

State of water resources and water use in the Eastern Partnership countries

An indicator-based assessment

Final draft



Photo: The Bic River in Chisinau, Moldova, June 2018; ©Lidija Globevnik

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Abbreviations

ADB –	Asian Development Bank
CEPA –	Comprehensive and Enhanced Partnership Agreement
DPSIR –	Drivers – Pressures – State – Impact – Response
EBRD –	European Bank for Reconstruction and Development
EEA –	European Environment Agency
EIONET –	European Environment Information and Observation Network
ENI –	Eastern Neighbourhood Instrument
ENP –	European Neighbourhood Policy
EPIRB –	Environmental Protection of International River Basins
ETC/ICM –	European Topic Centre for Inland, Coastal and Marine Waters
EU –	European Union
EUWI + –	European Union Water Initiative Plus
FAO –	Food and Agriculture Organization
GEF –	General Environmental Facilities
GDP –	Gross Domestic Product
HLPF –	High-level Political Forum
IAWD –	International Association of the Water Supply Companies
IWRM –	Integrated Water Resources Management
NFP –	National Focal Point
OECD –	Organization for Economic Cooperation and Development
PPP –	Purchasing Power Parity
QA/QC –	Quality Assurance / Quality Control
RBMP –	River Basin Management Plan
RBMU –	River Basin Management Unit

REC –	Regional Environmental Centre
RWR –	Renewable Water Resources
SEIS –	Shared Environmental Information System
SDG –	Sustainable Development Goals
UN –	United Nations
UNDP –	United Nations Development Program
UNECE –	United Nations Economic Commission for Europe
USD –	US Dollar
WB –	World Bank
WEI –	Water Exploitation Index
WFD –	Water Framework Directive
WHO –	World Health Organization

Executive summary

The European Union (EU) has been strengthening its political and socio-economic relations with Armenia, Azerbaijan, Belarus, Georgia, Republic of Moldova and Ukraine under the European Neighbourhood Instrument (ENI) with the aim of supporting political, economic and social reforms.

The overarching objective of the ENI SEIS II East project, which is supported by the EU under the European Neighbourhood Instrument, is to support the further implementation of the Shared Environmental Information System (SEIS) principles and practices in the six Eastern Partnership countries. The specific objective is to strengthen the regular production of environmental indicators and assessment as a contribution towards knowledge-based policy-making and good governance in the field of the environment. The European Environment Agency (EEA) implemented the project in strong collaboration with a network of national agencies operating in various areas of environment. This report is one of the outputs of the ENI SEIS II East Project, aiming to provide a regional overview on state of freshwater resources and water use in the Eastern Partnership countries.

Water is one of the major environmental concerns in the region as elsewhere. Significant water quality deterioration and water shortages are increasingly common in the Region. Insufficient policy measures in public water supply, over- abstraction and extremely high water loss in conveyance systems are some of the major common issues putting pressure on water resources and are becoming an indispensable part of regional political tension. Limited connection to waste water treatment – and low level of treatment efficiency in existing facilities – in addition to diffuse runoff from agriculture constitute key threats to water quality across the region. Almost all large basins in the Region are transboundary. However, lack of comparable and harmonised data and information, and insufficient expert and institutional capacity, are restricting the countries from undertaking assessments on the state of water resources, trends, pressures and drivers.

Almost 10 years has passed since the publication of the EEA *Assessment of Assessments* report on Europe's environments (EEA, 2011). One of the key issues highlighted in the report was the insufficient usage of existing environmental data and information for assessing water resources of European regions. Hence, taking stock of what has been addressed by the EEA report (EEA, 2011), the activities under the EU funded project Implementation of the Shared Environmental Information System principles and practices in the Eastern Partnership countries (ENI SEIS II East) aimed to fill those gaps in assessing state, trend, drivers and pressures on water resources via developing a set of water indicators from the UNECE environmental indicators (UNECE, 2007a).

This report has been built on selected water indicators from –so called- UNECE environmental indicators (UNECE, 2012a). The development of environmental indicators was done in close partnership with various UNECE structures and entities such as the UNECE Joint Task Force on Environmental Indicators (JTFEI) and the UNECE Working Group on Environmental Monitoring and Assessment (WGEMA).

The overall objective with this report is to present a regional overview rather than undertaking country comparisons. The indicators which provide main inputs into the development of this report have been implemented by the national experts of the national water agencies of the countries, following the same methodology as the EEA core set of water indicators.

The report explores the answer to various policy questions e.g. availability and sustainability of renewable freshwater resources, socio-economic pressures on water resources, provision of clean and safe water to the public, managing waste water etc.

Overall, the gross domestic product (GDP) for the region has increased over the years, but in many cases at the expense of deteriorating water quality or over-abstraction surface and ground waters. Much remains to be further developed towards integrated management of water resources in the Region.

1 Introduction

The European Union (EU) has been strengthening its political and socio-economic relations with Armenia, Azerbaijan, Belarus, Georgia, Republic of Moldova and Ukraine under the European Neighbourhood Instrument (ENI) with the aim of supporting political, economic and social reforms. The Eastern Partnership (EaP) is a joint initiative involving the EU, its Member States and six Eastern European Partners: Armenia, Azerbaijan, Belarus, Georgia, the Republic of Moldova and Ukraine (also referred to as the region in this Report). Belarus, Moldova and Ukraine border the European Union on the East, where Armenia, Azerbaijan and Georgia lie on the Caucasus region between the Black Sea and the Caspian Sea (Figure 1). The EU has association with the three Eastern Partnership countries (Georgia, Moldova and Ukraine) signed in June 2014.

The Eastern Partnership countries are home to around 70 million people and are still in the transition period to market economies. Population dynamics show mixed trends, decreasing in some countries e.g. in Armenia and sharply increasing e.g. in Azerbaijan. Ukraine has the largest population of 42 million, followed by Azerbaijan with 10 million. Belarus has a population of 9.46 million, Georgia 3.7 million, Moldova 3.5 million and Armenia 3.0 million.

The Eastern Partnership countries are located on lands where freshwater ecosystems are very diverse with floodplains, rivers and lakes. Water resources are key to maintain major economic sectors in the countries, such as agriculture.

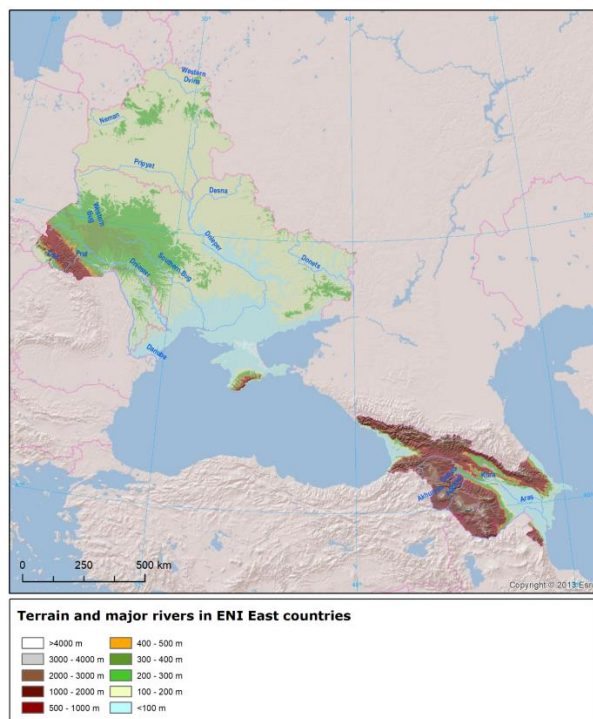


Figure 1: Terrain and major rivers in Eastern Partnership Countries

1.1 Purpose of this report

The ENI SEIS II East project ⁽¹⁾ is supported by the EU under the European Neighbourhood Instrument to underpin knowledge-based policymaking towards sustainable development in the region. The EEA implemented the project in strong collaboration with a network of national agencies operating in various areas of environment. This report is one of the outputs of the ENI SEIS II East Project, aiming to provide a regional overview on the state of freshwater resources and water use. The report has been built upon a set of water quantity and quality indicators which have been jointly developed with national water experts of the Eastern Partnership countries.

The report also briefly touches upon the gap in regional data and knowledge on the water resources and need for future work in improving knowledge-based environmental policy and sustainable management of water resources.

1.2 Structure of the report

The report has been organised in five chapters dedicated to various aspects of water resources management in the region. Chapter 2 describes the geographical setting and provides information on the policy background for water resources management with national and regional perspectives. Chapter 3 deals with assessments on renewable freshwater resources, pressures on water resources and water use efficiencies across all ENI East countries. Chapter 4 is dedicated to overall water quality issues, with a special focus on organic and nutrient pollution of waters and their drivers, while Chapter 5 addresses integrated water resources management, and provides an outlook for future work in the Region.

1.3 Context of the report

In 2011, the Astana Water Action (UNECE, 2011a) addressed the status of water and water-related ecosystems as a key issue and set possible actions to improve it by ensuring the sustainable development in the UNECE region. Eastern Partnership countries, as part of the UNECE region ⁽²⁾, host large areas of freshwater ecosystems including rivers and floodplains. Water is regarded as a strategic natural resource for supplying water to around 70 million people; and supports the key economic sectors such as agriculture and manufacturing industries in the region. However, renewable freshwater

⁽¹⁾ Implementation of the Shared Environmental Information System principles and practices in the Eastern Partnership countries

⁽²⁾ The United Nations Economic Commission for Europe (UNECE) was set up in 1947 by ECOSOC and its Member States include the countries of Europe (also Eastern countries; Belarus, Republic of Moldova, Ukraine), the Caucasus countries (Armenia, Azerbaijan, Georgia) but also countries in North America (Canada and United States), Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) and Western Asia (Israel)

resources in the region are either over-exploited by economic sectors or polluted with high level nitrate and phosphorus emissions, mainly from agriculture. A large portion of the population of the region still don't have access to a public water supply, whereas direct discharge or insufficient treated waste water exacerbate the pollution of surface and groundwater resources. These problems, partly or entirely, are common in all Eastern Partnership countries and have already been addressed in several publications (EEA, 2011; UNECE-OECD, 2014; UNECE, 2010a; REC 2011; UN, 2007; UNEP, 2011; Organisation für Sicherheit und Zusammenarbeit in Europa, 2015; Koszta et al., 2016)

Reports developed by the international organisations REC (2011), UNECE-OECD (2014) and UNECE (2011a) addressed the importance of data and information sharing on water resources at the regional level and emphasised the need for political attention and promoted the need for action.

Countries decided to develop a Shared Environmental Information System (SEIS) across the pan-European region at the Seventh Environment for Europe Ministerial Conference in Astana in 2011 (UNECE 2011b, 2020). The Joint Task Force on Environmental Indicators developed under the Working Group on Environmental Monitoring and Assessment has established a list of environmental indicators and guidelines (UNECE, 2020a) to support the national environmental monitoring efforts in the countries (UNECE, 2020c).

The context of this report has been defined by those UNECE water indicators selected by the Eastern Partnership countries for addressing common issues on renewable freshwater resources and water resources management, such as water pollution, water scarcity and resource efficiency.

Table 1: Selected water environment indicators

Water indicators	Armenia	Azerbaijan	Belarus	Georgia	Moldova	Ukraine
C1. Renewable freshwater resources						
C2. Freshwater abstraction						
C3. Total water use						
C4. Household water use per capita						
C5. Water supply industry and population connected to water supply industry						
C10. BOD and concentration of ammonium in rivers						
C11. Nutrients in freshwater						

Note: Individual indicators can be seen on the ENI SEIS II East project website: <https://eni-seis.eionet.europa.eu/east/indicators>

The suitability of indicators for individual countries was limited by their respective data provision. As the State Statistics Service of Ukraine doesn't have a mandate for collecting water quantity data, Ukraine's freshwaters are not covered by water quantity assessments. However, this report addresses water quantity in Ukraine to a limited extent, based on data available online in different national or international domains to ensure a proper regionally horizontal assessment.

The Drivers – Pressure – State – Impact – Response (DPSIR) framework is the main analytical approach applied in this report. The overall analytical approach of the report is also aligned with the UNECE guidelines for the preparation of indicator-based environment assessment reports (UNECE, 2007c).

2 Policy context of water resources management in Eastern Partnership countries

The history of socio-economic development in the Eastern Partnership countries has had various impacts and consequences on water resources. Although the focus has shifted from intensive extraction of natural resources during the Soviet period in 20th century into a transition towards more sustainable development, there is a legacy of long-lasting heavy pollution of water resources and water scarcity due to the ageing infrastructure of water supplies and the disintegration of previous systems in line with the new political boundaries (UNECE, 2000b, 2011b, 2007b, 2016b, 2016c, 2014a). After the collapse of the Soviet Union in 1991, some large river basins became international river basins (Yildiz, 2017) with respect to the Eastern Partnership countries. Today, Dnieper basin is shared between Belarus and Ukraine; Dniester between Ukraine and Republic of Moldova; Aras between Armenia and Azerbaijan; and Kura is shared among Armenia, Georgia and Azerbaijan (Figure 1).

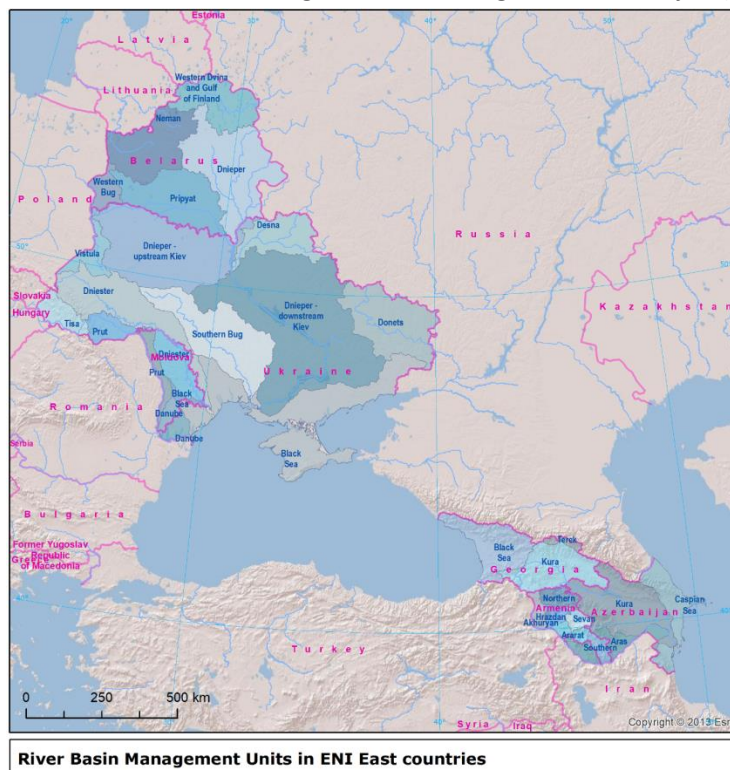


Figure 2: River Basin Management Units, based on major river basins in the Eastern European countries and the Caucasus.

Data source: ECRINS database (EEA, 2012a)

The problems arising on quality and quantity of water resources have already become more acute in almost all transboundary basins, which calls for joint actions of the countries. However, political conflicts between countries, e.g. Armenia and Azerbaijan, the reluctance among national water agencies to facilitate data and information exchange, and in some cases, the loss of 'institutional memory' due to frequent reorganisation of the water agencies, pose limitations for underpinning knowledge-based policy making in the area of water.

2.1 European Neighbourhood Policy

By signing agreements with the EU and its Member States in 2014, the Republic of Moldova, Georgia and Ukraine have started the gradual adjustment of their national legislation to European environmental standards and principles.

Many of the existing national water laws are adopting principles similar to European water legislation, particularly the Water Framework Directive and its daughter directives. For example, Water Law no. 272/2011 in Moldova has partly harmonised its water legislation with European (Republic of Moldova, 2011) on the protection of water against nitrate pollution from agricultural sources, bathing waters, environmental quality standards in the field of water policy and on urban wastewater treatment. In Ukraine, the process of implementation of European water policy started with the new legislation, namely, the Water Code of Ukraine (amended on 4 October 2016). The Code sets the basis for the implementation of extended water quality monitoring programmes, for example to support the assessment of ecological status of surface water bodies. Georgia adopted new water legislation in 1997, and at present is reforming its national environmental legislation and water protection sector to adapt to EU water legislation (Vystavna et al., 2018).

Azerbaijan and Armenia also participate in the European Neighbourhood Policy (ENP). Political cooperation between the EU and Azerbaijan started in 1999 with the signature of the Partnership and Cooperation Agreement. Political cooperation between the EU and Armenia is based on the Comprehensive and Enhanced Partnership Agreement (CEPA), which was signed on 24 November 2017. With this agreement the EU started to support Armenia in adoption of the EU environmental standards.

The EU provide financial and technical support to a number of international projects in the region aimed at strengthening the capacities of the governmental and public administration bodies in monitoring, water information systems, water supply, sanitation, river basin management, protection of freshwater ecosystems and public participation. For instance, the "EU Water Initiative Plus (EUWI+)" and the "Shared Environmental Information System (SEIS)" are those EU funded projects active in all six countries. The EUWI+ project focuses on the consolidation of monitoring systems and supports further reforms of water policies and the development of the river basin management plans in all six countries. The SEIS (now in its second phase) supports the capacity building for integrated assessment of the state of environment and data reporting to international bodies.

2.2 United Nations Sustainable Development Goals

All countries have taken actions to affirm their commitment to attaining the United Nations (UN) Sustainable Development Goals (SDGs) and are therefore actively involved in international policies for environmental protection and sustainable development. The main UN platform for joint and harmonised international actions for SDGs at the global level is the United Nations High-level Political Forum on Sustainable Development (UNHLPF, 2020). Since 2015, all six countries have actively worked with HLPF and are creating the necessary national infrastructure for the implementation of the SDGs, also in the area of water. Two most frequently referred political goals in the region are on drinking water supply and sustainable water use.

All six countries are members of the United Nations Economic Commission for Europe (UNECE) – the regional commissions of the United Nations (UN). The UNECE offers full political support to the SDG implementation process (UNECE, 2020c). Specifically, the support focuses on safe drinking water, adequate sanitation, water pollution reduction, public engagement in decision-making and access to environmental information. For this purpose, guidelines for the environmental indicators are available online (UNECE, 2020b). Indicators are designed to answer key policy questions and to serve as a basis for knowledge-based policymaking.

2.3 Bilateral and multilateral cooperation

In addition to international support such the European Neighbourhood Instrument, bilateral and multiparty agreements also give provisions for water cooperation in the Region (UN, 2007; FAO, 2009; Taslakyan, 2014; Yildiz, 2017). Some of the countries already develop joint monitoring systems, exchange information, and implement activities on water pollution prevention and control, water flow regulation in transboundary river basins. For instance, Ukraine and Republic of Moldova signed a bilateral treaty for the Dniester basin in 2012 to provide a framework for cooperation in various areas of water resources management (UNECE, 2012b).

Dniester treaty:

A bilateral Treaty on “Cooperation in the Field of Protection and Sustainable Development of the Dniester River Basin” by the Minister of Environment of the Republic of Moldova, Mr. Gheorge Salaru, and the Minister of Ecology and Natural Resources of Ukraine, Mr. Eduard Stavitskiy, took place in the Italian Parliament on the 29 November 2012 in the framework of the High-level segment of the sixth session of the Meeting of the Parties to United Nations Economic Commission for Europe (UNECE) Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention).

The new Treaty identifies principles and provides a framework for cooperation on water pollution prevention and control, water flow regulation, conservation of biodiversity and protection of the Black Sea environment. It also addresses the monitoring of data exchange, public participation and cooperation in emergency situations.

There are also bilateral agreements for managing water resources in the transboundary basins of the Aras and Kura rivers among Armenia, Georgia and Azerbaijan (Winston et al., 2015; Taslakyan, 2014; Yildiz, 2017).

Georgia and Azerbaijan are cooperating on the sustainable use of the Kura river. Since a long time, Georgia and Azerbaijan have been working on developing bilateral

agreement on the transboundary water cooperation (Zedginidze et al. 2013) with special focus on flood prevention and waste water management. In addition, both countries meet several times to identify priorities for further trans-boundary cooperation, such as capacity building, data bases updates and development of information sharing systems (Strosser et al., 2017). However, the efficiency of those bilateral agreements, not only between Georgia and Azerbaijan but also between Georgia and Armenia, and between Armenia and Azerbaijan, remains uncertain as hydropolitics in the region are very much tied with other economic, political and security dynamics (Yildiz, 2017).

2.4 Institutional organisation for water resources management

All six countries have governmental authorities responsible for water management and environmental protection. Overall, Ministries of Environment are the main governmental bodies responsible for developing water management policy and legislation. Within these ministries are dedicated institutions for monitoring, analysing and disseminating data and information on water quality and quantity. In most countries these are hydrometeorological and geological services. Some countries have also established special information centres engaged in environmental protection or/and natural resources management that can be sponsored by international programmes. Their overall function is to disseminate information to the public at large. They are typically involved in projects as the operators of information systems or web portals suitable for indicator publishing.

In all six countries there are also water agencies that manage water supply and use. Some of them are oriented towards implementing monitoring programmes of hydrometeorological and geological services. In some countries they are organised as joint-stock companies. The ministries of environment are supported by other ministries, for example: Ministry of Emergency Situation; Ministry of Health; Ministry of Regional Development; and Ministry of Agriculture.

3 Renewable water resources

Renewable water resources (RWR) are generated and replenished by precipitation and inflow of surface and groundwater from neighbouring countries throughout the hydrological year. Net precipitation (interflow as the difference between precipitation and actual evapotranspiration) replenishes surface run-off to rivers, lakes and recharge groundwater aquifers. Surface waters and groundwater flowing from neighbouring countries (external inflow or inflow from upstream countries) is an important part of the renewable water resources (UNECE, 2020b).

Due to natural hydro-climate conditions, renewable freshwater resources are not evenly distributed among the six countries. Similarly, there are regional variations in renewable freshwater resources within each individual country. Several indicators can be used for measuring available renewable freshwater resources. Three indicators are used in this analysis to address renewable freshwater

resources of the Eastern Partnership countries: water availability per capita; water stress level; and dependency ratio.

3.1 Water availability per capita in the countries

The Falkenmark indicator (Falkenmark, et al., 1989; Brown and Matlock, 2011) sets 1 700 m³/per capita/year of water availability as the threshold for water stress. Those countries having above 1 700 m³/per capita/year, of renewable freshwater resources are regarded as not being under water stress. In that context, none of the Eastern Partnership countries, excluding Ukraine as no data is available for assessing, suffered from the water shortage in 2017 (Figure 3: Water availability per capita (2017)).

