Structure - content of the material

The Alter Aqua educational material includes:

- 10 activities, each including some basic information on the issue at hand, plus objectives, the process step-by-step, practical tips and references. Each activity is accompanied by a respective Worksheet for students.
- Methodological guidelines for the educator, presenting in brief the main educational methods and practical tips for the implementation of activities.
- An information sheet providing an overview of the Water Resources and challenges in Malta.

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Wardija ancient open well in rock in Malta © Mario Gauci

Educational Material on Non Conventional Water Resources

An application of Education for Sustainable Development (ESD)

alter aqua

the Alter Aqua Programme

The current material is developed in the framework of the "*Alter Aqua Programme*" on *Non Conventional Water Resources* (NCWRs). The Programme was initiated in 2011 by the Global Water Partnership Mediterranean (GWP-Med) in partnership with the Ministry for Gozo (MGOZ) and the Eco-Gozo Project, aiming to mobilize NCWRs in the Island of Gozo, as a sustainable solution to address water scarcity issues, due to resources depletion, rising demand and climate change threats. In 2014, the second phase of the *Alter Aqua Programme* was launched in partnership with the Ministry for Energy and Health, expanding activities in the island of Malta.

Alter Aqua aims to optimise the use of NCWRs, such as rainwater harvesting, greywater and wastewater reuse, as a sustainable way of improving access to water in the water scarce Maltese islands.

The *Alter Aqua* Programme, through its holistic approach, focuses on three main pillars of action:
I. Infrastructure works for NCWR applications
II. Educational and training activities
III. Capacity Building and Awareness Raising activities.

The educational component (pillar II) in itself has four main types of activities:
1) Educational material for teachers & students, specially developed for the Programme
2) Teacher Training Workshops
3) School interventions in the islands of Gozo and Malta (hands-on sessions)
4) Training seminars on NWCRs for local technicians

The educational component of *Alter Aqua* is developed in collaboration with the Mediterranean Information Office for Environment Culture and Sustainable Development (MIO-ECSDE/MEdIES), Nature Trust Malta (NTM) and the EkoSkola Programme.

the Alter Aqua Partners

Ministry for Energy & Health: The Sustainable Energy and Water Conservation Unit (SEWCU), within the Ministry for Energy & Health, was established in 2014 and tasked to carry out functions related to the design, implementation and dissemination of water, conventional energy and alternative energy policy. In particular SEWCU's responsibilities include the coordination of co-funded projects related to water and the design, development of a sustained knowledge, education, information and communication framework directed to influence behaviour with regards to water and energy use.
E: customercare.meh-energy@gov.mt | W: www.energy.gov.mt

Ministry for Gozo / Eco-Gozo project: The Ministry for Gozo was established in 1987 with the mission to improve the quality of life in the Island of Gozo while protecting and improving the cultural, social and environmental characteristics of the island. In 2009, the Ministry was entrusted with the development and the implementation of a Local Sustainable Development Strategy for the Island of Gozo toward an eco-island vision for Gozo: the *Eco-Gozo* project. *Eco-Gozo* envisages that "*Gozo will become an eco-island by 2020, supported by a keen and committed sustainable community*". The Eco-Gozo project is led by the Ministry for Gozo, currently implementing the Short-term Action Plan (2010-2012) related to this vision, and involves the participation of Local Councils, Civil Society and the population of the island.
E: info@eco-gozo.com | W: www.ecogozo.com

Global Water Partnership - Mediterranean (GWP-Med): Global Water Partnership – Mediterranean (GWP-Med), is a regional partnership of the Global Water Partnership (GWP holds an inter-governmental status), established in 2002. GWP-Med is a multi-stakeholder platform that brings together competent organisations working on water issues from around the Mediterranean Region. Its goal is to promote action and exchange knowledge on Integrated Water Resources Management (IWRM) and the sustainable use of water resources at regional, national, local (including transboundary) level. Since 2008, GWP-Med has been implementing non-conventional water resources programmes in Mediterranean countries, focusing on water scarce insular communities.
E: secretariat@gwpmed.org | W: www.gwpmed.org

MIO-ECSDE / MEdIES: The Mediterranean Information Office for Environment, Culture and Sustainable Development (MIO-ECSDE), is a non-profit Federation of NGOs from the Mediterranean region working in the field of Environment and Sustainable Development. Established since 1995, MIO-ECSDE acts as a technical and political platform for representation and intervention of Civil Society. MEdIES is a Mediterranean wide e-network of educators of Education for Sustainable Development (ESD), launched in Johannesburg WSSD in 2002. Its main objective is to provide capacity building on ESD through publications, trainings and the facilitation of an e-network of ESD Educators from the Mediterranean Countries.
E: info@mio-ecsde.org, info@medies.net | W: www.mio-ecsde.org, www.medies.net

Nature Trust Malta (NTM) / EkoSkola: Founded in 1962, Nature Trust Malta (NTM) is a non-profit NGO in Malta. NTM works in four main areas: Environmental Education focusing on Sustainable Development, Ecological Site Management, Wildlife Rescue and Awareness Raising on issues such as climate change, biodiversity protection and many more. EkoSkola is an international programme, coordinated in Malta by NTM. Students of all ages are encouraged to take an active role in improving the quality of life in their school and community. Schools are awarded the prestigious Green Flag, an international eco-label which confirms that the school abides to a set of international quality standards.
E: info@naturetrustmalta.org | W: www.naturetrustmalta.org, www.ekoskola.org.mt

vision and scope of the material

The *Alter Aqua* educational material is the result of a fruitful cooperation of a committed team from Greece and Malta with the ambition to raise awareness and sensitise the educational community on the very crucial issue of *Non-Conventional Water Resources* across the Mediterranean, and particularly in the Maltese Islands.

The material has been developed based on the principles of Education for Sustainable Development (ESD). It aspires to be a flexible tool in the hands of the keen educator aiming to develop imagination, curiosity, creativity, observation, skills and knowledge to his/her students, as well as an attitude of "new water ethic" in line with sustainability.

Alter Aqua is based on the experience of the *Rainwater Harvesting Programme in the Greek Islands*. The valuable experience and knowledge of both programmes is currently shared with other water scarce Mediterranean countries (Cyprus, Italy, etc.), where the programme is replicated, adapted to the local needs.

objectives of the material

The *Alter Aqua* material aims to build the capacities of the English-speaking educational community of the Mediterranean region, and particularly of the Maltese Islands on issues relating to *Non Conventional Water Resources* (NCWRs). The material can be used by educators working directly within Environmental Education (EE) and Education for Sustainable Development (ESD), or indirectly across the curriculum. The main objectives for the students are:

- To be acquainted with the water cycle and the impacts of human activities on it.
- To be informed about the *alternative* or *Non Conventional Water Resources*.
- To explore the benefits and risks of the NCWRs at various levels: environmental, social and economic.
- To be aware of traditional and cultural aspects of water and to find out how the past "wisdom" can be transferred and applied in modern systems of water management.
- To develop the skills of critical thinking, decision making and participation.
- To acquire a positive attitude towards NCWRs and adopt responsible water consumption habits in their daily lives.

pedagogic approaches in the material

The material is addressed to teachers and students of late primary and early secondary level (8-13 years old). It has been developed in a multidisciplinary way involving disciplines such as Environmental Studies, Science, Meteorology, Home Economics, Mathematics, History, Language and Literature. The educational methods proposed include discussions, experiments, simulations, field work, role-play and surveys.

The activities contain a "theoretic" part, to be used mainly by the educator and a worksheet to be reproduced for each student. They are based on learner-centred and experiential approaches, stimulating the learners to questioning, working together and reaching conclusions. All activities require very simple materials and equipment. The teachers are welcome to apply them either as a whole or in parts, according to their needs, objectives and available time taking into account also the skills and interests of their students. To this end the activities are presented on separate A3 sheets.

This printed kit is not an end on its own: it is part of an educational pack that includes also a printed poster with water saving tips for students, available in English and Maltese; as well as a series of hands-on material to support the educators in their work. Moreover, particularly for the case of Malta an accompanying CD is included containing a soft copy of the educational material applicable for interactive whiteboards, extended references for the Maltese Islands and other support material.

6 Water in the **PAST** – Dramatising

Students have the chance to express themselves creatively through dialogue, writing and dramatisation on how water was collected, stored and used in their area some decades ago. Just like in role-plays, the focus should be on the process and the experience of drama (i.e. feeling empathy for the roles' characters) rather than on performing skilfully.

Developing the drama: Students should look into the story they dramatise by posing the following questions: Where is it taking place? When? Who is taking part? What are the relationships between the people (roles) in the story? What is the sudden unexpected dramatic event (causing an upset)? What could be the causes of the event? What are the alternatives for the people involved in order to confront the new situation? What are their choices? What are the consequences of their choices?

At the end, a *reflective discussion* should take place to debrief including questions such as "How did you feel during the activity?"; "What did you observe in the behaviour of the characters?"; "How would an outsider (e.g. neighbour, colleague) narrate the story?" "Where could the characters be 10 years later, and how would they interact?"

7 **RE**duce-**RE**use-**RE**cycle – Making calculations & estimations

Students calculate the amount of water that can be saved by wisely using water during e.g. a day, a week, a school year, etc. Additionally they estimate the water that can be collected by installing a rainwater harvesting system in the school building. In order to calculate the latter they should find the *drainage coefficient* that they must incorporate.

8 Water in the **MEDIA** – Analysing news items

In this activity students follow a certain type of media e.g. a newspaper, a TV channel, a radio station, a news blog, etc. for a particular period of time, preferably a school year. Such an educational practice attaches relevance to *timeliness* and the *society* around the school. The students should collect news-items, identify their key terms and note any unknown words. Gradually, they will elaborate more on the articles identifying the main issues raised, the main "players" and their respective arguments.

Specific questions should be answered through the *text analysis*, such as "Who are the stakeholders involved and what are their viewpoints?"; "What values are implied behind each viewpoint (social, economical, environmental, etc.)?"; "What is the personal viewpoint of the writer and what are his/her values?"

9 Water **CISTERNS** and **FOUNTAINS** through time – "Interpreting" a monument

In this activity students visit water related cultural monuments e.g. fountains, cisterns, etc. Their task is to study their particular characteristics (i.e. materials, architecture and decoration) by observing, taking photos and notes. With the help of an expert such as an archaeologist or architect students can learn how to discover the *"hidden messages" of monuments*, regarding e.g. the choice of the spot of building, the social status of the founder, the symbolism of the decoration, etc. Also, a painter or graphic designer can support the students in their own graphical representations.

Activities to help students focus on details are:

The telescope: "Close one eye and use your hand to make a telescope. Observe the monument's details. Is there something you hadn't seen before? What is the strangest detail you observe? What is the most striking thing you see?"

The photographer (for pairs): Solely observe a monument for 5min. Then, in pairs, one partner will be the photographer and the other the camera. The photographer "takes pictures" of various parts of the monument by "moving" and "zooming" the camera. When the shooting ends, the camera-student makes a drawing of what he/she focused on as a camera lens. Then the pair switches roles.

10 Water **CROSSWORD** puzzle

The answers to the crossword are:

HORIZONTAL: 1 RAIN 3 CISTERN 4 GUTTER 5 FILTER 7 PIPES 9 SEDIMENTATION 14 FLUSHING 18 IRRIGATION 20 RUNOFF 22 EVAPORATION

VERTICAL: 3 COLLECTION 7 STORAGE 8 DRAINAGE 9 DISINFECTION 11 PUMP 14a REVERSE 14b BIOLOGICAL 16a TANK 16b GREY 19 DESALINATION

methodological **GUIDELINES**
for the educator

This session serves to provide teacher with clarifications on the activities, the "correct answers" to worksheets, pedagogic guidelines and tips when applying the various methods, etc.

alter aqua

1 The WATER CYCLE in the Mediterranean – Constructing physical models

A model is a system's hypothetical representation with simplified imitations that help us understand it better, based usually on a series of analogies. A model can be a device, a plan, a drawing, or a computer program. The most common types are the physical ones. In this activity students construct a *physical model* of the water cycle. The method of *teaching with analogies* suggests the following steps (the educator should test it in advance):

(A) Introducing the *novel concept* (= the water cycle): The educator traces students' ideas about the cycle through brainstorming, or through photos, video clips, etc. showing its manifestations (evaporation, runoff, floods, droughts, etc.).

(B) Introducing the *known concept* (= bowl, membrane, etc.): Then, the students construct the model, working in groups according to their instructions.

(C) Identifying the *analogies* between the model and the actual cycle: Water in the large bowl (= *sea*); small bowl (=*land*); pot with plant (=*vegetation*); transparent membrane (= *atmosphere*); droplets on the membrane (= *condensed atmosphere moisture/clouds*); colour (= *water soluble substance*). The following can be discussed in order to elaborate more on the model: "What are the "water paths" in the model?"; "What is the behaviour of the colour?" (*The colour representing a dissolved pollutant -or salt- remains in the large bowl; unlike water it does not evaporate in these conditions of temperature and pressure. By this way, the water cycle "purifies" the water*).

(D) Evaluation - Conclusions: Students discuss about the *limits* of the model, in practical and conceptual terms. This debriefing session is very important for clearing up students' misconceptions about the novel concept (water cycle).

2 Where does water COME FROM? – Reading & drawing maps

In this activity students become familiar with the water resources including the NCWRs by constructing a *water map*, which includes all water resources and works in their area (both natural and manmade): lakes, ponds, streams, dams, aqueducts, wells, etc.

Literature differentiates between the ability to *read* and the ability to *draw* a map that requires higher order thinking skills of perspective, spatial arrangement, proportion, etc., Thus, educators should make sure that, prior to drawing, students perform well in the prerequisite skills of:

map-reading (= identify information on a map, e.g. locate the water resources);

map-analysis (= classify information e.g. the NCWRs and discover relationships between phenomena, e.g. between the water "generation" and consumption points); and

map-interpretation (= make statements or predictions using spatial relationships e.g. predict if the increased touristic demand will result in building more desalination plants).

! Usually in a map drawing, the resulting maps reflect learners' personalities as they tend to focus on different aspects of the topic.

! Maps can serve as a post field-trip activity or an evaluation tool.

3 NON-CONVENTIONAL Water Resources (NCWRs) – Preparing a field visit

In this activity students visit buildings equipped with a rainwater or greywater system, or they visit a sewage treatment or a desalination plant. Field work requires careful planning and preparation on behalf of the educator, including the following tasks:

- *Pre-visit* the area to examine its possibilities and limitations (e.g. access to people with disabilities, safety precautions, etc.).
- *Resolve practical issues* (e.g. permissions from school authorities; contacts with the buildings' owners or managers; costs estimation -transportation, materials needed, etc.).
- *Prepare the material* to be used during the visit (e.g. worksheets, etc.).
- *Do a pre-visit activity*, so students are prepared and know what to look for when in-the-field.
- Inform students of the particularities of the visiting place, the personal items to bring along and the appropriate code of behaviour. The latter refers to establishing a *contract*, which has been discussed and commonly agreed upon beforehand. (Negotiated issues of a contract may be "What do you think we are (not) allowed to do in a plant and why?" What's the best way to communicate in our groups?", "What should we do when we want to all speak at the same time?").

! *Post-visit activities* are very important and may include synthesizing and interpreting results (worksheets), presentations, designing a poster, writing an article, etc.

4 NCWRs: HOW do they WORK? – Conducting experiments

In this activity a set of simple-to-conduct experiments stimulates students to study the ways in which the NCWRs function. *Scientific experiment* is a key method to facilitate comprehension of scientific concepts, and practise in observing, recording, constructing, synthesising, etc.

During the preparation and when conducting experiments, the educator needs to pay attention to the following:

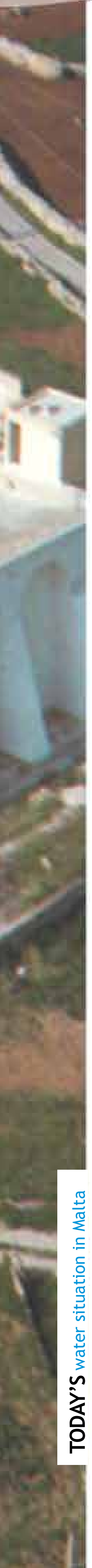
- Clearly set *safety regulations* in the laboratory and in the field.
- Encourage participation by assigning *responsibilities to all*.
- Ensure there is enough *time* to comment on the results and give feedback.
- Suggest *additional tasks* and activities after the experiment is over.

5 A day at the LOCAL COUNCIL – Organising a panel discussion

In this activity students explore the benefits and the risks of NCWR systems through a *role playing game*, specifically a panel discussion. In general role plays are characterised by strong expression and exposition on behalf of the players. However, when playing try not to put so much emphasis on the theatrical skills involved but instead on the quality of the arguments raised that show whether students have understood their roles, needs, motivations, etc.

