A Blueprint for Resilience: Charting the Course for Water Security in Europe and Central Asia

Diagnostic Report
June 2024

WORLD BANK GROUP
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A Blueprint for Resilience: Charting the Course for Water Security in Europe and Central Asia

Europe and Central Asia Region
Regional Water Security Assessment
(P170030)

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ABBREVIATIONS

AMBU	Agency for Water Resources Management
CAP	Common Agricultural Policy
CAPEX	capital expenditure
CAREC	Central Asia Regional Economic Cooperation
DALY	disability-adjusted life year
DMP	drought management plan
DRB	Danube River basin
DRPC	Danube River Protection Convention
EU	European Union
FD	Floods Directive
FRMP	flood risk management plan
GCM	global climate model
GDP	gross domestic product
GFDL-ESM	Geophysical Fluid Dynamics Laboratory Earth System Model
GHG	greenhouse gases
GNI	gross national income
ICPDR	International Commission for the Protection of the Danube River
ICWC	Interstate Commission for Water Coordination of Central Asia
I&D	irrigation and drainage
IFAS	International Fund for Saving the Aral Sea
IPSL-CM5A-LR	Institut Pierre-Simon Laplace coupled model for CMIP5
IPSL-CM6A-LR	Institut Pierre-Simon Laplace coupled model for CMIP6
IQR	interquartile range
IT	information technology
IWRM	integrated water resources management
km^3	cubic kilometers
m^3	cubic meters
MAR	managed aquifer recharge
MIROC-ESM-CHEM	Model for Interdisciplinary Research on Climate Earth System Model
MPI-ESM1-2-HR	Max Planck Institute Earth System Model
MRI-ESM2-0	Meteorological Research Institute Earth System Model
NATO	North Atlantic Treaty Organization
NEAP	National Environmental Action Program
NRW	nonrevenue water
NUTS2	level 2 of the Nomenclature of Territorial Units
OECD	Organisation for Economic Co-operation and Development
O&M	operation and maintenance
OPEX	operational expenditure
PPP	private-public partnership
RBMP	river basin management plan
RCP	Representative Concentration Pathway

RSE	Republican State Enterprise
SDG	Sustainable Development Goal
SKWRMIP Project	South Karakalpakstan Water Resources Management Improvement Project
SPEI	Standardized Precipitation-Evapotranspiration Index
SSP	Shared Socioeconomic Pathway
UKESM1-0-LL6F6F	UK Earth System Model
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNECE	United Nations Economic Commission for Europe
UNECE Water Convention	United Nations Economic Commission for Europe Convention on the Protection and Use of Transboundary Watercourses and International Lakes
UNW Convention	United Nations Convention on the Law of Non-Navigational Uses of International Watercourses
UWWTD	Urban Wastewater Treatment Directive
WASH	water supply, sanitation, and hygiene
WCA	water consumer association
WFD	Water Framework Directive
WICER	Water in Circular Economy and Resilience
WRM	water resources management
WSDF	Water Security Diagnostic Framework
WSS	water supply and sanitation
WUA	water user association
WUO	water user organization

All dollar amounts are US dollars unless otherwise indicated.

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Executive Summary

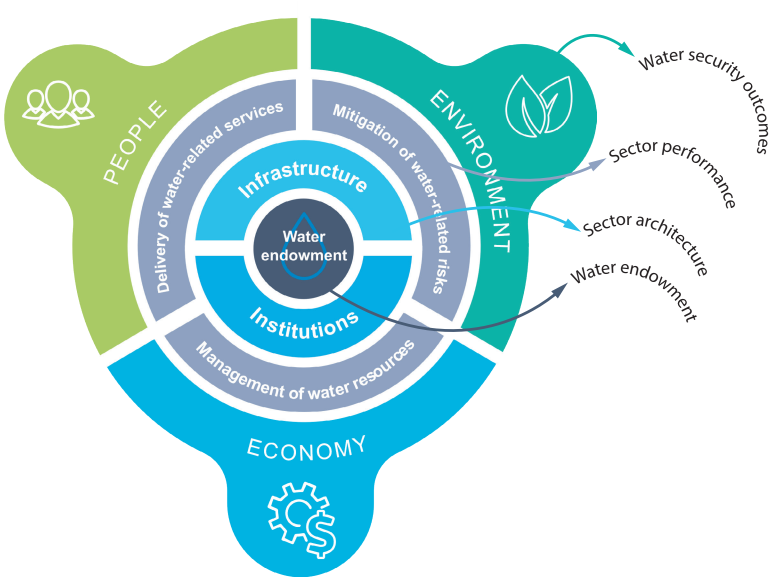
The Europe and Central Asia region is highly heterogeneous, and water security challenges vary widely. Some challenges, although relatively similar, are of a different size, especially given the different geographical, cultural, economic, and political departure points of each country. This assessment explores the main regional challenges and opportunities related to water security by delving into the situations faced by each of the three major subregions: the Danube, Central Asia, and the South Caucasus. Despite the region's heterogeneity, a common theme many countries share is the low and inconsistent political priority given to water. This report's goal is therefore threefold: (a) to raise awareness among policy makers of the importance of prioritizing water (including allocating adequate funds) for people, the planet, and economic prosperity; (b) to stimulate national and regional policy dialogue to harness water for greater economic, social, and environmental good; and (c) to offer clear, actionable recommendations that orient policy makers and sector practitioners toward sustainable, long-term regional water security.

METHODOLOGICAL APPROACH

This report uses the Water Security Diagnostic Framework (WSDF) to undertake a holistic yet comprehensive assessment of water security in Europe and Central Asia. Water security is a complex, multidimensional, and multisectoral concept that is typically driven by a combination of environmental, socioeconomic, technological, and governance factors. Even when water is abundant and the hydrologic regime is favorable, there may be mismanagement (for example, poor pollution regulation) or inadequate investments that can lead to water insecurity. The WSDF seeks to analyze the relationship between a country's evolving water endowment (the innermost ring in *figure ES.1*) and social (or people), economic, and environmental outcomes (depicted by the outermost ring in *figure ES.1*). It does so by examining water sector architecture, encompassing both infrastructure and institutions (the second ring in *figure ES.1*) and overall sector performance, including management of water resources, delivery of water-related services,

Figure ES.1

DIMENSIONS OF the Water Security Diagnostic Framework



Source: World Bank 2019.

and mitigation of water-related risks (the third ring in *figure ES.1*). The benefit of this approach is its ability to rapidly identify challenges and opportunities and facilitate global comparisons and benchmarking.

In the preparation of this report, the WSDF was operationalized through an innovative approach that leveraged readily available information and resources. A suite of quantitative and qualitative indicators was used to evaluate a country's maturity across each of the four dimensions (endowment, architecture, performance, and outcomes), supplemented by a qualitative analysis of regional and country-specific data, together with stakeholder engagement. This effort was undertaken through a phased approach: (a) the preparatory and diagnostic phase established the baseline for water security at the regional and country levels, considering both current and future conditions using Intergovernmental Panel on Climate Change (IPCC) climate and socioeconomic scenarios, and (b) findings from the diagnostic phase helped identify regional and subregional strategies needed to bolster water security.

This methodological approach gave rise to a comprehensive regional assessment that integrates diverse perspectives and data sources validated by relevant stakeholders in select countries to inform the identification and implementation of strategic actions to enhance water security across the region. This overall regional assessment draws on several assessments, including the Danube Regional Assessment, six deep-dive country assessments (Albania, Bosnia and Herzegovina, Croatia, Montenegro, Serbia, Ukraine), and eight general country assessments (Armenia, Azerbaijan, Georgia, Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkmenistan, Uzbekistan; see table 1.1 for a detailed breakdown and Appendix B for country level results).

Key Findings

The Importance of Water Security to People, the Environment, and the Economy in Europe and Central Asia

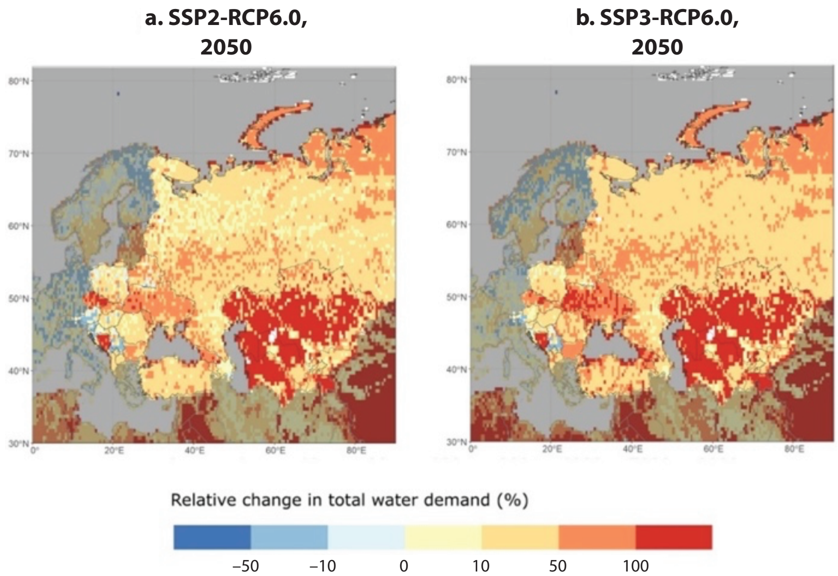
Water is a key driver of economic development across Europe and Central Asia. Almost one-third (27 percent) of the region's electricity comes from hydropower. About 15 percent of the region's agricultural gross revenues stem from irrigated crops, although this figure varies widely between subregions, ranging from 9 percent in the Danube (where irrigation is mostly limited to a few Balkan countries) to about 70 to 80 percent in Central Asia (except for Kazakhstan) and about 54 percent in the South Caucasus. These sectors and other water-dependent economic sectors, such as food processing, employ anywhere from 18 to 60 percent of the labor force in Europe and Central Asia. Meanwhile, water-dependent exports at the country level range from 17 to 98 percent, representing an important source of gross domestic product (GDP). Water also contributes to the economies of some countries through thermal cooling (for example, Turkmenistan and Uzbekistan), navigation (for example, the Danube River and the Sava and Drina Rivers corridor), and environmental flows and natural assets that are critical to tourism (for example, Albania, Croatia, Georgia, Moldova, Montenegro, and Türkiye). Finally, water is a fundamental pillar of socioeconomic well-being. Safe water and sanitation contribute to important human and environmental health benefits, and mortality and disability-adjusted life years (DALYs) attributed to unsafe drinking water supply, sanitation, and hygiene (WASH) in Europe and Central Asia are among the lowest in the world.

A business-as-usual approach to water management will likely increase economic challenges and exacerbate water scarcity. Water demand across the region is projected to increase sharply—from 34 to 51 percent by 2050 (*map ES.1*)—driven primarily by socioeconomic development. As economies across the region continue to evolve, industrial demands are expected to increase anywhere from 50 to 90 percent, coupled with a massive rise in domestic demand of between 57 and 105 percent. Water stress brought about by the compounding effects of increasing demands, changing availability, and inefficient management practices is likely to have cascading effects on the economy. Downstream and developing economies are especially vulnerable because they are affected by the actions of upstream countries and are already highly vulnerable to climate change. Moreover, developing economies often have low adaptive capacities and lack robust institutions, infrastructure, and management instruments.

Reducing water losses and improving water efficiency could lead to substantial economic benefits while preserving valuable resources. In some parts of the region, drainage systems are more predominant than irrigation; for example, 60 percent of arable land in the Western Balkans (part of the Danube subregion) is equipped with drainage compared with 6 percent with irrigation. Conversely, in Central Asia (except Kazakhstan), more than 70 percent of arable land is irrigated. Whatever system prevails, irrigation and drainage systems in Europe and Central Asia are generally inefficient and suffer from substantial water losses, largely because of a lack of maintenance resulting from underfunding. For example, an estimated 40 percent of all water is lost from irrigation canals in Central Asia, where rehabilitating and modernizing existing irrigation infrastructure could lead to water savings of as much as 7 percent of current water withdrawals by 2030 and as much as 10 percent by 2050. Meanwhile, nonrevenue water (NRW) losses across the region are substantial. Subregional averages range from a low of 35 percent in Central Asia to a high of 75 percent in the South Caucasus, whereas the Danube averages 44 percent. By contrast, average NRW in European Union (EU) Member States is about 23 percent. High

Map ES.1

RELATIVE CHANGE in Water Demands by 2050 Compared with 2010 across Europe and Central Asia



Source: Satoh et al. 2017.

rates of NRW and irrigation losses represent significant economic costs and raise concerns about water resources sustainability, especially given the pressing challenges of increasing water scarcity in the context of climate change.

Addressing large water productivity gaps could create additional water-related economic benefits. Water productivity in Europe and Central Asia (at $43.2 per cubic meter) is the second highest in the world, only marginally lower than in North America (at $43.7 per cubic meter) and more than double that of the next-highest region (East Asia and the Pacific at $21.2 per cubic meter).[1] However, across Europe and Central Asia, water productivity varies widely by subregion, averaging $52.2 per cubic meter in the Danube subregion, $6.1 per cubic meter in the South Caucasus, and $2.8 per cubic meter in Central Asia. At the country level, these rates range from a low of $0.95 per cubic meter in the Kyrgyz Republic to a high of $173 per cubic meter in the Slovak Republic. These vast differences are primarily a result of different cropping and irrigation practices, with low water productivity being driven by low-value crops and inefficient irrigation and drainage. This sharp contrast shows an untapped potential to boost economic growth and farm-level livelihoods across the region. For example, in Serbia, a shift to higher-value crops could bring yield increases ranging from about 8 and 20 percent for wheat and maize to as much as 30 and 35 percent for vegetables and top fruit.[2] Meanwhile, in Central Asia, rehabilitating existing irrigation infrastructure could increase crop yields by an estimated 20 percent by 2030 and 50 percent by 2050 (World Bank 2019).

The future of agriculture in Europe and Central Asia is irrigated, but without sufficient investments, the sector cannot reach its full potential. The irrigation sector in Europe and Central Asia is in transition in response to regional policy dynamics, changes in rural demography, elevated demands for water from other sectors that often have priority climate-change impacts, and the aspiration of governments to use irrigation as a tool for rural economic revival and not just food security. About 15 percent (11 million hectares) of all cropland is currently irrigated in Europe and Central Asia, with the potential for another 58 million hectares, but without sufficient investments in irrigation infrastructure, about 40 percent of irrigated areas will convert back to rain-fed areas or become abandoned (OECD/FAO 2023). Irrigation expansion is expected to play a land-sparing role and ease the protection of forests and natural land for biodiversity conservation. Investing in new irrigation infrastructure would spare more than 3 million hectares in natural lands from conversion, significantly increase the water productivity of irrigated areas, and produce 2 percent more crops (Palazzo et al. 2019).

Irrigation in Europe and Central Asia is characterized by a mix of aging, underdeveloped, and inefficient infrastructure. Few investments are directed to irrigation, leaving systems undermaintained and in need of upgrading and contributing to low water productivity and crop yields. In the Danube, where about 11 percent of cultivated land is irrigated, systems have fallen into disrepair because of a lack of maintenance or are simply outdated. Consequently, inefficiencies in Romania, for example, have led to maize yields of only 4 tons per hectare compared with 7.4 tons per hectare in neighboring Hungary. In the South Caucasus, irrigation practices vary but are generally inefficient, and water is underused. The situation in Central Asia is complex and varied, but overall, the infrastructure is similarly old and largely neglected, which has led to widespread salinization that affects half of all irrigated land, as well as substantial water losses.

Modernizing irrigation systems and adopting "smart," energy-efficient, climate-resilient technologies could enhance water efficiency, reduce energy consumption, and promote sustainable agriculture in the face of climate change. A dilapidated infrastructure means the agricultural sector is especially vulnerable to climate shocks, particularly droughts. Irrigation systems could play an important role in climate adaptation; however, increased water scarcity could limit their adaptation potential (Palazzo et al. 2019). Droughts have already resulted in substantial agricultural losses in some countries, and with droughts set to increase and drought management virtually absent, agricultural GDP, food security, and rural livelihoods depend on climate-resilient irrigation schemes that include upgrading existing infrastructure, increasing water storage, and incentivizing water-saving practices while considering overall water availability. Such irrigation schemes are particularly important given the cautionary tale of the Aral Sea—once the world's fourth-largest lake and now famous for its desiccation because of massive upstream diversions.

Significant strides have been made across Europe and Central Asia to expand access to water and sanitation, but large disparities in service levels persist. Most of the population has access to "at least basic" drinking water and sanitation.[3] However, almost one-third of the population lacks access to "safely managed" water and sanitation, and substantive efforts are needed to expand coverage. The sanitation gap is particularly acute in rural areas, where 50 percent of the population still lacks access to safely managed services. Similarly, although most of the region's population has access to a reliable (on average, 23 hours per day) source of drinking water, significant subregional- and national-level variations in continuity exist. For example, in Albania (where almost half the population lacks access to safely managed drinking water), on average, services are limited to 15 hours per day.

Regionally, less than two-thirds of all wastewater is collected, less than half of which is treated. Such high pollution loads threaten natural water ecosystems (for example, lakes, wetlands, and coastal areas) and may undermine tourism opportunities and affect drinking-water supplies. About 60 percent of all wastewater in Europe and Central Asia is collected (*figure ES.2*). Of this, approximately 43 percent receives at least primary treatment,[4] but only 6 percent undergoes further treatment or reuse (Jones et al. 2021). Sizeable subregional and country-level differences exist. For example, in the Danube, about 66 percent of wastewater is collected (of which 49 percent is treated), whereas only 39 and 24 percent of wastewater is collected and treated, respectively, in Central Asia and 51 and 29 percent, respectively, in the South Caucasus. Nationally, collection and treatment rates range from a high of 100 percent for both collection and treatment in Austria to a low of 24 and 5 percent, respectively, in Tajikistan. Many treatment plants across the region are outdated and lack the capacity to treat wastewater to modern standards, resulting in pollution and health hazards. Conversely, the low amounts of water reuse represent a significant opportunity to enhance regional water security, a move aligned with circular economy objectives.

Future Water Security Challenges in Europe and Central Asia

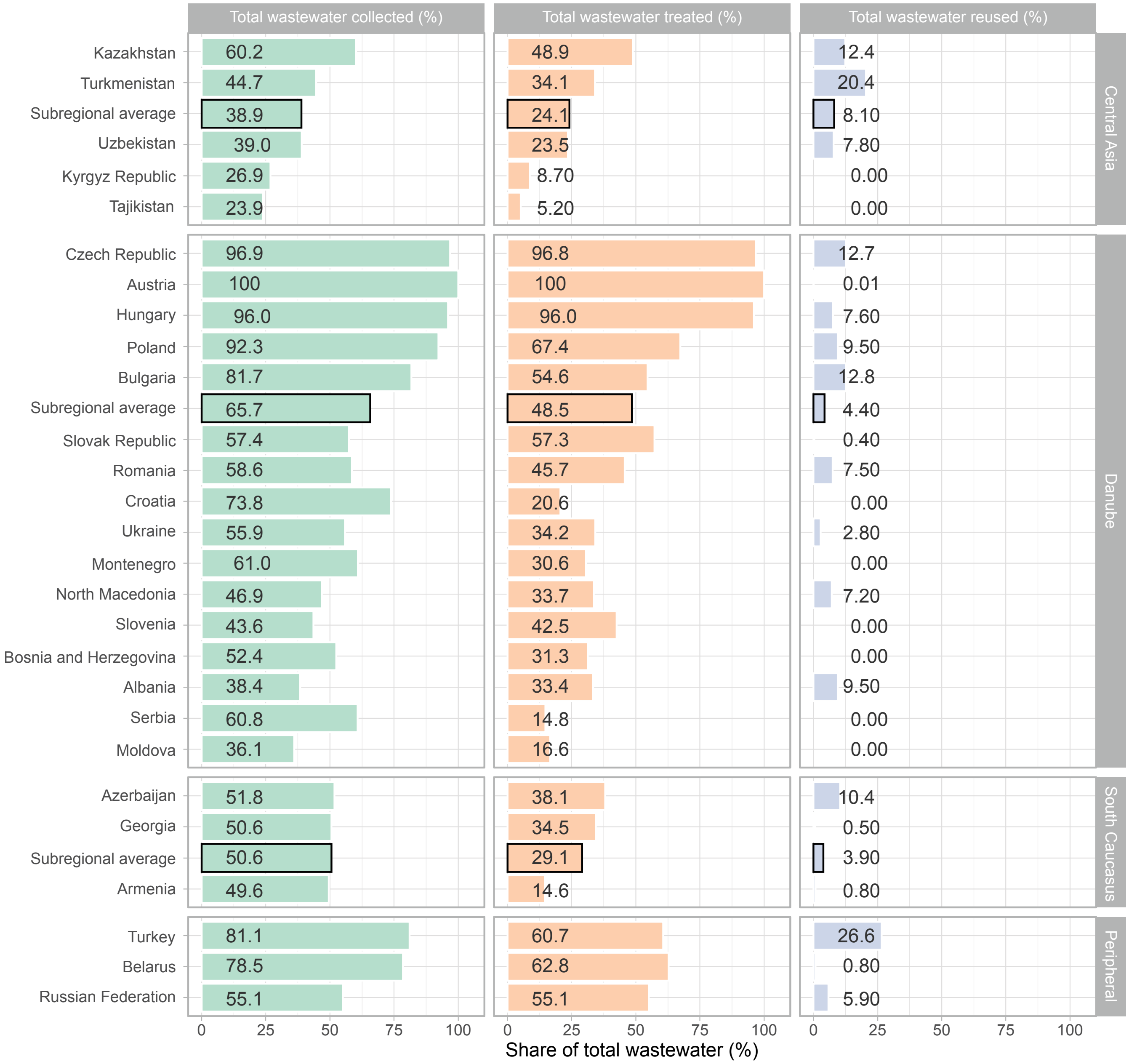
Important water security challenges are rapidly emerging across the region. Most countries depend heavily on transboundary surface waters that are subject to high seasonal and interannual variations, challenges that are expected to intensify with worsening climate change and increasing demands. On average, 41 percent of all surface water flows in Europe and Central Asia are transboundary, significantly more than in any other region in the world (*figure ES.3*, panel a). The dependency ratio is a good indicator of potential conflict over shared water resources and the need for cooperation. Central Asia is especially vulnerable, given its large dependency ratio (47 percent) and excessive water withdrawals, which exceeded 110 cubic kilometers in 2020 (*figure ES.3*, panel b), driven largely by the agricultural sector. By contrast, the Danube and the South Caucasus subregions withdrew 48 and 17 cubic kilometers, respectively.

Water storage—a critical tool for managing increasing variability—is a major concern across the region. Europe and Central Asia's dam storage capacity (1,128 cubic meters per capita) is 25 percent below the global average (*figure ES.3*, panel c), with increasing sedimentation (because of poor land management practices) reducing capacity by as much as 27 percent in some subregions. Glaciers and snow, key sources of water storage across much of Europe and Central Asia, particularly in the Danube and Central Asia, are also experiencing a progressive reduction because of global warming. Groundwater, a natural water store, remains inadequately regulated and under threat of pollution and overexploitation.

Climate change is expected to increase the frequency of extreme events and influence future water availability. Regional climate patterns suggest temperatures will rise

Figure ES.2

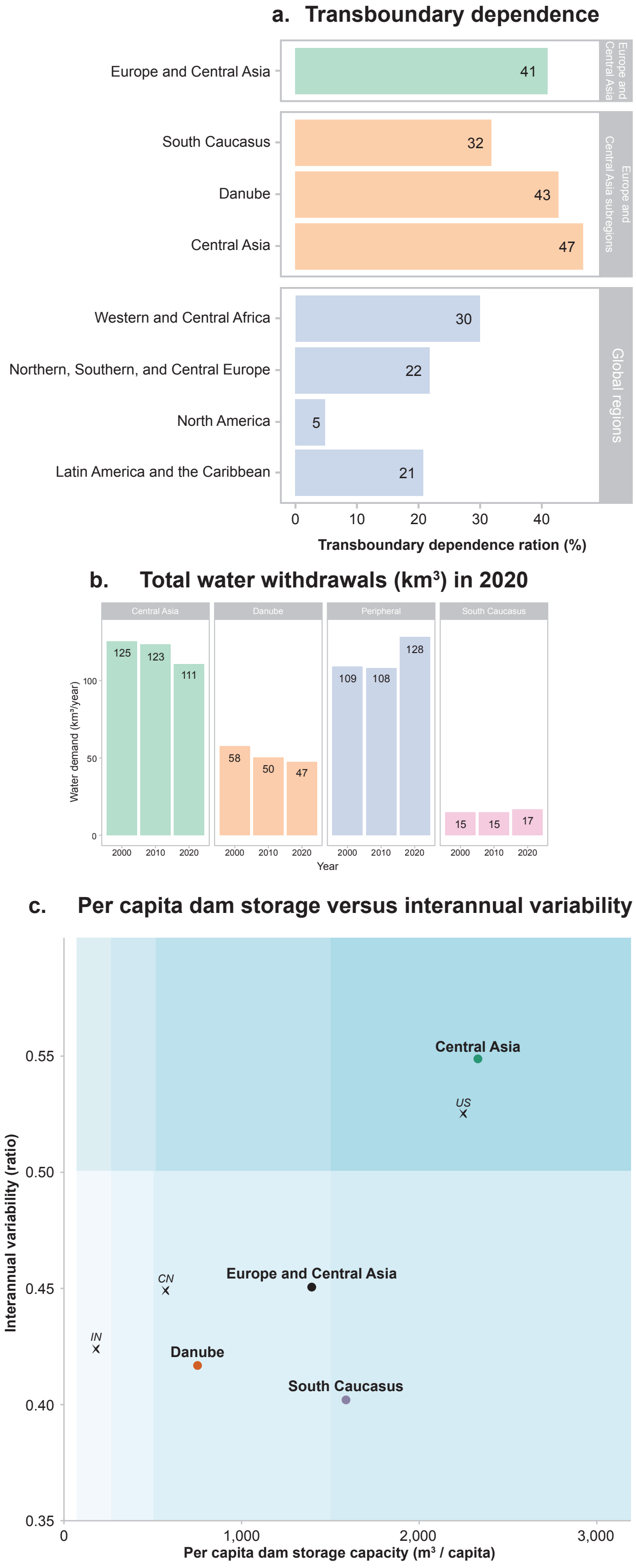
WASTEWATER TREATMENT by Country



Sources: United Nations Water Sustainable Development Goals (SDGs) indicator 6.3.2 (wastewater treatment).

Figure ES.3

KEY WATER Indicators across Europe and Central Asia



Source: AQUASTAT, 2024.

overall. Upstream countries are expected to experience an increase in rainfall and a reduction in snow storage, potentially leading to an increase in floods. Downstream countries are expected to experience decreased rainfall and reduced summertime flows (because of the reduced upstream snow melt), exacerbating drought risks in lowland areas (*map ES.2*).

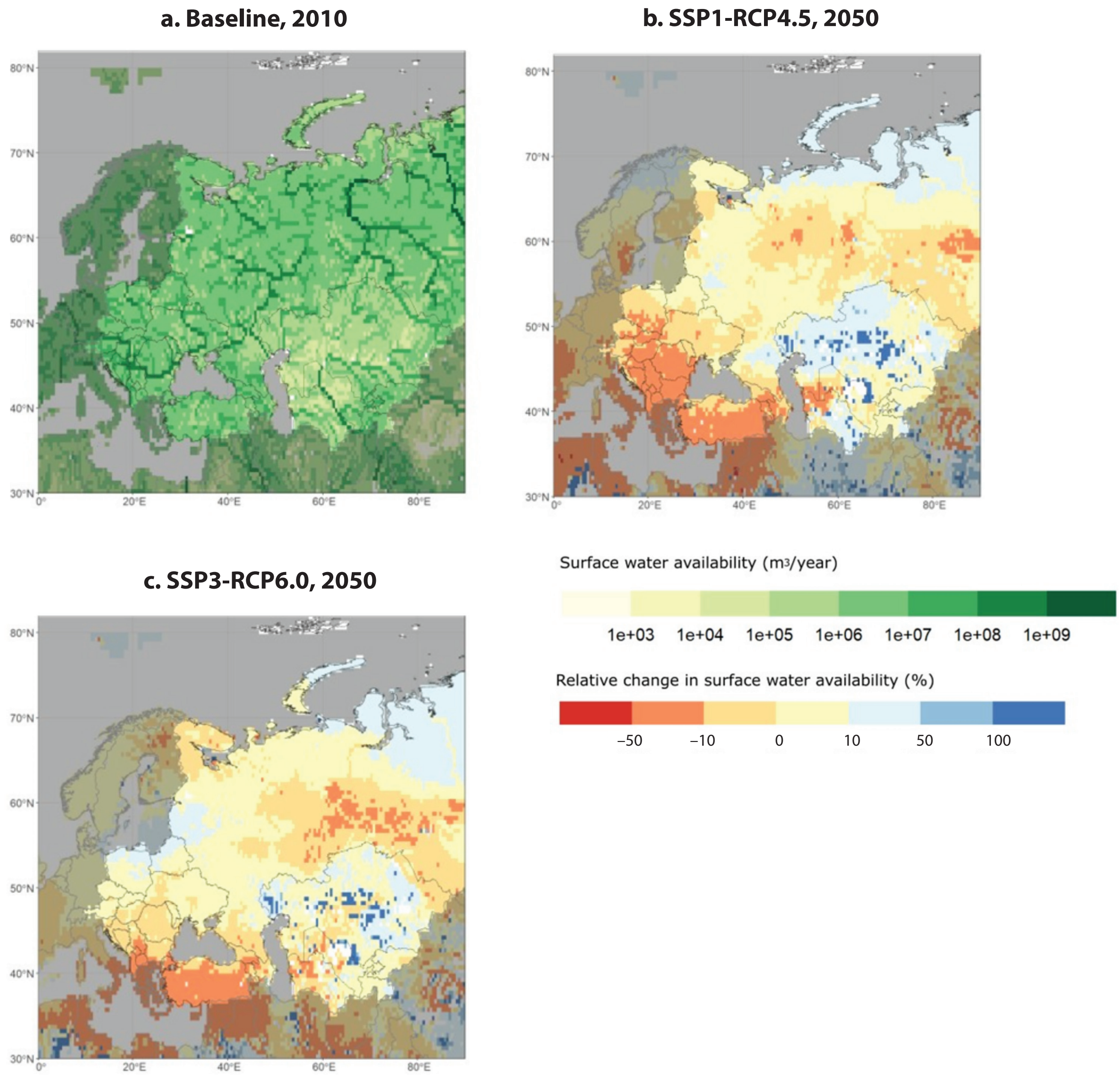
The Economic Costs of Water Security in Europe and Central Asia

Failure to mitigate climate change and implement adaptation measures could have serious economic consequences. The region's economic vulnerability to climate change underscores the importance of water security for resilience against extreme weather events, such as droughts and floods. Economic damages from such events in Central Asia could reach up to 1.3 percent of GDP annually, with crop yields potentially decreasing by 30 percent by 2050. Without adequate adaptation measures, the European region could face significant job losses and an annual climate-related extreme weather cost of approximately $184 billion by the end of the century. If current water management policies and practices remain unchanged, imminent climate and socioeconomic drivers could lead to a reduction of the subregional GDP in Central Asia of up to 11 percent by 2050 (figure ES.4), caused by water-related losses in agriculture, health, income, and property. Conversely, improving agricultural production, protecting environmental assets, and increasing green energy production could instead accelerate the subregion's economic growth by up to 12 percent.

The estimated cost of addressing water security and achieving water-related Sustainable Development Goals (SDGs) by 2030 amounts to $77 billion annually (0.6 percent of regional GDP). To deliver water security across Europe and Central Asia and achieve all the water-related SDGs, a rapid mobilization of $77 billion per year will be needed from 2015 to 2030 (*figure ES.5*; Strong et al. 2020). Larger relative efforts will be needed in Central Asia (2.2 percent of GDP) and the South Caucasus (1.3 percent of GDP) compared with the Danube (0.3 percent). The major share of these investments (approximately $30 billion per year) is needed to address challenges in water resources management (that is, water scarcity and integrated water resources management, including irrigation and drainage), whereas addressing water pollution will require $18 billion per year, closing the water supply and sanitation (WSS) services gap will require up to $16 billion per year, and addressing institutional reforms will require $13 billion per year. However, these investments are expected to be much lower than the potential social, environmental, and economic costs of inaction.

Map ES.2

COMPARISON OF Surface Water Availability between Baseline and Different Scenarios



Source: Satoh et al. 2017.

Note: RCP = Representative Concentration Pathway; SSP = Shared Socioeconomic Pathway.

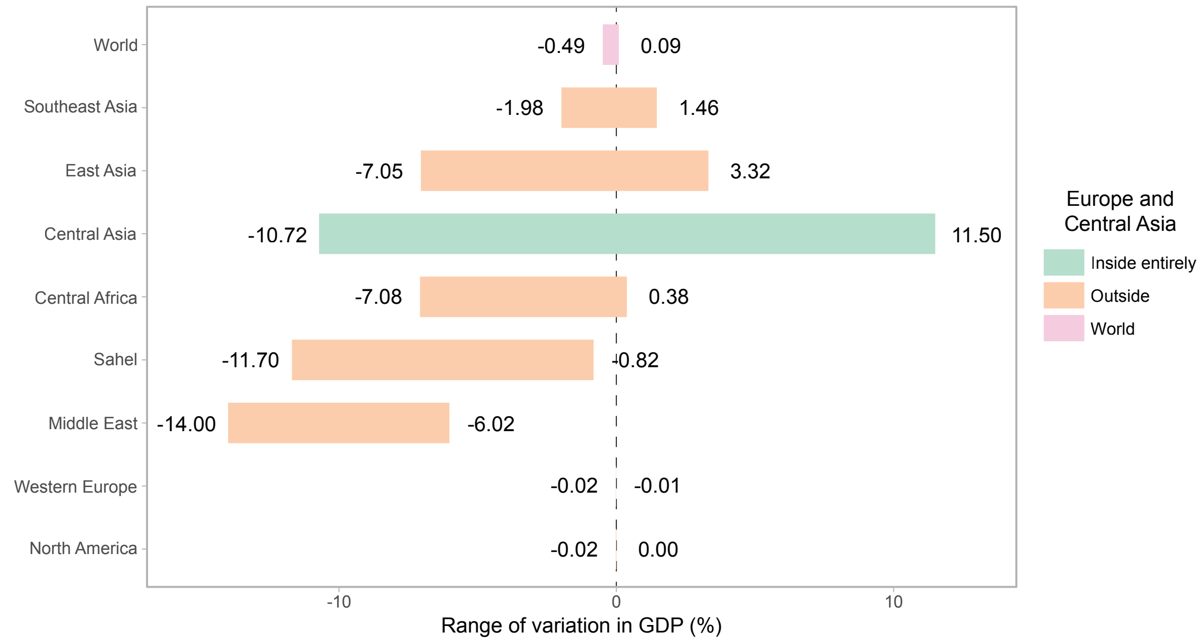
The Importance of Strong Institutions and Robust Infrastructure to Water Security in Europe and Central Asia

Overall, the Europe and Central Asia region is characterized by inadequate water sector architecture to meet water security challenges. Modernization of institutions, policies, and regulatory instruments is needed. Existing gaps limit the ability to maximize beneficial social, economic, and environmental outcomes that could otherwise be derived from water resources. These universal problems are symptomatic of three cross-cutting challenges and risks that underpin water security in Europe and Central Asia specifically:

1. Weak institutional capacity. The most pressing challenge is the need to strengthen and modernize institutional capacity across countries to support the full implementation of integrated water resources management (IWRM). This assessment reveals that there are important regulatory gaps in most countries, along with recurring institutional fragmentation, overlapping responsibilities, and limited cooperation

Figure ES.4

POTENTIAL CLIMATE-RELATED Impacts on GDP in 2050

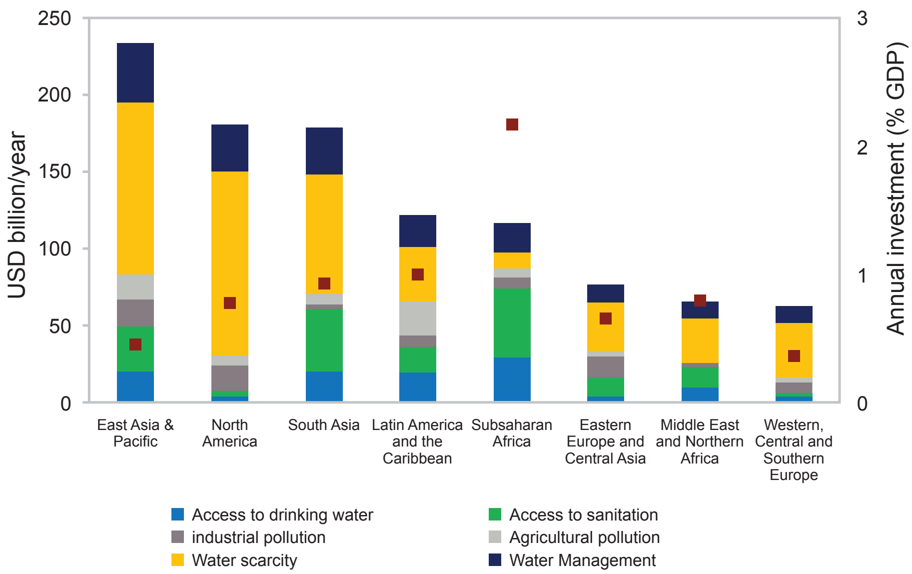


Source: World Bank 2016.

Note: The figure shows potential water-related climate-change impacts on GDP for select regions. It incorporates effects from different policy scenarios—for example, business as usual and better water allocation). GDP = gross domestic product.

Figure ES.5

ESTIMATED COSTS Needed to Achieve SDG 6, 2015–30



Source: Strong et al. 2020.

Note: Boxed *X* symbols represent annual investments by regions as a percentage of their regional GDP. GDP = gross domestic product; SDG = Sustainable Development Goal.

between institutions within and across countries. Adaptive capacities are low, with inflexible systems (for example, standards) for managing both short-term (droughts and floods) and long-term challenges (climate change).

2. Insufficient funding and inconsistent political commitments. These are two of the main causes behind the deteriorating state of water infrastructure, including severely compromised dam integrity in numerous countries, aging and inefficient irrigation systems, and extensive physical losses across water networks. With increasing demands in a more resource-constrained (physical and financial) environment, the infrastructure gap is widening in many countries, illustrated by, for example, inadequate water storage, limited coverage, and inadequate wastewater treatment. Finally, limited financial instruments constrain a provider's ability to fully cover costs and earn revenue from water management services. Such underperformance, coupled with an unattractive enabling environment, means private capital mobilization is currently limited in the region.

3. Low technical and human capacity. The water sector in Europe and Central Asia is grappling with significant gaps in capacity, underpinned by a shortage of professionals with the technical ability to operate and maintain infrastructure. This low technical and human capacity perpetuates a detrimental cycle of build-neglect-rebuild, further exacerbated by a lack of critical data and the limited adoption of new digital technologies and innovations (despite their prevalence in the private sector)—for example, the lack of comprehensive, remote-sensing-based water accounting in the South Caucasus and Central Asia, as well as some Danube countries. Further, there is limited understanding of groundwater, a vital resource for drinking and irrigation water throughout Europe and Central Asia, resulting in poor management and threats of pollution and overabstraction.

4. These limited technical and institutional capacities hinder the effective implementation of management instruments and the ability to respond to extreme hydroclimatic events, such as droughts and floods. A pervasive challenge throughout Europe and Central Asia is the absence of robust drought management strategies, despite increasing drought risks. This situation underscores the urgent need for enhancing technical capabilities and fostering a new generation of water professionals to ensure sustainable water management and infrastructure maintenance in the face of evolving environmental challenges.

PRIORITY ACTION AREAS TO ENHANCE WATER SECURITY ACROSS EUROPE AND CENTRAL ASIA

Several priority action areas for enhancing water security and achieving the water-related SDGs emerged from the preparation of this publication. Following the findings of this report, the action areas primarily address important gaps in water sector architecture—that is, institutions and infrastructure. A brief summary of the different action areas is presented next, grouped by the performance dimensions described in the WSDF: delivery of water-related services, management of water resources, and mitigation of water-related risks (see chapter 6 for a comprehensive review). Most investments and activities to strengthen water security across Europe and Central Asia will need to be implemented at the national level. However, regional activities are imperative, especially given the high level of transboundary dependency across the region. The successful implementation of the priority action areas therefore hinges on cross-cutting efforts to promote and strengthen regional cooperation.

Delivery of Water-Related Services

Modernize irrigation and drainage services to improve water efficiency and productivity. Addressing the needs of the irrigation and drainage sector will require substantial investments, climate-resilient strategies and technologies, and efforts to rehabilitate and modernize existing infrastructure while shifting to more efficient irrigation methods to improve water-use efficiency, reduce water losses, increase water productivity, lower costs, and increase agricultural production.

Expand WSS coverage and wastewater treatment to safeguard public health and the environment. Efforts to address gaps in the provision of WSS services include a set of institutional and financial reforms, prioritization of investments that can support the decarbonization of the water sector, and the adoption of climate-resilient infrastructure and services. A portfolio approach that includes a mix of technical and financial solutions will help the sector address coverage gaps, support socioeconomic development, and further reduce the burden of WASH-related disease.

Efforts to improve water-related services in Europe and Central Asia should generally target the following:

- Substantially increasing levels of funding to support the expansion of ongoing institutional and policy reforms, including creating a favorable enabling environment to increase private sector participation
- Modernizing and rehabilitating infrastructure and management practices to improve agricultural

productivity and efficiency, reduce water losses, expand access to safely managed WSS services, and protect the sector from climate shocks

- Strengthening and building capacities to improve the skills of service providers and increase commercial performance to attract private sector investment
- Devising and implementing innovative strategies to expand wastewater treatment and mitigate environmental pollution while fostering new, climate-neutral business models

Management of Water Resources

Modernize institutions and build capacity to support full implementation of IWRM. Widely ranging institutional and policy architecture reforms are needed to continue supporting and expanding IWRM across the region, along with targeted actions to increase the performance and management of water resources to mitigate water-related risks. As a first step, legislative and institutional frameworks must be strengthened or developed. This step includes prioritizing, developing, and implementing long-term, national water management strategies that address existing and future threats in countries where a strategy is still needed. Countries with national water management strategies already in place should continue adopting and implementing river basin management approaches while addressing existing related institutional weaknesses.

Develop innovative financing mechanisms that include a mix of taxes, tariffs, public funds, and private capital. Adequate funds should be earmarked and allocated to ensure that sustainable IWRM approaches are implemented in practice. Management instruments should be further developed to align with international best practices and increase the overall performance of water resources management, including in the following areas: planning documents; expansion and upgrading of monitoring systems; development of water information systems; and the promotion of data exchange, both between sectors and across basins and subregions.

Fast-track the adoption of smart technologies and modernize water information management systems. Monitoring, data collection, and information management systems are basic requirements of effective decision making, planning, and water resources management across and beyond the water sector. Efforts across Europe and Central Asia should focus on upgrading and expanding existing systems for irrigation and drainage and WSS services while adopting modern technologies designed to increase efficiency sectorwide. Such efforts include expanding and upgrading existing hydrological monitoring systems; developing groundwater and basin- and countrywide water balances; developing water information management systems; promoting the adoption of advanced technologies to enhance water planning, use, and management; and finally, sharing data and knowledge across the region.

Mitigation of Water-Related Risks

Enhance water-use efficiency and climate strategies to boost the economy and protect people and the planet. Given the high vulnerability of Europe and Central Asia's water resources and economies to the impacts of climate change, it will be key for countries to prioritize investments in water-use efficiency and build the necessary infrastructure and capacities to enhance systemwide climate resilience. Adaptation measures represent a great opportunity to rethink how countries in the region can boost economic productivity by lowering costs and increasing water productivity. Efforts to ensure water-related risks are adequately mitigated should generally prioritize funding, promote adaptation and mitigation measures, and tackle the sector's contribution to climate change. Specifically, efforts should include the following:

- Invest in technology and management practices for water-use efficiency, along with a strategy to rethink how water is managed across all levels of society, with a focus on increased water productivity across all sectors.
- Prioritize investments in measures for climate-change adaptation to build economic and social resilience. For example, upgrade existing facilities and networks to reduce water losses, and improve reservoir operations to better balance energy, enhance water security, and improve flood and drought mitigation.
- Promote adaptation measures to limit the impact of extreme weather events and rainfall variability, such as rehabilitating and increasing storage capacity and water-reuse systems.
- Invest in climate-resilient infrastructure and systems, particularly those that aim to reduce greenhouse gases (GHGs)—for example, addressing contributions to GHGs from wastewater treatment operations and throughout the sanitation service chain and reducing energy inputs across the sector.

Cross-Cutting Efforts to Promote Regional Cooperation to Strengthen Development Opportunities

Efforts to modernize institutions at the country level must be mirrored by efforts to promote cooperation at the regional level to strengthen development opportunities. Reforms and actions to enhance water security across Europe and Central Asia will require important efforts to strengthen, build, or rebuild regional relations and cooperation, especially given the high transboundary dependency across the region. Promoting greater regional cooperation to support the development and implementation of institutional and legal frameworks to jointly manage transboundary basin resources across all levels will unlock substantial benefits. Efforts to update (to include key principles of modern international water law) and implement existing agreements should be targeted. Boosting regional technical cooperation—including promoting regional policy dialogues on water resources management (WRM) to facilitate learning and exchange best practices—will reduce environmental and socioeconomic risks and costs, and reinforcing subregional political cooperation will further reduce the risks and costs of water insecurity and complement regional technical cooperation.

Notes

1. World Bank Data Bank; for more information, see *https://data.worldbank.org/indicator/ER.GDP.FWTL.M3.KD?most_recent_value_desc=true*.
2. Irrigation and Drainage Rehabilitation Project (Serbia), World Bank, 2021; for more information, see *https://projects.worldbank.org/en/projects-operations/project-detail/P087964*.
3. Drinking water from an improved source, provided collection time is not more than 30 minutes for a round trip, including queuing (see *https://washdata.org/monitoring/drinking-water*), and use of improved sanitation services, which are not shared with other households (see *https://washdata.org/monitoring/sanitation*).
4. Primary treatment is a physical process to remove debris that would either float or readily settle out by gravity (Ambulkar and Nathanson 2024).

1

Introduction

OBJECTIVE

Water security is a matter of increasing concern around the world. With rapidly growing demands for water and increasing variability in water availability because of climate change, Europe and Central Asia are no exception. Ensuring access for all users and mitigating water-related risks should be at the center of national and regional adaptation strategies.

Regionally, water drives positive socioeconomic trends. The region's relatively large water endowment has enabled it to become one of the world's largest grain and oilseed net exporters and a key player in global food security. As the third-largest producer of hydropower globally, the Europe and Central Asia region benefits from a stable domestic energy source that mitigates dependence on volatile fossil fuel markets. This is crucial for the region's energy security, especially in landlocked countries. Additionally, the low operating costs of hydropower translate to affordable electricity for millions. Finally, access to safe drinking water and sanitation services has improved the health and living conditions of millions of people.

Urgent management challenges nevertheless threaten the region's water security and sustainable development agenda. Growing water demands combined with inefficient management practices and climate-change impacts are leading to water stress; water conflicts are at the core of many political disputes between neighboring countries in Europe and Central Asia. Hydroclimatic extremes, such as floods and droughts, are becoming more frequent and more severe, negatively affecting economies, especially within lower-income countries. Access to safely managed water and sanitation services remains inequitable, with greater gaps in rural areas and marginalized communities in urban areas. Systemic challenges in water resources management (WRM), particularly in former Soviet Union countries, are not merely a matter of insufficient infrastructure but stem from a legacy of underprioritization and underfunding of water. These systemic challenges have hampered the development of robust institutions capable of effectively managing water as a vital, strategic resource, leading to difficulties in implementing integrated water resources management (IWRM) and ensuring the provision of high-quality services.

A unified document that encapsulates the complex narrative of regional water security is lacking. The Europe and Central Asia Water Security Initiative was launched and a comprehensive assessment undertaken to illuminate the various challenges and opportunities that lie on the path to achieving water security and catalyze a much-needed holistic dialogue across disparate sectors and institutions. The escalating threats posed by climate change underscore the urgency of this endeavor. By enhancing our understanding of the region's prevailing situation, more cohesive, strategic, and adaptive responses can be forged, and as feasible, the adverse impacts of climate change can be mitigated.

Addressing the pressing constraints in governance, infrastructure, and funding is pivotal for advancing the region's Sustainable Development Goals (SDGs). Central to this advancement is the management of water-related risks, which is integral to effective climate-change adaptation and mitigation strategies aimed at diminishing vulnerabilities and fortifying resilience across the region. To navigate these challenges and secure a water-resilient future, fostering robust collaborations among regional stakeholders, water practitioners, and policy makers is fundamental.

SCOPE AND STRUCTURE

This report offers a cohesive regional picture of current and future water security challenges, risks, and opportunities. Based on an extensive examination of development documents, planning materials, scientific literature, and in-country consultations, this report lays out a strategic framework and initial set of thematically organized priority actions. The report highlights areas where additional detailed assessments are needed to support a comprehensive approach to river basin management, sector-specific investment plans, and other essential planning and execution facets of water governance.

The report is meant for policy makers and decision makers working in water security or sectors for which water is a critical input, as well as sector practitioners. It aims to address the following four crucial questions:

1. What benefits do the region's water resources provide?
2. What are the challenges and risks to the region's water assets?
3. What opportunities are there to leverage the benefits of water for society, the economy, and the environment?
4. How could water security in the region be improved?

The structure of the report is designed to explore these questions as follows:

- The rest of chapter 1 introduces the Water Security Diagnostic Framework (WSDF).
- Chapter 2 provides an overview of the region's critical physical attributes and socioinstitutional dynamics.
- Chapters 3 through 6 present a thorough assessment of each of the WSDF's layers, beginning with a comprehensive discussion of the social, economic, and environmental outcomes of water security; followed by a presentation of the region's existing water endowment; then a detailed analysis of institutions and infrastructure (together, water sector architecture); and finally, an evaluation of performance that assesses the delivery of water-related services, management of water resources, and management of water-related risks.
- Chapter 7 presents key recommendations for enhancing water security in Europe and Central Asia.

METHODOLOGY

The Water Security Diagnostic Framework

Achieving water security is the overarching goal of water management. Water security is a complex, multidimensional, and multisectoral concept that involves building a water-secure future for people, the economy, and the environment in the face of local and global challenges. Creating a water-secure world is a double-edged sword that includes leveraging water productivity for human well-being, livelihoods, and environmental and socioeconomic gain while managing the destructive impacts of water, such as floods, droughts, and pollution, to protect societies, economies, and the environment. Water insecurity is driven by a combination of environmental, socioeconomic, technological, and governance factors. In the most water-insecure countries, there is typically a combination of challenging hydrological environments, weak institutions, and chronic underinvestment in water infrastructure. Even when water is abundant and the hydrologic regime is favorable, there may be mismanagement (for example, poor pollution regulation) or inadequate infrastructure investments that can lead to water insecurity.

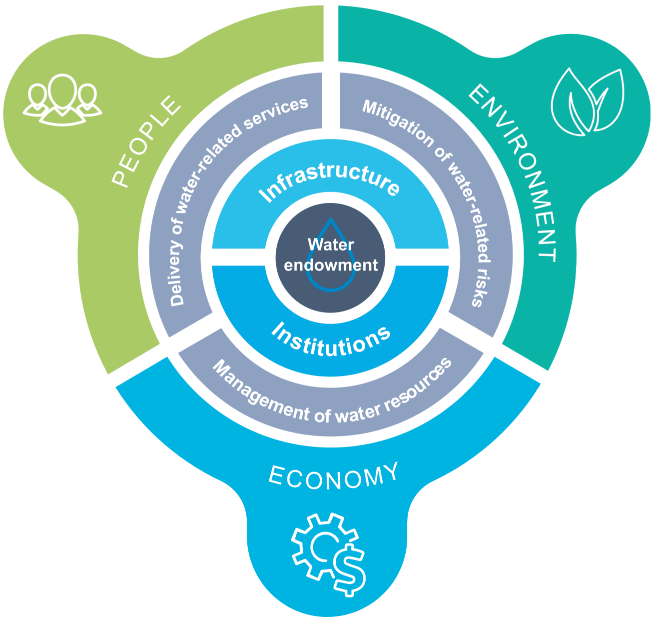
Water security is too complex to be adequately assessed by a single integrated index. Further, it often intersects with other security concerns, including energy, food, climate change, and overall national security. As an alternative to establishing a rigid methodology for measuring water security, the Water Global Practice of the World Bank developed a more holistic yet comprehensive approach: the WSDF (*figure 1.1*), which aims to establish a consistent and structured approach to diagnosing water security without being overly prescriptive. The benefit of this approach is its ability to rapidly identify the most severe risks and significant opportunities and facilitate global comparisons and benchmarking countries. The WSDF seeks to analyze the relationship between a country's evolving water endowment and social, economic, and environmental outcomes by examining water sector architecture (encompassing both infrastructure and institutions) and overall performance, including WRM, delivery of services, and mitigation of water-related risks.

Operationalizing the WSDF

The WSDF was operationalized through an innovative approach that maximizes already available information and resources. This was achieved by applying a set of integrated

Figure 1.1

WATER SECURITY Diagnostic Framework and Its Dimensions



Source: World Bank 2019.

quantitative and qualitative indicators that together allow a country or region's performance to be rapidly, consistently, and systematically assessed across each of the WSDF's four dimensions (endowment, architecture, performance, and outcomes). This approach promotes a dynamic learning cycle that continuously strengthens itself and accelerates the identification of new opportunities and gaps. It also provides the fastest possible pathway toward implementing high-impact actions that incrementally improve water sector performance while involving stakeholders from different institutional levels and water-related sectors. The framework adopted a phased approach, as described in the following subsections.

Phase A: Preparatory and Diagnostic

Phase A established the baseline for water security within Europe and Central Asia by delineating current conditions and forecasting future challenges, risks, and opportunities, considering both national and global influences. A suite of quantitative and qualitative indicators was used to evaluate the maturity of the WSDF's four dimensions, supplemented by a qualitative analysis of regional and country-specific data, together with stakeholder engagement through scoping interviews. The culmination of this phase led to a comprehensive diagnosis detailing regional water security, guided by the WSDF framework and detailed assessments of individual countries. These country-specific pages, presented in appendix B, offer valuable insights into key indicators, challenges, and opportunities for each nation. Those interested in understanding the context and data for each country should refer to them. Additionally, a full list of indicators can be found online http://documents.worldbank.org/curated/en/099062424121127642/P17003013a15d28d1942d1420e198a6115ac6adf91d9.

Phase B: Identification of Recommendations to Enhance Water Security

Drawing on the findings of the diagnostic phase, phase B aided in the identification of regional and subregional strategies needed to bolster water security across Europe and Central Asia. This phase involved identifying recommendations at the regional and subregional scales. The principal outcome was a strategic road map outlining recommendations that serve as a foundation for a strategic action plan. The plan aims to leverage existing momentum generated through the regional diagnosis to expedite policy reforms and investment strategies, fostering the realization of a long-term vision for regional water security.

The Europe and Central Asia water security diagnostic used a hybrid approach that combined a desktop review of existing literature, development reports, in-country consultations, and open-source data sets with insights from country-specific deep dives and general water security evaluations, including at the Danube subregional level (*table 1.1* and *Appendix B*). This methodological approach gave rise to a comprehensive regional assessment that integrated diverse perspectives and data sources validated by relevant stakeholders in select countries to inform the identification and implementation of strategic actions to enhance water security across the region.

Climate-Change Scenarios

The Intergovernmental Panel on Climate Change (IPCC) uses a set of climate and socioeconomic models to study future scenarios related to climate change. The climate scenarios called Representative Concentration Pathways (RCPs) comprise four projections of how concentrations of greenhouse gases (GHGs) in the atmosphere will change because of human activities. The four RCPs (that is, RCP2.6, RCP4.5, RCP6.0, and RCP8.5) range from low future concentrations (RCP2.6) to high (RCP8.5). In this assessment, three are considered; for simplification, these are referred to as low-emission (RCP2.6), medium-emission (RCP4.5), and high-emission (RCP8.5) scenarios. For each RCP, we used the projections of five different climate models: the Geophysical Fluid Dynamics Laboratory Earth System Model (GFDL-ESM4), the Institut Pierre-Simon Laplace coupled model for CMIP6 (IPSL-CM6A-LR), the Max Planck Institute Earth System Model (MPI-ESM1-2-HR), the Meteorological Research Institute Earth System Model (MRI-ESM2-0), and the UK Earth System Model (UKESM1-0-LL6F6F).

The socioeconomic scenarios called Shared Socioeconomic Pathways (SSPs) are five narratives describing alternative future development cooperation and priorities. For this assessment, we explored three scenarios: SSP1, SSP3, and SSP5. SSP1, "Sustainability Path," is optimistic and imagines a world acknowledging environmental boundaries, increasing equality and education, increasing economic growth motivated by human well-being, and decreasing the use of resources and energy. SSP3, "Regional Rivalry," is a middle-of-the-road scenario and envisions a future where there is a resurgent nationalism that increases concerns about competitiveness and security. Regional conflicts push countries to increasingly

TABLE 1.1 Countries Included in the Europe and Central Asia Regional Water Security Assessment Table 3 Estimated costs (in billion 2015 US$) to deliver sustainable water management in ECA region and its subregions

Europe and Central Asia subregion	Countries covered under Europe and Central Asia regional water security assessment	Europe and Central Asia regional assessment	Deep-dive country assessments	General country assessments	Danube regional assessment
	Austria	X			X
	Bosnia and Herzegovina	X	X		X
	Bulgaria	X			X
	Croatia	X	X		X
	Czech Republic	X			X
	Hungary	X			X
	Kosovo	X			X
	Moldova	X			X
	Montenegro	X	X		X
Danube	North Macedonia	X			X
	Poland	X			
	Romania	X			X
	Serbia	X	X		X
	Slovak Republic	X			X
	Slovenia	X			X
	Ukraine	X	X		X
	Albania	X	X		X
	Kazakhstan	X		X	
	Kyrgyz Republic	X		X	
	Tajikistan	X		X	
Central Asia	Turkmenistan	X		X	
	Uzbekistan	X		X	
	Armenia	X		X	
South Caucasus	Azerbaijan	X		X	
	Georgia	X		X	
	Belarus	X			
Peripheral	Russian Federation	X			
	Türkiye	X			

Note: The table also depicts the level of assessment performed at the country level as part of the World Bank Europe and Central Asia Water Security Initiative.

focus on domestic or, at most, regional issues. A low international priority for addressing environmental concerns leads to substantial environmental degradation in some regions. SSP5, "Fossil-Fueled Development," is pessimistic and imagines a world that places increasing faith in competitive markets, innovation, and participatory societies to produce rapid technological progress and development of human capital as the path to sustainable development. Each of the SSPs is associated with quantitative projections of population and gross domestic product (GDP; Jones and O'Neill 2016) that drive the changes in water demand. The report considers combinations of these climate and socioeconomic scenarios. The socioeconomic projections include population projections made using various assumptions, including fertility, mortality, migration, and education rates.

ADVANCING WATER SECURITY IN EUROPE AND CENTRAL ASIA

This report is designed to engage and inform a broad spectrum of stakeholders within Europe and Central Asia, encompassing national governments, regional entities, multilateral organizations, and regional nongovernmental organizations involved in water management and sustainability. With its comprehensive approach, the report serves two primary purposes.

First, it aims to trigger dialogue on current regional water security challenges among countries and relevant stakeholders and offer actionable recommendations tailored to the unique and shared water security challenges faced by individual countries within Europe and Central Asia. These recommendations aim to guide national policy reforms, investment strategies, and management practices crucial for enhancing water security at the country level. By identifying common issues across the region, the report provides a blueprint for national governments to implement solutions that are both effective in their local context and beneficial for the region's collective water security.

Second, the report underscores the critical role of regional action in promoting stronger cooperation and coordination across Europe and Central Asia. By highlighting successful case studies and best practices, it seeks to inspire stakeholders to embark on collaborative projects and initiatives that can leverage collective strengths and address the multifaceted aspects of water security. The report aims to promote a more cohesive and unified effort toward achieving sustainable water management, ensuring the long-term resilience and prosperity of the region against a backdrop of climate change and increasing water-related challenges.

2

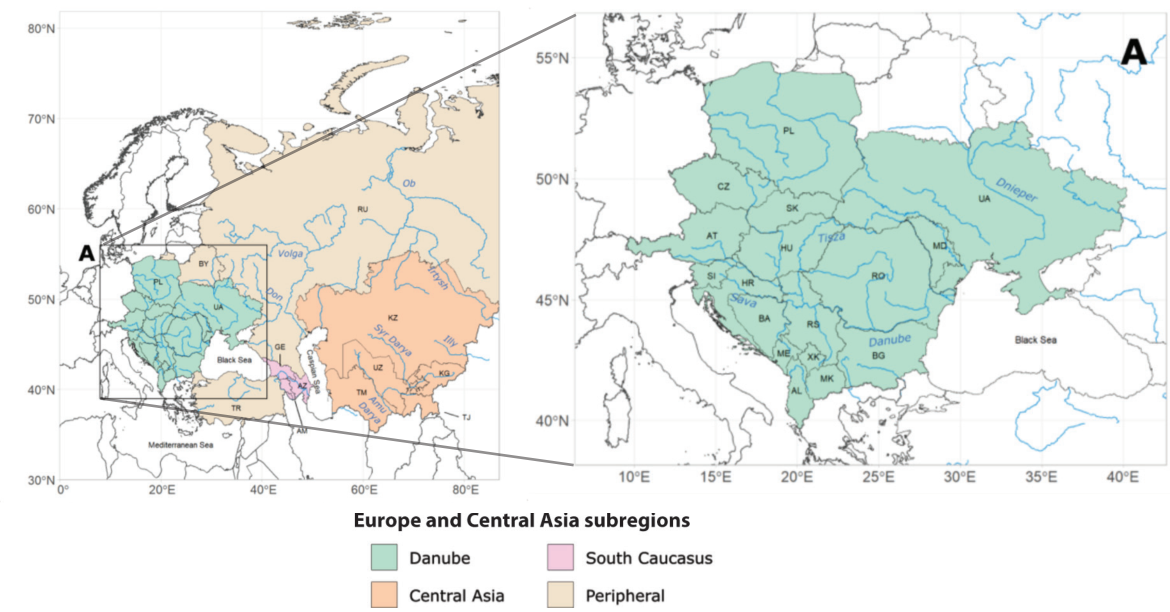
Setting the Scene

Countries in Europe and Central Asia are highly diverse from a geographical, cultural, economic, and historical viewpoint. There are also notable differences in socioeconomic circumstances and political regimes. In Eastern Europe, countries such as Hungary and Poland have experienced significant transformations since the fall of the Iron Curtain, each pursuing unique paths toward economic development. These efforts have led to diverse forms of governance and economic models, contributing to their economic growth and increased integration with broader European standards. Since gaining independence in the early 1990s, Central Asian countries have maintained distinct governance structures. Whereas Eastern European nations have developed closer affiliations with the European Union and the North Atlantic Treaty Organization (NATO), Central Asian nations have historically aligned more closely with the Russian Federation and China, although this dynamic is evolving. These diverse geopolitical orientations help shape the unique governance landscapes across these regions. Given the region's diversity, a nuanced understanding is critical. Appendix B includes country pages that delve into specific metrics and characteristics, enabling readers to explore how these elements vary from country to country.

For this assessment, the region has been clustered into three main subregions (*map 2.1*). This division acknowledges the

Map 2.1

MAPS DEPICTING Countries Assessed, the Main Rivers, and Three Subregions



distinct geographical features, climatic conditions, and socioeconomic contexts of each but also, importantly, shared transboundary waters.

The Danube subregion encompasses all countries that are part of the Danube River basin (DRB), including Eastern Europe and the Balkan countries. Although the subregion is highly diverse, in addition to being connected through the DRB, some countries share similar historical influences. For example, several Eastern European countries, including those in the Balkans, were part of the Soviet bloc during the Cold War, and the transition from communism to democracy and market economies has been a shared experience. Many Eastern European countries have become members of the European Union (EU), aligning themselves with Western European values and institutions. In contrast, most Balkan countries are still in the process of seeking EU membership. In the Danube subregion, organizations like the International Commission for the Protection of the Danube River (ICPDR), the Sava Commission, the Danube Commission, and the EU Strategy for the Danube Region play vital roles in enhancing water security. These entities work collaboratively on issues ranging from environmental protection and water management to navigation and sustainable development, ensuring the long-term health and security of the region's water resources.

The Central Asia subregion includes Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan. These countries are clustered together because of their geographical proximity and historical, cultural, and linguistic similarities. Geographically, Central Asia is located at the heart of the Eurasian continent and is characterized by vast steppe lands, deserts, and mountain ranges. This subregion is landlocked and shares borders with Afghanistan, China, Islamic Republic of Iran, Russia, and the Caucasus subregion. The region's complex river systems, including the Amu Darya and Syr Darya Rivers, which originate in the mountainous regions and flow into the shrinking Aral Sea, are crucial for the region's water supply, supporting agriculture, hydropower, and the livelihoods of millions. These countries also share common challenges and opportunities related to economic development, natural resource management, and regional water and energy security. Regional organizations like the Central Asia Regional Economic Cooperation (CAREC) program, the International Fund for Saving the Aral Sea (IFAS), and the Regional Environmental Centre for Central Asia play pivotal roles in fostering cooperation on common issues such as economic development, environmental sustainability, and water security.

The countries in the South Caucasus subregion—Armenia, Azerbaijan, and Georgia—share history and geographical proximity. They are located in the southern part of the Caucasus Mountains, which form a natural border between Europe and Asia. The region houses significant transboundary river basins, such as the Kura-Arak basin, which is a critical water resource for agriculture, hydropower, and domestic use across all of the countries.

HISTORY

Political changes have profoundly influenced water governance. Across Europe and Central Asia, the historical perspective on water sector development reveals a complex landscape. Each subregion presents a unique transition from centralized, often Soviet-influenced systems toward more fragmented and diverse approaches to water governance shaped by political, economic, and environmental reforms.

Water supply and sanitation (WSS) services in the Danube were significantly affected by the subregion's transition from centrally planned, Socialist economies to market-driven democratic systems in the 1990s. This shift led to a comprehensive transformation in service provision, mirroring the broader political and economic transformations within the region. This transition period saw efforts to improve efficiency, sustainability, and public service frameworks, marked by decentralization and increased private sector involvement. The expansion of the EU played a crucial role in shaping the future trajectory of water service provision in the Danube subregion, emphasizing the need for sustainable practices and compliance with EU environmental standards as countries in the Danube catchment moved toward EU integration. The Danube Commission and the ICPDR have been crucial during this transformative period and have guided the shift toward EU standards in water management, focusing on navigation, environmental protection, and sustainable water use. Their efforts facilitated regional cooperation, aligning national policies with EU directives and promoting sustainable development. Through these initiatives, the region has seen improved water quality, effective flood risk management, and enhanced biodiversity conservation, reflecting a successful integration of environmental goals with economic and political reforms.

Water sector development in Central Asia is characterized by the Soviet legacy of unified water management systems that facilitated integrated management of major river basins. The Soviet disintegration in 1991 introduced challenges to this cooperative framework, leading to difficulties in transboundary water cooperation among newly independent states. Efforts to continue collaboration, such as the establishment of the Interstate Commission for Water Coordination of Central Asia (ICWC), faced challenges because of tensions over water sharing and infrastructure management. The interdependence of water for agriculture and energy through hydropower in Central

Asia, particularly in countries like Uzbekistan, illustrates the critical water-energy nexus in the region. This accentuates the delicate balance required between sustaining agricultural output and meeting energy demands, which is essential for economic stability and growth.

Water and environmental protection in the South Caucasus subregion have changed significantly since the subregion gained independence from the Soviet Union in 1991. The approach to addressing environmental and water sector challenges in the subregion has evolved along political lines. Armenia and Georgia have seen developments toward mixed-governance models, whereas Azerbaijan has pursued a distinct governance path. These varied political landscapes have influenced strategies and priorities in tackling environmental and water-related issues, highlighting the diverse responses within each country to similar challenges. Environmental activism, particularly in Georgia, reflects the complex relationship between political interests, economic development, and environmental stewardship. In Armenia, environmental concerns, initially overshadowed by economic recovery efforts after independence, saw a resurgence of movements addressing the ecological and social impacts of development projects.

CLIMATE AND GEOGRAPHY

The Danube subregion is known for its extensive river system, which flows through numerous European countries, making it one of the continent's most vital waterways. The Danube River is a crucial resource for water supply, transportation, agriculture, and industrial activities. The subregional climate is predominantly continental, supporting a wide array of ecological systems and agricultural practices. This climate also brings challenges, such as seasonal flooding and subsequent degradation of water quality because of erosion.

The South Caucasus is geographically and climatically diverse, featuring high mountain ranges, fertile valleys, and arid plains. This subregion straddles the border between Europe and Asia and includes the southern part of the Greater Caucasus mountain range, the Lesser Caucasus mountain range (*map 2.2*, panel a), and various lowlands and plateaus. This diversity results in a range of climatic conditions, from humid and temperate climates in the mountains to semiarid and arid conditions in the lowlands. These geographical features influence water availability and affect every aspect of water management, from agricultural practices to hydropower generation and domestic water supply.

Central Asia's geography is characterized by vast steppes, deserts, and mountain ranges, with a predominantly arid and continental climate. The subregion is bounded by high mountain ranges to the east and south that significantly influence climate and water resources. Overall, the climate is characterized by hot summers and cool winters, with minimal precipitation (*map 2.2*, panel b), leading to heavy dependence on irrigation for agriculture, supplied largely by the Amu Darya and Syr Darya Rivers. The geography and climate of Central Asia pose significant challenges to water management, requiring innovative solutions for sustainable practices for water use and agriculture.

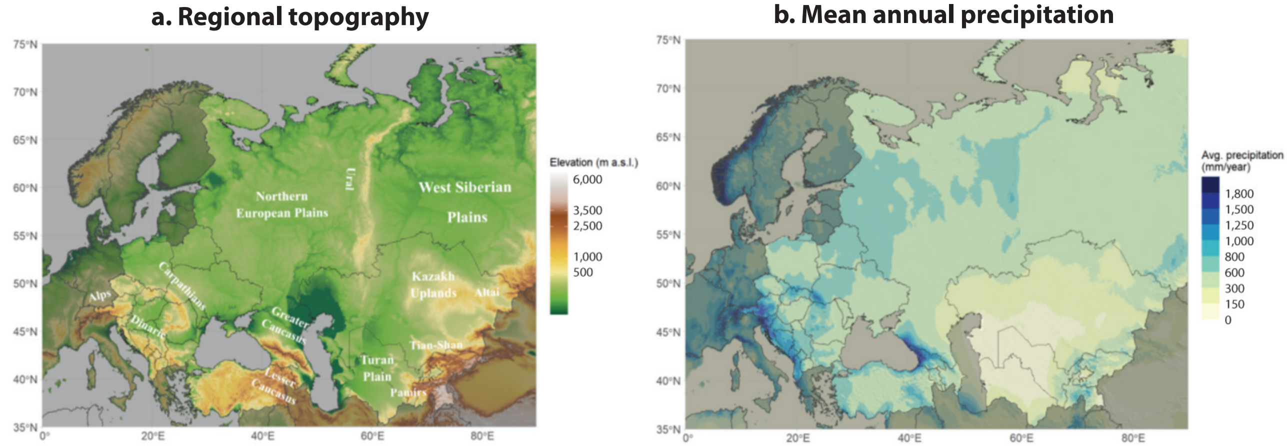
DEMOGRAPHICS

Urbanization across Europe and Central Asia reflects broader global trends that have seen a shift toward urban living. This transition brings opportunities and challenges in regard to infrastructure, service delivery, and sustainable

Map 2.2

TOPOGRAPHY AND Precipitation in Eastern and Central Europe

a. Regional topography **b. Mean annual precipitation**



development. On the one hand, urbanization can drive investments in water and sanitation infrastructure, promote water-use efficiency through innovation, and strengthen water governance. On the other hand, urbanization increases water demand, exacerbates water pollution, strains infrastructure, and heightens vulnerability to climate-related water risks. Rapid urban changes demand adaptable and resilient water management strategies to ensure sustainable development and equitable access to water resources.

Population trends in the region reveal a complex picture influenced by urbanization, demographic shifts, and migration patterns. The Europe and Central Asia region has a total population of close to 500 million people. Population dynamics are shaped by varying rates of urban-to-rural ratios, demographic changes in both urban and rural populations, and distinct migration flows that are evident when specific subregions are examined. Rural areas in Europe and Central Asia, especially in Eastern Europe, have experienced significant demographic changes over the past few decades, primarily characterized by aging populations, declining birthrates, and migration to urban areas. These changes have had profound impacts on agriculture in the region, affecting both the labor force and land use patterns.

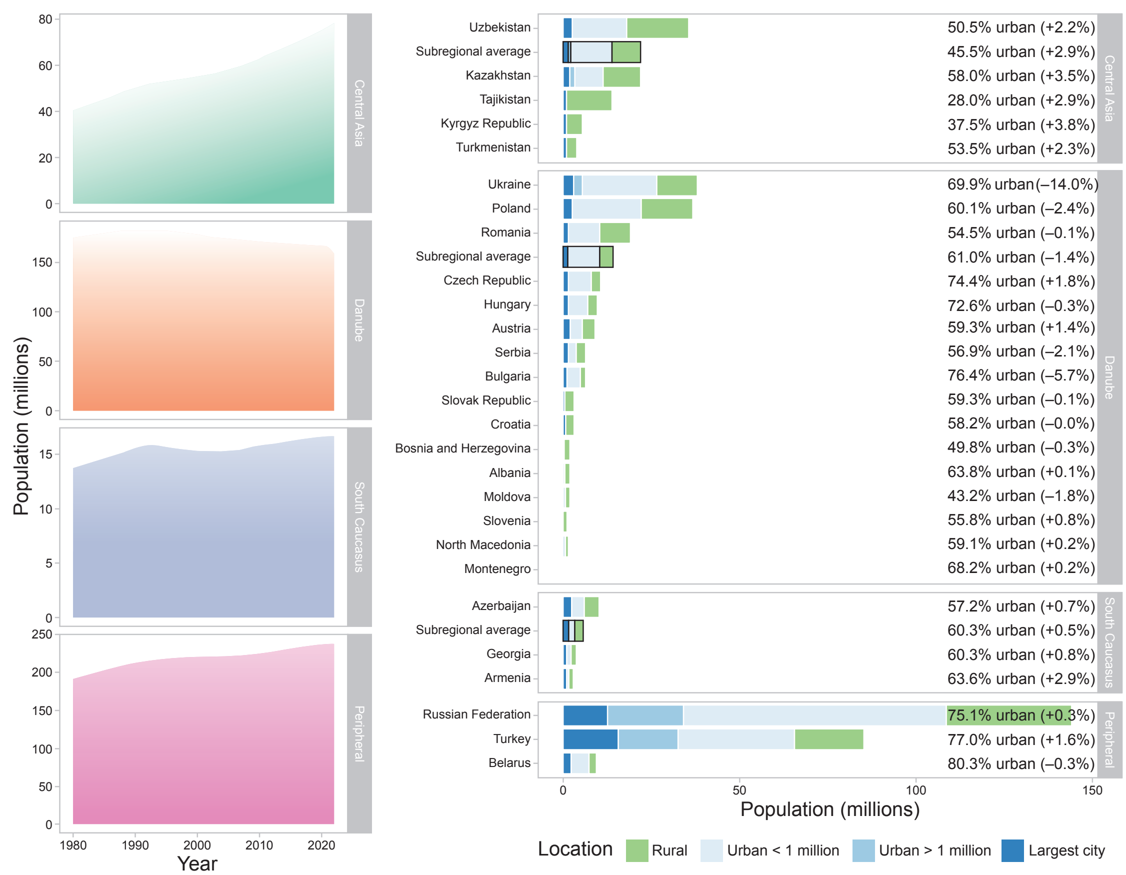
In the Danube subregion, the population has decreased slightly since 1990 and now stands at roughly 165 million. There are, however, different trends within countries regarding migration and urbanization (*figure 2.1*). Austria, Bulgaria, and Hungary have higher urban-to-rural ratios, indicating a predominantly urban population. For instance, Austria has seen a positive change in total population

Figure 2.1

HISTORICAL POPULATION Trends and Current Shares of Urban Population in Europe and Central Asia Subregions

a. Population in the Europe and Central Asia region by subregion and countries

b. Population in rural, urban, and city areas and growth rate of urban share of population in 2022 in parentheses



Source: World Bank 2024f.

owing to an increase in urban population and substantial international migration inflow. Bulgaria's urban share of the total population is one of the highest at about 75 percent, yet it, Romania, and Serbia face population declines with negative urban demographic trends, accompanied by significant numbers of people leaving the country. This outflow may be attributed to economic opportunities elsewhere and aging.

The South Caucasus subregion is the least populated in Europe and Central Asia and exhibits diverse trends (*figure 2.1*). Armenia's urban population has increased, but the overall trend is slightly negative, and there has been a notable outflow of migrants. Armenia's urban-to-rural ratio is the highest at 1.73, indicating that most of the country's 2.8 million people live in cities. Azerbaijan, with a population surpassing 10 million, and Georgia, with 3.7 million, also have urban majorities (urban-to-rural ratios of 57 and 60 percent, respectively; *figure 2.1b*). Azerbaijan presents a contrasting scenario with an increase in both total and urban populations and a relatively small but positive migration figure. Trends in Georgia are similar to those in Armenia, with a declining total population and significant migration outflow, indicative of the region's challenges, including economic and geopolitical tensions.