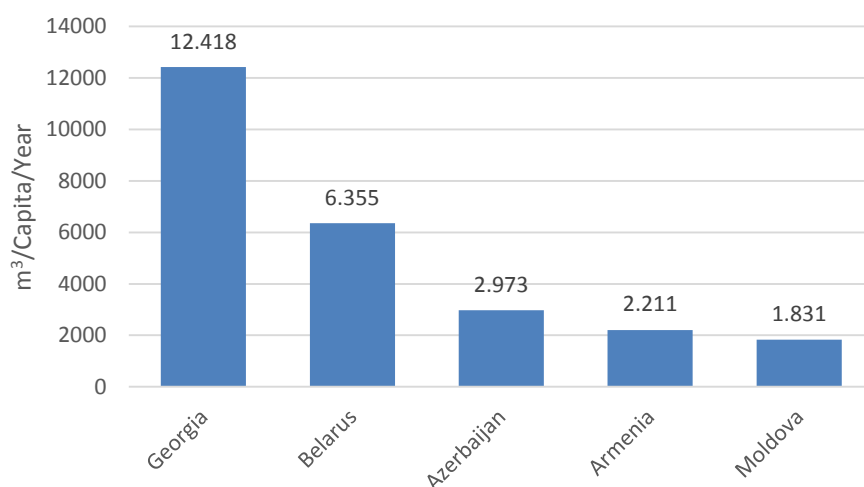


Figure 3: Water availability per capita (2017)

Note: Data provided under the ENI SEIS II East Project. Due to no data from Ukraine, this country could not be included into the chart.

Data source: Azerbaijan: State Statistical Committee of the Republic of Azerbaijan, World Bank; Armenia: ArmStatBank (Statistical Committee of the Republic of Armenia); Belarus: Belstat (National Statistical Committee of the Republic of Belarus); Georgia: National Statistics Office of Georgia; Moldova: Statistical Databank of the National Bureau of Statistics of the Republic of Moldova

Georgia holds the highest renewable freshwater resources per capita on average with 13 500 m³/capita/year, whereas the Republic of Moldova has the lowest 1 800 m³/capita – only slightly above the Falkenmark threshold of water stress. However, this assessment needs to be interpreted with caution due to data uncertainty on the renewable freshwater resources of Moldova.

Each country presents different internal and external dynamics in renewable freshwater resources over the years. As the indicator is affected by changes in total population and climate conditions inside and outside of the countries' territory, the trend of this indicator provides a very mixed overview across the countries. In all countries except Azerbaijan, there is a decreasing trend or stable condition in total population.

The Armenian population decreased by 8% between 2000-2018, which coupled with higher precipitation, increased renewable freshwater resources per capita from 1 000 m³/capita year in early 2000's up to 2 211 m³/capita in 2018.

Population dynamics in Georgia have remained stable over the last decade (2008-2017). Whilst Georgia has the highest renewable water resources per capita in the Region, it seems that climate conditions are impacting on its renewable freshwater resources. Renewable water resources per capita decreased by 6% between 2008-2017..

Azerbaijan presents a very dynamic population trend, with a remarkable increase of 22 % between 2000-2017. Over the same period, internal flow and inflow of water from other countries sharply decreased. As a result, RWR per capita dramatically decreased by 34 % in the country between 2000-2017.

Since 2000, there has been no significant change in the total population of the Republic of Moldova, nor has there been one in RWR per capita. Total population in the country has decreased by 1.4 % while RWR per capita increased around 1.3 % between 2000 and 2017.

Belarus also shows a strong correlation between population decrease and RWR increase per capita between 2000 and 2017: population decreased by 7%, and RWR per capita increased 8%.

Taking into account natural and man-made factors influencing renewable freshwater resources in the Region, a decreasing trend in renewable water resources might be expected in the near future, which would exacerbate shortages in seasonal and annual water supplies.

3.2 Water stress conditions

Comparing water availability to demand is another strong indicator to identify the level of water stress caused by man-made factors. Overall, water stress occurs when demand for water exceeds a certain level of water availability: above 20 % indicates moderate water stress, whereas 40 % and above indicates severe water scarcity conditions and unsustainable water resources management (Raskin et al., 1997). Changes in natural conditions such as decreasing precipitation or increasing evapotranspiration may negatively influence the availability of renewable freshwater resources. Similarly, man-made factors such as changing land cover/land use or increasing water demand might also increase the water stress level. The water exploitation index (WEI) is applied as a strong measure of the level of water stress. The WEI or withdrawal ratio is defined as the annual total abstraction of fresh water divided by the annual freshwater resources.

The application of the WEI indicates that Armenia and Azerbaijan have been experiencing severe water scarcity conditions (Figure 4).

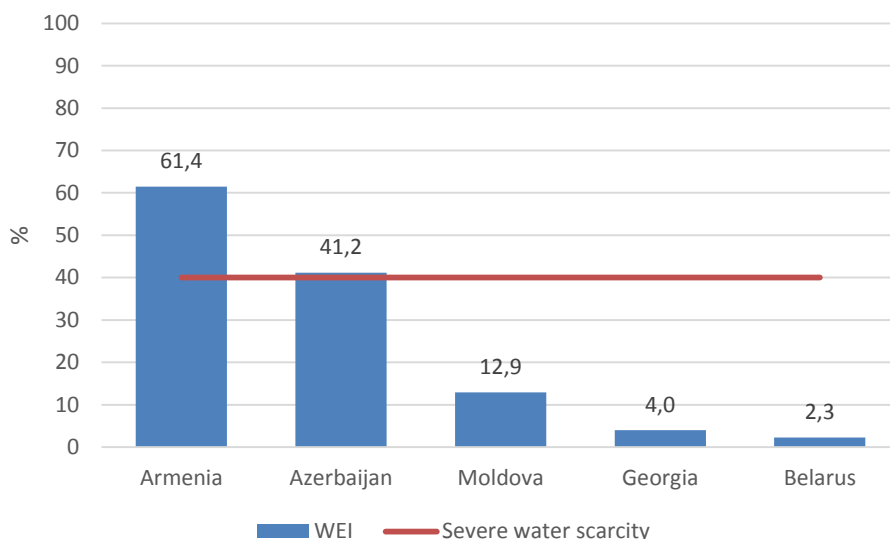


Figure 4 Annual water exploitation index (2017)

Data source: Azerbaijan: State Statistical Committee of the Republic of Azerbaijan; Armenia: ArmStatBank (Statistical Committee of the Republic of Armenia); Belarus: Belstat (National Statistical Committee of the Republic of Belarus), National environmental monitoring system of the Republic of Belarus, Water Cadastre Information System of the Republic of Belarus, World Bank Databank; Georgia: Water Division of the Department of Environment and Climate Change and the Integrated Management Division of the Department of Environmental Assessment - Ministry of Environmental Protection and Agriculture; Moldova: Statistical Databank of the National Bureau of Statistics of the Republic of Moldova, Agency Apele Moldova.

Note: Data provided under the ENI SEIS II East Project. Due to no data from Ukraine, this country could not be included into the chart.

The WEI in Armenia and Azerbaijan is ‘unsustainable’ and has resulted in severe water scarcity conditions. In fact, Armenia is not scarce in renewable water resources. Between 2000-2017 the annual renewable freshwater resource in the country was around 6 670 million m³, corresponding to 2 189 m³/per capita per year. However, due to poor water management practices (e.g. high water losses and leakages), it has been facing severe water stress conditions for a long time. The average annual WEI is above 40 %. The annual WEI in 2017 was even 61.4 %. That means that almost two thirds of all renewable freshwater resources in Armenia were abstracted to meet the country’s water demands. Despite the total population of Armenia decreasing around 8 % between 2000-2017, water demand has increased by 4.5 % over the same period. Ageing and inefficiency in water distribution system create tremendous pressure on the country’s water resources. As an example, 66 % of the total water supply was lost in 2000 due to leakage. During recent years, Armenia has been investing in improving the public water supply network, particularly to rural areas (World Bank, 2017), and water losses are slowly being reduced.

Armenia meets about 65 % of the total water demand from surface water resources. In particular, Lake Sevan plays an important role in meeting the country's water demand, which creates pressures on the ecological and hydrological conditions of the lake. In parallel, water abstraction from groundwater resources has also more than doubled since 2000. Groundwater is mainly used for drinking purposes and agriculture (UNECE, 2000b).

Azerbaijan is another country in the region facing severe water stress conditions, and where the annual average water exploitation index is above 30 %. The water exploitation index was estimated as 41.2 % in 2017 ⁽³⁾. As a result of climate conditions, only ¼ of total precipitation contributes to internal flow in the country's water resources. Annual average renewable freshwater resources are decreasing. In 2000, they were 38 000 million m³, but in 2017 only 30 000 million m³. In Azerbaijan, agriculture is the sector with the highest water demand. Irrigation accounts for 90 % of total water abstraction every year, watering around 4.8 million ha of agricultural land, mainly lying in the lowlands of the Kura and Aras basins. In general, agricultural land occupies 55 % of the total country area with no significant change in extent over time. The agricultural sector employs 38 % of the country's population (UNECE, 2011b). Water abstraction increased by 15 % between 2000-2017, while renewable freshwater resources decreased by 20 %.

Azerbaijan has very high rates of water use in irrigation. In 2017, water intensity in crop production was around 14 000 m³/ha (The State Statistical Committee of the Republic of Azerbaijan, 2019). Under similar climate conditions, water intensity of crop production in southern European countries is between 5,000-7 000 m³/ha. The available literature suggests almost 40-50 % of water is lost in irrigation conveyance systems in Azerbaijan (UNECE, 2011b).

The Kura and Aras are large rivers flowing into Azerbaijan that play a significant role in the overall water balance of the country. In addition, Azerbaijan has 63 reservoirs, of which only four have a volume larger than 1,000 million m³. The Mingechevir reservoir on the Kura river is the largest, with a capacity of 15 700 million m³. Water from this reservoir is also used for power generation and irrigation (UNECE, 2011b).

Water scarcity conditions are increasing in both Armenia and Azerbaijan, requiring the rapid implementation of climate change adaptation measures, as well as improving water use efficiency across economic sectors.

The Republic of Moldova is experiencing higher water stress conditions – the annual average water exploitation index is around 13 % – compared with its neighbouring countries, Belarus and Ukraine. However, the country is still relatively far from being under severe water stress conditions.

Water scarcity is not an issue for Georgia and Belarus. Both countries are water abundant.

⁽³⁾ More information on the water exploitation index of Azerbaijan can be found at;
<https://eni-seis.eionet.europa.eu/east/indicators/c2-2013-freshwater-abstraction-in-the-republic-of-azerbaijan>

3.3 Dependency to upstream

Inflow from upstream countries constitutes the backbone of hydropolitics among the six countries. Cooperation between upstream and downstream countries to fairly share water resources in line with international norms, such as the UNECE Water Convention, is a long-lasting UN endeavour. In many cases, a large proportion of renewable freshwater resources are generated in the upstream or riparian catchments of the transboundary basins. The measure of that part of renewable freshwater resources flowing from upstream countries to downstream countries is called the dependency ratio.

Almost all river basins along with Kura and Aras rivers are transboundary in nature. Hence, the dependency of renewable freshwater resources to upstream sub-basins also have political impacts in the region. Only the Enguri-Rioni and Bzipi-Kodori river basins have outlets to the Black Sea from the national territory of Georgia.

Overall, Azerbaijan is heavily dependent on inflow of surface water and groundwater from neighbouring countries, followed by Belarus (Figure 5). On average, Azerbaijan's dependency ratio for upstream water is greater than 70 % of its total renewable freshwater resources.

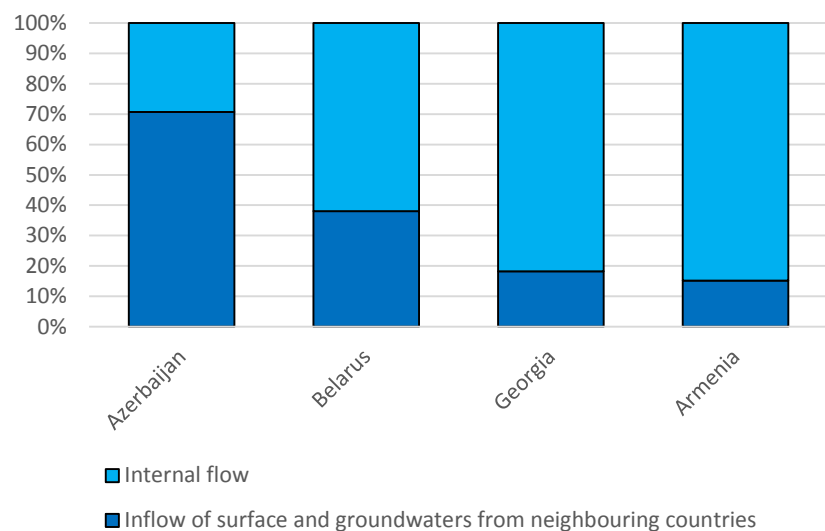


Figure 5: Generation of renewable freshwater resources in the countries (2017)

Data source: Azerbaijan: Ministry of Ecology and Natural Resources of the Republic of Azerbaijan; Belarus: Belstat (National Statistical Committee of the Republic of Belarus), National environmental monitoring system of the Republic of Belarus, Water Cadastre Information System of the Republic of Belarus; Georgia: Administration Division at the National Environmental Agency - Ministry of

Environment Protection and Agriculture; Armenia: ArmStatBank (Statistical Committee of the Republic of Armenia)

Note: Data provided under the ENI SEIS II East Project. Due to insufficient data from the Republic of Moldova and no data from Ukraine, these both countries could not be included into the chart. Inflow from neighbouring countries for Georgia has been estimated as multi-annual average between 1981-1991 as no data is available for the respective year.

The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, set a number of qualitative and quantitative targets for measuring the efficiency and effectiveness of cooperation between the countries that share river basins. In this context, UN SDG Goal no. 6.5 sets a target to implement integrated water resources management at all levels, including through transboundary cooperation where appropriate by 2030. The target is measured by the indicator 6.5.2: the proportion of transboundary basin area with an operational arrangement for water cooperation.

Implementing bilateral integrated water resource management across the Kura River Basin:

Azerbaijan Ministry of Ecology and Natural Resource and Georgia Ministry of Environment and Natural Resources Protection are cooperating in sustainable management of water resources of the Kura river. In 2017, the 4-year project “Kura II Project: Implementing IWRM Across the Kura River Basin” started. It is UNDP-GEF funded project with an allocated budget of USD 5.3 million. National partners in Azerbaijan and Georgia have contributed over USD 190 million in co-financing (UNDP-GEF, 2017).

The project is strengthening water institutions, builds capacity for water managers across sectors, promotes actions to reduce water stresses in critical areas, supports stakeholder education, builds awareness and empowerment, and employs science for governance. The Project Coordination Unit is based in Baku with a national project office in Georgia. The Project is implemented through the UNDP Istanbul Regional Hub. There is collaboration established with the EU Water Initiative Plus (EUWI+) project.

The Convention on the Protection and Use of Transboundary Watercourses and International Lakes from 1992 (Water Convention) not only promotes cooperation on transboundary surface waters and groundwaters, but strengthens their protection and sustainable management. It provides internationally recognised norms for measuring the effectiveness and efficiency of

sustainable development. Two Eastern Partnership countries have initiated the accession process to the Water Convention already in 90’s: Moldova in 1994 and Ukraine in 1999. Azerbaijan and Belarus have done this in 2000 and 2003, respectively (Table 2).

Table 2. Status of ratification of the Convention on the Protection and Use of Transboundary Watercourses and International Lake

Participant	Signature	Ratification, Accession(a), Acceptance(A), Approval(AA)
Azerbaijan		3 Aug 2000 a
Belarus		29 May 2003 a
Republic of Moldova		4 Jan 1994 a
Ukraine		8 Oct 1999 a

Source: UNECE (1992)

Georgia and Armenia have not ratified the Water Convention yet. Despite some legacy bilateral agreements among the Caucasus countries being in place in the Soviet era before 1991, it is not clear how relevant they are now in practice (Yildiz, 2017).

Eventually, under changing natural hydrological conditions associated with increasing socio-economic demand for water may exacerbate hydropolitical discussions in the Region. This may be overcome mostly by increasing the efficiency in water use; and improving monitoring programs, harmonising regional data and free the exchange of data and information at the regional level.

3.3.1 Importance of water data to regional cooperation

As outlined above, data availability and accuracy are the main concerns in assessing water flow between the countries in both transboundary and riparian basins. Processes of delineating river basins, identifying surface and groundwater bodies and deploying appropriate monitoring programs are still far from being sufficient in all countries in the region.

EU WI + Project (EU WI plus, 2020):

The project is the biggest commitment of the European Union to the Water sector in the Eastern European and the Caucasus countries. The project helps Armenia, Azerbaijan, Belarus, Georgia, Moldova, and Ukraine bring their legislation closer to EU policy in the field of water management, with a main focus on the management of trans-boundary river basins. It supports the development and implementation of pilot river basin management plans, building on the improved policy framework and ensuring a strong participation of local stakeholders.

The main objective of the project is to improve the management of water resources, in particular trans-boundary rivers, developing tools to improve the quality of water in the long term, and its availability for all. More specifically, the project aims to support partner countries in bringing their national policies and strategies into line with **the EU Water Framework Directive** and other multilateral environmental agreements.

There is no sufficient information available for estimating the water storage of groundwater aquifers as well as their recharge and discharge, for instance, in the Republic of Moldova, Belarus, Armenia, Georgia and Azerbaijan. Due to the reluctance among the national water agencies in exchanging and sharing the data, in many cases, estimating the renewable

freshwater resources is still also challenging, for example in the Republic of Moldova, and Georgia. In turn, the lack of monitoring programs and harmonised data at the regional level doesn't allow to support appropriately the knowledge-based policy implementation where the cooperation among the countries for sustainable management of water resources is the main concern.

4 Sectoral pressures on freshwater resources

4.1 Water abstraction by source

Water is an essential natural resource for human beings and economic development. Overall, surface waters meet the largest portion of water demand in the Eastern Partnership countries, while groundwater resources are the main source of water abstraction in Belarus and Republic of Moldova (Figure 6). Agriculture, public water supply and industry are the major sectors demanding water in the region.

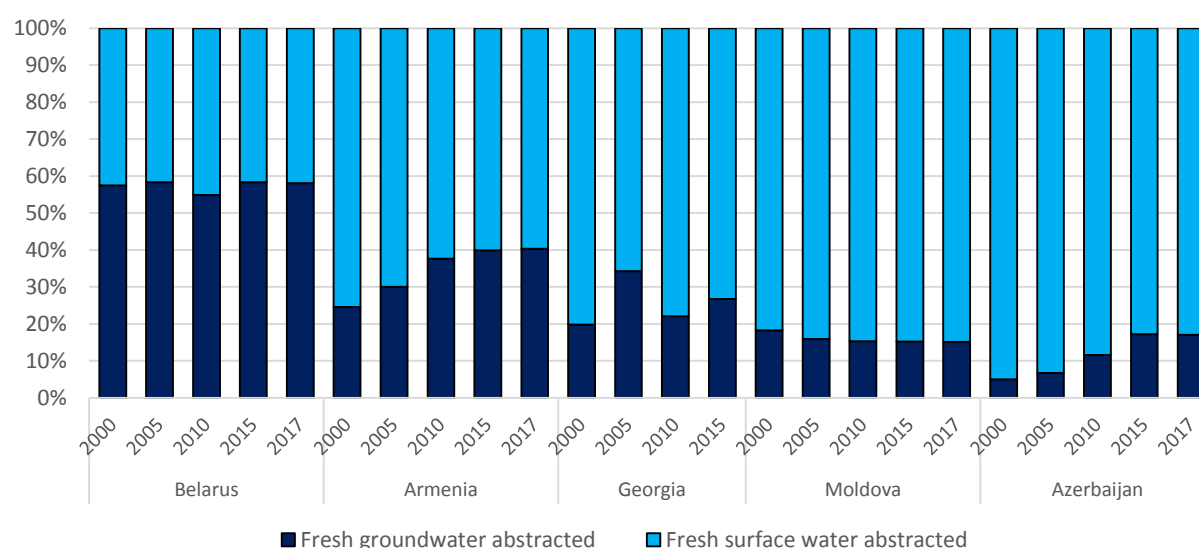


Figure 6: Water abstraction by source (2017)

Data source: Azerbaijan: Az STAT (State Statistical Committee of the Republic of Azerbaijan); Armenia: ArmStatBank (Statistical Committee of the Republic of Armenia); Belarus: Belstat (National Statistical Committee of the Republic of Belarus); Georgia: Water Division of the Department of Environment and Climate Change and the Integrated Management Division of the Department of Environmental Assessment - Ministry of Environmental Protection and Agriculture; Moldova: Statistica Moldovei (Statistical Databank of the National Bureau of Statistics of the Republic of Moldova) and Agency Apele Moldovei.

Note: Data provided to the European Environment Agency under the ENI SEIS II East Project.

Due to an economic recession and the introduction of water metering in the second half of the 2000s the total water abstraction in Belarus has decreased significantly in recent years (UNECE, 2016b). The annual average total freshwater abstraction is around 1 650 million m³, of which more than half is abstracted from groundwater resources and used mainly for drinking purposes. Long-term intensive groundwater abstraction has already caused large-scale water level reductions, and reduced flows of small rivers around the city of Minsk. As a policy response to the environmental consequences of intensive groundwater abstraction, the Government of the Republic of Belarus developed a strategy on environmental protection. They plan to reduce groundwater abstraction to 700-750 hm³ per year by 2025. The current level of annual groundwater abstraction is currently around 800 million m³ in the country

In Armenia, around 65 % of the total water demand is met by surface water resources, for which Lake Sevan is the main source. High water demand on Lake Sevan places continuous pressure on hydrological and ecological condition of the Lake. Meanwhile, Armenia had a remarkable increase in gross agricultural productivity (61 % increase between 2008-2018), at a cost of using a tremendous amount of phosphate fertilisers (almost 75 times more in 2015 compared to 2008) which caused increasing phosphate concentrations in rivers (More information in Chapter 6). Since then, pumping water from groundwater resources has been seen as a viable option, with 41 % increase of water abstraction for agriculture and drinking purposes. Similarly, poor treatment of urban discharge

Groundwater resources of the Ararat valley

The Ararat Valley with the Aras/Araks River (Armenia's border with Turkey), has high-quality artesian groundwater. Due to its rich groundwater resources, the valley is the largest agriculture zone in Armenia and is of strategic importance to the Armenian economy. Since 2000, a large number of fish farms have been established there. In 2013, groundwater use by fish farms alone exceeded the sustainable level (World Bank, 2017). As a result, artesian groundwater resources have sharply declined. Increased groundwater withdrawals caused decreased spring flow, reduced well discharges, falling water levels, and a reduction of the number of flowing artesian wells in the southern part of Ararat Basin in Armenia (Valder et al., 2018). This is causing conflicts with other artesian groundwater users, irrigation, domestic, industrial, and cooling waters. As an example, due to the reduced discharges of the Aknalich springs (located on the upstream left bank of the Sevjur River), the Armenian nuclear power plant Metsamor can take only half of its water requirement (Mendez England and Associates (ME&A), 2016).

exacerbates the deterioration of the surface water quality and intensifies the pressures on groundwater resources, particularly in downstream areas of urban settlements. In parallel to increasing trends in water abstraction from groundwater, water irrigation in Armenia has also increased by 21 % between 2011-2018 (Statistical Committee of the Republic of Armenia, 2020a).

