EDUCATIONAL PACKAGE

Water in the Mediterranean

to facilitate Education for Environment and Sustainability

and

promote Integrated Water Resources Management

Global Water Partnership
(GWP, GWP-Med)

Hellenic Ministry for Environment,
Physical Planning and Public Works

European Commission - DG Environment
(EC-DG ENV)

- United Nations Environment Programme
- Mediterranean Action Plan (UNEP/MAP)

United Nations Educational,
Scientific and Cultural Organization (UNESCO)

University of Athens

Mediterranean Information Office
for Environment, Culture and Sustainable Development

EDUCATIONAL PACKAGE

Water in the Mediterranean

to facilitate Education for Environment and Sustainability

and

promote Integrated Water Resources Management

• Argyro ALAMPEI • Aristea BOULOUXI
• Vasiliki MALOTIDI • Stavroula VAZEOU

• Scientific Coordinator: Prof. **Michael J. SCOULLOS**

• Athens | 2001

MIO-ECSDE
Mediterranean Information Office for Environment, Culture and Sustainable Development
✉ 28, Tripodon str. | 105 58 | Athens, Greece
(+3010) 3247490, 3247267 • 3225240
mio-ee-env@ath.forthnet.gr • www.mio-ecsde.org

Authors
Prof. **Michael J. SCOULLOS** • Scientific and Academic Coordinator
Argyro ALAMPEI • **Aristea BOULOUXI** • **Vasiliki MALOTIDI** • **Stavroula VAZEOU**

Text Editing
M.J. Scoullos • **A. Roniotes** • **C. Roniotes** • **A. Arsenikou**

Collaborating NGOs
Arab Office for Youth and Environment (AOYE)
Association for the Protection of Nature and Environment Kairouan (APNEK)
Club Marocain d' Education en Matiere de Population et d'Environnement (CMEPE)
Federation of Environmental and Ecological Organisations of Cyprus (FEEOC)
Green Steps for Environmental Literacy (GSEL)
Society for the Protection of Nature Israel (SPNI)

Coordination of Production
Bessie Mantzara • **Vangelis Constantianos**

Computer editing
S. Arsenikos

Art Direction
Oxy creative team

We would like to thank all those who worked for the completion of this package especially **D. Papadopoulos** for his contribution in activities **6c** and **9c** and the correlating paragraph in the theoretical section.

Sources of Photos Used in the Activities:
• **1a, 9e**, taken from: *History of Hellenic Nation* (Greek Encyclopedia), Athens Publishes • **4a**, taken from: Schmitz R., Reiniger P., Pero H., Quenauviller P., Warras M., *Europe and Scientific and Technological cooperation on water*, 1994 • **4f (1)**, taken from Parco Termale Acquatico, Grado, Italy, Italia, Azienda di Promozione Turistica di Grado e Aquileia • **(2)**, taken from Universite des Nations Unies, Reseau International de l'eau, de l'environment et de la sante (RIEES) • **6d**, taken from: *Με αφορμή μια στάμνα*, Psaropoulou Institute, Exhibition Catlogue, Athens, 1999 • **7g**, taken from Symposium on land degradation and poverty, IFAD, Chamber of Deputies, Palazzo San Macuto, Sala detReffetorrio, Rome, June 1995 • **8c**, Karapanagiotis B., Papastamatiou N., Fertis A., Chaletsos C, Physics, 9th Grade, Hellenic Republic, Ministry for Education and Religious Affairs • **7e** taken from: *Biodiversity: Questions and Answers...* Centre Naturopa, Council of Europe, 1996 • **7f**, **8b**, **9f** offered by Th. Papapavlou • **9b**, taken from *A B C Naturally!*, Mamata Pandya, South Asia Co-operative Environment Programme (SACEP), UNEP, 1994.

ISBN: 960-86312-3-8

This package should be cited as:
Scoullos, M., Alampei A., Boulouxi A., Malotidi V., Vazeou S., «Water in the Mediterranean», Educational Package, MIO-ECSDE and GWP-Med, Athens, 2001

«Contributing to water wisdom»

In order to reach the objective for sustainable use of water, we have to learn how to manage in an integrated way water resources and change in a positive way our behaviour and our overall «water culture». An unmistakable way to learn and enhance our willingness and abilities to act more wisely for the protection of the environment and the management of natural resources in the framework of sustainable development, is to strengthen Education in general and for All but also to work systematically with more specific forms of education, focusing on selected issues such as water. Water in this case, is not only the subject of our immediate concern but also the vehicle employed in order to introduce the student to the entire cluster of sustainability concepts, principles and practices.

The present package attempts to present a coherent process, which tries to combine current educational theory and practice with the initiatives and inputs from all possible sources and competent bodies, in order to obtain a product useful for educators and students of the first years of the secondary school. The material was designed, primarily, for the Mediterranean region. However it is structured in a way that can be easily adapted to other regions, as well as, for students of other education grades.

The process, which produced this educational package, started as collaboration between MIO-ECSDE and the University of Athens, with a postgraduate thesis of a group of students, of the ΔιΧnNET Course for Educators, under my instruction and supervision. All relevant material from UNESCO, UNEP, EEA, GWP and GWP-Med, as well as other input from the World Water Forum II (held in the Hague in 2000), were used as sources of information, together with basic references and the outcomes of UNECSO Conferences, such as the one held in Thessaloniki (1997).

The package, apart from being tested in greek schools, it was presented to a number of seminars, translated in English and distributed for experimental application and comments to educators of formal and informal education. The educators, come from six Mediterranean countries (Cyprus, Egypt, Israel, Morocco, Tunisia and Turkey) and belong to a nucleus of «Educators for Environment and Sustainability» working in the framework of the MIO-ECSDE network. This first part of the work was supported by the Greek Government, in the framework of the DAC-OECD Programme.

The comments and recommendations received from the educators and other sources were incorporated to the original material and a thoroughly amended new version was produced. Since the educational material is only one part of a continuous and dynamic education and public awareness process, the package will not remain «static» and unchanged but it will evolve. Comments will be collected, the theoretical part may be improved, while the 45 activities of the second part could be amended, replaced or complemented. The folder is designed in such a way that certain alterations could be made without difficulty.

The package is going to be reproduced in many thousands of copies in eight languages, to be distributed in all Mediterranean countries. This ambitious undertaking has become part of an educational and awareness campaign (complemented and combined also with a series of exhibitions for each country) of GWP-Med, supported by the Global Water Partnership (GWP), the Commission of the European Union - DG Environment, as well as UNEP and UNESCO. We plan to present the whole process in the World Water Forum III in Kyoto in 2003.

I am most grateful to all the aforementioned important organizations for their material and/or moral support, confidence, encouragement and collaboration.

Sincere thanks are due to:

- The University of Athens, ΔιΧnNET and its coordinator Prof. C. Tzougraki, for the excellent collaboration.
- My good and hardworking students, Argyro Alampei, Aristea Boulouxi, Vasiliki Malotidi, Stavroula Vazeou, whom the names appear also as co-authors.
- Prof. Mohamed Ftouhi, Ms. Fatma Akil and Mr. Mohamed Meluk from Morocco,
- Mr. George Sycallides, Ms. Antonia Theodosiou and Mr. Angelos Papageorgiou from Cyprus,
- Mr. Salah Azab, Ms. Hanaa El Gohary, and Mr. Essam Nada from Egypt,
- Ms. Leyla Celikel, Ms Gurlu Hotinli and Ms. Melek Tala from Turkey,
- Mr. Ameur Zeridi and Mr. Youssef Nouri from Tunisia,
- Mr. Eli Katz, Ms. Nana Oren and Ms. Edna Yahav, from Israel,

who have tested the original material and contributed valuable comments and amendments

- To MIO-ECSDE experts: Mr. Spyros Arsenikos, Mr. Vangelis Constantianos, Ms. Bessie Mantzara and Ms. Anastasia Roniotes for their valuable contribution in editing, designing and production of the present series.
- To the publisher «OXY publications» for their careful and artistic work.

Prof. Michael J. Scoullos
Chairman of MIO-ECSDE
Chairman of GWP-Med

Messages

Commission of the European Union - DG ENV

Water has always been in the centre of attention of the European Union since the beginning of the formulation of the Common European Policies. Among many problems associated with water, in the north of Europe we have experienced the acidification of lakes and rivers and increase of levels of nitrates in ground waters, while in the south draughts in combination to intensive water abstraction for irrigation has resulted in ground water salinization, drying out of wetlands and runoff pollution of critical water bodies.

The new water framework Directive is expected to contribute significantly in properly addressing these problems and the overall integrated water resources management for the present and the future generations.

I believe the present educational package provides an excellent tool assisting the work of educators who wish to focus this precious natural resource of Europe and more so of the Mediterranean region.

I am very glad that the European Commission is associated with this excellent initiative of MIO-ECSDE and I wish full success in the Educational and Public Awareness campaign.

Ms. Margot Wällstrom
Commissioner, DG ENV

Hellenic Ministry for the Environment, Physical Planing and Public Works

The Ministry for the Environment, Physical Planning and Public Works of Greece is very interested for the promotion of public awareness and Education for Environment and Sustainability, particularly in all issues related to water. Therefore, we greet with pleasure the circulation of the present package published by MIO-ECSDE.

The Policies of our Ministry related to water management take seriously into account the various problems and options identified in the relevant analyses of GWP and other international organizations, as well as the guidelines of Agenda 21 of Rio and the directives of the European Union. Our efforts to approach IWRM will be intensified in view of the Greek presidency of EU in 2003 which coincides with the WWF3.

It is my very strong belief that the Mediterranean waters and rivers such as Nile, Evros, Alfeios, Aoos, Po, Rhone and Ebro must become crossroads that will unite us. Our education focusing on them will, hopefully, lead us to a new Culture of the 21st Century, making the Mediterranean again the cradle of the new civilization based on peace and sustainability.

Ms. Rodoula Zisi
Deputy Minister for the Environment,
Greece

Global Water Partnership - GWP

It's an interesting fact that our thought and perceptions on what is important mostly derive from the first time we come across issues - often in school. So how we think about something as basic and essential as water - If we think about it all - probably derives from and early discussion with a teacher or parent. On the global level, education holds the key to sustainable, self-reliant development; we must continue and enforce the priority for girls' education, particularly at the primary and secondary levels. There is no other tool that has yielded such positive results simultaneously in the areas of food production, community level income, fertility decline, and later age of marriage. We can be certain that in the future, it will have a similar impact in water management.

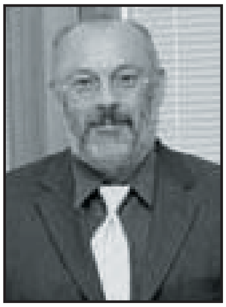
Ms. Margaret Catley-Carlson
Chair, GWP

United Nations Environment Programme - UNEP

The United Nations Environment Programme welcomes this educational initiative Water in the Mediterranean by MIO-ECSDE to inform the public about the importance of the sustainable use of water. Water for Development, the theme of this years World Water Day (22 March) aptly sums up the link between the sustainable use of water and the health and well-being of the planet and its people.

Water is a key element of sustainable development because it is an essential component of life and income generating activities. If managed appropriately, water is a vital contributor to poverty reduction. The sustainable use of water provides economic benefits through good health and income generating activities, including food production. Conversely, poor management of water results in unbearable health and ecosystem costs through pollution, disease and ultimately economic collapse. Let us act together responsibly to ensure water for all, for a better future.

Mr. Klaus Toepfer
Executive Director, UNEP



United Nations Educational, Scientific and Cultural Organization - UNESCO

Water is widely recognized to be one of the key factors to sustain life. This is as much true for every individual living creature as it is for societies and, in fact, for the whole human civilization.

This global truth manifests itself with particular emphasis in the Mediterranean Sea. In the Mediterranean basin, humanity has proved that organized water use and protection against water-related natural calamities were the basis of the development. Successes and failures of these cultures underline the importance of also addressing the question of sustainability. I therefore particularly welcome this initiative: to bring the subject into schools, to let the young generation be educated and aware of the value of water and our responsibility for it. The fragile environment of the Mediterranean makes efforts even more important than elsewhere.

This initiative, on the eve of the World Summit on Sustainable Development, being held in Johannesburg in August/September 2002, is very timely. UNESCO has also chosen for its present Medium Term Strategy (2002-2007) water and supporting ecosystems as the principal priority for the Sector of Natural Sciences. We consider the initiative of MIO-ECSDE as an additional dimension, strengthening UNESCOs water initiatives by extending the scientific and professional concern into the domain of education and public awareness raising.

I congratulate MIO-ESCDE for its excellent initiative and well chosen targets.

Prof. Walter R. Erdelen,
Assistant Director-General for the
Natural Sciences, UNESCO

Global Water Partnership | GWP

Building a worldwide network
promoting integrated water resources management

The Global Water Partnership is a working partnership among all those involved in water management: government agencies, public institutions, private companies, professional organizations, multilateral development agencies and others committed to the Dublin-Rio principles.

Today, this comprehensive partnership actively identifies critical knowledge needs at global, regional and national levels, helps design programs for meeting these needs, and serves as a mechanism for alliance building and information exchange on integrated water resources management.

The mission of the Global Water Partnership is to *«support countries in the sustainable management of their water resources.»*

The GWP's objectives are to:

- Clearly establish the principles of sustainable water resources management,
- Identify gaps and stimulate partners to meet critical needs within their available human and financial resources,
- Support action at the local, national, regional or riverbasin level that follows principles of sustainable water resources management,
- Help match needs to available resources.

Although it is widely understood that water should be holistically managed, it was not until the Dublin Conference on Water and the Environment in 1992 and the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992 that a more comprehensive approach to water management was judged necessary for sustainable development. This awareness, together with the need for participatory institutional mechanisms related to water, called for a new coordinating organisation. In response to this demand, the World Bank, the United Nations Development Program (UNDP) and the Swedish International Development Agency (Sida) created the Global Water Partnership (GWP) in 1996.

This initiative was based on promoting and implementing integrated water resources management through the development of a worldwide network that could pull together financial, technical, policy and human resources to address the critical issues of sustainable water management.

The partnership has a decentralised, self-reliant character through its presently active nine Regional Water Partnerships (Central America, Central & Eastern Europe, China, Mediterranean, South Africa, South America, South Asia, South East Asia, West Africa) and twenty Country Water Partnerships.

For more information please contact:

GWP Secretariat
Sveavägen 24-26, 7th floor
SE-105 25 Stockholm, Sweden
Tel: +46 (0) 8 698 5000
Fax: +46 (0) 8 698 5627
E-mail: gwp@sida.se
Web: www.gwpforum.org

Global Water Partnership - Mediterranean (GWP-Med)

The Global Water Partnership Mediterranean (GWP-Med) is a Regional Water Partnership under the global GWP umbrella. The idea to create GWP-Med, first as a Mediterranean Technical Advisory Committee (MEDTAC) was discussed within GWP in Stockholm in August 1997 and 1998. The establishment of MEDTAC was decided in Nicosia (1998) and its transformation to a regional water partnership as GWP-Med in Nice, June 2001. Today, GWP-Med is an open platform bringing together competent organisations from all over the Mediterranean.

The ultimate goal of GWP-Med is to promote the sustainable use of water resources in the Mediterranean region through their integrated management, within the general framework of the GWP.

To achieve its goal, GWP-Med:

- Promotes and sustains a strong partnership in the Mediterranean among competent organisations that have an impact on water management.
- Makes the principles of sustainable use and integrated management of water resources (IWRM) widely known, recognised and applied by all stakeholders in the Mediterranean, through appropriate mechanisms for sharing information and experience.
- Supports exemplary actions at local, national and regional level that demonstrate the value applicability and positive impact of the above principles.
- Seeks and facilitates the appropriate international funding and involvement of international institutions for activities.
- Introduces, helps to implement and adapts to the specificities of the Mediterranean region, global initiatives launched or adopted by the GWP.

The main organs of GWP-Med are the: Membership Platform, the Partnership Council and the Advisory Board. The Members of the GWP-Med Partnership Council (2002) are seven Mediterranean organisations / institutions with regional coverage and activity:

- Blue Plan (MAP/UNEP)
- CEDARE Centre for Environment and Development in the Arab Region and Europe
- CIHEAM International Centre for Advanced Mediterranean Agronomic Studies
- IME Mediterranean Institute for Water
- MedWet The Mediterranean Wetlands Initiative
- MIO-ECSDE - Mediterranean Information Office for Environment, Culture and Sustainable Development
- MWN Mediterranean Water Network

The main GWP-Med (former MEDTAC) products (1999-2000) were: *the Mediterranean Vision on Water, Population and the Environment* (Vision), *the Framework for Action for the Mediterranean: Achieving the Vision for the Mediterranean* (FFA), *the Mapping and the Core for Action Plan.*

At present, GWP-Med while solidifying and expanding the regional partnership, is working to achieve its main goals through its elaborate Work Programme of activities.

For more information please contact:

GWP-Med Secretariat
c/o MIO-ECSDE
28, Tripodon str., 10558 Athens, Greece
Tel: +3010-3247490, -3247267, Fax: +3010-3225240
E-mail: secretariat@gwpmed.org
Web: www.gwpmed.org

Mediterranean Information Office for Environment, Culture and Sustainable Development / MIO-ECSDE

The profile of MIO-ECSDE

The Mediterranean Information Office for Environment, Culture and Sustainable Development, is a Federation of Mediterranean Non-Governmental Organisations (NGOs) for Environment and Development. MIO-ECSDE acts as a technical and political platform for the intervention of NGOs in the Mediterranean scene. In co-operation with Governments, Intergovernmental and International Organisations and other socio-economic partners, MIO-ECSDE plays an active role for the protection of the environment and the promotion of the sustainable development of the Mediterranean Region and its countries.

Background

MIO-ECSDE became a Federation of Mediterranean NGOs in March 1996. Its roots go back to the early 80's, when the expanding Mediterranean membership of the European Community encouraged the European Environmental Bureau (EEB) to form its Mediterranean Committee, supported by Elliniki Etairia (the Hellenic Society for the Protection of the Environment and the Cultural Heritage). The Mediterranean Information Office (MIO) was established in 1990 as a network of NGOs, under a joint project of EEB and Elliniki Etairia and in close collaboration with the Arab Network of Environment and Development (RAED). The expansion of MIO-ECSDE's Mediterranean NGO network and the increasing request for constructive and structured NGO opinions and representation in Mediterranean and International Fora, led to the transformation of MIO-ECSDE to its current NGO Federation status.

Main Objective

To protect the Natural Environment (flora and fauna, biotopes, forests, coasts, natural resources, climate) and the Cultural Heritage (archaeological monuments, traditional settlements, cities, etc.) of the Mediterranean Region. The ultimate goal of MIO-ECSDE is to promote Sustainable Development in a peaceful Mediterranean.
Major tools and methods used by MIO-ECSDE in order to achieve its objectives are the following:

- Promotion of understanding and collaboration among the people of the Mediterranean, especially through their NGOs, between NGOs and Governments, Parliaments, Local Authorities, International Organisations and socio-economic actors of the Mediterranean Region at all levels.
- Assistance for the establishment, strengthening, co-operation and co-ordination of Mediterranean NGOs and facilitation of their efforts by ensuring the flow of appropriate information among relevant bodies.
- Promotion of education, research and study on Mediterranean issues, by stimulating collaboration between NGOs and scientific and/or academic institutions.
- Raising public awareness on crucial Mediterranean environmental and social issues, through campaigns, publications, exhibitions, presentations, etc.

MIO-ECSDE Activities

- **Networking**

The MIO-ECSDE Secretariat contacts its Members, as well as the wider NGO network it co-operates with, regularly through its Internal Information Bulletin (8 issues per year), its well known newsletter Sustainable Mediterranean (co-published with RAED and EEB), the various publications it produces and also through its regularly updated web site.

NGO Capacity Building

MIO-ECSDE has contributed already substantially to the capacity building of Mediterranean NGOs through its international residential training workshops on environmental issues for leading members and staff of Mediterranean NGOs. Such workshops take place on an annual basis, focussing progressively on more specific issues.

Promotion and Drafting of Common NGO Policies

As the major and most representative Federation of Mediterranean NGOs, MIO-ECSDE has managed to promote common NGO policies and to reinforce the collective voice of the Environment and Development citizens' organisations at international fora and conventions. In several cases, MIO-ECSDE has drafted and proposed common NGO policies; position papers and memoranda adopted by the widest possible environmental NGO movement and has represented the Mediterranean NGOs in major international conferences (Ministerial, Intergovernmental, etc.) and processes, presenting the NGO Declarations and views.

MIO-ECSDE has organised, alone or with other NGOs, a large number of particularly successful and influential conferences and meetings aiming to consolidate the NGO views on critical issues, such as Sustainable Development (Athens, 21-24 November 1991), Water (Rome, 24-27 October 1992; Athens, 17-19 March 1994; Athens, 2-4 November 2000; Cairo, 19-21 December 2001), Agenda MED-21 (Tunis, 27-28 October 1994), Waste (Cairo, 6-8 December 1999; Athens, 17-18 April 2000) Euro-Mediterranean Cooperation and the Barcelona Convention (Cairo, 26-27 April 1992; Barcelona, 2-4 June 1995; Stuttgart, 14-15 April, 1999), Environmental Education (Athens, 26-30 June 1995; Thessaloniki, 6-7 December 1997; Athens, 18-19 December 1998), Solid Wastes (Cairo, 6-8 December 1999), Trends in Production, Uses and Policies on Heavy Metals (EUPHEMET) (Athens, 17-18 April 2000), Towards a Mediterranean Core Action Plan for Water Stakeholders and Decision Makers (Athens, 2-4 November 2000), Sustainability of Archaeological Environments through Cultural Events (Nafplion, 6-7 September 2001), the Impact of Tourism on Water in Mediterranean Islands (Cyprus, 7-9 November 2001), the Mediterranean Contribution to the Johannesburg World Summit for Sustainable Development (Monaco, 13 November 2001), etc. It has also supported the organisation of a number of Roundtable discussions throughout the Mediterranean on some of the aforementioned issues, as well as others such as public participation and funding mechanisms for NGOs.

International Collaborations

MIO-ECSDE collaborates closely with the Commission of the EU, MAP/UNEP, UNESCO and other International and Regional Governmental Organizations (UNDP, IFAD, METAP, World Bank, EIB) and existing scientific and other Networks and Federations (EEB, RAED, FoE, WWF, RAMSAR Convention, MED Forum, CIESM, MEDCITIES, MEDMARAVIS, MEDPAN, MEDWET, IUCN, GWP, CREE, etc.).

MIO-ECSDE is a member of the Mediterranean Commission on Sustainable Development (MCSD), which was established in the framework of the Barcelona Convention and has acted as Task Manager of its Thematic Group on "Information, Awareness, Environmental Education and Participation", while it participated, as a member, in several other thematic groups. It is accredited by the United Nation's International Convention to Combat Desertification (CCD).

MIO-ECSDE is the Host Institution of the Global Water Partnership-Mediterranean (GWP-Med)(former MED TAC - Mediterranean Technical Advisory Committee). The members of the GWP-Med Partnership Council are: Blue Plan (MAP/UNEP), CEDARE, CIHEAM, IME, MedWet, MIO-ECSDE and MWN. GWP-Med aims in promoting IWRM in the Mediterranean.

MIO-ECSDE participated from the very beginning in the setting up and development of various loose cooperation schemes: One of these focuses on the Euro-Mediterranean Partnership issues. It is known as "Comité de Suivi" and comprises of seven NGO networks active at European and Mediterranean level (EEB, ENDA, FoE, MedForum, MIO-ECSDE, RAED, WWF).

Raising Public Awareness, Participation and Consensus Building

MIO-ECSDE launches and coordinates awareness campaigns with the collaboration of its member organizations on critical issues like water management (Mediterranean Water Year), waste and other issues(Mediterranean Action Day) and the creation of a Mediterranean Environment Fund ($/Euro per air ticket fund).

The participatory processes that MIO-ECSDE has initiated among NGOs since 1991 have contributed considerably to consensus building, mutual trust and solidarity in the Mediterranean and to the improvement of North-South, South-South and East-West cooperation.

Recognising the crucial importance of awareness and participation in the achievement of goals for both social and economic well-being of the Mediterranean people, MIO-ECSDE has invested considerable time in research, development and amelioration of participatory techniques leading to consensus among social partners and finally to action.

Research

MIO-ECSDE was the Mediterranean partner of the European research project "Sustainable Development for Cities and Regions - SUDECIR" (other partners: IEEP-Brussels, Taurus-Trier, Stenum-Graz) which developed a methodological framework for regional sustainable development, applied on a pilot basis on selected study areas. MIO-ECSDE's focus was on the formulation of tourism sustainability plans and emphasis was given on Mediterranean islands. MIO-ECSDE applied the SUDECIR methodology on the island of Rhodes. This expertise was used also in the framework of CAMP/Malta carried out with the help of PAP-RAC of UNEP/MAP. Now it is further transmitted and disseminated to MIO-ECSDE members through various collaboration schemes.

Environmental Education

In cooperation with UNESCO and the University of Athens MIO-ECSDE organized in 1995 the Inter-regional Workshop on Reorienting Environmental Education for Sustainable Development (Athens, June 26-30,1995). The results of the workshop were used as the basis of the International Conference on "Environment and Society: Education and Public Awareness for Sustainability" (Thessaloniki, 8-12 December 1997) - held 20 years after Tbilisi. This major Conference, attended by 1400 participants from 84 countries was, co-organised by UNESCO and the Greek Government, while its Secretarial support was undertaken by MIO-ECSDE together with the University of Athens. The most visible outcomes of the Conference were the drafting and the unanimous acceptance of the Thessaloniki Declaration and a series of positions included in the volume (900 pp) of the Conference Proceedings. These fundamental documents include, among others, principles and proposals through which the follow up process is facilitated. As a follow-up to this, MIO-ECSDE organised a Mediterranean Workshop on the Promotion of Education and Public Awareness for Environment and Sustainability in the Mediterranean, Athens, 18-19 December 1998, where the creation of a network of Environmental Educators throughout the Mediterranean cooperating with NGOs was decided. A visible product of this initiative is the currently running education project of MIO-ECSDE on water and waste, which is carried out jointly by six of its NGO members in six Mediterranean countries.

Introduction

In the last fifty years the Mediterranean countries have faced heavy pressures particularly along their coastal areas. Most of these are a direct result of human activities. Water is one of the most valuable and vulnerable natural resources anywhere on earth, but this is especially true for the Mediterranean. Water shortage and the increased demand associated to uncontrolled development, intensive agriculture, mass tourism, overpopulation and overconsumption result in a complexity of interrelated problems affecting social, economic and natural aspects of everyday life.

In order to properly address these problems an integrated policy approach is needed - *frequently referred to as Integrated Water Resources Management (IWRM)*. Through IWRM we must tackle the issue using a panoply of weapons which includes new, clean and/or appropriate technology, better allocation and preservation of water resources, legislation and economic incentives, and finally information and active involvement of citizens, users and stakeholders. To achieve the latter we need to prepare society and each individual through sound public awareness campaigns and well structured and targeted programmes on Education for Environment and Sustainability (EfES).

In general, modern societies and particularly young people seem to have a genuine interest and concern for environmental issues and the interaction between humans and the environment. Youth, once instructed through proper formal and non-formal education, become aware of their place and potential in society and tend to collaborate and act accordingly, in order to improve the environment. As youths themselves have stated, *«we need a more sustainable society and the way to start is by redefining our priorities and understand that sustainability is a main one»*. (Thessaloniki 1997).

It is extremely important that anyone about to use this package understands that appropriate education is a very significant tool in promoting the idea of better use, of conservation, respect and of integrated management of water. However, education alone cannot solve the problem. In depth understanding of all other means and aspects could create the needed synergy for concerted action and creative solutions. This is why particular effort has been invested in the present educational material to familiarize students with concepts, methods and tools.

This package is the result of the fruitful collaboration of NGOs from 7 Mediterranean countries (Cyprus, Egypt, Greece, Israel, Morocco, Tunisia, Turkey), environmental educators and a group of postgraduate students of the University of Athens, under the coordination of MIO-ECSDE and the scientific, academic and editorial supervision of prof. M. Scoullos.

The first draft form of the present package was presented in Athens, in November 2000. It was then adopted and applied in the abovementioned Mediterranean countries and evaluated during workshops and consultation meetings. Their results served as useful feedback for the amendment and enrichment of the initial material. The overall outcome is the present version of «Water in the Mediterranean», an educational package which will hopefully support the efforts of environmental educators.

As is usual in the educational process, we can never talk about a «finalised product». The present material should definitely not be considered as a finished product but rather as background material, on which comments, suggestions and input will be sincerely welcome.

Purpose of the package

The purpose of the educational package «Water in the Mediterranean» is certainly not to duplicate the various excellent initiatives on projects, materials and resources, which already exist at national level for pupils of different ages. It is an attempt to provide a useful Mediterranean-wide background resource and a collection of appropriate learning activities, to facilitate new initiatives on education for Environment and Sustainability (EfES) and/or to enhance and enrich existing work schemes, regarding water management and conservation in the Mediterranean region.
The package is designed to:

- Promote rigorous, active learning considering water as the central issue within a structured framework.
- Provide opportunities for linking a number of issues critical to water management with national curricula subjects and cross curricula themes.
- Facilitate educators to plan their own new work schemes and introduce new water topics of regional or local relevance.

One of the long-term goals of EfES, to which this package tries to contribute, is for students/citizens to develop the ability to *«learn how to learn»* throughout their lives, through continuous acquisition of knowledge and new skills.

The main objectives of the package are: To provide knowledge and comprehension, to develop the ability to analyse and synthesize, to assess and evaluate information useful for the protection of the environment as a whole, and water in particular, to adopt behaviour and to develop attitudes, skills and abilities in order to adjust one's life towards sustainable development and towards active protection of the Environment.