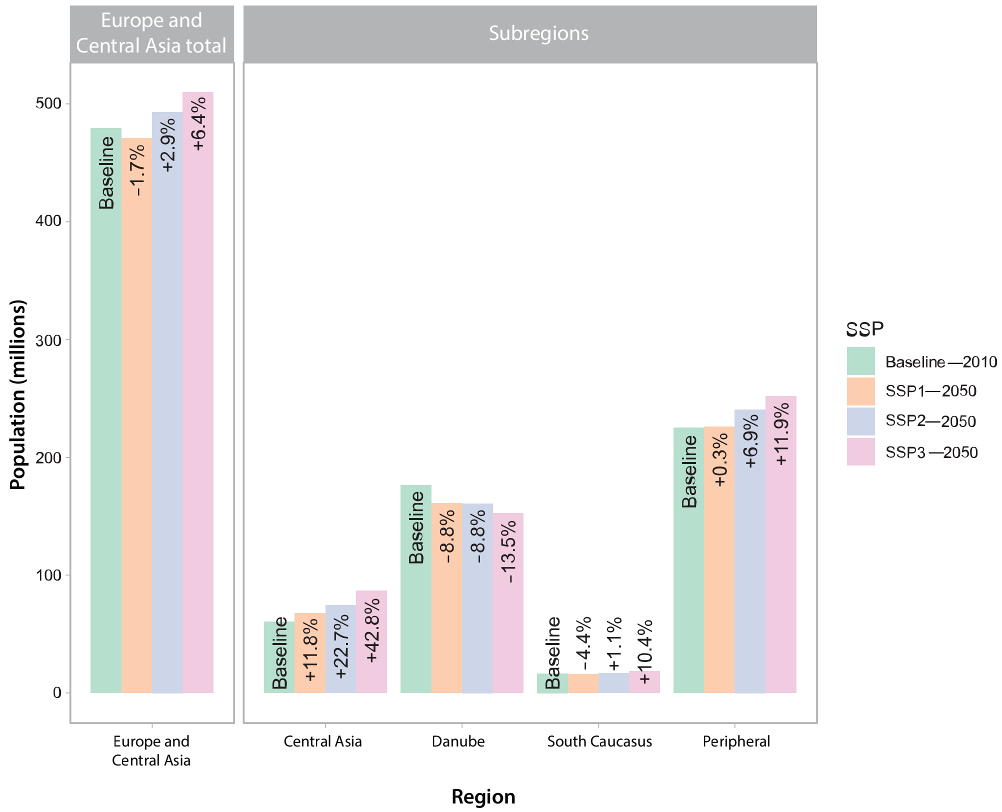
The Central Asia subregion is marked by high population growth (*figure 2.1a*), especially in Tajikistan, which has experienced the highest percentage increase among the subregion (*figure 2.1b*). This subregion is home to a burgeoning population, exemplified by Kazakhstan's 19 million people and Uzbekistan's 34.9 million, comprising large urban populations illustrated by urban-to-rural ratios of >1. The Kyrgyz Republic, Tajikistan, and Turkmenistan have lower urbanization rates, reflected in the urban share of their population of 37, 28, and 54 percent, respectively. However, each of these countries has experienced a negative migration trend, with Kazakhstan having the largest outflow. The otherwise lower urban-to-rural population ratios overall reflect the subregion's strong rural character and the associated challenges in urban development and migration.

POPULATION GROWTH

Future population projections for Europe and Central Asia suggest a varied demographic landscape influenced by factors such as fertility rates, migration, education, and economic development (*figure 2.2*). Overall, the regional

Figure 2.2

PROJECTION OF Future Population in 2050 for Europe and Central Asia under the Three Shared Socioeconomic Pathways (SSPs)



Source: SSPs outlined by Samir and Lutz 2017 in Satoh et al. 2017.

population is expected to stay close to 500 million through 2050, despite a population increase in the Central Asia subregion.

The Danube subregion is expected to experience a small population decline through 2050. All scenarios[1] predict a population decrease for the subregion: from a 2010 baseline of approximately 176 million to a potential low of nearly 152 million. In contrast, Albania could see its population increase to as much as 3.6 million, a stark contrast to its 2010 baseline of approximately 3.2 million. Although a declining population might reduce the strain on water resources, increasing economic activity could counteract this by intensifying water use (see "Water Availability" in *chapter 4*). Moreover, a diminished population could affect the financial support and scale of benefits that are essential to sustaining and modernizing water infrastructure.

Population projections for the South Caucasus subregion diverge under different narratives. With the Shared Socioeconomic Pathway (SSP) scenarios, SSP2 and SSP3 projections indicate a potential population increase of 0.2 to 1.7 million people, respectively, above the 2010 baseline of 16.6 million. However, SSP1 projects a potential population decrease of about 0.6 million. Under SSP3, Azerbaijan's population—expected to increase across all three scenarios—could grow to more than 11.5 million from a 2010 baseline of 9.2 million. This population increase will further stress the water supply systems in arid and semiarid areas. In contrast, Armenia's and Georgia's growth is more tempered across all scenarios, possibly because of their different economic and migration dynamics.

All scenarios predict a large population increase across Central Asia. SSP3 projects the highest increase to nearly 86.7 million, a significant jump from the 2010 baseline of 60.7 million. The SSP3 scenario also shows large increases in the Kyrgyz Republic and Tajikistan, potentially attributable to a combination of high fertility and lower migration rates, as well as economic policies that focus on self-sufficiency over international trade. The anticipated population increases suggest heightened demand for water in agricultural and urban settings that could exacerbate existing water scarcity.

SOCIOECONOMIC DEVELOPMENT

Socioeconomic transformations and challenges—marked by geopolitical tensions, the impacts of COVID-19, and significant economic restructuring—characterize Europe and Central Asia's current landscape. The water sector emerges as a critical element of socioeconomic development, underpinning agriculture, industry, and energy while posing challenges in sustainable management and environmental conservation.

The Danube subregion is home to a mix of developing and developed economic profiles. The Danube River is central to the subregion's development, supporting agriculture, industry, and energy while facilitating trade. The industry and service sectors dominate in economies like the Czech Republic and Hungary (*figure 2.3*) (88 and 82 percent of gross domestic product [GDP], respectively), reflecting their advanced manufacturing capabilities and dynamic service industries. In such industrial economies, water is a crucial input for manufacturing, energy production, and cooling processes. Meanwhile, the share of GDP attributable to agriculture varies, and it is much lower in developed economies such as Austria (1.1 percent) compared with developing economies such as Albania (19.1 percent).

The South Caucasus subregion has diverse economic structures, with GDP growth rates ranging from 2.7 to 5.4 percent in 2023 (*figure 2.3*). Azerbaijan's economy leans heavily on the oil and gas sector (41 percent industry value added), whereas Armenia and Georgia display a stronger orientation toward services (59 and 55 percent of GDP, respectively), indicating the burgeoning role of tourism and information technology (IT). Agriculture remains notable in Armenia (11.2 percent). Azerbaijan's oil wealth translates to a higher GDP per capita compared with its neighbors, which face challenges in achieving similar levels of economic prosperity. The subregion's economic activity is intricately linked to geopolitical dynamics, with strategic water resources management (WRM) playing a crucial role in agriculture, energy production, and the provision of necessary services for the upsurge in tourism. Ensuring reliable WSS services is vital to safeguarding workforce health in these countries, boosting productivity, and promoting economic growth.

The Central Asia subregion exhibits promising economic prospects, with 2023 GDP growth rates projected to be as high as 5.8 percent (*figure 2.3*). Agriculture contributes significantly to the economies of Tajikistan (23.8 percent of GDP) and Uzbekistan (25.1 percent of GDP), highlighting its role in supporting livelihoods and ensuring food security. The industry sector, particularly dominant in Turkmenistan (42 percent of GDP), underscores the region's reliance on natural resources, including vital water resources for irrigation and hydropower. The service sector's varying development, with Kazakhstan at the forefront (56.1 percent of GDP), signals efforts toward economic diversification. Trade dynamics indicate a balanced import-export scenario, reflecting global market integration. The criticality of WRM emerges here, given its essential role in agriculture and hydropower potential overall.

THE IMPORTANCE OF A WATER-SECURE FUTURE IN EUROPE AND CENTRAL ASIA

Vast tracts of arable land, extensive forests, and considerable freshwater reserves are central to Europe and Central Asia's economic vitality and the well-being of its population. The region holds a distinctive place in the global context because of its strategic geopolitical position, economic potential, rich cultural history, and significant natural resources. Encompassing a diversity of countries, from the EU accession states to the resource-abundant landscapes of Central Asia and the geopolitically pivotal South Caucasus, it is a crossroads between East and West.

The Danube is a crucial waterway within Europe and a symbol of international cooperation and ecological diversity. Water security is at the heart of Europe and Central Asia's global significance and is intrinsically linked to the region's stability and prosperity. Not just a regional concern, it has wider implications for global food security, energy production, and climate resilience. The Danube, for example, is not only a crucial waterway within Europe but also a symbol of international cooperation and ecological diversity. The Danube basin countries are working toward harmonizing their legal and regulatory frameworks with the EU, underpinning the region's commitment to sustainable water management.

Central Asia's reliance on transboundary rivers makes cooperation over water resources vital for maintaining peace and fostering regional integration. Although endowed with significant freshwater resources, Central Asia nevertheless faces potential water scarcity exacerbated by climate change and inefficient water use, particularly in agriculture. Countries like Kazakhstan and Uzbekistan are pivotal in this context, given their vast agricultural lands and energy needs.

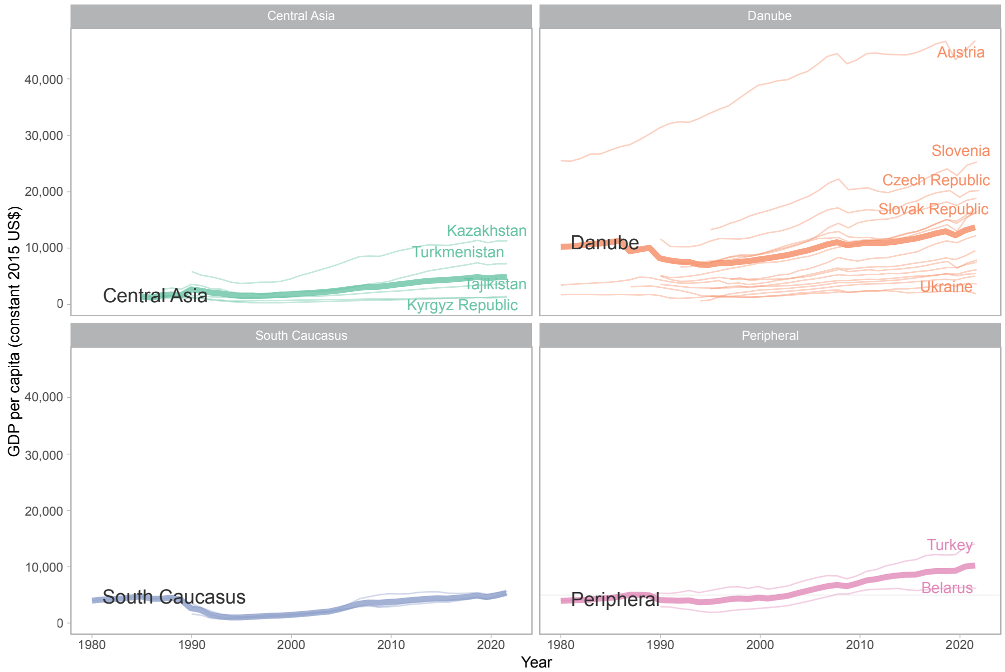
Bridging Europe and Asia, the South Caucasus subregion is rich in biodiversity and relies heavily on its water resources for agriculture and hydropower. It is susceptible to political tensions that can complicate collaborative water management efforts, and this context emphasizes the need for robust international agreements and shared management frameworks.

Water security in Europe and Central Asia is crucial for several reasons:

- Agricultural productivity. The region accounts for a substantial share of the world's arable land (19

Figure 2.3

GDP PER Capita of Different Countries and the Three Subregions in Europe and Central Asia

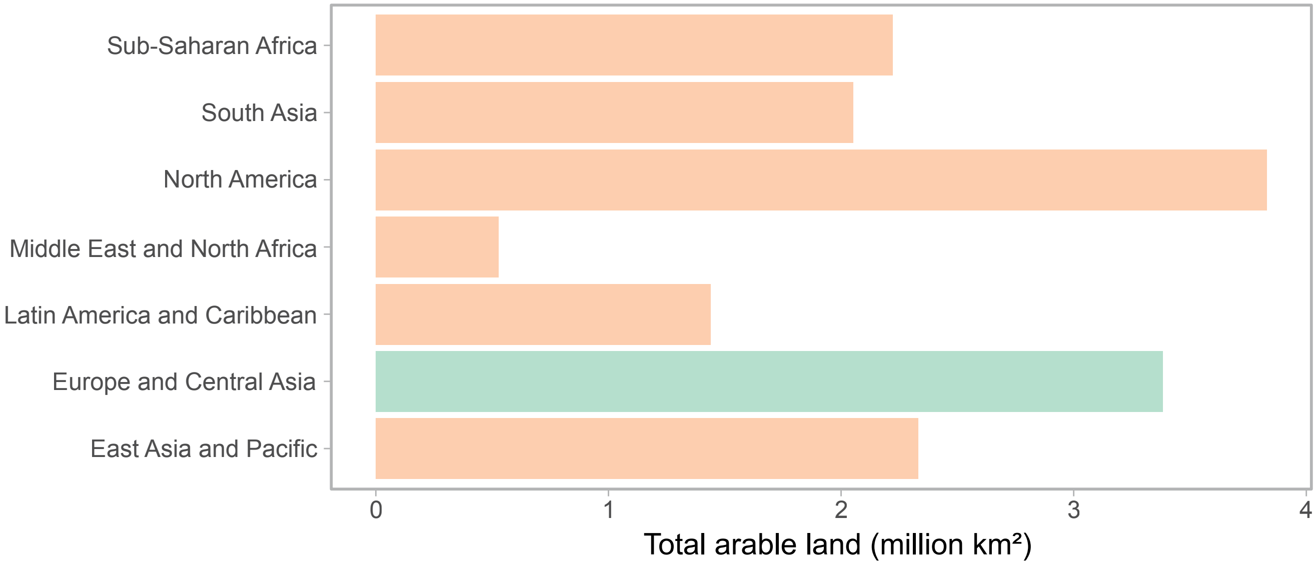


Source: World Bank 2024f.

Note: GDP is in 2015 constant US$. GDP per capita in the Europe and Central Asia region from 1980 to 2023. GDP = gross domestic product.

Figure 2.4

TOTAL ARABLE Land across Major Regions of the World



Source: World Bank 2021i.

percent; AQUASTAT 2024), making water availability key to agricultural output and, by extension, global food markets (*figure 2.4*). The region contributes 12 percent of the world's total agriculture and fish production value. Over the past decade, the Europe and Central Asia region has been responsible for nearly 13 percent of overall growth in the global net value of agriculture and fishery and an impressive 38 percent of the increase in global exports, highlighting its pivotal role in the international market (OECD/FAO 2023). The region is home to some of the world's largest grain and oilseed net exporters, such as Kazakhstan, Russia, Serbia, and Ukraine, which furthers the region's position as a key player in global food security. The agriculture sector sustains millions of rural communities, providing income and food security and employing nearly 8 percent of the total workforce in the region.

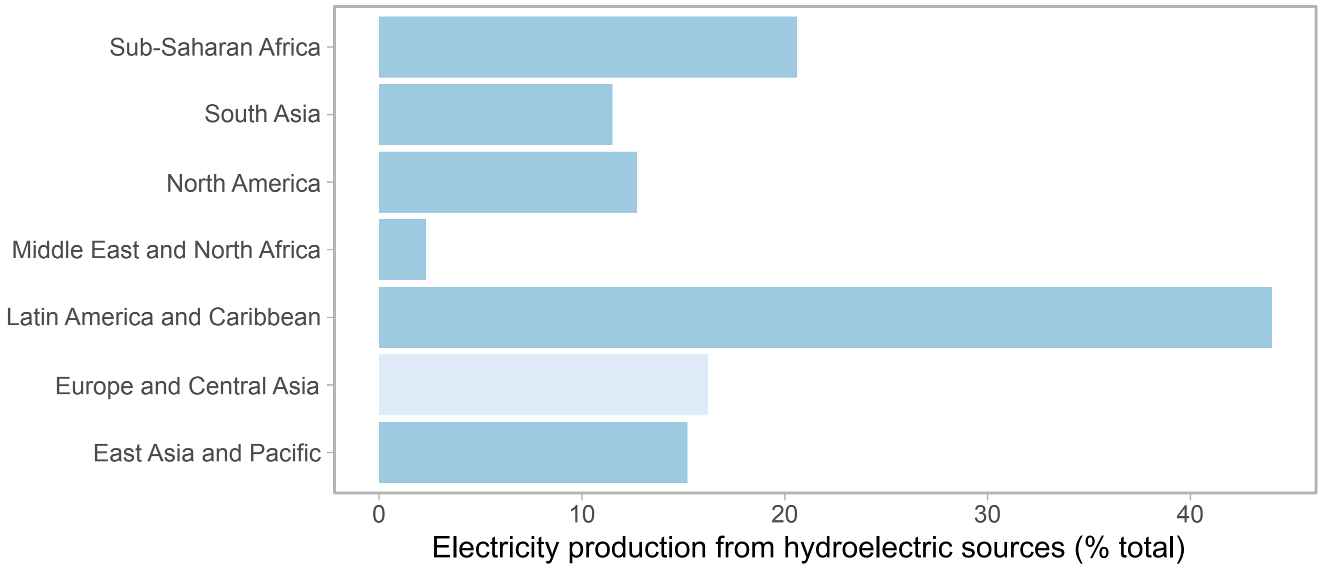
- Energy production. With abundant water resources, hydropower provides a stable domestic energy source, mitigating dependence on volatile fossil fuel markets. Hydropower is crucial for Europe and Central Asia's energy security, especially for landlocked countries (*figure 2.5*). Additionally, its low operating costs translate to affordable electricity for millions. Many countries, particularly in Central Asia and the South Caucasus, depend on hydropower as a primary source of energy. Water availability directly affects energy security and the potential for sustainable development. However, challenges such as aging infrastructure and sedimentation affect hydropower efficiency and sustainability, and hydropower operations raise many environmental concerns. Modernization, improved sediment management, and the use of new technologies like pumped storage are crucial for the sector's continued relevance.

- Economic growth. The Europe and Central Asia region acts as a crucial bridge between developed Western Europe and the emerging Asian economies in the East, facilitating trade and investment flows across continents. Water is a fundamental resource for sustaining various economic processes, and its scarcity could constrain economic growth by as much as 10 percent in Central Asia (World Bank 2016). Efficient water use contributes to higher water productivity, which is essential for the industrialized economies of the Danube countries.

- Climate-change mitigation and adaptation. The region's vulnerability to climate-change impacts underscores the importance of water security for resilience against extreme weather events, such as droughts and floods. Economic damages from such events in Central Asia could reach up to 1.3 percent of GDP annually, with crop yields potentially decreasing by 30 percent by 2050. The European region could face significant job losses and an annual climate-related extreme weather cost of approximately $184 billion by the end of the century without adequate adaptation measures (World Bank 2023c).

Figure 2.5

ELECTRICITY PRODUCTION from Hydroelectric Sources



Source: World Bank 2015a.

- Human health. Improving access to safe water and sanitation services in the region is crucial for enhancing public health because 32 percent of the population still lacks access to these services (JMP 2022). Ensuring safe and sustainable water and sanitation services can boost public health, educational opportunities, and labor productivity. Modernizing and expanding water infrastructure is key to preventing disease spread and improving life quality.
- Uneven progress in water management across the region. Water security is a critical concern in the region because of uneven progress toward sustainable water management, with EU members showing leadership in reforms while Central Asia faces challenges resulting from limited institutional capabilities and financial constraints. Achieving regional water security is essential for fostering economic growth, maintaining ecological balance, and enhancing social welfare, but it will require substantial investments in water infrastructure, legal and regulatory reforms, and enhanced regional cooperation, especially in managing transboundary water resources.

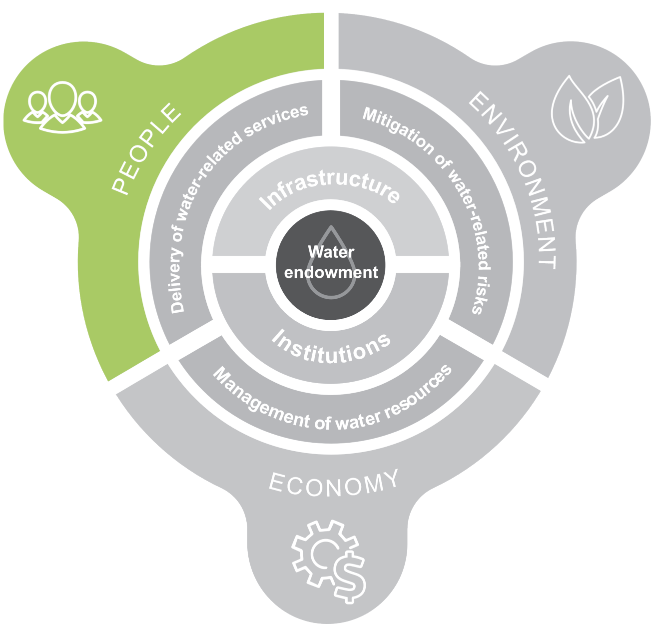
NOTE

1. There are three population scenarios: SSP1 envisions a sustainable world with low fertility and high migration, focusing on human well-being and environmental sustainability; SSP2 presents a middle-of-the-road scenario in which trends do not shift markedly, with moderate fertility rates and migration levels; and SSP3 depicts a fragmented world with high fertility rates, as well as low migration because of restrictive policies, leading to regional disparities and challenges in global cooperation (see "Climate-Change Scenarios" in chapter 1 for a detailed description).

3

People, Environment, and Economy

This chapter explores water-related benefits to the regional economy, society, and environment, as well as the risks and missed opportunities countries face by not managing water resources efficiently and sustainably. Water-related benefits are defined as outcomes and explored within the social, economic, and environmental dimensions. This section corresponds to the outermost ring of the Water Security Diagnostic Framework (WSDF), which encompasses people, the environment, and the economy (*figure 1.1*).



SOCIAL OUTCOMES

KEY MESSAGES

- Regionally, more than 161 million people (or 32 percent of the regional population) lack access to safely managed water, and 172 million (or 35 percent) lack access to safely managed sanitation.
- Lack of access is most prevalent in rural areas, often driven by the lack of economies of scale. Major urban centers in some countries also lack access, possibly because of limited investments and weak operation and maintenance (O&M) practices, including limited cost recovery.
- About 174 million people (or 35 percent of the regional population) live in water-stressed areas across the region, and competition for water resources is likely to increase as demands and climate variability grow.
- 77 million people, approximately 15% of the population in the ECA region, are exposed to flood risk with a 1 in 100 years return period.

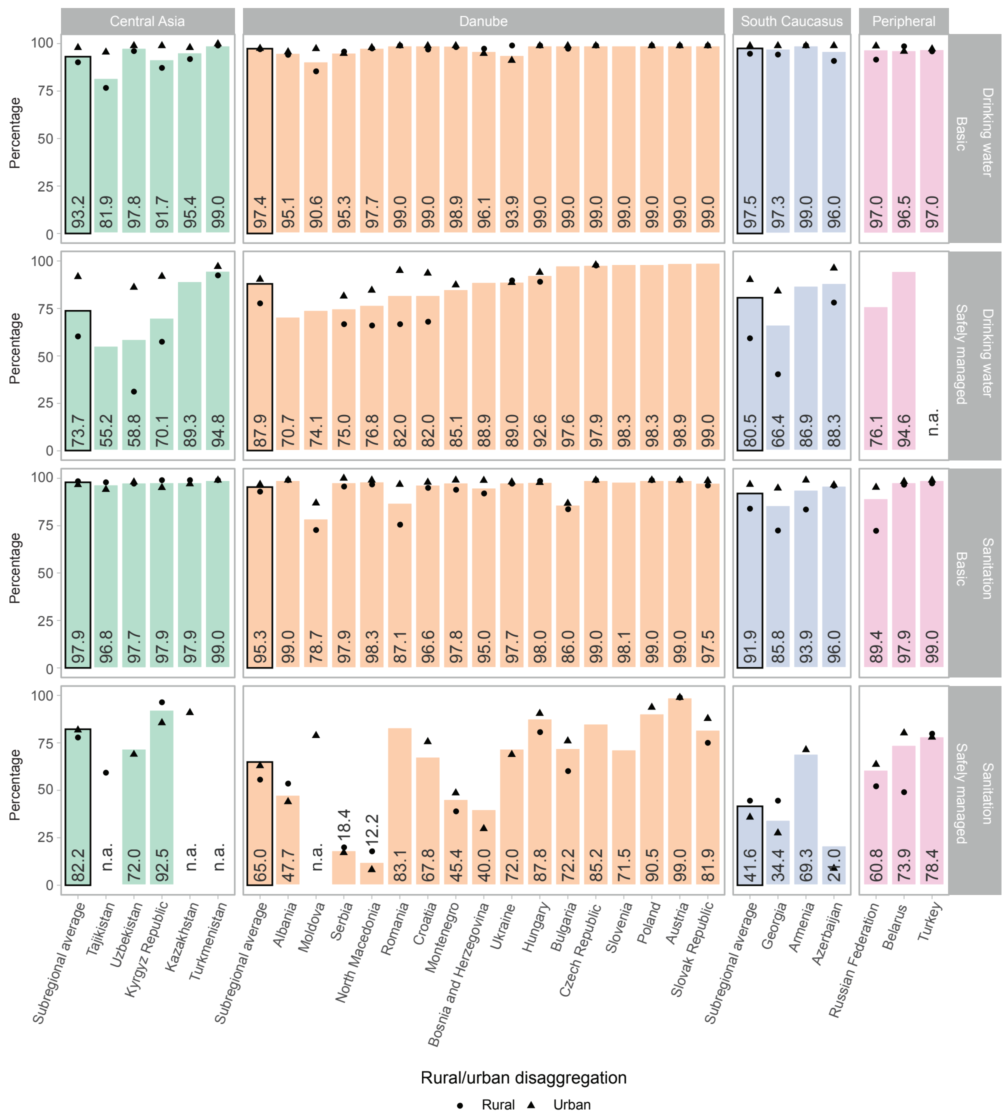
Health Benefits

Although access to "at least basic" water supply and sanitation (WSS) services is high across Europe and Central Asia, additional substantive efforts are needed to expand access to "safely managed" services. Most of the population has access to at least basic[1] WSS services (averaging 97 percent for drinking water and 95 percent for sanitation; *figure 3.1*). Access to safely managed WSS is, however, still lacking for more than 161 million people (or 32 percent of the regional population). By subregion, 26 percent of the population in Central Asia lacks access, followed by 19 percent in the South Caucasus and 12 percent in the Danube subregion. In some countries, such as Albania in the Danube and the Kyrgyz Republic, Tajikistan, and Uzbekistan in Central Asia, 30 to 40 percent of the population lacks access. Access to safely managed sanitation lags behind access to safe drinking water, affecting more than 172 million people (or 35 percent of the regional population). In the South Caucasus, 58 percent of the population lacks access to safely managed sanitation, followed by Central Asia with 40 percent and the Danube with 35 percent. In some countries, such as Azerbaijan in the South Caucasus and North Macedonia and Serbia in the Danube, this figure rises to more than 80 percent of the population, and research suggests achieving Sustainable Development Goal (SDG) target 6.2 (improved sanitation for all by 2030) will be especially difficult in Azerbaijan, Georgia, Moldova, and Romania under various future socioeconomic scenarios (van Puijenbroek et al. 2023).

Lack of access to safely managed WSS services is most prevalent in rural areas. In some areas of countries such as the Kyrgyz Republic in Central Asia, more than half the rural

Figure 3.1

ACCESS TO Basic and Safely Managed Water Supply and Sanitation in Europe and Central Asia, 2020



Source: JMP 2020.

Note: n.a. = not applicable.

population lacks access to safely managed drinking water, whereas 80 percent of the rural population in the Danube subregion countries North Macedonia and Serbia lack access to safely managed sanitation (*figure 3.1*). This low level of access in rural areas could be explained by the lack of economies of scale to provide cost-effective networked services, generally considered the gold standard for service delivery but not always the most appropriate response in rural areas. To meet the needs of the unconnected in these areas, off-network solutions and on-site management practices—in particular, nature-based solutions—should be considered, which may generate additional social benefits. However, in some countries, such as Albania, North Macedonia, and Serbia, access to safely managed sanitation is lower in urban areas than in rural areas. In North Macedonia, for example, 98 percent of the urban population lacks access to safely managed sanitation. These exceptional circumstances could be because of (a) limited investments in expanding coverage to connect the growing, often unplanned, urban or periurban settlements and (b) weak O&M practices with respect to aging and inefficient infrastructure because of the lack of operational cost recovery and willingness to pay (DWP 2019; see "Storage to Manage Water Variability" and "Transboundary Waters" in chapter 4 for further information on WSS infrastructure and services and their performance). To move into a positive feedback loop of adequate service provision that promotes willingness to pay, improvements in services are required. In turn, this would facilitate improvements in cost recovery and thus the ability to increase O&M to existing facilities and invest in new ones (World Bank 2019).

Regionally, mortality and disability-adjusted life years (DALYs) attributed to water supply, sanitation, and hygiene (WASH) are relatively low. Adequate access to WSS is crucial for socioeconomic development globally because it improves public health, frees up time for education, increases labor productivity, and supports various economic activities (fisheries, tourism, property markets, and so on); it also provides several environmental benefits (ecosystems services, biodiversity, and so on; OECD 2011a). Health benefits include a low prevalence of diarrheal diseases, intestinal nematode infections, and other diseases linked to unsafe WSS. In Europe and Central Asia, the levels of mortality (3.4 people per 100,000 inhabitants) and DALYs[2] (182 DALYs per 100,000 inhabitants) attributed to unsafe WASH are low compared with other regions of the world[3] (*figure 3.2*). Of the three subregions, the Danube shows the lowest levels of mortality (3.1 people per 100,000 inhabitants) and DALYs (73 DALYs per 100,000 inhabitants), whereas Central Asia shows the highest (4.6 people per 100,000 inhabitants and 367 DALYs per 100,000 inhabitants, respectively), although this is still much better than many other regions around the world. Continuous progress in upgrading access from basic to safely managed WSS services can significantly improve health status and provide development opportunities to the region (WHO 2023b).

Regional and national estimates of access to safely managed WSS in Europe and Central Asia often hide disparities within countries. Even in high-income countries, where access to safely managed WSS is generally high, rural areas and certain marginalized communities are underserved. For example, in Croatia and Romania, more than 30 percent of the rural population lacks access to safe WSS services, compared with 5 percent of the urban population; in Albania, more than 50 percent of the Roma population, an ethnic and linguistic minority, has no access to safe WSS (World Bank 2023b). Such communities may face higher health risks and, in some cases, be the source of major disease outbreaks (WHO 2023a; *figure 3.2*). Continuous investments in upgrading access from basic to safely managed WSS services could bring substantial additional social benefits.

The return-on-investment ratios for WASH services from health-related improvements and reduced deaths from water-related diseases range from 0.6 to 8.0 (Hutton 2012). In Central Asia, the investments needed to increase access to safely managed WSS are demonstrably lower than the actual costs. In Tajikistan, for example, the investment gap to achieve adequate WSS is 1.25 percent of gross domestic product (GDP) versus 4.25 percent of GDP in economic costs. Similarly, in the Kyrgyz Republic and Turkmenistan, the investment gap is about half the cost of inadequate WSS to the economy (World Bank 2019).

Protection from Water-Related Risks

Almost one-third of the region's population (or 174 million people) lives in highly water-stressed areas. This number is expected to increase in the coming years. Water stress occurs when available water resources are insufficient to meet water demands. A region or a country is considered highly water-stressed if the ratio of demands to withdrawals is greater than 0.4 (see "Environmental Outcomes" in chapter 3 for further details on water stress across Europe and Central Asia). The social outcomes of living in water-stressed areas may include a lack of reliable access to clean water; increased vulnerability to disease; reduced labor productivity; loss of crop yields and livestock production, causing a loss of food calories, income, and employment; and rural-to-urban migration, putting additional pressures on cities (Damania et al. 2017). Across the countries of Europe and Central Asia, there are large disparities in water stress and associated risks for their populations and economies.

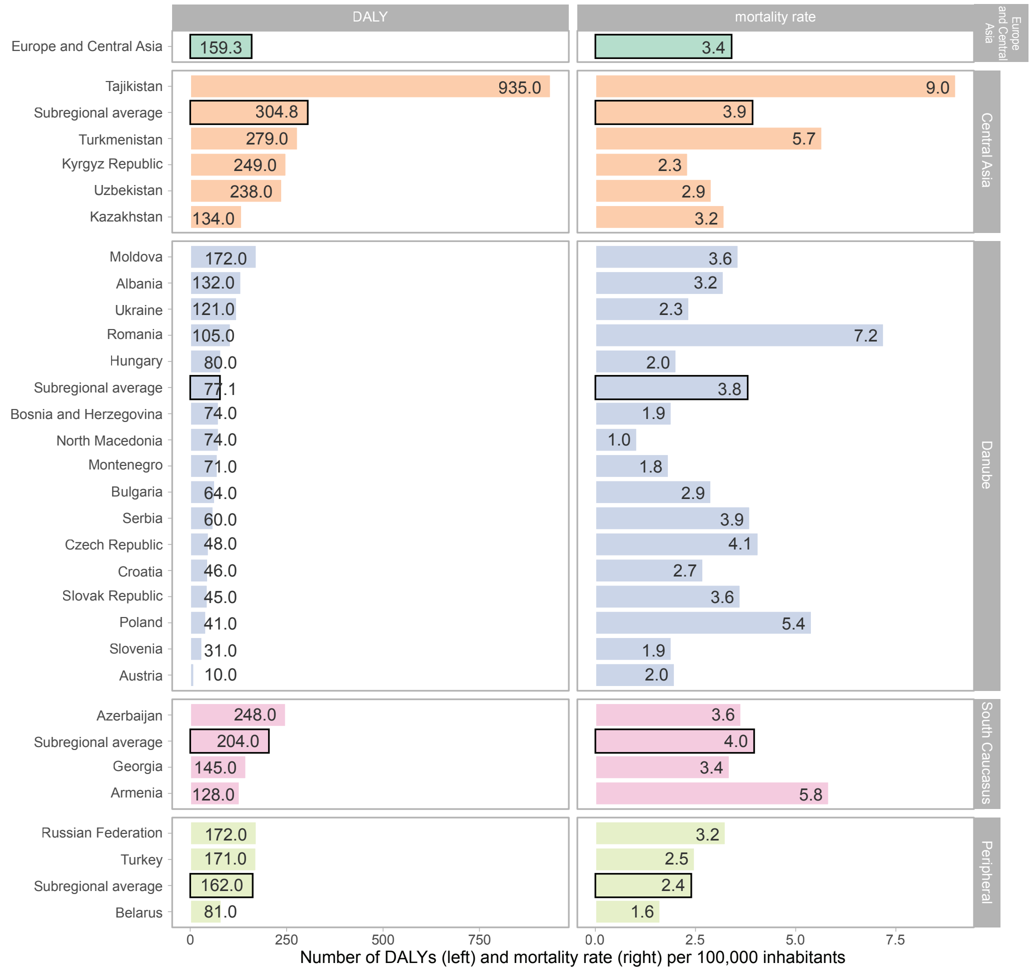
In Central Asia, 43 percent of the population lives under enduring water-stress conditions (*figure 3.3*). In the Kyrgyz Republic and downstream countries like Uzbekistan and Turkmenistan, almost half the population lives in high-water-stress areas (water stress ratio > 0.6), reflecting severe challenges in water resources management (WRM), with potential risks to human populations and sustainable development. These results underline the importance of transboundary cooperation for addressing water stress in Central Asia.

In the South Caucasus, about 32 percent of the regional population lives in high-water-stressed areas. Georgia benefits from being located upstream and experiences low levels of water stress, and none of its population is exposed to water-stress conditions. Azerbaijan and Armenia, conversely, experience moderate and high levels of water stress, respectively, and most of their populations live in water-stressed areas. As in Central Asia, these disparities underline the importance of transboundary cooperation for effective water management in the South Caucasus (see chapter 4 for more information on transboundary waters).

Water stress in the Danube subregion is generally low. With a water stress ratio of 0.12, only about 15 percent of the subregion's population lives in high-water-stressed areas; however, there are remarkable differences among countries. Despite being a water-rich country, Albania suffers from high water stress (water stress ratio of 0.6), which is driven by high water demand for economic uses (DWP 2015) and affects 76 percent of its population. This disparity highlights the importance of and need for effective strategies for demand management, even in countries with a high availability of water resources.

Figure 3.2

HEALTH OUTCOMES of Unsafe WASH



Sources: WHO 2023a, 2023b.

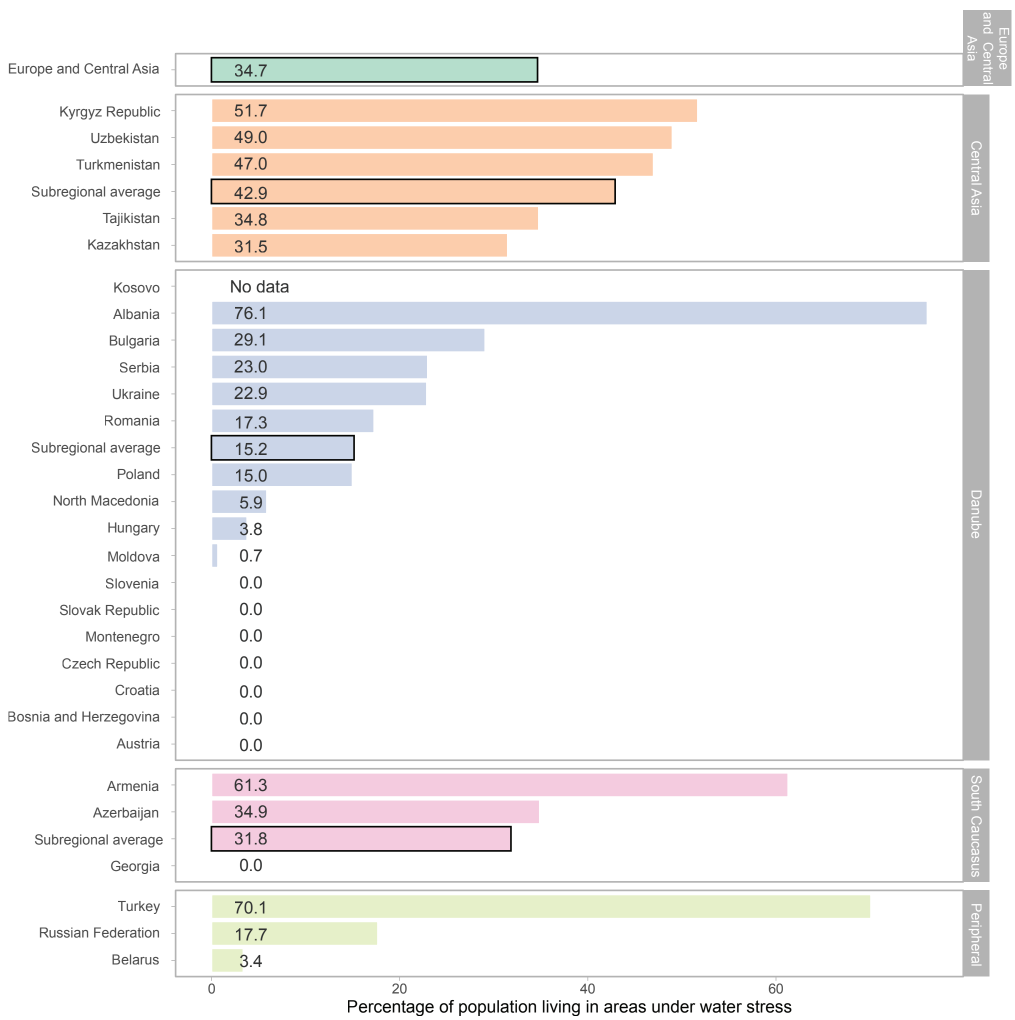
Note: People affected per 100,000 inhabitants. DALY = disability-adjusted life years; WASH = water supply, sanitation, and hygiene.

Riverine floods threaten the livelihoods of nearly 5.5 million people (or 1.6 percent of the population) regionwide.[4] Causalities, displacement, and damage to dwellings are among the most common outcomes of floods, occurring both in developed and less developed countries. Lethal flood events that occurred in the past two decades in the Czech Republic (2009) and Slovenia (2023) resulted in the displacement of more than 8,000 people and caused at least nineteen causalities (IFRC 2010, 2023). Floods reduce mobility and disrupt important services, including water and energy supply (ADRC 2006). Poor sanitation conditions in Azerbaijan (that is, using traditional toilets in the gardens of houses) have been shown to increase the risk of infectious diseases and chronic illnesses during floods (IFRC 2003).

Exposure to flood risk is highest in the South Caucasus subregion. Roughly 400,000 people in the South Caucasus (or 2.2 percent of the regional population) who live in densely populated river valleys in Azerbaijan and Georgia (CAREC 2022) are exposed to riverine floods (*figure 3.4*). Torrential rains are the main drivers of floods in this region (*table 3.1*), often causing destructive landslides (Leroy et al. 2022). This higher level of exposure (see *box 3.1*) is also related to the still-low development of a strategic approach to flood management (see chapter 6 for more on the management and mitigation of water-related risks). In Central Asia, more than 800,000 people (or about 1.4 percent of the regional population) are exposed to riverine floods, driven primarily by early snowmelt and heavy spring rains. In the Danube, about 2.8 million people (or 1.6 percent of the population) are exposed to riverine flood hazards,

Figure 3.3

PERCENTAGE OF Population Living in Severe Water-Stress Conditions in Europe and Central Asia

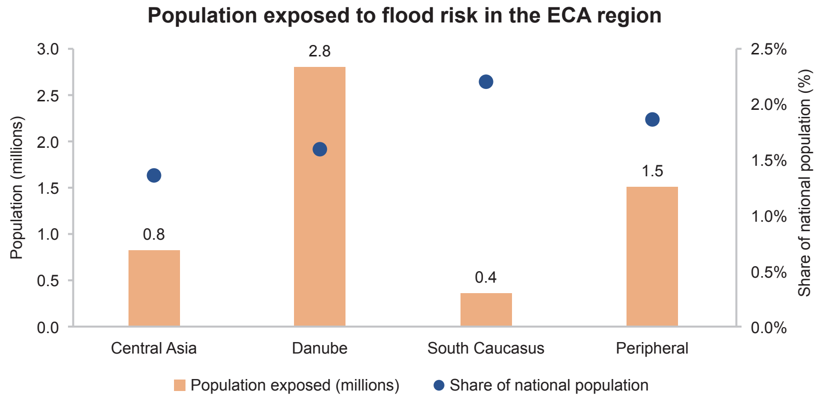


Source: World Resources Institute n.d.

Note: Severe water-stress areas are those where the ratio of withdrawals to availability, after considering the environmental flow requirements, is higher than 0.4.

Figure 3.4

PERCENTAGE OF Population Exposed to Floods in Europe and Central Asia



Source: Ward et al. 2013.

Note: Bars indicate absolute figures (left axis), and points indicate relative figures (right axis).

although these figures vary significantly among countries, with population exposure exceeding 2 percent in some upstream and midstream countries. As with Central Asian countries, the combination of early snowmelt and spring rains is a dominant driver in the Danube (*table 3.1*).

TABLE 3.1 Cumulative People Exposed to Floods by Flood Driver and Region

Region	Flood driver			
	Dam/levy	Snow, rain, ice	Heavy rain	Other
Central Asia	140 (15%)	723 (78%)	69 (7%)	0 .01 (<1%)
South Caucasus	0	0	35 (100%)	0 (0%)
Danube	2.4 (<1%)	3,067 (73%)	1,073 (26%)	60 (1%)
Europe and Central Asia	143 (3%)	3,789 (73%)	1,177 (23%)	60 (1%)

Source: Tellman et al. 2021.

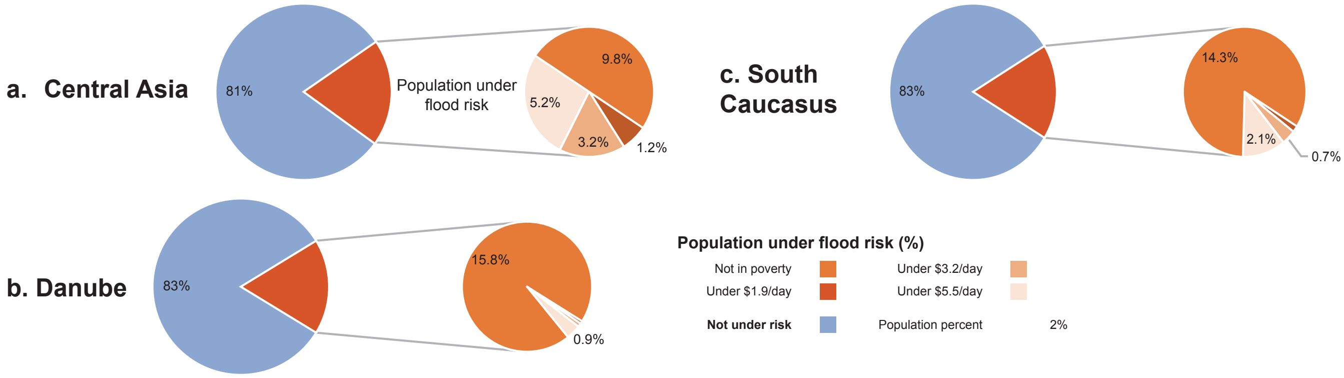
Note: Cumulative people (in thousands) exposed to floods (percent of total population exposed) from 2000 to 2018.

The poor condition of many dams is increasing the risk of dam failure and becoming an important driver of floods, particularly in Central Asia. Dams fulfill a pivotal role in water supply, hydropower generation, flood mitigation, and inland water navigation; however, dam leaks and failures often result in catastrophic outcomes for downstream populations. Overflows from reservoirs and flood defense structures (for example, levees) and dam failures are major flood drivers in the Danube and Central Asia (*table 3.1*). Bulgaria experienced two dam failures within five years: In August 2007, the Ezerche 1 and Ezerche 2 Dams burst, resulting in eight casualties, and in February 2012, the Ivanovo Dam failed, resulting in five casualties and displacing 1,000 people (Brakenridge n.d.; Nikolova and Nikolov 2021). Another major dam failure occurred in Uzbekistan in 2020, when the Sardoba Dam, completed in 2017, failed catastrophically, resulting in four casualties and 70,000 displaced people in both Uzbekistan itself and downstream Kazakhstan (Brakenridge n.d.). The high dam storage per capita in Central Asia (see "Infrastructure" in chapter 5) highlights the need for dam safety inspections and remedial works to avoid the possibility of disastrous failures and their cascading effects for downstream populations and assets.

Poor populations are the most vulnerable to floods because of their prevailing socioeconomic conditions. Unprotected areas with higher flood risks are often inhabited by poor households, which increases the poor population's exposure to the negative outcomes of floods. These effects are intensified by the lack of financial security nets (for example, savings or credit), which reduces poor households' capacity to cope with flood damages (Rentschler et al. 2022; Reyer et al. 2017). Flood impacts on agriculture, including crop and livestock losses, have a significant effect on the livelihoods of rural communities, women, and children (Reyer et al. 2017). In Europe and Central Asia, overall approximately 77 million people, or 15% of the population, are exposed to high-risk flood events estimated as a 1-in-100-year flood. Out of this, 11 million poor people are at risk, earning less than $5.50 per day, of which 1.2 million are the poorest people (*figure 3.5*). Both Central Asia (except Kazakhstan) and the South Caucasus (mainly Armenia and Georgia) are more vulnerable to floods because of their high share of exposed poor populations. In the Danube, poverty levels are lower than those in the other subregions, and the coping capacity of exposed populations is higher.

Figure 3.5

POPULATION LIVING in Poverty and Exposed to High-Risk Floods



Source: Rentschler et al. 2022.

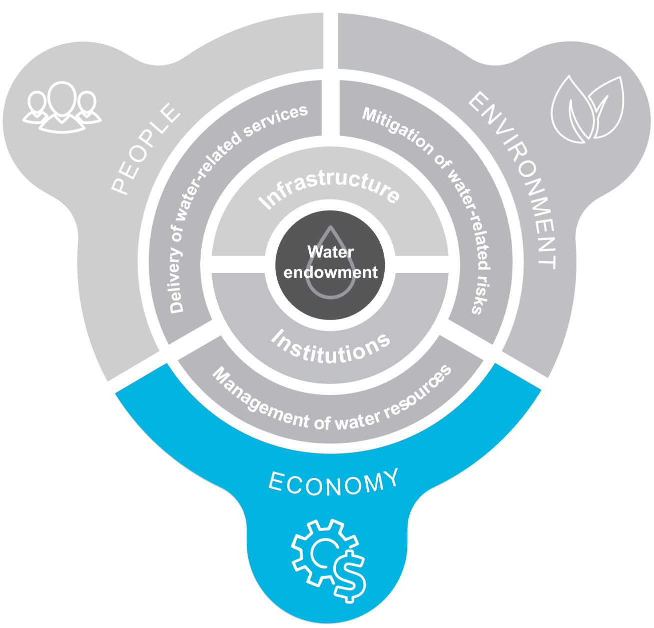
Note: High-risk floods are defined as a flood event with a 1-in-100-year probability and an inundation depth of up to 1.5 meters. Pie charts on the left show the share of the population that is not affected by the flood, and pie charts on the right show the distribution of the population at different daily income levels.

Box 3.1

CALCULATING FLOOD EXPOSURE RISK

The population exposed to flood risk indicator quantifies the cumulative potential for detrimental social outcomes of floods by integrating population exposure to floods under different probabilities. An exposure level of 1 percent means that 1 in 100 people is exposed to all flood types, subject to probability of occurrence. However, the population exposure drastically increases for a given flood event. For example, a relatively rare flood event (with a probability of 1 in 100 years) may affect as much as 17 percent of the subregional populations (see *figure 3.5*).

ECONOMIC OUTCOMES



KEY MESSAGES

- Irrigated crops contribute 15 percent of regional agricultural gross revenues, and hydropower produces 27 percent of the region's electricity. Water-dependent economic activities like these, as well as agri-food manufacturing and tourism, employ anywhere from 18 to 60 percent of the labor force and contribute from 7 to 98 percent of total country-level exports.
- Total water productivity in Europe and Central Asia averages $43.2 per cubic meter, but there are large disparities between countries: EU Member States in the Danube have some of the highest water productivity values in the world (> $100 per cubic meter), whereas Central Asian economies are far less productive (≈ $1.3 per cubic meter).
- Climate change is projected to reduce GDP by 11 percent by 2050 in Central Asia because of its very low water-use efficiency and the overall vulnerability of its economic sectors.
- To address the region's water needs, $77 billion (representing only 0.6 percent of regional GDP) per year from 2015 to 2030 must be rapidly mobilized.

Economic Benefits

Water underpins multiple economic benefits across the Europe and Central Asia region, including irrigated crops, industrial processes, tourism and water-based recreational activities, electricity (for example, hydropower), increased economic activities resulting from alleviating flood and drought risks, and labor productivity of healthy populations with access to safe WSS. Tourism also plays an important role in the economy of several countries, such as Albania, Croatia, Georgia, Moldova, Montenegro, and Türkiye. For example, Croatia receives 18 million to 20 million tourists per year, almost five times the country's population, contributing about 20 percent of GDP. Inland navigation is an important economic activity for countries along the Danube River (of which 87 percent is navigable by large ships [ICPDR 2024]), and the Sava and Drina Rivers Corridor (for example, Bosnia and Herzegovina, Croatia, Montenegro, Serbia, and Slovenia), alongside Romania, has the highest tonnage transported by water, with more than 10 million tons of cargo shipped annually. Many other countries also transport significant amounts (ICPDR 2021). The EU Strategy for the Danube Region recognizes the importance of the Danube River as a major transportation corridor connecting countries and regions within the Danube basin and beyond. Moreover, water-dependent economic activities, such as irrigated agriculture, agri-food manufacturing, hydropower production, and tourism, generate considerable employment opportunities, employing between 18 and 60 percent of national labor forces. Water-dependent exports contribute anywhere from 17 to 98 percent of total national exports, thus representing an important source of foreign currency.

Water productivity in Europe and Central Asia mirrors overall economic development. The water productivity indicator can be useful in monitoring how efficiently a given economy uses water over time. An increase in this indicator would capture the reallocation of water to more economically productive sectors of the economy. The total water productivity in Europe and Central Asia measured in constant 2015 US$ GDP per cubic meter of water averaged $43.2 per cubic meter in 2020 (*figure 3.6*), a figure that has climbed steadily year after year for the past twenty-five years.[5] This upward trend is driven strongly by highly industrialized countries in the Danube subregion, such as Austria, the Czech Republic, and the Slovak Republic, home to some of the highest water productivities in the world, at more than $100 per cubic meter, and giving rise to a subregional average of $52.2 per cubic meter. On the opposite end of the spectrum, total water productivity averages only $6.1 per cubic meter in the South Caucasus and $2.8 per cubic meter in Central Asia.

The sectoral composition of a country's economy and its overall levels of GDP play a role in shaping the economic impacts and productivity of water. The low water productivities in Central Asia and the South Caucasus compared with the Danube are mostly driven by the weight given to low-value irrigated agriculture (for example, agricultural water withdrawals represent more than 60 percent in seven out of the eight countries in Central Asia and the South Caucasus; more details are provided in chapter 4) and the very low irrigation efficiency (the share of irrigated land with flood irrigation amounts to more than 60 percent in all countries in Central Asia and the South Caucasus).

Service sector–oriented areas tend to use lower quantities of water to generate economic outputs. Water productivity tends to increase as income-generating activities shift from agriculture toward manufacturing and further into the service sector. Because value added is often higher in the manufacturing and services sectors, a shift of water as a means of production away from agriculture and toward these sectors could increase GDP (Roson and Damania 2017). Although reallocation of water from agriculture to more profitable sectors, such as manufacturing and services, is desired, it must, however, be balanced with other important values of agriculture, including food security, biodiversity conservation, climate mitigation, the links to the agri-food processing industry, exports, employment, and rural development.

The sharp contrast in water productivities shows an untapped potential to boost economic growth and farm-level livelihoods across the region. Such a boost can be achieved by implementing modernization and expansion of existing irrigated areas; shifting toward high-value crops; improving water-use efficiency (for example, shifting to efficient sprinkler and drip irrigation systems and adopting integrated soil, land, and water management practices); implementing incentives for reducing wastage, overuse, and pollution, such as water pricing; better water delivery control; and improved access to knowledge and finance for farmers. These efforts could lead to important economic gains. For example, in Serbia, a shift to higher-value crops could bring yield increases ranging from 8 percent for wheat and 20 percent for maize to about 30 percent for vegetables and 35 percent for top fruit.[6] Meanwhile, in Central Asia, rehabilitating the existing irrigation infrastructure could increase crop yields by an estimated 20 percent by 2030 and 50 percent by 2050 (World Bank 2019).

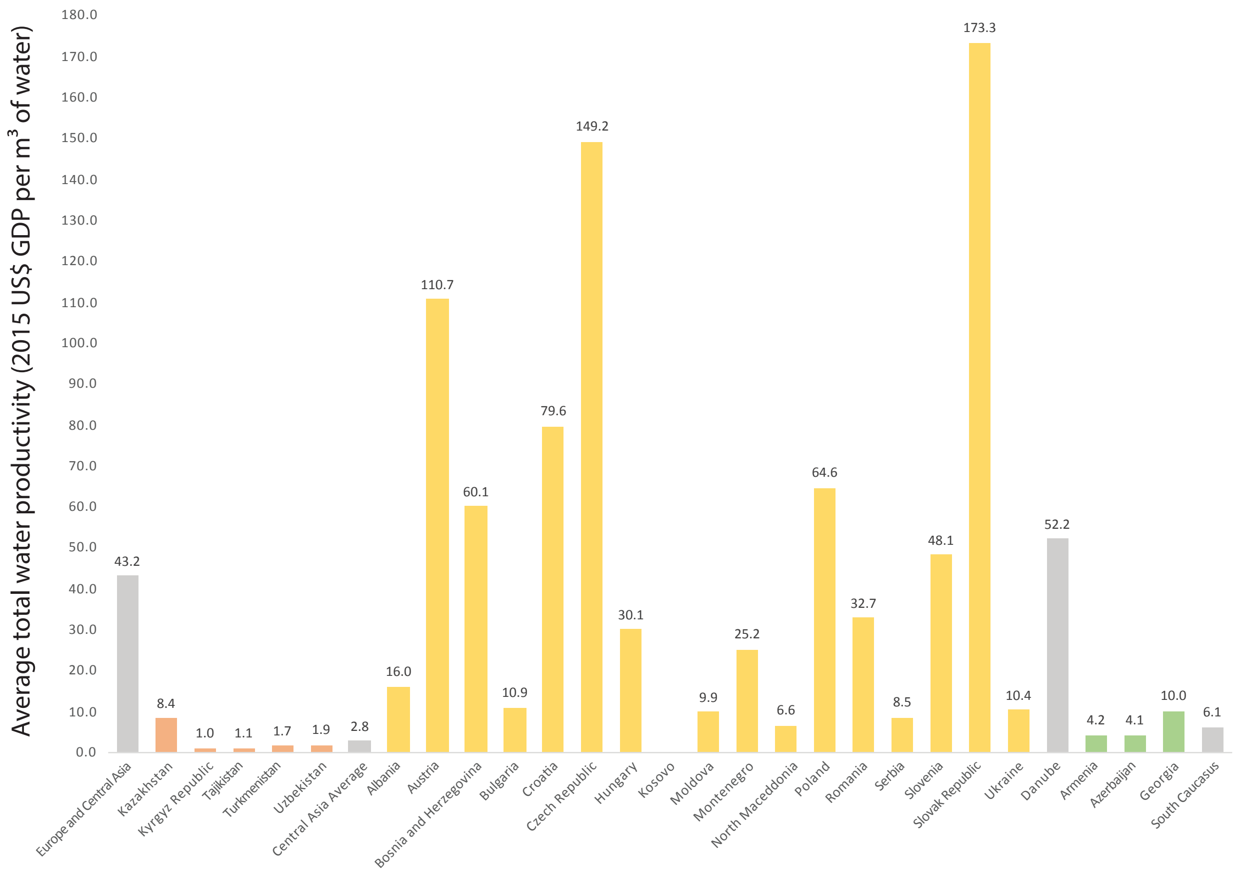
Agriculture

Agriculture remains an important sector in parts of Europe and Central Asia, with considerable potential for sustainable future development, contributing about 5.8 percent to the region's GDP, substantially lower than neighboring South Asia (16.6 percent) but higher than the European Union (EU; 1.7 percent). About 15 percent of regional agricultural gross revenues stem from irrigated crops. However, in the Central Asia subregion, agriculture contributes almost 13 percent to GDP, of which 56 percent stems from irrigated crops. Except for Kazakhstan, irrigation represents 70 to 80 percent of crop production gross values in all Central Asian countries. In the South Caucasus subregion, agriculture contributes about 8 percent of GDP, with irrigated crops contributing almost 54 percent of the crop production gross value. In the Danube, agriculture plays a minor role in the economy (averaging 4 percent of GDP). Similarly, irrigated agriculture contributes only 9 percent of the agricultural gross value. Irrigation is also limited to a few Balkan countries, with the rest of the Danube countries relying almost entirely on rain-fed agriculture.

High dependency on rain-fed agriculture in the Danube and aging and inefficient irrigation infrastructure in the South Caucasus and Central Asia increase the vulnerability of the region's agricultural production to climate shocks, such as droughts. For instance, in 2000, a drought in Georgia caused a 56 percent loss in wheat yield and $460 million in damages and losses in the agricultural sector (USAID 2017b). Despite this vulnerability, the agriculture sector in Europe and Central Asia has significant potential to help support future sustainable development within the region. Such efforts would require a transition to efficiently irrigated, high-value agriculture that supports exports while increasing the climate-adaptive capacity of rain-fed agriculture to sustain livelihoods; ensure employment; contribute to food security, biodiversity conservation, and climate mitigation; and help manage risks to the economy. Examples of such impactful measures include the following:

Figure 3.6

AVERAGE TOTAL Water Productivity by Subregion and Country



Source: World Bank Data Bank.

Note: GDP = gross domestic product.

- Changing cropping patterns, shifting to efficient sprinkler and drip irrigation, and pricing water to incentivize water savings
- Capturing more water and allowing it to infiltrate into the root zone with water-harvesting techniques, such as surface microdams and subsurface tanks, and with soil and water conservation practices, such as runoff strips and terracing
- Using available water more efficiently by increasing plant water-uptake capacity and reducing nonproductive soil evaporation with integrated soil, crop, and water management strategies, such as conservation agriculture and improved crop varieties

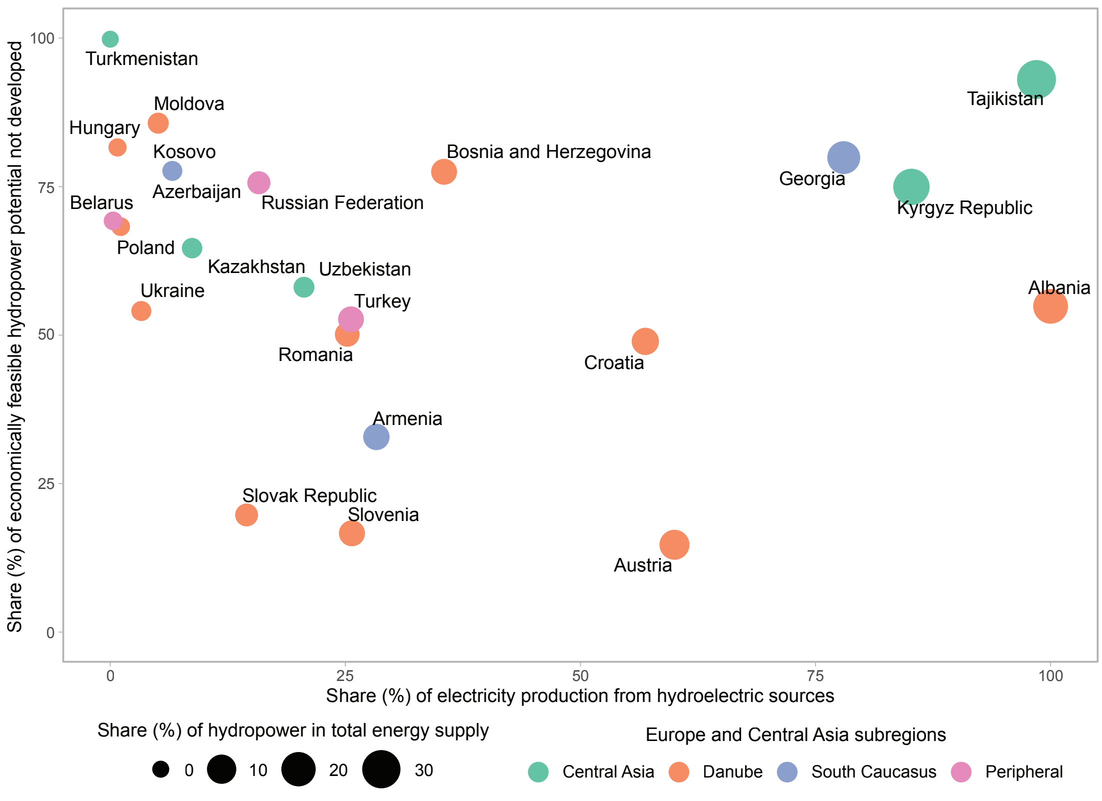
Hydropower

Although an important source of electricity in Europe and Central Asia, hydropower is highly vulnerable to climate-change variability and competition with other water uses. It accounts for 27 percent of the total electricity supply in Europe and Central Asia, yet less than 40 percent of the region's economically feasible hydropower potential has been developed (*figure 3.7*). Central Asia generates an average of 43 percent of its electricity through hydropower, followed by the South Caucasus with 38 percent and the Danube with 27 percent. There are, however, substantial differences between countries, with some producing close to none of their electricity from hydropower (for example, Hungary and Turkmenistan) and others relying almost exclusively on it (for example, Albania, the Kyrgyz Republic, and Tajikistan). This disparity suggests that countries with small hydropower generation might benefit from investing in expanding their hydropower capacity. Meanwhile, countries relying almost exclusively on hydropower would benefit from improving the efficiency of their hydropower plants and diversifying their electricity supply toward, for example, renewable energy technologies that are independent from water, such as solar and wind.

Hydropower expansion in Europe and Central Asia must consider impending climate change and the social, environmental, and financial implications. For instance, late 2021 to early 2022 was a very dry period in the Balkan countries, resulting in historically low water levels in

Figure 3.7

SHARE OF Electricity Production from Hydropower and Share of Economically Feasible Hydropower Potential Not Developed in Europe and Central Asia



Sources: IRENA 2018; World Bank 2015b, 2021a.

North Macedonia's reservoirs and a five-year low in Serbia. Albania had to halt electricity generation in eleven out of thirteen state-owned hydropower plants, declaring an energy emergency. Fluctuations in energy generation between years often result in the importation of expensive electricity (Gallop and Ralev 2022). Drought impacts on electricity production also cascade to other sectors because of electricity shortages or energy price increases. Moreover, climate-change projections indicate a reduction of annual hydropower usable capacity of between 5 and 15 percent by 2050 compared with observed conditions across Europe and Central Asia (van Vliet et al. 2016). Lastly, hydropower projects, especially large ones, can have important social and environmental impacts and sometimes face opposition. They also require large investments that are not always viable in contexts of economic and financial instability (World Bank 2022a).

Hydropower could play an important role in strengthening regional cooperation in Europe and Central Asia. Where hydropower production is based on reservoir storage, there can be flow management benefits for climate-change adaptation, including flood and drought prevention and mitigation, as well as timely delivery of irrigation and drinking water. Management of reservoirs and cascades for these multipurpose benefits will require robust water information systems. Analytical work would be required to size cascade and reservoir storage in a way that considers climate-induced flow and production-potential reduction, as well as storage and flow management functions to offset these climate-change impacts. Flow management and adaptation benefits to downstream users can be monetized. For example, downstream benefits achievable through upstream regulating and storage infrastructure can be used to raise financial resources for the construction of new infrastructure. Where these investments take place in transboundary contexts, additional international public and private financing can be unlocked based on cross-border cooperation agreements (World Bank 2019).

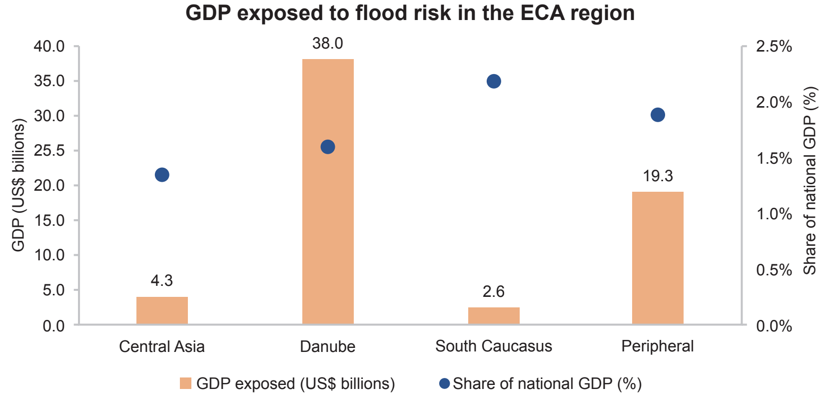
Economic Costs

Floods and droughts reduce water security and result in significant economic costs, slowing economic development. Historically, floods have inflicted losses to transportation infrastructure, housing, and agricultural lands that total $64 billion and account for 1.7 percent of regional GDP. Relative economic exposure to floods is highest in the South Caucasus, hitting 2.2 percent of subregional GDP (or $2.5 billion; *figure 3.8*). The Danube subregion's relative exposure is 1.6 percent of subregional GDP (or $38 billion), although six countries have a relative exposure higher than 2 percent. Central Asia has the lowest relative exposure (1.3 percent of subregional GDP, or $4.3 billion), with exposure in the Kyrgyz Republic and Tajikistan above 2 percent. Extreme flood events frequently lead to immense economic damages (*box 3.2*), often associated with massive damages to transportation infrastructure as roads and bridges are washed away. Agricultural activity is also highly exposed to floods, and relative exposure across the region ranges from 1 to 2.5 percent, mostly in South Kazakhstan, the Kyrgyz Republic, and Uzbekistan (Ward et al. 2013).

Droughts also drive significant economic losses in the region, mainly because of crop and livestock damage, reduced hydropower generation, and disruption to the water supply. The average marginal impact of dry periods on economic growth is significant in low- and middle-income countries at –0.54 percentage points and is most pronounced in cropland-dominated economies (Zaveri et al. 2023). In fact, the economic impacts of drought on the agricultural sector of the South Caucasus and Central Asia

Figure 3.8

GDP EXPOSED to Flood Risk in Europe and Central Asia



Sources: IRENA 2018; World Bank 2015b, 2021a.

have been especially acute (*box 3.3*). Although irrigation infrastructure is widespread in both regions, its low efficiency and deteriorated state make it less practical for mitigating drought risk. Widespread rain-fed agriculture in the Danube subregion makes it highly vulnerable to droughts, and fourteen out of sixteen countries are classified as having medium-high to high drought risk. Further, many countries in the Danube subregion are highly dependent on hydropower. Similarly, dependence on hydropower in the Western Balkans is significant in Albania and Montenegro and, to a lesser extent, Bosnia and Herzegovina, North Macedonia, Romania, and Serbia (IEA 2024).

The impacts of future water stress could compromise economic development in several countries in Europe and Central Asia. If current water management policies and practices do not change, future imminent climate and socioeconomic changes could cause a decline in the global growth rate of as much as 0.49 percent of GDP by 2050 because of water-related losses in agriculture, health, income, and property (World Bank 2016; *figure 3.9*). Central Asia is among the regions in the world most economically vulnerable to future water stress, and its growth rate could decline by as much as 11 percent of GDP by 2050 (World Bank 2016). However, by improving water management, Central Asia could instead accelerate its economic growth by as much as 12 percent by 2050 through increased agricultural production, green energy production, and the health of the region's environmental assets. Those results are partially because of the region's sensitivity to climate change but also because water-use efficiency is currently very low. Thus, there are key opportunities to reprioritize water use, nullifying and potentially even reversing the impacts that climate change is expected to have on the economy through water under a business-as-usual scenario.

Delivering water security requires the rapid mobilization of funds dedicated to water-related improvements and more effective use of existing resources. The cost of delivering sustainable water management for all globally has been estimated at $1.04 trillion (2015 dollars) annually from 2015 to 2030. The share of the global cost for Europe and Central Asia amounts to $77 billion, representing 7 percent of the global costs but only 0.6 percent of the current regional GDP (*table 3.2*). Addressing water scarcity is the largest component, totaling $30 billion annually,

Box 3.2

THE HIGH COST OF FLOODS

- Thus far, floods have inflicted the highest relative damage in Azerbaijan and Georgia. In 2015, flooding in Tbilisi caused almost $20 million in damages and losses to housing, the city zoo, and critical transportation and water infrastructure (World Bank 2015b).
- In 2023, Slovenia experienced its most devastating flood, causing major damages to houses, businesses, industries, and agricultural lands, with costs of rebuilding and further development estimated at roughly $10.9 billion (Bezak et al. 2023).
- In 2002, flooding caused $2.9 billion in damages in the Czech Republic, $750 million of which stemmed from damages to transportation infrastructure and water courses (Risk Management Solutions 2003). Indirect losses associated with damaged transportation networks are a result of increased travel time or higher operating costs (World Bank 2015b), as exemplified by the 2002 flood when thirteen underground stations in Prague had to shut down for approximately six months.

Box 3.3

THE HIGH COST OF DROUGHTS

- In 2000, Armenia experienced a severe drought that caused approximately $110 million in damages and an additional $43 million in agricultural losses. At that time, the agricultural sector's share of GDP was more than 30 percent and accounted for more than 40 percent of employment (World Bank 2017).
- A prolonged drought in 2000 to 2002 in Uzbekistan reduced cereal yields by 14 to 17 percent and other crop yields by up to 75 percent while also reducing productivity in the livestock sector, causing $130 million in losses (FAO 2017).
- A drought in the Western Balkans from October 2021 to March 2022 forced Albania into an energy emergency as it halted eleven out of thirteen government-owned hydropower plants (Gallop and Ralev 2022).
- Overall, droughts in the EU from 1980 to 2022 caused losses of about $56.5 billion, almost one-third of which resulted from the severe European-wide drought of 2022 (EEA 2023a).

TABLE 3.2 Estimated Costs (in Billion 2015 US$) to Deliver Sustainable Water Management in Europe and Central Asia

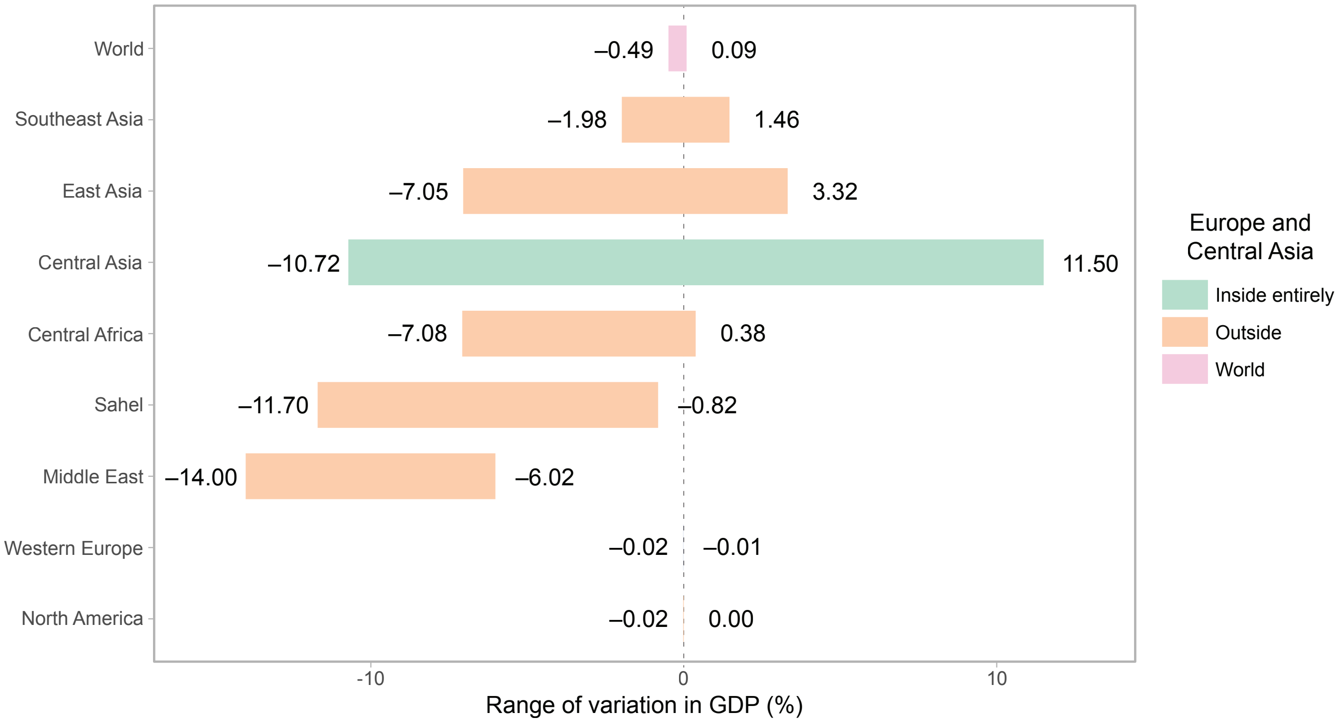
Water challenge	Central Asia	South Caucasus	Danube	Others	Europe and Central Asia
Access to drinking water	1.2	0.2	0.9	3.9	6.1
Access to sanitation	0.9	0.3	1.5	6.7	9.4
Water pollution (industrial and agricultural)	2.0	0.5	6.0	10.1	18.5
Water scarcity	13.0	1.6	4.6	10.8	30.0
Water management	3.4	0.5	2.6	6.3	12.8
Total cost	20.5 (2.2%)	3.1 (1.3%)	15.6 (0.3%)	37.7 (0.6%)	76.9 (0.6%)

Source: Strong et al. 2020.

Note: The total cost as a percentage of the current regional gross domestic product is in parentheses.

Figure 3.9

CLIMATE-RELATED IMPACTS on GDP, 2050

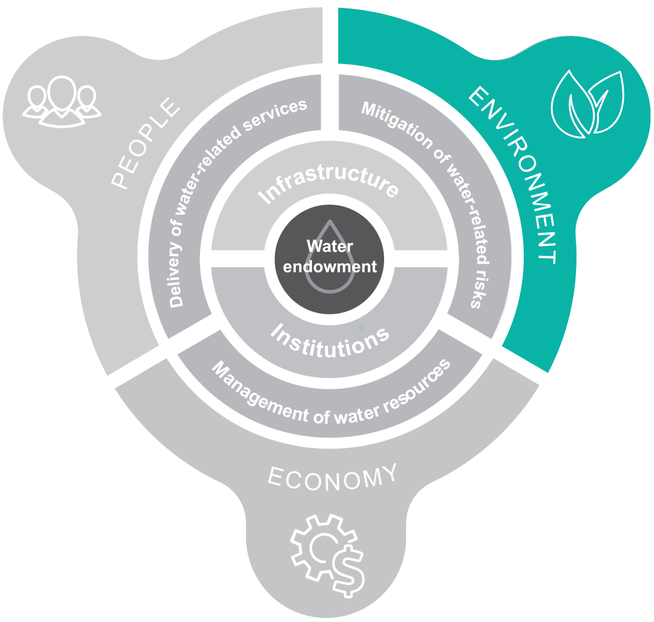


Source: World Bank 2016.

Note: The figure shows the range of climate-related effects on GDP for selected regions, incorporating different policy scenarios (for example, business-as-usual policies and those that encourage better water allocation). GDP = gross domestic product.

because of the size of the challenge, especially in Central Asia. The estimated costs of delivering sustainable water management vary by subregion, as do the most significant water challenges. Costs relative to GDP are the highest in Central Asia, followed by the South Caucasus and the Danube.

ENVIRONMENTAL OUTCOMES



KEY MESSAGES

- Freshwater ecosystems in Europe and Central Asia are at risk because of agricultural intensification, inefficient irrigation, and urbanization combined with climate change.
- Most of the region's water bodies (74 percent) report good ambient water quality; however, monitoring networks are very limited, and only a small share of water bodies is assessed.
- Groundwater, which is underused in many areas and facing depletion in others, suffers from low water quality and salinity, making treatment costly.
- Water stress, currently low in most of the Danube subregion but prevalent in Central Asia and Türkiye, is expected to increase in the coming decades, especially in downstream countries, driven by growing water demands and decreasing water availability.

