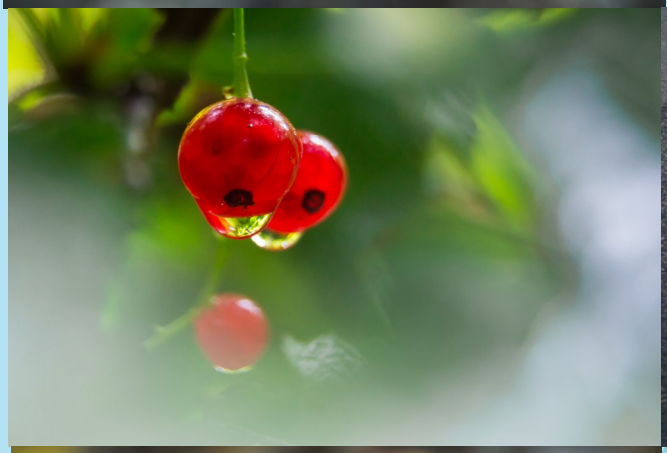
WAT.EDU



HANDBOOK

Water Education for Innovative Environmental Learning

Wat.Edu Educational Handbook and Teaching Methodological Guide for transmitting water-focused knowledge through innovative and experiential learning

Made within the framework of the **Wat.Edu—Water Education for Innovative Environmental Learning** project in cooperation with the following partners:

Peiramatiko Scholeio Panepistimiou Thessalonikis—Greece

Zakladni skola B. Dvorskeho— Czech Republic

JVIZ I. OS Rogaska Slatina—Slovenia

Kossuth Lajos Primary School of Egyházasrádóc—Hungary

ANATOLIKI S.A.-Organization for Local Development—Greece

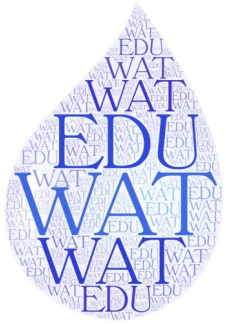
IREAS Insitute for Structural Policy—Czech Repablic

The Water Agency Association—Slovenia

IMRO-DDKK Nonprofit Kft.— Hungary

The photos on the cover were taken by Dávid Hérincs, a meteorologist and amateur nature photographer.

Preface



The source of life and the most essential element of human existence on the Earth is water. We have consciously chosen the water as the central theme of our handbook.

This handbook is the intellectual output of the Wat.Edu project developed within the framework of an Erasmus + application, the common work of four educational and four non-governmental institutions of four countries: Slovenia, the Czech Republic, Greece and Hungary.

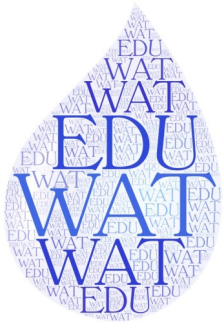
Our goal with the handbook was to provide assistance for teachers concerning the education of students between the age of 12-14 by giving ideas, methods, and background knowledge to them. It was clear to us that this topic could not be caught in the framework of a single subject, so we tried to compile a modern, creatively usable material, within the context of Biology, Geography, Chemistry, Art, keeping in mind the horizontal approach and the interdisciplinary relations.

This unique learning material is the result of 3 years of exciting, challenging work. I wish you a lot of success, creative thinking, and professional joy in its usage.

Erika Süle
Project Manager
Kossuth Lajos Primary School of Egyházasrádóc

How to use this handbook

Author: Erika Süle



The structure of the handbook

While elaborating our handbook, our goal was to provide teachers dealing with 12-14 - year- old students with an easy-to-use, inspiring tool that supports creative thinking and encouradges active student participation in the process of environmental learning.

Although water is considered as a cross-curricular theme, yet we felt it necessary to relate in some way to the subject frameworks used in educational structures. Therefore, we separated the tasks and activities according to the following subjects: Biology, Geography, Chemistry-Physics and Arts. This separation serves only technical purposes: it helps to find out easier. We do not think that water as a vital element is just a privilege of one or another school subject. The development of a complex approach towards the water was an important aspect for us, we wanted to present this important element of our environment from the aspect of several subjects.

The subject symbols help us to find our way in the handbook:

Biology 

Geography 

Fine Art 

Chemistry-Physics 

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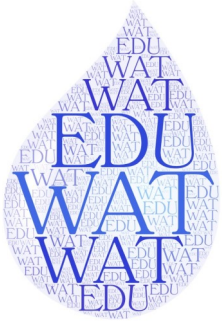

We covered three main topics during the development of this handbook:

1. Types of water and the water cycle
2. Water in our daily lives
3. The future of water

Each chapter can be divided into two major units: a theoretical and a methodological part.

The theoretical chapters provide background information that we considered important for the educator to have the appropriate professional competencies to teach the topic. This was important for us because we are convinced that environmental education, including water, cannot be linked to a teacher with a specialization, as it is the responsibility of every teacher to sensitize students, shape their attitudes and develop a commitment to the environment.

Obviously, everyone has different levels of knowledge in the field of water-related issues, so the theoretical content of the handbook - we hope - can help to develop a unified approach, even to acquire new knowledge. In addition, the chapters contain many interesting novelties, so they can be useful additions to the compulsory subject content.

Each chapter contains links (also available with a QR code) that you can open and read to learn more. The bibliography at the end of the chapters can help the reader to gain more knowledge and indulge in the topic even deeper.

The theoretical chapters have a similar structure. For each main topic, we assigned student activities and challenges within each subject area that promote the expansion of students' knowledge and the development of their competencies. As for the order of the tasks, we tried to follow the warm-up and tuning-in tasks with student activities that deepen the knowledge of the topic, and at the end, we present examples from the summative, final-type tasks.

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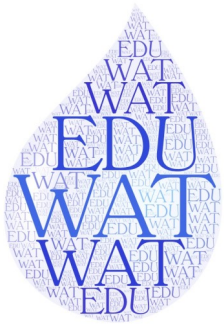

To make it easier and more conscious to use, we listed the necessary tools and materials in the case of each student activity. We briefly stated which student competencies can be improved effectively by the suggested activities.

In addition to most of the student activities, there are additional links that present similar types of student activities on the one hand, and provide practical help on the other (eg spreadsheets, memory cards, other downloadable documents). In order to develop digital competencies, we have created an online version of the majority of activities or we supplemented the original activity with an interactive online one (Wordwall activities). These can also be opened using the links provided in the manual or with a QR code.

To facilitate the chemical-physical experiments, we created short instructional videos that are also available to anyone via the links provided.

Additional tasks:

People's statements about water regime

https://wordwall.net/play/2421/286/483

Instructional video

Here's how to do the experiment:

https://drive.google.com/file/d/1IVOISghe-j6t0hyB8z1x9-OirG0gTwiz/view?usp=sharing

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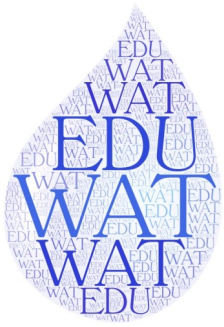

Proposed possibilities for use

The methodological part of the Wat.Edu handbook is a thematically organized set of activities with a central theme of water. It was not our goal to compile complete lesson plans, as each group of students is different. Our goal is to encourage teachers to freely choose their tasks according to the occasion and the needs of the group of children and to inspire them to use the activities in creative ways.

Possible frames of usage:

* The elaborated activities of different purposes are useful and motivating within the classroom.
* The elaborated learning material can serve as an effective tool in implementing complex lessons where the knowledge of different disciplines is grouped around a certain topic, in our case: water.
* We consider it an excellent opportunity to use the handbook activities to compile the programs of theme days and theme weeks.
* The activities can be used to prepare a thematic plan for professional sessions and club-like student gatherings.
* A significant part of the elaborated activities focuses on experiential learning, so it can be perfectly integrated into the programs of thematic student camps.

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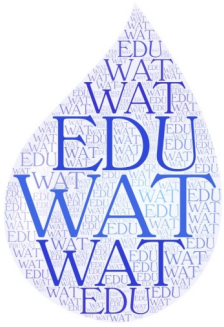

The methodology behind the activities

When describing the activities of this handbook, we often refer to the methodological elements and forms of work within the framework of which the given activity can be performed successfully. These references are based on the experiences of the creators of this handbook.

It was of primary concern while compiling the handbook that the activities should increase student activity, presuppose the application of cooperative techniques and the involvement of students in the learning-teaching process, and last but not least, provide an opportunity for experience-based learning.

Experiential learning is a broad category of teaching methods and activities that engage learners in the learning process. Experiential learning is based on the fact that people can learn best through their own experiences. The experiential learning model was developed by David Kolb in the early 1970s. In his words, "experiential learning is a process in which knowledge is created through the transformation of experience." (source: http://tapasztalati-tanulas-kepzes.hu/tapasztalati-tanulas/)

He identified 4 steps in the process of experiental learning:

1. Concrete Experience:

Kolb's learning process cycle begins with a concrete experience. This can either be a completely new experience or a reimagined experience that already happened. In a concrete experience, each learner engages in an activity or task. Kolb believed that the key to learning is involvement. It is not enough for learners to just read about it or watch it in action. In order to acquire new knowledge, learners must actively engage in the task.

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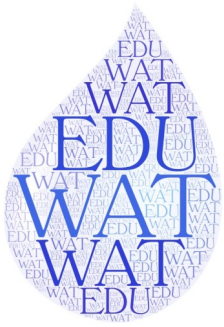

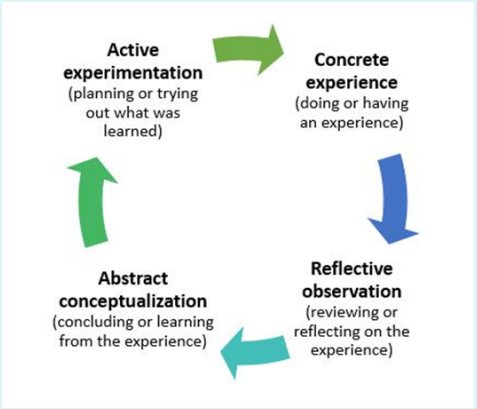

2. Reflective Observation:

After engaging in the concrete experience, the learner steps back to reflect on the task. This stage in the learning cycle allows the learner to ask questions and discuss the experience with others. Communication at this stage is vital, as it allows the learner to identify any discrepancies between their understanding and the experience itself. Good vocabulary also allows a solid review of the events that occurred.

3. Abstract Conceptualization:

The next step in the learning cycle is to make sense of these events. The learner attempts to draw conclusions of the experience by reflecting on their prior knowledge, using ideas with which they are familiar or discussing possible theories with peers. The learner moves from reflective observation to abstract conceptualization when they begin to classify concepts and form conclusions on the events that occurred. This involves interpreting the experience and making comparisons to their current understanding on the concept. Concepts need not be "new"; learners can analyze new information and modify their conclusions on already existing ideas.

4. Active Experimentation:

This stage in the cycle is the testing stage. Learners return to participating in a task, this time with the goal of applying their conclusions to new experiences. They are able to make predictions, analyze tasks, and make plans for the acquired knowledge in the future. By allowing learners to put their knowledge into practice and showing how it is relevant to their lives, you are ensuring that the information is retained in the future.

(source: https://educationaltechnology.net/kolbs-experiential-learning-theory-learning-styles/)

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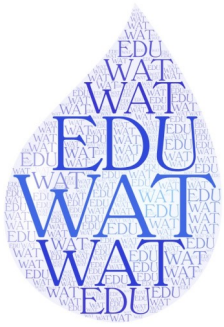

Some principles of experience-based teaching practice:

* Experiential education is effective when carefully selected experiences are followed by reflection, critical analysis, and synthesis.
* In the process of experiential education, the learner is actively involved in asking questions, researching, experimenting, solving problems, becoming curious, taking responsibility, showing creativity and forming opinions.
* Students are intellectually, emotionally, socially, spiritually, and physically engaged. This commitment makes the goal credible.
* Lessons are personal and therefore form the basis for future experience and learning.
* The learner's relationships with himself, others, his narrower and wider environment develop and prosper.
* The educator and the learner may experience success, failure, adventure, risk-taking, and the uncertainty that the outcome of an experience is not perfectly predictable.
* The primary role of the educator includes seeking appropriate experiences, raising issues, setting boundaries, supporting students, creating emotional and physical security, and stimulating the learning process.
* The educator recognizes and encourages spontaneous opportunities for learning.
* Educators strive to overcome their prejudices and preconceptions and know how they affect the learner.
* Planning an experiential situation involves the opportunity to learn from natural consequences, mistakes, and success.

(source: http://tapasztalati-tanulas-kepzes.hu/tapasztalati-tanulas/)

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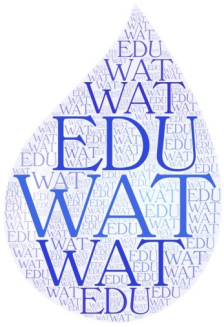

About the experiments

Almost every methodological chapter in our handbook includes student experiments or teacher demonstrations. Therefore, we consider it important to talk briefly about the purpose of the experiments and the way they were implemented.

Possibilities of experiments in the classroom from the view of organization: teacher demonstration experiment, student experiment (all students do the same), small group experiment (2-5 people experiment with the same tasks)small group experiment (2-5 people experiment with different tasks)

It is of utmost importance that the experiment serves a proper purpose. It should not be just an attraction, a "magic trick". Only an experiment from which students can draw the necessary conclusions is useful and valuable. The presentation of experiments can also be an important means of arousing interest and strengthening motivation. Through the experiments, students can get closer to understanding water-related phenomena and processes. Another goal is for the experiments to improve students 'observation and provide enough information to draw conclusions.

An important rule for presenting experiments: it must succeed. The teacher is required to test the experiment before the presentation. This is essential for success.

Teacher experiment is a way of illustrating the learning material. We consider it very important to involve students in the experiments, because it promotes experiential learning and is more motivating. It should be borne in mind that students should always be given observational aspects before the experiments.

Although it seems time-consuming to prepare and conduct experiments, their pedagogical value is high since children gain new knowledge from the experience.

The experiments in this handbook use various substances that can also be found in an average household (e.g., salt, pepper, food coloring, cooking oil, etc.) thus, there is a low accident risk during experimenting. In spite of this, we should draw students' attention to the possible sources of danger before making experiments.

(source: http://www.tanuljmaskepp.hu/tippek-ühmalakitasra/)

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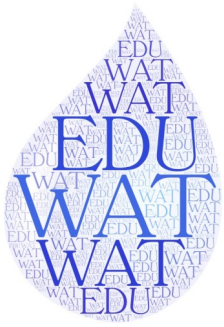

Some possible ways of grouping

Most of the tasks in this handbook require students to work collaboratively together. To do this, we need to divide our students into smaller to larger groups. There are countless forms of grouping. In the following part, we share a few simple, quick, imaginative ways of grouping.

Numbering: the fastest grouping method

The fastest is to give a number to the participants one after the other. We give as many numbers as we want in groups. If there is a class of 20 students and we want to form groups of four, we have to count to 5. The students with the same digit will form groups: we will have four students in each group.

Puzzle

Find images then cut them into four to five elements. We need as many pictures as many groups we have. The picture elements should be thrown onto the floor. The children take a walk to choose a piece for themselves, then silently find their groupmates with whom they put the pictures together!

Winters and summers

Everyone stand up. Ask the children to be organized into four groups based on their month of birth: one in the spring, one in the summer, one in the winter, and one in the autumn. You can further divide the existing four groups e.g. according to who was born after and before the 15th.

Colored sticky notes

Students create a circle and colorful post-it stickers of 6-8 colors (depending on the number of groups) should be put on their backs. They don't see their own color, just the others'. The task of the large group is to organize into small groups without any sound. The game also improves collaboration, as teams have to realize that they can only thrive with the help of their mates. (sourcee: https://www.komplexalapprogram.hu/cms/tartalom/megtekint/csoportmunka-eljen-de-hogyan-alakitsunk-csoportokat)

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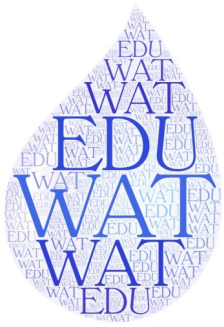

When did you wake up?

Ask participants to line up according to when they woke up that morning. They should form a line from the earliest to the latest date. Then the line should be bent in a way that those who wake up early can make pairs with those who get up late.

Finding a partner with eyes closed

We ask the participants to create a circle. The task is for everyone to move forward with their eyes closed and their arms outstretched and touch someone. The person they will touch for the first time will be their partner in work. Exciting, interesting experience. (source: http://www.tanuljmaskepp.hu/tippek-ühmalakitasra/)

MSG (Mix up! Stop! Get together!)

Players walk around the room. The referee says a sentence, a puzzle referring to a number (eg: so many dwarves lived in the forest cottage). At this point, players must form a group so that there can only be as many people in the group as there are in the pizzle. This game is repeated several times until there are as many people in the groups as we want.

Find your partner!

Some students are given cards with a question. Others are given cards with the answer/answers on them. Their task is to find all the answers to the questions, that is while matching the questions and the answers find the mates belonging to the same group. This is how the groups are formed. (source: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiWt6K48qH1AhV58LsIHQeqB0IQFnoECAgQAQ&url=http%3A%2F%2Fujalma.hu%2Fwp-content%2Fuploads%2F2012%2F01%2Fjatekgyujtemeny_tanaroknak.pdf&usg=AOvVaw2ELVpuTzOsswzzBvP_3BFZ)

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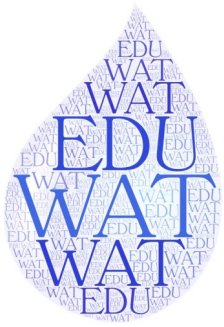


The E-learning and the gamification

(Based on George Rouvas, the creator of the e-learning toolkit)

An important additional element of our handbook is the e-learning toolkit which is based on the method of gamification and proved to be very popular among students.

Features: supports joint work by applying the principle of non-formal learning, supports discussion and sharing of experiences,interactive descriptive and explanatory, flexible and adaptable

Non-formal learning means for us educators that the learning process takes place outside the frames given by formal education, either in a separate way or as part of an activity with a wider scale. For children, all of this is reflected in the fact that the learning process is more fun, relaxed, playful, and without grades.

The mechanism of gamification is based on the following main elements:

* **Points**: Reward students for milestone fulfillment. Points can also be used to open new learning stages and / or rewards.
* **Badges**: Tools for visual rewarding of the results. They can be linked to learning milestones or outcomes.
* **Levels**: Help students understand when they reach milestones. Tools for regular feedback.

Three main pillars of the gamification:

* **Challenge**: Aims to encourage commitment by asking students to complete specific tasks.
* **Story and characters:** They help students immerse themselves in the learning process by adding "a pinch of reality" to potentially tedious learning materials.
* **Time-based activities:** Adding artificial "time pressure" motivates students to work faster and teaches them to work better and more effectively under pressure.

Types of water and the water cycle

Theoretical background

Authors: ANATOLIKI S.A.

GEOGRAPHY

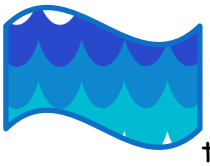
Introduction

This chapter will refer to the water and its cycle through the geographical zones of a region, country or the world. Water is a natural source deriving from the chemical compound of hydrogen and oxygen and it is symbolized as H_2O. Since ancient times, water is regarded as an essential good for humanity such as soil and air and no other artificial good has succeeded in replacing it.

The purpose of this chapter is to educate, inform and sensitize students and teachers on the water cycle and the use of water throughout the world, to highlight good practices of water management and set the preparatory basis so that children learn more on water in the classroom. Based on the research that has been made on the water topic, this chapter is separated into six different subchapters as follow. The first subchapter is an introduction to the water topic, the second offers definitions, the third presents some basic policies, the fourth is on water cycle, the fifth on alternative use of water and finally in the last chapter some conclusions about the geographical distribution of the different uses and types of water through the world are presented.

Definitions and terminology

Some basic definitions related to the water issue are crucial to be pointed out:



Surface water: rivers, lakes, water reservoirs and wetlands.
Ground water: underground water located under the surface of soil.
River: an inland waterway system which for the most part flows to the surface of the ground, at the same time a single part of its, may also flow underground.
Lake: an inland system of surface stagnant water.
Transitional water: surface water system closes to the mouth of rivers, which are also salty due to their vicinity in the sea (coastal water), but they are affected by freshwater streams may be lagoons.
Coastal water: sea.
Artificial water system: is the surface water system created by human activity, for instance, dams (water barriers).

(Source: www.ypeka.gr)

GEOGRAPHY

Distribution of water around the world and the types of water

Since ancient times, water is regarded as an essential good for humanity such as soil and air, being essential for human life whereas no other natural or artificial good has succeeded in replacing it. Water is a key natural source for the development of bio-communities and human societies, serving the basic needs of human existence, ecosystems and most human activities. Water is found in gaseous form in the atmosphere, in liquid in the surface waters such as lakes, rivers, seas, wetlands, ground waters, aquifers and in solid form in glaciers and peaks of high mountains and mountain ranges. Only 2,8% (36.000.000 km^3) of the total quantity of water on Earth's surface is fresh, while 2,15% of this amount constitutes the glaciers. Thus, only 0,65% of the total amount is fresh water in liquid state· though not always being available for use. Water's issue, has been on the spot during the last decades. In previous years, there was a perception that natural resources are freely available, inexhaustible and renewable meeting all human needs. This perception resulted in a wide range of water applications which made its consumption out of control.

Due to the fact that the amount of the fresh water is not so much, especially compared to the saltwater, and it is not equally distributed around the world, a sustainable water management is very important. Although water is seen every day and almost everywhere, there are different types of water according to its special characteristics, the location of the water sources and the treatment process that it has gone through. Based on those characteristics, water can be categorized into different types as follow.

Fresh water (drinking water): a) natural or after treatment water, used for drinking, cooking, food preparation, household purposes, with no regard to its origination and the distribution network (tank, bottles or containers), b) water used for food production or manufacturing, processing, preservation, marketing of products and substances intended for human consumption.

Sea water: water in or from the sea.

Mineral water: water that comes out of the ground naturally and is considered healthy to drink.

Waste water: any water that has been affected by human use. It is the used water from any combination of domestic, industrial, commercial or agricultural activities, surface runoff or storm water and ant sewer inflow or sewer infiltration.

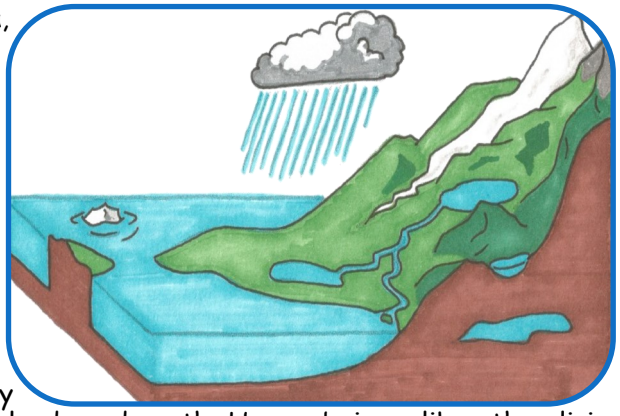
Grey water: clean waste water from baths, sinks, washing machines and other kitchen appliances.

(Source: Soulios G., 1986)

As seen above, there are many different types and sources of water and many different forms that include water as the main element. Additionally, water is not equally distributed around the world. As a result, different places around the world have different uses of water.

The water cycle

The hydrologic cycle or cycle of water includes a series of processes by which water circulates among atmosphere, hydrosphere, land and sea. In this chemical chain, water appears in all forms: liquid (river, lake, sea, rain and groundwater), gas (water vapor, humidity) and solid (snow, hail). The driving force that directs the water cycle is the sun (http://www.geo.auth.gr).



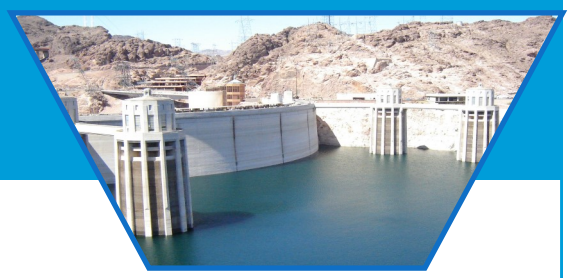
Surface water, namely water that exists into the sea, lakes, rivers and soil of the land, evaporates through solar radiation. This way, the liquid form of water is converted into gas that is called vapors. As vapors move to the upper layers of the atmosphere, they interface with cold air masses concentrating and forming the clouds. Thus, vapors fall back to the surface of the earth as rain, hail or snow due to the weight they gain. Water that falls on the land passes into the subsoil, absorbed by the roots of the plants or continues its journey to the sea, passing through canals, rivers and lakes. This continuous water recycling is called hydrological cycle or water cycle. There is a certain amount of water that is constantly renewed and moves in a closed loop among the sea, clouds and earth. Human beings, like other living organisms, use the same water again and again. Water flows steadily from Earth to the atmosphere through two main processes:

- **Evaporation** of water which exists into the sea, lakes, rivers, ice, snow, soil, etc. and
- **Evaporation** and **transpiration** of living matter.

The water's natural supply from the surface to the atmosphere and back to the surface plays an important role in determining the climate and ecological balance of the planet. For instance, trade winds that originates from cold latitudes travels to the equator. As trade winds travel, they carry moisture away and redeposit it in the regions of equator. Mountain ranges also affect shore rainfalls. As the air travels over a mountain range, it cools down and the transported moisture turns into rain on the side of the mountain exposed to wind and the leeward side of the mountain ranges receives less moisture(for example, mountain range of Pindos). It can therefore be concluded that, the pattern of humidity distribution on the surface is the result of several factors, most notably the combined effect of air travel and the relief pattern (anaglyph) of the continents and islands. This combination is directly related to the allocation of large ecosystems.

Another crucial aspect of the hydrological cycle is its role in the transport of matter. The surface run-off accounts for 35% of water's annual percentage that is received from land as rain. The water has the ability to dissolve and transport materials from one ecosystem to another, spoiling one and enriching the other. As water travels to lower altitudes, mountain areas tend to become poorer in nutrients than lowlands (for instance swamps). This enrichment with nutrients is, to a large extend, responsible for the high productivity of these areas (www.watersave.gr).

GEOGRAPHY



Different uses of water for different places

According to several studies, water is a key driver of economic growth and poverty alleviation as an input to almost all production, in agriculture, industry, energy and transport. On the other hand, it can be a force of destruction when it causes floods, landslides, desertification, contamination or epidemic diseases. It can be a source of life and prosperity and a cause of death and devastation (Grey D., Sadolf C., 2019).

The way we act and the way we use water plays a very important role to the quality and quantity of water that we have. There are many different uses of water. Based on its use, water can be categorized in:

Urban water use. Urban water reserves have as final consumer's households, industries and commercial areas and also, they are used for urban services such as city washing, fire fighting, maintenance of recreational areas (mills, lakes, swimming pools and amusement parks recreation).

Irrigation water use. Agriculture accounts for the highest use of water: about 40% of all water used in Europe per year. Despite the improvement of its efficiency in the sector since decade of 1990, agriculture will continue to be the largest consumer in the years to come and will burden the stress about the water in Europe. This is due to the fact that more and more agricultural land must be irrigated, especially in the countries of southern Europe. While only 9% of Europe's total arable land is irrigated, these areas account for around 40% of the total water use in Europe. In spring, this percentage may exceed 60% to help crops grow after planting.

Industrial water use. Industrial water use includes water used for purposes such as manufacturing, processing, washing, thinning, cooling or transporting a product. Water is also used by melting plants, oil refineries and other industries (chemical, food, product etc.).

Tourist water use. Water consumption by tourism is relatively low compared to other sectors such as agriculture. In particular, water consumption associated with overnight stays in a hotel, which accounts for a large share of tourist traffic. For example, it represents 4,5% of water demand in Malta and Cyprus and 2% in major tourist destinations such as Greece and Tunisia (Eurostat, 2009). The largest consumers in the tourism sector are hotels facilities, restaurants and outdoor activities.

Energy use of water. Energy production also requires very high water consumption, which accounts for 28% of the total annual water consumption in Europe. The use of water in this sector is mainly related to cooling in nuclear power stations and based on fossil fuels and also is used in the production of hydropower. With regard to hydropower, water is not consumed but it is recycled and returned to water bodies. Conversely, cooling for energy is the largest consumer of water in the energy sector.

(Source: Gnwsi Anaptyksiaki, 2019)

Erasmus+

GEOGRAPHY

Europe does not face water scarcity but natural water and rainfall are not evenly distributed between countries but also within each country. The North and West Europe enjoy often rainfalls while the South enjoys few rains, a contrast that is intensified during the summer.

The main source of water in Europe is surface water due to the easy and low cost pumping, supplying 81% of the total water. This mainly supplies power plants and industries. Groundwater, on the other hand is the main source of water supply (accounting about 55% of drinking water) and irrigation.

Total water abstraction across Europe is 288 km^3 per year, equivalent to 500 m^2 per inhabitant per year. Out of this, 44% is used for energy production, 24% for agriculture, 21% for watering and 11% for industrial activities. There are, of course, significant fluctuations in this division between regions. In southern Europe, the main consumer of water is agriculture, surpassing in many cases 80% while in the East is the energy production.

The problems faced by people with regard to the availability and quality of their water resources are:

The exhaustion and pollution of groundwater. This is attributable to their intensive and uncontrolled exploitation. 20% of all surface water in the European Union is seriously threatened by **pollution**.
Intense rainfall in the north. Although being an important source of water, their increases may lead to an increase in flood events.
The large population growth due to tourism in the southern part of the continent. This phenomenon has resulted in a seasonal increase in water demand in a region that is already suffering from droughts. (Source: Fraggou M., Kallis G., 2010)

In a global scale, 70% of consumed water is used in agriculture, 20% in industrial and 10% in households. The main issues in the world can be summarized as follow:

While the earth's population has tripled over the last 70 years, water consumption has increased six fold.

Major demographic changes have occurred with massive movements in urban areas and countryside abandon. As a consequence, increased pressure is exerted on water sources that supply urban constraints to the renewal of groundwater due to the extensive urbanization and, moreover, contamination of natural recipients.

The population increase has resulted in higher water requirements to ensure food and improve living standards, which increase demand for water.

Water losses are spotted due to leaks, illegal connections and waste account for 50% of drinking water in some countries.

Increased competition between users and uses is a reality.

Pollution from industrial, rural and urban sources threatens clean water.

(Source: Fraggou M., Kallis G., 2010)

Conclusions

The water topic is very important and people should get educated and awared. Water should not be taken for granted. According to a United Nations Study, 1.1 billion people (one in six) have no access to drinking water, 2,5 billion people do not enjoy safe personal hygiene, 1.6 million people die each year due to lack of water and personal hygiene (40% are children under the age of five) and water related diseases that could be prevented are responsible for the death of 10,000-20,000 people per day. It is estimated that in 2025, 3 billion people will live in 48 countries with water scarcity problems (Fraggou M., Kallis G., 2010). Solutions for these problems can be alternative sources of water for other than drinking water such as the collection of rainwater or reuse of grey water to plant gardens, parks etc. Actions for the education and sensitization of people, creation of a pricing system or financial incentives and penalties for the overuse of water are additional good practices managing the water. Last but not least, the establishment of planning strategies for irrigation systems in order to optimize irrigation times and water volume, water loss control systems and the usage of new technologies in agricultural and urban areas are some important steps for the sustainable use of water (Gnwsi Anaptyksiaki, 2019).

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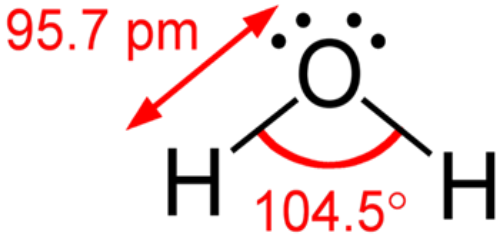
Types of water and the water cycle

Theoretical background

Autors: Dr Ildikó Galambos, Dr Renáta Berta Gerencsérné, Dr Ildikó Bíró

CHEMISTRY

Water is everywhere on the Earth. Most of it can be found in the World oceans, but it is there in surface water forms, such as in seas, lakes, rivers, streams, underground forms, such as ground water, aquifers, in the air, and also in solid form in glaciers or in the frozen icecap at the North and South Pole of the Earth.

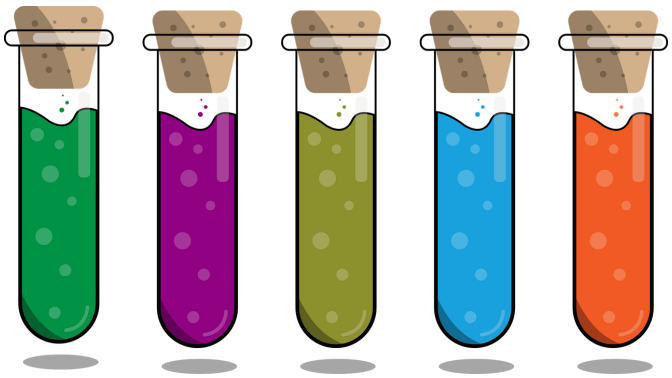


1. Figure: Structure of the water molecule

For the life on Earth water is fundamental. Water is the only substance which can be found naturally in three states: solid, liquid and gas form on Earth.

Water is a transparent, tasteless, odourless, and colourless liquid, which is the main ingredient of our planet's streams, lakes, and oceans, and the fluids of most living organisms. It is essential for all known forms of life. Its chemical formula is H_2O, which means that each of its molecules contains one oxygen and two hydrogen atoms, connected by covalent bonds [1. Figure]. Water is the name of the liquid form of H_2O at standard ambient temperature and atmospheric pressure.

Water is the only material naturally present on Earth in the three states of matter: solid, liquid and gas. Pure water passes from the liquid to the solid state, i. e. it freezes, at 0°C. At sea level, it boils at 100°C (the higher the elevation, the lower the temperature at which water starts boiling). When water freezes, it expands and its density decreases. Therefore, ice floats on water or a bottle full of water breaks when kept in the freezer.



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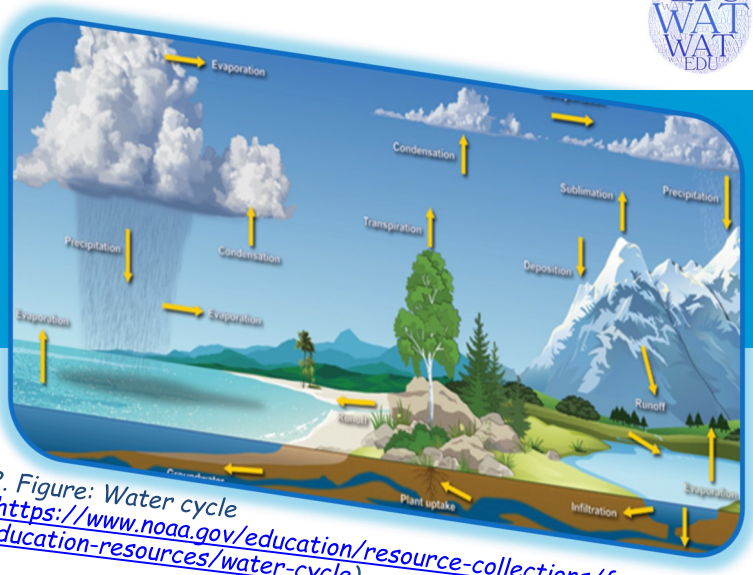
CHEMISTRY

H2O

Water cycle



2. Figure: Water cycle (https://www.noaa.gov/education/resource-collections/freshwater-education-resources/water-cycle)

Water in liquid form can be found in rain and dew, but mainly in oceans, seas, lakes and rivers. In solid phase, water is attended as ice, snow and frost. In gas phase it is present as vapour and fog. Water vapour is also a major ingredient of clouds.

