THE **KURA** BOX

Learning Toolkit

This learning toolkit was developed in the framework of the UNDP-GEF project "Advancing Integrated Water Resource Management (IWRM) across the Kura river basin through implementation of the transboundary agreed actions and national plans". It aims to provide a better understanding of the current state of water resources in the Kura river basin. It examines links between human activities and environmental degradation in the basin, as well as potential impacts of such global threats as climate change and disasters on water resources of the Kura river basin. The publication also includes interesting facts about water resources, related ecosystems and provides additional information about some environmental concepts. The toolkit is applicable as an additional source of information for the schoolteachers, students and everyone else who uses water.

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TABLE OF CONTENTS

ABBREVIATIONS:

CBD	Convention on Biological Diversity
CI	Conservation International
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GHG	Greenhouse Gases
HPP	Hydro-Power Plant
HPS	Hydro-Power Station
IPCC	Intergovernmental Panel on Climate Change
RBMP	River Basin Management Plan
MCM	Million Cubic Meter
SDG	Sustainable Development Goals
UN	United Nations
UNDP	United Nations Development Programme
UN Environment	United Nations Environmental Programme
UNESCO	United Nations Educational Scientific and Cultural Organization
UNFCC C	United Nations Framework Convention on Climate Change
UNISDR	United Nations Office for Disaster Risk Reduction
WWDR	World Water Development Report
WWF	World-Wide Fund for Nature (formerly World Wildlife Fund)

GLOSSARY OF COMMONLY USED TERMS[1]

Adaptation to Climate Change: actions that help communities and ecosystems to cope with changing climate conditions.

Biodiversity: the variety of life found in a place on Earth or, often, the total variety of life on Earth.

Climate: the pattern of weather in a particular place.

Climate Change: a long-term change in the Earth's climate (weather patterns) due to the rise of the air temperature.

Contamination: introduction into or onto water, air and soil chemicals, toxic substances, waste, wastewater or other pollutants in a concentration that makes them unfit for their intended use.

Deforestation: alteration of forested land to non-forested land caused by human activity.

Desertification: transformation of land into arid, semi-arid and dry sub-humid areas. Degradation can result from various factors, including climatic variations and human activities.

Disaster Risk: the potential loss of life, injury, or destroyed or damaged assets, which could occur as result of hazard.

Ecosystem: dynamic complex of plant, animal, microorganism communities and their non-living environment interacting as a functional unit.

Ecosystem services: processes and functions provided by natural ecosystems that sustain life and are critical to human welfare.

Endemic species: species that are native to a specific geographic area species.

Erosion: the process of loosening and displacement of soil (Earth's crust) by natural forces (wind, water or glacial ice). In agriculture, soil erosion refers to the wearing away topsoil by the physical forces of water (e.g. through irrigation) and wind. Farming activities such as tillage also contributes to erosion.

Exposure to natural hazards: the people, property, systems, or other elements present in hazard zones that are thereby subject to potential losses.

Extreme weather events: unexpected, unusual, unpredictable, severe or unseasonal weather. In recent years many extreme weather events have been attributed to global warming.

Global Warming: gradual increase of the air temperature caused by the greenhouse effect, which is induced by emission of greenhouse gases into the air.

Habitat: a place or type of the site where an organism or population naturally occurs.

Heatwave: a period of excessively hot weather.

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[1] Sources: definitions are adopted from the Glossary of Terms UNEP, 2007, Glossary of European Environmental Agency and the UNISDR (see references).

Hotspot: 1) area particularly rich in total numbers of species; or 2) area of especially high concentrations of pollutants.

Flood: an unusual accumulation of water above the ground caused by high tide, heavy rain, melting snow or rapid runoff from paved areas.

Flood Control: measures taken to prevent or reduce harm caused by floods. It often involves the construction of reservoirs and channeling structures.

Flash Floods: floods caused by sudden heavy rainfall or a broken dam. In a flash flood a completely dry riverbed can fill in minutes. Flash floods often occur in hilly country or around dry riverbeds.

Irrigation: application of controlled amounts of water to plants at needed intervals.

Mitigation of climate change: actions to cut net emissions of greenhouse gases and reduce climate change.

Monitoring of water: studies conducted to estimate the quantity and the quality of pollutants, nutrients and suspended solids contained in water bodies and to assess sources and factors associated with agricultural practices, industrial activities or other human activities.

Natural hazards: naturally occurring event that may have negative effect on humans. If natural hazard causes loss of life, injury or other health impacts, property damage, loss of livelihoods, social and economic disruption, or environmental damage than it is referred to as natural disaster. Not all natural hazards lead to a disaster.

Nature Stewardship: responsible use and protection of the natural **environment through conservation and sustainable** practices.

Renewable resource: resource **which** can be used repeatedly and replaced naturally. Examples include oxygen, fresh water, solar energy and biomass.

Wastewater treatment: treatment of wastewater in order to reduce pollutants before being discharged to the environment.

Water stress: water stress occurs when demand for water exceeds the available amount during a certain period or when poor quality restricts its use.

Water abstraction/withdrawal: pumping of water for different purposes.

Stakeholder: an institution, organization, or group that has some interest in a particular sector or system.

Sustainable Development: development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Pollution of water: any change or modification in the physical, chemical and biological properties of water that will have a detrimental consequence on living organisms.

Vulnerability: the degree to which a community, population, species, ecosystem, region, agricultural and other systems are susceptible to, or unable to cope with, adverse effects of climate change or disasters.

1

INTRODUCTION

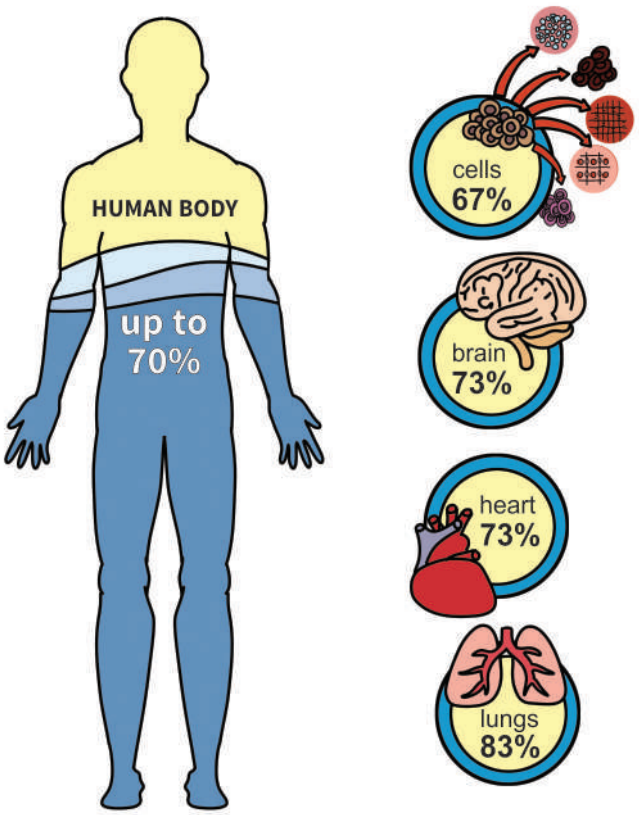
INTRODUCTION

There are only few essential substances on Earth without which the life, as we know it, would not exist. Water is one of such substances. While we humans can survive without food up to 3 weeks, we can hardly last longer than 3 days without a single drop of water. Water is the main driving force of all life-sustaining processes that take place in human body or other living organisms, be it a respiration, or a regulation of internal body temperature or a reproduction of cells.

Humans also need water to stay healthy - to practice personal hygiene and for recreational purposes. For thousands of years humans have been using water to grow food, harness energy and manufacture products. As technology advanced, humans found more efficient ways to utilize water but it is still used for the very same purposes as before – to produce food and goods[1], generate energy and sustain health.

Quick Facts: : How much water is in a human body

A body of an adult human contains up to 70% of water. 2/3 of this water is stored in cells and 1/3 surrounds cells from outside as fluids, for example as plasma in blood, cerebrospinal fluid in brain and spinal cord, saliva in mouth, etc. The brain and heart are composed of 73% water, and the lungs are about 83% water.



[1] Goods are products, for example computer, mobile, hamburger or soft drinks.

Our ancestors knew less about the science but the knowledge they have gained through observation and practice allowed them to build a comprehensive understanding of inter-linkages between water and surrounding environment. This knowledge defined traditions and customs of nature and water stewardship. *"Do not harm"* was the main guiding principle of the behavior of our ancestors in relation to nature, including water resources (see box 1 for examples).

BOX 1: Novruz Bayrami

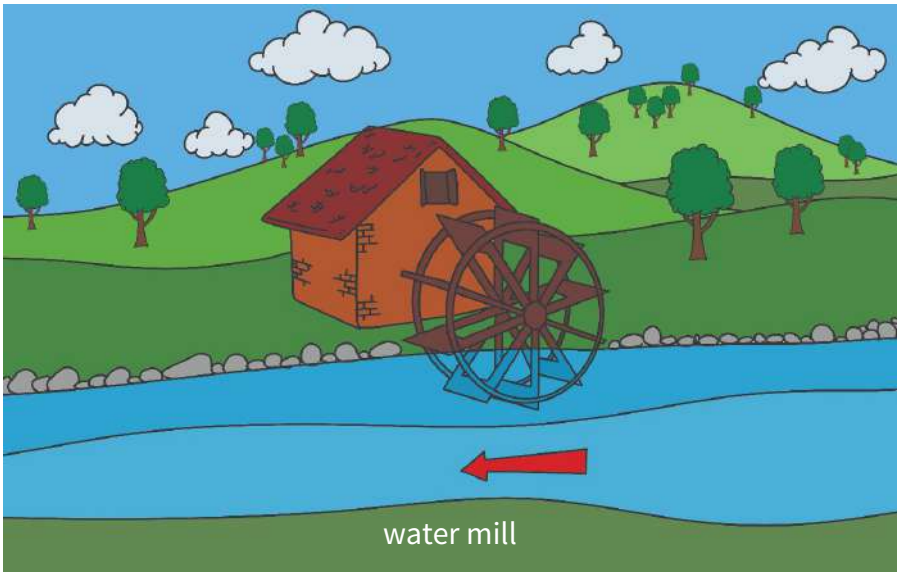
Novruz Bayrami is a traditional holiday in Azerbaijan that celebrates the beginning of spring. It begins one month prior to the main celebration day. Each of the forthcoming 4 weeks is devoted to one of the four elements of the universe - water, fire, earth and wind. Each Tuesday people celebrate the day of one of these four elements.

Many proverbs and customs from Azerbaijan and Georgia demonstrate such nature stewardship[2]. For example, the system of irrigation that is centuries old in Azerbaijan followed a strict schedule for irrigation in different seasons[3]. Established customary rules for irrigation were guided by principles of fair distribution of water among farmers and prevention of over-abstraction of water; "*The sea [lake] is doomed to drying up if waters do not discharge into the sea [lake]*" is an old saying from Georgia that demonstrates our ancestor's understanding of how harmful was the overexploitation of water resources. Dozens of myths and old rituals both in Azerbaijan and Georgia revolve around the water. In Azerbaijan according to the tradition of the first day of Novruz (that is referred to as the water Tuesday), families would visit a river or water spring to splash water on each other and wash off all hardships of the old year. The ritual was a symbol of a new beginning and freshness. Water was also a subject of worship and fear. For example, the Georgian proverb "*high waters ahead (referring to floods) and landslide behind*" warns of

[2] Nature Stewardship refers to protection and responsible use of natural resources through conservation and sustainable practices.

[3] Timing of irrigation, as well water distribution types in Azerbaijan had their unique names. Deyirmanlig, keshkel, batman (satsisqvilo is the equivalent in Georgia), bash (nakadeli is the equivalent in Georgia), karkhana, bel, arpalyg, agadja, go, gulag,girvanka are the terms used to describe the volume of water passing through an irrigation canal and water distribution method. The timing of irrigation also had different names. For example, chille-syjy refers to irrigation during 20 Dec -31 Jan; armudavar from the end of March till the first half of April; lehsan syjy – irrigation in may; den syiy- in June; dekhre syiy - after trimming of mulberry; khyra syiy –end of August (Guliev et al., 1977)

interlinkages between these two-water related natural hazards[4] and is a wisdom distilled from hundred years of observation of nature. There are also numerous prayers and spells all around Georgia that are related to water. Our ancestors would either call for the God's mercy in anticipation of droughts and floods or cast the spell against these water hazards[5] (Tandilava, 1996).



water mill

irrigation pump

[4] Natural hazards are extreme weather events that may cause loss of human life, damage to property and disruption of economic and other activities. Water related natural hazards are floods, landslides, tsunami, storms, drought.

[5] Source: Tandilava Z., 1996.

IS WATER AN ECONOMIC OR SOCIAL GOOD?

Water that is used for human needs is certainly an economic good[6]. Yet, since water is indispensable for life and survival, it cannot be treated same way as any other natural resource, as for example, wood, iron ore or natural gas. For this reason, the United Nations (UN) recognized the access to safe drinking water and sanitation[7] as a basic human right. The right to water and sanitation is also an important pre-requisite for the realization of other human rights. For example, the right to education cannot be fully realized if schools cannot provide adequate sanitation service; same applies to the human right to health. The lack of safe drinking water and poor sanitation causes serious health problems. In fact, it is the world's second biggest killer of children according to the UN.

Besides humans there are also ecosystems that require water for their needs. Water is essential for the growth of plants; it provides habitat [8]and breeding grounds for aquatic and other species; water is needed to support the movement of minerals and nutrients in nature. Ecosystems have as much right on water as we humans do and it is in humans' interest to ensure that ecosystems have enough water to sustain their functions. Further information about benefits provided by ecosystems to humans is presented in chapter 4.

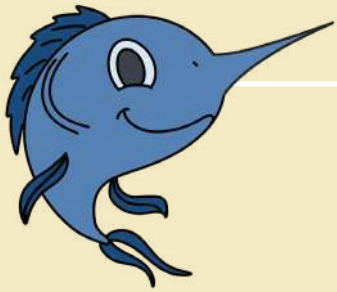
Quick Facts: : Minimum Daily Water Needs for Humans

According to the World Health Organization, an adult person needs between 50 and 100 liters of water per day to ensure that most basic needs are met.

[6] Economic good is defined as a product or service that is useful for humans and has price.

[7] Sanitation refers to the provision of facilities and faeces (definition of the World Health Organization)

[8] Habitat is natural environment in which a particular species of organism lives



BOX 1: Examples of the Nature Stewardship Practices in Azerbaijan and Georgia

- Crop rotation on a cultivated land was widely practiced to protect soils from erosion;
- Farmers would leave pastures untouched for a certain period of time to allow soil to restore its fertility and avoid overgrazing;
- Terrace cultivation was applied on slopes, that was widely practiced in the mountainous regions to prevent land erosion and maximize use of land and water;
- Hunting animal that was raising offspring was a taboo;
- In the mountainous regions cutting trees in the areas that were prone to avalanches was a taboo;
- Thinning of trees in forest was performed only in dense forests; clearcutting of forests was usually avoided;
- Collection of medicinal herbs was allowed only in certain period of the year to allow sprouting of herbs.

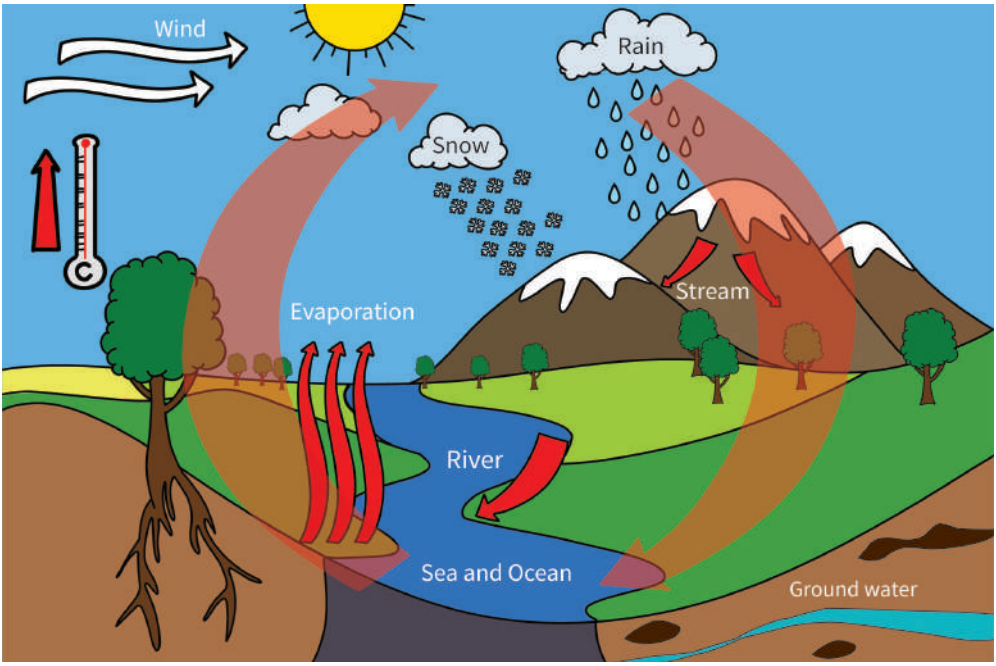
Sources: Khutsishvili K., 2006. and Tsagareishvili T., 2000

2

WATER CYCLE IN A NUTSHELL

WATER CYCLE IN A NUTSHELL

Water on Earth is constantly on a move. It is changing from one physical phase into another in a cyclic pattern. This movement is driven by sun energy. In nature we can observe water in three different phases - as an ice and snow when it is in a solid phase; as a vapor when it is in a gaseous phase; and as a rain and stream in river when it is in a liquid phase. While transforming from one state into another water goes through a cycle that is known as the **water cycle**. The water cycle is a continuous process that never stops.