- A *preparatory phase* by the class is important: Articles, texts, etc. related to NCWRM must be collected and studied beforehand. Care should be taken so that the main standpoints around the issue are all represented. Students should be prepared not only to defend their position but also to confront the viewpoints of the other panellists.
- During the panel discussion a *clear set of rules* should be followed about e.g. the time allotted to each speaker, their sequence, the polite tone, the discussion with the audience, etc.
- At the end, a *debrief session* "out" of the roles is necessary: It may address questions such as "How did you feel?"; "What have you learned from this experience?"; "If you were to repeat it what would you change?", "If in the future you experience a similar real situation would you behave the same way and why?").

references Alampei A. & Scoullos M. "Educational material 'Waste in our life' - Educator's book" MIO-ECSDE, 2007.
Scoullos M. & V. Malotidi "Handbook on methods used in Environmental Education and Education for Sustainable Development", MIO-ECSDE, Athens, 2004.



In the Maltese islands there exist three sewage treatment plants designed to treat all the sewage (blackwater) generated, a total of 50,000m^3/day, thus relieving the islands from coastline contamination. The plants are situated at:

- Iċ-Ċumnija, outskirts of Mellieħa (North of Malta)
- Ta' Barkat, outskirts of Xgħajra (South of Malta)
- Ras il-Ħobż (Gozo Island)

Currently about 87% of the resulting treated sewage effluent (approximately a total of 14,000,000m^3/year) is being discharged into the sea. For Malta to get in line with the EU Urban Wastewater Directive (91/271/EC) the treated effluent should instead be used for agriculture, industry and aquifer recharge. However, to use the effluent in such purposes prerequisites are:

- Further treatment to the resulting effluent;
- Installation of a separate distribution system for the resulting "second class" water.

Aerial view of wastewater treatment plant at Ras il-Ħobż, Gozo
© Department of Information, Malta

Malta's present water trends raise concern as sustainable water resources are vital to ensure peace of mind. Water is essential for every basic activity: every segment of society depends on access to water. Despite the very limited resources of the islands water has not, to date, been valued as the precious resource that it is, and has been taken for granted. In the publication "A Water Policy for the Maltese Islands" of the Ministry for Resources and Rural Affairs (June 2012), Malta's specific needs and obligations are identified and a series of measures have been proposed accordingly. Yet, the way forward is clear, since Malta's groundwater resources are becoming increasingly limited and being overexploited and polluted, a reversal in trend is required. This can only be achieved through a clear understanding of the situation in order to guarantee a sustainable supply of groundwater for the benefit of the Maltese community as a whole. In order to reach such a point, it is essential that maximum use is made of non-conventional water resources such as rainwater harvesting, greywater reuse and the use of treated wastewater.

Reservoir in Malta © Department of Information Malta

TODAY'S
water situation in Malta

Excavations, very old constructions and old documents all testify that Malta has had limited fresh water resources for thousands of years. The only possible source of water in the past was rainwater harvesting and groundwater extraction. Throughout history, it was only due to wise water management and rationing that the inhabitants of the Maltese islands managed to cope with water scarcity. Nowadays, it is only due to salt water desalination that Malta is being provided with a reliable supply of water.

alter aqua

Malta is densely populated and has limited fresh water resources. The demand for water is high and rapidly increasing. With an average annual rainfall of about 550mm which can vary greatly from year to year and no significant surface water available, the only natural source of water is rainwater harvesting and groundwater extraction. Some of the few existing fresh water springs tend to dry up during the summer months.

Throughout history, it was only due to clever water management and rationing that the inhabitants of the Maltese islands managed to cope with this scarce water situation. Nowadays, it is only due to salt water desalination that Malta is being provided with a reliable supply of water. The country is becoming increasingly dependent on this process.

Because of the high nitrate levels the groundwater resources have to be blended with nitrate-free Reverse Osmosis (RO) water - 43% groundwater to 57% RO water - to supply the population with acceptable nitrate levels in water. Chlorine is also added to kill off any bacteria still present, whilst lime is added to remineralise the water.

Household's supply comes from RO plants with a total production of approximately 100,000m^3/day. Unfortunately, this already high percentage, is bound to increase if strict water governance, targeted interventions and national awareness campaigns about the critical water situation do not intensify. RO plants are very energy intensive. Recent investment has improved operational efficiency producing a more cost effective output. New energy recovery devices and more efficient membranes have reduced electricity consumption by approximately 17%.

While the desalination plants have ensured reliability of supply in Malta, a less positive aspect is that they have encouraged a "water culture" that takes only limited interest in conservation or efficient use of water resources.

In the Maltese Islands, the domestic sector comes first in water consumption (39.4%), followed by agriculture (36.7%). Tourism accounts for 6.1% of the total water consumption in Malta with industry in close vicinity (5.5%). The vast majority (80.6%) of water used in agriculture is direct groundwater extraction with the remaining coming from rainwater harvesting and use of treated sewage effluent for irrigation. It is worth noting that tourism places additional strains on water resources especially during the peak summer months.

Notwithstanding the awareness campaigns that are being held, demand is still too high. Admittedly, when water tariffs increased in Malta, a significant number of households invested in water saving devices and started using water more efficiently thus resulting in a decrease in consumption. Yet, there is still a lot to be done.

The eco-Gozo Home Consultancy Visits project "SAVE and REDUCE" is an initiative whereby trained officers inform residents about how to reduce their carbon and water footprint, amongst other sustainable practices. This project is expected to help change the mentality towards more sustainable choices and lifestyle. This should encourage rainwater harvesting and greywater reuse at a domestic level.

! *In case of emergency, the amount of potable water stored in reservoirs in Malta and Gozo is calculated at nearly 300,000m^3, which equals the average reserve supply for just three days!*

The treatment of greywater (wastewater from showers, baths and wash-hand basins) on a household or hotel level is encouraged, but it is not very popular. Such water can be reused for the flushing of toilets and save up to 25-30% of a family's typical water use. Experiments carried out by Eng. Cremona at house level over the period 2004-2012, have shown that the amount of water used in showers and wash-hand basins generally exceeds the toilet water demand, especially when one uses water-saving devices in toilet flushing. That means it is not necessary to also treat wastewater from washing machines, which is dirtier than shower wastewater. The treated greywater can also be used for washing yards, but more research is required for the case of using this water for gardening.

The Misqa Tanks is a group of prehistoric rock-cut cisterns that used to collect the harvested rainwater found near Mnajdra temples in Malta. © http://aknoxx.alien.de/malta4.htm

With regards to rainwater harvesting, all houses in Malta are obliged by the Code of Police Laws and by a Legal Notice to have a well maintained cistern with a capacity of at least 3m^3 for every 5m^2 of room area to collect rain water runoff, but sadly enough, this is not often the case in reality. Prior to the 1940s all buildings used to have cisterns, but as the public water supply became more reliable and public perception and behaviour changed, rainwater harvesting tended to decrease in importance and hence resulted in a lot of buildings without cisterns.

A 25m^3 cistern (approx.) per household would collect around 25% of annual domestic demand and at the same time reduce the risk of flooding after heavy rainfall. Nationwide, this would result in the collection of about 4,500,000 m^3 of stormwater runoff (40% of current domestic water consumption).

Yet, it is important for the public to be informed that the use of harvested rainwater has to follow specific health and safety standards to avert undesired consequences to public health. There is always the possibility of contaminants from the collection surface and within the storage system. On the other hand, some buildings still have the rainwater runoff from roofs connected to the sewage system resulting in its flooding in case of heavy downpours.

A small amount of stormwater runoff is prevented from flowing down to the sea by a number of dams and roadside reservoirs: these amount to a only small fraction of the total surface runoff. This collected water is mainly used for agriculture and recharging the sea-level aquifers. One of the measures proposed in "A Water Policy for the Maltese Islands" (2012) concerns the restoration of existing old underground stormwater reservoirs as well as the rehabilitation, maintenance and upgrading of the dams crossing Malta's major valley lines.

Reverse Osmosis installations

Leaflet distributed to inform about the Home Consultancy Visits

Close view of greywater treatment system personally assembled by Eng Marco Cremona for his house in Malta © Rene Rossignau

Constructing an underground water reservoir to collect rainwater is somewhat costly and involves a lot of work but is a very worthwhile investment in the long run in such a water scarce island © Ministry for Gozo

web http://www.maltawater.org/index.php/themes/wastewater-reuse/mwa-viewpoint-on-wastewater-reuse
http://www.wsc.com.mt/content/reverse-osmosis-plants
http://www.closertoeurope.info/images/stories/file/TrainingProgramme9/presentation%207%20-%20water%20%20tourism.pdf
http://www.closertoeurope.info/index.php?option=com_content&view=article&id=79

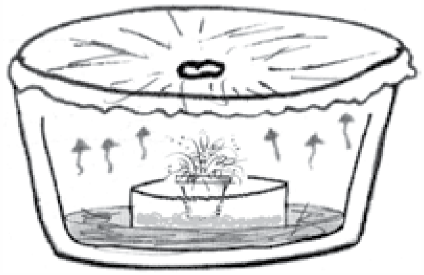
references Cremona, M., "Water Supply in the Maltese Islands: Malta's Experience", Nice, 2009.
Food and Agriculture Organization of the United Nations, "Malta Water Resources Review", Rome, 2006.
Ministry for Resources and Rural Affairs, "A Water Policy for the Maltese Islands", 2012.

Objectives

- To describe the water cycle
- To set up a model to simulate the water cycle
- To discover that interference in any part of the water cycle may disrupt the whole cycle
- To adopt an informed attitude against pollution and overconsumption of water

Material & Equipment

Large glass bowl
Small glass bowl
Small pot with a plant
Salt
Soil
Pebbles
One small stone
Transparent membrane (plastic)
Rubber band
Food colouring



Activity

1. Place the pebbles and some soil in the centre of the small bowl, and place the pot with the plant on top (see picture).
2. Place the small bowl in the middle of the large glass bowl.
3. Pour water and salt into the large bowl, making sure that no water gets into the small bowl.
4. Cover the large bowl with the membrane, making sure that it is firmly in place and that it seals the top completely (use the rubber band to secure it).
5. Place one small stone in the centre of the membrane. Your model is ready!
6. Place the model in a sunny spot and leave it for an hour or so. What do you notice?
7. Add one drop of food colouring to the water in the large bowl and repeat the whole procedure. What do you notice?

Methodological Tips

- You may use warm water in order to speed up the process of evaporation and see the results in just a few minutes.
- Make sure that the plastic membrane does not have any holes and that it is firmly placed so that no air gets into the large bowl and no vapour escapes.

about the **ACTIVITY**

Valley dam in Malta © Edward Gilson

1 the WATER CYCLE in the Mediterranean

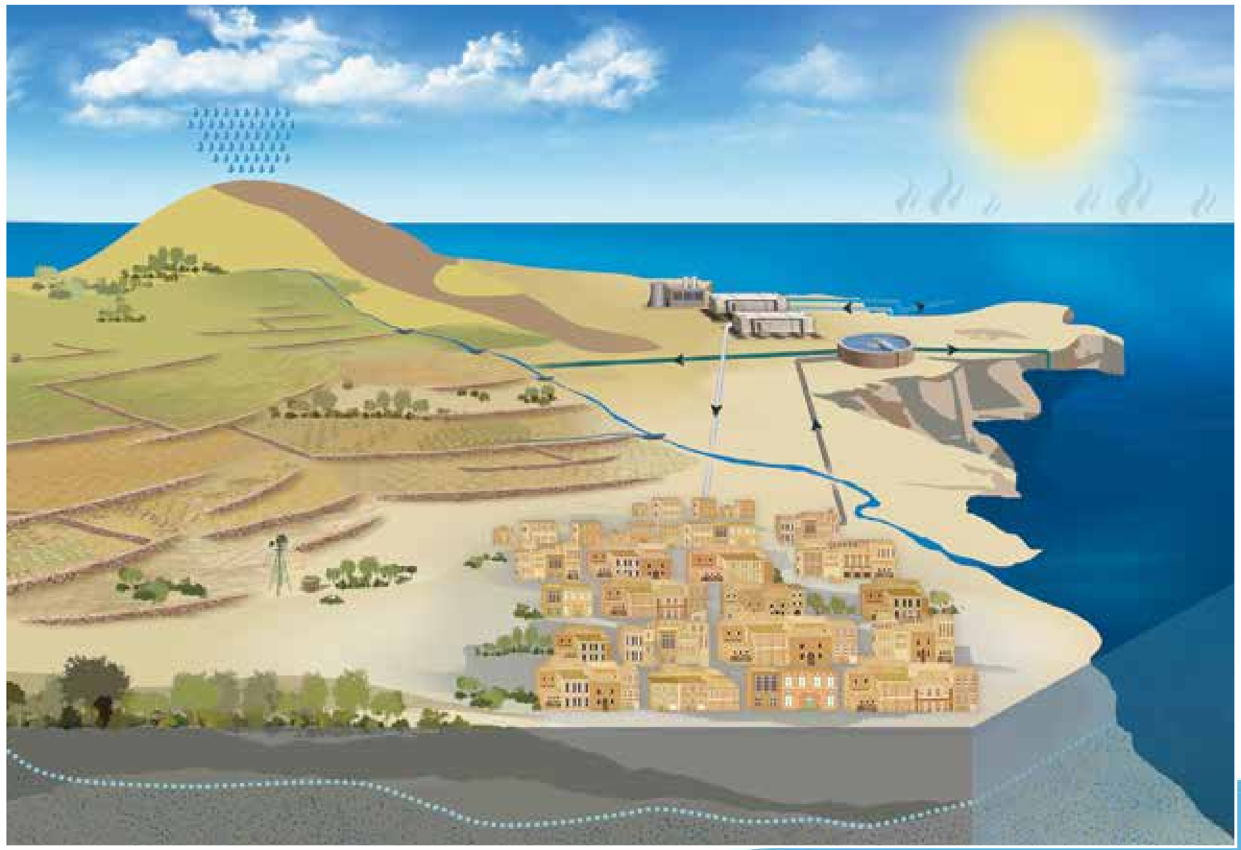
The amount of water on Earth remains more or less constant; however it has been in a continuous "cycle" for billions of years. This means that every drop we drink may have been drunk in the past by a dinosaur or a pharaoh... The cycle simply recycles water over and over again.

In this activity we explore the processes of the water cycle and we construct a 3D model to demonstrate how it works in a closed system.

alter aqua

The total amount of water on earth remains the same, while moving continuously in a closed system. The water cycle (or *hydrological cycle*) is the Earth's natural water recycling system and is of great importance for all other natural cycles (e.g. of nutrients, metals, etc.). As a result of the sun's heat, water evaporates mainly from the sea, lakes, ponds, etc. As vapour rises into the atmosphere, it cools down. The change in temperature causes the vapour to condense and fall back on earth (*precipitation*) as rain, snow, or hail. Precipitation falls back into the sea, or creates surface *runoff* that helps to fill lakes, dams, as well as rivers and streams that finally discharge into the sea. It also seeps through the soil or moves downward through ground openings, forming the karsts (by the dissolving action of water on bedrock), *and* replenishing the groundwater or *aquifer*. All kinds of water: streams, surface or underground, flow toward the sea. Plant *transpiration* leads also to water evaporation. During *respiration* of plants water evaporates from plant leaves through the *stomata (transpiration)* and keeps moving upwards from the roots to the leaves transporting nutrients through the tissues. The transpiration from the plants as well as the evaporation of water from the earth's surface waters and soil surfaces are also known as *evapotranspiration*.

? *Can you indicate on the image the words highlighted in the above paragraph?*



the time and space aspects of the water cycle

The water cycle varies between different areas because of different precipitation patterns. The Mediterranean region generally has rainy winters and very dry summers, while in the southern part of the region more water evaporates than precipitates. The seasonal contrast is more evident in the eastern and southern part of the region, as most of the annual rainfall may precipitate in a few days in torrential downpours.

human intervention

Over the last decades human interventions in the natural processes have affected the water cycle causing a decrease in water availability and quality. Such interventions may be:

Pollution: Even though the condensed vapour that forms clouds is relatively pure (free from minerals), atmospheric pollution may result in polluted rain. This results from the burning of huge quantities of fossil fuels (coal, oil, etc.) to produce electricity. This is then used for industries and transport: cars, airplanes, etc., which in turn all emit air pollutants. Chemical reactions producing acids occur when pollutants merge with humidity particles. *Acid rain* forms through this process. The damage acid rain leaves is extensive as it can destroy plants, buildings, monuments and other structures.

Overabstraction – Soil degradation: Groundwater is used for various purposes, mainly irrigation. This resource is being exploited to the degree of over abstraction. The result is the depletion of aquifers. Furthermore, pumping out more groundwater than nature can replenish causes the *intrusion* of sea water into the *water table*. This shift in the natural balance increases the salinity of groundwater and the process is very difficult to reverse (it may take from decades to centuries). Sadly, illegal boreholes are common in many parts of the Mediterranean. On the other hand, the clearing, drainage and sealing of land to create farmland as well as settlements and major infrastructures (airports, roads, etc.) disrupts the water cycle and degrades soil fertility and permeability as well as its ability to retain moisture.