Through the Sun's energy, Earth's water is always in movement. The natural water cycle, also known as the hydrologic cycle, describes the continual movement of water on, above, and below the surface of the Earth. Water is always in motion: all the processes through which water passes as it leaves the ocean, get into the atmosphere, arrives dry fields and then gets back to the ocean creates the water cycle. Water evaporates from different surfaces, from the soil, from living organisms and from surface waterbodies. The vapour that is created lifts to higher layers of the atmosphere and forms clouds, clusters of very small water droplets and ice crystals. When clouds become too heavy, they release the water that falls as rain, snow or hail. Accordingly, water falls to the earth's surface again: some of it gets into the surface watercourses and after a while reaches the sea once again, while some infiltrates into the ground and is absorbed by the roots of plants. Some of the water gets in the under depths of the subsoil and joins the water-bearing layer, a real underground water depot.

Three states of water

Water exists in three different states of matter: as a solid, liquid or gas [3. Figure].

Solid water

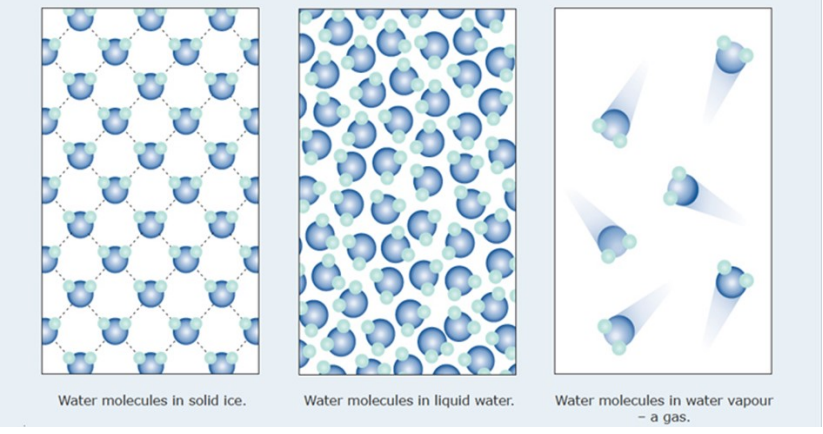
When water freezes, its H_2O molecules distance from each others, making ice less dense than liquid water. That means that ice will be lighter than the same volume of liquid water, and so ice will be afloat in water. The particles in a solid are strongly bonded to one another. Water freezes at 0° Celsius, 32° Fahrenheit. Ice cubes maintain their form regardless of the container that holds them.

Liquid water

This is the state of water with which we are most familiar. We use liquid state water in many ways, including washing and drinking. In liquid phase the molecules are no longer in an ordered state. The bonds between molecules are broken, and the liquid water takes the shape of its container. The particles are very close to each other, and so a liquid is incompressible.

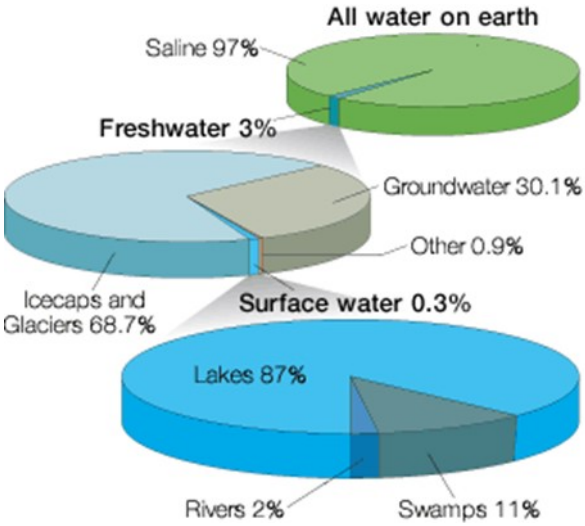
Water as a gas

Vapor is constantly present in the air. We cannot see it. When water is boiled, the water becomes from a liquid to a gas or water vapor. As some of the water vapor cools, it appears as a small cloud called steam. This cloud of steam is a mini version of the clouds floating in the sky. At sea level, steam is formed at 100° Celsius, 212° Fahrenheit. In gaseous phase, agitation and disorder are at the maximum level. Water vapor occupies all of the space in a container. The distances between molecules are large. A gas is compressible.



3. Figure: Three states of water (Source: https://www.sciencelearn.org.nz/images/658-water-in-its-three-states-of-matter)

Water types

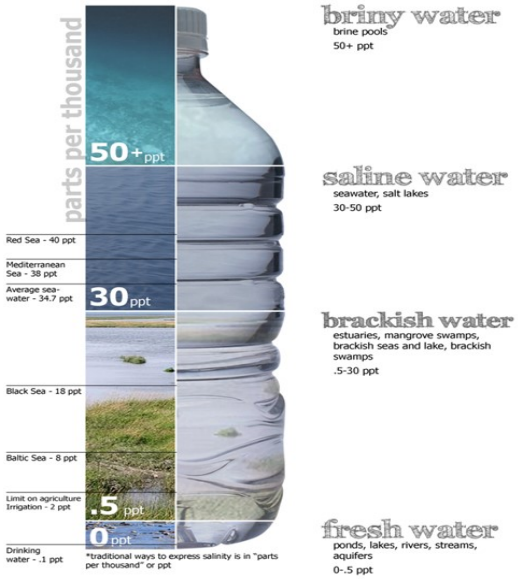


4. Figure: Water distribution (source: http://www.pacificwater.org/pages.cfm/water-services/water-demand-management/water-distribution/)

Water can be divided into two main categories: freshwater and saltwater. Saltwater is present in the ocean and sea, contains salt. Freshwater can be found in glaciers (frozen water), groundwater, and surface waterbodies (lakes, streams, ponds, rivers, and swamps).

Water covers nearly 71% of the Earth, but it is not evenly separated between freshwater and saltwater. 97% of the Earth's water is located in the oceans and seas [4. Figure]. Accordingly, only 3% of the Earth's water is freshwater. Since there is so little freshwater it is very important to know its quality, and how to keep it clean.

Salinity is the saltiness or dissolved salt content of a body of water. Generally, it is the concentration of mineral salts dissolved in water. Different types of water can be classified according to their salinity. Some of them are shown in 5. Figure.



5. Figure: Water salinity (Source: https://en.wikipedia.org/wiki/Brackish_water)

CHEMISTRY

SALTWATER

Salt water contains about 3.5% salt. It is located in the oceans and seas, as well as in smaller amounts in brackish water. Salt content can vary within the same body of water. It is less salty in some places, where fresh water flowing off mixes into the ocean or sea, generally from a river or melting glacier. Some salt water contains more salt, as is in the case of the Red Sea, because of the increased evaporation of water and lower fresh water runoff. The sodium in oceans and seas is considered to have leached from the ocean floor when it was being formed, while chloride derives from the hydrothermal vents and volcanoes from the interior of the planet. Part of the salt in sea water is also considered to come from water washing it from land and rocks into the ocean.

Salt water is denser compared to fresh water, because it has more matter per its volume. Fresh water's density is 1 g/ml, while saltwater' density is about 1.025 g/ml. Salt water does not freeze at the same temperature as fresh water, the temperature must be even

BRACKISH WATER

Some areas where freshwater and saltwater meet have water called brackish water. Brackish water has more salinity than freshwater, but not as much as seawater. Technically, brackish water contains between 0.5 and 30 grams of salt per litre.

FRESH WATER

Fresh water is water that has little or no dissolved salts and dissolved solids. When we say 'fresh water', we usually mean water from the lakes, rivers, snow, and ice, which is not salty. It also means water that people can drink.

MINERAL WATER

Mineral water comes from underground aquifers and mineral springs. In contrast to drinking water, mineral water does not go through chemical processing. As the name shows, mineral water holds high quantities of minerals, especially magnesium, calcium, and sodium. Mineral water is what contains at least 250 parts per million of total dissolved solids.

Mineral water may be classified as "still" or "sparkling" (carbonated/effervescent) according to the presence or absence of added gases.

Types of water and water cycle

Theoretical background

Authors: Michaela Hanzlová, Jan Macháč

BIOLOGY

The main objective of the module

Key subthemes

Global consequences related to inappropriate use of water
Sustainable Development Goals and water cycle

The existence of atmosphere is associated with the beginning of life on our planet, approximately 3500 million years ago. This is the place where all water processes occur and of course also whole water cycle is depending on the atmospheric processes. A small change of temperature or water flows can affect these processes and have big negative consequences which can affect also our daily life. We are changing these natural processes every day through our daily actions. In this section is necessary to explain to pupils how our daily actions affect global water cycle processes and how its changes can affect whole water system and other ecosystems. Water belongs to a most important resources in the world. The protection and appropriate water management is subject of many strategies and laws. At the international level this topic is involved in Sustainable Development Goals (SDGs). In the last part we move from a global scale SDGs to a micro-level. In this part you can find the description of the role of plants and roots in the water cycle.

GLOBAL CONSEQUENCES RELATED TO INAPPROPRIATE USE OF WATER

Today in addition to use of water for drinking, it is important to realize how many percent of fresh and drinking water we consume throughout industrial or agricultural production process. We often do not realize how much water was used in producing processes of the things we buy, and products such as mobile phone (910 l), cotton (250 g / 2 495 l) or just an apple (1 kg/822 l) need a lot of water to be produced as reported on website of NATURE (2013). This water is not visible, and we call it "Virtual Water". It explains contained water in various products we buy which maybe were produced on another part of the world, in this way we indirectly affect water resources throughout the world, and we can indirectly affect also the functionality of whole water cycle in a certain area. *Invisible water trade* has a global overlap and it is important source of water consumption and pollution. We can count how many liters we use every day through **Water footprint**.

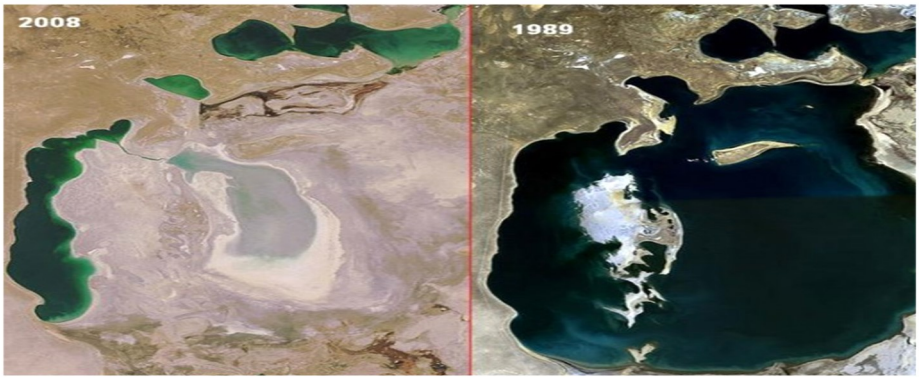
BIOLOGY

Household consumption can be easily calculated and ascertained, but this virtual water is defined as the "Sum of fresh water consumed to produce goods and services consumed by the population of the country (or person)" according to Water footprint (2019). We consume on average 5000 liters of water every day and we need to realize that everything we consumed needed water to be produced. To understand better this connection between water consumption and degradation of water ecosystem or water cycle we can mention one example which is just one of many: *Change of Aral Sea.*

Water footprint calculator :

https://waterfootprint.org/en/resources/interactive-tools/personal-water-footprint-calculator/

The Aral Sea is in central Asia and once it was the fourth largest lake in the world. The lake was an important source of livelihoods for the local population, who were fishing here. In 1960, the Soviet Union began using this water to irrigate cotton plantations. Cotton, which was used mainly to produce clothing, which was sold to European and other countries. Cotton needs a large amount of water, and as the water was pumped out at a very fast pace, the natural water level in the lake was not renewed.



As we can see on the Aral Lake map almost all the water has been drained. This was one of the problems, another significant factor was the pollution of the lake by fertilizers that leaked into the lake during the rains from the plantations.

As a result, there was a lack of livelihoods for the locals, the shipping has disappeared, the locals struggled with drought and with climate change and many of them had to migrate to find better conditions for their life. In this way we can say that this disaster has a global impact and these catastrophic examples that we can find all around the world, especially in developing countries, have resulted in the emergence of a global initiative for ***Sustainable Development Goals (SDGs).***

SUSTAINABLE DEVELOPMENT GOOLS AND WATER CYCLE

What are the Sustainable development goals?

Whole world is facing quick environmental changes, this fact is familiar to all geological or historical periods (Ice age), but the rapidity of this change is abnormal, not known to any other period in existence of the Earth. If we change whole water cycle it doesn´t affect just us in Europe, but climate will change through whole world. And how to deal with this rapidity of changes? It is possible face it from one part of the world or we need to find common solution for all the world together? As we have seen, cotton production can take place on one side of the world and on the other side of the world people are buying t-shirts made from it. So, who is responsible for drying up Aral Sea? People who buy t-shirts, or people who run these plantations? It is difficult to find only one culprit and therefore SDGs focus not only on the environmental part of the problem, but also on what these disasters are causing at the individual level. Under the auspices of *United Nations*, Sustainable Development Goals were born, they came into effect on 1 January 2016 and they are a landmark agreement by all countries on a blueprint for a better future. The objective is to produce a set of universal 17 goals that meet the urgent environmental, political and economic challenges facing our world.

UN and all 17 SDG goals:

https://sustainabledevelopment.un.org/?menu=1300

SDG 6

Although we have 17 Sustainable development goals, we will focus just on SDG number 6 Clean water and sanitation, because is of our interest. This goal is divided in another 6 chapters as: *6.1 Drinking water, 6.2 Sanitation and hygiene, 6.3 Water quality and wastewater, 6.4 Water use and scarcity, 6.5 Water resources management, 6.6 Water-related ecosystems, 6.a International cooperation and capacity building, 6.b Stakeholder participation.* Our focus is on chapter 6.6 Water-related ecosystems and the target of this goal is *by 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.* „It seeks to halt the degradation and destruction of water ecosystems, and to assist the recovery of those already degraded. The target includes water-related ecosystems such as vegetated wetlands, rivers, lakes, reservoirs and groundwater, as well as those occurring in mountains and forests, which play a special role in storing freshwater and maintaining water quality. Target 6.6 directly contributes to wider improvements in ecosystem health, both marine (SDG 14) and terrestrial (SDG 15). "(Sustainable Development UN, 2019). Although SDG 6 is focused on water topics, the water issue can be found in all 17 objectives:

The 17 sustainable development goals (SDGs) to transform our world:

Number of SDG	Name of SDG	Importance of water in SDG, examples:
No. 1	**No Poverty**	Clean water, sanitation, water infrastructure
No. 2	**Zero Hunger**	Drinking water available for all
No. 3	**Good Health and Well-being**	Dirty water causes many health issues - cholera, diarrhea, malaria (more concentration of insects around dirty water)
No. 4	**Quality Education**	Raise awareness about use of water in the future, importance of clean water and sanitation for health
No. 5	**Gender Equality**	In the countries of global South mostly women oversee transporting the water for long distances to their houses
No. 6	**Clean Water and Sanitation**	The World Health Organization estimates that 3.575 million people die from water-related diseases a year. The lack of sanitation (proper wastewater systems in towns, slums…)
No. 7	**Affordable and Clean Energy**	Hydroelectricity
No. 8	**Decent Work and Economic Growth**	Development of water distribution networks and of wastewater treatment plant can create also many workplaces and make economic benefits for the country

BIOLOGY

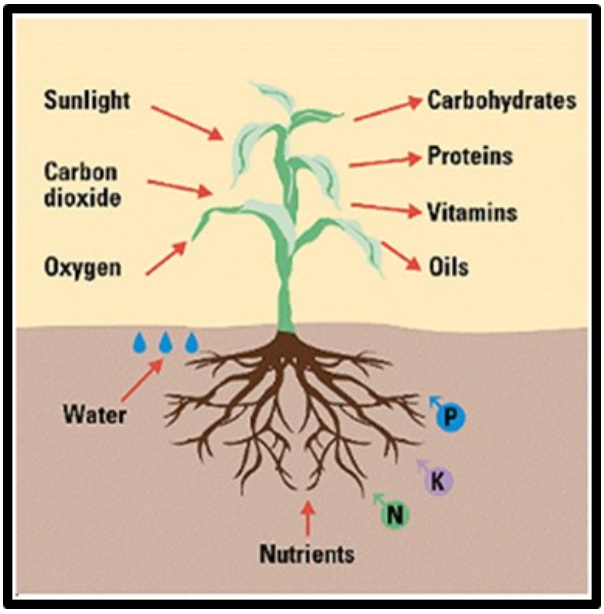
Source: UN (2019)

No. 9	**Industry, Innovation and Infrastructure**	Innovation in crop systems, innovation in distribution of water and wastewater treatment in global South and North countries
No. 10	**Reduced Inequality**	Appropriate wastewater systems, appropriate access to clean water
No. 11	**Sustainable Cities and Communities**	Retention of the water in the cities, Protection of water ecosystems, preservation of wetlands
No. 12	**Responsible Consumption and Production**	Responsible water use in households and wastewater treatment
No. 13	**Climate Action**	Importance of savings of water, Importance of water management everywhere, Protection of water ecosystems
No. 14	**Life below Water**	Marine life and its preservation
No. 15	**Life on Land**	Retention of the water in landscape – wetland, forests, meadows
No. 16	**Peace and Justice Strong Institutions**	Wars because of water resources (Actual Turkey and Syrian conflict interest for Efrat and Tigris rivers for example)
No. 17	**Partnerships to achieve the Goal**	Sharing of good practice: management of water resources, wastewater treatment and spreading of knowledge

As we mentioned before, one change in one part of the world can cause damages (floods or drought) in another part of the world. World impact on the earth´s water cycle is a crucial for a climate change that we can observe today. Water cycle distributes water from the oceans to atmosphere, soil, rivers and lakes to return to seas and oceans as reported in NASA (2010). The main problem is in this distribution, when it will be altered intensively also the weather in many parts of the world will change and these phenomena will have big impact on agriculture, production and on life of everybody. The best solution is to recognize future impacts and prepare in time, because today's world is very interconnected, and we can say we live in a *globalized world* and the impact of such changes can be huge. Production of gods requires a lot of water and human effort, this production is not always associated with appropriate approach to nature and human rights and often the entire ecosystem disappears (forests, water courses, healthy fields, etc.) in order to buy things that we are used to have. Therefore, it is important to be aware of actions we do and to be environmentally responsible. These environmental shifts cause major changes on the level of water distribution, climate change and on the water cycle. Where are no plants and water to left – there is no life.

Plant and global water cycle

How does plants participate in the global water cycle? How do they absorb or eliminate water from their bodies? Plants absorb food through their roots and transform it into organic matter through their leaves. But how it happens? The important role has soil and water: "Soil is the result of the mechanical alteration of rock and the chemical activity of organic transformations. It acts as a support for plants, and it provides the water, oxygen, and mineral salts they need to develop." Fertilizer machine (2012). It is water that transports the nutriments while soil retains water with efficiency.



Source: Quizlet (2019)

Now we know importance of the water and minerals from the soil for the plants. But the plants don´t just absorb water from the ground they can also produce water. We call this phenomena transpiration and it is the moment when water is used for metabolic and physiologic functions. The water is released to the atmosphere in this process through the plant's leaves and this process of transpiration can give rise to a small water cycle as reported in USGS (2019). Good examples are forests where weather can change due to transpiration in any moment. In this part is good to emphasize concrete examples. It can be question as; Do you remember when you saw vapor rise above the forest? And after vapor raised, it rained somewhere? Plants not only support a stable local climate but also retain soil and protect it against erosion.

BIOLOGY

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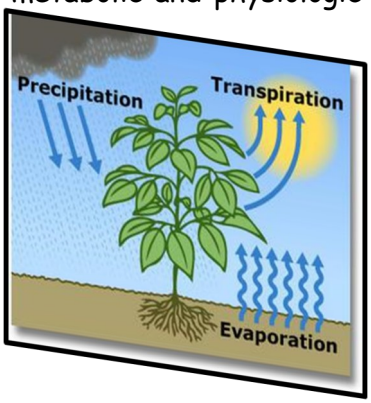

Source: Science for changing world (2019)

Another important thing is the adaptation of plants to the environment. For example, we can find succulents in their natural habitats (famous Aloe vera) almost just in the deserts because they can absorb and store water well, in this way they can survive extreme drought and heat. Within Europe plants do not have such a need to conserve water, because in this climate conditions rains much more so they are physiologically different. This all physiological characteristic are result of a long process of adaptation to the climatic condition in specific areas. But what can happen if the weather will change and plants from Europe won't be ready for higher temperature? Today we are facing global warming which is dangerous for forest and plants ecosystems and due these changes we can face loss of them. We are already losing a big part of rain forests due to human activity, mainly for the economic reasons and if we add also climatic changes loss, we can lose our world lungs which are producing the biggest amount of oxygen in the world and absorbing a big part of CO2. What we will do when there is no forest or plant left?

BIOLOGY

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Types of water and the water cycle

Theoretical background

Authors: Jože Cvetko, Majda Adlešić

FINE ARTS

Introduction

A mathematician and philosopher, Thales of Miletus, in the 6th century BC wrote: "It is water that, in taking different forms, constitutes the earth, atmosphere, sky, mountains, gods and men, beasts and birds, grass and trees, and animals down to worms, flies and ants. All these are different forms of water. Meditate on water!" Life began in water, or thanks to water, following numerous theories of the origin of life on the planet. The fact is that all great civilizations developed along the waters, rivers. Because of its importance, water has long played an important religious and philosophical role in human history.The development of man as thinking creative being started with the pursuit of art. And that art was practically a replication of everything seen in nature. So water became a topic and inspiration in art very early on.

Following the theme of water in the arts, we practically follow the development of human civilization. It required broad insight into the development of civilization and all arts disciplines: painting, literature, music, sculpture, landscape architecture, architecture, movie, strip, graphic design, photographic…Water as a topic in the natural sciences is clearly and explicitly describe: by processes, formulas, equations…

In artistic disciplines, water is explain by symbols, metaphorical images, transmitted meanings, associations…. Dealing with the connection between water and art, we can view it as a motive, as a symbol and as a means in the process of work. As like "added value", each module is horizontally linked to the theme of water supply and sewerage, that is, through the processes of drinking water production, water transport and wastewater transport and wastewater treatment.

Water cycle as natural phenomena and artistic provocation

At the heart of all water topics is the water cycle in nature.We cannot know for sure how long it took our ancient ancestor to perceive and understand the cycle of water and its laws. But it was certainly clear to him that the rains brought better crops but also floods, that because of the snow he had to provide wood and get better dressed. Also, that the river can feed and defend it but also endanger it. And that there may be another world on the far horizon of the ocean. Representing the water cycle in art as it is in the exact sciences is not usually but there are indeed a large number of works of art and less works of art that deal with phenomena that are elements of the water cycle in nature: rain, snow, clouds, winds, drops, rivers, seas, oceans *(Annex Module 1).*

There is a very picturesque description about that in a poem "A little drops of water", by poet Steve Roslonek in the interpretation of the great artist Meryl Streep.

Source: https://www.mamalisa.com/blog/little-drops-of-water-sung-by-meryl-streep/

"Little drops of water
Little grains of sand,
Make the mighty ocean,
And the pleasant land.
So the little moments,

Humble though they be,
Make the mighty ages
Of eternity".

Fig. 1. Verses from "A little drops of water",

For artists, the circulation of water in nature is the cycle of life; the cycle of life that begins in water and woman. In this sense, the painting "The Birth of Venus" by Renaissance painter Sandro Boticelli is an interesting example. Venus as a being of perfect beauty and woman is born of sea foam. Why does it look like this? Why sea foam? Liquid water was much smaller than it is today, so the "pre-soup" was made up of shallow seas. There are many assumptions about the composition of the atmosphere: nitrogen, hydrogen and ammonia. All that was needed for life was there - water, C, N, H, O, S ... as well as the energy needed.

FINE ART

So this image from the Renaissance, (the rebirth) image of all beginnings, the emergence of life in and out of water, and the cycle of life circulating through a woman's body as water circulates in nature. The life of each of us begins in the water of our mother's womb and every act of giving birth as like a work of art. Through history, man began to create works of art while creating products that met the immediate needs of life. Art emerged from the need to provoke a reaction in another being and therefore contact. And through art man shows his need for socialization. The language of art is very rarely direct, and often the provocation created by a work of art acts as a play. Just as water has its own circular path in nature as well as in the human world of water, so the theme of water cyclically or continuously returns to artistic directions from prehistory through classical art to contemporary creation.

Fig. 2: Sandro Botticelli , Birth of Venus,1480, (source of photo:private arhiv)

The language of art is universal, but it can be interpreted and read in a unique way through the discourse of each national culture. The original representations of water are basically graphic symbols of the forms in which man encountered water. Great civilizations were created along the rivers, first the Tiger and the Euphrates, then the Nile, the Danube and so on. Man's inspirations were the broken waves of water, the harsh lines of stormy rain, the stark lines of reservoirs that were being created. He conveyed what he saw to the nearest substrates, utility and decorative objects, walls and implements. Water was a friend and defender of man, and he perceived the behavior of water

In this handbook, we want to impart general knowledge to students with specific reference to the development of civilization based on the theme of water.

FINE ART

He represented the water in a simple graphical way. The relief pictured on left was found on an Assyrian monument and published in the book by the Victorian archaeologist Austen Henry Layard's "Monuments of the Nineveh" (source from "The city in history" by Lewis Mumford). The relief shows a simple way of presenting water with a simple method with clearly distinguished importance of water - the one that nourishes and the other that defends. He feeds on fishing from the water, on the other side it waters his plants to feed himself and the animals, everything is cyclical.

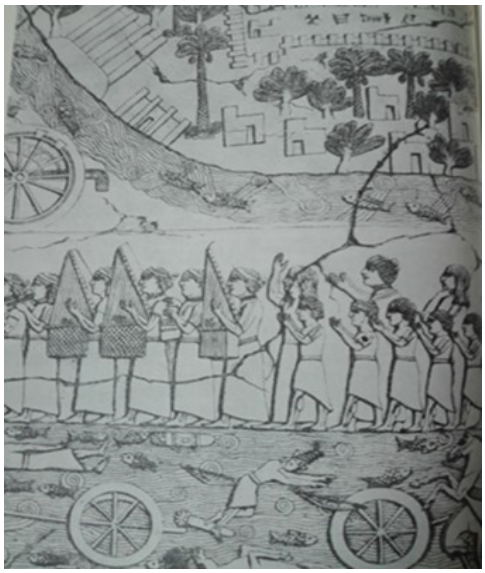

Fig.3. "Monuments of the Nineveh" (source for "The city in history" by Lewis Mumford)

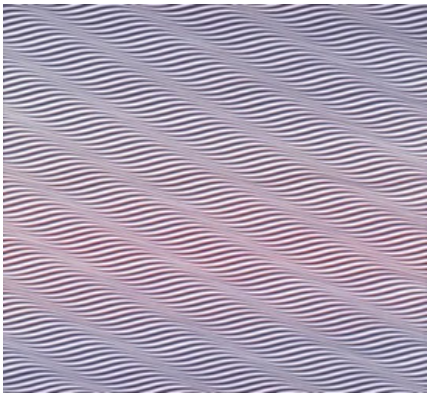

Fig. 4.Bridget Riley,1961,Cataract 3, (source: The Art Book)

Over time, that inspiration did not disappear; it changed its appearance throughout the history of art, so that it appeared in modernism in works of art in a very similar way. It circulated through works of art like water in nature. Thanks to modernism and artistic techniques, we can now feel these waves visually.

FINE ART

By connecting with nature and cycles in nature, man often associated religious rites as well as pagan customs with water. For example, the rite of baptism is associated with water. In the image "The Baptism of Christ", which abounds in light, in addition to the very act of baptism that introduces new life, we also see clouds and water on the ground as a mirror of the whole image. And that is a common motif in both literature and visual arts.

Fig. 5. Piero della Francesca, 1450, The Baptismo of Christ, (source: The Art Book)

Fig.6. Mycenaean vases
https://www.slideshare.net/marinachudov/

During the time, forms and motifs become stylized and in the coming civilizations become more artistic. Mycenaean vases with highly stylized representations of the water and wildlife of the sea are famous. As man began to discover the world around him, terrestrial and underwater, and recognized water-related phenomena, so did water-related notions become more figurative.

Following the cycle of water in nature, each phenomenon has attracted the attention of artists. The calm surface of the water as well as the powerful wave, the mist in the same way as the cloud, rain, snow, water in the depth of the earth…(Annex Module 1)

FINE ART

In addition to the fact that water is very artistic itself, visually appearing, water is also sonorous, musical. Every phenomenon of water produces sound, even melody, so it is a frequent inspiration for artists. In every national culture, a large number of compositions are dedicated to the rivers or seas the country prides itself on. By listening to the sounds of water, different "sources" of the sound of water, music is created. The water as like as a river, rain, snow is a motif in a large number of compositions of all kinds of music.

"Far from the Black Forest
you hurry to the sea
giving your blessing
to everything."

Fig.7. Verses from a choral section of a waltz written by Johann Strauss II, "The blue Danube". (orig. "An der schönen, blauen Donau", Op. 314).

There is an enormous number of compositions in all genres of music that are associated with water, talk about water or imitate water. And just as many composers have become recognizable. Very often associated with other artistic disciplines such as film and theater.

"The blue Danube" is the one of the most famous compositions whose sounds can feel all the power and beauty of this powerful river Danube.
https://www.youtube.com/watch?v=_CTYymbbEL4

Handel, Water Music
https://www.youtube.com/watch?v=mAyiidg25uE&t=146s

Federic Chopin, Raindrops, Prelude in D-Flat Major Op.28 No15,
https://www.youtube.com/watch?v=eg_NHrq_-Oc&fbclid=IwAR2ACjO-psvc5KMsVz6uWFXy0RcqVsWH9GpJGYcW5QFy-mYtf-Qbe6eNAv0

Rivers flow in you, Yiruma
https://www.youtube.com/watch?v=kG9KSWYg-Jc

Iconic „Singing in the rain", Gene Kelly, movie "Singing in the rain" (1952)
https://www.youtube.com/watch?v=D1ZYhVpdXbQ

Enya, Orinoco flow

https://www.youtube.com/watch?v=LTrk4X9ACtw&list=PL6n_XTD5fjYF6qSKFyBHotzxxauf-xTmd

FINE ART

Fig.8. "The Great Wave off the Coast of Kanagawa"(1823.-29), coloured woodcut, Metropolitan museum, New York. Photo on retrospective exibition in Martin Groupius Bau gallery in Berlin, 2011

Back again to visual arts. Some artists were aroused by the wild power of water in nature, such as the Japanese artist Kacushiki Hokusai and his woodcut "The great wave of Kanagawa". "The great wave of Kanagawa" was first interpreted as a metaphor for Mount Fuji, however, by analyzing all the graphics in the series, art critic Edmond de Gonkur confirmed that "The great wave of Kanagawa" is exactly what is seen in the graphic and shows the artist's admiration for the power of the ocean that surrounds his country. https://theculturetrip.com/asia/japan/articles/hokusai-s-great-wave/

How inspiring this woodcut, the depiction of powerful water, in itself as a water cycle, is also shown by the fact that it painted a block of buildings, as a mural (a new art discipline) in Moscow in 2018.

Fig.9.The great wave of Kanagawe on skyscapers in Moscow

https://www.gradnja.rs/hokusajev-veliki-talas-osvanuo-na-fasadama-moskovskih-zgrada

Others, multitalented and versatile, indulged in the design and painting of water, such as Claude Monet and his Giverny, the garden and the artist's inspiration and motive. One of the most famous Impressionists, a 20th-century artist Claude Monet, created a garden – water space of extraordinary beauty that became one of the most pervasive motifs in his paintings. Thanks to the paintings, the painter's estate Giverny has become one of the most visited places. Garden has two big parts – flower garden and water garden. At the end of the path from the flower garden, Claude Monet built another unit - a water garden, modeled on Japanese woodcuts, whose common motif was a traditional Japanese garden along the water surface with a bridge. The main inspiration for his artistic creation will still be a water garden with a pond. Willows, irises and bamboo reeds were around the edges of the pond. The water of the pond was filled with eel grass and algae, and water lilies floated on the surface.The recognizable motifs from his paintings, dating from 1901 to 1925, where water and water lilies predominate, can be visited almost all year long. Claude Monet was as passionate a gardener as a painter. Water and all natural phenomena were a common motif in the paintings of the Impressionists, whose idea was to leave the studio and work conditions and live contact with nature. That is why the paintings of the Impressionists, and therefore the motif of water on them, free from symbolism, already show the beauty of water and its soothing effect in the right way.

Fig.10/11. Claude Monet,"Waterlilly pond with Japanese bridge",in site in Giverny, and on oli on canvas, 1899

But Claude Moonet had a very rich opus of paintings dealing with different forms of water in nature. "Snow Scene at Argenteuil"1874/75 https://www.nationalgallery.org.uk/paintings/claude-monet-snow-scene-at-argenteuil and "Flood", 1896 https://www.nationalgallery.org.uk/paintings/claude-monet-flood-water

Fig.12. Claude Monet, Snowscene at Argenteuil

Fig.13. Claude Monet, Flood

Literature also abounds in works with motives for living next to water, fighting against nature for water, etc. Some of them are adventure novels such as "Robinson Crusoe" (by Daniel Defoe, 1719) "Twenty Thousand Leagues Under the Seas"(by Jules Verne, 1870), or "The adventures of Tom Sawyer"(by Mark Twain, 1876). A very inspiring novel about man's coexistence with water and its power as well as the beings who live in it, man's aspiration to overpower them, is Ernest Hemnigway's novel "The Old Man and the Sea", 1951. (Annex Module 1)

The cycle of water circulation in nature as well as life will remain an eternal inspiration for artists. It will change over time just as a drop of water changes as it makes its circle. Fascinated by the movement of water as a performance, and sometimes as a metaphor for life forces, rhythmic harmony and natural unity, Leonardo wrote: "In rivers, the water that you touch is the last of what has passed and the first of that which comes; so with present time." https://www.azquotes.com/quote/303092. In all of Leonardo's manuscripts, there is no better metaphor or true claim about his basic thesis that explains natural events and human life, revealed in a moment of time.

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https://www.azquotes.com/quote/303092.