Let's have a closer look at this process. It is made up of several stages. The cycle starts with the **evaporation**. When sun heats up the surface of oceans and seas, water starts to evaporate and water vapor, that is lighter than water, rises in the atmosphere. Unlike sea water, the water vapor is free of salts and is distilled. Because of cooler temperature in the atmosphere, water vapor starts to **condense** into droplets of water and then higher up into ice crystals that form the cloud. Clouds travel by wind over long distances.

When cloud particles grow so big that the air cannot retain any additional weight, condensed water droplets start to fall out on the surface of Earth as rain, snow or hail, depending on the air temperature. This is a process of **precipitation.** Precipitation can occur above oceans and land. Part of the water that falls on the land as a rain runs over its

surface and drains (collects) in rivers, lakes and seas. Water that falls as a snow collects in snow packs. Drops of water that end up on the surface of land either run over it as streams or **infiltrate** between the pores of the soil. Infiltrated water accumulates in underground water storage (aquifer) or is absorbed by plants through their root system. Absorbed water is transported in plant through a xylem (transport tissue in vascular plants) to every single cell of the plant. Water that is delivered to leaves escapes as a vapor via small pores on leaves. This process is referred to as **transpiration**. The term **evapotranspiration** is used to describe the evaporation of soil moisture together with transpiration from leaves of plants. Water that returns to water bodies or evaporates through evapotranspiration re-enters water cycle and the cycle starts all over again.

Quick Facts: : Evapotranspiration

Less than 5% of all water absorbed by plant is used for its growth. The rest of absorbed water is released back to the atmosphere through transpiration. 10% of water vapor in the atmosphere is generated by plants. The rest comes from the evaporation of water from waterbodies.

Sources: Nature Education, 2013; Water Science School, 2016

BENEFITS OF THE WATER CYCLE: the water cycle has many benefits for the environment and humans. First of all, waterbodies[1], such as rivers, lakes, wetlands, etc. are formed on the land surface through this process. It also creates ice caps[2] and ice sheets (Antarctica and Greenland) that are important sources of freshwater. The role of the water cycle is also essential for regulating the air temperature and shaping the Earth's climate. While moving from one phase into another, water also facilitates the circulation of minerals. The cycle also helps the self-purification of water through evaporation & precipitation and infiltration. In this process water is getting rid of polluting substances.

DURATION OF THE WATER CYCLE: the water cycle may take a year or thousands of years to complete, depending on how fast water moves from one phase to another. For example, rain that falls in oceans and rivers re-enters the cycle in relatively short period of time, as opposed to water that is captured in glaciers or aquifers (see box 2). It may take hundred years before ice sheet or glacier start to melt.

[1] Waterbody refers to any significant accumulation of water, generally on a planet's surface. Oceans, seas, lakes, wetlands, rivers, streams are examples of waterbodies.

[2] Ice caps are mass of ice that covers less than 50,000 km^2 surface.

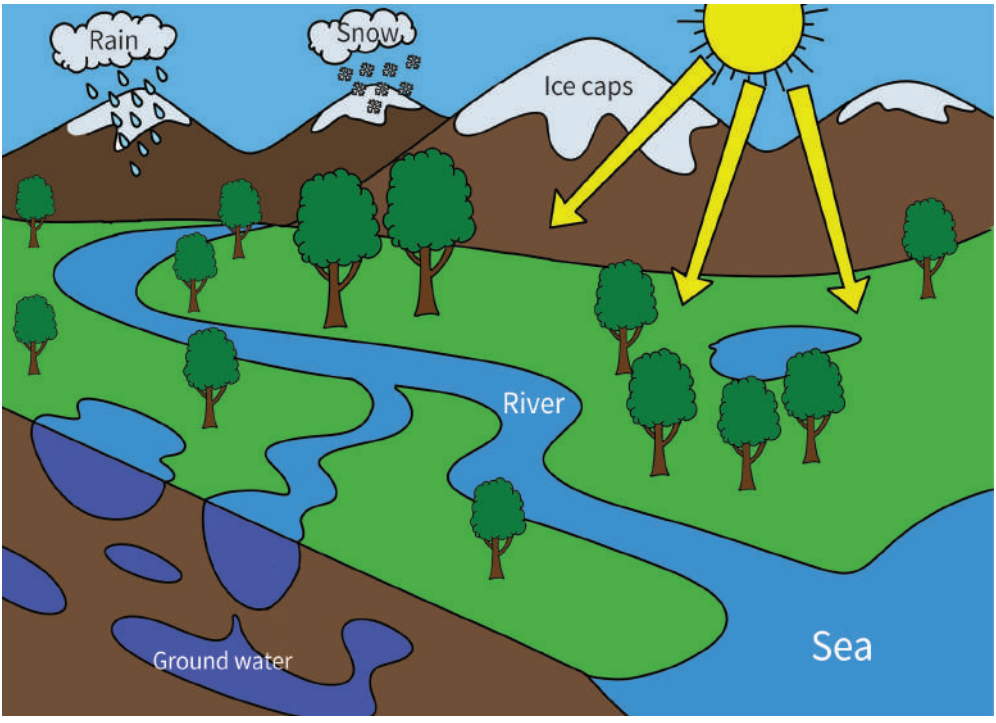
Quick Facts: : Duration of the Water Cycle

Water stays in the atmosphere around 9 days. Water that infiltrates upper layers of soil can remain there for 200-300 years, but if water penetrates deeper layers of soil and discharges into an aquifer it may stay confined there as long as 10,000 years. Glaciers trap water for 20-100 year but in ice shelf (for example in Antarctica) water can be trapped for 900,000 years. Water in oceans can remain for over 3,000 years. .

Sources: Nature Education, 2013; Water Science School, 2016

Same applies to groundwater that is stored the beneath of the land surface. It can be trapped there for thousands of years until groundwater is exposed to sun.

GLOBAL WARMING AND WATER CYCLE: scientist fear that the phases of the water cycle will accelerate as a result of global warming[3]. Warmer air will intensify evaporation of water from water bodies, land and surface of plants through accelerated transpiration. This will lead to an increased concentration of water vapor in the atmosphere and affect the seasonal distribution of precipitation and its intensity. Some areas might be subjected to longer and heavier rains, while others may suffer from droughts. Acceleration of the water cycle is a big concern for us, humans, as its outcomes are unpredictable.



[3] detailed information about global warming is provided in chapter 7

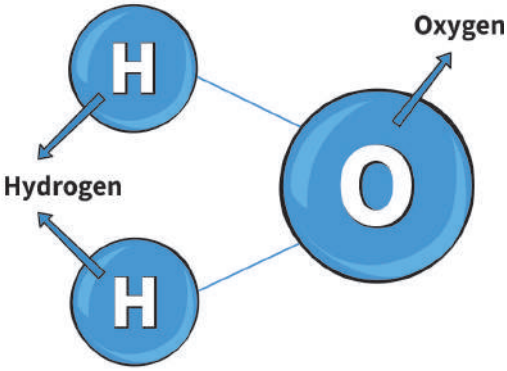
BOX 2: Groundwater and aquifers

Groundwater is an important source of fresh water resources on Earth. The probability that your drinking water in Azerbaijan and Georgia comes from this very source is very high. Groundwater is stored beneath the Earth surface and is formed by droplets of water that seep into the ground through porous layers of soil and migrate downward until water reaches an impermeable rock or a layer of clay, where it starts to accumulate. Water in this layer saturates the porous rock and forms a water bearing layer or an aquifer. The water itself that is stored in aquifer is a groundwater. For example, water we abstract from wells and springs is groundwater. Groundwater in aquifers can remain for thousands of years. Really old groundwater therefore is referred to as fossil water.

EXERCISE

TEST YOUR KNOWLEDGE

1. Review following properties of water: freezing and boiling points, surface tension, cohesion, conductivity, solubility, sound speed in water and discuss why these properties are important for the physical and biological processes on Earth.
2. Explain how water transits from solid into liquid and gaseous phases.



3

THE FRESH WATER RESOURCES AND WATER AVAILABILITY

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One quick glance at the physical map of the world is enough to know that far more than half of our planet is covered by water. To be precise, water makes up 71% of the Earth's surface. It is stored in oceans, seas, rivers, lakes, marshes, wetlands, ice caps and ice sheets. There is also "invisible" water – groundwater, that flows beneath the Earth's surface and accumulates in soil and aquifers.

Oceans and seas are the largest water bodies on Earth that accumulate 96.5 % of all water resources. They are followed by ice, glaciers and permanent snow that store around 1.74% of water. 0.013% of total water resources is accumulated in lakes. Wetlands are another important source of water, where 0,0008% of the world's water resources are deposited. When speaking about water sources, rivers probably are first to come to mind but in fact they only account for 0.0002% of planet's water resources. 97.5 % of Earth's water resources are saline.

Only 2.5% (35 mln km^3) of all water resources of our planet is fresh and can be used for human needs. Fresh water is also a source of life for 6.5 million terrestrial species and permanent dwelling (habitat) for 126,00 aquatic species.

Quick Facts: Water Salinity

Depending on the quantity of dissolved salts in water it can be either fresh or saline. Salinity is measured in grams of salt dissolved in one kilogram of sea water or in per-mille (‰) that is a sign for indicating parts per thousand.

Fresh waters have less than 0.5 ‰ salinity (0.5 g per kg of water). If concentration of salts in water exceeds 0.5 gr water is considered saline. For example, salinity of the Caspian Sea is 13 ‰, the Black Sea –17.6 ‰. Salinity of ocean reaches 35‰. The Dead Sea in comparison is 8.6 times as saline as the ocean. This is why it is uninhabitable.

Is this a lot or little? It may not seem a little but the fact is that not all of this water is accessible for humans. For example, the largest portion of the fresh water resources (68.7%) is trapped in glaciers[1] and ice sheets and therefore are inaccessible for human needs. Groundwater, that is the second largest available freshwater reserve on Earth (30%) cannot be abstracted easily. Only 0.3% of all

[1] Glaciers are mostly located in polar regions – in Antarctica, Greenland and Arctic.

fresh water resources, that are available in rivers and freshwater lakes as surface water, can be easily accessed by humans and terrestrial and other species[2].

Unfortunately, due to human activities many of these rivers and lakes are currently polluted, in some cases to the extent that water cannot be used either by humans or any other living organism. By polluting and degrading the quality of freshwater, we further reduce the availability of this precious resource.

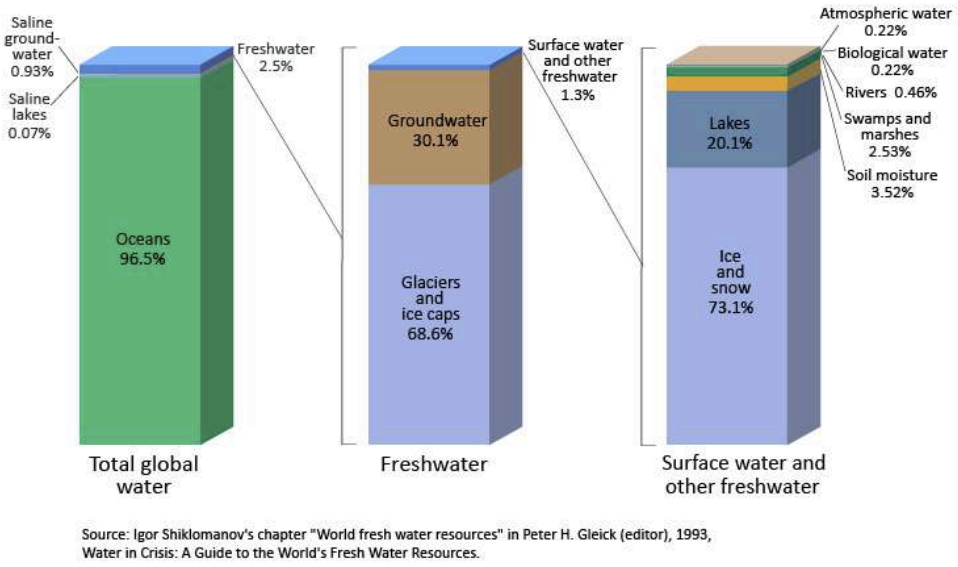


Figure 1: World water distribution

WATER STRESS AND SCARCITY

Water resources are unevenly distributed in around the world. Some parts of the planet are covered with a dense network of rivers, while others while others are scarce of water. Precipitation that is an important source of water for replenishing water resources, is also unevenly distributed. For example, arid areas receive less than 100 mm rainfall annually, while in rainforests precipitation can be as high as 3,240 mm per year. Variability of precipitation in time is also high. It is highest in the warmest months of the year.[3]

Quick Facts: Uneven Distribution of Water Resources

Six countries of the world – Brazil, Russia, USA, Canada, China and Indonesia have 45 % of world's freshwater supply. (UNESCO, 2012) The world's 5 poorest countries in terms of water resources per person are Bahrein, Jordan, Kuwait, Libya, Maldives.

Source: FAO

[2] Sources: UNESCO, 2012 A and UNESCO 2012 B.

[3] If you are interested to have a look at the annual precipitation of other countries you can visit the

Due to uneven distribution of water resources, as well as degradation of water resources by humans, water shortages and deficit has become a worrying reality in many parts of the world. When amount of fresh water resources is fixed but its consumption grows as a result of population growth and increased economic activities, less water becomes available per person and problems of water stress and scarcity arise.

A country is considered to suffer from an acute **water stress** if it has 500 m^3 - 1000 m^3 freshwater available per person per year. Countries and regions that experience **absolute water scarcity** have less than 500m^3 freshwater per person per year[4], which could either result from the limited physical availability of water or economic causes (lack of water infrastructure, etc). To put these figures in context, an Olympic size swimming pool stores 5 times the amount of water that is available per person per year in a country that experiences the absolute water scarcity.

Water scarcity in everyday life means that less and less water is available for cooking, washing, growing food manufacturing and etc. A country can compensate its water deficit if it decides to import from abroad food and goods that require considerable amount of water for production. This solution however, comes at the expense of growing dependence on other countries, not to mention the implications of such imports for food prices.

DO WE NEED TO WORRY ABOUT FRESHWATER AVAILABILITY IN AZERBAIJAN AND GEORGIA?

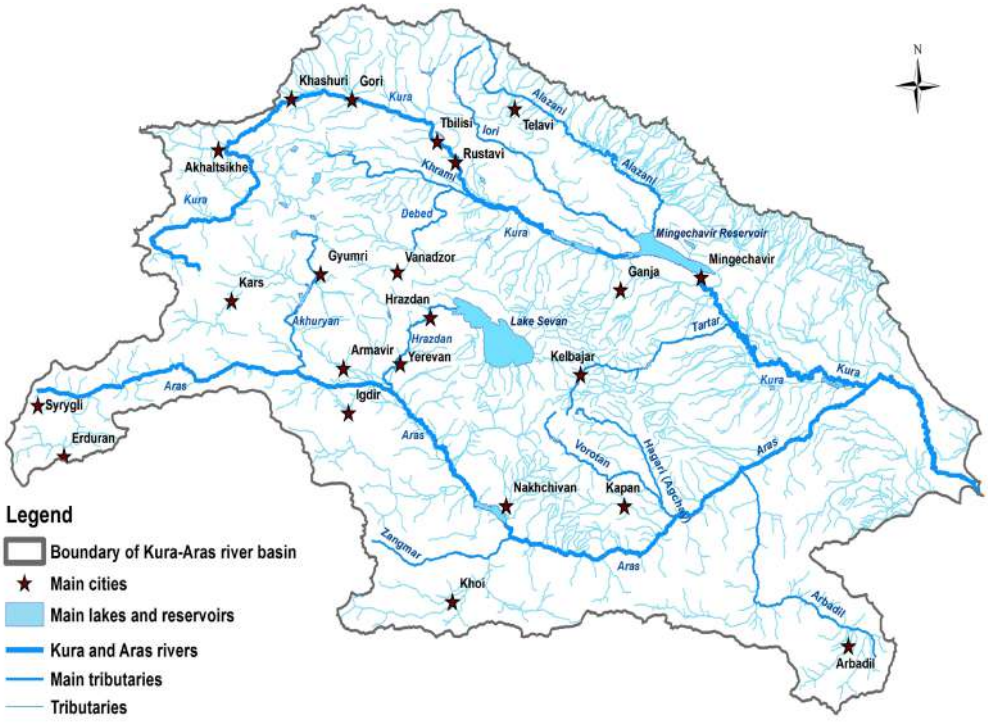
According to assessment of local experts and international organizations the total freshwater resources per inhabitant in Azerbaijan and Georgia is far above of the water scarcity levels. Nonetheless, we should not forget that water resources in Azerbaijan and Georgia, as elsewhere in the world, have spatial variability – while some regions have water in abundance others might struggle from water shortages. For example, western Georgia is three times richer with water resources than its eastern part where Kura basin is located. Azerbaijan and Georgia also depend on other countries for water (to a different extent), as part of their water resources originates outside of their boundaries in the neighboring upstream country/countries. For example, the Kura and Chorokhi (Coruh in Turkish) rivers in Georgia flow from Turkey. In Azerbaijan the Kura, Aras and Samur rivers flow from Georgia, Armenia/Iran and Russia respectively.