Climate Change: Climate change intensifies, but most importantly, disturbs all the water cycle processes -precipitation, evaporation, runoff- leading to phenomena such as drought and floods. It also alters the direction of sea currents, accelerates soil erosion and changes the distribution of surface water and groundwater.

Urbanisation: Urbanisation creates huge water demands and consequently, large quantities of wastewater that reduce the availability of clean water for ecosystems. It is worth noting that for cities to have a sufficient supply of water, the water has to be transported from long distances.

On the other hand, there are actions that can reduce the human impacts on the water cycle such as:

- *Reducing consumption and using water resources sustainably*
- *Harvesting and using rainwater*
- *Treating, recycling and reusing water*

web http://ga.water.usgs.gov/edu/watercyclesummary.html#.T7lkW1IwAjA
www.epa.gov/safewater/kids/flash/flash_watercycle.html

references Scoullos M. et al., "Water in the Mediterranean" Educational Package, MIO-ECSDE and GWP-Med, Athens, 2001
Scoullos M. & Tomassini B., "Handbook on freshwater in the Mediterranean", GWP-Med & MIO-ECSDE, Athens, 2003
MIO-ECSDE, "Water & Climate Change", Mobile Exhibition, 2008

Objectives

- To map water resources of one's home place (town or village)
- To identify the factors that determine water availability
- To collect, analyse and synthesise information
- To come into contact with the authorities responsible for water management
- To become responsible water users

Material & Equipment

Notebooks and pens
Sound recorder (for the interviews)
Geophysical map of the region
Camera
Various materials for map construction

Activity

Start a group research on the water resources of your region. You will need to do bibliographic research as well as field work. You should look for information about the following:

1) THE LANDSCAPE

- What is the geomorphology (the study of landforms and what shapes them) and geology (e.g. rock layers) of the area?
- What about the landscape? Are there any slopes and hills? Are these terraced? Are there many plant species? Are there any rivers or streams, wetlands, springs, ponds, etc.? Indicate them on the map of the region.
- Arrange a field visit to the identified spots, observe the landscape and take pictures. If possible, try to take pictures during or after a rainy day, as well as during a dry period.

2) THE CLIMATE

- What are the characteristics of the local climate, (i.e. rainy season, average rainfall, prevailing winds, average temperature)?
- Have any changes in the local climate been recorded?
- Interview the people from the Water Service, farmers and elderly who could provide evidence about changes in water availability, water use and agricultural practices.
- What could the impacts of climate change on water availability be?

3) THE WATER SYSTEM

- Where does the water come from (i) in your home and (ii) in your school? Is it from a groundwater source (well/bore hole), a rainwater cistern or from another source? How far has it come from?
- How is the water stored and distributed in your town/village?
- Try to also identify the oldest water storage system in your town/village.
- Visit the identified spots used for storing and distributing water, make observations and take notes and pictures.
- Does the water system of your area present problems e.g. old and worn pipes, leakages, etc.? How can this be confronted?

4) NON CONVENTIONAL WATER RESOURCES

- Identify where terraced fields, small dams, surface or underground reservoirs have been built to collect and store water.
- Collect data on the amount of water produced by the desalination plant in your area and study how it is processed. How is this water used?
- Collect data on the amounts of treated water produced by the sewage treatment plant. How is this water used?

5) MAPPING WATER RESOURCES

- Construct a map of your region on which you should include all the water sources and installations that you identified in the previous steps of your research: springs, streams, terraces, dams, cisterns, aqueducts, reservoirs, wells, treatment plants, etc.
- Draw different signs/symbols to indicate the various types of water related structures i.e. wells, aqueducts, cisterns, etc. so as to make your map readable to others.
- The map can be two-dimensional or three-dimensional. You are free to choose any material you like such as cardboard, paper, textiles, clay, plasticine, colours, photos you've taken, etc.

Methodological Tips

- Group work helps in organising students' research especially when dealing with multiple tasks.
- Students need to first study the geophysical map before going out for fieldwork.

about the ACTIVITY

Ancient aqueduct in Larnaca (Cyprus) © MIO-ECSDE / A. Michaelides

2 where does water COME FROM ?

Only 3% of the water on the planet is fresh, and of this about the 2/3 is trapped in glaciers or in deep aquifers. Apparently, the water of good quality that is available to humans is less than 1% of the global! And what is worse is that this precious amount is not evenly distributed on the planet...

In this activity we work outdoors to identify and "map" the water resources in our region.

alter aqua

The oceans and seas contain 97% of the world's water. Only the remaining 3% is fresh water. From this 3% of fresh water available on Earth 68.7% is frozen in the Polar Regions and mountain icecaps; 30.1% is groundwater (including fossil); 0.3% is surface (lakes, rivers, swamps); 0.86% is permafrost; 0.05% is soil moisture; 0.04% is atmosphere vapour; and only 0.003% is biological.

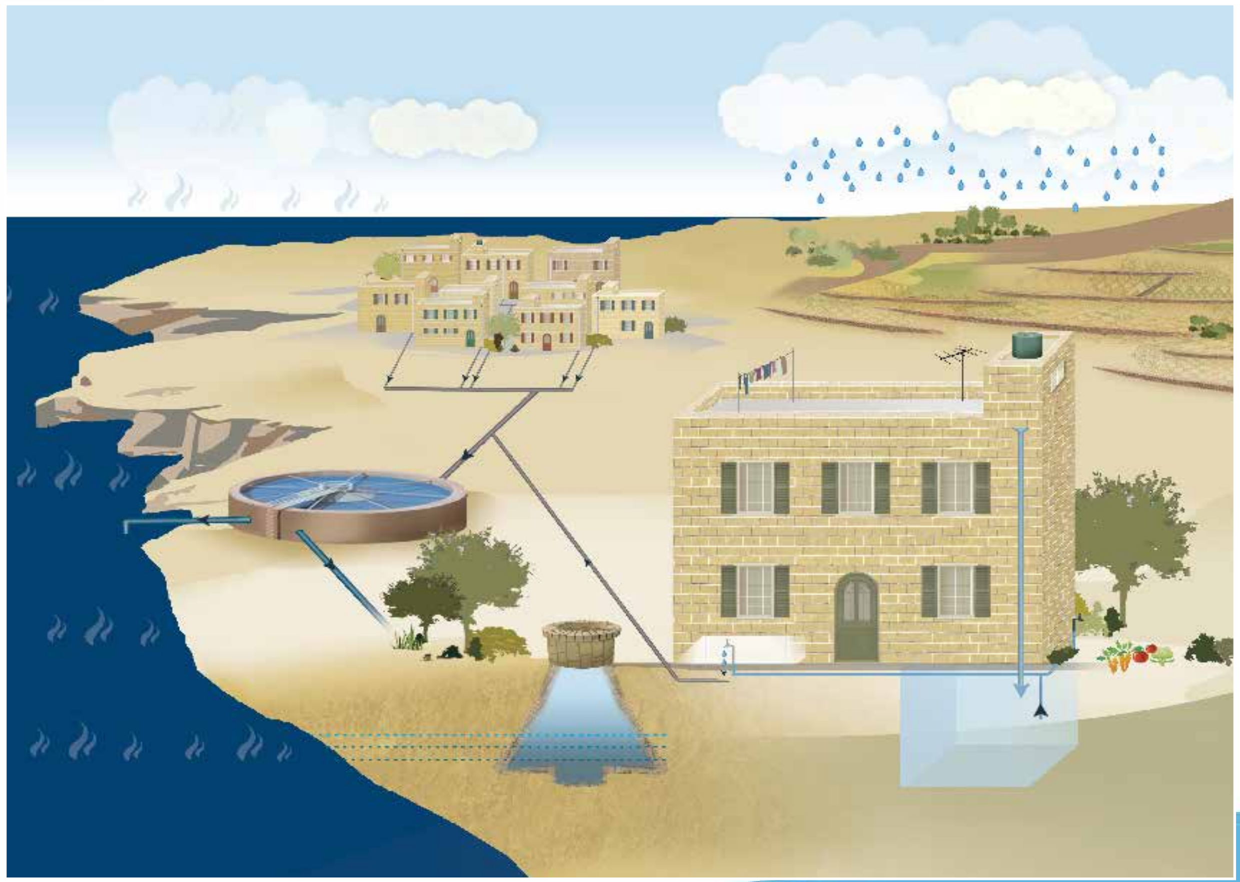
So, it is evident that the amount of water that is available and easily accessible to humans is quite limited and this is mainly surface water of good quality plus groundwater that can be extracted.

Evapotranspiration and mainly, *precipitation* are the two basic processes of the water cycle that determine water availability in a given region, and which depend largely on the local climate. Availability depends also on the characteristics of underground rocks (impermeability, etc.). Precipitation, including rainfall, hail, snowfall and humidity, enriches the surface waters (lakes, rivers, etc.) as well as the groundwater. *Groundwater* is mostly found in porous sand and gravel either beneath the soil or sandwiched between impermeable layers of clay and rock. *Aquifers* are underground layers of porous rock or sand that allow the movement of water between layers of non-porous rock (sandstone, fractured limestone, granite, etc.). Contrary to what most people think, aquifers do not have the form of underground lakes but rather, a saturated geologic layer where water is held in between rock particles. Water infiltrates the soil through pores, cracks (fissures), and other empty spaces until it reaches the zone of saturation where all of the spaces are filled with it. This process happens when water infiltrating the soil reaches an impermeable layer of rock that prevents it from penetrating further (known as an "aquitard" or "aquiclude"). The top surface of the *saturation zone* is the *water table*. The level of the water table is higher in regions with high rainfall than in regions with low rainfall. The water table can rise in wet years and descend in dry years.

Fossil water is deep groundwater that is non-renewable. It rests underground for thousands, even millions of years. Whereas most aquifers are naturally replenished by precipitation, fossil aquifers get very little recharge. Currently, Libya undertakes a grand scale project to mine the fossil aquifer beneath the Sahara desert.

This picture represents aspects of the water cycle in a typical Mediterranean coast. Mark on the picture the following terms that relate to the water cycle:

precipitation, evaporation, groundwater, saltwater intrusion, wastewater, sewage treatment plant



In the Mediterranean islands water demands increase dramatically during the summer due to tourism. In many cases these high demands are met by the desalination process in reverse osmosis plants. Some places resort to transporting water using ships (i.e. in Sardinia, Cyprus, the Cyclades Islands). Nevertheless, managing water in a sustainable way is vital and resort to such methods should be avoided.

Other measures that should by considered and followed are:

(i) Reducing water consumption.

(ii) Using all precipitation efficiently: collecting rainwater in proper reservoirs (open air or underground cisterns, small dams, etc.).

(iii) Enhancing water retention of soils and facilitating the recharge of natural aquifers, e.g. by small scale terracing of fields on hill slopes or by artificial recharge of groundwater, etc.

(iv) Maximising the use of other *Non Conventional Water Resources* such as the reuse of treated wastewater and greywater, and desalination using renewable energy.

CLIMATE & WATER RESOURCES IN MALTA

Due to its geographical location the Maltese archipelago enjoys a typical Mediterranean climate characterized by hot, dry summers and mild, humid winters. The average annual precipitation is 550mm, however rainfall is highly variable from year to year. The dry period extends from April to September. Strong winds, especially northwesterly ones are frequent thus further enhancing evaporation.

The sustainable yield of the aquifers in the Maltese Islands is estimated at 23 million m^3/yr. It is estimated that only 15 million m^3/yr of groundwater should be extracted to avoid further salt water intrusion.

web http://ga.water.usgs.gov/edu/waterdistribution.html
http://www.eoearth.org/article/Aquifer#gen1
http://www.maltairport.com/weather/page.asp?p=17356&l=1

references Malta Resources Authority, "Initial Characterisation of the Groundwater Bodies within the Maltese Water Catchment District under the Water Policy Framework Regulations", 2004
Scoullos M. & Tomassini B., "Handbook on freshwater in the Mediterranean", GWP-med & MIO-ECSDE, Athens, 2003

about the **ACTIVITY**

Objectives

- To participate in a field trip
- To observe and collect information on all available or officially planned NCWR systems
- To display the successive steps of a NCWR system in a diagram
- To understand the importance of *alternative* or *non conventional* water resources

Material & Equipment

Camera
Notebooks and pens

Activity

1. Divide the class into four groups and make the following field visits to:
   (a) A sewage treatment plant.
   (b) A desalination plant.
   (c) A building that includes a rainwater harvesting system.
   (d) A building that includes a greywater system.
2. Make observations and take pictures from the plants and water systems.
3. Keep notes of the components and study each part of the system.
   Observe and ask the staff working in the plant (case a, b) or the owners of the building (case c, d) about the processes of the systems in terms of *purpose, materials, products, waste produced, energy needed, etc.*
4. Fill in the respective parts of the Worksheet.
5. Post-visit activity: fill in the blanks on the respective sketches in the Worksheet with the appropriate words. If you noted differences between what is depicted in the sketches and what you observed during the visit, re-draw and amend the diagrams to include what you have identified.

Methodological Tips

- During the visit to a building with a rainwater harvesting or a greywater system the students should take notes on: *the parts of the system; their purpose; their materials; their condition; the uses of the water collected and/or produced.*
- During the visit to the wastewater treatment or the desalination plant students should collect data about the various processes in terms of: *their purpose and products, the source of energy used, the carbon footprint of the plant and the uses of the water produced.*

Wastewater treatment plant at Ras il-Ħobż, Gozo © Ministry for Gozo

3

NON CONVENTIONAL
Water Resources (NCWRs)

Collecting rainwater for household needs is a centuries-old tradition common in all water scarce regions of the Mediterranean. Today, the wisdom of this practice is being revived through modern rain harvesting systems designed for houses, schools, hotels, airports, etc. Apart from rainwater harvesting, other *Alternative* or *Non Conventional Water Resources* (NCWRs) are widely applied today in the Mediterranean and beyond.

In this activity we explore rainwater harvesting and other NCWRs.

alter aqua

Rainwater

The function of a typical rainwater harvesting system installed in a house is described herewith:

Rain falls on the *collection surface* (e.g. roof, yard) and flows through a gutter leading to filters that, depending on their properties, may retain particles from the size of leaves, pebbles, etc. down to the size of dust. The filtered water is then led into a storage tank (*reservoir*) that is usually built into the ground or is placed in the basement. The tank should be made of waterproof, opaque material. It has a volume proportional to the area of the collection surface and a storage temperature ideally below 18ºC. The traditional cisterns were stone-built or carved in waterproof rock, applying a special "mud" (like cement) to seal its interior where necessary. The reservoir generally contains an overflow pipe (*siphon*) that ensures aeration and allows the overflow of excess water. A *pump* and a system of *pipes* is necessary to distribute the stored water when required.

Rainwater is suitable for non-potable uses, i.e. toilet flushing, cleaning, watering and if thoroughly filtered also in industry. It can be used for drinking, provided it is properly disinfected (i.e. through UV lamps, chlorination, ozonation etc.).

Some types of roofing material are considered less appropriate for rainwater harvesting than others, such as:

- *Asbestos-cement roofs, which may cause filters to block and pose a health risk in the collected water.*
- *Bitumen or coated felt roofs may lead to colour and odour problems besides causing an organic type of pollution.*
- *Roofs covered by vegetation usually require extra treatment as the water is likely to mix with soil.*

Greywater

Greywater is the household's wastewater other than that from toilets (blackwater), meaning the one deriving from the sink, shower, laundry, etc. Today's technology offers different options for effective, easy and inexpensive greywater treatment. The most common greywater systems refer to the treatment of the shower/bath and laundry waters (kitchen sinks require more complex technologies). The following processes explain the procedure:

Greywater is led through pipes to a *screen* filter that removes the large suspended particles and any grease. As it is often warm and rich in organic matter (e.g. skin particles, hair, detergents, etc.) it provides ideal conditions for bacterial populations which cause a bad smell. The greywater is then led to the *collection tank* by a pump that also *aerates* the water. In the settling tank, the greywater cools and the suspended particles settle down. At this point some chemicals are sometimes added automatically. The aerated effluent is then passed through various types of *filters* depending on the water quantity and the degree of purification required. Sand filters are used for small quantities while multi-media filters (e.g. combining fine and coarse sand, gravel and wood chips) can treat larger quantities. Membrane filters can remove fine suspended solids. The filtered water is led to the *storage tank* where disinfectants are added to prevent bacterial incubation. An *overflow siphon* that discharges to the sewage system is also required. A control unit is included, so as to regulate the previous steps (e.g. empty the storage tank when the water is stored for a long period and in case of any hazard).

Treated greywater can be used mainly for toilet flushing, car and terrace/yard washing and for watering gardens.

