasing the use of resources and energy. SSP5 is called Fossil-Fueled Development. Each of the SSPs is associated with quantitative projections of population and GDP (Jones et al., 2016), which drive the changes in water demand. Population and GDP per capita projections are translated into water demands following the methodology of Wada et al. (2011).

### 3.2 Projections of some water security indicators

#### 3.2.1 Water availability, water demand, and water stress

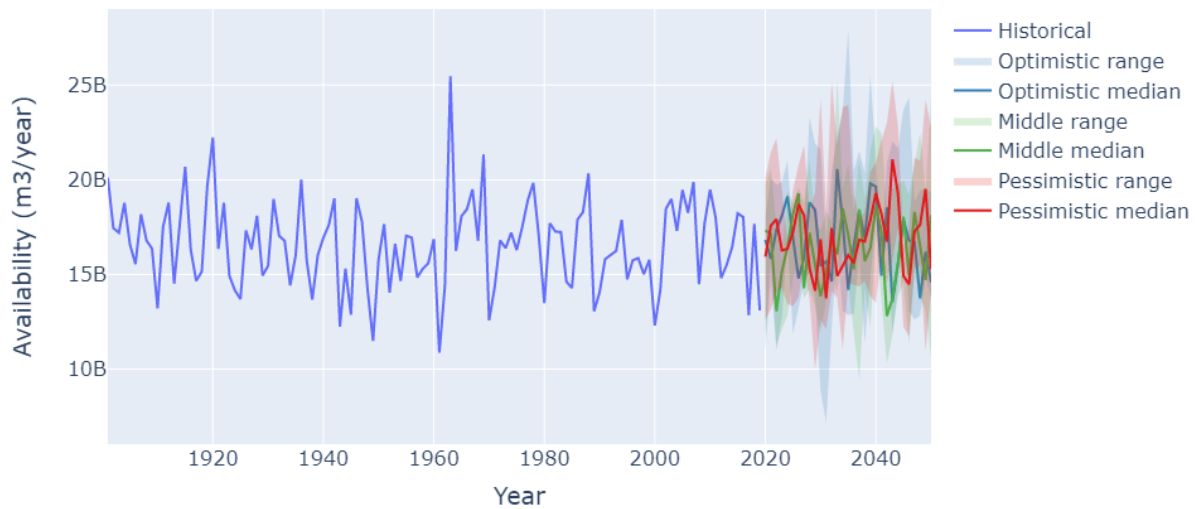
In this section, we provide future projections up to 2050 for some water security indicators, such as water availability and demand, under three climate and socio-economic scenario combinations to provide a range of possibilities. We refer to these combinations as Optimistic (combining SSP1 with RCP2.6), Middle (combining SSP3 with RCP7.0<sup>6</sup>), and Pessimistic (combining SSP5 with RCP8.5). The projections are the results of simulations conducted with the global hydrological models CWatM (Burek et al. 2020).

Figure 16 shows annual water availability in the historical period (1900-2020) and the future (2020-2050). Water availability annually experiences more extreme years, with examples of years that are wetter or drier than in the past. There is **no significant increasing or decreasing trend**, although extreme years may increase (Figure 16).

<sup>5</sup> The results of the climate models are taken from the ISIMIP project: <https://www.isimip.org/>

<sup>6</sup> Indicators related to flood risk use SSP2 with RCP4.5 for the Middle scenario.

## Armenia: Availability annually



## Armenia: Availability, annual statistics

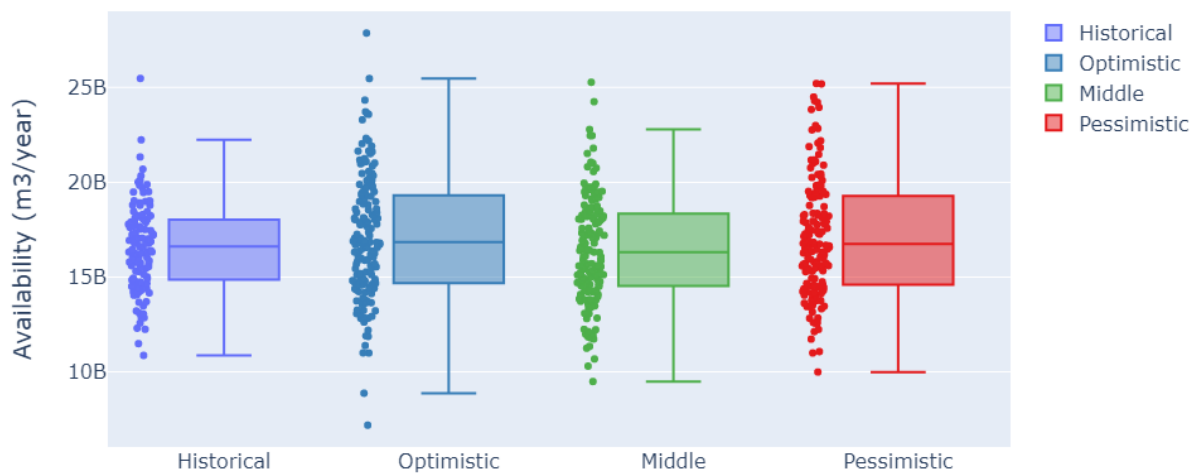


Figure 16: Annual water availability for historical and three future scenarios.

Top) Line graphs show the median of the five models for each scenario and the entire range as a shadow, Bottom) Box-whisker plots showing the data variance through quartiles – quartiles divide the data into four relatively equal sizes.

Figure 17 provides projections of total water demand by sector. These projections show that industrial and domestic demands increase or decrease slightly by 2050. It is important to mention that water demand projections do not consider potential changes in irrigated areas. Irrigated areas were kept fixed at the 2000 level for future projections. As a result of the projected changes in water availability and demand, water stress is projected to experience **steady or somewhat increasing water stress**. Projections show examples of significant experiences of water stress, up to double as compared to more regular years (Figure 18)

## Armenia: Demands annually

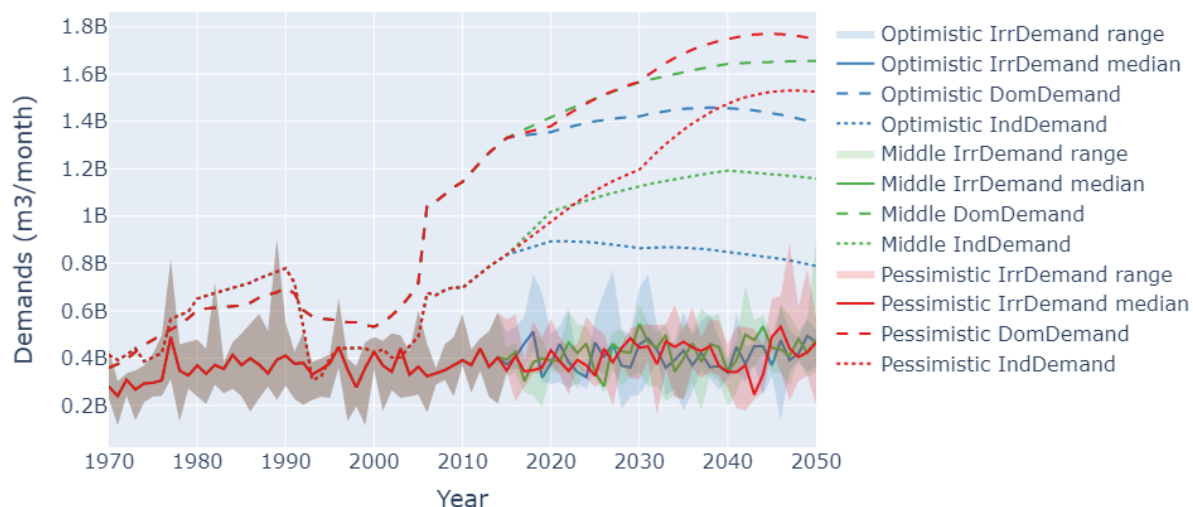


Figure 17: Sectoral demands for historical and future scenarios. Source: Burek et al. (2020)