Georgia meets 70 % of its water demand from surface waters, particularly from rivers. Groundwater is mainly used for drinking water purposes. River basins to the Black Sea generates 75 % of the total inland surface water (42 500 million m³/year), while the remaining 25 % of the total inland surface water is generated in the Caspian Sea basin (14 400 million m³/year). Between 1981-1991, an average of 35 000 million m³ of water flowed out of Georgian territory into the sea each year (corresponding to 75 % of the total outflow), and 10 000 million m³ (25 %) flowed into neighbouring countries. The current state of water supply and demand in Georgia is unknown because of the lack of sufficient data. As Georgia is a water abundant country, withdrawing water from surface water resources seems more economically viable than pumping groundwater. However, high rates of water loss in the conveyance system (see Chapter 5) exacerbates the environmental impacts of inefficient water use. Abstraction from surface water for agriculture has more than doubled in Georgia since 2003 (UNECE, 2016c). The leaching of nutrients from agricultural areas causes increased concentrations of nitrates, phosphates and ammonia in the waters (See Chapter 6).

Moldova meets 85 % of its annual water demands from surface waters, especially from the Dniester river. The Dniester basin is also a very important source of groundwater abstraction. Around 84 % of total water abstraction from groundwater occurs from the Dniester basin. However, as abstraction by individuals is not monitored in the country, this is unlikely to be the true level of overall abstraction.

Azerbaijan, on average, abstracts 11 000 million m³ of water annually to meet the water demand of various economic activities, of which 83 % is met from surface waters. The Kura and Aras are large rivers flowing into Azerbaijan that play a significant role in the overall water balance of the country. In addition, Azerbaijan has 63 reservoirs, of which only four have a volume larger than 1 000 million m³. The Mingęevir reservoir on the Kura river is the largest, with a capacity of 15 700 million m³, from which water is used for power generation and irrigation. The Samur river plays an important role in providing drinking water supplies and irrigation in north-eastern Azerbaijan and the Absheron peninsula, via the Samur-Absheron channel (UNECE, 2011b).

Azerbaijan is facing water scarcity conditions throughout the year, not only in quantitative terms, but also in terms of water quality. In order to meet increasing water demands from agriculture and drinking purposes, Azerbaijan began to abstract more groundwater. The country abstracted around four times more water from groundwater resources in 2017, compared to 2000, which creates environmental problems including aquifer depletion and contamination and landslide triggering (Israfilov et al., 2014). Pressures on groundwater will increase if the current trend of water abstraction continues in the country.

4.2 Water use by sectors

All economic sectors need water for their activities; agriculture, industry and most forms of energy production are not viable if water is not available (EEA, 2012b).

Agriculture and public water supply are the major sectors in the region, placing significant water demand on renewable freshwater resources. In Belarus and Moldova, agriculture, public water supply and other industries account for the largest portion of the water abstraction (Figure 7).

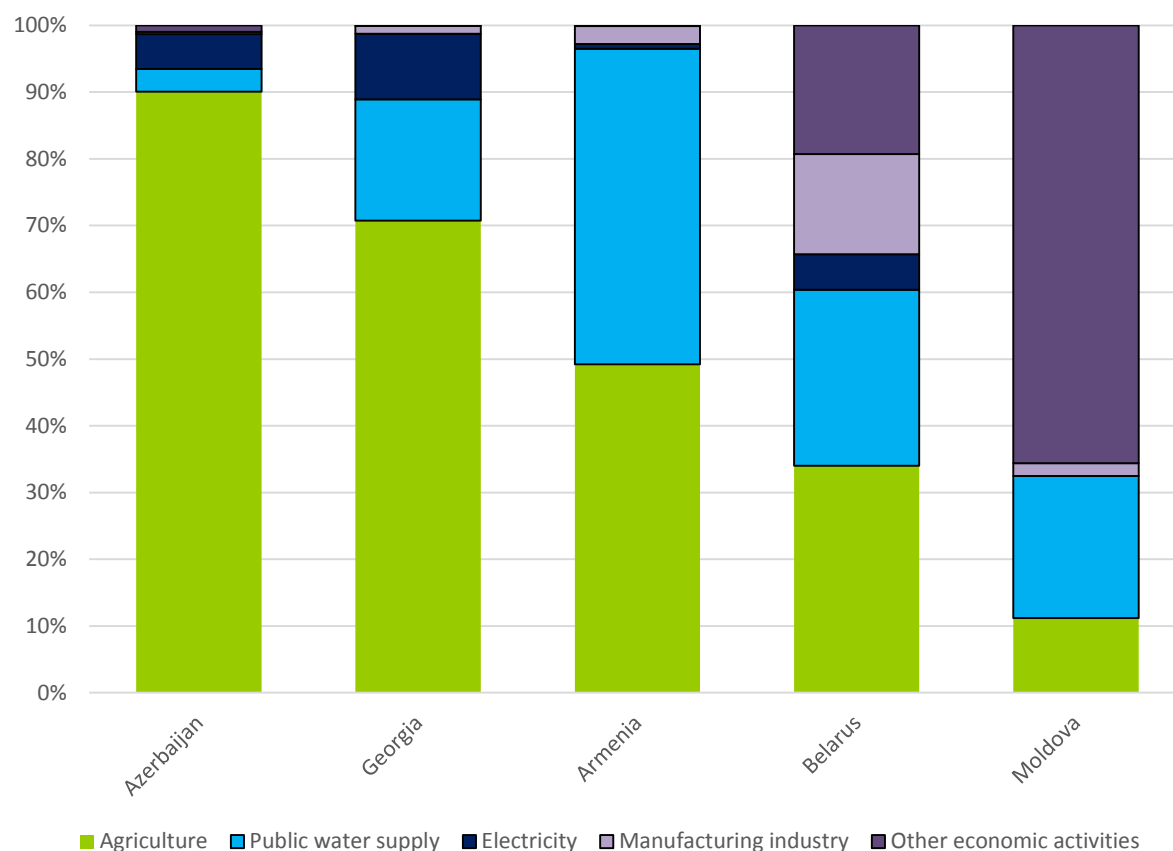


Figure 7: Water use by economic sectors (2017)

Data source: Azerbaijan: Az STAT (State Statistical Committee of the Republic of Azerbaijan); Armenia: ArmStatBank (Statistical Committee of the Republic of Armenia); Belarus: Belstat (National Statistical Committee of the Republic of Belarus); Georgia: Water Division of the Department of Environment and Climate Change and the Integrated Management Division of the Department of Environmental Assessment - Ministry of Environmental Protection and Agriculture; Moldova: Statistica Moldovei (Statistical Databank of the National Bureau of Statistics of the Republic of Moldova) and Agency Apele Moldovei.

Note: Data for Georgia 2016. Data provided to the European Environment Agency under the ENI SEIS II East Project.

In Azerbaijan, agricultural irrigation is the most significant demand on water resources and accounts for 90 % of total water use every year. Water abstraction for agriculture has increased by 76.5 % between 2001-2017. Water conveyance efficiency lowered dramatically during that period. In 2000, there was 8 050 m³/ha of water abstraction used for irrigation, whereas in 2018, this figure had increased to 14 000 m³/ha (The State Statistical Committee of the Republic of Azerbaijan, 2019). In parallel to water scarcity conditions in the country, environmental sanitation problems (The State Statistical Committee of the Republic of Azerbaijan, 2019) – due to return water from agriculture – have been experienced in small towns (Asian Development Bank, 2005). The use of fertilisers in agriculture caused increasing ammonium concentrations in rivers between 2009-2014, with the highest concentrations found in Gazakh-Ganja (see Chapter 6). The Asian Development Bank (2005) estimated there are 66 000 km of canals transporting water from surface water resources to the agricultural fields in the Kura and Aras basins, of which less than 4 % had been lined in 2005.

In Georgia, around 70 % of total water resources are used by agriculture. Irrigation is common in crop production, and accounted for 34 % of total water use in 2016. After the collapse of the Soviet Union in 1991, the abandonment of many agricultural and industrial areas resulted in a substantial decrease in water abstraction between 1990-1995 (UNECE, 2016d). In particular, the collapse of industry after the Soviet era, as well as the transition from state-owned farms to privately owned farms, resulted in a substantial decrease in water abstraction for manufacturing industries and agriculture. Since 2000, total water use in Georgia has more than doubled (1 834 million m³ in 2016) largely due to agriculture. Water abstraction and the demand for water use are projected to increase in Georgia in the years to come, while agriculture is expected to remain as the main sectoral pressure on renewable water resources (UNECE, 2016d).

As in the other Eastern Partnership countries, Armenia is an agriculturally dominant country. Gross agricultural productivity in the country has increased significantly over the last decade (61 %), employing around 8 % of the total rural population. In 2018, agriculture was the largest sector with the highest demand for water abstraction (49 %) followed by public water supply (47 %) (Statistical Committee of the Republic of Armenia, 2020b).

Around 50 % of the total arable land in Armenia is irrigated (UNECE, 2000). In addition, Armenia uses large amount of water for aquaculture (fish farms) which accounts for 13 % of total water abstraction. Fish farms are mainly located in the Ararat Valley, which is under high water stress conditions. In order to meet the valley's high water demands, water is transferred from other basins, such as Lake Sevan. Since the 1930s, the water level of Lake Sevan has reduced by more than 19 m, and there has been a 26 % increase in water use. Since 1981, water has been transferred to the Lake Sevan from the Arpa River to increase the lake's water level back again. However, water abstraction from the lake for irrigation and energy generation is still increasing and the water level of the lake Sevan has not recovered to its natural state. Overall, the total population of Armenia declined from 3 226 million in 2000 to 2 986 million in 2017, whereas total freshwater abstraction increased by 32 % over the same period (Statistical Committee of the Republic of Armenia, 2020a).

In Belarus, the sectors which use significant amounts of the country's water resources are agriculture, forestry and fishing, and public water supply. The annual average water abstraction for these sectors together accounts for 60 % of the total water use in the country. Agriculture, forestry and fishing is traditionally a sector that uses a large amount of water in the country: two-thirds of the volume of water it uses is consumed by the fishing and aquaculture sub-sector. The public water supply is the main sector that provides water for the population. The coverage of the households served by a centralised water supply system has reached 94.7 %.

In Moldova, available data is not sufficient to assess the actual level of pressure from individual economic sectors. In 2017, the heating and hot water supply sector was the main user of water (66 %), followed by the water supply industry (20 %) and agriculture (11 %). These shares have largely stayed steady since 2000. In the coming years, it is expected that water abstraction for agriculture will increase

because of policy reforms in the agriculture sector, which is the main income generator in the country's economy (UNECE, 2014a).

4.3 Water use efficiency

Water use efficiency (WUE) is the ratio between effective water use and actual water abstraction (FAO, 2019). The WUE indicator characterises the efficiency of water use in a region. The efficiency of water use, can be measured either per sector (e.g. water use efficiency in irrigation) or through the efficiency of conveyance systems.

Efficiency in water use can be increased by decreasing water inputs per unit of production through technological improvements, the implementation of the integrated water management measures or improvements in transport of water from the point of abstraction to the point of water supply – the so-called conveyance efficiency.

4.3.1 Water losses during transport (conveyance efficiency)

Water losses occur mainly in the transport – or conveyance – of water from its source to agriculture or public water supply systems. The total conveyance efficiency is measured as ratio between total freshwater use and water losses during the transport to all economic sectors, also known as 'losses of water during transport'.

In agricultural systems, field application efficiency is measured as the proportion of abstracted water that is delivered to the field (EEA, 2012b). However, there is no data available for assessing this additional efficiency indicator.

The total water losses and leakages are relative higher in Armenia and Azerbaijan compared to other countries in the region (Figure 8)

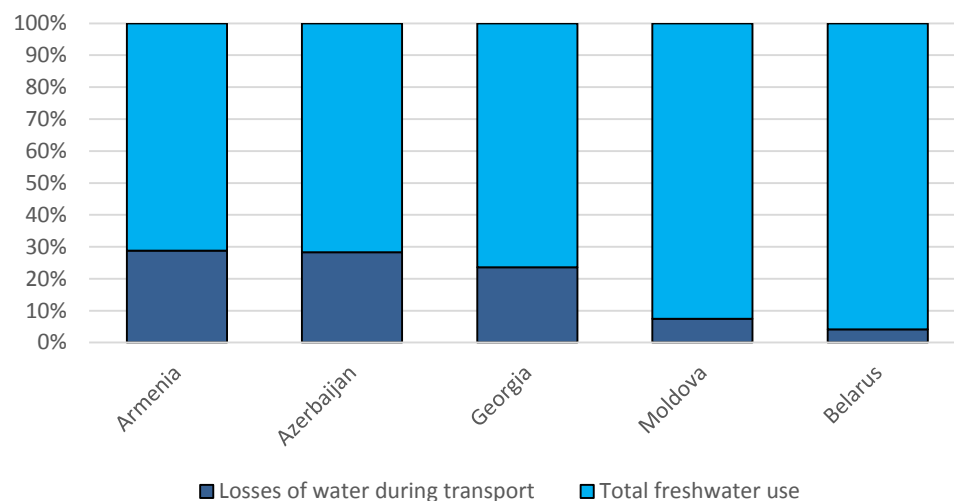


Figure 8: Total water conveyance efficiency (2017)

Data source: Azerbaijan: Az STAT (Statistical Committee of the Republic of Azerbaijan); Armenia: ArmStatBank (Statistical Committee of the Republic of Armenia); Belarus: Belstat (National Statistical Committee of the Republic of Belarus); Georgia: Water Division of the Department of Environment and Climate Change and the Integrated Management Division of the Department of Environmental Assessment, Ministry of Environmental Protection and Agriculture; Moldova: Statistica Moldovei (Statistical Databank of the National Bureau of Statistics of the Republic of Moldova) and Agency Apele Moldovei.

Note: Georgia 2016; Data provided to European Environment Agency under the ENI EAST SEIS II project.

In Armenia, on average 30 % of total freshwater abstraction is lost in the water transport system. During recent years, the percentage of total abstracted water that is lost during transport has increased from 758.9 million m³ in 2000 to 825.4 million m³ in 2017. Taking into account the severe water stress conditions in Armenia (WEI 61.4 % in 2017), the low efficiency of its conveyance system exacerbates water scarcity in the country. The average annual total freshwater use was around 2 550 million m³ in 2000, decreasing substantially to 2 040 million m³ in 2017. Considering the severe water stress conditions across the country, the current level of water abstraction and water use – particularly by the agricultural sector – has already exacerbated environmental problems.

Similarly, in Azerbaijan, almost one third of total water abstraction is lost during conveyance. As agriculture is the largest user of water resources, high rates of water losses in transport puts additional pressures on water resources. No significant improvement has been observed in the efficiency of water transport between 2000-2017 whereas water abstraction is steadily increasing.

In Georgia, around 1 980 million m³ of water was used by different economic sectors in 2016. Around a quarter of this water was lost during transport. Over the last decade, the country's water conveyance system has been partially improved and renewed. However, no significant progress has been made in the reduction of water losses since 2004. The combination of high water loss and increasing demands for water from agriculture and households will expose more acute water efficiency issues in Georgia in years to come.

Water loss in transport is relatively low in Belarus. Around 4 % of total water abstraction is lost during transport.

On average, Moldova uses around 800 million m³ of water annually. Around 7-8 % of all water abstraction is lost in the transport system because of leakages, water loss from open channels and ageing infrastructure. These losses amount to between 55 and 77 million m³ of water each year. Since 2000, no progress has been made in improving the water transport system.

4.3.2 Efficiency in public water supply system

Supplying sufficient and clean water to the public for different purposes, including for drinking, is the major service of the water collection, treatment and supply sector. Public water supply is the second largest sector in the Region, and accounts for a significant volume proportion of overall water use. Apart from the population pressures e.g. increasing water demand due to population growth, the major factors affecting the conveyance efficiency in public water supplies are ageing conveyance systems, and the distance between the source of water and the point of water supply (UNECE, 2000a; 2011, 2016a, 2016d, 2014b). More than 60 % of the water abstracted for the public water supply system in Armenia and Georgia is lost in the conveyance system, where half of the water is lost in Azerbaijan and Moldova (Figure 9).

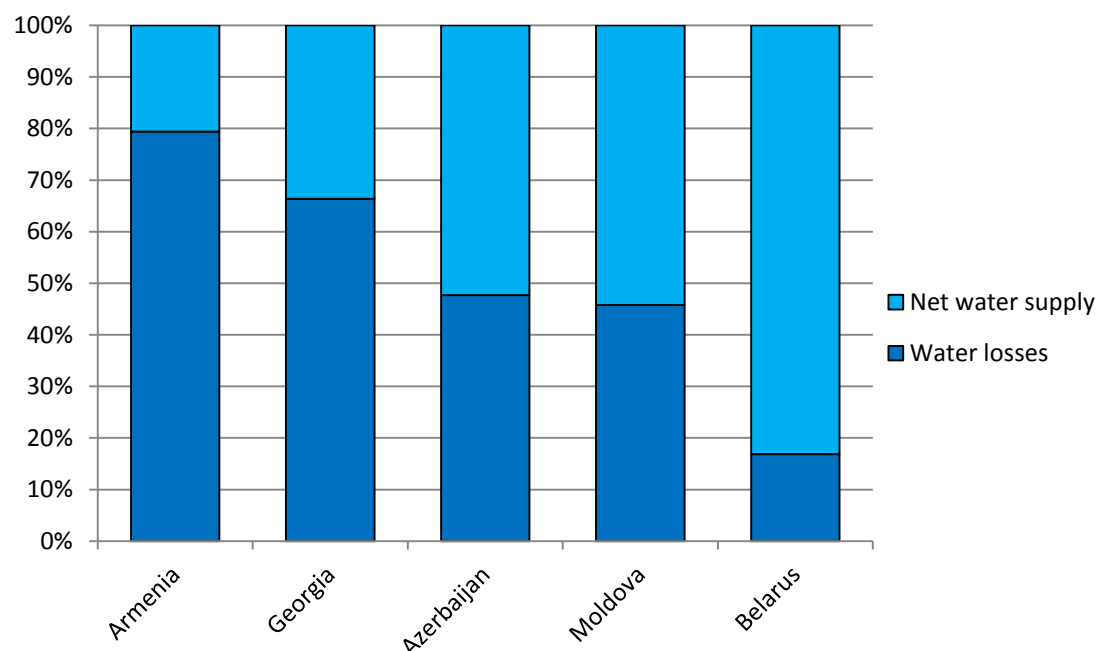


Figure 9: Water losses in water supply conveyance system (2017)

Data source: Azerbaijan: Az STAT (Statistical Committee of the Republic of Azerbaijan); Armenia: ArmStatBank (Statistical Committee of the Republic of Armenia); Belarus: Belstat (National Statistical Committee of the Republic of Belarus); Georgia: GEOSTAT - National Statistics Office

In Armenia 589 million m³ of water was supplied by the water supply system in 2018, of which 468 million m³ was lost in the water supply network, which corresponds to 79 % of the total water supplied. According to a UNECE environmental performance assessment carried out during the 2000s, around 80 % of the pipes in the network were more than 10 years old and 55 % were more than 20 years old. Their maintenance had been neglected. The number of interruptions in water supply in Armenia is thus increasing (UNECE, 2000b).

As Armenia is experiencing high water stress conditions, reducing water losses by a target of 50 % in public water supply to urban areas and agriculture /aquaculture may significantly reduce the water stress levels in the country. With financial support from the European Investment Bank, the Armenian government is implementing the Yerevan Water Supply Improvement Project to improve the water supply system in Yerevan (EBRD, 2016). However, water losses in the network are still incredibly high and continuously increasing. For instance, around 66 % of the country's total water supply was lost in 2000, but losses increased to 79 % in 2018. High – and steadily increasing – rates of water losses in the transport system look unsustainable in the long term in Armenia.

In Georgia, around 800 million m³ of water was supplied by the water supply system in 2018, of which 531 million m³ was lost in the water supply network, corresponding to 66 % of the total water supply. The country's water sector infrastructure has deteriorated because of a lack of adequate repair and maintenance and a shortage of funds to invest in modernising the water facilities in recent years (UNECE, 2016c). High water losses in the conveyance network are putting significant pressure on renewable water resources in Georgia.

In Azerbaijan, 609.1 million m³ of water was supplied by the water supply system, of which 290.5 million m³ was lost in the water supply network, which corresponds to 47.6 % of total water supply in 2017. As a result of the introduction of water metering and improvements in the distribution network (UNECE, 2011b), water use by households in the country decreased substantially (by 42 %) between 2000-2017, even though overall population increased.

To accommodate increasing needs for public water supply in large cities in Azerbaijan, the government is implementing some large projects. For instance, at 250 km in length, the Oğuz - Gabala - Bakü water pipeline is one the largest projects for water transfers between two basins in the world. It can transfer water at a rate of 5 m³/s (Sertyeşilişik, 2017). In addition, Azerbaijan meets around 15 % of its total water demand from recycled water. The share of water abstraction for drinking purposes has decreased due to improvement of the water supply systems (UNECE, 2011b). Nevertheless, there is still much improvement to be made in water efficiency in Azerbaijan, particularly in the agricultural sector, and in decreasing water losses during transport to the public water supply.

In Belarus, the water supply industry supplied 553 million m³ of water, which corresponds to 40 % of the total annual water abstraction in the country in 2017. On average, around 16 % of the public water supply is lost in the country's conveyance system. Belarus has been investing in renewing and expanding its water supply network in recent years. The total length of the public water supply network was increased from 31 156 km in 2010 to 38 204 km in 2017. In addition, over the same period, around 1 295 km of the total length of the water network was renewed, corresponding to 3.4 % of the existing supply network. As a result of these investments, water losses began to decline from 2011 onwards.