Biological treatment is generally used for large greywater (or sewage) quantities. Although it varies in complexity, its function relies on the use of bacteria to remove organic matter. Oxygen is introduced e.g. through aeration pumps to allow the bacteria to breath, reproduce and "digest" the organic material (into CO_2 and water). Biological treatment using plants (e.g. reed beds, the so-called "constructed wetlands") is another established method for "polishing" primarily treated sewage and can be used also for greywater. Wastewater is led through the reed bed and the naturally occurring bacteria decompose the waste as they are fed with nutrients from the wastewater and oxygen. Such systems require a relatively large outdoor space and some expertise to create and maintain.

Wastewater

The domestic sewage (or urban wastewater) is usually treated on a large scale at municipal level. This process involves various stages:

Screening removes large debris (e.g. rags, plastics, wood). The sewage flows at a slow rate to allow grit to settle in the bottom of the *sedimentation* tank (*primary settlement*) while the overflowing top liquid moves on for *biological treatment* (the main step of secondary treatment). This is based on biological filters (i.e. sewage is spread over a large surface layer of stones or other inert material; aeration occurs due to air spaces between the stones) or activated sludge (i.e. sewage held in aerated tanks in which bacteria is added). A *secondary settlement* stage follows so that the remaining solids (*sludge*) settle in tanks. The resulting effluent is clean enough to be discharged to a river or to the sea. In some cases tertiary treatment is needed, to ensure that vulnerable areas where the effluent is discharged remain unaffected. *Tertiary treatment* aims to remove the nutrients (nitrogen and phosphorus) using bacteria and/or chemicals. The effluent is then led to grass plots, reed beds or sand filters that "polish" and disinfect the treated water.

Treated wastewater can be used for agricultural or other types of irrigation (i.e. municipal parks, sport fields, golf courses etc.) as well as in industry (i.e. for cooling). It can also be used for aquifer recharge to control salt water intrusion, mainly through injection wells.

Treated urban wastewater provides a reliable water supply, relatively unaffected by low rainfall or droughts. And yet, Europe has hardly invested in this technology; only 2,4% of treated effluent is reused.

Sludge collected from primary, secondary and tertiary treatment is held in closed tanks for approximately two weeks, at around 35ºC. This anaerobic sludge digestion yields a product that is drier and in principle, nearly odourless thus containing fewer pathogens. With further treatment the digested sludge may be used as a fertilizer, a soil conditioner or as fuel. Methane is also produced by anaerobic sludge digestion and may be collected and used as "biogas" to generate hot water or electricity.

Desalination

Desalination refers to the process of removal of salts and other minerals from saline and brackish water to produce fresh water. It involves the following processes:

Seawater is transferred to the desalination plant through large pipelines (*intake*). Then, water is filtered to remove debris and floating particles as a *pre-treatment*. *Salt removal* can be done using various methods based either on thermal processes (distillation) or the use of membranes (reverse osmosis). During distillation, the water is heated until it evaporates as steam while salt stays behind. The steam is then cooled and condensed in another container while brine or "salts" are discharged. Reverse osmosis is the method widely applied using semi-permeable membranes and high pressure to separate salt from water. Both processes are energy intensive!

Desalinated water is further treated mainly to avoid bacterial infection or to improve its taste by passing it through carbonate rocks (*post treatment*). The water finally enters the distribution network. The output volume of the desalinated water is approximately half the incoming volume. The remaining half is used in the operation of the plant and includes the high salinity brine which is discharged back to the sea.

The Mediterranean region holds 17% of global seawater desalination capacity. Desalinated water can supplement municipal water supplies and it is used also in industry and irrigation. The limitations for using desalinated water for irrigation are mostly economic, as it is very expensive to produce. Furthermore, with the minerals removed, its suitability for irrigation has been questioned.

A less common NCWR is the freshwater abstraction from offshore underground water springs. Underwater devices that look like upside-down funnels are used to trap the spring water which is then led to shore through pipes.

web http://www.harvesth2o.com/
http://ga.water.usgs.gov/edu/drinkseawater.html

references "Harvesting rainwater for domestic uses: an information guide", UK Environment Agency, 2003
"Greywater for domestic users: an information guide", UK Environment Agency, 2008
"Water resources across Europe - confronting water scarcity and drought", EEA Report No 2/2009

Desalination

Some decades ago, desalination was only possible through vacuum distillation, i.e. the boiling of water at less than one atmospheric pressure at a temperature much lower than 100ºC. Some energy is saved because of the reduced boiling temperature. However, it is still energy reliant and unless combined with renewable energy resources it cannot be considered a sustainable option. Additionally, the warm discharge may create problems to the marine organisms living on the seabed (*benthos*). Another widely applied desalination method is reverse osmosis. Seawater is passed, under pressure, through semi-permeable membranes resulting in two solutions on each side of the membrane, one with fresh water and another with saline. This is also energy dependent due to the use of pressure pumping.

The major drawbacks of desalination are its high cost due to high energy consumption, expensive infrastructure and costly maintenance. Reverse osmosis tends to be less costly than distillation.

about the **ACTIVITY**

Objectives

- To describe the main principles behind distillation and reverse osmosis
- To set up apparatus for an experiment
- To make observations and reach conclusions

Material & Equipment

Erlenmeyer flask (or any other heat resistant transparent container)
Approx. 100cm rubber tube (6-8mm diameter)
A cork with a hole that fits the rubber tube
Bunsen burner
Salty water
Bowl filled with ice cubes
Empty bowl

Activity

1. Half fill the flask with the salty water and assemble the apparatus as in the sketch. For a successful distillation all the parts need to be firmly connected.
2. Start heating the flask keeping the fire on a medium flame.
3. Record your observations.
   What happens to the water in the flask once heated?
   What happens inside the rubber tube?

DESALINATION IN THE MEDITERRANEAN REGION (2008)

- *Reverse osmosis is applied in Egypt, Jordan, Iraq, Lebanon and Palestine (80-100%) while the Arab Emirates rely mainly on distillation.*
- *Spain has more than 700 desalination plants, enough to supply water to 8 million inhabitants.*
- *750,000m³ of water are produced per day in Italy by desalination.*
- *Cyprus has two plants and plans to expand them and build another four (75% of the Nicosia/Larnaca/Famagusta).*
- *More than 55% of total water needs in Malta are secured through desalination.*

Rainwater drainage grid © http://www.therainbarreldepot.com

4

NCWRs: **HOW** do they work?

Many of the conventional methods of securing water supply, such as dam construction, inter-basin transfers and desalination using fossil fuels are not sustainable in the long term. As a result, *Alternative* or *Non Conventional Water Resources* (NCWRs) have become increasingly important in recent years, especially in the water scarce Mediterranean countries. Although none of these methods reduces water use, they all have the potential to decrease abstraction from conventional sources.

In this activity we conduct a set of simple-to-do experiments to study the ways in which the NCWRs function.

alter aqua

Rainwater Harvesting

Rainwater harvesting refers to the processes of collecting rain for immediate or future use. The harvested rainwater can be used to partly cover the water needs of households, hotels, airports, sports facilities and golf courses, schoolyards, etc., as well as industries. Sites with extensive impermeable surfaces (e.g. parking lots, streets etc.) generate high levels of storm water runoff that could result in severe floods. This problem can be addressed by i.e. installing rainwater storage tanks, rain gardens, permeable paving and green roofs (storm water *retrofitting*).

about the **ACTIVITY**

Objectives

- To set up apparatus for an experiment
- To take measurements, record data, make comparisons and reach conclusions
- To appreciate that rain is a very important resource that is however, not always available

Material & Equipment

Plastic bottle
Ruler
Plastic funnel
Rubber tube
Marker

Activity

Importance is given to measuring the rainfall of the area since the capacity of any rainwater harvesting system must correspond to the rainfall.

1. Construct a rain-gauge: set up the apparatus according to the sketch. Make sure that the funnel and the bottle have the same diameter.
2. Place the rain-gauge in an open area. Fix it to a pot filled with sand, so that it cannot be overturned by wind or heavy rain.
3. Measure the height of the water in the bottle immediately after a rainfall. Record your data in a table. Calculate the monthly average rainfall.
4. Compare your monthly data to those published by the meteorological office. Are there any variations? Try to explain why.
5. Compare your monthly or annual estimates with published data of average rainfall of previous months/years. Try to explain any differences.

Methodological Tips

- Keep the rain gauge handy to use in cases of unexpected rain. Alternatively the class can make 2-3 rain-gauges and have them available not only on school premises.
- It is important to take height measurements directly after each rainfall; water starts to evaporate immediately.

Greywater system

The treatment of greywater (water that results from baths/showers, hand basins and laundry) varies depending on its quantity. Large treatment systems such as those in hotels, etc. tend to use more sophisticated methods than smaller, household systems. In general, greywater treatment can be classified as "physical" or "biological", while some systems are combinations of both. Systems combining physical and biological treatment produce water of high quality, but they are energy demanding and costly to purchase, operate and maintain. Physical treatment typically refers to filtration: a simple filter is required to remove the large solid particles and additionally, disinfectants are added to prevent the growth of algae or bacteria. Biological treatment, on the other hand, is based on the idea of introducing oxygen that allows the bacteria to "digest" the organic material.

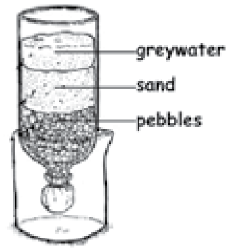
about the **ACTIVITY**

Objectives

- To describe the main principles on which greywater systems are based
- To set up apparatus for an experiment
- To take measurements, record data, make comparisons and reach conclusions
- To appreciate that greywater is an important Non Conventional Water Resource

Material & Equipment

Plastic bottles	Coffee filter
Gravel/small pebbles	Cotton wool
Beaker or similar	Stick
Water	Soap
Sand	Rubber band



Activity

1. Construct a filter using a plastic bottle with its bottom cut off as presented in the sketch:
   a. Place a thick layer of cotton wool at the bottle's neck. Attach the coffee filter to the neck of the bottle, using a rubber band.
   b. Turn the bottle upside down, placing it in a beaker or in the cut-off bottom of the bottle (in this case punch a hole on the side to allow air to escape).
   c. Place two successive layers of clean pebbles and sand on top of the pebbles.
   d. Clean the filter by slowly pouring 3 litres of clean drinking water.
2. Allow your hands to become very dirty by rubbing soil, mud, etc. Wash your hands using a lot of soap and collect the water in a bucket.
3. Wait for 30 minutes. Then stir the dirty water (greywater) using the stick.
4. Pour the greywater through the filter and collect the filtrate in a beaker. What do you notice? Stir the content of the beaker. What do you notice now? Compare the filtrate with the greywater you collected in step 2. *What can you use the filtrate for?*

Methodological Tips

- It is very important to clean the filter before using it for the first time, by slowly pouring clean water until the effluent is clear. Instead of throwing away this effluent, use it to water a plant. Each new filter can be used 4-5 times depending, of course, on the dirt-load of the greywater.

web http://water.chemistry2011.org/web/iyc

references The Global Experiment on Water, UN International Year of Chemistry, UNESCO 2011
Scoullos M. et al., "Water in the Mediterranean" MIO-ECSDE & GWP-Med, Athens, 2001

Objectives

- To practise defending arguments, exploring options and reaching consensus
- To become informed about the benefits and risks of NCWR methods and systems

Material & Equipment

Notebooks and pens

Optional: cloths, hats, scarves, stop watch, etc. for the role play

Activity

PREPARATION: Collect information about the advantages and the disadvantages of NCWRs, namely, rainwater harvesting, greywater treatment, desalination and wastewater treatment. You can start by studying the tables given here and expand data by doing your own research.

Based on your preparation, hold a panel discussion on the aspects of using NCWRs.

SCENARIO: A public hearing takes place at the Local Council offices in the presence of the planning Board - the engineer, the environmentalist, the treasurer and the Mayor - and some citizens also (the rest of the class). The theme of the meeting is the potential installation of a NCWR system in the new school that is to be built, with the overall goal to seek a consensus on a commonly agreed decision. The members of the planning board present their positions and develop their arguments. The citizens participate: they listen to the panel and then pose questions.

ROLE PLAY GUIDELINES: Assign the four main roles plus a discussion moderator and hand out their role cards from the Worksheet. Allow 15 minutes for students to come to grips with their role.

The moderator welcomes the participants and presents the agenda. He/she gives the floor to the panel for a first round of presentation of positions (each speaker will have 5 minutes).

After all views are heard a second round of discussion takes place among the panel members. Each speaker should make any necessary clarifications and also ask for clarifications from other speakers (each speaker should be given 5 minutes).

The moderator opens up the discussion to the class/citizens, asking for comments, questions or different views, etc. (not more than 2 minutes each).

The hearing needs to come, ideally, to a unanimous decision. If no consensus is reached from the discussion the citizens may also vote to hopefully reach a verdict.

REFLECTION: After the role play the teacher may hold a reflection discussion on the participants' feelings during the role play (refer to the Worksheet).

Methodological Tips

- During the role play the audience keeps notes on the Worksheet about the arguments raised by the panel (social, environmental & economic benefits and risks) as well as their behaviour (body language, temper, etc.).
- The moderator ensures that speakers are given equal time and keeps the discussion "on track". The role can be undertaken by an experienced student or by the teacher.
- If no consensus is reached because the panel lacks documentation, the meeting can be postponed until the students collect more data on issues such as the real costs, risks and benefits of each NCWR option.
- It is very important for all roles to understand that the objective is not to "*impose*" any given solution but to find and agree in earnest on the best option.

about the **ACTIVITY**

Overflowing dam in Gozo © Ministry for Gozo

5

a day at the
LOCAL COUNCIL

In some countries of the Mediterranean region the Non Conventional Water Resources (NCWRs) already contribute significantly to increasing their water supply. Nevertheless, experts argue that the region needs a new approach to water resource management focusing on saving it and using it more effectively, before greywater and desalination options are exploited.

In this activity we explore the benefits and the risks of installing a NCWR system through a panel discussion.

alter aqua

In some Mediterranean countries NCWRs are an indispensable contribution to their water supply. However, experts argue that water saving approaches and efficient water management should be given the highest priority. They agree that desalination and other options involving expensive and complex infrastructure should be considered only as a last resort. Countries should make an in-depth assessment of the benefits, the disadvantages and the risks of a NCWR and of how the local situation can be taken into account.

RAINWATER HARVESTING SYSTEM	
Benefits	***Risks***
Reduces the water consumption from other conventional resources. A household can easily collect more than half the water it consumes, e.g. for toilet flushing, garden watering, washing/cleaning purposes.	Water quality is questionable. Drinking rain water without proper disinfection may pose health risks as it may contain pathogens. Moreover, it is poor in some minerals.
Can be used to cover the needs of large complexes and constructions i.e. airports, industries (cooling purposes) and stadiums.	When a system is added after the building's construction (*retrofitting*) the cost is higher compared to installation from the beginning. Problems of leakages, proper insulation, etc. may also occur.
Reduces water bills.	Construction of relatively large storage tanks in places with poor rainfall may be costly.
Reduces the amount of urban storm runoff and thus, lessens the risk of flooding.	The system needs regular maintenance, especially before rainy periods: - *filters need regular cleaning;* - *gutters must be free of any debris and blockage;* - *the tank should be inspected at least once a year and silt should be removed.*

GREYWATER SYSTEM	
Benefits	***Risks***
Reduces the use of fresh water resources: Treated greywater can replace fresh water in toilet flushing, watering the garden and washing yards. This way approx. 65% of domestic wastewater could be recycled.	Increased installation costs, particularly for the fine treatment, is a constraining factor for the wider use of such systems. Considerations regarding the energy cost of greywater technology are also important.
Reduces the load to the septic tank system or to sewage treatment plants, extending their life expectancy and effectiveness.	When watering with treated greywater it is recommended: - *to water the soil directly and not use a sprinkler;* - *to use only for adult plants and not for seeds or young plants;* - *to use only for non-edible/leafy plants.*

DESALINATION	
Benefits	***Risks***
Ensures adequate and reliable water supply in dry areas enhancing economic and social development.	Entails high energy demands. If energy derives from fossil fuels it increases greenhouse gas emissions.
Provides a reliable supply of water regardless of weather conditions i.e. in droughts or in high demand periods, e.g. the tourist season.	Is mainly built in coastal areas: the cost of establishing a plant and piping system inland is much higher.
Has the potential to be linked with renewable energy sources (e.g. solar, wind).	Has negative impacts on marine biodiversity due to the intake and outlet pipes, especially in the discharge of residue brine.
	High cost of installation and maintenance.
	The location of the plant may affect the value of land (*NIMBY syndrome "not in my back yard"*); Noisy.