The educational objectives of this package are, in fact, classified following *Bloom's taxonomy*. Benjamin Bloom is recognized as a leader in the pursuit of defining educational objectives. In 1956 Bloom headed a group of educational psychologists, developing a classification system *(taxonomy)* of educational objectives. He divided his findings into three domains:

The COGNITIVE: The cognitive domain involves knowledge and the development of intellectual skills. There are six major categories, given below, in order of complexity from the simplest to the most complex:

1. **Knowledge:** remembering or recognising something previously encountered, without necessarily understanding, using or changing it.
2. **Comprehension:** understanding the material being communicated, without necessarily relating it to anything else.
3. **Application:** using a general concept to solve a particular problem.
4. **Analysis:** breaking something down into its constituent parts.
5. **Synthesis:** creating something new by combining different ideas.
6. **Evaluation:** judging the value of materials or methods, as they might be applied in a particular situation.

The AFFECTIVE: This domain includes the manner in which we deal with things emotionally, such as feelings, values, appreciation, enthusiasm, motivations and attitudes. The major categories listed in order are:

1. **Receiving:** being aware of or attending to something taking place in the environment.
2. **Responding:** displaying new behaviour as a result of experience.
3. **Valuing:** showing some definite involvement or commitment.

4. **Organisation:** integrating a new value into one's general set of personal values, giving it ranking among one's general priorities.
5. **Characterisation by value (internalisation):** acting consistently with the new value.

The PSYCHOMOTOR: The psychomotor domain includes physical movement, coordination and use of the motor skills. Development of these skills requires practice and is measured in terms of spread, precision, distance procedures or techniques in execution. The seven major categories listed in order are:
1. **Reflex movements:** actions that occur involuntarily in response to some stimulus.
2. **Basic fundamental movements:** innate movement patterns formed from a combination of reflex movements.
3. **Perceptual abilities:** translation of stimuli received through the senses into appropriate movements.
4. **Physical abilities:** basic movements and abilities which are essential to the development of more highly skilled movements.
5. **Skilled movements:** more complex movements requiring a certain degree of efficiency.
6. **Non-discursive movements:** ability to communicate through body movement.

How to use the package

This package is primarily addressed to high school students (12-15 years old). However, it can be adjusted for students of primary school (9-12 years old) and lyceum-college students (15-18 years old), according to the abilities and needs of the class, the experience and skills of the educators, and finally the national and specific school curriculum applied in each case.

The educational package can be used and integrated into the national curriculum by using either the *Interdisciplinary Model* (single subject) or the *Multidisciplinary Model* (infusion). Using the material upon a separate Environmental Education or EfES course pertains to the Interdisciplinary approach. The incorporation of the package into other established disciplines is referred to as the Multidisciplinary approach. The present educational material is designed to be applied in either case.

In each section there are opportunities for using the package as a context for developing knowledge and understanding in several curriculum subjects, such as Science, Mathematics, Sociology, History, Literature, Arts.

The package is intended to be a flexible resource guide. Educators may make adjustments to the educational material to fit the topics and concepts the class may already be studying or to address topics of particular importance to students in a given geographic area. We encourage educators to use their knowledge and experience of the local community traditions, geomorphology, biodiversity, economy, and so on, in order to add texture and to introduce a higher degree of relevance into the lessons.

Most activities include questions or statements to stimulate student discussion regarding an environmental issue. However, few have a single «correct» answer. These questions are mainly intended to draw on the students' ability to form sound opinions and to develop balanced judgements on environmental issues. They are designed to challenge students to identify various options, strategies and reasons when articulating their answers. Students should always be encouraged to compare approaches with their classmates, to explore why answers may vary and to determine which, if any, answer is the «best» solution to an issue. This approach helps students to develop critical thinking skills in a stimulating non-competitive environment.

The duration stated for each activity is a rough estimate and is provided only as a guide.

The actual time required will depend on the grade, the level of skill of the students and the facilities available in each class.

Contents of the package

PART I - THEORY: The first part of the package contains background information on water related issues focussing on the Mediterranean region. This is the basis on which the activities are built. It can be used to supplement the educators' lessons in a number of ways. Additionally, this information can be used by the students themselves. The sections included in the theoretical part are listed below:

Water on earth: This part explains the role of water in the evolution of life on our planet and how all living organisms depend on it. Furthermore, the hydrological cycle as well as human interventions on the cycle are described. Finally, a reference to the key-presence of water in the traditions and religions of the Mediterranean people is included.

The Mediterranean: This part describes the geography, geomorphology, climate and other special characteristics of the Mediterranean region. The critical issue of marine pollution is briefly tackled.

Uses and abuses: In this section the major water users are explored: agriculture, industry and households (domestic uses). Beginning with the agricultural sector, the various techniques applied are examined and attention is drawn to the currently applied non-sustainable agricultural practices. Furthermore, the major industries that are common throughout the Mediterranean region and their ensuing problems are examined. Issues such as drinking and waste water treatment, and water distribution systems are presented. The issue of waterborne diseases is also dealt with. Finally, there is a brief reference on methods/tools to deal with water management.

PART II - ACTIVITIES: The second part of the package includes 45 activities, which focus on developing and understanding basic concepts related to water. They are designed to be conducted by the students themselves under the guidance of the teacher. Activities from each section can be used alone or in various combinations to fit the needs of each class and grade level. This series of activities is divided into the following sections:

1. Water always present: Students identify the key-presence of water in all aspects of life, ranging from everyday elements (plants, animals, food products) to abstract cultural elements (legends, customs, traditions).

2. Unique properties of water: Students examine the special physical and chemical properties of this essential substance.

3. The story of a drop of water, Water cycle: Refers to the hydrological cycle, focusing on its specific aspects within the Mediterranean region.

4. Our drinking water: Covers the topics of fresh water resources, water treatment and water distribution. The issue of sewage treatment is also examined.

5. Water & Health Students discover the vital importance of fresh water to human health.

6. Water in our home: Students explore the ways we use and abuse water in our daily activities.

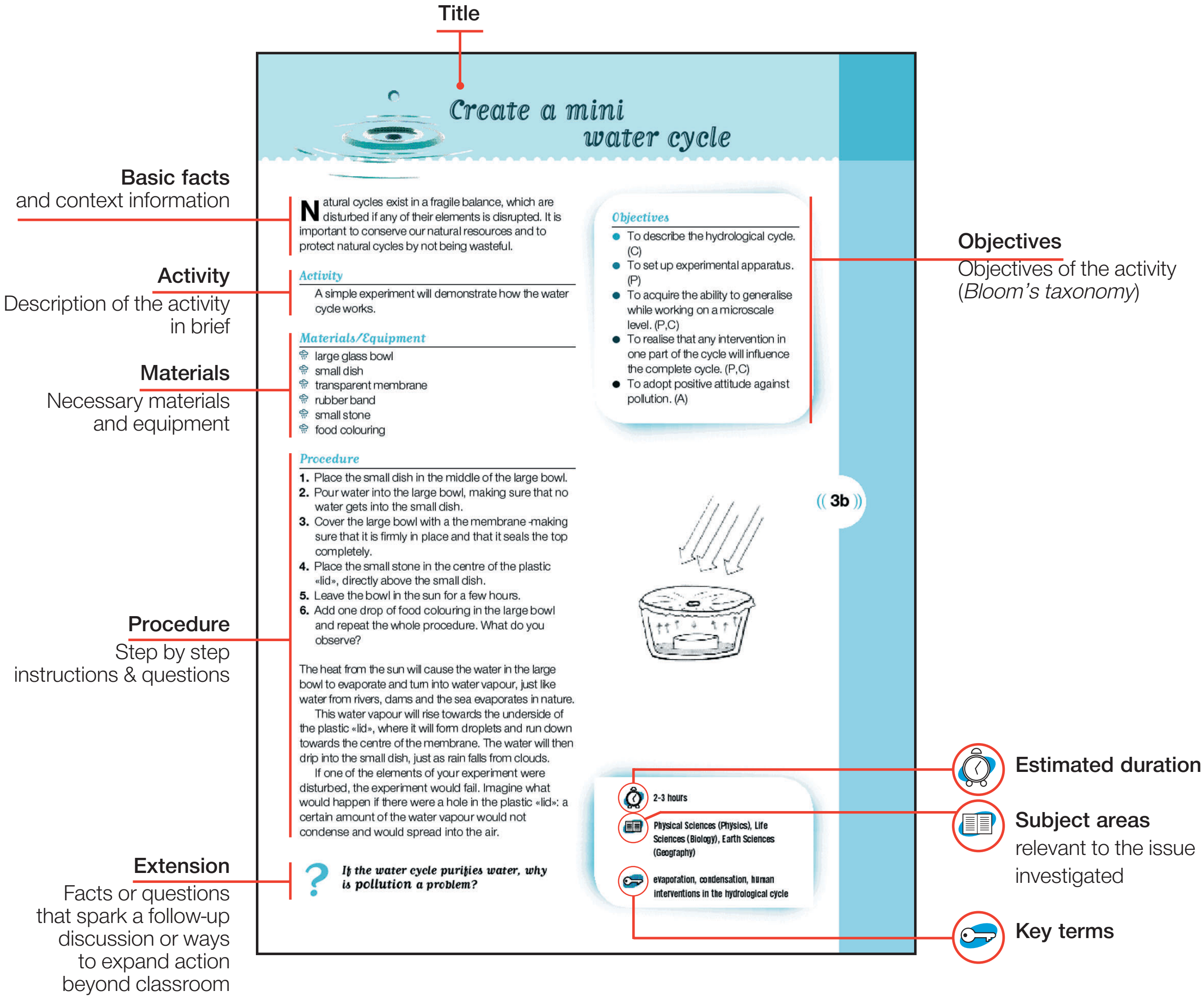
7. Water, Soil & Agriculture: Students recognise water as the major growth factor for plants and investigate the implications of non-sustainable human activities -particularly inappropriate agricultural practices- on land and ecosystems.

8. Water, Energy & Industries: Students realise that water is an important energy resource for hydroelectric applications and they explore its uses in industry.

9. Wetlands: By experiencing the «life forces» found in wetlands students realise their vast

importance for biodiversity. Furthermore, they may detect problems arising from human interventions.
Insets: They cover general water related issues or serve as guides for project implementation.

In the following picture an explanatory activity layout is presented:



Contents

Water on Earth

Water is present everywhere on our planet — in oceans, in lakes and in rivers, in wells, in the soil, and in the atmosphere. Water covers 71% of the Earth's surface. When viewing the globe from space, early astronauts called the Earth «the Blue Pearl» because of its expansive water surface.

The origin of life

It is said that life emerged from water.

Scientists date the birth of planet Earth about 4.5 billion years ago. From the beginning it has been in a state of flux, always changing; a hot ball that gradually cooled. There was no atmosphere or a surrounding layer of gases. Volcanic eruptions and asteroids collided into earth releasing water vapour, ammonia and methane which were transformed into nitrogen, hydrogen and oxygen, rapidly consumed to form oxides of the various elements, namely carbon dioxide and other substances. Mixtures of the metal oxides and carbonates formed minerals, while the gases and water were withheld by the earth's gravity, creating the first, primitive atmosphere -hydrosphere. Without such an atmosphere living creatures would be burned by the harmful radiation of sun. The water and all that was dissolved in it was «trapped» on the now cooled earth's surface and formed the first oceans.

One theory holds that the first biomolecules were formed deep in the primitive oceans. Scientists have suggested that early forms of life developed aproximately 10 metres below the surface of the water thus being protected from the sun. Ocean molecules containing carbon clustered together and developed the capacity to replicate. Reproduction was the first sign of life. The first single cells, the prokaryotes, were fed by allowing the uptake of nutrients dissolved in water through their membrane wall and released products back into the water. These nutrients were simple salts of nitrogen, phosphorus and silicon. Around 2.8 billion years ago cells began to rely on sunlight for growth. In the process called photosynthesis, cells use sunlight to change water and carbon dioxide into simple sugars needed for storing energy. Cells in the oceans gradually enriched the atmosphere with oxygen. As gases in the atmosphere increased, cells were shielded from the sun's dangerous rays and eventually were able to exist on land. Some cells evolved into aerobic cells and eventually some developed a nucleus. The first animals, called protozoa, appeared in the geological age between 2,500 to 500 million years ago. They were single celled, some had a tail, others had hair like filaments and could move through water. Multi celled organisms, the metazoans, were the next stage in evolution. Invertebrates -creatures without a skeleton or spine- were the earliest to evolve and depended on water for support. It took three billion years to reach these forms of life and would take another half a billion years to encounter human beings.

All life depends on water

Water is the main substance present on earth in natural conditions in all three states of matters: solid, liquid and gaseous.

Water is the only substance that is less dense in its solid state than in its liquid state. Ponds freeze top down and the layer of ice at the top insulates the water below from the icy air.

Due to the shape of its molecule water has a strong polar character. As a consequence

strong forces of attraction appear among its molecules. The high degree of internal cohesion of liquid water -due to hydrogen bonding- is exploited by plants as a means for transporting dissolved nutrients from the soil through the roots to the leaves. On the other hand, forces of attraction can be exerted between water molecules and molecules of other materials. Many physical and biological properties of cell macromolecules derive from their interactions with water molecules.
Water is considered as the «universal solvent». It can dissolve a very large number of natural or synthetic substances. In this way it cleans up the atmosphere and the surfaces of plants, rocks, buildings, etc.
The slight tendency of water to ionise is of crucial importance to the structure and function of biomolecules.
Due to the high specific heat of water oceans act as thermostats, contributing to the relative constant temperature on earth. This property is also useful to cells and organisms because it allows water to act as a «heat buffer», permitting them to maintain their temperature relatively constant.

The impact of the properties of water on the course of evolution has been profound. The first living organisms probably appeared in the primeval oceans; evolution was shaped by the properties of the medium in which it occurred. If life forms have evolved elsewhere in the universe, it is unlikely that they resemble those of the earth, unless their origin is also a place in which plentiful liquid water is available as solvent and «conditioner».

Water is one of the main components of cells, which make up all living matter. The miracle of «green» life, the flora, is linked to the existence of water; about 60% of a tree's weight is water. The miracle of «moving» life, the fauna, depends on water as well; in animals the amount of water varies from 65% to 80%.

Water makes up two thirds of the human body. Every system in our body uses water to digest food, to dissolve and transfer all elements in our blood, to carry away body waste and to control body temperature. About 75% of our brain, 22% of our bones and 83% of our blood is water. Human beings can live several weeks without food, but only a few days without water.

Water's distribution on earth

The oceans and seas contain 95% of the world's water. The remaining 5% is fresh water of which 4% is frozen in the polar regions. Thus, all the water in lakes and rivers, all the moisture present in the atmosphere, the soil, the vegetation and all the underground water amount to only 1% of the total. The distribution of this 1% liquid fresh water, is estimated as follows:

Biological	0.05%
Rivers	0.1%
Atmosphere	0.1%
Soil	0.2%
Lakes	1.0%
Groundwater	98.55%

The amount of water that is easily accessible to humans is broadly estimated to 0.03% of the total amount of water on earth; it is mainly surface water plus groundwater that can be drawn by humans. Ground water is mostly found in porous sand and gravel either beneath the soil or sandwiched between impermeable layers of clay and rock.

In some cases groundwaters are in dynamic equilibrium with surface waters that recharge them constantly. In other cases ground waters are considered as «fossil water». In other words, they are reservoirs that are a non-renewable resource, deposited thousands of years ago. Such water saturated areas form aquifers.

There are four characteristics of groundwater which are of special importance. First, groundwater is often found where surface water is insufficient or of negligible quantity. Second, fossil water is a valuable but non-renewable source. Third, underground water is less vulnerable to contamination than surface water. *But fourth, if an aquifer becomes over charged with pollutants such as synthetic organic compounds, nutrients or toxic metals, it may remain polluted for generations.*

«Water stress» is generally created by over-proportionate abstraction of water compared to the resources available in a particular area. Urban demand for fresh water can exceed the local long-term availability of the resource, thus water is frequently transferred by pipeline systems and canals over long distances. In the beginning of the 90's the gravest impacts of drought in Europe have appeared in areas where pressures on the available resources were greater, especially in those areas with a high demand for agricultural irrigation.

The consideration of water pressures is very important in the development and management of water resources. It should influence decisions concerning the extent and nature of water exploitation.

The hydrological cycle

Even though the total amount of water on earth can be considered as being constant, water is continuously moving in a closed system. The hydrological cycle, also known as the water cycle, is earth's natural water recycling system. As a result of the sun's heat, water evaporates. As vapour rises into the atmosphere water cools. The change in temperature causes the vapour to condense. It falls back to earth as rain, snow and other forms of precipitation. The precipitation falls back into the sea, or creates runoff that travels over the ground surface and helps to fill lakes, rivers and dams. It also percolates through the soil, moves downward through ground openings and replenishes underground aquifers. Waters forming streams (surface and underground) flow toward the ocean. Subject to human needs water may go through several other processes depending on its targeted use, e.g. for drinking water, for irrigation or for other domestic and industrial uses.

Another form of evaporation is transpiration. Water is transferred from plant roots to leaves transporting nutrients through plant tissues. Water is also produced during respiration. Therefore, most of the water absorbed by plants evaporates from the leaves and the whole process is called evapotranspiration.

Most minerals are left behind as water evaporates. So, rainwater when formed in the clouds is relatively pure. However, atmospheric pollution may result in polluted rain. The burning of fossil fuels, such as coal, releases sulphur dioxide into the atmosphere. Nitrous oxides from automobile exhaust lingers in the air as well. When sulphur dioxide and nitrous oxides combine with humidity they create two very destructive acids: sulphuric acid and nitric acid. The once pure rain may now contain life threatening acids that can destroy monuments and materials. What goes up as waste gases comes back down as acid rain.

But the hydrological cycle must also be considered from two other aspects: space and time. Some places receive more precipitation than others. This could result in strong sea currents. The Mediterranean is an area of net evaporation. Water from the Atlantic Ocean enters the Mediterranean basin through Gibraltar in a complex pattern. Water is unequally distributed around the Mediterranean. In the southern regions more water evaporates than precipitates. The seasonal contrast is more pronounced in the east and south part of the region, where most of the annual rainfall may fall in a few days of torrential downpours. In parts of Tunisia, as much as 60% of the annual rainfall often falls in a single day.

The water cycle within a catchment basin is therefore complex. Over the last decades human interventions have had profound implications on the entire water cycle, altering the availability of water both through space and time.

Such interventions include:

- Damming and groundwater withdrawal for irrigation and domestic water uses.
- Land drainage for cultivation
- Land sealing by urbanization or extensive constructions (airports, hotels, etc.).
- River canalisation for flood control and various drainage works for other purposes.

Climate change

Water and climate are intimately related. Large bodies of water, such as oceans and large lakes, have a moderating effect on the local climate because they act as large sinks of heat. Oceans, not only act as thermostats, but also as pumps that transfer huge amounts of thermal energy from areas with high temperatures to areas with lower temperatures. Regions near these bodies of water generally have milder winters and cooler summers than would be the case if they were not located near water.

Water plays a determining role in the climate system also because of the hydrological cycle. The evaporation of water requires enormous amounts of energy, which ultimately comes from the sun. When water vapour condenses to precipitation, this energy is released into the atmosphere. Thus, water acts as a means of energy transfer and storage for the climate system.

Several models on expected climate change predict a temperature increase of 1°C to 3.5°C by the year 2100. This, together with a decrease in precipitation in southern Europe, could lead to a serious reduction in renewable water resources around the Mediterranean.

Water in our tradition

Evolution started wherever water was present. The Minoan, the Mycenaean, the Classical and Hellenistic Greek civilizations as well as the Phoenician, Etruscan, Roman, Arab and Ottoman civilisations, all developed along the rivers and the coasts of the Mediterranean. The Egyptian civilization flourished along the river Nile. Herodotus wrote that Egypt was an acquired country, «the gift of the river''. Before the emergence of the Egyptian civilization, other great civilizations, closely linked to the Mediterranean, flourished along two large rivers in Mesopotamia, the Tigris and the Euphrates. In their attempt to control floods, irrigate land and distribute water, the ancient peoples of the region developed complex systems of reservoirs, channels and dams. The Assyrians dug one of the most important channels in 700 BC.

According to one of the «seven wise men» of the ancient world, the Greek philosopher Thales from Militos (Asia Minor, cotemporary Turkey) water is the primary substance from which every thing in nature derives. Other philosophers, for example Empedokles and later Aristotle, described water as one of the four «elements of matter». Besides the ancient Greeks, the Romans and the Arabs described the hydrological cycle and based a great part of their early science on water.

All mythologies and legends about the birth of the universe represent water as the symbol of life in one or another way. In the ancient Mediterranean pagan world one can trace innumerable sacred springs and ponds protected by various gods, nymphs and spirits. Many of those sites have survived to this day. Moreover, rivers were considered as adolescent feeders, helping youngsters to grow into adulthood and many of them were worshiped as gods.

Water has a special significance and importance not only in the ancient world, but also in the three great monotheistic religions of the region. For all of them water has been the symbol of purity and purification. Chronologically, in Judaism, Christianity and Islam water has been the symbol of purity and the medium for conferring Divine Grace or the Holy Spirit. The Law of Moses recommends frequent bathing and thus the love for water and cleanliness takes on a spiritual value. Followers of the Jewish and Moslim faith are required to cleanse themselves using water when entering places of worship. To enter the Christian faith a person is baptized in consecrated water. Concecrated water is also used for conferring «Divine Grace» on people or places, e.g. for the inauguration of new buildings, etc.

Apart from purely religious purposes, water plays a central role in all popular beliefs and traditions. Even nowadays in some Greek villages, people pour water before the feet of travellers leaving the village, which represents their wish that the traveller will roam as free as water flowing in the rivers.

In the last millennium the Mediterraneans -mainly the Genoans and the Iberians- conquered the new world, by exploring the oceans with their ships proving that water is not so much a border but a bridge.

The Mediterranean

Geographic setting

The Mediterranean Sea, the crossroads of the ancient world, lies between Europe, Asia and Africa and occupies an area of about $2.5km^2$ with an average depth of 1.5km (not including the Sea of Marmara and the Black Sea). Its surface is only 0.7% of the total surface of the world's seas and oceans. It is about 3,800km wide from east to west and its maximum distance from north to south is around 900km from France to Algeria. Yet, one is never further than 370km from the coast and most often considerably less, with more than half of the Mediterranean Sea being less than 100km from the coast. This feature played a decisive role in the history of navigation since the very early days of human history.

In the era of the «global village» where does the Mediterranean begin and where does it end? It may sound like a simple question but the answers vary according to the criteria used: olive tree cultivation, climatological, hydrological and sociocultural criteria have all been used. When one considers pollution its borders are further extended, dramatically.

According to the definition from the Convention for the protection of the Mediterranean Sea against pollution (Barcelona Convention, article 1), the geographic coverage of the sea is the following: «...the Mediterranean Sea Area shall mean the maritime waters of the Mediterranean Sea proper, including its gulfs and sea, bounded to the west by the meridian passing through the Cape Spatell lighthouse, at the entrance of the Straits of Gibraltar, and to the east by the southern limits of the Straits of the Dardanelles between Mahmetcik and the Kumkale lighthouses». It is obvious that from the hydrological point of view it extends to a vast area to include the entire watershed or catchment area (the line of the mountains that determines the flow of the rain waters towards the basin).

Its name comes from the Latin *medius* and *terra*; the word «mediterranean» means in the middle of the land, or «surrounded by land». And that is exactly what one sees when one looks at the world Atlas and the image that the satellites orbiting the earth send us every day. The Mediterranean Sea consists of a series of interacting parts and seas, with two major basins, the Western and the Eastern, connected by the straits formed by the SW coast of Sicily on one hand, and the NE coast of Tunisia on the other. It is surrounded by 22 countries and its present permanent coastal population is estimated at approximately 140 million.

Historical map of the various Empires and Kingdoms around the Mediterranean during the Middle Ages. Made by Felix Delamarche, son of the famous French Geographer Charle-Frasnoua Delamarche, it was published in 1829 in the *Atlas de la Geographie ancienne du moyen age et moderne.*

Geological characteristics & morphology

The Mediterranean Sea is the remnant of an older ocean, named «Tethys», that existed some ten to a few hundred of millions of years ago and was several times wider. According to the plate tectonics theory, the Tethys Ocean began to be consumed by the converging Euroasiatic and African continental plates, some 50-70 million years ago, at the same time as the Atlantic Ocean was expanding. The entire Mediterranean region is characterised by the presence of microplates: the resulting geodynamic model is very complex since the microplates move against the other.

Some of these tectonic processes are still active, especially in the east, where the eastern Mediterranean crust is submerging beneath the Aegean microplate. Thus, the eastern part of the basin is more active in terms of plate tectonics and is characterised by a more complex morphology than is the western part. Therefore, the eastern Mediterranean is subject to heavy seismic and volcanic activity, whose consequences for human life and society are an everpresent factor in the region.

Most of the area around the Mediterranean is mountainous and fragmented except for the south-eastern coast and the Egyptian-Libyan coast, features a very few large plains, little agriculturally useful land, ports and harbours tightly hemmed in between sea and rock and a few broad fluvial basins.

Along the coastal areas in the north, rocky shores predominate, with cliffs in Spain over 150m high and «megacliffs» in Croatia over 1,000m. While there are a few large plains associated with the large rivers of the region, the Mediterranean is essentially bounded by mountainous coasts.

Only a few large rivers flow into the Mediterranean Sea, yet these originally accounted for very large volumes of sediment injected into the system. The longest is the Nile, which extends deep into east Africa. Before the construction of the Aswan dam, its deposits formed a delta plain on the coastal area of nort-eastern Egypt and a huge submarine alluvial cone in front of its mouth (the Levantine Sea). This together with the submarine cone of the Rhone river, constitute some of the most striking morphological features of the Mediterranean basin. The Rhone in France, as well as the Po in Italy both have their springs in the Alps, whereas the Ebro in Spain runs out of the Pyrenees. About 500 smaller rivers flow into the Mediterranean, some of which drain vast basins with many agricultural and industrial activities. The pollution load they carry is higher than direct discharges from installations along the coast.

Climate & water circulation

The Mediterranean is the only sea in the world to have given its name to a type of climate. The Mediterranean climate is characterised by a windy, mild, wet winter and a relatively calm, hot, dry summer with the transition periods being too short to appear as well defined seasons. Still, the Mediterranean itself is a climatically transitional area, with a temperate damp climate in the north and an extreme arid climate in the south. The mountains around it are crucial for the vertical motion of air masses that give rise to regional and local winds.

The Mediterranean climate is considered by many as «the perfect climate». However its rain patterns are most inconvenient. The rain falls mostly when it is needed least. The region suffers frequently from years of low rainfall. Countries are using their water resources with growing intensity, so poor rainfall increasingly leads to water crisis. On the other hand, storms that often result to floods are a frequent phenomenon in the area. There is a growing debate among climatologists about whether these present phenomena are simply another manifestation of the notorious variability of Mediterranean rainfall or a sign of a long-term shift in rainfall patterns linked to global warming.

The water cycle plays an extremely important and reciprocal role in the climatic system both conditioning the climate and being affected by it. The Mediterranean Sea is characterised by high evaporation, especially under the influence of dry winds. It can be defined as a «concentration basin» because evaporation exceeds precipitation and river run-off (approx. 1m/yr). This deficit is mainly compensated by the inflow of the Atlantic surface waters through the strait of Gibraltar and the water contribution from the Black Sea through the Dardanelles.

The surface current system of the Mediterranean shows a migration of Atlantic water towards the east. The annual thermal changes of surface waters are very drastic and they control the density of water and the basic characteristics of the annual biocycle. Due to very pronounced evaporation processes, surface water gradually transforms to denser, deep-sea water with higher salinity. There is no surface return system from east to west. The return of Mediterranean water is by deep water flowing from east to west and spilling over the sill of Gibraltar into the deep Atlantic.

The limited exchange with the Atlantic Ocean and its great depth make the estimated turnover time quite high, around 75 to 100 years. The Gibraltar Sill prevents the deep and cold oceanic waters from reaching the Mediterranean Sea. That's why the temperature below 200m is higher than 12^{o}C. Waters entering the surface layer from the Atlantic are warmer and fresher than those flowing out; hence the Mediterranean Sea imports heat and exports salt.

However, the physical characteristics of the water masses have changed during the last decades. For example, in many areas of the Mediterranean Sea a slight increase in temperature and salinity has been recorded. The causes of such changes are still debated - whether they are due to global change or due to the diversion of fresh water input, such as the reduction of water discharge from the Nile after the construction of the Aswan dam in the 70's.

The present climate guarantees that for a long time to come the Mediterranean Sea will continue to be an evaporating area. As long as this is the case, Atlantic water will continue to flow in from the west, replenishing the water lost by excess evaporation.

Biological & chemical characteristics

The Mediterranean is relatively poor, not in variety, but in the quantity of biomass produced. In a surface layer about 100m deep phytoplankton change inorganic ions of nutrients (nitrogen, phosphorus and inorganic carbon) into organic matter. The scarcity of a specific nutrient and the possible surplus of others slow down photosynthesis. One of the main causes for the low nutrient content of the basin is the entrance of surface Atlantic waters, which are low in nutrients, and the simultaneous outflow of deep Mediterranean water -rich in nutrients- towards the ocean.

While production is abudant in surface coastal waters, maximum bioproduction in offshore waters takes place at a depth of about 100m in the summer, at the limit point where the dim light and the increased concentration of nutrients provide ideal conditions. The surface of the Mediterranean receives an average solar radiation of 1.5 million kcal/m^2 per year, but the average primary bioproduction corresponds to an assimilation of 80g carbon/m^{2}y, which is equal to 1050kcal, only 0.06% of the input. The water is transparent allowing the light to penetrate, but organisms can barely use it! Productivity can, however, be unusually high at the mouths of rivers or during late wintertime and early spring, when mixing of surface and deep waters leads to vertical homogenisation.