The use of water in everyday life

Theoretical background

Authors: ANATOLIKI S.A.

GEOGRAPHY

Introduction

This chapter describes the use of water in everyday life. The purpose of the chapter is to foster children to understand water as an integrated system and to develop attitudes and skills which are conductive to the achievement of ecologically sustainable development. The chapter is separated into four different subchapters where the importance of water, uses of water in schools and households and some proposed uses are presented.

The importance of water for social, economic and cultural development

Greece is considered to be a country with sufficient surface and underground water resources. The country owns, proportionally to her size, a significant number of rivers, lakes and sea. The geological conditions favor the development of underground aquifers. However, these available quantities cannot always be exploited.

Since prehistoric times, water has been closely associated with the human presence and cultural evolution. Wetlands have attracted human populations as they have provided drinking water, food (fertile soils and pastures) and the ability to quickly travel and transport. It is no coincidence that most major cities have been built on the shore or esturiaries of lakes and rivers or generally near water springs. Many large civilizations have developed near wetlands such as Mesopotamia or the Nile Delta.

Water, as a symbol of life, has become an object of worship since ancient times. It is considered as inexhaustible source of life and power and in most religions, water is a symbol of purification and healing.

Proposed good practices on water use in urban areas

To save water, bibliography offers good practices to follow in order water to be protected, well managed and monitored. To achieve a rational water management there are given good practices for urban spaces. The table below (Katirtzidou M., 2018) offers good examples that can be efficient in water saving at home, as well as outdoor activities and leisure areas:

GEOGRAPHY

HOME LEVEL	OUTDOOR SPACES
Basin: Reduce amount of water, Use parts to avoid leakage	**Gardens and lawns:** Choose plants resistant to water scarcity, Re-use water, Install drip and microspray systems, Irrigate at night, Use materials (leaves, fertilizer, bark) to reduce water evaporation, Check for weeds
Shower: Reduce discharge**,** Reduce the duration of the shower	**Pools and lakes:** Use water purifiers, In the case of fishing, use techniques similar to fish ponds
Washbasin: Reduce water pressure, Use valves with automatic closing, Wash dishes in a bowl (not under running water)	**Golf courses:** Adopt watering practices with easy management under water scarcity, Re-use treated effluent for irrigation, Create management irrigation strategies to tackle water scarcity
Washing machine: Use only full load, Use domestic appliances with low water consumption	**Parks and lakes:** Impose measures on water quality, Adopt integrated water resource management
Dishwasher: Use only when full, Use domestic appliances with low water consumption	**Sports facilities:** Water with micro-spray systems, Exact irrigation
Gardens and lawns: avoid overwatering of soil, Inform on watering needs/frequency	**Public swimming pools:** Use water and chemical cleaners, Implement health prevention measures
Washing of pavements and cars: Avoid washing with hose, Use of re-used water in car wash services	**Indoor facilities:** Apply water saving devices in toilets, showers, washbasins, Detect leaks and repair
Swimming pools: Use water purifiers, Cover pool to avoid evaporation	**General issues:** Publicize and promote water saving measures, Advertise / update audiences, Educate children and young people
Leakage control: Apply good techniques, Place good quality materials, Locate damage and repair	
Pressure control: Use pressure regulators	

(Source: Katirtzidou M., 2018)

The use of water in the households and schools

A large amount of water is used in households. Although the daily water use differs from country to country and from season to season, we drink or use averagely every day, two to three liters of water per person for cooking, we consume 145 liters daily for hygiene/toilet, bath, body care, washing clothes & dishes and household cleaning. It is estimated that a person needs about 50 liters per day to satisfy his personal and household needs despite the fact that in developed countries this amount can reach up to 400 liters per person. The water we use daily is not only wasted, but is also polluted by detergents and other chemicals that are dropped into water and, end up in nature if they are not moved away. Almost 40% of the water we use is used in the bathroom, 9 to 16 liters of pure water (6-10 large bottles of water) is used when flushing the toilet. According to studies, we consume about 15 liters of water per minute when we are in the bathroom. (www.watersave.gr)

Some activities for saving and water management in schools are:

Indoors:

Repair any leaks in taps and water fountains.

Close taps when not using water during activities such as washing dishees or paintbrushes.

Install aerators on faucetes.

Install low-flow shower heads in the shower.

Encourage shorter showers.

Replace toilets with low-flow toilets.

Replace irinals with waterless, censored or hand-flush options.

Do not use toilets as garbage receptacles.

Run school appliance only with full loads, use the quick cycle and use the cold water cycle.

When hand-washing dishes, do not run water continuously.

Drink tap water instead of buying bottled water.

Outdoors

Water lawn only at dawn or dusk.

Plant native plantsthat require minimal watering.

Reduce or avoid the use of pesticides.

Use sand rather than salt on sidewalks and driveways to get traction on winter ice.

Collect rainwater to be used in the gardens.

Participate in a community river/stream/marsh/shoreline cleanup in your area.

Down the Drain

Use environmentally feiendly biodegradable cleaners.

Ensure correct chemical disposal methods are in used.

Avoid dumping anyting down to storm drains as they often link directly to streams and lakes.

(Source: www2.gov.bc.ca)

GEOGRAPHY

School is the proper environment to sensitize multiple actors. Teachers, pupils, families and directors can be sensitized on water when being involved in designing water management practices at school. An indicative list of actions that can be done to educate pupils on water issue, may be the following:

For the schoolchildren:

* *Comply with procedures for use and care of water, sanitation and hygiene enabling facilities.*
* *Observe appropriate hygiene measures.*
* *Participate in the design and construction process.*
* *Play an active role in the cleaning and maintenance of facilities (e.g. through school health clubs).*

For the schoolchildren families:

* *Encourge children to comply with procedures for use and care of water, sanitation and hygiene-enabling facilities at school and develop positive hydiene bahaviors.*
* *Support, or participate actively in, parent-teacher associations or similar bodies.*

For the theachers:

* *Monitor the state and use of school water, sanitation and hygiene-enabling facilities.*
* *Organize the care and maintenance of facilities.*
* *Encourage schoolchildren to adopt appropriate behaviors at school and at home through hygiene education.*

For the school directors and head teachers:

* *Organize the setting of targets for water, sanitation and hygiene at school level.*
* *Ensure liaison with education authorities and other authorities at local and district level.*
* *Create conditions in which staff in motivated to achieve and maintain targets.*
* *Develop and enforce rule when required.*
* *Encourage parent-teacher liaison.*

(Source: Adams J., Bartram J., Chartier Y., Sims J., 2009)

Conclusions

The incerasing urbanization is also relatively increasing the importance of the sustainable management of water resources. At the same time, the "ecological footprint" of the modern city extends to a much wider area than its immediate area of influence (seas, lakes, rivers, city water supply). This implies the need for an integrated approach to urban water management by urban users (adults and children) for all uses and activities (home, schools, outdoor activities, buildings etc.)

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The use of water in everyday life

Theoretical background

Autors: Dr Ildikó Galambos, Dr Renáta Berta Gerencsérné, Dr Ildikó Bíró

CHEMISTRY

H2O

All life on our planet needs water to survive. People use water every day to drink, to prepare food, for cleansing, etc. Water is needed to keep our environment clean and is used in our homes to wash our clothes, dishes, cars, toilets and pets.

Water is important in every industry that supports our modern way of living. Water is needed for our food production in farms to irrigate crops, to water farm animals and for fishing. The mining industry is a big water-using industrial sector, and the manufacturing industries too. Water is used to generate the power that provides energy for our communities. Water also plays role in water sports and in the tourism industry where it is used for fun activities.

Water is essential to us and its daily use, we need to look after it and be Water Wise. We have to take care about stopping water pollution and removing the existing pollutants from our water bodies.

But what does it mean clean water? How can we classify a water as clean water?

In nature there is no clear water in chemical meaning. Each water and waterbody contain less or more chemical components. We qualify waters according the requirements it is used for. Water quality refers to the chemical, physical, biological, and radiological characteristics of water [1].

We use our sense organs to identify the visible quality of waters. Often the appearance, taste and odour of the tested water give us lots of information and are a good indicator of water quality. But besides that, waters have both sensible and insensible qualities and what is easily detectable does not tell the whole story.

The chemical properties of different waters are very important in water qualification. The chemical components are determined by laboratories.

In nature there is no clear water in chemical meaning. Each water and waterbody contains less or more chemical components.

CHEMISTRY

Cations

The main components are the followings:

Sodium

11
Na
Sodium
22,99 g/mol

Sodium is metallic element, which is found in the first group of the periodic table. It is the sixth most abundant element on earth. Sodium compounds are generally found dissolved in the oceans, in minerals, and even in our bodies. Sodium in the water stems from rocks and soils. Not only seas, but also rivers and lakes contain high amounts of sodium. Concentrations however are much lower, depending on geological conditions and wastewater contamination. Seawater contains approximately 11,000 mg/L sodium. Rivers contain only about 9 mg/L. Drinking water usually contains about 50 mg/L sodium. This value is clearly higher for mineral water[3].

Potassium

19
K
Potassium
39,1 g/mol

Potassium (K) is a silvery-white metal that is soft enough to be cut with a knife with little force. In the water it occures in ionic form, K^+. It is a natural component of water. Potassium occurs in various minerals, from which it may be dissolved through weathering processes.

Seawater contains approximately 400 mg/L potassium. It tends to settle, and after ends up in sediment generally. Rivers usually contains about 2-3mg/L potassium.. In water this element is mainly present as K^+ ions [3].

Calcium

20
Ca
Calcium
40,08 g/mol

Calcium is naturally present in all types of surface and ground waters. It dissolves from several rocks such as limestone, marble, calcite, dolomite, gypsum. Calcium is a determinant of water hardness, because it can be found in water as Ca^{2+} ions, , but it may also occur as $CaOH^+$ (aq) or $Ca(OH)_2$ (aq), or as $CaSO_4$ in seawater. Magnesium is the further hardness determinant. Calcium functions as a pH stabilizer, because of its buffering qualities. It also gives water a better taste. It is presented in seawater in amounts of about 400 mg/L calcium. Rivers usually contain 1-2 mg/L calcium, but in lime areas rivers the concentrations can be as high as 100 mg/L [3].

Magnesium

12
Mg
Magnesium
24,31 g/mol

After sodium, magnesium is the most commonly found cation in oceans. Magnesium is mainly present as Mg^{2+} (aq) in watery solutions, but also as $MgOH^+$ (aq) and $Mg(OH)_2$ (aq). In seawater it can also be found as $MgSO_4$. Seawater contains nearly 1300 mg/L magnesium, while drinking water contains between 1-10mg/L, but in some special mineral waters there is between 50-100 mg/L. Magnesium and calcium are responsible for water hardness. Water containing high amounts of alkali earth ions is called hard water, and water containing low concentrations of these ions is called soft water.

Iron

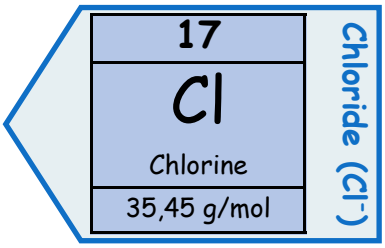
26
Fe
Iron
55,85 g/mol

The main iron minerals that naturally occurre are magnetite, hematite, goethite and siderite. Weathering processes release the iron element into surface waters. Both mineral water and drinking water contain iron carbonate. In seawater the iron concentration is between 1-3 μg/L. In rivers and lakes it is higher, nearly 0,5-1 mg/L, but in underground waterbodies, it can reach 100-200 mg/L.

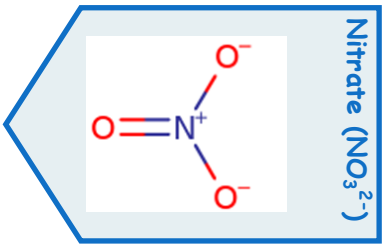
Anions

Chloride is a naturally occurring element that is common in most natural waters. Chlorides are widely distributed in nature as salts of sodium (NaCl), potassium (KCl), and calcium ($CaCl_2$). Chloride in surface and groundwater origin from both natural and anthropogenic sources. The existence of chloride in groundwater can result from several sources including the weathering of soils, salt-bearing geological formations, salt used against icing for roads, contributions from wastewaters and in coastal areas, intrusion of salty ocean water into fresh groundwater sources.

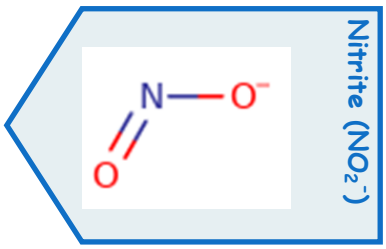
Most surface freshwaters (rivers and lakes) have chloride concentrations under 50 mg/L and any marked growth may be indicative of sewage pollution or, if the increase is seasonal, it is linked to the using of rock salt ('grit') to roads. The chloride amount of a sewage effluent flow could increase the chloride concentration of the receiving water by as much as 70 mg/L. In drinking waters the cloride concentration is between 50-250 mg/L. Brackish waters can hold several hundred mg/L of chloride, while seawater usually containing around 20 000 mg/L.



Nitrate is a naturally-occurring, inorganic form of nitrogen, is usually existing in small concentrations in rainwater, stream water and groundwater. Nitrogen forms cycles through soil, water, aire, and living organisms through the nitrogen cycle. In nature, nitrate is made by bacterial activity that metabolize further forms of nitrogen, and it is one of the main forms of nitrogen that can be absorbed by plants. The most serious health concern related to nitrate in groundwater is associated to its conversion to nitrite (another inorganic form of nitrogen) in the digestive system. In the public drinking water systems there is a limit in nitrate concentration, it must be under 50 mg/L.

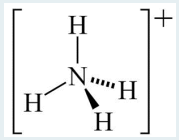


Nitrite is an other form of nitrogen that occurs naturally in the environment. Nitrite can pollute water through runoff water in contact with fertilizer or sewage, or from groundwater in contact with mineral deposits. Nitrite besides other nutrients can lead to environmental problems, for example to eutrophication. In drinking water, concentrations of nitrite need to be below 0,1 mg/L. Higher nitrite concentration causes "blue baby syndrome" by interfering with the ability of red blood cells to carry oxygen. This is mostly a problem for babies, unborn children and the elderly.



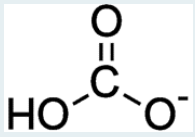
Anions

Ammonium (NH_4^+)



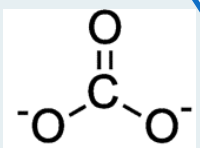
It is a biologically active compound found in most waters as a normal biological degradation product of nitrogenous organic matter (protein). It also may find its way to ground and surface waters through discharge of industrial process wastes containing ammonia and fertilizers. Raised levels of ammonium may origin from intensive agriculture in the catchment area of the water source. Ammonium is an indicator of possible bacterial, sewage or animal waste contamination. Ammonium alone is not a health risk but its concentration serves as a valuable indicator of source pollution.

Bicarbonate (HCO_3^-)



Bicarbonate is a typical substance in underground waters that have permeated limestone stratum, such as dolomite. Bicarbonate is a natural component of all mineral waters. Mineral waters that are sourced from limestone-rich areas typically have a high bicarbonate content. Bicarbonate plays a vital role in buffering acids. If it is dissolved in water in calcium or magnesium bicarbonate form [$Ca(HCO_3)_2$ and $Mg(HCO_3)_2$], it causes the temporary hardness of the water. The temporary hardness can be removed by boiling. On the other hand, the permanent hardness cannot be removed by boiling. It is caused by sulfates ($CaSO_4$ and $MgSO_4$) and chlorides ($CaCl_2$ and $MgCl_2$).

Carbonate (CO_3^{2-})

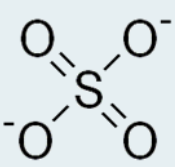


Carbonate is the conjugate base of the hydrogen carbonate (bicarbonate) ion, , which is the conjugate base of H_2CO_3, carbonic acid.

Other important anions

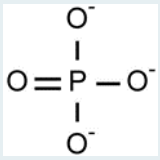
In natural water types there are a lots of other anions, for example sulphate, phosphate, fluoride.

Sulphate (SO_4^{2-})



The origin of most sulfate compounds or salts is the oxidation of sulfite ores, the presence of shales, or the industrial wastes. Sulfate is one of the major dissolved components of rain. High concentrations of sulfate in the drinking water can have a laxative effect when combined with calcium and magnesium, the two most common constituents of hardness.

Phosphate (PO_4^{3-})

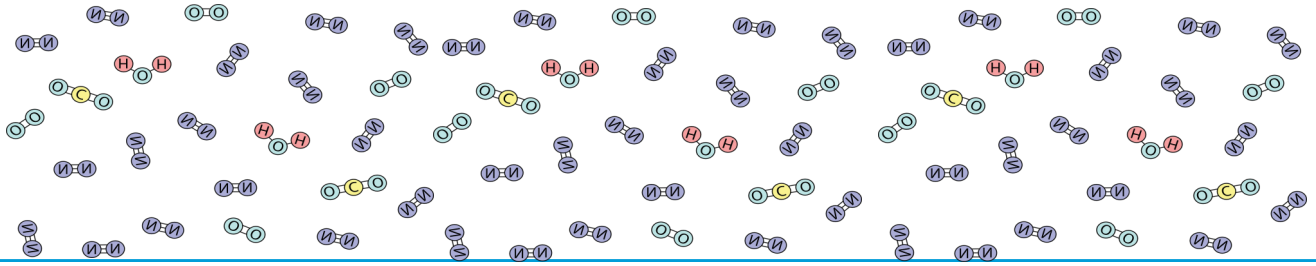


Phosphate starts its existence in nature as phosphate ions (PO_4^{3-}) in the rocks of the world. When it rains, the phosphates and other minerals are removed from the rocks and distributed in soils and the water all over the planet. Phosphates affect water quality by causing excessive growth of algae, called eutrophisation. The health effects of drinking water with phosphates are not known. Public water systems (PWSs) commonly add phosphates to the drinking water as a corrosion inhibitor to prevent the leaching of lead and copper from pipes and fixtures.

Fluoride (F^-)

F^-

Fluorine is a common element that does not occur in the elemental state in nature because of its high reactivity. It exists in the form of fluorides in a number of minerals, of which fluorspar, cryolite and fluorapatite are the most common. Fluoride is naturally present in groundwater and the oceans. Fluoride is often added to the public water supplies of industrialized countries in order to reduce the populations tooth decay.



Other mikroelements

Over the above-mentioned cations and anions, there are a lot of other ions, elements and compounds is the different natural waterbodies. Some of the most important of them are listed below.

Aluminium is present in drinking water as a result of its use as aluminium sulphate (a coagulant) in the water treatment process, though can be naturally present in some waters [4].

Arsenic has significant health effects in some parts of the world (e.g. Bangladesh). Arsenic is one of the few elements shown to cause cancer in humans through consumption of drinking water [4].

Copper is a nutrient essential for health, though at raised levels can become a contaminant (elevated levels cause acute gastrointestinal effects). In drinking water, the primary source of copper is from corrosion of internal copper plumbing [4].

Manganese commonly found in groundwater with iron. Manganese can cause staining problems. High levels of manganese also cause objectionable tastes in the water but there are no particular toxicological effects [4].

Lead is existing in drinking water mainly from its dissolution from lead pipes or lead-containing solder. Lead is a general toxicant that accumulates in bone tissue. Babies, children up to 6 years of age and pregnant women are the most susceptible to its toxic health effects. It is harmful to both the central and peripheral nervous systems [4].

Anthropogenic pollutants

Water pollution is the contamination of different water bodies (e.g. lakes, rivers, aquifers, groundwater and oceans), very often caused by human activities.

We talk about water pollution when pollutants (particles, chemicals) are discharged directly or indirectly into water bodies without sufficient treatment to remove harmful components. Contaminants get into water especially by human activity. Water pollution can be a Point-source, Non Point-source, or Transboundary in nature. Water pollution is the second most imperative environmental concern along with air pollution [5].

Water pollution is a challenge for the species and ecosystems in the nature. It can harm plants and animals and other living organisms in the water. The effect is damaging not only to individual species and populations, but also to the wider biological communities.

Agriculture is one of the major sources of water pollution, because the fertilizers given to the crops for better growth are washed into rivers and lakes, which in large amounts pollute the water.

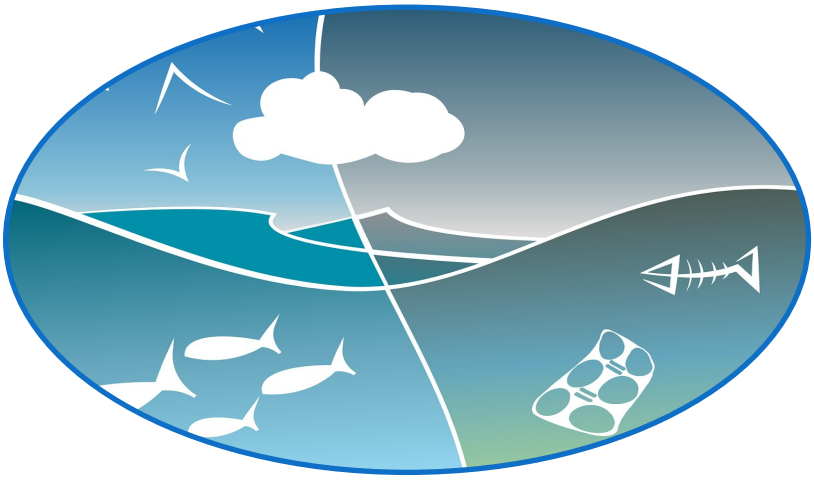
Organic pollutants

PCB's (Polychlorinated biphenyls) are used as hydraulic fluids, coolant fluids in transformers and plasticizers in paints. There are several different PCB's. None of them are water-soluble. In many countries PCB's are restricted.

Hidrocarbons
We differentiate two classes of hidrocarbons, the first being linear and branched single-bonded alkanes, double bonded alkenes and triple bonded alkynes and the second being cyclic aromatic hydrocarbons, which contain ring structures. Aromatic hydrocarbons such as PAH's (polycyclic aromatic hydrocarbons) are much more reactive than any of the first class kinds of hydrocarbons.

Insecticides, pesticides are very dangerous because they are toxic in higher concentrations and they accumulate in fat tissues of lower animals. Then they enter the whole food chain. They have been restricted for decades because of their toxicity.

Detergents are organic compounds, which have both polar and non-polar characteristics. They tend to exist at phase boundaries, where they are associated with both polar and non-polar media. Detergents can have poisonous effects in aquatic populations if they are present in enough quantities, and this includes the biodegradable detergents.



Inorganic pollutants

Metals are naturally found in the environment that have consisted through weathering of oure bodies, where they were left during volcanic action. They cause serious environmental damage in some cases. Examples of common pollutant metals are: lead, zinc, mercury, nickel, etc.

Inorganic fertilizers provide plants with the nutrients needed to grow healthy and strong. Some of them are not mostly toxic, but are still a risk to the environment because people use them so extensively. These fertilizers are nitrates and phosphates. Higher nitrate and phosphate concentrations cause algal blooms in surface water, which causes the oxygen amount of the water to decline. This leads to oxygen starvation because of the uptake of oxygen by microorganisms that brake down algae. This process is called eutrophication.

Microplastics

The definition of microplastics is small plastic particles less than 5 mm, with most microplastics being smaller than 1 mm. Microplastics are very small pieces of manufactured plastic used as additives to health and beauty products. 93% of bottled water around the world and 92% of tap water is contaminated with microplastics. An average person could be ingesting 100,000 pieces or 250 g of microplastics per year [7].

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The use of water in everyday life

Theoretical background

Authors: Michaela Hanzlová, Jan Macháč

BIOLOGY

The main objective of the module

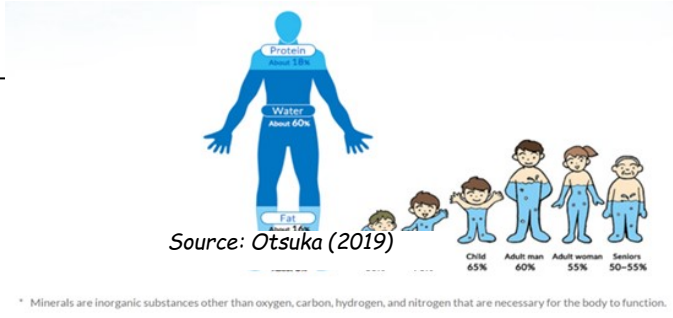
Key subthemes

1) Human body and water
2) Water consumption in households

This module focuses on the water in human body from the perspective of functionality in relation to the transport of nutrients, body cooling or importance of fresh and clean water for us. The next part focuses on water consumption and possibilities of water savings in the household. Pupils should learn how to treat and use water consciously and why it is such a valuable resource.

"The amount of water consumed is changing over time. In the past, people mostly carried water from the source (rivers or wells). This type of transport limits water consumption to the necessary level. The consumption in households was mostly connected with drinking, cooking or cattle breeding. Laundry was usually washed right by the river. Over time, hygiene has become more and more important to avoid diseases such as plague. Water was brought to public fountains in the vicinity of households; later, water was transported directly to houses in pipes. Water consumption increased rapidly due the washing of clothes at home. "Water agent (2019).

Human body and water

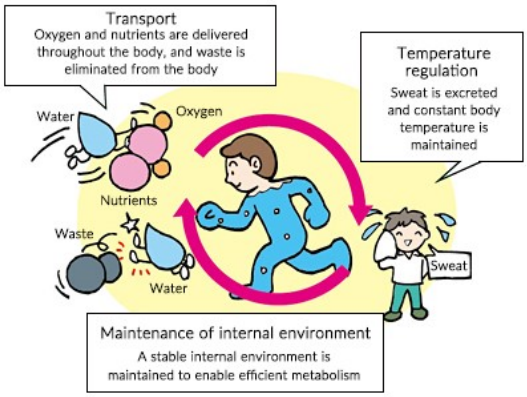


Source: Otsuka (2019)

What do we need to survive? Can we exist without air, water or food? The water is the most important element for our body, if we stay without water for 7 or 10 days we will day and while we stay without the food we can survive till 60 days. Why such a big difference between food and water? One of the answers can be find in the content of the water in our organs, for example our brain and heart are composed of 73% of water, lungs about 83% of water or skin about 64% of water as reported in Science for changing world (2018). Of course, this varies according to age and gender, and by where someone lives. We can find difference in amount of water we need to consume everyday adult male need about 3 liters per day while an adult female needs about 2.2 liters per day. All the water a person needs does not have to come from drinking liquids, as some of this water is contained in the food, we eat according Lavríková P., Fontana J. (2019).

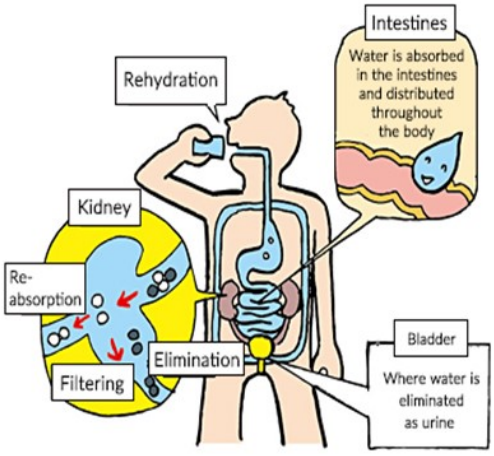
BIOLOGY

There just wouldn't be any of us without the existence of water on this Earth. „The cells in our bodies are full of water. The ability of water to dissolve substances allows our cells to use important nutrients, minerals, and chemicals in biological processes.„Science for changing world (2018). The carbohydrates and proteins that our bodies use as food are metabolized and transported by water in the bloodstream. Nutrients are important elements that allow our body to survive. The major nutrients our body needs to function everyday are carbohydrates, fats and proteins according to The Open University (2019). Water is very important in the distribution of nutrients in our body, it is acting as a pipeline and delivering to each household (organ) the important ingredients that a given household (organ) needs to function properly. Water composes blood and it makes blood flow. The nutrients we ingest, are absorbed by the water in blood and are carried by blood to different parts of our body. Water also helps manage the removal of wastes from our system. „Water delivers to each cell the exact ingredients the cell requires and carries away the end or waste products of its life-sustaining reactions" as explained in Science for changing world (2018). Here is a space for a real example: Orange - juice - vitamin C - transport in our body - strengthening of the immunity.



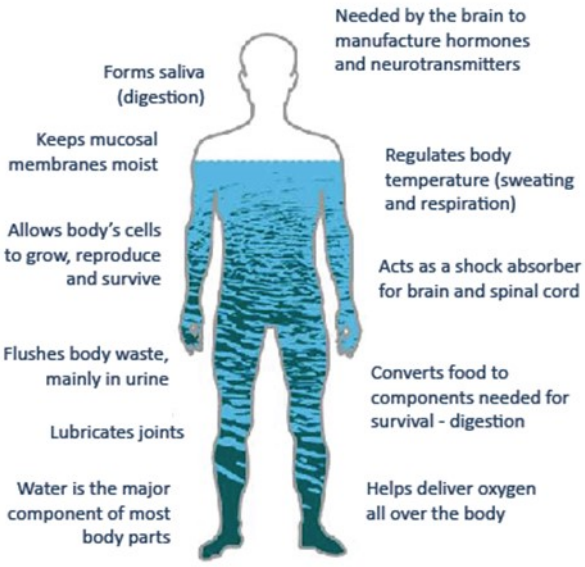
Source: Otsuka (2019)

We can imagine the transport of vitamins in our body in this way: While our food is digested, vitamins are absorbed in the small intestine. There are two basic types of vitamins in the food we eat: water-soluble and fat-soluble. The water-soluble vitamins (B vitamins and vitamin C) are absorbed easily along with the water in the small intestine, where they then travel through the body via the blood vessels. Water-soluble vitamins cannot stay in our bodies for a longer period of time, so it is advisable to supplement these vitamins more often than fat-soluble vitamins, which, on the other hand, remain in the body for longer time as reported Lavríková P., Fontana J. (2019). In this case, water is an essential element to get vitamins into our bodies and in this way we can survive. In this section it would be useful to go back to the original question. Can we survive without water? Another important aspect of water in the human body is - its cooling function.



Source: Otsuka (2019)

What Does Water do for You?



The fluids in our body serve as the transport for all nutrients but also for another substance. No less important is the ability of water to transport waste material out of our bodies through cooling process - sweating. „Water has also the capacity to regulate the internal temperature of the body in response to the external temperature. Sweat is the main means by which water prevents the human body overheating when the temperature outside is very high. The evaporation of sweat brings a loss of calories, in the form of heat and loss of waste substances. This release of energy enables our internal temperature to remain constant. Without this mechanism it would rise in conditions of hot weather or fever. To maintain stable body temperature, we must sweat and allow the sweat to evaporate. " as reported in Science for changing world (2018).

According Benelam, B., Wyness, L. (2010) we lose about 450 ml of water per day via perspiration in a temperate environment. When exercising, the amount of water lost by sweating increases significantly. For 1h of cycling, we can lose on average 0.8 liter of water while it goes up to 2 liters for 1 h of football as reported Burke L. M., Rehrer, N. J. (1996).

Water consumption in households

Water is undoubtedly one of the most precious assets we possess, a resource which is not inexhaustible but which is fundamental to learn not to waste. Even if it does not seem so, unfortunately there are many everyday occasions where waste of water is just around the corner: from personal hygiene to cleaning the house to irrigating the plants, we often consume much more water than we really need. And yet, to reduce wastage and expenses on the bill, very little is enough: it is enough to follow a few simple steps with the guaranteed result.

In this section it will be important for the pupils to think about how much water they waste and how to save water. During the activity, they should realise how much they consume every day with appropriate example.

Out of showing examples of quantity of water they consume in one day it should be also useful to make some examples of good practise – how to save water in everyday life. The following tables show the amount of water consumed for the activities, and it will be appropriate to make work with the pupils based on these data. The last table also lists alternatives to drinking water: Grey water and rainwater.

Tap water: Is the water, which is safe for a people to drink. At the same time, this water is most valuable because it is rarely found in its natural condition due to human activities that pollute it. On our planet, we have only one percent of this water

Grey water: Grey water is a part of domestic water that is free from faecal material and from kitchen wastewater: it comes from natural body hygiene, and therefore comes from showers, bathtubs and sinks. This water can be used for many activities we link bellow.

Rainwater: Rainwater derives from the condensation of water vapor, due to the continuous evaporation of the waters of seas, lakes and rivers. Rainwater can be collected in many ways. Using different collectors, by vegetation.

Table 1: Amount of water consumed for household activities per capita per day (average consumption in the Czech Republic)

Activity	Amount of water
Toilet	23 litres
Personal hygiene	31 litres
Cleaning, doing laundry	13 litres
Cooking (including dishwashing)	8 litres
Drinking	4 litres
Washing hands	5 litres
Watering plants and others	5 litres
Total average consumption (person per day)	**89 litres**

Source: Severočeské vodovody a kanalizace, a.s. (2018)

Table 2: Amount of water consumed per instance of activity

Activity	Amount of water per instance	Necessity for drinking water	Alternatives for use as rain or grey water etc.
flushing a toilet	3-10 litres		
taking a bath	50-150 litres		
taking a shower	30-80 litres		
washing hands	2-3 litres		
washing clothes in a washing machine	30-90 litres		
washing dishes in a dishwasher	7-30 litres		
washing a car	100-200 litres		
Average	90 l per person/ day		

Source: Combination of sources, e.g.: Výzkumný Technologický Institut (2018)

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The use of water in everyday life

Theoretical background

Authors: Jože Cvetko, Majda Adlešić

FINE ART

Introduction

By knowing water as a natural phenomenon that has its own cyclicity and various forms, man has found ways to use it. As the way of living changed, the possibilities of using water also changed. There is a huge number of human activities and needs in which it uses water: production of food and other products for everyday use; personal hygiene and living space hygiene; industrial production and traffic, energy production ..This increased the possibility of its pollution. Man has again entered a cyclical way of water, which this time he created himself. Like everything else through the development of civilization, these themes were found in works of art. In this module, the topics of horizontal connection with the topic of water in art can be found much more concretely. Many concrete usable creations today are in that function or have become artifacts.

Water in the service of humans habits - inspiration for artists

The first of the associations to the use of water are hand washing and drinking water.The symbolism of hand washing can be seen in many significant works in history. Often, hand washing as a motive does not mean physical activity itself, but a transferred meaning.The expression follows hands, meaning to take responsibility from oneself, is connected with the Roman governor of Judea, Pontius Pilate, who sentenced Jesus Christ to death by crucifixion. In the Gospel of Matthew, Pilate washes his hands as a sign that he is not guilty of Jesus' crucifixion and death. (Annex Module 2)

Fig. 1. Lucca Giordano, 1655, Christ before Pilat

(https://www.wikiart.org/en/luca-giordano/christ-before-pilate-1655)

FINE ART

Let's get back to everyday life and activities.This module, through art, brings us closer to man and his everyday situations and problems. Civilizations as the oldest cities were built around large rivers. Initially, it was important to provide their own food, and to defend themselves. Without water, all this was impossible. For example, the city of Susa (Shushan), originated in ancient Persia, present-day Iran, was built along the Karkheh Kūr River, as the capital of King Darius. Persia, in addition to irrigating fields for food production, also used water for the magnificent Persian gardens, but it also used rainwater and channeled the water created by the floods.