Sustainable water management is crucial for sustaining the health of Europe and Central Asia's environmental assets. Freshwater ecosystems include rivers, lakes, wetlands, streams, and underground aquifers. These ecosystems store and clean the water that is crucial for people and wildlife. Healthy, unpolluted, biodiverse freshwater ecosystems provide food, livelihoods, drinking water, transportation, and recreation and tourism, along with cultural, mental health, and other benefits. They also help to prevent erosion, store carbon, dispose of waste, and provide natural protection from flooding.

Freshwater ecosystems in Europe and Central Asia are consistently at higher risk of degradation than their terrestrial or marine counterparts. Globally, freshwater biodiversity decreased 83 percent between 1970 and 2018 (WWF 2022). Although some efforts have successfully halted species loss in freshwater ecosystems in Europe, the global downward trend of drastically reduced freshwater biodiversity persists and is growing in some subregions (Haase et al. 2023). The quantity and quality of habitats and the abundance of many species are declining as a consequence of agricultural intensification, inefficient irrigation, and urbanization, combined with climate change (Gozlan et al. 2019). Stronger conservation measures are needed to mitigate the impacts of new and persistent pressures on freshwater ecosystems, including emerging pollutants, excessive water abstractions, climate change, and the spread of invasive species. Irrigation expansion is expected to play a land-sparing role and ease the protection of forests and natural land for biodiversity conservation; investing in new irrigation infrastructure would spare more than 3 million hectares of natural lands from conversion (Palazzo et al. 2019).

The Danube subregion is rich in a diverse array of plant and animal species whose habitats are currently facing threats. These habitats include fast-flowing mountain streams, wide and slowly flowing lowland rivers, large sand and gravel banks, wetlands and floodplains, wet meadows, oxbows, small and large lakes, and the dynamic Danube delta. These habitats are home to approximately 2,000 vascular plants and over 5,000 animal species, including those of more than forty mammals, about 180 breeding birds, one hundred fish, and twelve reptiles and amphibians. The remaining large floodplain forests along the Danube and the Danube delta serve as the last sanctuaries in continental Europe for the white-tailed eagle and white pelicans. However, these freshwater ecosystems and the biodiversity they support are facing various pressures, including pollution from agricultural runoff, industrial discharges, inadequate wastewater treatment, the impacts of hydraulic infrastructure, and climate change (ICPDR 2021).

Recognized as one of the world's biodiversity hotspots, the South Caucasus subregion is similarly threatened by pollution and overabstraction. Characterized by a wide diversity of species and a high level of endemism, the plant and animal diversity in the South Caucasus is more than twice that of adjacent regions. Freshwater habitats in the South Caucasus are crucial for migrating and nesting birds, spawning fish, and providing water for human needs

(Kuljanishvili et al. 2021). The main threats to freshwater ecosystems in the South Caucasus are pollution, water abstractions, foreign species, and hydropower and water control dams (WWF 2015).

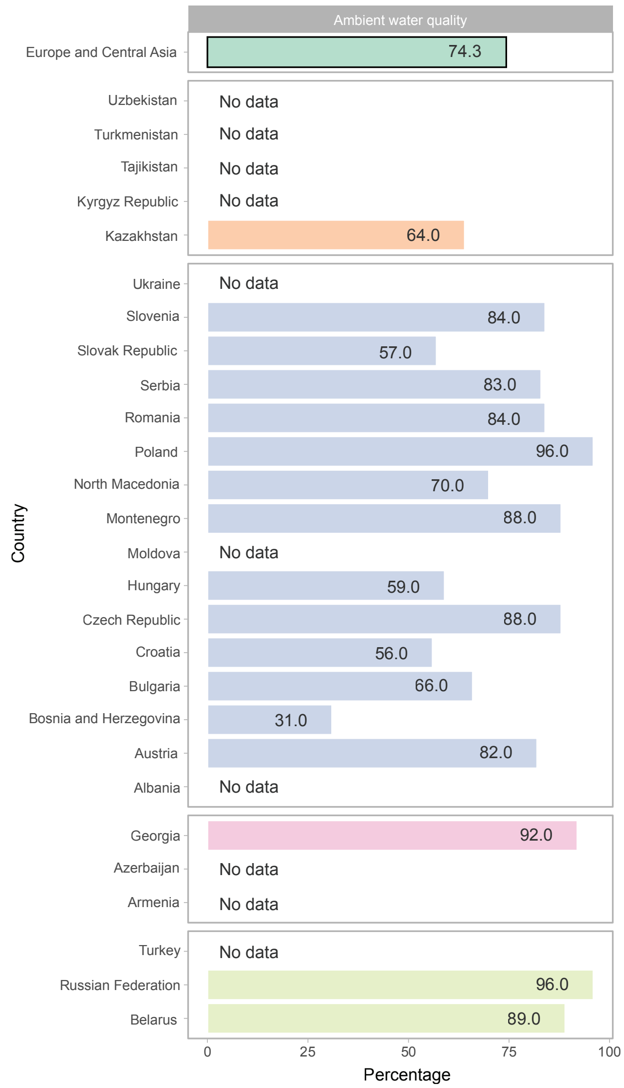
The Aral Sea was once the world's fourth-largest lake, but massive irrigation diversions have reduced it to one-tenth of its original size. The Central Asia subregion contains many natural lakes, such as the Aral Sea, that have important regulatory influences on the climate and functioning of other ecosystems. However, massive irrigation schemes diverted most of the water flowing to the Aral Sea, causing it to shrink to one-tenth of its original size and making it too saline for most fish (Pala 2011).

Overall, ambient water quality is considered adequate across Europe and Central Asia, but this is subject to high uncertainty because of the differing monitoring standards and limited networks across countries. Good water quality is an important factor for human health and the functioning of ecosystems. According to the SDGs, 79 percent of water bodies across Europe and Central Asia (for example, rivers, lakes, and groundwater) have good ambient water quality (*figure 3.10*). The large size of many water bodies helps buffer point-source and diffuse pollution, and in some places, such as the Danube subregion (especially EU Member States), stringent regulatory frameworks and large investments in pollution-prevention measures have helped limit pollution while maintaining the overall good status of water bodies. Nevertheless, standards differ widely among countries. Some countries have very ambitious monitoring programs that address a wide range of environmental dimensions, including diverse biological, chemical, and hydrological parameters, whereas others are limited to a few chemical parameters. Likewise, monitoring networks in many countries are scarce, and data on ambient water quality are missing in eleven Europe and Central Asia countries, which creates a lot of uncertainty.

Ambient water quality in the Danube is affected by the complex interplay among many factors, including human activities, geography, climate, and monitoring standards. More than 80 percent of water bodies in some Danube countries (for example, Austria, the Czech Republic, Hungary, Poland, Romania, and Slovenia) report good ambient water quality. Meanwhile, several other countries, such as Albania, Bosnia and Herzegovina, and Serbia, lag behind (*figure 3.10*). Water pollution from insufficiently treated urban and industrial wastewater and diffuse pollution from agriculture are the key pressures affecting water bodies in the Danube. Population density is often, but not always, highest close to rivers and lakes, meaning the relationship between wastewater treatment and ambient water quality is highly local. For example, 70 percent of the water bodies in North Macedonia reports good ambient water quality even though only 9 percent of wastewater is safely treated. Conversely, in Hungary, where 90 percent of wastewater is treated, only 59 percent of ambient water is considered good.

Figure 3.10

AMBIENT WATER Quality in Europe and Central Asia



Source: EEA, 2018.

Note: The figure shows the range of climate-related effects on GDP for selected regions, incorporating different scenarios (for example, business-as-usual policies and those that encourage better water allocation). GDP = gross domestic product.

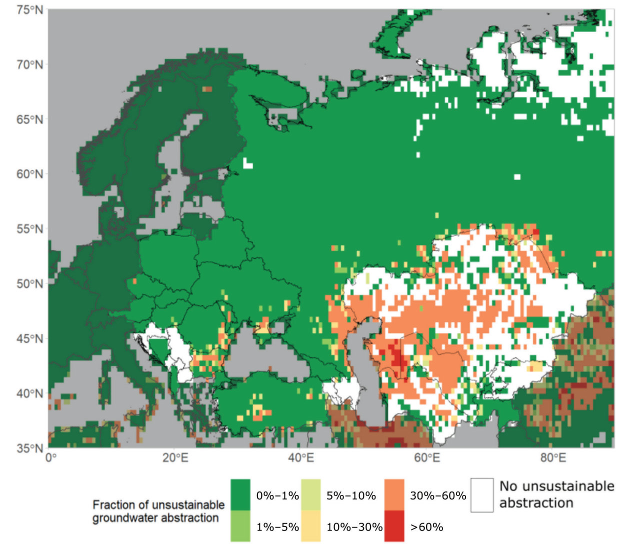
Information on ambient water quality is limited in Central Asia and the South Caucasus. Kazakhstan, the only country in Central Asia that has reported ambient water quality, is rated as moderate. The South Caucasus subregion faces a similar situation, with Georgia, the only reporting country, rated as good. A global water quality risk assessment indicates that the entire region is expected to experience an elevated to high water quality risk by 2050 (IFPRI and Veolia Water North America 2015).

Groundwater is underused in some areas and facing depletion, low quality, and pollution in others. Sustainable use of groundwater requires that abstraction rates not surpass recharge rates. As soon as it does, groundwater will start to deplete. In Europe and Central Asia, about 14 percent of abstracted groundwater is not replenished, compared with a global average of 39 percent (Wada et al. 2010). In the Danube and the South Caucasus, groundwater is still underused, and except for Bulgaria and the southern parts of Moldova and Romania, there is potential for this resource to be developed further (*map 3.1*). Central Asia, especially around the Aral Sea in Kazakhstan and Uzbekistan, faces the highest groundwater depletion rates in Europe and Central Asia, marked by unsustainable water abstraction. However, groundwater use remains sustainable in other parts of Central Asia and irrigated areas of Northern Kazakhstan (*map 3.1*). In the future, higher levels of water stress (see "Future Challenges and Opportunities" in chapter 4 for discussion of future water projections) and increased droughts will put additional pressure on groundwater resources. It follows that improving the currently fragmented integrated water resources management (IWRM) and developing drought management plans (see chapter 4 for more on the mitigation of water-related risks) are key steps to sustainable groundwater use.

Nevertheless, many aquifers suffer from low water quality, leading to additional treatment costs. Central Asia contains the world's largest area of saline and brackish aquifers, with salinity levels of up to 50,000 milligrams per liter (Li et al. 2020), meaning much of the groundwater must be treated before use. Similarly, the South Caucasus has extensive saline groundwater aquifers (*map 3.2*). This water source requires costly desalination that can cause environmental damage. Conversely, using untreated brackish water can lead to adverse environmental and health effects over time (Li et al. 2020). Groundwater quality in the Danube is also compromised in some areas by agricultural pollution or untreated wastewater, and high nitrate levels have been observed in aquifers in Croatia, Poland, Romania, and Serbia. Addressing high ion concentrations in groundwater requires costly pretreatment measures (Abscal et al. 2022). Additionally, using untreated groundwater may expose users to toxic substances, leading to health risks, and notable arsenic concentration hot spots have been observed in the Danube (Hungary and Romania) and Central Asia (Kazakhstan and Uzbekistan; Podgorski and Berg 2020).

Map 3.1

FRACTION OF Unsustainable Groundwater Abstraction in Europe and Central Asia



Source: Processed for this publication based on data from Wada et al. 2014.

Note: Hotspots of unsustainable groundwater use (top) and subregional summary (bottom). The boxes on the bottom chart show the interquartile range (IQR) and the median, the whiskers indicate a distance of 1.2 * IQR from the 25th and 75th percentile, and the points are outliers.

Map 3.2

SALINE AND Brackish Groundwater in Europe and Central Asia

Source: IGRAC 2009.

Note: All polygons indicate saline or brackish groundwater.

FUTURE CHALLENGES AND OPPORTUNITIES

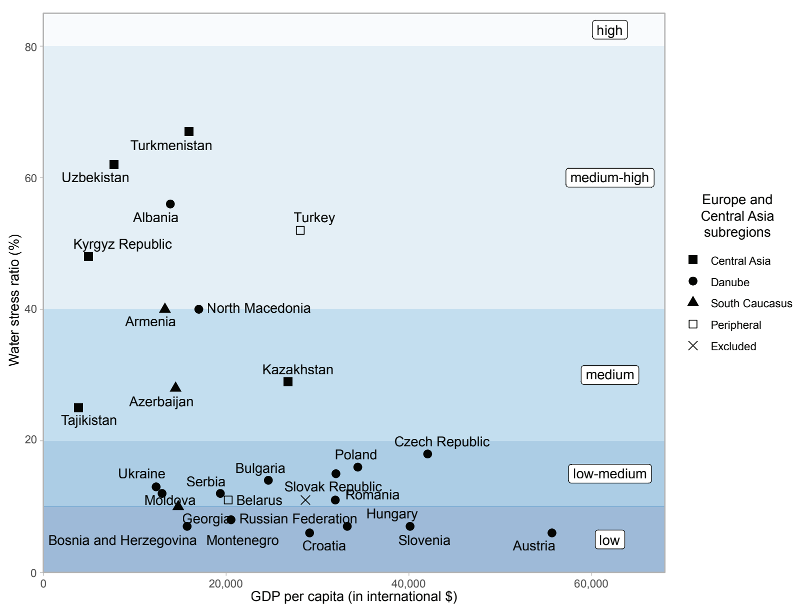
Water stress is mostly driven by water use, which typically increases with socioeconomic developments. Annual water stress is low in most of the Danube subregion but prevalent in Central Asia and Türkiye. Multiple countries already suffer from high water stress (that is, a water stress index higher than or equal to 40 percent), including Albania (56 percent), Armenia (40 percent), North Macedonia (40 percent), Türkiye (52 percent), Turkmenistan (67 percent), and Uzbekistan (62 percent). Water stress is expected to increase across Europe and Central Asia in the coming decades, especially in downstream countries, driven by growing water demands and decreasing water availability (see chapter 4 on endowment). Water stress, other than increasing competition among users, drives several environmental problems, including groundwater overexploitation and ecosystem degradation. When comparing the level of water stress against the level of economic development (measured in GDP per capita), it becomes clear that high levels of water stress are loosely associated with lower levels of economic development, driven mostly by the prevalence of agricultural activities with lower economic water productivity compared with other sectors (*figure 3.11*).

The size and frequency of floods are likely to decrease across most of Europe and Central Asia, but they will remain high. An ensemble of twenty-one climate models strongly agrees that flood hazards are likely to decrease overall across most of Europe and Central Asia, although Central Asia, Georgia, and parts of Belarus and Russia may experience an increase (Arnell and Gosling 2016). This decrease in flood hazards is slightly counteracted by projected population and economic growth. Nevertheless, relative subregional population and economic exposures are slightly reduced. Thus, even without risk-reduction measures, flood risks in Europe and Central Asia will decrease slightly but remain at an alarming level. In absolute terms, higher GDP exposure is expected across Europe and Central Asia, whereas population exposure is expected to differ by subregion, over time, and under different socioeconomic scenarios. High levels of uncertainty stem from assumptions on future population and economic trends, as well as spatial distribution, because different development pathways would result in different risk levels.

- Central Asia. An increase in flood hazards by up to 15 percent is expected, mostly in Northern and Eastern Kazakhstan, the Kyrgyz Republic, Tajikistan, and parts of Turkmenistan and Uzbekistan (Arnell and Gosling 2016). Larger increases in population and GDP exposure are expected in Tajikistan and Turkmenistan, but these are balanced subregionally by large decreases in exposure in both the Kyrgyz Republic and Uzbekistan. The opposite trend between hazard and exposure in the Kyrgyz Republic and Tajikistan may be associated

Figure 3.11

WATER STRESS Levels in Europe and Central Asia



Source: Sutanudjaja et al. 2018.

Note: Water stress levels are classified as follows: low (0%–10%), moderate (10%–20%), high (20%–40%), and extreme (>40%). GDP = gross domestic product.

with the spatial distribution of population and economic activity. Overall, the subregion can expect to experience a slight decrease in exposure, which nonetheless remains significant at 1.2 to 1.3 percent.

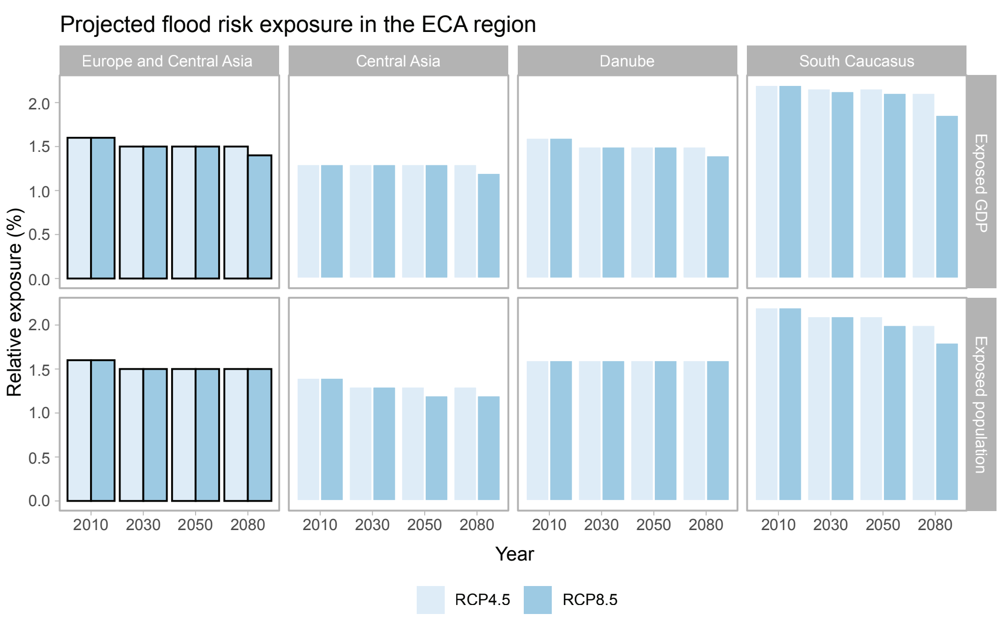
- Danube. Models largely concur that a decrease of up to 20 percent in flood hazards is expected by 2050 (Arnell and Gosling 2016). It follows that relative population and GDP exposure show a slight decrease, although risk levels are still important (1.4 to 1.5 percent for GDP and 1.6 percent for population). Exposure decreases significantly in some countries, including Kosovo, Montenegro, and Ukraine, while increasing in North Macedonia.
- South Caucasus. By 2050, flood hazards are expected to decrease by 10 to 20 percent in Armenia and Azerbaijan and slightly increase in Georgia (Arnell and Gosling 2016). Consequently, the relative GDP and population exposure is expected to shift from 2.2 percent to as low as 1.8 percent for Azerbaijan in 2080. In Georgia, exposure increases until 2050, and then it may either increase or decrease to 2080, depending on the Representative Concentration Pathway (RCP) and Shared Socioeconomic Pathway (SSP). Overall, a constant decrease in both relative GDP and population exposure is expected for the South Caucasus subregion by 2080, but a high risk level remains where population exposure ranges between 1.8 and 2 percent and the GDP exposure is slightly higher (*figure 3.12*).

Regionally, drought hazard is expected to increase by 2050, threatening multiple human and environmental systems. Various social, economic, and environmental systems are at risk from drought, and significant impacts have already been experienced. Assessing and predicting the impacts of droughts is challenging because of the complex links between droughts and impacts. Drought hazard indices depend only on climate data (that is, precipitation and evapotranspiration) and are a crucial factor in drought risk. The Standardized Precipitation-Evapotranspiration Index (SPEI) measures water deficit for a selected region over a predefined accumulation period. Smaller values of the SPEI indicate a higher drought hazard in 2050, and the drought hazard increases in Europe and Central Asia under both RCPs (as shown by a decrease in SPEI; *figure 3.13*).

Drought hazard is expected to increase significantly in Central Asia and the South Caucasus but reduce slightly in the Danube. If risk-reduction measures are not pursued, both regions can expect increased impacts on human well-being and higher economic loss resulting from droughts. In contrast, the Danube region shows a slight reduction

Figure 3.12

RIVERINE FLOOD Risk between 2010 and 2080 under Two Future Climatic Scenarios (RCP4.5 and RCP8.5)

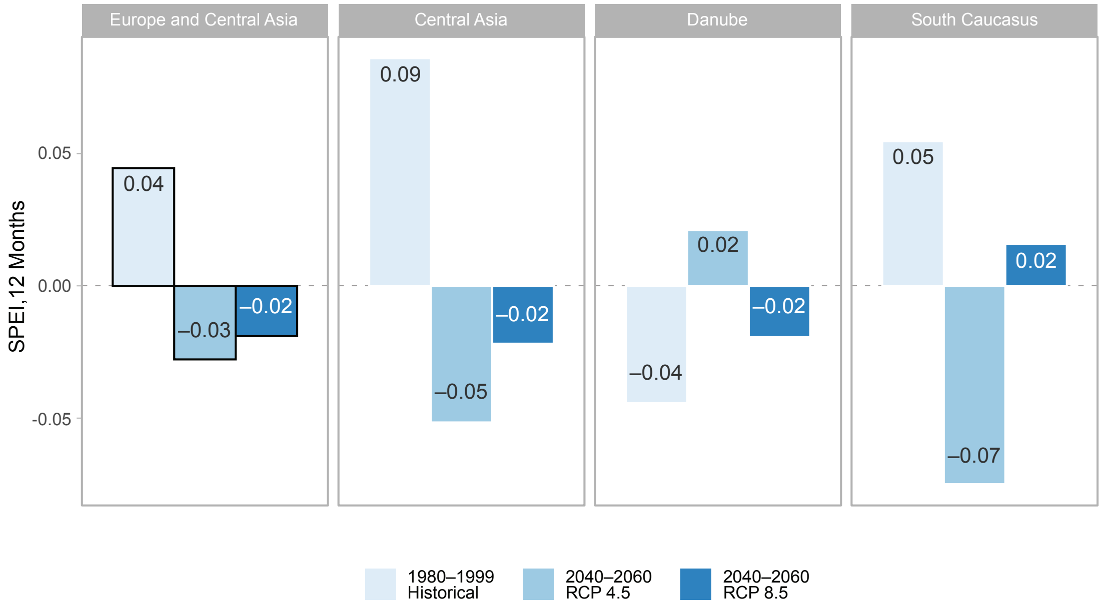


Source: Ward et al. 2013.

Note: Top shows exposure of GDP to riverine flood risk; bottom shows exposure of the population to riverine flood risk. The Europe and Central Asia toolbox's range bands differentiate between medium flood risk (1.0%–1.5% exposure), medium-high (1.5%–2.0%), and high (>2.0%).GDP = gross domestic product; RCP = Representative Concentration Pathway.

Figure 3.13

REGIONAL AVERAGE Historical (1980–99) and Future (2040–60) SPEIs over an Accumulation Period of 12 Months under RCP4.5 and RCP8.5



Source: Santini et al. 2023.

Note: The data points represent the average value of three global climate models (GCMs): the Geophysical Fluid Dynamics Laboratory Earth System Model (GFDL-ESM2M), the Institut Pierre-Simon Laplace coupled model for CMIP5 (IPSL-CM5A-LR), and the Model for Interdisciplinary Research on Climate Earth System Model (MIROC-ESM-CHEM). Negative values represent a more significant water deficit and higher drought hazard. RCP = Representative Concentration Pathway.

in future drought hazard. However, drought impacts in the Danube region may still increase if drought exposure remains high (for example, higher utilization of water sources for hydropower generation). Exceptionally, Austria, the Czech Republic, and North Macedonia show an increase in drought hazard.

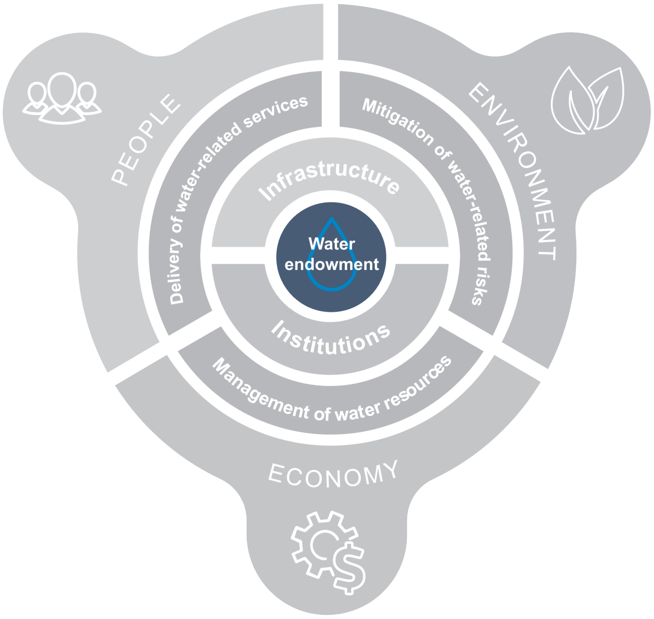
NOTES

1. *Safely managed drinking water* means water taken from an improved water source that is accessible on premises, available when needed, and free from fecal and priority chemical contamination, whereas *basic drinking water* means water taken from an improved source, provided collection time is not more than thirty minutes for a round trip, including queuing. *Safely managed sanitation* means the use of improved facilities that are not shared with other households and where excreta are safely disposed of in situ or removed and treated off-site, whereas *basic sanitation* refers to the use of improved facilities that are not shared with other households.
2. DALYs depict the overall burden of disease with a time-based measure that combines years of life lost because of premature mortality and because of time lived in states of less than full health, or years of healthy life lost because of disability. One DALY represents the loss of the equivalent of one year of full health.
3. The number of DALYs per 100,000 inhabitants amounts to 1,131 globally, 3,865 in Africa, 748 in Asia, 202 in America, and sixty-four in Europe. Mortality rates attributed to WASH amount to 17.01 people per 100,000 inhabitants in Asia, 3.71 in Europe, 6.51 in Latin America and the Caribbean, 2.26 in North America, and 49.16 in Sub-Saharan Africa (WHO 2023a).
4. Population figures based on elaboration on data from Ward et al. (2013), displayed in figure 3.4.
5. Data from World Bank DataBank; for further information, see https://data.worldbank.org/indicator/ER.GDP.FWTL.M3.KD?most_recent_value_desc=true.
6. Irrigation and Drainage Rehabilitation Project (Serbia), World Bank, 2021; for further information, see https://projects.worldbank.org/en/projects-operations/project-detail/P087964.

4

Water Endowment

Challenges and risks are typically linked to the volume, timing, and quality of water resources; abilities or deficiencies in water sector governance, including institutional weaknesses and financial gaps; and sector performance when essential functions for managing water resources, delivering services, and mitigating water-related risks are conducted. This chapter corresponds to the innermost ring of the Water Security Diagnostic Framework (WSDF), encompassing water endowment (*figure 1.1*).



KEY MESSAGES

- Regionally, water resources are generally abundant, but they face important challenges because of the high dependency on transboundary waters and increasing seasonal and temporal variations.
  - On average, 41 percent of all surface water flows originate upstream, and they vary seasonally and temporally by as much as 60 percent.
  - These figures increase to 47 and 90 percent in Central Asia.
- Groundwater represents only a small share of the region's total water endowment (about 10 percent), and it is often polluted or too saline to use without costly treatment.
- Climate-change impacts will manifest differently across the region, altering water availability and, importantly, increasing the risk of extreme events.
  - Temperatures are expected to rise overall.
  - Upstream countries will experience an increase in rainfall and a reduction in snow storage, potentially leading to an increase in floods.
  - Downstream countries are expected to experience decreased rainfall and reduced summertime flows (resulting from reduced snow melt), exacerbating drought risks in lowland areas.
- Water demands are expected to increase sharply across the region by 30 to 60 percent by 2050, driven by growing industrial and domestic demands in the Danube and irrigation in Central Asia and the South Caucasus.

WATER AVAILABILITY

Renewable water resources are above the global average but vary widely both regionally and across subregions. Average water availability in Europe and Central Asia stands at approximately 7,665 cubic meters per person per year, 20 percent higher than the global average of 5,600 cubic meters per person per year (*figure 4.1*). Nevertheless, the region experiences considerable spatial and temporal variations. Central Asia has the lowest endowment of the three subregions, with 3,450 cubic meters per person per year. Conversely, the Danube subregion is comparatively water-rich, boasting an endowment of 9,140 cubic meters per person per year, followed by the South Caucasus with 7,306 cubic meters per person per year. Notably, all three subregions significantly exceed the per capita water stress threshold of 1,700 cubic meters. Still, this is insufficient to meet the water demands of some countries, particularly Turkmenistan and Uzbekistan in Central Asia.

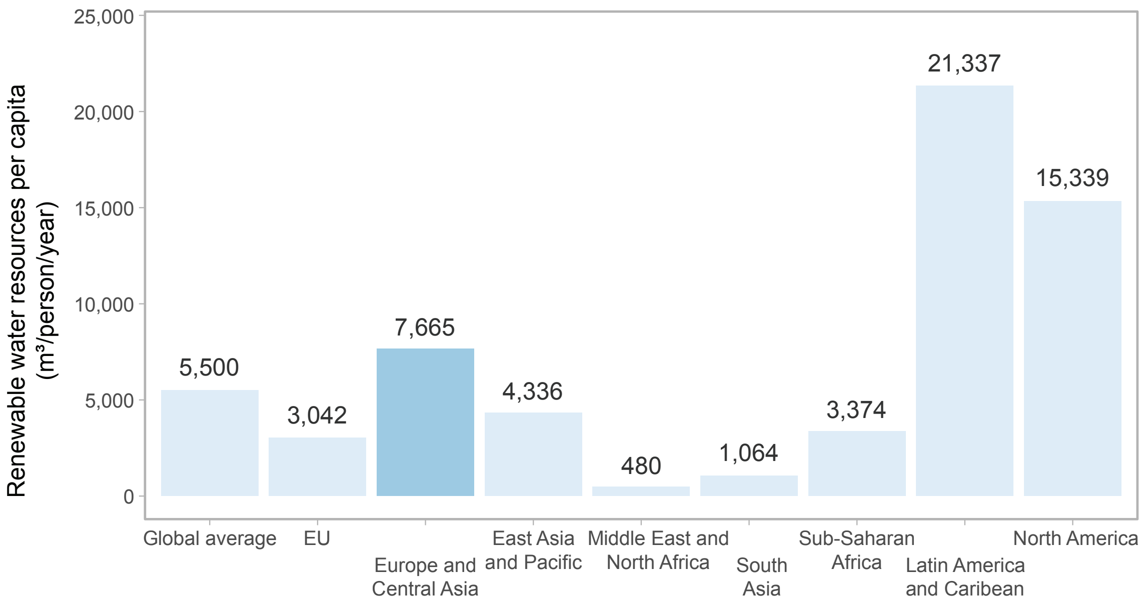
Water resources are unevenly distributed across the region. Surface water represents the largest stocks of water, whereas groundwater represents a small but critical share of water resources. The region has an average renewable water endowment equivalent to 1,600 cubic kilometers per year (significantly more than the region's average annual demand), 90 percent of which consists of surface water resources. There are, however, very important differences across the region, with 75 percent of all surface water resources and about 50 percent of groundwater originating in the Danube (*figure 4.2*).

The most water-abundant countries in the Danube subregion are located downstream. For example, together, Romania (212 cubic kilometers per year) and Ukraine (175 cubic kilometers per year) account for 40 percent of total water resources available (surface water and groundwater) in the entire Danube subregion. Croatia (102 cubic kilometers per year) and Serbia (162 cubic kilometers per year) are also home to large endowments despite being smaller in land area. Notably, a considerable share of these water resources originates from upstream countries, underscoring the critical transboundary nature of water dependency in downstream countries. Although these countries are largely abundant in surface water (which supports different uses, such as irrigation, hydropower, fisheries, and navigation), the utilizable fraction is much smaller because of the constraints of spatial access and availability. In Ukraine, groundwater is a key source, accounting for 12 percent of the country's total renewable water resources.

Water reserves are significantly lower in the South Caucasus and Central Asia. Georgia has the largest availability of water resources (63 cubic kilometers per year) in the subregion (predominantly surface water), whereas Armenia has the lowest (8 cubic kilometers per year, balanced between surface water and groundwater). These disparities highlight the varied dynamics of water resources distribution in the region. In Central Asia, Kazakhstan is the largest country in the region and is home to the largest endowments of surface water (100 cubic kilometers per year) and groundwater (33

Figure 4.1

TOTAL RENEWABLE Water Availability per Capita across Major Regions in the World, 2020



Source: AQUASTAT, 2024.

cubic kilometers per year). The Kyrgyz Republic, although having fewer total renewable water resources (24 cubic kilometers per year) overall, boasts a higher per capita availability because of its smaller population (3,815 cubic meters per person per year). Turkmenistan and Uzbekistan are highly dependent on transboundary surface water that is subject to seasonal fluctuations and upstream activities, making them especially vulnerable.

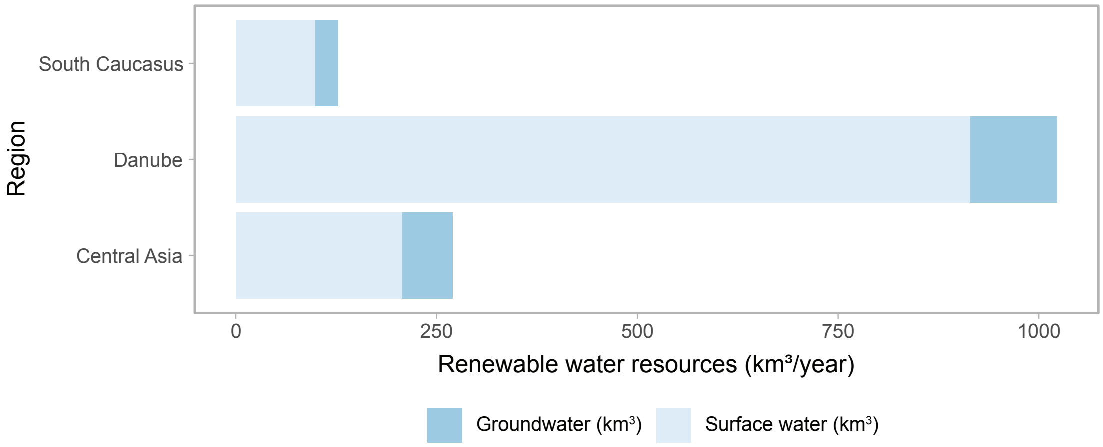
Groundwater plays a critical role as a buffer stock during prolonged dry periods. The availability of surface water and groundwater in Europe and Central Asia is a complex interplay between geographical, climatic, and anthropogenic factors, each shaping the regional water security narrative. The Danube subregion, characterized by its vast network of rivers, relies primarily on surface water to meet its water demand. However, the anticipated climatic changes could lead to increased variability, with potential surges in the Upper Danube's water availability contrasting with declines in the middle and lower regions. The interconnected nature of surface water and groundwater systems means that groundwater levels are replenished by high river water levels and, conversely, support river flows during dry periods, playing a critical role in drought mitigation. In the South Caucasus, both surface water and groundwater are critical for the region's sustainability and development. Surface water availability varies across the landscape, with regions like the Greater Caucasus and the Caspian Sea basin being relatively water-rich compared with the Kur-Aras Lowland. Artesian groundwater is crucial, especially in areas with limited surface water. Similar to the Danube, Central Asia has significant surface water resources fed by glacial melt and snowmelt, particularly in upstream countries like the Kyrgyz Republic and Tajikistan. This reliance is underscored by the high percentage of surface water use (more than 95 percent of all water withdrawals) compared with groundwater. Upstream demands in the Kyrgyz Republic and Tajikistan are increasing, reducing and altering the timing of outflows to Kazakhstan and Uzbekistan and affecting groundwater recharge downstream.

Water resources in Europe and Central Asia are subject to increasing spatial and temporal variability. Water availability is highly influenced by climate patterns and human activities. Seasonal variability1 is particularly relevant in Central Asia and the South Caucasus, given that surface water flows are highly dependent on snowmelt and, to a lesser extent, rainfall (*map 4.1a*). The Danube subregion exhibits fewer variations in water availability throughout the year, although upstream flows are highly reliant on snowmelt.

All subregions have experienced moderate changes in water availability throughout the past two decades (*map 4.1b*). Such variability has important socioeconomic and environmental consequences because it influences when and where water is available, thus affecting agriculture, hydropower generation, human consumption, and environmental flows. For instance, Central Asia's highly variable precipitation is heavily influenced by Indian summer monsoons and the Asian westerly jet, which play critical roles in ensuring water is available for irrigation and hydropower generation. Snowmelt, a significant contributor to river flow and freshwater supply during summer, is also closely linked to these seasonal climatic variations.

Figure 4.2

TOTAL RENEWABLE Water Resources Available in Europe and Central Asia, 2020



Source: AQUASTAT, 2024.

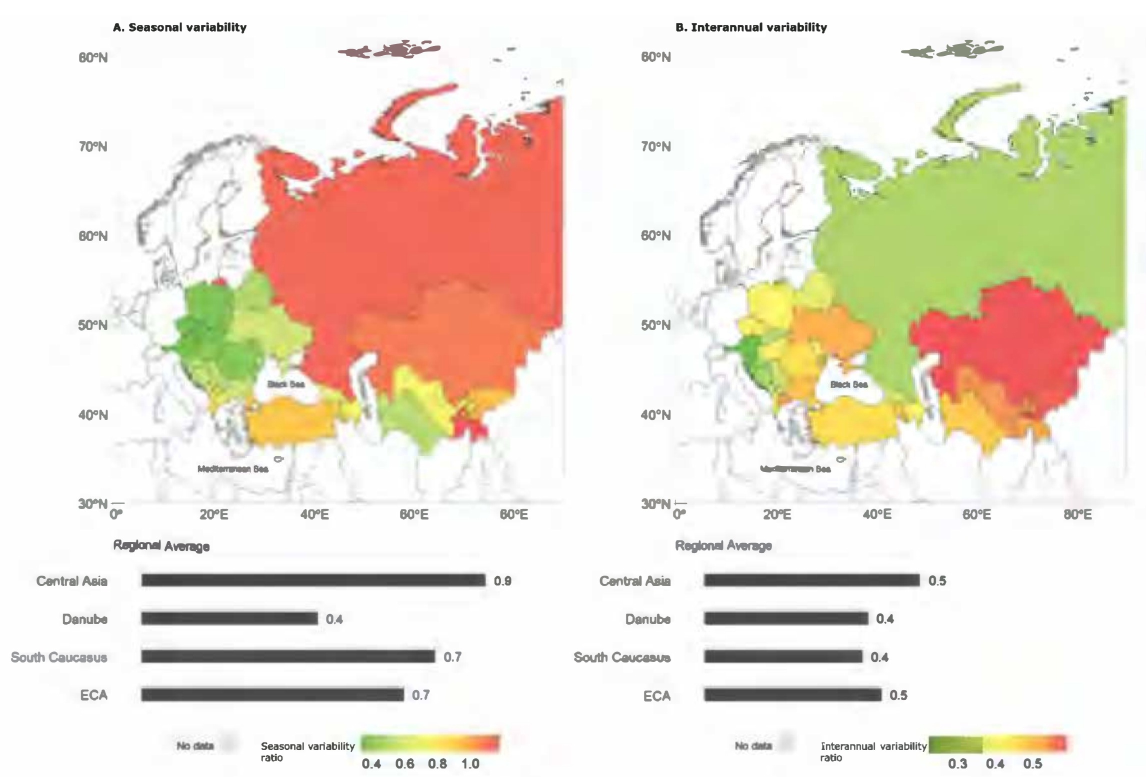
STORAGE TO MANAGE WATER VARIABILITY

The strategic use of storage can help mitigate risks associated with seasonal and interannual variability. Managing water variability in Europe and Central Asia requires an integrated approach that leverages various types of water storage, both natural and constructed. The region encompasses diverse climatic zones and hydrological conditions, making it imperative to use a spectrum of storage solutions to mitigate risks associated with water supply fluctuations. Natural storage in the region includes aquifers, soil moisture, lakes, and wetlands, which collectively account for most freshwater reserves. These natural reserves are critical for sustaining ecosystems, supporting agriculture, and providing water during dry spells. However, they are subject to various threats, such as climate change, overabstraction, and contamination, emphasizing the need for careful management and conservation efforts.

Although some countries in the Danube subregion have experienced a severe decline in groundwater, the loss is especially acute in Central Asia, driven by excessive extractions for agricultural and domestic use. Regions such as Kazakhstan, Turkmenistan, and Uzbekistan are particularly affected, with high rates of land subsidence because of overextraction of groundwater (Hasan et al. 2023). This unsustainable practice has led to a permanent reduction in aquifer storage capacity, threatening long-term water availability and exacerbating land degradation. The arid and semiarid climates of Central Asia further compound the challenge because natural groundwater recharge rates are low, making recovery difficult. Sustainable groundwater management practices, including managed aquifer recharge and continuous monitoring using remote-sensing technologies, are essential to mitigate these impacts and ensure water security in the region. Some countries in the Danube subregion also experienced severe declines in groundwater storage for 2003–20, with Ukraine (–2,220 cubic meters per year), Romania (–999 cubic meters per year), and Hungary (–519 cubic meters per year) being the most affected (Xanke and Liesch 2022). Balkan countries have also witnessed negative trends, ranging from a significant decline in the Slovak Republic

Map 4.1

SEASONAL AND Interannual Variability in Europe and Central Asia



Source: AQUASTAT, 2024.

Note: The indicators of seasonal and interannual variability of water resources represent how much the water availability varies within a year and between years from its long-term 20-year average, respectively. Higher values indicate wider variations of available supply.

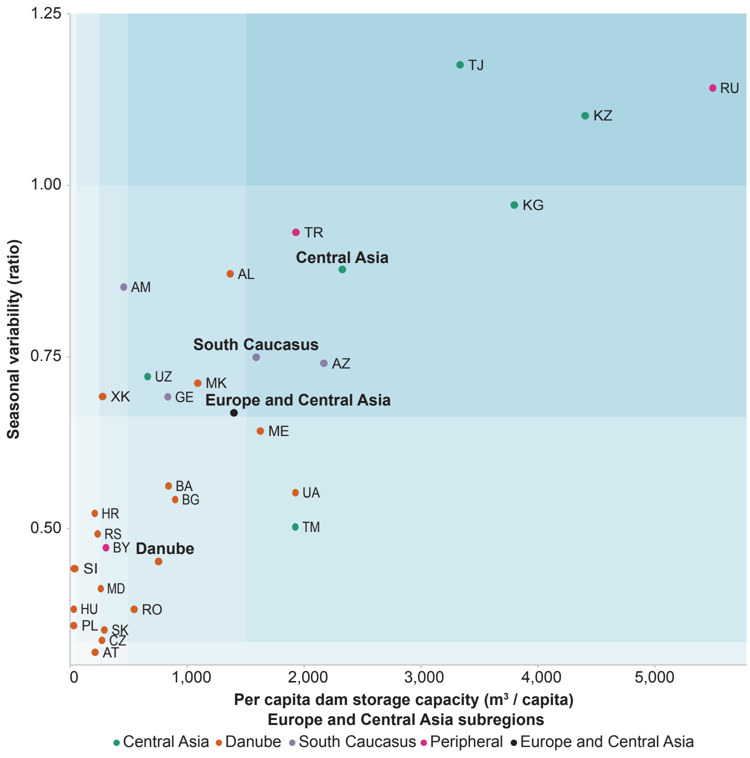
(–248 cubic meters per year) to a less pronounced decrease in Bosnia and Herzegovina (–133 cubic meters per year).

Built storage, such as dams and reservoirs, provides controlled storage options that offer flexibility in managing water supply. For example, reservoirs can hold water from surplus periods for use during periods of scarcity (*figure 4.3*). They also help manage the risk of floods and droughts and support hydropower generation. However, challenges such as sedimentation, environmental and social trade-offs, and hydrological risks must be managed to maximize the benefits of built storage. Hybrid storage systems combine natural and built elements, creating solutions that are adaptable to changing conditions. Managed aquifer recharge (MAR), for example, uses built structures to enhance the natural groundwater reserves, increasing water supply while maintaining quality. Urban sponge cities absorb and store rainwater, reducing the stress on conventional drainage systems and enhancing resilience to flooding. The interdependence of these storage types is crucial. For instance, the construction of dams can affect downstream aquifers and wetlands, whereas overabstraction of groundwater can affect river flows and reservoir levels. It is important to note that traditional large-scale infrastructure—such as reservoirs, or gray infrastructure—although crucial, must be part of a broader strategy that includes smaller-scale and nature-based solutions (green infrastructure) to effectively manage the variability of water availability.

The significance of reservoirs is particularly pronounced in Central Asia and the South Caucasus, where the reliance on snowmelt for surface water is paramount. These reservoirs act as buffers, capturing meltwater during peak flows and releasing it during drier periods, thus stabilizing water availability for agriculture, domestic consumption, and energy production. Central Asian countries, with high seasonal and interannual variability, have relatively high per capita dam storage, reflecting the need to manage water supplies that fluctuate significantly throughout the year. Water availability is more consistent in the Danube subregion; hence there are fewer dams per capita. The strategic use of reservoirs still helps in managing variations in upstream flow, also influenced by snowmelt. In the Danube River basin (DRB), the utility of reservoirs extends beyond conservation. Here, they help manage the river's flow regimes and water quality, as well as mitigate the impacts of extreme weather events, such as floods or droughts, by controlling the release and storage of water throughout the year. Moreover, in areas dependent on snowmelt, such as the upper reaches of the

Figure 4.3

PER CAPITA Dam Availability versus Seasonal Variability



Source: AQUASTAT, 2024.

Danube, reservoirs are essential in preventing springtime floods when the snowpack melts, storing water that will be crucial during the summer months. For further discussion of the reservoir infrastructure and its uses, see "Reservoirs" in chapter 5.

TRANSBOUNDARY WATERS

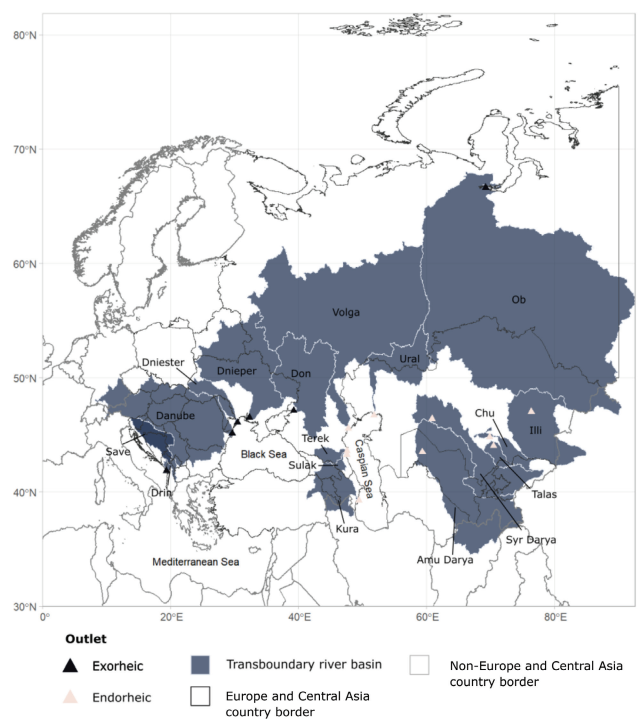
There is a large number of important transboundary river basins in the region. Europe and Central Asia's network of rivers includes more than 24,000 kilometers of transboundary stretches. Among these, approximately fourteen major river basins, each spanning an area larger than 20,000 square kilometers, serve as vital water sources for numerous countries (*map 4.2*). Notably, the basins of the Ob River and the Danube River stand out for their sheer size, each exceeding 800,000 square kilometers. The Danube River, renowned as the world's most international river, sets a global benchmark for transboundary water cooperation, offering a stark contrast to the more challenging cooperation scenarios observed in the South Caucasus and Central Asia (see "Institutions" in chapter 5 for further details on transboundary water governance). Central Asia is a hot spot for transboundary water challenges, housing the region's largest and most geopolitically significant river basins, including the Amu Darya, Ili, Syr Darya, and Ural. These basins traverse Kazakhstan, underscoring the country's central role in regional water dynamics.

The Europe and Central Asia region is also home to a large number of transboundary aquifers. There are more than sixty-six transboundary aquifers, each with an area larger than 1,000 square kilometers (*map 4.3*), that play a key role in supplying drinking water and irrigation. Most transboundary aquifers are located in Central Asia (60 percent), followed by the South Caucasus (30 percent). Those in the Danube are small and extend over smaller areas.

Large numbers of transboundary water bodies lead to high levels of water dependency, adding to the uncertainty and potential risks of water resource management and planning in the region. On average, 41 percent of national surface water endowments depend on upstream flows. Dependency is highest in Central Asian countries

Map 4.2

MAIN TRANSBOUNDARY River Basins in Europe and Central Asia



Source: Compiled based on data from FAO 2011; Lehrer and Grill 2013; McCracken and Wolf 2019.

Map 4.3

TRANSBOUNDARY AQUIFERS in Europe and Central Asia

Source: IGRAC 2021.

Note: Small aquifers are defined as water bodies with an area smaller than 1,000 km^2.

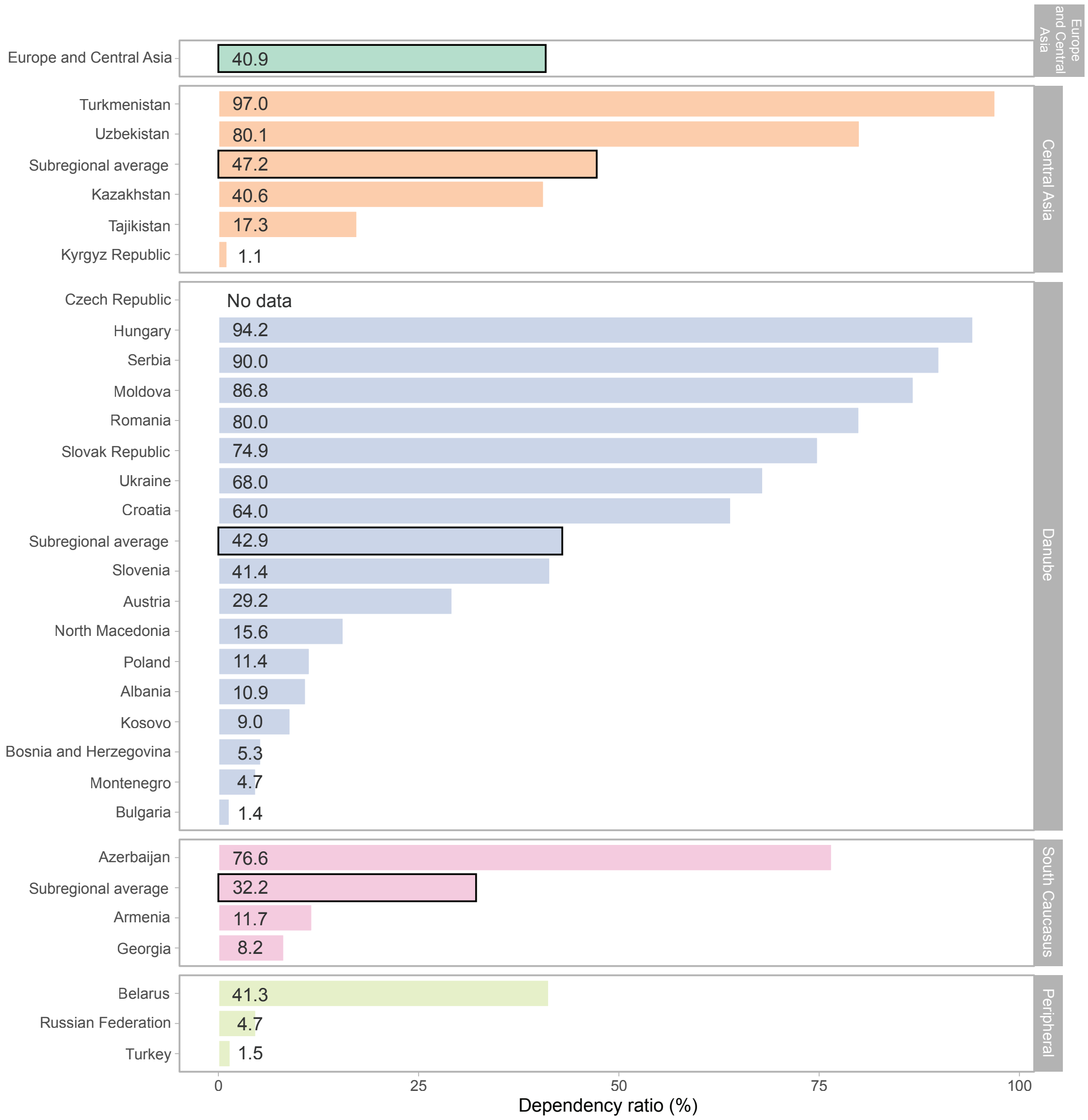
(dependency ratio equivalent to 47 percent), particularly those downstream, followed by countries in the Danube (43 percent; *figure 4.4*). Such large dependencies represent an important risk for countries, given that these flows are largely surface waters and highly vulnerable to climate fluctuations. Moreover, changing water demand in upstream countries can eventually reduce downstream inflows. In the South Caucasus, Azerbaijan's heavy reliance on upstream transboundary waters (dependency ratio equivalent to 77 percent) from the Kura and Aras Rivers makes it vulnerable to upstream water management decisions. In Central Asia, transboundary water challenges revolve mainly around the Syr Darya and Amu Darya Rivers, which are shared between the five countries of the subregion. There, a heavy reliance on surface waters to meet water demands and the high dependency ratios of downstream countries such as Turkmenistan (dependency ratio equivalent to 97 percent) and Uzbekistan (dependency ratio equivalent to 80 percent) make transboundary water management critical to ensuring equitable and sustainable water distribution.

WATER DEMANDS

Total water demand has decreased slightly over the past two decades across Europe and Central Asia. Although the region's total water demands are small (including peripheral

Figure 4.4

DEPENDENCY RATIO of Countries from Transboundary Surface Water Flows



Source: AQUASTAT, 2024.

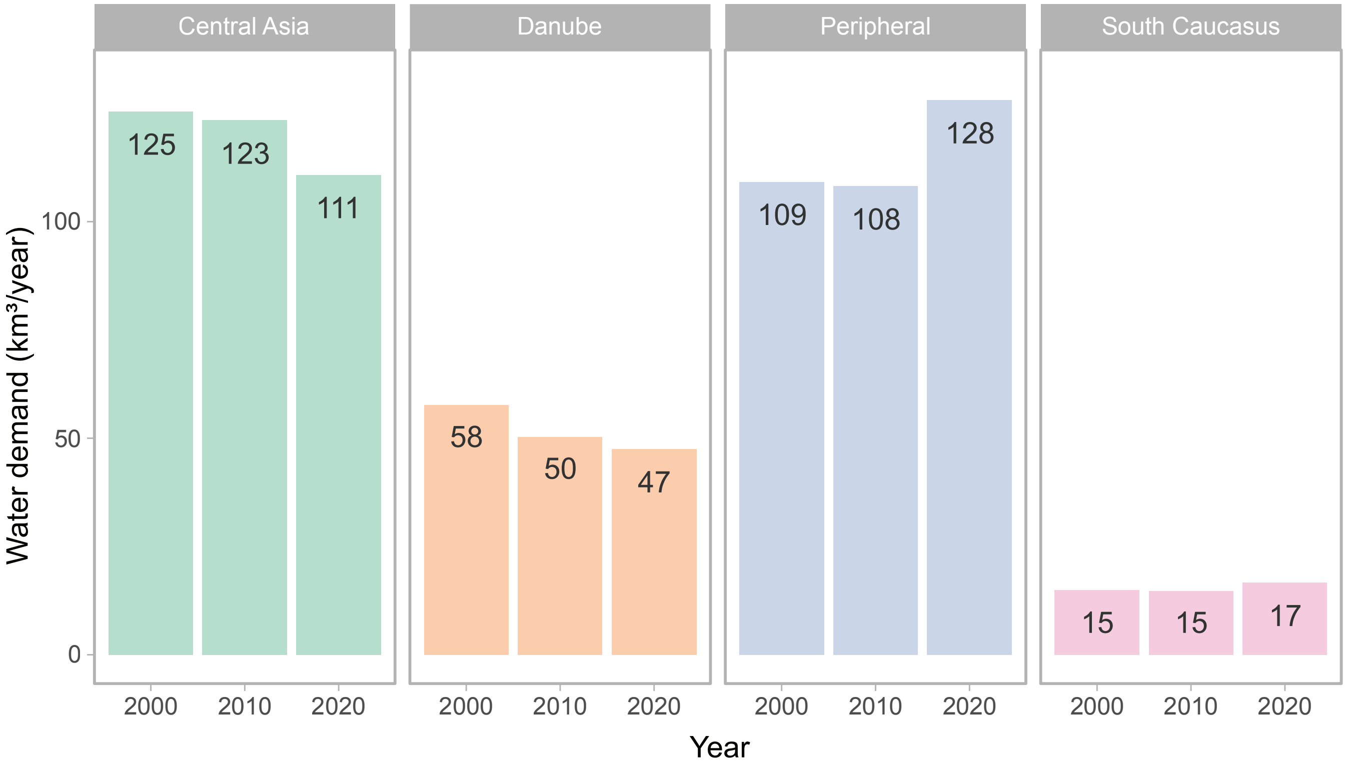
countries, demand represents less than 20 percent of total available renewable water resources) and experienced a 12 percent net decrease from 2000 to 2020 (from 198 to 175 cubic kilometers per year), regional demands exhibit contrasting dynamics (*figure 4.5*). Central Asia and the Danube subregions, for example, experienced net decreases in water demand of 12 and 18 percent, respectively, from 2000 to 2020 (from 125 to 111 cubic kilometers per year and from 58 to 47 cubic kilometers per year, respectively). Meanwhile, the South Caucasus experienced a 12 percent increase in water demand (from 15 to 17 cubic kilometers per year). Peripheral countries, such as Belarus, Russia, and Türkiye, also experienced an increase in water demand equivalent to 17 percent (from 109 to 128 cubic kilometers per year).

Agricultural-oriented economies consume the most water across Europe and Central Asia. The agricultural sector accounts for just over half (about 52 percent) of all annual freshwater withdrawals in Europe and Central Asia,[2] but this figure varies widely by subregion and country. Specifically, Uzbekistan, Kazakhstan, and Turkmenistan are the region's most significant users, withdrawing 55 cubic kilometers per year, 24 cubic kilometers per year, and 23 cubic kilometers per year, respectively (AQUASTAT 2024), largely driven by the demands of their agricultural sectors, particularly for irrigation (*figure 4.6*). In the South Caucasus, where Azerbaijan withdraws the most water, agriculture is also the primary user, accounting for 14 of the subregion's 17 cubic kilometers per year. In the Danube subregion, water use is generally less intensive, and except for Ukraine, most countries typically consume less than 10 cubic kilometers per year, with the majority allocated to industrial activities and domestic needs.

Europe and Central Asia's energy sector, from fossil fuels to electricity generation, demonstrates a high demand for water, which requires strategies to ensure sustainable energy production and water resources conservation. Water demand for energy production in Europe and Central Asia places a significant strain on water resources, with the industrial requirement for water in the energy sector demonstrating substantial variability across different countries and subregions. In countries like Austria, Bulgaria, and Hungary, water consumption for energy production ranges from 31.9 cubic megameters per year in Austria to 52.4 cubic megameters per year in Hungary, with a notable portion of this attributed to electricity and biofuels (Spang et al. 2014). These figures illustrate the reliance on substantial volumes of water for energy-production processes, such as cooling in power plants and processing in the biofuel industry. In Central Asia,

Figure 4.5

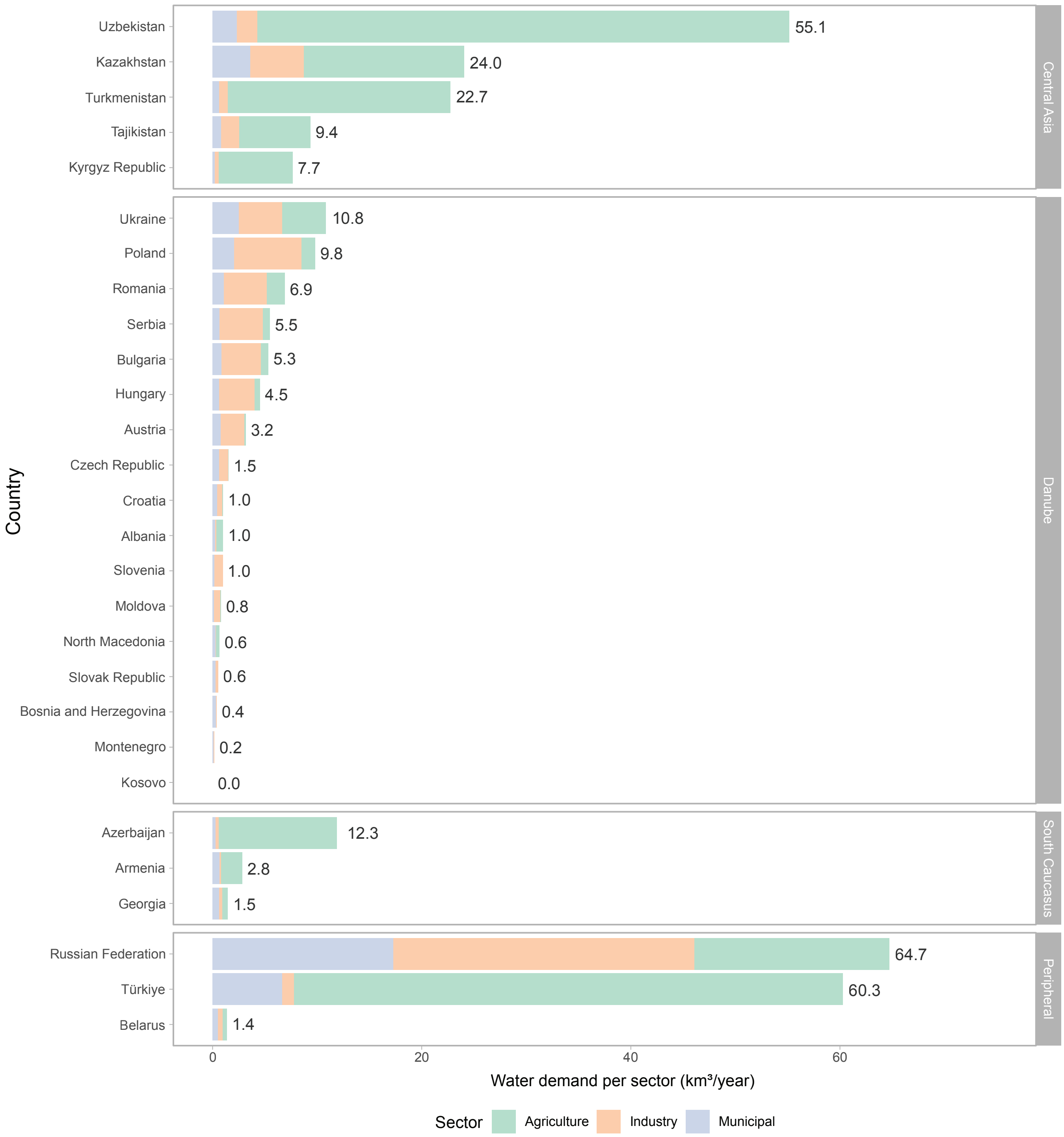
ANNUAL WATER Demand across Europe and Central Asia



Source: AQUASTAT, 2024.

Figure 4.6

AVERAGE ANNUAL Water Demand by Sector in Europe and Central Asia



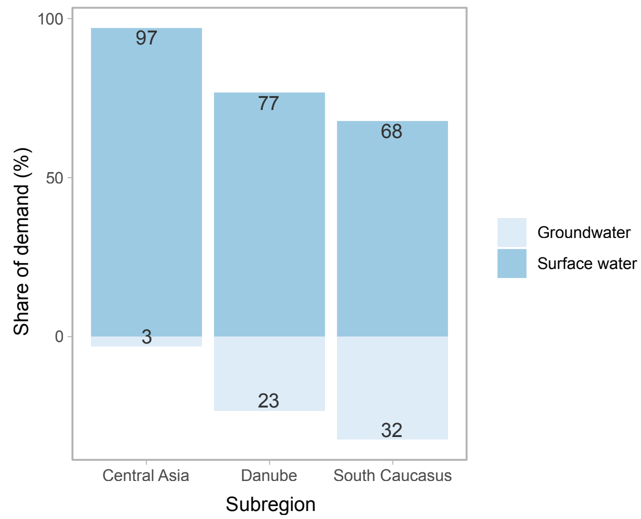
Source: AQUASTAT, 2024.

countries like Kazakhstan and Uzbekistan exhibit high water consumption for energy, with Kazakhstan's fossil fuel and nuclear energy sectors consuming a staggering 550.5 cubic megameters per year of water, reflecting the country's large-scale energy-production activities. The Kyrgyz Republic, with a more modest energy sector, reports 36.8 cubic megameters per year, indicating a lower but still significant water demand for energy production. In the South Caucasus, Armenia and Azerbaijan show contrasting scenarios: Armenia's energy sector has a negligible water demand because of the lack of reported consumption of fossil or nuclear fuels, whereas Azerbaijan has a high consumption rate, primarily for fossil fuels, amounting to 207.9 cubic megameters per year, which underscores the scale of the country's energy sector and its water requirements. Overall water withdrawals for the energy sector are higher than the actual water consumed. Water consumption represents a fraction of the actual water demand that is not returned to the environment. The high water demand for energy production emphasizes the need for integrating water-saving technologies and efficient management strategies to mitigate greenhouse gas (GHG) emissions and support climate-change mitigation in the energy sector.

Within Europe and Central Asia, countries mainly rely on surface water to meet socioeconomic demands, whereas groundwater is crucial for meeting drinking-water needs. Surface water is the primary source fulfilling socioeconomic water needs, accounting for about 80 percent of total water withdrawals (*figure 4.7*). There are, however, disparities across subregions. In the Danube subregion, countries primarily depend on surface water. However, groundwater plays a pivotal role in supplying drinking water, and most Danube countries consider it a critical resource (ICPDR 2015). The South Caucasus uses more groundwater than any other subregion, particularly for drinking and industrial purposes. Armenia stands out, with groundwater being a major source of water because of the country's significant per capita water availability of 2,630 cubic meters per person per year. Despite this, only a fraction of its groundwater potential is used, with just 295 of 437 aquifers being actively exploited. This underuse indicates substantial room for improved management and utilization of groundwater resources. Georgia, although primarily relying on surface water for agriculture, similarly depends on groundwater for a considerable part of its drinking-water supply, reflecting the critical role of groundwater in the subregion's water strategy (World Bank 2024e). Central Asia, however, relies less on groundwater, depending instead on surface water to meet its water requirements. The region is, however, witnessing a growing trend toward using groundwater for drinking and irrigation purposes, marking a shift in its water resources management (WRM) strategy. This increased dependence on groundwater is partly a result of environmental challenges, such as the desiccation of the Aral Sea, a critical issue faced by Kazakhstan and Uzbekistan. The strategic exploitation of groundwater in Central Asia is gaining importance as a way to enhance resilience to the adverse impacts of climate change and environmental degradation; groundwater exploitation, however, is not without challenges, given the high salinity levels of groundwater, which increase costs for most uses (see "Economic Outcomes" in chapter 3).

Figure 4.7

WATER DEMAND by Source of Water in Europe and Central Asia, 2020



Source: AQUASTAT, 2024.

FUTURE CHALLENGES AND OPPORTUNITIES

Climate change will reshape water availability across the Europe and Central Asia region, both spatially and temporally, presenting diverse challenges and risks. This shift in water dynamics, marked by regional disparities, is set to significantly affect agriculture, hydropower, and other water-dependent activities.

A divergent pattern in the Danube is likely to affect agricultural productivity and transboundary water management. The future of water availability presents a stark contrast between (a) the Upper Danube countries, such as Austria and the Slovak Republic, where an increase in water availability is expected because of increased precipitation, leading to potentially heightened flood risks, and (b) the Middle and Lower Danube regions, which are expected to face a significant decline in water availability, especially during the summer months, raising serious concerns about water scarcity and droughts (Burek et al. 2020; ICPDR 2018b). Additionally, changes in river flow, influenced by climate trends, will affect hydropower generation, riverine transport, and ecosystem services. The Upper and Middle Danube might experience increased peak flows, which, although beneficial for hydropower, also raise flood risks (Bissenlink et al. 2018). Conversely, the Lower Danube region faces reduced flows, negatively affecting river transport and hydropower (World Bank 2021a, 2021b, 2021c, 2021d).

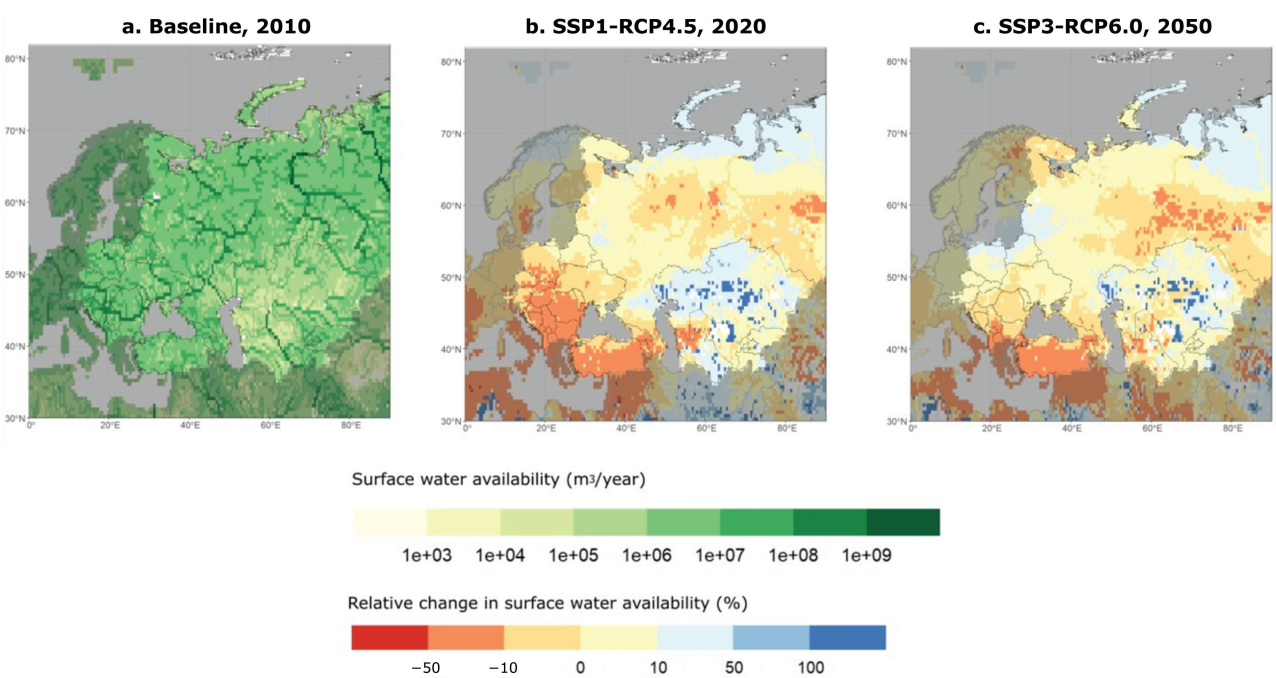
In the South Caucasus, climate projections through 2050 indicate a general decrease in water availability from 2010 levels (*map 4.4*). This trend is coupled with an expected increase in mean annual temperatures across the region. The impact of these changes will be profound, particularly on the Aghstev, Alazani, and Khrami-Debed tributaries of the Kura transboundary river (Westphal et al. 2011), and could lead to a decrease in hydropower generation. Projected declines in precipitation and increased water for crop requirements pose substantial threats to agricultural productivity and regional water resources, increasing the risk of droughts.

Central Asia's looming water crisis extends beyond agriculture to energy security, especially given the region's reliance on hydropower in upstream countries (Kennedy et al. 2003). Future scenarios using the Representative Concentration Pathways (RCPs) and Shared Socioeconomic Pathways (SSPs) project a moderate decrease in rainfall in upstream countries through 2050 (*map 4.4*), posing a significant threat to the stability of electricity production. This issue is exacerbated by population growth, which amplifies the demand for water, food, and energy. In downstream regions, while models predict short term increased stream flows from glacier melting, glaciers may have lost already 20-30% of their mass over the last 60 years, and no clear increase in stream flows have been observed. Analysis of data on surface water availability reveals crucial trends and fluctuations that are essential for understanding the future of water resources in this region. The region's high reliance on surface and transboundary waters for agriculture and energy accentuates the importance of implementing efficient water management strategies to navigate the challenges of changing water dynamics.

Water demand in Europe and Central Asia is on an upward trajectory, with the largest increases projected in the domestic and industrial sectors. Under most of the scenarios,[3] total regional water demand is projected to increase by 34 to 51 percent between 2010 and 2050 (*map 4.5*). The agriculture sector, the dominant water user, exhibits a rise of about 6 to 8 percent during the same period, under the assumption that the irrigated agricultural land area does not change relative to the 2010 baseline. The industrial sector's water demand is forecasted to grow substantially, ranging from 50 to 90 percent depending on the scenario.[4]

Map 4.4

COMPARISON OF Surface Water Availability between the Baseline in 2010 and RCP4.5 and RCP6.0 Scenarios in 2050



Source: Satoh et al. 2017.

Note: RCP = Representative Concentration Pathway; SSP = Shared Socioeconomic Pathway.

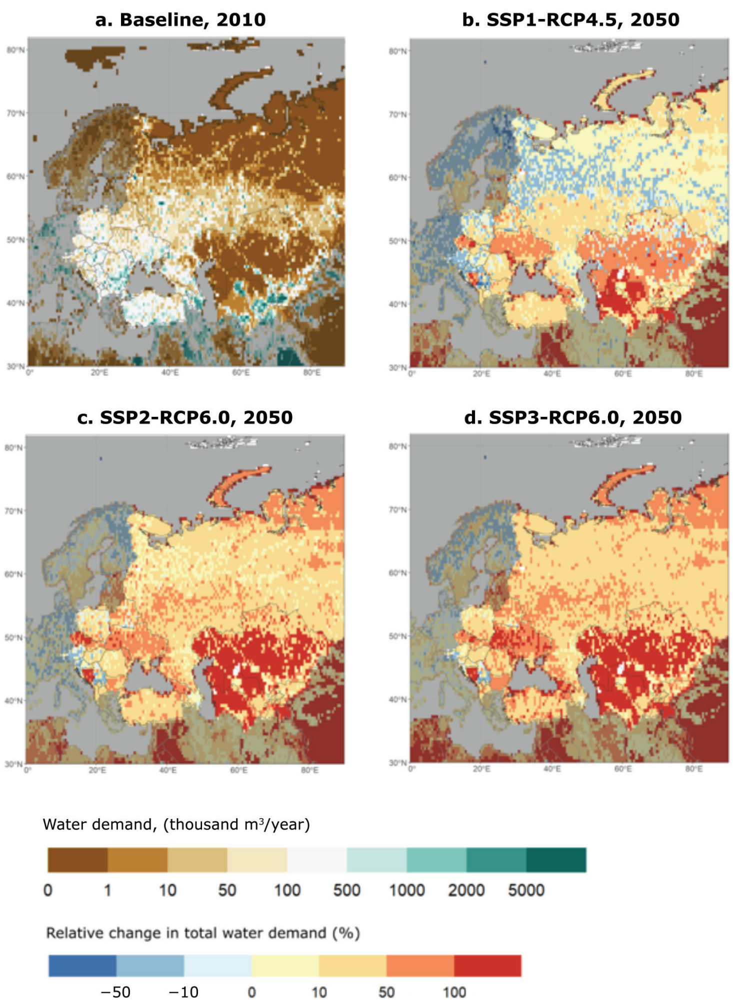
This range indicates significant industrial expansion with more water-intensive processes. Domestic water demand is also set to rise sharply by 2050, with projections showing an increase ranging from 57 percent to an even more striking 105 percent compared with the 2010 baseline. This trend suggests growing domestic water use, potentially driven by rising populations and higher standards of living and leading to greater per capita water consumption.

Increasing water demand in the Danube subregion mirrors regional trends, particularly in the industrial and domestic sectors. Countries like Hungary and Romania project an increase reaching 50 percent by 2050. In Bosnia and Herzegovina, Bulgaria, and Serbia, rising energy consumption is expected to drive the need for more cooling water, further straining available resources. These trends suggest a trajectory of intensified water use, likely driven by both climatic shifts and agricultural intensification to support a growing population and economy.

In the South Caucasus, Armenia's total water demand is similarly illustrative of regional trends. Armenia's industrial and domestic sectors reflect significant growth indicative of industrial development and an expanding urban footprint, and demand is expected to grow by 75 percent (or about 2.4 cubic millimeters per year) by 2050.[5] Armenia's rising domestic water demand, more than 100 percent by 2050,[6] underscores the pressures on water resources from urbanization and the lifestyle changes that accompany industrialization.

Map 4.5

COMPARISON OF Total Water Demand between the Baseline in 2010 and SSP1-RCP4.5, SSP2-RCP6.0, and SSP3-RCP6.0 Scenarios in 2050



Source: Satoh et al. 2017.

Note: RCP = Representative Concentration Pathway; SSP = Shared Socioeconomic Pathway.