In Moldova (including the territory on the left bank of the Nistru/Dniester river), the sector using the largest amount of water is the heating and hot water supply sector. In 2017, water use by this sector was 55 600 m³ which corresponds to 72 % of the total water use in the country. The sectors that are the next biggest users of water are the water supply industry (15 %) and agriculture (10 %). The remaining water is used by the construction and service sectors.

There are significant differences in public water supply coverage between urban and rural areas of Moldova. Whereas piped water supply 87 % of buildings in cities, it drops to 25 % of rural settlement buildings. The water supply system is technically outdated and in poor condition. Water pumps are often inefficient and there are many breaks in the pipe system, together causing high water losses (Salveti and Giovanna, 2015; UNECE, 2014a). These issues mean that the public water supply system in Moldova loses almost half of the water it abstracts each year. In addition, drinking water quality is poor, due to infiltration of waste water into pipes.

The level of investment into the Moldovan water industry sector is insufficient to reach the country's needs. For example, between 2009-2013, only 0.02 % of nominal national GDP was invested into the water sector. This figure is extremely low compared to the 1.2 % recommended by the OECD for low-income countries (OECD, 2011; Salvetti and Giovanna, 2015). There is also no long-term water supply planning strategy, nor any governmental requirements regarding economic and technical assessment of investment projects.

4.3.3 Water use efficiency and the economy

Water is not only a vital resource for the environment and freshwater ecosystems, it also plays a significant role in national economies. For instance, without water input, it would not be possible to sustain agricultural activities in parts of countries where irrigation is an inevitable practice for tackling water deficits. Similarly, water is also used for electricity generation (both in hydropower and cooling). Water supply is also crucial to aquaculture, which is one of the major economic sectors in Belarus and Armenia.

The efficiency of water use in an economy is measured by the comparison of water input (m³ or million m³) with per unit of gross domestic product (GDP). All six countries have succeeded in increasing their

gross domestic product (GDP at purchasing power parity at constant price), whilst resulting in decreasing water inputs per unit of GDP since 2000. Water use efficiency, unfortunately, has not increased significantly since 2000.

A country comparison of economic water use efficiency shows that (Figure 10) the best performing country in using less water per unit GDP is Belarus followed by Georgia. Regional economic water use efficiency is the lowest in Armenia at the regional level.

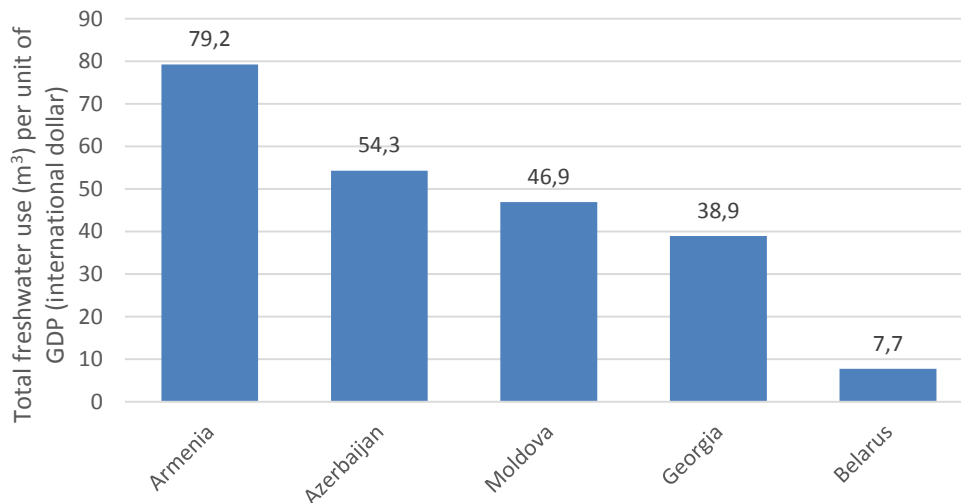


Figure 10. Total water use per unit GDP - gross domestic product (2017)

Data source: World Bank for GDP; Water use: Azerbaijan: Az STAT (Statistical Committee of the Republic of Azerbaijan); Armenia: ArmStatBank (Statistical Committee of the Republic of Armenia); Belarus: Belstat (National Statistical Committee of the Republic of Belarus); Georgia: Water Division of the Department of Environment and Climate Change and the Integrated Management Division of the Department of Environmental Assessment-Ministry of Environmental Protection and Agriculture; Moldova: Statistica Moldovei (Statistical Databank of the National Bureau of Statistics of the Republic of Moldova) and Agency Apele Moldovei.

Note: Georgia 2015; Data provided to European Environment Agency under the ENI EAST SEIS II project.

However, between 2000-2017, GDP in Armenia has almost tripled (USD 8.97 billion in 2000 compared with USD 25.75 billion in 2017). In parallel, the total water use by economic sectors in Armenia has increased by 44.5 % during over the same period. The relative decrease in the total freshwater use by the economy slightly improved the efficiency of water use and almost halved the total freshwater use per unit of GDP (Figure 11).

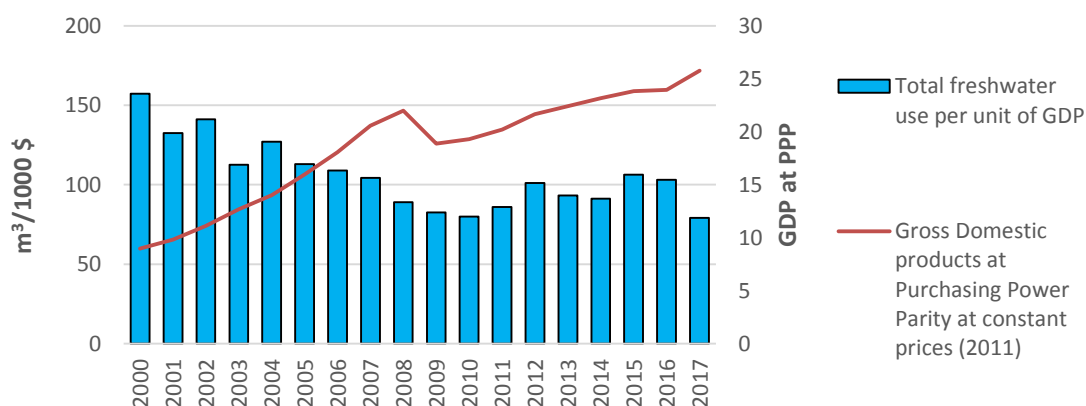


Figure 11: Development of total freshwater use per unit of gross domestic product at purchasing power parity (PPP) in the Republic of Armenia (2000-2017)

Data source: World Bank for GDP; Water use: ArmStatBank (Statistical Committee of the Republic of Armenia);

Note: Data provided to European Environment Agency under the ENI EAST SEIS II project.

In Azerbaijan, as a result of rapid economic improvements, GDP increased by more than a factor of four (4.4) between 2000-2017. GDP at purchasing power parity (PPP)⁽⁴⁾ increased from USD 35.9 to USD 156.3 billion. . Over the same period, water use in Azerbaijan decreased from 221 m³/USD 1,000 GDP to 54.3 m³/USD 1,000 GDP, indicating a relative decoupling of income generation and water use (Figure 12. Development of total freshwater use per unit of gross domestic product at purchasing power parity in the Republic of Azerbaijan (2000-2017) It should be noted that the total annual freshwater use increased by 7 % over the same period. Despite the relative efficiency gained, water losses in transport and an increasing demand for water in agriculture remain major ongoing challenges for water resources management.

⁴ A metric that compares different countries' currencies through a "basket of goods" approach and therefore compare economic productivity and standards of living between countries.

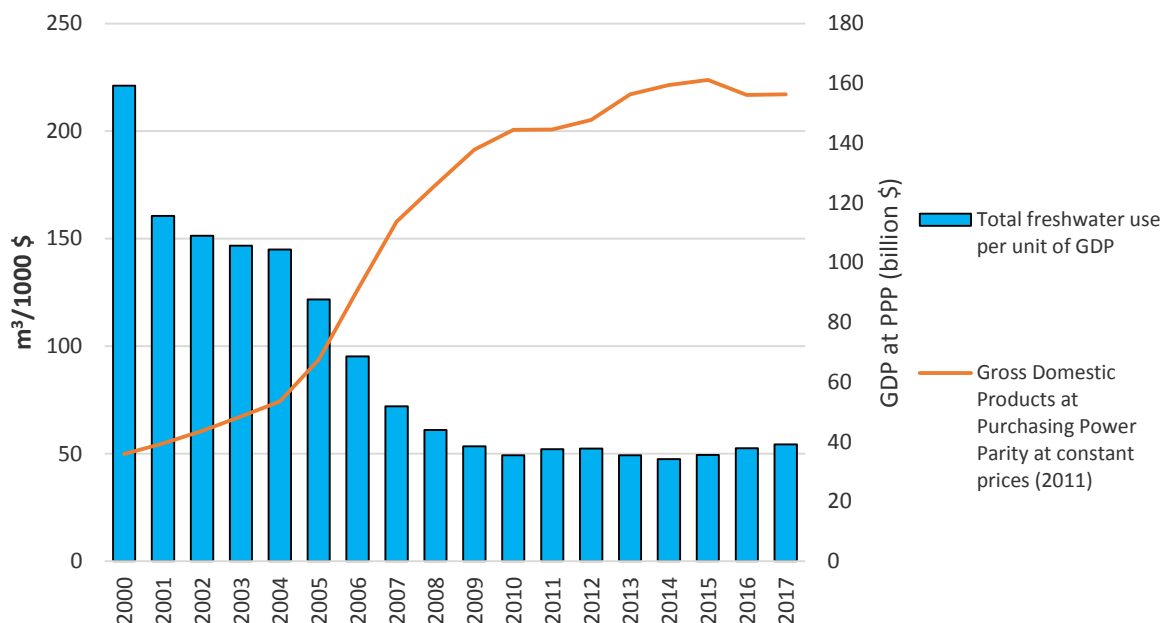


Figure 12. Development of total freshwater use per unit of gross domestic product at purchasing power parity in the Republic of Azerbaijan (2000-2017)

Data source: World Bank for GDP; Water use: Az STAT (Statistical Committee of the Republic of Azerbaijan).

Note: Data provided to European Environment Agency under the ENI EAST SEIS II project.

In Georgia, the GDP been increased by 44 % between 1990-2016. Although there has been an increase in GDP, there has not been a similar increase in water use efficiency. Nevertheless, in 1990, around 145 m³ of water was used in the country's economy to producing USD 1 000 by the economy, but 38 m³ of water was used in 2015 to produce the same unit of GDP (Figure 13).

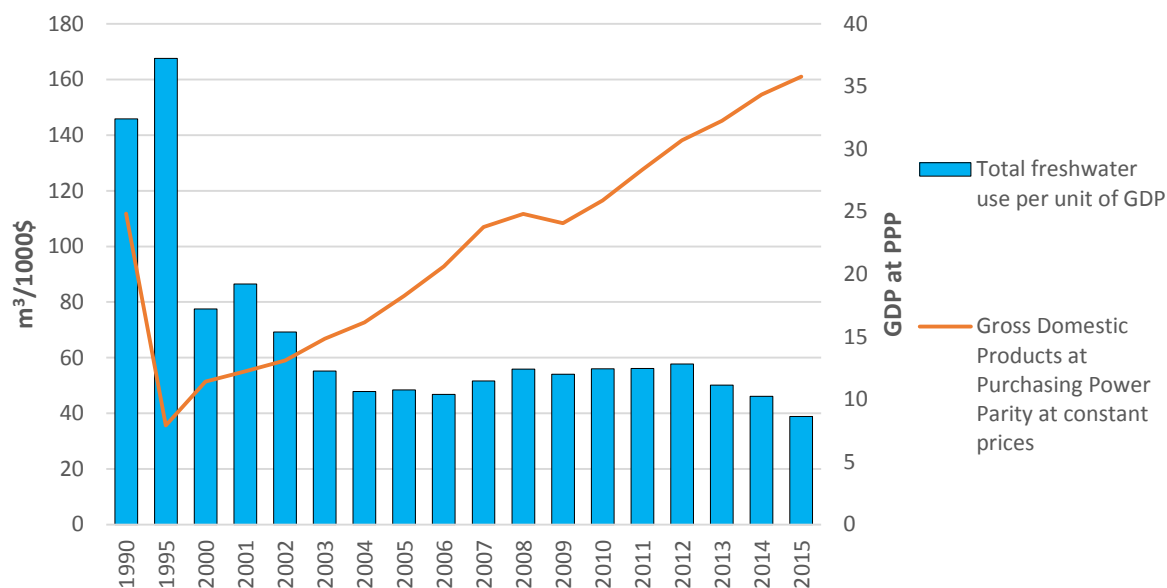


Figure 13: Development of total freshwater use per unit of gross domestic product at purchasing power parity in Georgia (1990-2015).

Data source: World Bank for GDP; Water use: Water Division of the Department of Environment and Climate Change and the Integrated Management Division of the Department of Environmental Assessment-Ministry of Environmental Protection and Agriculture.

Note: Data provided to European Environment Agency under the ENI EAST SEIS II project.

Belarus has significantly improved its water use efficiency in 2000s. As a result, water use per unit of gross domestic product (GDP) at purchasing power parity (PPP) has decreased from 33 m³/1 000 USD in 1990 to 8 m³/1 000 USD in 2017. Over the same period, GDP at PPP has roughly doubled, from USD 85 billion in 1990 up to 163 billion in 2017 (Figure 14).

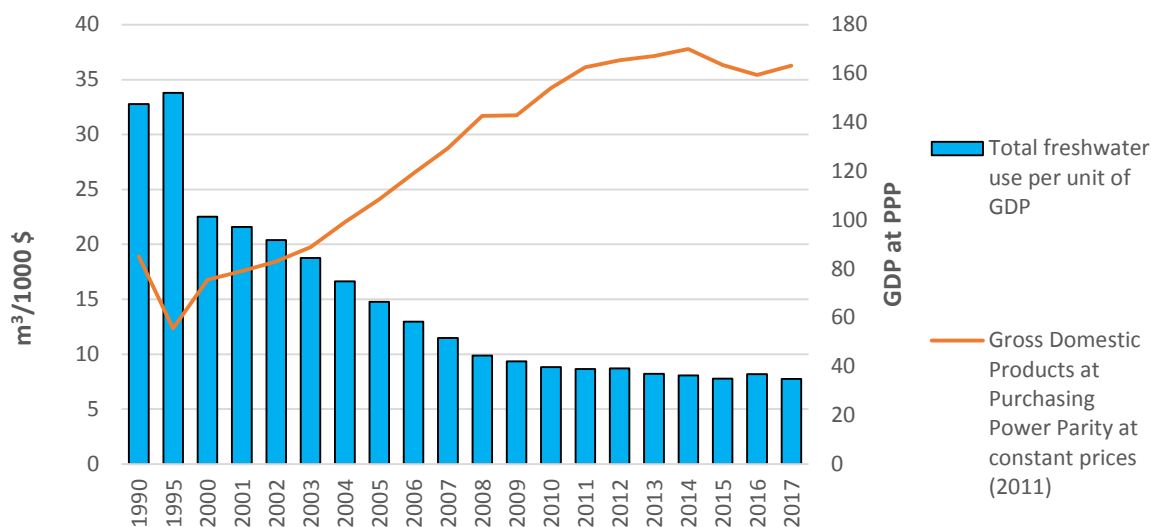


Figure 14: Development of total freshwater use per unit of gross domestic product at purchasing power parity in the Republic of Belarus (1990-2017).

Data source: World Bank for GDP; Water use: Belstat (National Statistical Committee of the Republic of Belarus).

Note: Data provided to European Environment Agency under the ENI EAST SEIS II project.

Similarly, in Moldova, the country's GDP more than doubled between 2000-2017 (Figure 15), from USD 8.4 billion in 2000 up to 18.4 in 2017 (The World Bank, 2020), while total freshwater use per unit of GDP has decreased by about 60 % (not including information on the left bank of the Nistru/Dniester river). The efficiency of total water use per unit of GDP was reached by decreasing water use while maintaining the upward trend in GDP. In 2000, around 104 m³ of water was used in the country's economy to produce USD 1 000 by the economy, which decreased to 43 m³ of water used in 2017 to produce the same unit of GDP. However, it should be noted that 43 m³ of water per GDP unit still is very high compared to other countries, and further water use efficiency improvements need to be made in the years to come.

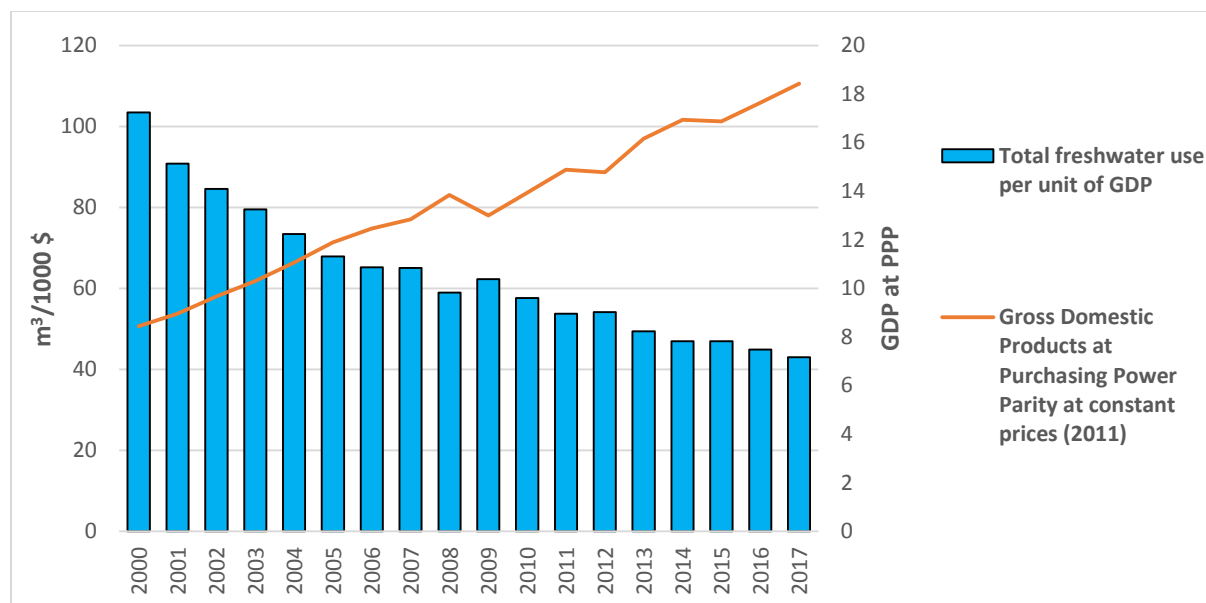


Figure 15: Development of total freshwater use per unit of gross domestic product at purchasing power parity in the Republic of Moldova (2000-2017).

Data source: World Bank for GDP; Water use: Statistica Moldovei (Statistical Databank of the National Bureau of Statistics of the Republic of Moldova) and Agency Apele Moldovei.

Note: Data provided to European Environment Agency under the ENI EAST SEIS II project.

5 Access to safe drinking water

Access to safe drinking water and sanitation has been recognised as a human right by the United Nations (UN, 2010). The purpose of sanitation – a term that covers collection, transport, treatment, disposal and reuse of waste water – is to provide a safe and clean water for citizens. Public water supply is one of the most effective ways to ensure safe drinking water provision.

The UN Sustainable Development Goal (SDG) no. 6 sets targets to ensure equitable access to drinking water and sanitation for all. It advocates for water use efficiency to be increased across all sectors and to reduce the number of people suffering from water scarcity. Similarly, countries set national targets in response to the Protocol on Water and Health of the Water Convention (UNECE, 2020d).

Access to water supply and basic sanitation services can be measured by two different indicators: *proportion of population connected to water supply*; and *household water use per capita*. The following chapters deal with these two indicators.

5.1 Population connected to water supply

The water supply industry provides water to the public for various purposes including domestic use, drinking, agriculture and industry.

The percentage of a national population connected to water supply services is a measure for quantifying the access to improved water supply services. The indicator is important for defining the level of development of the water economy services and the degree of water accessibility to cover all of the household needs of the population. In this this context, countries present highly variable levels of progress over the time (Figure 16).

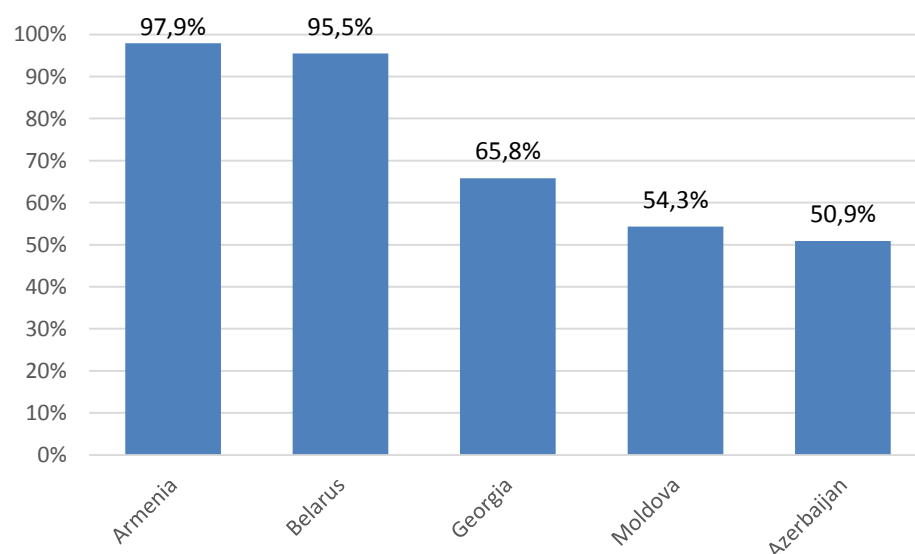


Figure 16: Population connected to water supply industry (2017)

Data sources: Azerbaijan: Az STST (State Statistical Committee of the Republic of Azerbaijan); Armenia: ArmStatBank (Statistical Committee of the Republic of Armenia); Belarus: Belstat (National Statistical Committee of the Republic of Belarus); Georgia: National Statistics Office of Georgia; Moldova: Statistica Moldovei (Statistical Databank of the National Bureau of Statistics of the Republic of Moldova) and Agency Apele Moldovei.

Note: Data provided to the European Environment Agency under the ENI SEIS II East Project.

