Educational material

Waste in our life

Learner's book

ATHENS, 2007

European Commission
DG Environment

United Nations Environment Programme
Mediterranean Action Plan

United Nations Educational, Scientific and Cultural Organization (UNESCO)
United Nations Decade on Education for Sustainable Development (UN DESD)

Greek Government
Ministry of National Education & Religious Affairs
Ministry of Environment, Physical Planning and Public Works

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Preface

The current English educational material is actually the second updated and enriched edition of the first Greek material prepared by MIO-ECSDE, which was targeted to Greek educators and students of secondary level (Scoullos & Papadopoulos, 2003). The pilot implementation of this material in several Greek high schools during 2003 and 2004 gave useful input for amendments. The translated first draft was prepared in English in 2004.

Further to a wide e-mail consultation for the elaboration the English version, 23 experts of the *MEdIES Task Group* met in order to discuss and work on its revision. These experts, many of which represented NGOs, made concrete comments and suggestions for improvements. They proposed resources to be included referring to waste management in their countries, in order to move to a 'Mediterranean-wide' background resource, including waste topics and examples of the entire region. All this material was collected, assessed and incorporated in the original draft.

'Waste in our life' in this thoroughly revised and enlarged edition attempts to serve as an appropriate tool to facilitate formal and non-formal educators engaged in EE & ESD programmes, who work with the -not so attractive- topic of wastes, providing background information and knowledge resources, a collection of pedagogic activities, as well as methodological guidelines for its implementation.

The material is primarily targeting students of secondary level; however, it may be applied to other interested groups (e.g. women, youth, primary school pupils etc.). That is why the material offers possibilities to be adjusted in each case to the learners' skills, interests and needs, to the educators' experience and personality, to the varying national curricula as well as to national and local conditions.

Prof. **Michael Scoullos**,
Chairman, MIO-ECSDE

Greeting Messages

EU Commission for Environment

Waste management is an important policy area for the European Commission. Over the past 30 years, the European Union has introduced a range of laws that protect human health and the environment from waste, the transport of waste and potential pollution from major waste facilities such as landfills or incinerators. In my time as Commissioner, I have brought forward new policies to move the EU towards a recycling society - one in which waste should be prevented as far as possible, and otherwise re-used or recycled.

Waste is one of the environmental issues that are most visible to citizens and has a direct impact on their lives. It is also an area where citizens can do much to improve the situation, for instance by preventing the generation of waste with their decisions as consumers and separating the waste they do produce to make it easier to reuse or recycle.

To achieve the full potential for prevention and recovery we have to educate people about the difference they can make and the simple everyday actions that together can have a big impact.

I therefore very much welcome this educational pack, which will contribute to this effort by helping to explain some of the main issues relating to waste and what can be done to ensure that waste does not damage the environment.

Mr Stavros Dimas • EU Commissioner for the Environment

United Nations Scientific & Cultural Organisation (UNESCO)

As the lead agency for the promotion of the United Nations Decade of Education for Sustainable Development (UNDESD), UNESCO welcomes the efforts of MIO-ECSDE in promoting education for sustainable development in the Mediterranean, which is crucial to ensure the long-term protection of the highly diversified, yet particularly fragile Mediterranean ecosystems.

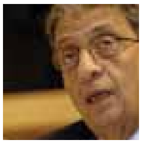
UNESCO particularly appreciates this educational initiative since it addresses the fundamental issue of sustainable consumption and production issues and highlights the importance of sustainable waste management options as pre-requisites for the future sustainability of both natural resources and global economy.

This educational package has an important role to play in educating the young generation on the impacts that lifestyle consumption habits have on our society and the environment and creating a more critical and responsible attitude towards consumerism in our everyday lives.

As such, it represents a valuable contribution to the pursuit of the main goal of the UNDESD, that is, to encourage changes in behaviour that will create a more sustainable future in terms of environmental integrity, economic viability, and a just society for all.

Koïchiro Matsuura • Director-General of UNESCO

The League of Arab States



By virtue of the geographical location of the Arab world, cooperation and partnership among the Arab countries and their neighbours in the Mediterranean, African and Asian space have become imperative in order to face the major challenges in the world.

The League of Arab States, like MIO-ECSDE, is fully convinced that education, environmental protection, the availability and rational use of natural resources which are closely linked, form one of the main challenges that should be urgently addressed.

The Arab world is afflicted by shortage of water, environmental pollution and knowledge deficiency. These represented high priority issues on the agenda of the last two Arab summits. We firmly believe that meeting these challenges successfully would contribute to achieving the prosperity that will aspire to in our region and beyond.

Aware of the fact that these problems are no longer national issues in the narrow sense of the word but have a significant regional and international dimension, the League of Arab States is looking forward to working closely with MIO-ECSDE towards a shared vision of a better future for generations to come.

Amre Moussa • Secretary General, League of Arab States

United Nations Environmental Programme (UNEP)

Economic and technological developments allied to global production and consumption patterns are dramatically increasing the levels and complexities of the world's waste streams and their potential to impact the environment and human health. These include solid, agricultural, hazardous and electronic-wastes.

It is vital that intelligent thinking is brought to bear on the issue of waste. Several promising initiatives are being developed which echo to this challenge. Under UNEP's Basel Convention for example partnerships have been forged with the mobile phone industry to 'take-back' handsets and to restore and re-sell refurbished phones with guarantees. Countries are also rising to the challenge. Japan is pioneering the 3R's—reduce, re-use and recycle and China, the Circular Economy—a concept that holds everything as a raw material for another process including heat.

Nevertheless there is still a great deal left to do and education and empowerment of the public is a key part of the solution. The United Nations Environment Programme as the principal voice for the environment within the UN system supports efforts to boost public awareness on issues such as waste. Therefore, we welcome this continuing initiative by MIO-ECSDE in providing the "Wastes in our Life" materials for secondary education.

Achim Steiner • UN Under-Secretary General and UNEP Executive Director

Hellenic Ministry of National Education and Religious Affairs

There is a wide recognition of education as a prerequisite and an efficient process to addressing environmental and sustainable development issues (See Agenda 21, Rio 1992; World Summit for Sustainable Development (WSSD) Plan of Implementation, Johannesburg, 2002; United Nations Decade of Education for Sustainable Development (DESD), 2005-2014; UNECE Strategy for Education for Sustainable Development (ESD), 2005). In line with the relevant Declarations and commitments, the Hellenic Ministry for Education and Religious Affairs is interested in contributing to the promotion of Education for Sustainable Development (ESD) and Environmental Education (EE) within Greece and beyond, particularly in the Mediterranean region. The latter could be partly obtained through the MEdIES network.

Currently, in the Mediterranean, as in almost all parts of the world, environmental and sustainable developmental concerns are in the heart of the political agenda together with the protection of biodiversity. However, although citizens become increasingly conscious of issues like climatic changes, they still lack proper understanding about energy saving, sustainable consumption and waste management. The material "wastes in our lives", produced in the framework of MEdIES, is very much welcome, as a well-prepared and useful tool in this endeavor for the teachers and students of the Mediterranean countries, addressing the issue of wastes in a holistic multidisciplinary and comprehensive way.

Giannakou Marietta • Minister of National Education and Religious Affairs

Hellenic Ministry of Environment, Physical Planning and Public Works

The Ministry of Environment, Physical Planning and Public Works acknowledging that awareness raising, education and training constitute important tools to achieve sustainability, especially as regards waste management, welcomes the present MIO-ECSDE publication.

Contemporary environmental policy in the field of waste management at European and international level calls for more substanciated analysis and different approach to environmental problems.

Guiding principles and policy directions of waste management are indorsed in the legislative and regulatory framework, in which for the first time the European and national legal order adopt legal dispositions for a uniform and aggregate waste management policy, regardless of waste-type, defining the basic guidelines for its implementation.

The general principles of waste management give priority to waste prevention, encourage re-use, recycling and waste utilization (materials/energy recovery), and promote environmentally safe processes of final disposal.

Given that protection of the environment concerns us all, integrated waste management can be achieved only by the active involvement of consumers. Informed, active citizens are the driving force towards sustainable development.

Stavros El. Kalogiannis • Deputy Minister for the Environment

The profile of MIO-ECSDE

Scope & Objective

The Mediterranean Information Office for Environment, Culture and Sustainable Development, is a federation of Mediterranean non-governmental organisations (NGOs) working in the field of environment, development, or culture. 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, it plays an active role in the protection of the environment and the promotion of sustainable development. The main objective of MIO-ECSDE is to protect the natural environment (flora and fauna, biotopes, forests, coasts, natural resources) and the cultural heritage (tangible and intangible) having as its ultimate goal the promotion of sustainable development in a peaceful Mediterranean.

Structure

It was established as a network of NGOs in 1990 and expanded to its current NGO Federation status in 1995. The Federation consists of full and corresponding member organisations, which jointly form the MIO-ECSDE General Assembly. The Annual General Meeting (AGM) of the member organisations is the main institution constituting the basis of the Federation. The administrative bodies of MIO-ECSDE are the Executive Bureau, the Chair and Co-Chair. These are supported by the Secretariat which is based in Athens, Greece.