WASTEWATER SYSTEM	
Benefits	***Risks***
Reduces the pollution of water bodies (rivers, sea and groundwater) by nutrients and other pollutants.	Possible enrichment of groundwater and soil with nitrates, heavy metals, and other substances and contaminants harmful to plants if wastewater is not treated properly.
Contributes to water resources when used for recharging aquifers.	Health risks arise when the treated wastewater is not processed properly.
Reduces the abstraction of conventional sources when used for irrigation.	Requires strict quality controls to minimise environmental and health risks.
The treated reclaimed wastewater, which is high in nutrients, reduces the need for fertilisers when used for irrigation.	Additional costs are incurred, mainly due to the requirement for a separate piping network for the distribution of treated wastewater.
Costs are low to medium for most wastewater reuse systems and are recoverable. Compared to a desalination plant, it is a cost-effective and a less energy intensive option.	The general public may refuse to consume products that are associated with wastewater reuse. This is a major cultural/religious/psychological issue.
The technology can be used for a wide range of activities allowing centralised (national water authority) and decentralised (industrial, municipal, farming) approaches.	

web www.gwpmed.org

references Koussai Quteishat "Non Conventional Water A New Paradigm" presented at the "Regional Conference on Advancing Non-Conventional Water Resources Management in the Mediterranean" organized by Ministry of Environment (Greece), Secretariat for the UfM, GWP-Med, Mission Water, 15/09/2011, Athens

Assessment of alternative water supply options - Final summary report, Study undertaken for the European Commission – DG ENV, Flemish Institute for Technological Research NV ("VITO") 2008

Mediterranean Wastewater Reuse Report, EMWIS, EUWI MED, 2007

Objectives

- To discover how water was collected, transferred and stored in the past
- To develop communicative, expressive and artistic competences
- To experience the water situation people in the past faced

Activity

Look up information on how people obtained fresh water in your town/village 4 to 5 decades ago. Prepare and play a theatrical act/drama based on the information gathered – a situation in which water is the main "protagonist". Your story should address how water was *managed* within a household in the past, including its origin, how it reached the household, how it was stored and how it was used. You should particularly refer to the role of women and children.

You may create your own story or work on an existing one taken from a novel, an article in the press, local tales and folklore, etc.

Make sure your story includes a "dramatic" or unexpected incident that affects people's lives. *For example, such an incident could be water theft or contamination, or the emptying of the public water supply due to an accident or a long drought*. Describe how people react to the incident and how their relationships are altered.

Guidelines for writing the scenario

The scenario of your story should include the following main points:

- Where does the story take place?
- When does it take place, i.e. 50 years ago?
- Who takes part in the story (define the roles, etc.)?
- How are the people in the story related?
- What is the dramatic incident of your story? (*"Suddenly we realised that the water in the cistern was no longer drinkable!", "Someone had stolen the water without leaving a trace!", etc.*)
- What could the reasons for the incident be?
- What alternatives do the people have in order to deal with or adapt to the new situation?
- What are their choices?
- What are the consequences of these choices?

Methodological Tips

- Apart from books, old news papers, etc. a lot of information about how people obtained and managed water in the past can be traced in contracts, agreements and dowries, dealing with water ownership, property, "water access" rights, "abstraction permits", etc., for the use of wells, springs, cisterns, and other sources.

about the **ACTIVITY**

Traditional water jars in ceramic shop, Aigina (Greece) © MIO-ECSDE / V. Psalidas

6

water in the **PAST**

Water has always been scarce in the Mediterranean. The efforts to safely collect, store and transfer good quality freshwater have always been an agonizing and rigorous process especially in dry areas. This is revealed by a great number of old water structures (e.g. cisterns, aqueducts, wells, etc.). Up until the recent past, and even today in some regions the lack of supply networks obliges people to carry water from public wells or springs to their homes.

In this activity we explore water related stories of the past, and try to revive them through a drama activity.

Water in Malta in the past

In the Maltese Islands up to 1965-1969 people didn't have bathrooms or even water taps in their homes. In the towns and villages one could find public water taps or 'standpipes' but more referred to as 'fountains' or 'springs' by the locals.

Before the installation of standpipes people could only get drinking water from natural springs and wells. These were often polluted thus making people ill with intestinal problems. After the standpipes provided access to fresh, clean water, people started to wash more frequently. Yet, their water was intended solely for drinking and cooking and only to be used for washing in case of urgency.

Standpipes were the centre of social activity, as people used to queue to fill their buckets or jugs, chatting calmly. They also provided a good excuse for the young ladies to meet their boyfriends. Sometimes quarrels broke out when someone tried to skip the queue.

At times, water pressure was so low that women would leave their buckets to fill up whilst doing other errands. Often, an impatient woman next in line would empty the bucket being filled into her own and leave before the other came back to find her bucket still nearly empty!

In Gozo, some villages only had water at night, as during daytime the main supply was barely enough to cover the needs of Victoria, the main town. Occasionally, people were caught taking water from a standpipe to irrigate their fields and gardens, or to fill huge barrels.

As people used to place their lips on the tap to drink, mouth infections were frequent. As a prank, boys sometimes would rub hot chili on taps and enjoy watching the reaction of their unsuspecting victims.

Many kinds of water vessels were used ranging from buckets, kettles, jugs, jars (*qannata*), pitchers (*bomblu*), bottles, to large antique earthenware jars (*qolla*). Women used to carry one vessel on the head over a piece of cloth cushioning whilst holding another in their free hand. Men would carry a wooden pole across their shoulders (*menza*) balancing two hanging buckets hanging on either side.

By 1969 all standpipes were closed. The Government decided to install water mains for free in the houses of those who were too poor to afford it and still relied on the standpipes.

(adapted from "Life in the past, Folkloristic Information from Gozo", A. F. Attard, 1991)

i

In Malta, up till 19th century, a water seller, carrying a small, wooden barrel full of fresh water used to sell "cups" of water to thirsty people during summer feasts and other occasions. Tin or ceramic cups hanging from the seller's belt were used over and over again by everyone – not hygienic, but that was what was available at the time. The water vendor, selling water from a large barrel mounted on a cart, was also a common sight.

(Text & sketches © G. Lanfranco, 2002)

Tales of a Greek cistern

Our house was built in 1958 at a time when water was not easily available. My father decided to build a cistern because it was not always possible to find water to buy. I remember that year we bought water from a fellow-villager who owned a cistern, a half-hour donkey-ride away from our house. We measured the amount of water we drew up using a rope and a bucket. We dropped the bucket into the cistern making sure that the rope was taut and once the bucket touched the cistern's bottom, we drew it up to measure the rope's wet length. We paid for a depth of water equal to double the length of a man's hand (~ 40 cm height in the cistern). Once we reached the quota we had to stop, or pay him more.

Bringing water to our house was my responsibility - nine years old at that time. I had to secure a board on each side of our donkey's saddle and hang two canisters from each one. So, off we went to collect water, our donkey and I, taking with us along with the canisters, some rope, a bucket and a funnel to pour the water into the canisters without spilling a drop … On the way back the poor donkey had to carry the full canisters (~80 kg) plus me (~25 kg), totalling some 105 kg.

Our new cistern was ready just before the rainy season. We kept out the water from the first "dusty" rains and then let the cistern fill up. In just a few days the cistern held about half a meter of water, and was full by late December, so I stopped going for water with the donkey.

We had placed a loose lid on the cistern, which did not manage to keep thirsty bugs from falling in. Often we "fished" them out on time before the water turned bad, but on some occasions the "intruders" spoiled it. The only remedy we knew was to hold a ritual whereby we poured a few drops of "purifying" holy water vigilantly kept from Epiphany. My godmother claimed that this was all what was needed, but fortunately, my educated mother advised my father to also add some lime or iodine.

(adapted excerpt from " Tales of a cistern", G. Pylarinos, 2006)

Can you imagine a day without water supply?

What would you do?

Would you bring water from a well or a cistern?

How would you use it?

Water vendor filling his tank, Athens, 1940 © *EYDAP*

web www.hydriaproject.net

references "Life in the Past: Folkloristic Information from Gozo – Mill-Ħajja ta' l-Imgħoddi: Tagħrif Folkloristiku minn Għawdex", Anton F. Attard, 1991
Lanfranco G., "Xogħol, Ġaħġiħ u Snajja li spiċċaw" (Maltese), 2002
Pylarinos G., "Tales of a cistern" (Greek), 2006
EYDAP, Photographic Review of the Water Supply and Sewage Corporation of Athens, 1999

Objectives

- To practice working with data collected and measurements taken
- To find out how much water can be saved when changing consumption habits
- To prioritise actions when saving water
- To develop a positive attitude towards the sustainable use of water

Material & Equipment

A volumetric bucket
Notebooks and pens
Calculators

Activity

1) Wash your hands and collect the water used in a bucket. Compare the amount of water used a) keeping the tap running and b) keeping the tap closed.
   Calulate:
   - How much water can one save in case (b) per day, for an average of washing hands three times a day?
   - How much water can be saved in a year by a family of four?
   - How much water can be saved during the school day if all students and teachers wash their hands with the tap closed while washing?
   - Fill in the appropriate spaces in the Worksheet.

2) Form a **"Water task force"** at school. Sensitise all pupils about your findings in part (1) and work towards developing a whole school approach that aims at a responsible consumption lifestyle. You should:
   a) Find out what was the quantity of water consumed during the previous year by checking water bills.
   b) Decide on an ambitious but realistic reduction target by a certain date, e.g. in a school year.
   c) Ask for support from other students to join your efforts. For guidance purposes design a draft poster with 10 easy-to-do water saving tips and pin it on all school notice boards. You can use the "*Alter Aqua*" poster.
   d) Monitor the water system on the school premises – pipes, taps, tanks – check out for any leakages, damages, etc. Inform the maintenance person, about damages and needs.
   e) At the end of the school year compare the amount of water used by the school with that utilised in the previous year (step 2a). How much water was saved?

3) Does your school have a rainwater harvesting system? If yes, how is the collected water used? If not, estimate what would be the amount of water that could be collected with such a system.

4) Go public: Inform other schools and the local community through e.g. a newsletter, an article in the local press, an awareness raising event in your school, etc.

5) Do not "close" the campaign at end of the school year: try to hand it over to younger students.

about the **ACTIVITY**


Tap dripping © Mario Gauci

7

REduce - **RE**use - **RE**cycle

The balance between water demand and its availability has reached a critical level in most Mediterranean countries as a result of over-abstraction and prolonged periods of drought. Addressing the water issue requires for citizens to not only be informed of it, but also be responsible in their choices and behaviours, so as to protect this valuable resource.

In this activity, we calculate the amount of water we can potentially save in our daily lives and investigate how we can take concerted action at school level to reduce consumption.

alter aqua

The Mediterranean is a region with irregular rainfall and "fragile" water resources and therefore special attention is needed to manage water. Irrigation (up to 80% in the southern countries), domestic consumption and the rapidly expanding tourism sector are the main water users. During the second half of the 20th century, water demand in Mediterranean countries doubled. This demand is expected to continue to increase in the future.

On the other hand, over-abstraction of groundwater has led to the depletion of many coastal resources and hence saline intrusion. Urbanisation may further deplete groundwater resources, particularly because sealed surfaces prevent rain from infiltrating the soil.

One of the hurdles many countries face in the water supply systems are leakages often due to wear and tear problems, as well as illegal abstraction. The rate of water that is lost or "*unaccounted for*" can reach as high as 60% in urban systems due to leaks and theft. Preventive maintenance and network renewal are key to minimise this loss (which should drop to 5-10% in well-maintained networks).

Unfortunately, mismanagement of water is also evident at the household level. The following data is indicative and explanatory:

- Though 50ℓ are enough to cover one's daily water needs, some people use up to 300ℓ a day.
- Approximately, 40% of daily household water demand is used for toilet flushing.
- Half a glass of water is enough to brush our teeth with. But, if we brush our teeth with the tap running, we may waste up to 5ℓ of water.
- The use of water saving devices, such as aerators, low flow taps, dual flush toilets, etc. could save up to 50% of water consumption at household level.
- Typically, tourists use much more water than locals: For example deluxe hotels of Malta and Greece consume more than 450ℓ per guest night.

!

What can we do to save water in our daily lives?

- *Turn the tap off whilst washing hands, brushing teeth, doing the dishes, etc.*
- *Use the washing machine and dishwasher only when fully loaded.*
- *Take a shower instead of having a bath.*
- *Check for leaking taps at home and at school and have them repaired immediately.*
- *Prefer carrying water in a thermos instead of buying bottled water.*
- *Add one or more plastic bottles filled with water in the toilet flushing and save up to 2ℓ per flush.*

Apart from the aforementioned water saving tips rainwater harvesting and use of treated greywater are practices that can save significant amounts of water, both at the household and the municipal level. In fact, regarding the rainwater harvesting, there is a simple formula to be used to calculate the amount of rainwater that is collected depending on the catchment surface and the rainfall volume. This formula is the following:

$$V = A * R * \text{Drainage coefficient}$$

V is the volume of water collected in cubic metres (m^3)
A is the catchment surface e.g. area of roof (m^2)
R is the average rainwater precipitation (mm/1000)

Drainage coefficient is a factor that expresses the capacity of the system to collect efficiently the rainwater. It is evident that even if a rainwater harvesting system is installed, it cannot collect every drop of rain that falls, as light rainfall will only wet the roof and then evaporate. A "drainage coefficient" factor is used to calculate such losses. Here are some examples of drainage coefficients for different roof types:

Pitched roof tiles: 0.75-0.9
Flat cement roofs: 0.9

TABLE

Volume of water that can be saved when using rainwater instead of treated tap water.

Using rainwater for	Water saved/year & person
Toilet flushing	8 m^3
Laundry	6 m^3
Household cleaning	2 m^3
Watering (for a surface of 100 m^2)	6 m^3

PEOPLE'S ATTITUDE TOWARDS THE USE OF TREATED GREYWATER

On average, Europeans consume around 150ℓ of water daily. About a third of this is used for toilet flushing and could be replaced by treated greywater. In general people tend to accept or reject the use of greywater depending on the type of reuse. It is relatively well accepted to use greywater in golf courses, parks and industry. But people are more reluctant to use it at home. Actually, the level of acceptance to use greywater is influenced by the degree of contact with it: people tend to accept it when contact is minimal, e.g. for toilet flushing; they are less ready to use it e.g. for watering; and tend to refuse to use it e.g. in washing machines. Other studies show that users prefer to reuse their own greywater rather than that of communal recycling schemes.

web
http://spectrum.ieee.org/video/green-tech/conservation/diy-replacing-the-water-grid-with-rainwater
http://www.youtube.com/watch?v=7cfqLrzb5Ug
http://www.timesofmalta.com/articles/view/20120524/local/water-consumption-in-hotels-industry.421162

references
"Grey water for domestic users: an information guide", UK Environment Agency, 2008
Benoit G. & Comeau A. (eds), "A sustainable future for the Mediterranean - The Blue Plan's Environment & Development Outlook", Blue Plan, 2005
"Harvesting rainwater for domestic uses: an information guide", UK Environment Agency, July 2003
"Water resources across Europe - confronting water scarcity and drought", EEA Report No 2/2009

Objectives

- To explore how the media promotes water management issues
- To develop a critical view on how the media presents issues
- To practise competences on communication, writing and argumentation

Material & Equipment

Notebooks and pens
Newspapers
TV
Radio
Camera

Activity

1) Select a type of media e.g. a newspaper (printed or web version), a TV channel, a radio station, a news blog, a social network, and follow it throughout the school year. Your goal is to find out how often the topics of water management and NCWRs (rainwater harvesting, wastewater and greywater recycling, and desalination) are presented and how.

   You may work in groups and each group can follow different types of media.

2) Make a card INDEX for each news item you record. Each card should contain the following information:
   - Title / Subject
   - Date
   - Name of writer/editor/reporter
   - Keywords related to the subject
   - Main issues presented (in 2-3 lines)
   - Main positions and/or arguments

3) Cross-check, if possible, with information from other sources on the same topic.

4) Draw conclusions on the promotion of water/NCWR topics in the media. Do you consider that the topics are “appealing” to the general public? Give reasons.

5) Create your own “**Water Media**”. It could be an internet blog, a school newspaper, etc. Include pieces of your work such as articles and essays, photos, comics, etc., focusing on the topics of water management in your region.

Methodological Tips

- Text analysis is a method useful for developing critical thinking and for analysing values. Try it out by working in three groups to analyse the three articles in this activity.
- In your groups answer questions like: Who are the main stakeholders in the article? What are their positions? (Highlight the exact phrases to indicate these). Does the author sufficiently present all sides of the issue? What are the values of the author? Can you detect any bias?

about the **ACTIVITY**

Rainwater reservoir installed within the RWH Programme in the Cyclades in 2011, Serifos (Greece) © GWP-Med / K. Toli

8 water in the **MEDIA**

Raising public awareness on water related issues is crucial for achieving a more sustainable management. Various means are available, amongst which websites and the mass media.