Around 64 % of Armenia's population lived in urban areas in 2018 (Statistical Committee of the Republic of Armenia, 2020a). Over recent years, Armenia has invested in improving the public water supply network, particularly to rural areas. By means of these investments, 97.9 % of the population was connected to the water supply system in 2018. Despite Armenia not setting a national target, with almost 98 % of its households connected to the water system, the country is very close to reaching the UN SDG Target 6.1, which asks countries to "achieve universal and equitable access to safe and affordable drinking water for all." However, according to an UNECE environmental performance assessment in 2000 (UNECE, 2000b), around 80 % of the Armenian public water supply system was more than 10 years old and 55 % was more than 20 years old. Since then, maintenance of the water supply system had been neglected. The number of interruptions in supply is now increasing regularly, and the system loses 79 % of water in transport before it reaches the public.

Almost half of the population in Azerbaijan was not connected to water supply system in 2017. Since the 2000s, the Azerbaijan government has implemented water supply projects to improve sanitation services in the country (UNECE, 2011b). By means of those investments the total number of people connected to the water supply has increased significantly from 3.6 million inhabitants in 2005 to 5 million inhabitants in 2017. Azerbaijan set targets to ensure access to improved sources of water supply with 24-hour uninterrupted water supply. The targets for 2020 were that 95 % of city residents and 65 % of those in rural areas would have uninterrupted water supplies; for 2030 the targets are for 100 % of city residents and 80 % of those in rural areas. However, two major issues remain as future challenges for water management in Azerbaijan: (1) increasing the percentage of the total population connected to the public water supply; and (2) decreasing the leakages from the transport system. Work on these issues needs to continue, requiring financial and technical investments in the public water supply network.

Drinking water supply in Georgia:

In Georgia, the water supply industry each year provides 800 to 900 million m³ of water, out of which three quarters can be lost. In 2017 the loss represented 66 % of all water supplied, but in 2015 it was 73 %. The water sector infrastructure has deteriorated because of a lack of maintenance and weak investments in modernisation of the water facilities in recent years (UNECE, 2016b). Nevertheless, there are signs of improvements. Net water consumption per capita decreased from 94 m³/year in 2015 to 91 m³/year in 2018 noting that in 2015, 60 % of the population was connected to the public water supply and in 2018 almost 66 %.

Around 66 % of the total population of Georgia was connected to the public water supply in 2018. Between 2015-2018, the percentage of the country's population connected to water supply industry increased by 10.4 %. Georgia have not set national targets for water supply yet, but the country's focus is primarily on urban areas, and aims to deliver a high-quality 24-hour drinking water supply to the population, and to improve the water supply and sanitation

system in urban areas. However, there is a low level of implementation of specific plans for rural water supply sustainability (WHO, 2015).

Belarus aims to supply water to all settlements with more than 100 000 inhabitants. In 2017, around 95 % of Belarusian citizens were connected to the water supply system, which corresponds to a 17 % increase compared to 2000. Sub-programme 5, 'Pure Water' of the state 'Comfort accommodations and an enabling environment for 2016-2020' programme, sets the target to supply drinking water to all public consumers by the end of 2020 (Council of Ministers of the Republic of Belarus, 2016). Belarus is very close to achieving this target, and the trend in the improvement of the water supply system is encouraging. Meanwhile, Belarus has been investing in renewing and expanding the water supply network in recent years. The total length of the public water supply network increased from 31 156 km in 2010 to 38 204 km in 2017. Over the same time period, the total length of the water network renewed was about 1 295 km, corresponding to 3.4 % of the existing supply network. As a result of these investments, water losses in the Belarusian water supply system have decreased.

The Republic of Moldova aims to provide access to improved drinking water systems to 99 % of its urban population and 85 % of its rural population by 2025. It aims to provide access to improved sanitation for the entire population, and to connect 85 % of the urban and 25 % of the rural population to sewerage systems by 2025. In Moldova, 1.6 million inhabitants (54.3 % of the total population) were connected to the public water supply system in 2016. The rest of the population met their water demand by self-supply. The water supply industry supplied 84.8 million m³ of water, which is equal to 10 % of the total annual freshwater abstraction in the country. As a result of the high pollution of surface water resources, the country is heavily dependent on groundwater resources, particularly for drinking purposes, which can result in the overexploitation of the groundwater resources (UNECE, 2014a). Because of the poor condition of the water supply system in Moldova, almost half of the water supplied is lost during transport.

Republic of Moldova's Millennium Development Goals pertaining to the natural environment also includes intermediate and long-term targets in water supply, defining that the percentage of population with access to safe water supply should grow for 9.2 % from 2002-2006 and 11.5 % from 2010-2015 (UNECE, 2005). Moldova is still far from meeting its national targets. The critical aspects related to the water supply infrastructure are: (1) the unsatisfactory technical condition of the drinking water system and waste water treatment systems; (2) the low percentage of the population with access to improved sanitation services; and (3) insufficient investment in the expansion and improvement of the water supply network and sanitation. The poor condition of the water supply network and insufficient financial and technical resources are making it difficult to implement the desired conditions within the water supply system in the country. The monopoly of the water services, overstaffing (Salveti and Giovanna, 2015), and the lack of financial resources are the remaining challenges lying ahead in the water sector.

5.2 Water use by households

Water supplied to households is mainly used for drinking, cooking and hygiene, including basic needs for personal and domestic cleanliness, and amenity uses such as car washing and lawn watering (Howard et al., 2003). The global target set by the UN Sustainable Development Goal No. 6.2 asks countries to “achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations” by 2030.

Water use by households is mostly driven by the population, the efficiency of conveyance systems, and the proportion of population connected to water supply services. Eastern Partnership countries present considerably different progress. Overall, there is a decreasing trend in population in all countries except Azerbaijan. In parallel to the development of connecting the more portion of population to the water supply systems, total water use by households has been increasing in all countries since 2010. Nevertheless, each country presents different trends in total water use for households, either due to improvements in conveyance systems or continuing increases in the total population (Figure 17 and Figure 18). Water use per capita is an indication on the performance of the water utility systems, as well as cultural behaviours of individuals water consumption. However, measuring the impacts of cultural behaviours in water consumption is challenging and requires peer-to-peer comparison within the same layer of sociological groups.

Among all six countries, Georgia exhibits the highest water use per capita due to high water loss in the conveyance system (Figure 17). Each Georgian citizen used on average 90.6 m^3 of water from renewable freshwater resources during the year of 2018. This corresponds to approximately 248 l of freshwater per capita per day. Georgia has improved its water supply network during recent years. About 40.5 % of the total population was not connected to the water supply in 2015, but this figure decreased by 6.3 % in 2018 as a result of improvements to the network. Although Georgia is a non-water-stressed country, about 34.2 % of its population was not connected to the public water supply in 2018 and had to manage their water demand by self-supply. In addition, the country’s water supply network is in poor condition, causing the network to lose 66.4 % of the total water supply in the network.

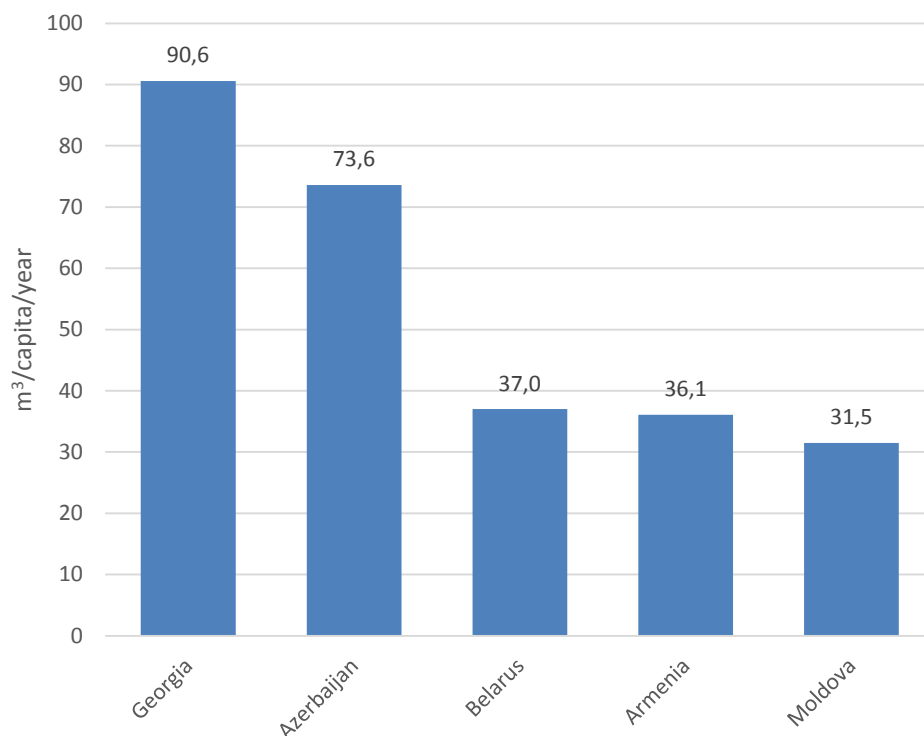


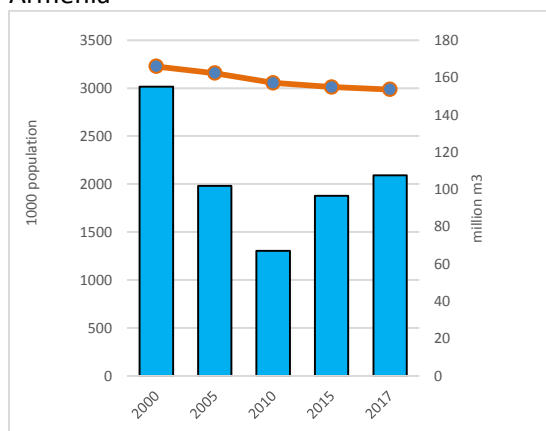
Figure 17: Water use per capita by households (2017)

Data sources: Azerbaijan: Az STST (State Statistical Committee of the Republic of Azerbaijan); Armenia: ArmStatBank (Statistical Committee of the Republic of Armenia); Belarus: Belstat (National Statistical Committee of the Republic of Belarus); Georgia: National Statistics Office of Georgia; Moldova: Statistica Moldovei (Statistical Databank of the National Bureau of Statistics of the Republic of Moldova) and Agency Apele Moldovei.

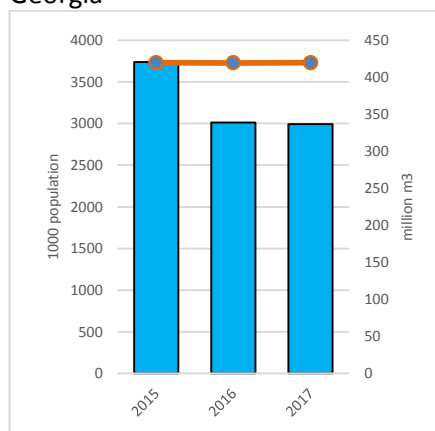
Note: Data for Georgia: 2018. Data provided to the European Environment Agency under the ENI SEIS II East Project.

In Armenia, annual household water use has fluctuated significantly in recent years, dropping between 2000-2009, and then increasing between 2009-2017, due to the expansion of the public water supply network to rural areas. As a result of this expansion, the total water volume supplied to households by the water supply industry increased from 61.4 million m³ in 2009 to 107.6 million m³ in 2017. Over the same time, the country's population has decreased by 7 %. Water losses during transport remain high, with an average rate of 30 % of total water supply, posing high pressure mainly on groundwater resources. In 2017, on average, an Armenian citizen used 36 m³ of water from renewable freshwater resources. This corresponds to approximately 98.6 l of freshwater per capita per day.

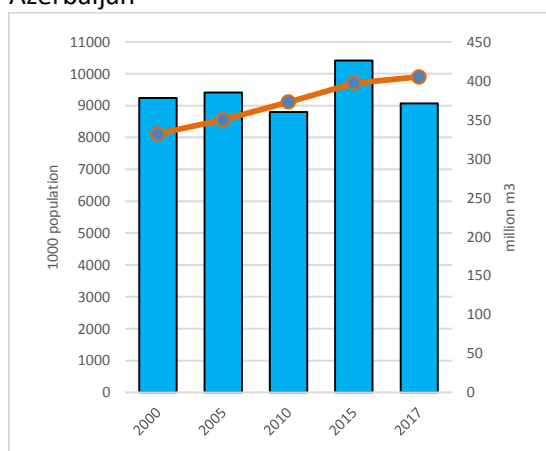
Armenia



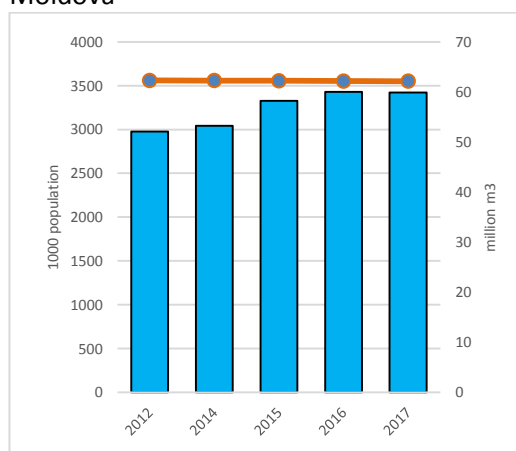
Georgia



Azerbaijan



Moldova



Belarus

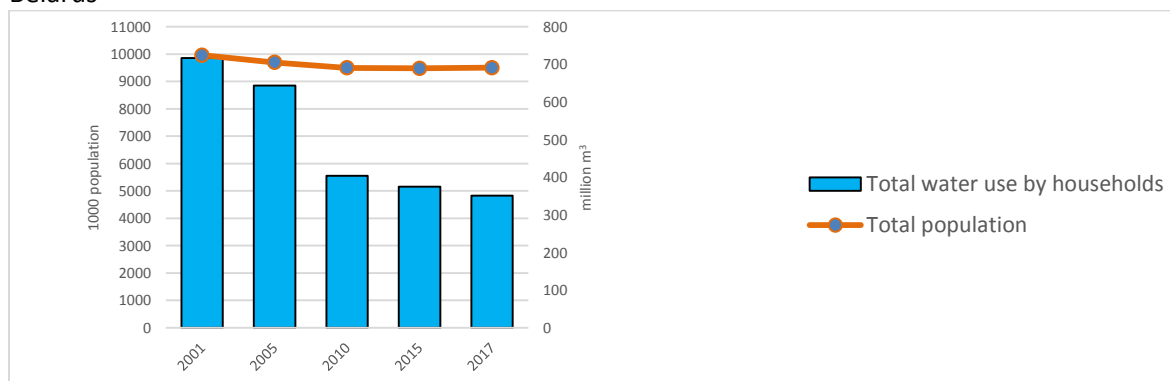


Figure 18: Development of total freshwater use by households

Data sources: Azerbaijan: Az STST (State Statistical Committee of the Republic of Azerbaijan); Armenia: ArmStatBank (Statistical Committee of the Republic of Armenia); Belarus: Belstat (National Statistical Committee of the Republic of Belarus); Georgia: National Statistics Office of Georgia; Moldova: Statistica Moldovei (Statistical Databank of the National Bureau of Statistics of the Republic of Moldova) and Agency Apele Moldovei.

Note: Data for Georgia: 2018. Data provided to the European Environment Agency under the ENI SEIS II East Project.

In Azerbaijan, total freshwater use by households has increased since 2000. In parallel, the total population of the country increased by 22 % between 2000-2017, whilst the percentage of the population connected to the public water supply increased only 9.3 % over the same period. In 2017, water use for households was estimated at an average of 201.6 l per person per day. It should be noted that between 2015-2017 total freshwater use decreased by 13 % due to investments in the water conveyance infrastructure. Nevertheless, as water is mainly supplied to households from surface water resources, any deterioration in water quality may pose high public health risks. As a result of the increasing proportion of the population connected to the water supply system, water use from the public water supply system increased by 15 % between 2012-2017. However, since half of the population is still not connected to the water supply services, further efforts are needed to achieve the UN target that there is 'by 2030, universal and equitable access to safe and affordable drinking water for all' (Sustainable Development Goal no. 6.1).

In Belarus, 351 million m³ water was supplied to households by the water supply industry, which corresponds 27 % of the total water supply at the country level. According to Belstat estimates, annual household water use in Belarus more than halved from 717 million m³ in 2001 to 351 million m³ in 2017. Despite there being no significant change in the population during this time period, the substantial decrease in demand for household water use can only be due to an increase in water efficiency. As stated in the UNECE third environmental performance review of Belarus in 2016 (UNECE, 2016b), because of increased water metering, water demand from households is expected to decline in coming years. The average Belarusian citizen used 37 m³ of water from renewable freshwater resources in 2017 compared with 72 m³ in 2001. This corresponds to approximately 107 l of freshwater per capita per day.

In Moldova, daily water use per person was estimated to be around 86 litres in 2017. Since 2012, there has been a considerable increase in the proportion of the population connected to the water supply system. In 2017, 53.5 % of the total Moldovan population was connected to the water supply system (compared with 42 % in 2012), of which the majority live in urban areas. Currently, almost 93 % of the country's urban population and only 27 % of the rural population has access to improved water supply systems (UNECE, 2014a). Groundwater is used as the main source of drinking water in rural areas, which puts high pressures on groundwater aquifers.

6 Water quality

Organic waste and nutrient pollution constitute serious threats to water quality, both from an ecological perspective and with respect to human uses such as drinking water, bathing water and recreation. Waste water – both municipal and industrial – as well as diffuse runoff from agriculture are the main sources of organic waste and nutrient pollution. All of these pressures affect water quality across the region.

Despite some remarkable progress made in connecting the population to public water supply systems in all six countries, treatment of waste water still remains insufficient. For instance, in Armenia there is hardly any biological treatment of waste water to break down the organic waste. In Baku, the capital of Azerbaijan, only half of the collected water is treated. In Georgia only a few of the municipal waste water treatment plants built in the 1980s operate. Organic pollution generated in cities is transmitted directly to the rivers. In Moldova most treatment plants operate with primary treatment only, so organic waste is not processed. In addition, poorly treated industrial waste water affects the performance of municipal treatment plants, and much untreated industrial waste water is discharged directly into rivers. In Ukraine the urban treatment plants have insufficient capacity and are in poor technical condition, while there is a general lack of sewage networks in rural areas. However, in the region there are new investments ongoing for improving the treated water discharge to the environment.

Due to suitable topographic and soil conditions, large areas of the region are used for agriculture and this sector employs millions of rural inhabitants. However, high – and increasing – applications of manure and inorganic fertiliser makes agriculture a major driver of nutrient, ammonium and organic matter releases into the water system.

Deterioration in water quality is therefore not a new issue in the region, but will exacerbate in the future with intensified agriculture and increased industrialisation and urbanisation, particularly if these developments are not supported by improved wastewater treatment. Lack of financial resources or insufficient management of water resources, institutionally or technically, will add to the problem.

In order to understand the water quality situation in the region, it is necessary to analyse causes of pollution and evaluate their impacts on water resources. The long-term analyses are necessary to show trends in water quality and connect them to socio-economic trends and environmental situation. Policy makers and environmental managers can use the information to guide the design and implementation of measures.

Organic matter and ammonium in rivers and nutrients in freshwater are used as measure to assess the situation of water quality in the region. The present state of water is defined as the average for the last three years with available data. For the pollutants in question there are no general thresholds for assessing whether the concentrations are acceptable or not from an ecological perspective. Such thresholds vary with water body type, characterised by factors such as geology, climate and or altitude.

The present state of water quality gives an indication of the pollution situation and shows whether the pollution is mainly a local issue, affecting a few sites, or a general issue nationally or regionally. The different Eastern Partnership countries often have national targets or maximum permissible concentrations for pollutants, but these are frequently quite high and may be targeted at other purposes than protecting the ecosystem, such as the use of water as drinking water. They are referred to in the next section. As a general reference, the targets for ammonium concentration and biochemical oxygen demand (BOD) in the EU Fish Directive (2006) are also used⁽⁵⁾.

6.1 Organic matter and ammonium in rivers

The discharge of large quantities of organic matter containing microbes and decaying organic waste, either from agriculture or as waste water from households or industrial effluents, may result in reduced chemical and biological quality in river water, reduced biodiversity of aquatic communities, and microbiological contamination that can affect the quality of drinking and bathing water. Organic pollution leads to higher rates of metabolic processes that demand oxygen. This can result in the development of water zones without oxygen (anaerobic conditions), which has profound direct impacts on the ecosystem. The transformation of nitrogen to reduced forms under anaerobic conditions, in turn, leads to increased concentrations of ammonium, which is toxic to aquatic life above certain concentrations, depending on water temperature, salinity and acidity. Organic matter in water is measured as biochemical oxygen demand (BOD), which is the amount of dissolved oxygen which is required for the aerobic decomposition of the organic matter present in the water. BOD is expressed in mg of O₂/litre, while ammonium concentration is expressed in mg of NH₄-N/litre.

6.1.1 Changes over time

The main source of organic pollution in Armenia is untreated or insufficiently treated waste water, which, due to the lack of treatment plants, is emitted into the rivers. There are only six water treatment plants in Armenia, with only mechanical treatment where organic waste is not processed. From 2008-2017 the BOD and ammonium concentration in rivers increased by 18 % and 72 %, respectively (**Hata! Başvuru kaynağı bulunamadı.**). An increase was mainly observed for at sites below settlements. Emission in the less populated areas have not changed a lot in this period. The River Hrazdan is one of the longest and most polluted rivers in Armenia. The effect of the influences of untreated wastewater is significant, especially at one highly polluted monitoring site located downstream, which is the nearest and most impacted site after Yerevan city, the capital of Armenia, which is home to around 1 million inhabitants. The pollution level of this site has a major impact on the country average, resulting in both higher absolute levels of pollution and a larger increase over time. This is particularly evident for ammonium.