MIO-ECSDE Activities

MIO-ECSDE activities over a wide range of actions including ***networking*** (ensuring flow of information through electronic (e-bulletins, e-newsletters, web site, etc.) and printed means (leaflets, quarterly newsletter, etc.); ***capacity building*** (training material, workshops, publications, etc.); ***the promotion and drafting of common NGO policies*** (seeking consensus among its members and promoting common NGO policies reinforcing the collective voice of the environment and development citizens organisations at international fora and conventions); ***international collaborations*** with many European, regional and international bodies (i.e. EU, MAP/UNEP, UNESCO, UNECE, UNDP, EEB, RAED, FoE, WWF, RAMSAR Convention, MEDCITIES, MEDWET, IUCN, GWP, etc.) and other schemes of co-operation (MCSD, GWP-Med, EuroMed NG Platform); ***Raising public awareness, promoting participation and consensus building*** (through campaigns, publications, exhibitions, the coordination of the 'Mediterranean Action Day', etc.); ***Research*** (SUDECIR project); the ***facilitation of Mediterranean networks*** (educators [MEdIES], parliamentarians [COMPSUD], and journalists [COMJESD]) etc.

In the field of ***Environmental Education (EE) and Education for Sustainable Development (ESD)***, MIO-ECSDE, together with the University of Athens 20 years after Tbilisi,facilitated the secretariat of the international conference 'Environment and Society: Education and Public Awareness for Sustainability', held in Thessaloniki, in 1997, co-organised by UNESCO and the Greek Government. The 1400 participants from 84 countries unanimously adopted the 'Thessaloniki Declaration' and a series of positions is included in the Proceedings of the Conference.

MIO-ECSDE currently coordinates various ESD activities, such as, producing educational material for students and educators (through the MEdIES initiative, see next page), organising conferences and seminars at national and regional level, etc. MIO-ECSDE has contributed substantially to the drafting of the *Strategy on Education for Sustainable Development* adopted by the Ministers of Environment and Education of the UNECE member states and plays a leading role in ensuring the Strategy's implementation in the Mediterranean region, within the framework of the UN Decade for ESD (2005-2014).

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The MEdIES Initiative

MEdIES, ***the Mediterranean Education Initiative for Environment and Sustainability***, is a Type II Initiative on Environmental Education (EE) and Education for Sustainable Development (ESD) that was launched in Johannesburg during the World Summit on Sustainable Development (Johannesburg, 2002).

Structure

Core Group: MEdIES is supported by the Hellenic Ministry for the Environment, Physical Planning and Public Works and the Italian Ministry for the Environment, Land and Sea. Leading partners of the Initiative are also UNEP/MAP and UNESCO. As of May 2006 MEdIES has been officially certified by the Hellenic Ministry of National Education and Religious Affairs as an International Network on ESD. MIO-ECSDE has been entrusted with the coordination of the Initiative (*Operational Coordinator*). These six entities comprise the Core Group of MEdIES. The MEdIES water issues are supported and implemented in close cooperation with GWP-Med and the Mediterranean EU Water Initiative (EUWI).

Task Group: There are many more confirmed partners, such as governments (through relevant ministries), educational institutions (universities, EE centres, etc.), NGOs and IGOs etc. active in the Mediterranean region. These comprise the MEdIES Task Group (also called the Partners Forum).

e-Network: The basis of this initiative is a network of individual ESD educators in countries around the Mediterranean basin, that implement integrated educational programmes on cross-cutting themes, such as water, waste, etc., as a vehicle to approach sustainable development. The e-Network receives relevant information through regular e-mails and is facilitated by MIO-ECSDE in communicating with each other, and in promoting their work. They have priority in receiving invitations to workshops and seminars on EE, organised in the context of MEdIES.

Goals & Objectives

MEdIES aims to facilitate the educational community to contribute, in a systematic and concrete way, to the implementation of Agenda 21 and the Millennium Development Goals, through the successful application of innovative educational programmes in countries around the Mediterranean basin.

So far, through its wide range of activities the MEdIES initiative has targeted the cross-cutting areas of (i) freshwater resources, (ii) waste and consumption issues, and (iii) linking cultural and biological diversity.

Main Activities

Main activities of MEdIES include:

- **Publications**, such as educational materials: ‘Water in the Mediterranean’ (produced already in 7 languages), the ‘Handbook on Methods used in EE and ESD’ (produced in 3 languages), etc.
- **The Webpage** www.medies.net which provides a platform for communication, online material and publications and announcements.
- **Seminars** taking place on a regional or national basis, aiming to support educators through proper teacher training in the field of ESD.

How to get involved with MEdIES

- Any relevant governmental body, institution, NGO, etc. with aims and activities compatible with those of MEdIES at Mediterranean, national and/or local level can join the Task Group by filling an application form and sending an expression of interest to the Coordinator (MIO-ECSDE).
- Any individual formal or non-formal educator may become a member of the MEdIES e-Network, free of charge, by signing on electronically at www.medies.net.

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MEdIES Secretariat

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Contents

Instructions for students: How to use the educational material

The learner's book of "Waste in our life" is addressed mainly to secondary level students who wish to explore the issue of wastes, be it through formal or non formal education systems. However, if adjusted, it can be used also by younger primary level students, as well as by other target groups, such as homemakers, etc.

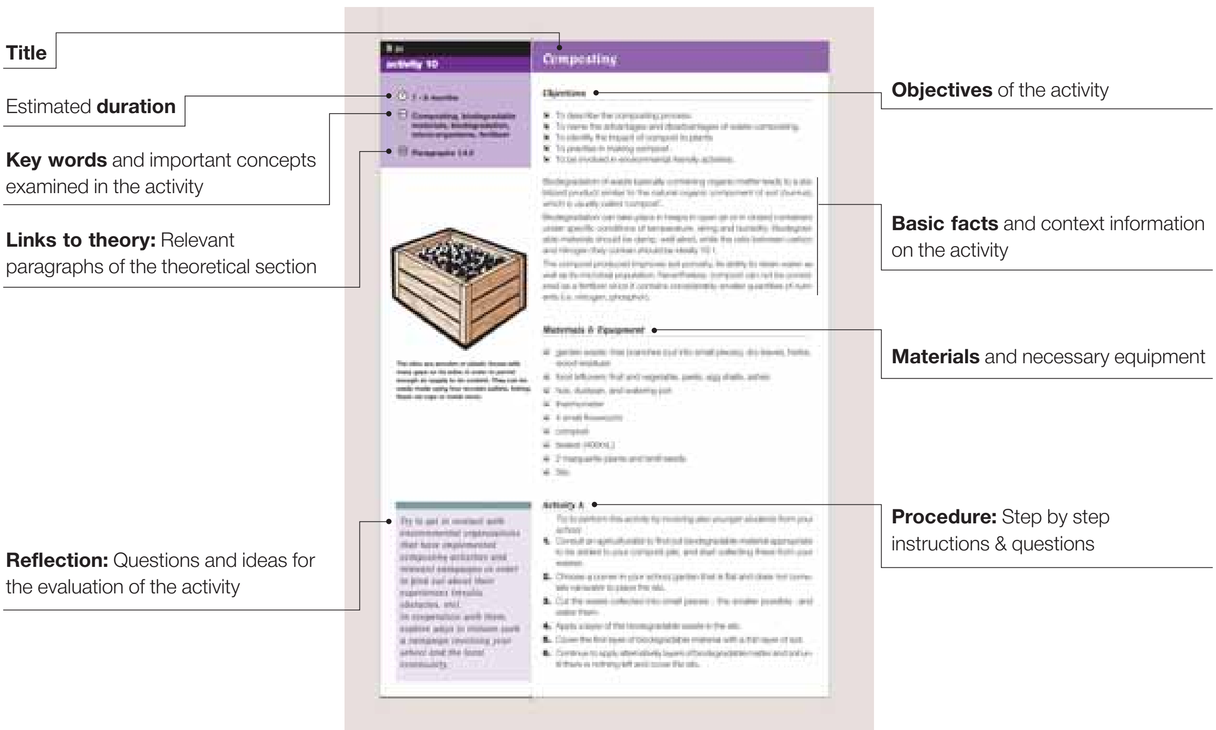
The book is comprised of two parts, theory and activities, which cover a wide range of topics ranging from daily generation of household waste, hazardous wastes, the hierarchy of waste management, intended policies and actual practice, to subjects like composting, composite packaging, etc.

It is proposed that learners begin with simple activities that can be performed at home and at school and gradually move to exploring more complex themes such as packaging, special types of wastes (hazardous, electric appliances, etc.) and general waste management issues. Obviously, the numbering of the activities in the book is indicative and needs not to be followed strictly. Each activity generally follows the same format, as indicated in figure 1.