In this activity we explore how the water issues are presented in the media. We monitor them through an INDEX, we analyse the views of the authors, and finally, we create our own “water media”.

alter aqua

70,000,000 litres of rain water - why should they be wasted?

By Beppe Grech & Christopher Busuttil, St Margaret College, Boys Secondary School, Verdala, Malta

Most of Malta's rainwater runs straight into the sea and goes to waste. The European Union, in a Strategic Environmental Assessment of the Storm Water Master Plan for the Maltese Islands, emphasizes the importance of Malta taking immediate action regarding this problem. In this Master Plan the building of new reservoirs is being proposed. The question is, can something be done with the existing abandoned reservoirs? How about restoring the Ħas-Saptan Reservoir on the outskirts of Birżebbugia?

This reservoir was built in 1977 when the new airport runway was constructed. Its purpose is to collect the rainwater that falls on this runway. This reservoir has a capacity of 70,000m³. From information provided by Eng. Marco Cremona, it loses water through leakages and is therefore not in use anymore.

He surveyed the reservoir's condition in the winter of 2006. After 48 hours of heavy rainfall, practically no water remained in the reservoir. The only amount of water that is not totally wasted is the water which seeps into the ground and recharges the aquifer. The rest runs rapidly down the valley ending up in the sea of Birżebbugia.

The situation seems to have worsened from 2006 till today. After 60.8mm of rainfall, as registered during 19-28 February 2011 by the Meteorological Office, the reservoir emptied in less than 24 hours, as this photo taken on the 29th of February shows. It's a shame that 70,000,000 litres of surface run-off water is wasted and not wisely used considering that water in Malta is a limited resource with an average of 547mm of rainfall, 85 days a year. This water can be used for irrigating green areas, cleaning roads in dry seasons or offered to the Malta International Airport for its landscaping.

(Article awarded 3rd place in the National Young Reporters for the Environment, 2011 Awards)

Burning water prices in the Cyclades Islands

Translated and adapted from: http://www.aftodioikisi.gr/proto_thema/19211, 30/04/2012

The price of water is a "burning" issue in many Cycladic islands these days. The cost of transferring the precious resource from Attica to the 16 small Aegean islands that have an urgent need for water, is very high. In 2012 alone the transport costs are expected to reach 4.5 million Euros, twice as much as it was in 2009.

According to data from the Ministry of Development, the transfer of 3.4 million cubic metres of water to the Cyclades islands during the period 2005 - 2011 has cost 30.3 million Euros, which is 12.5 times the value of the water itself (2.4 million)!

Is there another option that can reduce the burden of such water transport costs? Everyone agrees that there is: desalination. But is it applicable? Apparently not, as the establishment of a desalination plant of up to 1,500 cubic metres and with a <300 KW capacity, requires eight permits and two Ministerial decrees which have not even been drafted yet. Bureaucracy is "alive and kicking" here as well, while water prices are on the rise…

Water resource in critical state

By Anne Zammit, Sunday, 18/03/2012, Times of Malta

Despite widely lacking public awareness, a fresh sense of urgency over Malta's dwindling natural water resource has shown signs of well- ing up at the Malta Resources Authority. At a discussion on water organised by Żminijietna, Malta Resources Authority chief executive An- thony Rizzo cited a report on safeguarding Mal- ta's ground water, published last month by the auditor general. The performance audit, re- leased by the National Audit Office (NAO), spotlights an administration that continues to drag its heels despite the prevailing risk status of Maltese groundwater. Overall the NAO re- port concludes that the poor status of ground- water in both quantity and quality will contin- ue to worsen unless decisive action is taken.

"Water efficiency has to be the number one measure. For example, are we growing water-saving crops? What about the type of plants we are planting on roundabouts?" que- ried Mr Rizzo. He stressed the importance of giving independence to regulatory authorities.

Cracked and crumbling reservoirs go un- used as the price of energy rises and our de- pendence on reverse osmosis for water sup- ply grows. The Malta Environment and Planning Authority (MEPA) issues compliance certificates for electricity – but not for water, as planned underground cisterns are quietly converted to car parks below high-rises in- stead of providing space for water storage.

"How did we arrive at this point?", asked environmental and planning expert Alfred Baldacchino, adding that while water was be- ing wasted, fragmentation of responsibilities was the real problem. Water should not be under any one ministry, he remarked.

Problems of over-extraction and nitrates were already present in the 1970s but no one talked about it nor did much except seek to divert attention away from these ills with a technical solution, reverse osmosis. After wa- ter cuts led to roof tanks in the early 1980s the first reverse osmosis plant was built, giv- ing the impression that the water problem was solved. Oil was cheaper then.

Comparing Malta's high water stress index to that of other countries, Mr Rizzo noted that even if we harvested all rainwater we would still have to be cautious. Parts of England are now facing another hosepipe ban and water companies are planning an information offen- sive to encourage wise use of water. Heavy snow has not been enough to rehydrate strick- en areas because snow has only one-tenth of the water volume of rainfall.

Incidental pollution in the Wied il-Għasel valley water course from leaking oil drums set alarm bells ringing. Yet the theft of water from Malta's aquifers goes on day after day, resulting in seawater intrusion harming this precious resource.

The high incidence of antibiotic use in Malta shows up in our potential water re- source. During the course of a project carried out by the MRA in collaboration with the Wa- ter Services Corporation, antibiotics, thinners and other chemicals were found in discarded water which, after treatment, might have been useful to recharge the aquifer. Active medical ingredients are soon to be flagged as priority substances in the field of water poli- cy, with proposed amendments to directives currently undergoing public consultation.

"On analysis it's clear that chemical treatment is needed before this water can be reused," insisted the MRA chief executive. Mr Rizzo is equally convinced that the recharge project can go ahead if these elements are controlled, and he enquired about the role of the entity responsible for observing waste obligations (Wastserv Ltd) in this context.

As farmer Peter Axisa of the Ta' Qali pro- ducers group acknowledged, statistics show that Malta is gradually moving towards a situ- ation whereby it will be completely depend- ent on reverse osmosis. Mr Axisa asked why all farmers should suffer if one is breaking the law. He acknowledged that the dumping of nitrates-rich manure into boreholes was taking place at some animal farms. A legal notice in 2011 postponed implementation of the nitrates action plan.

Ground water production has been con- stantly declining over the past decade and its quality is mostly unacceptable unless blended with reverse osmosis water. The situation is so bad that some farmers have installed their own reverse osmosis plants to purify the ground wa- ter they are extracting! Voicing concern over where these farmers were throwing the reject water Mr Rizzo hoped it was not down another borehole, thus aggravating the problem… or into the sewage network, which is illegal.

Malta must achieve good ground water quality by 2015 or face penalties, yet the cur- rent price of production is "fictitious", partly because we are the only EU country not pay- ing drainage tariffs.

A law is needed to clarify to whom water belongs and to settle the question whether it is public or private. Until then, anarchy reigns, with entrepreneurs freely making a commer- cial profit of a national resource that they are pumping up without paying for it. A consider- able number of hotels are also helping them- selves to water directly from the aquifer. Hy- drologist Marco Cremona pointed out that in the lead up to EU accession the country de- cided to go for irrigated agriculture on the mistaken assumption that water was unlimited and will always be available and free.

Recent figures from the national statis- tics office show that water demand for agri- culture alone is 28 million cubic metres a year. This surpasses the sustainable yield of all the aquifers by 5 million cubic metres. Even if the WSC stopped pumping ground wa- ter, and if non-agricultural extraction from boreholes by bottling plants, bowser water suppliers, industry, concrete batching plants, laundries and animal husbandry came to a halt, the aquifers would still be over-extract- ed. Difficult decisions on making careful use of our dwindling natural water resource, a national priority, are now unavoidable if we are to avoid disaster. Yet such decisions re- main distasteful to politicians who prefer to procrastinate. Getting real with the water situation might be a good start. "We are tak- ing from the store of water that we inherited and that we should be saving to give to our children," added Mr Cremona.

An inter-ministerial committee chaired by Mr Rizzo now holds quarterly meetings to monitor progress on Malta's adoption of the water catchment management plan. Of 40 measures presented to the EU Commission, 9 have already been implemented and 25 are ongoing. Mr Baldacchino asked whether the committee could be opened up to stakehold- ers to enrich the discussion. Everyone needs to develop a sense of urgency over our water resource. Unfortunately, the installation of metres on boreholes was postponed from 2010 to 2013, allegedly due to a "technical" hitch. With an election approaching there may also be other reasons. Mr Cremona pro- posed that the relevant department of MEPA should join forces with the MRA and the Envi- ronmental Health Unit to form a single water authority which would be answerable to Par- liament rather than to one minister or an- other. The effect, he adds, of raising electric- ity rates was quite different from the water scenario. Putting up the electricity tariff in 2010 had led to clear energy conservation ef- forts on the part of the public. Yet, care has to be taken so that raising the price of water to reflect external costs will not lead to more illegal drilling of boreholes.

web www.timesofmalta.com
www.athensnews.gr
www.yremalta.org

Objectives

- To explore the cultural heritage linked with local water monuments
- To discover the interrelation between water culture and water technology/practice
- To practise one's skills: observation, interpretation, synthesis and creative thinking

Material & Equipment

Notebooks and pens
Camera
Map of the area

Activity

1) Visit a water monument, i.e. a fountain, an aqueduct, etc. and examine in detail its specific characteristics.

2) Identify the location of the monument on a map.
Observe its surroundings and establish its function.
Where does the water come from?
Where does it go?
Who was or still using it?

3) Observe the monument, take photos and notes and fill in the relevant sections of the Worksheet.

4) Does the monument have any ornamental elements?
If yes, what do these depict or symbolise?
Consult bibliography and ask experts.

5) Find out its history: when was it built and by whom?
Check for any inscriptions, dates, etc.
Has it been restored, altered or moved?
Ask people who live nearby and particularly the elderly about the monument.
Are there any local tales, legends, songs, traditions, customs, etc. linked to the monument?
Try also to find old pictures with the monument.
How has it changed?

6) Design your own water monument - fountain, aqueduct, etc.

about the **ACTIVITY**

Rainwater outlet in marble, Pergamon Museum, Berlin © Vicky Malotidi

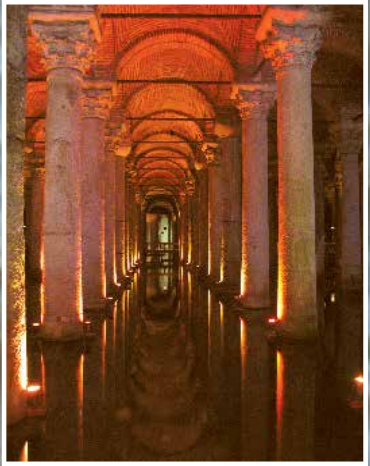
9

water **CISTERNS** and **FOUNTAINS** through time

People have appreciated the value of water since ancient times and have constructed lavish structures for its collection, storage and distribution. The cultural and ornamental elements of these structures were also essential and many a times conveyed the message that water is precious. Intricate fountains and cisterns have been at the heart of social life and trading activity for centuries.

In this activity we explore how some historic fountains and cisterns in the Mediterranean region were constructed and decorated.

alter aqua



Inside view of the Basilica Cistern

© MIO-ECSDE/V. Malotidi

The sideways head of Medusa

© MIO-ECSDE/V. Malotidi

The "Sunken Cistern" of Istanbul

Large scale underground cisterns have historically been built throughout the Mediterranean region. Particularly during the Byzantine period, cisterns of colossal dimensions were completely subterranean with only a few access points to keep out light, rodents and enemies... The famous "Basilica or Sunken Cistern" was built in Constantinople in the 6th century AD by the Emperor Justinian. The cistern, measures 141m X 66.5m and has a total capacity of 78,000m^3. It is an impressive vaulted structure with a "forest" of 336 columns about 9m high. Fed by a reservoir 20 km away, the cistern ensured the water supply especially during draughts or sieges.

The "Sunken Cistern" has been built using the ruins of older constructions. Some of these components are unique, such as the two carved Medusa heads that are said to have been placed in the cistern to protect against evil spirits.

A covered water fountain made of stone in Portaria, Greece

© Viglas et al., 2007

Offered by N. Mavrogenis in 1777 this public fountain in the centre of Paros aimed to support the islanders in dealing with water scarcity. It is built in marble and has a rich decoration

© MIO-ECSDE/V. Psallidas

Traditional water fountains in Greece

In contemporary Greece many traditions, customs and even superstitions that have survived through the ages are linked to the primitive worship of water. These have in turn inspired the rich decorative motifs of fountains such as dragons, eagles, snakes, lions, mermaids, etc. Eastern influences are evident by such items as pentacles, cypress trees, palm leaves, rosettes, trees of life, two animals that face each other, etc. Predominant western influences depict flower or fruit bearing urns, shellfish, plant motifs, etc. Religious symbols such as crosses and cherubs are also common. The traditional fountains are usually made of stone or marble and can be with or without roof.

Many customs and rituals are directly associated with the local fountains. For example, in wheat producing regions, people used to bake pies and leave them as an offering at the village fountain.

Fountain monuments in Malta

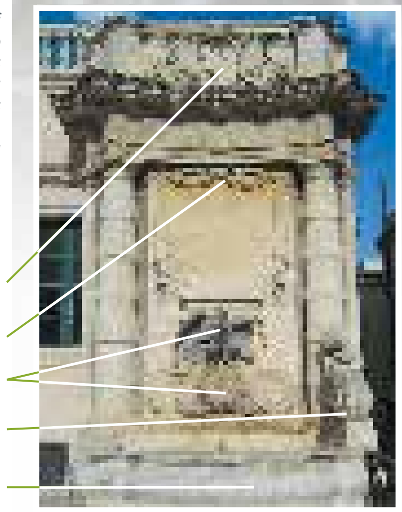
Water arrived in Valletta on the 21st April 1614. In 1610 the Grand Master Adolf de Wignacourt ordered the construction of 16 km long aqueducts to bring drinking water from Rabat. Their construction was completed in 1614, at the cost of 434,605 Maltese scudi. Of these, 40,000 scudi were earnings from the Knights' of St John bakeries; the rest coming from the Grand Master himself. A three-tiered, shell shaped, semi-circular fountain was constructed in the centre of the Palace Square to commemorate the arrival of the aqueduct. The fountain features a huge circular *basin* with three superimposed basins in the shape of *sea shells*, each one smaller than the one below it, supported by a cone-shaped pedestal with four *dolphins* with upturned tails.

Another notable fountain, the "Eagle Fountain", was constructed around 1623 in the San Anton Garden in the President's Residential Palace. This masterpiece is stone-built with its back wall made of uneven stones enclosed in stonework. The fountain shows a sculpture of two boys holding an eagle, standing on a shallow basin which is supported by four dolphins. Like all fountains of the time, water spouts by force of gravity and overflows into a large basin.

Later on, during the Emanuel de Rohan grandmastership (1775-1797) two nearly identical, symmetrical wall fountains were constructed against the facade of the Order's Conservatorio, one at either end of St George's Square, in Valletta. Each fountain consists of two columns between which stands the head of a bearded man with a spread-eagle above it. The water spouts from the head's mouth as well as from the eagle's beak. The two eagles (made of lead unlike the rest of the fountain) look in opposite directions towards the centre of the square. Above each eagle there is a sculpted cloak, and at the very top there is the coat of arms of the Grand Master de Rohan. At the base of the fountain on one side there is a scroll like sculpture in the shape of a dolphin. The eagles of the fountains symbolise authority and nobility, a symbolism used since the Roman Empire. The coat of arms on the very top symbolises the authority of the Grand Master.

The aqueduct built by the Grand Master Wignacourt (top) fed water to this lavish fountain originally in the Palace Square, Valletta (bottom) relocated to St Philip's Garden Floriana by the British Military

© (top) E.Gilson, (bottom) unknown



One of the two fountains in St George's Square, Valletta

© E. Saliba

The Eagle Fountain in San Anton Palace Gardens, Attard

© E. Saliba

web
http://www.tkwb.org/web/?page_id=8
http://constantinople.ehw.gr/Forms/fLemmaBody.aspx?lemmaid=11752

references Borg J., "The Public Gardens and Groves of Malta and Gozo", Media Centre Print, 1990 • Carapecchia F. R., "Cisterne e Gebbie", 1703 • De Giorgo R., "A City by an Order", Progress Press Co. Ltd, Valletta, 1985 • Delia D., Ellul Galea A. & Galea Scannura C., "Fountains in Malta", Water Works Department, Auberge d'Italie, Valletta, 1988 • Guillaumier A., "Old Springs and Fountains: Neptune's Fountain", A Mac Millan (ed), 1915 • Viglas P., Grassos G., Kaplanis X. (eds), "Water-The fountains of Makrinitsa", CEE of Makrinitsa, Hellenic Ministry of Education, 2007 • Zammit, Themi, "Valletta - An Historical Sketch", Critien, Malta, 1918 • Zammit, Themi, "The Water Supply of the Maltese Islands;" Empire Press, Valletta, 1924

Objectives

- To review concepts related to NCWRs
- To practise skills related to communication, vocabulary and expression

Material & Equipment

Pencils and rubbers

Activity

Complete the crossword puzzle presented in the Worksheet with the appropriate words associated to NCWR systems and water management in general. Shared letters are included while the clues/definitions of the missing words are given below.