Fig.2. Arial view of Susa

(Source: The legacy of Persia)

As cities grew and civilizations evolved in terms of developing new needs and lifestyles, so did the problem. Water was still a necessary companion. The overpopulation of cities began. The city of Rome and complete civilization in general were not only soldiers and military leaders but also builders. For many tourists and visitors to Rome, the fountains and Roman baths are impressive. Public baths or spas are original Roman buildings. At the end of the Roman time they were part of large country villas. Roman emperors were the first to build them as public buildings in all major Roman cities, and they were the center of public life and an everyday ritual, which showed what it meant to be a Roman. The first thermal baths in Rome were simple and were called balnea, and the first thermal monumental complex was built by Consul Agrippa.

Fig.3./4. Roman baths in Rome and in province, in Bath, England

FINE ART

In addition to buildings whose remains we admire today, there are also organic dykes, reservoirs and drainage channels. And just among the oldest monuments of the Roman Empire is the large drainage canal built in the 6th century BC. And it still serves a purpose. Equally significant is the undertaking to build the Trajan Waterworks, 109 BCE, which has made progress in the functioning of the city like none had ever had before. And at the same time, art came out of the beautiful and became necessary and applied. One of the latest archeological discoveries in the territory of the former Roman Empire is precisely the rest of the aqueduct - the aqueduct at Viminacium. It is about 10 kilometers in total and brought drinking spring water to the ancient city and the Viminacium military camp. An outstanding construction and engineering endeavor. From the spring to the Roman city and the military camp, the slope of the aqueduct is 1 to 2 ppm. (source: http://viminacium.org.rs/en/arheoloski- park/akvedukt/

It was completely clear that the consumption and contamination of water required a way to remove wastewater (and some more with it) from villas and bathrooms. "Cloaca Maxima": the most significant and least mentioned architectural endeavor of Ancient Rome or why would anyone go to Rome to admire the sewers? The Greek historian Dionysius of Halicarnassus also pointed out that the greatness of the Roman Empire rests on three things: aqueducts, good roads and sewers. Without an ingeniously designed wastewater drainage system, the construction of hundreds of public baths and toilets and, above all, the early recognition of the importance of population hygiene for the city's urban development, Rome would not be what it became in the coming centuries. This, unfortunately, did not prevent Rome from taking the elemental hygiene exam and kneeling in front of the plague as a single conqueror.

Fig.3/4. The site of the outflow, the visible part of the Cloaca, is located near the Ponte Roto and Ponte Palatino bridges in an environment whose attractiveness is inversely proportional to the importance it had for the overall development of the Roman Empire. (photo: Goran Crnojački)

Besides that, among the most famous examples of the extraordinary beauty and abundance of water play in different ways is the baths and gardens of the Alhambra in Granada, a work of Moorish architecture. The ways and "tricks" to which water is introduced as part of space come from a Hellenistic way of thinking. An interesting feature of this space is the connection between the artistic and practical aspects of water. Namely, the water used to refresh the space, as part of the architecture of the building, was also used to irrigate its beautiful vegetation that fills the space and as open waterway for buildings.A blend of the beautiful and the practical.

Fig. 5. Alhambra, https://www.flickr.com/photos/rmunoz_yeti/17422808065/in/photostream

Fig. 5 Latona's fountain of Versailles, inspired by The Metamorphoses by Ovide.

(Source: http://en.chateauversailles.fr/discover/estate/gardens/fountains#latonas-fountain)

A complex example of the system for using and functioning of water in the service of beauty are the fountains and canals in the park of Versailles. Simultaneously with the constructing of the garden, a garden water supply system was built, which provided water for the magnificent fountains, watefalls, pools and baths but also for watering of plants. The system was designed by the designer of the entire garden, Andre Le Notre, connecting the Grand Canal, which represents the east-west axis (from sunrise to sunset), and the whole through the pools and fountains. All water elements are spectacular and leave no one equally indifferent and even today, after 350 years, they work on the same technical principle.

FINE ART

In addition to man's need for beauty, even if connected with the practical, above all there is man's existential, health and hygienic need bacic for human survival is the consumption of water.Representing the dispensing of water, drinking water itself, carrying water from a spring to another place is a very common motif in art, as is the presentation of natural phenomena with the theme of water. In the spirit and recognizable atmosphere of his paintings, Diego Velázquez in the painting "The Waterseller of Seville", presents the scene of the sale of giant transport containers and the moment before drinking a glass of water.

Fig. 6. Diego Velázquez (1618)
"The Waterseller of Seville", Uffici Florance

Fig.7. Bartolomé Esteban Murillo
(1665)"Rebecca and Eliezer at the Weel" Prado
Madrid (source:private archiv)

Another Baroque artist, Bartolomé Esteban Murillo, presented the scene of drinking water at a well, where we also find a source of water and the act of drinking water. It is interesting for both images that the participants do not look at each other, do not make direct eye contact, which was conditioned by different groups of belonging. Regardless of the differences, water is necessary for everyone.

Bathing and bathers are a great inspiration for artist all the time. Painting and describing bathing and washing scenes involved deep touching in the intimacy of objects and at the same time the liberalization of art and the turning of art in general to prosaic, everyday life habits. The most beautiful works of the French impressionist Edgar Degas were often made in the pastel technique, which at the same time enabled the effects of lines, tones, and colors. His masterpiece in this technique is "Bathing", which was exhibited at the Eighth Exhibition of the Impressionists in 1886. This pastel is one of a series of seven paintings that Degas painted on the theme of women bathing.

Fig. 8. Edvard Degas, Bathing (1886), private collection
(Source: https://commons.wikimedia.org/wiki/Category:Paintings_of_bathers_by_Edgar_Degas

FINE ART

American painter Marry Cassat in a very expressive sense connects the scene of motherhood with activities related to water – bathing, swimming and similar. The image "The Child's Bath" is in the manner of Japanese woodcuts, which at that time had an influence on other arts in the world.

Fig.10. Marry Cassat , "The Child's Bath",1893, https://www.artic.edu/artworks/111442/the-child-s-bath

At the beginning of the 20th century, there was a serious shift in the understanding of art with the advent of modernism, and then in the second half of the 20th century with hints of postmodernism. Over time, the need to portray daily rituals, habits, needs was transferred to other media and genres of art: photography, design, film. That the art of situation and objects can make it bizarre is not unusual and new.

So, Marcel Duchamp's work "Fountaine" is a replica of the urinal which was originally purchased from New York plumbing supply in 1917. Piece of the art was signing with R Mutt. Thus began the movement of new conceptual art and Duchamp was one of the originators of Dadaism. This is actually just an introduction to all the later developments in art when it comes to water.

Fig. 11. Marcel Duchamp, "Fontaine" 1917 (source: The Art Book)

FINE ART

With the arrival of another art medium, namely photography and video, the exposure of everyday human habits and the need for water becomes much more public, and thus many of these displays gain the value of an artistic document. Photography is especially at the forefront.

Fig.12.Hamya Hirosi,
A woman plants rice", 1955

Fig.13. Kertesz Andre,
Swimmer,1917,

(source: 20th Century Photography Museum Ludwig Cologne)

„ Water", https://www.youtube.com/watch?v=2R0pRl18js8 is a 2005 Academy Award nominated Canadian film directed and written by Deepa Mehta. Film, like any other art, speaks a universal language and connects cultures and nations. India is the second largest, in terms of population and countries of contrast. At the same time with some of the biggest water pollutants, specifically textile factories of world brands, on the other hand one of the countries with the largest investments and innovations in the field of environmental protection. For example, they were among the first to abolish the use of disposable plastics on 2020, to innovate edible cutlery and plant packaging. It is one of the leading countries in the use of clean energy.The film "Water" has water in the lead role because everyday activities, customs with water and scenes in which it dominates run through the entire film.

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The future of water

Theoretical background

Authors: ANATOLIKI S.A.

GEOGRAPHY

Introduction

This chapter analyzes the important topic of the future of water in Europe and globally. The aim of this chapter is to make clear for everyone that without a common strategy on water, without the adaption of new technologies to the water sector and without the sensitization of people all around the world, the future is not going to be the same. It aims on the children and its material is for educational purposes, trying to show to children that water is a multifaceted issue that starts from the neighborhood and is going globally and also, it is a sector that is going to dramatically change in the future. The chapter is separated into 5 different subchapters where the issues of climate change, water pollution and some statistical data are presented. Finally, conclusions, good management practices on water and some future expectations that will affect water industry in a global scale are given.

Trends that shape the future

The world is changing and the water industry is changing along with it. Some trends which shape the world in the future and affect the water industry are:

Demographic Changes

The major demographic changes that will affect the future water consumption are:

* The world's population will continue to grow over the next few decades
* More and more people are moving from the countryside to cities
* The living standards in the two countries with the largest populations, China and India, are improving, leading to more intensifies water consumption.

Global population boom

According to UN expects, the world population will reach 9,6 billion, from 7,3 billion today, by the year 2050 and with this, the demand for water will of course increase in response to the population growth. Furthermore, demand for water in many places has grown at a faster rate than population grown as a result of continuously improving living standards.

Demand for food

The combination of population growth and the rising living standards is also having a big impact on the demand for water. According to studies, the demand for food is going to increase for around 60% between 2006 and 2050. The demand will be driven mainly in developing countries which are expected to expand their irrigated area from 202 million hectares between 1997 and 1999, to 242 million hectares by 2030.

(Source: RobecoSAM, 2015)

Increasing urbanization

Currently, 54% of the world population lives in cities. UN studies show that this percentage will increase to 60% by the year 2030. Cities are growing in number, but also in size too, creating a huge challenge for the water sector and increasing the demand for water services in cities.

Climate change

Apart from the abovementioned trends that are globally being formulated, some other factors also affect the water industry. Climate change is, for most people, the most important. The effects of climate change must be taken into serious consideration.

Climate change refers to the change in the global climate situation, which is reflected by significant fluctuations in average weather conditions that extend over decades. These changes have a direct impact on water resources and the global hydrological cycle, exacerbating the water crisis caused by poor management and high cost for people who have no access to clean water. The main anthropogenic cause of climate change is the constant increase of gas emissions from all kinds of combustion, which is directly linked to the rich north's development activity, in particular in the fields of industry, energy production and transport.

The impacts of climate change are not homogenous across the globe, but they are changing geographically. In central and northern Europe, the average rainfall is expected to increase significantly, while in the third world the drought will increase. In the Mediterranean, even if the area receives the same rainfall in relation to the past, the distribution of precipitation will change over time. This will result in alternating periods of extended drought with periods of intense rainfall, a distribution that does not favor the enrichment of natural water reservoirs.

Coastal zones and small islands are particularly vulnerable to climate change. There are already areas that are influenced by this abnormality. According to the 2nd Assessment Report of the Intergovernmental Panel for Climate Change, the Council of Ministers stated that the average increase of global temperature should not exceed 2°C. This target has to be a commitment in the future.

Climate change

The Mediterranean climate type is characterized as transitional, since it is geographically located between tropical and temperate zone and it could be defined as subtropical. It is characterized by summer drought, winter rains that vary every year, mild to hot summers, mild to cold winters and intense sunlight especially in the summer. Most areas in the Mediterranean region, receive solar radiation for around 200 to 300 days per year and in southern areas, this phenomenon appears more frequently.

In a typical Mediterranean climate such as Greece, 65% of annual rainfall accumulates during the period between November to January. Both in Western and Eastern Mediterranean (Aegean Sea), rainfall and river flows do not cover the loss of water, due to evaporation. Water's evaporation in the Mediterranean region is really intense and is the main cause of surface water circulation (Mpalafoutis X., 2003).

Climate is affected by numerous factors such as sunlight, vicinity to the sea or lakes, altitude, latitude, plant cover etc. Neither the climate of a region nor the climate of the earth is stable. Scientists' observations have shown that there have been periods in history of the planet with very low temperatures, snow and glaciers, the so-called Ice Age. There were also periods when the climate was warmer than nowadays.

However, there are significant differences for the observed changes from region to region, highlighting the complexity of the climate system and the effect of climate change to the hydrological cycle.

The effects of global warming include: floods in coastal areas due to increased sea level, changes in frequency and seasonality of rainfall, possible spread of subtropical deserts, changes in frequency and intensity of extreme weather conditions, plant's and animal's species eradication and changes in crop yields, etc. Temperature's raise tends to be greater in Arctic with a consequent continuation of glaciers' collapse in permanently frozen subsoil and sea ice.

Water scarcity, on the other hand, is the chronic shortage of water when water is not sufficient to meet our needs because of poor management and demand beyond the natural potential of the area. It is a phenomenon that can also be observed in areas with rich water resources and is a workable anthropogenic problem that can be encountered. Drought, on the contrary, is a natural phenomenon that in some parts of the world, like the Mediterranean, is repeated regularly and should therefore be taken into account in management issues. So, when we talk, for example, about the Thessalian plain, we are talking about water scarcity and not drought, which can be addressed by better management of existing water without the need of the river Acheloos diversion.

(Source: Fraggou M., Kallis G., 2010)

Table: Climate change and its corresponding impact on water resources

Climate Change	Impacts on Water Resources
Temperature rise	Changes in snow-dependent sources due to the decline in glaciers and the reduction in snow cover Increase in irrigation and drinking water requirements Water quality problems due to the growth of microorganisms Increased evaporation through transpiration Alteration of the natural chemical and biological characteristics of surface water
Reducing rainfall	Increasing drought affected areas Problems of water scarcity Reduction of the drainage areas Reduction on the replenishment of the aquifer
Instability in the intensity and frequency of rainfall	Increased flood probability Inability to filter rainwater from the ground
Increasing of the frequency of extreme weather events	Frequently occurred interruptions in water and power supply
Increase in the sea level	Reduction of available freshwater due to the sanitation of the aquifers

(Source: Fraggou M., Kallis G., 2010)

Environmental Impacts and water pollution

Many people argue that humans are responsible for the climate change. The earth's water resources are not inexhaustible and of a stable quality. A river can be exhausted not only seasonally but also permanently due to poor management, and even when its flow is adequate, its quality can be degraded to such an extent that it is unsuitable for any use. Groundwater is renewed, but in many cases so slow, practically making it a finite resource.

Water reserves are declining on a global scale due to unreasonable consumption and mismanagement. Pollution from rural, industrial and urban sources degrades water quality, putting at risk the biodiversity of the most sensitive areas and literally turning many sources of drinking water to waste. In addition, the climate change observed in recent years has led to disruptions in the hydrological cycle (Fraggou M., Kallis G., 2010).

The causes of water pollution can be divided into two groups: **Anthropogenic sources** of pollution are those due to human choices and **natural sources** are those resulting from forces intrinsic to the environment.

Anthropogenic source:

Discharge of poorly-treated or untreated sewage; run-off from construction sites, farms, or paved and other impervious surfaces e.g. silt discharge of contaminated and/or heated water used for industrial processes, acid rain caused by industrial discharge of sulfur dioxide (by burning high-sulfur fossil fuels) excess nutrients added by runoff containing large amounts of detergents or fertilizers.

Natural source:

Seasonal turnover of lakes and embayment's; siltation due to floods; eutrophication of lakes due to seasonal changes, acid rain caused by natural volcanic discharges or smog from factories, acid pollution of rivers and lakes by runoff from naturally acid soils, carbon dioxide discharges and runoff, volcanic or mineral

(Source: http://www.yemenwater.org)

Conclusions about the future of water

According to a McKinsey study, the global water requirements would grow from 4,5 thousand cubic kilometers in 2009 to 6,9 in 2030, which is 40% above the current situation of the first year. Furthermore, one-third of the world population, concentrated in developing countries, will live in basins where this deficit is larger than 50%. It is well established that economics and population growth are placing water resources under increasing strain. Most of the big regions of the world will face a massive water challenge in the upcoming decades if current trends continue and we don't adapt to the current situation (Source: McKinsey, 2009).

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The future of water

Theoretical background

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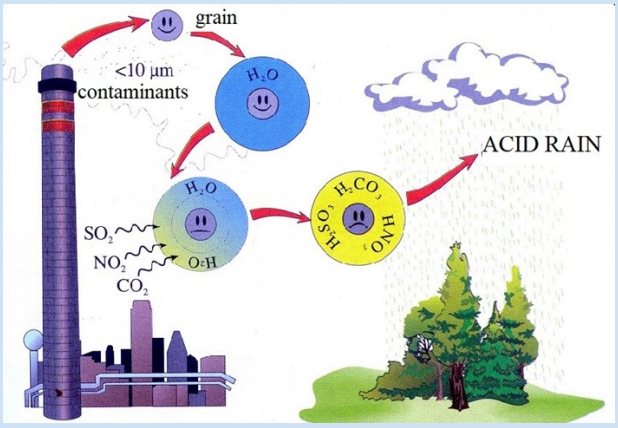
CHEMISTRY

H2O

Climate changes and its influence on water

Today, water is a treasure in every sense, so alternative uses of different types of water are very important. The water footprint can be divided into three basic areas regarding its occurrence / origin. These three types of water are green water, blue water and grey water. Green water is the water from rainfall, soil moisture that plants store in the root zone of the soil and evaporate or build up. It is particularly relevant for agricultural, horticultural and forestry products. Blue water is fresh water that is obtained from sources of surface water or groundwater, or taken from a body of water. Store in lakes, streams, glaciers and snow. Irrigated agriculture, industry and household water use all have blue footprints. Grey water is polluted water that has not been in contact with fecals. Grey water is the product water of household activities: bathing, washing and washing, or polluted water due to agricultural pesticides and fertilizer nutrients. It can be reused not for drinking but for irrigation. Because it has not been in contact with human waste, it can be used for watering plants and is safely absorbed into the soil.

If we look at the pollution of these waters, we can say that all three areas contain pollutants. As a result of climate change, air pollutants dissolve in precipitation and are absorbed through the roots of plants in the soil. Some materials, such as lead is stored in plants because it cannot decompose. As the plant grows into the crop, it also reaches humans, which sometimes presents a serious health risk. Green water is actually considered as soft water, as it was used to wash in rainwater (people of old age have recycled different types of water). Rainwater is also being recycled to an increasing extent today. Due to the large number of motor vehicles, various sulphur and nitrogen compounds released into the atmosphere are also contaminants of green water, which in part cause acid salts. Acid salt is a rain containing strong acids (sulfuric and nitric acid) that fall as a result of human activity, primarily air pollution caused by the combustion of fossil fuels. Acid rain can cause significant damage by changing soil pH. Acids with rainwater and other precipitation cause contaminants to fall to the surface, attacking tree leaves, acidifying groundwater and coastal waters, and causing corrosive effects on buildings.



6. Figure
(Source: https://enfo.hu/node/5031)

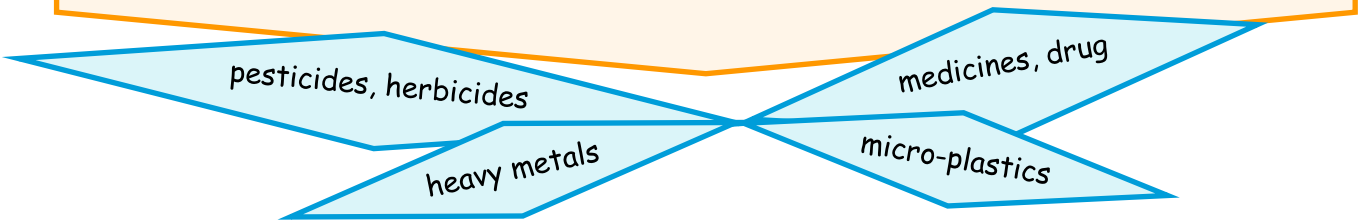
CHEMISTRY

Pollution of water

Today, acid rain is on a downward trend due to the reduction of catalysts, the improvement of gasoline base materials and the emergence of "green" transport. The erosion effects caused by acid rain have become less and less addressed these days. Unfortunately, there are other pollutants that are still very problematic in our age and we are increasingly paying attention to their release into the environment. These contaminants include micronutrient formulations, active ingredients, pesticides, and the other minor contaminants. Much of our drinking water supply comes from surface or near-surface waters, so great care is needed in pollutants released into the environment. Today's environmentally conscious lifestyle can reduce the amount of these pollutants released into the environment, but it will take a long time to reverse this harmful process. The current generation focuses on shaping attitudes, so prevention is the task of the next generations. What are these micro-contaminants and how do they get into our waters? In order to preserve human health and to cure diseases, various medicinal products and medicines are used in increasing quantities. These formulations are excreted as human metabolites in the human faeces, but no information is yet available on the potential effects of these metabolites on living organisms. However, we also have to deal with unused preparations, some of which are discharged into the environment as household waste or to a landfill, where it is washed away with rainwater in the form of leachate, causing adverse effects. In some cases, the preparations are also drained off, which is also released into the environment, affecting its quality. Diagnostic agents and contrast agents, which are used more and more frequently nowadays, are also released into the environment from the wastewater treated with inadequate technology in hospitals. If we rely only on high levels of steroids used, laboratory tests show that fish living in water containing micro-steroids have changed sex and a full feminisation of the fish has been observed. Their long-term effects are water contaminated with micro-contaminants of unknown quantity, so we must focus on prevention. We in Europe are fortunate, because the hygiene conditions are good for us, and we do not have to deal with pollution from poor hygiene. However, it is not only human-derived formulations that need to be considered in the water, but also veterinary formulations are used in large quantities (antibiotics, steroids, other anti-inflammatory preparations, nutritional supplements). Their metabolites are also excreted in animal faeces, affecting its quality. Surely the question for everyone is how much contaminated water will come out of drug factories? Pharmaceutical companies are subject to stringent regulations on the quality of water they release into the environment. Surprisingly, but the smallest pollutant emitter is the manufacturer itself. We humans cause the biggest problem with misuse and treatment. Not only are these waters dangerous to humans, but also to the plants and animals that live in our environment. Nowadays, we are seeing more and more diseases for which the products used in previous years have proven effective, but have now become ineffective. What is the reason for all this? Bacteria and viruses are becoming increasingly resistant to environmental influences and diseases. due to the presence of micro-contaminants therein, they become resistant to certain formulations. I would also mention, by way of example, that high levels of steroids excreted in human urine lead to females in humans (e.g. enlarged breasts in men).

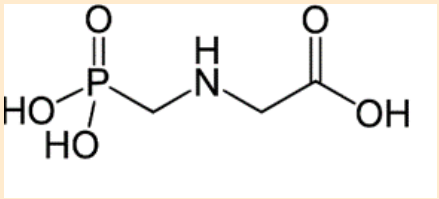
Micro-contaminants also include micro-sized plastics from the fragmentation of plastics, which pose a major threat to aquatic life. Once ingested by fish, these contaminants are not processed because they cannot be digested. The undigested plastic is stored in its flesh, which we humans consume. Our bodies cannot process these plastics, causing inflammation, suffocation, and other organ problems.

To group micro-contaminants, we can do the following:



Pesticides, herbicides

Pesticides are responsible for killing organisms that are harmful to humans, so that they are toxic to the human body and the environment. These formulations are also slowly degraded and can be detected in almost all agricultural fields and in all humans. One of these pesticides, banned on 2 July 2019 in Austria and the European Union, is glyphosate, which has been reported to have teratogenic and hormonal effects. It is believed that this compound may be the cause of gluten sensitivity, as it has been shown to be the most absorbed in fodder. The resulting pesticides have been formulated to be toxic in their carcinogenic, hormone agonist, and neurotoxic properties. The formulas of some pesticides are shown in the following figures [7. Figure, 8. Figure].



7. Figure Stucture of Gliphosate

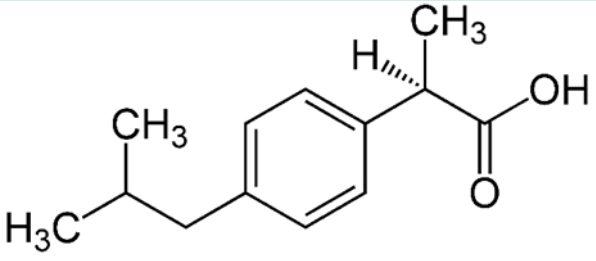
8. Figure Structure of Aminopiralide

The use of pesticides has been gradually decreasing since the 2000s and we hope that the use of these compounds will be increasingly overshadowed by the direction of green farming.

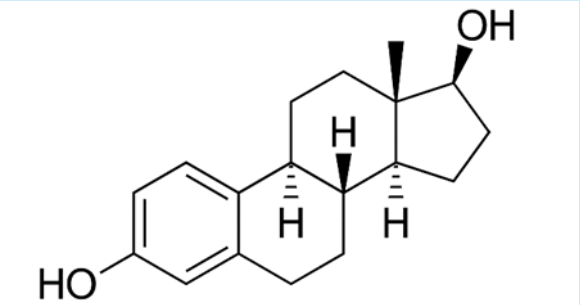
Medicines, drug residues

Nowadays, there are numerous medicinal products for maintaining or restoring health. Pharmaceutical companies are offering more and more formulations to patients. The use of anti-inflammatory drugs, antibiotics and hormone-containing preparations is the highest. Certain groups of molecules are responsible for triggering that effect. There are formulations that have an effect on one disease, while others are harmful to the body. Several formulations are known to cause obesity in addition to their beneficial effects, but in addition numerous side effects are known. If unused products are collected and disposed of carefully at the designated place, they will be disposed of and will not further contaminate the environment. Some of the low-active substance excreted products leave the body unchanged, while most of it is absorbed and metabolized, leaving the body as a metabolite and being released into the environment. Nowadays, the pharmaceutical industry has aimed to produce formulations which are excreted as biodegradable metabolites. This long-term solution can result in the suppression of micro-pollutants. However, by now, a considerable amount of medicine has entered our waters. But what does this mean for us? Drug residues in our waters are found in ng, ie 10^{-9} g in 1L of water. Assume the active ingredient content of a tablet is 50 mg. How much water do we need to drink to get the right amount of the active ingredient per tablet? 50 million liters. If a person drinks an average of 4 L of water per day, they will drink 12.5 million days, that means 34,000 years, for the active ingredient of a tablet. It also shows that we are talking about very small amounts, but the metabolites of these small quantities are unknown, and we do not know what effect it has on our body.

The formulas of some of the more prominent drug agents are shown in the following figures [9. Figure, 10. Figure].



9. Figure Ibuprofen (Algoflex, Nurofen drug)



10. Figure Estradiol (Noviana drug)

Heavy metals

At the beginning of the 2000s we heard a lot about the problem of arsenic waters, and in many settlements the amount of arsenic was found to be very high, which is why many drinking water quality improvement systems were built not only in Hungary. For water quality control, it is a matter of examining a number of parameters under a government decree, including several heavy metals, such as. lead, nickel, mercury, etc. These components are given a health limit, which must not exceed the amount of the metals in the water. If the surface water contains heavy metals and the plant is fed with this water, it is stored in different parts of the plant and we humans consume these plants so that they can get into our bodies. What causes e.g. consuming a mercury-contaminated plant? Mercury can cause kidney damage, while lead in soil is especially dangerous to children because it causes brain developmental defects. The tightening of pollutant limits has meant that metal pollutants are found in trace amounts in drinking water, while they continue to occur in our waters. As air pollution decreases, so does e.g. the amount of lead in the waters.

Micro-plastics

Nowadays, the most fashionable pollutant belongs to the category of microplastics. In fact, by exposing plastics to the environment, micro-plastics are created that cause a major problem in our environment. Plastic pieces smaller than 5 mm are called microplastics. However, it is the order of magnitude smaller pollutants that go through all the steps of water and wastewater treatment to cause human health problems. Micro-plastics are also used in cosmetics, which are used as microspheres in facial scrubs. Getting out of our synthetic clothes puts a lot of tiny pieces of plastic into the environment that we wouldn't even think they would degrade. The most common components are polyethylene, polypropylene, polyvinyl chloride (PVC) and polyethylene terephthalate (PET). It would take centuries to decompose these pollutants. Large plastic ocean islands have already formed from the accumulated pollutants. We would not even think about what kind of polluted water people get in certain Asian countries. We face many challenges. Water purification and water treatment will continue to have tasks that will pose new challenges for researchers. Micro-plastics have been discovered in countless areas, e.g. Chinese saltwater samples, bottled beer in Germany. Several lakes and wastewater treatment plants have also been examined for plastic pollution in Hungary. European rivers are still in good condition compared to Asian rivers, although there is a significant amount of plastic rubbish in our seas (e.g. river Tisza 62.5 pieces / m^3). It is predicted that by 2050 there will be more plastic in the water than fish. To avoid this, plastic carrier bags will soon be banned completely, and we can do our bit for the environment by not using formulations containing microspheres, by not taking bottled water and by collecting waste as selectively as we can.

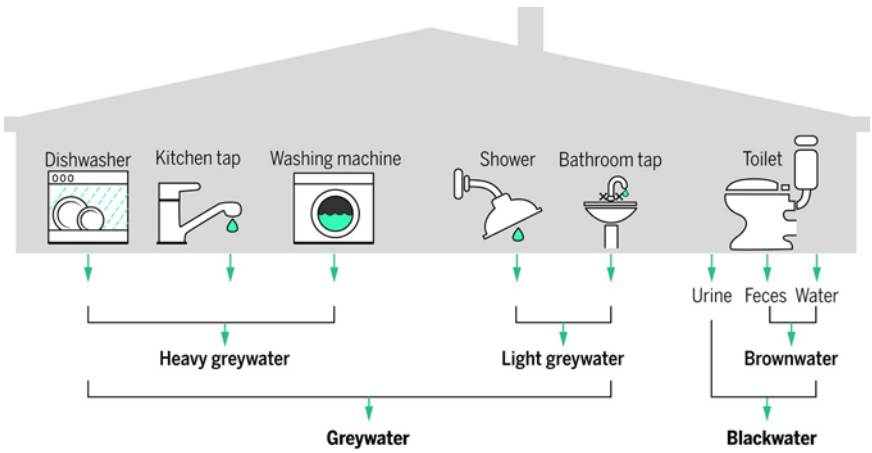
Nowadays, due to the development of analytical techniques, more and more pollutants have become known, which can be reduced by attitude shaping. To do this, we ask you children, help us protect the Earth!

Alternative use of water and water in industrial size

Here are a few words about other alternative sources of water! Household greywater can also be used as an alternative source of water. Greywater can come from the bathroom, the use of kitchen water, washing, washing dishes, and as a result, it has a lot of dirt. Greywater may also contain soap, toothpaste residue, detergents, hair, cooking pieces, oil, dishwashing detergents, surfactants (eg detergent, detergent) and grease particles (see summary table and illustration).

1. Table Source of greywater

Source	Percent of greywater	Contaminants
Bathroom (bathy, shower, basin)	50	hair, soap, shampoos, hair dyes, toothpaste, nutrients, body fats, oils and cleaning products. It may also contain some fecal contamination
Kitchen	15	food particles, oil, grease, etc
Laundry	30	oils, grease, laundry detergents, chemicals, soaps, nutrients. It may also contain some fecal contamination
Other	5	food particles, oil, grease, etc



11. Figure Figure Illustration of greywater and blackwater (Source: [12])

CHEMISTRY

An average of 356 L of grey water is produced per household per day, which is approx. 60% of total wastewater. Alternatively, this can save a significant amount of clean water. Can be used eg. for irrigation, garden decorations e.g. fountain operation, lawn irrigation, car washing. By reusing grey water, the load on sewage treatment systems is reduced, which increases the service life of the sewage system.

In fact, the composition of grey water changes daily depending on the use. Its sources are extremely complex in quality. The most important contaminant of grey water is the detergent, which is high in sodium and phosphorus. It is almost neutral, but tends to be alkaline due to chemicals. It has a high conductivity due to its many ionic detergents. In addition, its turbidity is higher than average due to the admixture of the fats and oils in it with detergents as a suspension is formed. Compared to the quality of drinking water, the composition of organic matter is more similar to that of sewage, but it may also contain bacteria and viruses in much lower concentrations than sewage. The chemical content of gray water, if not too high, can be handled by most plants, making it suitable for irrigation. There are solutions where the washing machine effluent is directly drained into the soil and used directly as irrigation water. However, there are also highly complex systems that can dramatically improve water quality.

In addition to using grey water, collecting rainwater can significantly reduce the use of clean water. Rainwater is ideal for toilet flushing, washing and irrigation. The quality of rainwater is influenced by air pollution, vehicle emissions, plant pollutants, animal excrement, solid debris, various waste, anti-slip materials for traffic areas, etc. [13]. If a household collects rainwater in a separate system, biological quality can cause quality problems and this can be prevented by adding different biocides. The various nitrogen oxides and sulphur dioxide in the flue gases can cause acidification, so that the pH can reach up to pH 4, but this can even be an advantage in household recycling. Organic substances from the roof can cause discoloration of water but are virtually non-hazardous. Lead plates and zinc used on roofs in earlier years may have dissolved in water due to acid rain, but in this case they contained more contaminants than allowed by the drinking water standard. Other water quality parameters e.g. ammonium, sulphate, calcium, magnesium, and the concentration of various metals is very low, even in many cases, even the drinking water limit is not reached, so the rainwater is extremely good quality.

So far, we have dealt with the recycling of household waste water, and here we look at some of the possibilities for recycling in industry. Industrial water streams, especially wastewater, which does not contain municipal wastewater, can be reused in many ways. Depending on the use, the water quality makes the water reusable with different pretreatments e.g. boiler water for heating, even high purity water can be used for different production processes. In fact, the needs of the industry determine the intended use of these waters. The quality of water is always determined by the place of use and the purpose of use. In general, we cannot say quality data, since different types of waste water are emitted in every industry. That is why companies are given specific limit values for the effluent discharged.

By utilizing the heat content of various industrial waters, it is possible to extract a sufficient amount of energy from the system for heating purposes, thus enabling even greater use. By recycling the effluent of a thermal water bath, for example. heating of certain sections can be solved, and by improving the quality of water (water purification equipment) it

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The future of water

Theoretical background

Authors: Michaela Hanzlová, Jan Macháč

BIOLOGY

The main objective of the module

In this module, it´s important that pupils understand how wastewater and drinking water are cleaned and they should experiment and build a self-made sewage treatment plant. In the first part, this module deals with the types of water pollution, in the second part how the water is cleaned, and the last part focuses on drought and floods, water retention through natural remediations.

Key subthemes

1. **The main source of water pollution**
2. **How can we purify water**
3. **Retention of water in nature „Landscape architects"**

The main source of water pollution

Water pollution is caused by multiple and specific factors: the discharges of waste from industrial and agricultural activities, inappropriate water treatment which leads to discharge waste from the usual human activities to the rivers, lakes and seas according data from UN (2014). The type of water pollution can be of a chemical, physical or microbiological nature origin and consequences can also endanger human health. Polluted rivers can have a negative impact on plants, animals and humans. If we water our agricultural products with polluted water, we need to be aware that these pollutants can get into our organism through the consumption of these products. There are two main ways in which pollutants reach the water, directly and indirectly. Pollution occurs directly when pollutants are discharged directly into waterways without any purification treatment. The indirect way, instead, occurs when the polluting substances arrive in the water courses through air and soil.