Most activities include questions or statements to stimulate discussion. Learners should keep in mind that most of these do not have a single 'correct' answer. These questions are mainly intended to stimulate the abilities to form and express opinions. They are designed to challenge learners to identify the various parameters around an issue, to articulate their judgements and to explore ways to reach the 'best' solutions, if any.

The theoretical part is aimed to be used as a resource by those who wish to find more information on a specific theme. It explores issues of household waste management in the Mediterranean countries (quantity, composition, disposal, legal & policy frameworks, etc.) as well as recycling of materials and packaging. Meanwhile, it contains sometimes contradicting case studies and examples from many Mediterranean countries to be compared and evaluated in depth by learners. The theoretic part has a clear and easily understood structure and its texts are complemented with explanatory tables and pictures.

FIGURE 1 The layout of an activity sheet in the learners' book



Part I

Theory

1. Household Waste Management

Getting rid of our solid wastes is a task we have to deal with on a daily basis, may that be in our homes, yard, place of work, etc. Since the mid-70s, urban solid waste has become a concern of outmost importance in urban management in the Mediterranean countries. Used substances and materials that people want or have to dispose of can be considered as waste. Waste can be divided into the following categories:

- municipal (or urban) waste
- industrial and manufacturing waste
- waste generated by transport and energy producing activities
- agricultural waste

Municipal is waste produced by households, restaurants, hotels, etc. that contains food leftovers (garbage) or waste produced by commercial venues, office buildings, schools, etc., that doesn't contain food remainders (rubbish). Municipal waste mainly includes food leftovers, garden waste, paper, glass, aluminium, various types of plastics, old furniture, damaged electric or electronic appliances, old vehicles, construction and demolition waste and hospital waste. However, one needs to bear in mind that for every tonne of household waste, another 5 tonnes is created at the manufacturing stage and 20 tonnes at the site of initial extraction (wastewatch.org).

Waste management refers to the set of actions that aim at limiting the adverse impacts of waste on the environment, including waste collection, transport and treatment, as well as disposal. Nowadays, waste management extends to the design of products in order to minimize the volume and mass of the waste produced or facilitate their recycling (eco-design).

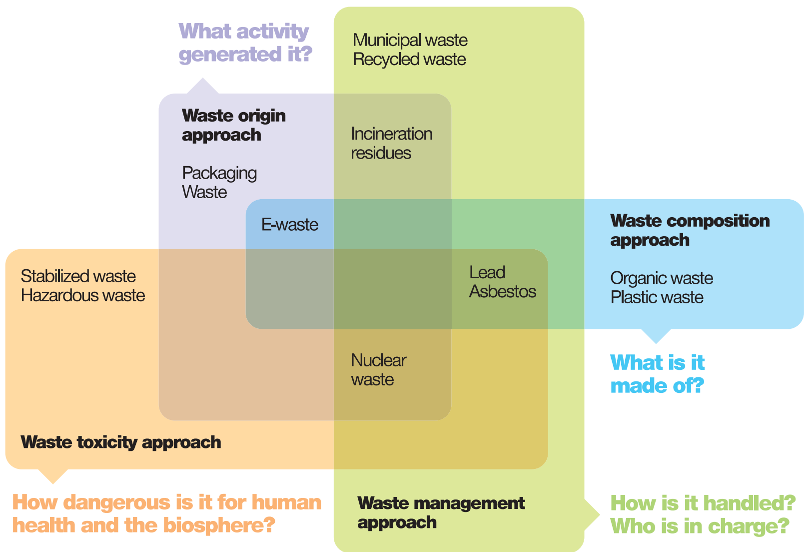


FIGURE 1 A multitude of approaches exists to classify the various categories of waste. This diversity is the major obstacle to data globalisation and comparison. (source: Vital Waste Graphics II)

1.1 *Quantity*

The quantity of household waste is increasing all around the world. This is due to two basic factors: *population growth* and the *dominant consumerism behaviour*. Generally speaking, the first factor applies to developing countries while the second one refers mostly to developed, industrialised countries, although due to the globalization of markets the latter is also visible in and affects all countries. Global experience indicates that as economies develop, the proportion of organic materials in the waste decreases while packaging-related waste increases.

Furthermore, the wide use of highly specialized products or disposables or products with excessive packaging contributes to the overall increase of waste.

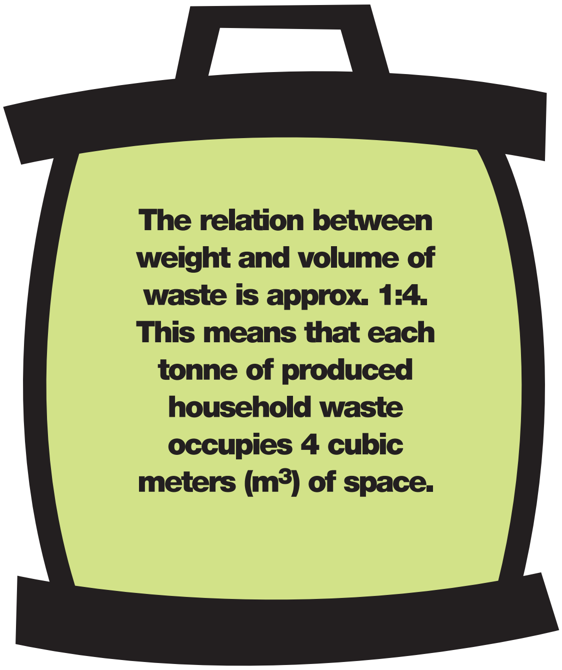
Throughout the Mediterranean region it is estimated that more than 40 million tonnes of municipal solid waste were generated in 2002 at an average rate of 0.68-0.71 kg/capita/day. Volumes of waste have doubled or tripled over the last 30 years: on the northern shore the very strong growth in waste volumes reflects the excess of consumer societies and the rapid increasing in packaging; on the southern and eastern shores the challenge for local authorities is to cope with a growth in waste closely linked to urban growth. There are also wide variations in waste generation rates between rural and urban areas of the same country: urban areas tend to generate more waste per inhabitant than rural ones. This is explained by the differences in income, as well as by the fact that traditionally in rural areas there is more waste recovery. For example, waste in rural areas is fed to animals, used as fuel in traditional ovens or composted and used as fertilizer or soil conditioner.

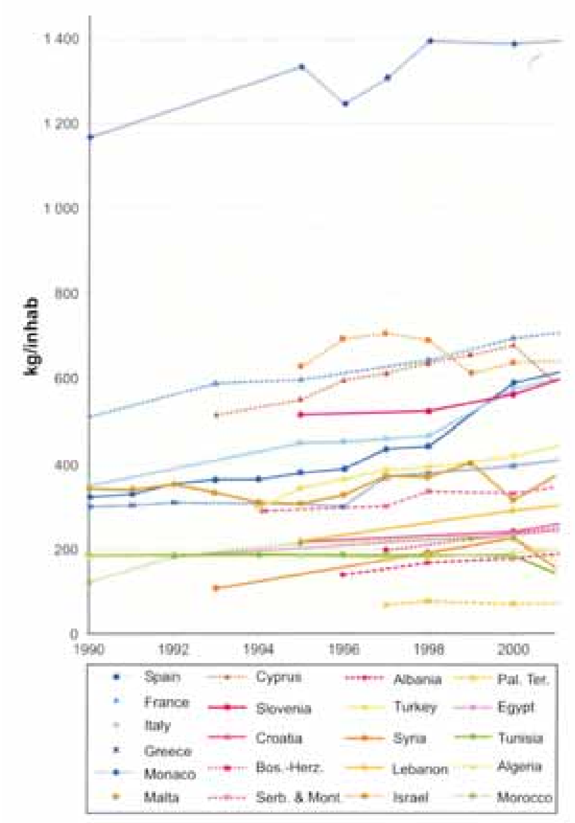
TABLE 1 Total quantity of waste disposed of in landfills in some Mediterranean countries for the time period 1990-2002.

Quantity of waste disposed of in landfills (in million tonnes)				
Country / Year	**1990**	**1994**	**1998**	**2002**
Croatia	30, 00	38, 00	60, 00	84, 00
Greece	1166, 38	1 406, 37	1 765, 20	2 398, 96
Portugal	692, 11	1 137, 15	2 236, 00	3 293, 38
Italy	16106, 16	21 238, 25	22 094, 72	20 630, 43
Slovenia	700, 68	880, 18	959, 44	933, 33
France	12799, 62	19 041, 77	23 098, 21	26 685, 67

TABLE 2 Daily production of household waste per inhabitant in various countries.

Waste generation per capita for 2002	
Country	**kg/ capita/ day**
Jordan	0.40
Syria	0.40
Croatia	0.73
Lebanon	0.84
Egypt	0.90
Japan	0.90
Portugal	1.09
Greece	1.16
Turkey	1.34
Italy	1.40
US	1.80





Between 1990 and 2000, the yearly waste production has increased as follows: Spain: increase from 323 to 588 kg/inhab/year; France: from 509 to 694 kg/inhab/year; Italy: from 350 to 573 kg/inhab/year; Greece: from 300 to 397 kg/inhab/year; Cyprus: from 513 (1993) to 677 kg/inhab/year. Monaco: is out of scale in the graph; its production being some 1.4 tonne/inhab/year during the decade.