World Bank web-site that has data of all countries: https://data.worldbank.org/indicator/ag.lnd.prcp.mm?view=map&year=2014

[4] Source: FAO, Water Scarcity

BOX 3: River and River Basin

While reading this book you will come across to a term of "river basin" quite often. It is therefore important to have clear understanding of the difference between river and river basin. River is a watercourse that originates at high altitudes (in mountains), flows downwards and discharges into sea/ocean/lake/wetland. Rivers are fed by precipitation (rain and snow melt) that collects on land surface in streams and discharges in rivers. River is also fed by glacier and ice (through snow/ice melt) and groundwater. Every river has certain water/river discharge that varies seasonally. Water/river discharge is volume of water flowing through river channel in a given time and is measured by cubic meter per second (m3/s). River basin on the other hand is the area of land that collects all precipitation and drains it into the river. Large river basin may include several sub-basins formed by smaller rivers that are tributaries of a larger river. For example, within the Kura river basin there are several sub-basins, such as for example, the Alazani/Ganykh or the Aras river basins. .



Hydrology of the Kura-Aras River Basin

EXERCISE

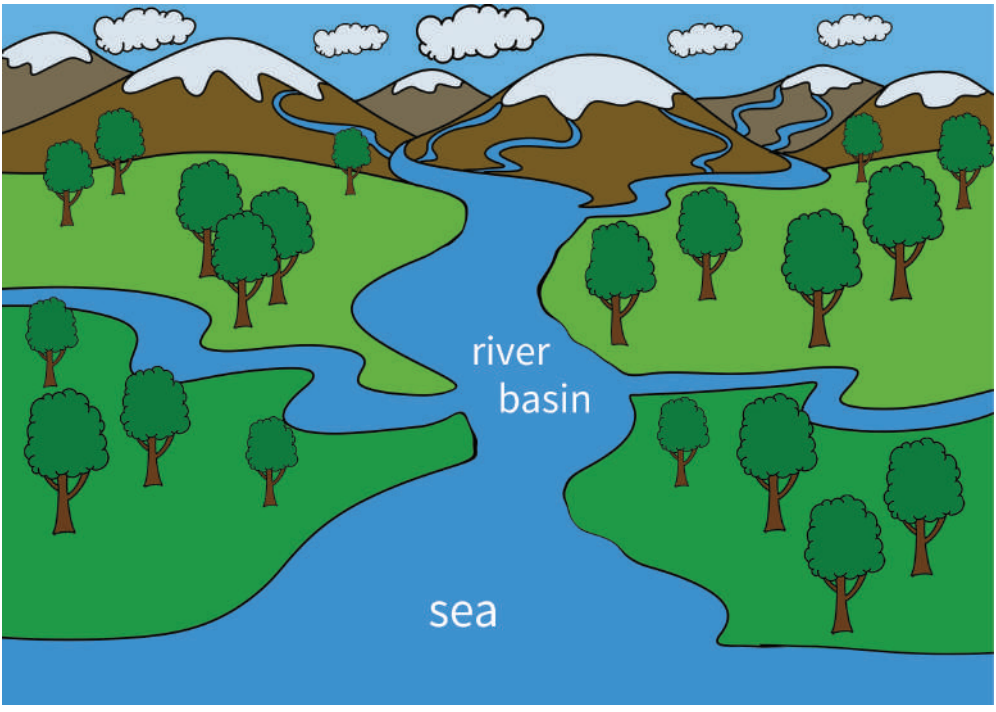
EXERCISE 1: Natural freshwater lakes

A) Study closely the physical map of the world (a hard copy or the Google Earth), review other resources as well and identify four biggest freshwater lakes of Earth. Where are these lakes located?

B) Identify four largest natural freshwater lakes located in Azerbaijani and Georgian parts of the Kura basin; where are they located?

EXERCISE 2: Degradation of fresh lakes – a case study of the Aral Sea

Carry out an online research about the Aral Sea disaster and discuss in classroom the causes and impacts of the Aral Sea degradation. Split into 2 groups and develop a poster or infographic on the Aral Sea problems and their causes.



4

ALL ABOUT THE KURA RIVER BASIN

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The Kura river is the longest and biggest river in the South Caucasus. Beginning in eastern Turkey at a height of 2,200-2,700 m above sea level, the river flows downstream through the eastern part of Georgia, crosses the border with Azerbaijan, discharges first into the Mingechavir Reservoir and then into the Caspian Sea[1]. Its length is 1, 515 km. Together Azerbaijan and Georgia cover 94,760 square km and represent 88% of the Kura basin. The Kura river waters are generated from seasonal snowmelts (36%), groundwater (30%), rain (20%), ice and snow melt from glaciers (14%)[2].

The Aras river is the longest and biggest (by water discharge) tributary of the Kura river. The river length is 1,072 km and its catchment area is around 102,000 km^2. It originates in Turkey and passes through Armenia, Iran and Azerbaijan. The river discharges into Kura on the territory of Azerbaijan. The second biggest tributary of the Kura River by length and water discharge is the Alazani/Ganykh river that originates in Georgia and flows through Azerbaijan. Among other important tributaries of the Kura river in terms of water discharge are the Khrami/Debed river, the Aragvi river, the Didi Liakhvi river, the Terter river, the Turianchay river and the Iori/Gabyrry river.

The Kura river basin is rich in groundwater resources but much of this water is hard to access and costly to abstract, as over 70% of the groundwater resources are stored in high mountain areas. The largest natural lakes (by surface area) in the basin are Sarisu, Ag-gyol, Jandari/Candar, Mehmangyl, Paravani, and Tabatskuri lakes.

TRANSBOUNDARY RIVER BASIN - WHO IS UPSTREAM/ DOWNSTREAM?

When looking at the map of the Kura river basin you will notice that the river itself and some of its tributaries cross the boundaries of more than one country. This is why some rivers have dual toponyms. For example, the river Kura is called Kura in Turkey, but in Georgia it is known as Mt'k'vari and in Azerbaijan it is referred to as Kür. Many of the basin's aquifers are also shared by two countries. There is also a lake at the border between Azerbaijan and

Georgia - the Jandari/Candar lake. 67% of it is located in Georgia and 33% in Azerbaijan. All these water bodies are **transboundary** in nature since they are shared by two or more countries.

[1] The wider Kura river basin includes the Aras (Araz) river basin as well, but since the focus of the present publication is the Kura river basin itself, issues related to the Aras (Araz) river basin are not discussed. Total catchment area of the wider Kura basin is 188,000 km^2.

[2] Source: UNDP/GEF, 2007.

A physical map of the South Caucasus

In rivers, water flows from a higher altitude (where snow melts and streams are formed) to lower altitude. The Kura river starts at 2,742 meters above sea level and flows downwards, discharging at 26.5 m below sea level in the Caspian Sea[3]. The difference in elevation determines the direction of the flow in Kura towards the Caspian Sea. **Upstream** refers to a direction towards the source of a river. Therefore, in the case of the Kura river Turkey is an upstream country for both Georgia and Azerbaijan and Azerbaijan is a downstream country for Turkey and Georgia. When dual toponyms are used for a river or lake, the name of the river used in upstream country comes first, followed by the toponym for the river used in the downstream country.

Downstream water users of a river basin (for example, towns, farms, and factories) depend on how water is used upstream. If upstream water users pollute the river or abstract large quantities of water, downstream inhabitants of the basin have to deal with the consequences of pollution and reduced water flow in river. The impact will be felt by downstream users not only within the country but beyond its boundaries as well, if the

[3] Source: Encyclopedia, 1984.

river is transboundary. Any changes in water flow or water quality in an upstream country therefore is likely to affect the water uses in the downstream country. Azerbaijan, as the country of the Kura basin that is furthest downstream, is particularly vulnerable to impacts on water resources that are imposed by its upstream neighbors.

Quick Facts: Transboundary Basins in Figures*

There are 286 global transboundary river basins and 300 aquifers in the world. These river basins span 151 countries and serve around 2.8 billion people. The transboundary river basin with the highest number of states sharing it is the Danube River basin that is located in Europe. It is shared by 19 countries.

Source: TWAP RB

Quick Facts: Biodiversity of Azerbaijan and Georgia in figures

The diverse landscape of Azerbaijan, which includes 9 out of 11 known climatic zones, harbors a high number of endemic species. Out of 5,000 species of vascular plants recorded in Azerbaijan, 210 species are endemic to the country. Azerbaijan also harbors 15,000 species of invertebrates and 641 species of vertebrates. The country is an important migratory path for many bird species travelling from Europe and Russia to Africa and Asia. Georgia's record of vascular plant species reaches 4,130. Around 21% are either Caucasian or Georgian endemics. There are 16,054 animal species recorded in Georgia, out of which 758 are vertebrates. The number of vertebrates that are endemic for the Caucasus region is 41. The region is also an important migration route for birds. The area is used as a stopover site by millions of migratory birds on route to breeding and wintering grounds. The Caucasus region also played an important role in developing number of breeds of important food crops including wheat, grapevines and fruits (including persimmons, chestnut, walnuts, and apples). A majority of these species are represented in the Kura river basin.

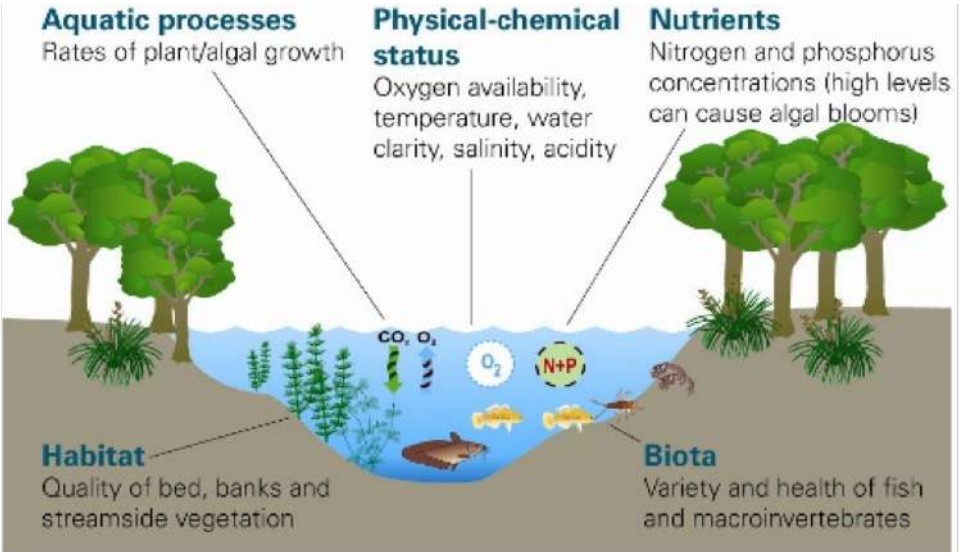
POPULATION

The population of the Georgian and Azerbaijani parts of the Kura river basin is 7.6 million. 52% of all Azerbaijanis and 64% of all Georgians reside in the basin. Tbilisi, the capital of Georgia, is the most densely populated area of the entire Kura basin. According to estimations, more than 1.1 million people live there. Baku, the capital of Azerbaijan, is located outside of the Kura river basin. Nevertheless, Baku receives a significant part of its drinking water supply from the Kura basin. Around 2.3 million people living in Baku[4] depend on these resources to some extent. This fact is a good illustration of the importance of the water resources of the Kura river basin not only within the basin itself, but beyond its boundaries as well.

[4] Source: The State Statistical Committee of Azerbaijan

CLIMATE

The Kura river basin has a wide range of climatic conditions that varies from dry subtropical (in the lowlands of the basin) to alpine (in the high mountains). The recorded maximum and minimum temperatures at different altitudes in Azerbaijan is +46 °C and -32°C respectively; in eastern Georgia it is +43 °C and -36°C. The rainfall peak is in April-June. The annual precipitation also varies across the countries. The annual precipitation in the Azerbaijani part of the basin in the lowlands is 225-350 mm, in the low mountainous is 350-500 mm and in the mountainous areas varies between 500 mm and 1,300 mm. In the Georgian part of the basin annual precipitation is 400-1,000 mm in the lowlands and 500-1,300 mm in mountainous regions. [5]



ECOSYSTEMS AND BIODIVERSITY

The rich biodiversity and magnificent nature in the two countries is one of the greatest sources of pride of Azerbaijanis and Georgians. The World Wildlife Fund (WWF) reports that forests and high mountain ecosystems, as well as arid and semi-arid landscapes in the Caucasus region contain twice the animal diversity found in Europe or Central Asia. The Caucasus region has some of the world's richest biodiversity with large number of endemic species. In the subalpine and alpine landscapes 25-30% of plants found here are endemic to the region.[6] Conservation International (CI) identified the Caucasus region as one of the world's 34 critical biodiversity hotspots[7] due to high diversity of species, but it also categorized it as an area where local ecosystems are significantly threatened. Freshwater habitats of the Kura River basin host a number of endemic fish and invertebrate species.

[5] Sources: The 3rd NCR AZ, 2015 and the 3rd NCR GE, 2015.
[6] Source: WWF, 2006.
[7] Biodiversity hotspots are habitats with exceptionally high number of species.

More than 70 species of fish occur in the Kura River basin and nearly 14 are endemic to the

Caucasus region. Moreover, the spawning grounds of five Caspian sturgeon species (Beluga, Russian sturgeon, Persian sturgeon, stellate sturgeon and ship sturgeon) are located in the Kura River. According to the WWF, the largest concentration of freshwater ecosystem in the South Caucasus can be found is in the Kura River basin with approximately 1.020,000 ha of freshwater habitats[8].

Unfortunately, ecosystems of the Kura basin have been under increasing pressure since the beginning of the 20th century. Intensive use of natural resources (through deforestation, over-fishing, hunting, etc.), expansion of urban areas and cultivated lands, as well as construction of roads, rails, tunnels, etc., brought fragmentation to the natural habitat of many species. Hundreds of species have become extinct and many face high risks of extinction (for more information see box 4). The main threats to freshwater biodiversity in the Kura River basin are pollution, water abstraction, alien species and hydropower and water control dams.






[8] Source: WWF, 2015

ECOSYSTEM SERVICES AND WHY WE SHOULD CARE ABOUT THEM

We humans rely heavily on natural resources. Plants we grow and animals we breed, wood we cut for construction, medical plants we use for treatment, and water we abstract for various needs are only a few examples of resources offered to us by nature. Besides these resources, ecosystems also provide us services that are absolutely critical for human survival. For example, protection provided by forests from floods, avalanches or pollination of plants facilitated by bees and birds are some of the most known ecosystem services. We are largely unaware of invisible and silent "work" carried out by ecosystems and take these services for granted.

Ecosystem services (or nature's services as it is referred sometimes) is defined as goods and services provided by ecosystems that benefit humans by maintaining and improving human well-being. Categories of ecosystem services are presented in box 5. Let's take a closer look at some of these services:

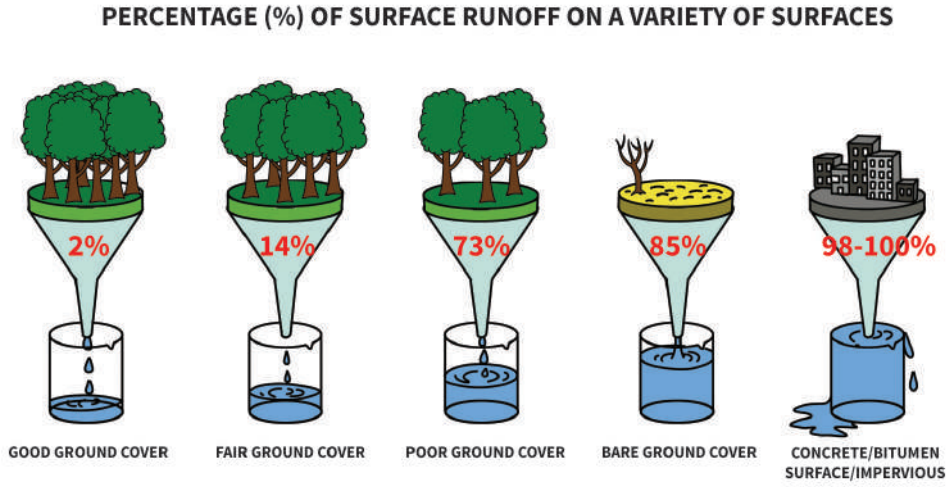


Figure 2: Percentage of Surface Runoff on a Variety of Surfaces
Source: Ohio Wesleyan University

Protection from floods and soil erosion: Outcomes of a heavy rain on barren land and in areas covered by dense vegetation (forest for example) differ significantly. Flash floods[9] occur almost every time barren land is exposed to high intensity rains; however, in forested areas flash floods occur much rarely.

Once rain droplets reach barren land most of them remain on the land surface and collect into surface water runoff. A few hours of intense rain are enough to form flash floods from increased volumes of surface water runoff. In contrast, in forests a large portion

[9] Flash floods are events when the water level rises within a few hours as a result of high intensity rains.

of raindrops are either intercepted by leaves or taken up by the root system of plants. Furthermore, forest soils that are rich in organic matter are more porous and can retain additional quantities of water through infiltration. Only a small portion of rain ends up on the land surface and forms surface water runoff. As a result of interception, infiltration and retention of rain water in forests, huge volumes of water are diverted from the surface runoff and risks of flash floods and floods in general decrease considerably. Figure 2 below demonstrates the difference in water retention capacity of lands with vegetation cover of different densities. If you live near the forest, the probability that your town or community will be affected by flashfloods is significantly lower than for those who live near barren land. The vegetation cover also protects land from erosion[10], thus reducing impacts from wind, water and heat.

Quick Facts: Ecosystem Services provided by Pollinators

Pollinators such as bee, birds and bats affect 35% of the world's crop production. As a result of their "invisible work" the leading food crop production worldwide increases by around 75%.