A major milestone is the Industrial Revolution, which began in Great Britain at the end of the 18th century. The manufactory has begun to switch to machine production, and agriculture has also experienced major changes in production of quantity of food. With this period, the beginning of water pollution, but also environmental pollution, started. Most of the waste production was discharged directly into the rivers, resulting in considerable fish losses, but also in significant and unusual human´s disease which were settled down near these water resources.

BIOLOGY

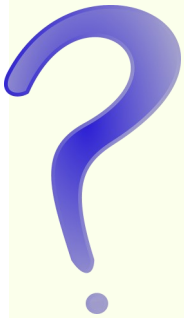
Over time, we began to realize the connections between human illnesses and pollution of the rivers, and we gradually began to develop water management and wastewater management. From this period there have been various restrictions at both national and European level and improvements in this sector, but still today we face this problem and we have a lot of work in front of us. The major improvements in water management occurred mostly in the industrialized countries but in developing countries we face the starting phase which Europe tries to resolve already for 100 years. And since we face the global climate change, this is also of our interest that these countries have healthy aquatic ecosystems.

Industrial pollution	Pollutants are discharged in large quantities by industries on a daily basis, causing damage to the entire aquatic ecosystem. The chemical industries, oil spills and mining activities are among the main causes of water industrial pollution.
Agricultural pollution	Derives from the use of fertilizers and pesticides in considerable quantities, also from the spreading of sewage from farms. These substances can reach underground aquifers and rivers due to soil run-off.
Urban pollution	Refers to the waters that derive from the discharges of houses, offices and other structures that, if not subjected to purification treatments, will affect water pollution. It was mainly the increase in the population that made the problem of waste and sewage discharges a very serious issue.
Natural pollution	It is an almost irrelevant source of pollution. Caused by atmospheric and seasonal events, floods and landslides. Another source of natural pollution is leaching of chemical substances from subsoils that arise in geological processes or increasing the temperature of the water during the drier periods resulting in an increase of microorganisms presence which reduce water quality.

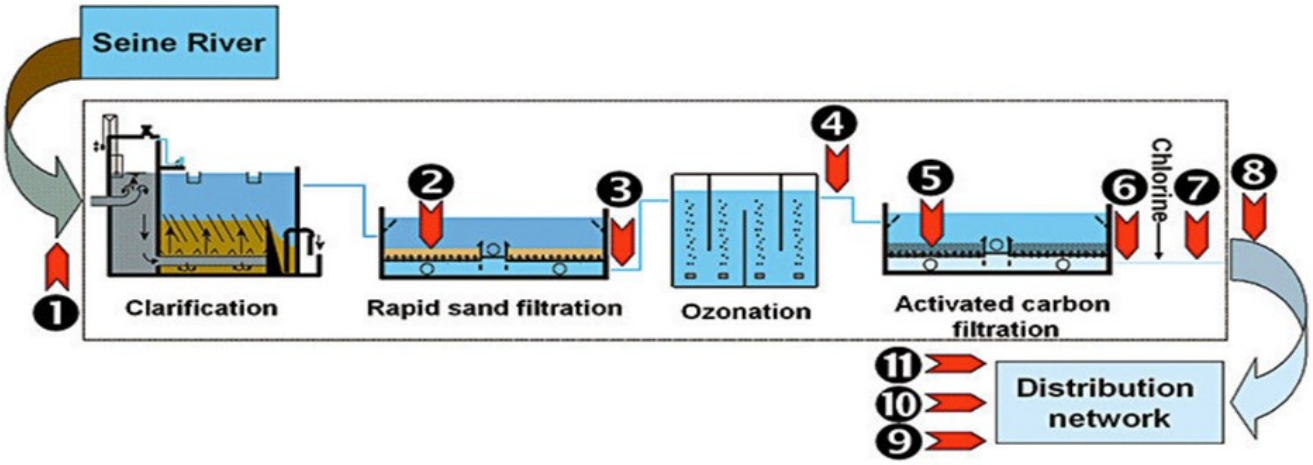
BIOLOGY

How can we purify water?

Wastewater is water which was damaged by human activity. It is either municipal wastewater that comes from households, offices, services, etc. or water that comes from industry as we mentioned before. Wastewater is discharged via a sewer system to a sewage treatment plant. It must be cleaned before being discharged to the river or another recipient as explained by Pražské vodovody a kanalizace (2019). This water, along with the rainwater, goes to wastewater treatment plants where this water is cleaned.



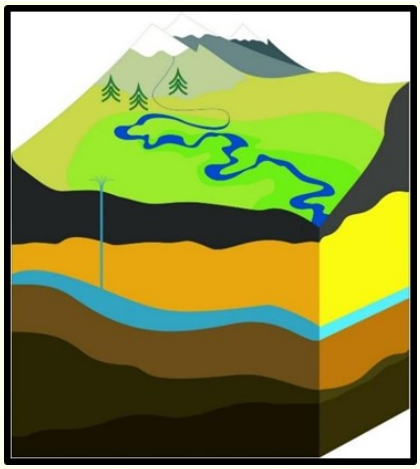
How do we get **drinking water?** Before drinking water reaches the household, it needs some technological treatments. Drinking water sources are underground (wells) or surface (lakes, rivers). Water in nature can contain various impurities therefore, it must undergo the process in the waterworks, where the water is purified. The technological process of producing drinking water varies according to source from which the water is taken. Stream water can infiltrate into the surrounding soil and due to wells is collected and modified in drinking water treatment plant. We can take water from reservoir or rivers, usually from where the water is best quality and modified it also in water treatment plant.



Source: Vincent Thomas (2012)

If our water from home is not heavily polluted and we don´t need to make drinking water out of it, we can produce our system of **root sewage treatment plants** at our facilities. This is a natural **gray water** purification process, which can be used for example for watering or washing clothes. Here is possible to realize the activity which can demonstrate the purification of water in classroom. In this process vegetation, soil, aquatic and wetland environments are involved in the cleaning process by creating a suitable filtration, sedimentation and sorption environment while ensuring the conditions for the development of microorganisms involved in the cleaning process TZB (2013). It is important to add that these water treatment plants are rather for smaller municipalities up to 500 inhabitants, schools or family houses. In this section, we can show children how the water is cleaned using gravel, sand and clay.

Source: Author (2019)



Retention of water in nature

As we know one small part of water gets during water cycle (infiltration) into the groundwater reservoir, the bigger part of it evaporates or it flows away. Infiltration of water needs specific conditions that are often neglected today. Because the number of people is growing, we also need larger areas for agriculture, flats, or large warehouses on the outskirts of towns and villages. These all human activities are transforming landscape, the state of water and its infiltration and retention in the soil.

Source: Voda zaklad života (2016)

BIOLOGY

What we can do? How we can retain water in the soil/landscape?

The soil can absorb large amounts of water, but, thanks to human intervention, today seems to be more prone to dry out than to hold and retain water. Thanks to water retention and infiltration in the landscape, especially due to rain, the content of underground water can grow. This natural water infiltration is influenced by climatic conditions and weather fluctuations can cause a lack of underground water.

In order to grow crops, we must often divert water from our land so as it does not cause yield damage. We usually divert it from its natural flow, after we straighten it, and in this way the water must spill somewhere else. This unnatural stream repair results in drought, groundwater shortage, local climate change and frequent floods. In this way we won´t help to the soil to retain water. So how we can have more underground water or uninterrupted water cycles? Floodplain forests, wetlands, meanders, ponds etc. play an important role in water retention. Creating space for these habitats assumed big importance today. These habitats have the natural ability to retain water in the landscape, provide water with space where it can gradually infiltrate into underground reservoirs and thus create reserves for the future.

Another great ability of these habitats is the fact that they slow down the peak flood wave. Because water does not flow only through artificial troughs, it can also spill and soak somewhere else during heavy rain and finally the process of water infiltration has also cleaning purpose. Through stones and roots of plants the water can be purified from organic waste. And why is important to have stocks of ground water? In periods of severe drought, these stocks may be important to us, especially because we´ll have water, plant roots will be able to absorb moisture from the soil profile and thus not dry, there will be stable local climate and also a natural water cycle will continue to work for all of us.

Source: Jan Ševčík(2019), Michal Pospíšil (2014), Marturius (2010)

BIOLOGY

Wetlands	„The wetland is a seasonally or permanently waterlogged or shallow flooded area contributing the complexity of the revitalization of the area, where are natural conditions for plant development adapted to life in the water. The aim of the measure is to accumulate water in the areas suitable for waterlogging and slow infiltration of water into the soil. "VÚV TGM (2018).
Floodplain	„Floodplain is a part of the valley that is regularly flooded, influenced and formed by floods. From the geomorphological point of view, it is a flat riverbed, which is formed by river deposits. In the floodplain the river naturally meanders if it is not regulated. "VÚV TGM (2018).
Inundation	„The aim is to accumulate water during increased flow and gradually increase it and soak up it in the floodplain. This will help to increase the groundwater level in the distant surroundings and in the dry season will help to subsidize the watercourse. To accumulate as much as possible the amount of water is suitable when the water does not return to the riverbed after the flood has subsided trough but if gradually soaks. "VÚV TGM (2018).
Riparian forest	Flooded forests are characterized by a cyclical seasonal system, with areas that are submerged in part of the year while in other parts of the year they are dry. The flora and fauna must therefore adapt to this radical change of habitat, sometimes adopting seasonal migration strategies.
Meadow	„Due to their rooted soils and their permanent cover, meadows and pastures provide good conditions for the uptake and storage of water during temporary floods. They also protect water quality by trapping sediments and assimilating nutrients. "Natural Water Retention Measures (2015).

BIOLOGY

Today, however, we cannot rely solely on nature-related water retention measures . It is important to realize that we should go back to a combination of natural and technological measures so that we can meet today's high demand for drinking water. An important technological tool for the supply of drinking water is artificially created reservoirs - dumps, which in the past swallowed several valleys, to serve us as a reservoir of drinking water. However, relying solely on these artificial constructions is not a suitable solution today, and therefore it is highly recommended to combine these two tools, which can now complement each other well. However, it is necessary to point out that today we rely on artificial dams and we have forgotten the natural functionality of aquatic ecosystems. Therefore, the aim of this module is to get acquainted with and deepen knowledge of this environmental component. A good tool through which pupils can demonstrate this interconnectivity is to provide them with the opportunity to create an ideal water retention area around their school. In this section, it would be also useful to discuss with pupils the importance of nature close remediations and their impact on water retention in the soil and return to water cycles from first chapter and close the last part with it.

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The future of water

Theoretical background

Authors: Jože Cvetko, Majda Adlešić

FINE ART

Introduction

Today's man, unfortunately, is very careless about water, so the future of water is very questionable. Topics related to the water problem: water pollution, inaccessibility of drinking water, privatization of water, climate change, are reflected in artistic content. By raising the environmental awareness of citizens and artists through works of art of new forms: perfomances, installations, films, attention is drawn to problem of water pollution. Engaged art is the one that could bring sobriety and change of consciousness and habits in dealing with water and nature in general. As Leonardo da Vinci wrote about water and Art: "Art is Queen of all sciences who impart knowledge to all generations of the world". While we admire beautiful works of art, engaged and applied art pushes boundaries in our consciousness and drives us to change behavior.

Coexistence of water and art

Thanks to modern technologies and communications that we can classify as applied art through various simulations, the potential consequences of climate change are highlighted. With the advent of large quantities of waste, recycling art has evolved, that is, processing of waste, not into raw materials but into artistic materials from which art objects are created. The critical moment in which we live: climate change, melting glaciers, ocean warming, unimaginable flood floods ... are topics that have found the answer in the specific means of expression of the artist. In the last decades of the 20th century, filmmaking began and there was public talk about major water pollution scandals by global corporations. Water pollution problems have reached life-threatening proportions, the survival of many species living in the seas and oceans; microplastics in water and food, increase in water footprint and pharmaceutical and narcotic recurrences in water endanger in as and species whose life depends on water. Human health is endangered through all this but also through the danger that comes from industrial lobbies who do not take over from kills an activist. Modern times are marked by film art and engaged music and literature. Engagement to draw attention to the current issue. Because of that, this kind of art is considered engaged art is clear from the messages that each of the examples gives us.

The movie "Erin Brokovich"(2000) is one of those. It points to the problem of pollution caused by multinational companies, which causes not only pollution and disappearance of rivers, but also diseases of the population and pollution of wider proportions. The film shows us that it is possible to initiate a solution to a problem by engaging an individual, and that we must be more active in dealing with the overall situation as individuals. By changing the behavior of each of us, in small steps, changes are possible on a global scale. https://www.theguardian.com/film/2020/mar/16/erin-brockovich-20th-anniversary-julia-roberts-steven-soderbergh

Fig. 1. Scene from movie Erin Brokovič

https://www.brockovich.com/the-movie/

Also, movie "Dark waters" (2019), https://www.nytimes.com/2016/01/10/magazine/the-lawyer-who-became-duponts-worst-nightmare.html which assures us that the solution to every problem is possible no matter how dark the path we take. Regardless of the fact that these are commercial films, not so much artistic, their impact on people's consciousness is much more accessible and therefore the effect is more expected. In both cases, these are true stories, that is, screened real events.

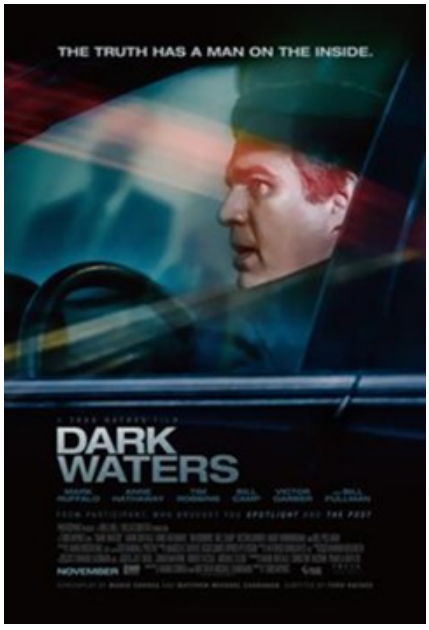


Fig. 2. Poster for movie "Dark waters" (2019)

https://www.hollywoodreporter.com/review/dark-waters-review-1254524

FINE ART

According to Jean-Paul Sartre, art requires social communication. He says: "Art exists only for the other and with the help of the other." Only the reader finishes the work: "Reading is a directed creation ... While he reads and creates, he knows that he can always go even further in reading, to create even deeper; and that is why the work seems to him as inexhaustible and opaque as things." Thus, "the writer therefore appeals to the freedom of the readers to cooperate in the creation of his work." That is why the work of art as an appeal to the freedom and spontaneity of the recipient appears "as a task that needs to be fulfilled", it is for Sartre "an act of trust in the freedom of man". The artists have only one plot: freedom. They make the work of art the driving force of social development.

The problems with water, which have been declared as "the water crises" for years, are the biggest attention of world organizations such as the UN. United Nations declare "Water Action Decade" from 2018 to 2028 https://sustainabledevelopment.un.org/wateractiondecade. As part of this, a large number of measures and activities are proposed to be implemented to reduce or eliminate the impact of factors such as: overcrowding, the tendency to increase the water footprint of large meat production, excessive use of products with recurrences, poor treatment of water utilities, endangered sources drinking water... It is necessary: Help people understand and connect to water; Inform water resource planning with new perspectives; Engage communities in participatory processes; Build bridges across different sectors and stakeholder groups; Mitigate the disruptive effect of construction projects; Integrate water infrastructure into the fabric of a community; and Support community activism. Art is one of the great channels for concrete activities that will not only draw attention but give a concrete result. https://vimeo.com/137494921

One of the examples of successful connection of concrete activity on solving the problem (in this case city floods) and art are rain retentions. Rain retentions are also used in private gardens, where their role can be crucial for draining surface water from the house. In this way, you will prevent the appearance of ponds and stagnant water in your garden, which can result in significantly more landscaped green areas with fewer mosquitoes and unwanted insects. The design of rain retentions is based on the use of natural, porous materials. Compositions of stone, sand, rock and wood with ornamental plants. These types of green areas with a special purpose in Europe are an important element given the increasing occurrence of urban floods in large cities. In addition to technical quality, these small oases of greenery and greenery are also artificial elements of landscaping.

Fig.3/4. Rain gardens - rainwater harvesting https://www.pinterest.com/bright1486/rainwater-harvesting/

FINE ART

At the same time, through architecture and other forms of applied branches of art it is shown how important coexistence with water is and not its exploitation. As early as the beginning of the 20th century, the necessity of this coexistence was pointed out through the language of architecture. Architect Frank Lloyd Wright has erected a structure called Fallingwater. Built into nature as a part of it, with water which is like a thread connecting the object and the rest of the ambience, showing in fact the unbreakable connection between man and nature.

Fig.5. View on Fallingwater, Frank Lloyd Wright , 1935
(source: The Garden Book)

As we stated in the first module, one of the exciting adventure books inspired by the sea is "20,000 miles under the sea! Gilles Verne. Nearly three centuries later, artist Jacq Chorlton, dedicated exclusively to art from recycled materials, made, in 2010, a sculpture of an octopus from 20,000 plastic bags found in the sea. This is just one of many examples. And it is good that this kind of art has developed until a person masters the "art" of making garbage. Salvation for nature and later is certainly zero waste behavior.

Fig. 6. "20,00 Bags Under The Sea", 2010, Jacq Chorlton,

http://www.greenecoservices.com/20000-plastic-bags-for-octopus-sculpture/

In addition to sculptural art made of recycled materials, in the XX and XXI century a whole discipline of large spatial objects developed, which with their message and size draw attention to water and its preservation. One of the most famous sculptures Man at Work, also known as Čumil, was made in 1997 by the Slovak artist Viktor Hulik. This unusual sculpture represents a man looking out of a manhole; it is assumed that the sculpture is dedicated to workers who work on the maintenance and repair of the sewer due to the problems created by the proximity of the Danube river.

Fig. 7. Man at work, Vuktor Hulik, 1997. (source: private archive)

FINE ART

During the United Nations Climate Change Conference COP25 in Madrid 2019 and related to its messages, a monumental sculpture "Support" by Lorenzo Quinn was placed on the facade of the Hotel Sagredo on the Grand Canale in Venice as part of the Biennial of Art. Just before this event, Venice and the monge coastal cities were hit by an unprecedented flood that occurs once every hundred years.

http://www.twenty6magazine.com/issue-l/art/interview-lorenzo-quinn

Fig.8.Support,Lorenzo Quinn, 2019,

The literature also abounds with examples that have a clear message regarding the conservation of water and nature in general. Maja Lunda's new novel draws attention to something that we all take for granted and that forms the very core of our existence: the importance of water. The novel "Blue", 2017, is part of the so-called of the Climate quartet, which this author writes about climate change. The novel follows two currents, the present and the near future of 2041, through the prism of water scarcity.

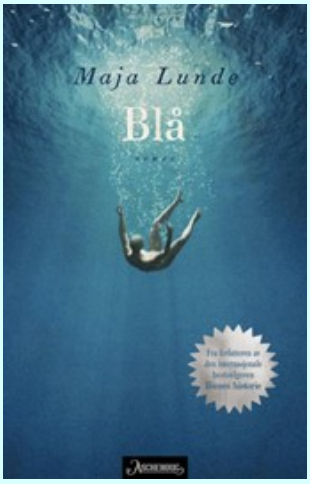
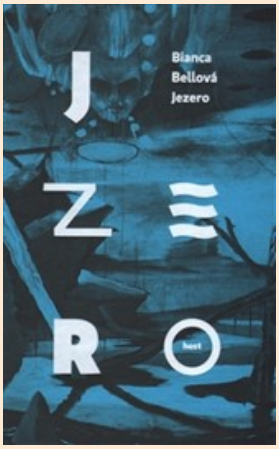


Fig. 9. Blue, Maja Lunde 2017



The second novel is "The Lake" by the Czech writer Bianca Bellova, which deals with the incredible events on the Aral Sea, hidden by a veil of secrets and misinformation, which have terrible consequences. It reflects the image of the world and the combination of politics and high capital to the detriment of nature, natural resources and man himself. She is the winner of the EU Literature Prize 2017 for this book.

Fig.10. "The Lake", Bianca Bellova, 2016

Erasmus+

FINE ART

"I wondered what is going on with us, so we were all damn fools. Why don't people, instead of spending time on idiocy, take a walk and look around? This pond, for example - and everything in it. Earthworms, water snails, water bugs, tulars, leeches and god knows how many other things that can be seen under a microscope. The mystery of their lives, there, underwater. You could spend your whole life watching them, ten lives even, and you still wouldn't even reach the end of this pond. And all that time there would be a living feeling of wonder in you, that special flame that burns in you. It's the only thing worth living, and we don't want it". George Orwell, Coming up for Air

All the answers and beauties are in nature.

Nature is the best artist.

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Types of water and the water cycle

METHODOLOGY

Authors: Zakladni skola B. Dvorskeho— Czech Republic

BIOLOGY

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Describe the small and large water cycle on Earth
* Desribe the individual parts and items of the cycles and its function in nature
* Clarify the terms - evaporation, condesation, infiltration, rainfall and runoff

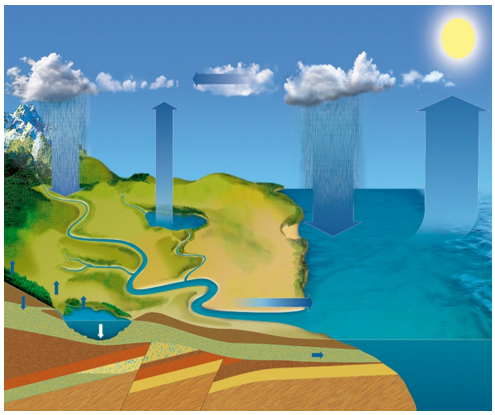
Skills:

- Ability to handle information, data, facts and group them by simple logic
- Be able to extract relevant informatin from the text, fotos, discover correlation

Instructions

Activity 1

1. Label the picture of water cycle with the right terms.



2. Match the words with their right descriptions

1. evaporation	2. condesation	3. rainfall	4. infiltration	5. runoff

_____ Water leaves the basin back to the sea, ocean, river etc.

_____ Water drops fall from the sky in the form of rain, snow, hail or sleet.

_____ Water vapor in the clouds cools down, it becomes water again.

_____ Water passes through the soil into the groundwater.

_____ Heat from the shinning sun causes change of the water from liquid to gas form and move of the water from oceans, lakes and rivers into the atmosphere.

BIOLOGY

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Verify thanks to a simple experiment natural physical laws.

Tools: **a glass, water, ice**

Skills:

* observability
* ability to draw conclusions
* identification, generalization

Additional tasks:

Types of waters - enlarged

https://wordwall.net/play/2264/947/104

Instructions

3. Describe simply in your own words the water cycle in nature.

Activity 2

Will sea levels rise after the glasiers will melt?

1. Fill in a half of a glass with water and mark the water level.
2. Put 4 ice cubes into the glass and mark the water level again.
3. Observe how the water level changes when the ice cubes melt.

Observing:

Conclusion:

BIOLOGY

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Find and observe mosses in the landscape under different climatic conditions
* Determine their differences (colour, shape, quantity and their changes)

Tools: Magnifying glass, notebook, pencils, measure tape, atlas of mosses to determine them

Skills:

* observation ability
* ability to justify, to prove
* learning skills

Additional tasks:

Water cycle - definitions

https://wordwall.net/play/2422/760/649

Instructions

Activity 3

Mosses in relation to water

Observe the existence of mosses in various plant communities (phytocoenosis) influenced by different climatic conditions: during periods of prolonged drought and on the other hand during the wet periods. Compare the features of moss plants - colour, form of mosses. What is different? What is similar or same? Has the form of moss plants changed?

1.	Measure an area of 2 x 2 metres in the forest. In this area count all the mosses plants.
2.	Use the moss atlas or plant identification key to find out which moss species are there?
3.	Repeat this procedure in another weather condition.
4.	Compare the reached data and draw a conclusions. Notise if there is a moss dependent on soil moisture or other environmental features. Briefly express your conclusions, put into context the role of mosses in nature.

Observing:

Conclusion:

Instructions

Activity 4

Find out how much water can hold a bunch of moss.

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Understand one of the basic role of mosses in the landscape, mainly the ability to absorb large amounts of water
* Learn how to use a certain type of scales

Tools: 3 bowls, water can, digital scale

Additional tasks:

Water cycle - picture

https://wordwall.net/play/2423/060/464

1.	Determine by weighing the weight of the tuft of moss in the dry state.
2.	Put the moss to the empty bowl and pour it with water in the way you imitate rain.
3.	Leave the moss in the bowl for 10-15 minutes until the water sucks in and then weight the moss again.
4.	Find out how many times the weight increased.

Observing:

Fill in the chart:

Weight of:	**Moss 1**	**Moss 2**	**Moss 3**
dry moss			
wet moss			
Change of weight (how many times)			

Conclusion:

BIOLOGY

Instructions

Activity 5

Try to find the mosses in the pictures in your area.

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Work with the identification key to identify mosses in nature
* Focus on the basic distinguishing features of individual moss species that occur in a certain area

Skills:

* observation ability
* ability to interpret
* recognizing the properties, relationships, antecedents, and consequences of things

plagiomnium affine

plagiomnium affine

hypnum cupressiforme

BIOLOGY

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Work with the identification key to identify mosses in nature
* Focus on the basic distinguishing features of individual moss species that occur in a certain area

Skills:

* observation ability
* ability to interpret
* recognizing the properties, relationships, antecedents, and consequences of things

Instructions

Try to find the mosses in the pictures in your area.

leucobryum glaucum

sphagnum

polytrichum formosum

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity , students will be able to:

* Understand the importance and the role of mosses in the nature
* Form a discussion and give examples of mosses and their role from your surrounding

Skills:

* Problem-solving skills
* communication skills
* learning skill
* ability to infer

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity , students will be able to:

* Find out necessary information in literature or on the internet
* Understand the importance of the mosses use for us in the past and today

Skills:

* problem-solving skills
* combinatorial ability

Instructions

Activity 6

Explain the role of mosses in nature.

Activity 7

Find out in the literature the use of mosses in the past.

Solution

Activity 1 :

1. **runoff** – water leaves the basin back to the sea, ocean and river etc.
2. **rainfall** – water drops fall from the skyin the form of rain, snow, hail or sleet.
3. condensation – water vapor in the clouds cools down, it becomes water again.
4. **infiltration** – water passes through the soil into the groundwater.
5. **evaporation** – heat from the shinning sun causes change of the water from liquid to gas form and move of the water from oceans, lakes and rivers into the atmosphere.

Activity 2:

When the glass is filled with water and ice cubes, ice melts, but the water does not overflow. Ice floating in glass melts. Therefore even if the ice melts, the volume of water in the glass does not change. When glasiers melt, ice melts on land not in the ocean. Mainland glacier water flows into the oceans and increases their level. Therefore, the massive melting could also increase the ocean level.

References:

Picture 1: https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQQx6Sl07Fjk54uAq9EcPvyx7o_SitWBx2Y_z5BhD_LJhVZf65yTQ:

Activity 6:

Moss has a great absorption capacity, it can hold a considerable amount of water in the landscape. It prevents soil erosion caused by rapid rainfall and drying out and increases humidity.

Activity 7:

Moss was used as a heat insulation for house constructions, insoles and fuel.

References:

Picture 1-5: https://www.google.com/url?sa=i&source=images&cd=&ved=2ahUKEwjR2_jN3M7jAhVD_qQKHaVYCeAQjRx6BAgBEAU&url=https%3A%2F%2Fcs.wikipedia.org%2Fwiki%2FMechy&psig=AOvVaw1X4yHUiFd61KXtbqGbf6HC&ust=1564097748779319

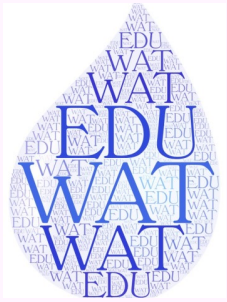
Picture 6:

https://www.google.com/url?sa=i&source=images&cd=&ved=2ahUKEwids-OH3c7jAhUCPewKHf12BEwQjRx6BAgBEAU&url=https%3A%2F%2Frumata.rajce.idnes.cz%2Fmechy_Sumava_1%2F&psig=AOvVaw1X4yHUiFd61KXtbqGbf6HC&ust=1564097748779319

The use of water in everyday life

METHODOLOGY

BIOLOGY



Instructions

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Work in a group of students
* Describe and label the individual parts of the human body
* Determine the percentage of water in individual parts of the human body

Tools: Copy of body outline (picture) and terms, posters, crayons.

Skills:

* learning skill

Note:

To make this activity more interesting, you can outline the outline of your body on a poster.

Children can be dividend into groups and each group can colour the body according to percentage of water content.

Activity 1

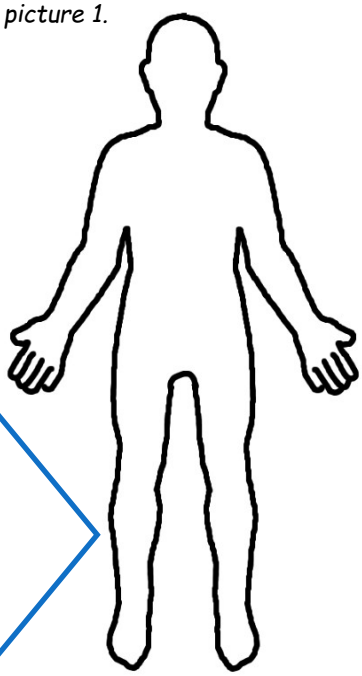
Human body and water, water percentage in body

Guess and complete the percentage:

The human body is made up of approximately ..... water.

Label the body with the terms
Guess how many percent of the water each part of the body is made up of.

picture 1.



BRAIN		8-10%
LUNGS		70-75%
LIVER		80-85%
SKIN		20-25%
HEART		75-80%
BLOOD		80-85%
TEETH		80%
BONES		70-75%
KIDNEYS		70-75%
MUSCLES		75-80%

BIOLOGY

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* To realize the changes of the body during our life in relation to the water content

Tools: 3 measuring cylinders or plastic bottles, coloured water.

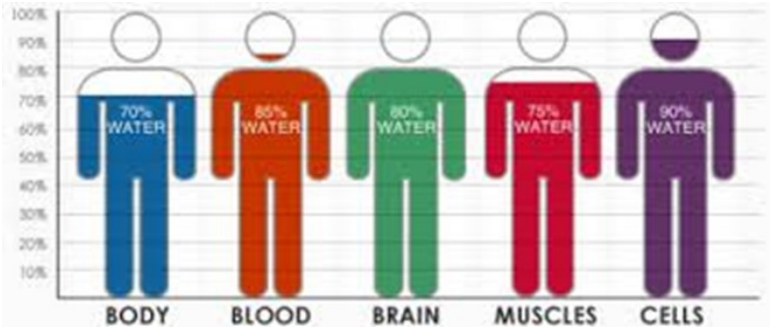
Skills:

* learning skill
* interoperability
* systematization ability

Additional tasks:

What does water makes good for you body?

https://wordwall.net/play/2262/141/500



Activity 2

Instructions

Water in human body

Our body contains the water in various amounts.

* Label the 3 cylinders with terms.
* Pupils fill the cylinders with 60 %, 70 % and 75 % of water.
* Then they match the right terms to the cylinder.

BABY	CHILD	ADULT
60 %	70 %	75 %

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Apply simple mathematical tasks to calculate the water amount in the body.

Tool: digital scale

Skills:

* counting ability
* rule induction capability

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* understand that the daily water intake needed depends on various factors
* (age, health, weight, physical activity)
* learn to convert the amount of water in liters to the number of glasses.

Skills:

* combinability
* problem-solving skills
* coding ability

Instructions

Activity 3

How much water contains in human body?

Calculate the amount of water in a human body.
Previous percentages can be used to calculate the amount of water in a human body.
For instance:
- A baby whose weight is 3 kg:
3 x 75: 100 = 2,25 kg
This baby has 2,25 kg of water in its body (it corresponds to 2,25 L)

Calculate:

Child whose weight is 40 kg.
An adult whose weight is 70 kg

Instruction

Activity 4

How much water do you need?

There are anagrams. Find out:

There is no easy answer to this question as it can depend on (place the letters to the right order):

Your **gae**
Bydo eigwth
Halthe
How **cative** you are
where you live/ **matecli**

The Institute of Medicine has determined that adequate intake for men is roughly 3 liters (.....cups) and 2.2 liters (.....cups) for women per day.

Can you guess how many cups are there?

Erasmus+

BIOLOGY

Instructions

Activity 5

How exactly does your body lose water?

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Work with the text, add missing words, which are derived from the given context.
* Apply their acquired knowledge

Skills:

* ability to interpret
* problem-solving skills
* communication skills

Additional tasks:

Role of water in our body

https://wordwall.net/play/2191/271/145

There is a gap in the text. Try to fill in the gaps.

Water is lost from your body through ……. Depending on the humidity level of the ……, we lose about 300 to 500 …… of fluid a day through **breathing**.

Another large source of water loss in your body is through **sweating**. Studies show that athletes can lose 2 litres of water per ……..while exercising. ……. is your body's natural ……..system by releasing H_2O in the form of perspiration.

We lose water through **urination**. A person typically loses ……..liters of …… a day through urine. If your water intake is high then your kidneys produce larger amounts of water to help maintain a balance. If your body does not have enough water, the kidneys will try to conserve …… by producing only a ……..amount of concentrated urine. Urine ……..is a measure of your body's hydration and internal water supply. If your urine is dark yellow or amber it could be a sign of dehydration. You may be hydrated if your urine is colorless or light yellow.

Instructions

Activity 6

Water Quiz

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Describe the terms associated with water in the human body
* Check that they understand the basic concepts of water in the human body in the form of domino game

Skills:

* problem-solving skills
* combinatorial ability
* ability to infer

The water quiz is played as dominoes. It means that you match the right answer to the question:

KIDNEYS	What system cleans your blood and removes waste?
Start	Which organs clean the blood and remove waste?
Worn-out blood cells give us a yellow tin. The same chemicals make bruises yellow	How long do kidneys take to clean all the blood in your body?
UNDER AN HOUR	How many kidneys do you have?
SIZE OF A GRAPEFRUIT	How much of your urine is water
THE URINARY SYSTEM	Why is urine yellow?
2	Where is urine stored in the body?
About 3 liters	END
94 %	What is the chemical formula of water?
IN THE BLADDER	How large can a bladder strech to hold urine?
H_2O	How much water do an male adult need to drink per day?

Instructions

Activity 7

What does water do for your body?

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Work in a group, develop cooperative skills
* Summarize the basic functions of water in the human body
* Compare their results with the facts obtained in the form of puzzle

Skills:

* ability to interpret
* systematization ability
* ability to think

* Work in groups and think about the functions of water in our body.
* Then everybody gets a piece of paper of different colour and they look for their partners and make a sentence together. They get the list of several things that water does for our body. Then pupils compare it with thein own ideas.