In the eastern Adriatic, the general upward trend has pronounced contrasts: In Slovenia there is a reported increase from 515 to 562 kg/inhab/year, with clearly lower volumes in the other countries: Croatia: from 218 to 241 kg/inhab/year; Bosnia-Hertgegovina: from 197 to 237 kg/inhab/year; Albania: increase from 138 to 178 kg/inhab/year.

For the Southern and Eastern Mediterranean countries a growth is clear, with higher volumes in Israel (637 kg/inhab/year) and lower ones in the other countries (1994-2000 period): Turkey: from 297 to 419 kg/inhab/year; Lebanon: from 290 to 333 kg/inhab/year; Syria: from 106 to 226 kg/inhab/year; Egypt: from 183 to 234 kg/inhab/year.

In the Maghreb countries, for the period 1990-2000, urban waste production ranges as follows: Tunisia: 184 kg/inhab/year; Algeria: from 183 to 190 kg/inhab/year; Morocco: from 120 to 226 kg/inhab/year.

FIGURE 3 The evolution in the urban waste production during the previous decade for the majority of the Mediterranean countries. (Source: Plan Bleu, 2005)

1.2 *Composition*

Materials commonly found in household waste are: food leftovers, garden waste, paper, glass, plastics, textiles, etc. In table 3 the composition of household waste in various countries, Mediterranean and non, is presented. It is noteworthy that packaging material accounts for 20% of the weight of total household waste!

Over the period of 1980-1998 the amount of organic matter has generally decreased: from 38% to 29 % in France; from 43% to 32 % in Italy; from 60% to 44% in Spain; from 62% to 47% in Greece; and, from 85% to 64% in Turkey. There has been a more or less parallel increase in packaging, plastics and toxic waste such as solvents, car batteries, paint and pharmaceutical products in dispersed quantities.

TABLE 3 Composition (%) of household waste in some Mediterranean countries.

Country / Composition*	Croatia	Greece	Portugal	Italy	Egypt	India	UK
Paper and cardboard	25	16.8	22.7	30.1	13.0	7.0	23.5
Food and garden waste	43	48.3	38.8	30.8	60.0	75.0	40.0
Plastics	* * *	10.2	11.7	15.0	1.5	1.0	5.0
Glass	* * *	3.8	5.1	6.0	3.0	2.5	9.0
Textiles	* * *	* * *	3.1	5.1	* * *	* * *	* * *
Other	* * *	20.9	18.6	12.9	21.5	14.5	22.5
Total	* * *	100	100	99.9	100	100	100

*Composition expressed in w/w (the percentage of the mass of each material to the total waste mass).

1.3 *Hazardous waste*

Hazardous waste is a term applied to wastes that due to their chemical reactivity, toxicity, explosiveness, corrosiveness, radio activeness or other characteristics, cause danger, or are likely to cause danger, to health or the environment (EEA Glossary). Generally, hazardous waste is any waste that possesses one or more of the following basic hazardous characteristics: they are toxic, flammable, explosive, corrosive, oxidizing, irritant or harmful to the environment.*

Although the definition of hazardous waste is not uniform in all countries, it mainly refers to pharmaceutical products, cleaning products, paint/varnish-thinners, batteries, mineral oils, sprays containing CFCs, etc. This waste originates either from households or in workplaces from various professional activities (shops, offices, workshops, etc.).

1.3.1 *Hazardous household waste*

Hazardous waste makes up less than 1% of its total waste generated in Europe. However, due to hazardous substances it contains, it presents a serious risk to health and the environment unless managed and treated properly. Some EU countries report excessive hazardous waste recovery, reaching even 40% (generally by separate collection and recovery as by-products). In other regions the situation is less clear and several countries report of unsatisfactory disposal.

In common household products, some dangerous substances may be found such as metals i.e. lead (Pb), mercury (Hg), cadmium (Cd), chromium (Cr) or synthetic organic compounds. Such substances may cause health problems to humans but also to plants and animals. The packaging of goods that contain hazardous substances usually bears warning signs referring to the potential risk their usage implies (Refer to Annex 3).

1.3.2 *Hazardous waste generated by professional activities*

Many professions are directly or indirectly associated with the use of substances that may be dangerous to human health or the environment and from which hazardous wastes result. Few examples are given below:

Dentists: Dental amalgam has been extensively used by dentists as a restorative material in teeth for over 150 yrs. Amalgam is a metallic alloy consisting primarily of 4 metals, mercury, silver, copper and tin, with mercury comprising 50% of the amalgam. Removed old fillings as well as leftovers remaining after preparing new amalgams may enter the waste streams when they are simply discarded. While dental mercury use and release continues relatively unabated in most Mediterranean countries, several measures are taken worldwide to reduce dental mercury pollution, according to UNEP's Global Mercury Assessment (2002). Such measures include the use of other types of dental fillings, the use of pre-dosed capsules of amalgams (France) the use of amalgam separators and treatment in special facilities (EU regulation), or the recycling of amalgam scrap (New Zealand).

Mercury is a known pollutant from the extreme case of Minamata disease which leads to paralysis, spasms, etc. In other cases it may cause human fatigue, dizziness, skin problems, heart and respiratory troubles, memory loss, etc.

Mercury is a persistent, bioaccumulative element (it has the potential to build up in the food chain) that even in minute quantities poses a risk to human health, wildlife and the environment. It is one of the most toxic non-radioactive elements, a volatile heavy metal that can be rapidly released into the atmosphere. A potent neurotoxin, mercury causes damage to the central nervous system, immune system, liver and kidneys of humans and it is particularly dangerous for embryos and young children.

At the dry-cleaner's, clothes are cleaned using organic solvents. The process is called 'dry-clea-

* The EU classification into hazardous and non hazardous waste is based on the system for the classification and labelling of dangerous substances and their preparation, which ensures the application of similar principles over their whole life cycle. For the iconographic symbols and indications of danger for dangerous substances and preparations refer to Annex 3.

ning' since no water is used and the resulting characteristic odour is due to the organic solvent used. Naphtha and organic compounds containing chlorine and fluorine are often used. Naphtha is a petrol by-product which is inflammable and leaves a strong odour on clothes. On the other hand, organic compounds containing chlorine and fluorine do not catch fire; often they do not smell, whereas less solvent is used and clothes dry faster. However, these compounds are responsible for the destruction of the ozone layer in the atmosphere. Organic compounds containing chlorine, such as 'Perk' (1,1,2,2-tetra chlorine ethylene) are considered as potential carcinogenics. Furthermore, substances such as active carbon or plastic fibres are used for the removal of the solvent. Several of the above-mentioned products contain substances harmful to human health and the environment.

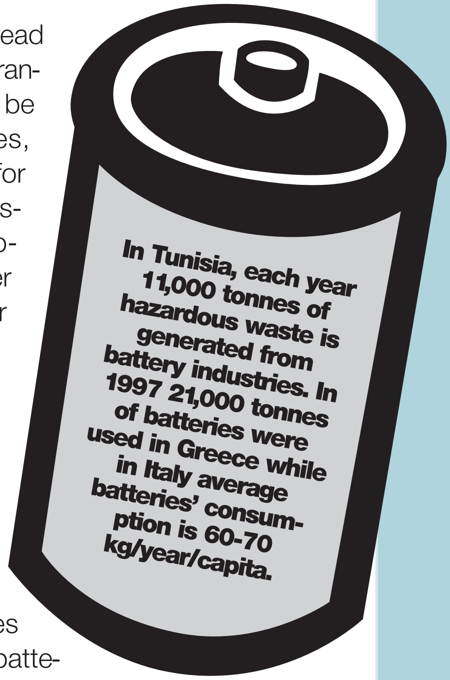
Every one or two weeks, remaining solid waste is removed from the washing machine. Although this solid waste is toxic and must be treated separately from household waste, in many cases it is disposed of in common garbage bins and mixed with ordinary municipal waste. Nowadays, there are more environmentally friendly dry-cleaning products. Their cost however is still relatively higher than that of common dry cleaning products.

Paints used in buildings consist of solvents and colouring substances. Organic solvents such as toluene and turpentine are harmful for workers' health. Several colouring substances contain lead (Pb) and cadmium (Cd), which are toxic metals. The rust-preventing background paint used in metallic constructions, for instance, contains lead oxide (Pb_3O_4).

In order to protect the environment as well as human health, water-soluble and heavy metal-free paints should be preferred instead. Paint containers should not be disposed until they are completely empty. They should also bear the appropriate warning signs referring to the potential risks implied by their improper use.

There are several more professions in which hazardous substances are commonly used, such as furniture manufacturers who use various types of varnishes; printing houses that fill their machines with dyes; and photo labs that use silver and organic toxic compounds such as hydroquinone. The use of pesticides by farmers may pose a great risk when they are unaware of the dangers of these substances. The risks are greatest in developing countries, where in many cases farm workers cannot read the warning labels because they do not know how to read or because the label is in a foreign language.