## Armenia: Water stress annually

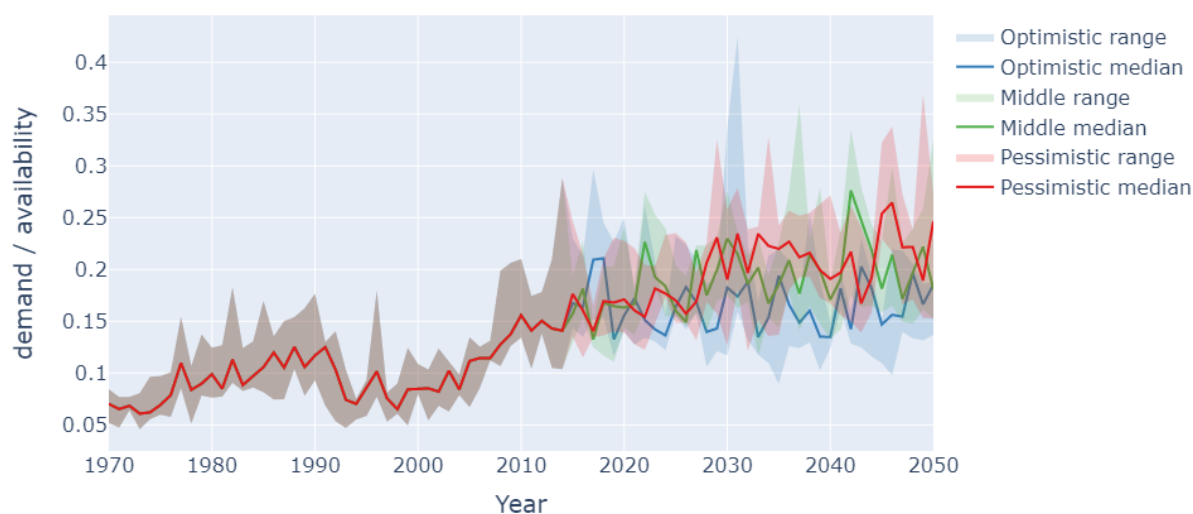


Figure 18: Annual water stress for historical and future scenarios. Source: Burek et al. (2020)

### 3.2.2 Flood risk

Flood risk due to climate change is expected to be similar or generally decrease. The most significant decreases are expected in Aragatsotn (~80% decrease; Figure 19), in terms of GDP relative to the baseline. However, future flood risk cannot only be considered through the lens of climate change. Flood risk is also, for a large part, dependent on several factors:

- The frequency and severity of the flood hazard. While the natural occurrence of floods is likely to increase, the actual occurrence also depends on the readiness of the flood defence system.
- The people/assets exposed in potentially affected areas. Here, the costs and benefits of further construction in at-risk areas must be carefully considered.
- The vulnerability of the people and assets when a flood occurs.

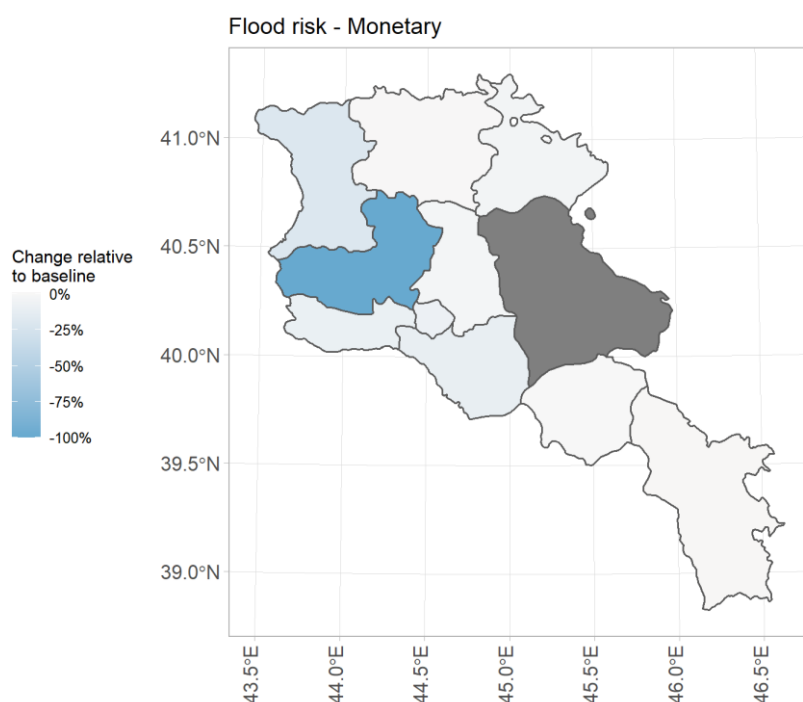


Figure 19: Flood risk in terms of relative change to baseline GDP for the year 2050 based on the Pessimistic scenario. Source: Hofste et al. (2019)

### 3.2.3 Drought risk

Like flood risk, drought risk is a complex combination of drought hazard, vulnerability and exposure, with many feedbacks between the components. Due to these complexities and uncertainties for future vulnerability and exposure, we limit the analysis to changes in drought hazards, mainly monthly precipitation (i.e., meteorological drought).

Based on a CMIP5 multi-model precipitation ensemble under RCP8.5 (see Figure 20), drought risk may increase gradually over the summer and early autumn over time. There are no clear trends during the winter, and the late spring (i.e., around May) shows mixed results. Overall, Armenia may expect reduced amount of precipitation. By 2100, the combination of precipitation and temperature anomalies (e.g., affecting evapo-transpiration) implies a large increase of drought hazard. The CMIP5 multi-model SPEI (Standardized Precipitation Evapotranspiration Index; see Figure 21) drought hazard index shows this increase in drought hazard, where the SPEI's negative values represent dryer conditions.