HORIZONTAL

1. The most common type of precipitation.
3. Water is stored in it.
4. A narrow trough or duct which collects rainwater from the roof of a building and diverts it usually into a drain.
5. It is used in order to remove solid particles from a liquid.
7. The water system is… full of them!
9. The process through which solid particles settle to the bottom of a tank.
14. It is the major water consumer in a household!
18. The largest consumer of water in the Mediterranean countries.
20. The flow of water, from rain, melting snow, or other sources, over the land.
22. The phenomenon of transition from the liquid to the vapour state that occurs on the surface of a liquid.

VERTICAL

3. This is the first step in a rainwater harvesting system.
7. People need to do this in order to have a water supply throughout the year.
8. The removal of groundwater or surface water, or of water from structures, by gravity or pumping.
9. A necessary process to kill the microorganisms that live in the water.
11. A machine that forces water (and other liquids) to move towards a desired direction.

14a. This type of osmosis is often used to desalinate water.

14b. With this type of treatment the organic matter contained in wastewater is decomposed by bacteria.

16a. Another word for reservoir.

16b. The wastewater coming from showers and baths, wash basins and washing machines.

19. The process through which the salt is removed from water.

about the **ACTIVITY**

Windlass well in Syros Island (Greece) © MIO-ECSDE / D. Papadopoulou

water **CROSSWORD** puzzle

In this activity we have the opportunity to revise terms and concepts we have come across in the activities. Once the crossword puzzle is completed, we can use it as a glossary. We can also create our very own water puzzle with local vocabulary we met in the 'journeys' of water.

alter aqua

In all cultures, the significance of water is reflected in proverbs, traditional songs or poetry, as well as in everyday expressions. Listed here are some popular English proverbs and sayings:

Like a fish out of water
Blood is thicker than water
Little drops of water make the mighty ocean
Don't make waves
Don't throw the baby out with the bath water
Don't wash your clothes in public
Dry up your drip
Gone water does not mill anymore
He is wet behind the ears
To keep one's head above water
Stolen waters are sweet
To be in deep water
It leaks water everywhere
It is like drinking a glass of water
It is raining cats and dogs
Dip your toes in the water
No sweat
Don't spit in a well; you may have to draw water from it
You never miss the water till the well runs dry
Still waters run deep
Fish in troubled waters
That is water under a bridge
The drop that makes the vase overflow
They are like water and fire
Injury graves itself in metal, but a benefit writes itself in water

To be in bad waters
To discover warm water
To go through fire and water
To have water up to the throat
To keep water in one's mouth
To lose oneself (drown) in a glass of water
To make a hole in the water
Pour oil on troubled waters
To throw water on fire
To work under water
Water, water everywhere and not a drop to drink
You bring water to the sea
You can lead a horse to water but you cannot make it drink
To pound water in a mortar
You draw water to your own mill
To be in hot water
To be walking on thin ice
You trouble the water
As welcome as water in one's shoes
Come with the wind, go with the water
Under water, famine; under snow, bread
He knows the water best who has waded through it
A great ship asks deep waters
Fire and water are good servants, but bad masters
To love somebody as the devil loves holy water

1. *Read these proverbs related to water. In groups, discuss their meaning.*

   Can you tell how old they are, or how the people's lifestyle was when they were invented?

   Can you give examples of situations when such sayings/ proverbs are used in everyday life?

   Can you think of ways to group some of the proverbs?

2. *Do you have similar sayings in your language? You are welcome to expand this list.*

3. *Create your own crossword puzzles with the vocabulary used locally to describe the "journeys" of water.*

1) Explain the objects used in the simulation model: what they represent and the process they are related to.

Model	→	*Water cycle*
Water in the large bowl	→	
Small bowl	→	
Pot with plant	→	
Stone on top of the membrane	→	
Transparent membrane	→	
Water droplets on the membrane	→	
Coloring	→	

2) Explain the water movement in the model. ....

....

....

3) What is the “behaviour” of the colouring? ....

....

....

4) What are the advantages of this model? For example, was it easy enough to construct? ....

....

....

5) What are the disadvantages of this model? For example, how could you improve on what did not work well? ....

....

....

→ What was the most interesting part of the activity for you? ....

....

....

→ Did you find some parts of the activity difficult? Explain what and why it was difficult. ....

....

....

→ Any other observation or suggestions that are not included in the above questions? ....

....

....

1. PRACTICE IN MAP READING

Use a geomorphologic map of your region and indicate elements of the landscape (e.g. hills) and the natural water resources (e.g. streams, ponds, springs, etc.)

2. THE CLIMATE

Rainfall period: from .... to .... Average annual amount of rainfall (mm) ....
(find data from the Meteorological Service)

Winds:..

Average temperature: Winter term .... °C Summer term .... °C

3. THE WATER SYSTEM & NON CONVENTIONAL WATER RESOURCES (NCWRs)

Main resource: ....

Method for collecting/pumping water: ....

....

Means for storing water: ....

....

System for distributing water: ....

....

The condition of the system: ☐ satisfactory ☐ needs light repairs ☐ needs heavy repairs

Particular observations in specific water system situation:..

....

....

4. WATER SUPPLIES of the Town/Village

The current year (m^3) ....

The previous year (m^3) ....

Five years ago (m^3) ....

Quality of the water supplied ....

Frequency/regularity of supply ....

Amount of water produced by desalination ....

How is this water used? ....

Amounts of treated water produced by the sewage treatment plant ...

....

How is this water used? ....

5. PRACTICE IN MAP DRAWING

Use an outline of your region to draw all the existing water resources. Use different colours & symbols to indicate: (i) the natural water resources (e.g. streams, springs) (ii) the traditional man-made water resources (e.g. dams, wells & boreholes) and (iii) the contemporary NCWRs (e.g. desalination, rainwater harvesting schemes, wastewater plants, etc).

→ What was the most interesting part of the activity for you? ....

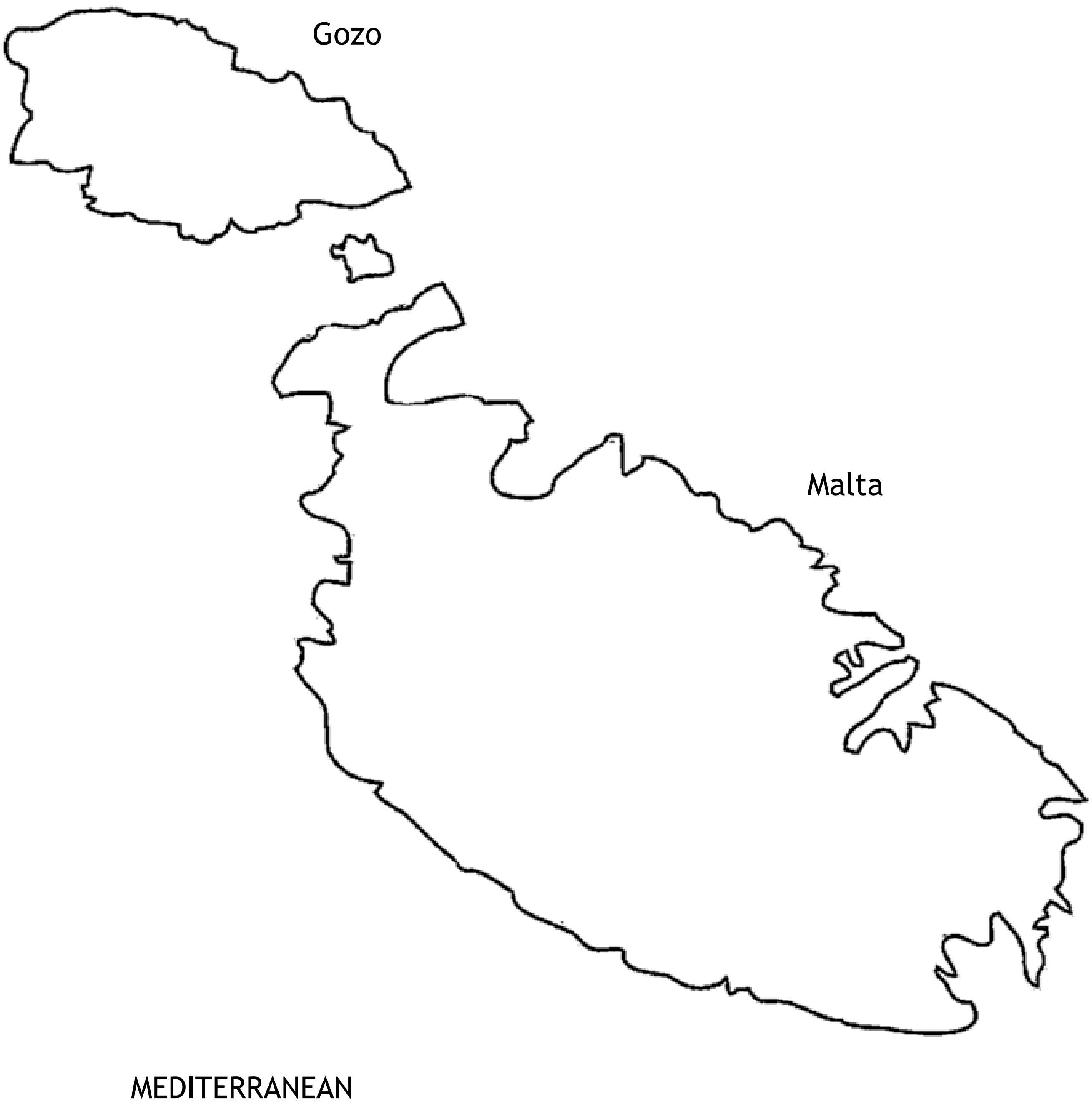
....

→ Did you find some parts of the activity difficult? Explain what and why it was difficult. ....

....

→ Any other observation or suggestions that are not included in the above questions? ....

....


Gozo
Malta
MEDITERRANEAN

THE SEWAGE TREATMENT SYSTEM

1) It treats the wastewater from ....

2) The average volume of wastewater treated is .... m^3/day

3) The process: Step (1) .... Purpose .... Products ....

Step (2) .... Purpose .... Products ....

Step (3) .... Purpose .... Products ....

Step (4) .... Purpose .... Products ....

Step (5) .... Purpose .... Products ....

4) The plant is in a ☐good ☐average ☐bad **condition**

5) What is the geographic location of the plant? Does the location of the plant facilitate or hinder the process? ....
....

6) What is the percentage of the volume of water produced that:
- returns to the sea ....%
- is used for a specific purpose e.g. in irrigation ....%

7) How much electricity does the plant consume to function and how is it produced? ....
....

8) How is the sludge that is produced being used? ....
....

9) What is the carbon footprint of the production of water?...

10) Is this water suitable for drinking? ....

What else needs to be done?...
....

→ What was the most interesting part of the activity for you? ....
....

→ Did you find some parts of the activity difficult? Explain what and why it was difficult. ....
....

→ Any other observation or suggestions that are not included in the above questions? ....
....

Write the following words with arrows pointing to the appropriate places on the sketch.
screening, sedimentation tank (primary settlement), biological treatment, secondary settlement, tertiary treatment, sludge digestion

If you noted differences between what is depicted in the sketch and what you noted during the visit amend or re-draw the sketch to include what you have identified.

THE DESALINATION PLANT

1) Water input comes from ....

2) The process: Step (1) .... Purpose .... Products ....
Step (2) .... Purpose .... Products ....
Step (3) .... Purpose .... Products ....
Step (4) .... Purpose .... Products ....
Step (5) .... Purpose .... Products ....

3) The plant is in a ☐ good ☐ average ☐ bad condition

4) What is the geographic location of the plant and why was it installed in its present location? ....
....

5) What percentage of the desalinated water derived from the plant is used for:
- domestic/tourism use ....% - industrial uses ....% - agricultural uses ....%

6) How much electricity does the plant utilise in order to function and how is it produced? ....
....

7) What type of 'waste' is produced by the desalination plant? ....

Where is it discharged? ....

How long is the discharge pipeline? ....

Are there adverse effects? ....

8) What is the carbon footprint of the desalination plant? ....
....

9) Is this water suitable for drinking? ....

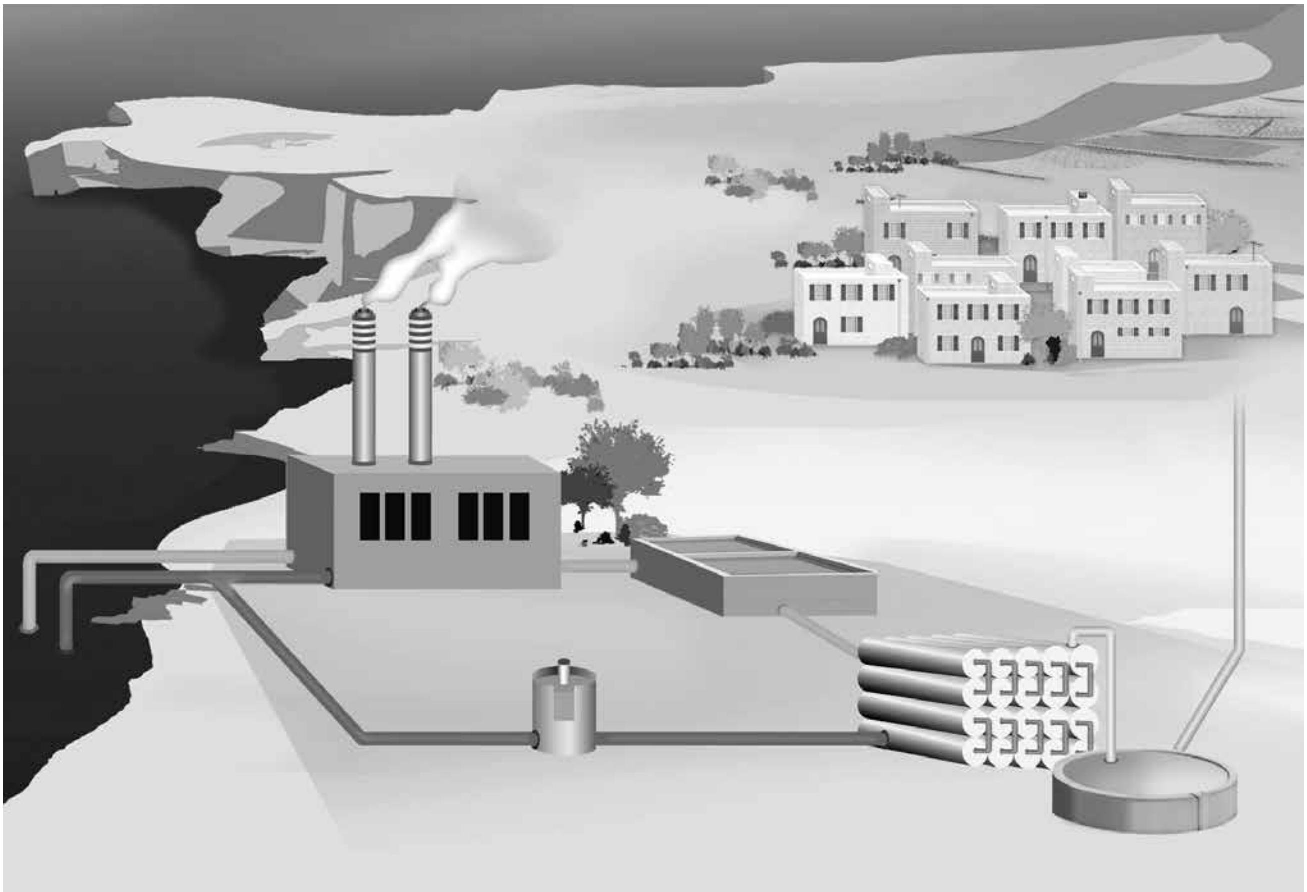
→ What was the most interesting part of the activity for you? ....
....
....

→ Did you find some parts of the activity difficult? Explain what and why it was difficult. ....
....
....

→ Any other observation or suggestions that are not included in the above questions? ....
....
....

Write the following words with arrows pointing to the appropriate places on the sketch.
intake pipes, power station, pre-treatment, reverse osmosis, post-treatment, distribution network, energy turbine, outtake / discharge pipes

If you noted differences between what is depicted in the sketch and what you noted during the visit amend or re-draw the sketch to include what you have identified.



THE RAINWATER HARVESTING SYSTEM

1) Collects water from ....

Water passes through .... which are placed ....

The system is made of ....

2) Stores water in .... having a volume of .... m^3

which is (where) ....