1.3.3 *Used batteries*



Batteries are widespread products with a wide range of uses. They can be found in several sizes, from very small ones for clocks, radio transistors, household appliances, etc., to rather large ones, such as car batteries. In general, manufacturing a battery requires 50 times more energy than the energy it will provide during its use. Depending on whether they contain a liquid or not, batteries are divided into 'dry' batteries (i.e. radio batteries) and 'liquid' ones (i.e. car batteries).

Batteries contain acids and bases as well as metallic electrodes made of lead (Pb), mercury (Hg), cadmium (Cd) and nickel (Ni). Mercury, lead and cadmium are by far the most problematic substances in the battery waste stream since all three are classified as hazardous waste, according to EU legislation. Therefore, the uncontrolled dumping of batteries can pose health risks to living organisms and serious environmental problems. The Mediterranean Sea is facing increasing pollution pressures resulting *inter alia* from the lead discharges from inland and coastal battery industries.

In Italy before Law 441 (29/10/1987) entered into force, batteries were burned to ashes or buried with municipal waste. The Compulsory Consortium for collecting and recycling batteries (Cobat) was established by 475 /1988 Law and became operational in 1990. By the year 2002 the collection rate of used batteries had reached 38%.

There are many proposals on ways to limit the problems caused by the disposal of old batteries. Efforts are being made to replace heavy metals with environmentally friendly substances. A more widespread use of rechargeable batteries is also encouraged.

FIGURE 4 ← Various types of batteries
→ Common Ni-Cd batteries

EU LEGISLATION ON BATTERIES

The European Legislation aims at minimising the negative impacts of batteries and accumulators on the environment and at harmonising requirements for the smooth functioning of the market. To achieve these aims the relevant EU Directive (2006/66/EC) that came into force in September 2006 introduced measures to prohibit the marketing of some batteries containing hazardous substances and to achieve high collection and recycling rates. Also, the Directive sets out minimum rules for producer responsibility and provisions with regard to batteries' labelling and removability from equipment. This new Directive applies to ALL batteries and accumulators, unlike the previous legislation (Dir. 91/157/EEC), which only applied to batteries containing mercury, lead and cadmium. The new directive ensures that the internal market functions properly, with equitable conditions for all the players involved in the life cycle of batteries. In the coming years Member States must set up schemes for producers to take back spent batteries and accumulators, free of charge, with a view to recycling their raw materials for use in the manufacture of new products. The ultimate disposal of industrial and automotive batteries and accumulators by incineration or landfilling is prohibited.

1.4 *Household waste disposal and management*

Waste management is the collection, transport, processing (waste treatment), recycling or disposal of waste materials, in an effort to reduce their effect on human health or local aesthetics or amenity. Waste management practices differ for developed and developing countries, for urban and rural areas, and for residential, industrial, and commercial producers. Waste management for non-hazardous residential and institutional waste in metropolitan areas is usually the responsibility of local authorities, while management for non-hazardous commercial and industrial waste is usually the responsibility of the generator.

The main methods in household waste management (some of which can be combined) are sanitary landfill, bio-gas production, incineration, composting, and recycling. According to the World Atlas (2002), only 20% of the solid waste produced in the world today is treated! In most Mediterranean countries waste ends up in landfills (waste dumps) and uncontrolled dumping is still largely predominant. However, the practice of controlled landfilling with at least regular coverage of waste, use of weight-bridges and gas collection systems is on the increase in the region (UNEP/MAP & Blue Plan/RAC, 2000).

Since the mid-90s countries have begun to close down some open uncontrolled dumps and replace them with controlled or sanitary landfills, while recovery and recycling policies are being introduced (Plan Bleu, 2005):

- In 1991, Turkey abandoned incineration and developed a policy of systematic recycling through a legal obligation to annually reclaim a certain tonnage for some economic sectors that are large consumers of packaging.
- In 1998, Tunisia granted a concession to a private operator for its first really controlled landfill in Djebel Chekir meant to serve Greate Tunis. In addition, a national inventory listed 400 sites used for illegal storage of household waste, which would need to be reclaimed.
- In Syria, the first controlled landfill was opened in Damascus in 1998 and the government decided to set up a controlled landfill in Aleppo.
- In 1999, Egypt opened three controlled landfill sites in Giza, Alexandria and Cairo and has built several composting units since 1990.

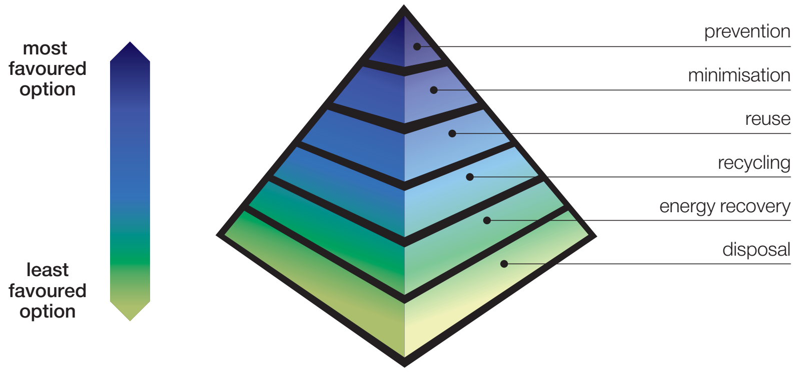


FIGURE 5 The waste hierarchy presents the options for dealing with waste. Those towards the top of the pyramid are more desirable than those towards the bottom. Many campaigns are based on the 3Rs: 'Reduce-Reuse-Recycle'. However at the top of the hierarchy is Prevention.

- The largest plant for solid waste treatment in the Mediterranean and Europe was constructed in Athens, in 2005. The plant has a maximum capacity of treating 1,200 tonnes of garbage per day producing compost, RDF and recycling metals.

1.4.1 *Waste collection methods*

While in some Mediterranean countries the proportion of population provided with regular waste collection exceeds 95%, in others it is as low as 35%, whereas it is almost absent in certain rural areas. Moreover, throughout the Mediterranean region, up to 25% of wastes may remain uncollected, even in areas where waste collection services are foreseen, due to poor efficiency and inadequate infrastructures.

A common sight in most urban areas is the so-called waste collection vehicle, a truck specially designed to collect smaller quantities of waste and haul it to landfills or to designated treatment facilities. These trucks, operated by garbage collectors, pass on a regular basis to empty the bins. The term 'collection rate' refers to the percentage of waste collected as compared with the amount of waste generated. Generally, the collection rate is relatively high in cities and towns and smaller in rural communities. For example, in Egypt collection rates vary from 0% in rural areas to 90% in high-income areas in large cities. Quite often, in poorer areas the only means of solid waste management is informal: scavenging by people and animals, natural degradation and dispersion, burning at the point of disposal or local self-help initiatives for waste collection/disposal.

When the final disposal site of garbage is far from the residential area, a waste (re-)transfer station is occasionally used. There, garbage from several trucks is usually compressed and retransferred to large containers, which in turn, reach the final destination (landfill or other). Such waste retransfer stations, though useful in densely populated areas (particularly if located far from waste disposal sites), are relatively few in Mediterranean cities. They should be seriously considered since they may help to improve traffic and to reduce costs.

'Garbage mills' are special devices, placed in the kitchen sink, able to mill all non-metallic, non-glass, etc. items that are not too hard. Their advantage is

General Points on Household Waste Management in the Mediterranean Region

- In most cases, the institution responsible for managing the collection of household waste is designated at local level. In France, responsibility lies with a national agency. Local initiatives on selective collection exist in many countries of the region. In France, Croatia, Tunisia and Monaco the law defines the measures to be taken and the commitment to be respected in collective selection.
- Disposal sites that meet international standards are rather rare in the region due to poor design, lack of technical capacity and poor operational budgets.
- Recycling throughout the region, is undertaken largely by the *informal* sector e.g. initiatives of NGOs in cooperation with the local authorities and the community.
- Composting is being undertaken in several countries; however, the results are until now rather disappointing in terms of economic benefits.

FIGURE 6 Two containers used at one of the seven existing waste transfer stations located in western Macedonia, Greece. The containers, once filled, are emptied in a sanitary landfill, washed, and brought back to the station. The pioneer integrated waste management project operating successfully since 1998 with the collaboration of four neighbouring prefectures, covers all stages starting from collection, re-transfer, sorting, recycling & manufacturing, sanitary landfill and special waste treatment.

that, when used by a whole settlement, waste does not need to be collected, transported and disposed of. However, a special treatment facility must be installed in every building and a much larger municipal sewage treatment plant is necessary. It also renders sewage treatment more difficult.