Source: FAO, Pollination Service

Purification of water is one of the key ecosystem services without which it is hard to image life on this planet. Living organisms in water remove harmful pathogens from polluted water and decompose (break down) large quantities of organic matter that is discharged daily by humans into water bodies. Vegetation growing on the river banks also helps to improve water quality by absorbing pollutants. Without the help of these organisms and vegetation, treating polluted water would be far more complicated and costlier.

Supporting agriculture: Farmers owe their harvest almost entirely to bees and birds, as these creatures play a pivotal role in pollinating flowers during vegetation season. Insectivorous birds are natural enemies of pests, and help farmers to control pests and diseases on their farmland. Soil fertility, which is key a factor for agriculture productivity, is largely determined by biodiversity of the soil. Among the "silent workers" of nature are also fungi and microorganisms that help to decompose organic matter in farms and elsewhere.

Climate: Ecosystems also influence climatic conditions and air quality. Millions of tons of carbon dioxide (CO_2) emitted in the process of fossil fuel combustion (by cars, machines, thermal power plants, etc.), are absorbed by plants. This process supports generation of oxygen, and plants supply us with fresh air continuously. At the same time, by absorbing CO_2 plants prevent the rise of temperature in the atmosphere (more information on this is provided in chapter 7). They also control the humidity of air through evapotranspiration and keep our climate stable and livable.

[10] Soil erosion is a form of soil degradation. It occurs when the upper layer of soil is displaced either by natural processes or human activity.

In order to maintain ecosystem services, we need to take better care of the surrounding environment by preventing degradation of ecosystems and restoring already damaged systems. Creating specialized areas, such as protected areas, is one of the ways to guard ecosystem services. To facilitate conservation of biodiversity and protection of ecosystems, the governments of Azerbaijan and Georgia established several protected areas throughout their countries. Such areas exist in the Kura basin as well (see exercise 3).

TThe Red List is a catalogue of plants and animals that are threatened with extinction. It provides information on the state of biodiversity in a country or globally and helps to mobilize action for conservation of species that are either threatened or endangered. The Red List of Azerbaijan from 2013 is the latest list of rare, endangered and threatened species in the country. It includes 300 species of higher plants, 14 species of fungi, 20 species of lower plants, 266 species of higher plants, and 223 species of fauna. Some of the globally threatened species found in Azerbaijan have benefited from conservation projects, including a reintroduction of 179 gazelles back into their historical habitats in the Caucasus, as well as recent efforts to save the critically endangered Caucasus leopard. Both of these projects are supported by the Heydar Aliyev Foundation and IDEA (International Dialogue for Environmental Action) campaign. The latest Red List of Georgia dates from 2014. It also includes critically endangered, endangered, vulnerable and threatened species. Among them are 29 mammal, 35 bird, 11 reptile, two amphibian, 14 fish and 56 woody plant species. The Red List is an indication that and increasing number of species have become threatened and endangered in the last decades as a result of destruction of their natural habitat or overexploitation of the species. *Sources: CBD AZ, 2014 and CBD GE, 2014*

BOX 5: Categories of Ecosystem Services

Ecosystem services are categorized into four groups:

Provisionary services – water, food, wood and other goods are examples of provisionary services that humans obtain from ecosystems.

Regulatory services – maintaining the quality of air, water, soil, providing food and disease control, pollinating crops, decomposing organic waste in fresh and marine waters are some of the regulatory services provided by ecosystems. When these services are compromised, human wellbeing can be affected severely (occurrence of natural disasters or spread of disease are some of the consequences of weakened or irreversibly damaged services).

Supporting services – photosynthesis, nutrient cycle, water cycle, soil formation, etc. are some of the services that ensure continuous functioning of ecosystems and environment.

Cultural services – experiencing spiritual enrichment and physical recuperation are nonmaterial benefits humans obtain from ecosystem. Fishing, rafting, hiking, swimming are examples of how humans use this service. Humans also have economic benefits from this service. Gains received from tourism and recreation are examples of material benefits obtained from this service.

Source: WWF, 2006

EXERCISE

EXERCISE 1: Dual toponyms of rivers and lakes of the Kura basin

If you take a closer look at the map of the Kura River Basin you will notice that some of the transboundary tributaries of the Kura basin have different toponyms. Names that Georgians use for a particular river/lake may differ from what Azerbaijanis call it. List rivers and lakes of the Kura river basin that have different toponyms in Azerbaijan and Georgia. Name other rivers in Azerbaijan and Kura that originate beyond the country borders.

EXERCISE 2: Who is upstream, who is downstream?

Find on the map the Dniester river located in Eastern Europe. What are the countries that share this river basin? Can you identify downstream and upstream countries and why this basin is unique?

EXERCISE 3: Protected areas of the Kura basin

Review a list of protected areas of Azerbaijan and Georgia provided by the teacher and identify which of these protected areas are located in the Kura basin. Mark them on a printed map of the Kura basin.

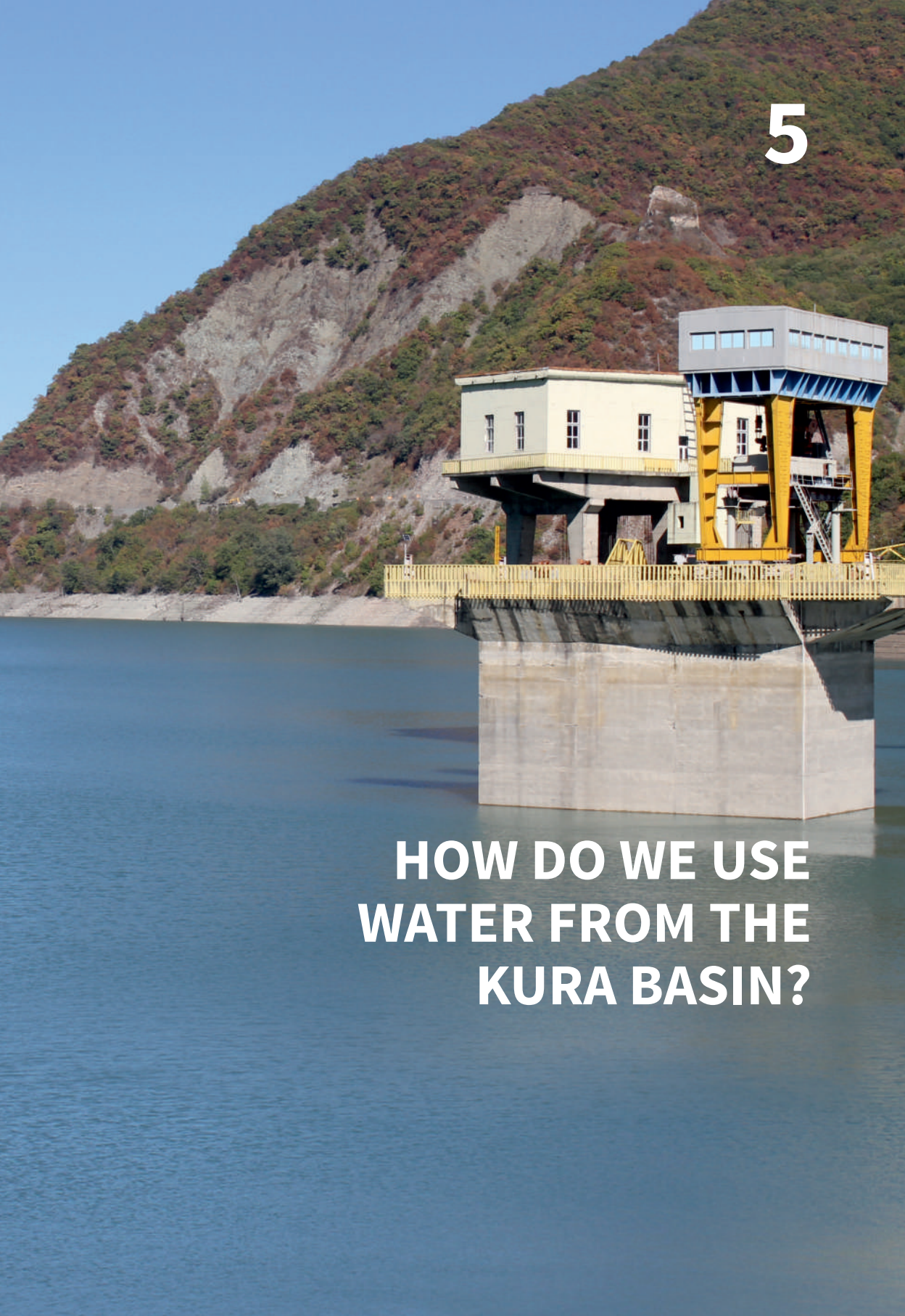
EXERCISE 4: Draw the linkages between ecosystem services and human well-being[11]

Break into four groups and select one of the following ecosystem services: 1) photosynthesis; 2) wood provision; 3) clean air 4) medical herbs. In each group, discuss the benefits provided by the selected ecosystem service. Review the following components of human wellbeing in respect to the selected ecosystem service and discuss which of the following components of human wellbeing is supported by the ecosystem service:

- Security: security from disasters, safe climatic conditions;
- Existence: nutrition, hygiene, shelter, livelihood;
- Health: access to clean water and air, physical wellbeing.

Present the outcomes of group discussions to the class in form of a diagram or infographic that shows linkages between ecosystem services and components of human wellbeing.

[11] This exercise was developed on the basis of a diagram on the linkages between categories of ecosystem services and components of human well-being that is presented in the publication on Ecosystem Services and Human Wellbeing - Synthesis, 2005. Millennium Ecosystem Assessment, pp 50.



5

HOW DO WE USE WATER FROM THE KURA BASIN?

HOW DO WE USE WATER FROM THE KURA BASIN?

WATER USES IN GENERAL[1]

Water uses are determined by human needs. We need water to maintain hygiene, grow food, manufacture and transport goods, harness energy, and to recover and regain strength.

Some of the most important water uses are at home. Water here is used for drinking, cooking, cleaning, personal hygiene and sanitation. This category of water use is known as domestic water use. Lack of water for domestic use can seriously impair hygiene and cause health related problems, such as diarrhea and infectious diseases. Domestic water use is also key for proper sanitation. Water is needed to adequately and safely treat and

Quick Facts: : Water Requirements for Manufacturing 1 unit of Goods

Car – 52,000-83,000 liters

Jeans – 8,000-10,000 liters

Leather shoes – 13,725 liters

Smart phone – 12,100 liters

Source: Water Footprint Calculator, 2017

[1] "Water abstraction" and "water use" is not the same. Water abstraction= water use + losses, whereas water use are how we use water over all. In this text we are referring to water use, and not specifically about losses. This will be discussed later in the Kura Box, as losses are very important to consider in water abstraction.

dispose human excreta. Water is supplied to our homes either by a water supply utility through a network of pipes or from a well or spring. Globally around 12 % of all freshwater withdrawn from water bodies is used for domestic purposes[2].

In many parts of the world due to climatic conditions food cannot be grown without irrigation. Huge quantities of water are therefore withdrawn from water bodies to supply farming lands with irrigation water. Even if countries have rain-fed agriculture[3], where crops receive sufficient quantities of water from rainfall, water is still needed for animal farms. The agriculture sector is the biggest water user worldwide. This sector accounts for 69% of total water abstraction globally. This figure varies from country to country and can be as low as 21% (in some countries of Europe where precipitation is high) or as high as 82% (in some countries of Africa that have extremely low precipitation levels and arid climate)[4].

Quick Facts: Navigational use of the Danube river

The Danube river and its tributaries are used for transportation intensively. Only in 2014 more than 40 mln tons of goods were carried on the Danube river and its tributaries. Cargo vessels and product carriers transport ores, metal waste, agricultural and forestry products, petroleum products, chemicals, etc. The river also is used by the residents of the river basin as a mean of transportation between countries and cities.

Source: Pro Danube International, 2016.

Huge quantities of water are used for the production of goods. There is hardly any manufacturing sector that does not require water in the production process. The mining industry, for example, uses water to extract and wash ore and to transport its byproducts. Water is also used to produce food, paper, medicine, fertilizers and even computer chips. The most common uses of water in manufacturing include cooling, cleaning, pollution control, transporting, dissolving, and generating steam. Water in factories is also used for employee sanitation. The manufacturing sector uses 19% of all water withdrawn globally[5].

Humans have been using water as a source of energy for centuries. Water mills that were used by our ancestors for grinding grain or sawing wood are examples of traditional uses of water for energy. As science and technology advanced, we learned to harness energy from water at a much larger scale. Today, hydropower stations built on rivers and lakes generate millions of kilowatt hours electricity. Water is also used for cooling generators in thermal power stations that run on coal, gas or nuclear fuel.

Waterways have been an important transportation route in many river basins for

[2] Source: FAO Aquastat.
[3] Rain-fed agriculture refers to a farming practice that relies on rainfall for growing crops.
[4] Source: FAO Aquastat.
[5] Source: FAO Aquastat.

centuries. Today, millions of tons of goods are transported annually through rivers. This transportation mode allows us to move goods in large quantities at a relatively low cost; this explains why rivers are still actively used for transportation. In Europe, for example, navigation is considered an indispensable element of Europe's transport policy[6]

We also use water for recreational purposes. Boating, swimming or rafting are some of the examples of how water is used for recuperation and recreation.

Besides human uses there is also an environmental use of water. Water is needed for ecosystems and environment.

TOTAL WATER ABSTRACTION AND USE IN THE KURA BASIN

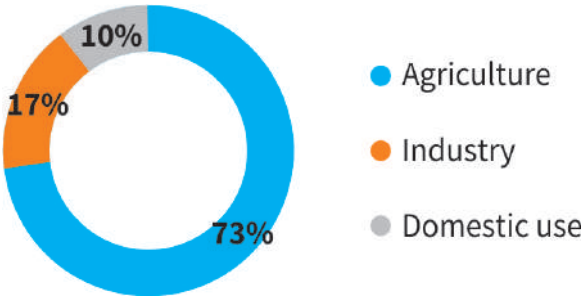


Figure 4: Total water abstraction in the Kura basin (2015)
Source: Source: Statistical data of Azerbaijan and Georgia

WATER USES IN THE KURA RIVER BASIN

The populations of Azerbaijan and Georgia use water resources for the same purposes as the rest of the world, but there is one exception - navigational use is almost non-existent in the Kura basin.

Agriculture: The agriculture sector in the Kura basin depends on irrigation. Water is mostly needed in summer to grow such crops as wheat, vegetables, potatoes, grapes, cotton, corn, rice, fruits, nuts, tea, and olives[7]. Water for irrigation is supplied from dozens of water reservoirs that have been constructed in the Kura river basin to secure stable provision of water throughout the whole vegetation season. Agriculture is the biggest water user in the basin. Around 73% of total water withdrawn from the basin is used for supplying water to farmlands[8]. Fisheries is another sector that uses water but its use is relatively modest as compared to crop cultivation. A larger portion of water is consumed in Azerbaijan as most of its cultivated

[6] Source: Pro Danube International, 2016.
[7] Some of the crops are grown only in the Azerbaijani part of the basin. These include cotton, rice, and tea.
[8] Data on water uses in the Kura basin is based on 2015 data.

lands are located in the Kura basin and climatic conditions necessitate irrigation for growing crops. Georgia uses a relatively small portion of irrigation water due to various reasons, including a decline of agricultural activity and the deteriorated state of irrigation infrastructure. Currently Georgia irrigates only one-fourth of what was irrigated in the country at the end of 1980s. Rehabilitation of the old irrigation channels is underway in Georgia.

Manufacturing sector: The manufacturing sector is the second largest water user in the Kura basin. It accounts for 17% of total water withdrawals. Main industries/manufacturers that use water in the Kura basin are construction, mining (oil, gas, minerals and sandstone), chemical industry (fertilizers, medicine), oil refineries, steel manufacturing and food processing plants.

Domestic water use: 10% of all abstracted water from the Kura basin is used by households. The average water consumption per person per day in the Kura basin is higher than in countries of the European Union or China. Per capita water consumption is particularly high in Georgia, as compared to Azerbaijan.

Energy: Kura basin water resources are used for energy generation, especially in Georgia. Across Georgia 80% of all electricity produced in the country comes from hydropower. Azerbaijan uses substantially less water for energy generation than Georgia. Electricity in Azerbaijan is generated at thermal power stations that run on oil and gas. Both countries use water in the energy sector for thermal power plants as well for cooling purposes but water use in thermal power plants is considerably less.

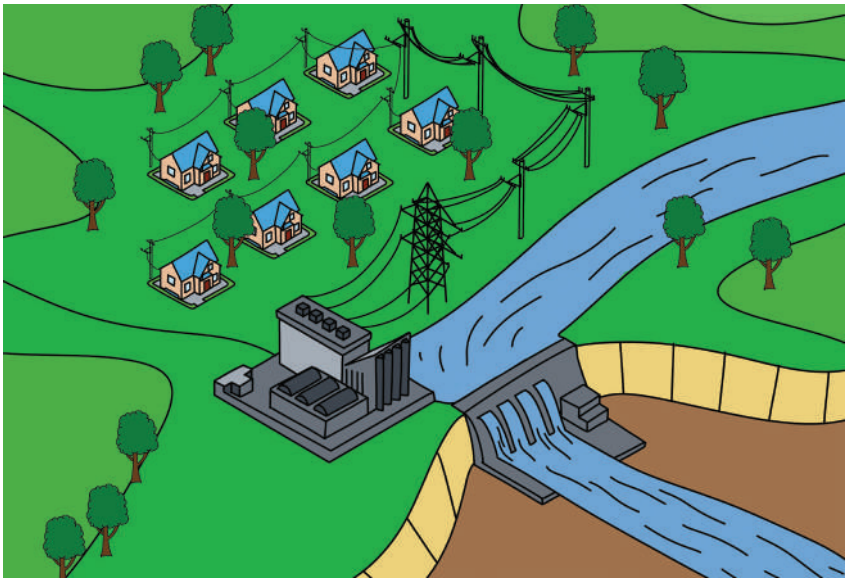
Water used for hydropower generation is considered to be a non-consumptive use as it returns water back to the river (see box 7).