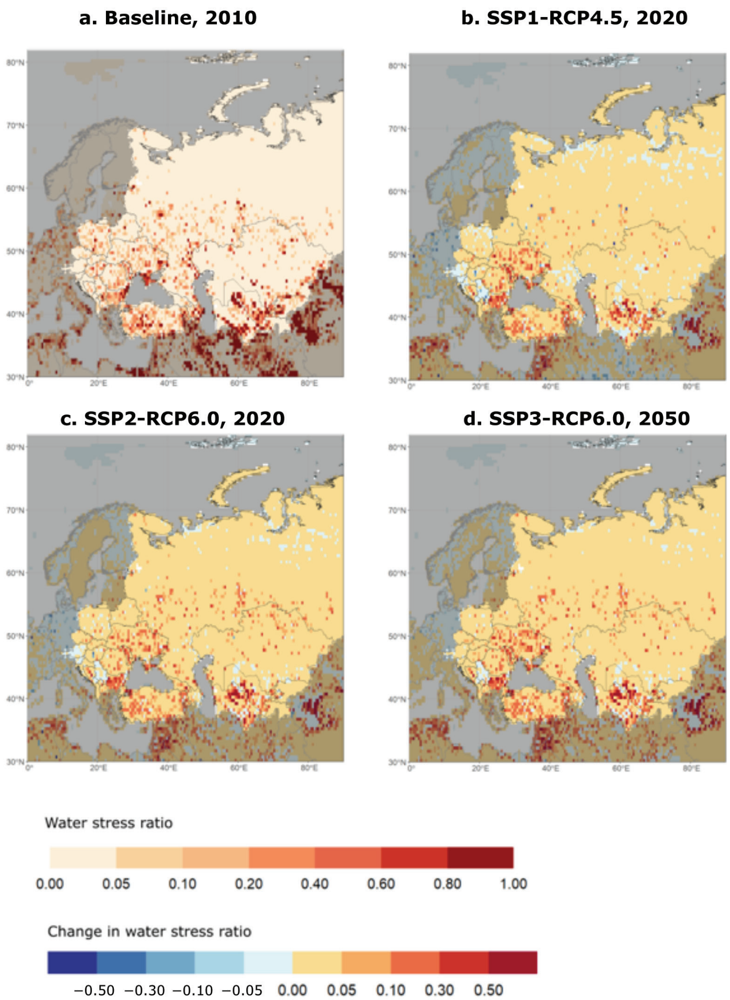
Central Asia exhibits a significant rise in total water demand, driven largely by agricultural needs. Kazakhstan's total water demand is projected to increase by 25 to 30 percent by 2050,[7] driven primarily by the agricultural and industrial sectors. Turkmenistan's and Uzbekistan's water demands follow a similar trend, hinting at broader regional challenges in balancing water resources amid agricultural and industrial expansion.

Water stress in Europe and Central Asia is projected to increase only slightly by 2050, but severe water-stress conditions are foreseen in some countries. Available projections (*map 4.4* and *map 4.5*) signal an increase in water demands across Europe and Central Asia and a reduction in water availability in some countries. This trend will translate into higher levels of water stress, although there are important differences within countries and subregions:

- Central Asia. This subregion shows the most alarming trends, with downstream countries like Turkmenistan and Uzbekistan expected to face high to severe water-stress levels by 2050. As for Uzbekistan, the stress ratio could potentially reach 0.75 under SSP1-RCP4.5 (*map 4.5*), highlighting an urgent need for reforms in the country's water management. Such an alarming situation is caused by not only an increase in national water demands but also, importantly, the growing allocation of transboundary water flows in upstream

Map 4.6

COMPARISON OF Water Stress Ratio between the Baseline in 2010 and SSP1-RCP4.5, SSP2-RCP6.0, and SSP3-RCP6.0 Scenarios in 2050



Source: Satoh et al. 2017.

Note: The water stress ratio is the ratio of total demands to total available surface water. RCP = Representative Concentration Pathway; SSP = Shared Socioeconomic Pathway.

countries, which reduces the volume of inflows downstream. In Kazakhstan, projections foresee punctual increases in water stress across the country, but the increases are less worrisome than those observed in the neighboring downstream countries.

- Danube subregion. Downstream countries like Bulgaria and Romania are expected to see an increase in water stress, but the levels remain relatively moderate, with Bulgaria reaching an increase of up to 10 percent by 2050 (*map 4.6*). Some projections suggest that climate change could lead to more severe flooding and water scarcity if global temperatures rise beyond 2 degrees Celsius, significantly affecting water resources and increasing the risks of droughts, particularly in the lower parts of the basin (Pistocchi et al. 2020).
- South Caucasus. The subregion, especially Armenia, is projected to experience a dramatic increase in water stress, with demands expected to match water resources availability by 2050 (*map 4.5*), indicating extreme water scarcity and underscoring the urgent need for robust water management strategies. This subregion's water stress is largely driven by climate change but also, importantly, a sharp increase in demands, including agricultural and industrial demands, that could strain water resources to critical levels.

NOTES

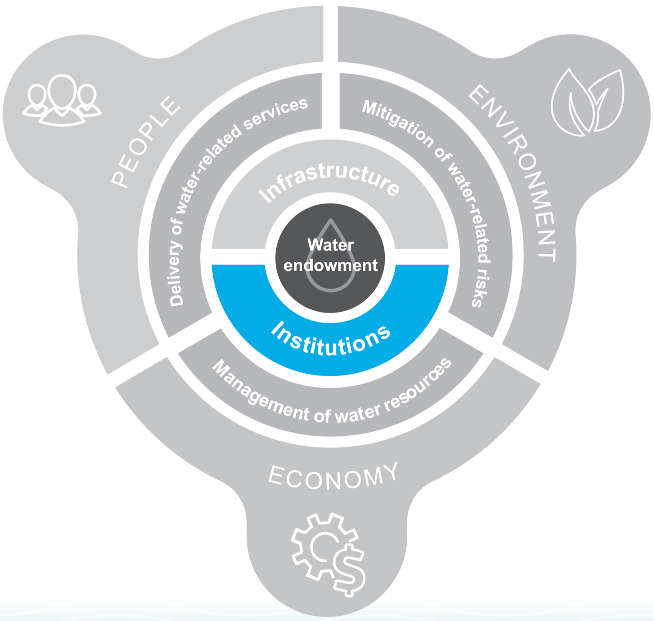
1. Seasonal variability measures the average within-year variability of the available water supply, including both renewable surface water and groundwater supplies. Higher values indicate wider variations of available supply within a year.
2. From World Bank Data Bank; for further information, see *https://data.worldbank.org/indicator/ER.H2O.FWAG.ZS?name_desc=false*.
3. The SSP1-RCP4.5, SSP2-RCP6.0, and SSP3-RCP6.0 scenarios.
4. An increase of 50 percent is expected under the SSP1-RCP4.5 scenario and upward of 90 percent under the SSP3-RCP6.0 scenario.
5. Under SSP1-RCP4.5, with a similar uptrend under SSP3-RCP6.0.
6. Under SSP1-RCP4.5.
7. Under the SSP1-RCP4.5 and SSP3-RCP6.0 scenarios.

5

Water Sector Architecture

This section explores the institutional setup of the water sector and existing infrastructure, highlighting the strengths, challenges, and risks faced by subregions and countries in sustainably governing water resources. The institutional analysis provides an overview of the status of the following subsectors: national, basin, and transboundary water resources management (WRM) and the water supply and sanitation (WSS) sector. The infrastructure assessment explores the status, challenges, and risks related to WSS services and irrigation, hydropower, and storage infrastructure. This chapter corresponds to the second innermost ring of the Water Security Diagnostic Framework (WSDF) diagram (*figure 1.1*).

INSTITUTIONS



KEY MESSAGES

- Significant strides have been made to support the implementation of integrated water resources management (IWRM); however, important gaps remain, and reforms must continue to create a strong enabling environment.
- Most national policies embrace key IWRM principles, but their implementation is lagging because of limited normative development (particularly on allocation mechanism, ecosystem protection, and drought management), a fragmented vision of the sector, insufficient funding, and limited prioritization of the most cost-effective measures.
- The growing political focus is leading to the consolidation of policy making for WRM within single or combined water ministries (for example, water, water and environment, or water and agriculture); still, fragmentation and overlapping responsibilities continue to exist in many countries, creating inefficiencies.
- The basin management approach is expanding, but institutions are insufficiently developed; hold limited authority; and largely act as consultative organizations, with minimum budget and IWRM capacities.
- Decentralization of the water management approach has not been fully realized.

Water Resources Management

The Europe and Central Asia region has made substantial leaps to improve WRM institutions and strengthen the implementation of IWRM principles. Here, institutions are understood as the entities (organizations) and rules (laws and regulations) that enable or constrain the management of water resources and the provision of water services. With a few exceptions, most countries in Europe and Central

Asia have developed national policies embracing all key principles of IWRM[1] (*table A.1*, *appendix A*). Competencies in policy making for WRM are well defined, largely falling under joint ministries (for example, water and environment, water and energy, or water and agriculture) or independent state agencies. In some cases, there are major fragmentations across different institutions (for example, in several countries of Central Asia, surface water and groundwater are sometimes managed under different ministry lines). The basin management approach is also expanding, and countries have, to a large extent, been transitioning from administrative to basin management areas. This has come along with the development of basin institutions, though progress is still needed in this domain. Generally, countries continue to have a heavily centralized state water management approach, and decentralization tends to be implemented through administrative offices whose jurisdictions do not necessarily overlap with those of the basin boundaries. Countries in Europe and Central Asia thus need to continue with planned institutional reforms; otherwise, gaps in infrastructure and WRM performance will persist; this will threaten regional opportunities to increase water security in the context of climate change.

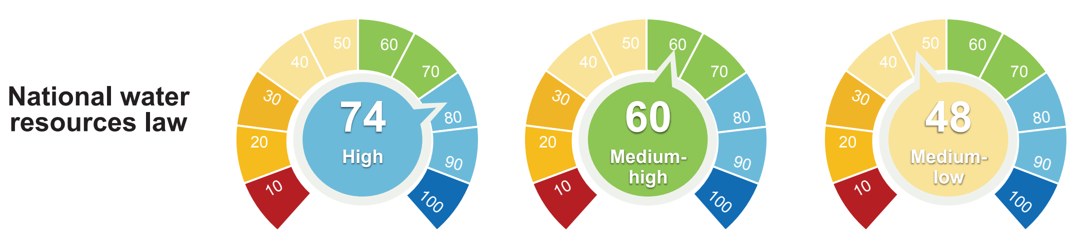
National Regulatory Frameworks

Water codes across the region integrate most IWRM principles, but there are significant disparities in the development of legal provisions that hinder effective implementation. The Danube subregion is leading the way in regard to having a modern and well-developed IWRM legal framework (*figure 5.1*), largely because of the strong support received from the European Union (EU). The South Caucasus is also receiving strong backing from the EU to undertake important national reforms. Central Asia is the subregion facing the largest gaps. Despite the efforts to upgrade the frameworks to integrate IWRM principles, reforms must continue across many countries to ensure that the enabling environment is conducive to supporting the implementation of water policies.

Within the Danube, EU Member States have the most advanced regulatory frameworks. EU candidate states are making significant reforms to adapt their national water legislation to align with relevant EU directives, but they are still facing implementation challenges (*figure 5.2*). In Albania, the latest amendments to the 2012 water law have led to the establishment of an Agency for Water Resources Management (AMBU) that is in charge of drafting an IWRM law that is fully aligned with EU water directives. Despite this progress, implementation challenges remain, including Albania's limited enforcement capacity and the financial constraints related to implementing IWRM policies. Several other Balkan countries are still facing impediments to aligning their regulatory frameworks with the EU Water Acquis. For instance, Montenegro lacks important normative developments regarding climate-change adaptation and drought management. In Bosnia and Herzegovina, the legal frameworks of the three districts—the Federation of Bosnia and Herzegovina, the Republic of Srpska, and the Brčko District—that have jurisdiction over water management do not yet satisfy the harmonization process with EU standards and require further improvements to clarify administration and organization of the water sector.

Figure 5.1

ADEQUACY OF the IWRM Legal Framework across Europe and Central Asia



Very high	91–100	Laws implemented and enforced
High	70–91	Laws based on IWRM implemented across the whole country
Medium-high	51–70	Laws based on IRWM and largely implemented
Medium-low	31–50	Laws based on IWRM approved and started to be implemented
Low	11–30	Laws developed but lacking important IWRM aspects
Very low	0–10	Laws not in place

Source: UNEP and UNEP-DHI n.d.

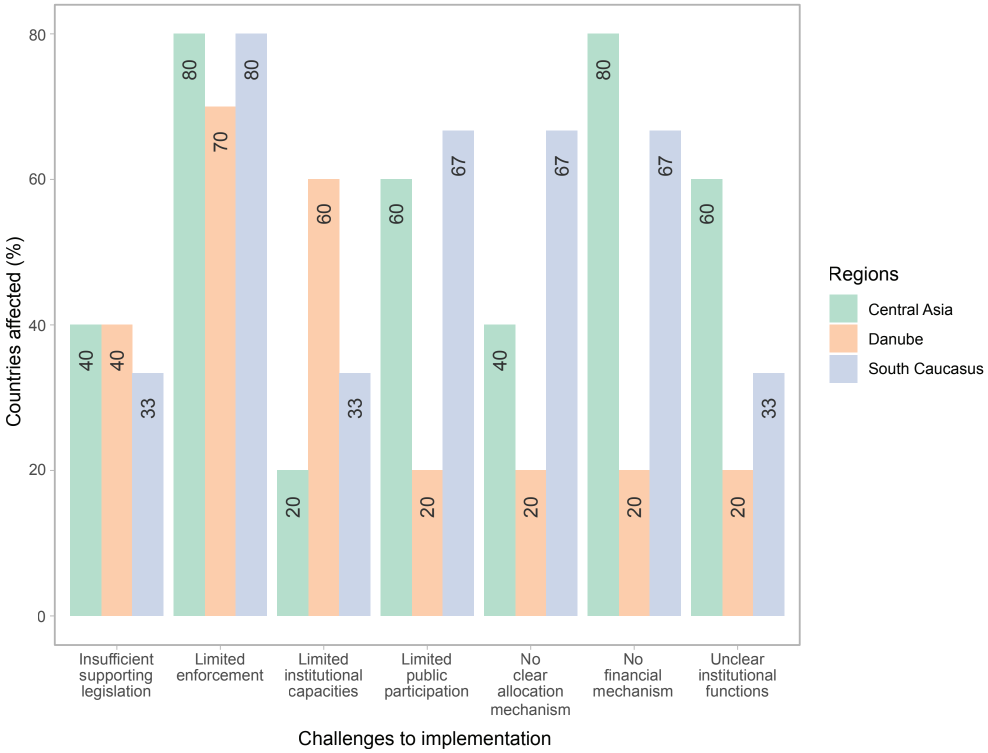
Note: IWRM = integrated water sources management.

Central Asia faces the largest barriers of all subregions to establishing a modern and fully implemented IWRM legal framework. Most countries have a water code in place, except for Uzbekistan, where it is still pending approval. The scope of the water codes addresses most of the critical aspects, at least in a basic form, but provisions for ecosystem protection are lacking in several codes (for example, those of the Kyrgyz Republic and Tajikistan), where water allocation is based largely on volumetric principles rather than reliance on efficiency and sustainability principles. Implementation challenges are recurrent (*figure 5.2*), especially because of the financing constraints of IWRM and the limited use of economic instruments (for example, user tariffs to support cost recovery). The overlapping, fragmentation, and lack of clarity in the roles and responsibilities of water institutions also represent a major gap in the national legislation. In the Kyrgyz Republic, only the functions of state bodies are identified, and the roles and responsibilities at other institutional levels (for example, basins) need to be identified. In Tajikistan, roles and responsibilities overlap, and the allocation of functions is frequently unclear. There is limited development of stakeholder participation mechanisms in all countries in Central Asia, and this represents an important barrier to both supporting the effective implementation of policies and promoting ownership.

In the South Caucasus, countries have made major efforts to develop water regulatory norms, driven by their interest in joining the EU and the corresponding support provided. All three countries have a water code and associated legislation in place, although the scope of some important areas is not clearly regulated, including water allocation (for example, in Georgia) and ecosystem protection (for example, in Azerbaijan; *figure 5.2*). Armenia has the most mature water legal framework in the South Caucasus subregion. The framework is quite extensive and includes the 2002 water code, supported by several additional norms regulating further aspects of the water sector.[2] All these regulations integrate the principles and mechanisms needed to implement IWRM in the country (Yu et al. 2015). The Armenian water code also clearly defines the functions of the various WRM institutions. Armenia is currently undergoing major reforms to harmonize the national legislation with the EU Water Framework Directive (WFD), but considerable legislation is still needed to support its implementation. Recent amendments to the water code in 2019 have introduced legal requirements to protect water resources during drought events. These requirements are implemented through the issuing of water permits, but improved administration to manage the permit system is still needed. The Armenian water code also contains

Figure 5.2

MAIN CHALLENGES to Implementing Water Resources Management Legislation across Europe and Central Asia



Source: AQUASTAT, 2024.

provisions for water allocation, but priority criteria still need to be developed. Georgia is also making good progress in modernizing its legal framework, establishing a holistic approach to water management with EU support. In July 2023, Georgia passed a new law on WRM. The law, which aims to align its WRM system with EU guidelines and the EU WFD, also outlines the principles of river basin management. Despite progress, this new law still lacks comprehensive and clear quantitative policies for water allocation among various sectors.

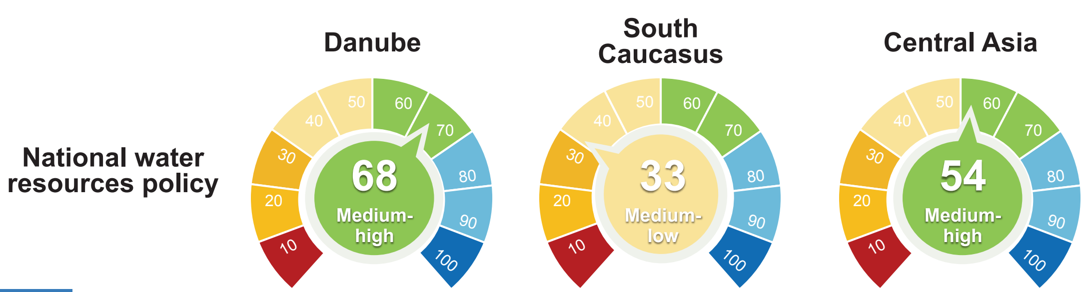
Most national water strategies are in place, but their implementation lags because of limited normative development, insufficient funding, and fragmented visions of the sector. Many countries in the region have made a major effort to develop comprehensive strategies to help set a unified vision for sector development, but there are wide regional disparities (*figure 5.3*) in ambition, strategic prioritization, and implementation capacity.

The Danube has the highest number of countries with established unified national IWRM strategies of all subregions. Implementation of these strategies is, however, disparate. Front-running countries include Austria and Croatia, both of whose strategies have been harmonized with the EU water directives, passed into national legislation, and entered into force. Such national policies include ambitious goals to support IWRM principles, although water risk management has a strong focus on floods, and droughts still need to be addressed (Schmidt et al. 2023). In EU candidate countries like Albania and Serbia, national water strategies are facing implementation challenges because of the limited budget availability and the lack of prioritization. Serbia's Water Management Strategy (2016–34) outlines critical water challenges; it defines strategic goals for the development of water management based on the current state of the water sector in the country and the international obligations involved in meeting the requirements of EU regulations. However, action plans lack a clear prioritization of measures, and funding is not secured. Albania's national Integrated Water Resources Management Strategy (2018–27) underpins the management of national water resources in compliance with EU water directives. Implementation of the national strategy should have been carried out through the National Sectoral Program for Integrated Water Management (2018–30), but it has not been approved, given that funding is not secured.

In Central Asia, the Kyrgyz Republic, Tajikistan, and Uzbekistan have an overarching national water strategy in place. Kazakhstan and Turkmenistan lack a national strategy; their water development priorities and goals are spread across different national development strategies and sector policies (for example, climate change, health, socioeconomic development, and agricultural policies). Moreover, existing national strategies face implementation challenges. In the Kyrgyz Republic, the implementation of the national water strategy is slow, with only some management instruments currently in place. Uzbekistan has recently approved its Concept for the Development of the Water Sector of Uzbekistan for the Period 2020–2030. Although IWRM principles are recognized as one of the main priorities of the concept, its main components have

Figure 5.3

ADEQUACY OF the IWRM National Policy Development across Europe and Central Asia



Very high	91–100	Laws implemented and enforced
High	70–91	Laws based on IWRM implemented across the whole country
Medium-high	51–70	Laws based on IRWM and largely implemented
Medium-low	31–50	Laws based on IWRM approved and started to be implemented
Low	11–30	Laws developed but lacking important IWRM aspects
Very low	0–10	Laws not in place

Source: UNEP and UNEP-DHI n.d.

Note: IWRM = integrated water sources management.

yet to be defined. In Tajikistan, the Water Sector Reform Program for 2016–2025 is the main policy document guiding the implementation of IWRM principles. It aims to create the foundations for the decentralization of the water management system, describing the legislative and institutional reforms required across all water-related subsectors to implement an IWRM system and adopt a basin management approach. Yet the water management approach remains heavily centralized, with limited development of the basin management areas and institutions (*table 5.1*).

The South Caucasus faces the largest challenges to developing clear national water sector visions and implementation pathways (*figure 5.3*). In the South Caucasus, national water strategies have expired, are still under development, or are spread across different policy documents without a clear integration of IWRM principles. In Armenia, the national water program, the main instrument for the development of water resources, expired in 2020, and there are currently no WRM strategies in place. In Georgia, goals and action plans related to WRM are captured in several national policies, such as the National Environmental Action Program (NEAP) and the national action plan to implement the EU-Georgia Association Agreement. The NEAP is a four-year program focusing on improving the environment and environmental governance. Georgia has made great efforts to improve WRM, including the establishment of the river basin management system, improvement of statistics on water resources use, development and adoption of the river basin management plans, and introduction of new standards for surface water quality. The national action plan operates on a yearly basis and focuses on specific aspects of WRM to ensure compliance with the EU water directives, particularly the EU WFD. Efforts are currently underway to develop a national strategy and action plan on the protection and use of water resources as an overarching framework for the management of water resources. This strategy will unify the key national water priorities and the activities to be implemented. Azerbaijan is in the process of developing a comprehensive national strategy for the water sector with the support of the United Nations Economic Commission for Europe (UNECE), the EU, and the Organisation for Economic Co-operation and Development (OECD). The strategy will support the implementation of IWRM principles.

National and Basin-Level Arrangements

The national water management responsibilities are highly fragmented within and across the water sector in many countries of Europe and Central Asia. This fragmentation has led to major gaps and overlaps with respect to clear roles and responsibilities. Major differences occur across the region (*figure 5.4*). Danube countries perform best, but overall, there is a high level of fragmentation, with many water functions coming under nonwater state institutions and often overlapping.

In Central Asia, national water management institutions are subject to perpetual reorganization. Recent reforms are helping to raise the profile of water on the government agenda with the development of water ministries or state water agencies rather than subordinating water functions to other sectoral ministries (for example, agriculture or energy; *table 5.1*). This change is a positive step toward increasing the quality of state water regulation, which is the financial and technical basis for the development of the sector. The extent to which the water development agenda, in practice, will remain independent of the powerful socioeconomic interests of the energy and agriculture sectors is still uncertain. In the Kyrgyz Republic, recent reforms have led to the integration of water management and environment-related functions (for example, the recently developed Ministry of Natural Resources, Ecology and Technical Supervision), with major water-related functions (for example, irrigation and reclamation) being kept with the Ministry of Agriculture. Uzbekistan is the only country where the main water management functions fall under state water institutions (for example, the Ministry of Water Resources). Irrespective of the rise of water on the political agenda, water management at the state level (water use and protection, water-related risks, water supply, and water infrastructure) is spread across different state institutions. Such fragmentation poses a major risk, giving rise to a lack of distinction between policy-making functions, regulatory functions, and control and monitoring. Many countries have ministries and state commissions that are directly dependent on the government, with different roles and responsibilities that sometimes overlap. Surface water and groundwater are often managed by different state bodies (for example, in Kazakhstan, Turkmenistan, and Uzbekistan), preventing the joint management that is crucial to achieving IWRM and mitigating the effect of climate change and water risks. Such institutional fragmentation is a key barrier to supporting the implementation of a coordinated IWRM approach, especially without strong coordination mechanisms (*figure 5.4*).

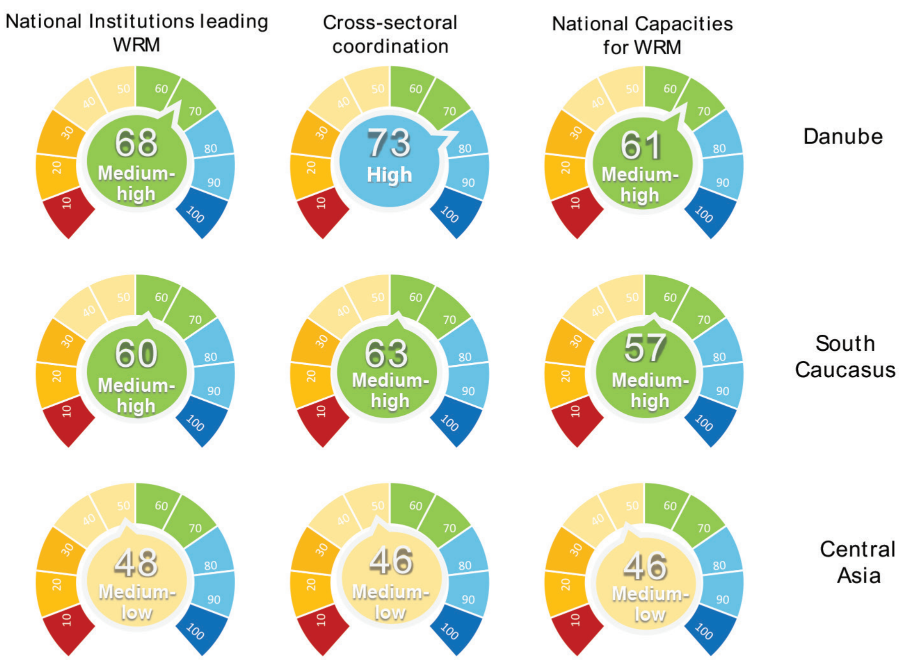
Except for Georgia, state water management functions in the South Caucasus are also highly fragmented. In Armenia, national water policies are spread across two main institutions, the Ministry of Environment, which is primarily responsible for environmental policies and regulations, and the State Committee of Water Resources of the Ministry of Territorial Administration and Infrastructure, which has a role in overseeing and managing the country's water infrastructure. In Azerbaijan, the Ministry of Ecology and

Natural Resources also leads activities and responsibilities related to WRM, regulation, planning, infrastructure development, and data collection. Water resources development for irrigation, however, is managed by a public company, the Azerbaijan Amelioration and Water Management Open Joint-Stock Company. Water-related risks are also managed by the Ministry of Emergency Situations. Despite this fragmentation, the government has taken a positive step toward developing a water commission intended to coordinate all water management activities in the country.

In the Danube subregion, institutional readiness to support WRM is very good overall, but there are important differences between countries (*table 5.1*). EU Member States have national water institutions with clear and distinct roles and responsibilities but with different levels of decentralization. Austria and Croatia, for instance, have a relatively centralized system for water policy and management, where regional institutions (basin or administrative units) mainly support implementation, monitoring, and enforcement. For instance, Croatia has two main state institutions, the Water Directorate within the Ministry of Economy and Sustainable Development, responsible for policy development, coordination, and international cooperation, and Croatian Waters, which is the legal entity for water management (World Bank 2024b). In Austria, most water management functions are under the responsibility of the federal Minister of Agriculture, Regions and Tourism (ECR 2022). In contrast, water governance is more decentralized in Romania, with the Ministry of Environment, Water and Forests holding a strong regulatory role, and the Basin Administrations of the National Administration for Romanian Waters holding the water management and planning functions.

Figure 5.4

INSTITUTIONAL READINESS of National Water Institutions across Europe and Central Asia



Very high	91–100	Authorities have the capacity to effectively lead periodic IWRM plan revision, and cooperation involves policy codesign among different water institutions
High	70–91	Authorities have the capacity to effectively lead IWRM plan formulation and implementation and periodic monitoring and evaluation
Medium-high	51–70	Authorities have the capacity to effectively lead IWRM plan formulation and implementation and good information sharing
Medium-low	31–50	Authorities have clear mandate to lead IWRM plan formulation & information sharing
Low	11–30	Authorities and capacities exist, with clear mandate to lead WRM & information sharing
Very low	0–10	No dedicated national institutions and capacities for WRM & no information sharing

Source: UNEP and UNEP-DHI n.d.

Note: IWRM = integrated water sources management.

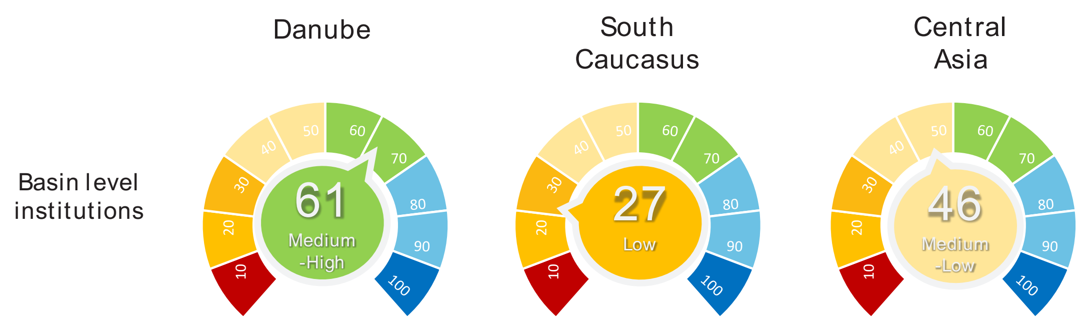
There is a high level of fragmentation of water functions spread over institutions within and outside the water sector that creates overlapping roles and responsibilities in candidate countries. In Serbia, there are at least seven ministries with critical responsibilities in the water sector (World Bank 2024d). The Water Directorate of the Ministry for Agriculture, Forestry and Water Management of Serbia is a central institution responsible for setting strategies and implementing the EU Acquis Communautaire in the water sector, but it is limited by the high fragmentation and overlap of responsibilities, which constrain the strategic investment planning and decision making by the many ministries and institutions involved. Another institutional weakness is the absence of a dedicated economic regulator scrutinizing the setting, monitoring, enforcement, and change in the water tariffs and service standards set for utilities. Montenegro faces a similar situation, with more than five different state institutions with unclearly defined water management functions and major overlapping of competencies (UNECE and Ministry of Sustainable Development and Tourism 2016). For example, water supply is a responsibility of the Ministry of Ecology, Urbanism and Spatial Planning, but the Ministry of Agriculture runs a program for water supply improvement in rural areas (World Bank 2023d). Clear-cut institutional roles and responsibilities are, however, needed for efficient investment planning, monitoring, and decision making. Against this background, countries like Albania have undertaken major institutional reforms to address existing inefficiencies and duplication, including the development of the AMBU; this is the powerful arm of the National Water Council, which assumes most water management competencies, including support for policy making and planning functions. Agencies like AMBU and Croatian Waters represent good examples of institutions with relatively strong institutional and technical capacities to support the effective management of water resources that can be replicated in other countries of the Europe and Central Asia region.

Basin institutions, although expanding, exhibit major institutional weaknesses, often with unclear water management functions, insufficient capacities, and limited authority. Proponents of IWRM have argued that basins are the appropriate territorial unit for water management, given that, at that scale, hydrological and socioeconomic interlinkages are stronger where water management is most important. Based on this rationale, basin organizations are intended to play a major role in ensuring basin WRM and planning and also ensure the coordination and engagement of all water stakeholders.

The basin water management approach is expanding, and basin institutions are being developed, albeit at different paces. This approach is most developed in the Danube

Figure 5.5

INSTITUTIONAL READINESS of Basin Water Institutions across Europe and Central Asia



Very high	91–100	Authorities have the capacity to effectively lead periodic IWRM plan revision
High	70–91	Authorities have the capacity to effectively lead IWRM plan formulation and implementation, and periodic monitoring and evaluation
Medium-high	51–70	Authorities have the capacity to effectively lead IWRM plan formulation and implementation
Medium-low	31–50	Authorities have clear mandate to lead IWRM plan formulation
Low	11–30	Authorities exist, with clear mandate to lead WRM
Very low	0–10	No dedicated basin institutions

Source: UNEP and UNEP-DHI n.d.

Note: IWRM = integrated water resources management; WRM = water resources management.

subregion, whereas Central Asia, particularly the South Caucasus, lags behind (*figure 5.5*). Basin institutions play different types of roles in countries in the Europe and Central Asia region. In some cases, they are relatively well developed and act as agencies for fulfilling the mandate of state bodies with water management functions (that is, supporting policy implementation, monitoring, and enforcement and taking a coordinating role in facilitating the dialogue among water stakeholders). In many instances, however, basin institutions have only a coordinating role among state water institutions and local executive bodies—they have water management responsibilities but no authority. Another major weakness is the focus that many basin organizations in Europe and Central Asia have on surface water management, without pursuing joint management of surface water and groundwater; they also have limited human and financial capacities. Establishing basin institutions is crucial in facilitating the implementation of IWRM. Any such efforts will, however, be futile unless those institutions are equipped with clear planning roles; authority; and adequate institutional, technical, and financial capabilities to enable them to carry out their functions effectively.

Planning and management in the South Caucasus remain either centralized or decentralized to the administrative level, with limited implementation of the basin approach. Armenia is the only country in the subregion where planning and management are conducted at the basin level. Six river basin management bodies have been created in Armenia under the Ministry of Environment, and these basin institutions have well-defined planning functions. They do, however, lack the capacity to fulfill those functions, given the large size of the basins and the limited human capacities available (UNEP and UNEP-DHI n.d.). In Georgia and Azerbaijan, the basin water management approach is still to be implemented, but the two countries are in the process of establishing basin councils, which act as advisory and consultative bodies to the respective ministries. In Georgia, basin councils act as technical advisory bodies to the Ministry of Environmental Protection and Agriculture and examine the river basin management plan (RBMPs) before government approval (OECD 2021a).

The level of development of river basin institutions is very diverse in Central Asia. Some countries are making good progress, whereas in others, the basin management approach and institutions are transitioning from provincial or territorial to hydrographic boundaries, or such reforms have not yet taken place (USAID 2020). Kazakhstan is a front-runner in Central Asia in that its decentralized water management approach combines a territorial and a basin approach, with water economic basins[3] that are a combination of administrative and hydrographic boundaries. Water management is largely coordinated by regional branches of the national water resources committee (the so-called Republican State Enterprise [RSE] Kazvodkhoz), and enforcement and monitoring of policy implementation are supported by basin inspections. Kazakhstan has also developed river basin councils for all eight basin water organizations. These councils are participatory spaces in which heads of local representative and executive bodies, heads of territorial divisions of state bodies, and representatives of water users discuss relevant basin issues, including the implementation of basin agreements, and address potential conflicts (Genina 2007). The sustainability of the councils is, however, limited, given that there is no dedicated budget and that funds allocation is done on a political or arbitrary basis. The Kyrgyz Republic is following a similar path and is currently embarking on a sector reform supporting the decentralization of water management to the basin level. Reforms have led to the development of five river basin districts and five basin institutions, which used to be provincial institutions (branches of the Ministry of Natural Resources, Ecology and Technical Supervision). Such reform has been easier, given the high overlap between administrative and hydrographic boundaries in the country. Basin institutions are not yet fully operational for several reasons related to insufficient human and technical capacities to perform planning and management functions. Consultative bodies such as basin councils have also been established in the Kyrgyz Republic, but like the basin organizations, they are not yet fully operational. In Uzbekistan, water management takes place at the basin irrigation level, which combines administrative (provincial) and hydrographic borders. At the other extreme, countries like Turkmenistan have not yet developed basin institutions beyond a few pilot schemes; water management is still centralized and supervised by the State Committee for Water Management and implemented at the territorial water management level (USAID 2020).

The basin management approach has been largely adopted in the Danube, but there are disparities in the maturity of basin institutions. In EU Member States, basin institutions have been developed to a large extent; these mainly support the implementation of EU policies and facilitate the engagement and participation of stakeholders in basin planning. For instance, in Romania, water planning is coordinated by the National Administration of Romanian Waters but carried out by eleven basin institutions that have sufficient technical and institutional capacities to develop and implement the river basin and flood management plans, as well as coordinate the public participation activities (ECR 2022). A different but relevant example is Croatia, where basin water management has been implemented but without river basin organizations as such. Croatian Waters, the national water management agency, is responsible for water planning, including the development of river basin and flood management plans, as well as the issuing of water permits. To cover the main basins, Croatian Waters has established so-called Water Management Departments, which support the state agency in the implementation of plans, monitoring, surveillance, and conducting public consultations (ECR 2022). The absence of basin institutions in Croatia is largely motivated by the fact that the country has only two main river basin districts, and Croatian Waters has very strong technical, human, and financial capacities to support policy design and implementation.

There are large disparities among EU candidate states in the Danube. Albania has a similar structure to that of Croatia, with AMBU being the national WRM agency coordinating water planning, supported by regional branches from AMBU across the territory. River basin councils have also been set up under AMBU and are chaired by the largest prefecture in the basin. Other countries, such as Montenegro and Serbia, despite having implemented a basin water management approach, have still not developed basin institutions, and planning is coordinated directly at the national level (World Bank 2024c, 2024d).

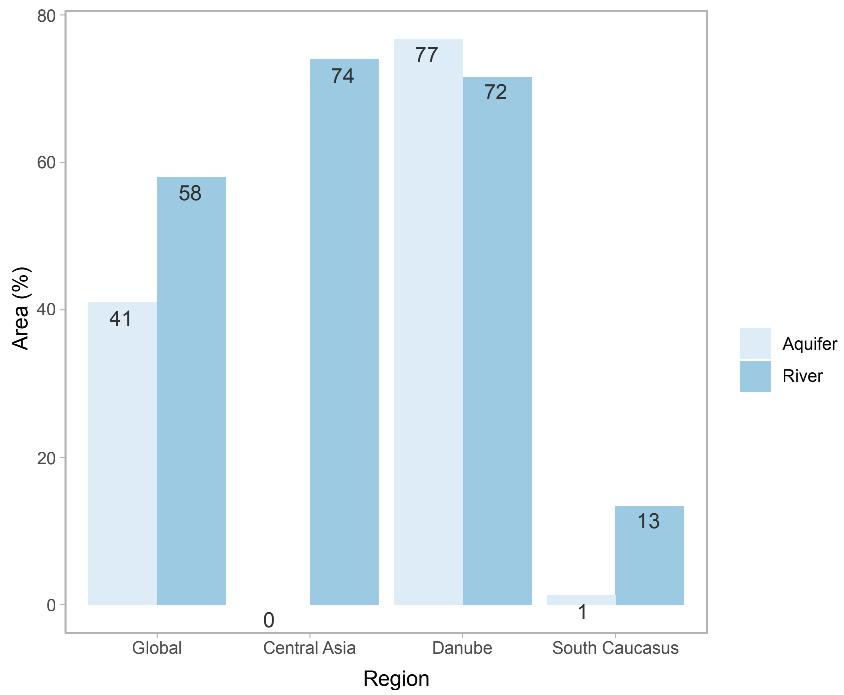
Transboundary Waters

KEY MESSAGES

- Sixty-five percent of transboundary river basin areas and 57 percent of transboundary aquifer areas have cooperation agreements in place. Although these shares are larger than the global averages, downstream countries remain highly vulnerable to upstream decisions, with limited ability to find sustainable strategies to cope with growing demands and increasing climate variability.
- The transboundary basin legal framework in Europe and Central Asia is very heterogeneous, and most treaties have yet to develop provisions for the no-harm principle.
- Environmental protection and cooperation and information-exchange processes are also insufficiently developed, particularly in the South Caucasus and Central Asia.
- Most treaties have a strong focus on water quality and do not regulate other areas of growing concern, such as water quantity, flood control, and hydropower management.

Figure 5.6

TRANSBOUNDARY AREA Covered by an Operational Agreement for Water Cooperation



Sources: UNECE and Ministry of Sustainable Development and Tourism 2016; UNESCO 2020.

The Europe and Central Asia region has one of the highest dependencies on transboundary waters in the world, yet less than two-thirds of transboundary water systems have cooperation agreements in place. In the Danube, water cooperation agreements are at a high level, covering about 84 percent of the transboundary river basin area and 78 percent of the transboundary aquifer area (*figure 5.6*). Transboundary insecurity is much higher in the South Caucasus, where only 13 percent of the transboundary river basin area and less than 2 percent of the transboundary aquifer area are covered by a treaty. Central Asia has an intermediate situation, with 74 percent of the transboundary basin area covered by an operational agreement but no transboundary aquifer agreements in place. The moderate to low level of transboundary rivers and aquifers covered under legal agreements raises the vulnerability of countries in Central Asia and the South Caucasus to upstream decisions and limits their ability to find sustainable strategies to cope with climate-change impacts on surface waters. Such circumstances raise the risks of higher socioeconomic and environmental impacts.

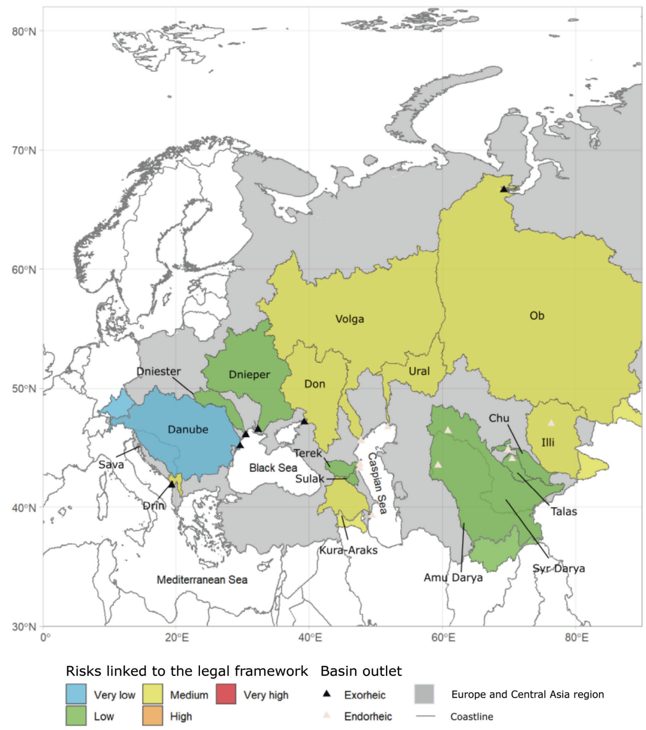
The transboundary basin legal framework in Europe and Central Asia is very heterogeneous in regard to the degree of compliance with key principles of international water law. Captured in modern international water conventions, agreements, and treaties,[4] they include the following principles: (a) equitable and reasonable utilization; (b) not causing significant harm; (c) environmental protection; (d) cooperation and information exchange, I notification, consultation, or negotiation; and (f) consultation and peaceful settlement of disputes (ILA 1996, 2004; McCaffrey 2003). Transboundary agreements in place across Europe and Central Asia show a wide disparity in how they integrate all of these, which translates into legal risks (*map 5.1*). When international water law principles are enshrined in the legal framework, the framework becomes a stronger basis for cooperation and negotiation across borders, thus lowering the risks.

- The Danube basin is the only transboundary basin across Europe and Central Asia where the basin legal framework is guided by all key principles of international water law to a very strong degree and where all countries have ratified the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (UNECE Water Convention), except Kosovo.[5]
- In Central Asia, the transboundary legal frameworks have medium compliance because they lack some of the important principles of international water law. Three out of the five countries are parties to one or both of the global conventions, with Uzbekistan having ratified both the United Nations Convention on the Law of Non-Navigational Uses of International Watercourses (UNW Convention) and the UNECE Water Convention, whereas Kazakhstan and Turkmenistan are parties only to the UNECE Water Convention.
- In the South Caucasus, not all basin legal transboundary frameworks are guided by key principles of international water law, which adds some risks. Additionally, some countries, such as Armenia, are not parties to the UNW Convention (UNECE 2020).

There are limited references to the no-harm principle in the transboundary agreements. Few basins in Europe and Central Asia have agreements that require countries to notify co-riparian states if they need additional water resources or are planning to construct water infrastructure such as dams or diversion channels (*table 5.1*). Other than the Danube basin, where the Danube Water Convention includes the principle of notification between all riparian states, several Europe and Central Asia transboundary basins lack this principle. Notification and consultation are necessary conditions to create the appropriate enabling environment for cooperation among riparian states and for ensuring the protection of international watercourses. In Central Asia, the lack of notification processes is an acute

Map 5.1

RISKS OF the Transboundary Basin Legal Framework across Europe and Central Asia



Sources: UNECE and Ministry of Sustainable Development and Tourism 2016; UNESCO 2020.

problem, and the available agreements barely establish any provisions for addressing environmental protection and data exchange, although the Interstate Commission for Water Coordination (ICWC) and the International Fund for Saving the Aral Sea (IFAS) are positive examples of cooperation mechanisms. In the Kura-Araks basin in the South Caucasus, existing agreements are mostly bilateral and often lack important elements to support cooperation; these include an absence of notification processes and a lack of data exchange.

Most treaties have a strong focus on water quality and ignore many other key aspects of WRM. All main transboundary basins in Europe and Central Asia, with few exceptions, have agreements in place to regulate aspects of water quality, but increasingly important topics such as water quantity management, flood control, and hydropower management are addressed only to a limited degree in existing agreements (*table 5.2*).

Agreements in Central Asia have a strong focus on joint management of interstate water infrastructure, but there is limited consideration of other key aspects related to important climate-change–related aspects, such as water quantity management and flood control. The absence of agreements and coordinated strategies on these topics represents a major socioeconomic risk, given that climate change is expected to increase the occurrence and severity of natural disasters, such as mudslides, floods, landslides, avalanches, waterlogging, torrential rains, droughts, hurricanes, hail storms, and heavy snowfalls. In the Chu and Talas basins, the risk of dangerous floods and mudslides during the summer is increasing because of the accelerated melting of glaciers and the shift of traditional maximum precipitation from spring and autumn to summer and winter (Zoï Environment Network 2014). In fact, future scenarios project an increase in water demands in these two basins (see "Future Challenges and Opportunities" in chapter 3 for more on future projections of water demands), which could reduce the water flows of the Talas and Chu by 20 and 44 percent, respectively, and

TABLE 5.1 Areas of International Water Law Addressed in the Transboundary Agreements of Selected Transboundary Basins in Europe and Central Asia

Region	Basin	Equitable and reasonable utilization	Environmental protection	Principle of cooperation and information exchange	Principle of notification	Peaceful settlement of disputes[a]
Central Asia	Amu Darya					
	Syr Darya					
	Chu				b	
	Talas				b	
	Ob					
	Illy					
Danube	Danube					
	Sava					
	Drin					
South Caucasus	Kura-Araks					

Source: Transboundary Freshwater Dispute Database 2018.

Note: Green cells indicate that the principle is captured in the respective transboundary agreements, either in the preamble or in a dedicated article; red cells indicate that there is no description of the principle or provision for it in any of the treaties.

a. There are diverse mechanisms. In Central Asia, it will normally be through diplomatic channels or arbitration. In the Danube, it is a similar situation, although third-party involvement and permanent judicial organs also exist (for example, Sava).

b. Although the Agreement on Utilization of the Water Facilities Use on the Chu and Talas Rivers (the main record included in the Transboundary Freshwater Dispute Database [2018] and thus the main input for this assessment) does not explicitly include—either in the preamble or in a dedicated article—principles of notification, there is a dedicated Joint Commission of the Republic of Kazakhstan and the Kyrgyz Republic for the Use of Interstate Water Facilities of the Chu and Talas Rivers that considers the principles of notification and cooperation.

also compromise national development strategies (Zoï Environment Network 2014). Another major risk in Central Asia is the low level of implementation of the existing treaties. This is not a result of a lack of awareness of their benefits but rather a lack of trust, which characterizes many of the bilateral relationships among the five governments (Pohl et al. 2017). Climate-change aspects have barely been considered in the main transboundary treaties. Most treaties were negotiated and signed in the 1990s after the collapse of the Soviet Union. At that time, climate change was not as prominent of an issue on the global agenda as it is today. The potential impacts of climate change on water resources were not as well understood or incorporated into treaty negotiations. Updating the treaties to incorporate climate-change considerations may require renegotiation and consensus among the treaty partners.

Few agreements are in place in the South Caucasus, and important transboundary issues related to water pollution, flood control, and water allocation are not yet addressed in existing agreements. Cooperation in the region is very limited between Armenia and Azerbaijan because of the ongoing political disputes, but cooperation is increasing between Georgia and the other two riparian countries on a bilateral basis. Armenia and Georgia are working on establishing mechanisms to address water pollution and protect biodiversity through different projects, for instance, in the Debed and Khrami Rivers. Azerbaijan and Georgia, with support from the OECD, are in the process of developing a joint agreement on the Kura River, which will provide the necessary regulation framework and help in setting up a joint commission on the sustainable use and protection of the Kura River basin. A large focus of the agreement will be addressing existing water-pollution problems and water allocation to secure water for different uses downstream (Strosser et al. 2017).

TABLE 5.2 Main Issues Addressed in the Transboundary Agreements in Europe and Central Asia

		Topics					
Region	**Basin**	**Water quality**	**Flood control**	**Water quantity**	**Hydropower electricity**	**Joint management of interstate water infrastructure**	**Navigation**
Central Asia	Amu Darya			a			
	Syr Darya						
	Chu						
	Talas						
	Ob						
	Illy						
Danube	Danube						
	Sava						
	Drin						
	Don						
	Dniester						
	Dnieper						
South Caucasus	Kura-Araks						

Source: Transboundary Freshwater Dispute Database 2018.

Note: Green cells indicate that the integrated water resources management (IWRM) aspect is captured in the transboundary agreements in place; red indicates that there is no description of the principle or provision for it in the treaty.

a. Although the two agreements revised for this assessment—the Protocol between the Union of Soviet Socialist Republics and Afghanistan on the Joint Execution of Works for the Integrated Utilization of the Water Resources in the Frontier Section of the Amu Darya River (1958) and the Agreement on Joint Activities in Addressing the Aral Sea and the Zone around the Sea Crisis, Improving the Environment, and Ensuring the Social and Economic Development of the Aral Sea Region (1993)—do not explicitly regulate water quantity, the By-law of the Interstate Commission for Water Coordination in Central Asia (ICWC) provides a framework for water allocation.

In the Danube, navigation is an important activity, and it is comprehensively addressed in the different transboundary agreements in place. Other aspects, such as cooperation in the space of flood control and hydropower generation, are addressed only to a limited degree other than in the Danube River Protection Convention. In fact, the Danube basin is the only basin in the Europe and Central Asia region to integrate all the legal requirements of modern international water law; as such, it constitutes a global example of successful cooperation (*box 5.1*).

Box 5.1

THE DANUBE RIVER BASIN: A GLOBAL BENCHMARK FOR TRANSBOUNDARY BASIN MANAGEMENT AND COOPERATION

The Danube River is the second-longest river in Europe (2,857 kilometers). Shared by nineteen countries, it flows through numerous large cities, including four national capitals (Belgrade, Bratislava, Budapest, and Vienna), before draining into the Black Sea. It is critical for drinking water (for more than 20 million people), hydropower, navigation, agriculture, recreation, and sustaining rich biodiversity.

Growing levels of nutrient and organic pollution reached a peak in 1990 when about 40,000 square kilometers of the Black Sea were declared dead. This ecological crisis and resulting socioeconomic consequences quickly evolved into the Danube River Protection Convention (DRPC) in 1994. Eleven initial signatories (Austria, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Moldova, Romania, the Slovak Republic, Slovenia, and Ukraine), along with the new parties (Bosnia and Herzegovina, Montenegro, and Serbia), agreed to cooperate on fundamental water management issues, including the conservation, improvement, and rational use of surface water and groundwater; preventive measures to control hazards originating from accidents, floods, ice, or hazardous substances; and measures to reduce the pollution loads entering the Black Sea from sources in the Danube River basin (DRB).

The DRPC established the International Commission for the Protection of the Danube River (ICPDR), the transboundary river basin organization that works to ensure the sustainable and equitable use of freshwater resources in the DRB for more than 80 million people. It consists of delegations from contracting parties that meet biannually to decide on aspects of basin management. The ICPDR also includes expert groups and task groups. The former are panels of specialists and external observers and include at least one national expert for each contracting party. These expert groups provide technical advice on aspects related to relevant basin planning and management, including monitoring and assessment, river basin management, pressures and measures, information management and exchange, accident prevention, public participation, and flood protection. Reporting to them are task groups, composed of national experts from ICPDR, contracting parties, and representatives of observer organizations.

The main goals of the ICPDR are as follows:

- Support implementation of the DRPC, making it a living tool to coordinate sustainable and equitable water management, including conservation, improvement, and rational use of water resources.
- Facilitate implementation of European Union (EU) policies (Water Framework Directive [WFD] and Floods Directive [FD]). With its contracting parties, the ICPDR has developed the Danube River Basin Management Plan, which helps coordinate the national river management plans developed by individual countries across the basin. Only the EU Member States in the ICPDR are legally bound to fulfill the Danube RBMP and achieve "good ecological status" by 2027; all countries in the ICPDR have, however, agreed to fully commit to implementing the plan and the directives. The ICPDR developed the first Danube Flood Risk Management Plan based on the solidarity principle, which is designed to prevent countries from simply exporting their flood problems to downstream neighbors. Application is essential because structural flood protection, such as dikes and demountable barriers, may simply transfer more water downstream during extreme flood events.
- Develop guidance and mechanisms to strengthen riparian states' institutional and technical capacities for basin and flood risk management. Through the expert groups and task groups, the ICPDR has also significantly strengthened the capacity of the Danube countries to continuously meet the challenges related to EU accession and the Acquis Communautaire.
- Moreover, political and economic incentives for environmental compliance resulting from the EU accession process have facilitated a speedier implementation of the DRPC's objectives. As more Danube countries implement EU water policies, the Danube becomes safer, cleaner, and healthier as expertise grows and more lessons are learned.

Box 5.1 *continued*

Key achievements within countries include:

- Danube countries are backed by solid environmental regulations and investments needed to meet their own environmental needs.
- Country capacities are strengthened to continuously meet the challenges of EU accession and the Acquis Communautaire.
- National decision makers have greater capacity to balance the competing needs and uses of the Danube River, such as hydropower, agriculture, and management of climate risks.

Key achievements at the Danube basin scale include:

- A basinwide climate-change strategy to help Danube countries develop more effective water management approaches in the face of increasingly extreme floods and droughts.
- Basinwide key plans to manage water resources and floods, regularly updated (every six years), are taking strategic measures across the entire river basin to meet EU water goals.
- The development of a vital learning hub and platform to (a) exchange experiences and innovation among countries facing vastly different economic and environmental challenges and (b) support pioneering intersectoral cooperation and structured dialogue across the different users of the Danube's water resources, from navigation and water supply to hydropower and sanitation.

Source: ICPDR 2018a.

Irrigation and Drainage

Generally speaking, the overarching policies and strategies governing the use and management of water for agriculture are espoused within broader frameworks dedicated to WRM (see "Institutions" earlier in the chapter). In some instances, these form part of basin management plans, as is the case for Danube River basin (DRB) countries—for example, the integrative management framework of the International Commission for the Protection of the Danube River (ICPDR; *box 5.1*), which targets land and water management strategies, and the WFD, which focuses on the status of all waters within the EU, including "efficiency of water use, adequacy of agricultural practices and coordinated water-pricing policies" (Dogaru et al. 2019, 5). Other water-related aspects of agriculture are governed by the EU's Common Agricultural Policy (CAP), whereby countries are incentivized to comply with the WFD while decreasing agricultural pressures on water, such as overabstraction, through targeted subsidies. These policies acknowledge the importance of sustainable agriculture in water management, efficient irrigation systems, water savings, and climate adaptation.

Regional, overarching frameworks are important guides, but their implementation in practice is complex. Rules governing the irrigation subsector are spread among various frameworks, with roles and responsibilities similarly spread among different ministries and agencies. At the national level, this means their coordination, implementation, and regulation are often fragmented (*box 5.2*), and transboundary frameworks are subject to regional idiosyncrasies that influence farmer and irrigation behavior. For example, in Serbia, farmers pay half the tariffs set out for irrigation, but in Romania, the cost of irrigation water is totally subsidized (Dogaru et al. 2019).

In irrigated areas of the Danube subregion, responsibilities for service delivery vary by country. Among the Balkans, where most of the subregion's irrigated croplands exist, responsibilities for the provision of irrigation services differ. In Albania and Montenegro, municipalities are responsible for the provision of irrigation services through irrigation and drainage (I&D) units, cooperatives, and municipal multiutility companies. In Croatia and Kosovo, water utility companies have this responsibility. In Bosnia and Herzegovina and North Macedonia, there is a mix of service providers ranging from water user associations (WUAs) to cooperatives, water utility companies, and water management enterprises.

In Central Asia, institutional reforms, policy development, and changes in legislation are needed to set the direction and framework for a modern irrigation sector. Some countries in Central Asia have established new policies for key irrigation modernization activities, such as the formation of WUAs and the establishment of private-public partnerships (PPPs), but changes in the culture and practices within the irrigation sector will require new, forward-looking policies and legislation. For example, WUAs have a central role in on-farm water management but require additional support to be fully effective. Institutional reforms that lead to changes in organizational cultures can establish the path for changes required at organizational and scheme levels. The single most important institutional (step) change in Central Asia is to develop a culture of bottom-up, customer-oriented service delivery to replace the current top-down, supply-driven management style.

Box 5.2

INSTITUTIONAL ARRANGEMENTS OF ALBANIA'S IRRIGATION SECTOR

Institutional responsibilities in Albania's irrigation sector are highly fragmented. They are poorly defined, especially at the local level; often overlapping; and sometimes contradictory. For the past several years, there has been a growing institutional gap related to the management of irrigation and drainage (I&D) systems. In the past, water user organizations (WUOs) were responsible for secondary and tertiary canals, but most have become inactive because of a lack of capacity building. As of 2016, the management for most of Albania's I&D systems had been transferred to municipalities.

Law No. 24/2017 on the Administration of Irrigation and Drainage determined the main tasks of the regional directorates of I&D, municipalities, and WUOs. Law No. 139/2015 on Local Self-Governance determined that municipalities were responsible for the administration, use, and maintenance of water and drainage infrastructure; hence these responsibilities were transferred to them. Government Decision No. 1108, dated December 30, 2015, stipulated the transfer of I&D infrastructure personnel and the movable and immovable assets of the regional boards of drainage of the Ministry of Agriculture and Rural Development to municipalities. There is a lack of synchronization of agricultural and irrigation development plans and interventions at the local (municipality) level. Furthermore, municipalities do not have development plans or strategies for the agricultural sector.

This change needs to be combined with measures (such as service delivery contracts) that drive up irrigation service fee payments to achieve levels of funding sufficient to cover the costs of service delivery.

Among countries in the South Caucasus, government and institutional capacity is limited. The development of agriculture is receiving more attention than ever from policy makers in the subregion. However, across the region, government and institutional capacity to provide support for sustainable land management is generally lacking. Farmers often do not have reliable access to water for irrigation. Consequently, the issue of sustainable land management relates not only to ownership but also to proper land stewardship and capacity, the lack of which increases the vulnerability to climate change.

Water Supply and Sanitation

KEY MESSAGES

- WSS institutions are fairly well developed but are experiencing major institutional fragmentation, which translates into jurisdictional asymmetries, with regulatory, management, and financing functions being spread across different institutional levels and not always fully coordinated.
- Policy making is normally developed at the national level and coordinated by different ministry lines, whereas planning and management are largely decentralized to the regional and municipal levels.
- There are different types of service providers, mostly public, with still very limited participation on the part of the private sector. The capacity of public service providers in periurban and rural areas is low, which affects the delivery and quality of services.
- Independent regulator institutions and functions are not always well developed, and they remain far from achieving their full potential. Where they do exist, they are often multisector.
- PPPs are not widespread across Europe and Central Asia, but successful examples show that they can support public utilities in improving their performance and services along the value chain by helping manage a specific subset of activities and addressing emerging performance challenges.

TABLE 5.3 Key Features of the Institutional Arrangement of the Water Supply and Sanitation Sector in Europe and Central Asia

Country	Institution in charge of policies	Institution in charge of planning	Dominant type of service provider (level of decentralization)	Is there an independent national regulator?	WSS legislation
Central Asia					
Kazakhstan	National	Regional and local government	Municipality-owned enterprise	Yes	Yes
Kyrgyz Republic	National	Regional and local government	Municipality-owned enterprise		Yes
Tajikistan	National	Regional and local government	Municipality-owned enterprise	Yes	Yes
Turkmenistan	National	Regional and local government	State-owned enterprise		Yes
Uzbekistan	National	Regional and local government	Joint-stock company		Yes
South Caucasus					
Armenia	National	National and local government	Joint-stock company	Yes	Yes
Azerbaijan	National	Regional and local government	Joint-stock company		Yes
Georgia	National	National and local government	State-owned company and privately owned company	Yes	Yes
Danube					
Albania	National	Local government	Joint-stock company	Yes	Yes
Austria	National	Local government	Municipality-owned enterprise		Yes
Bosnia and Herzegovina	Regional	Local government	Public utility company		Yes
Bulgaria	National	National and local government	State-owned enterprise	Yesa	Yes
Croatia	National	Local government	Public utility company	Yes	Yes
Czech Republic	National	Local government	Privately owned company		Yes
Hungary	National	National and local government	Municipality-owned enterprise	Yes	Yes
Kosovo	National	National government	Regional water company	Yes	Yes
North Macedonia	National	Local government	Municipal public enterprise	Yes[a]	Yes
Moldova	National	Local government	Municipal public enterprise	Yes[a]	Yes
Montenegro	National	Local government	Municipal public enterprise	Yes[a]	Yes
Romania	National	Local government	Regional operator	Yes	Yes
Serbia	National	Local government	State-owned enterprise		Yes
Slovak Republic	National	Local government	Joint-stock company	Yes	Yes
Slovenia	National	Local government	Municipal public enterprise		Yes
Ukraine	National	Local government	Communal enterprise	Yes[a]	Yes

Note: — = status unknown; WSS = water supply and sanitation. Multisector regulators, largely water-energy regulators, although in Ukraine, there are more sectors involved.

Although institutional arrangements are quite developed, there are important jurisdictional asymmetries in the governance of WSS in the region. In comparison with WRM, WSS institutions are more mature across the region, though with some differences. A recurring challenge is institutional fragmentation, which translates into the spread of regulatory, management, and financing functions across different institutional levels—these are not always fully coordinated. Regarding policies, the WSS agenda has received greater attention, and investments have contributed to reaching a good level of WSS coverage, although efforts now need to focus on increasing the quality of the services (see "Social Outcomes" in chapter 3 and "Water Sector Financing" in chapter 4 for further details). *Table 5.3* shows the institutional arrangements of countries in Europe and Central Asia and their different jurisdictions.

Policy-making responsibilities for WSS services in the Danube remain with the central government but are usually shared among different ministries, sometimes creating coordination challenges. For water service provision, responsibilities have been quite fragmented, but in the past few years, countries have embarked on several reforms toward creating single-line ministries. This consolidation has not been fully achieved, but the general trend is that WRM, utility affairs, and infrastructure, as well as wastewater treatment, fall under the responsibility of single ministries (often ministries of water, environment, or agriculture; DWP 2019). Nevertheless, drinking-water standards are mainly the responsibility of the ministry of health. There are exceptions, with countries still showing a high fragmentation (for example, the Czech Republic, Hungary, Kosovo, North Macedonia, and Serbia). The multiplicity of water-services–related ministries sometimes creates confusion or leads to a lack of ownership for any utility reform agenda. To alleviate this challenge, some countries have resorted to the creation of coordination bodies (for example, the Inter-ministerial Water Council in Kosovo and the regulatory authority in Hungary), which have taken on active policy coordination or advocacy roles.

Planning of WSS services is largely carried out at the local level. Decentralization of WSS services is the predominant form of organization across the Danube, with service provision and controlling jurisdiction accrued at the municipal level. Most recurrent types of service providers are formal and include the following: regional (37 percent), municipal (28 percent), and, to a lesser extent, private service providers (11 percent; *figure 5.7*). Formal providers predominate in the urban and periurban areas. In rural areas, water services are normally organized through a nearby utility or community-based organization, but in very remote areas, WSS services are often managed through self-provision (that is, informally). Many of the self-provision providers are not registered and do not necessarily follow the established national or local regulations and standards. Their financial and technical viability are limited, and governments' response is to pursue reforms that consider a menu of delivery model options to promote the expansion of formal services to ensure safe and adequate delivery of services, including the regionalization of rural service providers (DWP 2019). Successful regionalization processes have the following in common: a deliberate equity objective and a clear mandate, dedicated measures to support the integration of rural systems, and targeted investments and technical assistance to local governments and service providers to handle complexity. Multiple management models have been implemented, including the regional utility model and the small-scale municipal enterprises or community-organized models. Such regionalization is and should be considered an option not just for rural service providers but also for those in the urban and periurban areas facing technical and financial challenges.

The regulatory framework and sector reform are largely driven by the EU regulatory framework, which requires that countries review and strengthen existing regulatory frameworks to ensure cost-recovery principles. Although the EU water directives do not request specific governance reforms, most EU candidate states have also embarked on regionalization processes to increase their capacity to absorb EU funds, and they are still in the process of transposing the EU Water Acquis and updating national water strategies to reflect the main goals of the WSS sector.

In Central Asia and the South Caucasus, responsibilities for policy making in WSS are spread across different ministry lines. Typically, WRM is under the responsibility of the ministries of water, environment, or agriculture, whereas infrastructure policies are often led by ministries of industry and infrastructural development ministries. As with Danube countries, drinking-water standards are mainly the responsibility of ministries of health. To facilitate coordination among different institutions, some countries created national councils (for example, the National Land and Water Council of the Kyrgyz Republic and the new National Water Council in Tajikistan). These newly created councils will support coordination between the activities of ministries; state committees and agencies; other administrative bodies, such as local administrations; and self-governance bodies involved in WRM, protection, and service delivery (for example, WUAs; Sara and Proskuryakova 2022).

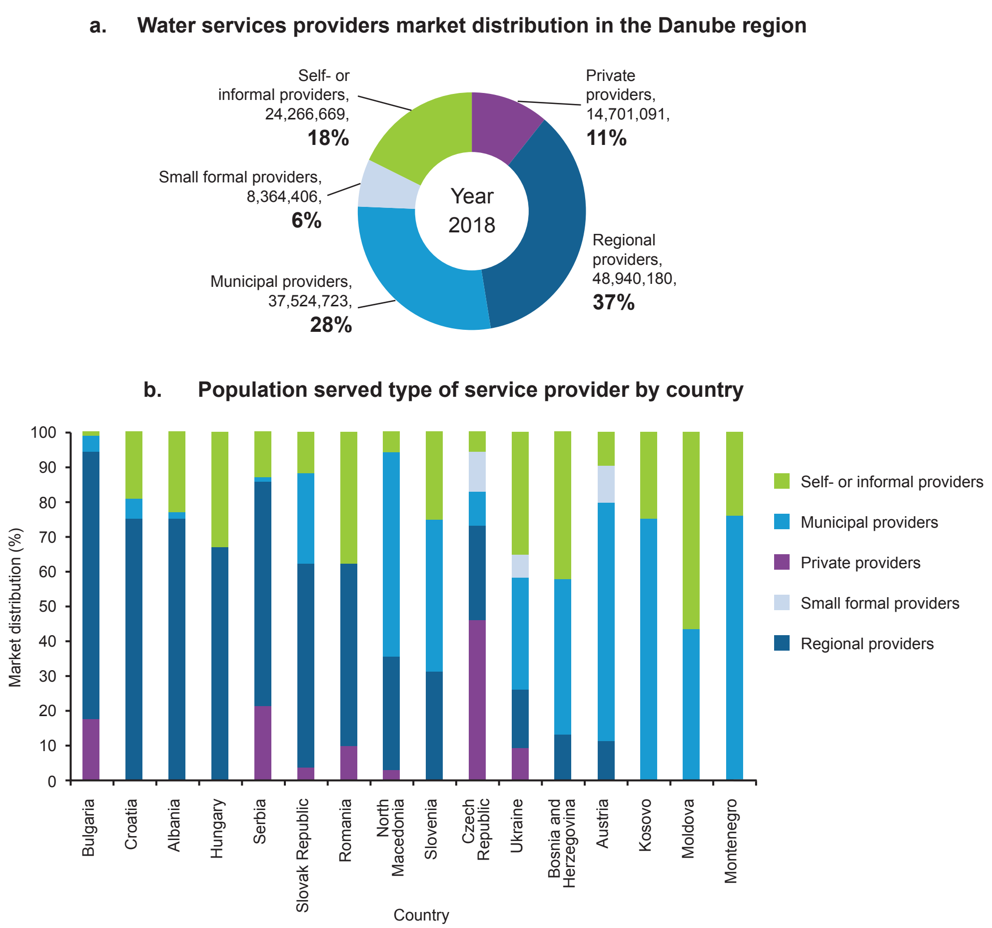
Service provision is more decentralized in Central Asia. Regional utilities are present in major cities, whereas municipal services providers (or Vodokanals) dominate in district capitals (for example, Kazakhstan and the Kyrgyz Republic). In rural areas, municipal water enterprises and community drinking-water user unions are the prevalent type of service provider (World Bank 2022c). In Kazakhstan, private sector involvement in service provision is allowed, whereas PPP projects are not extensively developed (Yoshino et al. 2022). In some cases, service providers are state-owned companies or joint-stock companies.

Service provision is more centralized in the South Caucasus, where joint-stock companies and state-owned companies provide most services. Private service providers are marginal, but they are present in some countries, such as Georgia (Georgian Water and Power). Such centralization has also been driven by the institutional and financial constraints that municipal services providers experience in this region, which have forced local governments to transfer the operation and maintenance (O&M) of water systems to national companies.

Overall, WSS institutions are more developed than those related to water management. This sector, however, faces major institutional challenges related to still-high fragmentation at the policy level (especially across countries in Central Asia and the South Caucasus) and, moreover, the limited human, technical, and financial capacities of the smallest service providers in most countries of Europe and Central Asia. Addressing these institutional challenges will require stepping up targeted policies and systems to bring the sector to Sustainable Development Goal (SDG) standards on water and to link improvements to a water security approach for the world of tomorrow. Structural reforms such as aggregations or regionalization are taking place and represent one way forward, but those alone cannot overcome the limited institutional capacities of many municipal and small service providers. In the Danube, utility associations have been playing a major role in strengthening local capacities (for example, specific training, technical assistance, standard setting, and so on), and there are good examples of such activities in countries like Albania, Austria, and Romania (DWP 2019).

Figure 5.7

WATER SERVICES Provision in the Danube Region



Source: DWP 2019.

Regulatory functions and institutions are not always well developed and remain far from achieving their full potential. The functions of national independent regulators related to standard setting include setting and controlling tariffs, granting licenses to operators, specifying asset conditions and efficiency or performance targets, defining standards for drinking water and effluent discharge, controlling service providers, monitoring consumer complaints, and setting service coverage. If such functions are well defined and executed, customers will be protected from low-quality or too-expensive services, and they will have access to safer drinking water and more secure management of wastewater. Standard setting will also contribute to reducing pollution loads discharged into the environment. Of the twenty-four countries of Europe and Central Asia, fifteen have established independent water regulators). In countries where there is no water regulator, regulatory functions are directly executed at the local level (for example, in Austria and Bosnia and Herzegovina) or there is no economic regulation at all (for example, in Serbia). Existing national independent regulators in Europe and Central Asia are often multisector, meaning that they exert regulatory functions over sectors other than water, most frequently energy. Although regulating several sectors might deliver positive benefits, namely for knowledge exchange, it also entails some risks, for example, water underprioritization. Although countries are making progress in the development of regulatory bodies, their functions could be strengthened to increase the accountability, efficiency, and transparency of service providers. This effort ultimately translates into a better quality of water services for consumers, society as a whole, and the environment.

Regulators in the Danube countries have started to gain greater independence, especially in countries with larger utilities. In the Danube region, eleven of the sixteen countries have an independent national regulator (Albania, Bulgaria, Croatia, Hungary, Kosovo, Moldova, Montenegro, North Macedonia, Romania, and the Slovak Republic), and in four countries, this regulator is multisectoral (Bulgaria, Moldova, Montenegro, and North Macedonia). The functions of independent regulators in Danube countries are very much focused on tariff setting and control, granting of operator licenses, and monitoring of consumer complaints, though several independent regulators are able to report shortcomings in the performance of these functions. For example, the tariff review is not conducted periodically but upon the request of the utility; regulators do not grant operator licenses; and in practice, they carry out limited monitoring of consumer complaints even though they have a legal mandate to do so (DWP 2019).

In Central Asia, most countries have an independent regulator (Kazakhstan, Tajikistan, and Uzbekistan). These institutions are normally antimonopoly committees[6] and are associated with a ministry line (for example, the ministry of economy), and they are often also multisectoral (mainly energy and water). Regulators mainly act to revise and approve the water tariffs approved by the service provider; thus, as in the Danube countries, their functions are not fully deployed: Their scope is narrow, and they lack autonomy.

In the South Caucasus, only Azerbaijan lacks an independent national regulator. In Georgia, the independent regulator (Georgian National Energy and Water Regulatory Commission) is mostly in charge of licensing and tariff setting in the energy and water sectors. Armenia also has an independent regulator, the Public Services Regulatory Commission, with functions including setting tariffs, monitoring service quality, and ensuring compliance with regulations in these sectors.

PPPs are not widespread in Europe and Central Asia, but successful examples show they can support public utilities in improving the performance of water services. Many countries in Europe and Central Asia are facing the challenges of sustainability and financial viability because they still have unsatisfactory WSS services and constrained budgets. The implementation of PPPs has been increasingly promoted as a way for governments to not only address infrastructure investment needs but also improve water services along the value chain. PPPs can help public utilities manage a specific subset of activities (for example, water distribution, treatment, and wastewater treatment) or address emerging performance challenges (for example, increasing energy efficiency and water availability through nonrevenue water (NRW) management or developing a new water source). Nevertheless, the success of PPPs depends on the following (ADB 2022): (a) the establishment of a strong water governance framework (supported by capable public institutions, a buoyant revenue regime, and transparent targeted subsidies); (b) an adequate enabling environment (through a sector-specific PPP strategy, rigorous project preparation, and a sound fiscal framework); and (c) the embedding of a transaction design that attracts financing, offers balanced risk allocation among stakeholders, establishes efficient and competitive procurement processes, and has clear key performance indicators directly linked to payments.

In the Danube subregion, PPP contracts are signed and in force for WSS service provision in seven of eleven countries. These partnerships have an increasing number of customers, and they benefit from a positive perception of PPPs for WSS services. Overall, 75 private operators are reported to serve close to 15 million people, equivalent to 11 percent of the market share. In 2014–19, the number of PPP arrangements decreased by 8 percent, but the total number of customers increased by 6 percent, underlining that private operators tend to expand services to additional customers rapidly, mainly in large and urban areas (DWP 2019). In Albania and Moldova, where there are presently no PPP contracts in place, dedicated legal provisions have been made to support PPP introduction because they are perceived as positive drivers for change and improvement. In other Danube countries, such as Austria, Bulgaria, the Czech Republic, and Slovenia, PPPs suffer from a negative perception in some instances, irrespective of their real efficiency and performance. Many of these countries instead have developed waterworks associations, which offer services within countries to strengthen the capacities of service providers through knowledge exchange, training workshops, drafting of technical standards and guidelines, and so on to lift the capacities of public service providers to increase their performance, efficiency, and accountability.

Currently, there is little private sector involvement in the delivery of WSS services in Central Asia. This situation is expected to change soon and will help close the financial gap and support the investment in climate-resilient water infrastructure (CAREC 2023).

In the South Caucasus, only Armenia and Georgia have allowed private involvement in service provision. In Georgia, four independent water companies serving the capital, Tbilisi, and the adjacent cities of Gardabani, Mtskheta, and Rustavi were merged in 2008 and privatized to form Georgian Water and Power (ADB 2020). In Armenia, the most important service provider is Veolia, a closed joint-stock company and PPP that was established in 2016 because of its successful PPP management and lease contracts (*box 5.3*). In Azerbaijan, water services are publicly managed, and there are no records of PPPs.

Water Sector Financing

KEY MESSAGES

- Europe and Central Asia's water sector remains underfunded, and about $77 billion per year (0.6 percent of gross domestic product [GDP]) is needed to meet the water-related SDGs in Europe and Central Asia: 20 percent to address the gap in access to WSS services and 80 percent to support the implementation of IWR
- The largest share of investments is needed in Central Asia, followed by the Danube and the South Caucasus.
- Most of the funding for IWRM comes from the state budget and international donors, whereas private investments are still symbolic. Funds are mainly allocated to new infrastructure and much less to O&M.
- Economic instruments to generate revenues for WRM are partly developed for WSS services but almost absent for other water uses (for example, irrigation). The revenues collected are not always earmarked and are often transferred to the general budget of the state or subnational governments.
- Most revenues are collected through water tariffs that are often insufficient to ensure cost recovery. Other fees, such as environmental and resource protection charges, are barely developed across the region, except for EU Member States in the Danube.

The estimated regional costs needed to achieve SDG 6 and its different targets amount to $77 billion annually, equivalent to 0.6 percent of the regional GDP. Regional investment needs are below the global average, especially compared with other parts of Asia and Sub-Saharan Africa (*figure 5.8*). Worldwide, there is a recurring pattern whereby the share of investments needed for WRM is much greater than that required in WSS, except for Sub-Saharan Africa. In Europe and Central Asia, the estimated investments needed to address WRM challenges (water scarcity, water management, and water pollution) amount to approximately $61 billion per year until 2030, whereas the level of investment needed to address the water supply, sanitation, and hygiene (WASH) gap amounts to about $16 billion per year.

Box 5.3

YEREVAN WATER SUPPLY, ARMENIA: MANAGEMENT OR LEASE CONTRACTS

In the past two decades, there have been three generations of public-private partnership (PPP) contracts related to Yerevan's water supply. The first, in 2000, was a PPP management contract, which was followed by second- and third-generation contracts in 2006 and 2017. This success demonstrates the positive impact of staying on the course with PPPs, especially when their involvement is backed by a governmental commitment to carry out enabling policy and sector-level reforms. A phased shift to deeper private engagement, building on lessons from earlier phases; enactment of policy actions to strengthen institutions and reform tariffs; and complementary multilateral financing to meet investment needs have delivered tangible development impacts and improvements in service delivery.

Drivers Underlying the PPP Contract

Following its independence in 1991, Armenia began experiencing a deterioration in its water networks. The water supply coverage of Armenia was relatively good; however, less than 15 percent of water connections received a continuous supply. Metering was not very prevalent, and nonrevenue water (NRW) levels were high. With user charges limited because of flat tariffs, operation and maintenance (O&M) cost recovery was less than 30 percent. To address these challenges, the government started its PPP program in 2000 to contract private operators in the management of Armenian water operations.