Pneumatic waste collection systems using air streams or air vacuum are operated in relatively few places, mostly in Scandinavia and the United States. The plant consists of a system of pipes and collectors. Such a system is easy to integrate in the initial construction plans of a settlement, but it is very difficult to be installed in an already developed area. Household waste is placed in special receptacles located in the building. With the use of air pressure or vacuum, garbage (and mainly refuse) is removed from the pipes and conveyed to specially designed treatment facilities or alternatively to vehicles. This method which could be used in specific circumstances has the advantage of limiting annoyance of transportation, noise and smell as well as the number of personnel needed for waste collection; however it is very expensive.

Generally, the siting of a disposal unit is a major issue in heavily urbanised areas and in places with particular geomorphological characteristics i.e. with limestone and lack of topsoil. In islands the available land suitable for landfilling is frequently scarce; there are strong winds that carry away some

Solid waste collection system in Cairo

According to the Egyptian Environmental Affairs Agency (1999) the following main challenges are to be tackled, regarding the waste collection system in Cairo:

- Collection and transport capacity does not exceed 60%.
- Garbage has accumulated for long periods in several parts of Cairo especially in the shanty districts.
- Lack of sub-stations in Cairo means that garbage is sometimes transported 50km to reach the final dumping site.
- The current slogan is “put garbage in your backyard” without any legal, administrative, financial or technical responsibility.

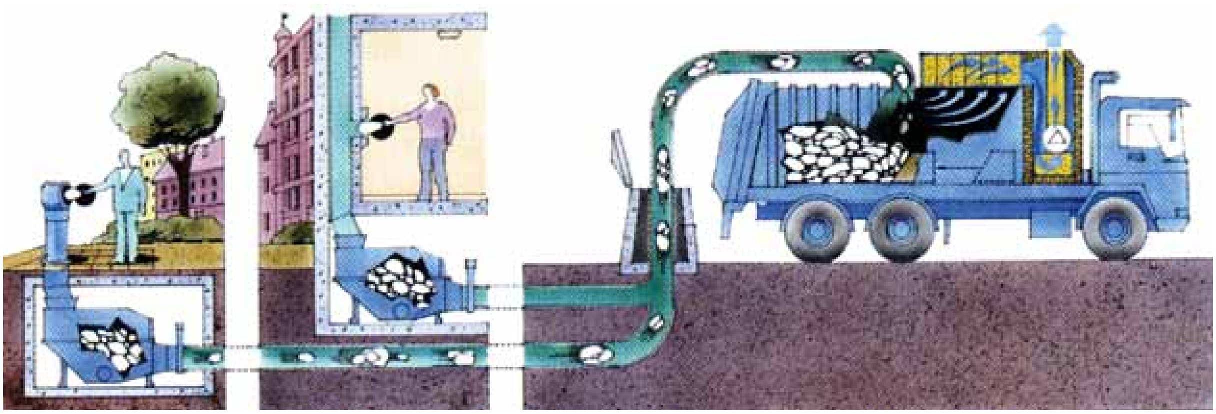


FIGURE 7 Diagram representing the operation of a vacuum waste collection system.

light waste during landfilling; and, due to tourism activities municipal waste generation and composition varies significantly according to the season. On the other hand, in mountainous regions the road network usually is insufficient; appropriate land is scarce and characterized by steep gradients. Often the subsoil is carstic with deep cracks. During winter many of these regions tend to experience isolation for some time due to extreme weather conditions.

1.4.2 *Disposal in sanitary landfills / Selection of the site*

In appropriate sanitary landfills waste is placed in adequately designed and carefully prepared spots. Such landfills are sealed and do not allow the contact of garbage nor their leachates with running or underground waters. They are closely monitored and regularly covered with soil under high pressure. Drainage liquids (leachates) are collected and treated either separately or together with municipal sewage. In order to determine the location of the waste disposal site an *Environmental Impact Assessment* (EIA) must be carried out in advance. Such an assessment must be based on data from a series of studies such as:

- hydrological and climatological, which evaluate the amount and patterns of rainfall and run-off in the area;
- hydro-geological (on the underground waters) which evaluates the water horizon level, its seasonal fluctuation, the direction of flows;
- bio-geological, of the area's soil, flora and fauna
- geo-chemical, determining the past or recent core pollution and eventually important geochemical mechanisms;
- a study on traffic circulation which could determine the optimal access to the waste disposal site and, of course, all these should take into account the more general urban planning to ensure the required distance from residential areas or other incompatible land uses.

Once the location of the site is determined, the next phase is its design and proper sealing. At first, a 0.30 meter-thick layer of clay is laid underneath. Above that two plastic membranes (ethylene and propylene) are placed in order to prevent pollution of the subsoil by waste leachates. The two plastic

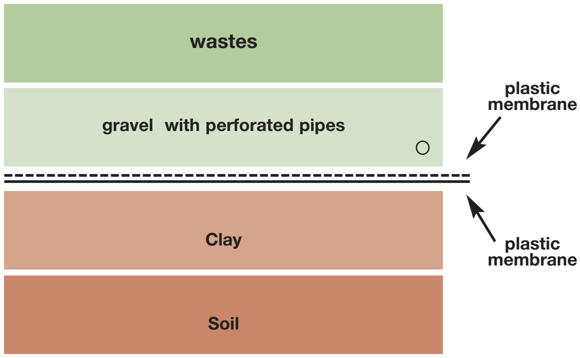


FIGURE 8 The bottom of the landfill is made water proof by adding clay, plastic membranes and gravel.

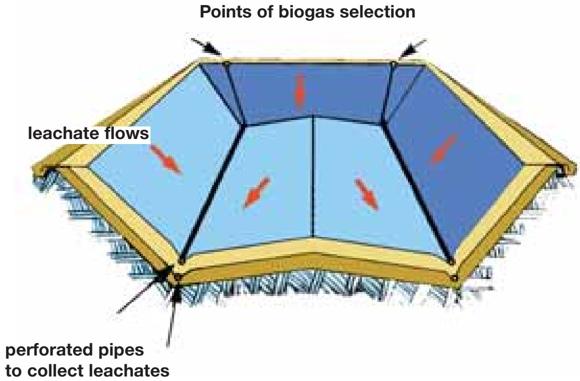


FIGURE 9 Cross section of a sanitary landfill.

membranes are covered with a layer of gravel. Perforated pipes are placed in between the gravel to collect and drain the leachates.

Waste is stored in layers, which are separated by sand or clay layers. In order to yield a high degree of compaction specially designed heavy vehicles roll over wastes and sometimes special equipment is used to bind the waste. Bulky waste such as old furniture is placed at the bottom of the waste disposal facility or in separate compartments. With the pressure of the above layers and the effects of corrosion-decomposition, their volume is eventually reduced very drastically. Perforated pipes are placed to remove and eventually collect (apart from the leachates) the produced biogas.

During the operation of the waste disposal facilities, leachates from the run-off in the area of the plant and produced biogas are frequently processed *in situ*. Drainage is usually submitted to biological treatment that could transform it into water potentially adequate for watering urban green. The generated biogas can be used in two ways: either letting it burn in order to prevent the formation of an explosive mixture with air (the uncontrolled emission of biogas from the plant can lead to explosion and fire outbreak); or using it to generate hot water for 'distance' or 'tele-heating', meaning the water distributed in a closed system to nearby settlements (for heating or cooling purposes), or alternatively, for the generation of the electric power necessary for the plant's operation.

When the plant is full, its time for the site's rehabilitation: Depending on the nature of the waste, a strong plastic membrane could be placed over it in order to prevent further direct contact with air and rainwater, etc. In other cases, with ordinary household waste, such a membrane might not be necessary. Various layers of soil are spread on top so as to make the site suitable for planting vegetation. The reclaimed site can be used as a 'compensation' for the previous 'misuse' for community purposes for leisure facilities, such as parks, playgrounds, golf-courses, etc.

Waste management in sanitary landfills has a relatively low operation cost and is adequate for a large range of types of waste. Furthermore, the biogas produced is eventually exploitable, and, after the plant's closure, the site can have a number of uses. Nevertheless, there is always some risk of groundwater pollution by drainage leakages in the case of the facility's malfunctioning and also the produced biogas may cause explosion or fire outbreak if not controlled properly. Energy recovery usually does not yield sufficient profits. Additionally, appropriate locations for the operation of sanitary landfills are often scarce. It is also noteworthy to mention that due to lack of proper information and education, the public, as well as local authorities, often tend to consider sanitary landfills to be the same as traditional landfills, and in most cases strongly oppose their establishment in their territory.

1.4.3 *Waste degradation - Biogas production*

When burying wastes we rely on the earth's natural recycling capacities to decompose various materials. Decomposition refers to mechanical, physical and biochemical decay and degradation into simpler particulate and dissolved inorganic or organic components. Some of them may further react in the soil among themselves and form new polymers, similar to those found in natural soils (e.g. humic or fulvic acids).

FIGURE 10
← A sanitary landfill gradually being filled in western Macedonia, Greece. The protruding tubes are for biogas collection
→ Perforated pipes to be installed at the bottom for leachate collection.