Zooplankton basically eats phytoplankton. The animals are able to utilise 20-90% of the

The most typical and well-known benthic flora community is that of the marine plant **Posidonia oceanica** *which develops as large meadows in the infralittoral zone (to a depth of 25-40m). This ecosystem appears to be heavily impacted upon and in some cases on its way to extinction particularly in the vicinity of large urban centers, ports and marinas.*

ingested food. The unused food together with faeces, moults and excretory products contribute to secondary bacterial food chains. The oligotrophic character of the Mediterranean Sea determines its low zooplankton biomass, compared to similar Atlantic areas.

Although the Mediterranean Sea is relatively poor in the quantity of organisms produced, it is rich in variety. The distribution of the species throughout its waters is not homogenous: it is greater in the western than in the eastern basin (by a factor of two for fauna). Its fauna is characterised by many endemic species and is considerably richer than that of the Atlantic coasts. The great richness of the Mediterranean fauna leads to the conclusion that the Mediterranean basin has probably functioned as a primary centre for the evolution and radiation of the eastern Atlantic fauna. According to this hypothesis a large contingent of the Atlantic species, possibly the majority, must have come from the Mediterranean.

As in other seas, the relationship between species diversity and ecosystems is still poorly understood. In the context of increasing human pressure the question arises as to how far the integrity of ecosystems can be sustained in spite of drastic decrease, not to say disappearance, of certain species in the Mediterranean Sea (monk seals, dolphins, turtles). The conservation of the rich Mediterranean biodiversirty, as it is still observed in certain areas today, will require adoption and application of sustainable ecosystem management practices.

Pollution

The Mediterranean is generally one of the most polluted marine areas in the world as a result of land-based activities and shipping, in particular oil pollution from tankers. Its waters serve as the recipient of a multitude of waste discharges from residential areas, industrial activities and tourist complexes. Domestic sewage, industrial discharges and agricultural runoff are the major contributors polluting its waters.

220,000 ships over 100 tons cross the Mediterranean each year. 20% of the international oil traffic transits through the Mediterranean, which represents 0.7% of the surface of the earth's seas and oceans.

Despite recent major improvements, a significant proportion of urban and industrial waste is still dumped untreated into the coastal waters. Industrial effluents contain heavy metals and if they end up into the sea, they enter the food chain, contaminate fish and shellfish and pose health problems. Microbial pollution is related to urban wastewaters, mainly to the discharge of untreated or partially treated sewage. The latter carries bacterial and viral pollution to seawater and may cause various diseases (typhoid, hepatitis, gastro-enteritis, etc.) either through consumption of seafood, or even by direct contact during swimming.

Uses and abuses

Water consumption

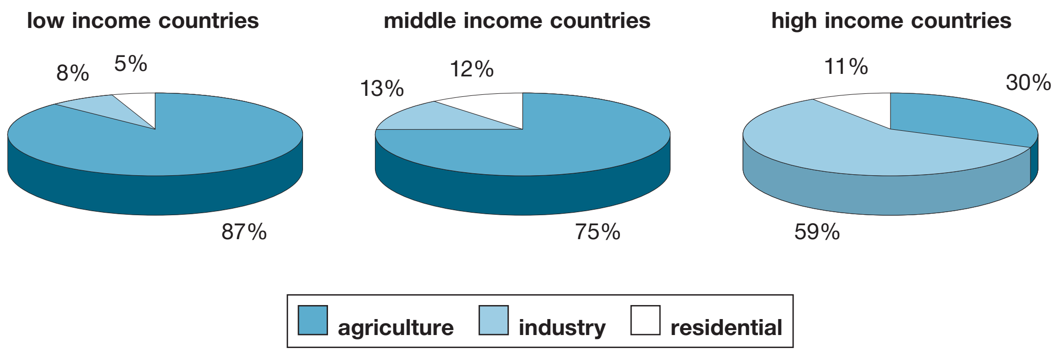
According to water consumption data published in 1998 by OECD*, agriculture is the largest water user accounting for 70% of the world's fresh water consumption. The industrial sector is the second largest water consumer accounting for 20%. Finally, *residential (domestic)* use requires lower volumes of water (10%), but of much higher quality.

The charts below summarise the distribution of water withdrawal for these sectors as a function of a country's income level. These data show three main trends:

Agriculture is the greater water user in low and middle income countries.

The share of water used for industry is greater in high income countries, due to different structures of economy and more efficient water use in agriculture.

Domestic consumption only accounts for a small share of total consumption in all countries, but quality requirements are high.



Agricultural use of water

Irrigation was practised even in ancient times. The Mesopotamians built the world's first great civilisation in the plains between the rivers Tigris and Euphrates by managing their waters. The ancient Egyptians channelled the Nile floodwaters onto their fields, so effectively that in a country with virtually no rain of its own the population density in the valley was almost double than that of modern France. The ancient Egyptians had managed to control the Nile's flood by conveying the water with the silt it contained to the neighbouring fields by conduits. The benefits were twofold: the silt enriched the land and improved its fertility; the water irrigated the soil. When it was absorbed, the farmers could proceed with planting or sowing their crops.

The height of the flood was a measure to anticipate a good or a bad yield. For this purpose the nilometres were invented, which were nothing but wells communicating with the river. They were graded and had an inner ladder. Thus, it was possible to measure the flood height and estimate the expected yield.

Since earliest recorded history, humans have created complex structures to tap, transport and store scarce water in the Mediterranean lands. Elsewhere in the region's deserts, complex agricultural systems were built to capture occasional floods. In the Libyan desert low walls diverted floodwaters to

* Organisation for Economic Co-operation and Development

fields that grew grain, olives and vines to meet the demand of the Roman market. Even more remarkable were the long tunnels, typically 5km long, that penetrated deep into hillsides. They captured underground water and transported it by gravity to farms and villages. According to tradition, the Persians had invented these tunnels and called them «qanats». «Qanats» of various types are still used for water supply in Cyprus and Egypt. In other cases throughout the Mediterranean, water for agriculture was obtained almost exclusively by rain. The hilly land was terraced to retain water and soil in order to increase its vegetation.

According to David Gilbertson, an archaeologist from the University of Sheffield in Britain, «the wisdom of the ancients in managing these harsh landscapes was more substantive than our own». But of course their needs were considerably fewer.

Agriculture is the greatest user of freshwater, since land needs freshwater to produce food. In the Mediterranean region 73% of water consumption is intended for irrigation. The role of agriculture in the region and especially in those countries that face water shortage is a key issue and apparently the limiting factor for development. Given that rainfall is low and that the evapotranspiration rate is high in these countries, many plantations have to be irrigated constantly, and more so during summer. Thus, the proportion of water demanded for irrigation exceeds 85% in Morocco, Tunisia and Egypt.

• *Reservoirs, dams & pumps*

The modern era of water supply has been dominated by two technological developments: boreholes and dams.

Natural springs, wells and qanats have been replaced by boreholes. The boreholes can tap water from deep underground (from a few hundred meters up to 1km in depth), using petrol-driven pumps. Such deep boreholes can provide water during periods of drought, when water tables fall and shallow wells dry up. Mining of aquifers -pumping out more water than nature can replenish- is widespread in the Mediterranean region, but it is more intensive in Libya and Tunisia. Saltwater intrusion quite frequently occurs when underground water near coastlines is overdrawn and the natural balance of water pressure is altered in favour of the sea. The salinization process, in most cases is non-reversible.

Five countries in the Mediterranean region obtain the majority of their water from non-easily rechargeable aquifers (and «alternative» sources e.g. desalination) namely Malta, Israel,

In Tunisia, the number of wells tripled from 20,000 to 60,000 between 1960 and 1980 and almost doubled again to approximately 110,000 by 1990. Shallow wells at Tunisia's Garaet El Haouaria wetland, which was converted to agricultural lands three decades ago, have now been abandoned because the lowered water table is deteriorated by saltwater intrusion.

In Israel the coastal and West Band aquifers were over-pumped resulting in major damage. In some places the water table in the coastal aquifer, which provides 20% of the country's water, has dropped below sea level, while it used to be 5m above sea level. As seawater rushes in, salt concentrations have risen to 150ppm, with 10% of the wells exceeding 250ppm (the limit for normal agriculture) while 50% are likely to exceed this level within 20 years, according to the Israeli Ministry for the Environment.

> *The largest dam in the Mediterranean region is the Aswan dam on the Nile close to Egypt's border with Sudan. It has a capacity of around 150km^3 and can hold back more than a year's river flow. Its purpose is to capture the annual floodwater and send it downstream throughout the year, allowing irrigation of the fields of the Nile's valley. Apart from its benefits its negative consequences in altering the geomorphology, hydrology, oceanology and ecology of the delta have been demonstrated.*

Tunisia, Libya and Gaza. The rest rely principally on taking water from rivers or rechargeable aquifers.

Dams are primarily designed to balance water supply and demand. Usually this means capturing water in the wet season for use during summer, when demand, especially for irrigation and tourism, is at its peak. Dam building policies are widespread in the Mediterranean region. Nowadays, their main function is for irrigation and water supply of cities as opposed to hydroelectric production, their primary purpose in the first half of the 20th century. Dams have been frequently seen as modern symbols of power, fertility and high technology. The multi-purpose uses of the waters they impound (irrigation, power generation, flood control, urban water supply, fisheries, transportation, recreation) appear to offer solutions to a variety of problems in one splendid construction of high visibility. Yet, experience has shown that dams often create more problems than they solve*. No doubt many of them, particularly the small-scale ones, can be justified in certain circumstances, if planned with care, but those who would undertake such enormous investments should weigh all likely negative consequences and thoroughly assess the alternatives.

• *Implications of irrigation on soil*

> *Iraq has launched a programme to restore the fertility of the Tigris-Euphrates floodplain, the conditions of which have not changed much since the Sumerian civilisation collapsed more than 3,000 years ago, largely due to residual salinity.*

Irrigation is as much a problem as it is a solution for improving agriculture. A significant proportion of the irrigated land in the south-eastern Mediterranean region is affected by waterlogging and build-up of salts.

Salts are among the commonest substances in soils and water. Normally they create no problem because rain flushes them through topsoil or seasonal flooding washes them away to rivers and to the sea. But if these natural processes are interfered with, as a result of intensive irrigation with poor drainage, salts accumulate as water evaporates. Salinity may soon reach toxic levels for many plants. Alkalis built up in similar fashion, affect the soil's pH. Constant saturation of the surface, combined with a rising water table, due to intensive irrigation, prevent excess salts and alkalis from being filtrated through subsoil. Saline and alkalis excess is frequently transferred downstream when flows wash some of the accumulated salts away.

• *Chemistry in the service of Agriculture*

The increasing demand for food leads to the use of fertilisers to improve the nutrient status of soils and to the use of pesticides. Increasing the yield per unit of land implies, in most cases

* Table in Appendix 1 presents the possible environmental changes associated with dams.

of current practice, wide use of fertilisers and pesticides. However, in many cases, their irrational use creates a number of environmental and health problems. It is often difficult to trace the exact origin of pollution resulting from agricultural activities. Pollution may appear in a watercourse far from the point where the polluting substance was applied to the soil. Both surface and groundwaters are affected by diffused agricultural sources. Groundwater pollution is a particular problem because the effect of discharges of certain substances into the water table may not become apparent for many years. Pollution of groundwaters is very difficult and expensive to abate effectively.

• *Desertification*

Desertification is the degradation of land in arid, semi-arid and dry sub-humid areas caused by climate change and human activity. It is accompanied by a reduction in the natural potential (productivity) of the land and the depletion of its surface and groundwater resources. The root causes of desertification are as highly complex as they are site specific. Deforestation, forest fires, irrational management of water resources -construction of dams, canalisation of rivers, overexploitation of groundwater, drainage of wetlands- are all causes that aggravate desertification.

The environmental impacts of desertification are also complex and interrelated to its root causes. Water scarcity, receding groundwater levels, reduction of biodiversity, soil erosion are some of the impacts of desertification.

Water and Industry

20% of the overall water consumption is attributed to industry.* Five industries -primary metals, chemicals, petroleum, pulp and paper, food processing- account for two-thirds of the industrial use of water. Yet water rarely represents more than 1% of their manufacturing costs. In the Mediterranean region industry remains a minor user of water, though it is of increasing importance in some areas. Algeria's pulp factories are major water users: one plant withdraws 30 million cubic metres annually, a quantity enough to supply a town of half a million people. Due to misuse and mismanagement of water some industrial plants withdraw and consume 5 to 20 times as much water as other plants manufacturing the same product. Withdrawal does not mean consumption in the literal sense, for, the greater amount of the water discharged is only partly used, without being recycled and with varying degrees of thermal, biological or chemical pollution.

Thermal pollution is caused by the discharge of water used for cooling from electrical power plants and other factories. Artificially heated water decreases the amount of dissolved oxygen. It can stimulate algae blooms, threaten certain species of fish, and therefore disturb the balance of the receiving water body. When this water is not reused (recycled) by industries or for heating the nearby communities, large amounts of energy are lost, as well.

Among the industrial sectors special attention must be paid to the *chemical industry* for several reasons: it is growing in some parts of the Mediterranean, it often creates toxic waste and it is extremely diverse. It is estimated that by 1986 about 80,000 organic and inorganic chemicals had appeared on the market. Since then, 1,000-2,000 new chemicals appear annually. In addition, it is difficult to obtain systematic information about hazardous effects largely due to the confidential nature of the processes used.

In many cases, industrial wastewater contains organic matter, which can cause reduced oxygen levels in water bodies and may lead to changes in the composition of aquatic biota.

* Source OECD, 1998.

The surface waters in southern Europe contain the highest levels of organic matter as a result of discharges of industrial wastewater.

Industrial sources are primarily responsible for heavy metal discharges significant for their toxicity and bioaccumulation. Data evaluated for mercury, lead, chromium and zinc show that inputs are largely due to river discharges. Considerable amounts of metals are also transported into lakes, rivers and into the Mediterranean Sea through the atmosphere. In the Mediterranean the heaviest pollution loads are discharged in the northwestern basin, which borders on three industrialised countries (Spain, France, Italy) and also receives major river discharges (from the Rhone and the Ebro). In addition to the considerable amounts of organic matter and suspended solids, industrial waste discharges are also responsible for the release of significant loads of other types of pollutants, such as heavy metals, phenols, mineral oil and other hydrocarbons.

Around the Mediterranean several hazardous residues such as solvents, organic and inorganic chemicals, spent catalysts and inflammable substances are currently discharged directly to the sewage network or disposed off in the form of sludge in poorly managed landfills. Consequently, in order to cope with this complex water pollution problem, there is an increased trend among Mediterranean countries to install wastewater and solid waste treatment plants. Once properly treated, wastewater may be used to recharge aquifers by percolation from shallow pools or injection wells. Such practice requires experience and particular care, in order to avoid secondary pollution by trace organics or metals. While this is not yet a common practice in the Mediterranean countries, another practice which has been recently applied in some parts of the region is using properly treated wastewater for watering public gardens and parks or golf courses.

Although for thousands of years humanity has discharged untreated or inadequately treated waters into rivers, lakes and seas, only recently has industrial development created new forms of pollution including manmade pollutants «unknown» in nature.

It is however, noteworthy that modern, clean industrial production processes have managed to drastically reduce both pollution and water consumption. One of the problems now is how efficiently, equitably and quickly new clean technologies will be shared, in order to replace the old polluting ones.

• *Technological alternatives and innovations*

Nowadays, modern industrial installations tend to recycle wastewater and use «closed loop» systems. New wastewater treatment and disposal plants are expected to also include biological treatment. For efficient biological treatment, particular attention needs to be paid to the specific requirements of smaller wastewater treatment operators in rural zones and along the perimeters of urban areas, where local expertise and maintenance are, often, not at the level required. A number of potential innovative «alternative» approaches should be also considered. Such alternative approaches are various types of desalination which constitutes a method already employed for the production of considerable quantities of freshwater by using brackish or even marine water. Malta depends for more than 60% of its annual water needs on desalination, applying the metod of reverse osmosis. Such a system has high energy requirements. There is a continuing need for research and development in the area of alternative water resources, as well as in the processes regarding disinfection of sludge resulting from biological treatment. This work is directed at obtaining safe water low in metal and organic content. One should always bear in mind that the potentially most interesting applications of this sludge -i.e. as composts, soil conditioners and fertilisers- are not exploited to their full extent across the Mediterranean, mainly because of public health concerns.

Domestic use of water

There are countless domestic uses of water besides drinking. We need water for personal hygiene, cooking, washing dishes, laundering, home cleaning, watering gardens, washing cars, toilet flushing, and eventually for recreation. Water is indispensable for a healthy life and that is the reason why it was and still is closely linked to social life.

* *Roman baths had an important social aspect.*
* *Islamic baths, the hamam, were also a place of social gathering.*
* *At the village fountain women meet, news is spread, events are announced.*
* *In towns social and commercial life is usually developed around a water source.*

From the archaeological findings of Tyrinth, the Mycenean greek town of the Peloponese, we know that bathrooms with drainage systems existed within palaces built more than 3,000 years ago. In the excavated palace of King Philippos, the father of Alexander the Great, in the Northern Province of Greece, Macedonia, and also in less prestigious residences in other Greek towns, the drainage systems reflect the extended and sophisticated use of water in ancient Greek households. Later the Romans further advanced the water distribution networks of towns by using aqueducts and canal water transportation systems, thus promoting the development of the famous Roman municipal baths and fountains. The Arabs and the Ottomans used these systems as well and built magnificent public baths and fountains.

Water for domestic use can be obtained from springs, wells, rivers, ponds, pools, lakes, dams, house reservoirs collecting rainwaters, village fountains and now (in the majority of Mediterranean households) from taps within the house. However, before water becomes available at home, ready to be safely used, four main operational phases are needed: *transportation*, *storage*, *treatment* and *distribution.*

• *Water transportation*

The vast needs for water transportation or irrigation are met, mainly, through the use of canals and pipelines. Apart from the fact that this mode of tranport/tranfer often changes the hydrological regime of the area from where water is abstructed, the socio-economic and technical problems implied are also significant. Such problems include losses through evaporation and leakages frequently rising up to 50% of the water in the supply system.

Whatever the means of transportation is, water can always be subject to pollution or contamination if protective measures are not taken. Moving water by muscle power, be it human or beast or by tankers and lorries involves a combination of both transportation and temporary storage. All vessels transporting water must be free of everything that can contaminate it. They have to be scrupulously cleaned before they are used for transporting water, especially if they have been initially used for other purposes. It is obvious that vessels previously used for agrochemicals (pesticides or fertilisers) or for fuels and petrochemicals (petroleum, benzene, organic solvents, etc.) are not suitable for water transportation.

• *Water storage*

Water storage is a serious operation since water stored in dams or closed reservoirs is frequently vulnerable to pollution. Water is never completely sterilized even when treated, unless it is boiled. This means that it always contains a certain small bacterial population above which any increase may make it unsafe for drinking purposes and for several other uses. When stored over long periods in tanks its bacterial population tends to increase. Therefore, all reservoirs and containers, even buckets, have to be cleaned regularly.

• *Water treatment*

Water treatment makes the water safe for people to use. Being a good solvent, water picks up all sorts of pollutants. In nature, what seems like «clean» water is not always «safe», particularly when considering drinking water. Germs were identified in water for the first time in 1850 when the microscope was invented. In 1902, Belgium was the first country to use chlorine to treat water in the public water supply. Today, water undergoes treatment in almost every city worldwide. Treatment usually includes the following steps:

Various types of intake and removal of solids: Water is taken from the source. Logs, fish, stones and plants -large solid particles, in general- are screened out at this step and then water is drawn into the treatment plant. If the source is groundwater, the «screening» is done by the soil as the water travels through it. In some cases very little treatment is required for groundwater.

Chemical Addition, Coagulation & Flocculation: Aluminium sulphate (alum) and/or polymers are added to water. These improve taste and odour and help solids to settle in water. Water is mixed together with these chemicals. The aluminium salts and/or the synthetic polymers help colloidals and fine particles to come together and form larger particles called «flocs». This process is called coagulation and the tendency of flocs to precipitate is called flocculation.

Sedimentation: The water and the floc particles flow into a sedimentation basin, where the flocs settle to the bottom and form sludge (sediment).

Filtration: Leaving the sedimentation basin, the water flows through filters. Filters are made of layers of sand and gravel and they are used to remove any remaining particles left in the water.

Disinfection and Storage: A small amount of chlorine or other disinfecting chemicals is added. The water is placed in a closed tank or reservoir called a clear well. This allows time for disinfectants to mix throughout the water body, in order for effective disinfection to take place. The disinfectants are used to kill any remaining germs and to keep water safe, as it is now ready for disribution to the public through the supply network . In water systems using pumping from groundwater sources this step might be the only treatment needed.

• *Water distribution-leakage*

The fourth phase of a public water system is the distribution network through which water is sent from the treatment plant to the users (homes and various enterprises). Leakage and theft of water are a constant and aggrevating drain on many water-supply systems. Most countries have only a vague idea of how much water is lost in this way. Few have installed the complex systems necessary to monitor the flow of water through the pipelines. It is common that in many Mediterranean cities losses exceed 30% and in some cases are over 50%. Therefore, there is a considerable margin for saving clean, treated water by reducing losses by the appropriate maintenance of the distribution networks. There is also huge potential in reducing water leakage in the piping and plumbing systems of houses, offices and factories.

Furthermore, these days, many countries, towns and enterprices promote water-saving devices such as low flow taps and variable-flow toilet systems, which are compulsory in new buildings in some countries (e.g. Israel). Because leakage tends to worsen as public and private systems age and pipes crack, reducing leaks is nowadays a major priority for all Mediterranean countries. In Morocco, a program for improving water mains in urban centres has saved an estimated 450L per second -enough to supply a city of 120,000 people! In Israel, leaks from water mains have been reduced to an estimated 10%, which is considered as the lowest feasible loss limit.

Large amounts of untreated water are also lost from open reservoirs and long-distance aqueducts, due to leaks and evaporation. Sicily seems to suffer enormous losses due to defective conduits, waste and theft, resulting in an unusually high rate of water use on the island. Several countries, including Algeria and Morocco, have begun projects to reduce these losses by lining aqueducts.

The toilet water

It is estimated that 40% of residential water used is attributed to toilet flushing; every flush accounts for 6-11L of water. Overuse of toilet flushing, does not only consume clean water, it also produces higher volumes of sewage. As most developed countries know, getting rid of sewage sludge is a difficult problem placing a heavy burden on the environment. On the other hand, most of the alternatives available are not fully developed yet: there are biological toilets that leave no residue; incinerating toilets that leave a sterile ash; oil-flushed toilets that constantly recycle the oil and vacuum systems using only a litre of water per flush. Also, there are aerobic tanks, in which a small air pump speeds up decomposition and digesters (fermentation tanks) that use a mixture of other organic material to produce methane as well as fertiliser. All Mediterranean countries have adopted policies for the establishment of sewage treatment plants, in all coastal cities with more than 100,000 inhabitants as a matter of priority.

• *Wastewater treatment*

Wastewater deriving from domestic use and from cities in general, is called sewage. Full sewage treatment relies on a combination of physicochemical separation of pollutants from water and of biochemical removal of organic substances and nutrients. Biodegradation, which would occur naturally in the environment, is basically the decomposition of organic pollutants into smaller molecules and finally into carbon dioxide and water with the use of bacteria. This process is accelerated by providing optimum conditions, such as good air supply to aerobic bacteria. Sewage treatment typically takes place in stages, as follows:

Screening and grit removal: Screens remove large debris such as paper, rags, plastic and bits of wood. The sewage flow rate is reduced to allow grit to settle down. Floating oils, etc. are also removed through a process using air bubbles called floatation.

Primary settlement: Sewage is held in sedimentation tanks. Sludge settles at the bottom of the tanks while the liquid moves on for biological (secondary) treatment.

Biological treatment: Usually, one of the folowing two methods are used, biological filters or activated sludge.

Biological filters: Sewage is spread over a bed of stones or other inert material, providing a large surface area for the growth of bacterial film, which decompose the organic matter contained in the sewage. Large pore spaces between the stones ensure that there is good contact between air, bacteria and sewage.

Activated sludge: In this method sewage is held in tanks in which bacteria are added and air is blown. Aeration encourages rapid growth of bacteria, which are suspended in the sewage and decompose the organic matter.

Secondary settlement: Solids remaining from the biological treatment stage are known as sludge. This settles in secondary settlement in sludge tanks. Following this stage of treatment the effluent may be clean enough to be discharged to a river or to the sea.

Tertiary treatment: This may include removal of nutrients (nitrogen and phosphorus). Nitrogen is removed by employing special bacteria, which cause the denitrification -release of nitrogen gas under carefully controlled conditions. Phosphorus is removed by the addition of chemicals such as iron or aluminium salts. The consequent flocs of insoluble phosphates are removed by precipitation. A final treatment, by passing the effluent through grass plots, reed beds or sand filters may be used to remove residual solids and to further reduce trace contamination by organic matter, so that the treated effluent could be recycled.

Sludge collected from primary, secondary and tertiary treatment is held in closed tanks for approximately two weeks, at around 35^{o}C. This process, known as anaerobic sludge digestion, yields a product that is drier and less odorous, containing fewer pathogens. With further treatment the digested sludge may be used as a fertiliser, a soil conditioner or as fuel. Methane is also produced by anaerobic sludge digestion and may be collected and used to generate hot water or electricity.

• *Baths, soaps & detergents*

Soaps and detergents are chemical products used for cleaning purposes. People have been concerned about their personal cleanliness since prehistoric years. Even primitive people knew that water had a cleansing capacity.

Soap came by its name, according to a Roman legend, from the mountain Sapo, where people used to sacrifice animals. Rain used to wash out a mixture of melted animal fats and ash on clay soil along the river Tiber. Local women discovered that this mixture of fats and ash cleaned clothes with less effort.

It is not known when proper soap was first produced. However, it was known before the Roman era. A material resembling soap was found in a clay vase during excavations in ancient Babylon. This is proof that the production of soap was already familiar in 2,500 BC. A recipe describing mixing animal fats and vegetal oils with basic salts was found written in a papyrus dating from 1,500 BC. According to this recipe, a material produced that was very much like soap, was used for curing diseases and for cleanness. Around 600 BC Phoenicians made soap from goat fat and wood ash, a practice known also to Greeks. Romans cared for their personal hygiene using warm water and constructed many baths. After the fall of Rome in 467AD people in the western Mediterranean were less concerned with cleanliness and infrastructures were neglected. Subsequently, contaminated water lead to the spreading of mortal diseases such as the plague and people died in massive numbers. However, the use of Roman baths continued in the East and was taken up by the Arabs in a refined form known as the «hamam». In the 17th century cleanliness and bathing returned to fashion throughout Europe and the Mediterranean.

Soaps are sodium and potassium salts with fatty acids from plant and animal fats. They are produced by a reaction called saponification. Detergents are mixtures of surfactants, «builders» and other components in various analogies. The active components of the detergents are anionic, cationic, nonionic and amphoteric organic substances, which consist of two parts: one part that dissolves in oily dirt and a second part that dissolves in water. Builders are salts essential for the creation of the necessary microenvironment. Phosphates are the most common.

Detergents were first produced during World War I and today constitute the primary cleaning products. They were invented because soap has no effect in hard or brackish waters nor in acidic environments. Another reason is that the alkalinity of common soaps can harm our skin. Moreover, raw materials for the production of soaps are fats and oils, substances which could constitute valuable food for people.

Apart from surfactants and builders a number of other components are contained in detergents, depending on their type and specific use. Such substances could be abrasives, acids, alkalis, anti-microbial agents, bleaches, colorants, corrosion inhibitors, enzymes, fabric softening agents, fluorescent whitening agents, fragrances, opacifiers, preservatives, solvents and sud control agents.

Today cleaning products exhibit a great degree of specialization. In the market one comes across personal cleansing products, laundry detergents and laundry aids, dishwashing products and household cleansers. Detergents come as solids, liquids or in the form of tablets. Liquid detergents are produced in different levels of concentration. Detergents are packaged in paper boxes, plastic bottles, plastic bags or tins. The choice of packaging depends on cost, safety, appearance of the product, etc.

Early detergents were not biodegradable. Micro-organisms were not able to consume these substances because their molecules had branched carbon chains. They accumulated in the environment and caused various problems. These problems were solved by the production of biodegradable active surfactants with a linear carbon chain.

Now phosphate salts are the main disadvantage of most detergents. Phosphorus is a nutrient for all plants and therefore also for phytoplankton and algae. Since phosphate salts are rather limited on earth (and in natural waters) phytoplankton and algae do not normally over-develop in aquatic systems. When large quantities of detergents are used, considerable amounts of phosphorus enrich the waters and algae bloom. This phenomenon is called eutrophication. Phosphates also derive from minerals, which frequently contain significant concentrations of arsenic and cadmium. These two elements are toxic. Using large amounts of detergents results in high concentrations of these toxic elements in the aquatic environments.

In order to tackle these problems many solutions have been proposed. The most important of these are listed below:

- Limitation of phosphates in detergents.
- Replacement of phosphates with other less harmful builders.
- Removal of phosphates from wastewaters.
- Encouraging consumers through public awareness and environmental education to use smaller quantities of detergents.
- Application of ecotaxes on detergents.

Water and health issues for humans & ecosystems

Of all environmental ills, contaminated water presents the most devastating consequences. More than 3 million children under five die of diarrhoea every year in developing countries. Malaria is another waterborne disease, which infects about 100 million people annually. Similarly, typhoid and cholera are endemic in many developing countries. Bilharzia and river blindness are also common diseases caused by mismanagement of water. The relationship between water and health is immensely complex and involves the environment as a whole. Providing drinking water of adequate quality to those without it is the only proper solution.

Another issue is the harmful effect to the health of ecosystems due to pollution caused by agricultural chemicals, the return flow from irrigation and direct pollution from effluents. This is a mounting problem in both developing and developed countries. The overloading of seas, lakes, rivers and streams with nutrients (nitrogen and phosphorous substances) can result in a series of adverse effects leading to pollution of water bodies -eutrophication. Phosphorus and to a less extent nitrogen are the key elements for eutrophication. In severe cases, massive blooms of algae occur. Some of these blooms (e.g. *dinoflagelates)* are toxic. As dead algae decompose, the oxygen dissolved in the water is used up; animals dwelling at the bottom of a body of water die while fish either die or leave the affected area. The unbalanced ecosystem makes water unacceptable for human consumption.