Recreation: The Kura basin is widely used for recreational purposes, especially in warm seasons when residents of the basin flock to rivers and lakes to escape summer heat. The many artificial reservoirs in the Kura basin are used for recreational purposes almost as much as natural water bodies, although their main purpose is provision of water either for energy, irrigation or domestic use.

Quick Facts: Per capita water consumption in the Kura basin

Tbilisi residents consume on average 400 l of water per day. The water consumption is considerably higher among the residents of private houses. Daily consumption here can reach up to 1000 l per person. Daily per capita water consumption in Azerbaijan in 2012 in urban areas was 164 l. For comparison, a resident of Brussels consumes around 96 l a day. Per capita daily water consumption in EU countries is in a range of 100-200 l. (Brussels Environment, 2012) It is relatively higher in the USA - 300-380 l per day per person..

Sources: Forbes GE, 2017; UNDP/GEF, 2013; USGS, 2016;



BOX 7: Consumptive and Non-consumptive Water Uses

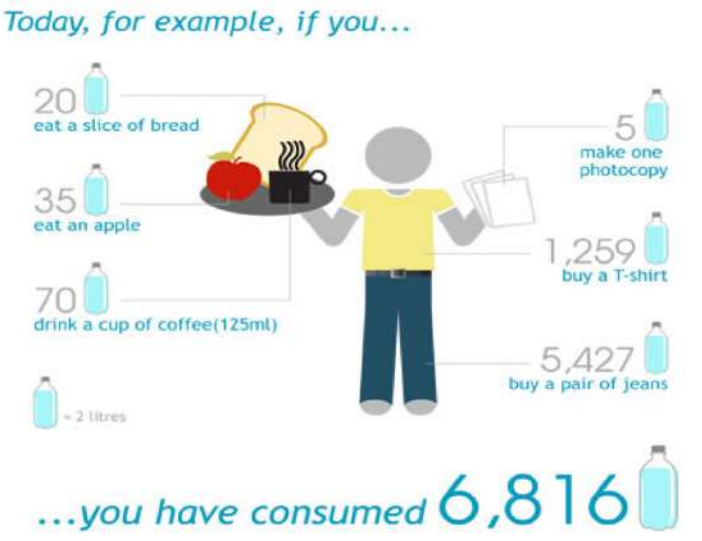
Water consumption refers to a type of water use that is not returned to the original water source (river, lake, aquifer) after being withdrawn. For example, water that is used for irrigation is considered to be a **consumptive use** since water that is applied on the land is no longer available for other uses. It is either taken up by plants and transpired or evaporated from soil into atmosphere. Irrigation water that infiltrates soil may return back to water bodies (through discharged groundwater) but this process takes time. If water use does not involve water withdrawal from a water body and use takes place directly on the river or lake water use is considered to be non-consumptive. For example, a hydropower station or a resort at the lake are **non-consumptive** water users.

BOX 8: Water Footprint

The water footprint is the amount of water used to produce goods and services. It can be measured for a particular product, company, person, city or entire country. Personal water footprint represents the volume of water that was used for production of food person eats, goods she or he buys and uses. Some of the goods we consume are produced locally but others are produced outside of our countries. For example, average EU citizen's footprint is 4,815 liters per day, 40% of which is water that is used outside of the country for production of consumed goods. Water footprint helps us to measure the impact of a person, business, city or a country on water resources. By knowing how much water each of us consumes, we can decide how to use water more reasonably. We can do this by reducing our water consumption and changing consumption behavior by choosing less water intensive products. Following web-site provides information about water footprint of certain products: http://waterfootprint.org/en/resources/interactive-tools/product-gallery/ (in English)

Water Footprint

- *Water footprint is a way of measuring our direct and indirect water use*
- *All human activities use water: drinking, cooking, washing, etc.*
- *The total volume of freshwater used to produce the goods and services consumed by an individual or a community (e.g. production of food, paper, clothes, etc.)*



Source: Food and Agriculture Organisation of the United Nations (FAO) | © 2013 World Vision Hong Kong

World Vision Hong Kong, incorporated with limited liability, is a Christian humanitarian organisation working to create lasting change in the lives of children, families and communities living in poverty.

EXERCISE

EXERCISE 1: Review following list of water uses and identify uses that are consumptive. Explain why are consumptive uses?

1) Agriculture farm; 2) Nuclear 3) Power Plant; 4) Hospital; 5) Fish farm; 6) Rafting club

EXERCISE 2: From the list of water uses presented bellow which sectors have conflicting uses of water and why?

1) Agriculture; 2) fishery; 3) energy; 4) industry; 5) domestic use; 6) transportation 7) water uses for ecosystems;

EXERCISE 3: Use following web-sites to calculate your water footprint.

http://waterfootprint.org/en/resources/interactive-tools/personal-water-footprint-calculator/
or
http://voda.org.ru/save-water/water_calculator/index.php

6

FRESHWATER CHALLENGES IN THE KURA BASIN

FRESHWATER CHALLENGES IN THE KURA BASIN

In the last 150 years rapid population growth, expansion of industrial and agriculture production and urbanization imposed immense pressure on fresh water resources globally. One of the striking examples of over-abstraction of water resources is the Aral Sea in Central Asia that is currently only 10% of its original size[1]. Quality of water has also suffered greatly as a result of human activities. Worldwide large volumes of pollutants are being discharged directly or indirectly in rivers and other water bodies daily. Global warming and water related natural disasters are additional pressure factors that influence the quantity and quality of water resources on Earth. Due to these reasons water availability has been gradually declining worldwide, in some parts of the world at alarming pace. What is situation in this regard in the Kura basin?

Figure 3: Satellite Image of the Aral Basin

The Kura basin suffers from similar problems. Variation and reduction in water flow, pollution of water and degradation of aquatic and other ecosystems are the most pronounced environmental problems of the Kura basin. Climate change and natural disasters in the basin magnify negative impacts of already existing problems. Following sub-chapters and chapter 7 take closer look at the causes of these problems and how they may affect the well-being of the Kura basin inhabitants.

WATER DEMAND VS SUPPLY

Recently conducted studies indicate that in the last decades water flow in rivers of the Kura basin has declined notably. Currently this problem is felt only in the lowlands of the Kura of the basin, where farmers are experiencing water shortages but if water uses expand in the basin, water shortages may become widespread. There are two main factors that will influence the water availability in the Kura basin in future: demand on water and global warming.

Demand on water: experts from Azerbaijan and Georgia expect that in coming decades demand on water will continue to grow in the Kura basin, since the basin will become more populous (particularly its Azerbaijani part) and more households will have access to

[1] Water was abstracted from the Amu Darya and the Sir Darya rivers for irrigation that led to significant reduction of the Aral Sea that was fed by these two rivers.

centralized drinking water supply and sanitation. Demand on water is expected to increase in agriculture and manufacturing sector as well because of expansion of irrigated lands for producing food and manufacturing more goods.

Currently huge volumes of water are lost in the basin through leakages in water supply network, irrigation channels and unrepaired faucets and toilets at home. Low water efficiency also leads to excessive water use in agriculture and manufacturing sectors. If this trend continues, water demand in the basin will grow at higher rates than expected.

BOX 8: Water Use Efficiency

The water use efficiency helps to measure how effective is water user in producing or manufacturing a product or service and whether or not water is wasted (used excessively). It refers to a ratio between volume of water required for production of a good and supplied water; by producing more products with less water manufacturer or farmer increases the water use efficiency.

Climate Change: Climate change will affect both, the water availability and demand. As we will see in chapter 7, climate change is expected to cause reduction of water flow in rivers in the Kura basin. Furthermore, with the rise of temperature, crops that are grown in the basin will require additional water for transpiration. Evaporation of water from rivers, lakes, reservoirs and soil will also increase under warmer weather conditions.

The Kura river basin has fixed amount of freshwater resources. If water flow continues to decline as result of climate change, water uses in the Kura basin might be constrained notably. This will affect the wellbeing of the Kura basin population and lead to social and economic problems. Such risk can be avoided or minimized if water resources of the basin are use more efficiently and water losses are reduced significantly.

DO ECOSYSTEMS HAVE ENOUGH WATER TO SUSTAIN THEIR SERVICES?

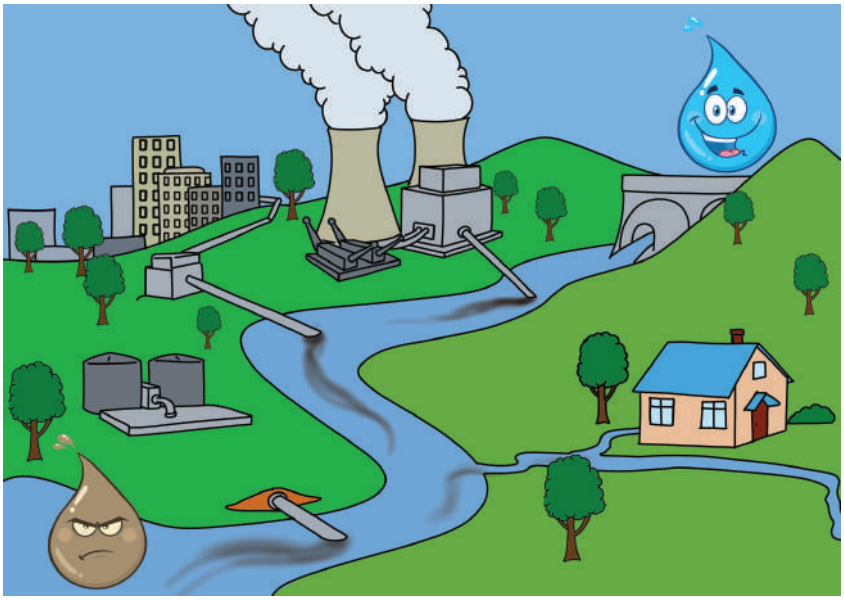
In recent years dried-up rivers have become a common sight in many parts of the Kura river basin. Warm weather conditions that accelerate evaporation is a natural cause of reduction of flow in rivers but if it is combined with excessive abstraction of water, rivers may run dry over long period of time. Decreased flows in rivers affect not only aquatic ecosystems that are immediate victims of the flow reduction but surrounding ecosystems will also suffer as the local climate becomes drier.

Reduction of flow also affects the water quality. Amount of pollutants that are considered safe to discharge due high level of dilution in water, under conditions of low river flows can become deadly for aquatic species and surrounding environment.

River continuity interruptions affect the ichthyofauna/fish populations considerably. For example, the construction of in-stream reservoirs and dams in the Kura basin led to a significant decrease of sturgeon population in the Caspian Sea, as dams prevent sturgeon from accessing spawning grounds that are upstream.

Ecosystems of the Kura basin also suffer from the heavily regulated water flows in rivers making it homogenous[2] throughout the whole year. Declining population of fishes, or sea water intrusion in certain areas of the Caspian coast are some of the examples of negative impacts of regulated flow. In nature the flow of a river changes seasonally. It is higher in spring season and low in summer. Natural variation of flow in rivers is important for performing many ecosystem services. For example, some species reproduce when waters are high in rivers; groundwaters are being recharged when floodplain areas are covered by water (during high water seasons); high flows also protect the coastal aquifers and lands from intrusion of salt from sea. When flows in rivers are constantly low (because of flow regulation or over abstraction of water) recharge of groundwater is prevented or too slow, salty water from the sea starts to migrate to aquafers making groundwater saline. These are few examples of how ecosystem services become disrupted when river flow is heavily regulated.

Reservoirs and dams are important for humans in many ways. They secure water provision for all types of water uses throughout the year. At the same time, they provide protection from floods and droughts. The challenge is to regulate the flow of water in rivers in way that benefits humans but does not endanger ecosystems and their services and biodiversity.



[2] Water level in rivers that are regulated are almost constant throughout the year. The flow in rivers is controlled by water reservoirs and dams that are constructed on rivers. Water engineers decide when and how much water should be released into the river.

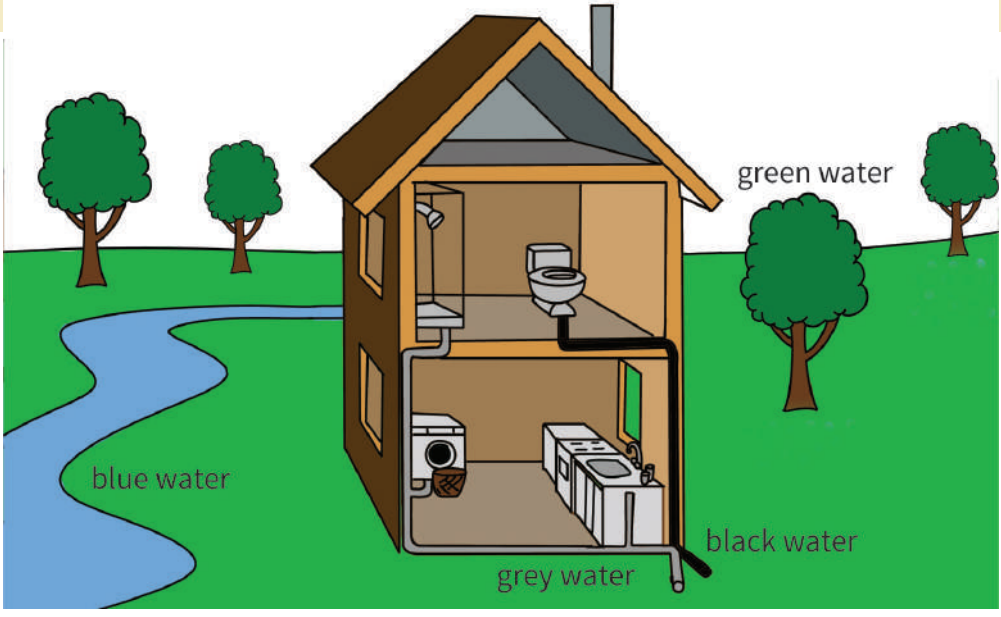
WHERE DO WASTEWATERS AND MUNICIPAL WASTE GO?

In the Kura basin wastewaters are generated by households and manufacturing sector. Particularly large quantities of wastewaters are produced in urban areas by households. Wastewaters that is created at home are collected in sewage networks and delivered to specialized facilities for treatment. These facilities are known as Wastewater Treatment Plants (WWTP). Wastewater from manufacturing sector undergoes initial treatment at the factory to remove pollutants and make it safe for discharging it into waterbodies. What is the situation in this regard in the Kura basin?

BOX 9: Categories of Domestic Wastewater

Wastewaters are categorized into two groups – greywater and backwater. Wastewater that comes from households and does not contain feces (toilet water) is a **greywater**. The greywater is generated from bathing, washing mashies, sinks, kitchen. It usually contains detergents (washing powder), soap, shampoo, cooking oils, food scraps, etc. Greywater makes up the largest (over 50%) portion of total wastewater. Greywater can be recycled and reused for non-drinking purposes (for example for irrigation and industrial use). It is considered to be an important source for reducing freshwater consumption. Blackwater refers to the wastewater that comes from toilets and contains feces, urine and water. It also contains toilet paper and cleansing material used for cleaning toilets. **Blackwater** usually is not reused even after treatment but with increasing water scarcity and technological advancement that allows to treat blackwater to drinking water standards, its reuse is likely to expand and not only in agriculture and industry (more information on this is provided in chapter 9).

Term "sewage" is used to describe domestic wastewater that consists of grey and black waters. You may also come across to such terms as blue and green water. **Blue water** refers to freshwater (water in rivers, groundwater, etc). The soil moisture that is absorbed by plants is **green water**.



The water quality in the Kura basin has suffered from significant deterioration during the last hundred years. Experts argue that water pollution was particularly high in the end of 1980s. Since then it has improved as a result of the closure of many industrial facilities in 1990s but the pollution from domestic water uses has increased in the same period. Because of lack of maintenance, the WWTPs were either put out of operation or perform treatment only partially. The situation has been improving gradually, as new WWTPs are being constructed and old WWTPs are rehabilitated, particularly in Azerbaijan by the Azersu JSC supported by the Government of Azerbaijan. Georgia plans to do same in coming years, but there is still long way to go before pollution from domestic wastewater is completely eliminated both in Azerbaijan and Georgia.

Polluting substances enter the Kura river and its tributaries from manufacturing sector as well. Here one of the main polluters is the mining sector that is responsible for disposal of insufficiently treated wastewaters. Other sectors that contribute to increased loads of pollutants in rivers are construction, oil refineries, chemical industry, etc. Agriculture sector is also responsible for degraded water quality in the basin. Fertilizers, herbicides and pesticides that are applied on the land by farmers leach in groundwater. Groundwater then transports these compounds to rivers and lakes elevating levels of chemicals there. Through monitoring of chemical parameters of waters, it has been determined that for example, in the Kura Basin in Georgia the Suramula, Lekhura and Mashavera rivers suffer most from pollution. In Azerbaijan, downstream from the major cities the Kura rivers the water quality suffers from increased pollution loads.