Microorganisms such as bacteria are mainly responsible for decomposing the various materials. During this process microorganisms (*decomposers*) are nourished by extracting chemical substances (mostly organic carbon) from organic wastes using these to produce energy (*biodegradation*). The decomposers produce their own "waste" which, in turn, will also decompose, eventually returning inorganic nutrients to the soil. These nutrients can then be taken up by plants' roots enabling them to develop, so that inorganic and organic material is naturally recycled.

However, not all wastes are equally susceptible to decomposition. 'Biodegradable' waste products are organic materials containing carbon in particular forms and structures. Paper and cardboard, food leftovers, garden waste, wood, some categories of new generation plastics are the biodegradable organic fraction of municipal waste. Conventional plastics, although they contain carbon, are not considered as biodegradable within a reasonable timeframe.

The chemical properties of the various materials as well as the prevailing weather conditions (sunlight, wind, temperature, humidity, pressure) and mechanical pressure exerted on the waste,determine the speed of their decomposition. Although they do not cause direct toxic pollution, plastics and aluminium are characterized by a very slow decomposition rate and therefore are considered as problematic wastes.

During the anaerobic degradation of organic matter found in household waste *biogas* is produced. Biogas consists mainly (>90%) of equal parts of carbon dioxide (CO_2) and methane (CH_4). It also contains small quantities of ammonia (NH_3), hydrogen (H_2), hydrogen sulphide (H_2S), nitrogen (N_2) and oxygen (O_2). The composition of biogas depends on the properties and texture of the decomposed material and the prevailing conditions (temperature, pressure, light, etc.) that determine the type of microorganisms that are developed.

Sometimes usable biogas can be extracted also from old landfills. In such a case, vertical pipes are implanted in the old site allowing the accumulated biogas to be collected and used. Biogas production should be combined with other waste management techniques (e.g. recycling of plastics, metals, etc.) and used in integrated management (e.g. for distance heating etc.) in order to be considered as economically viable and an environmentally sustainable waste management method.

1.4.4 *Incineration*

Incineration is a waste treatment method that may function as an alternative to landfilling and composting. Incineration technology actually involves

TABLE 4 Decomposition time of some common items found in a landfill: The decomposition time of materials varies depending on factors like temperature, presence of oxygen, moisture, presence of micro organisms, etc.

Material	***Decomposition time***
Bus ticket	2-4 weeks
Cotton fabric	1-5 months
Rope	3-14 months
Woollen fabric	1 year
Painted wood	13 years
Tin	50-100 years
Aluminium can	100-200 years
Plastic bottle	around 450 years (widely depending on its chemical characteristics
Glass bottle	unknown (glass items made 3000-4000 years ago survive to our day)

Green materials

New materials and products appear in the market daily in an attempt to use natural renewable resources and as little as possible new material ('dematerialisation approach'). As they are mainly of plant origin, they are biodegradable and they can be safely disposed or even incinerated. For example, plastics made from potato, corn wheat or rye starch, as an alternative to traditional oil by-products, help avoid the depletion of non-renewable resources and stimulate agriculture by offering new outlets. These materials should however undergo a full life-cycle analysis (water and energy demand, component materials, end-of-life collection, etc.) depending on their usage, to guarantee they are indeed more beneficial to the environment.

the combustion of waste at high temperatures, which is why the method is frequently described as 'thermal treatment'. In effect, incineration of waste materials converts the waste into heat (that can be used to generate electricity or hot water for 'teleheating' in the neighbourhood), sends gaseous emissions to the atmosphere and makes residual ash. The method may be carried out with or without energy recovery. A *waste-to-energy* plant (WtE) is a modern term for an incinerator that burns wastes in high-efficiency furnace/boilers to produce steam and/or electricity and incorporates modern air pollution control systems and continuous emissions monitors.

During incineration (waste combustion, burning) the organic compounds in the waste are ideally transformed to carbon dioxide and water. In order for incineration to be operational and economically viable, the following are required:

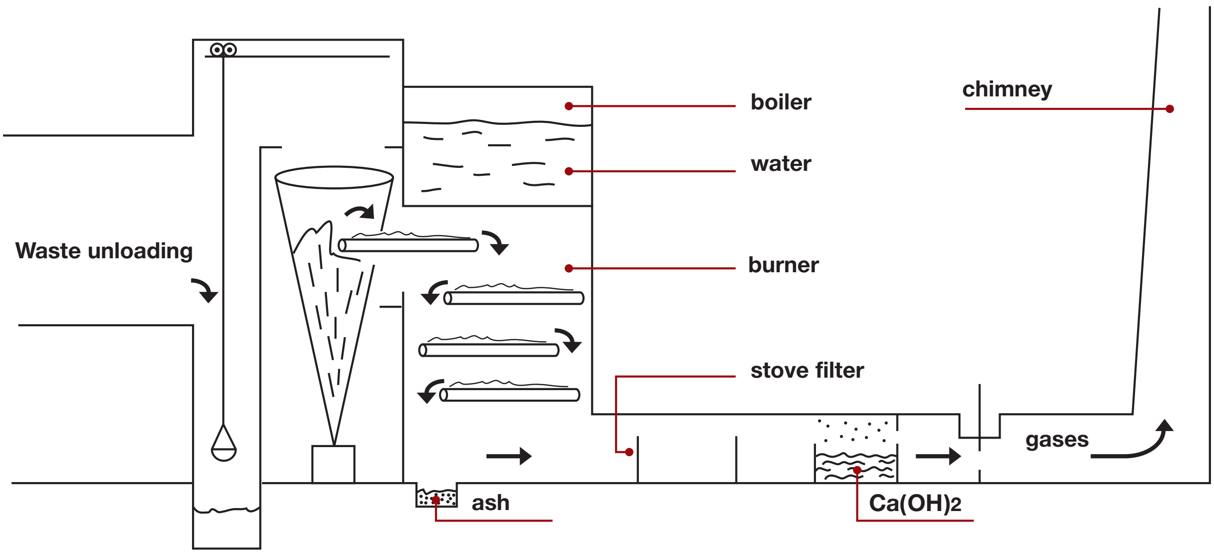
- Waste must contain more than 40% of combustible matter
- Waste humidity must be less than 50%
- Ashes produced should not exceed 25% of the original waste's volume

The basic unit of an incineration plant is the stove -where waste is normally led through a conveyor belt- to be burnt while heating a quantity of water. Water usually turns into vapour which is used for the production of electric power. Alternatively, it may be used for heating the plant and for distance heating. The ashes produced are regularly removed from the stove and transported by trucks to specially designed facilities for the storage of toxic substances. Alternatively, they may be mixed with inert material and used e.g. in preparing cement concrete, etc.

Gases are controlled through appropriate filters, which retain their toxic/harmful substances, and subsequently gases are wasted and treated with an alkaline solution to neutralise acids. Treated gases are then released to the atmosphere through high chimneys. Besides carbon dioxide (CO_2) and water (H_2O), combustion may also generate carbon monoxide (CO), nitrogen oxides (NO_x), sulphur oxides (SO_x) and suspended particles (i.e. ethales). The most important concerns, however, rise from the eventual release of persistent stable in high temperature organic substances existing or formed during incineration such as chlorinated hydrocarbons, dioxins, etc., as well as relatively volatile metals such as mercury.

The technology to burn waste has improved significantly over the past 30 years and incinerators are now much cleaner and safer than they used to be. However, despite improvements in the operation of incinerators, there is strong public concern about their eventual impact on the environment, including contribution to climate change as well as on health. Also, from a resource point of view, incineration may not be the best way to deal with poten-

FIGURE 11 A cross section of a typical waste incineration plant. There are various types of incinerator plant designs: Simple - Fixed or moving grate combustion - Rotary kiln - Multiple/stepped hearth - Fluidised bed.



tially recyclable material. Even if energy is obtained through the process, incinerating our rubbish may be a waste of valuabe resources and contribution to generation of green house gases (CO_2).

Open air incineration of municial waste currently practised in Egypt, Syria, Lebanon and Morocco has been identified as a major source of pollution deteriorating air quality, especially through dioxin and particle emissions. The overall advantages and disadvantages of the method are presented in table 5.

1.4.5 *Composting*

Composting is the process that refers to the decomposition of the organic fraction of waste, resulting to a partly decomposed stabilised organic product, compost. Compost may be used in agriculture as a supplement to fertilisers. Compost in itself is not considered as a fertiliser, having usually low quantities of phosphorus and nitrogen; however, it enhances the fertility of soils by increasing their ability to retain oxygen and water, contributing to crops of good quality. The overall ad-

The European Union's Directive (2000/76/EC) on the incineration of waste is based on an integrated approach: new limits for discharges into water and emissions to atmosphere are added. The Directive requires all plants to keep the incineration or co-incineration gases at a temperature of at least 850°C for at least two seconds. If hazardous wastes with a content of more than 1% of halogenated organic substances are incinerated, the temperature has to be raised to 1100°C for at least two seconds. The Directive includes limit values for incineration plant emissions to atmosphere concerning heavy metals, dioxins and furans, carbon monoxide (CO), dust, total organic carbon, hydrogen chloride (HCl), hydrogen fluoride (HF), sulphur dioxide (SO_2), nitrogen monoxide (NO) and nitrogen dioxide (NO_2). The quantity and harmfulness of incineration residues (ashes) must be minimised and residues must, when possible, be recycled.