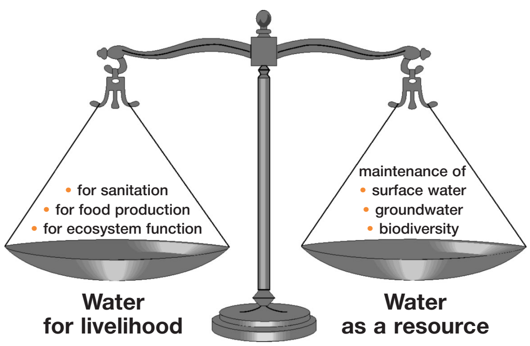
In developing countries untreated sewage is the primary cause of water pollution, while in industrialized countries the most serious water problems derive from toxic organic chemicals and heavy metals.

Tools and methods to deal with water problems

• *Integrated Water Resources Management (IWRM)*

Water in the Mediterranean, is a critical and vulnerable resource, invaluable for human welfare and sustainable development and essential for the maintenance of the rich biological diversity of the region. The main dilemma the majority of Mediterranean countries are facing is how to balance demand and supply of water in order to ensure self-sufficiency in meeting agricultural, industrial and domestic water needs without damaging natural aquatic ecosystems.
Integrated Water Resources Management (IWRM) is a precious tool for this purpose. IWRM aims at ensuring the coordinated development and management of water, land and related resources by maximizing economic and social welfare without compromising the sustainability of vital environmental ecosystems.
The basic principles of IWRM are the following:

- Freshwater is a finite and vulnerable resource, essential in sustaining life, development and the environment.
- Water development and management should be based on a participatory approach involving users, planers and policy makers at all levels.
- Women play a central role in the provision, management and



The challenge for the future is to implement an integrated management policy which reconciles economic uses with the conservation of wetland ecosystems.

safeguarding of water.
- Water has an economic value in all its competing uses and should be recognised as an economic good.

It is considered that the knowledge and technology of what needs to be done to implement IWRM at regional and national level is to a certain extent already available or at least obtainable. Nevertheless, in many areas and fields a lot more needs to be clarified, tested or adapted to local conditions. Most importantly political will and public commitment are indispensable. Therefore, IWRM can only be achieved through the active participation of all stakeholders involved: the governments, the users, the local authorities, the private sector and the NGOs. Obviously, social and cultural changes will be required so as to shift to a more sustainable and responsible consumer behavior and also to adjust the public and the private sector's methods of planning and operation of water works and practices.

The EU Water Framework Directive is an attempt to implement the global concept of IWRM in a particular region taking into account the existing EU Institutional framework.

• *The Water Framework Directive*

The increasing demand by citizens and environmental organisations for cleaner rivers and lakes, safe groundwater and unpolluted coastal beaches is evident. This demand by citizens is one of the main reasons why the Commission has made water protection one of the priorities of its work. After 25 years of European water legislation the new European water policy was developed through a consultation process primarily with the Council and the European Parliament and inputs from interested parties, such as local and regional authorities, water users and non-governmental organisations (NGOs). The main piece of new European policy is the so called Water Framework Directive (WFD).

The main objective of the Water Framework Directive (WFD) is the protection of inland surface waters, transitional waters, coastal waters and groundwater, in order to prevent and reduce pollution, promote sustainable water use, protect the aquatic environment, improve the status of aquatic ecosystems and mitigate the effects of floods and droughts.

The following are the key aims and targets:
- Expand the scope of water protection to all waters, surface waters -rivers, lakes coastal waters- and groundwaters.
- Achieve «good status» for all waters by setting a deadline.
- Set up a system of management within river basins.
- Ensure active participation of all stakeholders, including NGOs and local communities, in water management activities.
- Ensure reduction and control pollution from all sources like agriculture, industrial activity and urban areas, etc.
- Require water pricing policies.
- Combine approaches of emission limit values and quality standards.
- Balance the interests of the environment with those who depend on it.

WFD is one of the most comprehensive and ambitious EU Policies and it could be considered as the Community response to Integrated Water Resources Management. It is not an easy task and requires efforts at many levels, from the individual user to the highest levels of administration.

It is expected that the WFD will provide the basis for subsequent legislative initiatives, particularly through the «Common Strategy on the Implementation of the WFD», which includes the setting up of a coordination group as well as 11 working groups on all its critical aspects.

Appendix 1

Table: Environmental changes associated with dams*

CAUSE OF IMPACT	POSSIBLE DIRECT EFFECTS	POSSIBLE INDIRECT EFFECTS
Creation of the dam	Creation of a major obstacle in the river	• Barrier to migration for certain aquatic vertebrates, in particular fish.
	Associated construction work (e.g. noise, explosions, temporary channels, etc)	• Disruption of habitat (e.g. disturbance in the bird nesting season). • Increased sediment erosion and temporary effects on river water quality.
	Modification of landscape	• Presence of new water body in landscape (particularly a in semi-arid landscape). • Cumulative effect on landscape of several dams in the same river basin. • Presence of newly-built associated structures (turbine plants, treatment plants). • Change in slope gradient-possible increase in erosion. • Creation of a tourist attraction (for recreation). Seasonal population influx.
Reservoir impoundment	Flooding of land	• Habitat destruction-possible loss of rare species. • Destruction of archaeological and historical features. • Decomposition of organic material, resulting in temporary eutrophication. • Splitting of continuous forested areas in two belts. • Possible migration barrier for terrestrial fauna.
Presence of a permanent still water body	Creation of a still water habitat	• Change from riverine to lacustrine ecosystem. • Stratification of the water body, with associated changes to the ecosystem.
	Creation of a new micro-climate	• Increased humidity and attenuated temperature changes upstream of the reservoir. Possible increase of average temperature and decrease of the period of snow and ice presece with significant impacts on floods, soil erosion, etc.
	Rise in groundwater levels upstream of the reservoir	• Possible flooding of land (waterlogging) and increased salination. • Changes in groundwater flow regime.
	Effect on bedrock	• Possible induced seismic activity (only in the largest impoundment).
	Water use	• Changes in downstream land use due to the availability of a new water resource (for example, irrigation). • Potential conflicting water demands.

* J. Leonard, P. Crouzet, Lakes and reservoirs in the EEA area, European Environmental Agency, November 1998, p. 94 (modified).

CAUSE OF IMPACT	POSSIBLE DIRECT EFFECTS	POSSIBLE INDIRECT EFFECTS
Accumulation in the reservoir	Sediment trapping	• Sedimentation of the reservoir with associated water volume reduction. • Reduction of particulate matter in downstream watercourse. Leaching of nutrients and other substances.
	Nutrient trapping and enrichment, causing eutrophication	• Evolution of ecosystem. Appearance of water detrimental to recreation uses-toxic algae. • Increased water treatment required for drinking water supply.
	Chemical pollution	• Accumulation of pesticides, heavy metals and other micro-pollutants.
Reservoir operating rules	Artificially-controlled flow discharges/compensating flows	• Changing downstream ecosystem due to artificial flow regime in the river (flood attenuation, change in flood frequency, seasonal flow reversals, increased flow in dry season). • Changes in downstream ecosystem due to modified water quality. • Changes in downstream ecosystem due to gradual variations of shock water temperature. • Possible impacts on downstream riverine fisheries. • Change in downstream river morphology. • Downstream riverbed degradation-effect on bring piers or water intakes.
	Periodic emptying	• Impact on downstream ecosystem. • Possible clogging of downstream banks if no sediment management rules are enforced.
	Water level variations in reservoir	• Modification of shoreline ecosystem. • Effect on landscape of bare rock shoreline.
Controls on upstream catchment	Legislation, regulation or education to reduce sedimentation or nutrient loads to upstream river.	• Changes in catchment land use. • Alteration of fertiliser application practice. • Installation of wastewater treatment plants. • Improvement of upstream river water quality.

Appendix 2

WATER AND ECOSYSTEMS

An aquatic ecosystem is a group of interacting organisms dependent on one another and their water environment for nutrient and shelter. Familiar examples are lakes and rivers, but aquatic ecosystems also include wetlands, such as river deltas, and coastal lagoons. More specifically, wetlands are defined as lands saturated by surface or near surface waters for periods long enough to promote the development of hydrophytic vegetation and gleyed (poorly drained) or peaty soils.

Aquatic ecosystems usually contain a wide variety of life forms including bacteria, fungi, and protozoans; bottom-dwelling organisms such as insect larvae, snails and worms; free-floating microscopic plants and animals known as plankton; large plants such as cattails, bulrushes, grasses, and reeds; and also fish, amphibians, reptiles, and birds. The assemblages of these organisms vary from one ecosystem to another because the habitat conditions, unique to each type of ecosystem, tend to affect species distributions. For example, many rivers are relatively oxygen-rich and fast-flowing compared to lakes. The species adapted to these particular river condition are rare or absent in the still waters of lakes and ponds.

ECOLOGY OF RIVERS AND STREAMS

The physical characteristics of a river - current, salt content, gradient, temperature- continuously change as the river progresses from its source to its mouth. Thus a river typically begins as a small, cold, fast flowing and turbulent stream with a bed of large stones or pebbles, but slowly grows in size and depth as tributaries merge into it; the gradient and current decrease, and the river bed becomes sandy and silty. Thus, as a river system is a continuum of habitats that vary according to local physical and chemical conditions, it is able to support an impressive array of biological communities along its entire length.

The current is the physical characteristic of rivers that mostly influences biological communities. The variable rate at which bottom material is sorted as the river progresses from upstream reaches to those downstream produces a great variety of substrates for the colonisation and development of biological communities. In the fast flowing reaches everything that is not attached or not sheltered is swept away by the current. The greater the current, the larger the amount and size of particles that can be carried by the flowing water. The only plants present are sessile algae attached to exposed stone surfaces, rooted plants being absent because of the fast flow and the lack of a fine sediment in which to grow. To avoid being swept away the benthic invertebrates present usually live on or in the shelter of the stones and are structurally adapted to the fast current. The fish are also dependent on the shelter provided by stones or the bank. In contrast, in slowly flowing rivers rooted plants are abundant in unshaded areas and the fauna is dominated by animals associated with the vegetation or living in the sediment. In the larger rivers phytoplankton may play an important role as primary producers.

In addition to internal primary production, an important source of energy in river ecosystems is externally supplied organic matter. Whereas in small streams most of the organic input is derived from the terrestrial environment, in large rivers most of the organic input is derived from upstream reaches and tributaries, as well as from the periodic flooding of adjacent floodplains. Of course, antropogenic activities contribute a lot in the received loads.

ECOLOGY OF LAKES

Standing water is the most distinctive characteristic of lakes. Their size and depth significantly influence their ecology. The water in shallow lakes is usually well mixed all the year round, whereas lakes deeper than 5-10m are usually thermally stratified in the summer, with a well mixed surface layer and a separate, more stagnant bottom layer. Lakes have a number of typical biological communities, each of which depends on primary production of organic matter by phytoplankton and higher plants. Primary production in undisturbed lakes is generally limited by the availability of nutrients and of light. Thus, the dominant primary producers are rooted plants in lakes with water so shallow, that the light can penetrate to the lake bottom, but free-floating phytoplankton in lakes with deeper water. The phytoplankton is eaten by the zooplankton which in turn is eaten by larger zooplankton and fish. Phytoplankton that settles to the lake bottom is consumed by benthic invertebrates or is decomposed by bacteria.

Lake water nutrient levels are extremely dependent on external nutrient loading, and thus on the characteristics of the lake catchment. The nutrient levels generally determine the magnitude of a lake's primary production, and to some extent the relative importance of the various biological communities. Because lakes with high nutrient levels tend to be dominated by phytoplankton, light cannot penetrate to the lake bottom and the rooted plants therefore partially or totally disappear.

ECOLOGY OF WETLANDS

Wetlands are important to species from many well-known classes of animals, as well as to less commonly known creatures. Every drop of water contains microscopic zooplankton, which is a vital component of the food chain. Fish, amphibian and reptile groups are all dependent on the habitat provided by wetlands. Wetlands are the incubators of fish, the shelter of species found nowhere else. Upstream wetlands are also important regulators of groundwater.

The Mediterranean was once a region rich in wetlands, as rivers overflowed their banks and meandered across floodplains, coastal zones and deltas. During the 19th and 20th centuries, most wetlands, especially inland, have been drained either for agriculture or to drive out malarial mosquitoes. In drained wetlands, however, the natural vegetation is superseded by dry land vegetation and erosion increases, with very serious consequences for the fauna. Yet, because wetlands do not appear immediately productive to man and may even seem threatening, they are endangered everywhere. Man's impulse to drain or fill swamps is very old and very powerful. In recent decades, the surviving wetlands have come under threat from large water-supply projects that have dammed rivers, diverted water out of wetlands or pumped out aquifers, so depriving wetlands of their supply of water.

With many countries reaching the limits of their water supplies, the threats to wetlands are growing, even though, in theory, many are protected by their governments under the Ramsar Convention on Wetlands of International Importance. Among the most important surviving wetlands are the deltas of major rivers that flow into the Mediterranean. These include the deltas of the Po, Ebro and Rhone, the Evros, Axios and Acheloos in Greece, the Menderes and Goksu in Turkey and the Nile in Egypt. In the Maghreb, there are few river deltas, but several large areas of salt marshes and lakes that act as occasional drainage basins for flash floods. Usually the water forms such lakes and then evaporates before the next rain. The depressions, called chotts* or sebkhets**, sprout masses of vegetation when wet, and attract large numbers or migrating birds. For instance, thousands of flamingoes occasionally breed at the Sebkhet Sidi El Hani in Tunisia.

* **Chott:** seasonal salt lake.
** **Sebkhet:** semi-permanent salt lake.

Contents

Water: our common cradle

A quick review of the history of mankind reveals that evolution is closely linked to places where water was present.
It is evident that in almost every tradition and in the very ancient documents, water takes on spiritual and mystic significance.
But above all, water has a special meaning and importance in all great religions. It is the symbol of purity, purification, rebirth and creation.

Activity

1. Find out about customs and traditions in your country related to water.
2. Collect information about customs and traditions related to water in other Mediterranean countries. Detect similarities and differences.
3. Set up an exhibition to present your findings. Include photographic material, essays, old water pots, etc.

Copper statue of God Poseidon

Objectives

- To practise collecting and synthesising information. (P,C)
- To practise organising exhibitions. (P)
- To relate the presence of water to human evolution. (C)
- To value water as a strong link among Mediterranean religions, traditions and customs. (C,A)

Greek mythology is full of references about man's intervention on the environment. According to a myth, Eurotas, the King of Laconia, dug a channel in an attempt to drain a valley from stagnant waters. Thus, a river was formed. It was named Eurotas. That's where Helen, the beautiful wife of Menelaos, used to bathe.

1 academic year

English, History, Social Studies, Arts, Home Economics

religion, tradition, customs, Mediterranean Civilisations

Water present «everywhere»

1b

About 70% of the earth's surface is covered with water.

- About 83% of our blood is water.
- About 65% of an animal's weight is water, and about 60% of a tree's weight is water.
- Plant products (e.g. juices) as well as animal products (e.g. milk, eggs) contain a significant amount of water.

Activity

Find out how much water fresh produce and animals/insects contain.

Materials/Equipment

- scale
- metal or ceramic tray
- oven
- fresh vegetables or fruits: tomato, orange, celery stalk, onion, grapes, banana, pea pods, etc.
- small dead animals or insects: fish, frog, cockroach, etc.

Procedure

1. Weigh the item (fresh product or animal/insect) you intend to experiment with. Note down its mass in the table below.
2. Place the item in a tray and oven-dry at low temperature. You may observe and weigh every 15minutes.
3. When the item is totally dry (two successive weight measurements are the same), weigh its remaining bulk. Note down its mass as before.

item	mass before drying (g)	mass after drying (g)	water quantity (g)	water's percentage (%)

4. Calculate the mass of the water lost.
5. Now you can calculate the percentage of water in the item.

The answer might surprise you!

Objectives

- To discover the presence of water in fresh produce and organisms. (C)
- To develop the skill of taking weight measurements using a scale. (P)
- To calculate the amount of water in various items, work out the results and perform quality and quantity control. (P)
- To relate water to life. (C,A)

1 day

Physical Sciences (Chemistry), Life Sciences (Biology)

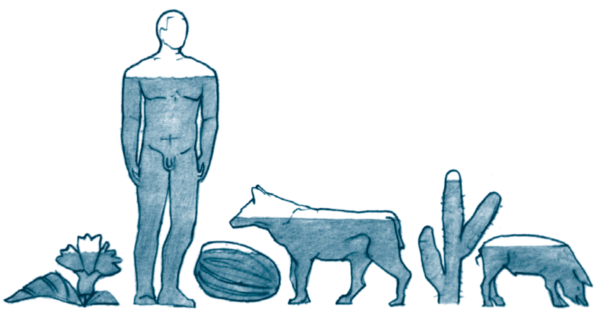
quality and quantity control

Compare the percentages of water contained in different fruits, vegetables, animals, and insects. Can you explain why they differ?

You may also describe the change in their appearance, colour, etc. Can you explain the differences?

Compare your results to data in the table below.

Animal products	g water/100g of product	Plant products	g water/100g of product
beef	56	asparagus	92
lamb	55	green beans	69
pork	47	soya	73
codfish	81	cabbage	92
herring	66	carrot	89
sardines (tinned)	50	celery	95
poultry	64	cucumber	96
egg yolk	45-51	garlic	61
egg white	85-90	mushrooms	92
cow's milk	77	pepper	93
goat milk	77	onion	92
milk of sheep	66	potato	78
butter	<18	spinach	90
cheese	30-45	tomato	94
cream cheese	45-80	pea	79



The three «faces» (phases) of water

((2a))

Water is the only common substance that occurs on the surface of Earth simultaneously in all three states (phases) of matter:

Solid water -ice- is frozen water. When water freezes its molecules move further apart, making ice less dense than water. This means that ice floats on water.

Liquid water is wet and fluid. This is the form of water, which we are most familiar with. We use liquid water in many ways, such as drinking, washing, cooking and swimming.

Water as a gas -vapour- is always present in the air around us, although we cannot see it. When we boil water, it changes from liquid to gas. Some of the water vapour cools and we see it as a small cloud called «steam». This cloud is a mini version of the clouds we see in the sky.

Objectives

- To be able to set up an apparatus. (P)
- To identify the three states of water. (C)
- To explain the different properties of the three states of water in terms of structure. (C)
- To realise that ice, liquid water and steam are actually the same substance: H_2O. (C)

Activity

Let's set up an apparatus to observe the three «faces» (phases) of water.

Materials/Equipment

- Erlenmeyer (or any other thermo resistant) flask half filled with ice (frozen fresh water)
- cork with hole
- rubber tube (6-8mm diameter)
- camping gas
- bowl filled with ice cubes
- empty bowl

Procedure

1. Assemble the apparatus according to the figure.
2. Start heating the flask very carefully. The flask should never come in contact with the flame.
3. Record your observations.

Note that a white precipitant remains at the bottom of the Erlenmeyer flask.

1 week

Physical Sciences (Chemistry, Physics)

Hydrological cycle, states of matter

Ice floats on water

- Water can occur in three states: solid (ice), liquid or gas (vapour).
- Ice is lighter than the same volume of water, so ice floats on water.
- Water freezes at 0°C.

Objectives

- To realise that water exists in three states. (C)
- To find out that ice is less dense than liquid water. (C)
- To relate the special properties of water to life. (C,A)

Activity

Find out the increase inthe volume of water when it turns to ice.

Materials/Equipment

- plastic bottle or glass with narrow neck
- marker
- freezer

Procedure

1. Half-fill the bottle or glass with water and mark its level.
2. Place it in the freezer until all the mass of water turns to ice.
3. What do you observe when you remove the bottle/glass from the freezer?
4. Mark again the level of ice in the bottle.
   Discuss your observations in class.

Discuss how this particular property of water is related to the maintenance of life.

Have you ever wondered what would happen to the living organisms of a lake, during wintertime, if ice were heavier than liquid water?

2-3 hours

Physical Sciences (Chemistry, Physics), Life Sciences (Biology)

freezing point, density

Water: the universal solvent

Water can dissolve most natural and synthetic substances on earth. That's why it is called the universal solvent. Whether we live and work in cities, towns or farms, we all add things to water as we use it for domestic, agricultural or industrial activities. So, when water leaves our homes, places of business or factories, it is never as clean as it was when it first came out of the tap.

Activity

We can demonstrate that water is a very good solvent.

Materials/Equipment

- four glasses filled with fresh water
- vegetable oil
- food colouring
- eye dropper
- bird feathers

Procedure

1. Add four drops of food colouring to a glass full of water. Observe what happens.
   Our shampoos, cleaning products and soap bubbles have the same potential to pollute clean water.
2. Add four drops of vegetable oil to the second glass of water. Observe what happens now.
   Pouring oil and grease into our sink at home causes the same type of film to form on the surface of waters, where many oily substances often end up. This kind of oily surface scum prevents certain fish from surface feeding. Furthermore, sunlight is partly reflected and partly absorbed and inhibited from reaching deeper waters. This reduces photosynthesis.
3. Add four drops of vegetable oil to the third glass. Then carefully add two drops of food colouring on the oil's surface. Wait for a few seconds and observe what happens.
   Imagine this is an oil spill on the ocean surface. Would you want to swim in it?
4. Add oil to the fourth glass of water. Place bird feathers into the glass.Wait for a few seconds and observe what happens. Discuss how oil spills affect marine life.
5. Sum up the implications of non-reasonable human activities (i.e. oil transfer, use of detergents, etc). Describe the future of a more sustainable way of human action.

Objectives

- To realise that water dissolves and transfers most of the substances around us. (C)
- To be able to make analogies and generalisations while working on a micro-scale level. (C,P)
- To find out how pollution is spread in the environment through water. (C)
- To outline the implications of oil transfer in the Mediterranean. (C)
- To adopt a positive attitude and behaviour against polluting water. (A)

During the last 50 years, more than 500 accidents took place in the Bosporus area. In 1979 the collision of two tankers led to an explosion, while 100.000 tons of crude oil spilled into the straits. Another tanker collision in 1994 left 98.600 tons of oil, 600 tons of fuel and 250 tons of diesel burning for days.

Although the Mediterranean covers only 0.7% of the total surface of the world's seas and oceans, 20% of world oil transits through its waters!

1-2 hours

Physical Sciences (Chemistry, Biology)
Earth Sciences (Geography), Social Studies

photosynthesis, solvent, pollution, oil spill, sustainability

Water: the carrier of nutrients in plants

Evaporation from plants is called transpiration. Water evaporates through the tiny pores (stomates) that are scattered across a leaf's surface. Water moves from the moist soil into the roots, through the plant and finally out of the leaf's pores. Coherence and affinity are responsible for water and nutrient transfer from the roots to the leaves.
Coherence: due to the polar character of water molecules, strong forces of attraction appear between them.
Affinity: strong attractive forces are also exerted between water molecules and molecules of other substances.

Objectives

- To be able to conduct simple experiments. (P)
- To find out that water flows from roots to leaves through plant tissues. (C)
- To realise that water is the medium through which nutrients are carried to plants. (C)
- To realise how evaporation in plant leaves affects water pathways. (C)
- To make analogies (nutrients-ink). (C)
- To practise plotting graphs. (P,C)

Activity

((2d))

Let's travel along with water and nutrients from roots to leaves!

Materials/Equipment

- jar
- knife
- transparent membrane
- 8 stalks of celery or fresh (green) onion (approx. of the same size)
- ink (or watercolour)
- watch
- ruler

Procedure

1. Cover half of the stalks with the membrane.
2. Place all the stalks (covered and uncovered) in a jar containing water and a few drops of ink or water colour.
3. Wait 5min. Remove the first pair of covered and uncovered stalks.
4. Make a vertical cut in each stalk 1cm from the end of the stalk. Are the tissues coloured? Make more cuts until you reach a point where the tissue is not

1-2 hours

Physical Sciences (Physics, Chemistry), Life Sciences (Biology, Botany), Maths

evaporation, transpiration, stomates, tissues, coherence, affinity coloured.

5. Measure the length of the coloured tissue in each stalk and note down your measurements in the table.

6. Repeat steps 4 and 5 every 5min for each pair of stalks.

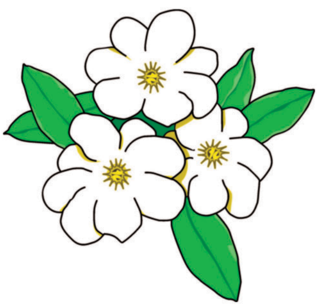
7. Compare the height of the coloured tissue in each case. Discuss your results.

8. Plot a graph of colour height against time, for covered and uncovered stalks separately.

time (min)	colour height (cm)	
	covered	uncovered
5		
10		
15		
20		

What happens when you place a fan in front of the jar with the stalks? Can you explain?

Experiment with white flowers (e.g. jasmine) for a more spectacular result!



Water: the sink of heat

- One of the unique properties of water is its high heat capacity.
- Large water bodies, such as oceans, seas and large lakes, have a moderating effect on the local climate because they act as large thermostats.

Activity

Let's experiment with water heat capacity.

Materials/Equipment

- water bath (50°C)
- three beakers
- water, alcohol, oil
- watch
- a large bowl
- thermometer
- ice cubes

Procedure

1. Add 100mL of the three liquids (water, alcohol and oil) in three beakers, respectively.
2. Place the beakers in a large bowl full of ice cubes, until the temperature of the three liquids reaches 5°C.
3. Place the beakers in a water bath of 50°C (in a large bowl with hot water).
4. Measure the temperature of each liquid every 1min, until it reaches 50°C. Record your measurements in the table below.
5. Compare the rate of increase in the temperature of the three liquids. Comment on the behaviour of water.

	temperature (°C)		
t (min)	water	alcohol	oil
1			
2			
3			
...			

Why are coastal areas warmer than inland areas? Start a discussion in class and relate water heat capacity to the Mediterranean climate.

Objectives

- To practise taking temperature measurements. (P)
- To find out that due to its heat capacity, water resists temperature changes. (C)
- To relate water heat capacity to the Mediterranean climate. (C)
- To make generalisations. (P,C)

«Have fun with balloons discovering water's heat capacity»

- *Fill a balloon with water.*
- *Place a lit lighter near the bottom of the balloon.*
- *Does it blow up? Why not?*

2 hours

Physical Sciences (Physics, Chemistry), Earth Sciences (Geography)

heat capacity, water bodies, climate, Mediterranean climate

The "portrait" of the water cycle

Remarkably, ever since water first appeared on Earth, it is in a ceaseless state of motion, yet its quantity has been more or less stable. Little has been added or lost over millions of years.
Water evaporates. It travels into the air and becomes part of a cloud. It falls down to earth as precipitation; then evaporates again. This procedure repeats itself in a never-ending cycle. Water keeps moving and changing from solid to liquid to gas, over and over again.

Objectives

- To comprehend and describe the hydrological cycle. (C)
- To realise that the hydrological cycle is constant and never ending. (C)
- To develop drawing skills. (P)
- To practise in setting up an exhibition. (P)

Activity

Let's draw the water cycle!

Materials/Equipment

- paints or coloured markers
- 2 sheets of cardboard
- a pair of scissors
- pins

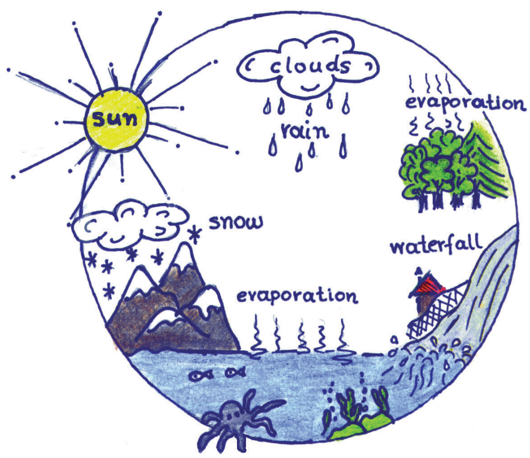
3a

Procedure

1. Use one sheet of cardboard to make nine labels and write the following keywords of the hydrological cycle in each one of them.

Ice	*Precipitation*	*Groundwater*
Ocean storage	*Evaporation*	*Percolation*
River flow	*Evapotranspiration*	*Lake storage*

2. Use the second sheet to draw the hydrological cycle. Try to include all nine keywords.
3. Pin the labels on the appropriate possition on your drawing and connect them with arrows.
4. As you walk around your community identify elements of the water cycle that you see. Use a camera to capture water pathways.
5. Organise a photography competition on the water cycle and set up an exhibition.



Would you believe that your last drink of water may once have been drunk by a dinosaur?

2-3 hours

Physical Sciences (Physics), Life Sciences (Biology), Earth Sciences (Geography)

hydrological cycle, precipitation, evaporation, evapotranspiration, percolation

Create a mini water cycle

Natural cycles exist in a fragile balance, which are disturbed if any of their elements is disrupted. It is important to conserve our natural resources and to protect natural cycles by not being wasteful.

Activity

A simple experiment will demonstrate how the water cycle works.

Materials/Equipment

- large glass bowl
- small dish
- transparent membrane
- rubber band
- small stone
- food colouring

Procedure

1. Place the small dish in the middle of the large bowl.
2. Pour water into the large bowl, making sure that no water gets into the small dish.
3. Cover the large bowl with a the membrane -making sure that it is firmly in place and that it seals the top completely.
4. Place the small stone in the centre of the plastic «lid», directly above the small dish.
5. Leave the bowl in the sun for a few hours.
6. Add one drop of food colouring in the large bowl and repeat the whole procedure. What do you observe?

The heat from the sun will cause the water in the large bowl to evaporate and turn into water vapour, just like water from rivers, dams and the sea evaporates in nature.