Even without specific national policies or legislation, the implementation of PPP contracts in Armenia was accompanied by various sector reforms. These included delegating the responsibility for sewerage and water supply services to local authorities in 2002, establishing a state committee on water systems, formulating the water code, and introducing a national water policy in 2005 and a national water program in 2006. The establishment of the Public Services Regulatory Commission to regulate public utilities and the creation of the Yerevan and Armenia water utilities (Yerevan Water and Sewerage Company and Armenian Water and Sewerage Company) were significant steps. The government of Armenia also secured funding from multilateral agencies to expand, upgrade, and enhance infrastructure and service delivery. These initiatives, along with efforts to develop enabling policies and reform institutions, played a crucial role in attracting private sector participation and improving service delivery, despite the absence of specific PPP policies or legislation in Armenia.

Salient Features of the PPP Arrangements

- Management contract (2000–2005): Acea, an Italian utility, took over the O&M of Yerevan's network in June 2000 after a competitive bidding process.
- Lease contract (2006–16): The lease contract was revised to transfer more risks to the private sector, including billing and collection risks. The private operator was responsible for investment implementation and expanding the service area to cover thirty villages around Yerevan.

Outcomes and the Way Ahead

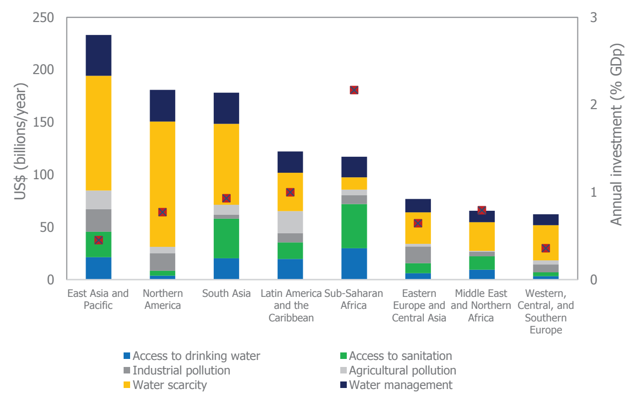
The lease contract resulted in significant operational and financial improvements, with increased tariffs and collection rates, leading to a substantial rise in revenue. By 2011, water services became fully self-financing, although NRW levels remained high. The operator achieved about $4.1 million in cumulative operational profit before taxes from 2006 to 2015.

Multilateral support from organizations like the World Bank, the Asian Development Bank, the European Bank for Reconstruction and Development, and the European Union played a crucial role in supporting the investment program and assisting the government in implementing reform measures. The project offers valuable insights for structuring PPPs in water distribution.

Key factors contributing to the success of the program include the government of Armenia's commitment to reforms and institutional stability, sustained commitment to PPPs while learning from experience, a focus on service delivery over investment financing, and the adoption of a countrywide approach to an efficient water supply. The transition to a composite contract with Veolia for 2017–32 marked a significant shift in strategy and is worth further examination.

Figure 5.8

ESTIMATED COSTS (US$ Billion/Year) of Achieving SDG 6, 2015–30

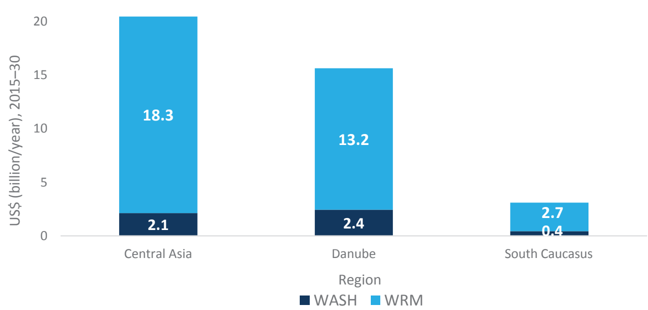


Source: Strong et al. 2020.

Note: Boxed X symbols represent annual investments by regions as a percentage of their regional GDP. GDP = gross domestic product; SDG = Sustainable Development Goal.

Figure 5.9

ESTIMATED COSTS of Meeting SDG 6 WASH-Related Targets (SDG 6.1 and SDG 6.2) and IWRM (SDG 6.3 through SDG 6.6), 2015–30



Source: Strong et al. 2020.

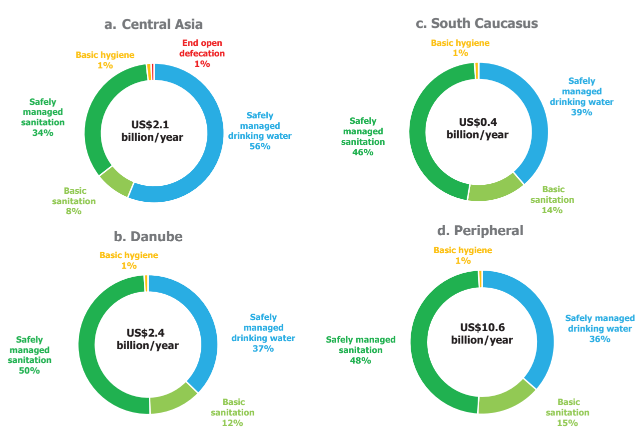
Note: IWRM = integrated water resources management; SDG = Sustainable Development Goal; WASH = water supply, sanitation, and hygiene.

Investment needs are the largest in Central Asia, with the total needed equaling roughly $20 billion per year, or 2 percent of the subregional annual GDP. The Danube would require investments totaling approximately $16 billion per year, equivalent to 0.4 percent of its subregional GDP. The South Caucasus needs about $3 billion annually, equivalent to approximately 1.5 percent of its subregional GDP (*figure 5.9*). Across all three regions, addressing the gap to meet IWRM represents the largest share of the investment needs (up to 82 percent in Central Asia and 70 percent in the South Caucasus), although in the Danube, the distribution is more even, with 51 percent needed for WRM.

To address the gap in access to WSS services by 2030, countries will require annual investments equivalent to $16 billion per year. Different levels of investment will be needed across the subregions, with the largest amounts required in Central Asia ($2.1 billion per year) and the Danube subregion ($2.4 billion per year). The estimated costs needed to bridge the gap in the South Caucasus amount to $0.4 billion per year (*figure 5.10*). As described in chapter 3 (see "Social Outcomes"), access to at least basic WSS services in Europe and Central Asia is fairly high overall, and the largest investment needs are required for increasing the quality of services up to safely managed across urban and rural areas. The peripheral countries (Belarus, Russia, and Türkiye) face a similar situation, though investment needs are higher ($10.6 billion per year). Overall, investments needed to close the WASH gap are small in comparison with those required for other sectors, such as transportation or telecommunications, in Europe and Central Asia. Yet the benefits could be substantial because bridging this gap will improve health conditions and have cascading positive effects on the productivity and overall socioeconomic performance of the countries in Europe and Central Asia.

Figure 5.10

BREAKDOWN OF Annual Estimated Costs of WASH SDG 6 Targets (SDG 6.1 and SDG 6.2) in Europe and Central Asia, 2015–30



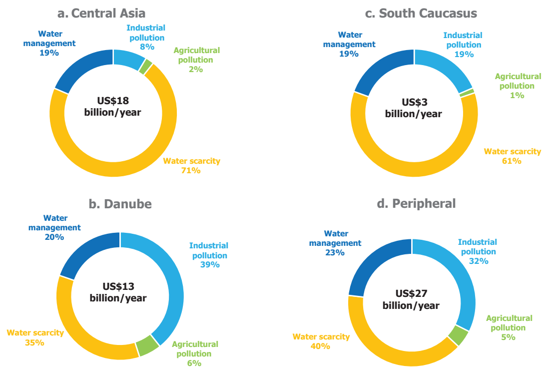
Source: Strong et al. 2020.

Note: SDG = Sustainable Development Goal; WASH = water supply, sanitation, and hygiene.

Full implementation of SDG 6 IWRM-related targets requires investments that are four times larger than those required to meet the SDG 6 WASH-related ones. As discussed earlier in the chapter, major reforms and investment programs are still needed to support the implementation of IWRM and achieve SDG 6. There are disparities across regions and targets. Half of all investments in Europe and Central Asia (about $30 billion per year) are needed to support the development of infrastructure programs to address ongoing water scarcity and improve the efficiency of water use (although there are some disparities across the subregions; *figure 5.11*). Investments are particularly needed in the irrigation sector, where dilapidated infrastructure must be replaced, along with an increase in water-use efficiency and support for agricultural productivity growth. About $18 billion per year is required to address water pollution, both point source (industrial) and non–point source (agriculture). Average regional investments oriented to support institutional reforms (policy, capacity development, and institutional development) are estimated to be about $13 billion annually. Here, too, there are major differences across subregions, with Central Asia and the South Caucasus requiring the largest investments needed to address water scarcity. In the Danube, addressing water pollution, especially industrial pollution, is the biggest challenge (requiring up to 39 percent of annual investment needs), but water scarcity is also notably important (accounting for 35 percent of the estimated costs; *figure 5.11*).

Figure 5.11

BREAKDOWN OF Annual Investments (2005 US$) Needed to Achieve SDG 6 Targets Related to IWRM (SDG 6.3 through SDG 6.6) in Europe and Central Asia, 2015–30



Source: Strong et al. 2020.

Note: Water scarcity costs include costs to improve the water gap for irrigation and industrial and domestic water supplies. SDG = Sustainable Development Goal; WASH = water supply, sanitation, and hygiene.

Underfinancing threatens water security and the region's ability to fulfill SDG 6, affecting regional economic growth and sustainability. Water sector financing in Europe and Central Asia mainly comes from public budgets, with donors and international funds expanding and private funding still marginal. Countries in Europe and Central Asia are putting mechanisms in place to collect revenues from WRM (for example, water tariffs, abstraction and pollution charges), but they are still insufficiently developed (*table 5.4*). Overall, most countries report a financial gap in meeting the required investments (*box 5.4*). Both national and subnational budgets dealing with WSS, infrastructure, and IWRM activities (for example, policy development, enabling environment, stakeholder participation, data collection, and monitoring) are affected by important financial gaps, as are revenues collected from WRM. A recurring issue in many countries is the inadequate prioritization of disbursed funds, which stems from the fact that decisions regarding financing sources and instruments are primarily influenced by nationally driven policies or political processes. Consequently, this hinders the development of an investment strategy capable of maximizing benefits within a constrained budget environment. However, despite the financial gaps, most countries in Europe and Central Asia underexecute their allocated budgets. Budget execution rates (that is, the ratio of executed expenditure to the allocated budget) averaged about 87 percent during 2009–20 (higher than the global average of 73 percent), meaning that some 13 percent of allocated funds go unspent. Low budget execution rates point to systemic constraints in the sector's absorptive capacity, which in turn is anchored in a range of institutional, governance, project management, and political economy factors. Higher execution rates, by themselves, would narrow the water sector's financing gap, with a lesser need for greater financial outlays (George et al. 2024).

TABLE 5.4 Financing Allocation to Water Resources Management in Europe and Central Asia

Region	Country	National budget water infrastructure	National budget for WRM	Subnational budget water infrastructure	Subnational budget for WRM	Revenues from WRM
Central Asia	Kazakhstan	40	40	20	20	40
	Kyrgyz Republic	20	20	20	20	30
	Tajikistan	50	50	30	40	40
	Turkmenistan	80	70	80	80	70
	Uzbekistan	50	30	40	20	30
	Regional average	**48**	**42**	**38**	**36**	**42**
South Caucasus	Armenia	60	40	60	n.a.	60
	Azerbaijan	70	50	50	40	40
	Georgia	40	40	40	40	20
	Regional average	**57**	**43**	**50**	**40**	**40**
Danube	Albania	40	40	20	40	40
	Austria	60	100	60	100	n.a.
	Bosnia and Herzegovina	n.a.	n.a.	80	80	n.a.
	Bulgaria	50	60	50	50	60
	Croatia	60	80	n.a.	n.a.	80
	Czech Republic	60	60	70	70	60
	Hungary	50	70	50	50	70
	Montenegro	20	40	20	20	20
	North Macedonia	30	30	30	n.a.	30
	Poland	60	60	60	40	60
	Republic of Moldova	20	20	20	20	40
	Romania	60	60	40	n.a.	40
	Serbia	20	20	20	20	20
	Slovak Republic	40	40	30	n.a.	50
	Slovenia	90	90	n.a.	n.a.	80
	Ukraine	20	20	40	n.a.	40
	Regional average	**45**	**53**	**42**	**49**	**49**

Very high	91–100	Budget: sufficient budget fully realized; revenues: revenues cover all IWRM activities
High	70–91	Budget: sufficient budget disbursed and used; revenues: revenues cover most IWRM activities
Medium-high	51–70	Budget: sufficient budget disbursed; revenues: revenues cover some IWRM activities
Medium-low	31–50	Budget: sufficient budget planned but not fully disbursed; revenues: some revenues raised
Low	11–30	Budget: some budget allocated; revenues: process for collection in place but revenues not collected
Very low	0–10	Budget: no budget allocated; revenues: no revenues

Source: UNEP and UNEP-DHI n.d.

Note: This is a qualitative assessment based on the 2020 reporting on SDG 6.5.1 with respect to the degree of implementation of financial instruments for IWRM. IWRM = integrated water resources management; n.a. = not applicable, either because budgets are only national or fully decentralized to subnational levels or because revenues for WRM do not exist as such; SGD = Sustainable Development Goal; WRM = water resources management.

Box 5.4

A STUDY OF SPENDING COMPOSITION AS A SHARE OF GDP BY COUNTRY AND SECTOR

Spending in the water sector (including hydropower) as a share of national gross domestic product (GDP) varies considerably between countries. In a study of nine countries across the region, Croatia spent significantly more overall (49 percent) than any other country, exceeding the group average of 30 percent, whereas Poland and Tajikistan spent significantly less (17 and 11 percent, respectively; *table B5.4.1*). Relatively speaking, infrastructure spending also varied considerably and ranged from a high of 5.7 percent in Kosovo to a low of 1.3 percent in North Macedonia, with a study average of 2.8 percent.

TABLE B5.4.1 Average Annual Spending as a Share of GDP by Sector and Country

Country	Total spending	Total INF	Total WSS	Total irrigation	WSS + irrigation	Period
Albania	29.40	3.73	0.69	0.22	0.91	2010–20
Armenia	26.00	2.67	0.35	0.43	0.78	2006–20
Bulgaria	35.80	3.19	0.42	n.a.	0.42	2006–20
Croatia	48.90	2.50	4.73	0.004	4.73	2016–20
Kosovo	29.40	5.70	0.11	n.a.	0.11	2009–20
Moldova	36.20	2.38	0.16	0.03	0.19	2006–18
North Macedonia	39.00	1.26	0.22	0.01	0.23	2011–20
Poland	16.70	1.71	2.20	n.a.	2.20	2006–20
Tajikistan	10.80	1.76	n.a.	0.04	0.04	2007–11
Study average	30.24	2.77	1.11	0.12	1.07	2009–20
Regional average					0.87	2009–20
Global average					1.53	2009–20
Global average (WSS only)					0.87	2009–20

Source: Fenwick and Khan 2023.

Note: Global and regional averages also include hydropower and water used for transport. Data are reported to the hundredth decimal place (and for spending in irrigation in Croatia, to the thousandth) but are considered accurate to the tenth decimal place only. GDP = gross domestic product; INF = infrastructure; n.a. = not applicable; WSS = water supply and sanitation.

Spending in water supply and sanitation (WSS) ranged from a high of 4.7 percent in Croatia to a low of 0.1 in Kosovo, with a study average of 1.1 percent, which is slightly above the global average of 0.9 percent. Considering that the regional average accounts for spending in hydropower, Croatia and Poland (2.2 percent) spend substantially more on WSS than all other countries and the regional and global averages. Consequently, when Croatia and Poland are excluded, the study average drops to 0.3 percent, significantly less than the global average. In fact, except for Croatia and Poland, all countries spend less than the global average of 0.9 percent. Spending on irrigation averaged 0.1 percent for the study group and ranged from a low of 0.004 percent in Croatia to a high of 0.4 percent in Armenia.

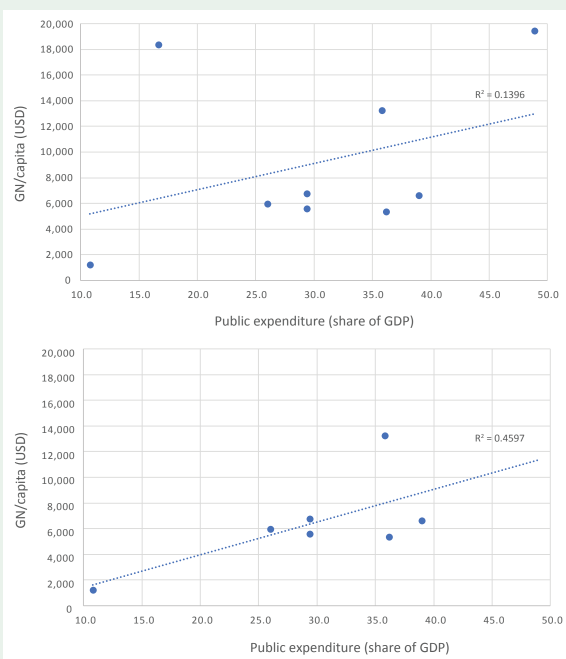
Box 5.4 continued

The bulk of infrastructure spending was directed to the transport sector in all cases except Tajikistan, where the lion's share was dedicated to the energy sector. On the whole, the share of infrastructure spending dedicated to WSS was much smaller than most other sectors—and in irrigation, infinitely so; in general, only the telecoms sector received less.

Spending (total, infrastructure, and by sector) does not appear to be correlated with poverty as measured by the share of population below the national poverty line or gross national income (GNI) per capita ($-0.2<R^2>0.2$); however, the data set is exceptionally small, and the results should be interpreted with caution. Furthermore, the study group is highly disparate and includes two low-middle-income countries (Moldova and Tajikistan) and one high-income country (Poland), whereas the remaining six are classified as upper-middle-income countries. In fact, when Croatia and Poland are excluded, a moderately positive correlation exists between total spending and income, as might be expected (*figure B5.4.1*).Central Asia has the largest investment gap, especially the Kyrgyz Republic but also the downstream countries of Kazakhstan and Uzbekistan (*table B5.4.1*). In fact, Kazakhstan and Uzbekistan have the largest investment needs of all countries, given they face some of the most acute water challenges (Vinokurov et al. 2021). The budget for WRM infrastructure normally comes from state budgets and is implemented through state programs and subnational budgets. To address the existing infrastructure financial gap, many Central Asian governments are developing strategies to increase the financial capacities of the water sector by attracting private and foreign investments (UNEP and UNEP-DHI n.d.). Financing for IWRM activities is also clearly insufficient, and in some countries, there is still no specific budget line (for example, the Kyrgyz Republic). Revenues from IWRM are also deficient, given that water tariffs for water services (for example, irrigation and industry) are symbolic and do not cover operational costs, are not established on a volumetric basis, or are not differentiated by user and source (*box 5.5*). Water abstraction and pollution charges are also not developed. In Uzbekistan, the problem of low revenues from water services is compounded by the cost of electricity, which has grown by almost 87 percent in the past decade and currently amounts to almost 27 percent of the total cost of water provision. A common feature in several countries (for example, Tajikistan and Turkmenistan) is that revenues from WRM are not earmarked and are frequently transferred to the regional or state budget to become part of the government's general revenues and thus are not necessarily reinvested in WRM.

Figure B5.4.1

RELATIONSHIP BETWEEN Public Expenditure and Income



Total infrastructure spending is defined as spending in the energy, transport, WSS, irrigation, and telecoms sectors. Spending data in these sectors were generally available for all countries. Spending data in the irrigation and telecoms sectors were limited and, when available, represented such a tiny fraction of infrastructure spending that their exclusion in some cases is unlikely to affect general trends.

In this study, water used for transport was included in the transport sector, but it nevertheless represents a tiny fraction of all spending that is unlikely to affect the results. Conversely, because data for hydropower were not considered in this study, the global average (WSS only) likely represents a more reasonable comparison.

Source: Based on 2023 World Bank data (unpublished).

Note: GDP = gross domestic product; GNI = gross national income.

Some countries in the South Caucasus report having adequate resources, but nevertheless, all countries face constraints similar to those of Central Asia. For example, Armenia and Azerbaijan report having sufficient financing for infrastructure programs and projects, most of which comes from state budgets through donor funds (*table B5.4.1*). Budgets disbursed in Georgia are subject to major fluctuations, often being split between several budget categories and considered insufficient to meet water sector investments. Regardless, all three countries face similar problems to those of Central Asia, with water tariffs charged for non-WSS services being too low and water abstraction and pollution charges being not yet established (for example, Georgia), too low, or unfairly distributed among water user groups (for example, in Armenia, water abstraction fees for all users are <0.002 euros per cubic meter, and irrigation is for the most part exempt). As with Central Asia, revenues from WRM are not earmarked and are generally returned to the central budget (for example, in Azerbaijan). All in all, this scenario of low levels of charges, unfair distribution of charges across water user groups, and unearmarked budgets poses a major risk to the financial sustainability of WRM in the region, and targeted legal reforms are required to upwardly revise water tariffs and charges to support the application of the user-pays and polluter-pays principles, a mandatory requirement for eventual accession to the EU.

There are large disparities in financing capacities across countries in the Danube. EU Member States perform best in national and subnational budgets disbursed and revenues derived from IWRM to meet the EU water policy goals and associated SDGs (*table B5.4.1*). This disparity is largely because of the financial support received through EU funds, along with the legal requirements of the EU WFD, which requires countries to ensure cost recovery through the development of affordable but financially sustainable water user tariffs, taxes, and environmental charges (*box 5.5*). Nevertheless, and despite the legal requirements and financial support of the EU, not all Member States of the Danube subregion are achieving full cost recovery of water management services and have sufficiently developed environmental charges (see *table 5.5*). EU candidate states face problems similar to those in Central Asia and the South Caucasus, with infrastructure and WRM budgets mainly relying on the public budget and insufficient international funding (for example, Albania, Moldova, Montenegro, North Macedonia, and Serbia, among others), as well as issues with water management–related activities (policy development, enabling environment, stakeholder participation, data collection, and monitoring). Water tariffs for water users are in place but are insufficient to achieve cost recovery, and environment and resource charges have not been established (*box 5.6*). This financial gap in candidate countries is largely driven by legal financing

Box 5.5

WATER PRICING IN CENTRAL ASIA AND THE SOUTH CAUCASUS

Water pricing is crucial for managing water resources in Europe and Central Asia, and it is increasingly affected by water stress resulting from overextraction, climate change, and deteriorating infrastructure. Effective pricing mechanisms could incentivize water conservation, ensure financial sustainability, and support efficient and equitable water allocation. In Central Asia, particularly in Kazakhstan and Uzbekistan, traditional area-based pricing has led to inefficiencies and overuse because charges are based on irrigated land area rather than actual consumption. Transitioning to volumetric pricing, which charges based on the volume of water consumed, could promote water conservation but requires substantial investments in metering infrastructure. Kazakhstan has made progress with cost-recovery tariffs for urban water supply and sanitation (WSS), but rural areas still face challenges, with low tariffs and poor service delivery. Similarly, low irrigation tariffs lead to inefficient water use and inadequate maintenance. Turkmenistan and Uzbekistan maintain highly subsidized water tariffs for both WSS and irrigation, hampering efficiency and sustainability efforts. The Kyrgyz Republic and Tajikistan also struggle with low water tariffs that do not reflect actual service costs, hindering infrastructure investments.

In the South Caucasus, Armenia and Azerbaijan face challenges resulting from variable water availability exacerbated by changing precipitation patterns and overextraction. Volumetric pricing and water-saving technologies are being considered to ensure sustainable use. Armenia's low household water tariffs create financial challenges for service providers, limiting infrastructure investment. Irrigation tariffs are often insufficient to cover operational costs, requiring government subsidies. In Georgia, WSS pricing is more structured, with higher urban tariffs compared with rural areas. However, irrigation pricing remains inadequate, heavily relying on state support. Azerbaijan's water tariffs for both WSS and irrigation are among the lowest in the region, resulting in inefficiencies and financial shortfalls.

Sources: O'Hara 2003; Wilchens et al. 2010.

TABLE 5.5 Financing Tools for WRM, Cost Recovery, and Revenue Allocation

Country	Financial		Environmental and resource charges		Revenues earmarked for WRM?	Cost-recovery-level WSS (%)	Cost-recovery irrigation (%)
	WSS water tariff	Irrigation water tariff	Abstraction	Pollution			
Austria	x	No data	No data	No data	No	100	n.a.
Croatia	x	No data	x	X	Yes	90–100	8
Hungary	x	x	x	No data	No	<90	No data
Czech Republic	x	No data	x	No data	Partly	100	No data
Slovak Republic	x	x	No data	X	Yes	100	No data
Slovenia	x	No data	x	No data	Partly	100	No data
Romania	x	No data	x	X	Yes	<90	No data

Source: Original elaboration for this publication based on data from OECD 2011b, 2022b, and Strosser et al. 2021.

Note: n.a. = not applicable; WRM = water resources management; WSS = water supply and sanitation.

Box 5.6

FINANCING WATER RESOURCES MANAGEMENT IN THE EUROPEAN UNION

The most important funding sources for water management in Europe to support the implementation of the European Union (EU) Water Framework Directive (WFD) and Floods Directive (FD) are water and sanitation tariffs—this is despite many EU Member States still requiring significant investments in infrastructure for drinking water and wastewater treatment—along with EU funds and national public funds. Water tariffs for other water users (irrigation, industry, hydropower) complement the revenues from water services. Environmental and resources charges (including abstraction and pollution charges) also generate significant revenues. The revenues from water tariffs and charges to the different water users are not always earmarked for water management; thus, in some countries, they are transferred to the state, regional, local, or municipal budgets. Private investments supporting the implementation of the WFD and FD are limited. Some EU countries use innovative funding arrangements, such as, for example, Payments for Ecosystem Services schemes, financial assistance schemes combining public funding and financial participation by recipients (for example, farmers), or an environmental fund financed by hydropower companies.

Revenues for water resources management (WRM) in Europe rest on two main principles: polluters pay and cost recovery. The former is implemented through pollution charges or fines to incentivize water users, particularly industries, to reduce their pollution footprint, adopt cleaner technologies, and improve waste management practices. The latter implies that water services costs, including operational, maintenance, and capital costs, as well as environmental and resource costs, should be recovered from users based on their usage. These two principles translate into different types of water tariffs and charges (*figure B5.6.1*). Abstraction charges can vary depending on the user and source of water, and they might reflect the scarcity value.

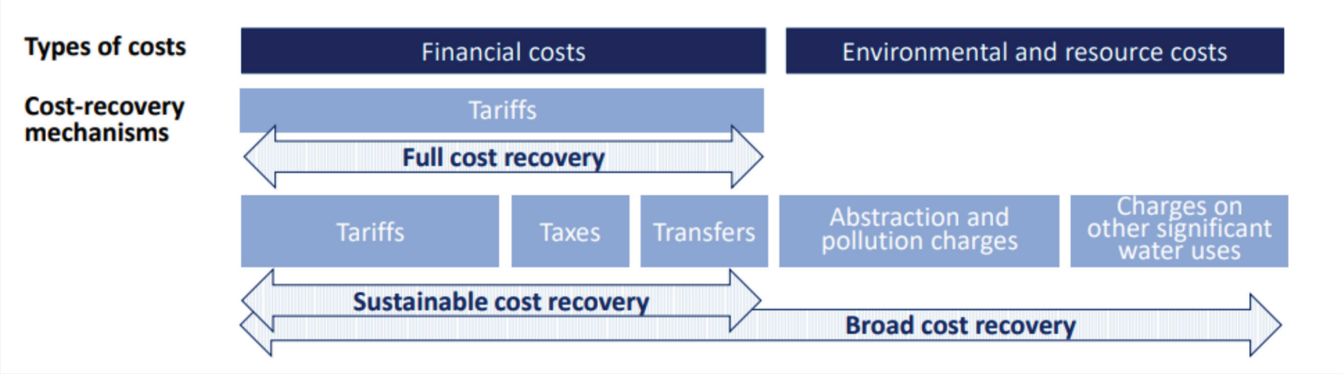
Full cost recovery has been reported in only 30 percent of the EU Member States and only for WSS services. There is still no full cost recovery for irrigation water services in any EU Member State, and the best-performing countries (for example, France and Spain) report values equivalent to 78 to 87 percent. In most countries, full recovery of irrigation services is far from possible because of the low water tariffs for irrigation.

Box 5.6 *continued*

Sharing of experience by EU Member States on how they have achieved cost recovery could help support the wider implementation of water policy goals across Europe and beyond—namely, how additional financial arrangements (for example, private investments or innovative funding arrangements) are designed and implemented and their performance effectiveness in raising the additional financial resources. An additional challenge preventing the current financial investment level is not related to money but concerns the absorption capacity of EU funds. Drivers include the following: limited ability within countries to establish priorities; a lack of capacity to cofinance some of the investments from the national budget; the mutual incompatibility, inconsistency, and instability of national regulations, especially on sectoral policy; and the weaknesses and lack of readiness of the implementing organizations and related institutions, among other factors.

Figure B5.6.1

MECHANISMS TO Support Cost Recovery of Water Services



Source: OECD 2022a, 2022b.

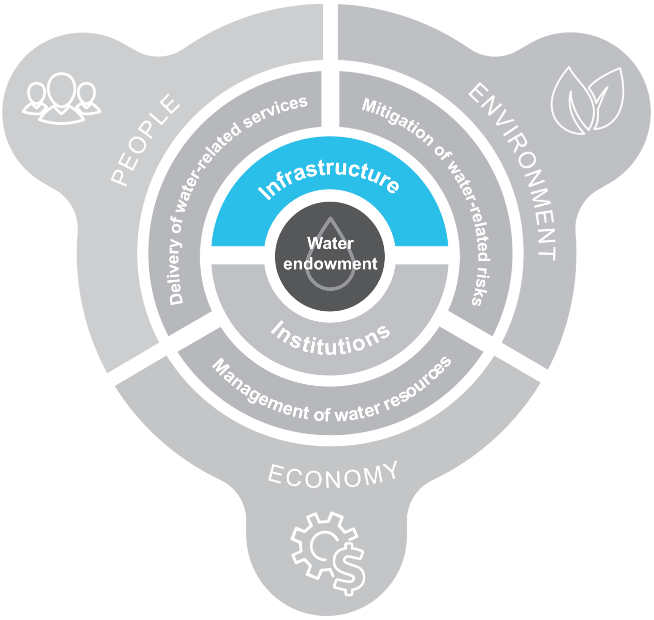
Note: Charges on other significant water uses are charges on water uses other than abstraction and pollution charges, such as taxes on pesticides or nitrates.

Source: Strosser et al. 2021.

frameworks that are still inconsistent with the EU Water Acquis and, moreover, with nonmonetary drivers related to the limited absorption capacity of EU funds by country institutions. This issue is not unique to candidate states but also affects Member States. The financial gap is linked to a lack of capacity to provide the requisite cofinancing from the national budget; the incompatibility, inconsistency, and instability of national regulations, especially on sectoral policy; and the weaknesses and lack of readiness of the implementing organizations and related institutions (Strosser et al. 2021).

Investments in WRM represent only a small fraction of the priority investments needed across Europe and Central Asia, yet they make economic sense. Overall, however, these are not translating into investment at scale. The widespread undervaluing of water resources and the benefits associated with water investments by both public and private actors constrains financing opportunities (OECD 2022b) and prevents countries in Europe and Central Asia from reaching the SDG 6 agenda and, eventually, good standards of water security across countries.

INFRASTRUCTURE



Water infrastructure encompasses the systems that collect, treat, and distribute water and collect, treat, and release wastewater. This includes dams and reservoirs for storage, treatment plants for drinking water and sewage, pipes for distribution, stormwater systems to manage runoff, and irrigation systems for agriculture. These structures and networks are vital for ensuring water security, public health, and environmental protection.

KEY MESSAGES

Water Supply and Sanitation

- The WSS infrastructure in Europe and Central Asia is well developed but aging and inefficient.
- NRW losses are substantial across all three subregions.
- Overall, less than 40 percent of wastewater is currently collected and treated in Europe and Central Asia, putting ecosystems at risk and negatively affecting economic activities that depend on water quality, such as tourism and fishing.
    - Important regional differences exist: Wastewater treatment rates exceed 80 percent in the Danube subregion (especially in EU Member States), whereas less than 29 and 48 percent of wastewater is treated in Central Asia and the South Caucasus, respectively.

Water Storage

- Dam storage capacity is below the global average, and the region is facing important storage losses because of increasing sedimentation.
- Increases in both gray and green storage solutions will be needed to address fluctuating water availability and increasing demands.

Irrigation

- Irrigation in Europe and Central Asia represents a mix of aging, underdeveloped, and inefficient infrastructure, though modernization efforts are ongoing.

Water Supply and Sanitation

Despite extensive coverage, WSS infrastructure suffers from inefficient asset management and policies, leading to a build-neglect-rebuild cycle. This highlights the urgent need for improved institutional frameworks and asset management practices. The disparities in coverage and status between urban and rural areas and among countries within the subregions are large and, overall, underscore the need for targeted improvements, regulatory reforms, and increased financing to secure the future sustainability and resilience of the WSS sector.

The Danube subregion (and particularly EU Member States) is characterized by good coverage of water supply infrastructure with a strong legacy of investment and regulatory frameworks from the EU *(map 5.2*; see “Social Outcomes” in chapter 3 and “Institutions” earlier in this chapter for further details on coverage and legal frameworks). However, because most efforts over the past decades went into infrastructure expansion, with limited investments into maintenance and upgrading (see chapter 6), a substantial part of the existing water supply infrastructure is aging and in need of modernization. This situation is largely driven by the limited cost recovery of water services, and many utilities fail to cover operating costs with billed revenues, let alone the costs necessary for regular maintenance, asset management, and renewal (see "Institutions" earlier in this chapter for further details on financing). Despite the EU WFD's requirement for cost recovery, even within the EU, countries like Bulgaria, Hungary, and Romania struggle with financial self-sufficiency in utilities (DWP 2019).

NRW rates in the Danube subregion are, on average, about 44 percent, nearly double the EU average (23 percent; EurEau 2017). *Nonrevenue water*, a term used to describe water that has been produced but is "lost" before it reaches the customer through leaks, theft, inaccurate metering, or legal usage for which no payment is made, is a pressing issue. High rates represent significant economic losses and also raise concerns about water resource sustainability, especially given the pressing challenges of climate change and increasing water scarcity. Furthermore, NRW compromises the quality of the water delivered. The Western Balkan countries, such as Albania, Montenegro, and North Macedonia, have some of the highest rates in the subregion (greater than 60 percent). Countries like Serbia and Croatia, meanwhile, also face substantial NRW challenges, suggesting losses are a result of aging infrastructure and the need for better water management practices. Croatia, for instance, reports rates of about 44 percent and is implementing a national support program to address water leakages.

Sanitation infrastructure in the Danube region varies by country, and important gaps remain, particularly in providing access to safely managed sanitation services in EU candidate states (*map 5.2*; see "Social Outcomes" in chapter 3). In these countries, most efforts have been placed on achieving full access to drinking water, and investments in sanitation are only now expanding. Similarly, wastewater treatment remains a widespread challenge (see "Environmental Outcomes" in chapter 3), indicating a need for continued investment and policy focus on wastewater treatment facilities.

The divide in service provision between urban and rural areas is acute, especially for sanitation. Closing the gap will require dedicated strategies and an enhanced enabling environment for diverse service delivery models that meet the unique needs of rural communities, which may include encouraging self-supply mechanisms. Moreover, although innovative and decentralized sanitation systems offer cost-effective solutions and advantages, such as lower investment requirements and suitability for rural and less urbanized regions, they have not been fully explored or used in these countries. Adopting on-site sanitation and decentralized wastewater treatment systems could thus represent an untapped opportunity to achieve universal access to sanitation in a more economically viable manner.

In the South Caucasus, water supply infrastructure also shows disparities between urban and rural areas (*map 5.2*). Armenia nears universal basic coverage but faces high NRW rates of approximately 75 percent. Although urban sanitation coverage is high, half the rural population relies on unimproved facilities. Azerbaijan and Georgia also have high water supply coverage, but service continuity is an issue, particularly in Azerbaijan, where continuity of service is only sixteen hours per day. The subregion's rural sanitation services lag behind those of urban centers. Georgia has made progress in reducing technical losses, but the urban-rural divide remains stark.

Central Asia's WSS infrastructure is marked by degradation and technical inadequacy, and a high proportion of the infrastructure is more than 50 years old (*map 5.2*). The average NRW for this region is about 35 percent, with large disparities across countries. Access to at least basic water is robust in Kazakhstan, where NRW is well managed compared with its regional counterparts. Despite high coverage, the Kyrgyz Republic grapples with substantial NRW challenges, with losses reaching more than 50 percent. Both Tajikistan and Uzbekistan also must focus on enhancing the water supply and reducing high NRW levels. Turkmenistan appears to have good coverage; however, there is a significant lack of data on NRW and service continuity. This data scarcity is critical, given reports indicating challenges such as limited hours of daily water supply and considerable water losses (about 75 percent) in some regions, spotlighting the need for improved water management and infrastructure development (UNDP 2010).

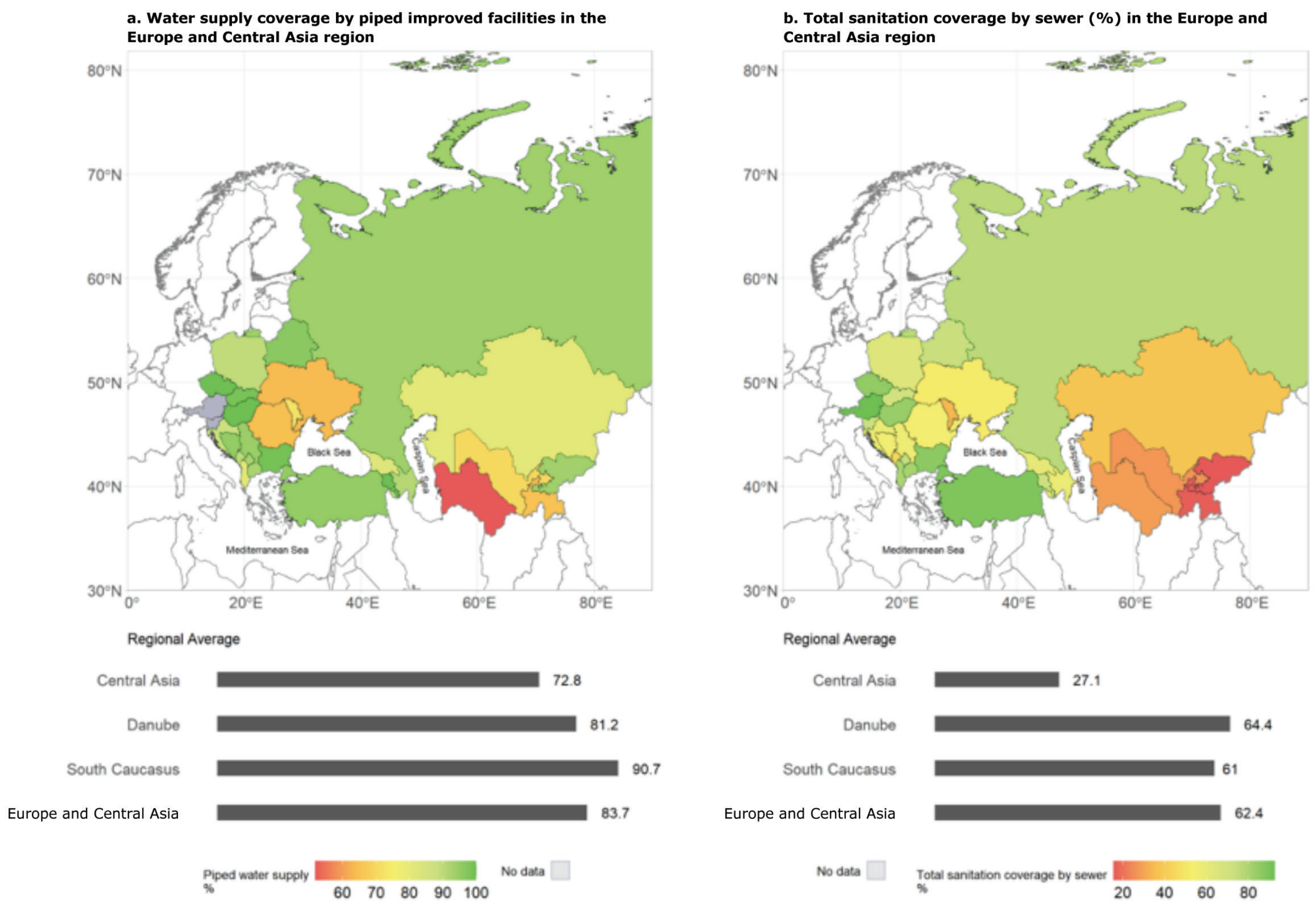
Across Central Asia, there is a clear need for modernization of the WSS infrastructure, reduction in NRW rates, and investment in sanitation and wastewater treatment facilities. These efforts should come along with strengthening the capacities of service providers to improve the management of service delivery. The disparities between urban and rural areas need to be addressed through targeted policies and investment in infrastructure, along with the development of institutional capacities in water utilities to support governance capacities.

Challenges in wastewater treatment across the region include the need for investment in new technologies, rehabilitation of existing facilities, and compliance with environmental standards. Many treatment plants across the region are outdated and lack the capacity to treat wastewater to modern standards, resulting in pollution and health hazards. The disparity between urban and rural treatment facilities is also a concern because the latter often lack the infrastructure and resources to manage wastewater effectively. Basic wastewater treatment exists across many countries, but the overall share of treated wastewater at the source or through centralized wastewater treatment plants before being discharged into the environment is lagging across all subregions (*figure 5.12*). On average, around 60 percent of all wastewater discharged in the region is collected. Of this, 43 percent is treated with at least primary treatment, whereas only 6 percent of the treated wastewater undergoes further treatment for reuse (Jones et al. 2021; *figure 5.12*). The low amounts of water reuse represent a significant opportunity for enhancing regional water sustainability and mitigating scarcity by increasing the reuse of treated wastewater, a move that aligns with circular economy objectives by converting waste into a valuable resource for various uses (*box 5.7*).

Under the influence of EU policies and funding, the Danube subregion has made significant strides in developing the wastewater treatment infrastructure. It is the best-performing of the three subregions, although the average level of wastewater treatment remains moderate (66 percent wastewater collected and 49 percent treated; *figure 5.12*). The EU's Urban Wastewater Treatment Directive (UWWTD) sets rigorous standards for the collection, treatment, and discharge of urban wastewater, aiming to protect the environment from the adverse effects of wastewater discharge. Countries like Croatia and Serbia have made significant investments in collecting and treating wastewater, but additional efforts are required to meet the directive's requirements. For instance, Serbia's adherence to the UWWTD is pivotal, given its status as a potential EU candidate state, which demands significant upgrades to its wastewater treatment infrastructure. Currently, Serbia lacks both an investment plan and the necessary agglomeration studies for designing and developing the requisite infrastructure (see "Institutions" earlier in this chapter). Engaging private sector participation presents a viable solution for securing the needed investment to meet

Map 5.2

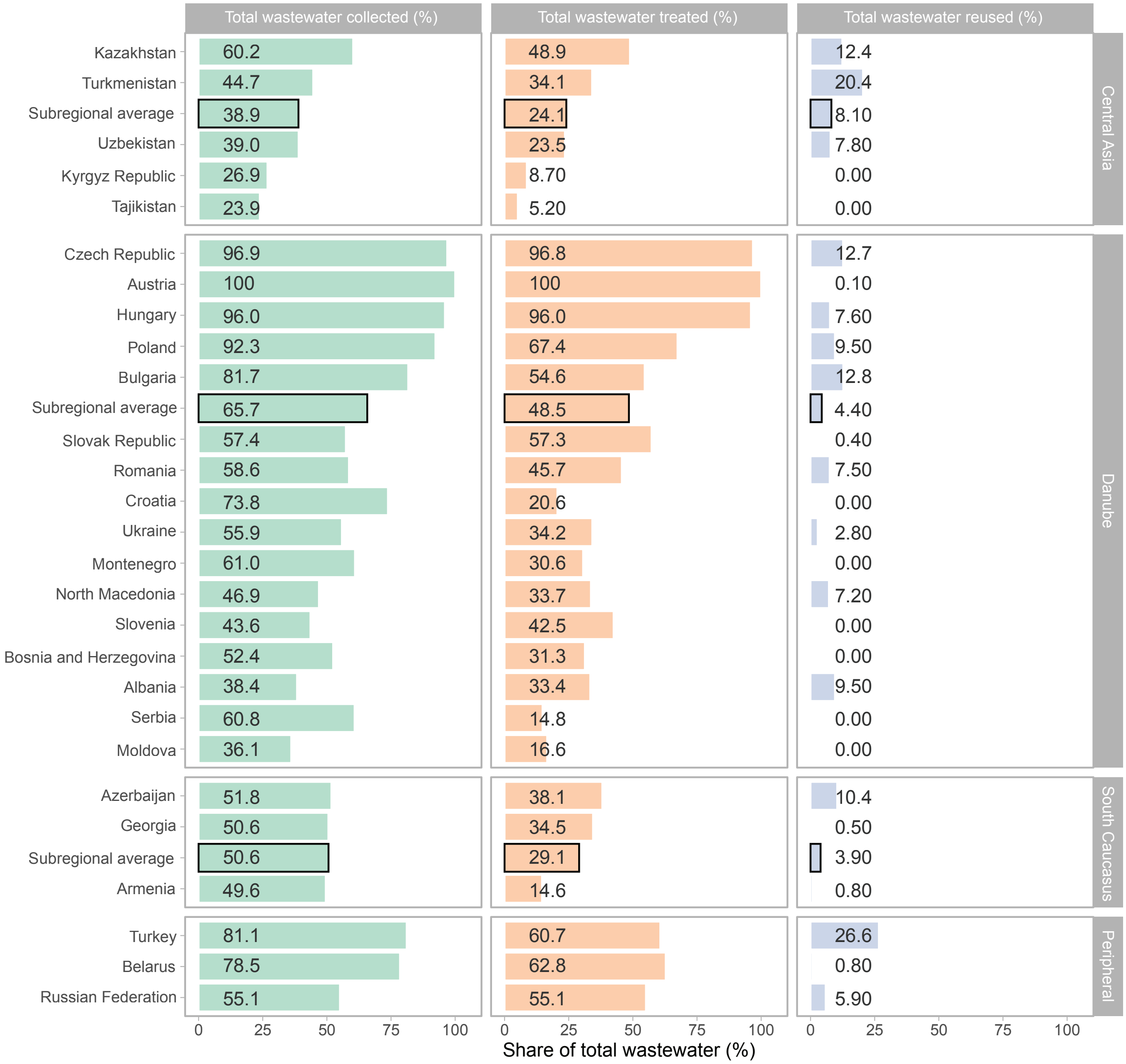
WATER SUPPLY and Sanitation Coverage in Europe and Central Asia



Source: JMP 2022.

Figure 5.12

WASTEWATER TREATMENT by Country



Source: United Nations Water Sustainable Development Goals (SDGs) indicator 6.3.2 (wastewater treatment).

these requirements efficiently. The forthcoming revision of the UWWTD introduces even stricter requirements, including broader coverage down to agglomerations of 1,000 population equivalent, advanced treatment processes, and a push toward energy neutrality by 2045. This revision aims to intensify the directive's environmental protection objective, mandating producers of certain pollutants to cover a significant portion of treatment costs and setting ambitious goals for reducing greenhouse gas (GHG) emissions within the wastewater treatment sector. For the Danube countries, these impending changes highlight the need for continued investment and innovation in wastewater management to align with the EU's enhanced environmental and sustainability standards.

In the South Caucasus, the focus on improving wastewater treatment is increasing, but infrastructure still lags. The share of wastewater collected is about 51 percent, and the rate of treatment is about 29 percent. Armenia has received support from various international organizations to rehabilitate its water supply, but the treatment of wastewater is not keeping pace with water supply improvements, and currently, less than 15 percent of the wastewater collected is treated (*figure 5.12*). The South Caucasus region requires modern treatment facilities, better management practices, and enhanced environmental regulations to effectively address the challenges of wastewater disposal. Georgia's wastewater treatment facilities, for example, require modernization to handle the increasing demand and prevent the release of untreated effluents into natural water bodies.

Central Asian countries face considerable challenges in wastewater treatment because of aging infrastructure, technical inadequacies, and limited investment. This is the subregion with the lowest share of wastewater collected and treated (39 and 24 percent, respectively). Kazakhstan, although having reasonable water coverage, has a fragmented and not easily accessible account of wastewater treatment facilities, particularly in rural areas. In Uzbekistan and Tajikistan, the wastewater treatment facilities are not sufficient to serve the growing urban populations, and there is a need for investment in both urban and rural wastewater infrastructure to improve sanitation and environmental outcomes.

GHG emissions in Europe and Central Asia, most notably from wastewater treatment, are substantial yet often underestimated. Globally, wastewater treatment produces emissions equivalent to nearly 1.8 percent of global GHG emissions. The water sector's emissions are exacerbated by outdated infrastructure and practices, contributing to both direct emissions at treatment plants and indirect emissions through energy consumption for water pumping and distribution; electricity alone accounts for about 43 percent of emissions at wastewater treatment facilities. The implications for climate mitigation are clear: Modernizing the water sector's infrastructure and enhancing efficiency are pivotal to reducing these emissions and require a concerted effort toward energy-efficient technologies; renewable energy adoption; and improved water management, including the conservation of wetlands, which are significant carbon sinks.

Box 5.7

WATER IN CIRCULAR ECONOMY AND RESILIENCE

The Water in Circular Economy and Resilience (WICER) framework of the World Bank advocates for a transformation in urban water management by embracing circular economy principles and strengthening system resilience. This innovative approach aims to extend the life span of water as a resource—valued for its utility role in energy and nutrient cycles and potential for reuse and recycling. The circular economy model encourages the conservation and sustainable management of water, reduction of waste, and promotion of the restoration of natural ecosystems. Resilience in the WICER framework ensures that water systems can withstand and adapt to various stressors, maintaining functionality during unforeseen events. This aspect is crucial for growing cities in developing nations, where the equitable distribution of benefits from circular water economy practices can contribute to inclusive development.

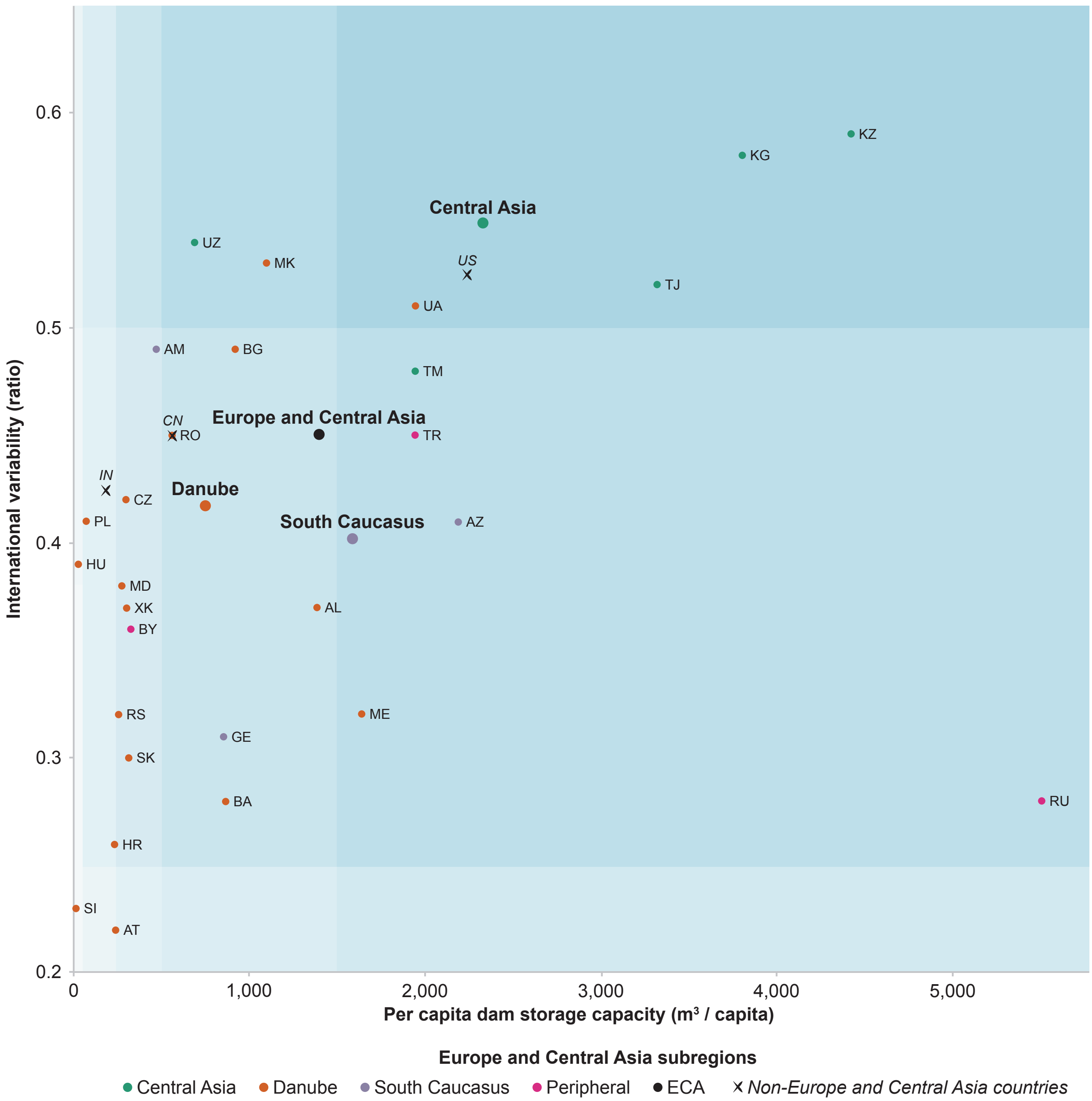
The framework guides the adoption of these principles in urban water sectors, helping stakeholders from policy investment and design to apply WICER principles effectively. An ideal application of the framework is seen in modern wastewater treatment plants that integrate renewable energy production, water recycling, and material recovery, embodying sustainability and resilience—for example, a wastewater treatment facility that not only purifies water to safe standards for reuse in agriculture or industrial processes but also incorporates solar energy and biogas production to power its operations. Such a facility exemplifies circularity by generating its own renewable energy and repurposing treated water, which diminishes the draw on freshwater sources and bolsters regional water resilience. Moreover, the plant's waste-to-resource initiatives—transforming treatment by-products into biomass—illustrate how circular economy practices can lead to resource recovery and additional economic benefits. These initiatives turn organic residuals into biofertilizers or energy sources, reducing waste and supporting a low carbon footprint. By integrating these elements, the wastewater treatment plant becomes a paragon of the circular economy, demonstrating how water systems can be designed to be self-sustaining, environmentally friendly, and resilient to future challenges while ensuring the judicious use and reuse of water resources.

Reservoirs

Reservoir infrastructure across Europe and Central Asia is pivotal for addressing water and energy needs, yet it faces the challenge of aging facilities in need of modernization. The average dam storage capacity is equivalent to 1,128 cubic meters per capita, which is below the global average (1,500 cubic meters per capita). However, there are important differences across the Europe and Central Asia subregions, with the Danube having an average dam storage of 650 cubic meters per capita and Central Asia having as much as 2,837 cubic meters per capita. Dam storage in the South Caucasus is equivalent to the Europe and Central Asia average, amounting to 1,170 cubic meters per capita (*figure 5.13*).

Figure 5.13

PER CAPITA Dam Storage Capacity versus Interannual Variability in Europe and Central Asia



Source: AQUASTAT, 2024.

Inadequate storage capacity represents an important risk as water demands grow and climate variability increases. The Europe and Central Asia region is subjected to high seasonal and interannual variability (see "Water Availability" in chapter 4), which can only be buffered with the existence of gray and green (or hybrid) storage. In addition to dam storage, snow storage is also important across Europe and Central Asia, particularly in the Danube and Central Asia, where much of the flow depends on snowmelt. Dams across Europe and Central Asia have also faced important storage losses over the decades since they were originally constructed. According to Perera et al. (2023), in 2022, dam storage losses ranged between 12 and 27 percent in Danube countries, between 14 and 22 percent in the South Caucasus, and between 12 and 20 percent in Central Asia. The main driver underpinning such losses is sedimentation.

Human interventions have significantly reshaped the Danube subregion's reservoir infrastructure to serve flood control, hydropower, and navigation purposes, drastically affecting its ecological integrity. Hydropower plants, although contributing to renewable energy, have caused habitat fragmentation, altered flow regimes, and obstructed sediment and species migration, requiring interventions like dredging and sediment supplementation. The adoption of the *Guiding Principles on Sustainable Hydropower Development in the Danube Basin* in 2013 represents a strategic effort to balance hydropower's benefits against ecological costs through upgraded technologies and mitigative actions. Regulatory measures for flood protection have modified more than 80 percent of the Danube, affecting floodplain ecosystems and groundwater levels crucial for drinking water. With a low per capita dam storage capacity of 616 cubic meters, disparities in capacity across the Danube countries exist, highlighting the need for cooperative transnational water management to enhance resilience against climatic fluctuations and hydrological extremes. The river is essential for the water supply and supports a significant portion of the region's electricity generation through hydropower, which accounts for an average of 28.3 percent of the energy production. Yet the expansion of hydropower is subject to varied technical, economic, and environmental factors, with substantial transboundary implications for the basin's hydrology and ecosystems (see "Economic Outcomes" in chapter 3).

In the South Caucasus, Armenia, Azerbaijan, and Georgia have distinctive approaches to managing their water resources and developing hydropower. Armenia, with a relatively modest per capita dam storage capacity of 471 cubic meters, has developed a substantial hydropower sector, generating about 28 percent of its electricity from this source. Lake Sevan, the largest freshwater lake in the South Caucasus, is a central reservoir serving multiple purposes, from irrigation to energy generation and recreation. Azerbaijan, with a per capita dam storage capacity of 2,188 cubic meters, is progressively increasing its hydropower significance, with hydropower now accounting for about 6.6 percent of its electricity production. New projects like the Dash Salahli and Girkan plants are part of the country's strategy to expand its hydropower capacity. Georgia stands out, with 78 percent of its electricity coming from hydropower, supported by a per capita dam storage capacity of 852 cubic meters. The country is working to enhance its energy independence and mitigate climate variability's impact on future water demands. However, Georgia faces winter reliability issues and dependency on imports, requiring a strategic approach to energy supply, especially during the dry winter months.

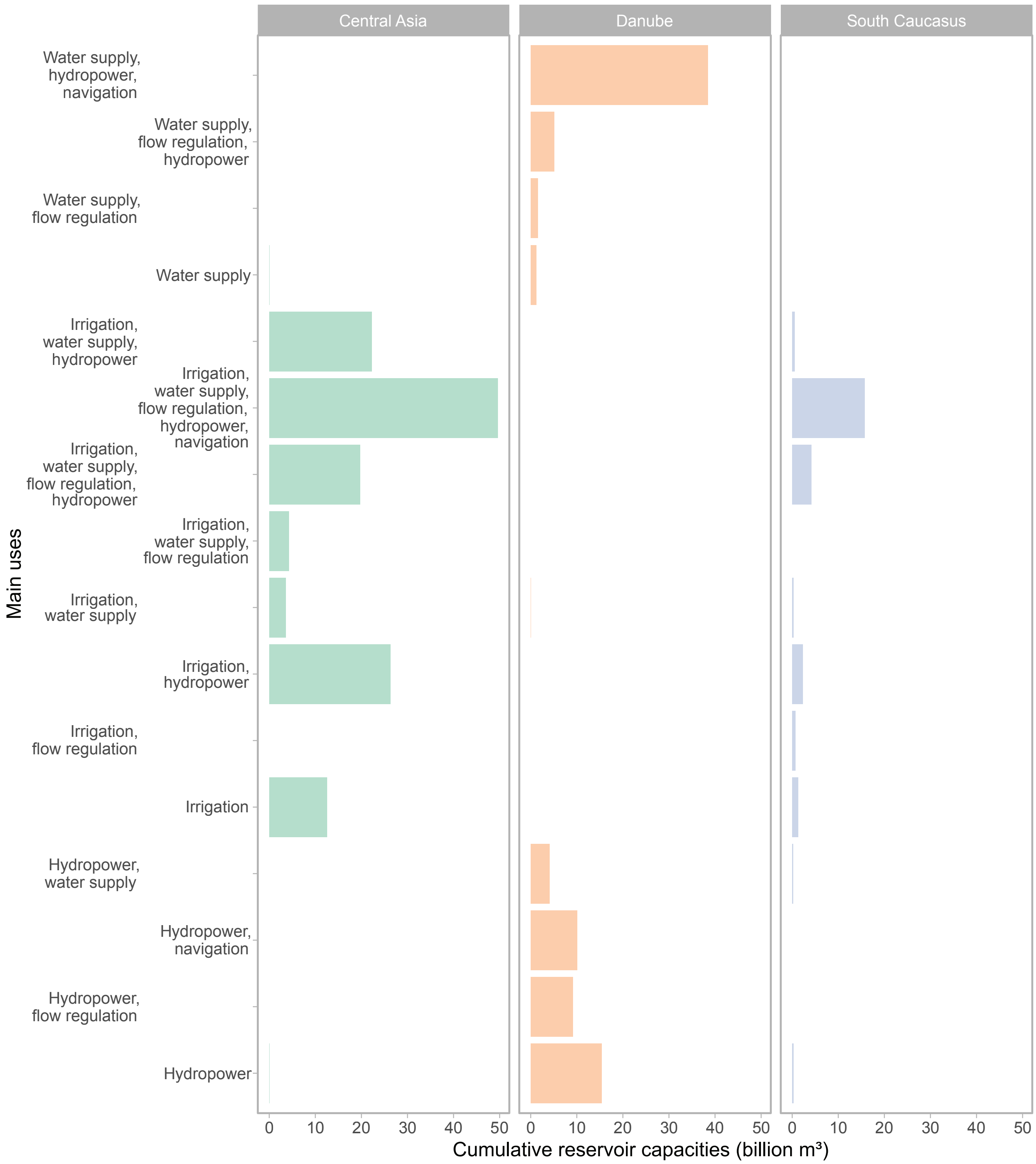
Central Asia's reservoir infrastructure development, focused on irrigation and hydropower, plays a pivotal role in the region's water and energy dynamics (*figure 5.14*). The construction boom between 1950 and 1980 resulted in more than sixty reservoirs with a combined capacity of more than 163 cubic kilometers, which is crucial for regulating over 50 percent of the regional river flow monthly (Rakhmatullaev et al. 2010). This infrastructure is key to food security, agricultural production, energy sector support, and environmental protection in the landlocked nations of Central Asia. Upstream countries like the Kyrgyz Republic and Tajikistan, with per capita dam storage capacities of 3,808 cubic meters and 3,323 cubic meters, respectively, exploit their reservoir networks primarily for winter hydropower generation, addressing energy demands and enhancing energy security. Significant hydropower projects, such as Tajikistan's Rogun hydropower plant and Kazakhstan's involvement in the Kambarata-1 hydropower plant, highlight a strategic shift toward maximizing hydropower potential and developing energy export capabilities. Conversely, downstream countries like Uzbekistan, with its modest per capita storage of 689 cubic meters, focus on augmenting water storage to ensure agricultural viability and reduce dependence on uncertain upstream water releases, reflecting the region's complex water-energy interplay and the critical need for sustainable reservoir management.

Irrigation and Drainage

Modernizing legacy irrigation systems and adopting more efficient technologies stand out as key measures for mitigating the increasing frequency and intensity of droughts and addressing future water stress in the Europe and Central Asia region. Much of the irrigation infrastructure was constructed during the Soviet era, and since the breakup of the Soviet Union, the irrigation infrastructure has been ownerless, with countries not investing in maintenance and upgrade. With a few exceptions, the infrastructure is currently in a state of decay, highly inefficient, and contributing to low water productivity. Similarly, distribution across Europe

Figure 5.14

RESERVOIR CAPACITIES and Their Main Purposes in Europe and Central Asia



Source: AQUASTAT, 2023.

and Central Asia is uneven. Irrigation expansion is expected to significantly increase the water productivity of irrigated areas and produce 2 percent more crops (Palazzo et al. 2019). Decommissioning and replacing outdated irrigation assets with modern systems is critical to improving water efficiency, reducing operational and energy costs, and enhancing the resilience of agricultural systems in the face of climate change.

In the Danube, irrigation infrastructure is largely not built or built and not in use, representing a significant opportunity for investment to enhance resilience against growing water scarcity and droughts. On average, only 10.5 percent of cultivated land in this subregion is under irrigation, mainly in the form of flood and sprinkler types of systems (*figure 5.15*). The predominant form of agriculture is rain-fed farming because of the relatively high and reliable precipitation. However, where irrigation systems exist, they are often partially nonfunctional because of a lack of maintenance or outdated designs, leading to inefficient water use and large water losses. Romania stands out for its high fresh surface water use for irrigation, but this has not translated into proportionally high yield levels because of inefficiencies such as outdated infrastructure and poor coordination among water suppliers and farmers. The data indicate that in Romania, maize yields reach 4 tons per hectare as compared with 7.4 tons per hectare in Hungary, pointing to substantial room for improvement in water-use efficiency. Climate change introduces additional uncertainties in water availability, with potential impacts on agricultural productivity. The droughts of 2017 and 2022, for instance, led to substantial economic losses in the agricultural sector across several countries in the region. In Bulgaria and Hungary, extensive but often inoperative irrigation systems from Communist times suggest significant potential for modernizing infrastructure to better manage water resources, particularly in light of predicted increasing drought intensity and frequency in Central and Eastern Europe. Developing climate-resilient agricultural strategies, including expanding and modernizing irrigation and improving the climate-adaptive capacity of rain-fed agriculture, is vital for mitigating these impacts.

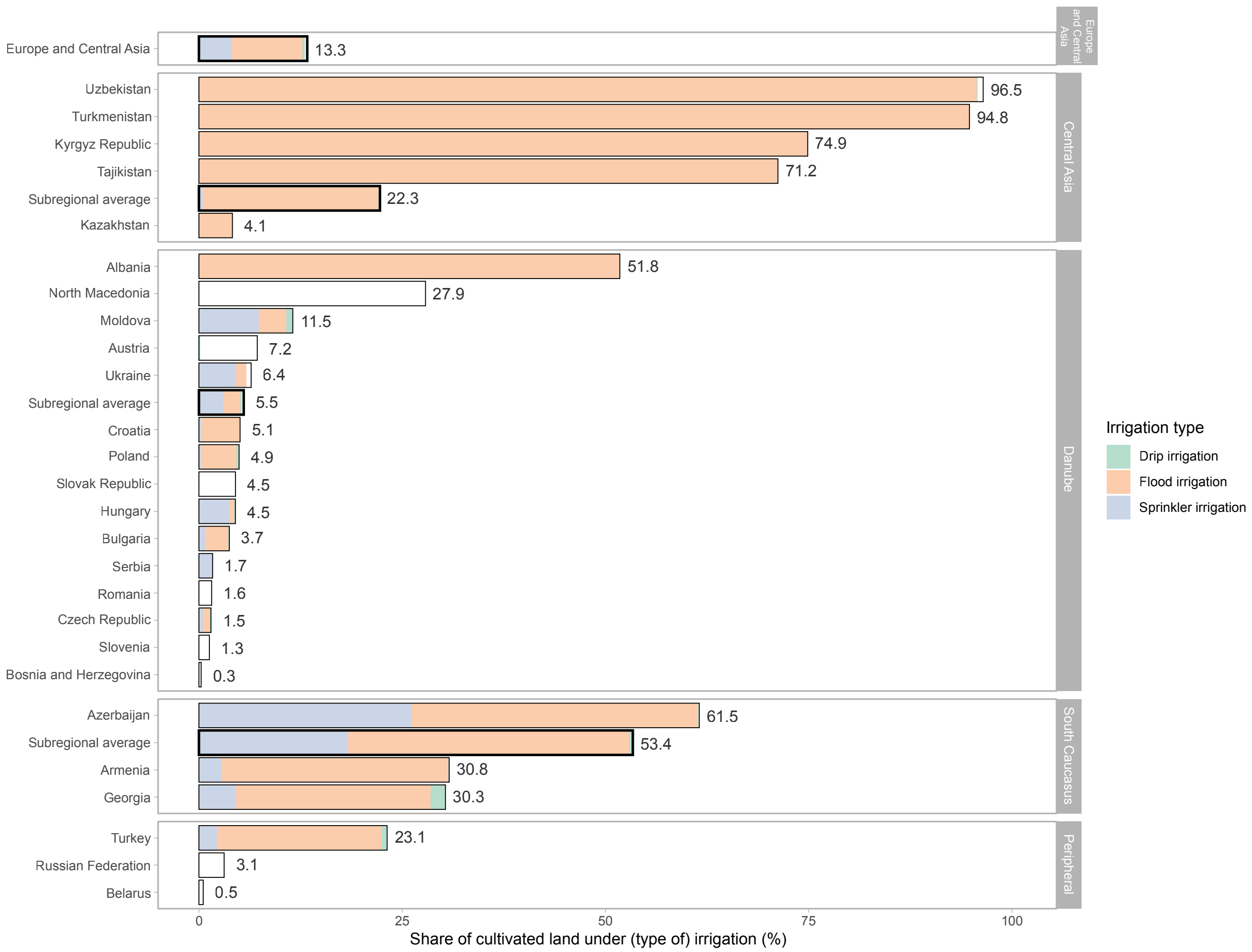
In the South Caucasus, irrigation infrastructure and water management practices display a regionwide contrast, with varying levels of development, challenges, and strategic priorities. Despite a significant expansion of the irrigation infrastructure, as seen with Georgia's nearly 250 percent increase in irrigated areas over the past decade, the subregion as a whole does not fully use the water supplied for irrigation. This underutilization, combined with an urgent need for modernization and efficient water management practices in countries like Azerbaijan and Armenia, underscores the broader regional challenge of aging infrastructure. The implications of these challenges are profound, directly affecting the region's agricultural productivity and food security by leading to inefficient water use and limiting the achievement of maximum agricultural potential. To address these issues, the region should prioritize the revitalization and modernization of irrigation systems, including the adoption of more efficient irrigation methods, such as drip irrigation over traditional flood irrigation. These efforts will not only enhance crop production capacity but also contribute to the sustainable management of water resources across the South Caucasus.

The state of irrigation infrastructure in Central Asia presents a complex and varied picture. Across the subregion, the irrigation systems are generally antiquated and technically deficient, suffering from significant degradation (EDB 2023). A critical issue is the lack of essential equipment for accurate metering and effective distribution of water for irrigation purposes and for controlling its usage in the fields. A striking feature of this infrastructure is its age—most of it is more than 50 years old, with most of the systems using the least efficient flood irrigation system (*figure 5.15*). This aging system has led to widespread problems, including salinization, affecting as much as half of the irrigated land. Additionally, the region grapples with substantial inefficiencies in water usage for agriculture, with an estimated 40 percent of water being lost in the canal systems. As few as 30 percent of canals are estimated to be equipped with antifiltration lining, which contributes to low efficiency in irrigation water delivery. This inefficiency results in significant water wastage because only a fraction of the water withdrawn for irrigation reaches the plants' roots. Pumping plays a crucial role in irrigated agriculture in Central Asia, leading to substantial sunk and O&M costs. For instance, in Uzbekistan, electricity for I&D pumps accounts for a significant portion of the national electricity generation and budget. In Kazakhstan, only a small fraction—4 percent—of the cultivated land is equipped for irrigation. This limited coverage is compounded by the deterioration of existing systems, which significantly hampers agricultural productivity. Moreover, the current irrigation practices, including the rates and timing of water application, are predominantly inefficient, underscoring an urgent requirement for significant enhancements and modernization of the irrigation infrastructure. Contrastingly, the Kyrgyz Republic exhibits a higher level of irrigation development, with 75 percent of its arable land being irrigated. Despite this higher coverage, the predominant irrigation technologies in use are outdated and inefficient, indicating a gap between potential and actual agricultural productivity. Tajikistan, with 71 percent of its cultivated area equipped for irrigation, faces issues similar to those in Kazakhstan and the Kyrgyz Republic. Challenges related to the maintenance and overall condition of the irrigation systems are prevalent, adversely affecting the agricultural sector's efficiency and productivity. These challenges highlight the urgent need for substantial upgrades and modernization of irrigation infrastructure, incorporating advanced water technologies and service management and monitoring systems, to unlock the full agricultural potential of Tajikistan and the broader Central Asia region. Projects like the South Karakalpakstan Water Resources Management Improvement Project (SKWRMIP) in Uzbekistan illustrate such upgrades. The SKWRMIP transformed an outdated irrigation system into a more efficient and sustainable gravity-fed model, significantly reducing water losses and operational costs and enhancing agricultural productivity (see *box 5.8*). Improving irrigation efficiency not only reduces the costs associated with inefficient water use but also increases agricultural production, productivity, and income; it can also contribute to reducing public expenditures and enhancing economic growth in the region.

The irrigation sector also produces GHG emissions. Inefficient practices like flood irrigation and water losses contribute to higher methane and nitrous oxide emissions. Pumped irrigation can also play a role because of their reliance on energy, often derived from fossil fuels. The drainage of wetlands can harm ecosystems and lead to loss of soil carbon, a vital carbon sink. To mitigate these impacts, enhancing irrigation efficiency through technologies like drip or sprinkler systems is essential. These methods deliver water directly to plant roots, reducing water waste and emissions. Modernizing infrastructure to transition from energy-intensive pumped systems to

Figure 5.15

SHARE OF Cultivated Land under Different Types of Irrigation in Europe and Central Asia



Source: AQUASTAT, 2024.

Note: For empty bars without fill, no data on types of irrigation used are available.

Box 5.8

MODERNIZATION OF IRRIGATION IN SOUTH KARAKALPAKSTAN, UZBEKISTAN

The South Karakalpakstan Water Resources Management Improvement Project (SKWRMIP) in Uzbekistan focused on transforming an outdated irrigation system into a more efficient, sustainable model. The primary objective was to shift from energy-intensive pump-based irrigation to a gravity-fed system, significantly enhancing water management and reducing operational costs.

Infrastructure Upgrades

The project rehabilitated 133 kilometers of main canals and 694 kilometers of secondary canals, converting them to a gravity-fed system. These changes reduced water losses and the reliance on costly and energy-consuming pumping stations. As a result, annual electricity savings amounted to 61,404 megawatt-hours, and greenhouse gas (GHG) emissions were cut by approximately 23,600 tons of carbon dioxide equivalent per year. These improvements decreased public and water consumer association (WCA) expenditures for pumping by 78 percent.

Sustainable Agricultural Practices

The SKWRMIP promoted modern agricultural techniques, including laser land leveling and deep soil ripping over 16,000 hectares, enhancing water distribution and reducing runoff. The project also facilitated crop diversification, moving 28,172 hectares from water-intensive cotton to other crops, far exceeding the initial target of 8,000 hectares. This shift improved water-use efficiency, increased agricultural productivity, and boosted farmer incomes.

Institutional Strengthening

The project provided training and support to WCAs and the newly formed Special Services Units within district-level irrigation departments. These efforts professionalized local water management bodies and improved their financial sustainability through better fee collection and the introduction of a water tax based on usage.

Overall, the SKWRMIP effectively modernized irrigation infrastructure and practices, leading to significant improvements in water-use efficiency, operational cost reductions, and enhanced agricultural productivity. The project's comprehensive approach is a model for sustainable water and agricultural management initiatives.

gravity-fed systems can significantly cut energy consumption and associated emissions. Preserving and restoring wetlands is also crucial because they act as natural carbon sinks and water filters. Protecting these areas prevents the release of stored carbon and maintains their climate-regulation functions. Furthermore, managed aquifer recharge projects can enhance water availability and drought resilience while maintaining natural carbon sinks. By implementing these strategies, the irrigation sector can significantly contribute to climate mitigation, reducing overall GHG emissions and enhancing the sustainability of water and agricultural practices.

NOTES

1. Key IWRM principles include the development of provisions and plans to manage water quantity, water quality, and water services; management of and protection against water-related risks; protection of water bodies; definition of the functions of water institutions; participation; and basin planning.

2. Most relevant are the 2002 Law on Water User Associations and Federations of Water User Associations, the 2005 Law on the Fundamentals of the National Water Policy, and the 2006 Law on the National Water Program.

3. For management purposes, basins in Kazakhstan are determined by physical and administrative boundaries into so-called water economic basins. The eight water economic basins are as follows: Aralo-Syrdarya, Balkash-Alakol, Ertis, Esil, Nura-Sarysu, Shu-Talas, Tobyl-Torgai, and Zhayik-Caspian.

4. For example, the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (UNECE Water Convention) and the United Nations Convention on the Law of Non-Navigational Uses of International Watercourses (UNW Convention).

5. Because Kosovo is not an official member of the United Nations.

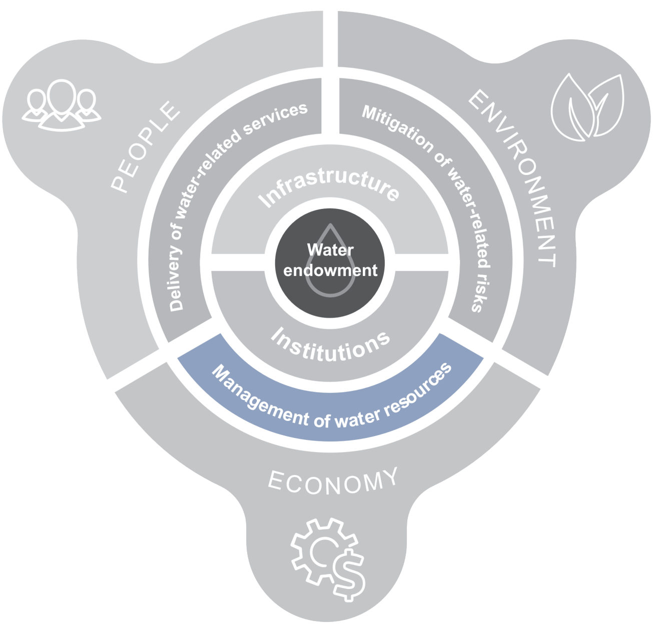
6. An antimonopoly committee is a regulatory body responsible for enforcing competition laws and promoting fair competition within a country's economy. The committee's primary goal is to prevent monopolistic practices—such as price fixing, market allocation, and other anticompetitive behaviors—that could harm consumers or other businesses.