TRANSPORTS	NUTRIENTS AND OXYGEN	INTO CELLS

MOISTURIZES	THE AIR	IN LUNGS

HELPS	WITH METABOLISM

PROTECTS	OUR VITAL ORGANS

HELPS	OUR ORGANS	TO ABSORB	NUTRIENTS BETTER

DETOXIFIES

PROTECTS	AND MOISTURUZES	OUR JOINTS

Instructions

Activity 8

There are individual everyday activities and water consumption

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Become aware of which daily activities we urgently need water for
* Estimate water consumption in liters per activity

Skills:

* ability to interpret
* systematization ability
* ability to infer

Edditional tasks:

Daily activities and water consumption

https://wordwall.net/play/2423/473/826

Match the individual everyday activities and water consumption together.

Activity	Water consumption
Toilet flush	
Washing machine	
Have a shower	
Have a bath	
Have a drink	

Water consumption:

a) 40 – 80 liters	b) 5 – 10 liters	c) 2 liters	d) 150 – 200 liters	e) 20 – 60 liters and more




BIOLOGY

Instructions

Activity 9

Specify, how much water you use in these activities every day

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Apply the knowledge gained in the previous activity to their daily life

Skills:

* cognitive skills
* ability to justify, prove, control
* communication skills
* ability to infer

Activity	Liters of water
Toilet	
Personal hygiene, shower….	
Washing, cleaning	
Cooking, washing dishes	
Hand washing	
Watering	
Drinking	
Others	
In sum	**100**

Note:

On average, a person consumes about 100 liters of water every day.

BIOLOGY

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Realize the need for careful water consumption
* Create a poster in the group to advertise to save water.

Teaching objectives and expected results:

After this activity, students will be able to:

* Lead a discussion
* Find out the reasons to prefer tap water not bottled water

Skills:

* problem-solving skills
* combinatorial ability
* ability to infer
* creativity
* coding ability

Instructions

Activity 10

Class discussion:

What can you do to reduce the water consumption?

Make a poster to recommend your ideas how to reduce the water consumption.

Instructions

Activity 11

Why should we use for drinking a tap water instead of water in plastic bottles?

Write ideas – What can you do to reduce the water consumption?

1. _____
2. _____
3. _____
4. _____

BIOLOGY

Instructions

Activity 12

Calculate how much 1 liter of tap water costs and then compare it with bottled water in PET bottles.

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Calculate the price of tap water
* Compare the price of tap water and water in PET bottles.
* Realize that using of tap water save your money as well as the environment

Skills:

* counting ability
* operational capabilities
* cognitive skills

Calculation:

Note:

You have to find out the cost of water in your town and country because price varies.

In the Czech Republic (Ostrava, 2019) 1 cubic meter of water (= 1000 liters) cost about 81 CZK (3,24 EURO), price varies by location.

BIOLOGY

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Realize the need to prefer water to sweetened drinks for reasons of price and, above all, health.

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Explain individual terms (soft water, hard water, distilled water, artesian water) in the form of domino game

Skills:

* learning skills
* decision making ability
* systematization ability
* ability to interpret

Instructions

Activity 13

Find out how much it costs to buy 1 liter of your favourite lemonade and compare it with the price per liter of tap water.

Name					
Price					

Instructions

Activity 14

Small Quit

Color the same information on the dominoes as they go together.

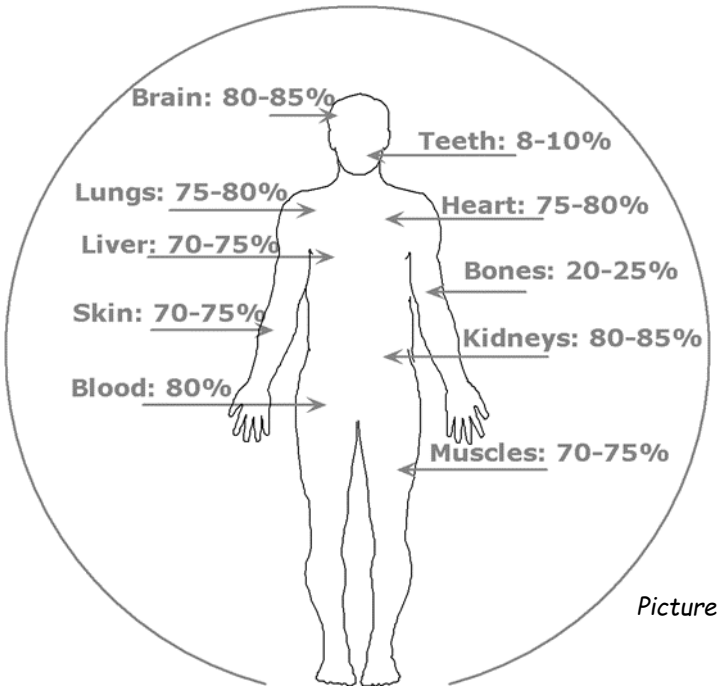
Contains no minerals	**Hard water**
A device that captures coarse dirt from water	**About 5 liters**
Daily fluid intake for men	**Soft water**
High mineral water	**Groundwater**
Causes corrosion of pipes	**Distilled water**
Quality drinking water from deep underground	**About 2 liters**
Daily water consumption for hand washing	**Coarse filter**

Solution

Activity 1:

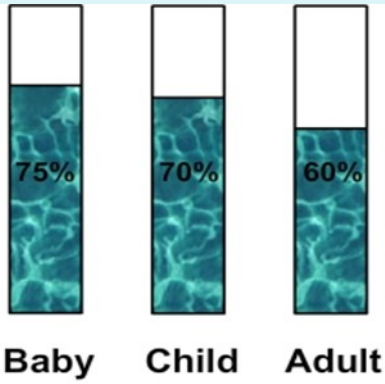
The human body is made up of approximately 60 % water.

BRAIN	80 - 85 %
LUNGS	75 - 80 %
LIVER	70 - 75 %
SKIN	70 - 75 %
BLOOD	80 %
TEETH	8 - 10 %
HEART	75 - 80 %
BONES	20 - 25 %
KIDNEYS	80 - 85 %
MUSCLES	70 - 75 %



Picture 2

Activity 2:



Activity 3:

A: A child whose weight is 40 kg:

40 x 70 : 100 = 28 kg

This child has 28 kg of water in its body (it corresponds to 28 L)

B: An adult whose weight is 70 kg:

70 x 60 : 100 = 42 kg

This adult has 42 kg of water in its body (it corresponds to 42 L)

Activity 6:

Start	Which organs clean the blood and remove waste?
KIDNEYS	What systém cleans your blood and removes waste?
THE URINARY SYSTEM	Why is urine yellow?
Worn-out blood cells give wee a yellow tin. The same chemicals make bruises yellow	How long do kidneys take to clean all the blood in your body?
UNDER AN HOUR	How many kidneys do you have?
2	Where is urine stored in the body?
IN THE BLADDER	How large can a bladder strech to hold urine?
SIZE OF A GRAPEFRUIT	How much of your urine is water?
94 %	What is the chemical formula of water?
H_2O	How much water do a male adult need to drink per day?
About 3 liters	END

Activity 4: How much water do you need?

There is no easy answer to this question as it can depend on:

* ***your age,***
* ***body weight***
* ***health,***
* ***how active you are***
* ***where you live/ climate***
*

The Institute of Medicine has determined adequate intake for men is roughly 3 liters (13 cups) and 2.2 liters (9 cups) for women.

Activity 5:

Text:

* Water is lost from your body through **breathing**. Depending on the humidity level of the **air**, we lose about 300 to 500 **milliliters** of fluid a day through breathing.

* Another large source of water loss in your body is through sweating. Studies show that athletes can lose 2 litres of water per **hour** while exercising. **Sweating** is your body's natural **cooling** system by releasing H_2O in the form of perspiration.

* We lose water through urination. A person typically loses **1.5** liters of **water** a day through urine. If your water intake is high then your kidneys produce larger amounts of water to help maintain a balance. If your body does not have enough **water**, the kidneys will try to conserve water by producing only a **small** amount of concentrated urine. Urine **color** is a measure of your body's hydration and internal water supply. If your urine is dark yellow or amber it could be a sign of dehydration. You should be hydrated if your urine is colorless or light yellow.

Activity 7:

There are several things that water does for your body:

Transports nutrients and oxygen into cells

- Moisturizes the air in lungs
- Helps with metabolism
- Protects our vital organs
- Helps our organs to absorb nutrients better
- Regulates body temperature
- Detoxifies
- Protects and moisturizes our joints

Activity 8

Toilet flush: 5 – 10 liters
Washing machine: 40 – 80 liters
Shower: 20 – 60 liters and more
Have a bath: 150 – 200 liters
Drinking: 2 liters

References:

Task 1: Pictures: 1.https://www.google.com/url?sa=i&source=imgres&cd=&cad=rja&uact=8&ved=2ahUKEwiYjdTtpJHjAhWFJFAKHVorD9oQjRx6BAgBEAU&url=http%3A%2F%2Fwww.cndajin.com%2Fgroup%2Fperson-outline%2F&psig=AOvVaw2WvDbkFCwBxIm9W5M1nvgV&ust=1561986904466963

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http://cwc.gov.in/information-kids

https://www.havefunteaching.com/resources/science/human-body/

Activity 9:

Consumption is different in the city and in the countryside, also younger and older people consume a different amount of water.

Toilet:	**25 l**
Personal hygienne,shower:	**40 l**
Washing, cleaning:	**14 l**
Cooking, washing dishes:	**8 l**
Handwashing:	**5 l**
Watering:	**3 l**
Drinking:	**2 l**
Others:	**3 l**
In sum:	**100 l**

Activity 11:

it is healthy, contains naturally balanced substances
it is a subject of a strict control
It is cheap
it is always fresh
it is stored cold and dark in the water pipes
it saves the environment
no truck transportation

BIOLOGY

Activity 12:

Calculation: 81 : 1000 = 0,081 Cz

The price for one liter of a water is 0,081 CZK (0,003 EURO)

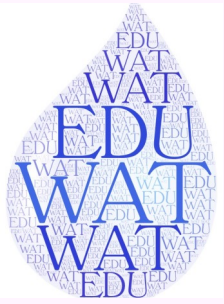
Activity 14:

Contains no minerals	**Hard water**
A device that captures coarse dirt from water	**About 5 liters**
Daily fluid intake for men	**Soft Water**
High mineral water	**Groundwater**
Causes corrosion of pipes	**Distilled water**
Quality drinking water from deep underground	**about 2 liters**
Daily water consumption for hand washing	**Coarse filter**

The future of water

METHODOLOGY

BIOLOGY



Instructions

Activity 1

Water in the landscape
How much water is in the soil?

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* compare the absorption potentials of different types of materials
* realize different composition and characteristics of different types of soils in the landscape and their role in nature

Tools: 3 small flower pots (diameter 10 cm) with holes in bottom, 3 wider plastic bottles, sand, clay, horticultural substrate, graduated cylinder, water

Skills:

* learning skill
* observation ability
* ability to justify, prove, control
* ability to interpret

* Cut off the neck of plastic bottles.
* Put one pot into each bottle so that there is sufficient space between the bottom of the pot and the plastic bottle to drain the water.
* Fill the first pot with sand, the second with clay and the third with substrate.
* Using a graduated cylinder, measure 100 ml of water three times.
* Wait one day and compare the water level in all plastic bottles.

Observing:

Conclusion:

BIOLOGY

Instructions

Activity 2

How to purify the water?

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* As a simple experiment use available materials to remove impurities from the water

Tools: 2 flower pots, 2 tissues, gravel, sand, plastic bottle, water, clay, food colouring subsatnce, charcoal, friction bowl, 3 glasses, tablespoon, microscope, dropper, slide and cover slip

Skills:

* observation ability

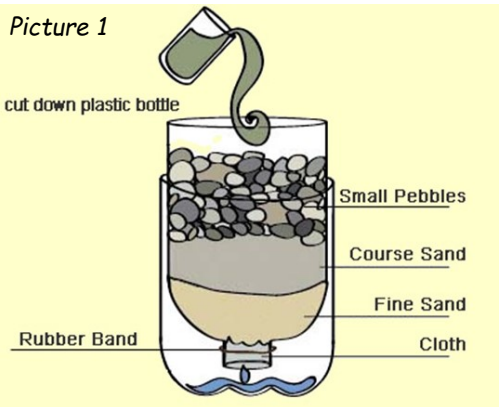
Additional tasks:

Quiz- purifier

https://wordwall.net/play/2262/991/476

* Put a tissue on the bottom of the pots and a layer of gravel (about 5 cm) on it.
* Put a layer of sand (about 5 cm) in one of the pots.
* Crush the charcoal in the friction bowl and mix it with the sand.
* Mix the charcoal with the sand into the second pot (5 cm layer).
* Put pots on glasses so that water can run into them.
* Pour water into the PET bottle, add two tablespoons of clay and food colouring substance and mix it well.
* Pour water from PET bottle into pots.
* Pour water back into the pot three times.
* Finally, observe a drop of water under the microscope both from the first and then from the second pot.

Picture 1



Observing:

Conclusion:

To make the next activity you need to visit the sewage treatment plant in your area, or to watch a film related to this topic.

You can watch the video: https://youtu.be/FvPakzqM3h8/ (10 minutes long)

Instructions

Activity 3

Label the water cycle arrows in the water industry in the picture

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Describe the water cycle in water supply
* Realize the difficulty of preparing drinking water and its way to the consumer

Skills:

* learning skill
* cognitive ability
* problem-solving skills
* ability to interpret

You can see in the picture number 2 the water cycle in the water industry. This cycle helps to create and conserve the important and natural source – water. You can see that we need energy to create drinking water. The water in the dam often contains germs and particles and it needs to be cleaned out at a **water treatment plant**. This water is then used in houses and idustry.

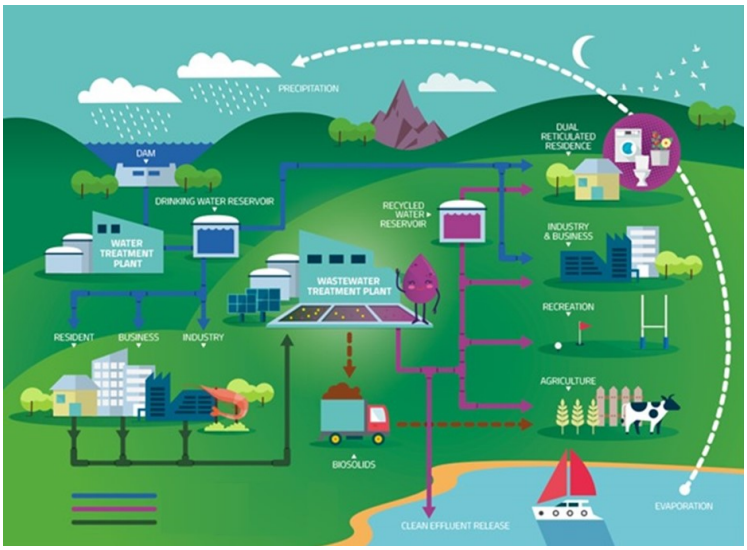
When the water is poured down the drain it is carried by pipes to the **waste treatment plant**. This water is again used.

Label the three types of water: (you can recognize them by their colours)

Recycled water

Drinking water

Wastewater



Picture 2

BIOLOGY

Instructions

Activity 4

Small Quiz

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Check their knowledge by means of a test

Skills:

* learning skill
* cognitive ability
* problem-solving skills
* ability to interpret

Additional tasks:

People's statements about water regime

https://wordwall.net/play/2421/286/483

1. What is a wastewater treatment plant for?

a) it only captures garbage from dirty water

b) it removes sludge and other impurities from the water

c) it removes all impurities and solutes from the waste water (eg washing powders)

2. Why waste water needs to be cleaned?

a) not to get rubbish into the rivers

b) so that drinking water can be produced from it

c) clean water is leaving the rivers to improve the environment

3. 100 years ago, what was one of the reasons why sewerage was began to build and drain waste water?

a) improvement of hygiene conditions and reduction of morbidity (plague, cholera)

b) reducing occurance of rodents in the streets

c) reduce the bad smell in the streets

4. Can a person become ill in contact with waste water?

a) No, illnesses come from people

b) Yes, only when swallowed

c) Yes, it is full of harmful germs

BIOLOGY

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Distinguish what is appropriate and what is not drained into the sewerage
* Be aware of ecological consequences of inappropriate waste management

Skills:

* Learning skills

Additional tasks:

What can go to drain?

https://wordwall.net/play/2263/939/809

5. Is it possible to build a new factories without wastewater treatment plants?

a) Yes

b) No, sewage treatment must always be ensured a part of it

6. How to drain wastewater from the valley?

a) run off into the environment

b) creating wastewater lakes

c) using pumping stations

7. Are there in all cities in the Czech republic wastewater treatment plants?

a) yes

b) no, but after the Czech Republic joined the EU, a township over 2,000 inhabitants will have to have wastewater plants

Instructions

Activity 5

Answer the questions and complete the chart

Where does household waste water drain?
How does it get to the wastewater treatment plant?
Determine which substance can be discharged into the drain and which cannot:

BIOLOGY

	YES	NO
Beer, limonade		
Food leftovers		
Medicaments		
Colours, thinners and other chemicals		
Oil from the car		
Dishwashing water		
Wet wipes		
Cooking oil		








BIOLOGY

Solution

Activity 1:

Observation:

Almost all water flows through the sand, clay soil is able to hold some water. There will be at least water in a plastic bottle under a pot with a garden substrate.

Conclusion:

The sand is very coarse and can retain only a little water. Clay is a mixture of sand and clay. The pores between the clay particles are narrower, therefore, clay can retain water better than sand itself. The horticultural substrate consists mainly from peat, that can store moisture well. The plants have a sufficient supply of water in the soil for an extended period of time.

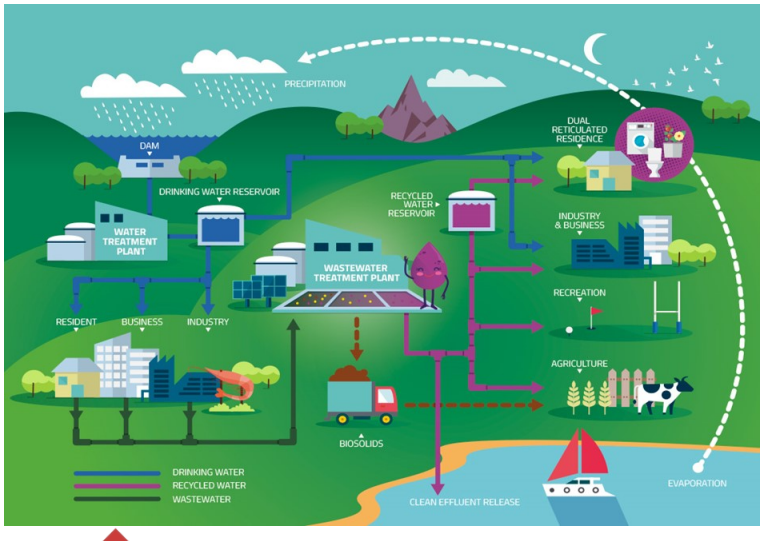
Activity 2:

The water that flowed through the charcoal-free pot was clean. The water flowing through the charcoal pot was clean, without microorganisms.

Activity 4:

1c, 2c, 3a, 4c, 5b, 6c, 7b

Activity 3:



Solution

Activity 5:

1. Where does household waste water drain?

Into sewerage. For houses that are not connected to a sewer network, to the sumps.

2. How does it get to the wastewater treatment plant?

Using a sewer network. It is a piping system and other equipment, which serves to drain waste water from individual houses and from the public space to the wastewater treatment plant.

3. Determine which substance can be discharged into the drain and which cannot:

	YES	NO
Beer, limonade	x	
Food leftovers		x
Medicaments		x
Colours, thinners and other chemicals		x
Oil from the car		x
Dishwashing water	x	
Wet wipes		x
Cooking oil		x

References:

https://vodnistrazci.cz/files/2016/2016-pracovni-listy.pdf

Picture1: https://www.ukpreppersguide.co.uk/wp-content/uploads/2013/08/purify-water-basic-filter.jpg

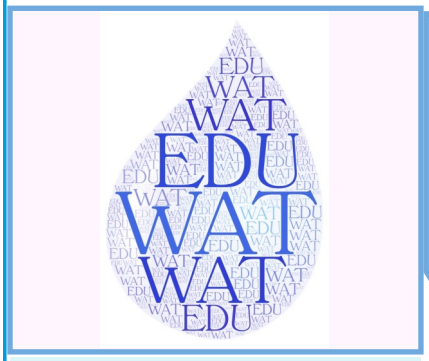
Picture 2: https://www.google.com/url?sa=i&source=imgres&cd=&ved=2ahUKEwjP9dre8NPqAhUH8xQKHVvBDqYQjRx6BAgBEAQ&url=https%3A%2F%2Fstemlyndalesc.weebly.com%2Fwater-cycle.html&psig=AOvVaw2N0yUaas3g7QQWLbMx2dz7&ust=1595061358151308

Types of water and the water cycle

Methodology

Authors: Experimental School of the University of Thessaloniki

GEOGRAPHY



Age level: Ages 12-14

Teaching objectives and expected results:

The general objective of the following activities is that the students understand the importance of the water cycle for life and learn the different stages it includes. Additionally, students will learn about the river features and acquire information about the major and longest rivers of the world as well as the major European rivers.

Specifically, after those activities, the students will be able to:

* describe the process and different stages of the water cycle and the terms associated with it
* define what a river is, describe the river features and recognize the major and longest rivers of Europe and of the world
* read a map and locate rivers on it

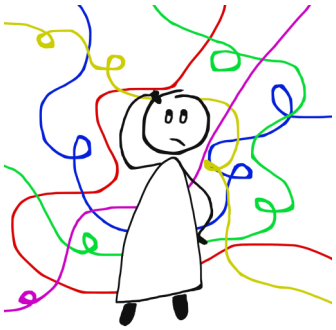
Instructions

Activity 1

Study of the water cycle and the way it varies between different geographic regions.

Show students an introductory video from TEDEd (Where did Earth's water come from? - LINK: https://www.youtube.com/watch?v=RwtO04EXgUE), in which the origin of water on earth is outlined and discuss their ideas on the quantity of water on our planet, the evidence supporting the theories about its origin and why is it so rare in the rest of the solar system.

Start with two open questions concerning "What is precipitation?" and "Why is it important to study and understand the water cycle?" and record students' initial answers.



Show NASA's video "The Freshwater Connection" (https://pmm.nasa.gov/education/videos/gpm-freshwater-connection) in which scientists discuss why it is important to study and track Earth's freshwater resources and explain the purpose of the Global Precipitation Measurement mission.

GEOGRAPHY

* create charts and maps about the famous rivers of the world and their time evolution
* understand that rivers and lakes are dynamic systems that can change over time

Tools:

Computer, laptops

Skills:

* observability
* ability to draw conclusions
* ability to identify, generalize
* communication skills
* interpersonal ability

Instructions

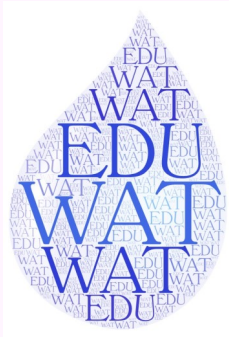
Discuss (students may first work in teams and then present their answers) the answers to the two questions based on the video.

Show water cycle video (http://www.youtube.com/watch?v=iohKd5FWZOE) and discuss the stages involved: precipitation, condensation, transpiration, evaporation, runoff, infiltration, groundwater flow, solar radiation (discriminate between stages that require heating, cooling or are driven by gravity)

Discuss the different stages of the water cycle and the students' answers to the worksheets.

Show video in order to summarize the water cycle: "Water, Water, Everywhere" (http://pmm.nasa.gov/education/videos/water-water-everywhere).

+ extra subactivities for relation between the water cycle and geomorphology



Instructions

Activity 2

Create your own rap song about the Water Cycle

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* understand the water cycle
* determine and characterize the types of river water

Tools:

* computer,
* laptop,
* musical instruments

Skills:

* active learning
* developing creativity
* systematization ability: identification, generalization, classification,

To increase student participation and encourage active learning, we introduce them to "How To Rap (Fitting lyrics to a beat)" by listening to the song "Black And Yellow" (a song by the American rapper Wiz Khalifa (https://www.youtube.com/watch?v=xR6lFaPTxh0). During class discussion pupils bring out themes/points about how to fit lyrics to beats and they are then asked to come up with the lyrics of a song about the Water Cycle, organize the lines into a rhyme scheme, practice the song transitions and finally record and edit the song.

Instructions

Activity 3

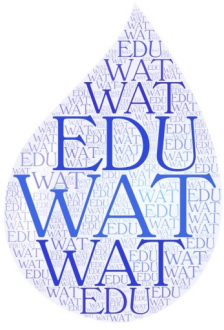
What is a river?

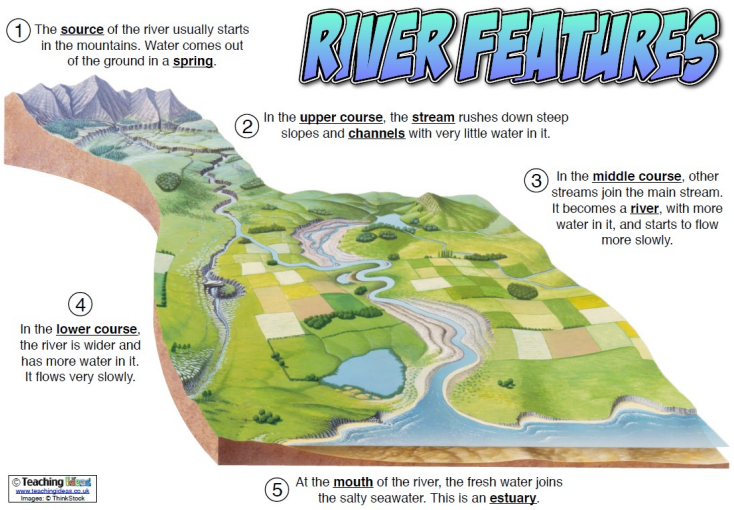
Students initially watch the video "**what is a river?** (https://www.youtube.com/watch?v=dgYYzSXPmPo) about the river definition and its features.

They should then study the diagram **River Features** (https://www.geogreece.gr/rivers_en.php) in order to learn the main features of a river source, estuary, banks, upper course, main course, mouth etc.

A glossary of river features will be also available to the students to make them familiar with key words related to rivers http://www.texasthestateofwater.org/screening/html/gloassary.htm Journey of a River Factsheet.pdf - Google Drive River Glossary - River Keywords (primaryhomeworkhelp.co.uk) and interactive comprehension questions follow.

GEOGRAPHY





RIVER FEATURES

bank	The land at the side of the river.
bed	The ground at the bottom of the river.
channel	A groove in the land. Rivers flow along these grooves, cutting through the rock.
confluence	The place where two streams or rivers meet.
dam	A barrier that is built to hold back water or divert its flow.
delta	An area of sediment (in the shape of a fan) that builds up at the mouth of a river.
drainage basin	The area of land that is drained by a river and its tributaries.
estuary	The place where the fresh river water mixes with salty seawater, at the mouth of the river.
floodplain	A flat area of land near to the river banks, usually found in the lower course of the river. This area sometimes floods.
lake	A large area of water that is surrounded by land.
lower course	The lowest part of the river. It is wider and flows very slowly here.
meander	A bend in the river.
middle course	The middle part of the river, where other streams join the main stream. It has more water and begins to flow more slowly.
mouth	The end of the river, where it meets the sea.
river	A winding watercourse that drains water from a drainage basin.
sea	Large areas of salt water, surrounding the land.
source	Where a stream begins.
spring	A place where water comes out of the ground.
stream	A small, narrow river.
tributary	A stream that joins a main stream or river.
upper course	The first part of the river. It is usually a stream, rushing down steep slopes, with very little water in it.
waterfall	Where water in a river or stream falls from a height.

Erasmus+

GEOGRAPHY

Instructions

Activity 4

The Journey of a river

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* understand the effects of human activities along the river

Tools:

Computer

Skills:

* comprehension ability
* creativity development
* ability to infer
* communication skills

The students have to study a text with information about the Journey of a River, **The Journey River activities** https://www.youtube.com/watch?v=1TwaEjAei4M, https://www.youtube.com/watch?v=iKd2IhwmbVg, https://www.youtube.com/watch?v=5KjocOVfUaQ&t=9s and then answer in pairs reading comprehension questions about it.

After answering the questions and according to the information provided by the text, they will be asked to draw the course of a river and as a follow – up activity they will have to work on the **River Puzzle** https://drive.google.com/file/d/1zci32jzNpeq-7LSHwI3CgKqygxZ89yI0/view in groups of 4-5 students.

This puzzle shows how each human activity or use along the river could affect people, plants, animals downstream – in the direction of, or closer to, the mouth of a river.

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GEOGRAPHY

Instructions

Activity 5

Major Rivers

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* gather information about rivers
* work together in pairs

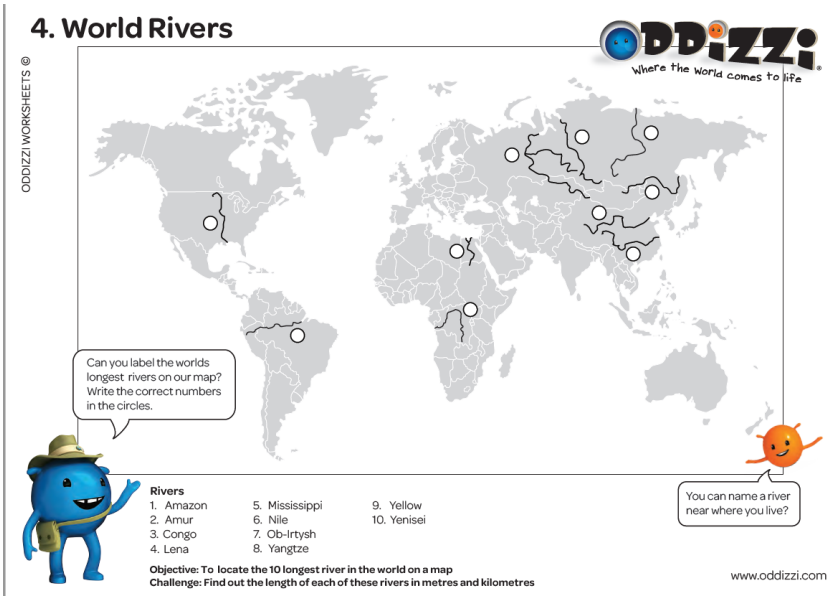
Tools:

* Computer, laptops

Skills:

* Organizing ability
* observability
* cognitive skills
* thinking skills
* interoperability

In order to identify the biggest/longest rivers of the world, **a World Map** (https://drive.google.com/file/d/1PM4rqM7ANj-vPT4ZWrtg4pGxkqFx0Unq/view) is shown and students are asked if they know which are the biggest/largest rivers of each part of the world. They then watch the video **"Top ten rivers of the world"** (https://www.youtube.com/watch?v=_HnxbbGSX8o) and they should watch and write down notes with information about the rivers. An activity **Label the rivers on World map** (https://drive.google.com/file/d/1PM4rqM7ANj-vPT4ZWrtg4pGxkqFx0Unq/view) follows and students have to work in pairs to complete the activity. To learn some interesting facts about rivers a video is shown to the students **Rivers of the world game questions** (https://www.youtube.com/watch?v=t8FrY4tGgnY) who have to complete the **Major Rivers World Activity** by answering the questions (https://drive.google.com/file/d/1LXDjZkiQNLWrw6FOmi2TXUuj5ZKkIr75/view, https://drive.google.com/file/d/13z64sNL1bEq3GOYOeOZaTP9MmnUHE2ym/view, https://drive.google.com/file/d/19fA-pkfnbUoVQs0pQgM-kTH2HZ3bPXAA/view based on the previous video.



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GEOGRAPHY

Instructions

Activity 6

Major Rivers in Europe

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* gather information on Europe's major rivers

Tools:

Computer, laptop

Skills:

* topographic ability
* systematization ability
* cognitive ability

This activity is designed so that students can learn about the major rivers in Europe. Initially, they watch a video which shows the names of the major rivers in Europe on a map which doesn't have the names of the European countries written and they should use prior knowledge to find out in which countries the major rivers of Europe located. The students watch the video **The most important rivers of Europe** (https://www.youtube.com/watch?v=0A_CK8qR8Tk) and then they have to answer questions about the location of the rivers. In order to provide a better illustration, a map of Europe (https://drive.google.com/file/d/1ruT8Tat-4D3EJSgUjlGzeCUS4CybAS3p/view, https://drive.google.com/file/d/13BM9W-LbSRfu41JWy4oFqEGfGO8IyCCf/view)

is then shown to the students and they are asked again about the major rivers in Europe. Then a leaflet **Europe major rivers** (https://www.worldatlas.com/rivers/major-rivers-of-europe.html, https://www.rivieratravel.co.uk/blog/2019/03/15/8-most-beautiful-rivers-in-europe/) is given to the students with information about the major rivers in Europe and the students are asked to study thoroughly all the information by looking at the map. The students in groups of 4-5 they have to label the rivers on the map **European rivers activity** and answer the questions. (https://wordwall.net/resource/4577315/geography/river-features-matching-game, https://wordwall.net/resource/10612443/geography/we-are-anthropologist-uses-of-the-river, https://wordwall.net/resource/234473/geography/rivers-quiz

GEOGRAPHY

Instructions

Activity 7

Geographical representations of water in Literature – map creation

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* realize the importance of water in human life and understand its many representations

Tools:

* literary excerpts
* Textbooks
* Computer, laptops

Skills:

* Ability to interpret
* combinatorial ability
* problem-solving skills
* creativity

Through a close examination of emblematic greek and foreign literary texts of various forms which refer to water (rain, seas, rivers, lakes, etc), students will come to realize the importance of water in human life and come to terms with its numerous representations. This journey will start with an introductory presentation of geographical terminology from school textbooks. More specifically, students will explore textbook units that talk about rivers and lakes (definitions, maps, geomorphology) and will look for information concerning their change over time in literary texts. In the end, students will try to create a map showing the time evolution and change of water resources in a specific area, as they are presented in literature.

Instructions

Activity 8

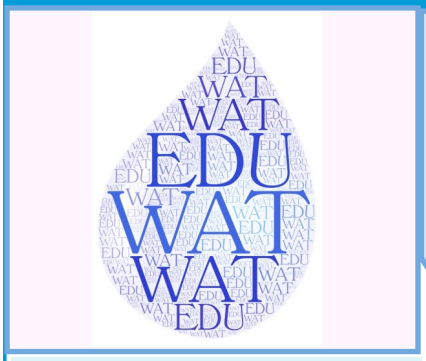
Examining rivers in different historical moments

In this activity, the students choose to study specific rivers of their country and explore their presence and role in different historical moments. Through selected historical sources, the students will have the chance to understand how the rivers influence and were influenced by different parameters through time. In the end, students will try to create interactive maps showing the evolution and change of the environment, uses and importance of the river for the development of the surrounding area.