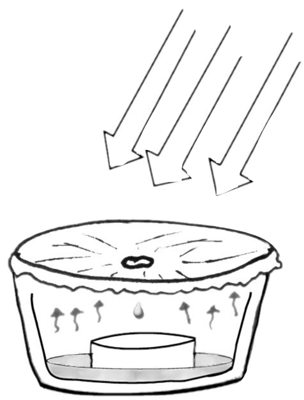
This water vapour will rise towards the underside of the plastic «lid», where it will form droplets and run down towards the centre of the membrane. The water will then drip into the small dish, just as rain falls from clouds.

If one of the elements of your experiment were disturbed, the experiment would fail. Imagine what would happen if there were a hole in the plastic «lid»: a certain amount of the water vapour would not condense and would spread into the air.

? *If the water cycle purifies water, why is pollution a problem?*

Objectives

- To describe the hydrological cycle. (C)
- To set up experimental apparatus. (P)
- To acquire the ability to generalise while working on a microscale level. (P,C)
- To realise that any intervention in one part of the cycle will influence the complete cycle. (P,C)
- To adopt positive attitude against pollution. (A)



2-3 hours

Physical Sciences (Physics), Life Sciences (Biology), Earth Sciences (Geography)

evaporation, condensation, human interventions in the hydrological cycle

Modelling the Mediterranean Sea

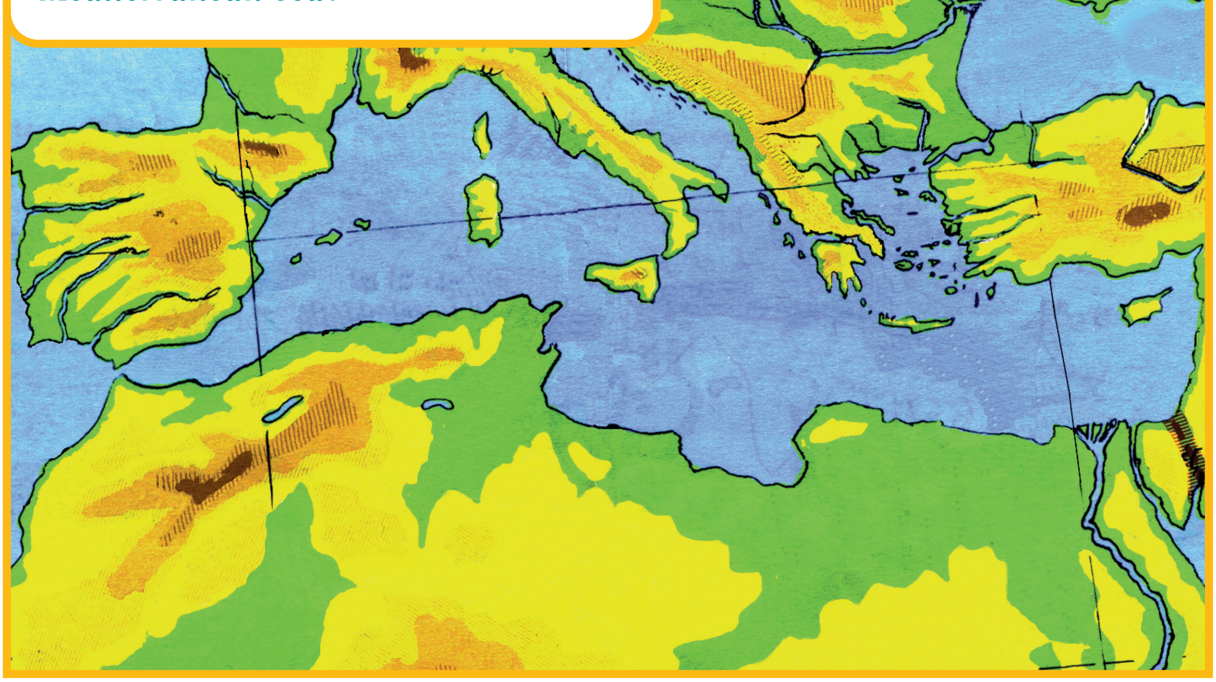
In the age of the «global village» where does the Mediterranean begin and where does it end? It may sound like a simple question but the answers vary according to the criteria used: the extent of olive tree cultivation, climatological, hydrographical and sociocultural have all been considered as possible criteria. However, the boundary of the Mediterranean must be extended dramatically when taking into account the entire watershed and pollution spread.

The Danube is the second longest river in Europe and one of the principal traffic arteries on the continent. The Danube has always been an important route between Western Europe and the Black Sea. It is the only major European river to flow from west to east: It springs from the Black Forest Mountains of Germany and flows in a generally easterly direction, passing through Ulm, Regensburg, and Passau in Germany; Linz and Vienna in Austria; Bratislava in Slovakia; Budapest in Hungary; Belgrade in Serbia; and Galati and Brúila in Romania. Finally, after a watercourse 2.900 Km long, the Danube empties on the Romanian coast into the Black Sea.

Do you think the Danube affects the Mediterranean Sea?

Objectives

- To describe the geological characteristics of the Mediterranean region. (C)
- To name the major rivers that flow into the Mediterranean basin and the countries they flow through. (C)
- To practise reading maps and charting by collecting the appropriate information. (P)
- To practise constructing models. (P)
- To be able to make analogies and generalisations while working on a microscale level. (C,P)
- To estimate how river management influences the state of the Mediterranean sea. (C)
- To adopt an informed attitude against pollution. (A)

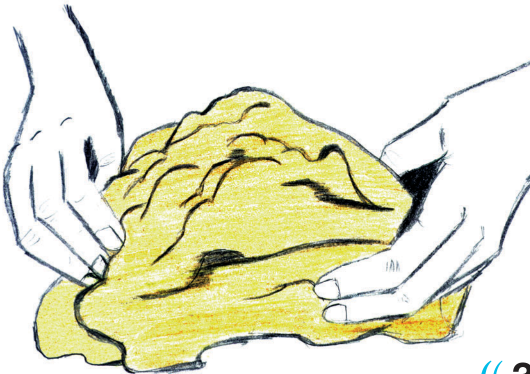


Activity

Time to model the Mediterranean!

Materials/Equipment

- geomorphologic map of the Mediterranean
- strong cardboard or plywood
- plastic film for covering the cardboard
- newspaper or old plastic bags and PVA (white) glue or clay
- paint (oil or other) - blue, green, yellow and brown- that does not dissolve plastic
- brushes
- water
- red food colouring
- white vinegar
- indicator (phenolphthalein)
- small pieces of wood



((3c))

Procedure

1. Use the geomorphologic map as a guide and construct the model of the Mediterranean region using the above material. Cover carefully the plywood with plastic. Nail and glue the pieces of wood in the mountainous areas and build around them the «mountains».

2. Allow to dry and paint. Allow to dry again before the next step.

3. Fill in the basin with some water.

4. Pour water from the source of a river and watch it flow towards the sea.

5. Repeat step 4 by adding food colouring using a dropper. The food colouring represents pollution (sewage or industrial discharge) in the water poured. What do you observe now?

6. Empty and refill the basin with clean water and a few drops of the indicator.
Repeat step 4 by adding vinegar in the water poured. What do you observe?

aprox. 2 weeks

Physical Sciences (Chemistry), Earth Sciences (Geography, Geology), Arts, Social Studies

Mediterranean, geomorphology, pollution, acid rain, water cycle

The unequal distribution of water

((3d))

Objectives

- To comprehend and describe the characteristics of the Mediterranean climate. (C)
- To take measurements, record data, derive and compare conclusions. (P)
- To describe the problem of acid rain, its causes and its implications. (C)
- To describe the problem of water shortage in various Mediterranean countries. (C)
- To recognise that water is an important natural source, not always available, and therefore in need of reasonable management. (A)
- To adopt an informed attitude towards saving fresh water. (A)

For many people the Mediterranean climate, with its hot dry summers and cool wet winters, represents the perfect climate. But the provision of water is hardly effective. Most of the rain falls when it is least needed and there is hardly any rainfall when it is vitally needed. The classic definition of the Mediterranean climate designates a climate in which winter rainfall is more than three times the amount of summer rainfall. The seasonal contrast is more pronounced in the South and the East areas of the region, where most of the annual rainfall may occur in just a few days of torrential downpours.
It is not only the quantity and frequency of rainfall that matters, but also its quality. If the rain washes through a polluted atmosphere it frequently becomes acidic.

Activity

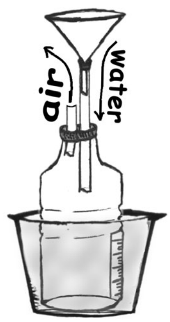
Monitor the amounts of rainfall in your region throughout the period of a year.

Materials/Equipment

- plastic bottle
- ruler
- plastic funnel
- universal indicator
- rubber tube
- marker

Procedure

1. Construct your own rain-sampler. Set up an apparatus according to the figure.



1 year

Physical Sciences (Chemistry, Physics), Earth Sciences (Geography)

annual rainfall, pH, water shortage, Mediterranean climate

2. Place the rain-sampler in an open area. Make sure it is not get blown away or knocked over. Secure it by putting it in a flower pot or plastic basket filled with sand.

3. Take height measurements immediately after a rainfall.
   Each time calculate the pH by using the universal indicator. Record your data in a table.

date	height (mm)	pH

Compare your data (or sections of it) to those published in the local newspapers or shown on television. Annual comparisons can also be made to previously published data. You can have access to this data by visiting local libraries or weather offices. Are there any variations? Can you explain them?

Classroom discussion

- water shortage in various Mediterranean countries.
- acid rain, its causes and its implications on the environment.

Where does drinking water come from?

((4a))

- Only 0.6% of the total amount of water on earth is fresh water. Yet, only 5% of this amount is easily accessible to man (0.03% of the total amount of water on earth).
- The Mediterranean is one of the most densely populated areas on Earth. More than 130 million people live in cities, towns and villages on or near the Mediterranean coasts. Tourists more than double this population every summer.

Activity

1. Where does fresh water at your school come from? Is it groundwater, spring water, river water or does it come from another source?
2. Talk with people responsible for the storage and distribution of water in your town.
3. Identify factors, which might inhibit water supply in your village, town or farm area. Find and propose strategies to solve this problem.
4. Collect information about the water supply system in your region as it is today and as it was a few decades ago. Make comparisons.
5. Display your findings by composing an essay, or by preparing a poster. Inform your school, your families and the community.

Ships transport water to many small Greek islands during the summer period. Marseilles has recently supplied Sardinia. Gibraltar, until recently received large quantities of water transported by tankers. In 1995 the Israeli water department announced that it hoped to agree financial terms with the Turkish government to buy 60 million cubic meters of drinking water per year.
In many rivers that flow into the Mediterranean water is captured behind dams. Water is transferred and delivered by long canals, pipelines, and specially adapted tankers or giant plastic containers, called medusas.

Objectives

- To describe the journey of water until it reaches one's home. (C)
- To be informed that the amount of fresh water available to man is limited. (C)
- To be able to collect and evaluate data. (P)
- To contact people responsible for water management in one's region. (P)
- To identify factors that may inhibit the adequacy of fresh water in one's region. (P,C)
- To be able to develop arguments and to propose solutions regarding a local environmental issue. (P)
- To adopt a positive attitude towards saving water. (A)
- To appreciate the actual value and price of water. (A)

2-4 weeks

Earth Sciences (Geography, Geology), Social Studies, History, Arts

water supply system, water resources, water shortage

The evolution of the water supply system in the city of Athens

Three rivers flowed through Ancient Athens: the Kifissos, the Ilisos and the Iridanos. There were also three small springs: the Asclepeion, the Klepsidra and the Kaliroi. The first waterworks were constructed on the Ilisos and the Iridanos rivers to meet the water demand of the city's population.
The most important waterworks were constructed during the Roman Ages. Such works include the «Adrianion» aqueduct and reservoir and the pipeline system, through which water was distributed to the entire city. There were no significant changes in the Athens water supply system since then, until the mid-19th century. In 1851, the municipalities replaced the whole system and the first water treatment plant was constructed. Fiftyfive public taps (fountains) were installed throughout the then small town! A portion of the city's water originated from the springs of Mount Parnes and part of it was groundwater.
In 1926 the construction of a large-scale dam began. The lake formed behind the dam was named Lake Marathon. This was a construction of vital importance for the population. In 1938 the Kakosalesi aqueduct was constructed and later, in 1957, the construction of the Yliki aqueduct began. Today, Athens also uses the waters of the Mornos River and until 1999 it exploited the waters of the Evinos River.

Mediterranean countries	Access to an improved water source*			
	Urban % of polulation		Rural % of population	
	1990	2000	1990	2000
Algeria	–	98	–	88
Egypt, Arab Rep.	97	96	91	94
Jordan	99	100	92	84
Lebanon	–	100	–	100
Libya	72	72	68	68
Morocco	94	100	58	58
Syrian Arab Republic	–	94	–	64
Tunisia	94	–	61	–
Turkey	82	82	76	84

Resource: www.worldbank.org

* **Access to an improved water source** refers to the percentage of the population with reasonable access to an adequate amount of water from an improved source such as a household connection, public standpipe, borehole, protected well or spring or rainwater collection.
Reasonable access is defined as the availability of at least 20L a person a day from a source within 1km of the dwelling.

Filtration

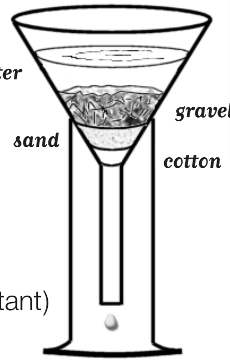
Part of the hydrological cycle is the filtration of water through soils. Water percolates into soil and permeable bedrock. The soil's texture and structure influence the infiltration capacity.
Filtration is the process followed in order to separate particles suspended in a liquid. The filters used in water treatment are usually made of layers of sand and gravel.

Activity

Experiment with filtration.

Materials/Equipment

- funnel
- sand
- gravel
- cotton
- cylinder
- soluble coffee beans (for representing solid wastes)
- mixtures:
  1.water + soil
  2.water from a pond
  3.water + watercolour
  (for representing a soluble pollutant)
  4.water + detergent
  5.water + cooking oil



Procedure

1. Set up the apparatus as in the figure above.
2. Pour mixture No 1 into the funnel.
3. After the mixture is filtered what do you observe? Stir the content of the cylinder with a stick. What do you observe?
   Take a sample from the content of the cylinder and observe it using a microscope.
   Note down your observations.
4. Empty the cylinder.
5. Repeat the experiment with mixtures No 2, 3, 4 and 5, after replacing the gravel, sand and cotton.
6. Place a few grains of coffee between two layers of cotton and gravel and pour water. Observe the results.

Can you think of a phenomenon similar to this experiment occurring in nature?

Objectives

- To discover the role of filtration in the natural process of «purification» of water. (C)
- To explain the importance of filtration in the water treatment process. (C)
- To develop skills for assembling an apparatus. (P)
- To develop skills for making analogies (experiment-percolation). (P)
- To adopt an informed attitude against polluting water by pouring hazardous substances in it or in the ground. (A)

If an aquifer becomes polluted with substances such as synthetic chemical compounds and toxic metals, it may remain polluted for generations, a continuing hazard to man and the environment.

2 hours

Physical Sciences (Chemistry), Earth Sciences (Geology), Life Sciences (Biology)

filtration, percolation, pollutants, contaminants, aquifer, water treatment

Disinfection of water

One of the most important steps in the water treatment process is disinfection. During disinfection, the pathogens that water might contain get inactivated. The substances that are used for this purpose (disinfectants) are substances that contain chlorine (free chlorine Cl_2, chlorine dioxide, ClO2 and chloramines), ozone or ozone in combination to hydrogen peroxide. Using free chlorine is the most common method of disinfection of water. Chlorine inactivates effectively a wide range of pathogens, leaves a residual in the water (keeping it clean while it is distributed to the public) and it is economical. On the other hand, chlorine reacts with many naturally occurring organic and inorganic compounds in water, producing undesirable products. Also, high chlorine doses can cause taste and odor problems.

Objectives

- To be able to contact simple experiments. (P)
- To detect the presence of chlorine in drinking water. (P)
- To realise that what we call safe drinking water, in many cases, actually contains chemicals. (C)
- To comprehend to what extent some chemicals are necessary in water treatment in order to safeguard human health. (C)

Activity

We can detect the amount of chlorine in drinking water.

Materials/Equipment

- 2% solution of potassium iodine (KI)
- beaker (250mL)
- tap water
- starch or flour (as an indicator)
- camping gas

Procedure

1. Half-fill the beaker with tap water.
2. Add ten drops of the KI solution and a pinch of flour.
3. Start heating the beaker. If water contains enough chlorine it will turn blue.

Chlorine contained in water takes part in a series of chemical reactions, which lead to the formation of iodine (I_2). Iodine and starch form a cluster, which has a deep blue colour.

Throughout the human history epidemics have often been the cause of horrific fatality among populations. Water contamination is one of the major causes of an epidemic. Even today, 4 million children under the age of 5 die of diarrhoea in developing countries, every year.

((4c))

The chemistry of the water disinfection (free Cl_2 method)

Chlorine gas is hydrolysed in water and form hypochlorous acid, HOCl as:

$Cl_2 + H_2O \rightarrow HOCl + H^+Cl^-$

The hypochlorous acid dissociates slightly into hydrogen and hydrochlorite ions (when pH is between 6,5 and 8,5) as:

$HOCl \leftrightarrows H^+ + OCl^-$

In a pH above 8,5 the HOCl dissociates completely. As the germicidal effect of HOCl is much higher than that of OCl-, chlorination at a lower pH is preferred.

aprox. 1 hour

Physical Sciences (Chemistry), Life Sciences (Biology)

disinfection, pathogens, epidemic, waterborne diseases

Water treatment

4d

Throughout human history epidemics have often afflicted populations with massive fatality. These epidemics were often caused by the use of contaminated water.
Unless water comes from an artesian well (underground water source, under pressure) carefully pumped under a closed system, water has to be treated before used as drinking water because:

- One can never be sure of what is going on upstream.
- One can never know whether no polluting or contaminating objects or creatures, such us small animals, birds, snakes, etc. have fallen into an open well.
- Very often water is polluted by traces of human excretions that are present somewhere quite close to it.
- Springs are not always safe, especially if they are in carstic areas. They may be safe only if water is collected at that very spot.
- Lake or pond water is very dangerous for drinking, since very often it is polluted by waste from industrial, domestic or agricultural activities and animals or people may have contaminated it.

In all these cases water treatment is necessary. Very often in areas with water shortages, rainwater collected in reservoirs or ponds and stagnant water are the only solution for survival. The basic and necessary treatment, in such cases, includes filtration, the addition of lime (CaO) and boiling.

Activity

1. Visit the water treatment plant of your area. Observe the steps in the water treatment process and keep notes.
2. Fill in the blanks on the sketch on the next page with the appropriate word from the table.

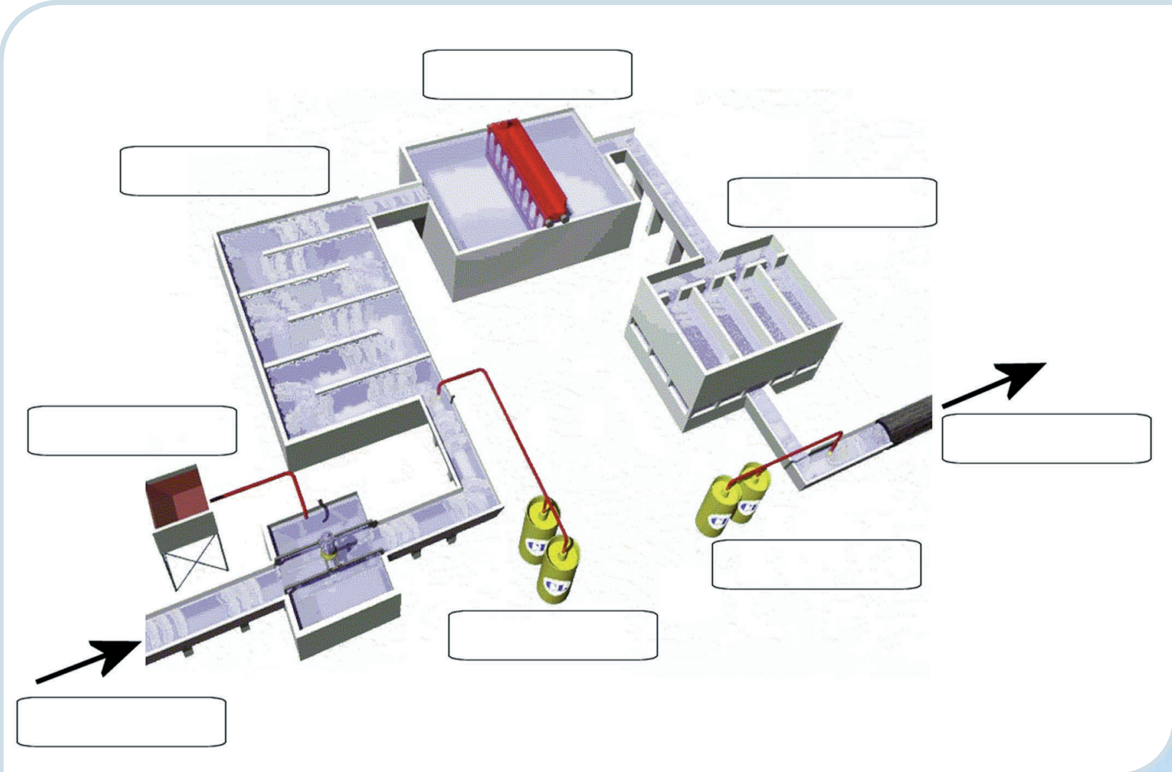
Objectives

- To participate in a field trip. (P)
- To observe and collect information on the process of water treatment. (P)
- To describe briefly and precisely the steps followed during water treatment. (C)
- To display the successive steps of a process described in a diagram. (P)
- To comprehend the importance of water treatment for human health. (A,C)

1 day

Physical Sciences (Chemistry)

filtration, sedimentation, distribution system, coagulation, flocculation, disinfection



4d

Intake	Sedimentation
Filtration	Distribution
Chemical addition	Coagulation & Flocculation
Storage	Disinfection

Water lost in the city

((4e))

Distribution networks are the means for supplying adequate quantities of water of good quality, to individual households and industrial plants. However, leakage and theft of water are a constant and in some cases increasing drain on many of these water-supply systems. Moreover, leakage tends to increase as systems age and pipes crack, so constant maintenance is necessary to reduce losses on the one hand and the risk of contamination on the other.
The rate of water that is lost or «unaccounted for» can reach as high as 60% in urban delivery systems due to leaks and theft. A survey in 17 Greek towns at the beginning of the 80's recorded average water losses of 45%. In 1989 Damascus was left without water during most nights, while an estimated 30% of its resources were lost due to leaks in the distribution network.

Objectives

- To find out what a distribution network is and why water flows through it. (C)
- To be able to make generalizations and analogies. (P)
- To comprehend why a great amount of freshwater is lost through water supply systems. (C)
- To adopt a positive attitude towards conserving water. (A)
- To take action in reducing water leakages. (P,A)

Activity

Let's calculate the loss of water through a tiny hole.

Materials/Equipment

- volumetric cylinder (500mL)
- 2 beakers (1L)
- rubber tube (6-8mm diameter, 45cm length)
- sewing needle
- lighter

Procedure

1. Add exactly 500mL of water (by using the cylinder) in each beaker.
2. Close one end of the tube with your finger, fill it with water and place each end in the two beakers respectively.
3. Place the beakers at different levels. Observe the water flow from one beaker to the other. Why does this happen?
   Have you ever wondered why aqueducts are at the highest point in a town?
4. Using the above apparatus you can check the loss of water from a small hole in the tube. Heat the sewing needle using the lighter and make a small hole in the rubber tube, just as water starts to flow.
5. Calculate the amount of water lost.

Public education is a major element in any programme to reduce wastage of water. Israel's «Every drop counts» programme brought substantial savings in urban water use at the height of water scarcity in the early 90's. Despite a 25% increase in population, Jerusalem used less water in 1991 than 1983. Other countries have taken similar steps. «Greece is running dry» stickers appealing to tourists, appeared in every hotel room in Athens during the drought of 1993.

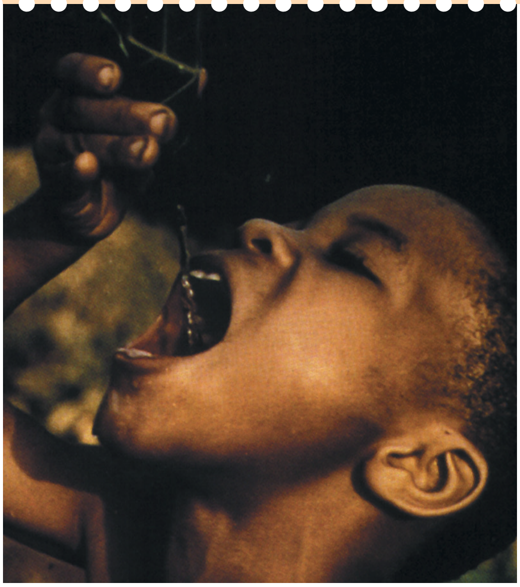
1-2 hours

Physical Sciences (Physics), Home Economics

water distribution network, water leakages, water scarcity

Striving for water

It has been said that the degree of civilization, which humanity has achieved, can be measured by the amount of water consumption for domestic purposes. And yet, humanity actually faces tremendous water shortages in almost half of the planet. The most affected areas are the Middle East, the Sahel and North Africa.



*Over **1 billion people** lack access to minimum quantities of safe water.*

***Two thirds** of the world population will be **striving** for water by 2025.*

In desert and in semi-arid zones women invest valuable time and energy in the search for water.

Nearly 30% of the women in Egypt have to walk more than one hour a day, to reach the nearest water resource.

In Wayen and Burkina Faso, mothers walk daily for two or three hours to stagnant water holes 12 kilometres away, to return with only 25 litres of water carried on their head.

Objectives

- To practise collecting data. (P)
- To comprehend the problem of water shortage in many parts of the planet. (C,A)
- To compare water consumption between developed and developing countries and analyse the consequences. (C,A)
- To gain an informed attitude towards conserving water. (A)
- To suggest ways for wiser models of water management in order to reduce the gaps between developed and developing countries. (C,A)

Activity

Use the pictures and the texts to start a discussion in class. Express your ideas and feelings towards the huge gap in water consumption between a child in a developed and a developing country. Try to analyse the consequences for the economy, social stability and peace as well as the impact on the state of the environment in both cases.

Collect information (from libraries, the Internet, etc.) on water consumption and water shortages in developed and developing countries.

Present your findings in class.

Suggest ways for a «wiser» model of water consumption throughout the world.

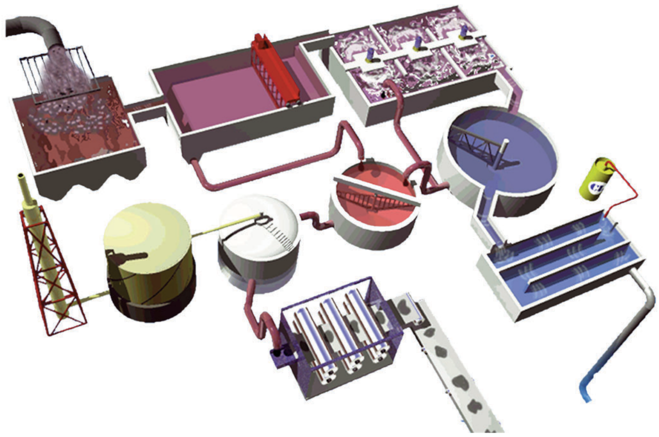
1-2 weeks

English, Earth Sciences (Geography), Social Studies, Economics

water consumption, water shortage, developed/ developing countries, sustainable management of water resources

Sewage treatment

Cities have a long history of polluting their own water supplies. Ancient Rome fouled the Tiber so severely, that by 140BC locals could no longer use the water for drinking. Today, sewage pollution prevents water in many rivers from being abstracted downstream; natural systems may be devastated by pollution. In developed countries municipalities treat their sewage to reduce water pollution and eutrophication. Additionally, water can be recycled after treatment in order to reduce



pressure on water resources.

Activity

1. Visit a sewage treatment plant in your area.
2. Learn about each step of sewage treatment. Keep a diary with your observations.
3. Find out whether water returns to a river or the sea, or whether it is used for irrigation or other purposes after its treatment.
   Is this water suitable for drinking? What more could have been needed and at what cost? Seek an expert's advice, if possible.
4. Based on your recorded notes write a small essay on your visit
5. Try to draw or set up the model of the plant you visited. Does it look like the model above? Make

Objectives

- To collect information on the process of sewage treatment. (P)
- To describe the steps followed in a sewage treatment plant. (C)
- To participate in a fieldtrip. (P)
- To practise building models and illustrations. (P)
- To realise the importance of sewage treatment for the reduction of pollution and eutrophication. (C,A)
- To realise the important role of technology in sustainable environmental management. (C,A)

Coastal waters, rivers and wetlands suffer badly from pollution generated by the disposal of untreated sewage. Many big cities throughout the Mediterranean still do not have adequate waste water treatment facilities. All countries acknowledge the urgent need for efficient treatment works to handle sewage and industrial discharges in order to improve water quality but, quite often, find it hard to summon the political will to construct and then maintain them. From the necessary purification plants, a cosiderable number have been constructed, but only few are in effective operation, while the remainder either operate inefficiently or have been abandoned, because of lack in personnel and in financing for maintainance.

1 day

Physical Sciences (Chemistry), Life Sciences (Biology, Ecology)

screening, primary settlement, biological treatment (activated sludge), secondary settlement, tertiary treatment, sludge digestion, eutrophication, water pollution

Germs are happy in water

Diarrhoeal diseases are mainly the result of waterborne viral and bacterial infections. Pathogenic microorganisms include bacteria, protozoa and viruses. They are present in very large numbers in human and animal excretions or raw sewage. Once water is infected, it becomes unsuitable for drinking, swimming or watering vegetables.