⁽⁵⁾ Water for cyprinid fish targets: 0.16 mg NH₄-N/l and 6 mg O₂/l; water for salmonid fish: 0.03 NH₄-N/l, 3 mg O₂/l

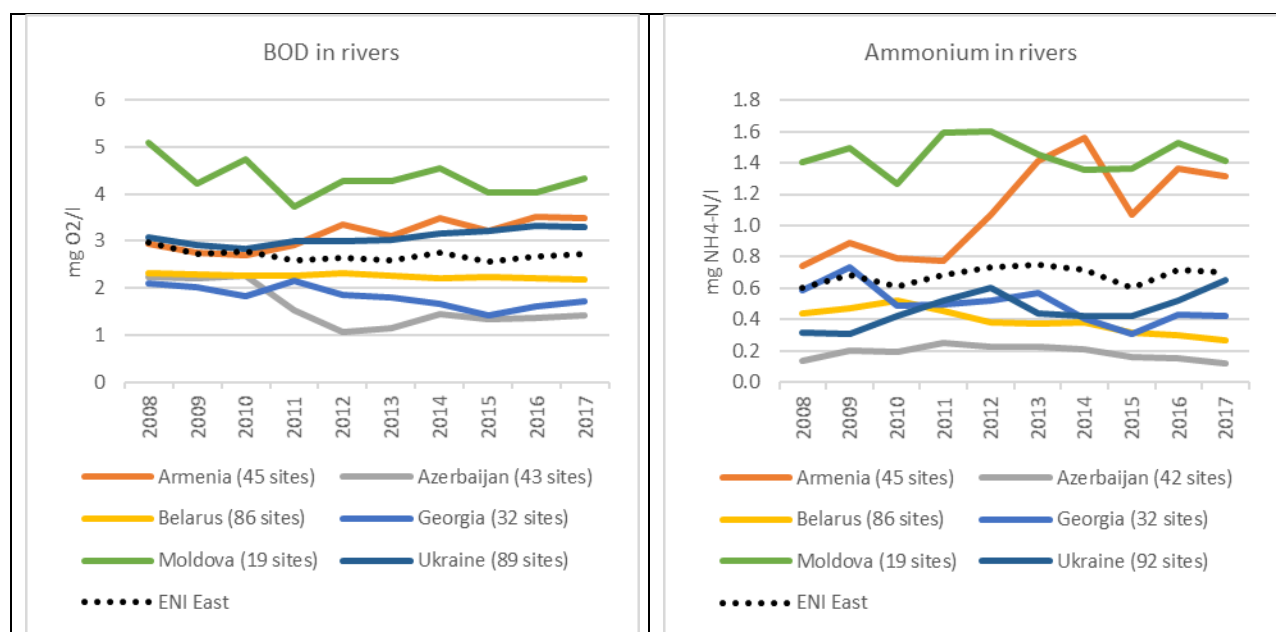


Figure 19: Average annual BOD (left) and ammonium concentration (right) for river sites in the ENI East countries over the time period 2008-2017

Data sources: Armenia: Environmental Monitoring and Information Center SNCO, Ministry of Nature Protection; Azerbaijan: National Environmental Monitoring Department of the Ministry of Ecology and Natural Resources; Belarus: National Environmental Monitoring System by the Ministry of Natural Resources and Environmental Protection; Georgia: National Environmental Agency of the Ministry of Environmental Protection and Agriculture; Environment Quality Monitoring Division of the State Hydrometeorological Service of the Ministry of Agriculture, Regional Development and Environment; Moldova: Ministry of Agriculture, Regional Development and Environment; Ukraine: Ministry of Ecology and Natural Resources.

Note: Only complete time series after inter/extrapolation are included.

Between 2001-2017 there was a slight increase in ammonium concentration and a slight decrease in BOD (by 32 % and 25 %, respectively, if comparing the average of the last three years to that of the first three years) in Azerbaijan. However, BOD has increased from its minimum level in 2012, while ammonium has decreased in recent years. For both pollutants there was a period with higher levels than currently. For BOD this happened mainly before 2008, while it occurred mainly after 2008 for ammonium. The time series patterns seen at the national level are broadly similar at the regional level.

Transboundary transport, industrial and agricultural production, old sewer systems, and a lack of solid waste management in some rural areas led to an increase in organic pollution in Azerbaijan up to 2010. The Shamkir and Mingechvir reservoirs along the Kura river were affected by the discharge of waste water from many settlements in the Kura River Basin. Over the last 7-8 years however, the installation of new modern waste water treatment plants in the country has reduced organic pollution.

In Georgia, BOD decreased somewhat between 2004-2018 (by 11 % when comparing the average of the last three years to that of the first three years). The main decrease was in the Black Sea river basin (21 %). The average for the Kura river basin increased towards 2006 but has decreased since then. Ammonium concentration showed a more pronounced decrease (50 %). The largest decrease was

observed for rivers in the Kura river basin (62 %). The results for the years 2011-2013 should be treated with some caution, due to lower numbers of samples per year. This may explain some of the variability observed for ammonium concentration in this period.

The decreases in BOD and ammonium concentrations in Georgia can be attributed to measures such as the improvement of urban and industrial wastewater treatment. Further improvement is expected for the Black Sea river basin where the large cities have not previously had wastewater treatment plants. Water treatment plants are currently under construction in Zugdidi and Poti and the construction of a treatment plant in Kutaisi is planned.

The average BOD has decreased since 1992 at the country level in Belarus, particularly in the period 1997-1998. For the whole time period 1986-2017 the BOD decreased by 19 % (comparing the average of the last three years to that of the first three years). The largest decrease was observed in the Western Bug river basin, followed by the Dniepr and Pripyat river basins, while there has hardly been any change overall in Western Dvina, the river basin with the lowest BOD levels.

Concentration levels of ammonium have been more variable in Belarus, but there has been a steady decrease since 1998. This is also seen in the different river basins, however, all except Western Dvina experienced a sharp increase in 1998. This is in contrast to the marked decrease in BOD in the same period and may partly indicate different sources of pollution. However, the decreasing levels in both parameters –ammonium in particular –over the last two decades, indicates an overall reduction in pressure from organic pollution.

In Moldova, the average BOD and ammonium concentration in rivers show similar patterns over the time period 1992-2017, with declining levels until 1997-1998 then fluctuating higher levels, and finally returning to similar levels to the start of the time period. Ammonium concentrations were highest between 2001-2004, while BOD was highest around 2003-2008. However, the increases in pollution can be attributed to sites in the Dniester river basin. For the sites in the Prut river basin and the two sites on the Danube and its tributary (Cogîlnic) ammonium concentrations generally decreased over time and BOD levels were stable or slightly decreasing.

River water downstream of cities and towns in Moldova was significantly more polluted than that upstream. Upstream of cities, ammonium concentrations have decreased steadily since 1992, although less in recent years, while the concentrations downstream have increased. This trend can be attributed to non-treated effluent from the cities. The up-downstream difference is less for BOD. Here the downstream level has decreased in recent years, approaching that of the upstream level.

Over the period 2000-2017 the average BOD in Ukrainian rivers was lowest in 2010, after which it has increased. However, the current level is similar to that of 2003-2004. The ammonium concentrations have fluctuated significantly, but overall, the concentrations increased between 2000-2017.

6.1.2 Current state

In Armenia, 31 % and 44 % of the river sites belong to the two highest concentration classes for BOD and ammonium levels, respectively, based on data for 2015-2017 (Figure 21). The highest average BOD concentrations were found in the Hrazdan river basin, followed by Akhuryan (**Hata! Başvuru kaynağı bulunamadı..**). Hrazdan is the most populated river basin in Armenia, while the second most populated city (Gyumri) is located in the Akhuryan river basin. The waste waters of both cities discharge directly into the rivers, due to a lack of waste water treatment plants. The best water quality conditions were found in the Sevan river basin. The rivers here are mainly subject to diffuse sources of water pollution, which do not have a big significant impact. However, even here the two sites had average ammonium concentration above the recommended levels for cyprinid fish in the EU Fish Directive (2006/44/EC). To reduce pollution of surface waters (especially in the Sevan river basin) there is new legislation that requires local treatment of wastewater from recreation areas before it is discharged to rivers or lakes.

All but one Armenian river basin, Ararat, had river sites where the current ammonium concentration exceeded the recommended concentration for cyprinid fish. In total, 49 % of sites exceeded recommended ammonium concentrations. Most of the elevated concentrations were found downstream of settlements, but some were found above settlements, possibly because the headwaters are not protected by legislation. The Armenian authorities are filling the gap in the legislation to protect headwater areas, starting with the Akhuryan river basin. The recommended BOD level for salmonid fish was exceeded at 31 % of monitoring locations in Armani. Two sites also exceeded the BOD threshold for cyprinid fish. The good/moderate thresholds in the national legislation are generally higher than the recommended levels in the EU Fish Directive.

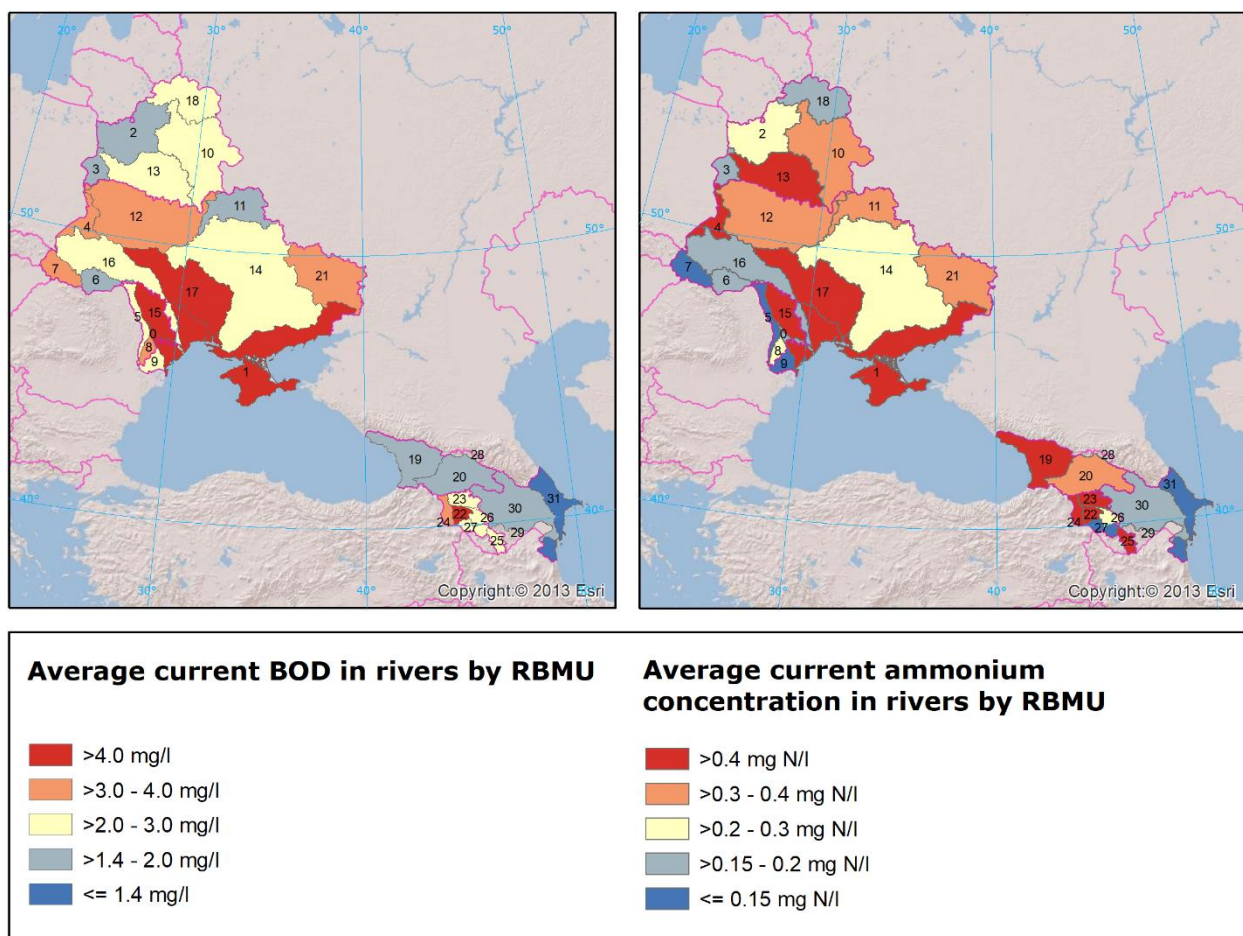


Figure 20: Average river BOD and ammonium concentration for 2015-2017 by River Basin Management Unit.

Data sources: Armenia: Environmental Monitoring and Information Center SNCO, Ministry of Nature Protection; Azerbaijan: National Environmental Monitoring Department of the Ministry of Ecology and Natural Resources; Belarus: National Environmental Monitoring System by the Ministry of Natural Resources and Environmental Protection; Georgia: National Environmental Agency of the Ministry of Environmental Protection and Agriculture; Environment Quality Monitoring Division of the State Hydrometeorological Service of the Ministry of Agriculture, Regional Development and Environment; Moldova: Ministry of Agriculture, Regional Development and Environment; Ukraine: Ministry of Ecology and Natural Resources.

Note: RBMUs: 0 - Black Sea (MD), 1 - Black Sea (UA), 2 - Neman (BY), 3 - Western Bug (BY), 4 - Vistula (UA), 5 - Prut (MD), 6 - Prut (UA), 7 - Tisa (UA), 8 - Danube (MD), 9 - Danube (UA), 10 - Dnieper (BY), 11 - Desna (UA), 12 - Dnieper - upstream Kiev (UA), 13 - Pripyat (BY), 14 - Dnieper - downstream Kiev (UA), 15 - Dniester (MD), 16 - Dniester (UA), 17 - Southern Bug (UA), 18 - Western Dvina and Gulf of Finland (BY), 19 - Black Sea (GE), 20 - Kura (GE), 21 - Donets (UA), 22 - Hrazdan (AM), 23 - Northern (AM), 24 - Akhuryan (AM), 25 - Southern (AM), 26 - Sevan (AM), 27 - Ararat (AM), 28 - Terek (GE), 29 - Aras (AZ), 30 - Kura (AZ), 31 - Caspian Sea (AZ). No data are available for uncoloured RBMUs.

In Azerbaijan, none of the river sites were assigned to the three upper BOD classes. Moreover, no sites exceeded the national maximum allowable concentration for ammonium concentration (0.4 mg $\text{NH}_4\text{-N/l}$), which corresponds to the highest ammonium class. Still, 20 % of the sites had current ammonium concentration corresponding to the second highest ammonium class. The recommended ammonium concentration level for salmonid fish was always exceeded, and the cyprinid threshold was exceeded at

35 % of sites. River sites in the Kura river basin had somewhat higher ammonium concentrations and BOD than river sites outflowing to the Caspian Sea.

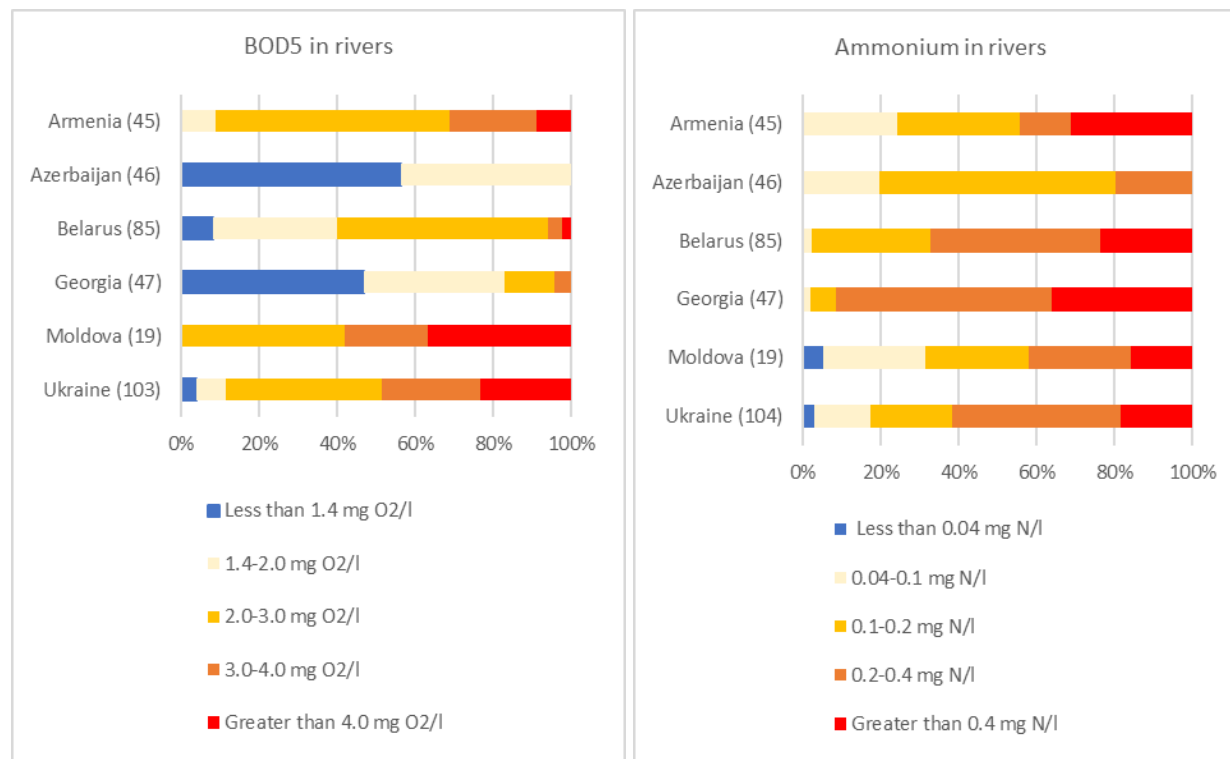


Figure 21: Distribution of river monitoring sites to BOD (top) and ammonium concentration (bottom) classes in the ENI East countries, based on the average of annual mean concentrations for 2015-2017

Data sources: Armenia: Environmental Monitoring and Information Center SNCO, Ministry of Nature Protection; Azerbaijan: National Environmental Monitoring Department of the Ministry of Ecology and Natural Resources; Belarus: National Environmental Monitoring System by the Ministry of Natural Resources and Environmental Protection; Georgia: National Environmental Agency of the Ministry of Environmental Protection and Agriculture; Environment Quality Monitoring Division of the State Hydrometeorological Service of the Ministry of Agriculture, Regional Development and Environment; Moldova: Ministry of Agriculture, Regional Development and Environment; Ukraine: Ministry of Ecology and Natural Resources.

Note: The number of monitoring sites per country is given in parenthesis.

In Georgia, the current BOD was below the national maximum permissible concentration of 6 mg O₂/l for all sites. Moreover, only two sites in the Kura river basin had BOD above the stricter criteria set in the EU Fish Directive for salmonid fish (3 mg O₂/l). However, 91 % of the sites belonged to the upper two ammonium concentration classes, and 36 % of the sites had average concentration above the national maximum permissible concentration (0.39 mg NH₄-N/l). Only two river sites in Georgia had current ammonium concentrations below the EU Fish Directive recommended level for cyprinid fish, and none were below the threshold for salmonid fish. While average BOD was slightly higher in the Kura than the Black Sea river basin, the opposite was true for average ammonium concentration. The high ammonium

concentrations in the Black Sea river basin probably reflect the poor level of waste water treatment in this region.

Only 6 % of river sites in Belarus had current BOD above the lowest national maximum permissible concentration (3 mg O₂/l). The average BOD level was relatively similar among the different river basins. The situation was worse for ammonium concentration, with 67 % of the sites in the upper two concentration classes. The highest average BOD concentration was found in the Pripyat and Dnieper basins. In Belarus, 25 % of the sites had ammonium concentration above the national maximum permissible concentration (0.39 mg NH₄-N/l), but this level is quite high compared to EU Fish Directive recommended levels. 82 % of the sites were above the recommended BOD level for cyprinid fish.

In Moldova, 58 % and 42 % of the river sites belonged to the two highest classes for BOD and ammonium concentration, respectively. The highest average levels were found for sites in the Dniester RBMUs. Average levels of ammonium concentration were far higher here than in the other RBMUs, and 67 % of the sites in Moldova were above the EU Fish Directive recommendation for cyprinid fish. Across all river basins 47 % of the river sites were above the recommended level.

In Ukraine, 49 % of the river sites had BOD concentrations above 3 mg O₂/l. The average levels were by far the highest for sites in the Black Sea river basin, but an additional five river basins had average levels above 3 mg O₂/l. 69 % of the sites had current ammonium concentrations above the EU Fish Directive recommendation for cyprinid fish. The highest average concentrations were found in the Southern Bug, Black Sea and Vistula basins.

6.2 Nutrients in freshwater

Significant inputs of nitrogen and phosphorus to freshwater bodies from urban areas, industry and agricultural areas can lead to eutrophication, characterised by excessive algal growth, which may result in oxygen depletion. Eutrophication can cause ecological impacts such as the loss of plant and animal species (reduction in ecological status) and have negative impacts on the use of water for human consumption and other purposes. In this next section, the concentration of phosphate and total phosphorus is expressed in mg of P/litre, while the concentration of nitrate is expressed in mg of NO₃-N/litre in rivers and mg of NO₃-N/litre in groundwater.

6.2.1 Changes over time

The main sources of nutrients in Armenia are agriculture, waste water and storm water. There are only six water treatment plants in Armenia, with mechanical and no organic matter treatment. Nitrate pollution is mainly associated with agricultural run-off.

In Armenia, river nitrate concentrations increased by an average of 18 % between 2008-2017 (Figure 22). However, the increase was associated with sites downstream of settlements. Above settlements there was a slight decrease in nitrate concentrations. In contrast, there were similar levels of increased phosphate concentrations. The increase was about the same upstream and downstream of settlements for river phosphate concentration. Overall, the nitrate concentrations increased by 33 % between 2009-2017. This increase is much larger compared to 2008, but concentrations were particularly low that year. Increasing nitrate concentrations are the result of increased emissions from wastewater and agriculture. The River Hrazdan is one of the longest and most polluted rivers in Armenia and has very high phosphate concentrations, particularly at the nearest site downstream of Yerevan City. Removing this site from the overall average reduces the national phosphate concentration markedly. No such effect is seen for nitrate, indicating that waste water is the major contributor at this site.

In the Lake Sevan, average nitrate and phosphorus concentrations increased markedly between 2008-2012. This might be a consequence of an increase in the lake level, an attempt to restore the natural state of the lake (see Chapter 4.2); when water covered buildings, roads and forests on the lake shore led to increased nutrient pollution. Average total phosphorus concentrations in the lake also increased between 2013-2017. Diffuse runoff from agricultural land and untreated domestic waste water continues to be significant sources of phosphorus pollution. These pollution sources do not have a big impact on the rivers in the region, but they affect Lake Sevan due to direct discharges into the lake. Moreover, phosphorus stored in bed sediment can keep lake concentrations high and prevent improvement of the water quality through management measures.

In Azerbaijan, river data are available from 2001. A strong decrease in average river nitrate concentration occurred from 2005, and particularly from 2011 onwards, reaching very low average levels from 2014 onwards. The time series pattern was fairly similar between the different regions. For river phosphate concentration, the time series showed different patterns between regions. The concentrations in Gazakh-Ganja, and particularly in Shirvan, increased markedly between 2009-2011. A slower, but steady increase also occurred in the Guba-Khachmaz region. These patterns are reflected in the overall time series for the whole country, where the average phosphate concentration doubled between 2001-2011.