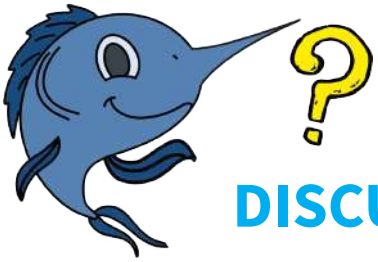
Water quality is a problem for the entire Kura basin but particularly vulnerable to this problem are the downstream water users in Georgia and particularly in Azerbaijan, especially in summer season when concentration of pollutants increases as a result of low water flow.

Quick Facts: : how long does it takes to plastic bottle to decompose

Average time for degradation of a plastic bottle is 450 years or more; breaking down of plastic bag may take from 10 to 20 years.

Pollution of water by plastic: pollution of water bodies by plastic is an unfortunate reality in the Kura basin. The problem becomes evident in spring season once the flow in rivers increases. The sight of floating plastic bottles on rivers and reservoir becomes are particularly striking in Tbilisi and Mingechavir. Annually large volumes of plastic end up in rivers and other water bodies. This problem is caused by improper management of municipal waste both in Azerbaijan and Georgia and negligence of people. Particularly noticeable is the problem in rural areas, where population lacks access to proper municipal waste management services. It is often the case that the

waste accumulated in households is nowhere to dispose and households either burn it or dispose at illegal landfills. Such landfills are often located in close proximity to rivers. In spring season when waters are high in rivers waste that is disposed at river banks is easily washed away and transported downstream. This is a type of water pollution that can be easily avoided if every resident of the Kura basin behaves more responsibly and either avoids creating plastic waste or disposes it safely, away from water bodies.



DISCUSSION QUESTIONS

- Can you think of any unsustainable water use practices in the area where you live? Discuss in classroom how water is wasted and if wasteful uses can be avoided?
- How can water pollution affect the availability of water for human or ecosystem needs?
- What happens to the water pollution when water flow in rivers declines?

7

LESS CERTAIN FUTURE DUE TO CLIMATE CHANGE AND DISASTERS

LESS CERTAIN FUTURE DUE TO CLIMATE CHANGE AND DISASTERS

SCIENCE OF CLIMATE CHANGE

Climate change is considered to be a biggest threat to human development and security. It is a great challenge for the Kura basin as well, in terms of its impacts on water resources, land and ecosystems. This chapter provides a short overview of climate change causes and its impacts globally and in the Kura basin.

Climate change is not a new phenomenon for our planet. In fact, climate on Earth has been changing continuously. The change was driven by natural factors, such as solar radiation, volcanic eruptions, etc. In past it would occur gradually and span over hundreds, thousand- or even millions of years allowing the nature and living organisms to adopt to changing climatic conditions[1]. The change that is being observed during the last 150 years is different. It is happening rapidly leaving little or no time for adapting to new climate. This change is largely attributed to human activities that caused the accumulation of unprecedented amount of heat trapping greenhouses gases in the atmosphere.

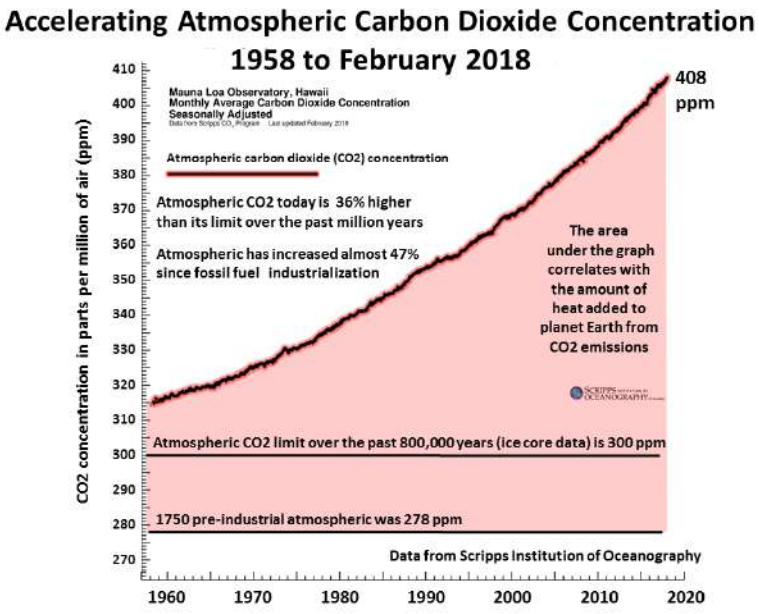


Figure 5: Carbon Dioxide Concentrations (ppm) by years

[1] the Earth experiences seven ice ages and warming periods cause by natural factors.

It all started after the industrial revolution in the end of 18th century, when the steam engine was invented. Fossil fuels[2] were used to generate energy and to keep engines running. Since then humans have been burning fossil fuels at ever growing rates for machines, transportation means, heating and cooling houses and for generating electricity.

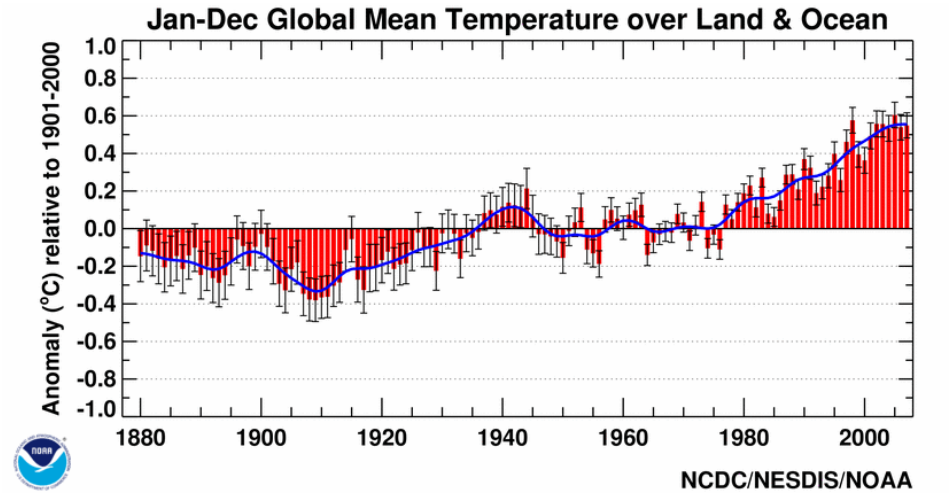


Figure 6: Land and ocean surface temperature anomaly 1850-2012

In the process of fossil fuel burning large quantities of gasses are emitted. Emissions among others gases include carbon dioxide (CO_2), methane (CH^4), water vapor, halocarbons and nitrogen oxide (NO_2) that are known as greenhouse gasses[3]. These gases trap sun energy near the earth surface and warm up the atmosphere. This is a natural process taking place on Earth as long as it exists but since the last 150 years humans have been releasing into atmosphere increasing volumes of greenhouse gases. Scientific evidence shows that since 1790 the concentration of CO_2, CH_4 and NO_2 emissions in the atmosphere increased by 40%, 150%, and 20%, respectively[4]. Increased amount of GHGs trap more heat on Earth that causes the rise of temperature.

Quick Facts: Where the Greenhouse gases come from

Currently energy sector is the largest source of GHG emissions. In 2010 it accounted for the release of 35% of total GHG emissions. Agriculture, forestry and other land use was responsible for 24% of GHG emissions; 21% was released from industry; 14% - by transport and 6.4% - by the building sector. Since 2000, GHG emissions have been growing in all sectors, except in agriculture, forestry and other land use.

Source: IPCC, 2014 WG III, AR5

[2] Fossil fuels include oil, coal and natural gas. These materials are combustible deposits that were formed from decayed plants and animals in the earth›s crust over hundreds of millions of years.

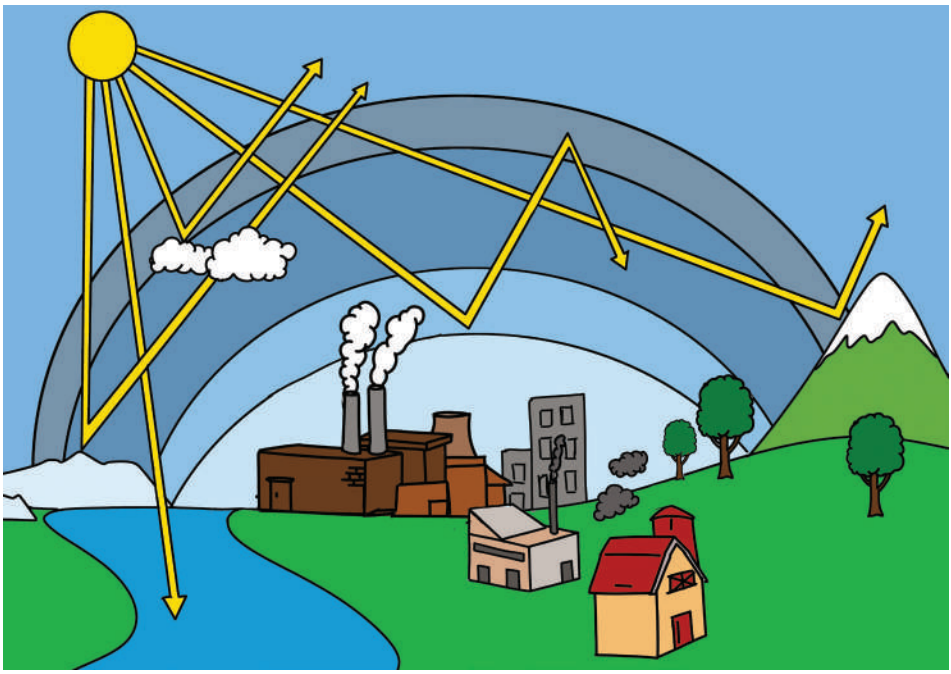
[3] Other gases that contribute to greenhouse effect are CO, NO_2, SO_2, NH_3, etc

[4] Source: IPCC, 2014

WHY SHOULD WE WORRY ABOUT CLIMATE CHANGE?

The average global temperature on Earth has increased by 0.85°C since 1880 to 2012[5]. The rise of atmospheric temperature by less than 1 °C has triggered huge changes all around the plant. Glaciers have been shrinking in size at alarming speed; the Artic sea ice and northern hemisphere snow cover have continued to decrease; loss of ice mass is being observed in the Greenland and the Antarctic and extreme weather events are on raise globally.[6]

These changes will have dramatic consequences for human life. Global sea that is projected to rise by 0.3-1.2 meters, will affect the population living in coastal areas. Humans will suffer from natural hazards that are expected to become more frequent and severe in future. There are other adverse impacts as well - reduced water flow in rivers, land desertification, spread of diseases, changes in biodiversity and ecosystem services are just few to name.



CLIMATE CHANGE IMPACTS IN THE KURA BASIN

Current trends: Historical weather data of Azerbaijan and Georgia confirms the increase of annual temperature in both countries. According to the scientific data of the last decades, in the Kura basin, average temperatures rose by 0.7°C in Georgia and 0.9°C in Azerbaijan. The increase of temperature was observed mainly in summer season. The amount of precipitation decreased during the same period in both countries. The number of days

[5] Source: IPCC, 2013
[6] Source: IPCC, 2014 WG III IPCC

with temperature above 25°C have been on raise. For example, during 2001-2010 in Baku the number of such days increased fivefold compared to 1961-1990. Another worrying sign of climate change in the basin is the recession of glaciers. In Georgia for example in the last 50 years the glacial area was reduced throughout whole country by 30%. In Azerbaijan it shrunk by approximately 45 % since 1890.[7]

Projections: Scientists use climate models (computer programs) to predict how the climate may evolve in the future. These models help to calculate how much and how fast the climate may change under certain conditions. For example, climate models help us understand how the climate would respond to an increase of GHG emissions, or how a change of temperature by 1 or 2 degrees would affect the glaciers or the water flow in rivers.

By applying various climate models for analysis, climate scientists from Azerbaijan report on a possible increase of temperature by 0.7-1.58 °C during the period 2015-2050 according the National Report on Climate Change. No change of temperature is expected in the eastern part of Georgia but a significant reduction of water flow in the Kura river and its tributaries is likely to occur in both countries. The most sensitive sector to climate change will be agriculture. The glacier recession is expected to continue. In the short run this will lead to the creation of glacial lakes and an increase of water flow in rivers, but in the long run the retreat of glaciers will result in reduction of water flow in rivers and lakes. If the current trend of temperature rise continues, glaciers in Georgia will completely disappear by 2160. Glaciers are critical for the generation of water flow in rivers of the Kura basin. If we take into consideration that 14% of the water flow in the basin is generated from the melting water of glaciers, it is likely that the impact on river flow will be substantial if glaciers continue to retreat. Climate models also forecast an increase in the number of hot days in urban areas. Tbilisi and Baku are expected to suffer the most in this respect.

There is no doubt that climate change will remain as a problem for the rest of the 21st century and beyond. The extent to which the climate is going to change and how severe the impacts of climate change will be on human lives depends on how well we manage to

[7] Sources: The 3rd NCR AZ, 2015 and the 3rd NCR GE, 2015

adapt to its impacts and whether or not the global community manages to stop the further rise in temperature.

Climate change is a global challenge that does not know borders. Greenhouse gases emitted by individual countries creates a cumulative impact that affects the whole world. Therefore, only joint action to reduce greenhouse gas emissions can slow down the temperature increase and give us and the planet sufficient time to adapt to emerging changes.

VULNERABILITY OF THE KURA BASIN TO NATURAL DISASTERS

Natural hazards such as landslides, mudflows, floods and flash floods are among the most frequently occurring climate-induced hazards in the Kura basin. Many urban areas in the Kura basin are located in mountainous terrain, which makes them more susceptible to natural disasters. These events have been on the rise during the last several decades. Floods in Azerbaijan and Georgia tend to occur in June-July (at high altitudes) or in spring and autumn (at lower altitudes) as a result of snow melting and rainfall. In many catchments in the Kura basin, extreme precipitation also leads to mudflows. The farmers of the basin periodically suffer from droughts, frost, hailstorms and strong winds as well.

Hazards have major impact on human well-being by endangering lives and affecting properties. Extreme weather events damage harvests and destroy houses and livelihoods of people. Unfortunately, natural disasters also result in human casualties. In Georgia, for example, during the period 1987-2013 up to 600 people lost their lives and 60,000 families were relocated as a result of natural disasters[8]. In Azerbaijan, in 2015-2016 the Ministry of Emergency Situations Management recorded 263 natural disasters[9].

Studies suggest that these extreme events are mostly attributed to climate change and that natural hazards are expected to become more intense and severe in future.

Natural Disaster Risks = Natural Hazard x Exposure x Vulnerability

How natural hazards affect communities depends on three main factors: 1) how intense is natural hazard 2) how exposed is the population to this hazard and 3) how vulnerable are communities to damages inflicted upon them by the hazard. For example, cities and towns, where population density is high, are more exposed to floods or forest fires than areas with no population. The settlements with important infrastructure (for example an oil terminal or port) are also considered to have high exposure to natural hazards because of high probability of damage from natural hazards. Exposure to natural hazards cannot be fully avoided but it can be reduced if population is evacuated before natural hazard strikes and infrastructure is reinforced or protected. Poor design and construction of buildings also affect the vulnerability of population to natural hazards, as such buildings are more predisposed to damages from natural hazard. For example, reinforced buildings are less susceptible to damage from earthquake. Poor communities are particularly vulnerable to natural disasters because they have limited means to cope with disaster – means to escape affected area and resources to rebuild their livelihoods (houses, farms, etc.).

[8] Source: SoE, 2013.
[9] Source: MES, 2018

EXERCISE

EXERCISE 1: Greenhouse gases

- Discus how are greenhouse gasses generated. Consider both natural and anthropogenic sources.

EXERCISE 2: Self-reinforcing nature of climate change

- Consider climate change impacts and discuss in class why global warming once triggered is self-perpetuating and reinforcing?

EXERCISE 3: Climate change impacts in the Kura basin

Based on information provided in chapter 7 discuss in 2 or 3 groups what are climate change implications for development in the Kura basin? Summarize all impacts in form of infographic and present it to the class.

8

WHY DO WE NEED TO MANAGE WATER?

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MANAGING WATER

Countries may have freshwater resources in sufficient quantities but water becomes usable and accessible only after it is abstracted from a water body and delivered to water user on a particular time, in required volumes and acceptable quality. For this purpose, countries build water reservoirs, irrigation canals, drainage systems, dams, water supply and sanitation network, pumping stations, drinking water and wastewater treatment facilities, etc. Water infrastructure is a broad term for these facilities that are used to supply, treat and store water resources. This infrastructure also provides other services as well, as for example, protection from flood. Water infrastructure requires operation and maintenance to provide services uninterruptedly. Skilled work force and financial resources are needed for this purpose. To secure the quality and quantity of water and allocate water resources equitably certain laws and regulations have to be introduced by lawmakers. There have to be institutions[1] that implement and enforce these laws and protect water resources. All above listed are important elements of water governance and management.

Water management has multiple objectives. It aims to:

- make water available for all water users including environment and ecosystems in sufficient quantities
- ensure that water resources are in good quality and are used efficiently
- minimize water related disaster risks (such as flooding, drought and contamination).

[1] Water institutions are organizations or establishments that govern different aspects of water management. For example, some institutions monitor water quality or reinforce the laws, while others are responsible for operation and safety of water infrastructure.

These objectives are implemented in life by law makers (in parliament), water resources managers (in institutions) and water service provider companies and water users, such as industries, farmers, general population etc. The figure 7 below gives an overview of responsibilities and functions of each stakeholder in relation to water management.