6

Water Sector Performance

This chapter explores instruments developed by countries within Europe and Central Asia to manage water resources and how economies are performing when managing water-related risks (floods and droughts) and delivering water-related services. This chapter corresponds to the third ring of the Water Security Diagnostic Framework (WSDF) diagram (*figure 1.1*).

MANAGEMENT OF WATER RESOURCES



KEY MESSAGES

- Main bottlenecks to widespread adoption of basin planning include institutional weaknesses, a lack of financing, and technical shortcomings.
- Although basin planning is instrumental in supporting integrated water resources management (IWRM), it requires large amounts of institutional, technical, and financial capacities, which are lacking across most countries in Europe and Central Asia.
- Most countries have established water extraction permits to manage water allocation and, in some cases, a register of water users. However, systems are not always up to date, and countries are failing to charge water tariffs.
- Insufficient knowledge of the availability and status of water resources is a key barrier to planning resulting from insufficient monitoring, out-of-date water data infrastructures, and poor information flow among water sector institutions.
  - Knowledge gaps are greatest with respect to the ecological, hydromorphological, and quantitative status of water bodies.
- Groundwater remains poorly understood and managed.
  - There is limited information regarding the quantitative and chemical status of groundwater, which represents a key socioeconomic risk.
- Data exchange and cooperation are required within and across borders to support IWRM, but both have significant shortcomings.
  - Within countries, data-exchange mechanisms are often insufficient, if not obsolete, except in the European Union (EU) Member States of the Danube. There are also regulatory gaps in several countries regarding open data.
  - Data-exchange mechanisms among countries are also rare because of the limited normative development in international water treaties and political disputes among neighboring countries.
- Although reflected in the regulatory frameworks of many countries, in practice, stakeholder participation is limited and not as inclusive as intended. Mechanisms for public participation, where they exist, are generally articulated around river basin councils, but even these institutions have limited resources and capacities to engage wider groups.

Management Instruments

The absence of strong river basin planning reduces coping capacity to manage the risks of water scarcity, disputes among water users, environmental degradation, and water-related hazards. The cornerstones of effective and sustainable basin planning include overcoming and addressing persistent challenges related to financing, monitoring of infrastructure, data, public participation, and building technical and human capacities. Overall, river basin planning is expanding in Europe and Central Asia, and countries are beginning to implement the basin approach in their planning processes, but much more progress is needed, especially in the South Caucasus and Central Asia. The main bottlenecks to supporting the full implementation of the basin planning and management approach in many countries are insufficient financing and the as-yet-limited development of strong basin authorities.

In the South Caucasus, some countries, such as Armenia and Georgia, have started to develop river basin management plans (RBMPs). Because this is an obligatory component of EU membership agreements, these RBMPs comply with the EU Water Framework Directive (WFD). Many of these plans have been developed in the framework of international projects, and although some have been approved, they have not yet been implemented because of financial constraints regarding the financing of the program of measures (OECD 2021b). Given the current limited maturity of basin institutions (see "Institutions" in chapter 5), public participation has been limited to ad hoc projects. Azerbaijan has not yet started implementing the basin management approach; no plans are thus in place, nor is the required institutional setup present to support their implementation at the basin scale. Overall, further efforts will be required to support the strength of basin capacities, including the institutionalization of public participation in basin planning (for example, through the development and strengthening of basin councils).

In Central Asia, basin planning is slowly developing, although in some countries, the approach has not yet been stipulated in legislation (*table 6.1*). Where plans have been adopted, they have largely been developed with the support of international funds, but implementation is limited because of financial constraints and the limited development of institutional capacities for basin management (see "Institutions" in chapter 5).

In the Danube, EU Member States have developed comprehensive RBMPs and flood risk management plans (FRMPs). Required by the EU WFD and the Floods Directive (FD), these address relevant aspects of IWRM (water allocation, water quality, water services provision, management and protection from water-related risks, and protection of water ecosystems). EU candidate states are also investing significant efforts in developing EU-compliant RBMPs. Nevertheless, the WFD is very ambitious and requires significant efforts and investments on the part of countries to generate the knowledge base needed and to support the implementation of the program of measures. The legal requirement of the WFD establishes planning cycles of six years in duration, after which plans need to be revised and updated to monitor progress and identify emerging pressures. EU Member States are currently implementing the third RBMP (planning cycle 2021–27). Since the first plans were developed (2009–15), Danube EU countries have made substantive progress along different axes. Investments oriented toward ecosystem protection have had two positive outcomes: (a) moderate improvement of the ecological status of water bodies across some countries (for example, Austria, Bulgaria, the Czech Republic, and Romania) and (b) improved the knowledge base on the status of water bodies across some countries, with important gaps (for example, Hungary and Poland). Yet Danube countries remain far from reaching the target of achieving good status for all water bodies (initially set for 2015 and later extended to 2027 for all Member States; *figure 6.1*).

TABLE 6.1 Summary of the Implementation of the Basin Approach in Central Asia

Country	Basin approach stipulated in the water code or related water legislation?	Basin management units delineated?	River basin management plans developed/river basins delineated
Kyrgyz Republic	Yes	Yes	0/6
Kazakhstan	Yes	Yes	2/8
Tajikistan	Yes	Yes	2/5
Uzbekistan	No	No	n.a.
Turkmenistan	No	No	n.a.

Source: Original assessment for this publication.

Note: n.a. = not applicable.

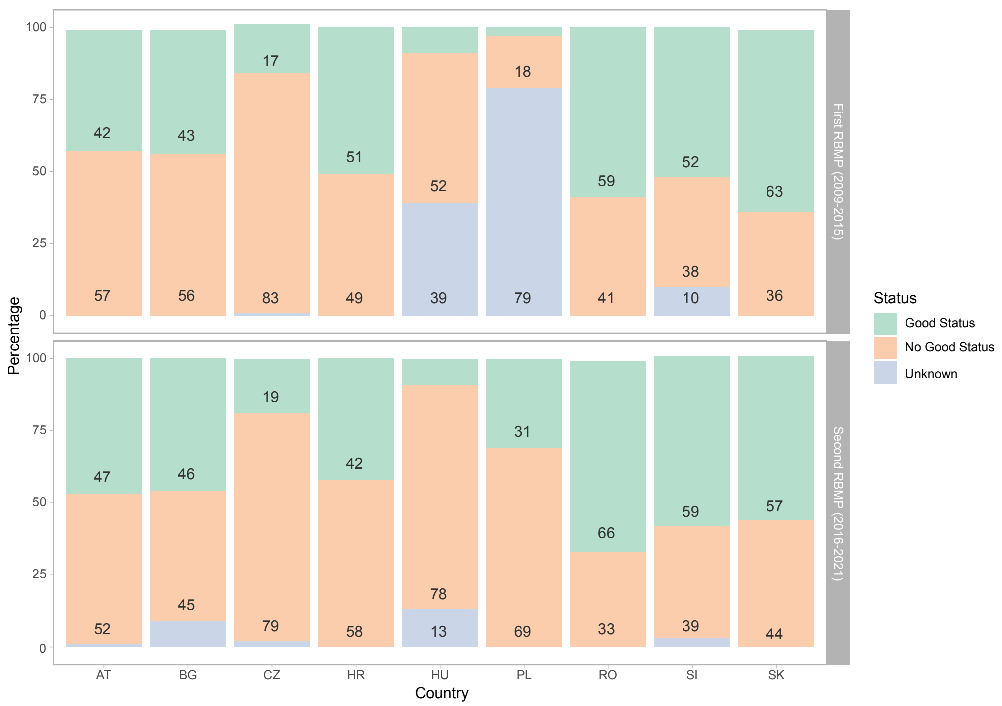
In the past two basin planning cycles, water allocation mechanisms have been put in place. All countries have established water permit systems and have developed a register of water abstractions. In some cases, permits are required only above a certain volume of abstractions (for example, in Bulgaria and Slovenia), but in most cases, permits are required regardless of the volumes extracted (European Commission 2021). As for the control of water quality, all EU Member States in the Danube have an authorization or permit regime to control wastewater point-source discharges and have developed a register of wastewater discharges for both surface water and groundwater. The Czech Republic and Romania have water quality control systems only for surface water. Although such measures represent a positive step toward monitoring water quantity and quality, they need to be backed by strong enforcement and surveillance mechanisms, which are still lacking in many countries.

In fact, despite the progress, EU Member States face important challenges in fulfilling the implementation of the program of measures from the RBMPs (*figure 6.2*). Some of the most important challenges are related to the limited financing, the bureaucracy that needs to be overcome to implement some of the measures, and the limited application of cost-effective approaches to prioritize measures. Governance aspects related to the limited technical and human capacities to enforce existing regulations are also a recurrent problem. Croatia, for instance, has a water abstraction permitting system and a water-use register in place, but surveillance and enforcement mechanisms are insufficient, and it is estimated that reported water abstractions are only 60 percent of the real abstractions taking place (World Bank 2023b).

EU candidate states are making significant efforts to adapt their institutional frameworks to the requirements of the EU Water Acquis. There are, however, major gaps with respect to river basin planning. River basin districts have been identified in most countries (for example, in Albania, Montenegro, and Serbia), and RBMPs are being developed, often with international funds, but most lack government approval and are thus not being implemented. The development of the plans has also revealed major gaps that need to be filled, including (a) the limited knowledge

Figure 6.1

COMPARISON OF the Ecological Status of the Surface Water Bodies in Danube EU Member States between the First (2009–15) and Second Planning Cycles (2016–21)



Source: WISE-Freshwater (database), Water Information System for Europe (WISE), European Commission/European Environment Agency, https://water.europa.eu/freshwater.

Note: EU = European Union; RBMP = river basin management plan.

base on the status of water bodies because of the narrow coverage of monitoring systems required to monitor biological, ecological, hydromorphological, and chemical quality and (b) limited data on the hydrogeological functioning of aquifers, which prevents the formation of an accurate picture of the dynamics and quantitative status of groundwater bodies.

EU candidate states have made major efforts to advance the establishment of water allocation mechanisms. Water codes and associated legislation require users to obtain a water permit for water abstractions (World Bank 2023d, 2024c, 2024d). Major gaps remain, however, including the following: (a) technical gaps, given that water cadasters, even if available, are not well maintained and have information that is scattered across the different institutions issuing the permits; (b) governance-related gaps, given countries' limited capacities for surveillance and enforcement, which prevent them from having realistic control over water abstractions (for example, in Albania and Serbia); and (c) financial gaps, given that even when a water tariff for different water users exists, cost recovery is not achieved; moreover, environmental and resource cost charges have not yet been developed (for example, in Albania and Montenegro; see "Water Sector Financing" in chapter 5). Overcoming these technical, institutional, and financial gaps is key to strengthening the implementation of river basin management instruments and adopting the IWRM approach at the basin scale.

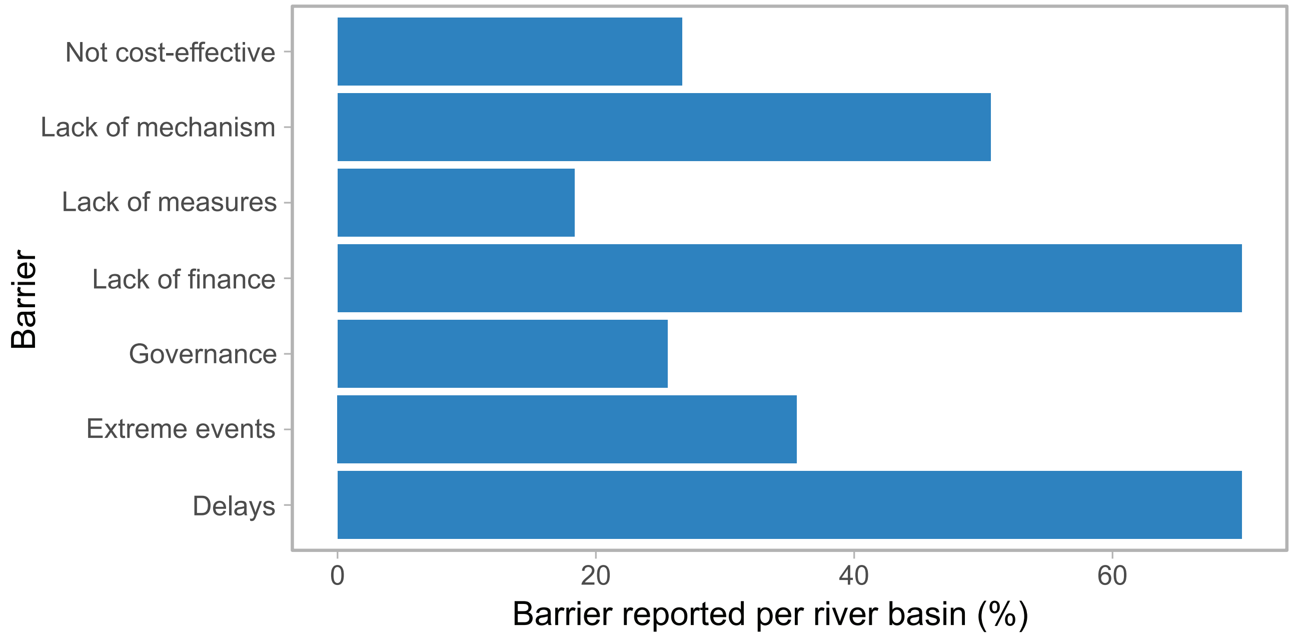
Data and Monitoring

There is inadequate technical knowledge on water resources because of insufficient and decaying monitoring infrastructure and weak institutional capacities. These deficiencies seriously undermine planning capacities. There are wide disparities across the region, with the EU Member States in the Danube being more advanced than countries in Central Asia and the South Caucasus, where the problems of monitoring water resources have not received sufficient attention. Poor material and technical equipment and low human and technical capacities limit the development of cooperation in the field of monitoring and assessment of water resources.

In the South Caucasus, there is a major deficit in water monitoring at all levels (hydrometeorological, hydrological, and water quality) across the three countries. Efforts are under way in Armenia and Georgia to upgrade and expand the monitoring networks (World Bank 2024a, 2024h). In Azerbaijan, outdated or inappropriate equipment and techniques are still used, although there has been an encouraging move toward modernization over the

Figure 6.2

BARRIERS AFFECTING the Implementation of the Program of Measures in River Basin Management Plans to Achieve the River Basin Planning Goals in EU Member States of the Danube



Source: European Commission 2021.

Note: EU = European Union; RB = river basin.

past few years (World Bank 2024c). Monitoring of water quality mostly focuses on physicochemical parameters (to detect nutrients and pollutants from agriculture, urban wastewater, and diverse industries), whereas other important aspects of ecological monitoring, such as biological and hydromorphological parameters, are not monitored. Reliable data on water quantity of both surface water and groundwater are largely missing. There is a serious lack of information on water abstractions. Only Armenia has a water cadaster, although this is in the process of being updated and opened to the public. Overall, the lack of reliable, timely, and spatially appropriate data on water quantity and quality significantly compromises national and regional water security.

In Central Asia, monitoring is insufficient, and the existing monitoring system is largely antiquated and has fallen into disrepair. Currently, evidence-based decision making for water resources planning and management is almost impossible. Between 1985 and 2008, the number of functioning monitoring stations and equipment declined by 30 to 60 percent in the various countries (World Bank 2019). Most of the monitoring systems in place are manual, and there are important gaps in the data series. Monitoring stations need to be urgently reestablished, automated, and combined with modern decision-support systems. Until now, most countries in Central Asia have focused on monitoring hydrometeorological and basic physical and chemical aspects of water quality, whereas there is barely any monitoring of ambient water quality and hardly any capacities in place for it. Because of the poor status of the existing infrastructure and the fact that most monitoring is still manual, there are important gaps in the data series, which prevent a reliable and up-to-date understanding of water quality and quantity—the very knowledge base required to support effective water resources planning.

In the Danube, there are large disparities in monitoring capacities between EU Member States and candidate states. EU Member States have made major progress in expanding their monitoring systems and currently have reasonably good monitoring networks, although there are some monitoring gaps for biological, chemical, and hydromorphological parameters (*figure 6.3*). In the EU candidate states of the Danube, monitoring programs still need to be expanded much further, with regard to all key parameters for determining the ecological status of surface water (biological, chemical, and hydromorphological status) and groundwater (quantitative and chemical status). Technical capacities to coordinate and manage the monitoring approach are also inadequate, which reveals that along with investments in expanding the monitoring network, efforts are also required to enhance institutional and technical capacities for monitoring.

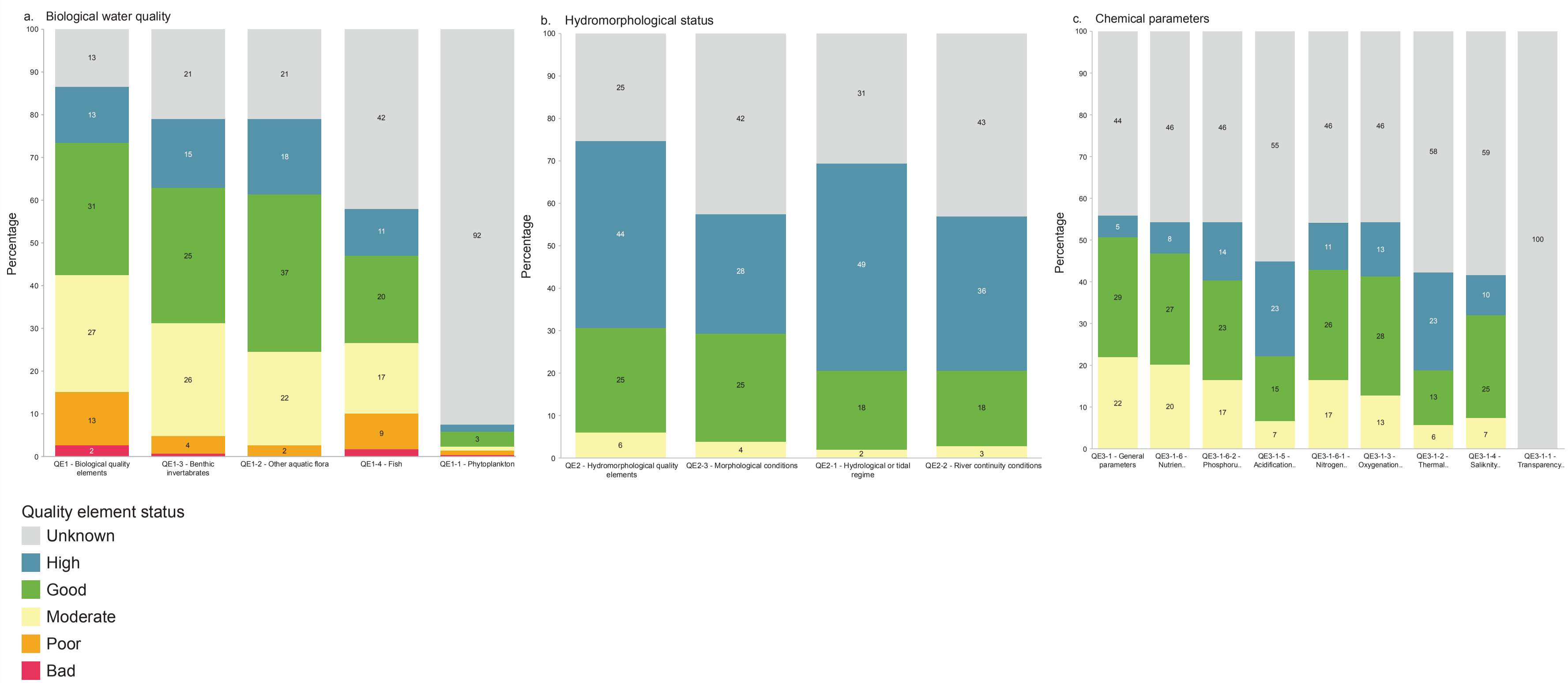
Groundwater is a strategic resource for drinking water and irrigation across Europe and Central Asia, but it is poorly managed. Despite surface water being the most abundant and most used source of water there, groundwater is an important source of drinking water across the entire region and for irrigation in some subregions, such as Central Asia. Yet groundwater is poorly managed, largely driven by the limited knowledge and monitoring of a resource (see chapter 4 on endowments) that is likely to become more strategic soon while countries adapt to climate change yet are already facing important pollution and overextraction challenges (see “Environmental Outcomes” in chapter 3), particularly in Central Asia and the South Caucasus.

In Central Asia, increased groundwater use is connected to the drying of the Aral Sea, shared by Kazakhstan and Uzbekistan, forcing farmers to seek alternative reliable water sources. Uzbekistan is also highly dependent on upstream surface waters from the Kyrgyz Republic and Tajikistan and is progressively gearing its irrigation investments toward groundwater. Irrigation accounts for 28 percent of the groundwater abstractions in Uzbekistan, but the country is already using 99 percent of its renewable groundwater resources (see chapter 4 on endowments), which represents a major threat to the sustainability of the Syr Darya aquifer and all dependent water uses (*figure 6.4*). In the rest of Central Asia, the ratio of abstraction is lower, with most countries having extraction rates in the range of 25 to 60 percent. Nevertheless, the subregion is exposed to several compounding risks related to its exploitation of groundwater. One is that groundwater resources in Central Asia are highly dependent on surface waters from the Syr Darya and Amy Darya River basins, and as climate change is expected to decrease the amount of runoff, this will likely affect groundwater recharge and possibly reduce the groundwater table and increase the extractions of nonrenewable groundwater (see “Environmental Outcomes” in chapter 3). Likewise, diffuse pollution from agriculture is becoming increasingly serious, threatening the quality of groundwater resources (Liu et al. 2020).

Groundwater plays a vital role in the Danube, providing nearly 72 percent of the drinking water for about 59 million people and serving agricultural irrigation and industrial needs, including cooling and heating applications. However, in this subregion it is under significant threat from pollution, primarily stemming from untreated sewage, agricultural fertilizers and pesticides, and chemicals leaching from industrial waste sites. Groundwater abstractions for drinking water and agriculture are increasingly putting pressure on groundwater bodies. To ensure the sustainable use of Danube groundwater, the International Commission for the Protection of the Danube River (ICPDR) has set up a Groundwater Task Group, which has managed to identify relevant groundwater bodies of transboundary importance and develop strategic visions

Figure 6.3

BIOLOGICAL CHEMICAL and Hydromorphological Parameters Monitored to Assess the Ecological Status of Water Bodies in the EU Member States of the Danube Countries



Source: EEA 2023b.

Note: EU = European Union.

to address and manage pollution and overabstractions. Of the twelve transboundary groundwater bodies identified in the Danube, 75 percent have a good chemical status, and 86 percent have a good quantitative status (*map 6.1*).

In the South Caucasus, there is little information on usable groundwater resources, which is a risk in itself. Along with the limited quantitative information, groundwater bodies are increasingly being polluted, especially downstream in Azerbaijan because of the high level of pollution of the two most important rivers, the Kura and Aras, the main source of aquifer recharge. Groundwater pollution is not a regional issue; it is highly concentrated around irrigated areas and near urban areas. The absence of monitoring systems and the use of stationary hydrogeological models inhibit the ability to forecast, prevent, and manage groundwater risks.

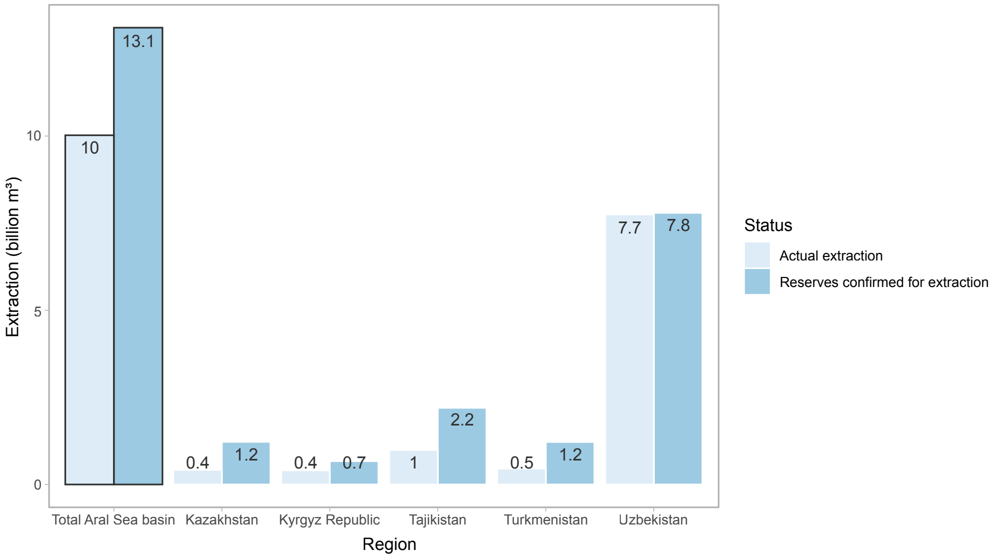
Poor information flow among institutions in the sector impedes coordinated responses to risks and leads to inefficient planning. Except for the EU Member States in the Danube, most countries in Europe and Central Asia have not incorporated data-exchange frameworks into their national monitoring systems, which prevents the establishment of a unified data-exchange system to facilitate data exchange within countries.

In the South Caucasus, there are hardly any formal data-exchange mechanisms within the countries. There is also limited access to freely available water data. There are a few projects supporting the development of water information portals (for example, the water online platform EcoPortal in Armenia and the water information system of Georgia); these still need to be further developed and populated with new data as they are generated. An additional problem is the limited digitalization in place. Common functions among public institutions need to be found, as do generic, applicable, and interoperable solutions to enable ease of data exchange among them. A cross-sectoral approach to digitalization is thus required that involves the participation of all ministries. The technological gaps are also aggravated because some countries lack a legal basis for open data access.

In Central Asia, water monitoring is spread across many different agencies, each with its own programs that often are not coordinated with regard to sampling sites, parameters analyzed, and measuring frequency. In most countries, the monitoring network density is not sufficient to cover all main water bodies (UNECE 2018). Typically, water quantity information for surface water and groundwater is gathered by different institutions (hydrometeorology and hydrogeology bodies, respectively). The quality of environmental, drinking, and irrigation water is also monitored by different institutions. Interagency disunity and poor coordination among national authorities often inhibit proper data exchange. Measures are needed to strengthen intersectoral interaction and form unified national databases on the use of the water fund. Moreover, data are often not made freely available, although this is slowly changing, and countries are also beginning to support the development of water information systems to

Figure 6.4

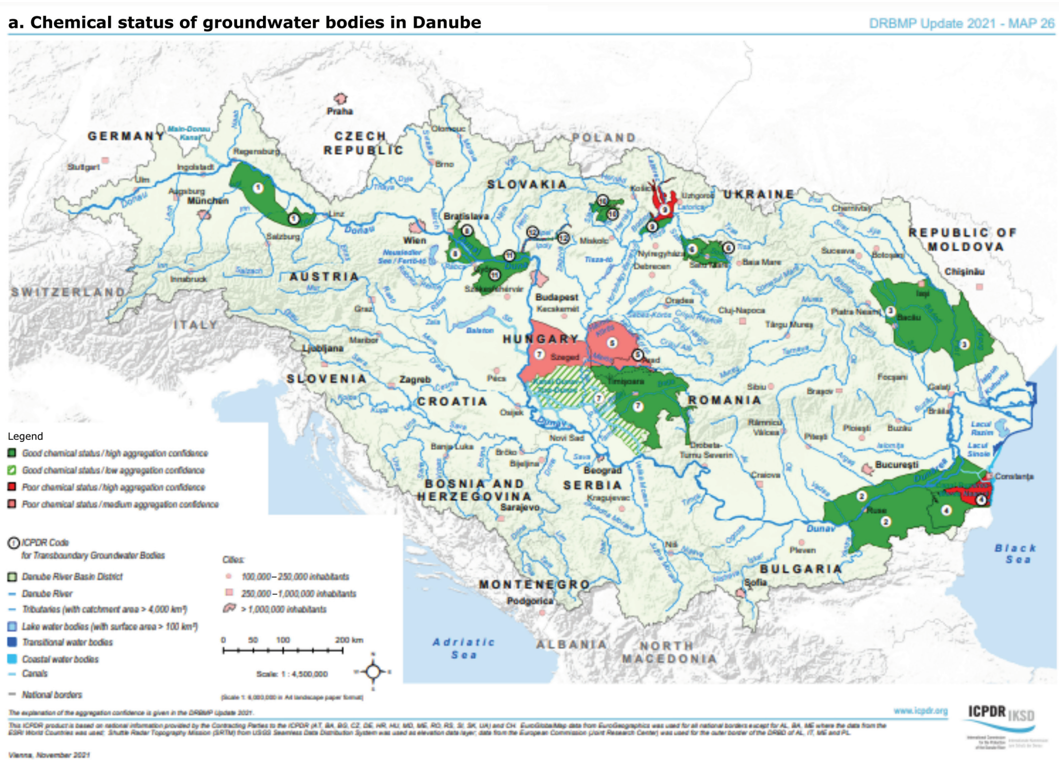
GROUNDWATER EXPLOITABLE Reserves and Extraction in Central Asia

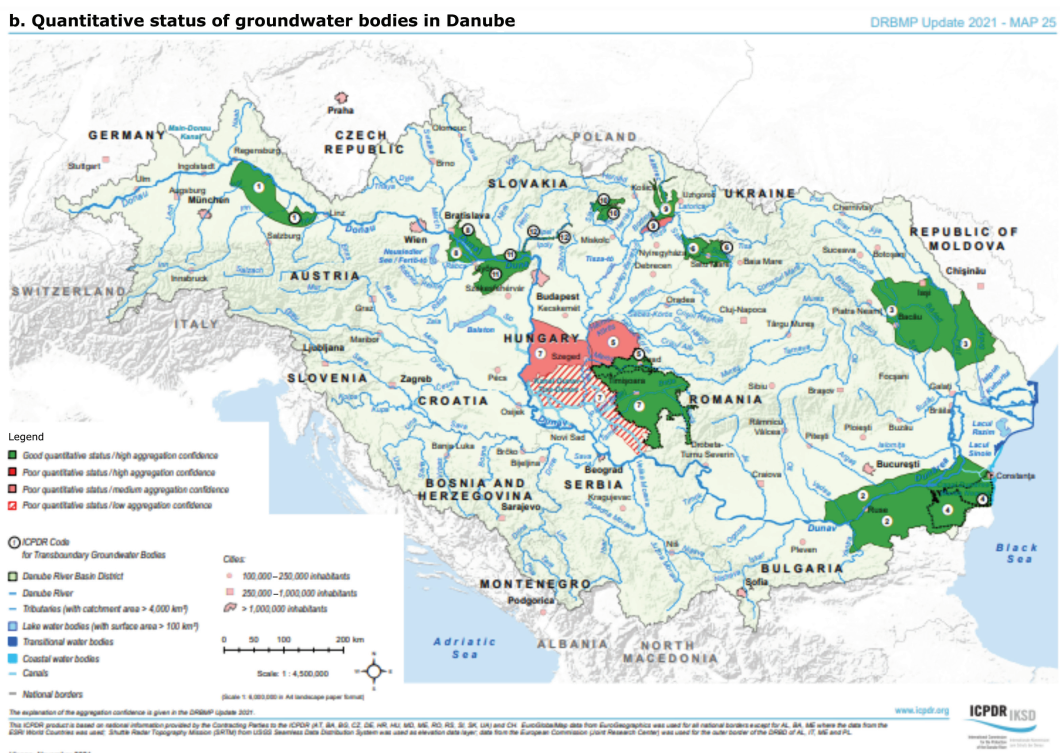


Source: Liu et al. 2020.

Map 6.1

CHEMICAL AND Quantitative Status of Groundwater Bodies of Basinwide Importance





Source: ICPDR 2021.

Note: Green indicates good status; red indicates poor status.

facilitate cooperation with other national institutions and make data accessible to the public.

In the Danube, EU Member States have the most developed national water information systems (for example, the Water Information System in Austria). At the EU level, the European Commission and the European Environment Agency have created the Water Information System in Europe, a comprehensive portal containing relevant water resources management (WRM) information on the status and pressures of surface water and groundwater, water resources and use, and wastewater treatment. Candidate states are also developing national water information systems, but those are still in progress in many countries. For such systems to be useful for planning and management, candidate states need to focus on designing systems that are responsive to information needs and, importantly, based on open data principles.

Data exchange and cooperation in transboundary settings are the exception rather than the norm. In the South Caucasus, there are no formal mechanisms for data exchange across countries, largely caused by limited transboundary cooperation (see "Institutions" in chapter 5). There is some communication and data exchange on water quality, quantity, and hydrological forecasting between Georgia and Azerbaijan. For instance, the national environmental agency of the Ministry of Environmental Protection and Agriculture of Georgia provides data to the respective agency of Azerbaijan on the daily water level and flow in certain locations in the Kura (Mtkvari) River basin and the Alazani River basin. Georgia also provides data on the snow height in Gudauri and Bakuriani (resorts in Georgia) to its counterpart agency in Azerbaijan, which is responsible for hydrological forecasting. There are high political tensions between Armenia and Azerbaijan, although there are some ongoing efforts by international organizations to facilitate dialogue and cooperation on water-related issues in the region.

In Central Asia, there is insufficient information exchange among riparian countries overall, which prevents the adoption of a regional IWRM approach to water planning and management. Cooperation and exchange are narrowed down to data on volumes of allocated water between the countries, maintenance and exploitation of transboundary water infrastructure, and the general safety of hydrotechnical structures (see "Institutions" in chapter 5). The political tensions between upstream and downstream countries, each with different national priorities related to the joint use and exchange of water and energy, plus breaches in allocation agreements, have created an atmosphere of mistrust (ICWC 2023). The lack of exchange of hydrometeorological information prevents countries from obtaining more accurate forecasts of water availability. Similarly, there is practically no cooperation on water quality and water-related ecosystems (UNECE 2018).

In the Danube, transboundary cooperation is highly successful, and the ICPDR is considered a front-runner in facilitating cooperation and exchange between countries. The ICPDR leads the development and maintenance of several data-exchange platforms (for example, the DanubeGIS), compiling information from all Danube countries on industrial and urban pollution sources, wastewater treatment, continuity interruptions to fish migration, hydrological alterations, and the status assessment of water bodies. The DanubeGIS also helps monitor and support the implementation of the two main directives, the EU WFD and FD. Such data-exchange practices represent good practices to be scaled to other transboundary basins.

Public Participation

The lack of public participation is a key barrier to achieving equitable, efficient, and sustainable water management outcomes. Engagement of water users in the planning process is fundamental for creating ownership, commitment, and transparency and thus enabling the implementation of river basin plans.

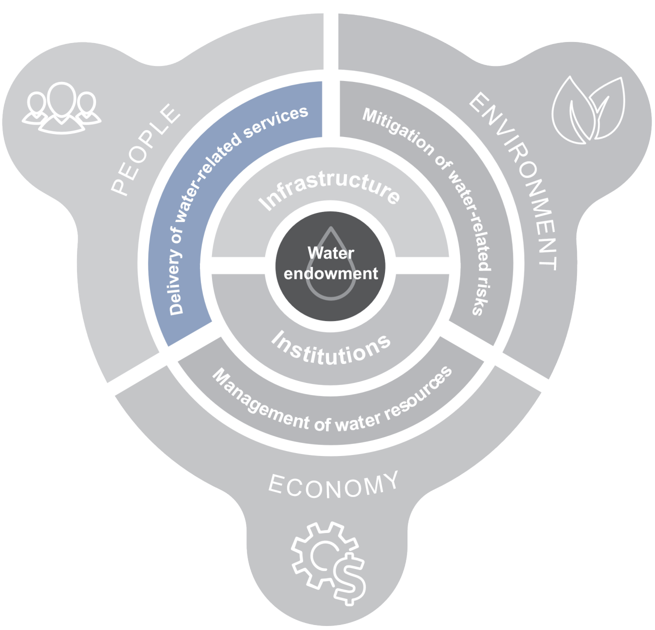
In the Danube, participation is mandatory in the development of the RBMPs per the requirements of the EU WFD. Still, there is a disparity in the level of both the institutionalization and the inclusivity of public consultations. Basin councils are being promoted to facilitate public consultations and are normally composed of representatives from different groups of water users and water-related institutions. Although these institutions have proved to be useful in encouraging communication and engagement, they often represent the interests of a reduced group of powerful stakeholders, leaving smaller communities and vulnerable groups underrepresented.

In the South Caucasus, there are no formal mechanisms for public participation in water resource management at the basin level. Dialogues have been held during the development of basin plans in Georgia and Armenia; these have involved local authorities, nongovernmental organizations, the private sector, and academia. Such consultations have not, however, been institutionalized because basin councils are not yet fully developed. In Azerbaijan, public participation is nonexistent; basin planning is yet to take off (see "Institutions" in chapter 5).

In Central Asia, participation at the basin level is articulated through basin councils (for example, in Kazakhstan, the Kyrgyz Republic, and Tajikistan). These RBCs should normally involve different government and nongovernment institutions, but in some countries, such as Kazakhstan, the level of engagement is reportedly low overall, as is representation of a wide group of stakeholders (UNEP and UNEP-DHI n.d.). In Tajikistan, all river basins have established basin councils, and these organize meetings on a regular basis (UNEP and UNEP-DHI n.d.). In countries like Uzbekistan, where river basin planning is not reflected in the water policy, engagement is conducted at regional and national levels through the so-called water consumer associations (WCAs), which are composed of farmers and other water users and act as legal entities to coordinate water relations, as well as to provide representation and protection of common interests. There are also several nongovernmental organizations and environmental associations that are significantly involved in inspections and analytical activities carried out by members of the parliament.

Although there are major differences between subregions, for the most part, participation has not yet been institutionalized across Europe and Central Asia. The main reasons for this are related to the limited development of enabling institutions (that is, specific regulations dealing with public participation and underdeveloped basin councils), but other contributors include the limited technical capacities to facilitate participatory processes and prevailing cultural norms.

DELIVERY OF WATER-RELATED SERVICES



KEY MESSAGES

- Water supply and sanitation (WSS) coverage across Europe and Central Asia is high, and service continuity is almost guaranteed (twenty-three hours per day), but there are large disparities among and within subregions and countries, with pronounced gaps in the South Caucasus and Central Asia.
- Many countries across Europe and Central Asia are able to generate enough revenue from the delivery of WSS services. Some, however, though able to achieve cost recovery, also have a high preponderance of nonrevenue water (NRW), meaning surpluses are not necessarily invested in upgrading existing infrastructure.
- Electricity costs as a share of total operating costs for providing WSS are expected to increase services across the region as countries expand wastewater treatment. Reducing energy costs will require demand management approaches, such as addressing NRW and revising water tariffs to reflect its often underpriced value.

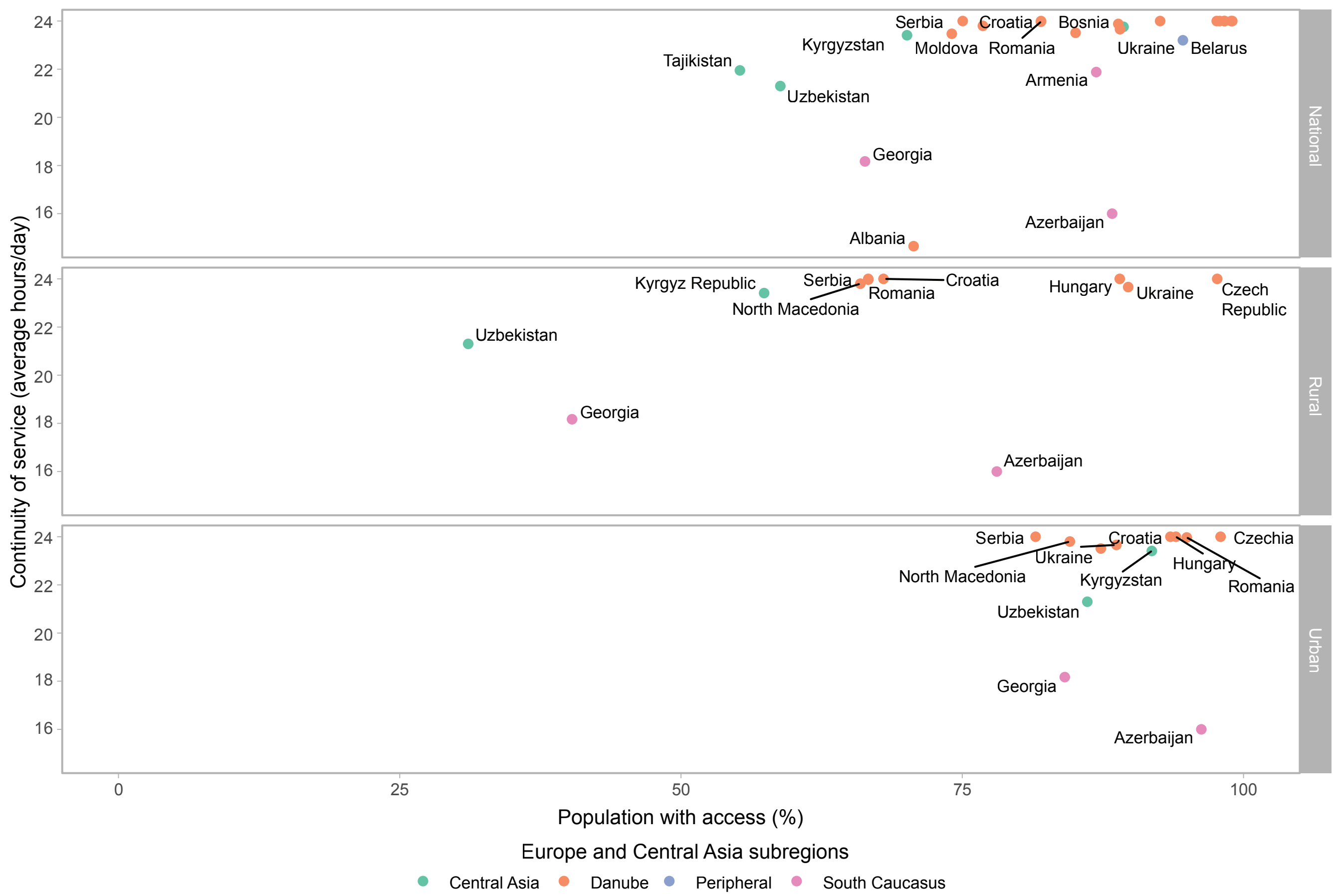
Water Supply and Sanitation Service Coverage and Quality

Service quality is highest in countries that have invested in expanding access to safely managed drinking-water services and embarked on institutional reforms to strengthen capacities. Service quality, measured as the benefits of having a continuous, piped supply of safe drinking water delivered to household premises, is key in supporting socioeconomic development and reducing the time and effort required to collect water, and it is also essential for health reasons, given that service continuity is more likely to provide water that meets required standards for drinking-water quality (Brocklehurst and Slaymaker 2015). Across Europe and Central Asia, those countries that have prioritized investments to achieve safely managed standards of WSS services (see "Social Outcomes" in chapter 3) and undertaken institutional reforms to strengthen sector institutions and policies (see "Institutions" in chapter 5) display the highest service quality (*figure 6.5*).

On average, continuity across Europe and Central Asia reaches twenty-three hours per day, although there are major differences between urban and rural areas and this figure is expected to rise as a result of climate change (*box 6.1*). In the Danube region, water services are generally available throughout the day, with only minor interruptions (average availability of 23.5 hours per day). A significant gap is observed in Albania, with an average of fifteen hours of service a day, well below the regional average. Albania also has one of the lowest coverages of safely managed drinking-water services (about 55 percent; *figure 6.5*). A potential reason is the number of breaks in the water distribution network, reportedly 3.71

Figure 6.5

WATER COVERAGE in Terms of Continuity and Percentage of Population with Access to Safe Drinking Water



Source: IBNET, n.d.; JMP, 2022.

Note: The Y-axis cutoff is at fifteen hours.

breaks per kilometer per year. Although the number has declined from 4.27 in 2013, the lack of planned preventive maintenance procedures is unresolved (World Bank 2023a). There is significant room to improve water service delivery in the South Caucasus subregion, especially Azerbaijan and Georgia, who both have service continuity below eighteen hours per day. Moreover, the coverage of safely managed drinking-water services is low, especially in rural areas. Continuity of service in Central Asia is not a major issue, with an average of more than twenty-one hours per day. Tajikistan and Uzbekistan have the lowest continuity, correlated with levels of access to safely managed drinking water that are less than 60 percent.

Water Supply and Sanitation Sector Efficiency and Management

Spending composition in the WSS sector is fairly homogeneous across countries, but the amounts invested vary considerably (*table 6.2*). Based on an analysis of nine countries, most spending goes to capital expenditure (CAPEX), whereas operational expenditure (OPEX) receives the least. Spending composition in Poland reflects its status as a high-income country and is indicative of a well-established WSS sector and infrastructure network. Although spending composition might reflect the maturation of a country's WSS sector or economy, it does not speak to spending efficiency. Instead, the rate of execution provides some insight into a sector's spending

Box 6.1

MITIGATING CONTINUITY CHALLENGES WITH RESILIENT INFRASTRUCTURE IN THE FACE OF CLIMATE CHANGE

A recent study of global water supply utility drought risk and adaptation optioneering served to highlight the challenge of realizing resilient WSS services in the face of future climate change in Europe and Central Asia (Becher et al. 2024). Risk was characterized in the study as unsustainable water supply days, describing the number of customer days where the utility supply is unsustainable or disrupted. Apart from this, associated tariff revenue at risk was estimated to simulate cost-benefit ratios of three alternative infrastructure interventions—namely, increased water storage capacity, desalination, and leakage reduction.

Based on this, the rate of unsustainable disrupted utility supply in Europe and Central Asia's water supply utility customer base was estimated at 16 percent but is projected to rise to 21 percent (15 to 29 percent) under the Shared Socioeconomic Pathway (SSP) and Representative Concentration Pathway (SCP) future climate-change scenario SSP3-RCP7.0. It was found that the future increase in risk could be fully mitigated through the implementation of one of three considered adaptation actions: leakage reduction, reservoir storage, and seawater desalination. For approximately half of the utilities in the Europe and Central Asia region, leakage reduction was identified as the optimal adaptation option. Given high physical water losses across the region, this is an important first step toward a more climate-resilient future for utilities. Reservoir storage was found to be the most cost-effective action for 40 percent of utilities, where sufficient excess surface waters were found to be available for storage. For the remaining 10 percent of utilities, the most cost-effective action was found to be desalination, particularly utilities in proximity to the Mediterranean coast.

The study found that implementing options where the cost-benefit ratio exceeds 1 would achieve only approximately a quarter of this benefit. This approach is particularly problematic in less developed countries in Central Asia, Eastern Europe, and the Caucasus, where tariff rates are much lower relative to the costs of service provision compared with Western European countries, where water supply tariff rates are higher. This situation underlines the challenge of attracting investment in climate adaptation for water utilities in lower-income countries in Europe and Central Asia.

Source: Becher et al. 2024.

efficiency. Ideally, budget execution (or spending) will match budget allocation. Over- or underspending generally indicates inefficiencies. Some causes of overspending (spending more than the allocated budget) and underspending (spending less than the allocated budget) are similar, whereas some are unique (*box 6.2*).

TABLE 6.2 Average Annual Spending Composition as a Share of Total WSS Spending by Country

Country	CAPEX	Subsidies	Wages	OPEX
Albania	87.27	8.01	2.38	0.41
Armenia	52.56	11.76	2.13	0.02
Bulgaria	87.98	0.09	0.44	0.62
Kosovo	89.07	n/a	5.81	0.29
Moldova	68.20	25.32	0.14	0.05
North Macedonia	90.05	2.39	0.54	0.11
Poland	28.79	0.50	14.67	3.19
Study average	71.99	8.01	3.73	0.67

Source: Fenwick and Khan 2023.

Note: Data are reported to the hundredth decimal place to avoid zeros but are not presumed to be accurate beyond the tenth decimal place. CAPEX = capital expenditure; n.a. = not applicable; OPEX = operational expenditure; WSS = water supply and sanitation.

Box 6.2

POTENTIAL CAUSES OF OVER- AND UNDERSPENDING IN THE WATER SUPPLY AND SANITATION SECTOR

Potential causes of overspending include the following:

- Poor budget planning
- Changes in the scope of projects and programs (possibly politically motivated) and subsequent failure to adjust
- Off-budget spending (often political)
- Fear of losing budget allocation
- Potential causes of underspending include the following:
- Poor budget preparation, project planning, and programming
- Lower-than-expected or unrealistic revenue projections
- Poor governance
- Off-budget spending
- Virement—that is, the transfer of funds from one budget to another (for example, transferring from an underspent budget to an overspent budget)

Most countries underspend their WSS budget allocation. The average rate of execution for the entire period for the study group was 87 percent, well above the global average of 73 percent, suggesting greater efficiency overall (*table 6.3*). However, there is significant variability between countries. Interestingly, only Moldova overspent its allocated budget, whereas all other countries except Croatia underspent, as is the trend in the WSS sector worldwide.

On average, revenues from WSS services are sufficient to support operation and maintenance (O&M) costs, though there is a large disparity among countries and service providers. Management includes pricing and cost structures. Hence, the operating cost coverage ratio is a key indicator of service delivery efficiency. This indicator is defined as the total annual operational revenues versus the total annual operating costs and should be above 1 to be efficient and financially sustainable. In the assessment, a rigid boundary is not defined (for example, slightly or clearly below 1) because the ability of the utility to attain cost break-even (move beyond 1) and the ability to accumulate savings are considered in tandem. On average, the ratio in a typical country in Europe and Central Asia is 1.15, showing a surplus of water utilities of 17 percent (*figure 6.6*). In other words, revenues exceed operational and maintenance costs by 15 percent of revenue costs. No regional trends emerge.

Instead, performance differs strongly from country to country, often even within countries and from operator to operator. Three geographically dispersed countries exhibit very high operating ratios, allowing them to save for major capital maintenance and expansions: Azerbaijan (68 percent exceeding revenue share in operating cost coverage), Poland (70 percent), and Montenegro (93 percent). In well-supplied countries such as Poland and Montenegro, where less than 3 percent of the population has no access to clean and safely managed water for drinking or sanitation, surpluses will likely not provide access to the last remaining households. Instead, higher capital reserves for future maintenance and upgrading can be built up, or investments in infrastructure upgrading can be implemented instantly. In countries such as Azerbaijan,

TABLE 6.3 Rate of Execution in the WSS Sector by Country

Country	Percentage	Period
Albania	96	2010–21
Armenia	72	2010–20
Bulgaria	91	2006–20
Croatia	100	2016–20
Kosovo	72	2006–20
Moldova	109	2009–18
North Macedonia	62	2011–20
Poland	93	2006–20
Study average	87	Variable
Global average	73	2009–20

Source: Fenwick and Khan 2023.

Note: Total spending data were not available for Tajikistan; interannual variability at the country level is vast, and in some cases, the period average may be misleading. WSS = water supply and sanitation.

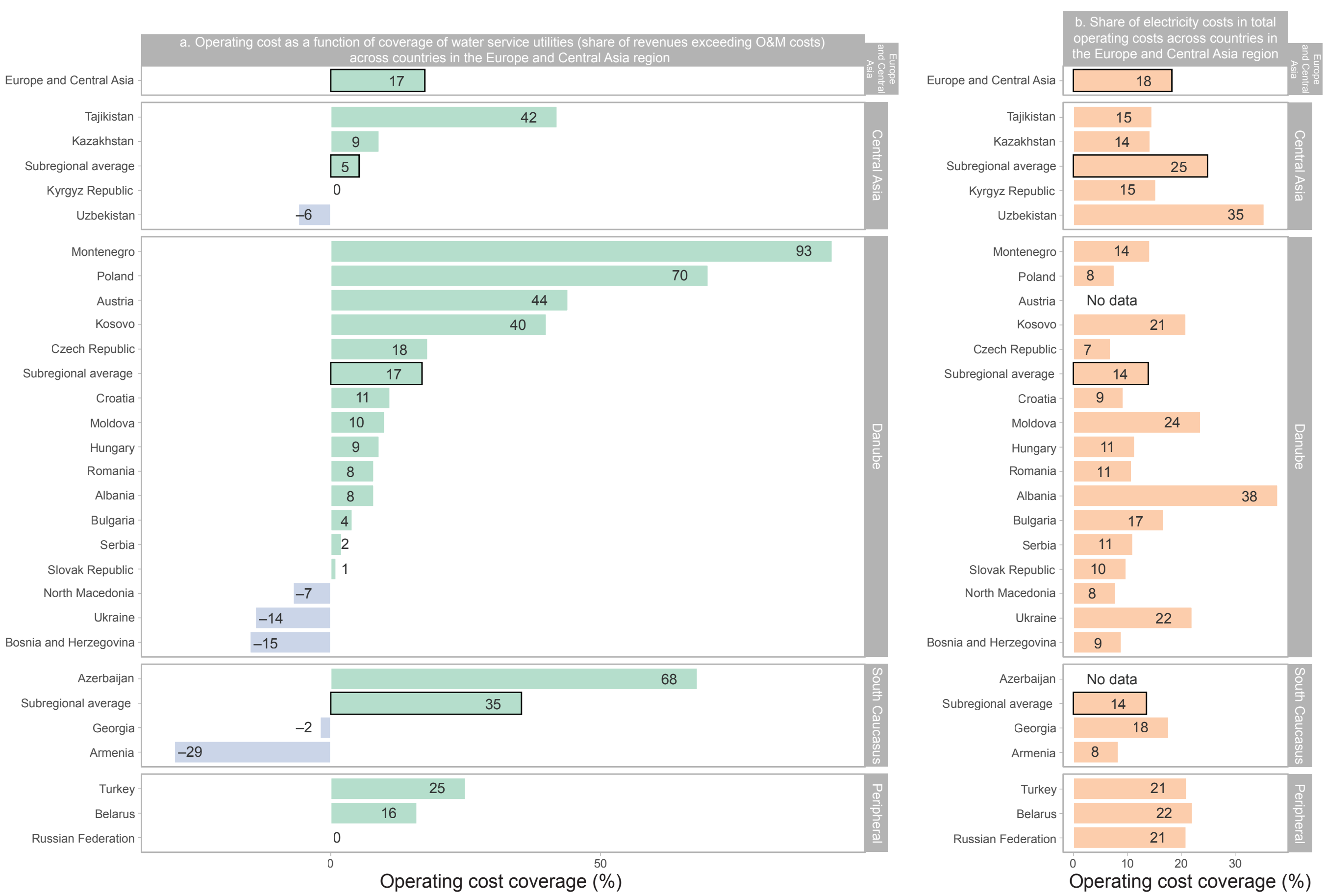
where higher shares of the population lack access to even basic drinking-water (4 percent) and sanitation (9 percent) services, higher priority should be given to investing current surpluses in the expansion of networks before further accumulating surpluses. In countries like Uzbekistan and Georgia, less than half of the population (31.1 percent and 40.3 percent, respectively) has access to safe drinking water. Water utilities in these countries usually operate at small losses, however. To improve access to safe drinking water, increasing revenues and investments from the government and private sector in the water sector can help secure funds for future improvements (*box 6.3*).

In contrast to overall regional efficiency, some countries fail to break even on average for the operation of water services. The most notable examples where the operating cost to coverage ratio is well below 1 are Armenia (revenues cover only 71 percent of operating costs—that is, 29 percent deficit), Bosnia and Herzegovina (−15 percent), and Ukraine (−14 percent; *figure 6.6*). Especially in Armenia, close attention must be paid to the operation of water services. Here and in other low-efficiency areas of service delivery, the revenue-to-cost ratio can be very low, and the poor shape of the infrastructure thus prohibits professional supply operations. These countries will need substantial investments and possibly reforms in their water sectors to be able to substantially increase operations in the sector. In Georgia, North Macedonia, and Uzbekistan, utilities also operate at losses, on average, albeit small. Some efforts, including restructuring operations or increased government investments, should be assessed to lift the operations to a profitable level.

Business efficiency is partly associated with technical efficiency, but other factors need to be considered to ensure sustainability for water users and service providers. Some losses

Figure 6.6

AVERAGE OPERATING Costs as a Function of Coverage and Average Energy Costs of Water Utilities in Europe and Central Asia



Source: IBNET n.d.

Note: O&M = operation and maintenance.

Box 6.3

ASSET MANAGEMENT IN THE WESTERN BALKANS

In the Western Balkan countries, asset management of water-related infrastructure varies significantly, and urban areas are often better managed than rural ones. In Bosnia and Herzegovina, asset management practices are generally rudimentary and mainly present in larger public utility companies in cities like Sarajevo and Banja Luka, where geographic information systems are used. However, rural areas lack consistent O&M systems, resulting in untested water quality and inadequate infrastructure management. The financial sustainability of water supply systems is hindered by inefficiencies and tariffs that fail to cover total operational costs, requiring external funding for significant investments.

In Serbia, asset management is primarily reactive, with insufficient tariff levels preventing the adoption of predictive maintenance practices. Larger cities like Belgrade have developed asset management systems, but most public utility companies lack the necessary tools and strategic planning, leading to inefficient water service delivery. The establishment of an asset management hub in thirty towns shows promise, yet much work remains to integrate comprehensive asset management practices across the sector.

Montenegro boasts a strong legal framework but faces challenges in financing and capacity building. Stable energy costs resulting from hydropower resources provide some operational reliability, but new projects must balance energy independence with environmental conservation. Asset management is largely underdeveloped, especially in rural areas, and preventive maintenance is rare.

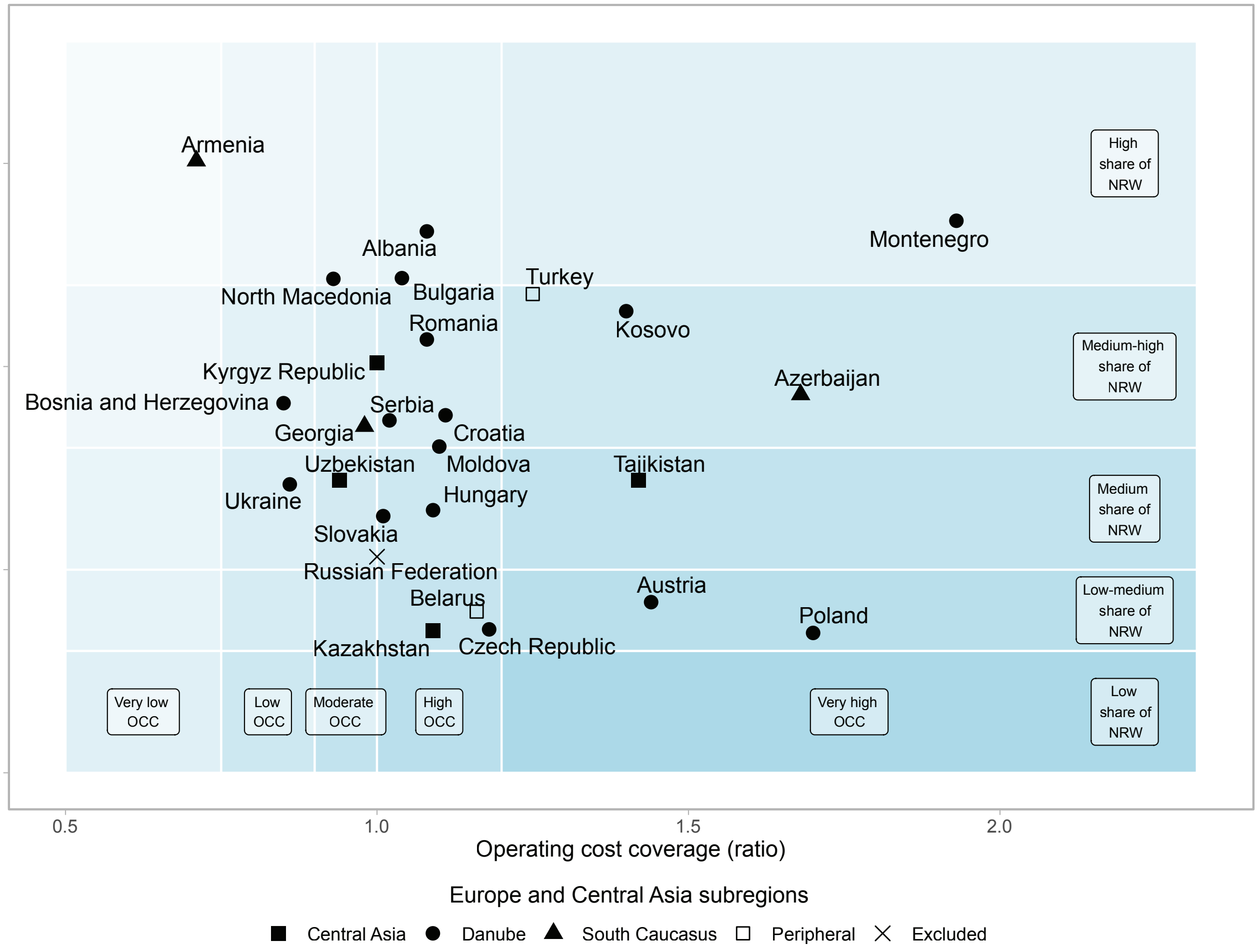
Albania is undergoing significant reforms aimed at regionalizing water utilities to enhance efficiency and financial sustainability. Despite this, asset management practices remain basic and underfunded, particularly in rural areas, where proper asset inventory and documentation are lacking. The new tariff-setting methodology aims to improve financial planning, but comprehensive asset management is still needed to ensure sustainable water service delivery.

in the piped system can be linked to financial losses. Across several subregions in Europe and Central Asia (*figure 6.7*), the countries with the largest amounts of NRW are also those with lower operating expense ratios and thus they generate lower revenues from service provision. Armenia provides the most drastic example in the Europe and Central Asia region, with only about 25 percent of the water being revenue water and average revenues from water services being 29 percent smaller than actual O&M costs. On the other extreme, Poland is a good example of a country where indicators are well on track; its low levels of NRW contribute to a high operating cost to coverage ratio. However, although business efficiency is partially driven by technical efficiency, some countries—such as Montenegro, with a substantial NRW equivalent of 67 percent—are still able to generate significant revenue surpluses (equivalent to 93 percent). This example showcases that other factors, such as water tariffs, can buffer and sustain the business model. However, this is likely to be unsustainable in the future because infrastructure requires upgrading and O&M costs increase (for example, quality standards become more stringent, electricity costs increase, new sources of water need to be developed, and so on). Increasing costs could compromise the financial sustainability of service providers and the affordability of water tariffs for water users.

Electricity costs in WSS services as a share of the operating costs could grow if water stress increases and wastewater treatment expands. Electricity costs are complex because they depend on multiple factors, such as the energy price, the source of water used, the distance or depth from which it is transported or pumped, the status of the pipe network, the level of treatment, and the differences in altitude, among other factors. At the regional level, electricity costs represent 14.3 percent of the operating costs for delivering water services (*figure 6.8*). There are, however, major differences across subregions, with the Danube and the South Caucasus in the range of 14 percent and Central Asia exhibiting larger shares equivalent to 25 percent (*table 6.4*). When analyzing different aspects that could be influencing the share of electricity costs, it is clear that in the Danube, the high share of NRW and the higher level of treatment could explain electricity use and its costs. In the South Caucasus, the combination of water stress and pollution, which probably increases the costs of pumping and pretreatment, as well as high NRW, could explain the above-average energy costs in this subregion. This situation leaves substantial room for increasing the energy efficiency of water utilities in the future. Lastly, in Central Asia, levels of NRW are lower on average compared with the other subregions, but water stress is higher, meaning that electricity costs could be influenced by pumping and pretreatment costs. In the future, decreasing the quantities of electricity used for the water supply could help reduce greenhouse gas (GHG) emissions accruing during electricity generation, thereby reducing the impact of the water sector on climate change.

Figure 6.7

PERFORMANCE OF Water Services



Sources: IBNET n.d.; World Bank, 2015c.

Note: Revenues as share of operating costs (OCC) compared to nonrevenue water (NRW) as share of total water supplied.

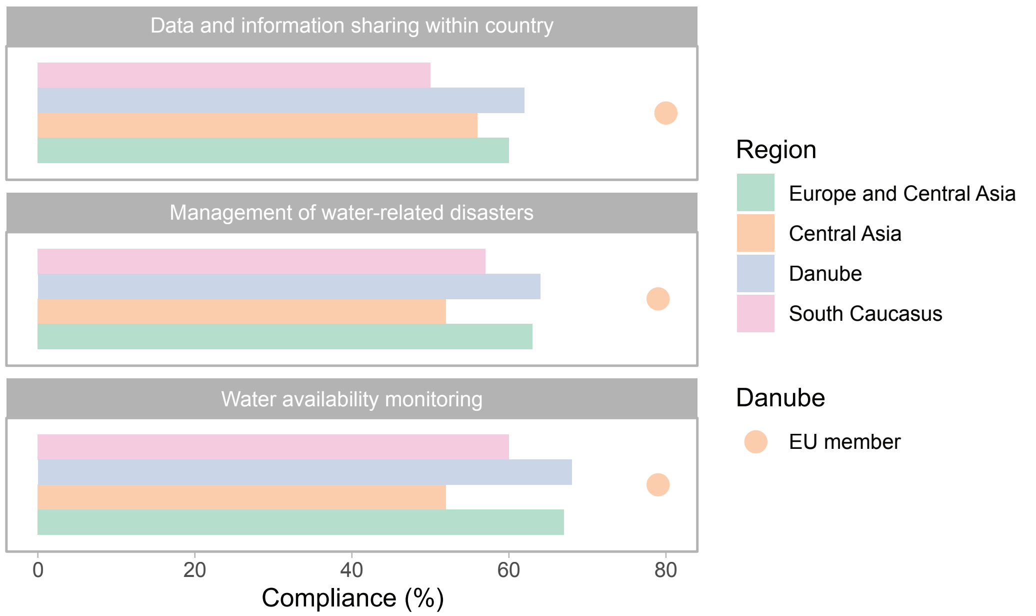
TABLE 6.4 Key Features Related to Water Supply and Sanitation Services in Europe and Central Asia

Subregion	Electricity share of the total operating costs (%)	Predominant source of water for drinking purposes	Water stress (ratio)	Treatment (% water treated)	Nonrevenue water (%)
Danube	14	Groundwater	Low	48	42
South Caucasus	14	Groundwater	Moderate	29	55
Central Asia	25	Groundwater	Moderate-high	24	35

Source: IBNET, n.d.

Figure 6.8

COMPLIANCE WITH SDG Goals on Sharing Data, Monitoring Water Availability, and Managing Water-Related Disasters

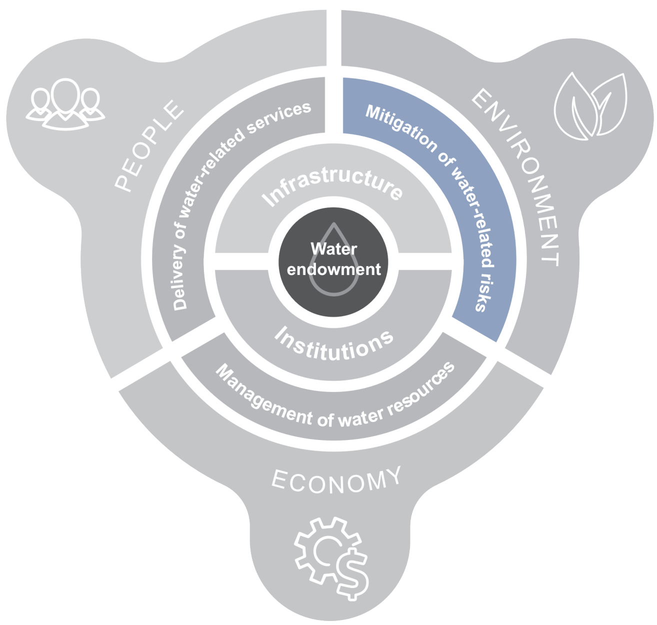


Source: UNEP and UNEP-DHI n.d.

Note: Based on countries' qualitative reporting and assessment. EU = European Union; SDG = Sustainable Development Goal.

Projected increases in climate variability will likely need adapted infrastructure, including storage that can safely supply water throughout the year. In Europe and Central Asia, many areas depend on the dynamics of snowmelt and glacier melt, as well as water from mountainous areas in general. The peaks associated with glacier melt could, however, be substantially reduced in the future. Relying on surface water for shares of water supply throughout the entire year might thus be less feasible than it is today. Similarly, the increasing probability of flood occurrences could destroy water infrastructure more frequently if no additional measures for disaster risk reduction are implemented (Howard et al. 2016). The locally adapted mix of surface water and groundwater for water supply and required infrastructure must hence be evaluated across countries and sectors and adapted to changing future conditions. Expanding and leveraging existing storage capacities is needed at varying degrees across countries to cope with increasing climate variability. For example, the fifty-five reservoirs providing 20 billion cubic meters of water storage capacity in Uzbekistan need investments in safety and sedimentation, and some additional dams should also be considered in certain areas. Other countries, such as Kazakhstan, mainly need upgrading and expansion of multipurpose storage in various facilities countrywide (World Bank 2022b, 2023e). Barriers to adaptation lie more in institutional capacity and partial inertia than in biophysical conditions (Oberlack and Eisenack 2018). Setting up and improving institutions for water governance and infrastructure must thus take into account how they can be shaped to fit future conditions under climate change.

MITIGATION OF WATER-RELATED RISKS



KEY MESSAGES

- All countries in Europe and Central Asia are developing planning tools to manage flood risks, but drought management is not yet implemented.
    - The Danube subregion is the most advanced in flood management and is transitioning from a reactive to a preventive management approach.
    - In the South Caucasus and Central Asia, flood management instruments are poorly developed.
- The lack of funding, institutional capacities, and effective monitoring and data management platforms constrain ongoing efforts to support flood risk management.
- Implementing a drought management approach requires further development of the enabling environment (normative development and institutional capacities) and technical support (an agreed-upon drought risk assessment approach, data and monitoring infrastructure).

Reducing the risk of water-related disasters calls for understanding the hazards, limiting the exposure of populations and assets, and reducing vulnerability. These goals can be achieved by undertaking a risk assessment, instituting planning for and regulation of land cover and use, setting up early warning systems, investing in a mix of gray and green infrastructure, and building institutional and financial capacities to mitigate risks and manage crises. Risk assessments are needed to improve the understanding of the specific hazards, as well as the exposure and vulnerability of populations and economic assets and sectors to the specific water risks (for example, floods and droughts). A recent study by the World Bank (2023c) conducted a flood risk assessment in Central Asia and found that countries could reduce their economic exposure by 31 percent annually (from $2.2 billion to $1.5 billion per year) if appropriate flood control measures were implemented, including both gray infrastructure (for example, dams and levees) and nature-based solutions (for example, wetland restoration and riverbank stabilization). These flood control measures can help reduce the overall risk and protect vulnerable areas from the destructive impact of floods. Likewise, countries would need to prioritize investments in early warning systems to significantly reduce the impacts of floodwater risks by providing timely alerts to at-risk communities and allowing for proactive measures to be taken. Countries in Europe and Central Asia are taking positive steps with regard to flood management, particularly in the Danube, largely driven by the EU policies (*box 6.4*).

FRMPs are being developed across Europe and Central Asia, but drought management tools are still absent. Within the Danube, the EU Member States have reached the highest level of water-related disaster risk management. The EU WFD (2000/60/EC) and the FD (2007/60/EC) are effective instruments for advancing flood and drought risk management. Most of the EU Member States have already completed the development of FRMPs, and the candidate countries are at advanced stages of this process (*table 6.5*). The Danube region and particularly EU Member States report the highest compliance with Sustainable Development Goal (SDG) 6.5.1 aims regarding data and information sharing, monitoring of water availability, and management of water-related disasters (*figure 6.8*). Candidate countries like Albania, Bosnia and Herzegovina, and Serbia report lower (medium-low to medium-high) compliance but are constantly closing the gap with the EU Member States by developing flood risk maps and management plans. A recent assessment of drought preparedness and management led by the European Commission reports that although EU Member States have made significant progress in flood management, drought management is still pending (Schmidt et al. 2023).

TABLE 6.5 Status of Flood Risk Management Planning in Europe and Central Asia

Subregion	Status of flood risk management planning
Central Asia	Flood hazard maps have been developed for the region as a part of the World Bank Strengthening Financial Resilience and Accelerating Risk Reduction program. This effort is, however, not aligned with the guidelines of the EU Floods Directive.
South Caucasus	Georgia is still adapting its legislation to support the development of flood hazard and risk mapping and the preparation of an FRMP, following the EU-Georgia Association Agreement.
Danube	Most EU countries have completed the second cycle of FRMPs (Austria, Czech Republic, Croatia, Hungary, Poland, Romania, and Slovenia). FRMPs in Bulgaria and the Slovak Republic are under public consultation and not yet approved (as of January 2024). Candidate countries are slowly adopting the Floods Directive and are in the process of preparing their first FRMPs. Some countries are in the process of public consultations or have recently completed them (Bosnia and Herzegovina, Montenegro, and Serbia), and Albania is in the process of developing flood hazard and risk maps for most of its river basin districts.

Source: Original compilation for this publication based on the information in this report and "deep-dive" reports.

Note: EU = European Union; FRMP = flood risk management plan.

Box 6.4

THE EU FLOODS DIRECTIVE: A BEST PRACTICE FOR FLOOD RISK MANAGEMENT

The European Union (EU) requires all Member States to assess and manage flood risks across all areas where significant floods could take place and to take adequate risk-reduction measures. For that purpose, each country shall conduct the following activities for each river basin district:

- Preliminary flood risk assessment to describe past (and potentially future) floods that had (or could have) significant adverse impacts.
- Flood hazard maps to delineate areas with low, medium, and high flooding probability and quantify the flood extent, water depth, and flow velocity.
- Flood risk maps to show the potential adverse impacts of floods on populations, economic sectors, and installations that might cause accidental pollution during flood events.
- Flood risk management plans (FRMPs), which are meant to be operational instruments detailing the measures to reduce the potential adverse impacts of floods on human health, the environment, cultural heritage, and economic activities. FRMPs are prepared, implemented, and renewed on a six-year cycle like EU river basin management plans (RBMPs). The active involvement of interested parties in the production, review, and updating of FRMPs shall be actively encouraged by the countries.

Source: Original elaboration for this publication based on the EU Floods Directive (2007/60/EC).

In general, the South Caucasus has shown little progress in flood and drought risk management. Since the EU-Georgia Association Agreement, Georgia has been gradually adapting its legislation to align with EU legislation and instruments that aim to improve the assessment and management of flood risks (UNDP 2022). Armenia and Azerbaijan have some infrastructure to reduce flood risk and foresee strategic planning as the next step (UNEP and UNEP-DHI n.d.).

In Central Asia, the World Bank is promoting the program for Strengthening Financial Resilience and Accelerating Risk Reduction, which supports the development of regional flood hazard maps and assesses the economic risks of floods (World Bank 2023c). To manage flood risks effectively, Central Asian countries need to identify high-risk zones for prioritizing risk-reduction actions and establish early warning systems. A further regional effort was made in December 2019 to establish the Regional Scientific and Technical Council, a public expert consultative body responsible for facilitating cooperation between the Central Asia countries' emergency authorities, carrying out scientific and technical regional assessments, and planning and implementing programs at the regional level (World Bank 2023d).

Lack of funding, institutional capacities, and effective monitoring and data management platforms hinder efforts toward flood risk management. Many Balkan countries are gradually implementing measures to manage flood risks but still often lack the regulatory instruments and the agency capacity and coordination to perform complex risk management tasks. For example, in Montenegro, the Ministry of Agriculture, Forestry and Water Management; the Water Administration; and the Ministry of Interior are mainly responsible for flood risk management (World Bank 2024c). In general, the institutions have a relatively weak capacity to deal with flood risk, and outside expertise is required to adequately assess it. In other cases, the lack of funding can stall or completely halt the implementation of measures to reduce flood risk. In Serbia, for example, the budget for flood risk management is insufficient to effectively manage flood risk in all places, and the authorities managing food risk are understaffed (World Bank 2024d). Flood risk management could benefit from more structural long-term funding, which would reduce dependency on donors for large projects. Land use planning, regulation, and enforcement are crucial, for example, to prevent construction in areas with higher flood hazards (for example, Albania and Croatia) and also to enhance forest conservation, promote management practices for regulating runoff, and prevent overgrazing (World Bank 2023a, 2024b).

Transboundary flooding requires collaborative planning and implementation of measures to reduce flood risk and provide early flood warnings. Transboundary management controls are limited to the Danube, Ob, and Syr Darya River basins. Floods are caused by the combination of severe precipitation and human actions, including land use changes, river channel modifications, and reservoir operation or failure. Often, developments or events upstream drive floods in downstream countries. For example, on May 1, 2020, the Sardoba Dam located in North Uzbekistan collapsed, and flooding spilled over into downstream areas, uprooting more than 31,000 people from their homes in South Kazakhstan (Simonovic et al. 2021). Given the deteriorated state of many large-scale water storage infrastructures in parts of the Danube region, Central Asia, and the South Caucasus, the risk of an acute flood affecting local and downstream populations should be taken into account. Although many river basins in the Europe and Central Asia region are transboundary, only three have included some measures of control on transboundary flooding management—namely, the Danube, Ob, and Syr Darya (see "Institutions" in chapter 5).

Drought management is promoted by such transnational organizations as the European Commission and the United Nations Convention to Combat Desertification (UNCCD). Development of drought management plans (DMPs) and their adoption at the national level are, however, still lacking. Some EU Member States in the Danube region are the most advanced countries in Europe and Central Asia with regard to drought management; for example, the Czech Republic, Hungary, and Romania already have DMPs in place or under preparation. Both Croatia and Slovenia are planning to develop national plans (Schmidt et al. 2023). North Macedonia and Serbia have recently submitted a national drought plan as part of the UNCCD 2018–30 strategic framework (Tsegai et al. 2021). In the South Caucasus, Azerbaijan has also submitted a national drought plan to the UNCCD, though the plan lacks some key components of drought management. For example, it only provides some examples of potential reactive and proactive drought management measures but does not allocate responsivities, timelines, and budgets for promoting them. Instead, it states: "In the future it is important to complement and enhance this national plan, in close collaboration with stakeholders to develop a series of action plans, where appropriate, to better manage water scarcity at a local level," but it does not set a timetable for future development (UNCCD 2020, 36). The UNCCD (2021) compiled a regional strategy for drought management in Central Asia. Uzbekistan also submitted a national drought plan to the UNCCD (Tsegai et al. 2021). All five Central Asian countries are taking some proactive or reactive measures to target droughts and water shortage, including upgrading irrigation systems, increasing water storage, incentivizing farmers to buy water-saving systems or seeds, and so on (Tsegai et al. 2021). Promoting these measures is, however, challenging because the governments do not currently account for the direct or indirect losses from droughts. The key challenges are similar across all subregions and include the lack of political commitment to developing a comprehensive drought policy (in the EU, only some of the Member States have developed DMPs). Such challenges are often accompanied by institutional fragmentation and a lack of synergy and information exchange. Both technical and financial resources for developing adequate monitoring and early warning systems are lacking. Further, drought issues are not fully integrated into land use, and there is a general lack of awareness of drought risk (Tsegai et al. 2021).