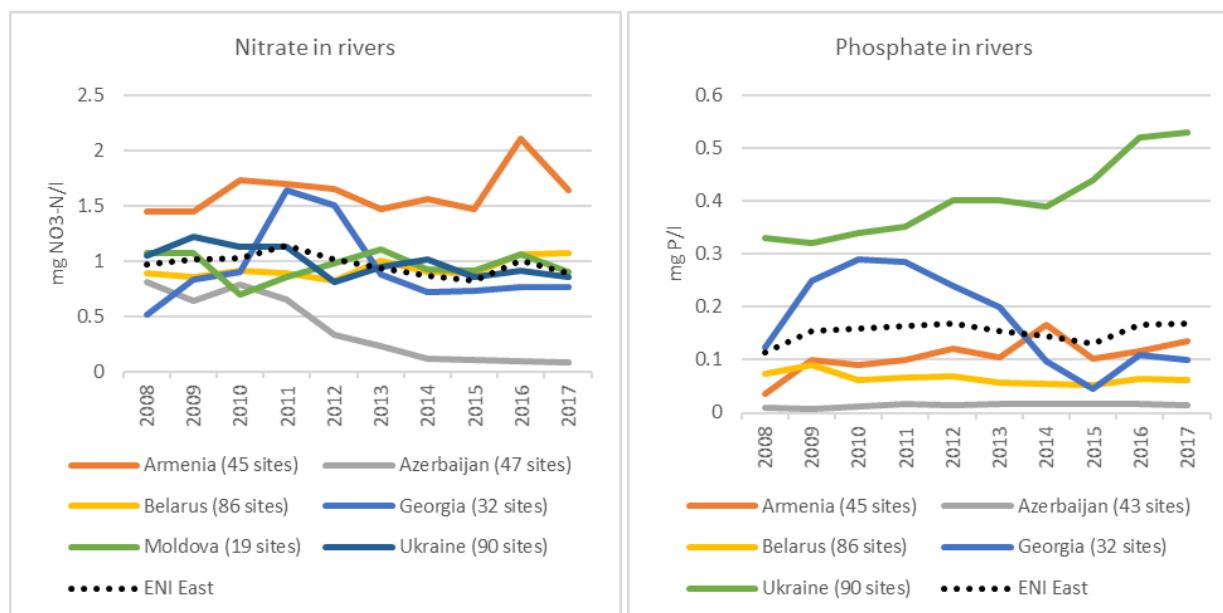


Figure 22: Average annual nitrate and phosphate concentration for river sites in the ENI East countries over the time period 2008-2017.

Data sources: Armenia: Environmental Monitoring and Information Center SNCO, Ministry of Nature Protection; Azerbaijan: National Environmental Monitoring Department of the Ministry of Ecology and Natural Resources; Belarus: National Environmental Monitoring System by the Ministry of Natural Resources and Environmental Protection; Georgia: National Environmental Agency of the Ministry of Environmental Protection and Agriculture; Environment Quality Monitoring Division of the State Hydrometeorological Service of the Ministry of Agriculture, Regional Development and Environment; Moldova: Ministry of Agriculture, Regional Development and Environment; Ukraine: Ministry of Ecology and Natural Resources.

Note: Only complete time series after inter/extrapolation are included.

Data from eight lakes and reservoirs in Azerbaijan shows an abrupt increase and subsequent decrease for both phosphate and nitrate concentrations, starting in 2009 and 2007, respectively. Despite the decrease, the current levels are far higher than at the beginning of the time series in 2001. The overall decrease in nitrate concentrations in rivers was not observed for lakes and reservoirs.

In Georgia, there was a marked increase in both phosphate and nitrate concentration between 2004-2017. These increases were associated with sites in the Kura RBMU, where on average, phosphate concentrations were more than three times higher at the end of the time series, whilst nitrate concentrations doubled. Data from 2011-2013 should be treated with some caution, due to lower numbers of samples taken each year. This can explain the higher concentrations observed in these years. The concentrations for sites in the Black Sea RBMU have been fairly stable, with a slight decrease observed for nitrate.

Lake data were available for Lake Paliastomi, located close to the coast in the west of Georgia. Here phosphate concentrations decreased sharply from 2005 and have been relatively stable since 2008. The nitrate concentrations have been highly variable, with the lowest values observed between 2012 and 2014.

The time series data from Belarus starts in 1986. Since then, there has been an increase in average nitrate concentrations. This is observed both for the country as a whole and in the different regions. In the last decade there has only been a slow increase in nitrate concentrations. The maximum concentrations for river phosphate occurred between 1988-1990. Concentrations were also high between 2003-2004. Over the past decade, there has been an increase in phosphate concentrations in the Western Dvina and Neman RBMUs, and a decrease in the Western Bug and Dnieper RBMUs, but the overall trend is a slight decrease.

Average lake total phosphorus concentration in Belarus was highest between 1988-1995 and 2003-2007. The highest concentrations were observed in the Pripyat RBMU. Over the past decade, the average total phosphorus concentration decreased in all RBMUs.

In Moldova, there was a general decrease in nitrate concentrations in rivers, barring a peak in 1998. The general decrease can be related to a decrease in agricultural activities. Data were available for three lakes/reservoirs in Moldova. Total phosphorus concentration showed a steady decrease in the two reservoirs (Dubăsari Centrala Hidroelectrică and Costești Centrala Hidroelectrică) between 1992-2017. However, for Lake Ghidighici in the Chișinău area there was a marked increase between 2005-2012, with a subsequent decrease back to original levels. The increase might be related to a larger input of untreated urban waste water and higher fertilisation rates in agricultural activities.

The river nitrate concentration in Ukraine in 2000 was at about the same level as is at present, but there was a marked decrease after 2000 and then an increase, peaking in 2009. River phosphate concentrations were lower around 2009 but have increased since then and are currently more than 0.1 mg P/l higher than in 2000. The increase in the concentration of phosphate may indicate a lack of waste water treatment and an increase in the use of phosphate-based detergents. There is some variation in concentration patterns between the different rivers. In the Prut and Dniester rivers, both nitrate and phosphate concentrations have been decreasing.

6.2.2 Current state

In Armenia, the current river nitrate concentration was in the range between 3.6-5.6 mg N/l at three sites and above 6 mg N/l at one site (Figure 24). These sites were found in the Hrazdan and Northern RBMUs which, along with the Akhuryan river basin, had the highest average nitrate concentrations (Figure 23: Average river nitrate and phosphate concentration for 2015-2017 by River Basin Management Unit.. About 36 % of the sites belonged to the lowest nitrate concentration class. For river phosphate, 40 % of the sites belonged to the upper three concentration classes. The average concentration was far higher in the Hrazdan and Akhuryan river basins. As seen for organic pollution, these river basins stand out with particularly high nutrient concentrations. These are the two most populated river basins with the two largest cities in the country, Yerevan and Gyumri. The waste waters of both cities discharge directly into the rivers due to lack of waste water treatment. Across all river basins, nutrient concentrations were generally higher downstream than upstream of settlements, due to emissions of waste water.

The four lake sites of Lake Sevan all had low nitrate concentrations. Additionally, the current total phosphorus concentration was relatively low (below 0.05 mg P/l), but if the increasing trend continues it may reach levels that can cause eutrophication.

Current phosphate and nitrate concentrations were generally low at river sites in Azerbaijan, and way below the national maximum allowable concentrations (1.1 mg P/l and 10 mg NO₃-N/l, respectively). The nitrate concentration was always below 0.2 mg NO₃-N/l. At 28 % of the sites (all in the Kura RBMU) phosphate concentrations were in the range 0.02-0.05 mg P/l. These sites should receive particular attention in terms of management measures to reduce nutrient pollution.

Low nitrate concentrations were also found in lakes and reservoirs, although concentrations were slightly higher than in rivers. Lake Shabran had nitrate concentrations above 0.8 mg NO₃-N/l, and only Ceyranbatan reservoir was below 0.2 mg NO₃-N/l. For phosphate, the difference between the sites was bigger, and three sites had current concentration above 0.1 mg P/l, which can be sufficient to cause eutrophication.

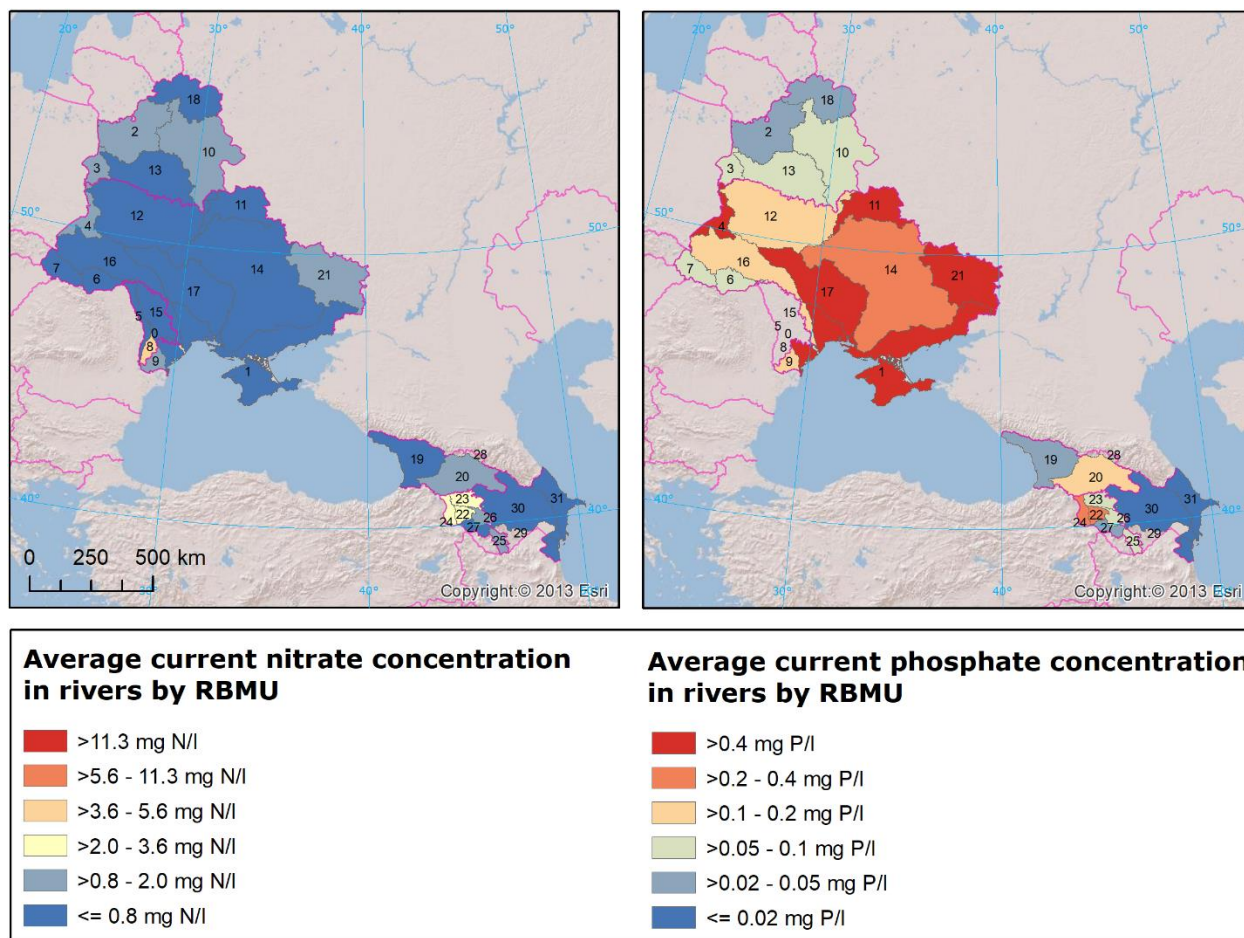


Figure 23: Average river nitrate and phosphate concentration for 2015-2017 by River Basin Management Unit.

Data sources: Armenia: Environmental Monitoring and Information Center SNCO, Ministry of Nature Protection; Azerbaijan: National Environmental Monitoring Department of the Ministry of Ecology and Natural Resources; Belarus: National Environmental Monitoring System by the Ministry of Natural Resources and Environmental Protection; Georgia: National Environmental Agency of the Ministry of Environmental Protection and Agriculture; Environment Quality Monitoring Division of the State Hydrometeorological Service of the Ministry of Agriculture, Regional Development and Environment; Moldova: Ministry of Agriculture, Regional Development and Environment; Ukraine: Ministry of Ecology and Natural Resources.

Note: RBMUs: 0 - Black Sea (MD), 1 - Black Sea (UA), 2 - Neman (BY), 3 - Western Bug (BY), 4 - Vistula (UA), 5 - Prut (MD), 6 - Prut (UA), 7 - Tisa (UA), 8 - Danube (MD), 9 - Danube (UA), 10 - Dnieper (BY), 11 - Desna (UA), 12 - Dnieper - upstream Kiev (UA), 13 - Pripjat (BY), 14 - Dnieper - downstream Kiev (UA), 15 - Dniester (MD), 16 - Dniester (UA), 17 - Southern Bug (UA), 18 - Western Dvina and Gulf of Finland (BY), 19 - Black Sea (GE), 20 - Kura (GE), 21 - Donets (UA), 22 - Hrazdan (AM), 23 - Northern (AM), 24 - Akhuryan (AM), 25 - Southern (AM), 26 - Sevan (AM), 27 - Ararat (AM), 28 - Terek (GE), 29 - Aras (AZ), 30 - Kura (AZ), 31 - Caspian Sea (AZ). No data are available for uncoloured RBMUs.

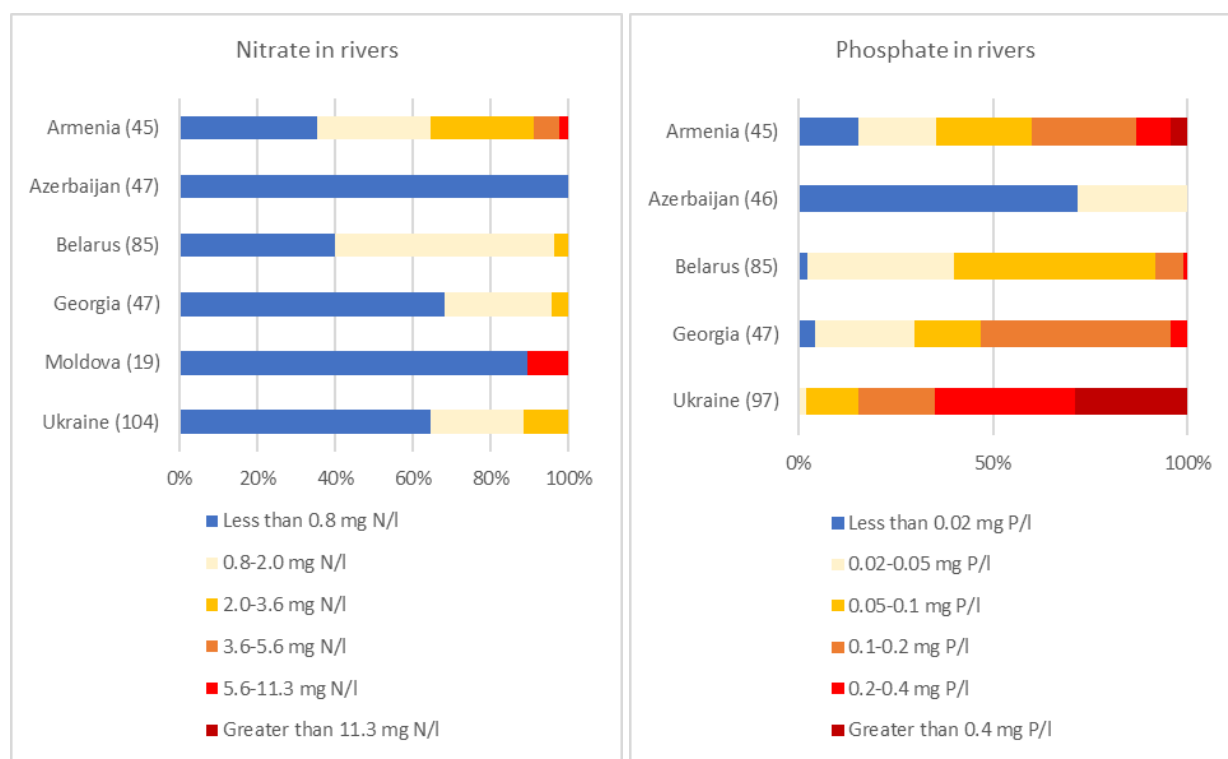


Figure 24: Distribution of river monitoring sites to nitrate (top) and phosphate (bottom) concentration classes in the ENI East countries, based on the average of annual mean concentrations for 2015-2017

Data sources: Armenia: Environmental Monitoring and Information Center SNCO, Ministry of Nature Protection; Azerbaijan: National Environmental Monitoring Department of the Ministry of Ecology and Natural Resources; Belarus: National Environmental Monitoring System by the Ministry of Natural Resources and Environmental Protection; Georgia: National Environmental Agency of the Ministry of Environmental Protection and Agriculture; Environment Quality Monitoring Division of the State Hydrometeorological Service of the Ministry of Agriculture, Regional Development and Environment; Moldova: Ministry of Agriculture, Regional Development and Environment; Ukraine: Ministry of Ecology and Natural Resources.

Note: The number of monitoring sites per country is given in parenthesis.

Most of the Georgian river sites were in the lowest nitrate concentration class (68 %), and there were no sites in the three highest classes. For phosphate, nearly half of the sites (49 %) had current concentrations between 0.1-0.2 mg P/l, and there were also two sites in the second highest class. The average phosphate concentration was highest in the Kura river basin, where 64 % of the sites were above 0.1 mg P/l. This is considered sufficiently high to cause eutrophication. Nitrate concentrations were high in the Kura river basin, but overall nitrate concentrations were relatively low. The current phosphate and nitrate concentrations never exceeded the national maximum permissible concentrations (10.2 mg NO₃-N/l for cyprinid waters, 9.0 mg NO₃-N/l for salmonid waters, and 1.1 mg P/l). These thresholds are, however, very high compared to EU standards, and do not necessarily reflect poor ecological conditions of the water bodies.

The current concentrations of nitrate and phosphate in Lake Paliastomi are low. According to available data for 2016-2017, the concentrations were generally low, and far below the national threshold (50 mg NO₃/l, in line with the EU Drinking Water Directive 98/83/EC). All but one monitoring site had an average concentration below 10 mg NO₃/l.

In Belarus, all the river sites were in the low nutrient concentration classes. The highest average concentrations were found in the Dnieper and Neman river basins. Also for phosphate, the vast majority of river sites were in the three lowest classes. The sites with concentrations above 0.1 mg P/l were found in the Dnieper, Pripyat, Neman and Western Bug river basins. The highest average phosphate concentration was in the Western Bug. Overall, the current phosphate concentration exceeded the national maximum permissible concentration (0.066 mg P/l) at 38 % of the sites. Current total phosphorus concentrations above 0.1 mg P/l were only observed for seven lakes. High phosphorus concentrations can in some cases be related to direct discharges of waste water into lakes.

In Moldova, all but two river sites were in the lowest nitrate concentration class. The two sites with higher concentration (5.9 and 6.7 mg NO₃-N/l) were both in the Danube RBMU. Moldova did not provide phosphate data for rivers, but the total phosphorus data show that the situation is worse than for nitrate. More than half (58 %) of sites had total phosphorus concentrations above 0.1 mg P/l, and out of these three were above 0.4 mg P/l.

The three lakes/reservoirs in Moldova all belong to the lowest nitrate concentration class. Lake Ghidighici had the highest current total phosphorus concentration (0.19 mg P/l). The two reservoirs were both below 0.1 mg P/l.

In Ukraine the majority (64 %) of river sites were in the lowest concentration class for nitrate, and there were no sites in the three highest concentration classes. The highest average concentration was found in the Danube, Donets and Vistula river basin in Ukraine. River phosphate concentrations were generally high, with 85 % of the sites in the three highest classes, including 28 sites with concentrations higher than 0.4 mg P/l. The Donets river basin had the highest average concentration, with all sites in the highest concentration class. However, all river basins except the Prut and the Tisa had average concentration above 0.1 mg P/l.

7 Outlook

As water is a cross-cutting focus across natural environment, socio-economic development and public health and wellbeing concerns, water resources management can't be undertaken in isolation. Implementing appropriate measures, either to ensure the sustainability of water resources and water dependent ecosystems or to secure the water supplies which society and the economy depend on, water management requires the involvement of numerous stakeholders. As underlined by the OECD (OECD and UNECE, 2014), sectoral competition for water in Eastern Partnership countries is already intensifying as water demands grow over time. These trends require urgent actions to be taken in various domains of water resources management, including changes in legal framework, better integration of institutions, introduction of strategic planning, increased financing, and development of human resources. The importance of using available data and information to support knowledge-based policy making should be underlined. A key process is sharing available data and information among national water agencies, as well as with external stakeholders, along with integrating all data relevant to water resources management. This will help provide a robust baseline for developing water-focused environmental policies, not only at the national level, but also at the regional level – an essential process in improving cooperation among the transboundary river basins.

The experiences already available from the implementation of the EU Water Framework Directive (WFD), as well as data harmonisation and sharing under the EIONET voluntary dataflow, will bring tremendous inputs into the national and regional processes of data exchange in the Eastern Partnership countries.

7.1 Needs for integrated water resources management

EU water legislation places the river basin management approach at the core of water management policy. Countries draft River Basin Management Plans (RBMPs) in line with WFD, either for selected rivers or for the whole country, many with international support. For example, Belarus and Ukraine prepared the Upper Dnieper River Basin Draft River Management Plan with the support of the European Union and EPIRB Environmental Protection of International River Basins (Koszta et al., 2016). With the EPIRB project support and that of the European Union Water Initiative Plus for the Eastern Partnership (EUWI+, 2019), ENI East countries are improving knowledge and skills for development of elements of RBMPs. These include: water body delineation and typology, classification of status of water bodies based on available data, identification of data and information gaps to improve monitoring, identification of pressures and development of programs of measures, public involvement, and awareness raising activities. The main beneficiaries of these projects are the environment ministries, which gives hope that ENI East countries will soon start establishing management plans themselves.

However, there are still a number of important institutional and managerial challenges for countries to face. Specifically, attention should be given to the establishment of river basin councils, the development of models and practices of public involvement, and the production of credible data. The

challenges still ahead include: the development of a positive attitude towards data sharing; the need to assess the environmental status of water resources; and to identify key pressures on the waters.