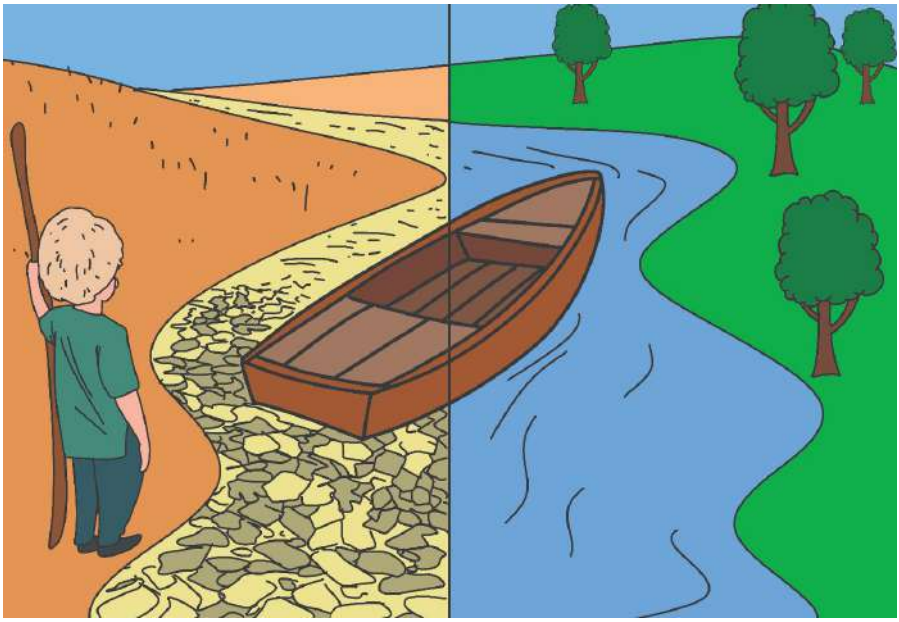
Figure 7: Who does what in relation to water management?

WHY DO WE MONITOR WATER RESOURCES?

Managing water resources is a complex task. Managers and decision makers have to find the most effective and efficient solutions to emerging water problems. To propose such solutions, they need to be well informed about the state of water bodies. In particular, decision makers require data on: water quantity and quality, how efficiently water is used, what is water demand trend in near future, what is the risks of natural disaster in a certain area, etc.

Data gathered through water monitoring is one of the important sources of information for decision making. Water monitoring tracks the change in water quality and quantity and helps to analyze possible implications of these changes on environment and humans. This information is needed to identify the most affected parts of the river basin and to develop practical measures for eliminating problems. Monitoring data is also used to advise population whether they can use a certain water body (lake, sea, reservoir) for recreational purposes.

Each country regularly collects data about its water resources. Data is collected at hydro-meteorological stations, where meteorological and hydrological observations are carried out. The stations measure the water level and discharge value to track the changes in water flow. Water samples collected from water bodies at different locations are used for analyzing water quality. Water quality monitoring looks at temperature, pH level, concentrations of oxygen, nitrogen, phosphorus, sulphates, calcium, potassium, nitrites and nitrates, phenols, and heavy metals, depending on the country. In addition to the chemical profile of water, monitoring agencies also analyze the sediment and observe biological elements (for more information on bio-monitoring see box 11).



This is necessary to assess the health of aquatic ecosystems. Monitoring is conducted with a certain frequency that allows to observe seasonal changes. In the Kura basin hydro-chemical observations are carried out at over 100 sampling points (32 points in Georgia and 68 points in Azerbaijan)[2]. Some of the hydro-meteorological stations are equipped with automated stations that measure hydrometeorological parameters and transfer data automatically to environmental monitoring agencies.

COMPUTER MODELS

Water managers or specialists of emergency situation management are often confronted with situations when they have to make decision in a relatively short time, for example in the event of natural hazards. Information on precipitation level, water flow, population density, location of industries in the area, etc. are usually available but it is difficult to predict the course of events and identify areas that will be affected the most or first. With the help of computer models, it is possible to simulate and predict the outcome of such events (for example, heavy rain or forest fires) and calculate precisely which settlements are to be affected. Based on these analysis managers can decide on how to respond to an emergency situation and minimize disaster risks. Commuter models are also used to calculate future water demand or to determine the most optimal water allocation between different water users. Possible impacts of climate change that was reviewed in chapter 7 is based on predictions computed by such climate change models.

BOX 11: What is Aquatic Bio-monitoring

Traditional methods of monitoring of water resources include physical and chemical measures of water quality. Measuring these parameters helps to understand the extent to which water bodies are polluted, but it tells us little about the health of aquatic ecosystems. Bio-monitoring on the other hand helps to observe how degradation of the water quality has affected ecosystems, biodiversity and their habitat by looking at the number and types of organisms present in a water body and the conditions in which they live. It also helps to detect whether certain segments of the water bodies have ever been exposed to pollution. As monitoring of physical and chemical parameters of water quality takes place only with a certain regularity, it provides information only on the condition of water when water samples are taken. Thus, some discharges of pollutants into rivers may never be detected (for example illegal discharges of wastewater at night). Such pollution, however, does not stay "unnoticed" by aquatic species. Bio-monitoring therefore helps us to observe the condition of a particular water body over a relatively long period of time. Bio-monitoring uses plants and animals to assess the state of a water body. In particular, it focuses on invertebrates, algae, macrophytes (aquatic plants), fish and amphibia. Bio-monitoring is a relatively new method of water monitoring for Azerbaijan and Georgia. Georgia started to regularly monitor macroinvertebrates only recently. In Azerbaijan bio-monitoring is currently performed seasonally.

[2] Based on information of the Ministry of Ecology and Natural Resources of Azerbaijan and the Ministry of Environmental Protection and Agriculture of Georgia.

SUSTAINABLE DEVELOPMENT GOAL 6

Water is critical for social development and economic prosperity of countries. This is why water issues have been always high on the agenda of international organizations and global discussions. In September 2015 at the UN Summit on Sustainable Development was adopted *the 2030 Agenda for Sustainable Development.* The UN member states agreed to work together to achieve 17 Development Goals that address the challenges related to poverty, inequality, climate change, environmental degradation. A separate goal (the Goal # 6) is dedicated to water and aims to ensure the availability and sustainable management of water and sanitation for all people by improved access to water and sanitation, reducing water pollution, increasing water use efficiency, improving cooperation between countries and protecting and restoring water related ecosystems. Water issues are of high relevance for other SDGs as well. This is why several targets under various goals refer to water (see exercise 1).

Azerbaijan and Georgia, as responsible members of international community, have already engaged in the implementation of SDGs and are aligning their national development plans to SDGs and their targets.

EXERCISE

EXERCISE 1: Sustainable Development Goals: Review Sustainable Development Goals and their targets from the resources provided by the teacher. Identify goals and targets of that are directly or indirectly linked to water and explain their link to the Sustainable Development Goal (SDG) 6.

9

A BETTER WAY TO A BRIGHTER FUTURE FOR THE KURA BASIN

A BETTER WAY TO A BRIGHTER FUTURE FOR THE KURA BASIN

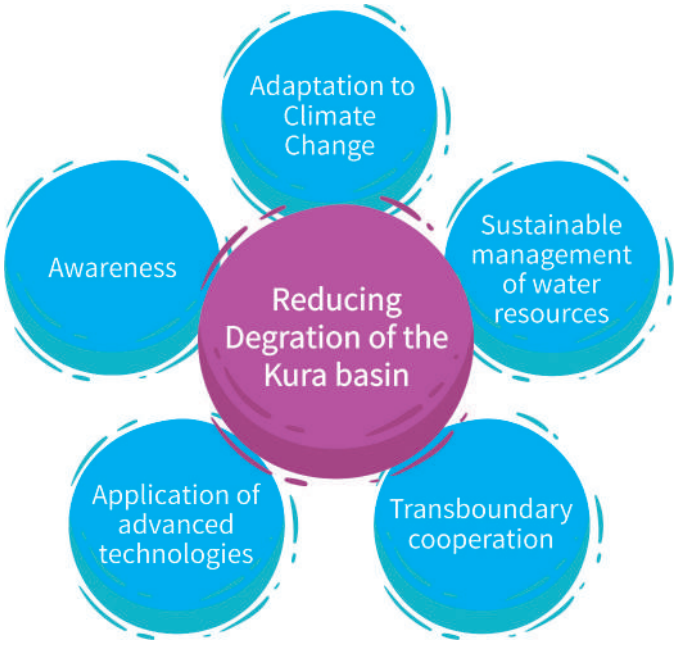
The Kura river is an essential source of fresh water resources for Azerbaijan and Georgia. The river is transboundary in nature and has complex surface and groundwater systems that cover almost two thirds of the South Caucasus region. The water resources of the Kura are used by more than 7.6 million Azerbaijani and Georgian residents of the basin for irrigation, energy generation, industrial and domestic uses. An additional 2.3 million residents of Baku[1] also benefit from the water resources of the Kura basin. The water resources and surrounding environment of the basin is therefore considered to be a key element for the prosperity and security of the two nations.

As we have seen in chapters above, economic activities and population growth had a significant impact on the water resources, environment and ecosystems of the Kura River Basin. As a result of this development, the Kura river basin today faces many challenges that require an immediate action. Reduction in water flow, unsatisfactory water status, impacts of climate change, increased threats from natural disasters and degradation of ecosystems are the most pronounced problems of the Kura basin that are acknowledged by both countries.[2] Good news is that Azerbaijan and Georgia agree that degradation of the basin is a problem that needs to be addressed immediately and through joint efforts.

[1] Source: The State Statistical Committee of Azerbaijan
[2] Source: UNDP/GEF, 2013

In order to improve the state of the basin its problems have to be approached from different angles simultaneously. For example, by applying **sustainable water management practices** further reduction of water flow in rivers can be prevented and the quality of waters can be improved. Application of **advanced technologies** will help to conserve water resources and reduce abstraction of water from water bodies; **adaptation to climate change** would minimize possible adverse impacts of climate change; strengthened **transboundary cooperation** will help countries to promote sustainable water management at transboundary level. **Awareness of public** (including school students) about the problems of the Kura basin and best practices to resolve these problems, is an important prerequisite for speedy and successful transformation towards more sustainable future for the Kura basin.

Figure 8: Key elements of reduction of the Kura basin degradation



SUSTAINABLE MANAGEMENT OF WATER RESOURCES

In order to manage water resources sustainably certain principles and rules have to be observed by water managers. For example, a decision on development of a new hydropower station cannot be made individually without taking into consideration other water uses in the river basin – for example farmers or municipalities depending of the water resources of the basin. The actions and plans of water users have to be **coordinated** and agreed among all water users. Water managers should make sure that if additional volumes of water are to be withdrawn from water bodies remaining water is sufficient to support the environment and ecosystems services.

Water bodies have to be closely monitored to control the level of pollution in water bodies (not to allow pollution concentrations to exceed the maximum permissible levels) and to protect ecosystems of the water bodies from major alterations. This is done through **monitoring the changes in aquatic living organisms, hydro-morphology of water bodies** (water flow, depth, structure of river bed, etc.), as well as **chemical characteristics** (phosphor, nitrate, dissolved oxygen, etc.). By looking at all these parameters we can understand how healthy are water bodies and to what extent are ecosystems disturbed by pollution and reduced water flow.

Incentivizing water users to use water resources more efficiently and penalizing water losses is another important aspect of sustainable water management that promotes **conservation of water resources**.

As international practice shows, above listed approaches to water management yield positive results only when they are applied across the entire river basin. Therefore, water managers need to develop a **River Basin Management Plan** (RBMP) for whole basin that proposes concrete actions to be implemented in a given period of time. When rivers are transboundary, such RBMP has to be discussed and agreed among the countries sharing the river basin. Such plans are being developed in Azerbaijan and Georgia for rivers of the Kura basin but currently such a joint plan does not exist for the transboundary Kura basin.

CLIMATE CHANGE ADAPTATION

Temperature increase in the Kura basin by 0.7-0.9°C [3]has already resulted in recession of glaciers, decrease of precipitation and reduction in water flow. Climate change models indicate that the impacts of climate change are likely to intensify in the future. Increased water shortages, decreased agricultural productivity, degradation of pastures, and intensification of extreme weather events are some the anticipated adverse impacts in the Kura basin. The changes in temperature and precipitation are likely to affect the basin's biodiversity and ecosystem services as well. Climate models suggest that extreme weather events will become more frequent and severe in future.[4] Politicians and water managers in Azerbaijan and Georgia agree that climate change can undermine prosperity of the countries and therefore adaptation is needed to minimize its adverse impacts. The Kura river basin would significantly benefit from a basin wide climate change adaptation plan that would help Azerbaijan and Georgia to coordinate and complement national climate change adaptation measures.

[3] Temperature in the Kura basin in Georgia rose by 0.7°C during last 50 years and in Azerbaijan by 0.9°C during 1991-2010.

[4] Sources: The 3rd NCR AZ, 2015 and the 3rd NCR GE, 2015.

TRANSBOUNDARY COOPERATION

Azerbaijan and Georgia have been enjoying good neighborly relations for centuries. These relations are based on trust, mutual respect and support. The countries cooperate on a broad range of issues such as energy development, transportation, trade, and emergency situations management[5]. There have been many transboundary initiatives to build cooperation and harmonization for shared management of the Kura River Basin since the year 2000 which benefit the people of the region.

ADVANCED TECHNOLOGIES FOR CONSERVATION OF WATER RESOURCES

As we have seen in the chapter 6, water demand in the Kura basin is expected to rise in coming decades. There are two options to ensure that increased demand is satisfied: 1) to increase water withdrawals from water bodies and 2) to manage water demand through water conservation. Water conservation refers to activities that aim at reducing demand on water, improving the water use efficiencies and reducing the losses and wasteful uses of water. If first option requires huge investments for development of new water infrastructure (water reservoirs, network of pipes, etc.), the second option allows to tap into already supplied water that was either lost in the system to leakages or used excessively due to

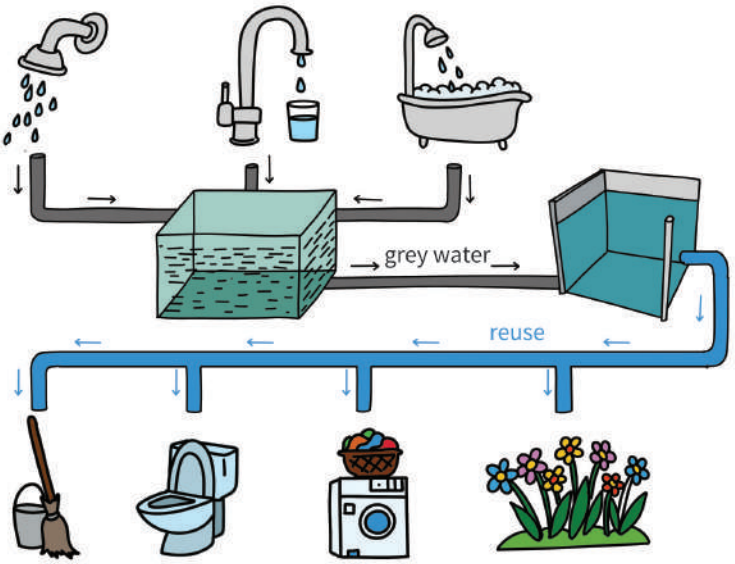
Quick Facts: Water Efficiency and Water Reclamation

Israel managed to increased its agriculture production significantly with only a slight increase of water consumption. This was achieved through increased efficiency of irrigation (up to 77%) and use treated wastewater. Currently 38% of all water used in agriculture comes from treated wastewater. Israel plans to further increase the share of treated wastewater in agriculture up to 67% by 2050. In Canada the 51% of water used in industry is recirculated/reused water.

Sources: Rejwan, A. 2011; WWDR 2017

[5] The Baku-Tbilisi-Kars railway project and the Southern Gas Corridor project are among the latest joint partnership projects.

low water efficiency (wasteful uses of water). Furthermore, in a view of climate change, the first option does not guarantee that available freshwater resources will be sufficient to match demand on water if it continues to increase continuously. But if water losses are reduced considerably and water productivity and efficiency is increased, additional quantities of water will be "created" (freed up) in the system that can be used to satisfy increased demand on water. Advanced technologies can play a key role in creating this "additional" water. Here are presented some of the available technological solutions for water conservation that are applied worldwide.



AGRICULTURE: advanced irrigation methods, such as for example drip and sprinkle irrigation[6] help to reduce use of water in agriculture and create additional sources of water for possible expansion of irrigation lands in the Kura basin without changing much the total water abstraction for agriculture. Agriculture can also benefit from introducing drought resistant crops as they use less water than their traditional alternatives.

Quick Facts: Six most water thirsty crops

Crop	Typical water requirement (in liters) per kilogram of crop
Cotton	7,000-29,000
Rice	3,0000-5,000
Sugar Cane	1.500-3.000
Soya	2,000
Wheat	900
Potatoes	500

Source: WWF, 2006

[5] Drip irrigation allows water to drip slowly to the roots of plants and to apply exact amount that matches plant water requirement. Sprinkle irrigation allows to spray water into the air in a controlled manner. It imitates the effect of a rain. Both methods require a network of pipes, pumps and valves

HOUSEHOLDS: another important source of water is wastewater. 99% of sewage consists of water. If this water is removed and made clean again through treatment, large amount of water can be reclaimed for use in agriculture or industry. In some countries the wastewater treatment process is so advanced that **reclaimed water** is used for drinking purposes as well. For example, population of Australia, Namibia and Singapore, New Mexico and some settlements in the USA including in California and Virginia are already drinking treated wastewater[7] .