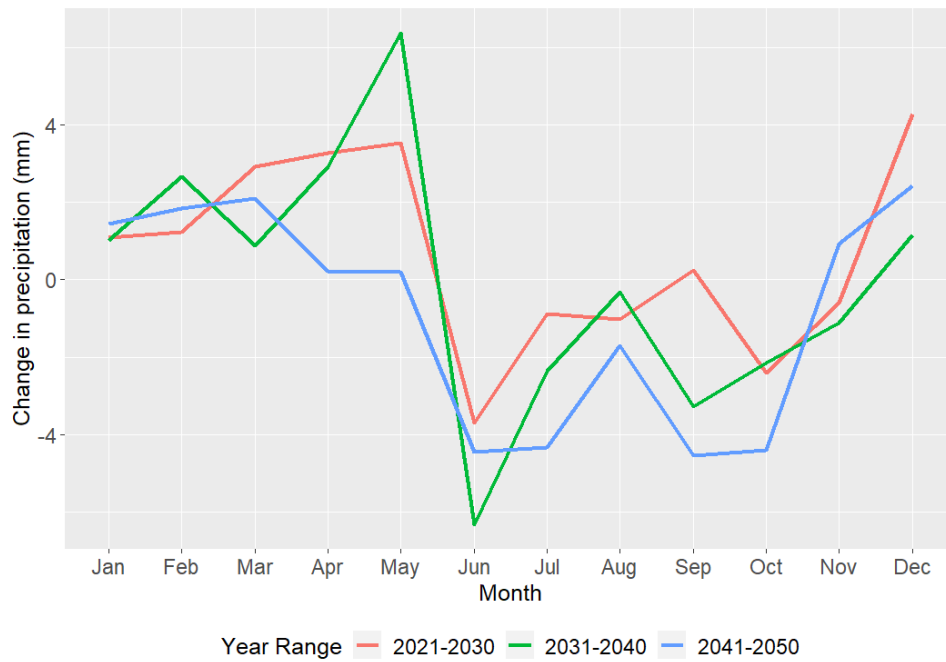


Figure 20: CMIP5 ensemble projected change in monthly precipitation (mm) relative to the 1986–2005 baseline under RCP8.5. (Source: World Bank, 2023)

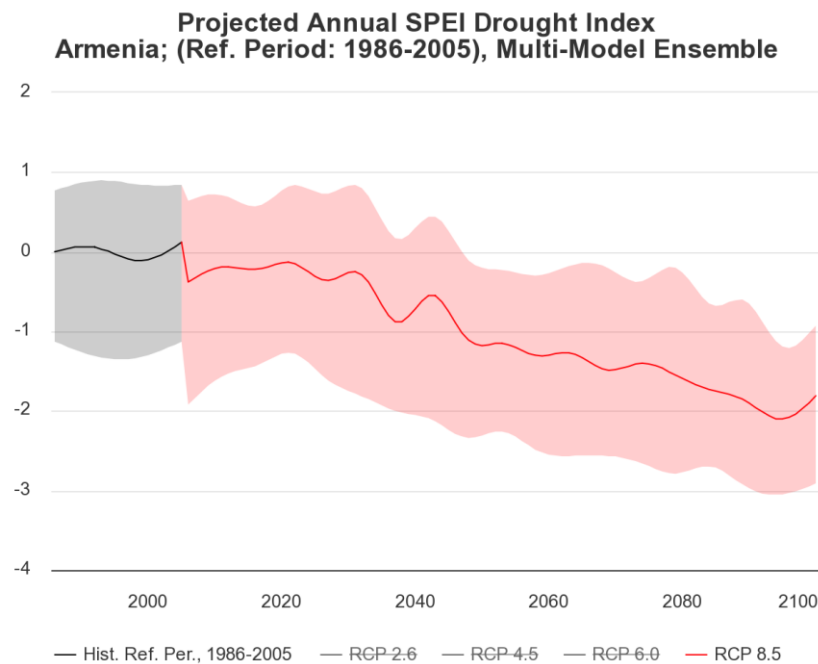


Figure 21: CMIP5 ensemble historical (1986 –2005) and projected drought risk (based on the SPE index) by 2100 under RCP8.5.

The line represents the median ensemble value, and the filled area represents the 10th and 90th percentiles. (Source: World Bank, 2023)

## 4 Country Narrative and priority actions to increase water security

This section summarizes the main elements emerging from the water security diagnosis, by focusing on the strengths, risks and opportunities Armenia is facing. This narrative is used as a basis for outlining several general recommendations that will help the country to become more water secure.

### Endowment

#### Availability and demands

**The increase of water efficiency is key for the sustainable use of water resources in Armenia.** Water shortages can occur, especially during the dry summer months. The partly outdated irrigation systems are often not very efficient, but irrigation is necessary for the agricultural sector. There are initiatives to introduce drip irrigation, but 90% of the systems are still flood irrigation systems and not well maintained. The irrigation sector faces high electrical costs for large scale pumping. Due to insufficient tariffs, pumping stations are not operated at their full capacity. Some large water bodies are transboundary. Despite the conflict with Azerbaijan, cooperation with all neighboring countries including Türkiye, Georgia and Iran is desirable.

#### Priority actions

- 1) Promote Water Efficiency and Conservation. Encourage the adoption of water-saving technologies and practices in agriculture, which is a major water user in the country. This includes the use of efficient irrigation methods, such as drip irrigation
- 2) Collaborate with neighboring countries on transboundary water management and regional initiatives to address shared water resources and potential climate-induced conflicts.
- 3) Research on the status and availability of groundwater and its recharge potential.
- 4) Upgrade and maintain water infrastructure, including reservoirs, irrigation systems, and pipelines, to ensure efficient storage, distribution, and supply of water.
- 5) Develop and implement an adequate tariff methodology for irrigation.

### Architecture

#### Institutions

**The institutional set-up in the water sector in Armenia is relatively well structured compared to other countries in the ECA region.** There are two ministries responsible for the water sector agendas, the Ministry of Environment and the Ministry of Territorial Administration and Infrastructure. In addition, there is an independent regulator at the national level, which is not subordinate to any ministry. On the other hand, the coordination between the ministries is insufficient. The Water Committee has limited capacities to manage the water infrastructure. The Water Supply Agency is understaffed and therefore not able to manage the irrigation systems adequately. As a result, the irrigation management of Armenia is at a bad state and needs to be improved. A special characteristic of Armenia is the role of Water User Associations (WUAs) carrying out the operation and maintenance of irrigation systems. WUAs are local organizations established to facilitate community participation in water resource management and irrigation.

**Priority actions**

- 1) Enhance collaboration and coordination among Armenia's key institutions including the Water Committee, the Environmental Protection and Mining Inspection Body, and the Public Services Regulatory Commission (PSRC) and the Ministry of Agriculture.
- 2) Strengthen the regulatory authority for effective and transparent regulation.
- 3) Capacity building and training for water sector professionals, including staff within government agencies, water utilities, and WUAs.

Regulatory framework**The Water Code as the primary legal framework governing water management in Armenia.**

It outlines the legal principles, rights, and responsibilities related to water resources, including allocation, protection, and pollution control has been amended in 2022.

**Improving the regulatory framework in Armenia's water sector is essential for ensuring fair and transparent regulation, protecting consumer interests, promoting investment, and fostering sustainable water resource management.** Reforms should be carried out in consultation with stakeholders, including government agencies, service providers, civil society organizations, and the public, to ensure broad support and effectiveness.

**Priority actions**

- 1) Review and update existing laws and regulations related to the water sector, ensuring they are clear, comprehensive, and aligned with international best practices.
- 2) Ensure the regulatory authority, the Public Services Regulatory Commission (PSRC), has autonomy in decision-making and is protected from undue influence.
- 3) Strengthen the regulatory authority's capacity for data collection, analysis, and monitoring to ensure effective oversight of service providers.
- 4) Develop and implement an adequate tariff methodology for WSS and irrigation.
- 5) Review and update of the existing (outdated) irrigation norms.