Materials/Equipment

- microscope
- Pasteur pipette
- 4 beakers
- chlorine
- water from:
  - a pond
  - a vase with flowers
  - a pot
  - a water tap

((5a))

Activity

Let's go on safari in a drop of water!

Procedure

1. Number the beakers. Add a small amount of water from a pond, a vase, a pot and a tap in each one respectively.
2. Take samples from each beaker and observe them under a microscope.
   Note down your observations.
3. Add a few drops of chlorine as a disinfectant in each beaker. Take samples from each beaker and observe them again under the microscope.
   Note down your observations.

Discuss your findings in class.
Discuss with an expert or search in an encyclopaedia for information on how to distinguish the difference between pathogenic and non-pathogenic microorganisms.

A Turkish proverb states:
«Running water is clean water».
Is this true?

Objectives

- To acquire the skill of using the microscope. (P)
- To improve skills for observing the number, shape, size and movement of cells. (P)
- To find out the effect of chlorine on microorganisms. (C,P)
- To realise the necessity for chlorination during the water treatment process. (P)
- To classify microorganisms as pathogenic and non-pathogenic. (C)
- To comprehend that what looks «clean» is not always «safe» drinking water. (C)

Even a drop of water is an aquatic ecosystem, since it contains or can support many living organisms. In fact, ecologists and microbiologists often study in vitro small samples of water taken from lakes and rivers, to understand the eventual problems associated with the use of these large water bodies.

1-2h

Life Sciences (Biology)

microorganisms, pathogens, «unsafe» water, waterborne diseases, ecosystems

Deadly water

Objectives

- To relate water to human health. (C)
- To practise collecting information (bibliographic research). (P)
- To name the epidemics that are spread through water. (C)
- To realise that waterborne diseases are very common in developing countries. (C)
- To become acquainted with medical baths, spas, etc. in the Mediterranean countries. (C)
- To practise drawing maps. (P)
- To comprehend the necessity for clean water and the «value» of clean, safe water for all aspects of life (ecosystems, health, economy). (A)

There is no life without water. It is an «element» indispensable to all human activity. Human beings can live several weeks without food, but only two or three days without water. Life is inconceivable without water since health and cleanliness are not possible without it. In ancient Greece and other parts of the Mediterranean water therapy was particularly developed. Medical baths were taken with medicinal herbs against certain diseases. On the other hand, water is very vulnerable to contamination and it is the perfect medium for the speading of pathogens. The most common waterborne diseases are cholera, typhoid, hepatitis, poliomyelitis, diarrhoea and dysentery.

((5b))

Unsafe water not only jeopardises human health but also has negative implications on economies and ecosystems. Without an adequate supply of safe water, agriculture and enterprises (e.g. food factories) that depend on clean water may have to discontinue their activities, even temporarily; workers absent due to illness may affect production; fisheries may be destroyed.

Activity

Conduct a bibliographical research:

a) On diseases that are spread through water in your country and other parts of the Mediterranean and the rest of the world.

b) On spas and medical baths existing in your country and the Mediterranean.

Newspaper, national statistics, statistics and information by WHO, UNEP and UNICEF are available.

Draw two Mediterranean maps displaying your research findings.

Propose ways for purifying water in an emergency situation, such as in a flood.

2-3 weeks

English, Life Sciences (Biology), Earth Sciences (Geography), Social Studies

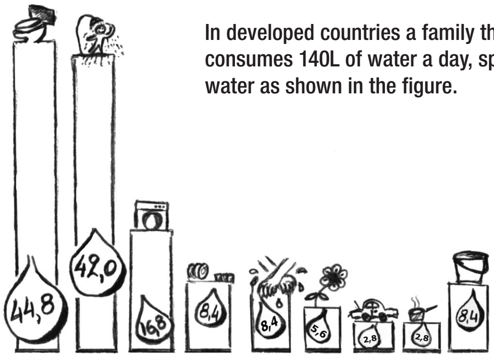
pathogens, waterborne diseases, developed/ developing countries

How much water did you use today?

What more precious substance could we wish to have at home?

- During hot nights, half-asleep, we seek this precious liquid: a glass of water next to our bed.
- The day starts with some water splashed on our face: we need it as plants need the morning dew.
- A refreshing shower.
- In a hurry, a cup of coffee, and off we go...

Activity



In developed countries a family that consumes 140L of water a day, spends water as shown in the figure.

6a

A student should wash his/her hands, having placed a bucket under the tap in order to collect the water he/she is going to consume.
Measure the amount of water under the following conditions:
a) keeping the tap on while washing
b) turning the tap off while washing
Fill in the appropriate cells of the table on the following page.

Calculate

- How much water is saved in the second case, per day, per person.
- How many more students could have washed their hands with the wasted wate.

Can you think of other ways to save water during your daily habits?

The same activity can be carried out at home in order to calculate the amount of water that can be saved when brushing our teeth, washing dishes, etc.

You may go on calculating the amount of water that your family, those living in your building or even the whole city can save throughout a day, a week, a month or a year, by adapting their daily habits in an environment-friendly way.

Objectives

- To take measurements, work out and produce original data. (P)
- To find out how much water one could waste due to careless common habits. (P)
- To comprehend that we can save water by changing small things in our daily habits. (A)
- To adopt a positive attitude towards saving water. (A)

Quite frequently up to 5L of water are consumed while brushing our teeth. We probably need only 1-2 glasses of water.

1 hour

Home Economics, Social Studies, Maths

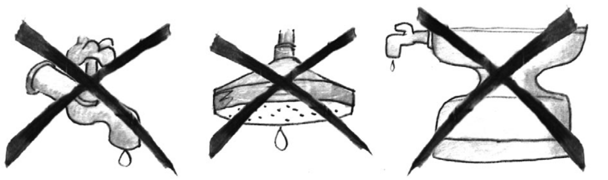
water consumption

«Waterconsuming» daily habits	Water spent when tap is turned on	Water spent when tap is turned off	Water wasted	Water wasted per day by a single person	Water wasted per week by a single person	Water wasted per year by a single person
Washing hands						
Taking a shower						
Brushing teeth						
Shaving						
Washing hair						
Washing dishes						
Other						
TOTAL						

Water lost in our home

A garden hose or tap left running can waste about 20 litres per minute. That's over 1,200L per hour, enough water to fill 8 bathtubs. In around three days that water is enough to fill an average swimming pool of approximately 100m^3. This treated, clean water, is enough to provide the minimum water needed for a rural community of 400 people for 100 days (25Lper person daily)!
Each hole in a damaged hose results in water lost!

Slow drip:	1 mm leak:	1.5 mm leak:	3 mm leak:
5,000L wasted in 3 months	100,000L wasted in 3 months	225,000L wasted in 3 months	600,000L wasted in 3 months



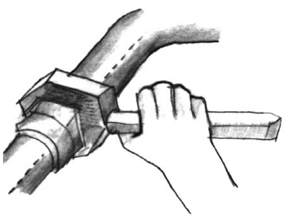
Activity

Let's calculate the loss of water from a leaking tap in our home or school.

Procedure

Measure the amount of water lost from a leaking tap for exactly 5min.
Calculate:
- the amount of water lost during a day
- the amount of water lost during a month
- the number of thirsty people that could have been provided with water, instead.

Use a water company bill to calculate what the cost of a leaking tap is for a whole year.



Look for leaking taps and tanks and other water losses in your school. Inform your school principal about your findings and ask the school plumber to repair the damages. Organise a group of students that will check water taps and the piping system of your school on a regular basis and write a short report for the principal.

Objectives

- To realise that a great amount of fresh water is lost even after it reaches our home. (C)
- To take action in order to reduce water losses. (P,A)
- To adopt a positive attitude towards conserving water. (A)

Even the smallest leak from the water tank in the toilet adds up to hundred of liters per day!
Are you sure that the tank in your house or school is not leaking?
You can check it by adding food colouring in the tank and wait for an hour before flushing. If you observe any colour in the toilet, call your plumber!

1-2 hours

Physical Sciences (Physics), Home Economics

water distribution network, water leakages, water scarcity

Excess cleaning products in water

((6c))

In this day and age detergents are used widely and quite often irrationally. The excess of detergents ends up in water bodies and pollutes them causing eutrophication. Eutrophication disturbs the balance of the ecosystems and may also cause the death of aquatic organisms.

Objectives

- To practise conducting simple experiments. (P)
- To discover that detergents are commonly overused. (C)
- To associate overuse of detergents to eutrophication. (C)
- To practise conducting a market research. (P)
- To adopt an informed attitude against overuse of cleaning products. (A)

Activity

Let's find out how much water and detergent is necessary to clean a dirty plate!

Materials/Equipment

- five plates
- volumetric cylinder
- liquid soap
- olive oil
- sponge
- bucket

Procedure

1. Spread two table spoons of oil on the surface of each plate, respectively.
2. Wash the first plate. Count the number of drops of detergent you use. Fill in the appropriate blank in the table below.
3. Repeat step 2 using 1, 2, 4 and 8 drops of detergent, respectively. Collect and measure the amount of water needed in each case. Fill in the table.

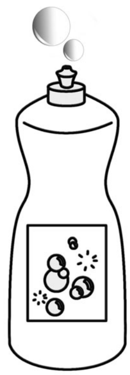


plate	drops of liquid soap	amount of water (mL)
1		
2	*1*	
3	*2*	
4	*4*	
5	*8*	

1-2 weeks

Physical Sciences (Chemistry), Life Sciences (Biology), Home Economics,

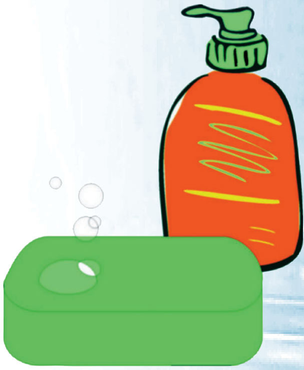
cleaning products, eutrophication, overuse, consumption

4. Experiment with the wastewater of the 5th plate. Add 100mL in the volumetric cylinder and shake for about 3 sec. How long does it take for the foam formed on the surface to disappear? Is there any detergent remaining in the water?

5. Repeat the experiment at home. Ask your mother to wash the dishes after lunch, as she usually does, but measuring the detergent and the water needed.

   She must collect it and pour it first in a bucket whose volume you have measured. In order to determine the volume of the bucket you can fill it once using a clean, plastic or glass bottle of specific volume (e.g. a 1L water bottle).

   Don't throw the wastewater: water a plant instead!



6. After dinner wash the same amount of plates, by adding half of the detergent your mother used. You will need two basins full of water, one for washing and one for rinsing. Immersing the plate three times in the rinsing water is usually enough to remove all of the detergent. Measure the wastewater again and calculate the difference.

7. Calculate the difference in the cost of water and detergent. You may find out that even half of the originally used detergent is still too much. Inform your family about your results, and ask them to join you in your efforts towards a more sustainable use of water and other resources.

A water vessel from the Mediterranean

Water vessels and jugs are the common containers for transporting and storing water, in all Mediterranean countries. They were used for storing oil and wine as well.

The water vessel is considered as one of the most difficult ceramics to produce, due to the high demands regarding its delicate shape, thin walls and small weight.

The major steps followed during the production of a water vessel are: working the clay, shaping the vessel on a poter's wheel, drying, firing in kilns and lastly cooling.

Activity

Let's find out the past and present status of water vessels.

Materials/Equipment

- clay
- oil paints
- pastels

((6d))

Procedure

Can you think of any places where you can find old water vessels? In your storeroom, in the basement or in attic? In your grandparents' house or another place? If you identify some in use ask the owners for information on the vessels (i.e. how old they are, their orginal use, etc.). If possible borrow the water vessels and bring them to your class, with great care.

1. Compare the various shapes, decorations, uses, origins, local names, etc.
2. In class discuss the necessity of using water vessels in various circumstances, such as water shortage, inadequate water supply systems, etc.
3. Make and decorate your own water vessel using clay and oil paints. You may even draw the vessel of the Mediterranean country of your choice using pastels.
4. Set up an exhibition to inform and entertain the people of your school the local community about different shapes you have encountered in your town or in books. Make sure you include the old water vessels, informative and explanatory posters, as well as your own artwork.

Objectives

- To discover the everyday uses of water vessels and the water management of the past. (C)
- To identify water vessels as components of cultural heritage and tradition in all Mediterranean countries. (C)
- To become acquainted in identifing and appreciating old objects and collectables. (C,A)
- To practise collecting historical information. (P)
- To gain experience in setting up exhibitions. (P)
- To recognise that water was also an important natural resource in the past, not always available, thus in need of reasonable management. (C,A)

Water vessels were the only means of providing fresh water in many rural Mediterranean households, due to the lack of water supply systems up until the 60s.

Water vessel seller in Skyros, Greece, 1960

1 month

History, Arts, Social studies

ceramics, potters, water supply system

Is there growth without water?

All living organisms require water to develop. Plants as well as animals cannot survive in the absence of water.
The availability of water is one of the most important factors determining the character and productivity of all farming systems.

Activity

Let's test if a plant can grow without water.

Materials/Equipment

- lentil or bean seeds
- test tubes, test-tube rack
- cotton
- water

Procedure

1. Place a piece of wet cotton at the bottom of the two tubes and a piece of dry cotton in the third one.
2. Add a few germs in each tube.
3. Cover the tubes with a very loose piece of dry cotton allowing aeration of the tube.
4. Keep the tubes in a sunny place.
   Check the plant's growth in each tube for a fortnight. Make sure that the cotton of the first two tubes is kept wet adding, if necessary, just a few drops of water.
5. Allow the cotton in the second tube to remain dry for a few days.

Keep records of your observations for all three tubes.

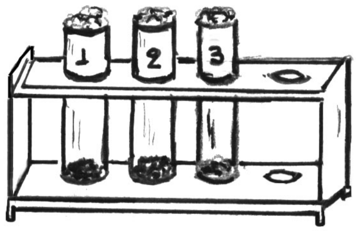
Discuss your findings with your classmates.

Discuss the implications of drought on crops as well as on the availability and cost of fruits and vegetables.

Is there any living organism (plant or animal) that can survive and grow in the absence of water?

Objectives

- To observe the steps of a plant's growth. (P)
- To realise the importance of water in plant growth. (C)
- To find out the relation between periods of drought to farming as well as to availability and cost of fresh products. (P,C)
- To comprehend that all life depends on water. (C,A)



1 fortnight

Life Sciences (Biology, Botany), Economics

water (as a growth factor), agriculture, drought

The quality and quantity of water determines plant growth

Agriculture is one of the most ancient human activities through which we secure the production of adequate quantities of food of good quality. Our society should appreciate the work of farmers who must, in turn, respect the land by using good agricultural practices e.g. by applying rational amounts of fertiliser and pesticide, by avoiding pollution of aquifers and by using the needed and not excess water. The world's most successful and sustainable agricultural systems are those that have adapted to natural variability in water availability.

Objectives

- To monitor the steps of a plant's growth. (P)
- To realise that plant growth depends on both quantity and quality of water. (C)
- To find out how pollution may affect growth. (C)
- To be able to propose strategies towards wiser water management that would result in sustainable agriculture. (P,A)

Activity No 1

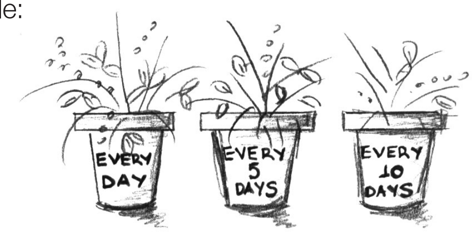
Relate water quantity to vegetable growth.

Materials/Equipment

- pots
- soil
- ruler
- seeds of vegetables, water

Procedure

1. Grow vegetables in pots. Water them according to the following schedule:
   pot No 1 twice a day
   pot No 2 every day
   pot No 3 every 3 days
   pot No 4 once 5 days
   pot No 5 once a week
   pot No 6 every 10 days
   pot No 7 once every 2 weeks
2. Use a ruler to measure plant height every week. Fill in the table below.
3. Find out which watering rate results in the best yield of plant growth. Try to explain why.



An example of sustainable agricultural systems is the rice cultivation in Southeast Asia's, where rice is grown in paddy fields which trap the summer monsoon rains, and is harvested in October, with the onset of the dry season.

pot	height			
	1st week	2nd week	3rd week	4th week
No 1				
No 2				
No 3				
No 4				
No 5				
No 6				
No 7				

1 month

Life Science (Biology, Botany), Physical Science (Chemistry), English

water (as a growth factor), agriculture, fertilizers, detergents, pollution, water management, sustainable methods of agriculture

Activity No 2

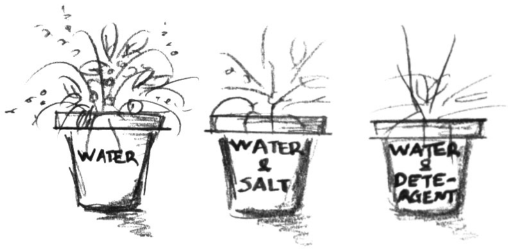
Relate water quality to vegetable growth.

Materials/Equipment

- pots
- seeds of vegetables
- common salt
- ruler
- soil
- chlorine water
- detergent, fertiliser
- water

Procedure

1. Grow vegetables in pots. Water the plants in the pots with tap water and water containing detergent, salt, chlorine water, and fertiliser. In each case use the appropriate amount of water (according to the results of activity No 1). Use a ruler to measure plant height every week. Fill in the table below.
2. Compare the results and make a report. Discuss the results you obtained in activity 1 and 2.



pot contains...	height			
	1st week	2nd week	3rd week	4th week
fresh water				
water & detergent				
water & salt				
water & chlorine				
water & fertilizer				

How do water «pollutants» influence plant growth?
Interview a farmer about the past and present situation of the land, as well as water quality and quantity.
Can you think of ways of reasonable water management in agriculture?
Can you think of strategies of conservation of water supplies?
Compile your findings in an essay and inform other classes in your school and your community.

Water used in cities and farms can be recycled. Morocco and Egypt already reuse substantial amounts of water for irrigation of tree plantations. Sometimes, if this is done in an unsystematic way, the water used may be contaminated with sewage. It has been reported that sometimes farmers illegally divert water from the main sewer of big cities in southern Mediterranean to irrigate crops. However, the use of untreated or partially treated sewage, raises health risks. Dangerous diseases may be passed on via food crops. Israelis still remember a cholera outbreak in Jerusalem in 1970, which was attributed to illegal irrigation of salad crops with raw sewage.

Eutrophication

Some eutrophication occurs naturally with the input of nutrients and sediment through erosion and precipitation, resulting in a gradual ageing of closed systems such as lakes. Humans, however, accelerate this natural process and expand its presence in rivers, lakes and coastal marine waters by releasing huge quantities of nutrients, -particularly phosphates- through municipal and industrial effluents and agricultural run-off. The situation is aggravated due to increased soil erosion by poor land-use practices. Eventually, many of the aquatic systems mentioned above have high nutrient concentrations and dense growths of aquatic weeds and algae (water plants known as algae grow in many varieties and are often found as green, slimy blobs or strands in streams and ponds). These plants die and decompose causing depletion of dissolved oxygen in water. This process often results in the reduction of aquatic populations and changes (mainly reduces) biodiversity.

Objectives

- To practise using the microscope. (P)
- To describe the phenomenon of eutrophication and its main causes and implications. (C)
- To relate eutrophication to the overuse of fertilisers and detergents. (C,P)
- To comprehend the fragility of an ecosystem. (C,P)
- To propose environmentally-friendly products, as alternatives to fertilisers and detergents. (P)
- To adopt a positive attitude towards environmentally-friendly products. (A)

Activity

Make a mini ecosystem and test its fragility.

Materials/Equipment

- glass jar
- microscope
- detergent/fertilisers
- notebook

Procedure

1. Add water from a pond to a clear glass jar.
2. Place two uncovered jars in a sunny place for several days.
3. After a few days add more water from the pond as it evaporates.
4. Eventually a green or brown growth will appear in the jars.
   Study this algal growth under the microscope.
5. You can observe the impact of nutrients first using one jar without any interference.

1 week

Physical Sciences (Chemistry), Life Sciences (Biology), Home Economics

ecosystem, eutrophication, algae, nutrients, detergents, fertilizers, environmentally-friendly products

6. You can test the fragility of this mini ecosystem, by
(a) letting the algae overcrowd their living space,
(b) letting the water get too warm or
(c) letting the water get too cold.
In all three situations the algal community will collapse and die, leaving you with a jar of very smelly water.
7. Another way to test its fragility is to deliberately «pollute» the water with a few drops of detergent or fertiliser.
8. Record your observations.

Discuss in class the phenomenon of eutrophication, its causes and implications.
Collect photos of rivers, lakes, etc. suffering from eutrophication.
Propose environmentally-friendly products, as alternatives to fertilizers and detergents.

Salinization

- All irrigation water contains dissolved salts originating from soluble minerals found in the soil; rainwater also contains some salts. As water evaporates from the soil's dry surface, salts are left behind.
- Salinization refers to a build up of salts in soil, eventually to toxic levels for plants. It is a worldwide problem, particularly acute in semi-arid areas, where considerable quantities of irrigation water is used for agriculture. This water is often of bad quality (e.g. brackish water) and the fields are poorly drained, and almost never get well flushed.
- Eventual salinization of groundwater is due to underground intrusion of marine waters due to their overpumping.

Objectives

- To be able to conduct simple experiments. (P)
- To acquire the ability to generalise while working on a micro scale level. (P)
- To practise collecting information. (P)
- To comprehend and describe the phenomenon of soil salinization. (C)
- To be able to provide solutions to an environmental issue. (C,P,A)

Activity

Let's observe the process of salinization.

((7d))

Materials/Equipment

- transparent glass beaker
- water
- camping gas

The earliest civilisations emerged where soils were richest and water most available. They declined when soil became waterlogged and saline through faulty irrigation, when watersheds had been deforested and when soil erosion and silting had destroyed the very basis of agriculture. Herodotus wrote that Egypt was «an acquired country, the gift of the river». Such a gift, can easily be taken away by continued misuse.

Procedure

1. Half-fill the beaker with water.
2. Leave the beaker in a sunny place until all water evaporates. Repeat a few times (Alternatively, you can heat up the beaker, using the camping gas -if the beaker is heat resistant- in order to accelerate evaporation).
3. Note that a white precipitant remains on the walls and the bottom of the beaker. Record your observations.

The analogous of this procedure occurring in nature is called salinization. Collect information (libraries, Internet, etc.) on this phenomenon, its causes and its implications on the environment. Can you suggest ways to prevent it?

1day-1 week

Physical Sciences (Chemistry, Physics), Earth Sciences (Geography, Geology)

salinization, evaporation, water cycle, irrigation, agriculture

Erosion and Desertification of land

7e

Objectives

- To describe the phenomena of erosion and desertification, their causes and implications. (C)
- To relate the special characteristics of the Mediterranean region (vegetation, topography, climate) to desertification. (P,C)
- To detect the role of plants and trees in preventing erosion. (P)
- To suggest ways to reduce desertification in the Mediterranean region. (P,C)
- To adopt a positive attitude towards sustainable management of water resources. (A)

The Mediterranean region is a complex mosaic of diversified landscapes and uneven relief. It consists, to a large extent, of various types of poor and highly erodable soils. Its very high climatic variability is characterised by frequent, relatively long periods of draught and short periods of relatively heavy rainfall. These semi arid and arid climates provide unfavourable natural conditions, which enhance soil degradation and desertification in the area.
Moreover, human activities connected to deforestation, overgrazing, forest fires, unsustainable agricultural practices, and irrational management of water resources accelerate desertification.

- Almost 80% of cultivated Mediterranean soils have become in the second half of the 20th century rather vulnerable because of unsustainable agricultural practices (overuse of agrochemicals, heavy machinery, etc.) despite the fact that approximately 22% of these soils have been cultivated for many millennia.
- Annually, the world loses 7 million hectares of fertile land through erosion. This corresponds to an area equal to the surface of Ireland.
- It takes 2 to 3 hundred years to recover surface soil 1cm thick.

Activity

Let's find out how a plant prevents soil erosion.

Materials/Equipment

- 2 flat (preferably rectangular) pots
- soil
- seeds of grass
- a small piece of plastic tube
- volumetric cylinder
- water

2-3 weeks

Earth Sciences (Geography, Geology), Life Sciences (Botany)

erosion, desertification, Mediterranean climate, semi-arid climate, arson, deforestation, (in)flammable vegetation

Procedure

1. Make a small hole at the bottom edge of each pot and fix the plastic tube taking care that there is no leaking water.
2. Fill both pots with the same amount of soil and plant the seeds only in one of them.
3. Place both pots with an inclination of approx. 45^{o}, as shown in the figure.
4. Water both pots every other day with the same quantity of water, allowing part of it to run off the surface of the soil and measure only the amount of water dripping out of the tube of each pot (and not the runoff).
   Note down your measurements.
5. Go on watering both pots for 2 weeks at least.

After the end of the activity compare the results.
Are there any differences? Can you explain them?
Explore other possible ways to restrain soil erosion on a broad scale.

Forest fires are quite widespread in the Mediterranean region. Fires find favourable ground in the area because of inflammable vegetation, topography, summer draughts and strong winds that favour their spreading. Although fires are considered as a natural component of the Mediterranean woodland ecosystem, their frequency and impact have recently become much higher due to intentional arson and accidents due to negligence.

Role-playing game: «If I were a farmer...»

Objectives

- To realise that agriculture is by far the largest «consumer» of fresh water. (C)
- To put oneself in someone else's position. (P)
- To argue and support one's ideas. (C,P)
- To be able to compromise and settle on the most appropriate solution. (C,P)

- Land needs water to produce food.
- Agriculture is by far the greatest user of freshwater, mostly in the form of open canal irrigation.
- There is a trend towards specialisation (monoculture) and intensification in agriculture.
- Extended irrigation schemes in one area frequently create problems in the water balance of a wider region.
- The ever-increasing demand for food, particularly at a very low price, leads to the intensive use of fertilisers to improve the nutrient status of soil and pesticides to control pests. Still, in agriculture there are no entirely «safe» chemicals; there are only safe ways of manufacturing, handling and particularly, using them. However, in most cases the prevailing practices are not economically and ecologically sound.

Activity

((7f))

Organise a role-playing game including a farmer, a government official, a local citizen-consumer, an agent from a chemical industry and an ecologist. Try to find arguments for each role. The teacher may sum-up and conclude.

Of the currently available practices in irrigation, the most efficient ecologically and economically in the medium and long term is drip irrigation, in which water is distributed through plastic pipes with small holes. Water drips through the holes directly to the roots of plants. This achieves the same result with only a very small proportion of the water needed through other systems, such as open canals or artificial rain. The only disadvantage is that it may require a higher initial investment and/or more work by the farmer.

In the Mediterranean region, 73% of fresh water is consumed for irrigated agriculture. The proportion of water demanded by irrigation exceeds 85% in Libya, Morocco, Syria, Tunisia and Egypt! In traditional irrigation, water is flooded into fields. Most of it either evaporates or seeps into groundwater. Only a small proportion is taken up by the roots of plants.

1 week

Physical Sciences (Chemistry), Life Sciences (Ecology), Social Studies, Economics, English

agriculture, fertilizers, pesticides, applied practices of irrigation, drip irrigation

The action process: Adopt a Tree

This action aims at initiating positive emotion and long-lasting commitment to nature and the maintenance of healthy forests, which is the very basis of water management.

Forests are linked both to water and agriculture. They protect the watershed by preventing soil erosion. They act as water reservoirs that improve the climate by controlling both rain and wind.
The importance of regulation and control of water can hardly be exaggerated. It is in countries where forests have been vastly destroyed, that alternating floods and droughts have caused extensive destruction to food crops, destruction of entire towns and brought about severe cases of starvation. Additionally, vegetation not only holds water, releasing it slowly into the ground, but also improves the characteristics of soil due to the organics supplied from dead leaves, roots, etc. Thus, the humus created from the remnants of tree parts and produce through biodegradation and other complex biogeochemical processes is the natural fertilizer which enhances soil structure, impedes runoff, and increases the capacity of soil to absorb moisture and inorganic nutrients (nitrogen, phosphorus, metals). So, the first rule of water management is the protection of plant cover and more specifically of forests and woodlands through reforestation if they have been destroyed.

Action

«Investigate» your area to find out why trees are needed:

- to maintain the watersheds
- to attract rainfall
- to prevent erosion
- to «clean» water as the first part of a water cycle
- to provide shelter for other species (mainly fauna)

1. Consult a specialist to find out what type of trees suit the needs of your area for better water maintenance. Start a nursery of these trees, plant them and take care of them.
2. If you are lucky enough to have a forest or a park with trees near your school, go there and «adopt» a tree that you consider weak or in danger. Water it, if needed, from time to time and occasionally take pictures of it. A few years later, through these pictures you will see whether you have managed to save it and make it strong.
3. Don't abandon «your» tree when you leave school. You have to hand down this tradition to the newcomers in your school, who could use your example and adopt another weak or small tree.

Let's make a water-mill

In the dawn of civilisation, Sun, Water and Winds were worshipped as Gods, because these were powers and «phenomena» of unknown origin far beyond humans' control or understanding and were necessary because they provided humans with what we understand today as «energy».
In an oversimplified way, according to today's standards, humans have always tried to capture and use amounts of energy from these «powers». The concern for capturing, converting and conserving energy in all its forms is still one of our major preoccupations.

Objectives

- To obtain the skill of making simple constructions. (P)
- To comprehend in which way water could provide energy that can be used by humans. (C)
- To be able to make analogies. (P,C)
- To be able to organise exhibitions. (P)

Activity

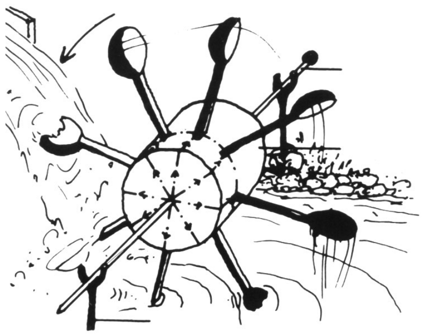
Construct a water-mill!