The system is made of ....

3) Distributes water through .... to ....

Which is placed ....

The system is made of ....

The pump used is ☐ hand powered ☐ wind powered ☐ electrically powered

The system is in a ☐ good ☐ average ☐ bad condition

→ What was the most interesting part of the activity for you? ....

....

....

....

→ Did you find some parts of the activity difficult? Explain what and why it was difficult. ....

....

....

....

→ Any other observation or suggestions that are not included in the above questions? ....

....

....

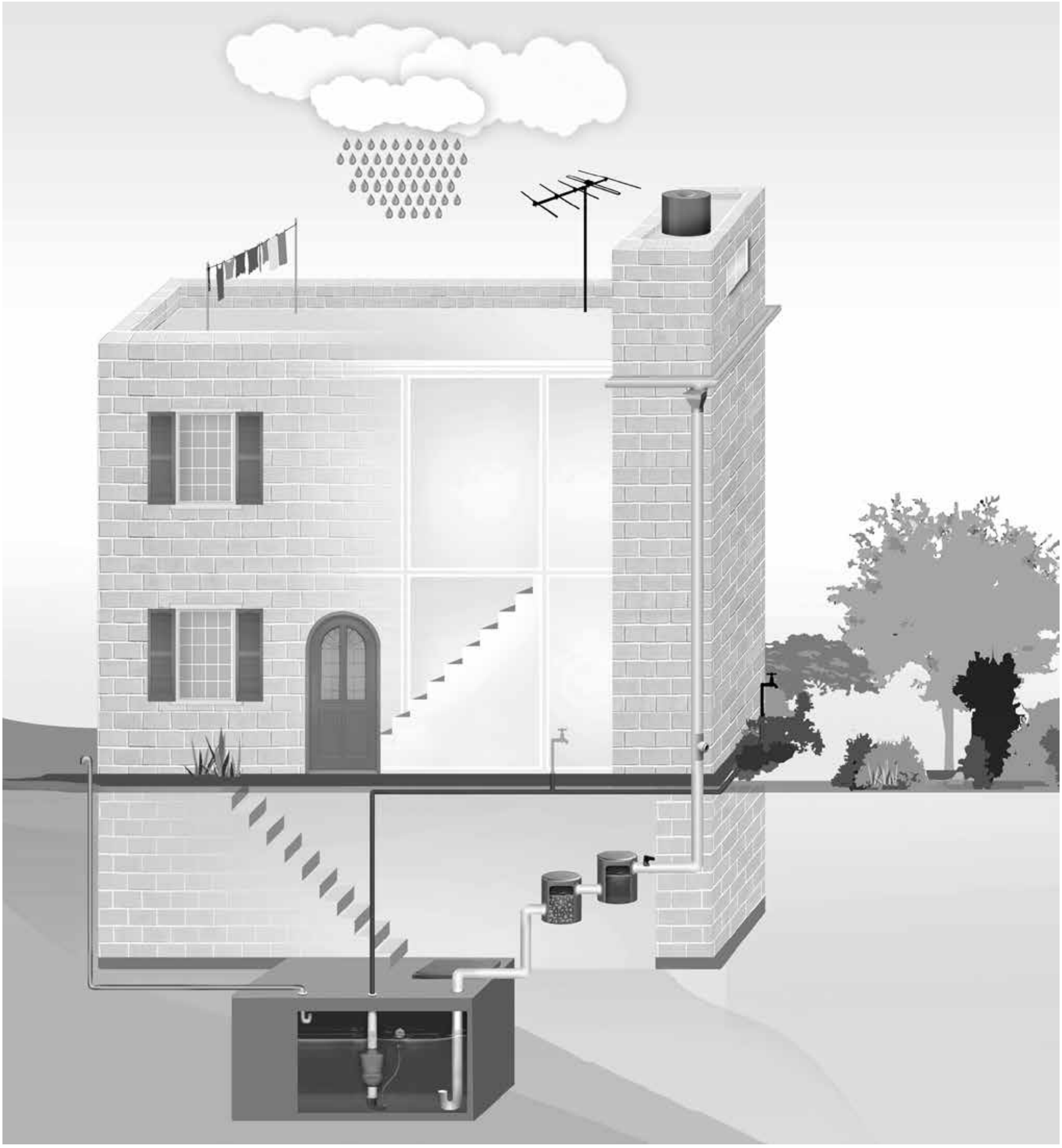
....

....

....

Write the following words with arrows pointing to the appropriate places on the sketch.
collection surface, gutter, screen filter, storage tank, settling filter, sand filter, overflow pipe (siphon), pump, circulation pipes

If you noted differences between what is depicted in the sketch and what you noted during the visit amend or re-draw the sketch to include what you have identified.



THE GREYWATER SYSTEM

1) Collects water from ....

2) Stores water in .... which has .... m^3 volume

which is (where) ....

made of (materials) ....

Then water passes through ....

Is the storage tank big enough, just the right size or never filled to the top? ....

....

3) Water is treated through the usage of ....

4) Water is distributed through .... to ....

5) The system is in a ☐ good ☐ average ☐ bad condition

→ What was the most interesting part of the activity for you? ....

....

....

....

→ Did you find some parts of the activity difficult? Explain what and why it was difficult. ....

....

....

....

→ Any other observation or suggestions that are not included in the above questions? ....

....

....

....

....

Write the following words with arrows pointing to the appropriate places on the sketch.
screen, collection tank, (aeration) pump, filter, storage tank, disinfection, overflow siphon, (distribution) pump, control unit

If you noted differences between what is depicted in the sketch and what you noted during the visit amend or re-draw the sketch to include what you have identified.

(A) RAINWATER HARVESTING

Location ....

Date (day/month)	*Height (mm)*
Average (month)	
Average (year)	

Did you find any differences between the data you collected and the reading given by the weather service station?

☐ yes ☐ no

Possible reasons: ....

....

(B) GREYWATER SYSTEM

What does the water look like before filtration?

Colour: ....

Turbidity: ....

Odour: ....

What does the water look like after filtration?

Colour: ....

Turbidity: ....

Odour: ....

What is the residue on the filter? ....

....

(C) DESALINATION

Describe what happens when you heat the water in the flask. ....

....

Describe what happens in the rubber tube. ....

....

Could you spot some changes in the bowl? Why? ....

....

→ What was the most interesting part of the activity for you? ....

....

→ Did you find some parts of the activity difficult? Explain what and why it was difficult. ....

....

→ Any other observation or suggestions that are not included in the above questions? ....

....

....

ROLE CARDS

THE MEMBERS OF THE PLANNING BOARD

The **engineer** supports the option of installing a greywater system using the most modern and appropriate technology to ensure good water quality. The greywater that will be collected would derive from hand washing sinks and showers (in a sports area). The treated greywater will be used for flushing toilets and watering the school garden. This way significant water saving can be attained thus safeguarding natural resources. In parallel, the system reduces the load carried by the septic tank or sewage system. In the medium/long run it may turn out to be very cost effective too.

The **environmentalist** opts for the installation of a rainwater harvesting system, as it can save important amounts of freshwater – using the collected water to flush toilets and to water the school garden. The school premises provide a particularly big collection surface (roof and yards). A rainwater harvesting system has lower cost demands compared to a greywater system that uses more complex technology. Having a rainwater harvesting system or a greywater system on the school premises sensitises students to work towards economising water and embracing an environmental-friendly lifestyle. Yet, if priority for investment is given to a greywater system then the installation of a rainwater harvesting system may be delayed or abandoned.

The **treasurer** is against installing either greywater treatment or rainwater harvesting system because such installation costs cannot be afforded. The money available barely meets the school completion costs. Additionally s/he argues that "water is not so expensive" locally and conventional water use is paid gradually. The economic benefits from the installation of the NCWR systems are long term and rather insignificant. The construction of the new school building should be based on the most cost-effective option; but at the same time NCWRs are sustainable options. Provision for the future can be considered.

The **Mayor** raises the issue of the technical requirements and the costs of NCWR systems. The Mayor proposes to simply connect the new building with the water system, taking water from the desalination plant that already exists. The desalination plant provides the area with water regardless of the weather conditions – whether it rains or not - also during high water demand periods (i.e. the tourist season). But s/he admits that to connect to the desalination plant, piping costs are high because of the distance and that some additional water collected from NCWRs should be regarded as a future option.

The **moderator** facilitates the whole discussion: takes note of the arguments raised, gives equal time to speakers and ensures that the persons on the panel do not deviate from the subject. During the process the moderator may ask the speakers to clarify their points, s/he should restrain from taking sides, at least not before the concluding discussion.

NOTES TO BE KEPT BY THE AUDIENCE (CITIZENS)

	The environmentalist	The engineer	The treasurer	The Mayor
Opinion / Position				
Strong arguments (in key-words)				
Weak points (in key-words)				
Behaviour e.g. gestures, expressions, temper, listening to the others				
Does s/he have a conciliatory attitude?				

What was your initial position? ....

....

Did it change by participating in this activity? Why? ....

....

REFLECTION

→ How did you feel during the role play?..

....

→ If you were to repeat your part, would you change anything?..

....

→ In case you experience a similar real situation in the future how would you behave? ....

....

→ Did you find some part of the activity difficult? Please explain. ....

....

Rewrite the diary entry imagining that you are one of the characters in the story.

Clearly write which character you are. ....

How do you think a neighbour would have recorded the events? ....

Continue the story. ....

1) WATER SAVINGS

Calculate the quantity of water used to wash your hands while:	Litres (ℓ)
a) keeping the water running while washing	
b) turning the tap off while washing	
Amount of water saved:	
Amount of water that could be saved in a school day (by every person in school washing their hands ~ 3 times a day):	
Amount of water saved within a school year:	

2) THE WATER TASK FORCE

Average quantity of water used in the school during the previous school year:	m^3
Condition of water system - pipes, taps, tanks	☐ leakages .... ☐ damages.......................... ☐ repairs needed................. ....

3) IF RAINWATER IS COLLECTED...

Catchment area surface (A)
(E.g. the school building's roof and/or yard surface) ....m^2

Average annual rainfall (R)
(Check information from the Weather Service or as you have calculated in Activity 4) ....mm

Amount of rainwater that can be collected = A * R/1000 * drainage coefficient ....m^3

→ What was the most interesting part of the activity for you? ....

....

→ Did you find some parts of the activity difficult? Explain what and why it was difficult. ....

....

→ Any other observation or suggestions that are not included in the above questions? ....

....

....

alter aqua

NEWS PIECE A

Name of media

Title

Date published/uploaded/presented

Name of author/editor/reporter

Subject

Keywords related to the subject

Main issues presented ....

....

What are the positions and arguments presented? ....

....

NEWS PIECE B

Name of media

Title

Date published/uploaded/presented

Name of author/editor/reporter

Subject

Keywords related to the subject

Main issues presented ....

....

What are the positions and arguments presented? ....

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NEWS PIECE C

Name of media

Title

Date published/uploaded/presented

Name of author/editor/reporter

Subject

Keywords related to the subject

Main issues presented ....

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What are the positions and arguments presented? ....

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1) Type of water structure: ☐Fountain ☐Aqueduct ☐Cistern ☐Other (specify):

2) Materials used for its construction: ....

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....

3) Are these materials abundant in the area or have they been transported from elsewhere? ....

....

4) What are the main parts of the monument i.e. does it include any pipes, reservoir, basin/s, roof, pillars, channels, taps, openings, etc. Describe its shape and architecture. ....

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5) Are there any decorations on the monument? Do these decorations have any particular meaning? ....

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6) What is the date or period of this construction?..

7) How is this monument called or known as? ....

8) Have you discovered any local tale, legend, tradition, song, proverb, etc., linked to the monument? ....
Describe it in a few lines..

....

....

9) Design your own water fountain or cistern or aqueduct on the back of this paper.

→ What was the most interesting part of the activity for you? ....

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→ Did you find some parts of the activity difficult? Explain what and why it was difficult. ....

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→ Any other observation or suggestions that are not included in the above questions? ....

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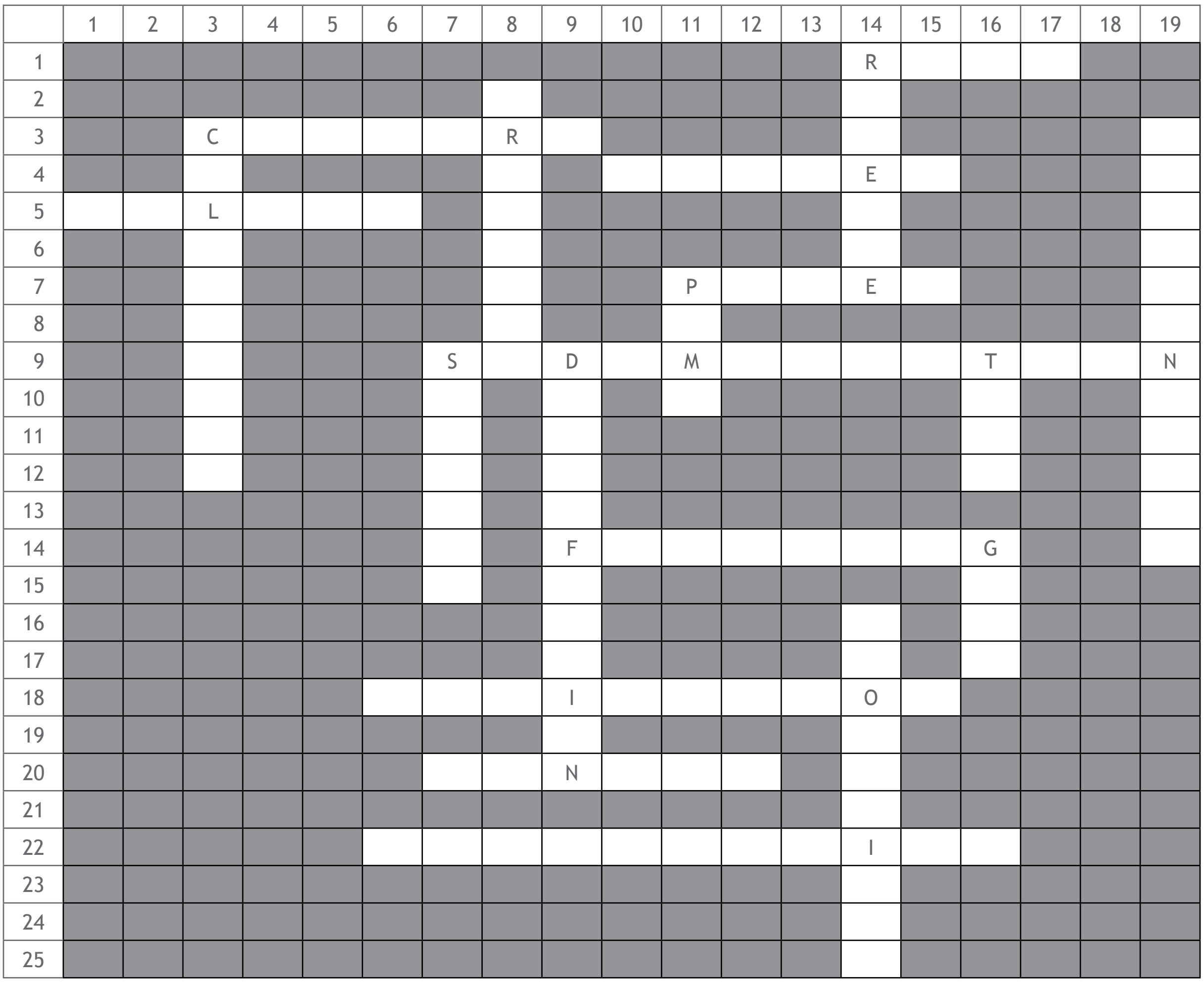

HORIZONTAL

1. The most common type of precipitation.
3. Water is stored in it.
4. A narrow trough or duct which collects rainwater from the roof of a building and diverts it usually into a drain.
5. It is used in order to remove solid particles from a liquid.
7. The water system is… full of them!
9. The process through which solid particles settle to the bottom of a tank.
14. It is the major water consumer in a household!
18. The largest consumer of water in the Mediterranean countries.
20. The flow of water, from rain, melting snow, or other sources, over the land.
22. The phenomenon of transition from the liquid to the vapour state that occurs on the surface of a liquid.

VERTICAL

3. This is the first step in a rainwater harvesting system.
7. People need to do this in order to have a water supply throughout the year.
8. The removal of groundwater or surface water, or of water from structures, by gravity or pumping.
9. A necessary process to kill the microorganisms that live in the water.
11. A machine that forces water (and other liquids) to move towards a desired direction.

14a. This type of osmosis is often used to desalinate water.

14b. With this type of treatment the organic matter contained in wastewater is decomposed by bacteria.

16a. Another word for reservoir.

16b. The wastewater coming from showers and baths, wash basins and washing machines.

19. The process through which the salt is removed from water.