As water management is cross-sectoral, countries set up various water related agencies to deal with different aspects of managing water at the local and national level. However, in many cases, data and information exchange among the respective water agencies either remains insufficient to inform decision-making, or is hampered by a reluctance to share the agencies' 'own data' with other agencies. Even where agencies are willing to participate in data exchange, it is common for monitoring systems to be incompatible, or the data formats not comparable among the water agencies.

In order to bring together experiences from the EIONET and WFD implementation in the EU, the ENI SEIS II East project has initiated water quality data harmonisation in Eastern Europe and the Caucasus. In addition, the project supported the development of pilot water information systems in Armenia, Azerbaijan and Georgia to enable a common platform among the water agencies where they can share the harmonised water data.

Nevertheless, much remains to be developed in the near future in terms of data collection, harmonisation and integration to support the implementation of integrated water resources management in the region. In many cases, measures for the implementation of integrated water resources management requires actions at the basin level rather than national level. Hence, integrating statistical and spatial data is becoming very crucial for countries in the region.

7.2 Future works

There are numerous environmental protection and natural resources management projects running at the national and regional levels, many of them funded by international organisations and communities such as European Union, OECD, UNECE, World Bank GEF etc. Sustainability of the activities and ownership of products made under the projects remain a serious concern for the further improvement of data collection, knowledge creation and underpinning knowledge-based policymaking.

Even if data and information are available, a lack of capacity often creates a bottleneck in supporting policy makers. To overcome this issue, we propose to develop targeted data collection, data harmonisation and integrated assessment of the water resources in the region. Development of such data and information system presents tremendous potential in the Eastern Partnership countries.

The United Nations System for Environmental and Economic Accounting Central Framework (EC et al., 2013) integrates economic and environmental data to provide a comprehensive view of the interrelationships between the economy and the environment, and the stocks of environmental assets, as they bring benefits to humanity. It contains internationally agreed standard concepts, definitions, classifications, accounting rules and tables for producing internationally comparable statistics and accounts. It is a formally recognised statistical standard by the UN Member countries. As there is a clear

relationship between data collection, water accounts and indicator (information) development (Figure 25: Indicator pyramid and its relationship with water accounting development through SEEA. Adapted from Mazza et al. (2013).), the development of water accounts will support the six countries in designing their monitoring programs, the organisation of their databases, as well as streamlining and developing their indicators.

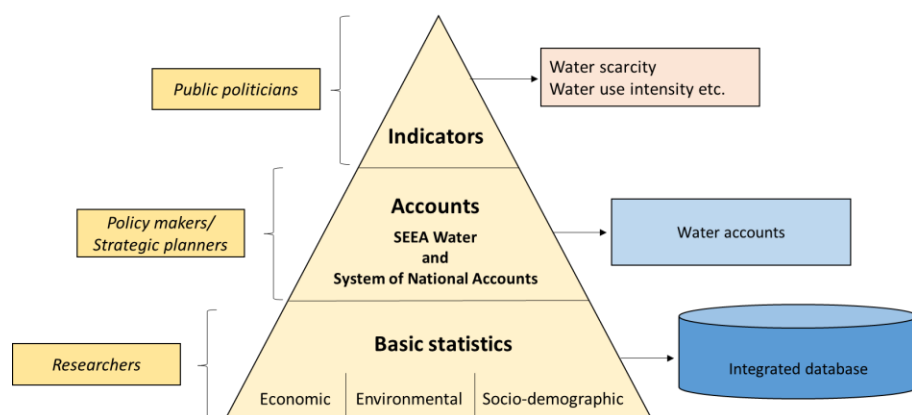


Figure 25: Indicator pyramid and its relationship with water accounting development through SEEA. Adapted from Mazza et al. (2013).

Based on the experiences from the pilot studies in Belarus and Azerbaijan under the ENI SEIS II East project, the outputs of water accounting using SEEA methodology give a strong basis for decision-makers to develop water resources management measures around issues such as water allocation and the identification of areas for urgent measures.

7.2.1 Institutional cooperation and capacity building

While a good knowledge capacity already exists in terms of water resource issues, the majority of water management institutions would benefit from investing in data processing capacity to treat their own datasets. This would provide the basis for effective data standardisation and increase the possibility of data sharing among institutions. In addition to technical capacity, legal support (especially in terms of data sharing protocols) is needed for facilitated sharing.

While the ENI SEIS II East project has offered support in terms of developing technical infrastructure at the national level⁶, this can only be fully effective once institutions are able to provide good-quality data inputs to the portals, and the institutional content experts are able to communicate their technical

⁶ Web based water information systems are developed in Armenia, Azerbaijan and Georgia as other products of the ENI SEIS II East project.

needs to the information technology support staff. It is thus advised that there is further capacity-building, especially in terms of developing chains of cooperating experts.

While the manual handling of data by content experts without advanced IT application is currently feasible, there is significant potential in further developing of the assets through:

1. Common understanding of the benefits of dedicated data management support in all phases of dataflow (collection, storage, processing, assessment, publishing) by **all involved national institutions**; this would be followed by policy decisions towards centralisation of infrastructure.
2. Employment and development of dedicated **data management experts**; rather than outsourcing production of web portals, the dedicated data management experts would be an important link between IT developers and water topic content experts; based in respective institutions, they would be able to support all phases of the dataflow.

In addition to purely technical expertise, understanding the knowledge-building potential of the rich datasets available at the institutions would make way for various derived products, such as more detailed environmental indicators, spatial analyses, and environmental data integration and mining.

7.2.2 Development of water information systems

In addition to the technical capacities that have been developed by the national institutions with support by ENI SEIS II East project, further growth of infrastructure such as information system software according to the best-available standards is advised.

Water information systems deployed in 2020 in Armenia, Azerbaijan and Georgia are offering the cooperating institutions the following functionality:

- Data dictionary and harmonised water quality dataset, which enables dataset comparability between different institutions;
- SQL database, data processing protocols and procedures for water quality indicator production;
- Web portal, which enables data and information presentation through text blocks, dynamic and interactive charts, and GIS visualisations.

Effective use of the established information systems depends on two key processes. These should be followed and reviewed after the systems have been in place for some time, with all involved stakeholders able to use them.

The first process is to enhance staff expertise in using the information systems. It is an ultimate goal of capacity building to establish a functioning team of both water content and IT experts working in synergy, and who are able to successfully communicate regarding issues and requests. The institutional working processes that use the information system should be well-established, documented on a centralised platform, and repeatable.

The second process is that technical features of the portal should be reviewed for their efficiency and upgraded where needed. While the information systems were built in a way to be easily upgraded, the focus of further technical development should be on the following:

- Deployment of different databases containing water data, thus centralising national datasets and facilitating their sharing; this would also decrease the need for many data managers in individual institutions, which are largely not present now.
- Establishment of data management procedures; this includes repeatable processes of data collection, QA/QC, storage, dataset assessment, and production of dissemination products (charts, maps, etc.); currently, only the basic data management procedures are in place, but serve as a starting point to develop further processes.
- Development of further environmental indicators, potentially expanding beyond the topic of water; these environmental indicators should be based on clearly defined data analysis processes;
- Collecting and managing spatial datasets, enabling spatial analysis and presentation of data on interactive maps; currently, only basic spatial presentation is available on the existing information systems.

7.2.3 Monitoring programs, data and information exchange among water agencies

Water monitoring systems are mostly implemented as a state service, divided into regional divisions in the areas of hydrometeorology (water quantity), geology (groundwater), hydrochemistry (water quality), hydrobiology (ecology) and public health (drinking water). All countries have monitoring programs on water resources and water use, however, the usability of that data in policy making needs further interpretation as the data is mostly collected and managed in a very fragmented manner among several governmental services and agencies. This often creates bottlenecks in compilation and organisation of water quantity data, for example, in developing water asset and flow accounts with the aim of identifying water availability and sectoral pressure on water resources (Globevnik et al., 2018).

In all countries, data on existing water resources and water use is annually reported to state statistical offices. They publish (bi)monthly bulletins and annual statistical books. As regards water quality, they inform on exceedance of limit values, but do not deal with integrated status assessments and trends over long periods. Overall, water policy recommendations are missing.

Water state services and agencies in the six countries are generally very reluctant to share their data and information on different domains of water management, which inhibits comprehensive integrated assessments at national or regional levels. Staff turnover, combined with frequent reorganisations in the water agencies or respective ministries, cause the loss of ‘institutional memory’ and lower capacities of the water agencies to be effective. For instance, the Republic of Moldova reorganised its Ministry of Environment three times between 2017-2019. Similarly, Georgia changed the structure of its Ministry of Environment twice in the same period.

Efforts under the implementation of the ENI SEIS II East project aimed to partly overcome the problems of data and information availability and harmonisation at the regional level by means of developing water indicators with the methodology of the EEA, as already implemented in the EEA Member countries. In addition, the project supported the development of water information systems in three Caucasus countries by replicating the overall structure and philosophy of the Water Information System of Europe.

Similarly, a set of UNECE water indicators, C1-C5 and C10-C11, that has been used as the main inputs to the development of this report, has been developed jointly with the national experts by following the EEA indicators template. The overall purpose of this work was to build the capacity at the national and regional level in using available water data to support knowledge-based policy making.

The ENI SEIS II East project also put emphasis on standardising and sharing the datasets needed for indicator composition. Further maintenance and sustainability of similar datasets should be ensured as of the ENI SEIS II project. This includes mobilisation of water data experts who deal with knowledge-building and environmental assessment; and IT experts who offer technical support in data processing, dissemination and sharing.

Reference List

- Asian Development Bank, 2005, *Country Environmental Analysis—Azerbaijan*, Manila, Philippines (<https://www.adb.org/sites/default/files/institutional-document/32178/aze-cea.pdf>) accessed 31 March 2020.
- Brown, A. and Matlock, M., 2011, *A Review of Water Scarcity Indices and Methodologies*, Arkansas, USA (<https://www.sustainabilityconsortium.org/tsc-downloads/a-review-of-water-scarcity-indices-and-methodologies/>) accessed 31 March 2020.
- Council of Ministers of the Republic of Belarus, 2016, 'State programme "Comfort accommodations and an enabling environment for 2016-2020"' (<http://www.government.by/upload/docs/file8c3586a94739667b.PDF>) accessed 21 April 2020.
- EBRD, 2016, 'Yerevan Water Supply Improvement Project', European Bank for Reconstruction and Development (<http://www.ebrd.com/work-with-us/procurement/p-pn-160104c.html>) accessed 31 March 2020.
- EC, 2006, Council Directive 2006/44/EC of the European Parliament and of the Council of 6 September 2006 on the quality of fresh waters needing protection or improvement in order to support fish life (OJ L 264, 25.9.2006, pp. 20–31).
- EC, et al., 2013, *System of environmental-economic accounting 2012: experimental ecosystem accounting — white cover publication*, European Commission, Luxembourg (http://unstats.un.org/unsd/envaccounting/eea_white_cover.pdf) accessed 31 March 2020.
- EEA, 2011, *Europe's environment: an assessment of assessments*, EEA Report, European Environment Agency, Copenhagen (<https://www.eea.europa.eu/publications/europes-environment-aoa>).
- EEA, 2012a, 'European catchments and Rivers network system (Ecrins)', European Environment Agency (<https://www.eea.europa.eu/data-and-maps/data/european-catchments-and-rivers-network>) accessed 31 March 2020.
- EEA, 2012b, 'Water for agriculture', European Environment Agency (<https://www.eea.europa.eu/articles/water-for-agriculture>) accessed 31 March 2020.
- EUWI+, 2019, 'EU Water Initiative Plus for Eastern Countries', EUWIPLUSEAST (<https://euwipluseast.eu/en/>) accessed 31 March 2020.
- Falkenmark, M., et al., 1989, 'Macro-scale water scarcity requires micro-scale approaches', *Natural Resources Forum* 13(4), pp. 258-267 (DOI: 10.1111/j.1477-8947.1989.tb00348.x).
- FAO, 2009, *Transboundary River Basin Overview – Kura*, Rome, Italy (<http://www.fao.org/publications/card/en/c/CA2130EN/>) accessed 5 February 2020.

- FAO, 2019, 'AQUASTAT database Glossary Search' (<http://www.fao.org/nr/water/aquastat/data/glossary/search.html>) accessed 31 March 2020.
- Globevnik, L., et al., 2018, *Support for the implementation of the ENI-SEIS East 2017-2018 regional and country work plans in the thematic area of water*, ETC/ICM, Leipzig, Germany.
- Howard, G., et al., 2003, *Domestic water quantity, service level and health*, No WHO/SDE/WSH/03.02, World Health Organization, Geneva, Switzerland (<https://apps.who.int/iris/handle/10665/67884>) accessed 31 March 2020.
- Israfilov, R., et al., 2014, 'Groundwater exploitation and its impact on the environment in Azerbaijan', *Seismoprognozis observations in the territory of Azerbaijan* 11(1), pp. 51-55.
- Kosztka, I., et al., 2016, *Upper Dnieper River Basin: Draft management plan*, EPIRB, Kyiv, Ukraine (<http://www.rec.org/publication.php?id=553>) accessed 31 March 2020.
- OECD, ed., 2011, *Meeting the challenge of financing water and sanitation: tools and approaches*, OECD, Paris, France.
- OECD and UNECE, 2014, *Integrated Water Resources Management in Eastern Europe, the Caucasus and Central Asia - European Union Water Initiative National Policy Dialogues progress report 2013*, UNECE, New York (USA) and Geneva (Switzerland) (http://www.unece.org/fileadmin/DAM/env/water/publications/NPD_IWRM_study/ECE_MP.WAT_44_en.pdf) accessed 2 February 2020.
- Raskin, P., et al., 1997, 'Comprehensive assessment of the freshwater resources of the world. Document prepared for the fifth session of the United Nations Commission on Sustainable Development, 1997', Stockholm Environmental Institute, Sweden (<https://www.sei.org/mediamanager/documents/Publications/SEI-Report-WaterFutures-AssessmentOfLongRangePatternsAndProblems-1997.pdf>).
- REC Caucasus, 2011, *Europe's Environment. Caucasus - An Assessment of Assessments*, The Regional Environmental Centre for Caucasus, Tbilisi, Georgia (<http://rec-caucasus.org/storage/uploads/files/1557346709.pdf>).
- Republic of Moldova, 2011, Law of the Republic of Moldova of December 23, 2011 No. 272 'About water' (272).
- Salvetti, G. and Giovanna, M., 2015, *Water and wastewater services in the Danube region : Moldova country note*, No Report 97245, The World Bank (<http://documents.worldbank.org/curated/en/262431468190744899/Water-and-wastewater-services-in-the-Danube-region-Moldova-country-note>) accessed 1 April 2020.
- Sertyeşilişik, E., 2017, 'AZERBAIJAN IN SU KAYNAKLARININ EKONOMİ POLİTİĞİ', *Journal of International Social Research* 10(54), pp. 365-371 (DOI: 10.17719/jisr.20175434601).
- Statistical Committee of the Republic of Armenia, 2020a, 'ArmStatBank', ArmStatBank (<https://armstatbank.am/pxweb/en/ArmStatBank/?rxid=602c2fcf-531f-4ed9-b9ad-42a1c546a1b6,602c2fcf-531f-4ed9-b9ad-42a1c546a1b6>) accessed 31 March 2020.

Statistical Committee of the Republic of Armenia, 2020b, *Statistical Committee of the Republic of Armenia ArmStatBank Database*, Database, Statistical Committee of the Republic of Armenia (<https://armstatbank.am/pxweb/en/ArmStatBank/?rxid=0947bacc-9878-4ef6-8215-3cf37ba4abf2>) accessed 21 April 2020.

Strosser, P., et al., 2017, *raskin*, OECD Environment Working Papers No No. 114, Organisation for Economic Co-operation and Development, Paris, France (https://www.oecd-ilibrary.org/environment/the-potential-benefits-of-transboundary-co-operation-in-georgia-and-azerbaijan_a14da8ec-en) accessed 19 April 2020.

Taslakyan, L., 2014, 'Transboundary Management of the Kura-Araks River Basin', Dundee, UK, 2014.

The State Statistical Committee of the Republic of Azerbaijan, 2019, 'Environment Protection', The State Statistical Committee of the Republic of Azerbaijan (<https://www.stat.gov.az/source/environment/?lang=en>) accessed 31 March 2020.

The World Bank, 2020, 'The World Bank Database on gross domestic products of the Republic of Moldova', Moldova (<https://data.worldbank.org/country/moldova>) accessed 1 March 2020.

UN, ed., 2007, *Our waters: joining hands across borders: first assessment of transboundary rivers, lakes and groundwaters*, United Nations, New York.

UN, 2010, Resolution adopted by the General Assembly on 28 July 2010. 64/292. The human right to water and sanitation (A/RES/64/292).

UNECE, ed., 2000a, *1st Environmental Performance Review of Armenia*, United Nations, New York.

UNECE, ed., 2000b, *Environmental performance reviews: second review. Armenia*, UNECE, New York.

UNECE, ed., 2005, *Republic of Moldova: environmental performance reviews: second review*, United Nations, New York.

UNECE, 2007a, 'Environmental monitoring: Guidelines for the application of environmental indicators in eastern Europe, Caucasus and Central Asia', UNECE (<https://www.unece.org/fileadmin/DAM/env/europe/monitoring/Belgrade/CRP1.Indicators.En%20edited.MK..pdf>) accessed 23 April 2020.

UNECE, ed., 2007b, *Environmental performance reviews: second review. Ukraine*, United Nations, New York.

UNECE, 2007c, 'Guidelines for the preparation of indicator-based environment', UNECE (<https://www.unece.org/fileadmin/DAM/env/europe/monitoring/Belgrade/CRP2.Assessment.En%20edited.MK.pdf>) accessed 31 March 2020.

UNECE, 2011a, 'Astana Water Action, Note by the Chair of the Bureau of the Convention on the Protection and Use of Transboundary Watercourses and International Lakes', UNECE (<https://www.unece.org/fileadmin/DAM/env/documents/2011/ece/ece.astana.conf.2011.5.e.pdf>) accessed 20 April 2020.

UNECE, 2011b, *Environmental performance reviews: second review. Azerbaijan*, UNECE, Geneva, Switzerland.

UNECE, ed., 2011c, *Second assessment of transboundary rivers, lakes and groundwaters*, United Nations, Geneva, Switzerland.

UNECE, 2011d, *Seventh "Environment for Europe" Ministerial Conference*, UNECE, Astana, Kazakhstan (<https://www.unece.org/fileadmin/DAM/env/documents/2011/ece/ece.astana.conf.2011.2.e.pdf>) accessed 5 February 2020.

UNECE, 2012a, 'Guidelines for Developing National Strategies to Use Air and Water Quality Monitoring as Environmental Policy Tools Eastern Europe, the Caucasus, Central Asia and South-Eastern Europe', UNECE (http://www.unece.org/fileadmin/DAM/env/europe/monitoring/Publications/Air_and_Water_Quality_Monitoring/documents/ECE-CEP-168-EN_for_DNS_CLEAN.pdf) accessed 23 April 2020.

UNECE, 2012b, 'The Treaty between the Government of the Republic of Moldova and the Cabinet of Ministers of Ukraine on Cooperation in the Field of Protection and Sustainable Development of the Dniester River Basin', United Nations (https://www.unece.org/fileadmin/DAM/env/water/activities/Dniester/Dniester-treaty-final-EN-29Nov2012_web.pdf) accessed 2 February 2020.

UNECE, ed., 2014a, *Environmental performance reviews: third review. Republic of Moldova*, United Nations, New York.

UNECE, ed., 2014b, *Environmental performance reviews: third review. Republic of Moldova*, United Nations, New York.

UNECE, ed., 2016a, *Environmental Performance Reviews- Belarus*, United Nations, New York Geneva.

UNECE, ed., 2016b, *Environmental performance reviews: third review. Belarus*, United Nations, New York, USA.

UNECE, ed., 2016c, *Environmental performance reviews: third review. Georgia*, United Nations, New York, USA.

UNECE, ed., 2016d, *Environmental performance reviews: third review. Georgia*, Geneva : United Nations, New York.

UNECE, 2020a, 'Environmental Monitoring and Assessment', Environmental Monitoring and Assessment (<https://www.unece.org/environmental-policy/environmental-monitoring-and-assessment/envema.html>) accessed 5 March 2020.

UNECE, 2020b, 'Guidelines for the Application of Environmental Indicators', Guidelines for the Application of Environmental Indicators (<https://www.unece.org/env/indicators.html>) accessed 23 February 2020.

UNECE, 2020c, 'Supporting countries to achieve the SDGs', Supporting countries to achieve the SDGs (<https://www.unece.org/info/about-unece/mission/unece-and-the-sdgs.html>) accessed 1 April 2020.

UNECE, 2020d, 'Targets set by Parties', Protocol on water and health - Targets set by parties (https://www.unece.org/env/water/pwh_targets_set.html) accessed 5 January 2020.

UNHLPF, 2020, 'High-level Political Forum: Sustainable Development Knowledge Platform' (<https://sustainabledevelopment.un.org/hlpf>) accessed 31 March 2020.

Vystavna, Y., et al., 2018, 'Water laws of Georgia, Moldova and Ukraine: current problems and integration with EU legislation', *Water International* 43(3), pp. 424-435 (DOI: 10.1080/02508060.2018.1447897).

WHO, 2015, *Sanitation, drinking-water and hygiene status overview. Country Highlights - Georgia*, No WHO/FWC/WSH/15.54, Geneva, Switzerland (https://www.who.int/water_sanitation_health/monitoring/investments/georgia-11-nov.pdf?ua=1).

Winston, H., et al., 2015, *Toward integrated water resources management in Armenia*, The World Bank Group, Washington, USA.

World Bank, 2017, *Republic of Armenia - Support to Armenia's Second Generation Water PPPs*, No ACS22367, World Bank, Washington, USA (<https://ppiaf.org/documents/5694/download?otp=b3RwIzE1NzIxMTkzOTA=>).

Yildiz, D., 2017, *Transboundary Rivers and Water Diplomacy in the South Caucasus*, No 10, Hydropolitics Association, Ankara, Turkey (<https://www.hidropolitikakademi.org/uploads/wp/2017/05/aa-min.pdf>).

Zedginidze, G., et al., 2013, *Georgia – national water policy dialogue on integrated water resources management; results and lessons learnt from Georgian National Policy Dialogue on Integrated Water Resources Management under European Union Water Initiative*, UNECE and OECD, Tbilisi, Georgia (https://www.unece.org/fileadmin/DAM/env/water/publications/NPD_Publication_2013/ge_policy_brief_en_final.pdf).