Materials/Equipment

- 8 plastic spoons
- a big cork, 5cm in diameter
- knitting needle
- 2 Y-shaped sticks

Procedure

1. Push the needle through the centre of the cork, until it protrudes equally from both ends of the cork.
2. Using a pencil mark eight symmetric spots round the central area on the side of the cork, where the handles of each spoon should be inserted.
3. Make a split on the cork for each spoon. Put some glue on each handle and fix them one by one into each split, making sure that all spoons are facing the same direction.
4. Place the 2 Y-shaped sticks on either side of the cork and rest the protruding ends of the needle on the sticks, as in the figure.
   The force of the water should move the water wheel around when it falls into the bowls of the spoons in turn.
5. Find out the possible uses of a water wheel. Collect photographic material, stories and tales regarding water-mills and set up an exhibition.



This simple structure demonstrates the principle and the concept of function not only of traditional water-mills but of modern hydroelectric plants too.

Falling water (e.g. in natural waterfalls, dams, etc.) may transfer significant amounts of energy and this can be noticed during heavy rainfall. Watch how water has the power to transport huge quantities of solid matter. Describe it to your classmates.

1 day-1 month

Physical Sciences (Physics), History, Social Studies, English

energy, water-mill, hydroelectric plant

Dams

Rivers are dammed to create water reservoirs for power production, downstream flood control, irrigation and recreation. Yet, experience has shown that large-scale dams often create problems such as silting; erosion of coastal low downstream lands, due to lack of supply of sediment; waterlogging; significant water losses through evaporation; seepage; changes of the local microclimate; earthquakes; destruction of habitats at the mouth of a dammed river and of the settlements or monuments in the area of the new lake.

Objectives

- To describe the benefits and drawbacks of a large-scale public infrastructure such as a dam. (C)
- To compare large to smaller dams, as to their environmental impact. (C,P)
- To comprehend how the construction of a dam has an impact on the environment and society. (C,A)
- To estimate all consequences and thoroughly assess the alternatives (conduct a very elementary EIA). (C,P)

Dam in Plastira Lake, Greece

Activity

1. Visit the nearest water dam in your region. Is it considered a large, or relatively small construction? How high is it?
2. Find out what determines the life span of a dam.
3. Describe the impact of the dam on the landscape and the environment at large. This is the starting point of an Environmental Impact Assessment (EIA).
4. Contact inhabitants and experts and find out if the construction of the dam bears any consequences on the society.
5. Compare the positive and negative aspects of large and smaller dams.

1 day-1week

Physical Sciences (Physics), Earth Sciences (Geography, Geology), Life Sciences (Biology, Botany, Zoology), Social Studies

power production, flood control, irrigation, silting, salting, waterlogging, evaporation, seepage, earthquakes, fisheries, waterweeds, EIA

Environmental Impact Assessment (EIA) is a method, which can be used as a tool to harmonise the granting procedures for planned projects and certain human activities. The purpose of EIA is to assess the possible impacts of projects on the environment as early as possible in the decision-making process and to secure proper information and consultation of the public about the project. This procedure is carried out for certain types of projects (e.g. dams) that are likely to have significant environmental impact.

For thousands of years, the silt load brought down by the Nile has been vital to the creation of its delta and the fertility of soils throughout its valley. The Nile brings down around 130 million tonnes of silt in its muddy flood. Before the construction of the Aswan dam in the 60's, between 10 and 15 million tonnes of silt would end up in the Nile floodplain and its delta in annual layers about a millimetre thick. But since 1964, very little silt passes the dam. It will be hundreds of years before the capacity of the reservoir itself is seriously reduced. But the reduction in silt load downstream could ultimately prove detrimental to the fertility of the Nile delta, which makes up two-thirds of Egypt's farmland due to «widespread erosion».

Hydroelectric plant

Non-renewable energy resource is an energy resource that is not replaced or is replaced only very slowly by natural processes, in comparison to its consumption. Primary examples of non-renewable energy resources are fossil fuels (oil, natural gas and coal). Fossil fuels are continuouslly produced by decay of plant and animal matter, but the rate of their production is extremely slow, much slower than the rate at which we use them.

Renewable energy resource is an energy resource that is naturally regenerated -virtually inexhaustible. Typical examples are wind (aeolian energy), geothermal and sunlight (solar energy).

One of the most important methods of producing electricity is through hydroelectric plants. This is, indeed, one of the least polluting conventional large-scale methods of generating electricity, using waterfalls. Still, hydroelectric schemes have a number of distinctive environmental disadvantages, related mainly to the impact of dams.

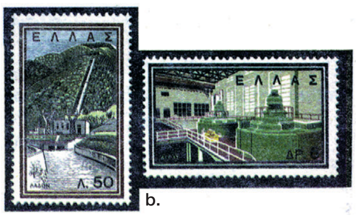
Activity

1. Visit a hydropower station and try to find out how energy can be produced by the water flow.
2. Observe the surroundings of the plant. Can you trace any effects of the plant on the environment?
3. Try to draw or describe in a short text a model of a hydropower station.

Do you consider that we use more or less energy nowadays than in the past? Can you figure out from books or goverment reports etc. future energy demands?

Compare the advantages and disadvantages of renewable and non-renewable resources of energy.

Do you consider energy derived from a hydroelectric plant as renewable or non-renewable? Why (not)?

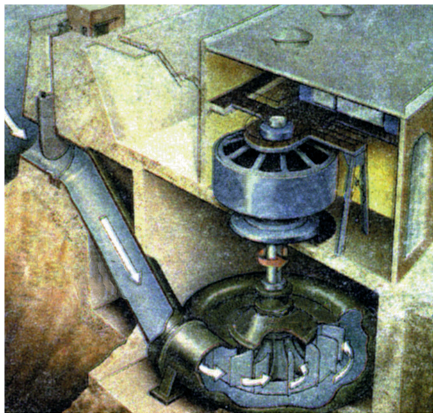


a. b.

Stamps published in 1962, Greece
a) Hydropower station at the Ladonas River.
b) Alternators inside the hydropower station at the Agras River.

Objectives

- To observe and briefly describe the steps of producing electricity in a hydroelectric plant. (C)
- To comprehend why hydroelectric projects often have adverse effects on the environment. (C,A)
- To compare renewable to non-renewable energy resources, considering the advantages and disadvantages in each case. (C,P)
- To predict future energy demands and the necessity for renewable forms of energy. (C,A)



The imterior of a hydroelectric plant

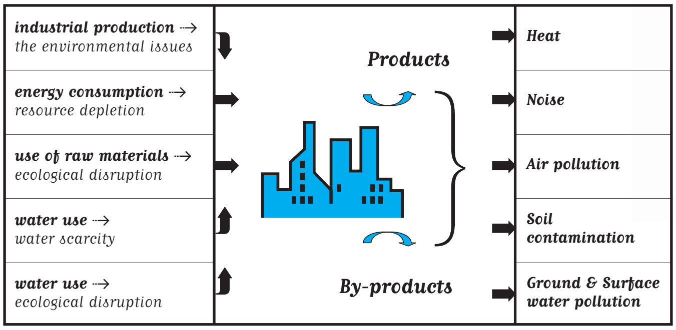
1 day-1 week

Physical Sciences (Physics), Earth Sciences (Geography, Geology), Life Sciences (Ecology), Economics

power production, flood control, irrigation, silting, salting, waterlogging, evaporation, seepage, earthquakes, fisheries, waterweeds

Water & Industry

Industry provides society with goods that improve quality of life in material term. Industry now produces seven times more goods than it did in 1950. Significant amounts of water are required in the production process for product transfer, cleaning-washing, dilution or cooling. Water is also the medium through which liquid wastes that contain pollutants are discharged to recipient water bodies such as ponds, lakes or the sea. Peculiar as it may seem, industrial release of gases in the atmosphere is another form of water pollution. Once released into the atmosphere oxides of sulphur and nitrogen and a large number of other pollutants dissolve in rainwater forming a harmful, frequently acidic solution. What goes «up» as a gas comes «down» as acid rain.



Activity

1. Visit a factory; You should previously have kept notes on what you expect to see and on what to look for, with particular reference to waste disposal and pollution (laws, regulations). Consult relevant environmentalists about the existing problems and experts from the factory about the measures taken for prevention of pollution. Draw your own conclusions.
2. Measure, if possible and relevant, the temperatures upstream and downstream near the plant. What are the differences in the fauna and flora in those two locations or near to and far from the discharge of the wastes of the factory? What are the reasons behind these differences?
3. Write a report indicating the impacts of the factory on the local environment. Propose measures to diminish those implications. Try to include the economic cost of each measure you suggest.
4. Organise a photography competition on industrial pollution and set up a photo exhibition. Also present and discuss your report.

Objectives

- To learn and describe why and where water is needed in industry. (C)
- To comprehend how industry may cause water pollution. (C)
- To find out what measures could be taken and/or have been taken to limit pollution, regarding industries. (C,P)
- To estimate consequences and assess the available alternatives. (C)
- To describe features of a more sustainable industry. (C,A)
- To practise in writing reports. (P)
- To practise in setting up exhibitions. (P)

Thermal Pollution is another problem caused by many industries and combustion power stations: after water is drawn for cooling, it is returned to its source warmer. As the temperature of water increases, its ability to hold oxygen decreases; this can dramatically alter the ecological balance of a stream, lake or river.

Did you know that «for each car produced 400.000L of water are consumed»?

1 day-1 month

Physical Sciences (Physics, Chemistry), Life Sciences (Biology, Botany, Zoology), Economics, English, Arts

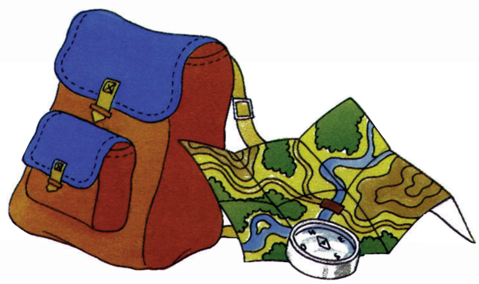
industry, technology, forms of pollution, industrial wastes, acid rain

Visiting a Wetland

Objectives

- To participate in fieldwork. (P)
- To observe and discover the great variety of flora and fauna. (C,P)
- To practise collecting and classifying data in a scientific manner. (P)
- To practise drawing maps. (P)
- To comprehend and describe basic concepts referring to wetlands such as: flora, fauna, food chain. (C)
- To study and understand the delicate balance existing in an ecosystem. (C,P)
- To comprehend the importance of wetlands for natural water management. (C,A)
- To adopt a positive attitude towards protecting and conserving wetlands and their functions. (A)

Wetlands are areas which contain a lot of water but are not ponds or lakes. Wetlands such as *marshes*, *river deltas* and *coastal lagoons* are usually a refuge for many species of plants and animals. Usually, they nurture the region's fisheries while acting as «buffer» zones between water bodies of different properties e.g. riverine and marine waters. They prevent salinization and facilitate the cleansing of waters through natural processes such as biodegradation, flocculation, sedimentation and removal of nutrients and organics.



Materials/Equipment

- measuring tape
- 4 poles
- pencils
- string
- millimetre paper

((9a))

Procedure

1. Set your boundaries: mark the area you will work on, using string and poles. Make sure your marked area is representative of the total region.

EXAMINE THE FLORA

2. List the various types of trees and plants. For each species, measure the approximate height and note down their number in the table below:

h: tree's height		
trees h>10m	trees 10<h<2m	trees h<2m

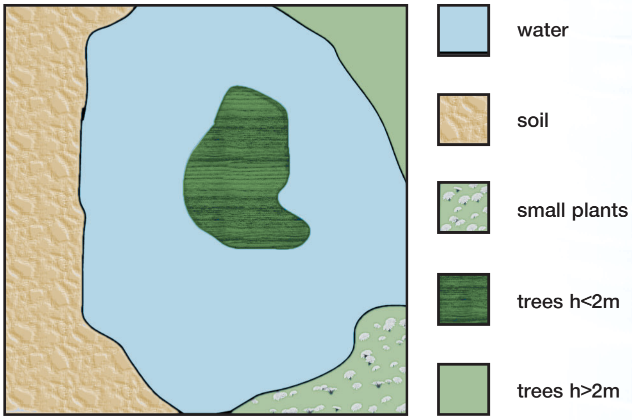
1 month

Life Sciences (Biology, Botany, Zoology), Earth Sciences (Geography), English, Arts, Maths

wetlands, marshes, river deltas, coastal lagoons, flora, fauna, food chain, biodiversity, ecosystem

→ → →

3. Use the millimetre paper to record the coverage percentage of your area. See the example below.



EXAMINE THE FAUNA

4. Identify and record the type and number of species of insects, reptiles or animals you come across. Make a list.

SET UP A WETLAND ROLE-PLAYING GAME

Collect information about the food chain and the interaction among the species you examined. Remember that some species are by far more vulnerable than others to enemies or pollution. Identify them using information from books and discussions with biologists-ecologists.

Set up a wetland role-playing game, in which each student represents one of the species you examined.

Use your imagination... The following questions may help you with your scenario:

- What happens when a particular species increases in number? How do the other species react?
- What happens when a species vanishes? Who profits?
- What happens when fresh water decreases dramatically?
- What happens when water gets slightly polluted?
- What happens when water gets severely polluted?

Wetland Research

The Mediterranean was once a region rich in wetlands, as rivers burst their banks and meandered across floodplains, coastal zones and deltas. During the last two centuries most wetlands, have been drained either for agricultural purposes, expansion of tourist settlements, urban constructions (e.g. airports, etc.) or to drive out malarial mosquitoes. In recent decades, the surviving wetlands have come under further threat from large water-supply projects such as damming rivers, diverting water out of wetlands or pumping out aquifers, thus depriving wetlands of their water supply.

Objectives

- To practise in fieldwork. (P)
- To discover the great variety of wetland species. (C,A)
- To comprehend that wetlands form a unique habitat and shelter for fish and birds, especially for the migratory ones. (P,A)
- To experience the «beat» of life in wetlands and detect any existing problems. (P,A)
- To practise in preparing informative material. (P)
- To acquire a positive attitude and propose strategies to protect and preserve wetlands. (C)

1day-1 month

Physical Sciences (Chemistry), Earth Sciences (Geology, Geography), Life Sciences (Biology, Botany, Zoology), Social Studies, History, Literature, Arts

wetland, delta zone, flood plains, flora, fauna, food chain, geomorphology, human interventions, salinization, overgrazing

Equipment/Materials

- raincoat
- photo camera
- thermometer
- oxygen-meter
- notebook
- a pair of binoculars
- plastic rubbers
- salinometer
- measuring tape
- pencils

Action

1. Observe the area. Collect data concerning the biodiversity, geomorphology and special characteristics of the wetland.

2. Try to find information concerning current human interventions in this wetland. What are the consequences?

3. Select historical information about the state of the wetland a few decades ago. Compare it to its present one.

4. Try to find literature and historical (traces, signs) evidence, monuments, etc. associated to the wetland.

5. Use a pair of binoculars to observe the wetland carefully and a camera to document your observations. Record your data and observations in your notebooks.

6. Check with the means you have or from information you may collect, whether there is a problem of salinization around the wetland and relate it to the fertility of the nearby lands.

7. Collect data concerning eventual overgrazing and its impact on flora. Explain the particular role of the wetland on the water quality of neighbouring water bodies.

8. Find out if there is a relation between the wetland and the occupations of the inhabitants or whether it is connected to their economic and social life and recreation. What is the status of hunting there?

9. Prepare and distribute a brochure related to the history, current state, problems and probable solutions for the wetland. Propose strategies to protect and preserve the wetland.

Have a nice trip!

Foam on water bodies

Once water leaves our home, it may end up in water bodies without treatment. If it contains detergents foam will be formed on the surface of rivers, lakes or even seas. This layer of foam reduces the penetration of light. Consequently, photosynthesis is inhibited and oxygenation is not efficient. Oxygen exchange between the atmosphere and water is also reduced.

Objectives

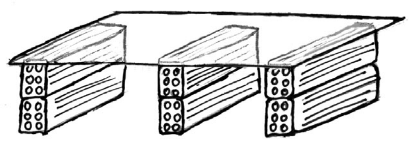
- To practise in setting up an apparatus and conducting simple experiments. (P)
- To explain the formation of foam in water bodies. (C)
- To relate light's intensity to photosynthesis. (C)
- To acquire an informed attitude against the overuse of cleaning products. (A)

Activity

Let's test how easily light penetrates foam!

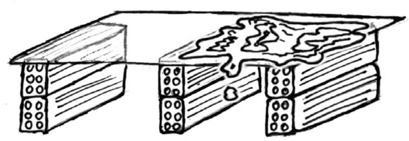
Materials/Equipment

- piece of glass
- three pieces of foam rubber
- cardboard or bricks
- beaker (1L)
- pocket torch
- liquid soap
- water



Procedure

1. Set up the apparatus as in the first picture.
2. Add soap and water in the beaker and stir to create foam. Spread the foam on half of the glass surface, as in the first picture.
3. Turn off the lights. Shine the pocket torch on the surface of the glass and observe the light's intensity in the presence and absence of foam.



Discuss in class your observations. Refer to how overusing detergents has a negative impact on the environment. Don't forget that these phenomena are also related to eutrophication.

1h

Physical Sciences (Physics), Life Sciences (Biology)

water bodies, foam formation, light intensity, phytoplankton, photosynthesis

Investigating a coastal zone

Activity No 1

Examine the flora and fauna of the seashore, a few metres from the coast, inside the sea.

Identify the presence of molluscs

a) ***Gastropoda:*** these molluscs (mollusc means soft and denotes the soft fleshy body) usually have single, coiled shells.
How many different species of these did you find?

b) ***Scafopoda:*** molluscs of this group have a tubular, usually white shell, open at both ends. They live just beneath the surface of the sea bottom. How many of these did you find?

c) ***Lamellibranchiata:*** these molluscs have a double shell of which the two parts are hinged together and closed by strong internal muscles. How many of these species did you find?

Fill in the blanks in the table below.

species	alive	empty shells
Gastropoda		
Scafopoda		
Lamellibranchiata		

Identify the presence of other benthic animals

a) ***Annelida:*** these are worms and can be found either with many bristles (*polychaetes*) or few bristles (*oligochaetes*).

b) ***Crustacea:*** these range from crabs and lobster to small shrimps, amphipods and isopods.

How many of these species did you find?

species	alive	empty shells	total
Annelida			
Crustacea			
Others			

Identify the presence of benthic plants

a) *Algae:* algae do not have flowers, stems or roots and can be green (*chlorophyceae*), brown (*fucophyceae*) or red (*bangiophyceae*). They grow in the sea bottom (benthic), but can also be found washed up on the beach.

b) *Phanerogams:* these are plants with stems and roots.

	low	medium	high
Algae quantity			
Phanerogams quantity			

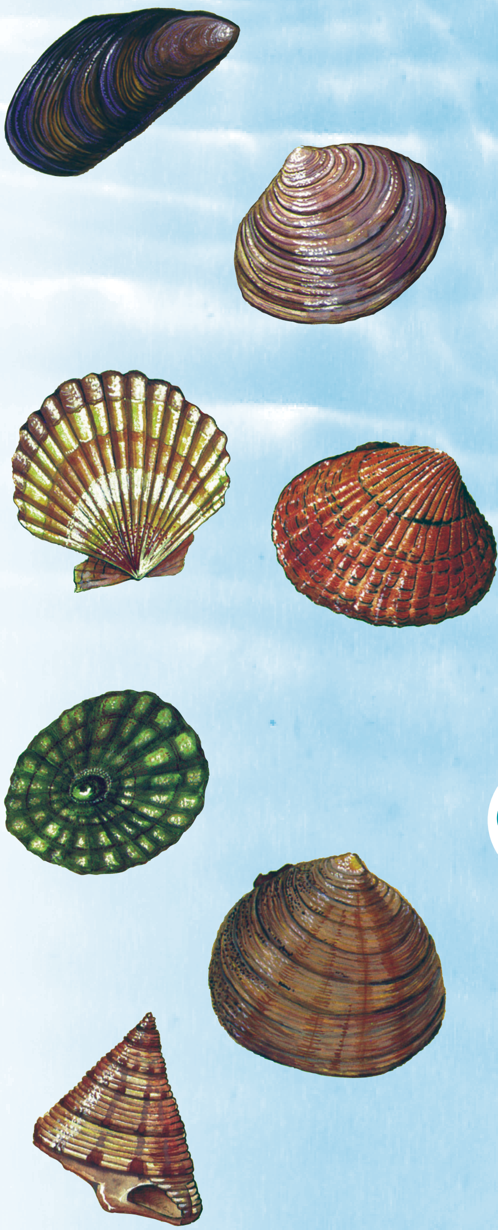
Objectives

- To participate in fieldwork. (P)
- To develop observation skills. (P)
- To practise in collecting and classifying data in a scientific manner. (P)
- To discover variety of flora and fauna found in the seashore, detect similarities, differences and special features of various species. (P,C)
- To relate the impact of waste from various human activities to flora and fauna. (C,A)
- To prepare informative material. (P)
- To acquire a positive attitude towards keeping the beach-area clean. (A)

1 month

Physical Sciences (Physics, Chemistry), Life Sciences (Biology), Social Studies

molluscs, benthic plants and animals, algae, visibility, salinity, litter



Activity No 2

Examine the factors that influence the cleanliness of seawater.

Measure water «transparency»

Pollution ending up in the sea may reduce water transparency.

Construct a so-called «Secchi» disk of your own (see Instruction Box) and from a boat use it to measure the transparency of a relatively «deep» water body (more than 2-3 metres) from the surface.

Dip the disk into the sea or lake and mark the depth at which you can no longer see the reflection of the disk.

Identify the salinity of the seawater

Sewage or outlets can affect the salinity of the sea. Weigh the remaining salts, after boiling and evaporating to dry1L of seawater.

salts (%w/v)	...

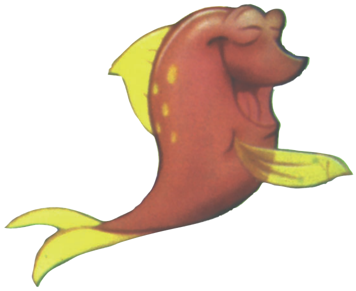
Activity No 3

Clean up the beach.

Firstly, select your «investigation zone» by setting a specific length and width of the coast.

Wear gloves and collect all non-biological items in the zone in plastic bags. Sort these into categories as indicated below and count them.

	Quantity		Quantity		Quantity		Quantity
GROUP 1: Plastics				**GROUP 4: Glass**			
plastic bags		plastic bottles		soft drink/beer/wine bottles		food containers	
plastic straws		plastic toys		pieces of broken glass			
plastic utensils		nylon net		**GROUP 5: Wood**			
GROUP 2: Metal				pieces of wood		wooden boxes	
soft drink/beer		cans tins for food		wooden pallets			
pieces of metal		pieces of wire		**GROUP 6: Rubber**			
GROUP 3: Paper				rubber gloves			
juice/milk cartons		paper wrapping		car tyres			
paper cups		newspapers		**GROUP 7: Others**			
cigarette packets		cigarette butts		pieces of brick/concrete		pieces of ceramic	



Activity No 4

Interview visitors at the beach.

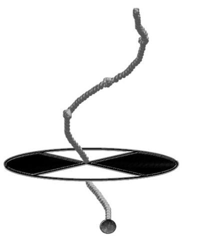
A lot of information concerning a beach can be obtained by interviewing visitors. Many Mediterranean countries rely heavily on foreign tourism to alleviate local employment and strengthen the economy. It is also important to find out what foreign visitors think about the quality of the water and the beach.

Record the conversations with visitors using a tape recorder, so that the data can be analysed at a later stage.

Record all your findings (activities 1,2,3 and 4) and publish a newspaper to inform and sensitise people of your community.

INSTRUCTION BOX

How to make a «Secchi» disk:
Use a hot nail to make a hole in the centre of a hard plastic plate (e.g. those used for sweets and old music records).
Paint it with a non water-soluble paint and allow it to dry well.
Pass a plastic string through the small hole as shown in the figure and make big knots to secure the plate.
Place a weight of 1-3 kg at the end of the string, and mark the string with a marker or knot every one metre.



Once upon a time...

Activity

Search for poems, stories, tales, myths or legends of your country and other Mediterranean countries that are related to water (rivers, lakes, seas, rain etc.).
Collect your findings and prepare a brochure or booklet.
Set up an exhibition to entertain the people of your school or community.

«The Argo», Greek urn of the first half of the 6th century BC

((9e))

According to Greek mythology, Jason was the rightful heir to the throne of Iolcus. His uncle, the usurper Pelias decided to send Jason in search of the Golden Fleece. This was a very dangerous mission and Pelias hoped that Jason would never return. Jason first commissioned the master builder Argus to construct a special ship. Argus named the magnificent fifty-oared ship Argo. With the help of the Gods, Argo became the strongest and fastest ship. Jason gathered a group of prominent Greek heroes to join him on his expedition. This was just the beginning of the famous journey of the Argonauts through the Eastern Mediterranean and Black Sea.

Objectives

- To practise in collecting historical information. (P)
- To be introduced to literature as an art form to be experienced and enjoyed. (P,C,A)
- To realise that water provides a unique source of inspiration for writers and poets all around the Mediterranean. (C,A)
- To be sensitised towards the aesthetic aspects of the aquatic environment. (A)
- To practise preparing informative material. (P)
- To practise setting up exhibitions. (P)

1 month

English, Literature, Social Studies, History, Arts

The action process: Adopt a stream, a pond or a shore

Adopt a stream, a pond or a shore

Adopt a stream, a pond or a shore for a long period of time (e.g. one year). Make a map of the area and carry out an investigation. Act in a way that will demonstrate your environmental awareness and commitment, for example by keeping the shoreline and adjacent woodland or park free from litter and misuse.
Carry out a project that will improve the wildlife habitat such as:

- prevent soil erosion (e.g. plant trees on a hillside or build stone watersheds on a nearby trail).
- remove litter and garbage.
- trace and label storm drains that flow into the region's streams.
- after securing permission from authorities, put up a sign saying «Do not dump toxic materials», «This pond drains into a stream full of wildlife: Do not litter».
- make paintings of the site and organise an exhibition for your school, parents and local community.

*A **lake** is a sizeable water body surrounded by land and fed by rivers, springs or local precipitation.*
***Ponds** are smaller bodies of still water located in natural hollows such as limestone sinks.*
They might also result from dams made either by humans or beavers. Ponds are found in most regions and may appear seasonally or persist from year to year.
***Rivers** and **streams** are bodies of fresh flowing water. Water runs permanently or seasonally within a natural channel into another body of water such as a lake or the sea.*

Small coastal wetland in Argolida, Greece

The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty, which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are presently (September 2001) 128 Contracting Parties to the Convention, with 1094 wetland sites, totalling 87 million hectares, included in the Ramsar List of Wetlands of International Importance.
Are you familiar with the Ramsar Convention?
Did your country sign and ratify the Ramsar Convention?
Which are the sites listed? Find them on the map and find out why each is important.

The article

Present the following or a similar article from a newspaper of your country in class to spark off a discussion among the students. You can use it either at the beginning of the programme to make students aware of the problems related to water, or at the end to give a few finishing touches.

High and dry*

Water, focus of the second World Water Forum, will be a critical issue this century

By **Tim Radford**

Mikhail Gorbachev, president of Green Cross International, calls the issue «more explosive than dynamite». People with big business in mind call it «the blue gold» of the 21st century. More than 160 governments at the second World Water Forum in the Hague recently declared it a «a basic human need» (their original draft called it a basic human right). People who don't have much see it as life itself. People in rainy maritime climates call it just water, and complain when it falls from heaven.

First, the facts. Almost 70% of the planet is covered in water, and all but 2.5% of this is salty. Most of the remainder is locked up in Antarctica or as mountain ice. The rest runs through the world's rivers and lakes. The sun's heat evaporates the top 1.1m of sea in the course of a year. Of this vast vapour bath, around 46,000 cubic kilometres is precipitated over land, and runs down the world's rivers in the course of a year.

The huge cascade falls unevenly. Most years it drops on South Asia in a seasonal monsoon. A huge proportion drains from great rivers that run through largely unoccupied countryside, such as the Ob and the Yenisei in Siberia, or the Amazon in Brazil.

The remainder - «the accessible runoff» - has become very precious. How precious was demonstrated by a team from Stanford University, California, in 1996. Gretchen Daily and her colleagues calculated that humans now use 54% of the acceptable runoff. Put it another way: there could be 7m species on the globe, but one species now uses 54% of the accessible rivers and streams.

She also calculated that humans now use 26% of all evapotranspiration: that is, the rain that falls on land and is taken up by plants. It might, she argues, be difficult to use much more. Most land suitable for rain-fed agriculture is already being used. New dams could, over the next 30 years, increase the «accessible runoff», but there is a catch. Over the next 30 years the world's population is projected to rise by 45%.

Water is life's bottom line. Humans are just bags of water. A man weighing 70kg will contain 43 litres of water, and even in a mild climate he will lose 2.5 litres a day by respiration, perspiration and urination. Thirst becomes intense when 2% of bodyweight is lost and not replaced; delirium sets in when 10% is lost.

Water is also, in effect, food. It takes 900 litres to grow a kilogram of wheat; 1,900 to grow a kilogram of rice - and 100,000 to raise a kilogram of grain-fed beef. Water -

* Reprinted from «The Guardian», Thursday April 6, 2000

a powerful solvent - is vital in building, manufacture and food preparation.

It also plays host to the major diseases of diarrhoea, hookworm, schistosomiasis and trachoma; it is necessary for the spread of malaria, cholera and polio. Every eight seconds a child dies of a water-borne disease. Paradoxically a clean water supply is the most powerful single force in public health. Fresh, clean water is a non-negotiable commodity: it is the liquid currency of survival. Right now, according to the World Water Forum experts, 1bn people go without safe clean water, and 3bn go without adequate sanitation.