Infrastructure

**NRW of about 75% in Armenia is a serious problem in drinking water supply.** It is also a good indicator of the state of the supply systems. Many pipes and other crucial assets of the systems are outdated and are responsible for the high losses (leakages). Inadequate maintenance and lack of resources have exacerbated the problem. Adequate asset management is essential for water and energy efficiency.

**Priority actions**

- 1) Reduce NRW and increase water and energy efficiency of water utilities
- 2) Investing in the upgrade and maintenance of water supply infrastructure in urban areas and expand the coverage in the rural areas
- 3) Reduction of interruptions in water supply and increase the average continuity of service
- 4) Capacity building of utility staff at all levels

**Especially in rural areas, investments are needed to improve sanitation services.** The majority of the population has only basic sanitation facilities. Adequate on-site solutions and faecal sludge management in rural areas and the construction or rehabilitation of wastewater treatment plants in urban areas require high investments.

**Priority actions**

- 1) Secure investment to improve rural sanitation services and faecal sludge management in rural areas
- 2) Promote adequate on-site sanitation practices to increase the safely managed sanitation coverage
- 3) Secure investments for wastewater treatment plants and sewer systems

**Armenia's irrigation infrastructure is aging and in need of maintenance and modernization.**

Agriculture is a significant water user in Armenia, and it accounts with 70% for a substantial portion of the country's water consumption. More than 90% of the Country's irrigation systems is flood irrigation, which means that there is a high potential to increase efficiency through alternative irrigation methods.

**Priority actions**

- 1) Investments to modernize existing irrigation schemes. This will not only support more efficient use of water but can also increase crop yields, reduce water stress and maintenance costs. The opportunities to develop further the irrigation sector and increase overall the productivity of agriculture are very large and could also help retain the population in the rural areas.
- 2) Increase the access to credit of small farmers, as this will help them invest in new irrigation infrastructure or adopt new technologies that could improve productivity.
- 3) Capacity building and trainings for WUAs

**Performance**Water resources management

**Armenia has achieved significant legislative and institutional reforms in terms of water resources management and protection.** These measures establish the principles and mechanisms needed to implement integrated water resources management (IWRM) in the country. In general, these laws are comprehensive in scope and serve as a strong foundation for planning and management in the water sector.

**Priority actions**

- 1) Allocate more resources to support the hydrological, agrometeorological, climate and meteorological monitoring using Geographic Information Systems.
- 2) Engage stakeholders, including local communities, in water resource management decision-making processes. Encourage public participation and raise awareness about the importance of water conservation and sustainable use.
- 3) Continue placing efforts to support transboundary cooperation with all neighbouring countries and promote transboundary water management agreements, especially for shared rivers and basins, to address water resource challenges collaboratively.

Risk management

**Armenia faces flood and drought risks in many regions.** There is a risk of flooding both along the major rivers and in small catchment areas in mountainous regions of the country. In addition, there are dangers and damage from landslides. Besides earthquakes, floods are the greatest natural hazards

in Armenia. Large parts of the country, especially the semi-arid areas in the south of the country, are also exposed to drought.

#### Priority actions

- 1) Developing and implementing flood risk management plans that take into account the specific risks and vulnerabilities in different regions of the country.
- 2) Investing in flood protection infrastructure such as levees, dams, and flood walls to reduce the risk of flooding in vulnerable areas.
- 3) Improving early warning systems for floods, including the use of advanced weather forecasting and monitoring technologies.
- 4) Developing and implementing drought risk management plans.
- 5) Enhancing public awareness about flood and drought risks and the importance of taking preventative measures. This can involve public education campaigns, community outreach, and other efforts to raise awareness about those risks and the importance of preparedness.

### Outcomes

#### Social

**Armenia has a high coverage of drinking water supply but needs to increase the proportion of safely managed services especially in rural areas.** Only 62.2% of the rural population has access to safely managed drinking water services. Countrywide the access to safely managed drinking water is 82.4%, which means that 17.6% remain with only basic service.

**93% of the population in Armenia has access to at least basic sanitation services.** But only 10,75% has access to safely managed sanitation services highlighting the importance of prioritizing efforts in the rural areas. In rural areas, even 16% have only unimproved or even limited sanitation facilities.

#### Priority actions

- 1) Improve WSS infrastructure in rural areas, to ensure that rural communities have access to reliable and safe water supplies and appropriate sanitation services.
- 2) Promote safely managed on-site sanitation solutions and adequate faecal sludge management
- 3) Enhancing financing mechanisms: There is a need to enhance financing mechanisms for water supply and sanitation projects in rural areas. This could involve the establishment of dedicated funding sources, such as a rural water and sanitation fund, to support investment in rural infrastructure.

#### Environment

**Armenia needs to enhance monitoring and reporting of water quality and the ecological status of water bodies.** To improve water quality and ecological status in Armenia, it's important to address pollution, protect natural ecosystems, and promote sustainable land and water management.

#### Priority actions

- 1) Establish a comprehensive water quality monitoring program to regularly assess the state of water bodies across the country.
- 2) Implement and enforce regulations that limit the release of pollutants into water sources, including stringent controls on industrial discharges, agricultural runoff, and improper disposal of hazardous waste.

- 3) Upgrade and expand wastewater treatment facilities to ensure that domestic, industrial, and agricultural effluents are adequately treated before being discharged into water bodies.
- 4) Engage stakeholders, including local communities, businesses, and non-governmental organizations, in water quality improvement efforts, encouraging their active participation and support.
- 5) Collaborate with neighbouring countries on transboundary water quality management and pollution prevention to address shared water resources and cross-border pollution.

### Economic

**The overall economic water productivity in Armenia is low.** The agricultural sector contributed almost 12% to GDP. Agriculture is a vital source of employment in Armenia, particularly in rural areas. The agricultural sector has very low water productivity due to the cultivation of water intensive crops. High-value crops like fruits and vegetables often require more irrigation. Hydropower is one of the primary sources of electricity generation in Armenia. It contributes significantly to the country's energy supply, providing a substantial portion of the electricity consumed domestically.

#### **Priority actions**

- 1) Promote the adoption of modern technologies such as precision farming techniques. This could involve training programs for farmers, as well as subsidies or other incentives to encourage the adoption of new technologies like drip irrigation.
- 2) Strengthen the institutional capacities of water user associations, as well as creating more favorable enabling environments to improve efficiency and implement environmental and rural development policies.
- 3) Support research and development to identify new technologies and practices that can help to improve water productivity.
- 4) Implement a transparent and fair pricing system for water that reflects its true economic and environmental value, including the costs of sourcing, treatment, and infrastructure maintenance.