The use of water in everyday life

METHODOLOGY

GEOGRAPHY



Age level: Ages 12-14

Teaching objectives and expected results:

The students compare their water use with the use of water in other places of the world, so after the following activities, they should be able to:

* Estimate their use of water on a daily/weekly/monthly basis
* Create graphs to compare their water use with that of people in other countries
* Discuss about the availability of clean water in different countries around the world

Skills:

* systematization ability
* ability to infer
* communication skills
* ability to justify, prove, control

Instructions

Activity 1

Common uses of water

Ask students to identify the ways in which they use water at home and make a list of the different uses of water. They should then work in small groups in order to identify the ten most common uses of the list and compare them with the results of other teams. Provide students with a list of the most common uses of water worldwide and the typical number of liters used for each purpose, and discuss the differences between this list and the students' ideas.

Instructions

Activity 2

Calculate your personal water footprint

Ask students to estimate how much water they use in their everyday life and make the list of all the uses they make. Use the Water Footprint Calculator (https://www.watercalculator.org/) in order to calculate the amount of water they use. Search information about the water consumptions in the different European countries, discuss and compare the results.

GEOGRAPHY

Instructions

Activity 3

Water use in the world

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Estimate their use of water on a daily/weekly/ monthly basis
* Create graphs to compare their water use with that of people in other countries
* Discuss about the availability of clean water in different countries around the world

Provide each student with an index card which has the name of the country and the amount of water each person uses every day in this country. Each student will now represent the country written on his/her card. Show the world map and have each student locate his/her country and write on the country on the map the number of liters of water used each day. Look at the world map and discuss about the disparity in water use from country to country. In which countries do people use the most and in which the least amount of water? On which continent and in which areas do people suffer from a shortage of clean water? Discuss the difficulties people face in countries where water use is less than where they live and ask students to search for information in the internet and answer the questions on the worksheet.

Tools:

Internet, laptops

Skills:

* Ability to justify, prove, control
* problem-solving skills
* communication ability
* ability to draw conclusions

Instructions

Activity 4

Let's go to dinner GAME

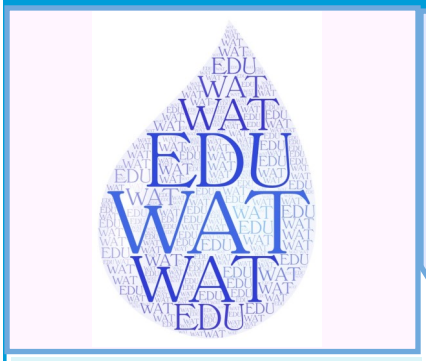
discover the local cuisine!

Provide each student with a list of traditional recipes from different countries and a list with the water footprints of all the ingredients. The students will work in teams and each team will be assigned to "prepare" a meal and a dessert for tonight choosing from the recipes they have. They will then have to calculate the water footprint of their meal, they can compare the water footprings of popular recipes of each country and the team that will choose the meal with the lowest water cost will be the winner!

The future of water

METHODOLOGY

GEOGRAPHY



Instructions

Activity 1

The water crisis in figures and graphs

Age level: Ages 12-14

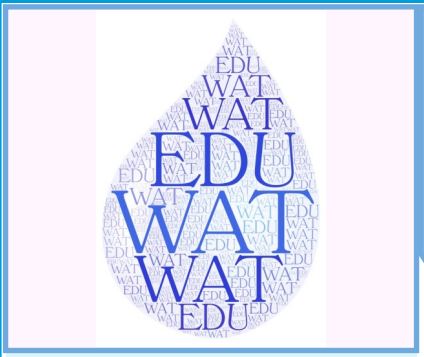
Teaching objectives and expected results:

Water scarcity and the global water crisis are concepts that students from countries of the developed world have difficulty visualizing. Additionally, in order to foster a future with more sustainable water resource management, the students should understand what is meant by the terms sustainable, sustainability and sustainable development. After the following activities the students should be able to:

* discuss on the concepts and challenges relating to water scarcity
* describe the global distribution of clean drinking water and explain some of the causes and consequences of water scarcity
* realize that in several parts of the world clean drinking water is unavailable

In this activity, the students will become actively involved in interpreting different figures and graphs concerning the distribution of earth's water, the global water scarcity, the global annual water withdrawal, the average daily water use per person for selected countries etc. The students will work in teams and they will have to answer questions using graphs and maps of different types. After interpreting the data, each team will have to prepare a presentation with facts about the global distribution of fresh water geologically. Specifically, in order to increase the students' awareness of the problem, the topics covered will include: areas of the world that do not have access to enough clean drinking water, per capita water usage, wealth, and access to sanitation for several countries and consequences from drinking contaminated water.

GEOGRAPHY



Instructions

Activity 2

Global water crisis case studies

* identify causes of water pollution
* propose ways to make water safe to drink and help solving the global water shortage problem
* develop an understanding of the concepts sustainable, sustainability and sustainable development.
* discuss examples of unsustainable water use
* discuss how pursuing different sustainable development ideals can affect our future with regard to water resources
* evaluate and compare ways to conserve water

The students will be assigned to research one of the following nations that face serious problems concerning water quantity and quality: Bangladesh, Ethiopia, Honduras, India and Kenya and record their findings on graphic organizer. They will first work individually in order to complete an activity chart for the country they have been assigned to research and then work in groups to organize and present information on the specific country. Each presentation should include country demographics, description of the water crisis, major water, health and sanitations issues and recommendations for improvement of water and sanitation conditions.

Instructions

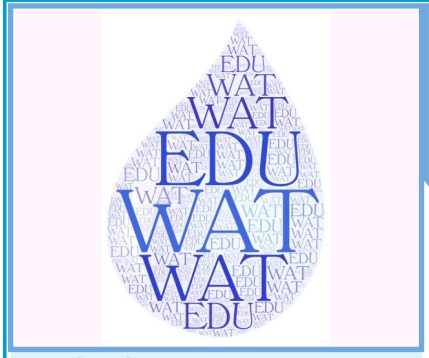
Activity 3

Water scarcity stations game

Skills:

* learning skills
* communication skills
* Decision making ability
* ability to interpret
* rule induction capability

In this activity, the students will go through three different stations (Water Abundance, Physical Scarcity and Economic Scarcity Station) in order to experience the effects of water scarcity. Each station will represent a part of the world with a different condition of water and the students will "travel around" the world, stopping in each station to read about the specific situation and then provide their citizens with water by filling a water bottle according to their needs, eg agriculture, industry, population etc (which will be given in the instructions sheet). In each station, they will have to think, discuss and decide how to distribute the disposable water in order to cover the country's needs.



Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* understand the concept and ethical foundations of sustainability,
* they become sensitive to water management problems

Tools:

Computer, laptop, Internet

Skills:

* learning skills,
* interpretive skills,
* observation skills
* problem-solving skills
* creativity
* communication skills: the ability to understand, interpret and create communications

Instructions

Activity 4

Water sustainability and water conservation solutions

At the beginning, students are assigned specific readings and watch interactive videos in order to participate in a group discussion which introduces them to the concept of sustainability, its ethical underpinnings and how it can relate to water resource problems and management. After the initial discussion, the students break into small groups (4-5 students) and they are asked to come up with ideas about possible solutions for water conservation and then watch the video "How do we meet the growing need for water" (https://www.calacademy.org/educators/how-do-we-meet-the-growing-need-for-water). Discussion follows concerning growing need for freshwater, water waste, aquifer overpumping, and agricultural water use. Students are then divided into teams, they are given a worksheet and watch videos introducing them to possible solutions to the above mentioned problems of water waste (https://www.calacademy.org/educators/waste-water-recycling), aquifer depletion (https://www.calacademy.org/educators/recharging-aquifers) and agricultural water use (https://www.calacademy.org/educators/water-wise-farms). Working in groups and following the worksheet's instructions, they will proceed through an exercise weighing the pros and cons of the solution(s) introduced in the videos, uncovering environmental, social, cultural, or economic factors that relate to proposed solutions. Finally, the students are asked to find information and create a poster proposing different ways of saving water in their region.

Instructions

Activity 5

Unsustainable water use in agriculture – case studies

Students are first divided into groups and each one of these groups is given a different article to read, discuss and come to some collective consensus on the water resource problems detailed in their article. Then, the students are shuffled into new groups so that each group has a representative for each of the 5 articles. After each student outlines from their article how water use in agriculture is not sustainable, the groups are challenged to identify the common problems between their articles and then come up with viable solutions for water sustainability in agriculture.

Types of water and the water cycle

Methodology

Authors: The Water Agency Association—Slovenia

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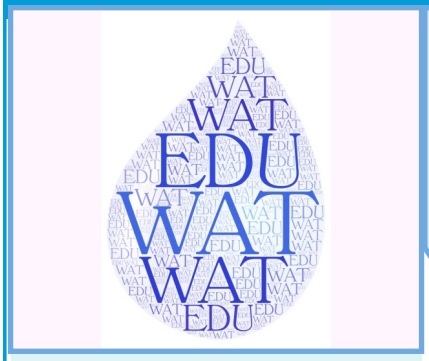

Instructions

Activity 1

Making water cycle poster

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* represent the 4 main phases of the water cycle

Tools: labelled diagram, cardboard, felt - tip pens/crayons, scissors, paper, glue stick, wadding, pieces of different clothing material, moose, wooden sticks, sand, other waste materials from nature.

Skills:

* problem-solving skills
* creativity
* communication skills

Creating a model of the water cycle is more visually appealing and interesting compared to listing or writing the same down on the board.

After the completion of the unit on the water cycle, the students should be able to correctly define and use basic vocabulary terms associated with it (collection, evaporation, condensation, precipitation, etc.). This is a great opportunity for them to illustrate a labelled diagram or create a model of the water cycle using the waste materials found in nature.

Students prepare a model that demonstrates their knowledge of the four main phases of the water cycle: collection, evaporation, condensation, and precipitation. Scenes such as rivers, lakes, oceans, and similar are easiest for students to conceptualize and illustrate/create.

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Instructions

Activity 2

Make a mini water cycle modell

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* have a deeper understanding of the water cycle

Tools: a bowl, a glass, water, plastic wrap.

Skills:

* Ability to recognize connections
* Ability to display information
* Creativity

1. Put the cup in the bottom of the bowl.

2. Pour water around the cup so that it come up to 2/3rd of the cup. Draw on the bowl mark where the water level is.

3. Cover the bowl tightly with the plastic wrap.

4. Watch to see what happens!

Observing You should be able to see the water condensing on the inside of the cling film and that the water level in the bowl has dropped. That is evidence of evaporation. The condensation droplets are the clouds. They will be dripping back into the bowl but you should find that some of the water is now in the cup (your mountains) demonstrating precipitation!

During observing, ask students, what is happening. Write on the board key words. Print or write key words on cards and let students draw them. Stick them on the board to make it easier to remember.

evaporation	**rain (drops)**
precipitation	**condensation**

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Instructions

Activity 3

My life like a drop

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* adapt their environmental knowledge in other disciplines

Tools: glass, water, paper, pen

Skills:

* Creativity
* cognitive skills
* ability to apply knowledge
* communication skills

The funny thing is that the water that falls from the sky as rain today, might have fallen last week, last month, last year or thousands of years ago. It is the greatest recycler of all time! Use these facts for a creative story.

Water cycle. Dkit. Retrieved August 25, 2020, from https://www.dkit.ie/wow/cycle.php

To start, put a glass of water on the table next to your students. Ask students to take a good long look at the water and think about it. "Where do you think it came from? How far do you think it travelled in a day? A week? A year? How long do you think it's been around? How many drops is in?" … After giving them enough time to think and discuss, each students will write a story with the following instructions:

EVERY DROP COUNTS

Write a creative short story about drops journey through the water cycle. The student's "journey" can start at any point of the water cycle. The story can be creative, students can include literary ornaments, but the parts of the water cycle should remain factual. Include plants, animals, etc.

After finishing, student can prepare presentation. Include illustrations and turn the story into a book.

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Instructions

Activity 4

Making rain gauge

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* understand the process of rain
* get to know the type of precipitation

Tools: An empty plastic bottle, permanent marker, scissors, ruler

Skills:

* analytical ability
* observation ability
* ability to think
* ability to infer

Why is rain important? Tell student to make a list of reasons why we need rain and discuss them. How much water falls during a storm? Find out by making your own rain gauge, recording the results, and analyse your findings.
A rain gauge is an instrument used by meteorologists and hydrologists to measure precipitation (e.g. rain, snow, hail or sleet) in a certain amount of time.

Method

1. First, you need to cut off the top of the bottle, approximately 5 cm down, place it upside down into the body of the bottle, so it acts as a funnel for the rain.
2. Next, use the ruler to mark the measurement scale on the side of the bottle, so it's easy to check the rainfall.
3. Place it outside in an open area. You may need to secure it to prevent the bottle being blown away by the wind. For example, I stuck it between two pots.
4. Take measurements each day and record them. We printed a worksheet from the internet, but a homemade one would work just as well.

We now check and record the rainfall every day.

Instructions

Activity 5

Create Water Cycle Sing Song

Age level: Ages 12-14

Teaching objectives and expected results:

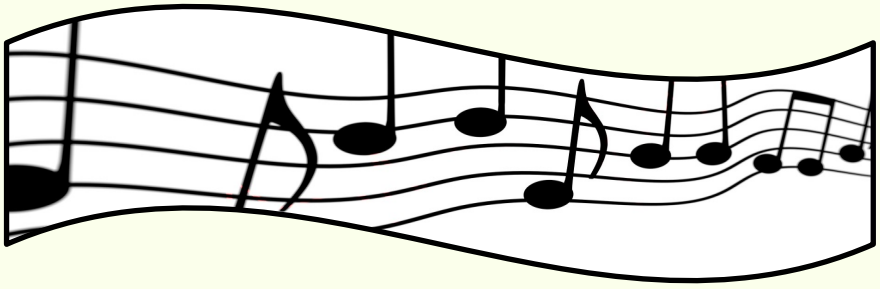
After this activity, students will be able to:

* understand the water cycle

Tools: possibly musical instruments, rhythm instruments

Skills:

* creativity
* communication skills
* combinatorial ability
* developing a sense of rhythm



Earth's water is always in movement and the water cycle, describes the continuous movement of water on, above, and below the surface of the Earth.
First, have a class discussion to explore students knowledge of the water cycle. Write the words associated with it on the board.
After this, let students create Water Cycle Sing Song. It's opportunity to help students recall each step of the water cycle. It could be just a minute long which makes it easy to remember.

For example:

Water, up, down, around, evaporation, condensation, rainfall, infiltration, runoff, sun, sea, ocean, river, rain, snow, ground

Have Fun Teaching. (2015, January 27). Water Cycle Song [Video]. YouTube. https://www.youtube.com/watch?v=TWb4KlM2vts

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Instructions

Activity 6

How Clouds Make Rain

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* understand the process of cloud formation,
* to learn about each type of cloud

Tools: jar, water, shaving foam, food colours

Skills:

* ability to observe
* creativity
* ability to interpret
* ability to justify, to prove

Talk with studets about clouds

A cloud is a mass of water drops or ice crystals suspended in the atmosphere. Clouds form when water condenses in the sky. The condensation lets us see the water vapour. There are many different types of clouds. Clouds are an important part of Earth's weather and climate. (https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-are-clouds-58.html)

There are different types of clouds, and they are classified according to their height and shape.

There are different types of clouds. Cirrus Clouds, Cirrostratus Clouds, Cirrocumulus Clouds, Altostratus Clouds, Altocumulus Clouds, Stratus Clouds, Stratocumulus Clouds, Cumulus Clouds, ... Each has a different altitude and appearance.

You can easily present this to your students using a few simple materials. You'll need shaving foam, a jar, water, and food colours.

1. Fill the jar with water almost to the top.
2. Cover the top with a "cloud" of shaving foam.
3. Drop food colour into the cloud until it starts "raining" into the water below. Explain that this is how rain works too. The water collects in the cloud until there is too much, and then it leaks through, forming rain.

Instructions

Activity 7

Marine animals and plants from clay (in a form of aquarium on a wooden board)

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* use their knowledge in a creative way

Tools: clay, plasticine

Skills:

* learning skills
* creative ability

In Arts, the students have a chance to use their knowledge from other subjects like Science and Environment, and create marine animals and plants that they have learned about. Animals and plants will be attached to a blue wooden base representing an aquarium/life in the sea.

The use of water in everyday life

Methodology

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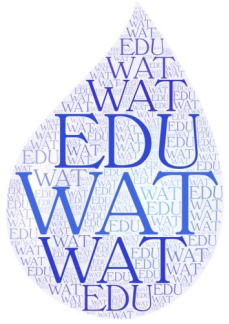

Instructions

Activity 1

The theatre play/making a music video

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* interpret the movement of water as a dance

Tools:

* videos about water,
* music about water

Skills:

Children will expand their gross-motor, observational, and communication skills as they engage in movement activities about water.

Working together to display students action in a creative way!

Water in nature is always in motion. When a human being is moving through space using the elements of time and energy, it is called dancing. Although dancing on water is hard, and could be a subject to discussion, many artists, including dancers, are inspired by water. Water manifests itself in many ways, we find it in lakes, streams, rivers, waterfalls, geysers and oceans. Water can be tranquil like a lake or wild like a tsunami. Visually the sunset or sunrise over water can be arresting and can give an artist a whole colour scheme for costumes or lighting.

What about water consumption at homes? We use water to drink, to do the dishes, to take a shower, to flush the toilet, to cook dinner and for many other purposes.

Engage the children in a discussion about water. How does water move when it`s raining? How does it move in the sea? **Explain to the students that they will create dances about water's movement.** Let they think about the sights, sounds and even the smells you might express through dance. Feeling the water with all the senses and expressing it through dance can help people become more aware of the ways to take responsibility for valuing and protecting not only water, but the planet itself.

Music can be collected by students or teachers (for example The Beatles - Octopus's Garden, Yellow Submarine, Bedřich Smetana – Vltava …).

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Instructions

Activity 2

Clay Ancient Greek pots

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* get to know the values of Greek culture

Tools: clay, water, templates

Skills:

* creativity
* cognitive skills

Video:

Student create their Ancient Greek vases using clay. They use a variety of lines and shapes to make interesting patterns.

Greek pots are historicaly important, because they tell us about life in the past. After learning about this topic by History, students can create magnificant things by Art.

They can learn to use Greek patterns and Greek alphabet, patterns, templates, examples of finished vases.

The Art Institute of Chicago. (2013, April 15). LaunchPad: Ancient Greek Vase Production and the Black-Figure Technique [Video]. YouTube. https:// www.youtube.com/watch?v=TWb4KlM2vts

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Instructions

Activity 3

The well says

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* gain knowledge about different water wells

Skills:

* observation capabilities
* interpersonal skills
* learning skills
* ability to interpret

Optional activities:

• Events near the wells (cultural events, Commemoration of the World Water Day, Earth Day, etc).
• Create calendar on the theme of wells.
• Writing and researching poems on the topic of wells.
• Three-dimensional construction of a well, made of waste cardboard, plastic, etc.

Ask students what kinds of water well they have seen and where they have seen them.
What is water well? In small groups, students talk about this topic and then present their thoughts about how a well works.

It is a structure or excavation made in the ground by digging or drilling to access underground water, such as an aquifer. People have been using wells to obtain water for thousands of years.

During this activity students will use wells in their neighbourhood or nearby area to explore different topics related to water. This activity helps students to develop a positive attitude towards cultural and historical heritage in their closer area, and beyond.

Research activities:

After the introductory part, students explore wells in their neighbourhood. Students can work individually, in pair or in small groups. Each team will choose one well. After researching, they will share their responses to reflection questions:

• Where are the wells/well inventory? (Students mark them on the map)
• Is the well public or private? If private, who owns it now, and who it used to belong to?
• Age (at least approximately).
• Type of water: drip, groundwater, etc.
• The exterior; which materials were used for its construction?
• What purpose the well served in the past?
• What's its purpose today?
• Is the water in the well potable or not?
• Story - if the fountain has one.

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Instructions

Activity 4

Raising Awareness of the Importance of Water - posters

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* gather information on the subject of waste water treatment

Tools: tools for making posters

Skills:

* creativity
* communication skills
* ability to interpret

Optional activities:
Brochures about water

In Biology, Geography an Chemistry students learn facts about water. In language class, they learn about basic features of articles and write them. In Arts, students design the layout of the brochure and insert a picture that fits the theme. In Computer Science, the students design a brochure using software tools and print it. Brochures should be distributed among pupils and parents at the school.

Poster about raising the awareness of the importance of water

As wastewater is deposited into a river, downstream at the next town, drinking water is being pulled from the same river. So, even though drinking water is treated before it enters our tap, wastewater must also be treated and cleaned before it is returned to a river.

The problem of wastewater treatment can be addressed by making billboards, posters (drawings), models, schemes for wastewater treatment, etc. This way the students will learn about the wastewater treatment technology, practice drawing and making shapes etc.

Students discuss the importance of water and its conservation. The outcomes of the discussion are used for writing the poster content. The poster about water awareness should be put in a visible place in school.

Did you know?
Access to clean drinking water is a basic human right?

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Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* get to know the components of mineral waters,
* to create creative mineral water labels

Tools: mineral water bottle, felt-tip pen, paint, glue, laptop, mineral water labels as a sample

Skills:

* problem solving skills
* creativity
* combinatorial abilities
* ability to think
* ability to work in a group

Instructions

Activity 5

The water motif in national painting works

Students do a research on the theme of water represented in national fine art. As a final product, they deliver a research paper with their own reproductions of the art pieces they have found.

Ivan Vavpotič, Trnovski pristan, 20. stoletje, olje na platnu. (MGML, foto M. Paternoster)

Instructions

Activity 6

Water bottle (ideas about appearance, labels)

There are many brands of bottled water, which could be an interesting topic to research. In the Municipality of Rogaška Slatina, for example, brands water (Donat and Tempel) are bottled. In History, pupils mainly focus on history of bottled waters in Slovenia (it is allowed to only focus on the 3 the most well-known ones) and the development of their labels and bottle design. This topic can be covered by linking history and geography – have the students sort the chosen brands of water according to the region they are bottled. (It would be interesting to do a research about the regions where most of the water is being pumped out and bottled.) In Arts students choose one of the water brands and develop the bottle design and label in drawings. Their works should be put on display at school.

Instructions

Activity 7

Memory game

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* cooperate with each other
* recall knowledge in a playful way

Tools: memory cards (made by students)

Skills:

* observability
* ability to concentrate
* creativity
* willingness to cooperate
* interpersonal skills

Memory game has for a long time been one of the favourites for all generations. It is easy to play and learn. It improves observational skills, concentration and memory.
For this activity, students should create the water themed cards and the activity can start.
The basic variation of the game requires that all the cards have the uniform pattern on the back, and the information on the other.
There are several ways to adjust the difficulty level of the activity:

- finding identical pairs,
- combining images with words,
- combining question with answer.

lake		peninsula	
mountain		headland	
palisade		strait	
stream		harbor	
waterfall		fjord	

https://www.pinterest.com/pin/203576845630168720/?lp=true

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Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* easily analyze water-related literature

Tools: excerpts from literary works

Skills:

* creativity
* communication skills
* learning skills
* interpretive skills
* analytical ability

Optional activities: In Music, students choose one poem and, under the guidance of a mentor, compose a tune to it. In Arts, students illustrate the same poem.

Instructions

Activity 8

National poetry

1. Students discuss national poetry that has water as a theme. They research the motif, the authors and the period in which the poems came out.

2. English poems about water

In English, the students translate one of the English poems about water, rivers, lakes, and seas. In Fine Art, students write down a poem in calligraphy and turn it in a piece of art, either as a painting or a sculpture, perhaps a graphic or a drawing.

Example of Slovenian poem:

Niko Grafenauer	Niko Grafenauer
Voda	Water
Voda je izmuzljiva in mnogoobrazna. Včasih se na široko razliva, a včasih je neopazna.	Water is evasive as it wears many faces. It spills broadly at times or just unnoticeably lies.
V ivnato čipko se skrije ali kot solza za veke. A vidna je, ko se razvije v tekoči trak reke.	It hides within a lace of frost or behind an eyelid it shivers. Yet it's visible as it unfolds into running ribbons of rivers.
Najlepša je, kadar kraljuje razlita čez celo obzorje. Takrat se voda imenuje morje.	It's finest when it reigns spilt all across the horizon. Then such water free of chains is watched over by Poseidon.
Voda kljub starosti sije venomer mlada. In nikdar se ne ubije, četudi pada.	Water shines despite its age, being young it never stops. It's not killed at any stage although it often drops.
Ker voda ne more biti neživa. Saj mora z življenjem pojiti vse, kar prebiva.	Water cannot be but alive and kicking. For it must fuel with life everything existing.
	Translated by Andrej Pleterski

Instructions

Activity 9

Microorganisms in water (from a river, after shaving, in a bottle)

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* Observe the bacteria that live in the water and then display their characteristic features in drawings

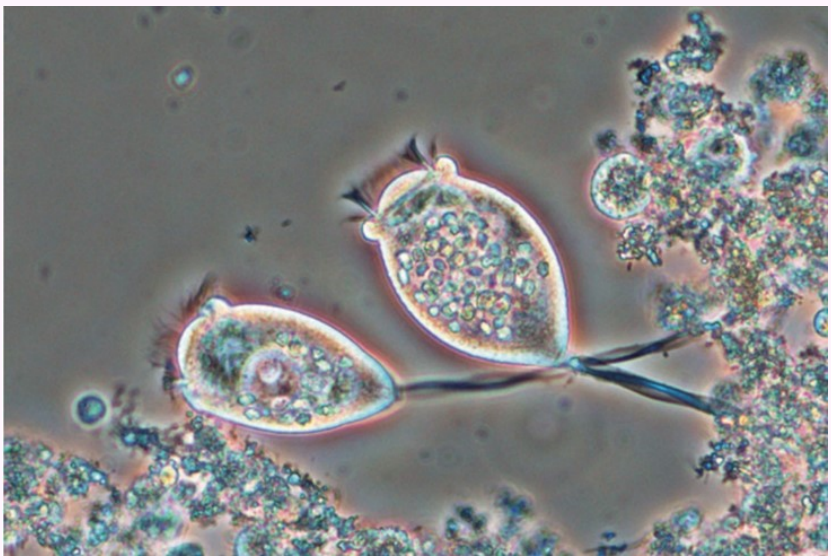
Tools: microscope
paper for poster, felt-tip pens, paints

Skills:

* observation ability
* creativity
* coding capability (display information in other formats)
* learning skills
* cooperation

Observe the microorganisms present in activated sludge under the microscope, and draw them. Students draw various shapes, learn Latin names of microorganisms, make a billboard, and make an album for their drawings of microorganisms which can be used for educational purposes later on.

Students go on a field trip to a local wastewater treatment plant to learn about methods of treating wastewater and activated sludge process. Activated sludge is a mixture of water and sludge from wastewater accumulated in a biological reactor, due to the biological treatment of wastewater. Using a microscope, students examine a sample of activated sludge and study the microorganisms present in it. After the observation, each student draws one microorganism on a separate sheet of paper, and writes down its Latin name. All the drawings are collected into a folder to be used as a workbook students made on their own through observing and drawing.



The future of water

Methodology

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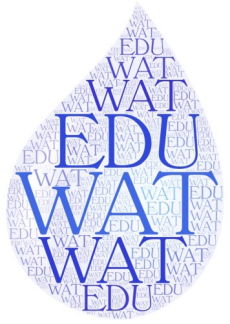

Instructions

Activity 1

"Cleanup" Film

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* recognize the effects of water pollution,
* draw their attention to the environmental effects of water pollution,
* to take responsibility for the area they clean up

Tools: protective equipment for water purification, camera, collection bag

Skills:

* observation ability
* ability to infer
* ability to think
* creativity

Water pollution is one the main environmental issues that we are facing, as more than 70% of the Earth is covered with water. Talk about this with your students. What causes water pollution? What are its effects? What are the possible solutions to prevent water pollution? And what can we do now?

If you want to make really positive impact on the environment and in community, organize a river, stream or a lake clean-up event. Talk with students about trash floating down our rivers, streams, and in our lakes and wake them up!

1. Choose the date. It can be any ordinary day or some special day (3rd Saturday of September is World Clean-up Day, April 22nd is Earth Day, March 22nd is World Water Day).
2. Look for a nearby river, pond or waterway - define a start location and route.
3. Promote your event! Create a video about it, how it was before and after the clean-up event.

An awareness video can be a powerful tool in a lot of different situations. It can be used to:

- Raise awareness about who you are and what you do;
- Educate and inspire people;
- Share a story of change.

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Instructions

Activity 2

Sculptures made from plastic bottles and caps

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* think environmentally consciously,
* make an impact on school students

Tools: plastic bottles, caps, knives, glues and other wastes for decoration

Skills:

* attention concentration
* creativity

For this activity, students bring plastic bottles and caps to school. They sort the waste immediately at the doorstep giving a positive example to the people. Students use plastic bottles and caps to make sculptures of marine animals. Making art pieces from the waste plastic sends a direct message and raises awareness about plastic pollution, and the increasing amount of plastic bottles in the environment, especially the seas. Animal sculptures made from plastic should be placed in the school lobby as a reminder of dangers from everyday water pollution.

PLEASE RECYCLE

https://www.abc.net.au/news/2018-09-28/artist-turns-waste-into-art-to-raise-awareness-of-plastic/10264376

https://inhabitat.com/artist-veronika-richterova-recycles-plastic-bottles-into-beautiful-plant-and-animal-sculptures/plastic-bottle-art-by-veronika-richterova-12/

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Instructions

Activity 3

Making water mill from waste packaging

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* build a water mill out of waste material
* cooperate with each other

Tools: waste material

Skills:

* creativity
* interoperability
* ability to think critically
* attention concentration
* ability to think
* ability to infer
* the ability to consciously design

At this activity students explores how watermills have helped harness energy from water in the history. Lesson focuses on how watermills generate power. Students build their own water mill out of waste material (bottles, cans, waste wood, straws). In Arts, student use creative painting techniques to decorate the mills so that they stress out the importance of water and its protection. After this, students test their design in a stream. Student watermills must be able to sustain three minutes of rotation. Students then evaluate the effectiveness of their watermill and those of other teams, and present their findings to the class. After the presentation, they can figure out what they can do differently to make the mill even better.

Erasmus+

FINE ARTS

Instructions

Activity 4

The Water Song

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* cooperate with each other
* for the free soaring of their imagination
* convey information through the language of music

Tools: musik, paper, pen

Skills:

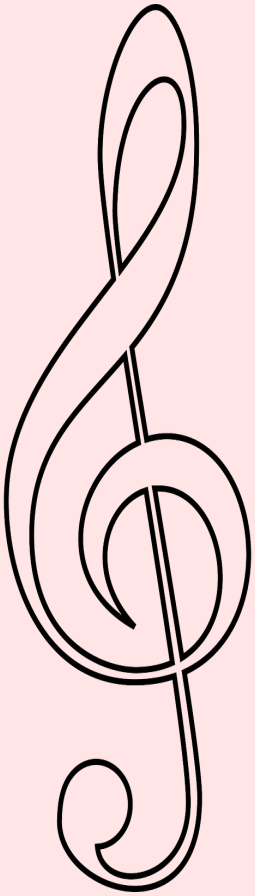
* creativity
* social skills

Some ideas:

https://www.songsforteaching.com/environmentnature/cleanwaterconservation-green.htm

Every organism needs water. Many of us think that water will always be there for us when we want it. Explore the water cycle with students, human activities that affect the water cycle, and what we can do to protect our water. A discussion about this can tap into your students' interests and motivate them for new ideas – for example, writing a song about water conservation and clean water.

Songs on this link can help you with some ideas.



1. A Topic
What is your song going to be about?
What are they learning about in school?
What time of year is it? Spring, winter...
The inspiration for making up songs with students is all around us!

2. A Melody
Students can use the tunes of songs they already know. Some classics like *If You're Happy and You Know It!* or some pop songs. Basically, you can use whatever you and your students are listening to. All you need to do is use the melody as a guide and replace the lyrics to suit your song topic.

3. Some Verses
The verses are where you can elaborate on the topic of the song or start to tell the story. You can write as many of these as you want.

4. A Purpose
What are you writing this song for? You may simply be writing it for fun, or to learn something new, share your knowledge or make mundane tasks more interesting.

FINE ARTS

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* recognize the connection between water and the arts
* make a comic

Tools: t-shirts, textile paint, computer

Skills:

* creativity
* ability to think
* problem-solving skills
* combinatorial ability

Instructions

Activity 5

Create environmental message

Create effective messages and materials about water treatment: easy to understand, memorable.
Use recycled or natural materials and make: **Magnets**, **bookmarks**, **T – shirt with footprint of the city (printmaking technique that uses the manhole covers and similar)**

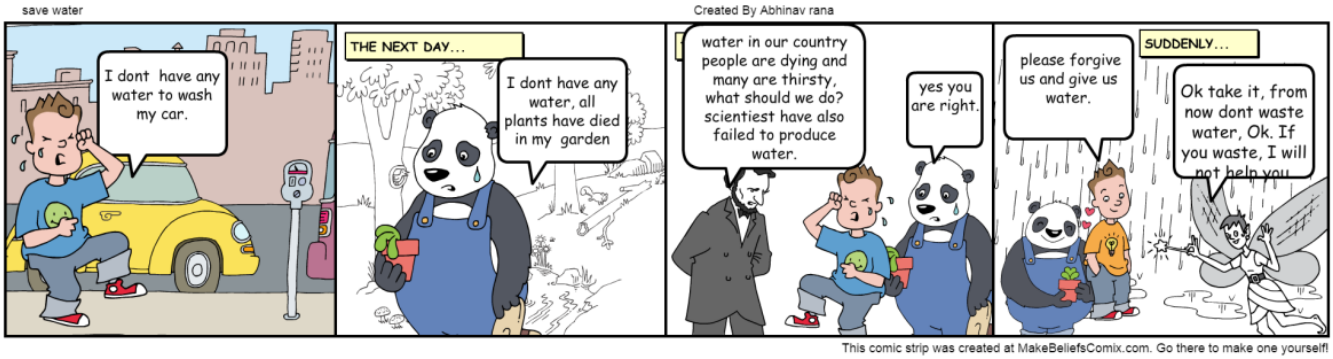
Show the students project **raubdruckerin** (https://raubdruckerin.de/en/) - experimental printmaking project that uses urban structures like manhole covers, grids, technical objects and other surfaces of the urban landscape, to create unique graphical patterns on streetwear basics, fabrics and paper.
Connect the activity to the city's water supply, visit the public water service, explore the water resources in city, and print the water shafts on students' T shirt.

Instructions

Activity 6

Comic book about water

In Arts students make their own comic book related to water. They write the comic book story in national language. Later on, in Arts, the students form and draw their comic book. Comic books will be exhibited in school for other students to see.