But over the next 25 years almost 3bn people will be short of water. In 10 or 15 years, Gorbachev warned the forum, there could be war in the Middle East over water. In 25 years' time, people who live in 17 countries in the Middle East, Southern Africa and parts of Asia will not have enough water to maintain agriculture to the per capita food production levels of 1990. There are 1bn people in these countries now. By 2025 they will number 1.8bn. Another 24 nations, mainly in sub-Saharan Africa, according to a study by the International Water Management Institute, are classified as suffering from «economic water scarcity». That is, there might be enough water to meet demand in 2025, but to do so they would have to double their efforts to extract water. But they are caught in the poverty trap: they cannot afford dams and irrigation systems.

There are other countries which in total have adequate water supplies, but which are increasingly experiencing drought in some areas. This is because glaciers are retreating, groundwater levels are falling, and because some of the world's largest rivers are already being drained dry before they reach the sea. The Worldwatch Institute in Washington calculates that water tables are now falling in China, India and the United States, which between them produce half the planet's food.

Groundwater is falling by 1.5m per year under the north China plain. In India underground water is being extracted at twice the rate it is being replenished by rainfall.

Irrigation has been cut back in the southern great plains of the US as aquifers fail: Texas is losing irrigated land at the rate of 1% a year. The rivers, too, are beginning to run dry. Only a trickle of the Nile now reaches the Mediterranean. The Nile now provides food and water for 153m people. By 2025 it will be the only source of life for 343m humans.

There is worse: the world is warming. As a result, ice caps are retreating. Many communities depend entirely on glacial meltwater. The glacier that supplies 10m people in Quito, Ecuador is retreating by some 30m a year. The Himalayan glaciers are expected to shrink by one-fifth within the next 35 years: bad news for the 500m living on the tributaries of the Indus and Ganges who rely on melting ice for irrigation. Because the world is warming, there should be more evaporation. But water vapour is also a greenhouse gas. Could more clouds damp down global warming? Or will more water vapour feed the warming process?

Either way, climate extremes are expected to increase. Between 1970 and 1994, according to the Red Cross, drought and famine killed or harmed 58m people a year, while floods killed or harmed an average of 56m a year. But climate-related disasters have increased in scale and severity throughout the past decade. Insurers pronounced 1998 the worst for climate-related disasters - until 1999 came along. And worse can be expected in years to come.

The action process

Environmental education is mainly education in problem solving. From a philosophical point of view it is inspired by the so-called holistic approach and by the notions of sustainability and enhancement of the human abilities and talents in order to obtain a wise overall stewardship for our environment both, natural and manmade. As we become environmentally educated, we begin having favourable experiences with the environment so that we can develop an appreciation, an awareness and a sensitivity to it. This develops first into a willingness to learn more about it (knowledge objective). Based on our knowledge and experience, we develop a positive attitude towards it (attitude objective) and the skills we need to investigate the environment more and its associated problems and issues (skills objective). Finally, we use the acquired awareness, knowledge, attitudes and skills to act in favour of the environment, in order to resolve problems and make a difference in the world around us (participation objective).

Environmental action is the ultimate aim in environmental education. It is based on a process including many steps, which could assure its success. The interests, ages, skills and experiences of the students, and the local needs will help us to determine the best project or activity for each unit (e.g. school or class etc.), or even for each individual member. Participation in such activities brings out many benefits. The knowledge, experience and skills youth gain may last throughout their lives. There is a logical step-by-step procedure for planning, taking action and evaluating. Students may work in groups on an action project or they may work individually. Either way, the action process remains essentially the same. A description of the process follows. A list of key questions is included with each step.

Procedure

Step 1 • Plan for action

The first thing the teacher needs to do is to help the students identify a problem that they feel strongly about. Perhaps their efforts may be best directed towards solving a part of a major problem than towards solving a smaller problem entirely. Students should be encouraged to survey or interview local citizens or experts from a university or public authorities for input.

Step 2 • Collect information

Next, the students need to collect information to determine the causes of the problem so that they know where to focus their efforts in order to solve it. The students must be reminded that other people may not see the same things as problems or solutions related to the issue. The students should be encouraged to put themselves in the shoes of those affected by the problem. The following questions should be answered to complete Step 2:

- What is the cause of the problem? Describe it in detail and try to determine its source.
- For how long has the problem existed?
- Who is affected by the problem?
- How frequently does the problem occur?
- How do those affected by the problem feel?
- How do you feel about the problem?
- Is anyone benefitting from the existence of the problem? If so, how and who? How do they feel, if all other players know?

Step 3 • Decide which way to go

This step involves brainstorming about all possible approaches towards solving the problem. Each alternative is researched to determine which one provides the «best» answer to the problem (remember that one option may be to «do nothing»). After a possible solution is identified, the students will need to ask themselves whether or not

they can organise an action in conformity to the solution they have identified.
The following questions will guide students through step 3:

- What are the possible alternatives to solving this problem?
- What are the costs and benefits as well as advantages and disadvantages of each alternative?
- What are in more detail the legal and social consequences of each alternative?
- How will each alternative affect the environment?
- What environmental action strategy or combination of strategies may be most appropriate to take?
- Do you have enough time, skills, and courage to take the action?
- If you select this alternative, will you be taking action, which is consistent with your own values?
- Based on the answers to the above questions, which alternative is most realistic and appropriate for you?

Step 4 • Moving ahead

After an alternative has been selected and the students have determined the appropriate strategies for action, they need to let others know about it. They should be encouraged to get others involved. Try to answer the following questions:

- Will your action be more effective with the support of others? If so who else could be involved? Try to target the appropriate groups of «stakeholders» (partners
- Does your action require permission from the authorities?
- Is your plan well detailed and set for action?
- If you are planning a group action project, does each person have a role to play in its implementation? Do you understand the importance of your role? Do the others understand your role and their own?
- Do you anticipate any problems or opposing forces affecting your action? If so, have you considered how you might deal with them if they arise?

Step 5 • Do it!

Put the plan into action. Ask questions throughout the implementation stages of the project:

- What changes are needed to improve or continue taking action effectively?
- What responses have you received from those affected by your action? How do you feel?

Step 6 • Look back

Teachers should encourage students to evaluate their environmental action projects. A posteriori evaluation is more accurate than foresight. The students should be prompted to ask themselves questions such as:

- Did the proposed solution actually solve the problem?
- Were there any additional problems created?
- What did you learn as a result of taking action?
- Did others benefit from the efforts?
- Were others negatively affected by your action?
- How do you feel about the experience?

Step 7 • Share with others

After all this effort, why not share it with others? Encourage other students to help other partners by sharing their experience with them. It may help to motivate third parties to plan similar actions. It may also give the students the chance to have a success and a moment of «glory».

Reference:

Vretta-Kouskoleka Helen, *Water is Life, Vol. II: Educational material*, UNEP & WAGGGS, 1991.

The Newspaper: Water

November 5, 2001

The journalists

Chemical Education and New Educational Technologies:
An inter-University programme for post-graduate studies

Prepare, publish and distribute a newspaper to sensitise people of your community on the subject of water.

Our precious water

The puppet show or the theatre

Prepare a performance of a puppet show or a play with the subject: «living in water». Take into consideration how water creatures «feel» when water gets polluted.

The play

INSIDE THIS ISSUE

Conflicts & Collaborations

Political boundaries often do not follow hydrological boundaries. For thousands of years there has been close communication between the peoples of the Mediterranean due to the geography and history linked by a common sea. Water scarcity has always been part of the history and everyday reality of the Mediterranean. Water crises and the eventual resulting famine leads to conflicts.

The first water wars were conducted between city-states in Mesopotamia. Today Egypt, which uses most of the flow of the Nile, is in constant fear that upstream neighbours such as Ethiopia will begin to harness the water for their own use. Similar conditions exist throughout the Middle East. Boutros Boutros Ghali, former Secretary General of the United Nations and former foreign minister in Egypt, has frequently warned that the next war in that region might be fought over water.

Activity

1. Read the above text.
2. Start a discussion in class on the statement «rising water demand inevitably creates conflicts».
3. Search for references on specific sensitive regions in the Mediterranean area where problems of water use have resulted or may result in serious conflicts.

Integrated Water Resources Management (IWRM)

YEAR	POPULATION[1]	INCREASE (%)
1980	9,642,000	-
1990	10,160,000	5.1
2000	10,940,000	7.1
2010	10,653,000	-2.6
2020	10,555,000	-1

YEAR	FOREIGN TOURIST ARRIVALS[2]	INCREASE (%)	OVERNIGHT STAYS
1992	9,756,012	...	36,260,000
1995	10,712,145	9.8	38,771,623
1999	12,605,928	17	45,803,360

WATER PRODUCTION / SOURCES OF SUPPLY (km^3/y)[3]				
SURFACE	UNDERGROUND WATER	IMPORTS WATER	DESALINATION	WASTEWATER REGENERATION FOR REUSE
5.03	~2.0	0	0	0

WATER DEMAND (km^3)				
YEAR	DOMESTIC	AGRICULTURE	INDUSTRY	TOTAL
1980	0,696	4,220	0,119	5,035
1990	1,15	5,66	0,22	7,03
«Conventional» scenario[4]				
2010	1,50	7,70	0,30	9,50
2025	1,80	9,00	0,40	11,20
«Sustainable» scenario[5]				
2010	1,00	5,10	0,23	6,33
2025	1,00	4,00	0,24	5,24

1. The tables above present freshwater resources and consumption data, during the last 20 years in the case of a Mediterranean country, Greece, where population growth is not a problem. Study the past and present values as well as the estimated future figures carefully.
2. Organise a role-playing game and propose strategies and methods of water management to balance water *supply* and *demand* in the future. The table WATER SAVING PRACTICES might give you ideas for further discussion.

   Role assignment: Ministers (environment, agriculture, tourism, industry, etc.)
   Local authorities representative
   Private sector representative (manufacturer, hotel-owner, land-owner or farmer, etc.)
   National water company representative
   NGO member
   Citizen

1. Source: European Housing Statistics
2. Source: Greek National Tourism Organisation
3. Source: Water for the 21st Century: Vision to Action, date of value 1990.
4. According to the «conventional» scenario the current trends in economic, technological and demographic development continue.
5. According to «sustainable» scenario water management objectives comprise social and environmental concerns to ensure sustainable development.

3. Collect similar data concerning your country. How do they differ from the above? In your case what is the role of population growth? Which are the major water-consuming sectors? Repeat the role-playing game and decide on the most suitable strategies of IWRM in the case of your country.
4. Organise an event in the school premises to inform and sensitise your schoolmates, parents, citizens, local authorities, etc. on future trends and need for wise governance.

WATER SAVING PRACTICES	
Domestic demand	Most of the water used in north Mediterranean households is for toilet flushing (33%) and bathing/showering (20-32%). Only 3% is used for drinking and cooking. The use of water saving devices, such as reduced volume toilet flushes in households can achieve savings of about 50%. The introduction of a metering and progressive pricing system can result in a 10-25% reduction of consumption. Information to users is essential if any process of water tariff changes. Losses in water distribution networks can reach as high as 50%. This percentage drops to 10-25% in well-maintained networks. Leakage reduction through preventive maintenance and network renewal should be one of the main targets of managing demand.
Industrial demand	Using recycling and/or substitution of water in industrial processes can give rise to immediate savings. Processes in «closed circuits» can reduce water use by 90%. Appropriate incentives for companies include: Economic incentives, abstraction charges, wastewater fees etc. Legislative requirements for cleaner technologies Environmental image (e.g. ecolabel, environmental auditing schemes, EMAS, ISO 14000 etc.) Partnership, liability, responsibility over water supply.
Agriculture	The main water use within the agricultural sector is for irrigation, with minor use by live stock farming and fish farming. Policies to encourage the modernization or substitution of traditional irrigation methods is an important tool in the hands of governments and other stakeholders for achieving reduction in the water used. These policies may include: Plans to increase the size of properties to allow the introduction of modern irrigation techniques. Financial incentives or direct subsides to farmers for changing irrigation equipment. Restructuring of cultivations for plants (or varieties) adapted better to the climate with lower water demands. Restructuring of the economic activities in the region followed by reallocation of water resources. Water pricing; however the use of water for irrigation responds moderately to this.
Education and public awareness	General education and provision of information for water users are important parts of initiatives encouraging more rational water use and changing habits.

Bibliography

English

Bock R. • *The Story of Drinking Water*, American Water Works Association, 1990.

Byrne K. • *Environmental Science*, University of Bath Science, Nelson, 1997.

Cambell A.J., Rood R. • *Incredible Earth*, John Wiley & Sons, 1996.

Danish Ministry for Environment and Energy • *European Rivers and Lakes Assessment of their Environmental State*, European Environment Agency, 1994.

Environment Canada • *A primer on water: questions and answers*, Ministry of Supply and Services Canada, 1991.

European Commission • *Freshwater: A challenge for Research and Innovation*, 1998.

European Environment Agency • *Environmental signals 2000* - regular indicator report, 2000.

European Environment Agency • *Human Interventions in the Hydrological Cycle*-Topic Report 13, 1996.

European Environment Agency • *Nutrients in European ecosystems, European assessment report No 4*.

European Environment Agency • *State and Pressures of the marine and coastal Mediterranean Environment*, European assessment report No 5.

Global Water Partnership • *Water for the 21st Century: Vision to Action, Mediterranean vision on water, population and the environment*, January 2000.

Global Water Partnership • *Water for the 21st Century: Vision to Action, Framework for Action for the Mediterranean*, January 2000.

Global Water Partnership, MED TAC, • *«Core» Action Plan 2001-2005*, Draft, November 2000.

Jeftic L. • *State of the marine environment in the Mediterranean Region*, UNEP 1990.

Krinner W., Lallana C., Estrella T., Nixon S., Zabel T., Laffon L, Rees G., Cole G. • *Sustainable water use in Europe, Part 1: Sectoral use of water*, European Environment Agency.

Leonard J., Crouzet P. • *Lakes and reservoirs in the EEA area*, European Environment Agency, November 1998.

Pearce F. • *Wetlands and Water resources*, MedWet, 1996.

OECD • *Water consumption and Sustainable Water resources Management*, Environment Directorate, Paris, 1998.

Philip W. O. • *Water The Essential Resource*, National Audubon Society, International Series Number Two, December 1976.

Rees J., Williams S. • *Water for life, Strategies for Sustainable Water Resource Management*, CPRE, 1993.

Scoullos M. • *Environment and Society: Education and Public Awareness for Sustainability*, Proceedings of the Thessaloniki International Conference organized by UNESCO and the Government of Greece (8-12 December 1997), Athens, 1998.

Scoullos M., Arsenikos S. • *Join forces against Desertification in the Mediterranean*, MIO-ECSDE, December 1999.

Scoullos M., Mantzara B. • *Long Range Study in Water Supply and Demand in Greece*, Elliniki Etairia, November 1996, Athens, Greece. Prepared for the International Centre for Water Studies and the EU.

Stern A. • *Water in Europe What to expect from the E.U. policy review, for the Conference of club de Brussels*, November 1995.

UNESCO-UNEP • *International Environmental Education Program, Environmental Educational Series, No 22, Procedures for developing an Environmental Education Curriculum*, USA, 1994.

Vretta-Kouskoleka H. • *Water is life, Vol. I, Facts and Incentives*, UNEP & WAGGGS, 1991.

Vretta-Kouskoleka H. • *Water is life, Vol. II, Educational material*, UNEP & WAGGGS, 1991.

WRI, UNEP, UNDP • *World Bank: The world resources 1996-97, a guide to the global environment, the urban environment.*

Greek

Andriotis M., Markaki L., Gouvra M., Katsorhis T., Pavlidis G. • *Laboratory manual of Biology 9th Grade*, Hellenic Republic, Ministry for Education and Religious Affairs, OEDB, 1999.

Boutsinos G., Kosmas K., Kalkanis G., Soutsas K. • *Management of Natural Resources*, Hellenic Republic, Ministry for Education and Religious Affairs, OEDB, 1998.

Georgopoulos A., Tsaliki E. • *Environmental Education*, Gutenberg 1997.

Kafetzopoulos K., Georgiadou T., Provis N., Spirellis N., Xiniadis D. • *Laboratory manual of Chemistry-9th Grade*, Hellenic Republic, Ministry for Education and Religious Affairs, OEDB, 1998.

Kastorinis A., Katsoris Th., Moutzouri I., Paulidis G., Peraki V., Sapnadeli K. • *Laboratory manual in Biology-7th Grade*, Hellenic Republic, Ministry for Education and Religious Affairs, OEDB, 1998.

Scoullos M. • *Chemical Oceanography, Part A, an introduction to the chemistry of the marine environment*, University of Athens, Athens, 1997.

Scoullos M. • *Chemical Oceanography, Part B, Marine Pollution, Marine Resources, fresh water from the sea, chapter 13*, University of Athens, Athens, 2nd ed., 1987.

Scoullos M., Siskos P. • *Environmental Chemistry II: Environmental management*, University of Athens, Athens, 1997.

Trikaliti A., Stathopoulou R. • *Environmental Education for Sustainable Cities*, Elliniki Etairia, Athens, 1999.

Vretta-Kouskoleka H., Vokotopoulou I., Moupagiatzi P., Ekaterinidis G. • A box full of water, Kalidoskopio, November 1997.

Recommended websites

- Mediterranean Information Office for Environment, Culture and Sustainable Development: **www.mio-ecsde.org**
- Global Water Partnership-Mediterranean: **www.gwpmed.org**
- Global Water Partnership: **www.gwpforum.org**
- United Nations Educational, Scientific and Cultural Organisation: **www.unesco.org**
- United Nations Environment Programme: **www.unep.org**
- World Bank: **www.worldbank.org**
- World Water Council: **www.worldwatercouncil.org**
- World Water Forum III: **www.worldwaterforum.org**
- Environmental Education Links: **www.eelink.net**
- Mediterranean Hydrological Cycle Observing System: **www.medhycos.mpl.ird.fr**
- The World's Water Site: **www.worldwater.org**
- Organisation for Economic Co-operation and Development; **www.oecd.org**
- International Office for Water: **www.oieau.fr**
- Environmental Education Resources: **www.sofweb.vic.edu.au**
- European Environment Agency: **www.eea.eu.int**
- European Environment Information and Observation Network: **www.eionet.eea.ey.int**
- USA Environmental Protection Agency: **www.epa.gov**

Water in Cyprus

There are more than 4,000 islands in the Mediterranean sea, belonging to eight countries, with a population estimated at around 11 million which is 2.6% of the total population of the Mediterranean countries. Population density varies considerably from island to island with a mean average of 98 persons per square kilometre, compared to 47 persons per square kilometre for the whole Mediterranean region.

Water resources on all Mediterranean islands are very limited, fragile and threatened. Fresh water on the islands derives from rainfall, which either recharges the aquifers or is impounded during winter months in human made surface reservoirs, where feasible, for use during the whole year. Freshwater supplies are unequally distributed in both time and space. Biggest islands seem to have more water than the smaller ones and in most cases droughts result in water shortage or even scarcity.

Cyprus is an island located in the Eastern Mediterranean Basin; it covers an area of 9,251 km^2 and has a population of 759,000 people. Topographically the island consists of two mountains one situated along the north coast and the other in the centre of the island, a central lowland plain and the coastal plains around the island, which extends from a few hundred metres up to a few kilometres. The mountain along the north coast consists mainly of limestone while the central massive mountain is made up of volcanic and igneous rocks and reaches an elevation of 2,000 metres.

The economy of Cyprus is based on tourism and services with a minor help from agriculture. Tourism, with an annual number of visitors around 2.7 million with an average stay of 11.5 days, contributes around 22% to the GDP, whereas agriculture contributes only 4-5%.

Cyprus is characterised by a typical Mediterranean climate, with hot dry summers and mild wet winters. The average precipitation is 500mm per year falling mostly during the winter months. The total annual water crop is estimated at around 900 million cubic metres (MCM), out of which 600MCM is surface water and the remaining 300MCM is groundwater. However the water that can actually be used now is only 300MCM per year, 230MCM in the area controlled by the Republic and 70 MCM in the Nothern part (under the Turkish Cypriot rule). This corresponds to 405m^3/cap/year. Out of the amount of water that is actually exploited, 25% is used for domestic, industrial and commercial consumption and the remaining 75% is used for irrigation. For the Republic of Cyprus, with around 2.4 million tourists annually and population of around 663,000, the water for domestic, industrial and commercial consumption (including tourism) is estimated at 60-65MCM per year, while irrigation water is around 165-170MCM.

In recent years Cyprus has been suffering from water scarcity caused by repeated droughts. Since 1991 in only two cases was rainfall above average whereas during all the other cases it was near or much below average. A gradual reduction in rainfall is observed which results in dramatic reduction of run-off. During the last 15 years the recorded rainfall gives an average rainfall that is 14% lower than the long-term average of the period from 1916 to 1985. In the same period the measured inflow to the existing dams was lower than the previous years average by 35-40%.

This forced the authorities to impose restrictions on the domestic and irrigation water supply, promoted the use of low quality water, introduced water demand management and recycling of domestical treated effluents and desalination and increased public awareness.
It seems that Cyprus has reached the maximum level of its natural fresh water resources. Building dams across the rivers has developed available surface water resources. Cyprus has 101 small dam reservoirs with a total capacity of 300MCM. Few rivers are left without dams but there are plans for further dam construction. On the other hand, groundwater is overexploited with coastal aquifers getting saline and inland aquifers depleted. Groundwater abstraction should be reduced in order to avoid water quality deterioration.

The use of non-conventional water in a few

Mediterranean islands is the result of water scarcity and structural differences. In Cyprus the first seawater desalination plant started operating in 1997 to supply water for domestic uses. A second one was put into operation recently and a third is at a tender stage. It is estimated that 40MCM of water will be supplied for domestic use annually when all three plants are in full operation. Additionally, re-use schemes are in operation and efforts are under way to speed up the house connections for increasing the quantities. All big towns have sewage treatment plants.

Cyprus adopted a master plan on water resources management in 1970, which was materialised from 1975 to 1998. The water resources management plans were based on the Integrated Water Resources Management (IWRM) approach. Water conveyance and distribution is made through closed conduits with minimum losses. Furthermore, 95% of the irrigation, which is the largest water consumer, is carried out with modern highly efficient farm irrigation techniques.

Concerning water demand management Cyprus since the1960's implements a water demand management concerning water conveyance and water application in the field. Since 1990 water demand management is applied to the domestic sector as well by taking the necessary measures for reducing water losses and avoiding wasteful use of water.

***Table 1.* Mediterranean island area and population data**

Island/Group	Country	Surface area (km^2)	Population	Density (Habitants/km^2)
Dalmatian Islands	Croatia	6,235	46,000	7.4
Cyprus	Cyprus	9,251	734,000	79.3
Corsica	France	8,722	753,000	86.3
Greek Islands	Hellas	28,827	1,303,000	45.2
Italian Islands	Italy	49,547	6,830,000	137.8
Maltese Islands	Malta	315	372,000	1,177.0
Balearic Islands	Spain	4,883	605,000	123.9
Jerba	Tunisia	514	20,000	39.0
Total/Averages		108,298	10,663,000	98.5

***Table 2.* Natural renewable water resources of the Mediterranean islands**

Island/Group	Country	Precipitate/yr		Water resources in km^3/yr			m^3/cap
		mm	km^3	Surface	Groundwater	Total	
Dalmatian Islands	Croatia	970	6.05	0.910	1.860	2.770	27,700
Cyprus	Cyprus	497	4.60	0.600	0.300	0.900	1,226
Corsica	France	917	8.00	5.400	0.600	6.000	7,968
Greek Islands	Hellas	463	13.34	2.91	0.320	3.230	2,478
Italian Islands	Italy	749	37.10	16.45	2.650	19.100	2,796
Maltese Islands	Malta	634	0.20	0.0005	0.040	0.040	107
Balearic Islands	Spain	614	3.00	0.265	0.444	0.709	1,172
Jerba	Tunisia	214	0.11	0.000	0.000	0.000	6,500
Total/Averages		668	72.40	26.535	6.214	32.749	3,070

Water in Morocco:
From abundance to shortage

Water is essential for life. People living in dry areas have always acted wisely, by forming specialised social groups that worked on techniques to transfer, use and save water and thus developed their cities and civilizations near water sources.

However, never in human history had water ever taken on the importance that is attributed to it today. Its geo-political dimension is such that many consider that given the lack of an international policy and regulatory regime on water, the dominance and management of water resources may be the cause of war during the 21st century, especially between countries in the Middle East and Eastern Africa.

It seems that in the case of Morocco, the risk of war is not the main water issue. The country relies on water resources that are located within its borders and are under the political supervision of the Moroccans exclusively. But there are three major water related problems that inhibit future growth in Morocco. We will present them, herewith, in more detail.

Limited and Irregular water resources

Sited at a point with high subtropical pressures, Morocco is a country primarily arid with limited water resources. The mean amount of water resulting from annual rainfalls is estimated at about 150 billion cubic metres. Most of this (120 billion cubic metres) is lost due to evaporation. So each year, the country relies on just 30 billion cubic metres, from which 8 billion are captured behind the 85 existing dams, and 3.7 result from exploiting underground waters.

Due to the country's geographic location, rainfalls are rather "capricious" and this makes the estimation of the available water quite difficult. The volume of the annual rainfalls may range from 40 billion cubic metres (dry year) to 400 billion cubic meters (rainy year), but dry years tend to be more frequent than the rainy ones. So, Morocco has to be well-prepared to confront draught as well as floods. The state soon realised this and supported the independence of dam-politics.

Apart from human wastefulness the durability of this essential resource is also at stake due to pollution. Domestic discharges and industrial effluents that end up in rivers without proper treatment make water unsuitable to use and pollute the sea.

The irrational use of pesticides in agriculture poses serious threats to the quality of underground water, which is at risk due to pollution and intensive cultivation.

In this context what emerges as a necessity is the joint concerted efforts of the public, the government and local authorities for the conservation and protection of this valuable natural resource. Indeed, extra measures need to be taken in the issues of managing the already used water, solid waste treatment and the development of areas with non-hygienic conditions. Likewise, the departments of the Ministry for Agriculture are called upon to increase their efforts in the agricultural sector, so as to reduce the risk of polluting underground water bodies due to overuse of pesticides.

Water resources that are under great pressure

Due to population growth, economic development and urbanisation more and more attention is drawn to the issue of water resources. The state seems unable to arbitrate the conflicts between the major water users. Agriculture is by far the greatest water user exploiting 80% of the water resources and this percentage is expected to increase as this sector will grow and water demand will rise. The increasing water demand for agriculture can only be restrained if radical modifications in the irrigating practices are put into force. In either case, such an option seems the only way out in order to counterpart the increase in water demand due to population growth on one hand and due to the development of other sectors (industry, tourism, etc.) on the other.

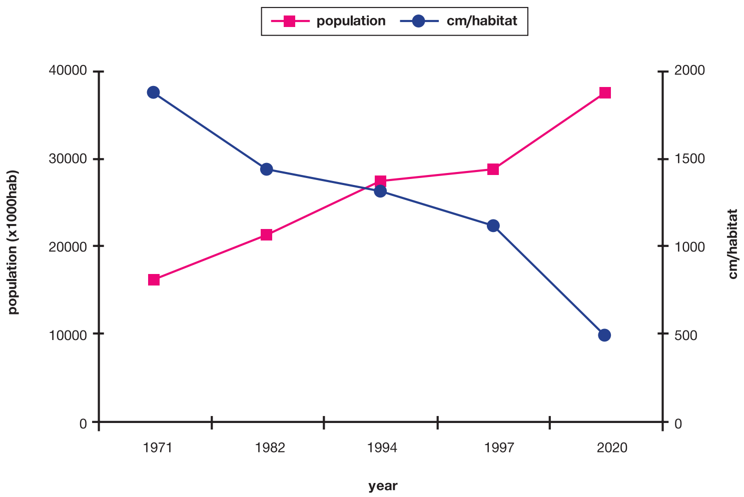
Non-sustainable practices using water resources

The issue of water resourses also has a cultural and social dimension. It seems that the prevailing perceptions regarding water haven't changed much over time. The majority of people still perceive water as an inexhaustible resource; they do not realise the importance of conserving it and they care little about saving it.
Large amounts of water are misused in agriculture because of the inappropriate irrigation techniques and the lack of maintenance of the water distribution networks. This stands for both modern as well as traditional irrigation schemes. In some cases modern irrigation practices are applied, but these are usually put in practice by only a few privileged farmers. The prevalence of such new practices is constrained due to high costs, the absence of appropriately educated farmers as well as the structure of land.
Water demand in the non-agricultural sectors is expected to rise as population grows and urbanisation becomes more intense. The implementation of public awareness and participation campaigns and programmes, as well as the enforcement of appropriate appraisement policies are considered necessary. There is also room for improvement in water saving through sustainable management in the sectors of industry and tourism.

Above all we need conscious, active citizens willing to change their daily habits in order to save water.

The table presents the total amount of renewable water available per habitat, in several Mediterranean countries.

The following graph presents the amount of water (cubic metres) available for each Moroccan inhabitant from 1971 to 1997. The projection represents the estimate for 2020.



Country	Annual renewable water resources (million cubic metres)	Amount of water available per habitat (cubic metres) *year 1900*	Amount of water available per habitat (cubic metres) *year 2000*	Amount of water available per habitat (cubic metres) *year 2025*	Reduction of the available amount of water per habitat from *1900* to *2025* (%)
Algeria	18.4	731	552	353	48
Egypt	55.5	1054	845	571	54
Jordan	0.9	285	200	102	36
Libya	3.8	1418	1274	929	66
Morocco	29.7	1184	935	633	53
Libya	0.7	154	108	50	32
Syria	5.5	438	305	151	35
Tunisia	3.8	465	376	270	58

Source: UNESCO, (1999)