## 5 References

- Center for International Earth Science Information Network (CIESEIN), Columbia University. 2018. Gridded population of the world, Version 4 (GPWv4): Population density, Revision 11. Palisades, NY: NASA Socioeconomic Data and Application Center (SEDAC). Retrieved March 16<sup>th</sup> 2023 from: <https://sedac.ciesin.columbia.edu/data/set/gpw-v4-population-density-rev11>
- FAO 2022. AQUASTAT Core Database. Food and Agriculture Organization of the United Nations. Retrieved November 1<sup>st</sup> 2022 from: <https://www.fao.org/aquastat/en/databases/maindatabase/>
- Fick, S.E. and R.J. Hijmans, 2017. WorldClim 2: new 1km spatial resolution climate surfaces for global land areas. *International Journal of Climatology* 37 (12): 4302-4315
- Gassert, F., M. Landis, M. Luck, P. Reig, and T. Shiao. 2014. "Aqueduct Global Maps 2.1." Working Paper. Washington, DC: World Resources Institute. Available online at <http://www.wri.org/publication/aqueduct-metadata-global>
- Global administrative areas. 2022. GADM database of global administrative areas, version 4.1. Available online at: <https://gadm.org/>
- Hofste, R., S. Kuzma, S. Walker, E.H. Sutanudjaja, et. al. 2019. "Aqueduct 3.0: Updated Decision-Relevant Global Water Risk Indicators." Technical Note. Washington, DC: World Resources Institute. Available online at: <https://www.wri.org/publication/aqueduct-30>.
- Lehner, B., and Grill, G. 2013. Global river hydrography and network routing: baseline data and new approaches to study the world's large river systems. *Hydrological Processes*, 27(15): 2171-2168.
- Lehner, B., Verdin, K., and Jarvis, A. 2008. New global hydrography derived from spaceborne elevation data. *Eos, Transactions, AGU*, 89(10):93-94.
- Natural Earth data. No date. Available online: <https://www.naturalearthdata.com>
- Simonovic, S. P., Kundzewicz, Z. W., and Wright, N. 2021. Floods and the COVID-19 pandemic-A new double hazard problem. *Wiley Interdisciplinary Reviews: Water*, 8(2): e1509.
- U.S. Department of Agriculture (USDA). 2020. Azerbaijan, Armenia and Georgia – Crop production maps. Retrieved March 17<sup>th</sup>, 2023, from: [https://ipad.fas.usda.gov/rssiws/al/aag\\_cropprod.aspx](https://ipad.fas.usda.gov/rssiws/al/aag_cropprod.aspx)
- World Bank, Climate Change Knowledge Portal, 2023. Climate Risk Country Profile: Armenia. Retrieved on March 30<sup>th</sup>, 2023, from: <https://climateknowledgeportal.worldbank.org/country/armenia>
- FAOLEX Database 2023: Water Code Water Code of the Republic of Armenia (Law No. HO-373-N), from: <https://faolex.fao.org/docs/pdf/arm34344.pdf> FAOLEX
- EUWI 2023: Revised National Targets of Armenia in The Context of the Unece - Who/Europe Protocol on Water and Health, from: [https://unece.org/fileadmin/DAM/env/water/Protocol\\_on\\_W\\_H/Target\\_set\\_other\\_states/Armenia/EU\\_WI\\_Armenia\\_publication-final.pdf](https://unece.org/fileadmin/DAM/env/water/Protocol_on_W_H/Target_set_other_states/Armenia/EU_WI_Armenia_publication-final.pdf)
- UNO: Information on the relevant issues included in the questionnaire for thematic reports submitted by the UN Special Rapporteur during the sessions of the UN Human Rights Council and the General, from: <https://www.ohchr.org/sites/default/files/2022-01/Armenia2.pdf>
- World Bank, GFDRR, Risk Profiles: Armenia, 2023, from: <https://www.gfdr.org/sites/default/files/Armenia.pdf>
- World Bank, Directions in Development, Toward Integrated Water Resources Management in Armenia, 2023, from <https://documents1.worldbank.org/curated/en/433731468218409267/pdf/Toward-integrated-water-resources-management-in-Armenia.pdf>

Research gate 2023, Map of Armenia with collecting sites, Philippe Rekacewicz, Emmanuelle Bournay, UNEP/GrID-Arendal. from [https://www.researchgate.net/figure/Map-of-Armenia-with-collecting-sites-Map-provided-by-Philippe-rekacewicz-Emmanuelle\\_fig1\\_349916216](https://www.researchgate.net/figure/Map-of-Armenia-with-collecting-sites-Map-provided-by-Philippe-rekacewicz-Emmanuelle_fig1_349916216)

Research gate 2023. Annual mean air temperature (left) and yearly sum of precipitation (right) in Armenia during the reference period of 1961–1990. ASHMS, 2011c; Gevorgyan, 2014 (for air temperature), modified, from: [https://www.researchgate.net/figure/Annual-mean-air-temperature-left-and-yearly-sum-of-precipitation-right-in-Armenia\\_fig2\\_238101515/](https://www.researchgate.net/figure/Annual-mean-air-temperature-left-and-yearly-sum-of-precipitation-right-in-Armenia_fig2_238101515/)

The Government of the Republic of Armenia: <https://www.gov.am/>

Statistical Committee of the Republic of Armenia: <https://armstat.am/en/>

ADB Publications, ADB annual report 2011, from: <https://www.adb.org/documents/adb-annual-report-2011/>

World Bank Publication: Adapting to Climate Change in Europe and Central Asia: Lessons from Recent Experiences and Suggested Future Directions, 2012, from: <https://openknowledge.worldbank.org/entities/publication/fdea3c30-0465-5a0c-bbd6-c1d09b0e617b>

World Bank Publication: Drought: Management and mitigation assessment for Central Asia and the Caucasus, 2010, from: <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/135721468036310201/drought-management-and-mitigation-assessment-for-central-asia-and-the-caucasus>

Asian Development Bank Publications. Asian Water Development Outlook 2013: Measuring Water Security in Asia and the Pacific, from: <https://www.adb.org/sites/default/files/publication/30190/asian-water-development-outlook-2013.pdf>

World Bank Publication: Europe and Central Asia: Country Risk Profiles for Floods and Earthquakes, from: <https://www.worldbank.org/en/region/eca/publication/europe-and-central-asia-country-risk-profiles-for-floods-and-earthquakes>

UN Sustainable Development Group. Leave No One Behind, Diverse Resources, from: <https://unsdg.un.org/2030-agenda/universal-values/leave-no-one-behind>

## 6 Annexes I: List of indicators used in the O-WM

Please note that the general country assessment of water security performed in Armenia is based only on the core indicators listed below in the table. The supporting indicators requires stakeholder engagement which is beyond the scope of this report.