By replacing old household appliances (such as for example less efficient washing machines, dishwashers, flash toilers, facets and showers) with alternatives that use less water, water consumption in households can be reduced considerably. In some places around the world, where precipitation levels are high **rain water harvesting** is another way to reduce water use in households. For example, in Flemish region of Belgium 43% of all households collect rainwater and use it for various purposes at home[8].

DESALINIZATION: is another example of reclamation of freshwater. It is widely used in countries of the Middle East. Large volumes of water are produced from the sea water through desalination process and supplied to households and industry. Desalinization is carried out in Azerbaijan as well. The seawater desalination plant on the Caspian Sea coast that was put in operation in the Salyan rayon in 2013. The plant has the capacity to desalinate up to 20,000 m^3 per day.

[6] Source: WWDR, 2017

[7] Source: Brussels Environment, 2012

INDUSTRY: water saving gains can be considerable in industry as well. It can be achieved through water **recycling**, application of **water efficient technologies** and **elimination of water losses**. Depending on the type of production process the industry can use its own wastewater either in a treated or untreated state. Recycling of water can be repeated many times.

EXERCISE

EXERCISE 1: Wastewater treatment: Review background material (Box 4) about the wastewater treatment and develop a scheme/diagram illustrating the water reclamation from wastewater;

EXERCISE 2: Water polluters: Discuss in class the reasons why industries continue to discharge wastewater although they have to pay fines for violating wastewater discharge regulations.

EXERCISE 3: Efficient irrigation methods: Four volunteer students will be requested to prepare a homework on five different types of irrigation methods - surface irrigation, drip irrigation and sprinkle irrigation. Each student will gather information (from suggested online sources) on a particular method of irrigation and prepare a short note (maximum one page). The group will present results of their research to the class and disseminate the notes about the irrigation methods. The class will then discuss what are the advantages and disadvantages of each method and if they can be applied in their region/country.

10

TIME TO ACT – MY ROLE IN PROMOTING SUSTAINABLE WATER USE IN THE KURA BASIN

10. TIME TO ACT – MY ROLE IN PROMOTING SUSTAINABLE WATER USE IN THE KURA BASIN

If you have reached this chapter of the publication, it means that you now have a pretty good understanding of why Kura basin has reached its current level of degradation and what are the main challenges of the basin. We also took a glimpse of the future by analyzing what can happen in the basin when population grows, economic activities intensify and air temperature continues to rise. You may feel that your individual efforts to reduce the degradation of the Kura basin will not make a difference because challenges are too big and many. But you should not forget that these very problems the basin suffers from, have been created by us, humans and therefore, it takes an effort of all of us to fix them. Think of a snowball effect. As snowball rolls on the snow-covered hillside, it picks up more snow, grows in mass and size and accelerates its speed. It can even turn into a massive avalanche impacts of which are significantly greater than that of a small snowball. You can compare your contribution to the reduction of the basin degradation to the snowball effect. The more people follow the suit the greater will be the impact of your actions and faster will be the transition towards more sustainable water use and management in the Kura basin. Below presented exercises will provide you with some ideas about what you, as an individual, could do for:

- conservation of water resources of the Kura basin;
- adopting to climate change to minimize its negative impacts on your family and the Kura basin in general.
- promoting the cooperation between Azerbaijan and Georgia at school level.

TOOLBOX FOR WATER CONSERVATION AT HOME AND SCHOOLS[1]:

Water conservation is the practice of using water efficiently and avoiding wasteful use of water. Using water more efficiently does not come at the expense of your life standards. You can still enjoy same comfort and services but use less water if you use water more efficiently and avoid unnecessary water losses. Conservation of water for domestic use can be achieved through implementation of following measures:

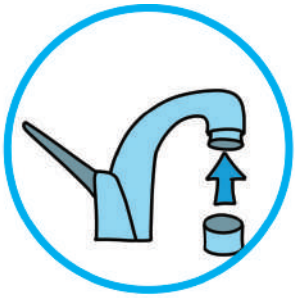
[1] Information about water saving tips is sought from following sources: the UN website on SDGs https://www.un.org/sustainabledevelopment/takeaction/; the web-site of the US Environmental Protection Agency – Water Sense: https://www.epa.gov/watersense/about-watersense, the website of the Alliance for Water Efficiency, Saving Water -Efficiency Tips https://www.home-water-works.org/water-conservation-tips/home

KITCHEN:

- For washing dishes, you can fill up the sink with water instead of washing dishes under running water
- Consider installing water saving devices – for example a dishwasher
- Do not defrost food with running water. You can defrost it in fridge overnight or during the day
- Do not cool soft drinks, mineral water, watermelon or melon under running water
- When washing dishes in dishwasher, always pay attention if it is fully loaded. Avoid washing half loaded machine
- Keeping drinking water in fridge instead of running water from tap until the water is cool
- Look for leaks regularly and when detected repair them as soon as possible

water conservation tips

water plants
morning or night

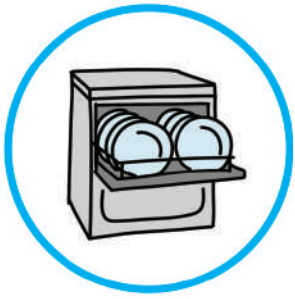


installing water saving devices
to stop leaks

taking short showers

regularly repair leaks

close water faucets
when you brush teeth



load the dishwasher fully

BATHROOM:

- Close water faucets when you brush teeth or shave; teach your siblings and other family members to do same
- Detect shower or toilet tank leaks and repair them
- Replace old faucets and flash toilets with water saving models. For example, old toilets have one flush, while water saving models have two options for different flush volume. You can reduce water consumption by flushing with less water; pull-out faucet also helps to save water as it allows you to shut off water instantly
- Check what is the flowrate of your showerhead per minute. If it is greater than 9 liters,

replace it with a low flow shower head (using 7-8 liters per minute)
- Taking short showers (5-10 min) instead of bath in a bathtub saves a lot of water
- When washing laundry in washing machine, always pay attention if it is fully loaded. Avoid washing half loaded machine.

- Collect rainwater for using it watering plants in your yard (if you have a house)
- Water/irrigate yards in the morning to minimize water evaporation
- Check your garden hose for leaks and fix or replace if it leaks
- Replace old models of garden hose nozzles with water saving models that regulate water intensity (pressure) and can be instantly shut off
- Install water sprinklers for garden irrigation
- Consider washing your parents' car or your own bicycle with a bucket of water instead of running water (with house)
- When cleaning out fish tanks (if you have fishes at home) you can use water from fish tank for watering plants as it is rich of nutrient
- water plants in your garden deeply to facilitate deep root growth. In this case you will need to water plants less frequently and also helps them to become drought tolerant
- water plants only when necessary. Overwatering is as harmful as underwatering

TOOLBOX FOR CLIMATE CHANGE ADAPTATION (MEASURES RELATED TO WATER USE ONLY)[2]:

IRRIGATION:

- harvesting rainwater run-off from road or adjacent lands in pond or tank for further use for irrigation. It reduces dependency on rain or irrigation water;
- retaining crop residues on the soil surface to slow water run-off, increase soil infiltration and reduce water evaporation. It has positive impact on crop productivity but the method requires proper pest management;
- applying raised bed planting and furrow irrigation (digging trenches between crop rows) to increase the surface irrigation efficiency by boosting water infiltration rates;
- deficit irrigation – applying less water than what is required. This method can be applied in certain growth stage that are less sensitive to moisture deficiency. Deficit irrigation does

[1] Information is sought from: Climate-Smart Agriculture - Sourcebook, 2013. FAO; Reeves, T.G., Thomas G., Ramsay, G. 2014. Save and Grow in Practice, FAO. Chapters 2 and 5

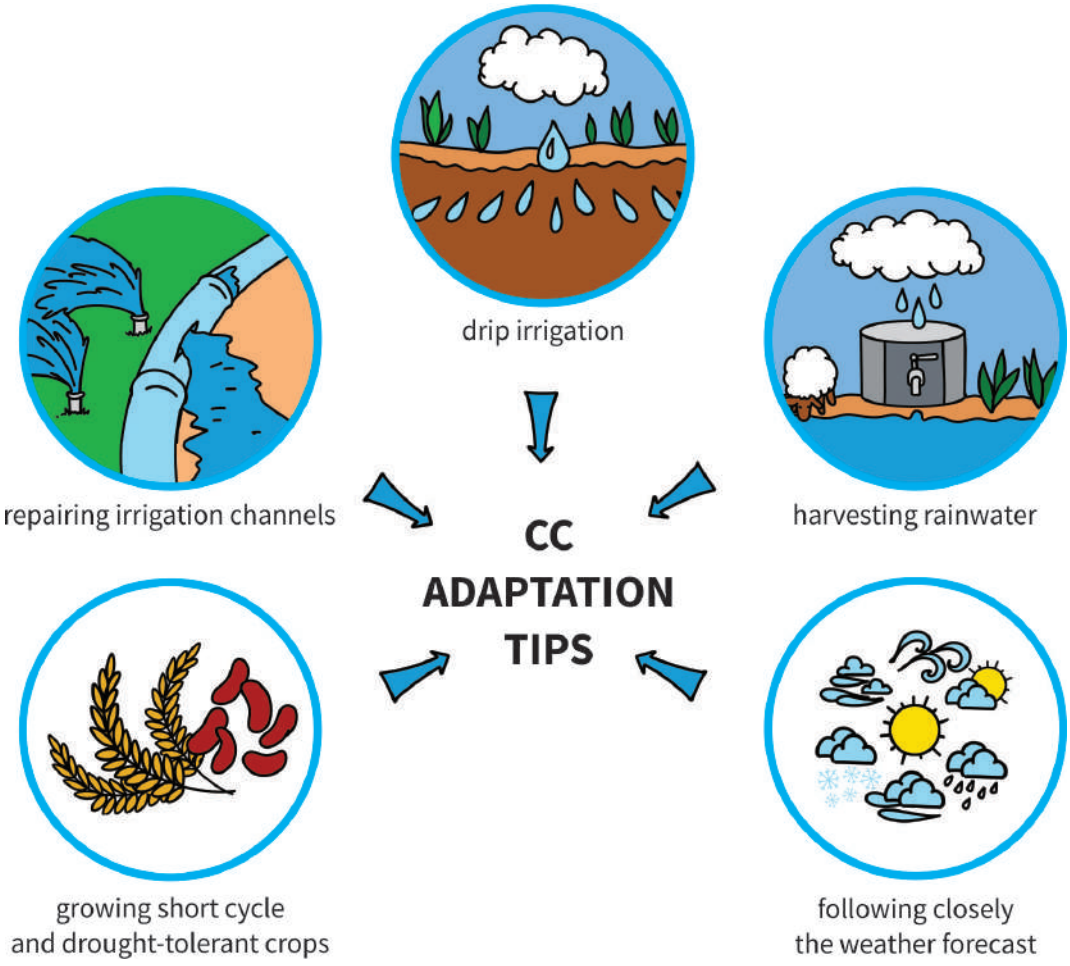
not affect yields and saves significant quantity of irrigation water. According to studies higher water savings are possible in fruit trees, compared to herbaceous crops;
- introducing drip irrigation to improve water productivity;
- reducing water loss in irrigation channels that supply the village/area by repairing and lining them up
- reusing grey water from households for irrigation.

CROP CULTIVATION:

- diversifying crops that are cultivated on land to reduce the risk of complete crop failure that may occur due to various reasons. Different crops respond differently to changing conditions and chances that one of the crops will give yields increases under drought conditions.
- growing short cycle (fast growing) and drought tolerant/resistant crops to reduce dependence on irrigation and precipitation;
- applying crop rotation on a land where wheat is grown. Rotating wheat with other crops (summer crops such as maize, canola, oat, sunflower) during follow period. During follow period the land is kept out of cultivation to conserve water and nutrients for the next year's wheat cultivation;
- changing crop calendar to adopt to new temperature and rain patterns. This way the risk that crops will be affected by possible heat stress conditions or heavy rainfall during critical stages of vegetation will be avoided;
- planting trees in farm to generate multiple uses of trees. It allows to reduce impacts from heat stress and drought;
- zero tillage practices improve the structure of soil. It improves infiltration of moisture captured from melting winter snow;
- applying raised bed planting improves water productivity.

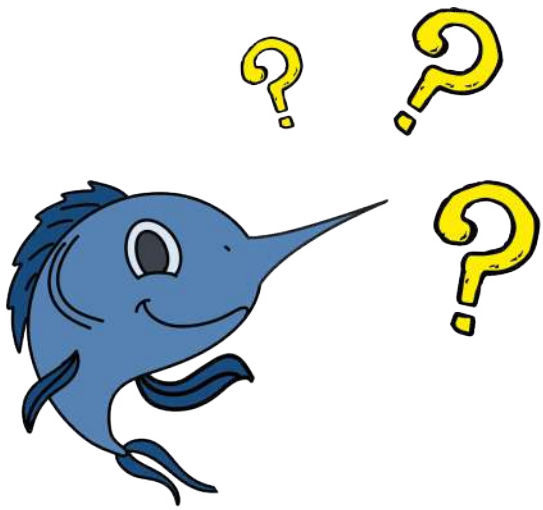
PROTECTION FOR WATER RELATED HAZARDS (STORMS, HAIL, FLOODS) AND DROUGHT:

- participating in government assistance programmes for agriculture insurance. Crop, aquaculture and cattle insurance reduces losses incurred during natural disasters;
- preparing for extreme weather events by following closely the weather forecast, subscribing to early warning services;


drip irrigation
repairing irrigation channels
harvesting rainwater
CC
ADAPTATION
TIPS
growing short cycle
and drought-tolerant crops
following closely
the weather forecast

EXERCISES - 1	INSTRUCTIONS
Develop a project proposal on how to save water in your school and submit it to the school principle / and management board for consideration. Discuss potential funding sources in your town / village with charitable organizations, business sector, townhall, etc. In agreement with the school's management organize meetings with the potential donors for fundraising.	Instruction: In order to properly carry out this exercise it is advised that students first will organize a brainstorming session where all possible water saving measures will be reviewed and assessed against two main criteria - their applicability and implementability in the school. After reviewing all measures students have to select the most appropriate measures for the school. This exercise has to involve representatives of several classes (volunteers). Nominate 4 representatives from the group who will develop a full project proposal on "How to Conserve Water in Our School". (alternative name "Reducing Water Footprint of Our School". Two representatives will be responsible for drafting project proposal. Other two representatives will consult the plumber of the school or parents of classmates/students who may have experience in the area of water conservation and cross-check with them if proposed measures are implementable and how much would it cost. All four preventatives will be responsible to make a cost estimation of the whole project. The project proposal must include following sections: - Project title - Objectives of the project - Expected project outcomes (results) - Background information (about water use in the school and shortcomings that prevent water conservation and efficient use - water leakages, inefficient use of water due to old appliances/equipment) - Activities to be implemented (in toilets, cafeteria, schoolyard, in the chemistry/ biology lab, etc.) - Approximate cost of each activity - Timeframe for implementation of the project When developing project activities consider information provided in the toolbox for water conservation and select those that are applicable for the assignment. Activities should not be limited to water conservation measures only. It may also include an awareness raising activity for our peers, school teachers and parents on water conservation. Present the project proposal to classmates and after they endorse the project proposal present it the school management board. Consider developing project proposal further in line with provided comments of the school management board members. Discuss with the school management the list of potential funding sources (enterprises operating in your village/town, international organizations, municipality, etc.). Under the guidance of the school management organize meetings with potential donors and present the project idea.

EXERCISES - 2	INSTRUCTIONS
How can your family be better prepared for the potential impacts of climate change? Design farm level climate change adaptation measures that can be implemented in your farm. *This exercise is manly for school students who have farms*	Climate change impacts on agriculture: climate change affects agriculture in several ways: - water demand increases as evaporation and transpiration intensify; - crop productivity is affected due to various reasons related to climate induced risks (risks of exposure to new or more resistant pests, diseases, natural hazards that damage harvest, etc.); - vegetation time may change; - exposure to increased risks of extreme weather events increases; - livestock may be affected by heat stress and water availability; - etc. Adaptation to climate change therefore, has to be approached from several angles – water management, land management, crop production systems, forest management, livestock management, etc. The focus of this exercise is water management. Instruction: organize a brainstorming session in the class on the main challenges of your farms due to climate change impacts. Consider focusing your discussions on these climate change impacts that are related to water – precipitation, water availability, water related natural hazards (flooding, drought, hails, storms). After identifying main challenges of your farms review the toolbox for climate change adaptation and propose adaptation measures that are applicable and implementable in your village/farm and prioritize them according to their importance and urgency.



EXERCISES - 3

Discuss how can your school cooperate with a school in Azerbaijan/ Georgia on water issues and come up with an idea for a joint activity that can be implemented either together or in parallel.

INSTRUCTIONS

Instruction: Schools in Azerbaijan and Georgia are encouraged to find a partner school in the neighboring country and establish regular communication and exchange through e-mails or skype.

Exchange ideas about joint activities and select the most feasible activity that can be implemented either jointly or in parallel. The exchange can take place via e-mails and skype conference call.

The ideas for joint activities may include but not limited to:

- clean up initiative: this activity would include following steps: identifying location of illegal landfill for municipal waste hat is located in close vicinity to the river. In cooperation with the executive structures of the municipality organize a clean-up day in in Azerbaijan and Georgia simultaneously. The municipality could provide necessary equipment for removal of collected waste. Inform each other about the results of the activity and exchange photos.
- School visit to one of the National Parks located in the Kura basin. Students will collect detailed information about the park, take photos and develop a digital brochure (one or two pages long) about the park. It will then be shared with the partner school in Azerbaijan/Georgia.
- etc

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