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FINE ARTS

Instructions

Activity 7

Making wastewater treatment plant

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* becomes able to understand the steps of water purification
* give advice to avoid water pollution

Tools: paper, colored pencils

Skills:

* creativity
* observability,
* ability to think
* communication skills

Lesson focuses on following of a water drop to see how water is cleaned to make it safe to drink. Along the way, water drop have picked up many things that make it dirty. How to solve water pollution? How can water pollution be prevented? Write or draw a list of water pollution solutions on paper and draw a drop of water around it.

What is water pollution?

Prepare an exhibition with students of your water drops. If the students will take care of the water, as they draw or. Write, we can call this exhibition „wastewater treatment plant".

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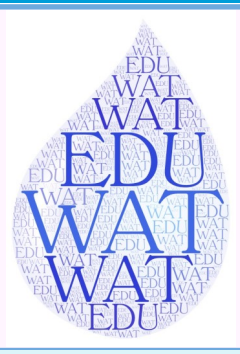
FINE ARTS



Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* think more environmentally consciously,
* to articulate their thoughts creatively on the topic of water pollution

Tools: paper, colored pencils

Skills:

* interpersonal skills
* social skills
* ability to think
* ability to interpret
* decision making ability

Haiku Writing

The children could be introduced to the format of a haiku poem (written about water, environment, and nature).

Instructions

Activity 8

Save water signs

Discuss with students aboutthe ways we waste water in our daily lives. The children then design the waste-water warning signs for toilets, dining rooms, and other places around school to encourage people not to waste water. The best signs can actually be placed in those areas.

RESPECT WATER,
RESPECT LIFE

WATER IS A LIFE

Stick me on the wall next to your taps to remind your family and friends to conserve water and use it wisely!

Instructions

Activity 9

Write for bright future

With this activity, students will express their knowledge, feelings and values related to water. For the beginning, students can read the literature written about water topic. Let the creation begin!

Creative writing on different topics:

How does water come to our homes?

Water conservation?

The story of bottled water.

Poetry

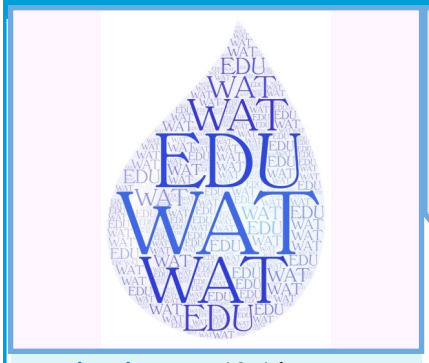
The students can try to write an acrostic poem about water.

Types of water and the water cycle

Methodology

Authors: Erika Süle, Kossuth Lajos Primary School

CHEMISTRY



Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:
Students will get information on water cycle by using the tools of experiment-based learning. They learn evaporation, cloud formation, precipitation, the difference between fresh water and salt water.

Tools: internet connection, computer, interactive whiteboard, tablet

Skills:

* ability to concentrate and remember
* spatial vision and orientation ability
* logical thinking
* visuality, perception
* failure tolerance

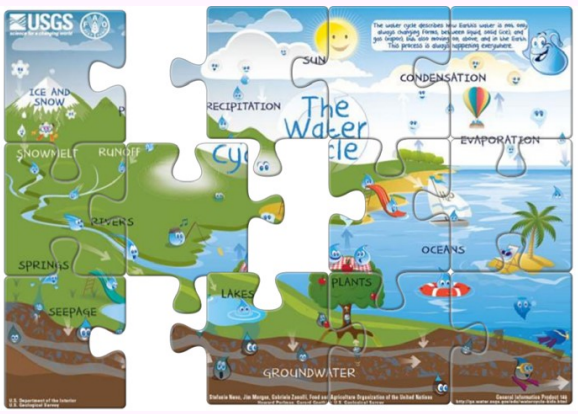
Instructions

Activity 1

Water cycle puzzle

The task is to put together a picture of the water cycle using a puzzle maker. The program is free to use after registration (https://www.bookwidgets.com)

https://www.usgs.gov/centers/sa-water/science/water-cycle-students



Students solve the task on a tablet or interactive whiteboard. The form of work can be individual, pair work, group work or even frontal - as required.
To interpret the picture of the puzzle and to explain the concepts, we recommend the following:
- directed conversation about the topic frontally (This is important to reveal possible misconceptions, misinterpreted concepts, processes.)
- to practice the knowledge elements, we recommend task 1 of topic 1 of the biological module.

Instructions

Activity 2

Song about the water cycle

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

Focus their attention on the topic

Tools: internet connection, computer, interactive whiteboard, rhythm instruments

Skills:

* concentration and memory development
* developing a sense of rhythm,
* concentration of attention,
* creative thinking, development of English language skills

https://wordwall.net/hu/resource/5980815

https://drive.google.com/file/d/1uv2Tfc0QYrzmicjCnGA_uJYfFLT-Un_3/view?usp=sharing

The task makes it easier to tune in to the topic and should be considered a warm-up task.

Students can listen to the song about the water cycle in the video. If possible, children can learn the song. The songs can be downloaded from the link below:

https://www.schooltube.com/video/8befaab71cafac5a3bb7/COOL%20water%20cycle%20song

https://youtu.be/TWb4KlM2vts

https://youtu.be/gBbFxl6Oy94

The task is well connected: Arts module Topic 1 Activity 5 (Create Water Cycle Sing Song).

As a methodological advice, we recommend that you first listen to the song together once or twice, and then try to memorize the lyrics and melody line by line. The use of different rhythm instruments can be a good additional activity, as well as supplementing the singing with movement and possibly dance steps.

We can help students learn songs by giving them gapped text. Some important words are missing from the text. These words are related to the water cycle.

Another methodological option: We give word cards to the children. On the cards there are the more important words of the song. If the student hears their own word in the song, they stand up or crouch or clap, and so on. Very fun!

Instructions

Activity 3

Experiment 1: Water Cycle in a plastic bag

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* understanding the water cycle
* recognition of the stages of the hydrological cycle, separation of the individual stages
* collaboration with peers during the experiment
* complete simple experiments alone or in groups

Tools: thick-walled plastic bag (lockable), alcohol-based pen, water, blue food coloring

Skills:

* Rule induction skill
* Observation skills
* Ability to think
* Inference skills

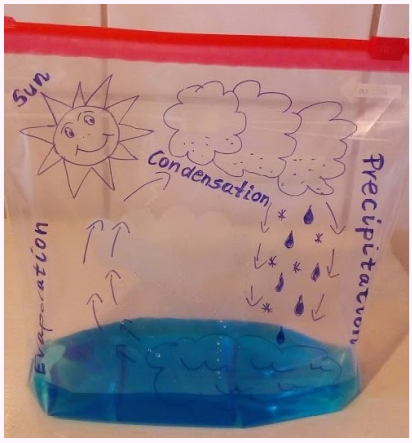
Instructional video

Here's how to do the experiment:

https://drive.google.com/file/d/1jyvPfJ5WyLJk2xNtEOjT0236eTrquxhY/view?usp=sharing

Students experience the process of evaporation, cloud formation and precipitation in a closed system that simulates the Earth's water system.

It is advisable to work the students in groups for this task. (A group of 3-4 people is ideal) This is about simulating the water cycle we have already learned. It is important to understand that our planet is as closed a water cycle as it is seen in the experiment.



Fotos by autor

Description of the activity

Pupils draw the stations of the water cycle and their names on the bag in any color. They are then filled with approx. a quarter of the bag with colored water. We recommend that the finished work be placed in a warm place so that evaporation begins as soon as possible.

Instructions

Activity 4

Experiment 2: The evaporation

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* recognize the change of state in the water cycle (from liquid to gas)
* understand the motion and structure of water molecules during evaporation
* prove by simple experiments the evaporation of water and the factors influencing it.

Tools: black, red paper discs, glue, white paper, 4 small bowls, water

Skills:

* combinatorial ability
* application of logical operations
* observation skills
* coding ability: display of information in different forms, image comprehension
* ability to draw conclusions

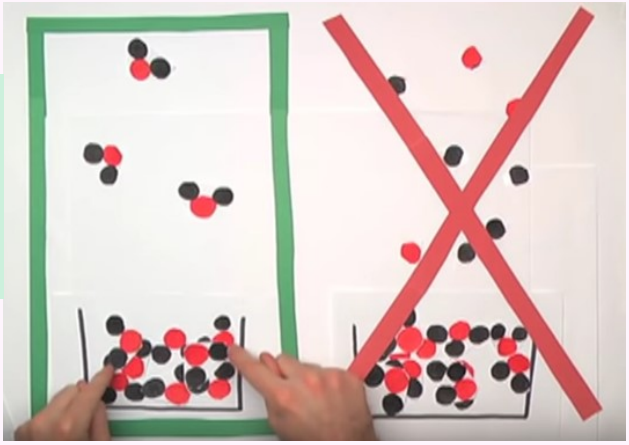
True or false

https://wordwall.net/hu/resource/1697272

In this case, the substance is converted from a liquid to a gas. The particles exit the surface of the liquid and become free-moving particles. We can experience this by leaving a little tap water in the glass for a few days. The content of the cup disappears and the water evaporates. It is not necessary to reach a specific temperature for evaporation, it takes place at any temperature.

Instructional video:

https://drive.google.com/file/d/1VrO33XMa6eLcKwylbbYkILjSJcWA0Xra/view?usp=sharing



https://www.youtube.com/watch?v=fSD-mEHWAMk

Description of the activity

Prepare water molecules based on the image. Place them on a white piece of paper. Then modell the evaporation. Make students aware that when a liquid boils or evaporates to become a gas, the molecules DON'T come apart.

Pour 4 little bowls of equal volume of water. One is placed on a desk in the classroom, the other on the radiator, the third on the windowsill, and the fourth into the fridge.
Notice the evaporation rate. Which evaporates faster? Why? What does the evaporation rate depend on?
Recommended form of work: prepare the water molecules in small groups. Presentation of evaporation as a teacher demonstration.

Instructions

Activity 5

Experiment 3:The condensation

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* understand the process of condensation
* perform a simple experiment in a group, collaborating with each other

Tools: Hot water, 3 or 4 ice cubes, a jar, hair spray

Skills:

* observation skills
* ability to draw conclusions,
* ability to recognize sequence,
* generalization,
* identification,
* interpersonal skills

Instructional video:

https://drive.google.com/file/d/1TmX7Zc7X3VSsxrOsatmT1ePsHX3rcVBB/view?usp=sharing

Cloud in a jar

Instructions:
Pour boiling water into a jar.
Spray hairspray into the jar.
Place the lid on the jar. Then place ice cubes on top of the lid.
Wait for 1 to 2 minutes.
Observe the cloud inside your jar.

Conclusion:

1. Clouds are made of water.
2. In order for the liquid water on earth to turn into clouds, it has to first become a gas known as water vapor. (A process called evaporation).
3. To form clouds, the water vapor has to collect or condense into tiny droplets of water. (A process called condensation.)
4. In order for the water vapor to condense, it needs something to condense onto, like dust (or hairspray, in our case).

Foto by Peter Szendi

Description of the activity

The experiment is recommended in groups of students (3-5 people). Each group solves the same task. Before starting the experiment, take the students' prior knowledge of the topic with the help of guided teacher questions. Formulate the purpose of the experiment, also give observation aspects to the students. Students carry out the experiment independently under the guidance of the teacher (with the exception of adding hot water) Danger of accidents!

Instructions

Activity 6

Experiment 4:The precipitation

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* understand the process of precipitatiion
* perform a simple experiment in a group, collaborating with each other

Tools:

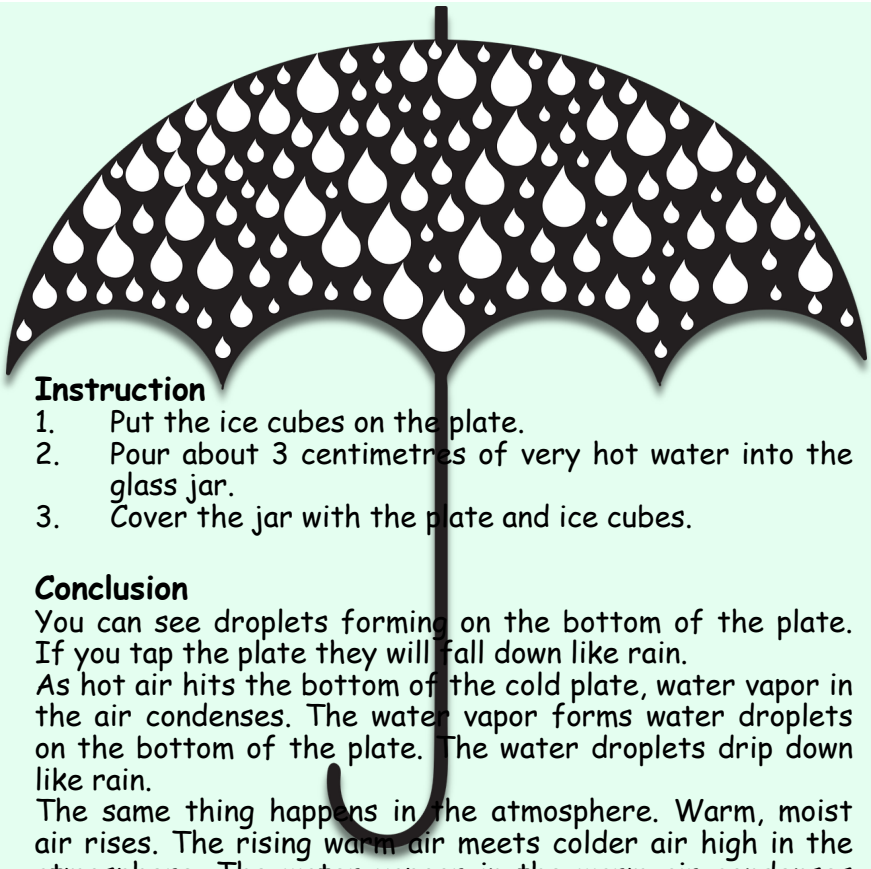
Ice cubes, wide glass jar, plate, very hot water

Skills:

* observation skills
* ability to draw conclusions,
* ability to recognize sequence,
* interpersonal skills

Instructional video:

https://drive.google.com/file/d/18aq6qhz9iR-SEGZJ4MbTY6dlKGfgBb42/view?usp=sharing



Instruction

1. Put the ice cubes on the plate.
2. Pour about 3 centimetres of very hot water into the glass jar.
3. Cover the jar with the plate and ice cubes.

Conclusion

You can see droplets forming on the bottom of the plate. If you tap the plate they will fall down like rain.
As hot air hits the bottom of the cold plate, water vapor in the air condenses. The water vapor forms water droplets on the bottom of the plate. The water droplets drip down like rain.
The same thing happens in the atmosphere. Warm, moist air rises. The rising warm air meets colder air high in the atmosphere. The water vapoor in the warm air condenses and forms water droplets. The water droplets fall to Earth as rain.

It is recommended to perform the experiment in small groups. Due to the hot water, the experiment is dangerous. Be careful.

Instructions

Activity 7

Experiment 5: Salt water

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* understand the differences between saltwater and freshwater
* understand the buoyancy of water in different types of waters
* complete simple experiments alone or in groups

Tools: Backing soda, salt, water, jewelss, spoons, 3 transparent glasses

Skills:

* monitoring the properties of things
* the ability to interpret data collected from observations
* rule induction skills: rule recognition, insight into relationships

Instructions

Dissolve 2 tablespoons of salt in one cup, 2 tablespoons of baking soda in another cup. Add fresh drinking water to the third cup. (This will be the "control group.")

Have students think about what can happen when jewelry is thrown into each cup. Do the jewelry sink or float?

Drop the jewelry into each glass to see if the students 'tips are correct.

Foto by Erika Süle

Conclusion

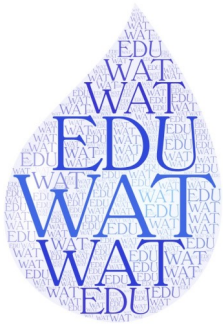
Salt water and baking soda should float the jewelry. Why? By adding salt water, the water becomes denser. That means it will be harder. Many freshwater submerged objects float in salt water. Object floats in baking soda water because baking soda is a type of salt.

Methodological proposals

Because the experiment is simple and safe, it is a good idea to do this in pairs or in small groups with the children. Before the experiment, students "brainstorm" what will happen? Justify their decision. After the experiment, we repeat what we have learned before about the buoyancy of water. Let the children give examples of the buoyancy of water from everyday life.

CHEMISTRY

H2O



Instructions

Activity 8

Find your partner - game

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* summarize the topic
* generalize the experience of the experiments
* work with peers

Tools: question and answer cards, internet connection, computer + interactive whiteboard or tablet

Skills:

* systematization skills
* communication skills
* cooperation skills
* ability to use ICT tools

Other summary online tasks

https://wordwall.net/hu/resource/1679956

https://wordwall.net/hu/resource/1687940

https://wordwall.net/hu/resource/1689307

As a summary of the topic, the children draw a task card. One set of cards consists of questions and the other set of answers. The challenge: find your partner and read the question and answer aloud. Question-answer cards can be supplemented with additional questions and answers.

Questions	Answers
What is H2O?	The chemical symbol for water.
What is the sun?	The source of energy for the hydrologic or water cycle.
What is the condensation?	The process by wich a vapor becomes a liquid or a solid.
What is the water cycle?	The constant circulation of water from the atmosphere to the land and the oceans and back again.
What is the infiltration?	The movement of water down through the earth's surface.
What is the evaporation?	The substance is converted from a liquid to a gas.
What is the precipitation?	It is any liquid or frozen water that forms in the atmosphere and falls to the Earth. It is one of the three main steps of the global water cycle.

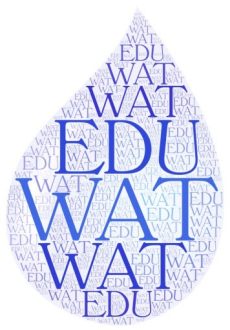
Printable question and answer cards can be found using the link below or the QR code:

https://drive.google.com/file/d/1XVHT0FuyPlJUgGNITkMXNpyivYDIEa-A/view?usp=sharing

The use of water in everyday life

Methodology

CHEMISTRY



Instructions

Activity 1

Brainstorming – warming up

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* listen to the opinions of his / her classmates,
* consider the opinions, f
* ormulate his / her own opinion and justify it

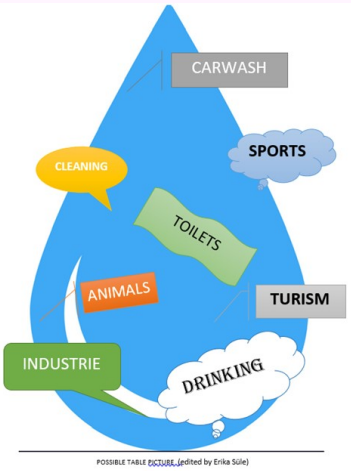
Tools: a large blue water drop made of paper, glue, post-it, crayon or felt-tip pen

Skills:

* thinking ability
* systematization skills
* communication skills
* reasoning skills

The purpose of this lesson is for students to understand that water is an essential part of our daily lives and that we are in constant contact with it. It is therefore very important to be aware that it is everyone's responsibility to keep the water clean.
The chemical components in the water influence the quality of the water, so it is important that students learn about these elements. (just elementary).
From a methodological point of view, play-by-play, experimentation, process interpretation, flow charts are the focus.

We put a big drop of water on the board. We ask students to think about where people need water in our daily lives. Have the children write down the ideas in a post-it. Stick the post-it on the water drop. Let's talk about the topic with the kids in an informal way.



Instructions

Activity 2

Hard or soft? - experiment

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* understand the difference between hard and soft water
* understand the impact of hard water on the household
* successfully participate in simple experiments alone or in small groups
* transfer what they have experienced in the experiment to their daily lives

Tools: 3 test tubees, test tube rack, distilled water, tap water, calcium chloride solution, soap shavings, teaspoon

Skills:

* Observation ability
* cooperation skills
* concentration skills
* reasoning, proof, control ability

Instructional video:

https://drive.google.com/file/d/1i8UgR3TsNXnBHgNP1gtRu0xnSFC2bLM_/view?usp=sharing

This experiment shows students the difference between hard and soft water. Hard water contains large amounts of dissolved minerals, usually calcium carbonate or magnesium salt. This is not necessarily a bad thing - most of the water in our households has a certain degree of hardness. Both hard and soft water are perfectly good for your health.
It is important to remind students during the experiment that hard water can also be a problem in the household because more soap and detergent is needed to make bubbles or foams. Calcium and magnesium salts can occasionally accumulate in pipes and prevent water from flowing and eventually cause corrosion.

In which water is the soap (detergent) most soluble and foamy?

Instruction:

1. Pour distilled water into one of the test tubes, tap water into the other and calcium chloride solution into the third.
2. Place a little soap chips in each of the three test tubes.
3. Shake the solutions.
4. Let's examine the differences.
5. Draw on the worksheet what they experienced during the experiment.

Soft water (distilled water)	*Hard water ($CaCl_2$-solution)*	*Tap water*

Instructions

Activity 3

Water filtration - experiment Mini-project

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* make a decision and justify their decisions,
* correct a wrong decision
* plan the experiment
* record the experimental data
* to make a comparison

Tools: digital scales, graduated cylinders—250 ml (for measuring simulated waste water), empty 0,5 L plastic water bottles (2 per team), scissors (1 pair per team), paper towels, 10 cmx10 cm squares of cheesecloth (1 per team, to cover mouth of bottle, rubber bands (1 per team, to attach cheesecloth to bottle), variety of materials to use as filter media (cotton balls, coffee filter, aquarium gravel, play sand, uncooked macaroni, zeolite, activated carbon), paper or plastic cups (to use as scoops in loose filter media), simulated wastewater (4 L), pH testers

Instructional video:

https://drive.google.com/file/d/1u_9OzbDL0FSQNKvT7_1xiMtjiBKXAu83/view?usp=sharing

In this activity, students are challenged to desingn and build a water filtration device using commonly available materials. Students build, test, and measure the performance of the filter tool, analyze the data collected, and use this information to improve their original design. Finally, the department will build the best water filtration equipment based on suggestions and experience.

Procedures

The student-built filtration device is made from two 0.5-liter water bottles with the bottoms cut off. The bottles will be stacked so as to allow the wastewater to filter through filter media in the top bottle and collect in the bottom bottle. The challenge is for students to determine which filter media they should use to get the purest filtered water. **Clearly communicate to students that the water filtration devices they are about to make will remove some impurities, but they will NOT make the water safe to drink.**

https://www.jpl.nasa.gov/edu/teach/activity/water-filtration-challenge/

CHEMISTRY

H2O

Instructions

Activity 4

Water filtration - experiment

Skills:

* observation ability
* interpretive skills
* ability to justify, prove, control
* thinking skills
* systematization skills
* inference skills
* combinatorial skill
* problem-solving skills
* creativity
* decision ability

Other project proposals

https://science.lovetoknow.com/science-fair-projects/homemade-water-filter-science-project

Methodological advice

* The experiment can also be interpreted as a mini-project.
* We recommend that students work in groups of 2-3 people.
* Before starting the experiment, introduce students to the simulated wastewater and allow them to smell it.
* Introduce students to the available filter materials.
* Discuss the meaning of pH, the ideal pH of drinking water, and measure the pH of tap water in their school. Students can also measure the pH of other common liquids such as vinegar, baking soda dissolved in water.

Student procedure

* Remove the labels from two 0.5-liter water bottles. Discard one screw cap. Securely affix the other screw cap to the bottom bottle.
* Use scissors to remove the bottoms from both bottles.
* Secure cheesecloth (folded as necessary to retain filter media in bottle) around the neck of the open top bottle with rubber band.
* Nest the two bottles.
* Fill the top bottle to within 5 cm of its top with filter media of various types and layers. Document the amounts and sequence of filter media used.
* Measure and record the pH of the simulated wastewater.
* Slowly pour 200 milliliters of simulated wastewater through each student-built water-filtration device.
* Measure and record the pH of the filtered water.
* Compare the results (color, odor, pH,) among student groups. Discuss the filter media used and results achieved.
* Allow each group to design and build a better filter, based on the class data.

https://www.jpl.nasa.gov/edu/teach/activity/water-filtration-challenge/

CHEMISTRY

H2O

Instructions

Activity 5

Summary activity – Chemistry memory

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* work with peers
* recognize, based on their characteristics, the major chemical elements that are also found in water

Tools:
internet connection, computer, interactive whiteboard, memory cards

Skills:

* communication skills
* cooperation skills
* concentration and memory skills
* ability to use ICT tools

Other practice opportunities

https://wordwall.net/hu/resource/1695778/

Knowledge of substances in water is important. To do this, we developed the chemistry-memory game, which can be used as a traditional memory game. If the teacher thinks, he can use the cards as a matchmaking task.
Recommended for pair work, but also suitable for small groups.

11
Na
Sodium
22,99 g/mol

Metal element, its compounds are generally soluble in the oceans, minerals and in our body. It comes from rocks and soil.

19
K
Potassium
39,1 g/mol

Silvery-white metal, in the water it occures in ionic form.

20
Ca
Calcium
40,08 g/mol

It is a determinant of water hardness, functions as a pH stabilizer, because of its buffering qualities. It also gives water a better taste.

12
Mg
Magnesium
24,31 g/mol

With calcium they are responsible for water hardness.

https://docs.google.com/document/d/1Bkt-dIuSAgP2ROh-T9nPLInYENxyKURk/edit?

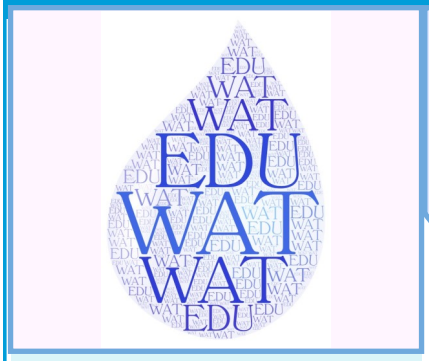
additional downloadable memory cards

The future of water

Methodology

Authors: Erika Süle, Kossuth Lajos Primary School

CHEMISTRY



Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* use water more consciously and thoughtfully
* use water more sparingly
* collect and evaluate information

Tools: computer, laptop

Skills:

* ability to think
* ability to recognize connections
* ability to draw conclusions

Instructions

Activity 1

Brainstorming - warming up

The water footprint is an important metric that shows how much water is consumed by foods, products or processes in our lives.

Only 3% of the Earth's water supply is suitable for human consumption, of which 11% is used by households, 19% by industry and 70% by agriculture. An average resident of the developing world uses 300 liters of water a day, for example, for washing, showering and washing. But we actually consume much more water, even 5,000 liters a day, since approximately 90% of our actual water consumption is invisible to us! This is what experts call virtual water. It is worth looking at some common products and how much water is used to make them. (Source: https://www.elobolygonk.hu/Klimahirek/Viz/2017_11_21mindennapi_rejtett_vizfogyasztasunk)

What do you think? How much water is used to make the following products? Match the products with the amount of water!

Products	Amount of water
an average T-shirt	2700 liters
one apple	125 liters
one pair of jeans	8000 liters
one slice of bread	44 liters
one egg	20 liters
one cup of coffee	145 liters
200 kg of beef	3,1 million liters
Glass of milk, 200 ml	200 liters

Source: https://waterfootprint.org/media/downloads/Zygmunt_2007_1.pdf

Instructions

Activity 1

Brainstorming - warming up

Other project proposals

https://science.lovetoknow.com/science-fair-projects/homemade-water-filter-science-project

After completing the exercise, listen to the children on the topic. Have the children ever heard of the water footprint? Introduce the idea of water consumption or a water footprint—the amount of freshwater used by a person, company, or country. Explain that the water usage of people and groups include both water they directly use for activities, such as watering lawns and flushing toilets, and water they indirectly use, such as what's needed to grow food or to make products. Explain that unlike water we directly use, we don't get to see all the water that goes into making the goods we purchase. Scientists refer to the hidden amount of water it takes to make products—from growing and creating raw materials to manufacturing items and shipping them—as water footprints or virtual water. This table can help you talk to the kids.

Source:http://www.scholastic.com/browse/article.jsp?id=3758597

Instructions

Activity 2

Oil on the water—experiment

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* understand the environmental impact of oil pollution,
* identify chemical causes
* participation in a simple experiment, collaborative work with classmates

Tools: water, half liter plastic bottla, vegetable oil, food colorint, pipette

Skills:

* Observation skills,
* ability to recognize connections,
* cooperation skills, interpretation skills

Instructional video

Here's how to do the experiment:

https://drive.google.com/file/d/1aKGgxXkoCI-9kkqWCzziQVBCeSPOLUEI/view?usp=sharing

1. Fill a plastic bottle with half water.
2. Add 5-10 drops of blue food coloring to it. Shake it.
3. Carefully pour 1 dl of cooking oil into the bottle.
4. Place the bottle on the table and wait half a minute.
5. Describe what you see? What could be the reason?
6. Shake the materials in the bottle.

Photo by the author

7.Put the bottle on the table and wait half a minute. What's happening? Why?

Conclution:

The density of the oil is less than the density of the water, so the oil floats on the surface of the water.

This feature makes environmental disasters associated with oil spills so severe. The oil forms a film on the surface of the water. Relatively small amounts of oil can damage wildlife in large areas.

Methodological proposals:

Work in small groups or in pairs.

We recommend that the children perform the experiment on their own according to the instructions.

Let's discuss the experience. Give an example of this type of environmental damage.

Instructions

Activity 3

Walking water—experiment

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* set up a simple hypothesis,
* perform a simple experiment,
* justify their decisions,
* understand the principle of capillary operation

Tools: 6 glasses, water, food coloring, paper towel

Skills:

* cognitive skills
* observation ability
* ability to draw conclusions

Instructional video

Here's how to do the experiment:

https://drive.google.com/file/d/1IVOISghe-j6t0hyB8z1x9-OirG0gTwiz/view?usp=sharing

1. Prepare the tools.
2. Pour half the water into the first, third and fifth glasses.
3. Then add a few drops of food coloring to the water.
4. Take a piece of paper towel, fold it in half several times.
5. Place one end of the paper towels into the glasses with the water. Then place the other end into the glass that is empty.

Can water walk upwards despite gravity?

In this experiment, water defies gravity. Using a few simple kitchen tools, students can see how the capillary works, learn how gravity and grip move water from one glass to another.The water molecules also adhere to each other and to the fibers of the paper towel. Because water molecules are attracted to the fibers of the paper towel, they also drag other water molecules with them. The adhesive force between the fibers of water and the paper towel is stronger than the cohesive force between water molecules. As a result, water travels upward through the paper towel from one glass to another.

Methodological proposals:

The children describe their hypothesis of what will happen. Then come back in an hour to check what happened. What will happen if we wait a few more hours? Why?

Instructions

Activity 4

Egg carton pollution—experiment

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* understand water pollution is never a local problem, causing global change,
* recognize their own responsibilities in environmental pollution.

Tools: water, egg carton, pepper or flax seed, food coloring, paper towel

Skills:

* ability to observe,
* ability to draw conclusions, a
* bility to anticipate,
* ability to organize
* joint work, ability to think

Instructional video

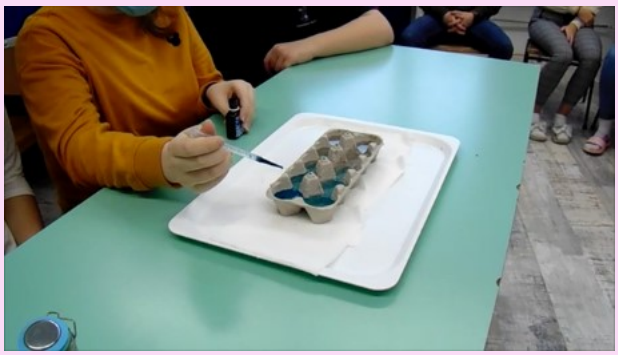
Here's how to do the experiment:

https://drive.google.com/file/d/1u8UP147UYjEIiVtM-PfNbwTJm9ESbATP/view?usp=sharing

1. Take an egg carton and fill it with water.
2. Put the egg carton on a tray and place a paper towel under it.
3. Put pepper or flax seed in one of the cups.
4. Watch what happens.
5. Now put a few drops of food coloring in another cup.
6. Watch what happens.
7. Wait half an hour and observe what happened.

What does the experiment show?

Local pollution can become global. The pollutant we discharge into rivers and lakes never stays at the site of pollution.



Methodological proposals:

Before the experiment, talk to the kids about what could pollute the waters, how to prevent this. During the experiment, the children try to "predict" what will happen. Look for an explanation for what you see. It is recommended to perform the experiment in small groups, so that everyone will have a task during the implementation, and it will also be easier to observe the phenomenon.

Erasmus+

CHEMISTRY

H2O

Instructions

Activity 5

Summery activity

Age level: Ages 12-14

Teaching objectives and expected results:

After this activity, students will be able to:

* understand environmental problems in a more complex way,
* formulate more precisely their views on pollution

Tools: computer or laptop

Skills:

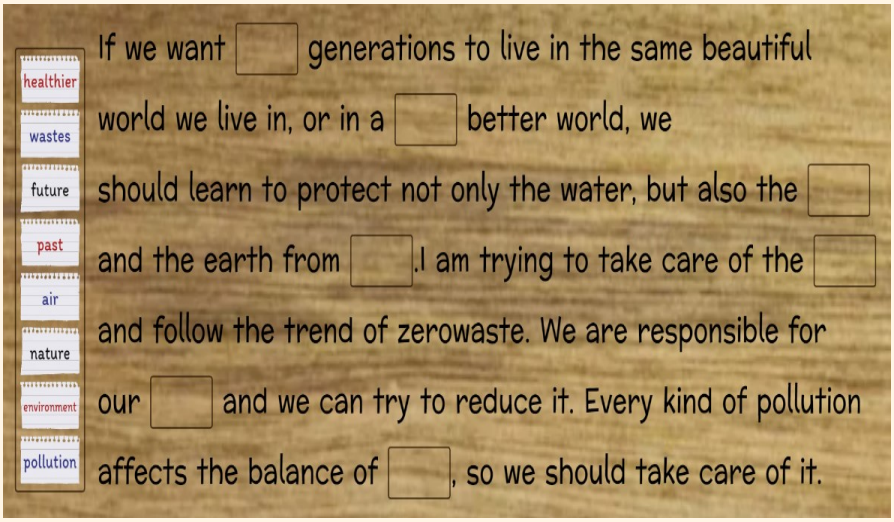
* communication skills
* text interpretation capability
* ability to recognize correlations

Wordwall task:

https://wordwall.net/hu/resource/8170005

The main goal:

A final conclusion - how the environment is affected by our behaviour: our consumption, our habits, our attitudes towards the world we live in.



Methodological proposals:

This is a perforated text that we created in the Wordart interface. It consists of three parts. It is relatively difficult, requiring teacher assistance or explanation as needed. As a form of work, we recommend individual or pair work.

We think it is useful to have a joint conversation with the children about pollution before the task is solved.

Tartalomjegyzék

Tartalomjegyzék