WATER SECTOR OUTCOMES			
Social			
1. Basic and safely managed drinking water coverage	CORE	QUANTITATIVE	
2. Basic and safely managed drinking water coverage urban/rural	CORE	QUANTITATIVE	
3. Basic and safely managed sanitation coverage	CORE	QUANTITATIVE	
4. Basic and safely managed sanitation coverage urban/rural	CORE	QUANTITATIVE	
5. Number of DALYs (disability-adjusted life years) due to unsafe water, sanitation, and handwashing	CORE	QUANTITATIVE	
6. Mortality rate attributable to unsafe water, sanitation, and hygiene (unsafe WASH services)	CORE	QUANTITATIVE	
7. Number of people affected by floods	CORE	QUANTITATIVE	
8. Exposure of people to flood risks	CORE	QUALITATIVE	SUBNATIONAL
9. Exposure of people to drought risks	CORE	QUALITATIVE	SUBNATIONAL
10. Exposure of people to water stress	CORE	QUALITATIVE	SUBNATIONAL
11. Affordability of WASH services	SUPPORTING	QUANTITATIVE	
12. Deaths from floods	SUPPORTING	QUANTITATIVE	
13. Non-availability of flush toilets	SUPPORTING	QUANTITATIVE	
14. Number of diarrheal DALYs from inadequate water, sanitation, and hygiene	SUPPORTING	QUANTITATIVE	
15. Percentage of deaths caused by diarrhea in children under 5 years of age	SUPPORTING	QUANTITATIVE	
Environmental			
16. Share of wastewater safely treated	CORE	QUANTITATIVE	
17. Proportion of water bodies with good ambient water quality (%)	CORE	QUANTITATIVE	
18. Wetland loss	CORE	QUANTITATIVE	
19. Groundwater decline	CORE	QUANTITATIVE	SUBNATIONAL
20. Water stress ratio	CORE	QUANTITATIVE	SUBNATIONAL
21. Share of surface water bodies (rivers) with good ecological status (EU	SUPPORTING	QUANTITATIVE	

WFD)			
22. Share of surface water bodies (lakes) with good ecological status (EU WFD)	SUPPORTING	QUANTITATIVE	
23. Share of groundwater bodies with good chemical status (WFD)	SUPPORTING	QUANTITATIVE	
24. Share of groundwater bodies with good quantitative status (WFD)	SUPPORTING	QUANTITATIVE	
25. Terrestrial and marine protected areas	SUPPORTING	QUANTITATIVE	
Economic			
26. Water use efficiency per sector	CORE	QUANTITATIVE	
27. Economic water productivity	CORE	QUALITATIVE	SUBNATIONAL
28. Agricultural gross value generated by irrigated agriculture	CORE	QUANTITATIVE	SUBNATIONAL
29. Electricity production from hydroelectric sources	CORE	QUANTITATIVE	
30. Share of hydropower in total primary energy supply	CORE	QUANTITATIVE	
31. Tourism share of GDP	SUPPORTING	QUANTITATIVE	
32. Water productivity of irrigation	SUPPORTING	QUANTITATIVE	
33. Water productivity of industry	SUPPORTING	QUANTITATIVE	
WATER SECTOR PERFORMANCE			
Management of water resources			
34. Degree of implementation of water resources management instruments	CORE	QUALITATIVE	
35. Availability and adequacy of national water resources management instruments	SUPPORTING	QUALITATIVE	
36. Availability and adequacy of basin management instruments	SUPPORTING	QUALITATIVE	
37. Availability and adequacy of aquifer management instruments	SUPPORTING	QUALITATIVE	
38. Availability and adequacy of national management instruments to ensure efficient and sustainable water use	SUPPORTING	QUALITATIVE	
39. Availability and adequacy of water quality management instruments	SUPPORTING	QUALITATIVE	
40. Data collection and sharing within countries and across borders	SUPPORTING	QUALITATIVE	
Delivery of Water Services			
41. Operating cost coverage	CORE	QUANTITATIVE	
42. Electrical energy costs as percentage of operational costs	CORE	QUANTITATIVE	
43. Level of water and sanitation strategic planning and strategic investment	SUPPORTING	QUALITATIVE	

planning			
44. Maturity of water and sanitation performance monitoring framework	SUPPORTING	QUALITATIVE	
45. Quality of rural water and sanitation infrastructure operation and maintenance system	SUPPORTING	QUALITATIVE	
46. Quality of asset management	SUPPORTING	QUALITATIVE	
47. Quality of irrigation infrastructure, investments, and operation and maintenance system	SUPPORTING	QUALITATIVE	
<b>Mitigation of risk</b>			
48. Riverine flood risk – population affected	CORE	QUANTITATIVE	SUBNATIONAL
49. Riverine flood risk – monetary	CORE	QUANTITATIVE	SUBNATIONAL
50. Drought risk	CORE	QUANTITATIVE	SUBNATIONAL
51. Management instruments to deal with droughts	SUPPORTING	QUALITATIVE	
52. Management instruments to deal with floods	SUPPORTING	QUALITATIVE	
<b>WATER SECTOR ARCHITECTURE</b>			
Institutions			
53. Fragile State Index (FSI)	CORE	QUANTITATIVE	
54. Degree of IWRM implementation	CORE	QUANTITATIVE	
55. Level of legal and policy framework maturity	SUPPORTING	QUALITATIVE	
56. Level of operationalization of international treaties	SUPPORTING	QUALITATIVE	
57. Variety of government institutions registered in FAO database	SUPPORTING	QUALITATIVE	
Infrastructure			
58. Per capita dam storage capacity	CORE	QUANTITATIVE	SUBNATIONAL
59. Total water supply coverage by piped improved facilities	CORE	QUANTITATIVE	
60. Total sanitation coverage by sewer facilities	CORE	QUANTITATIVE	
61. Non-revenue water	CORE	QUANTITATIVE	
62. Continuity of service	CORE	QUANTITATIVE	
63. Wastewater treatment	CORE	QUANTITATIVE	
64. Share of cultivated land under irrigation	CORE	QUANTITATIVE	SUBNATIONAL
65. Share of irrigated land with flood irrigation	CORE	QUANTITATIVE	
66. Share of irrigated land with sprinkler irrigation	CORE	QUANTITATIVE	

67. Share of irrigated land with drip irrigation	CORE	QUANTITATIVE	
68. Level of adequacy of water supply infrastructure	SUPPORTING	QUALITATIVE	
69. Adequacy of water and sanitation design standards and guidelines and approval process	SUPPORTING	QUALITATIVE	
70. Level of adequacy of irrigation infrastructure	SUPPORTING	QUALITATIVE	
71. Irrigation infrastructure financing	SUPPORTING	QUALITATIVE	
72. Level of adequacy reservoir/hydropower infrastructure	SUPPORTING	QUALITATIVE	
<b>WATER SECTOR ENDOWMENT</b>			
Supply			
73. Total renewable water resources per capita	CORE	QUANTITATIVE	SUBNATIONAL
74. Share of surface water to total water availability	CORE	QUANTITATIVE	SUBNATIONAL
75. Share of groundwater to total water availability	CORE	QUANTITATIVE	SUBNATIONAL
76. Share of non-conventional water resources to total availability	CORE	QUANTITATIVE	SUBNATIONAL
77. Transboundary dependency ratio	CORE	QUANTITATIVE	
78. Water quality index	CORE	QUANTITATIVE	
79. Inter-annual variability	CORE	QUANTITATIVE	SUBNATIONAL
80. Seasonal variability	CORE	QUANTITATIVE	SUBNATIONAL
Demand			
81. Water withdrawal per capita	CORE	QUANTITATIVE	SUBNATIONAL
82. Share of surface water to total withdrawals	CORE	QUANTITATIVE	SUBNATIONAL
83. Share of groundwater to total withdrawal	CORE	QUANTITATIVE	SUBNATIONAL
84. Share of agriculture water use to total water withdrawals	CORE	QUANTITATIVE	SUBNATIONAL
85. Share of industrial water use to total water withdrawals	CORE	QUANTITATIVE	SUBNATIONAL
86. Share of municipal water use to total water withdrawals	CORE	QUANTITATIVE	SUBNATIONAL