Drought risk assessment is crucial for the understanding of drought impacts and the planning of risk-reduction measures. Recent scientific advances provide quantitative tools to estimate drought-associated losses in at-risk systems. The complexity of droughts makes it challenging to estimate a drought's impacts or even to define it. In fact, EU Member States use a significantly diverse set of drought definitions in their national DMPs (Schmidt et al. 2023). Drought and other natural hazards compound events and make it difficult to quantify the drought-associated impact or loss (UNCCD 2020). Recent advances in drought risk assessment provide quantitative, data-driven tools for estimating the impact on specific at-risk systems, for example, hydropower generation and irrigated or rain-fed agriculture (*box 6.5*). Such approaches provide a pathway for countries to assess and manage droughts, which is becoming increasingly important for climate-change adaptation.

Box 6.5

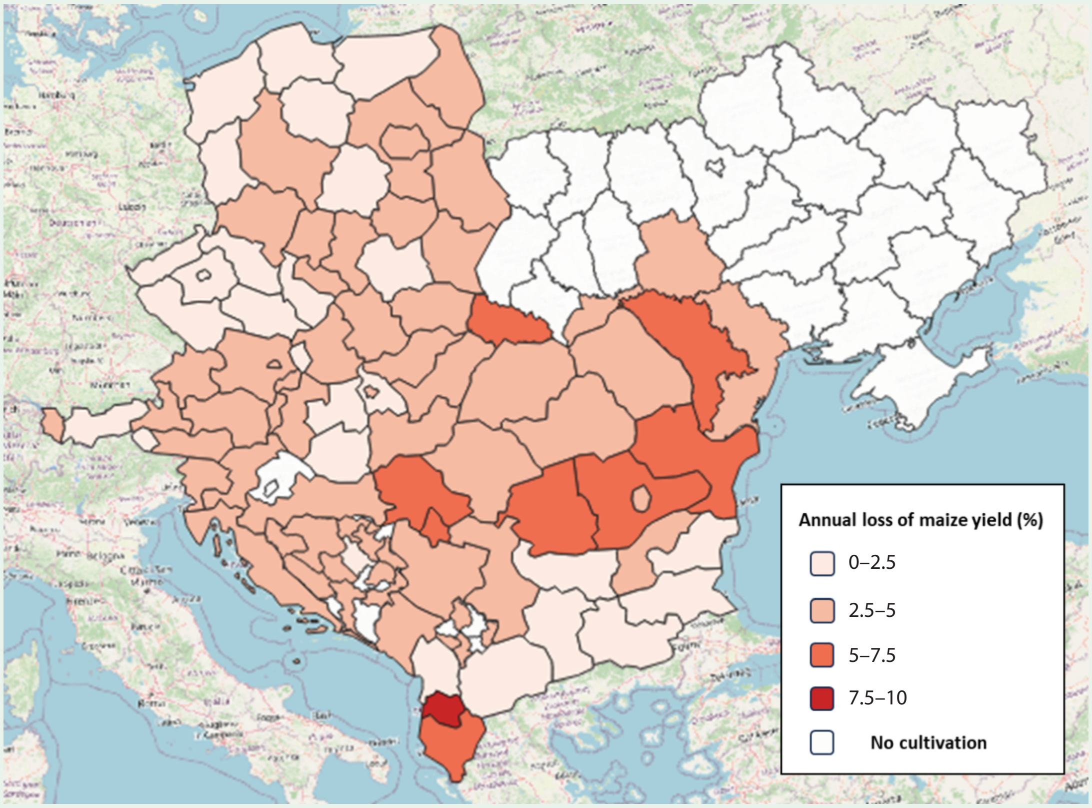
DROUGHT RISK IMPACT ASSESSMENT FOR THE DANUBE USING A DATA-DRIVEN APPROACH PROVIDES A DEEPER UNDERSTANDING OF DROUGHT IMPACTS

Recent advances in drought risk assessment provide tools to quantify multisector drought-driven impacts. The European Drought Observatory Risk Assessment led by the European Commission Joint Research Center has developed a data-driven approach for sectoral drought risk impact assessment as part of the European Drought Risk Atlas (Rossi et al. 2023). Supported by the World Bank Group, this work was extended by the Water Research Group at the International Institute for Applied Systems Analysis to include the Western Balkans and Eastern Europe (Fridman et al. 2023).

The Danube region experiences substantial annual average productivity losses across multiple at-risk systems, ranging from 2.5 to 5 percent for wheat and maize yield in vast areas across the Danube region, though some regions at level 2 of the Nomenclature of Territorial Units (NUTS2) experience higher losses. For example, annual average productivity losses of higher than 5 percent are expected in Albania, Moldova, Romania, Serbia, and West Ukraine (*map B6.5.1*).

Map B6.5.1

ANNUAL AVERAGE Losses of Maize Yield in the Danube Region at a NUTS2 Spatial Resolution



Sources: Fridman et al. 2023; Rossi et al. 2023.

Note: NUTS2 = level 2 of the Nomenclature of Territorial Units.

7

Recommendations for a Water-Secure Future in Europe and Central Asia

Water is critical to the smart, cost-effective policies needed to meet global climate and sustainability targets while generating significant co-benefits across goals. Countries in Europe and Central Asia operate within global frameworks that establish international and national development objectives for tackling common priority challenges. The 2030 United Nations (UN) Sustainable Development Goals (SDGs) and the Paris Agreement provide reference frameworks for countries to advance their sustainable development agendas. National development pathways should support efforts to achieve these overarching goals, such as reducing poverty, providing clean water and sanitation, ensuring food security, improving health, promoting affordable and clean energy, fostering employment and economic growth, reducing inequalities, creating sustainable cities, forming development partnerships, and taking climate action, among other targets. Given the size of the challenge worldwide, and particularly in Europe and Central Asia, it is crucial that countries design smart, cost-effective policies to meet the required targets while also generating significant co-benefits across other goals. Investing in water security is essential to achieving universal access to water supply and sanitation (WSS) services and, if done smartly, can pave the road for materializing many cross-sectoral objectives.

Pathways to water security should be designed to improve livelihoods, protect the planet, and boost economic prosperity. Although climate change is fundamental, water interventions must be tailored to regional and national priorities and capacities. Based on these diagnostic and national development priorities across Europe and Central Asia, five main action areas have emerged that offer clear opportunities for countries to improve their water security and deliver larger economic, social, and environmental benefits to the region (*figure 7.1*), bolstered by the imperative for cross-cutting efforts to promote regional collaboration.

Although this chapter outlines strategic recommendations for improving water security across the region, it is important to consider the unique circumstances of each country. Appendix B provides detailed country pages illustrating how these general recommendations align with the specific needs and situations of individual nations. Policymakers and stakeholders are encouraged to consult the appendix for tailored insights that can guide implementation at the country level.

Most of the activities proposed to strengthen water security will unfold at the national level. In practice, most activities must be undertaken at the national scale. However, given the region's unique hydrological interdependence on transboundary rivers and shared cross-border hydraulic infrastructure, regional cooperation and cross-border investments are key to managing hydrological risks, addressing the effects of climate change, and taking advantage of regional coordination and trade prospects. Thus, the successful implementation of the priority action areas hinges on the promotion and strengthening of regional cooperation efforts.

DELIVERY OF WATER-RELATED SERVICES

Action area 1: Modernize irrigation and drainage services to improve water efficiency and productivity.

Substantially increase levels of funding to the irrigation sector and create a favorable enabling environment to attract private sector investment. Levels of investment in irrigation are insufficient to meet each country's needs or achieve the SDGs in a timely fashion. A public expenditure review of a small group of countries revealed that spending on irrigation is considerably less than spending on WSS and completely dwarfed by spending on infrastructure, often representing less than 0.5 percent of a country's gross domestic product (GDP). There is a need to strengthen the coordination of development partners at national, regional, and international levels to harmonize irrigation policies and strategies and leverage investments, including the potential for cofinancing, parallel financing, and co-creation of knowledge. Moreover, there is a need to leverage public finances by enhancing or supporting the already significant private investments in irrigation in Europe and Central Asia. Private or farmer-led irrigation schemes have become increasingly significant in the region and often focus on the introduction of advanced irrigation technologies, such as drip irrigation, automated sprinkler systems, and precision agriculture technologies. These investments are driven by the need to maximize water-use efficiency and crop yields, particularly in regions facing water scarcity. Thus, the promotion of farmer-led irrigation can lead to more rapid adoption of innovative technologies and practices. Companies and private farms tend to be more flexible and quicker in implementing new technologies compared with public sector programs, which can be slowed by bureaucratic processes. Private-public partnerships (PPPs) in irrigation are more likely to succeed when the policy environment supports high-value and commercial agriculture and where farming is profitable, and policy reforms will be needed to ensure an attractive enabling environment for private participation.

Deepen and expand ongoing institutional and policy reforms. Europe and Central Asia's irrigation sector has undergone substantial policy reforms, focusing on improvements in irrigation service delivery and more efficient and sustainable water use. The reforms include decentralization, the establishment of water user associations, and water pricing. These initiatives require tailor-made legislation to ensure their success. In some cases, revisions to existing water laws and codes may be required, as was the case for the Kyrgyz Republic in 2003. This comprehensive change in legislation, supported by technical assistance from the World Bank and promoted through Parliament by the State Water Resources Agency, provides a useful model for modern water resources planning and management. Such reforms lay the groundwork for a more integrated and adaptive water management strategy. The irrigation service delivery needs to be transformed from the bureaucratically administered allocation model to on-demand systems to allow flexibility in irrigation water supply and enhance the entrepreneurial capacities of beneficiaries. Reforms need to allow for the enhanced role of farmers in the development and operation and maintenance (O&M) of irrigation systems.

Figure 7.1

ACTION AREAS for Water-Secure Development Pathways in Europe and Central Asia

DELIVERY OF WATER-RELATED SERVICES		MANAGEMENT OF WATER RESOURCES		MITIGATION OF WATER-RELATED RISKS
ACTION AREA 1	ACTION AREA 2	ACTION AREA 3	ACTION AREA 4	ACTION AREA 5
Modernize irrigation and drainage services to improve water efficiency and productivity	Expand WSS coverage and wastewater treatment to safeguard public health and the environment	Modernize institutions and build adaptive capacity to support a full implementation of IWRM	Fast-track the adoption of smart technologies and modernize information management systems	Enhance water-use efficiency and climate strategies to boost the economy and protect people and the planet
NATIONAL	NATIONAL	NATIONAL	REGIONAL AND NATIONAL	REGIONAL AND NATIONAL
CROSS-CUTTING EFFORTS				
ACTION AREA 6: PROMOTE REGIONAL COOPERATION TO STRENGTHEN DEVELOPMENT OPPORTUNITIES				

Note: IWRM = integrated water resources management; WSS = water supply and sanitation.

Rehabilitate and modernize existing irrigation systems and management practices to improve agricultural productivity. The irrigation sector in Europe and Central Asia represents a mix of aging, underdeveloped, and inefficient infrastructure. Development in the Danube is insufficient; where present, it suffers the same fate as the other subregions: Infrastructure is decaying (as much as 50 years old) and therefore highly inefficient and at the root of low water productivity. The potential to improve agricultural water productivity exists in many countries. In Central Asia, for instance, rehabilitating current systems could lead to water savings of up to 7 percent of current water withdrawals by 2030 and up to 10 percent by 2050. In tandem with policy reforms, the region needs to embark on a modernization campaign that includes dams and reservoirs, as well as upgrades to irrigation infrastructure, including canals, pipelines, and water distribution networks. Specifically, these measures may include (a) converting open canals to piped, closed, and pressurized systems; (b) embracing technical and process innovations; (c) transitioning from flood irrigation to modern techniques; (d) adopting smart and prepaid irrigation water meters to support accurate pricing of irrigation water; and (e) instituting modern information management systems for irrigation.

Invest in more efficient irrigation methods to further improve water productivity and protect the agricultural sector from climate shocks. High dependency on rain-fed agriculture in the Danube and aging and inefficient irrigation infrastructure in the South Caucasus and Central Asia increase the vulnerability of the region's agricultural production to climate shocks such as droughts. Shifting toward efficiently irrigated, high-value crops while increasing the climate-adaptive capacity of rain-fed agriculture, implementing pricing mechanisms to reduce overuse and pollution, implementing better water delivery control, and improving access to knowledge and finance for farmers are some of the ways to enhance water use and productivity in the agricultural sector. Further shifts in irrigation methods might include the following:

- Changing cropping patterns, shifting to efficient sprinkler and drip irrigation, and pricing water to incentivize water savings
- Capturing more water and allowing it to infiltrate into the root zone with water-harvesting techniques, such as surface microdams and subsurface tanks, and with soil and water conservation practices, such as runoff strips and terracing
- Using available water more efficiently by increasing plant water-uptake capacity and reducing nonproductive soil evaporation with integrated soil, crop, and water management strategies, such as conservation agriculture and improved crop varieties
- Reusing treated wastewater for irrigation as part of a greater water resources management (WRM) strategy in Europe and Central Asia, especially in response to increasing water scarcity and the need for sustainable agricultural practices

Strengthen agricultural practices, especially at the farm level. Irrigation modernization must be accompanied by modernization of agricultural practices, including O&M of physical infrastructure, to deliver optimal results for (expensive) physical system modernization. But importantly, support needs to be provided to enterprising and entrepreneurial lead farmers who can act as catalysts for change at the farm level and support other farmers who may not have received adequate training in crop husbandry or irrigated farming practices. Providing credit to farmers may be a key part of this process and may require policy and legislative changes by the government. The development of online education and training programs is a cost-effective way of upgrading knowledge for farmers and irrigation professionals. These programs can be developed with the assistance of university, training, and research institutes as part of an external program. Such programs can be fee-earning offerings or subsidized by government or interested private sector organizations.

Ensure the inclusion of women and youth. Actively increasing the gender equity of irrigation includes involving women in the design of irrigation systems, providing women equal access to information on irrigation technologies and credit that considers women's lower access to collateral, ensuring that women's time use is not increased through the adoption of irrigation technologies, and so on. The aging demographic in rural Europe and Central Asia means there are fewer young people entering the agricultural workforce, which needs to be ameliorated by crafting and promoting youth-friendly agricultural policies and technologies. If given opportunities, members of the younger generation are more open to embracing innovations and new business models.

Action area 2: Expand WSS coverage and wastewater treatment to safeguard public health and the environment.

Adopt a portfolio approach to address the gap in WSS services, support socioeconomic development, and reduce waterborne disease. Most countries have achieved close to universal access to at least basic drinking water and sanitation (97 and 95 percent, respectively). Still, nearly 17 percent of the regional population lacks access to safely managed drinking water, and 32 percent lacks access to safely managed sanitation. This gap is particularly prevalent in rural areas, where less than 50 percent of the population has access to safely managed sanitation. Upgrading service standards will have added socioeconomic benefits—for example, improved health leads to increased productivity, as can providing better services to growing sectors such as tourism. To meet the needs of the unconnected, countries will have to explore different service delivery options rather than pursuing a one-size-fits-all approach. Mixed delivery models should prioritize centralized solutions in large urban centers. But in periurban and rural areas, where centralized systems are often unaffordable or economically unfeasible, on-site and decentralized services need to be explored. Implementing this portfolio approach will require countries to develop legislative frameworks and financing measures that recognize and enable a variety of service models along the value chain and set up targeted investment programs for the unconnected located in periurban and rural areas. These investment programs should be developed in cooperation with local governments and communities to find affordable yet effective solutions.

Devise innovative strategies to extend wastewater treatment and mitigate environmental pollution while fostering new, climate-neutral business models. Wastewater treatment has received less attention than drinking water and sanitation, and currently, only 60 percent of the wastewater in Europe and Central Asia is collected, of which only 43 percent receives (at least primary) treatment. There are large disparities across the region, with treatment rates in Central Asia and the South Caucasus below 25 percent, whereas treatment rates in European Union (EU) Member States exceed 70 percent. As with WSS services, different solutions are needed, including centralized wastewater treatment plans in the largest agglomerations, alongside decentralized and cost-effective technologies, such as nature-based solutions, in rural and periurban areas where expensive technology is less economical and less affordable. Wastewater treatment offers attractive business opportunities for service providers to promote green and circular economy models, for instance, through the development of wastewater reuse, which shows great potential in Europe and Central Asia, given that less than 5 percent of wastewater treated is currently reused. Water reuse can become an effective solution in those areas where pumping costs make irrigation economically unviable and generate additional revenues for service providers. Likewise, shifting to a new paradigm of "from waste to resource" can also become a business opportunity through the recycling of sludge for biogas or agriculture fertilizers.

Strengthen existing institutional capacities and enabling environments to improve the capacity of service providers and increase operational and financial performance. Institutional arrangements for WSS services are well developed in Europe and Central Asia, but major institutional fragmentation persists, which translates into jurisdictional asymmetries with a spread of regulatory, management, and financing functions across different institutional levels—these are not always fully coordinated. Such fragmentation is rooted in the decentralization processes of many Europe and Central Asia countries. Nowadays, most policy-making functions (and financing) are coordinated at the national level by different ministry lines (that is, water, infrastructure, health and environment), whereas planning is largely decentralized to regional and municipal levels. This process needs further reforms so that regional and local governments have sufficient financial and institutional capacities to match investments with coverage needs.

Institutional reforms should target the professionalization and capacity building of service providers, which should also be captured in legal frameworks. Good practices include the development of waterworks associations, such as those developed across several countries in the Danube, which provide technical assistance, knowledge exchange, and technical guidelines to service providers. Likewise, countries in Europe and Central Asia should also pursue the expansion of national regulatory bodies that, as yet, are present in only fifteen of twenty-four countries. Either multisector or water-specific regulators can play a major role in improving the quality and efficiency of water services by protecting customers from low-quality or costly services through tariff setting and control, granting operator licenses, and developing standards for safe drinking water and wastewater treatment.

Enhance the sector's overall financial framework by utilizing a mix of tariffs, taxes, and transfers to boost financial capacity and provide the enabling environment to mobilize private capital. To meet SDG 6 by 2030 will cost \$16 billion per year, whereas reducing the proportion of untreated industrial wastewater by half in the same time frame will cost about \$18 billion per year (or 0.25 percent of the regional GDP combined). Current investment levels are low, and funds from different sources (either through taxes, tariffs, further transfers from state budgets and international funds, or private investments) will need to be mobilized. Good practices to improve financial frameworks include reviewing tariff methodologies and overall levels versus affordability thresholds, leveraging available grant funding and tax allocations under a strategic sector financial planning approach, and developing financing strategies and policies. Tariffs represent the most important source of funding for overall sector expenditures across Europe and Central Asia. Service providers can also be incentivized to improve their performance to increase cost recovery and reduce the public funds required to finance pending projects needed to close existing gaps. Good practices to increase financial sustainability include performance-based financing to service providers to incentivize efficiency and performance, financing of infrastructure renewal, and capital expenditure (CAPEX) with strong externalities from public budgets. Finally, private capital mobilization has proved to be a successful strategy for addressing infrastructure needs in many countries, as well as helping public utilities (for example, through the establishment of PPPs) to manage different services along the value chain, including wastewater treatment services.

Enhance management of service revenues to improve service efficiency and modernize deteriorating infrastructure. Nonrevenue water (NRW) across Europe and Central Asia averages above 44 percent, meaning 4 out of every 10 cubic meters of water produced are not charged to users, either because water is physically lost across the network or is illegally abstracted. These physical water losses translate to significant financial losses, and revenues from water tariffs are unlikely to be sufficient to cover asset management as well as the renewal of infrastructure. Investments to upgrade existing water services infrastructure can help reduce NRW, achieve cost recovery, and generate surpluses that can be reinvested in the maintenance and expansion of infrastructure. But such investments need to accompany or be preceded by institutional reforms to strengthen cost recovery for O&M, as well as those necessary for asset management and the renewal of infrastructure. Otherwise, new infrastructure will not be maintained, perpetuating the build-neglect-rebuild cycle. Many countries across Europe and Central Asia are caught in this vicious cycle (for example, Montenegro), where operating costs of >1 are insufficient to counteract significant NRW. This cycle becomes even more unsustainable as infrastructure requires upgrading and O&M costs increase (for example, quality standards become more stringent, electricity costs increase, new sources of water need to be developed, and so on), compromising the long-term financial sustainability of service providers and the affordability of water tariffs for users. A first step out of this vicious circle would be to take stock of existing assets, identify maintenance opportunities, and look for efficiency gains in the system. Involving the private sector via performance-based management contracts to identify and reduce technical losses in the system has proven to be a successful approach to making systems more efficient.

MANAGEMENT OF WATER RESOURCES

Action area 3: Modernize institutions and build adaptive capacity to support a full implementation of IWRM.

Reinforce the legislative and institutional frameworks to support a full implementation of integrated water resources management (IWRM). Countries in Europe and Central Asia have made important strides to support the implementation of IWRM, undertaking reforms to adapt new regulatory frameworks, allocating responsibilities for policy making and management across institutions, and identifying financing needs. However, major gaps remain, and reforms must continue to create a strong enabling environment. Most countries in Europe and Central Asia have water regulatory frameworks in place that address key aspects of IWRM, but their implementation is lagging because of limited normative development, particularly on allocation mechanisms, ecosystem protection, and risk management. In a context where water demands are increasing, conflicts between users within and across borders (for example, water-energy disputes in Central Asia) are on the rise. Where climate variability and environmental degradation are growing, further development and modernization of existing regulatory frameworks are needed to address these critical aspects. Such regulatory reforms should also address the existing institutional fragmentation and overlaps of responsibilities within and across the water sector observed in many countries. Progress has been achieved, and many countries have pursued the development of water ministries to centralize water policy functions. However, many still have water functions spread across multiple state bodies—for example, water policy functions in Serbia remain spread across seven ministry lines, and surface water and groundwater continue to be managed by different state bodies in countries like Kazakhstan and Uzbekistan. Such reforms are quite complex and require in-depth institutional assessments to identify an effective and efficient pathway to reform.

Develop, prioritize, and implement long-term national water management strategies to address existing threats and anticipate future ones, especially in countries where a strategy is still needed. Most countries in Europe and Central Asia lack a comprehensive water strategy, and where present, they are often constrained by limited normative development and insufficient funding. Water management functions are very broad and require a large effort to facilitate their implementation. Although national strategies need to provide a comprehensive vision for the water sector and guidance on how to overcome existing and emerging threats, strategies also require an incremental approach to implementation. Such an approach means that countries will have to prioritize reforms and investments over a determined timeline to ensure these can be implemented to fulfill the vision of the strategy. Setting up such a strategy and securing the relevant capacity needs requires long-term political support and prioritization of water in the political agenda as a key asset to socioeconomic development.

Develop innovative mechanisms to support sustainable financing of WRM, including a mix of taxes, tariffs, public funds, and private capital. Similar to WSS services, WRM is mostly underfinanced across Europe and Central Asia. Available funding is mainly allocated to new infrastructure development and much less to O&M of existing infrastructure or to support the actual management of water resources. This underfunding is also largely driven by the fact that economic mechanisms to generate revenues for WRM are not well developed, and where present, they are insufficient or transferred to the state budgets without being earmarked for WRM. In most countries, revenues are obtained through water tariffs, which are often too low or insufficient to meet the cost recovery of water services. Other financing mechanisms, such as environmental and resource protection charges, are barely developed across Europe and Central Asia, except for a few EU Member States in the Danube subregion. To overcome this financial gap, different principles for water resources financing can be considered, including the polluter-pays principle, which allows countries to develop water charges for resource protection. A complementary mechanism is the cost-recovery principle, which implies that water service costs, including operational, maintenance, and capital costs, as well as environmental and resource costs, should be recovered from users based on their usage. A third possible principle is the policy coherence principle, which seeks to ensure that different policy areas (agriculture, energy, land use, urban development, and trade) do not have negative impacts on water availability, quality, and freshwater ecosystems or increase the cost of water management. At the institutional level, this can be supported by the consolidation of policy making for water quantity and quality management under one ministry.

Continue implementing the river basin management approach and overcome existing associated institutional weaknesses. The experience gained in Danube EU Member States shows that basin planning is instrumental in supporting the implementation of IWRM. However, the required substantive institutional, technical, and financial capacities are lacking in many countries within Europe and Central Asia. Most countries have made important efforts to implement the basin water management approach and develop decentralized management institutions, such as river basin organizations, although in some subregions, these are still underdeveloped (for example, Central Asia and the South Caucasus). Where river basin organizations have been established, they face important institutional weaknesses, mainly because they have limited authority and largely act as consultative organizations, with minimum budget and IWRM capacities. In some cases, decentralization of water management has been directly delegated to regional branches of the state body or administrative regions with jurisdictional borders that do not align with hydrographic basins. Therefore, to support the implementation of IWRM at the basin scale, it is fundamental that existing and new institutions are provided with expanded functions beyond a consultative function so that they can plan, manage, and allocate water within basin boundaries. In the same way, institutions need to be provided with sufficient human and technical capacities and financial resources. Enhancing participation and improving technical autonomy, accountability, transparency, and efficiency principles are also key to robust and well-performing institutions.

Further develop management instruments to increase the performance of WRM. The main priorities in implementing IWRM include the following:

- Establish water allocation mechanisms. Water tariffs for services beyond water supply and sanitation (for example, irrigation), as well as economic instruments, such as environmental and resources charges, need to be further developed. This needs to be accompanied by a strategy to ensure service cost recovery to ensure the financial sustainability of service provision while generating the appropriate incentives for users to use water efficiently and sustainably.
- Enhance public participation and promote the development of stronger river basin councils. Although reflected in the regulatory frameworks of many countries, in practice, stakeholder participation is limited and not always inclusive. Where mechanisms for public participation exist, these are generally articulated around river basin councils, but such institutions have limited resources and capacities to engage wider groups. Strengthening public participation will help empower local communities, improve decision making to develop consensus on the best way of conserving and utilizing water, and ultimately, create a common ground for developing solutions and potentially avoiding future conflicts.
- Develop and regularly update operational planning tools to support the effective management of water resources and water-related risks. Basin, flood, and drought management plans are basic instruments for WRM and risk mitigation and management. Basin plans are being developed across many countries, but further efforts are required to support the practical implementation of IWRM at the basin scale. Such plans could be guided by the EU Water Framework Directive (WFD) and by learning from the experience gathered in Europe, particularly in Danube countries. Flood management plans need to be further developed to support the transition from a flood-reactive to a flood-preventive management approach, where risks are well identified and mitigation measures (soft

and hard) are implemented. Drought management plans are still lacking across the entire region, and the first step will require taking stock of the different countries' approaches to and experiences with managing droughts, co-defining a standard approach to the measurement of drought risks, and establishing management measures. Drought management plans represent a cornerstone for climate-change adaptation in Europe and Central Asia, given that rising temperatures and growing rainfall variability will increase the risks of extreme events, especially droughts. rising temperatures and growing rainfall variability will increase the risks of extreme events, especially droughts.

Action area 4: Fast-track the adoption of smart technologies and modernize information management systems.

Rehabilitate, modernize, and promote the adoption of advanced technologies to enhance water planning, use, and management. There is growing potential for the adoption of transformative digital solutions in the water and irrigation sectors to leverage the latest enabling technologies, including cloud platforms, mobile platforms, intelligent infrastructure, sensors, communication networks, artificial intelligence, and big data analytics. Technological advances have the potential to do the following:

- Improve decision making and help actors anticipate and adapt to uncertainty and change, for example, by providing accurate and real-time data, as well as knowledge, to optimize resource allocation, anticipate potential challenges, and take proactive measures to mitigate them
- Contribute to protecting and improving water systems in the context of water scarcity, including, for example, generating efficiency gains by reducing NRW and irrigation losses and, for wastewater treatment, helping plants reduce their greenhouse gas (GHG) emissions
- Generate benefits for service providers, end users, and the environment alike, creating an open dialogue among actors and enabling better monitoring, management, and optimization of service delivery

Expand and upgrade data-monitoring systems. Most countries have established a water abstraction permit system, and some have developed a cadaster of water uses; however, data are often not up to date and are scattered across institutions. Surveillance mechanisms (for example, metering) in the field are largely missing and need to be strengthened. Data-monitoring systems (meteorological, hydrological, chemical, hydromorphological) are underdeveloped, and the existing network has limited coverage, is largely antiquated, and has fallen into disrepair; this means evidence-based decision making for water resources planning and management is almost impossible. Countries have started to reinvest in modernizing their water information systems, yet allocation of adequate funds for ongoing investments and O&M remains a challenge.

Adopt and implement smart water technologies to support the modernization of the irrigation sector. The adoption and implementation of modern technologies designed for the irrigation sector—such as laser land leveling; a change in irrigation methods on some schemes from surface to drip and sprinkler irrigation; conversion of some systems to on-demand piped irrigation supplies; and remote-sensing technology for irrigation planning, scheduling, and water accounting—need to be accelerated.

Develop water information systems and promote data exchange. Currently, most countries lack a water information system, or the water system is very basic. Developing such systems will also facilitate data exchange across water institutions and increase transparency with the public. Promoting such an information system with open data policies will require addressing existing regulatory gaps—namely, gaps in skills that some countries might face.

Develop a country- and basinwide water balance. Almost no country in Europe and Central Asia has a comprehensive water balance at either the country or basin level. This information is necessary now and for use as a structural tool in the future; countries can benefit from the use of advanced Earth observation technologies and open-source hydrological and hydroeconomic models for planning purposes. There is a particular knowledge gap with respect to groundwater, which needs to be addressed because groundwater is the main source of drinking water across many countries.

MITIGATION OF WATER-RELATED RISKS

Action area 5: Enhance water-use efficiency and climate strategies to boost the economy and protect people and the planet.

Implement a combination of investments to improve water-use efficiency, along with a strategy to rethink how water is managed, with a focus on increased water productivity. Water productivity in Europe and Central Asia is highly diverse: certain countries in the Danube subregion have some of the highest water productivity levels in the world (averaging more than $100 per cubic meter). At the other extreme, and despite being relatively highly industrialized, albeit with a less profitable sector specialization, water productivity is substantially lower in Central Asia and the South Caucasus (equivalent to $2.8 per cubic meter and $6.1 per cubic meter, respectively). This sharp contrast between subregions shows there is an untapped potential to increase the efficiency and management of water resources and contribute to boosting economic growth while increasing resilience to climate change. Because added value is often higher in the manufacturing and service sectors, a shift away from agriculture (the largest water user) toward the manufacturing and service sectors could increase GDP and water productivity. However, agriculture is a key sector contributing to the achievement of other important regional objectives, such as food security, biodiversity conservation, climate mitigation, links to the agri-food processing industry, exports, employment, and rural development. Agriculture is, and will remain, a critical sector for the region in regard to both rural livelihoods and water management, and strategies should therefore focus on improving productivity across the different sectors, including agriculture, while adapting to changing climate conditions. Climate change will have multiple economic impacts in Europe and Central Asia, and the latter is considered one of the most vulnerable regions in the world to future water stress, with its growth rate declining by as much as 11 percent of GDP by 2050 because of the vulnerability of its economic sector and low water-use efficiency. By improving water management and investing in water efficiency, however, Central Asia could instead accelerate its economic growth (by as much as 12 percent by 2050) through improved agricultural production, green energy production, and improved health of the region's environmental assets.

Prioritize investments in measures of climate-change adaptation to build economic and social resilience. Almost one-third of Europe and Central Asia's population lives in water-stressed areas— that is, areas where there is already growing competition for water resources. The situation is likely to worsen because of two compounding effects: climate change and growing demands resulting from population growth and socioeconomic development. The former is likely to affect water availability by altering hydrology, inducing changes in seasonal flows, causing a temperature-driven increase in water demand, and inducing a reduction in snowpack storage. Meanwhile, water demands are expected to increase across the region sharply, from 30 to 60 percent by 2050. Under this scenario, water stress will likely increase, increasing conflicts between water users. To reduce future conflicts and increase resilience, countries must prioritize adaptation measures to build broader economic resilience to climate change. Key adaptation measures include (a) expanding water storage (either through gray or green infrastructure) to buffer the impacts of climate-change variability and address the alarming rates of current dam storage losses; (b) upgrade existing water facilities to reduce water losses in irrigation and WSS; (c) develop alternative water sources (desalinization, water reuse, rainwater); and (d) improve reservoir operations to better balance energy security, water supply, and flood mitigation.

Promote adaptation measures to limit the impact of extreme weather events and rainfall variability. Population and economic exposure to floods are expected to increase across the region. Increasing storage capacities and water-reuse systems will go a long way toward building resilience. Better urban planning, risk management, and citizen engagement will likewise reduce the exposure of cities to flood risks. In rural areas, expanding crop insurance programs can protect farmers against rainfall shocks. Capital investments, such as dams, levees, and green solutions, are needed to protect cities from floods. Because the precise impacts of climate change are uncertain and large investments are costly and irreversible, their siting and design must be carefully chosen to reduce regret.

Investments in sanitation and wastewater treatment, along with irrigation and drainage, must prioritize climate resilience. Sanitation and wastewater systems contribute to GHG emissions directly, through the breakdown of excreta discharged into the environment or during treatment processes, and indirectly, as an energy-intense process. Even though concrete figures for Europe and Central Asia are incomplete, evidence (see, for example, Li et al. [2015] and Lu et al. [2018]) suggests that centralized treatment plants require considerable energy inputs, estimated to be equivalent to 3 percent of global electricity consumption. In addition, the degradation of organic matter during wastewater treatment contributes roughly 1.57 percent of global GHG emissions. On-site sanitation solutions like pit latrines, one of the main options for low-income users, are estimated to account for about 1 percent of global anthropogenic methane emissions. These emissions are rarely considered by countries or development organizations when selecting technologies to close sanitation and wastewater treatment gaps. There is significant potential to reduce emissions from sanitation and wastewater systems through recovery of energy and nutrients contained in waste while also providing indirect reduction of emissions through renewable energy production and reduced dependency on fossil-based chemical fertilizers. This approach would contribute to climate action and reduce the discharge of contaminants into the environment, as well as provide co-benefits through increased food and energy security across Europe and Central Asia.

The irrigation sector also produces GHG emissions. Inefficient practices like flood irrigation and water losses contribute to higher methane and nitrous oxide emissions. Pumped irrigation can also contribute to an increase in GHGs, whereas drainage of wetlands can harm ecosystems and lead to loss of soil carbon. Strategies such as improving irrigation efficiency and modernizing infrastructure can mitigate the sector's carbon footprint.

CROSS-CUTTING EFFORTS

Action area 6: Promote regional cooperation to strengthen development opportunities.

Strengthen regional technical cooperation to reduce environmental and socioeconomic risks and costs and support the implementation of existing agreements. Despite having one of the world's highest transboundary dependency rates, data exchange and cooperation in transboundary settings are the exception rather than the rule in Europe and Central Asia. This limited exchange is motivated by the lack of data but often political disputes as well, especially in Central Asia and the South Caucasus. Increased exchange of data and information related to water resources and their use, the establishment of joint monitoring and early warning systems, and joint research activities can reduce existing data and knowledge inefficiencies. However, increased technical cooperation on its own, without political agreements, limits the remit of potential mutually beneficial trade-offs and constitutes a weak basis for long-term investments.

Reinforce subregional political cooperation to further reduce the risks and costs of water insecurity, complementing technical cooperation. Political cooperation could include the development of bi-, tri-, or multilateral agreements that would govern the management of specific infrastructure (for example, dams) and coordinate water resources use in country subbasins. Typical agreements might include regulations on water flows, potentially combined with agreements on energy trading and joint operation of and investments in specific infrastructure projects, such as wastewater treatment plants, hydropower projects, or dam safety, with cost sharing and co-benefits. Political cooperation would increase the potential scope of beneficial trade-offs and reinforce expectations of future cooperation, thereby improving the basis for investments.

Promote regional cooperation to support the development and implementation of institutional and legal frameworks to jointly manage transboundary basin resources and unlock substantial benefits. This would include comprehensive agreements on the management and protection of water resources and also related issues like energy. Although countries in the Danube have well-developed regional agreements in place, there are fewer agreements in Central Asia and the South Caucasus, and these agreements are often breached because of conflicting national priorities and mistrust. Such overarching frameworks are therefore challenging to implement in Central Asia and the South Caucasus, and the current emphasis on leveraging top-down regional frameworks would probably be more effective if complemented with subregional and technical cooperation efforts as first steps to building the trust required to negotiate those areas that offer the greatest joint benefits.

Promote regional policy dialogue on WRM to support knowledge sharing and transfer. Most countries in Central Asia and the South Caucasus would need to make significant reforms and investments to have modern and efficient WRM systems in place. Danube countries are front-runners in the implementation of an ambitious IWRM agenda, and Central Asia and the South Caucasus can benefit from exchanging and receiving advice on how to implement different reforms. Within the Danube subregion, EU candidate states have received support and advice from Member States through multiple mechanisms, including policy dialogue. This practice has provided valuable support to help orient candidate states in prioritizing their reforms to comply with the EU Water Acquis. The United Nations Economic Commission for Europe (UNECE) is currently leading the National Policy Dialogues on Water Resources Management under the EU Water Initiative[1] involving Central Asia and the South Caucasus. These dialogues are resulting in improvements in the legal and regulatory frameworks in line with IWRM principles and EU water policies; support to develop river basin management plans in line with the EU WFD; and a regular exchange of lessons learned, shared, and communicated among stakeholders. Further efforts to complement the portfolio of activities of UNECE could help to speed up pending reforms and support the development of IWRM capacities.

Update existing operational agreements to include key principles of modern international water law. Many of the existing treaties have not developed provisions for a number of aspects that are at the core of many existing transboundary basin disputes in Central Asia and the South Caucasus. These principles include the absence of notification processes to co-riparian states when countries are in need of additional water resources, plans to construct water infrastructure such as dams or diversion channels (that is, the no-harm principle), and conflict resolution mechanisms. Such gaps are important sources of conflicts between riparian countries. These two principles should thus be prioritized in subregional and regional cooperation strategies. Other important aspects, such as environmental protection mechanisms, are also frequently missing and should similarly be included as a priority.

NOTE

1. See https://unece.org/euwi-npds for further information.

APPENDIX A

Key Features of the Institutional Arrangement of Water Resources Management in Europe and Central Asia

TABLE A.1 Key Features of the Institutional Arrangement of Water Resources Management in Europe and Central Asia

Country	Legal framework integrating key IWRM principles	National IWRM strategy	Institutions in charge of developing WRM policies	Institutions in charge of WRM planning and management	Basin water management approach
Central Asia					
Kazakhstan	+++	Sectoral policies (for example, State Programs for Water Resources Development (2020-30), State Program on WSS (2020–25)	Water Resources Committee of the Ministry of Water and Irrigation (surface water) and Ministry of Industry and Construction (groundwater)	Regional branches of the National Water Resources Committee (RSE Kazvodkhoz) and basin inspections	Yes[a]
Kyrgyz Republic	++	National Water Strategy (2023–)	Ministry of Natural Resources, Ecology and Technical Supervision (water management) and Ministry of Agriculture (irrigation services)	The Water Resources Service (National)	Yes
Tajikistan	+++	Water Sector Reform Programme (2016–25)	Ministry of Energy and Water Resources	Ministry of Energy and Water Resources	Yes
Turkmenistan	++	Sectoral policies (National Strategy on Climate Change, National Program "Health")	State Committee for Water Management	Territorial water organizations belonging to the State Committee for Water Management	Not yet
Uzbekistan	+++	Concept for the Development of Water Sector of the Republic of Uzbekistan (2020–30)	Ministry of Water Resources (surface water) and State Committee of the Republic of Uzbekistan on Geology and Mineral Resources (groundwater)	Basin water organizations and basin irrigation system authorities	Yes[b]
South Caucasus					
Armenia	+++	National Water Program (expired)	Ministry of Environment (water protection) and Water Committee of Ministry of Territorial Administration (infrastructure)	Regional river basin management bodies	Yes
Azerbaijan	+++	National Strategy and Action Plan on the Protection and Use of Water Resources (under development)	Ministry of Ecology and Natural Resources (State Water Reserves Agency)	Regional water departments	Not yet[c]

Georgia	+++	Several sectoral policies (for example, National Environmental Action Program)	Ministry of Environmental Protection and Agriculture (surface water) and Ministry of Economy and Sustainable Development (groundwater)	Ministry of Environmental Protection and Agriculture	Yes
Danube					
Albania	+++	Integrated Water Resources Management Strategy (2018–27)	Water Resources Management Agency (depending on National Water Council)	Regional branches of the Agency for Water Resources Management	Yes
Austria	+++	National Plan for the Management of Waters (2021)	Federal Ministry of Agriculture, Forestry, Environment and Water Management	Provincial government	Yes
Bosnia and Herzegovina	+++	Water Management Strategy for the Federation of Bosnia and Herzegovina (2010–25) Integrated Water Management Strategy of the Republic of Srpska (2014–44)	Entity Ministry of Agriculture, Water Management and Forestry	River basins and regional water agencies	Yes
Bulgaria	+++	National Strategy for Management and Development of the Water Sector (2012–37)	Ministry of Environment and Water	River basin directorates	Yes
Croatia	+++	Croatia’s National Water Management Strategy (2008–38)	Ministry of Economy and Sustainable Development (Croatian Waters)	Regional branches of Croatian Waters	Yes
Czech Republic	+++	Strategy of the Ministry of Agriculture of the Czech Republic with a View to 2030 (2016–30)	Ministry of the Environment (protection) and Ministry of Agriculture (water management)	River boards (state enterprises)	Yes
Hungary	+++	National Water Strategy—Kvassay Jeno Plan	Ministry of Interior	Regional water directorates	Yes
Kosovo	+++	National Water Strategy (2017–34)	Ministry of Environment and Spatial Planning	River basin authority	Yes
North Macedonia	+++	National Water Strategy (2012–42)	Ministry of Agriculture, Forestry and Water Resources Management	Ministry of Agriculture, Forestry and Water Resources Management	Yes

Moldova	+++	Only sectoral policies (for example, Water Supply and Sanitation Strategy [2013–27])	Ministry of Environment	Regional development authorities	Yes
Montenegro	+++	National Water Management Strategy (2017–35)	Ministry of Agriculture, Forestry and Water Management	n.a.	Yes
Romania	+++	National Strategy for Water Management (2023–35)	Ministry of Environment, Water and Forest	National Administration of Romanian Waters and basin administrations	Yes
Serbia	+++	Water Management Strategy (2016–34)	Ministry of Agriculture, Forestry and Water Management	Provincial governments, local agencies, and public water management companies	Yes
Slovak Republic	+++	Orientation, Principles, and Priorities of the Slovak Republic's Water Policy (2015–27)	Ministry of Environment	Branch offices of the Slovak Water Management Enterprise	Yes
Slovenia	+++	Slovenian Development Strategy (2030)	Ministry of Natural Resources and Spatial Planning	Regional branches of Water Management Office	Yes
Ukraine	++	Water Strategy of Ukraine (2022–50)	Ministry of Environmental Protection and Natural Resources	Basin management and regional departments of water resources	Yes

Source: Original elaboration for this publication.

Note: IWRM = integrated water resources management; n.a. = not applicable; RSE = Republican State Enterprise; WRM = water resources management, WSS = water supply and sanitation.

[a.] In Kazakhstan, water planning and management are undertaken within water economic zones, which integrate physical and administrative borders.

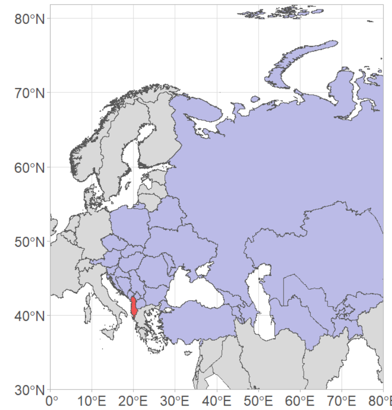
[b.] Water management is done within basin irrigation basins, which combine territorial (provincial) with hydrographic boundaries.

[c.] A proposal for the delineation of the river basin districts has been developed but not yet adopted.

APPENDIX B

Country Pages

Country page: Albania ECA Water Security Assessment

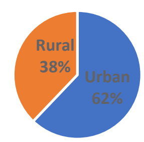


Population
2.8 M

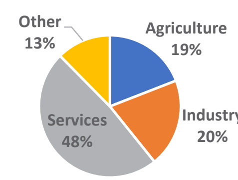
GDP [Billions]
39.4 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	95.1	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	98	99.3	110
Basic and safely managed sanitation [%]	2020	99.3	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	100	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	132	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.2	0.4	4
People affected by floods [People per 100k]	1980-2021	166	83.6	915
People living in areas under water stress [%]	-	76.1	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	13	55.5	99
Water bodies with good ambient water quality [%]	2017-2020	-	79.6	96
Wetland loss [%]	2017-2021	54.4	60.9	100
Groundwater table decline [cm/yr]	1990-2014	-0.04	0.07	0.34
Water stress ratio [-]	2019	56	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	6.7	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	1.7	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	22.9	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	31.4	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	47.6	25.6	100
Electricity production from hydroelectric sources [%]	2015	100	20.7	100
Share of hydropower in total primary energy supply [%]	2015	21	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2015	47	63.6	93
Operating cost coverage [ratio]	-	1.1	1.2	1.9
Electrical energy share of operational costs [%]	-	0.4	0.2	0.4
Riverine flood risk - population affected [%]	-	2.3	1.7	3.2
Riverine flood risk - monetary [%]	2021	2.8	1.6	3.1
Drought Risk [1-5]	2020	3.1	3.2	4
Degree of IWRM implementation [0-100]	2020	47	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	1397.3	1398	5507.8
Water supply coverage by piped improved facilities [%]	2015	0.8	0.8	1
Sanitation coverage by sewer facilities [%]	2015	0.8	0.6	0.9
Non-revenue water [%]	2020	0.7	0.4	0.8
Continuity of service [hours]	-	14.7	23.2	24
Wastewater treatment [%]	-	49	49.9	79.6
Cultivated land under irrigation [%]	2018-2022	57.4	25	113.2
Irrigated land with flood irrigation [%]	2018-2022	100	73.5	100
Irrigated land with sprinkler irrigation [%]	2018-2022	0	22.3	93.9
Irrigated land with drip irrigation [%]	2018-2022	0	2.7	62.4

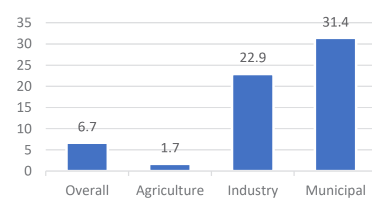
Urban and Rural population



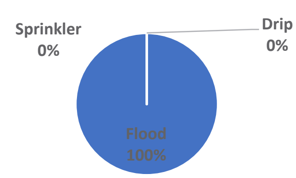
Value added % of GDP



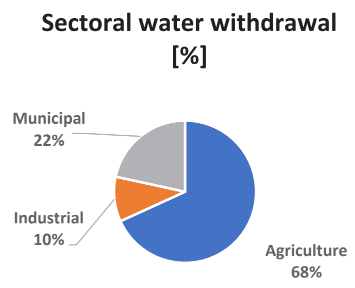
Economic water productivity [$US/m³]

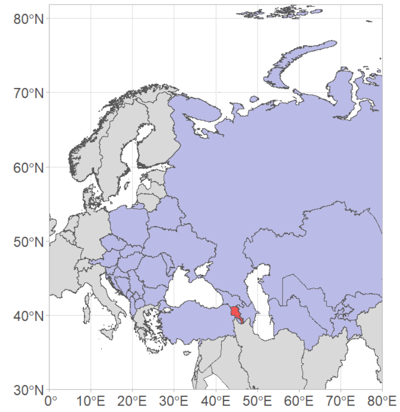


Irrigation land by irrigation systems [%]



Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	10476	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	83	84.9	100
Share of groundwater to total water availability [%]	2018-2022	17	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	10.9	39.2	97
Drinking Water Quality Index [0-100]	-	50.2	55.2	100
Interannual Variability [CoV]	2018-2022	0.4	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.9	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	332.3	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	91	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	9	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	68.2	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	10.2	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	21.6	17.9	75





Country page: Armenia ECA Water Security Assessment

Population

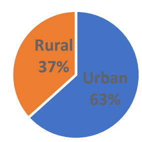
3 M

GDP [Billions]

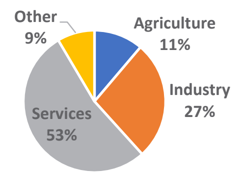
39.4 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	100	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	100	99.3	110
Basic and safely managed sanitation [%]	2020	93.9	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	83	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	128	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.2	0.4	4
People affected by floods [People per 100k]	1980-2021	5.7	83.6	915
People living in areas under water stress [%]	-	61.3	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	40	55.5	99
Water bodies with good ambient water quality [%]	2017-2020	-	79.6	96
Wetland loss [%]	2017-2021	100	60.9	100
Groundwater table decline [cm/yr]	1990-2014	0.07	0.07	0.34
Water stress ratio [-]	2019	40	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	3.3	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	0.2	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	19.1	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	9.7	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	37.5	25.6	100
Electricity production from hydroelectric sources [%]	2015	28.3	20.7	100
Share of hydropower in total primary energy supply [%]	2016	5.8	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2016	47	63.6	93
Operating cost coverage [ratio]	-	0.7	1.2	1.9
Electrical energy share of operational costs [%]	-	0.1	0.2	0.4
Riverine flood risk - population affected [%]	-	1	1.7	3.2
Riverine flood risk - monetary [%]	2021	1	1.6	3.1
Drought Risk [1-5]	2020	3.1	3.2	4
Degree of IWRM implementation [0-100]	2020	52	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	471	1398	5507.8
Water supply coverage by piped improved facilities [%]	2016	1	0.8	1
Sanitation coverage by sewer facilities [%]	2016	0.7	0.6	0.9
Non-revenue water [%]	2020	0.8	0.4	0.8
Continuity of service [hours]	-	21.9	23.2	24
Wastewater treatment [%]	-	52.3	49.9	79.6
Cultivated land under irrigation [%]	2018-2022	19.3	25	113.2
Irrigated land with flood irrigation [%]	2018-2022	90.5	73.5	100
Irrigated land with sprinkler irrigation [%]	2018-2022	9.1	22.3	93.9
Irrigated land with drip irrigation [%]	2018-2022	0.4	2.7	62.4

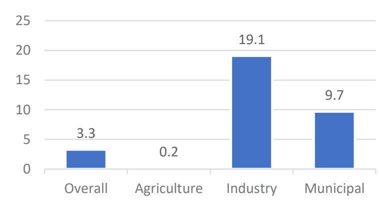
Urban and Rural population



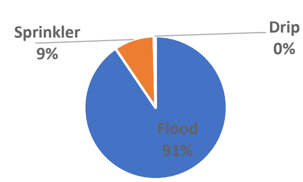
Value added % of GDP



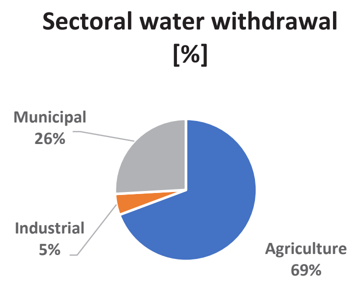
Economic water productivity [$US/m³]



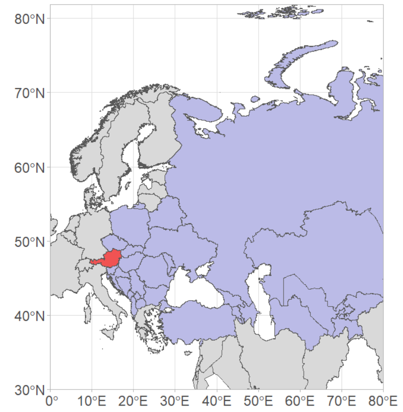
Irrigation land by irrigation systems [%]

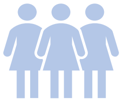


Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	2632	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	54	84.9	100
Share of groundwater to total water availability [%]	2018-2022	46	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	11.7	39.2	97
Drinking Water Quality Index [0-100]	-	61.5	55.2	100
Interannual Variability [CoV]	2018-2022	0.5	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.9	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	919.5	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	60	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	40	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	69.3	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	4.8	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	25.9	17.9	75



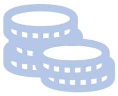
Country page: Austria ECA Water Security Assessment





Population

8.9 M

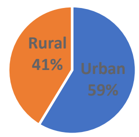


GDP [Billions]

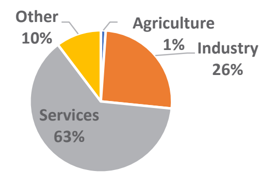
496.2 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	100	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	100	99.3	110
Basic and safely managed sanitation [%]	2020	100	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	100	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	10	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.1	0.4	4
People affected by floods [People per 100k]	1980-2021	16.7	83.6	915
People living in areas under water stress [%]	-	0	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	99	55.5	99
Water bodies with good ambient water quality [%]	2017-2020	82	79.6	96
Wetland loss [%]	2017-2021	57.3	60.9	100
Groundwater table decline [cm/yr]	1990-2014	-0.02	0.07	0.34
Water stress ratio [-]	2019	6	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	100.7	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	3.3	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	35.3	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	369.6	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	5.4	25.6	100
Electricity production from hydroelectric sources [%]	2015	60	20.7	100
Share of hydropower in total primary energy supply [%]	-	11.2	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	-	93	63.6	93
Operating cost coverage [ratio]	-	-	1.2	1.9
Electrical energy share of operational costs [%]	-	-	0.2	0.4
Riverine flood risk - population affected [%]	-	2.8	1.7	3.2
Riverine flood risk - monetary [%]	2021	2.7	1.6	3.1
Drought Risk [1-5]	2020	2.4	3.2	4
Degree of IWRM implementation [0-100]	-	91	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	241.2	1398	5507.8
Water supply coverage by piped improved facilities [%]	-	-	0.8	1
Sanitation coverage by sewer facilities [%]	-	0.9	0.6	0.9
Non-revenue water [%]	2020	0.2	0.4	0.8
Continuity of service [hours]	-	24	23.2	24
Wastewater treatment [%]	-	79.6	49.9	79.6
Cultivated land under irrigation [%]	-	7.1	25	113.2
Irrigated land with flood irrigation [%]	-	-	73.5	100
Irrigated land with sprinkler irrigation [%]	-	-	22.3	93.9
Irrigated land with drip irrigation [%]	-	2	2.7	62.4

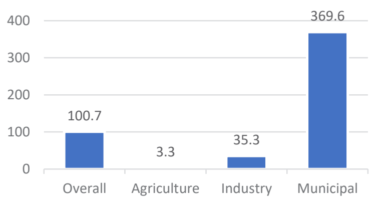
Urban and Rural population



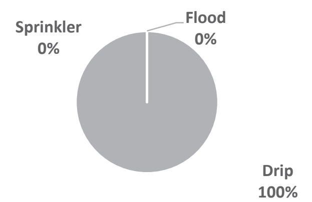
Value added % of GDP



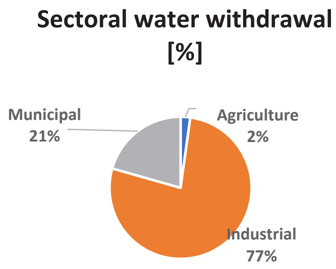
Economic water productivity [$US/m³]



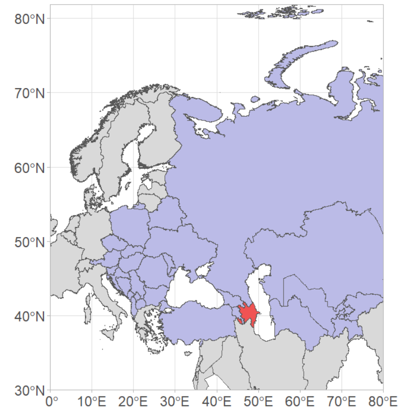
Irrigation land by irrigation systems [%]



Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	8738.8	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	96	84.9	100
Share of groundwater to total water availability [%]	2018-2022	4	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	29.2	39.2	97
Drinking Water Quality Index [0-100]	-	100	55.2	100
Interannual Variability [CoV]	2018-2022	0.2	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.3	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	392.8	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	70	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	30	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	2.2	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	77.2	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	20.6	17.9	75



Country page: Azerbaijan ECA Water Security Assessment

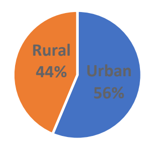


Population
10.1 M

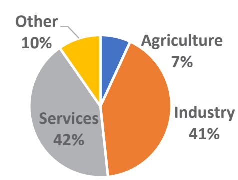
GDP [Billions]
146.1 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	96	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	91	99.3	110
Basic and safely managed sanitation [%]	2020	96.4	97.5	100
Basic and safely managed sanitation [rural/urban]	-	-	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	248	154.1	935
Mortality rate due to unsafe WASH [-]	2016	1.1	0.4	4
People affected by floods [People per 100k]	1980-2021	433	83.6	915
People living in areas under water stress [%]	-	34.9	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	57	55.5	99
Water bodies with good ambient water quality [%]	2017-2020	-	79.6	96
Wetland loss [%]	2017-2021	100	60.9	100
Groundwater table decline [cm/yr]	1990-2014	0.34	0.07	0.34
Water stress ratio [-]	2019	28	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	3.7	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	0.2	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	50.3	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	46.6	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	72	25.6	100
Electricity production from hydroelectric sources [%]	2015	6.6	20.7	100
Share of hydropower in total primary energy supply [%]	2009	0.6	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	-	54	63.6	93
Operating cost coverage [ratio]	-	1.7	1.2	1.9
Electrical energy share of operational costs [%]	-	-	0.2	0.4
Riverine flood risk - population affected [%]	-	2.2	1.7	3.2
Riverine flood risk - monetary [%]	2021	2.2	1.6	3.1
Drought Risk [1-5]	2020	3.6	3.2	4
Degree of IWRM implementation [0-100]	2020	57	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2019	2188.1	1398	5507.8
Water supply coverage by piped improved facilities [%]	2009	0.9	0.8	1
Sanitation coverage by sewer facilities [%]	2009	0.6	0.6	0.9
Non-revenue water [%]	2020	0.5	0.4	0.8
Continuity of service [hours]	-	16	23.2	24
Wastewater treatment [%]	-	46.5	49.9	79.6
Cultivated land under irrigation [%]	2018-2022	61.8	25	113.2
Irrigated land with flood irrigation [%]	2018-2022	57.3	73.5	100
Irrigated land with sprinkler irrigation [%]	2018-2022	42.5	22.3	93.9
Irrigated land with drip irrigation [%]	2018-2022	0	2.7	62.4

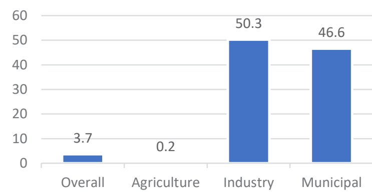
Urban and Rural population



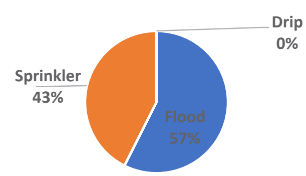
Value added % of GDP



Economic water productivity [$US/m³]

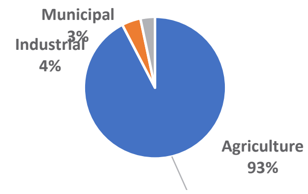


Irrigation land by irrigation systems [%]

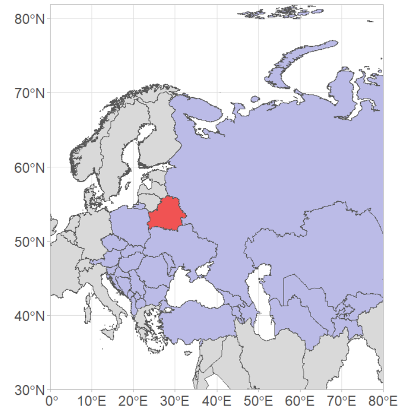


Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	3485.1	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	87	84.9	100
Share of groundwater to total water availability [%]	2018-2022	13	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	76.6	39.2	97
Drinking Water Quality Index [0-100]	-	46.4	55.2	100
Interannual Variability [CoV]	2018-2022	0.4	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.7	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	1222.9	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	94	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	6	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	92.4	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	4.3	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	3.3	17.9	75

Sectoral water withdrawal [%]



Country page: Belarus ECA Water Security Assessment



Population

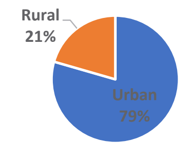
9.4 M

GDP [Billions]

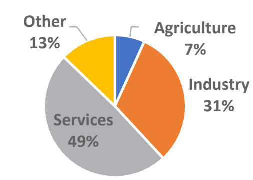
189.8 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	96.5	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	103	99.3	110
Basic and safely managed sanitation [%]	2020	97.9	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	98	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	81	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.1	0.4	4
People affected by floods [People per 100k]	1980-2021	23.2	83.6	915
People living in areas under water stress [%]	-	3.4	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	56	55.5	99
Water bodies with good ambient water quality [%]	2017-2020	89	79.6	96
Wetland loss [%]	2017-2021	54.9	60.9	100
Groundwater table decline [cm/yr]	1990-2014	0.11	0.07	0.34
Water stress ratio [-]	2019	11	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	32	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	0.1	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	36.2	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	56	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	0.7	25.6	100
Electricity production from hydroelectric sources [%]	2015	0.3	20.7	100
Share of hydropower in total primary energy supply [%]	2018	0.2	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2018	66	63.6	93
Operating cost coverage [ratio]	-	1.2	1.2	1.9
Electrical energy share of operational costs [%]	-	0.2	0.2	0.4
Riverine flood risk - population affected [%]	-	0.9	1.7	3.2
Riverine flood risk - monetary [%]	2021	0.9	1.6	3.1
Drought Risk [1-5]	2020	2.8	3.2	4
Degree of IWRM implementation [0-100]	2020	54	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	328	1398	5507.8
Water supply coverage by piped improved facilities [%]	2018	1	0.8	1
Sanitation coverage by sewer facilities [%]	2018	0.7	0.6	0.9
Non-revenue water [%]	2020	0.2	0.4	0.8
Continuity of service [hours]	-	23.2	23.2	24
Wastewater treatment [%]	-	53	49.9	79.6
Cultivated land under irrigation [%]	2018-2022	0.5	25	113.2
Irrigated land with flood irrigation [%]	2018-2022	-	73.5	100
Irrigated land with sprinkler irrigation [%]	2018-2022	-	22.3	93.9
Irrigated land with drip irrigation [%]	2018-2022	-	2.7	62.4

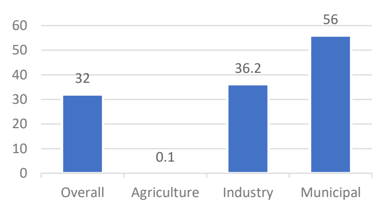
Urban and Rural population



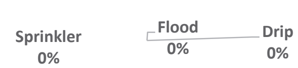
Value added % of GDP



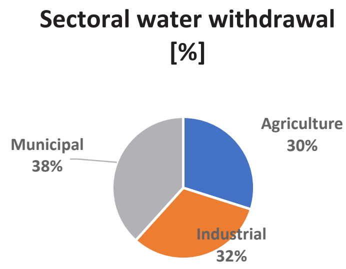
Economic water productivity [$US/m³]



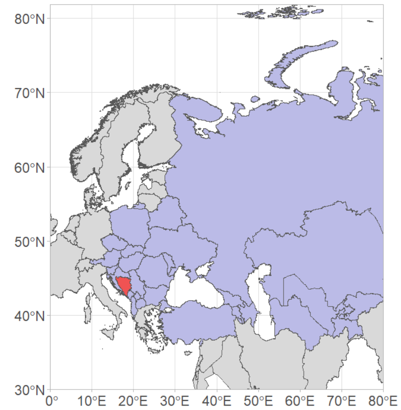
Irrigation land by irrigation systems [%]



Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	6125.3	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	86	84.9	100
Share of groundwater to total water availability [%]	2018-2022	14	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	41.3	39.2	97
Drinking Water Quality Index [0-100]	-	60.6	55.2	100
Interannual Variability [CoV]	2018-2022	0.4	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.5	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	147.2	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	42	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	58	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	29.9	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	31.8	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	38.3	17.9	75



Country page: Bosnia and Herzegovina ECA Water Security Assessment



Population

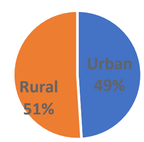
3.3 M

GDP [Billions]

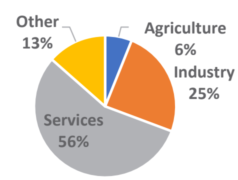
51.6 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	96.1	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	103	99.3	110
Basic and safely managed sanitation [%]	2018	95.4	97.5	100
Basic and safely managed sanitation [rural/urban]	2018	93	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	74	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.1	0.4	4
People affected by floods [People per 100k]	1980-2021	915	83.6	915
People living in areas under water stress [%]	-	0	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	47	55.5	99
Water bodies with good ambient water quality [%]	2017-2020	31	79.6	96
Wetland loss [%]	2017-2021	43	60.9	100
Groundwater table decline [cm/yr]	1990-2014	-0.04	0.07	0.34
Water stress ratio [-]	2019	7	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	-	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	-	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	45.7	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	29.4	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	0	25.6	100
Electricity production from hydroelectric sources [%]	2015	35.5	20.7	100
Share of hydropower in total primary energy supply [%]	2020	5.3	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2020	56	63.6	93
Operating cost coverage [ratio]	-	0.9	1.2	1.9
Electrical energy share of operational costs [%]	-	0.1	0.2	0.4
Riverine flood risk - population affected [%]	-	2	1.7	3.2
Riverine flood risk - monetary [%]	2021	2	1.6	3.1
Drought Risk [1-5]	2020	3.2	3.2	4
Degree of IWRM implementation [0-100]	2018	53	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2018	869	1398	5507.8
Water supply coverage by piped improved facilities [%]	2020	1	0.8	1
Sanitation coverage by sewer facilities [%]	2020	0.6	0.6	0.9
Non-revenue water [%]	2020	0.5	0.4	0.8
Continuity of service [hours]	-	23.9	23.2	24
Wastewater treatment [%]	-	45.4	49.9	79.6
Cultivated land under irrigation [%]	2018-2022	1.1	25	113.2
Irrigated land with flood irrigation [%]	2018-2022	-	73.5	100
Irrigated land with sprinkler irrigation [%]	2018-2022	-	22.3	93.9
Irrigated land with drip irrigation [%]	2018-2022	-	2.7	62.4

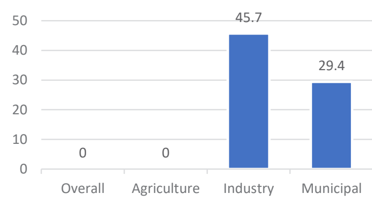
Urban and Rural population



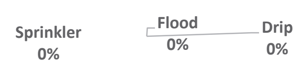
Value added % of GDP



Economic water productivity [$US/m³]

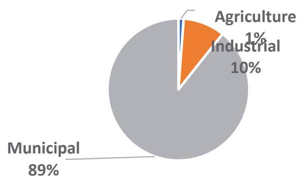


Irrigation land by irrigation systems [%]

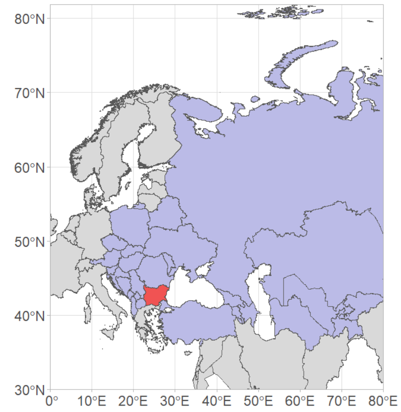


Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	11282	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	83	84.9	100
Share of groundwater to total water availability [%]	2018-2022	17	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	5.3	39.2	97
Drinking Water Quality Index [0-100]	-	57.1	55.2	100
Interannual Variability [CoV]	2018-2022	0.3	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.6	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	88	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	27	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	73	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	1	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	8	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	75	17.9	75

Sectoral water withdrawal [%]



Country page: Bulgaria ECA Water Security Assessment



Population

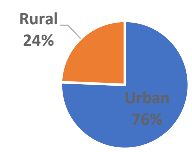
6.9 M

GDP [Billions]

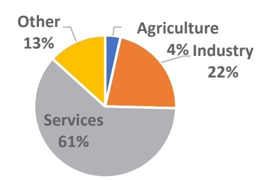
170.7 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	99	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	98	99.3	110
Basic and safely managed sanitation [%]	2020	86	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	96	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	64	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.1	0.4	4
People affected by floods [People per 100k]	1980-2021	20.8	83.6	915
People living in areas under water stress [%]	-	29.1	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	79	55.5	99
Water bodies with good ambient water quality [%]	2017-2021	66	79.6	96
Wetland loss [%]	2017-2021	38.9	60.9	100
Groundwater table decline [cm/yr]	1990-2014	-0.1	0.07	0.34
Water stress ratio [-]	2019	14	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	7.9	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	0.1	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	2.7	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	41.9	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	3.5	25.6	100
Electricity production from hydroelectric sources [%]	2015	11.6	20.7	100
Share of hydropower in total primary energy supply [%]	2016	1.3	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2015	70	63.6	93
Operating cost coverage [ratio]	-	1	1.2	1.9
Electrical energy share of operational costs [%]	-	0.2	0.2	0.4
Riverine flood risk - population affected [%]	-	1	1.7	3.2
Riverine flood risk - monetary [%]	2021	0.7	1.6	3.1
Drought Risk [1-5]	2020	3.3	3.2	4
Degree of IWRM implementation [0-100]	2020	69	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	917.8	1398	5507.8
Water supply coverage by piped improved facilities [%]	2016	1	0.8	1
Sanitation coverage by sewer facilities [%]	2016	0.9	0.6	0.9
Non-revenue water [%]	2020	0.6	0.4	0.8
Continuity of service [hours]	-	24	23.2	24
Wastewater treatment [%]	-	57	49.9	79.6
Cultivated land under irrigation [%]	-	3.2	25	113.2
Irrigated land with flood irrigation [%]	-	77	73.5	100
Irrigated land with sprinkler irrigation [%]	-	20.1	22.3	93.9
Irrigated land with drip irrigation [%]	-	2.9	2.7	62.4

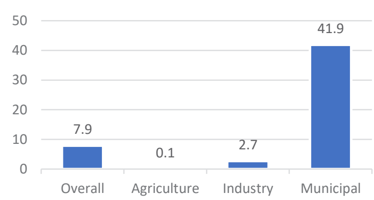
Urban and Rural population



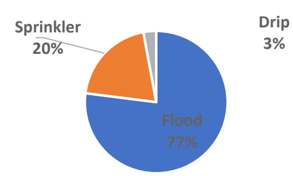
Value added % of GDP



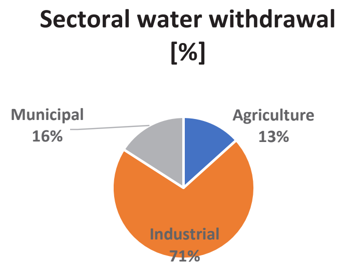
Economic water productivity [$US/m³]



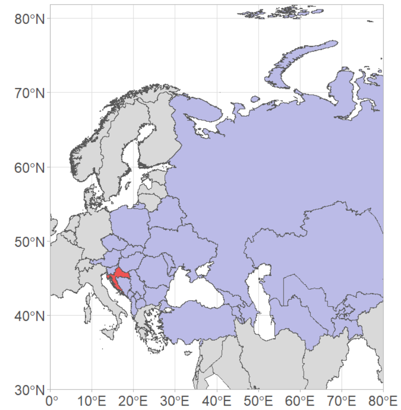
Irrigation land by irrigation systems [%]



Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	3020.6	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	83	84.9	100
Share of groundwater to total water availability [%]	2018-2022	17	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	1.4	39.2	97
Drinking Water Quality Index [0-100]	-	57.8	55.2	100
Interannual Variability [CoV]	2018-2022	0.5	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.5	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	769.3	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	90	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	10	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	13.3	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	70.7	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	15.9	17.9	75



Country page: Croatia ECA Water Security Assessment



Population

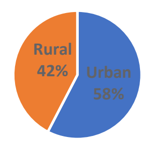
4 M

GDP [Billions]

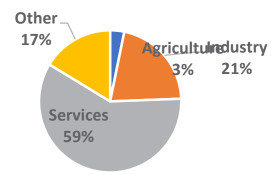
117.9 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	100	97.6	100
Basic and safely managed drinking water [rural/urban]	-	98	99.3	110
Basic and safely managed sanitation [%]	2020	96.6	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	97	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	46	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.1	0.4	4
People affected by floods [People per 100k]	1980-2021	8.9	83.6	915
People living in areas under water stress [%]	-	0	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	60	55.5	99
Water bodies with good ambient water quality [%]	2017-2022	56	79.6	96
Wetland loss [%]	2017-2021	55.6	60.9	100
Groundwater table decline [cm/yr]	1990-2014	-0.05	0.07	0.34
Water stress ratio [-]	2019	6	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	59	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	0.7	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	49.6	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	74.3	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	3.2	25.6	100
Electricity production from hydroelectric sources [%]	2015	56.9	20.7	100
Share of hydropower in total primary energy supply [%]	2015	7	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2015	84	63.6	93
Operating cost coverage [ratio]	-	1.1	1.2	1.9
Electrical energy share of operational costs [%]	-	0.1	0.2	0.4
Riverine flood risk - population affected [%]	-	2.3	1.7	3.2
Riverine flood risk - monetary [%]	2021	1.9	1.6	3.1
Drought Risk [1-5]	2020	3	3.2	4
Degree of IWRM implementation [0-100]	2007	90	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	230	1398	5507.8
Water supply coverage by piped improved facilities [%]	2015	0.9	0.8	1
Sanitation coverage by sewer facilities [%]	2015	0.6	0.6	0.9
Non-revenue water [%]	2020	0.4	0.4	0.8
Continuity of service [hours]	-	24	23.2	24
Wastewater treatment [%]	-	51.7	49.9	79.6
Cultivated land under irrigation [%]	-	3.3	25	113.2
Irrigated land with flood irrigation [%]	-	94.6	73.5	100
Irrigated land with sprinkler irrigation [%]	-	5	22.3	93.9
Irrigated land with drip irrigation [%]	-	0.4	2.7	62.4

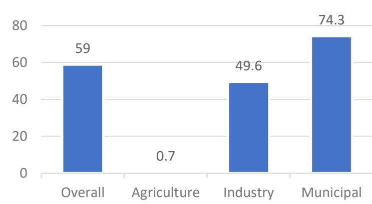
Urban and Rural population



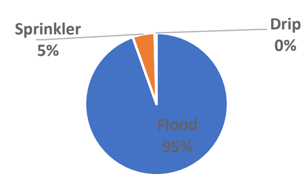
Value added % of GDP



Economic water productivity [$US/m³]

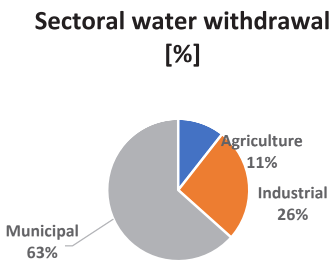


Irrigation land by irrigation systems [%]

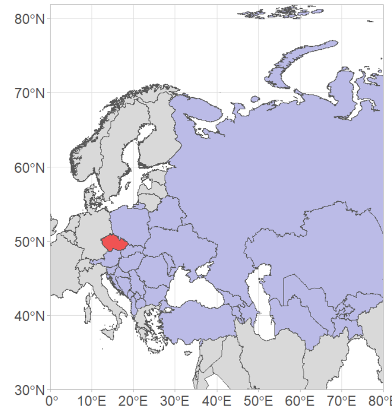


Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	25383	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	90	84.9	100
Share of groundwater to total water availability [%]	2018-2022	10	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	64	39.2	97
Drinking Water Quality Index [0-100]	-	63.1	55.2	100
Interannual Variability [CoV]	2018-2022	0.3	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.5	0.7	1.2

Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	172.7	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	35	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	65	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	10.6	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	26	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	63.4	17.9	75



Country page: Czech Republic ECA Water Security Assessment



Population

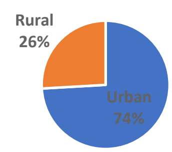
10.7 M

GDP [Billions]

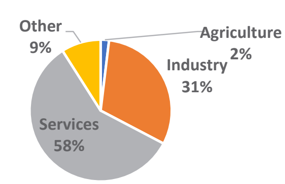
449.9 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	99.9	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	100	99.3	110
Basic and safely managed sanitation [%]	2020	99.1	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	100	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	48	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.2	0.4	4
People affected by floods [People per 100k]	1980-2021	363	83.6	915
People living in areas under water stress [%]	-	0	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	90	55.5	99
Water bodies with good ambient water quality [%]	2017-2023	88	79.6	96
Wetland loss [%]	2017-2021	26.8	60.9	100
Groundwater table decline [cm/yr]	1990-2014	-0.04	0.07	0.34
Water stress ratio [-]	2019	18	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	107.5	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	1.2	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	66.5	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	186.8	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	1.4	25.6	100
Electricity production from hydroelectric sources [%]	2015	2.2	20.7	100
Share of hydropower in total primary energy supply [%]	2013	0.4	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2013	83	63.6	93
Operating cost coverage [ratio]	-	1.2	1.2	1.9
Electrical energy share of operational costs [%]	-	0.1	0.2	0.4
Riverine flood risk - population affected [%]	-	1.5	1.7	3.2
Riverine flood risk - monetary [%]	2021	1.4	1.6	3.1
Drought Risk [1-5]	2020	3.1	3.2	4
Degree of IWRM implementation [0-100]	2020	80	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2019	299.3	1398	5507.8
Water supply coverage by piped improved facilities [%]	2013	1	0.8	1
Sanitation coverage by sewer facilities [%]	2013	0.9	0.6	0.9
Non-revenue water [%]	2020	0.2	0.4	0.8
Continuity of service [hours]	-	24	23.2	24
Wastewater treatment [%]	-	71	49.9	79.6
Cultivated land under irrigation [%]	-	1.8	25	113.2
Irrigated land with flood irrigation [%]	-	58.5	73.5	100
Irrigated land with sprinkler irrigation [%]	-	28.5	22.3	93.9
Irrigated land with drip irrigation [%]	-	13	2.7	62.4