## 7 Annex II: Results of Core indicator assessment

\*) topic/issue reference to Annex 3 of the ToR and the Toolkit

Ind. Number	Dimension	Sub-dimension *)	Indicator	Unit	Data Source	VALUE	RANGE BAND
1	Outcomes	Social	Basic and safely managed drinking water coverage (%)	% population	UNICEF/WHO Joint Monitoring Programme (JMP) <a href="https://washdata.org/data">https://washdata.org/data</a>	100	HIGH
2	Outcomes	Social	Basic and safely managed drinking water coverage (%) rural/urban	Ratio rural-urban (rural/urban x 100): 0-100	UNICEF/WHO Joint Monitoring Programme (JMP) <a href="https://washdata.org/data">https://washdata.org/data</a>	100	HIGH
3	Outcomes	Social	Basic and safely managed sanitation coverage (%)	% population	UNICEF/WHO Joint Monitoring Programme (JMP) <a href="https://washdata.org/data">https://washdata.org/data</a>	93.9	MEDIUM-HIGH
4	Outcomes	Social	Basic and safely managed sanitation coverage (%) rural/urban	Ratio rural-urban (rural/urban x 100): 0-100	UNICEF/WHO Joint Monitoring Programme (JMP) <a href="https://washdata.org/data">https://washdata.org/data</a>	83	MEDIUM-HIGH
5	Outcomes	Social	Number of DALYs (disability-adjusted life years) due to unsafe water, sanitation and handwashing	DALYs/100.000 inhabitants	Global Health Database Exchange <a href="http://ghdx.healthdata.org/">http://ghdx.healthdata.org/</a>	128	MEDIUM
6	Outcomes	Social	Mortality rate attributable to unsafe water, sanitation, and hygiene (unsafe WASH services)	People affected annually per 100.000 inhabitants	SDG 3.9.2 monitoring	0.18	MEDIUM-HIGH
7	Outcomes	Social	Number of people affected by floods/a/100k inhabitants 1980-2021	People affected annually per 100.000 inhabitants	EM-DAT, the International Disaster Database ( <a href="https://public.emdat.be/">https://public.emdat.be/</a> )	5.7	HIGH
10	Outcomes	Social	People living in areas under water stress	% population		0	HIGH
16	Outcomes	Environmental	Share of wastewater safely treated (%)	%	SDG Indicator 6.3.1 <a href="https://www.sdg6data.org/indicator/6.3.1">https://www.sdg6data.org/indicator/6.3.1</a>	40	LOW

Ind. Number	Dimension	Sub-dimension *)	Indicator	Unit	Data Source	VALUE	RANGE BAND
17	Outcomes	Environmental	Proportion of bodies of water with good ambient water quality (%)	%	SDG Indicator 6.3.2 <a href="https://sdg6data.org/indicator/6.3.2">https://sdg6data.org/indicator/6.3.2</a>		No Value
18	Outcomes	Environmental	Wetland loss	Score 0-100	Environmental Performance Index/Yale University <a href="https://epi.yale.edu/epi-results/2020/component/wtl">https://epi.yale.edu/epi-results/2020/component/wtl</a>	100	HIGH
19	Outcomes	Environmental	Groundwater table decline (cm/yr)	cm/yr	WRI AQUEDUCT Water risk atlas: <a href="https://www.wri.org/aqueduct">https://www.wri.org/aqueduct</a>	0.074895792	HIGH
20	Outcomes	Environmental	Water stress ratio	%	WRI AQUEDUCT Water risk atlas: <a href="https://www.wri.org/aqueduct">https://www.wri.org/aqueduct</a>	57.8	LOW-MEDIUM
26	Outcomes	Economic	Economic water productivity: Overall	USD/m3	FAOSTAT (SDG 6.4.1 indicator) <a href="http://www.fao.org/sustainable-development-goals/indicators/641/en/">http://www.fao.org/sustainable-development-goals/indicators/641/en/</a>	3.26	LOW
26a	Outcomes	Economic	Economic water productivity: Agriculture	USD/m3	FAOSTAT (SDG 6.4.1 indicator) <a href="http://www.fao.org/sustainable-development-goals/indicators/641/en/">http://www.fao.org/sustainable-development-goals/indicators/641/en/</a>	0.22	MEDIUM
26b	Outcomes	Economic	Economic water productivity: Industry	USD/m3	FAOSTAT (SDG 6.4.1 indicator) <a href="http://www.fao.org/sustainable-development-goals/indicators/641/en/">http://www.fao.org/sustainable-development-goals/indicators/641/en/</a>	19.1	MEDIUM
D26c	Outcomes	Economic	Economic water productivity: Municipal	USD/m3	FAOSTAT (SDG 6.4.1 indicator) <a href="http://www.fao.org/sustainable-development-goals/indicators/641/en/">http://www.fao.org/sustainable-development-goals/indicators/641/en/</a>	9.7	LOW
28	Outcomes	Economic	Agricultural gross value generated by irrigated agriculture	%	FAO AQUASTAT <a href="http://www.fao.org/aquastat/statistics/query/index.html">http://www.fao.org/aquastat/statistics/query/index.html</a>	37.5	MEDIUM
29	Outcomes	Economic	Electricity production from hydroelectric sources	%	World Bank <a href="https://data.worldbank.org/indicator/EG.ELC.HYRO.ZS">https://data.worldbank.org/indicator/EG.ELC.HYRO.ZS</a>	28.3	LOW-MEDIUM
30	Outcomes	Economic	Share of hydropower in total primary energy supply	0 to 100	IRENA database <a href="https://www.irena.org/Statistics/Statistical-Profiles">https://www.irena.org/Statistics/Statistical-Profiles</a>	5.8	MEDIUM
34	Performance	Management of Water Resources	Degree of implementation of integrated water resources management instruments	0 to 100	National: SDG 6.5.1 monitoring	47	MEDIUM

Ind. Number	Dimension	Sub-dimension *)	Indicator	Unit	Data Source	VALUE	RANGE BAND
41	Performance	Delivery of Water Services	Operating cost coverage (ratio)	ratio	International Benchmarking Network for Water and Sanitation Utilities (IBNET) <a href="http://www.ib-net.org">www.ib-net.org</a>	0.71	LOW
42	Performance	Delivery of Water Services	Electrical energy costs as percentage of operational costs	%	International Benchmarking Network for Water and Sanitation Utilities (IBNET) <a href="http://www.ib-net.org">www.ib-net.org</a>	0.083648894	HIGH
48	Performance	Mitigation of Risks	Riverine flood risk - population affected	% population per year	WRI Aqueduct Water Risk Atlas: <a href="https://www.wri.org/publication/aqueduct-30">https://www.wri.org/publication/aqueduct-30</a> .	0.980447037	MEDIUM-HIGH
#NV	Performance	Mitigation of Risks	Riverine flood risk - monetary	% GDP per year	WRI Aqueduct Water Risk Atlas: <a href="https://www.wri.org/publication/aqueduct-30">https://www.wri.org/publication/aqueduct-30</a> .	0.981485986	MEDIUM-HIGH
50	Performance	Mitigation of Risks	Drought Risk	Rating between 1 and 5	WRI Aqueduct Water Risk Atlas: <a href="https://www.wri.org/publication/aqueduct-30">https://www.wri.org/publication/aqueduct-30</a> .	3.110787695	LOW-MEDIUM
53	Architecture	Institutions and governance	Fragile State Index (FSI)	Index between 0 and 120	Accessible online database <a href="https://fragilestatesindex.org/country-data/">https://fragilestatesindex.org/country-data/</a>	69.8	MEDIUM
54	Architecture	Institutions and governance	Degree of IWRM implementation	Degree between 0 and 100	Accessible online database <a href="http://iwrmdatportal.unepdhi.org/countrydatabase">http://iwrmdatportal.unepdhi.org/countrydatabase</a>	52	MEDIUM
58	Architecture	Infrastructure	Per capita dam storage capacity	m3/person	FAO AQUASTAT <a href="http://www.fao.org/aquastat/statistics/query/index.html">http://www.fao.org/aquastat/statistics/query/index.html</a> Subnational: GRanD database	470.97	MEDIUM
59	Architecture	Infrastructure	Total water supply coverage by piped improved facilities (%)	Percentage [%]	Joint Monitoring Programme for Water Supply and Sanitation (JMP) (WHO/UNICEF) <a href="https://washdata.org/data">https://washdata.org/data</a>	0.9997118	HIGH
60	Architecture	Infrastructure	Total sanitation coverage by sewer facilities (%)	Percentage [%]	Joint Monitoring Programme for Water Supply and Sanitation (JMP) (WHO/UNICEF) <a href="https://washdata.org/data">https://washdata.org/data</a>	0.7147303	MEDIUM-HIGH
61	Architecture	Infrastructure	Non-revenue water (%)	Percentage [%]	International Benchmarking Network for Water and Sanitation Utilities (IBNET) <a href="http://www.ib-net.org">www.ib-net.org</a>	0.7532	LOW
62	Architecture	Infrastructure	Continuity of service	h/day	International Benchmarking Network for Water and Sanitation Utilities (IBNET) <a href="http://www.ib-net.org">www.ib-net.org</a>	21.88	MEDIUM
63	Architecture	Infrastructure	Wastewater treatment	Score between 0 and 100	Accessible online database <a href="https://epi.yale.edu/epi-results/2020/component/wwt">https://epi.yale.edu/epi-results/2020/component/wwt</a>	52.3	MEDIUM-HIGH

Ind. Number	Dimension	Sub-dimension *)	Indicator	Unit	Data Source	VALUE	RANGE BAND
64	Architecture	Infrastructure	Share of cultivated land under irrigation	%	FAO AQUASTAT <a href="http://www.fao.org/aquastat/statistics/query/index.html">http://www.fao.org/aquastat/statistics/query/index.html</a>	19.3	Informative
65	Architecture	Infrastructure	Share of irrigated land with flood irrigation	%	FAO AQUASTAT <a href="http://www.fao.org/aquastat/statistics/query/index.html">http://www.fao.org/aquastat/statistics/query/index.html</a>	90.5	Informative
66	Architecture	Infrastructure	Share of irrigated land with sprinkler irrigation	%	FAO AQUASTAT <a href="http://www.fao.org/aquastat/statistics/query/index.html">http://www.fao.org/aquastat/statistics/query/index.html</a>	9.1	Informative
67	Architecture	Infrastructure	Share of irrigated land with drip irrigation	%	FAO AQUASTAT <a href="http://www.fao.org/aquastat/statistics/query/index.html">http://www.fao.org/aquastat/statistics/query/index.html</a>	0.4	Informative
73	Endowment	Supply	Total Renewable Water Resources per capita	m3/year/person	FAO AQUASTAT <a href="http://www.fao.org/aquastat/statistics/query/index.html">http://www.fao.org/aquastat/statistics/query/index.html</a>	2632.002	LOW-MEDIUM
74	Endowment	Supply	Share of surface water to total water availability	%	FAO AQUASTAT <a href="http://www.fao.org/aquastat/statistics/query/index.html">http://www.fao.org/aquastat/statistics/query/index.html</a>	54	Informative
75	Endowment	Supply	Share of groundwater to total water availability	%	FAO AQUASTAT <a href="http://www.fao.org/aquastat/statistics/query/index.html">http://www.fao.org/aquastat/statistics/query/index.html</a>	46	Informative
77	Endowment	Supply	Share of non-conventional water resources to total availability	%	FAO AQUASTAT <a href="http://www.fao.org/aquastat/statistics/query/index.html">http://www.fao.org/aquastat/statistics/query/index.html</a>		Informative
76	Endowment	Supply	Transboundary Dependence Ratio (Water Independence)	%	FAO AQUASTAT <a href="http://www.fao.org/aquastat/statistics/query/index.html">http://www.fao.org/aquastat/statistics/query/index.html</a>	11.7132192	MEDIUM-HIGH
78	Endowment	Supply	Drinking Water Quality Index	0	<a href="https://epi.yale.edu/epi-results/2020/component/uwd">https://epi.yale.edu/epi-results/2020/component/uwd</a>	61.5	MEDIUM-HIGH
79	Endowment	Supply	Interannual Variability	coefficient of variation	FAO AQUASTAT <a href="http://www.fao.org/aquastat/statistics/query/index.html">http://www.fao.org/aquastat/statistics/query/index.html</a> Subnational: WRI Aqueduct Risk Atlas	0.49	MEDIUM-HIGH
80	Endowment	Supply	Seasonal Variability	coefficient of variation	FAO AQUASTAT <a href="http://www.fao.org/aquastat/statistics/query/index.html">http://www.fao.org/aquastat/statistics/query/index.html</a> Subnational: WRI Aqueduct Risk Atlas	0.85	MEDIUM
81	Endowment	Demand	Water Withdrawal per capita	m3/year/person	FAO AQUASTAT <a href="http://www.fao.org/aquastat/statistics/query/index.html">http://www.fao.org/aquastat/statistics/query/index.html</a>	919.4561	LOW-MEDIUM
82	Endowment	Demand	Share of Surface water to total water withdrawal	%	FAO AQUASTAT <a href="http://www.fao.org/aquastat/statistics/query/index.html">http://www.fao.org/aquastat/statistics/query/index.html</a>	60	Informative
83	Endowment	Demand	Share of groundwater to total water withdrawal	%	FAO AQUASTAT <a href="http://www.fao.org/aquastat/statistics/query/index.html">http://www.fao.org/aquastat/statistics/query/index.html</a>	40	Informative

Ind. Number	Dimension	Sub-dimension *)	Indicator	Unit	Data Source	VALUE	RANGE BAND
84	Endowment	Demand	Share of Agriculture water use to total water withdrawal	%	FAO AQUASTAT <a href="http://www.fao.org/aquastat/statistics/query/index.html">http://www.fao.org/aquastat/statistics/query/index.html</a>	69.34414	LOW-MEDIUM
85	Endowment	Demand	Share of Industrial water use to total water withdrawal	%	FAO AQUASTAT <a href="http://www.fao.org/aquastat/statistics/query/index.html">http://www.fao.org/aquastat/statistics/query/index.html</a>	4.789978	LOW
86	Endowment	Demand	Share of Municipal water use to total water withdrawal	%	FAO AQUASTAT <a href="http://www.fao.org/aquastat/statistics/query/index.html">http://www.fao.org/aquastat/statistics/query/index.html</a>	25.86588	LOW-MEDIUM