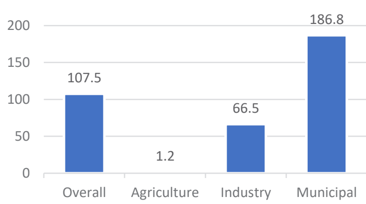
Urban and Rural population



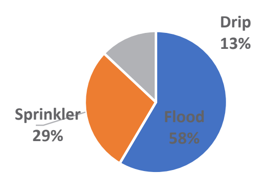
Value added % of GDP



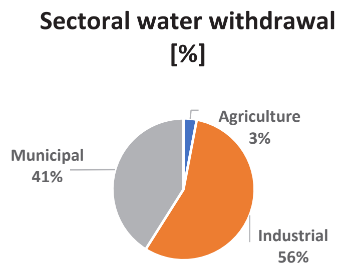
Economic water productivity [$US/m³]



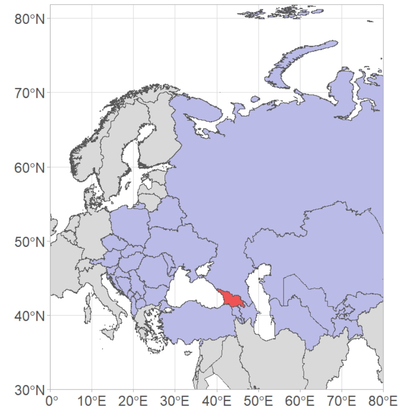
Irrigation land by irrigation systems [%]



Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	1232.9	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	95	84.9	100
Share of groundwater to total water availability [%]	2018-2022	5	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	-	39.2	97
Drinking Water Quality Index [0-100]	-	65	55.2	100
Interannual Variability [CoV]	2018-2022	0.4	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.3	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	149.1	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	77	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	23	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	3	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	56	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	41.1	17.9	75



Country page: Georgia ECA Water Security Assessment



Population

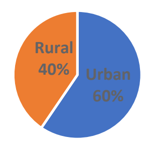
3.7 M

GDP [Billions]

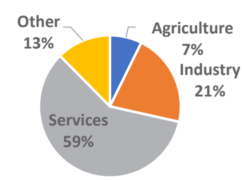
54.8 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	97.3	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	95	99.3	110
Basic and safely managed sanitation [%]	2020	85.8	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	76	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	145	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.2	0.4	4
People affected by floods [People per 100k]	1980-2021	100.4	83.6	915
People living in areas under water stress [%]	-	0	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	46	55.5	99
Water bodies with good ambient water quality [%]	2017-2020	92	79.6	96
Wetland loss [%]	2017-2021	41.6	60.9	100
Groundwater table decline [cm/yr]	1990-2014	0.12	0.07	0.34
Water stress ratio [-]	2019	10	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	7.4	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	0.8	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	13.7	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	17.1	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	41.3	25.6	100
Electricity production from hydroelectric sources [%]	2015	78	20.7	100
Share of hydropower in total primary energy supply [%]	2008	16.8	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2008	39	63.6	93
Operating cost coverage [ratio]	-	1	1.2	1.9
Electrical energy share of operational costs [%]	-	0.2	0.2	0.4
Riverine flood risk - population affected [%]	-	3	1.7	3.2
Riverine flood risk - monetary [%]	2021	3	1.6	3.1
Drought Risk [1-5]	2020	2.6	3.2	4
Degree of IWRM implementation [0-100]	2020	44	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	851.6	1398	5507.8
Water supply coverage by piped improved facilities [%]	2008	0.8	0.8	1
Sanitation coverage by sewer facilities [%]	2008	0.6	0.6	0.9
Non-revenue water [%]	2020	0.4	0.4	0.8
Continuity of service [hours]	-	18.2	23.2	24
Wastewater treatment [%]	-	41.3	49.9	79.6
Cultivated land under irrigation [%]	2018-2022	113.2	25	113.2
Irrigated land with flood irrigation [%]	2018-2022	79	73.5	100
Irrigated land with sprinkler irrigation [%]	2018-2022	15	22.3	93.9
Irrigated land with drip irrigation [%]	2018-2022	6	2.7	62.4

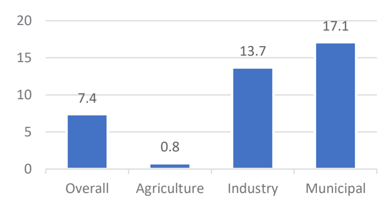
Urban and Rural population



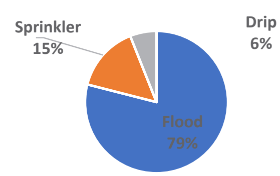
Value added % of GDP



Economic water productivity [$US/m³]

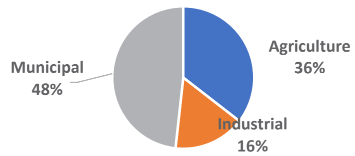


Irrigation land by irrigation systems [%]

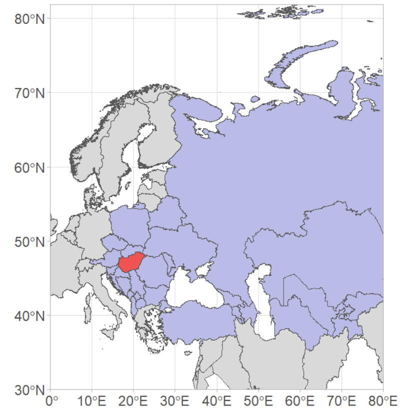


Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	15821	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	85	84.9	100
Share of groundwater to total water availability [%]	2018-2022	15	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	8.2	39.2	97
Drinking Water Quality Index [0-100]	-	52.2	55.2	100
Interannual Variability [CoV]	2018-2022	0.3	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.7	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	322.5	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	66	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	34	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	35.5	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	16.3	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	48.3	17.9	75

Sectoral water withdrawal [%]



Country page: Hungary
ECA Water Security Assessment



Population

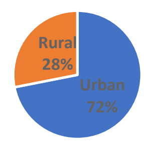
9.7 M

GDP [Billions]

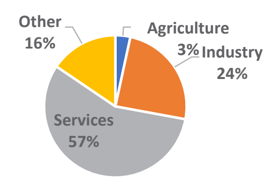
324.2 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	100	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	100	99.3	110
Basic and safely managed sanitation [%]	2020	98	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	101	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	80	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.2	0.4	4
People affected by floods [People per 100k]	1980-2021	59.1	83.6	915
People living in areas under water stress [%]	-	3.8	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	90	55.5	99
Water bodies with good ambient water quality [%]	2017-2020	59	79.6	96
Wetland loss [%]	2017-2021	43.4	60.9	100
Groundwater table decline [cm/yr]	1990-2014	-0.09	0.07	0.34
Water stress ratio [-]	2019	7	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	23.9	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	0.3	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	9.6	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	126.5	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	3.4	25.6	100
Electricity production from hydroelectric sources [%]	2015	0.8	20.7	100
Share of hydropower in total primary energy supply [%]	2007	0.1	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2007	77	63.6	93
Operating cost coverage [ratio]	-	1.1	1.2	1.9
Electrical energy share of operational costs [%]	-	0.1	0.2	0.4
Riverine flood risk - population affected [%]	-	2.4	1.7	3.2
Riverine flood risk - monetary [%]	2021	1.9	1.6	3.1
Drought Risk [1-5]	2020	3.5	3.2	4
Degree of IWRM implementation [0-100]	2020	75	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	26.4	1398	5507.8
Water supply coverage by piped improved facilities [%]	2007	1	0.8	1
Sanitation coverage by sewer facilities [%]	2007	0.8	0.6	0.9
Non-revenue water [%]	2020	0.3	0.4	0.8
Continuity of service [hours]	-	24	23.2	24
Wastewater treatment [%]	-	63.7	49.9	79.6
Cultivated land under irrigation [%]	-	5.1	25	113.2
Irrigated land with flood irrigation [%]	-	13.4	73.5	100
Irrigated land with sprinkler irrigation [%]	-	83.5	22.3	93.9
Irrigated land with drip irrigation [%]	-	2.9	2.7	62.4

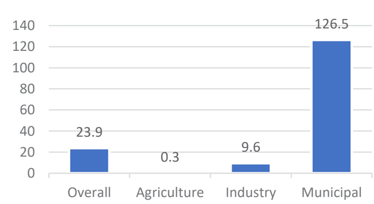
Urban and Rural population



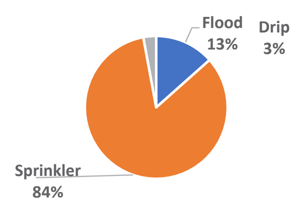
Value added % of GDP



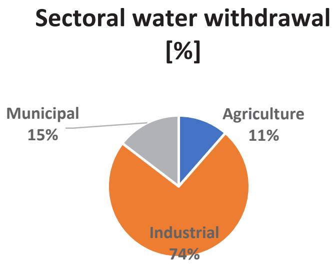
Economic water productivity [$US/m³]



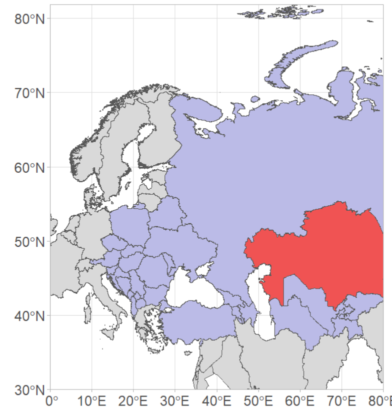
Irrigation land by irrigation systems [%]



Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	10713	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	97	84.9	100
Share of groundwater to total water availability [%]	2018-2022	3	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	94.2	39.2	97
Drinking Water Quality Index [0-100]	-	60.5	55.2	100
Interannual Variability [CoV]	2018-2022	0.4	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.4	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	464	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	87	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	13	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	11.5	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	74.5	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	14.7	17.9	75



Country page: Kazakhstan ECA Water Security Assessment

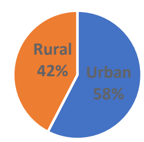


Population
18.8 M

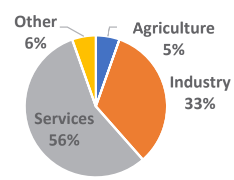
GDP [Billions]
501.6 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	95.4	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	94	99.3	110
Basic and safely managed sanitation [%]	2020	97.9	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	102	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	134	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.4	0.4	4
People affected by floods [People per 100k]	1980-2021	23.4	83.6	915
People living in areas under water stress [%]	-	31.5	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	36	55.5	99
Water bodies with good ambient water quality [%]	2017-2020	64	79.6	96
Wetland loss [%]	2017-2021	67.7	60.9	100
Groundwater table decline [cm/yr]	1990-2014	0.08	0.07	0.34
Water stress ratio [-]	2019	29	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	7.1	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	0	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	11.6	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	31.4	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	6.9	25.6	100
Electricity production from hydroelectric sources [%]	2015	8.7	20.7	100
Share of hydropower in total primary energy supply [%]	2016	0.8	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2016	51	63.6	93
Operating cost coverage [ratio]	-	1.1	1.2	1.9
Electrical energy share of operational costs [%]	-	0.1	0.2	0.4
Riverine flood risk - population affected [%]	-	1.2	1.7	3.2
Riverine flood risk - monetary [%]	2021	1.4	1.6	3.1
Drought Risk [1-5]	2020	2.5	3.2	4
Degree of IWRM implementation [0-100]	2020	46	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	4421.8	1398	5507.8
Water supply coverage by piped improved facilities [%]	2016	0.8	0.8	1
Sanitation coverage by sewer facilities [%]	2016	0.4	0.6	0.9
Non-revenue water [%]	2020	0.2	0.4	0.8
Continuity of service [hours]	-	23.8	23.2	24
Wastewater treatment [%]	-	44.7	49.9	79.6
Cultivated land under irrigation [%]	2018-2022	4.3	25	113.2
Irrigated land with flood irrigation [%]	2018-2022	96.6	73.5	100
Irrigated land with sprinkler irrigation [%]	2018-2022	2.5	22.3	93.9
Irrigated land with drip irrigation [%]	2018-2022	0.9	2.7	62.4

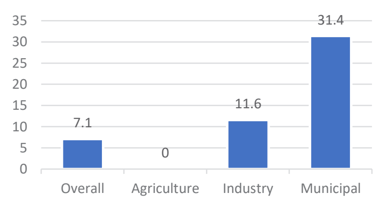
Urban and Rural population



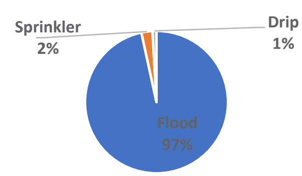
Value added % of GDP



Economic water productivity [$US/m³]

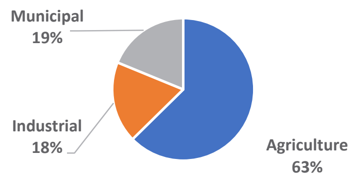


Irrigation land by irrigation systems [%]

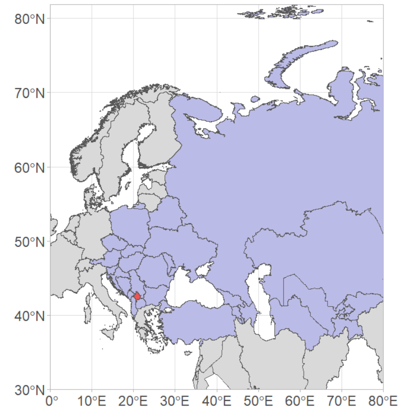


Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	5917.7	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	75	84.9	100
Share of groundwater to total water availability [%]	2018-2022	25	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	40.6	39.2	97
Drinking Water Quality Index [0-100]	-	55.8	55.2	100
Interannual Variability [CoV]	2018-2022	0.6	0.5	0.6
Seasonal Variability [CoV]	2018-2022	1.1	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	1366.3	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	95	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	5	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	62.6	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	18.5	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	18.8	17.9	75

Sectoral water withdrawal [%]



Country page: Kosovo
ECA Water Security Assessment

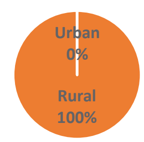


Population
1.8 M

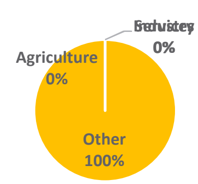
GDP [Billions]
20.2 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	-	-	97.6	100
Basic and safely managed drinking water [rural/urban]	-	-	99.3	110
Basic and safely managed sanitation [%]	-	-	97.5	100
Basic and safely managed sanitation [rural/urban]	-	-	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	-	-	154.1	935
Mortality rate due to unsafe WASH [-]	-	-	0.4	4
People affected by floods [People per 100k]	1980-2021	-	83.6	915
People living in areas under water stress [%]	-	48.8	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	-	55.5	99
Water bodies with good ambient water quality [%]	2017-2020	-	79.6	96
Wetland loss [%]	2017-2021	-	60.9	100
Groundwater table decline [cm/yr]	1990-2014	-	0.07	0.34
Water stress ratio [-]	2019	-	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	-	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	-	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	-	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	-	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	-	25.6	100
Electricity production from hydroelectric sources [%]	2015	2.3	20.7	100
Share of hydropower in total primary energy supply [%]	2016	-	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2016	-	63.6	93
Operating cost coverage [ratio]	-	1.4	1.2	1.9
Electrical energy share of operational costs [%]	-	0.2	0.2	0.4
Riverine flood risk - population affected [%]	-	-	1.7	3.2
Riverine flood risk - monetary [%]	-	-	1.6	3.1
Drought Risk [1-5]	-	-	3.2	4
Degree of IWRM implementation [0-100]	-	-	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2018	300	1398	5507.8
Water supply coverage by piped improved facilities [%]	2018	0.9	0.8	1
Sanitation coverage by sewer facilities [%]	2018	0.7	0.6	0.9
Non-revenue water [%]	2020	0.6	0.4	0.8
Continuity of service [hours]	-	23.4	23.2	24
Wastewater treatment [%]	-	-	49.9	79.6
Cultivated land under irrigation [%]	2018-2022	-	25	113.2
Irrigated land with flood irrigation [%]	2018-2022	-	73.5	100
Irrigated land with sprinkler irrigation [%]	2018-2022	-	22.3	93.9
Irrigated land with drip irrigation [%]	2018-2022	-	2.7	62.4

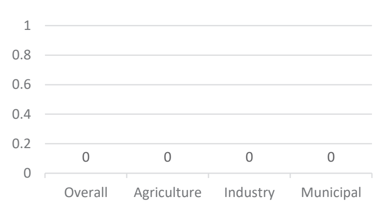
Urban and Rural population



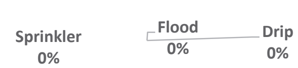
Value added % of GDP



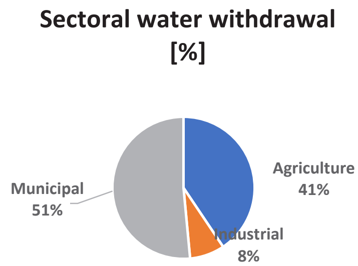
Economic water productivity [$US/m³]



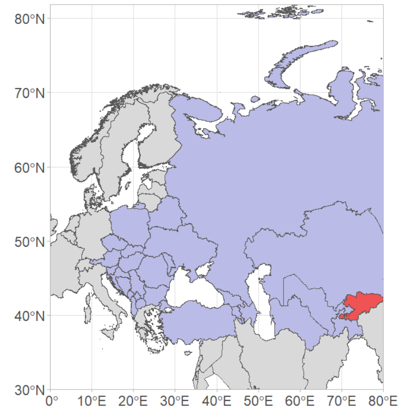
Irrigation land by irrigation systems [%]



Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018	1600	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	-	84.9	100
Share of groundwater to total water availability [%]	2018-2022	-	15.1	62
Transboundary Dependence Ratio [%]	2018	9	39.2	97
Drinking Water Quality Index [0-100]	-	-	55.2	100
Interannual Variability [CoV]	2018-2022	0.4	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.7	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018	191.2	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	-	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	-	18.2	73
Agriculture water use to total water withdrawal [%]	2018	41	52.8	94.3
Industrial water use to total water withdrawal [%]	2018	8	30	81.9
Municipal water use to total water withdrawal [%]	2018	52	17.9	75



Country page: Kyrgyz R. ECA Water Security Assessment



Population

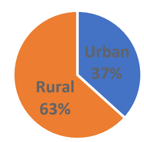
6.6 M

GDP [Billions]

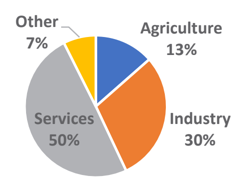
32.7 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	91.7	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	88	99.3	110
Basic and safely managed sanitation [%]	2020	97.9	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	105	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	249	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.8	0.4	4
People affected by floods [People per 100k]	1980-2021	8.1	83.6	915
People living in areas under water stress [%]	-	51.7	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	19	55.5	99
Water bodies with good ambient water quality [%]	2017-2021	-	79.6	96
Wetland loss [%]	2017-2021	-	60.9	100
Groundwater table decline [cm/yr]	1990-2014	0.11	0.07	0.34
Water stress ratio [-]	2019	48	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	0.8	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	0.1	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	5.5	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	17.3	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	84.1	25.6	100
Electricity production from hydroelectric sources [%]	2015	85.2	20.7	100
Share of hydropower in total primary energy supply [%]	2014	25	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2014	43	63.6	93
Operating cost coverage [ratio]	-	1	1.2	1.9
Electrical energy share of operational costs [%]	-	0.2	0.2	0.4
Riverine flood risk - population affected [%]	-	2.2	1.7	3.2
Riverine flood risk - monetary [%]	2021	2.6	1.6	3.1
Drought Risk [1-5]	2020	2.9	3.2	4
Degree of IWRM implementation [0-100]	2020	31	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	3807.9	1398	5507.8
Water supply coverage by piped improved facilities [%]	2014	0.9	0.8	1
Sanitation coverage by sewer facilities [%]	2014	0.2	0.6	0.9
Non-revenue water [%]	2020	0.5	0.4	0.8
Continuity of service [hours]	-	23.4	23.2	24
Wastewater treatment [%]	-	39.8	49.9	79.6
Cultivated land under irrigation [%]	2018-2022	74.9	25	113.2
Irrigated land with flood irrigation [%]	2018-2022	100	73.5	100
Irrigated land with sprinkler irrigation [%]	2018-2022	0	22.3	93.9
Irrigated land with drip irrigation [%]	2018-2022	0	2.7	62.4

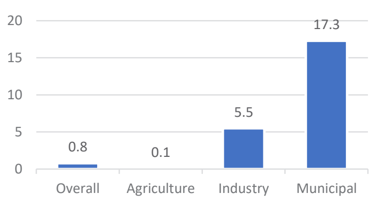
Urban and Rural population



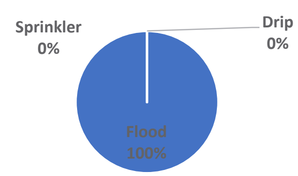
Value added % of GDP



Economic water productivity [$US/m³]

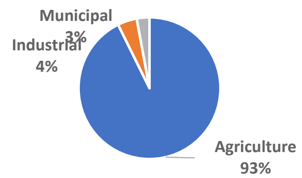


Irrigation land by irrigation systems [%]

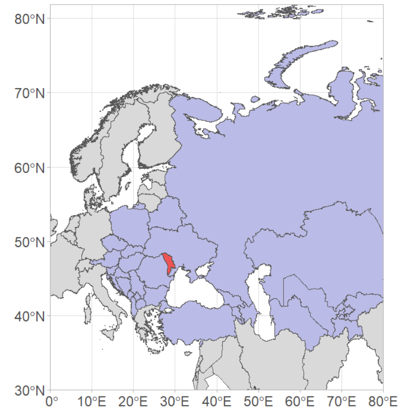


Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	3746.5	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	66	84.9	100
Share of groundwater to total water availability [%]	2018-2022	34	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	1.1	39.2	97
Drinking Water Quality Index [0-100]	-	47.2	55.2	100
Interannual Variability [CoV]	2018-2022	0.6	0.5	0.6
Seasonal Variability [CoV]	2018-2022	1	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	1215.1	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	96	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	4	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	92.7	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	4.4	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	2.9	17.9	75

Sectoral water withdrawal [%]



Country page: Moldova ECA Water Security Assessment



Population

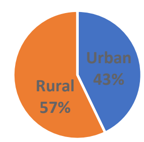
2.6 M

GDP [Billions]

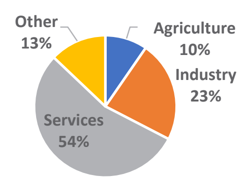
34.1 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	90.6	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	88	99.3	110
Basic and safely managed sanitation [%]	2020	78.7	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	84	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	172	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.1	0.4	4
People affected by floods [People per 100k]	1980-2021	30.7	83.6	915
People living in areas under water stress [%]	-	0.7	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	38	55.5	99
Water bodies with good ambient water quality [%]	2017-2020	-	79.6	96
Wetland loss [%]	2017-2021	100	60.9	100
Groundwater table decline [cm/yr]	1990-2014	0.07	0.07	0.34
Water stress ratio [-]	2019	12	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	7.6	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	0.6	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	2.6	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	33.8	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	2.8	25.6	100
Electricity production from hydroelectric sources [%]	2015	5.1	20.7	100
Share of hydropower in total primary energy supply [%]	2018	1.1	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2018	46	63.6	93
Operating cost coverage [ratio]	-	1.1	1.2	1.9
Electrical energy share of operational costs [%]	-	0.2	0.2	0.4
Riverine flood risk - population affected [%]	-	1.4	1.7	3.2
Riverine flood risk - monetary [%]	2021	1.6	1.6	3.1
Drought Risk [1-5]	2020	4	3.2	4
Degree of IWRM implementation [0-100]	2020	46	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	277.7	1398	5507.8
Water supply coverage by piped improved facilities [%]	2018	0.7	0.8	1
Sanitation coverage by sewer facilities [%]	2018	0.3	0.6	0.9
Non-revenue water [%]	2020	0.4	0.4	0.8
Continuity of service [hours]	-	23.5	23.2	24
Wastewater treatment [%]	-	44.4	49.9	79.6
Cultivated land under irrigation [%]	-	11.6	25	113.2
Irrigated land with flood irrigation [%]	-	29.9	73.5	100
Irrigated land with sprinkler irrigation [%]	-	63.5	22.3	93.9
Irrigated land with drip irrigation [%]	-	6.6	2.7	62.4

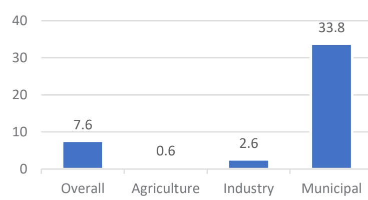
Urban and Rural population



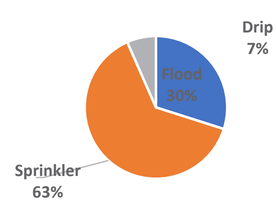
Value added % of GDP



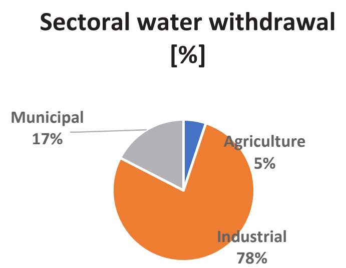
Economic water productivity [$US/m³]



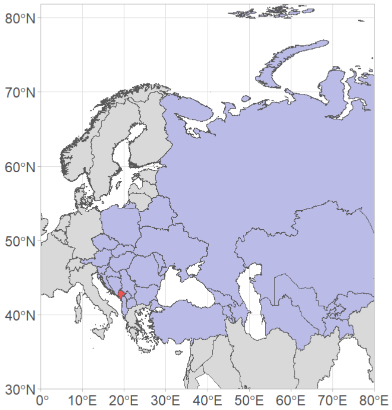
Irrigation land by irrigation systems [%]



Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	3028.2	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	93	84.9	100
Share of groundwater to total water availability [%]	2018-2022	7	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	86.8	39.2	97
Drinking Water Quality Index [0-100]	-	50.6	55.2	100
Interannual Variability [CoV]	2018-2022	0.4	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.4	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	206.6	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	85	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	15	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	5.1	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	77.4	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	17.4	17.9	75



Country page: Montenegro ECA Water Security Assessment

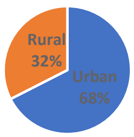


Population
0.6 M

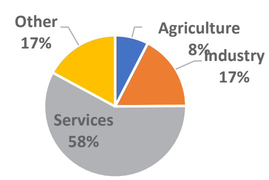
GDP [Billions]
12.8 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	98.9	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	99	99.3	110
Basic and safely managed sanitation [%]	2020	97.8	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	94	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	71	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0	0.4	4
People affected by floods [People per 100k]	1980-2021	29.8	83.6	915
People living in areas under water stress [%]	-	0	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	45	55.5	99
Water bodies with good ambient water quality [%]	2017-2020	88	79.6	96
Wetland loss [%]	2017-2021	100	60.9	100
Groundwater table decline [cm/yr]	1990-2014	-0.03	0.07	0.34
Water stress ratio [-]	2019	8	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	20.9	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	47.3	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	7.9	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	30.6	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	26	25.6	100
Electricity production from hydroelectric sources [%]	2015	49.6	20.7	100
Share of hydropower in total primary energy supply [%]	2020	13	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2020	38	63.6	93
Operating cost coverage [ratio]	-	1.9	1.2	1.9
Electrical energy share of operational costs [%]	-	0.1	0.2	0.4
Riverine flood risk - population affected [%]	-	2.2	1.7	3.2
Riverine flood risk - monetary [%]	2021	2.2	1.6	3.1
Drought Risk [1-5]	2020	3.2	3.2	4
Degree of IWRM implementation [0-100]	2020	35	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	1638.1	1398	5507.8
Water supply coverage by piped improved facilities [%]	2020	0.9	0.8	1
Sanitation coverage by sewer facilities [%]	2016	0.4	0.6	0.9
Non-revenue water [%]	2020	0.7	0.4	0.8
Continuity of service [hours]	-	23.5	23.2	24
Wastewater treatment [%]	-	46.3	49.9	79.6
Cultivated land under irrigation [%]	2018-2022	16.5	25	113.2
Irrigated land with flood irrigation [%]	2018-2022	0.2	73.5	100
Irrigated land with sprinkler irrigation [%]	2018-2022	37.3	22.3	93.9
Irrigated land with drip irrigation [%]	2018-2022	62.4	2.7	62.4

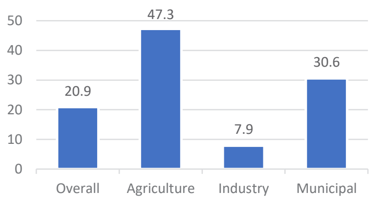
Urban and Rural population



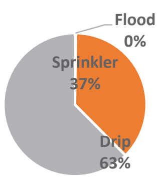
Value added % of GDP



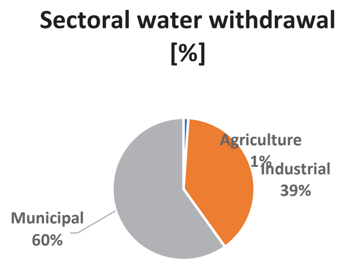
Economic water productivity [$US/m³]



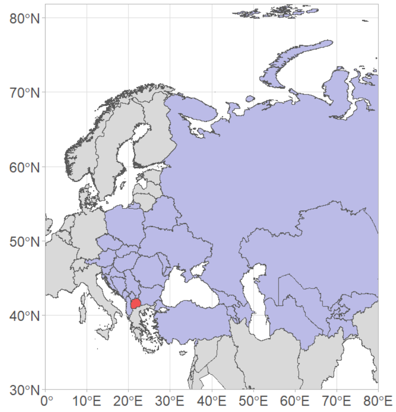
Irrigation land by irrigation systems [%]



Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	21395	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	38	84.9	100
Share of groundwater to total water availability [%]	2018-2022	62	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	4.7	39.2	97
Drinking Water Quality Index [0-100]	-	56.7	55.2	100
Interannual Variability [CoV]	2018-2022	0.3	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.6	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	256.3	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	-	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	-	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	1.1	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	39	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	59.9	17.9	75



Country page: North Macedonia ECA Water Security Assessment

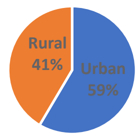


Population
2.1 M

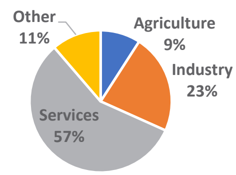
GDP [Billions]
35.3 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	97.7	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	100	99.3	110
Basic and safely managed sanitation [%]	2020	98.3	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	97	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	74	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.1	0.4	4
People affected by floods [People per 100k]	1980-2021	290	83.6	915
People living in areas under water stress [%]	-	5.9	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	9	55.5	99
Water bodies with good ambient water quality [%]	2017-2020	70	79.6	96
Wetland loss [%]	2017-2021	19.9	60.9	100
Groundwater table decline [cm/yr]	1990-2014	-0.03	0.07	0.34
Water stress ratio [-]	2019	40	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	10.2	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	0.6	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	9.6	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	20.7	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	27.3	25.6	100
Electricity production from hydroelectric sources [%]	2015	33	20.7	100
Share of hydropower in total primary energy supply [%]	2016	4.5	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2016	43	63.6	93
Operating cost coverage [ratio]	-	0.9	1.2	1.9
Electrical energy share of operational costs [%]	-	0.1	0.2	0.4
Riverine flood risk - population affected [%]	-	2.2	1.7	3.2
Riverine flood risk - monetary [%]	2021	3.1	1.6	3.1
Drought Risk [1-5]	2020	3.2	3.2	4
Degree of IWRM implementation [0-100]	2020	33	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	1099.9	1398	5507.8
Water supply coverage by piped improved facilities [%]	2016	0.9	0.8	1
Sanitation coverage by sewer facilities [%]	2016	0.8	0.6	0.9
Non-revenue water [%]	2020	0.6	0.4	0.8
Continuity of service [hours]	-	23.8	23.2	24
Wastewater treatment [%]	-	55.4	49.9	79.6
Cultivated land under irrigation [%]	2018-2022	28	25	113.2
Irrigated land with flood irrigation [%]	2018-2022	-	73.5	100
Irrigated land with sprinkler irrigation [%]	2018-2022	-	22.3	93.9
Irrigated land with drip irrigation [%]	2018-2022	-	2.7	62.4

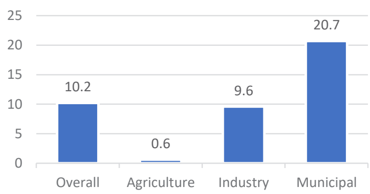
Urban and Rural population



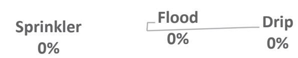
Value added % of GDP



Economic water productivity [$US/m³]



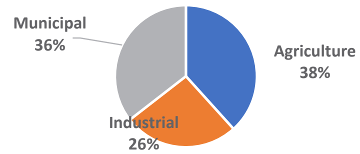
Irrigation land by irrigation systems [%]



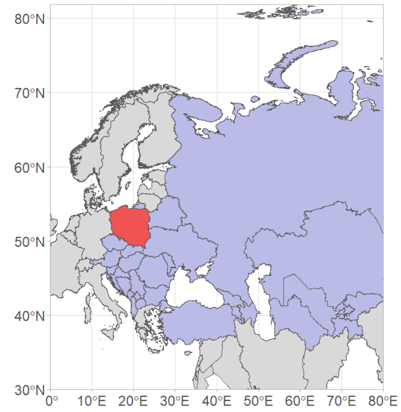
Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	3072.6	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	100	84.9	100
Share of groundwater to total water availability [%]	2018-2022	0	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	15.6	39.2	97
Drinking Water Quality Index [0-100]	-	58.1	55.2	100
Interannual Variability [CoV]	2018-2022	0.5	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.7	0.7	1.2

Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	413.1	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	84	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	16	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	38.3	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	26.2	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	35.5	17.9	75

Sectoral water withdrawal [%]



Country page: Poland ECA Water Security Assessment



Population

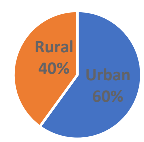
38 M

GDP [Billions]

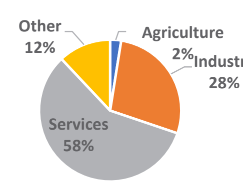
1305.7 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	100	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	100	99.3	110
Basic and safely managed sanitation [%]	2020	100	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	100	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	41	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.1	0.4	4
People affected by floods [People per 100k]	1980-2021	23	83.6	915
People living in areas under water stress [%]	-	15	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	82	55.5	99
Water bodies with good ambient water quality [%]	2017-2021	96	79.6	96
Wetland loss [%]	2017-2021	45.7	60.9	100
Groundwater table decline [cm/yr]	1990-2014	0.1	0.07	0.34
Water stress ratio [-]	2019	16	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	43.6	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	0.1	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	20.8	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	154.1	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	1.1	25.6	100
Electricity production from hydroelectric sources [%]	2015	1.1	20.7	100
Share of hydropower in total primary energy supply [%]	2015	0.2	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2015	72	63.6	93
Operating cost coverage [ratio]	-	1.7	1.2	1.9
Electrical energy share of operational costs [%]	-	0.1	0.2	0.4
Riverine flood risk - population affected [%]	-	1.1	1.7	3.2
Riverine flood risk - monetary [%]	2021	1	1.6	3.1
Drought Risk [1-5]	2020	3.4	3.2	4
Degree of IWRM implementation [0-100]	2020	74	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	77.9	1398	5507.8
Water supply coverage by piped improved facilities [%]	2015	0.9	0.8	1
Sanitation coverage by sewer facilities [%]	2015	0.6	0.6	0.9
Non-revenue water [%]	2020	0.2	0.4	0.8
Continuity of service [hours]	-	24	23.2	24
Wastewater treatment [%]	-	60.9	49.9	79.6
Cultivated land under irrigation [%]	-	0.7	25	113.2
Irrigated land with flood irrigation [%]	-	88.8	73.5	100
Irrigated land with sprinkler irrigation [%]	-	4.3	22.3	93.9
Irrigated land with drip irrigation [%]	-	6.9	2.7	62.4

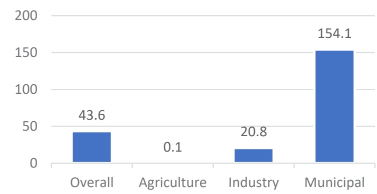
Urban and Rural population



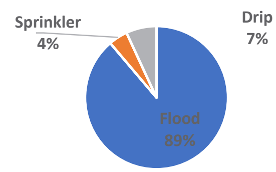
Value added % of GDP



Economic water productivity [$US/m³]

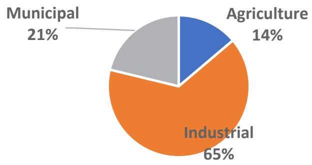


Irrigation land by irrigation systems [%]

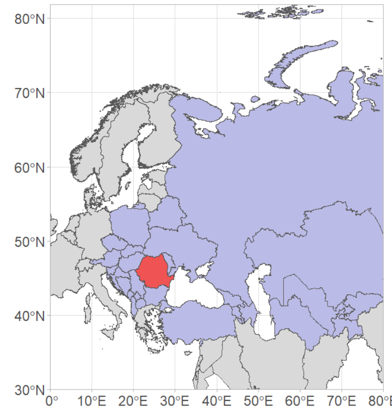


Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	1595.4	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	89	84.9	100
Share of groundwater to total water availability [%]	2018-2022	11	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	11.4	39.2	97
Drinking Water Quality Index [0-100]	-	65.6	55.2	100
Interannual Variability [CoV]	2018-2022	0.4	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.4	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	264.5	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	83	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	17	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	13.8	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	64.9	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	21.2	17.9	75

Sectoral water withdrawal [%]



Country page: Romania ECA Water Security Assessment



Population

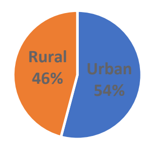
19.3 M

GDP [Billions]

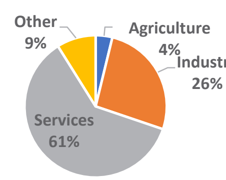
616.1 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	100	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	100	99.3	110
Basic and safely managed sanitation [%]	2020	87.1	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	78	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	105	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.4	0.4	4
People affected by floods [People per 100k]	1980-2021	49.3	83.6	915
People living in areas under water stress [%]	-	17.3	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	48	55.5	99
Water bodies with good ambient water quality [%]	2017-2020	84	79.6	96
Wetland loss [%]	2017-2021	66.6	60.9	100
Groundwater table decline [cm/yr]	1990-2014	-0.03	0.07	0.34
Water stress ratio [-]	2019	11	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	25.5	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	0.3	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	13.8	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	114.5	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	4.7	25.6	100
Electricity production from hydroelectric sources [%]	2015	25.2	20.7	100
Share of hydropower in total primary energy supply [%]	2020	3.9	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2020	82	63.6	93
Operating cost coverage [ratio]	-	1.1	1.2	1.9
Electrical energy share of operational costs [%]	-	0.1	0.2	0.4
Riverine flood risk - population affected [%]	-	1.8	1.7	3.2
Riverine flood risk - monetary [%]	2021	1.7	1.6	3.1
Drought Risk [1-5]	2020	3.4	3.2	4
Degree of IWRM implementation [0-100]	2018	77	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	562.9	1398	5507.8
Water supply coverage by piped improved facilities [%]	2020	0.6	0.8	1
Sanitation coverage by sewer facilities [%]	2020	0.5	0.6	0.9
Non-revenue water [%]	2020	0.5	0.4	0.8
Continuity of service [hours]	-	24	23.2	24
Wastewater treatment [%]	-	64.7	49.9	79.6
Cultivated land under irrigation [%]	-	3.7	25	113.2
Irrigated land with flood irrigation [%]	-	-	73.5	100
Irrigated land with sprinkler irrigation [%]	-	-	22.3	93.9
Irrigated land with drip irrigation [%]	-	-	2.7	62.4

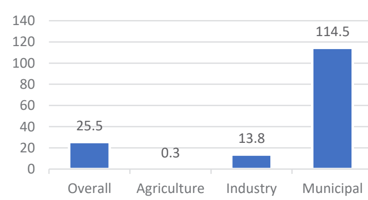
Urban and Rural population



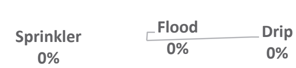
Value added % of GDP



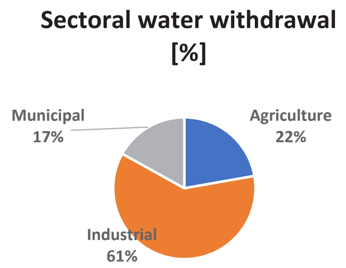
Economic water productivity [$US/m³]



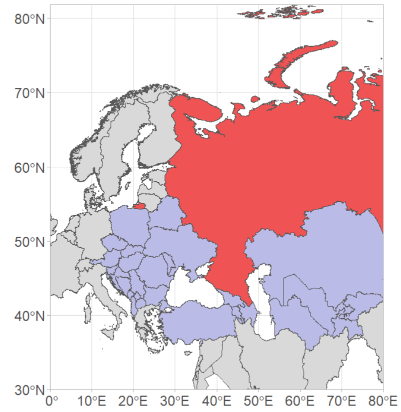
Irrigation land by irrigation systems [%]



Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	10869	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	98	84.9	100
Share of groundwater to total water availability [%]	2018-2022	2	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	80	39.2	97
Drinking Water Quality Index [0-100]	-	55.3	55.2	100
Interannual Variability [CoV]	2018-2022	0.5	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.4	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	328.9	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	90	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	10	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	22.2	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	60.8	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	16.9	17.9	75



Country page: Russian Federation ECA Water Security Assessment

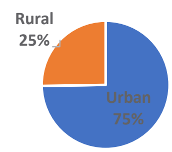


Population 144.1 M

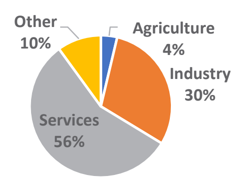
GDP [Billions] 4133.1 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	97	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	93	99.3	110
Basic and safely managed sanitation [%]	2020	89.4	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	76	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	172	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.1	0.4	4
People affected by floods [People per 100k]	1980-2021	39.3	83.6	915
People living in areas under water stress [%]	-	17.7	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	13	55.5	99
Water bodies with good ambient water quality [%]	2017-2021	96	79.6	96
Wetland loss [%]	2017-2021	43	60.9	100
Groundwater table decline [cm/yr]	1990-2014	-0.08	0.07	0.34
Water stress ratio [-]	2019	11	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	18.7	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	0	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	14.2	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	47.4	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	2.1	25.6	100
Electricity production from hydroelectric sources [%]	2015	15.8	20.7	100
Share of hydropower in total primary energy supply [%]	2020	2.5	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2020	87	63.6	93
Operating cost coverage [ratio]	-	1	1.2	1.9
Electrical energy share of operational costs [%]	-	0.2	0.2	0.4
Riverine flood risk - population affected [%]	-	1.9	1.7	3.2
Riverine flood risk - monetary [%]	2021	1.9	1.6	3.1
Drought Risk [1-5]	2020	0.7	3.2	4
Degree of IWRM implementation [0-100]	2020	88	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	5507.8	1398	5507.8
Water supply coverage by piped improved facilities [%]	2020	0.9	0.8	1
Sanitation coverage by sewer facilities [%]	2020	0.8	0.6	0.9
Non-revenue water [%]	2020	0.3	0.4	0.8
Continuity of service [hours]	-	24	23.2	24
Wastewater treatment [%]	-	50.5	49.9	79.6
Cultivated land under irrigation [%]	-	2.9	25	113.2
Irrigated land with flood irrigation [%]	-	-	73.5	100
Irrigated land with sprinkler irrigation [%]	-	-	22.3	93.9
Irrigated land with drip irrigation [%]	-	-	2.7	62.4

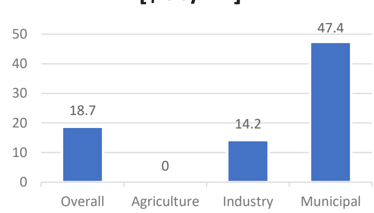
Urban and Rural population



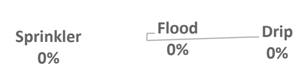
Value added % of GDP



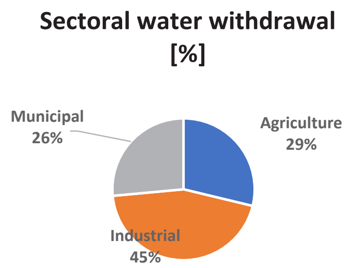
Economic water productivity [$US/m³]



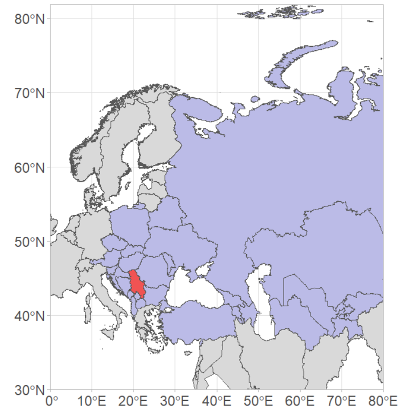
Irrigation land by irrigation systems [%]



Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	31053	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	88	84.9	100
Share of groundwater to total water availability [%]	2018-2022	12	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	4.7	39.2	97
Drinking Water Quality Index [0-100]	-	55.7	55.2	100
Interannual Variability [CoV]	2018-2022	0.3	0.5	0.6
Seasonal Variability [CoV]	2018-2022	1.1	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	444.8	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	83	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	17	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	28.8	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	44.8	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	26.5	17.9	75



Country page: Serbia ECA Water Security Assessment

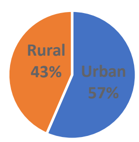


Population
6.9 M

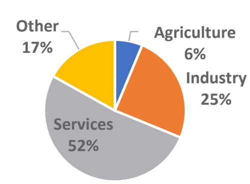
GDP [Billions]
133.8 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	95.3	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	101	99.3	110
Basic and safely managed sanitation [%]	2020	97.9	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	96	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	60	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.7	0.4	4
People affected by floods [People per 100k]	1980-2021	28.9	83.6	915
People living in areas under water stress [%]	-	23	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	27	55.5	99
Water bodies with good ambient water quality [%]	2017-2020	83	79.6	96
Wetland loss [%]	2017-2021	56.6	60.9	100
Groundwater table decline [cm/yr]	1990-2014	-0.06	0.07	0.34
Water stress ratio [-]	2019	12	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	5.9	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	0.2	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	2.2	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	35.4	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	3.2	25.6	100
Electricity production from hydroelectric sources [%]	2015	26.8	20.7	100
Share of hydropower in total primary energy supply [%]	2020	5.3	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2020	42	63.6	93
Operating cost coverage [ratio]	-	1	1.2	1.9
Electrical energy share of operational costs [%]	-	0.1	0.2	0.4
Riverine flood risk - population affected [%]	-	2.4	1.7	3.2
Riverine flood risk - monetary [%]	2021	2.3	1.6	3.1
Drought Risk [1-5]	2020	3.5	3.2	4
Degree of IWRM implementation [0-100]	2020	36	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	257.1	1398	5507.8
Water supply coverage by piped improved facilities [%]	2020	0.9	0.8	1
Sanitation coverage by sewer facilities [%]	2020	0.6	0.6	0.9
Non-revenue water [%]	2020	0.4	0.4	0.8
Continuity of service [hours]	-	24	23.2	24
Wastewater treatment [%]	-	1.7	49.9	79.6
Cultivated land under irrigation [%]	2018-2022	2.5	25	113.2
Irrigated land with flood irrigation [%]	2018-2022	0.1	73.5	100
Irrigated land with sprinkler irrigation [%]	2018-2022	93.9	22.3	93.9
Irrigated land with drip irrigation [%]	2018-2022	6	2.7	62.4

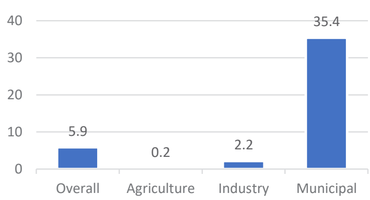
Urban and Rural population



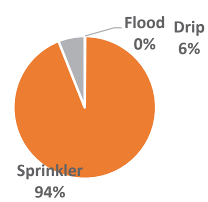
Value added % of GDP



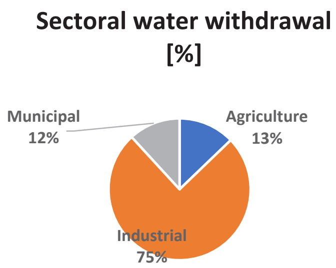
Economic water productivity [$US/m³]



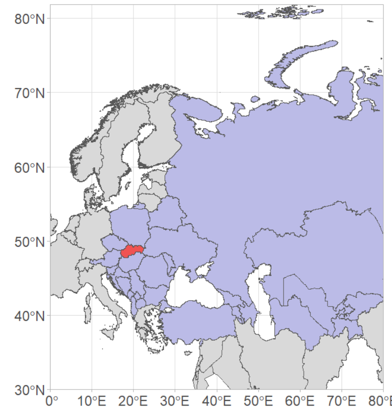
Irrigation land by irrigation systems [%]



Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	18426	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	95.9	84.9	100
Share of groundwater to total water availability [%]	2018-2022	4.1	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	90	39.2	97
Drinking Water Quality Index [0-100]	-	60.3	55.2	100
Interannual Variability [CoV]	2018-2022	0.3	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.5	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	631.3	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	91	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	9	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	12.8	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	75.4	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	11.8	17.9	75



Country page: Slovakia ECA Water Security Assessment

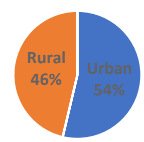


Population
5.5 M

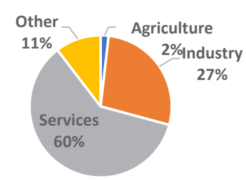
GDP [Billions]
174.8 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	99.8	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	100	99.3	110
Basic and safely managed sanitation [%]	2020	97.5	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	97	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	45	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0	0.4	4
People affected by floods [People per 100k]	1980-2021	21.5	83.6	915
People living in areas under water stress [%]	-	0	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	80	55.5	99
Water bodies with good ambient water quality [%]	2017-2022	57	79.6	96
Wetland loss [%]	2017-2021	100	60.9	100
Groundwater table decline [cm/yr]	1990-2014	-0.05	0.07	0.34
Water stress ratio [-]	2019	15	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	146.2	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	1.4	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	110.3	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	199.3	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	3.1	25.6	100
Electricity production from hydroelectric sources [%]	2015	14.5	20.7	100
Share of hydropower in total primary energy supply [%]	2013	2.3	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2013	62	63.6	93
Operating cost coverage [ratio]	-	1	1.2	1.9
Electrical energy share of operational costs [%]	-	0.1	0.2	0.4
Riverine flood risk - population affected [%]	-	3.2	1.7	3.2
Riverine flood risk - monetary [%]	2021	3.1	1.6	3.1
Drought Risk [1-5]	2020	3.1	3.2	4
Degree of IWRM implementation [0-100]	2018	61	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	317	1398	5507.8
Water supply coverage by piped improved facilities [%]	2013	1	0.8	1
Sanitation coverage by sewer facilities [%]	2013	0.7	0.6	0.9
Non-revenue water [%]	2020	0.3	0.4	0.8
Continuity of service [hours]	-	24	23.2	24
Wastewater treatment [%]	-	68.3	49.9	79.6
Cultivated land under irrigation [%]	-	7.3	25	113.2
Irrigated land with flood irrigation [%]	-	-	73.5	100
Irrigated land with sprinkler irrigation [%]	-	-	22.3	93.9
Irrigated land with drip irrigation [%]	-	-	2.7	62.4

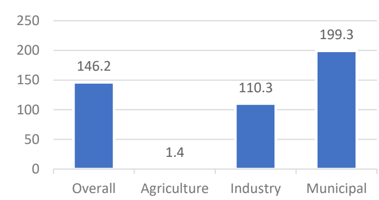
Urban and Rural population



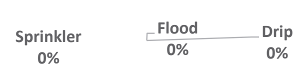
Value added % of GDP



Economic water productivity [$US/m³]

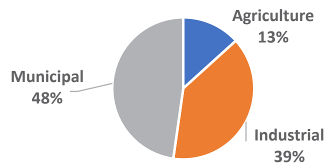


Irrigation land by irrigation systems [%]

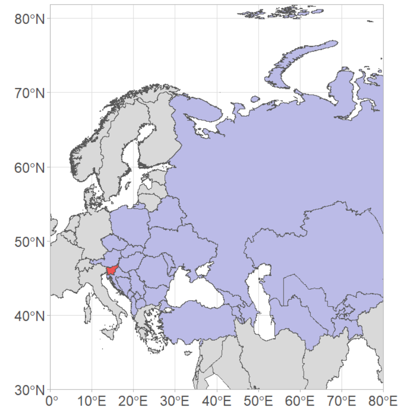


Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	9187.6	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	98	84.9	100
Share of groundwater to total water availability [%]	2018-2022	2	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	74.9	39.2	97
Drinking Water Quality Index [0-100]	-	64.5	55.2	100
Interannual Variability [CoV]	2018-2022	0.3	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.4	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	112.2	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	44	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	56	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	13.3	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	39	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	47.8	17.9	75

Sectoral water withdrawal [%]



Country page: Slovenia ECA Water Security Assessment



Population

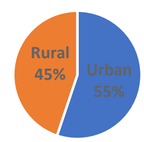
2.1 M

GDP [Billions]

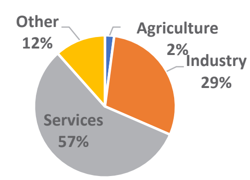
84.3 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	99.5	97.6	100
Basic and safely managed drinking water [rural/urban]	-	-	99.3	110
Basic and safely managed sanitation [%]	2020	98.1	97.5	100
Basic and safely managed sanitation [rural/urban]	-	-	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	31	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0	0.4	4
People affected by floods [People per 100k]	1980-2021	16.6	83.6	915
People living in areas under water stress [%]	-	0	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	67	55.5	99
Water bodies with good ambient water quality [%]	2017-2023	84	79.6	96
Wetland loss [%]	2017-2021	100	60.9	100
Groundwater table decline [cm/yr]	1990-2014	-0.04	0.07	0.34
Water stress ratio [-]	2019	7	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	42.6	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	6.5	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	15.9	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	168.1	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	1.9	25.6	100
Electricity production from hydroelectric sources [%]	2015	25.7	20.7	100
Share of hydropower in total primary energy supply [%]	-	5.4	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	-	81	63.6	93
Operating cost coverage [ratio]	-	-	1.2	1.9
Electrical energy share of operational costs [%]	-	-	0.2	0.4
Riverine flood risk - population affected [%]	-	2.1	1.7	3.2
Riverine flood risk - monetary [%]	2021	1.9	1.6	3.1
Drought Risk [1-5]	2020	2.3	3.2	4
Degree of IWRM implementation [0-100]	-	87	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	16.1	1398	5507.8
Water supply coverage by piped improved facilities [%]	-	-	0.8	1
Sanitation coverage by sewer facilities [%]	-	0.7	0.6	0.9
Non-revenue water [%]	2020	0.3	0.4	0.8
Continuity of service [hours]	-	24	23.2	24
Wastewater treatment [%]	-	72	49.9	79.6
Cultivated land under irrigation [%]	-	1.1	25	113.2
Irrigated land with flood irrigation [%]	-	-	73.5	100
Irrigated land with sprinkler irrigation [%]	-	-	22.3	93.9
Irrigated land with drip irrigation [%]	-	-	2.7	62.4

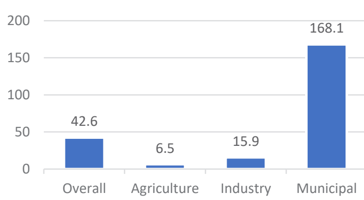
Urban and Rural population



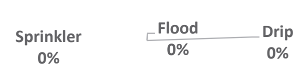
Value added % of GDP



Economic water productivity [$US/m³]

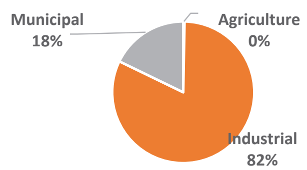


Irrigation land by irrigation systems [%]

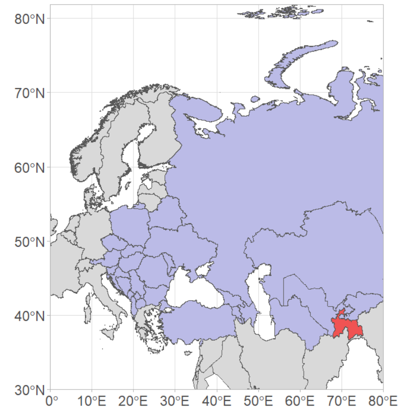


Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	15338	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	78	84.9	100
Share of groundwater to total water availability [%]	2018-2022	22	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	41.4	39.2	97
Drinking Water Quality Index [0-100]	-	70.1	55.2	100
Interannual Variability [CoV]	2018-2022	0.2	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.4	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	462.5	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	80	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	20	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	0.3	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	81.9	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	17.8	17.9	75

Sectoral water withdrawal [%]



Country page: Tajikistan ECA Water Security Assessment



Population

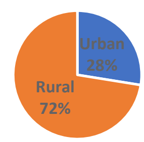
9.5 M

GDP [Billions]

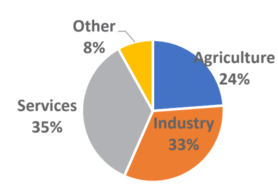
36.8 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	81.9	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	80	99.3	110
Basic and safely managed sanitation [%]	2020	96.8	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	104	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	935	154.1	935
Mortality rate due to unsafe WASH [-]	2016	2.7	0.4	4
People affected by floods [People per 100k]	1980-2021	205	83.6	915
People living in areas under water stress [%]	-	34.8	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	-	55.5	99
Water bodies with good ambient water quality [%]	2017-2022	-	79.6	96
Wetland loss [%]	2017-2021	100	60.9	100
Groundwater table decline [cm/yr]	1990-2014	0.03	0.07	0.34
Water stress ratio [-]	2019	25	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	0.7	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	0.2	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	1.6	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	5.5	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	90.3	25.6	100
Electricity production from hydroelectric sources [%]	2015	98.5	20.7	100
Share of hydropower in total primary energy supply [%]	2015	31.9	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2015	48	63.6	93
Operating cost coverage [ratio]	-	1.4	1.2	1.9
Electrical energy share of operational costs [%]	-	0.1	0.2	0.4
Riverine flood risk - population affected [%]	-	2.2	1.7	3.2
Riverine flood risk - monetary [%]	2021	2.2	1.6	3.1
Drought Risk [1-5]	2020	2.5	3.2	4
Degree of IWRM implementation [0-100]	2020	46	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	3322.5	1398	5507.8
Water supply coverage by piped improved facilities [%]	2015	0.6	0.8	1
Sanitation coverage by sewer facilities [%]	2015	0.2	0.6	0.9
Non-revenue water [%]	2020	0.4	0.4	0.8
Continuity of service [hours]	-	22	23.2	24
Wastewater treatment [%]	-	38.2	49.9	79.6
Cultivated land under irrigation [%]	2018-2022	85.5	25	113.2
Irrigated land with flood irrigation [%]	2018-2022	100	73.5	100
Irrigated land with sprinkler irrigation [%]	2018-2022	0	22.3	93.9
Irrigated land with drip irrigation [%]	2018-2022	0	2.7	62.4

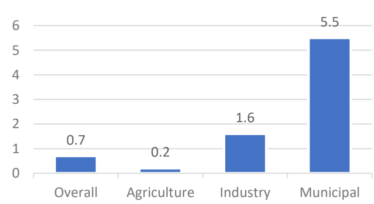
Urban and Rural population



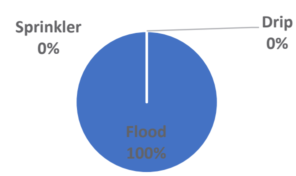
Value added % of GDP



Economic water productivity [$US/m³]

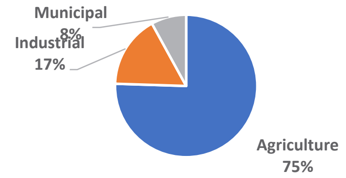


Irrigation land by irrigation systems [%]

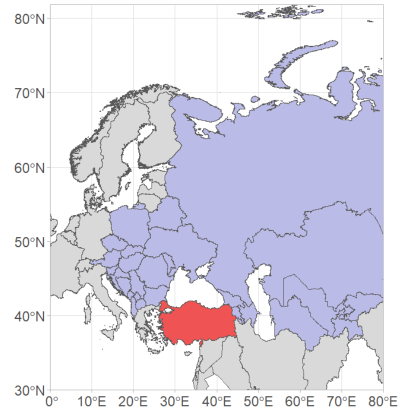


Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	2407.5	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	79	84.9	100
Share of groundwater to total water availability [%]	2018-2022	21	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	17.3	39.2	97
Drinking Water Quality Index [0-100]	-	31.6	55.2	100
Interannual Variability [CoV]	2018-2022	0.5	0.5	0.6
Seasonal Variability [CoV]	2018-2022	1.2	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	1074	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	95	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	5	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	75.5	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	16.5	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	8	17.9	75

Sectoral water withdrawal [%]



Country page: Turkey ECA Water Security Assessment

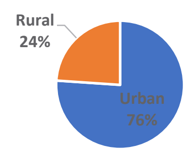


Population
84.3 M

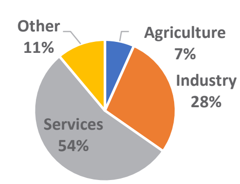
GDP [Billions]
2371.1 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	100	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	99	99.3	110
Basic and safely managed sanitation [%]	2020	99.2	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	97	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	171	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.3	0.4	4
People affected by floods [People per 100k]	1980-2021	51	83.6	915
People living in areas under water stress [%]	-	70.1	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	63	55.5	99
Water bodies with good ambient water quality [%]	2017-2024	-	79.6	96
Wetland loss [%]	2017-2021	47.5	60.9	100
Groundwater table decline [cm/yr]	1990-2014	0.08	0.07	0.34
Water stress ratio [-]	2019	52	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	13.6	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	0.3	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	86.7	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	84	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	26	25.6	100
Electricity production from hydroelectric sources [%]	2015	25.6	20.7	100
Share of hydropower in total primary energy supply [%]	2008	5.2	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2008	73	63.6	93
Operating cost coverage [ratio]	-	1.3	1.2	1.9
Electrical energy share of operational costs [%]	-	0.2	0.2	0.4
Riverine flood risk - population affected [%]	-	2	1.7	3.2
Riverine flood risk - monetary [%]	2021	2	1.6	3.1
Drought Risk [1-5]	2020	3	3.2	4
Degree of IWRM implementation [0-100]	2020	72	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	1945.7	1398	5507.8
Water supply coverage by piped improved facilities [%]	2008	1	0.8	1
Sanitation coverage by sewer facilities [%]	2008	0.9	0.6	0.9
Non-revenue water [%]	2020	0.6	0.4	0.8
Continuity of service [hours]	-	24	23.2	24
Wastewater treatment [%]	-	42.6	49.9	79.6
Cultivated land under irrigation [%]	-	22.9	25	113.2
Irrigated land with flood irrigation [%]	-	87.8	73.5	100
Irrigated land with sprinkler irrigation [%]	-	9.4	22.3	93.9
Irrigated land with drip irrigation [%]	-	2.8	2.7	62.4

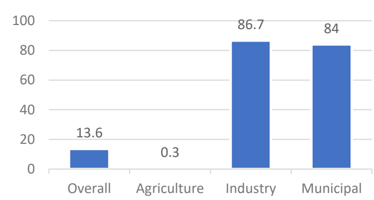
Urban and Rural population



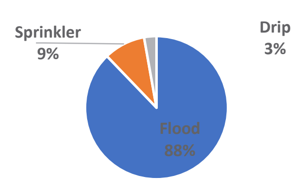
Value added % of GDP



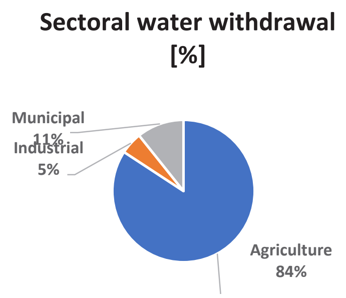
Economic water productivity [$US/m³]



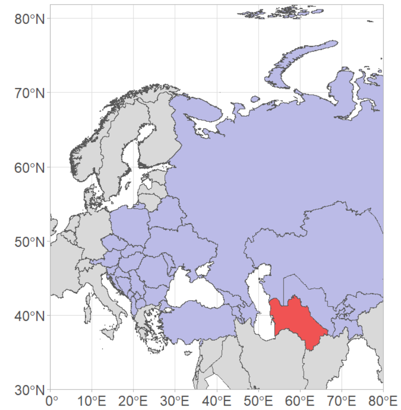
Irrigation land by irrigation systems [%]



Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	2569.8	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	75	84.9	100
Share of groundwater to total water availability [%]	2018-2022	25	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	1.5	39.2	97
Drinking Water Quality Index [0-100]	-	46.9	55.2	100
Interannual Variability [CoV]	2018-2022	0.5	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.9	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	721.2	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	74	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	26	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	87.1	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	5.2	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	11.1	17.9	75



Country page: Turkmenistan ECA Water Security Assessment



Population

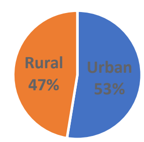
6 M

GDP [Billions]

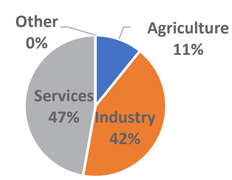
96.2 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	100	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	100	99.3	110
Basic and safely managed sanitation [%]	2020	99.4	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	101	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	279	154.1	935
Mortality rate due to unsafe WASH [-]	2016	4	0.4	4
People affected by floods [People per 100k]	1980-2021	0.2	83.6	915
People living in areas under water stress [%]	-	47	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	-	55.5	99
Water bodies with good ambient water quality [%]	2017-2023	-	79.6	96
Wetland loss [%]	2017-2021	100	60.9	100
Groundwater table decline [cm/yr]	1990-2014	0.06	0.07	0.34
Water stress ratio [-]	2019	67	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	1.4	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	0.1	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	28.9	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	19.2	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	100	25.6	100
Electricity production from hydroelectric sources [%]	2015	0	20.7	100
Share of hydropower in total primary energy supply [%]	-	0	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	-	63	63.6	93
Operating cost coverage [ratio]	-	-	1.2	1.9
Electrical energy share of operational costs [%]	-	-	0.2	0.4
Riverine flood risk - population affected [%]	-	1.2	1.7	3.2
Riverine flood risk - monetary [%]	2021	1.2	1.6	3.1
Drought Risk [1-5]	2020	2.7	3.2	4
Degree of IWRM implementation [0-100]	2020	64	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	1945.7	1398	5507.8
Water supply coverage by piped improved facilities [%]	-	0.5	0.8	1
Sanitation coverage by sewer facilities [%]	-	0.3	0.6	0.9
Non-revenue water [%]	2020	-	0.4	0.8
Continuity of service [hours]	-	-	23.2	24
Wastewater treatment [%]	-	43.9	49.9	79.6
Cultivated land under irrigation [%]	2018-2022	22.9	25	113.2
Irrigated land with flood irrigation [%]	2018-2022	100	73.5	100
Irrigated land with sprinkler irrigation [%]	2018-2022	0	22.3	93.9
Irrigated land with drip irrigation [%]	2018-2022	0	2.7	62.4

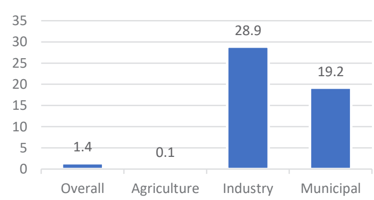
Urban and Rural population



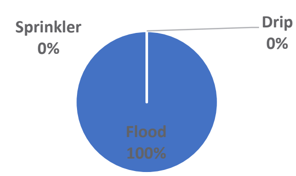
Value added % of GDP



Economic water productivity [$US/m³]

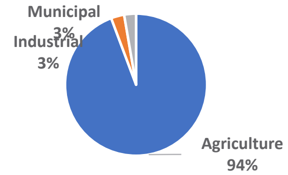


Irrigation land by irrigation systems [%]

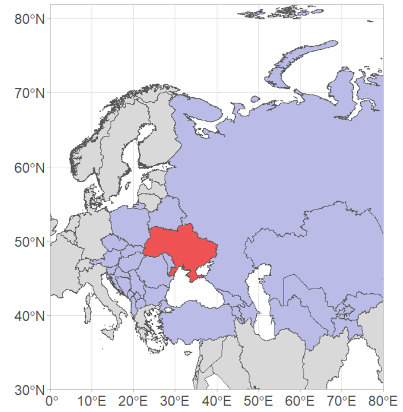


Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	4232.7	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	98	84.9	100
Share of groundwater to total water availability [%]	2018-2022	2	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	97	39.2	97
Drinking Water Quality Index [0-100]	-	47.6	55.2	100
Interannual Variability [CoV]	2018-2022	0.5	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.5	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	4777.7	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	99	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	1	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	94.3	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	3	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	2.7	17.9	75

Sectoral water withdrawal [%]



Country page: Ukraine ECA Water Security Assessment

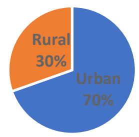


Population
44.1 M

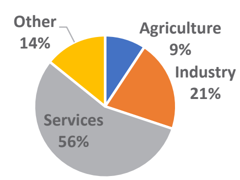
GDP [Billions]
544.8 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	93.9	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	110	99.3	110
Basic and safely managed sanitation [%]	2020	97.7	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	99	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	121	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.3	0.4	4
People affected by floods [People per 100k]	1980-2021	147.2	83.6	915
People living in areas under water stress [%]	-	22.9	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	34	55.5	99
Water bodies with good ambient water quality [%]	2017-2020	-	79.6	96
Wetland loss [%]	2017-2021	86.9	60.9	100
Groundwater table decline [cm/yr]	1990-2014	0.07	0.07	0.34
Water stress ratio [-]	2019	13	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	7.8	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	0.1	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	4.8	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	22	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	2	25.6	100
Electricity production from hydroelectric sources [%]	2015	3.3	20.7	100
Share of hydropower in total primary energy supply [%]	2015	0.6	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2015	40	63.6	93
Operating cost coverage [ratio]	-	0.9	1.2	1.9
Electrical energy share of operational costs [%]	-	0.2	0.2	0.4
Riverine flood risk - population affected [%]	-	1.1	1.7	3.2
Riverine flood risk - monetary [%]	2021	1	1.6	3.1
Drought Risk [1-5]	2020	4	3.2	4
Degree of IWRM implementation [0-100]	2020	39	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	1945.7	1398	5507.8
Water supply coverage by piped improved facilities [%]	2015	0.6	0.8	1
Sanitation coverage by sewer facilities [%]	2015	0.5	0.6	0.9
Non-revenue water [%]	2020	0.4	0.4	0.8
Continuity of service [hours]	-	23.7	23.2	24
Wastewater treatment [%]	-	49.5	49.9	79.6
Cultivated land under irrigation [%]	-	7.7	25	113.2
Irrigated land with flood irrigation [%]	-	20.2	73.5	100
Irrigated land with sprinkler irrigation [%]	-	70.8	22.3	93.9
Irrigated land with drip irrigation [%]	-	0	2.7	62.4

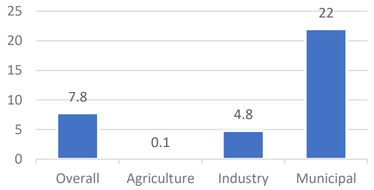
Urban and Rural population



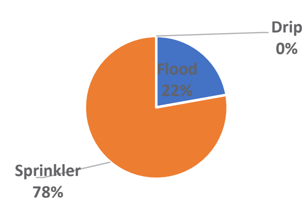
Value added % of GDP



Economic water productivity [$US/m³]

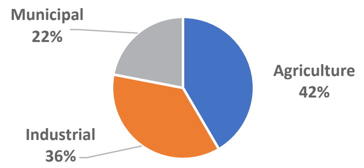


Irrigation land by irrigation systems [%]

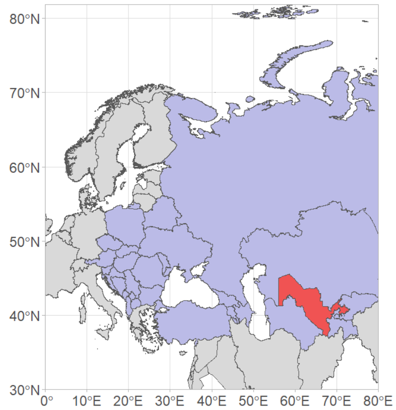


Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	3961.5	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	92	84.9	100
Share of groundwater to total water availability [%]	2018-2022	8	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	68	39.2	97
Drinking Water Quality Index [0-100]	-	55	55.2	100
Interannual Variability [CoV]	2018-2022	0.5	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.6	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	253.2	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	86	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	14	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	41.6	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	36.5	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	22	17.9	75

Sectoral water withdrawal [%]



Country page: Uzbekistan ECA Water Security Assessment



Population

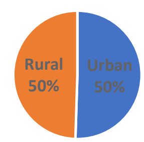
34.2 M

GDP [Billions]

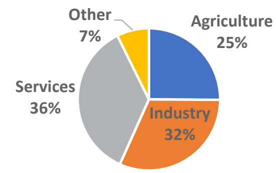
264.7 $

Indicator	Year	Value	ECA Average	ECA best
Social Outcomes				
Basic and safely managed drinking water [%]	2020	97.8	97.6	100
Basic and safely managed drinking water [rural/urban]	2020	97	99.3	110
Basic and safely managed sanitation [%]	2020	100	97.5	100
Basic and safely managed sanitation [rural/urban]	2020	100	97.3	105
Disability-adjusted life years due to unsafe WASH [DALYs]	2019	238	154.1	935
Mortality rate due to unsafe WASH [-]	2016	0.4	0.4	4
People affected by floods [People per 100k]	1980-2021	5.2	83.6	915
People living in areas under water stress [%]	-	49	34.7	76.1
Environmental Outcomes				
Share of wastewater safely treated [%]	2020	32	55.5	99
Water bodies with good ambient water quality [%]	2017-2024	-	79.6	96
Wetland loss [%]	2017-2021	56	60.9	100
Groundwater table decline [cm/yr]	1990-2014	0.17	0.07	0.34
Water stress ratio [-]	2019	62	30.6	67
Economic Outcomes				
Economic water productivity: Overall [$US/m3]	2018	1.3	22.2	146.2
Economic water productivity: Agriculture [$US/m3]	2018	0.5	0.5	47.3
Economic water productivity: Industry [$US/m3]	2018	12	35.7	110.3
Economic water productivity: Municipal [$US/m3]	2018	14	78.4	369.6
Gross value generated by irrigated agriculture [%]	2017	90.2	25.6	100
Electricity production from hydroelectric sources [%]	2015	20.6	20.7	100
Share of hydropower in total primary energy supply [%]	2010	1	4.1	31.9
Performance and Institution				
Degree of implementation of WRM instruments [0-100]	2010	60	63.6	93
Operating cost coverage [ratio]	-	0.9	1.2	1.9
Electrical energy share of operational costs [%]	-	0.4	0.2	0.4
Riverine flood risk - population affected [%]	-	1.1	1.7	3.2
Riverine flood risk - monetary [%]	2021	1	1.6	3.1
Drought Risk [1-5]	2020	2.8	3.2	4
Degree of IWRM implementation [0-100]	2020	48	61	91
Infrastructure				
Dam storage capacity [m3/capita]	2020	688.7	1398	5507.8
Water supply coverage by piped improved facilities [%]	2010	0.7	0.8	1
Sanitation coverage by sewer facilities [%]	2010	0.3	0.6	0.9
Non-revenue water [%]	2020	0.4	0.4	0.8
Continuity of service [hours]	-	21.3	23.2	24
Wastewater treatment [%]	-	44.3	49.9	79.6
Cultivated land under irrigation [%]	2018-2022	97.5	25	113.2
Irrigated land with flood irrigation [%]	2018-2022	99.2	73.5	100
Irrigated land with sprinkler irrigation [%]	2018-2022	0	22.3	93.9
Irrigated land with drip irrigation [%]	2018-2022	0.1	2.7	62.4

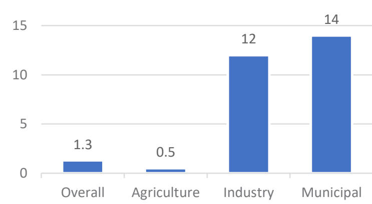
Urban and Rural population



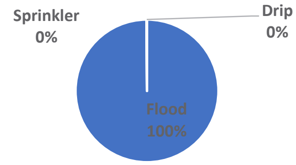
Value added % of GDP



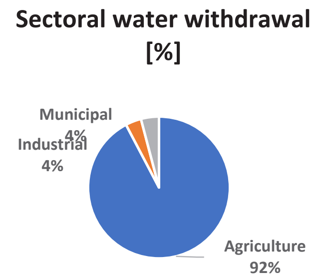
Economic water productivity [$US/m³]



Irrigation land by irrigation systems [%]



Endowment: Supply				
Total Renewable Water Resources [m3/capita/year]	2018-2022	1504.8	4739.3	31052.8
Share of surface water to total water availability [%]	2018-2022	84	84.9	100
Share of groundwater to total water availability [%]	2018-2022	16	15.1	62
Transboundary Dependence Ratio [%]	2018-2022	80.1	39.2	97
Drinking Water Quality Index [0-100]	-	53.8	55.2	100
Interannual Variability [CoV]	2018-2022	0.5	0.5	0.6
Seasonal Variability [CoV]	2018-2022	0.7	0.7	1.2
Endowment: Demand				
Water Withdrawal [m3/capita/year]	2018-2022	1813.6	747.9	4777.7
Surface water to total water withdrawal [%]	2018-2022	99	81.8	99
Groundwater to total water withdrawal [%]	2018-2022	1	18.2	73
Agriculture water use to total water withdrawal [%]	2018-2022	92.3	52.8	94.3
Industrial water use to total water withdrawal [%]	2018-2022	3.6	30	81.9
Municipal water use to total water withdrawal [%]	2018-2022	4.1	17.9	75



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