TABLE 5 Advantages and disadvantages of incineration (adapted from Mousiopoulos & Karagiannides, 2005).

The volume (V) of waste is significantly reduced (V_{final} = 10% $V_{initial}$). Due to oxidation into gaseous compounds released in the atmosphere the weight (W) of waste is also reduced (W_{final} = 25-35% $W_{initial}$).	Incineration plants are costly to construct, and more expensive during operation and decomussioning compared to all other methods of waste management. However the cost of operation drops as the treatment capacity grows.
More energy is recovered compared to biogas production.	The resulting gasses contribute to the green house effect. Toxic gas emissions such as dioxins may also be formed, if not propery operated.
It is the only recommended and reliable method for special types of wastes, i.e. hospital wastes.	During the incineration process there is release of some metals to the atmosphere and accumulation of most of the metals in the ashes.
Applying high temperatures results to converting all organic compounds to inorganic ones.	The resulting ashes are toxic and require disposal in appropriate facilities. Alternative treatment to be neutralised is at a rather an experimental stage.
Incinerator plants do not require large areas to be constructed (unlike landfills).	In order to be economically viable they need to service rather large population groups. A minimum serviced population per plant is estimated at ~80,000 inhabitants, but this may vary depending on the technology applied.

vantages and disadvantages of the composting method for treatment of municipal waste are presented in table 6.

Materials proper to be composted include green or brown leaves, cut grass, fruit and vegetable leftovers, small quantities of napkins, egg shells, withered flowers and ashes. Contrary, animal products (meat, fish, bones), sick plants, animal excrements, large tree branches, toilet paper, metal, plastic and glass, papers and magazines and chemicals should not be added to the compost pile.

Garden and kitchen leftovers are ideal foodstuff for bacteria, fungus, earthworms and other small insects taking part in the composting process. It is estimated that kitchen vegetal leftovers constitute 30% of the total household waste volume. Moreover, having high moisture, these leftovers are difficult to incinerate, compared to other materials.

Of the many elements required for microbial decomposition, carbon and nitrogen are the most important. Carbon provides both an energy source and the basic building block making up about 50% of the mass of microbial cells. Nitrogen is a crucial component of the proteins, enzymes, and nucleic acids necessary for cell growth, function and reproduction. As microorganisms oxidize carbon for energy, oxygen is used up and CO_2 is produced. The exothermic chemical reactions heat up the composting heap and result in the reduction of its mass and volume. Nitrogen supplied in excess will be lost as ammonia gas, causing undesirable odours. On the other hand, insufficient nitrogen will hinder the growth of microbial populations and consequently slow down the degradation process. Oxygen is also essential for successful composting, that is why good aeration of the heap is necessary. Without sufficient oxygen, the process will become anaerobic and produce undesirable odours, including the rotten-egg smell of hydrogen sulphide gas. Other factors that influence the fermentation process are humidity, temperature and the size of the decomposing particles.

A pH between 5.5 and 8.5 is optimal for compost microorganisms. As bacteria and fungi digest organic matter, they release organic acids, which often accumulate in the early stages of the process. The resulting drop in pH encourages the growth of fungi and the breakdown of lignin and cellulose tissues. Usually the organic acids become further broken down during the composting process. If the system becomes anaerobic, however, acid accumulation can lower the pH to 4.5, severely limiting microbial activity.

In order to make compost, one should start with sorting out wastes. The proper ratio of 'green' to 'brown' materials is rather critical. Roughly, their volume ratio is two parts brown to one part green (2/1). One should not forget that glass, metals, plastics and any material having undergone any chemical process should NOT be added to the heap.

TABLE 6 Advantages and disadvantages of the composting method.

☺	☹
Environmentally friendly method for waste treatment that improves soil's characteristics (porosity, ability to retain water, helps maintain its natural levels of pH and microbial fauna).	Problematic when compost contains unacceptable materials (i.e. glass, metal or plastic, substances containing heavy metals, etc).
Less energy consumed for collection and less use of other methods of waste management (i.e. landfill).	Pathogenic microorganisms may develop if prerequisites are not met.
By reducing the need for chemical fertilizers we prevent groundwater pollution and protect lake and sea water bodies from eutrophication.	In economic terms, demand for compost is low since its use in agriculture increases the yield only marginally.
Less volume of waste ends up in landfills.	
Saves money for buying soil and fertilizers and is less demanding on water resources.	

green **N**	These maintain high levels of humidity and decompose fast. *Example: green leaves, grass, withered flowers, vegetable leftovers from kitchen (green or boiled, but not cooked), used coffee filters and tea bags, fruit peelings, etc.*
brown **C**	These contain mainly carbon, are rather dry and decompose slowly. *Example: dry leaves, tree branches, sawdust (non processed with chemicals), straw, paper, etc.*

Fermentation in heaps takes place in the open air and usually under a shelter (made of plastic membrane or other material) aiming to protect from rain during winter and from extended evaporation during summer. It is preferable that the heap is in touch with the ground. This will help the moving of microorganisms from and to the soil, and also facilitate proper draining. A good size for a small scale composting heap would be 1m x 1m x 1m (piles higher than 1,80m should be avoided because they inhibit aeration). Every 2-3 days the pile needs to be stirred using a rake, to move material from the outside to the inside of the pile, where temperature is higher (should reach 50ºC-60ºC in a few days). Moisture should also be checked frequently, as the pile needs to resemble a well squeezed wet sponge (wet, but not dripping).

The fermentation period is estimated to last approx. 4 weeks, depending on the climatic conditions and our interventions on the pile. The maturation period, necessary to acquire a stable, firm product takes at least another 4-8 weeks. The final product has a dark brown colour, it crumbles easily, has a pleasant smell of wet ground, and none of the initial materials are recognised. It may be used in pots or mixed with soil, and there is no danger of 'over-composting', as its components are released slowly into the ground.

Fermentation in heaps calls for low investment and operation costs. This is why several small composting initiatives i.e. by local authorities or NGOs are often successful. However, individuals' reluctance to take up compost initiatives may be attributed to the required relatively big plots of land, the long fermentation times, the possibility of generation of odours, as well as the lack of compost's homogeneity from heap to heap.

Composting can also take place also inside bioreactors. The advantages of such a process inclu-

The EU Mediterranean countries have to comply with the EU Landfill Directive that imposes strict targets for the reduction of biodegradable municipal waste that should be disposed of in landfills. Taking 1995 as the starting point, a reduction of 35% by 2016 is expected to be achieved. Source separation, separate collection, more incineration, more composting combined with limits and bans on landfills are needed to reach this target.

The majority of Mediterranean countries do not have sufficient provisions for utilising organic waste. In most cases, composting plants and projects are run at local level as a result of voluntary initiatives. Egypt, Lebanon and Malta run national programmes for composting and the agricultural use of compost. In Cyprus compost is used to improve soil. In Turkey composting plants are under construction in several cities (UNEP/MAP, 2000). Bosnia-Herzegovina has a plan for reusing organic waste. At local level, compost producing initiatives are common in many countries including Tunisia, Algeria, Albania, and Slovenia. In Spain household waste is partially composted. Israel subsidises individual composting plants. Some large composting plants also operate in the Mediterranean region in combination with recycling. The one in Athens receives and treats 1,200 tonnes of municipal wastes everyday, some 15-17% of which provides compost while also RDF and metal are produced. The composting plant of Damascus produces 82,000 tonnes of organic fertilisers and 4,000 scrap metal every year (1999). In Italy, the good quality characteristics and the rules for the use of compost are defined in a particular decree (27/07/84).

Success stories on composting and separate collection in many European cities have been compiled in a booklet, produced by DG Environment, available in many languages at http://ec.europa.eu/environment/waste/publications/compost_success_stories.htm de the homogeneity of the final fermentable portion and the good quality of compost produced, as well as the speeding up of the process. The duration of fermentation is considerably shorter, compared to heaps, ranging between few days to a few weeks, depending on the type of the reactor and the synthesis of the parent material. Nevertheless, fermentation in bioreactors has a relatively high cost of operation.

1.4.6 *Recycling*

The term re-cycling refers to the circular process of collecting and treating certain wastes in order to recover their raw material and use it again to manufacture the same or different products. The marketing of a recycled product is part of the same circle.

The process of separation and collection of waste to be recycled may be carried out by users themselves (through separation 'at source') or through mechanical separation by a responsible agency that may be the municipality, a recycling company or an NGO. For separation at source, the users place the garbage in seperate bags or bins bearing appropriate signs. Sometimes, they may undertake the task of carrying the waste to the recycling plants. In most cases, however, special trucks regularly empty the bins containing the appropriately separated waste and transfer it to the plants.

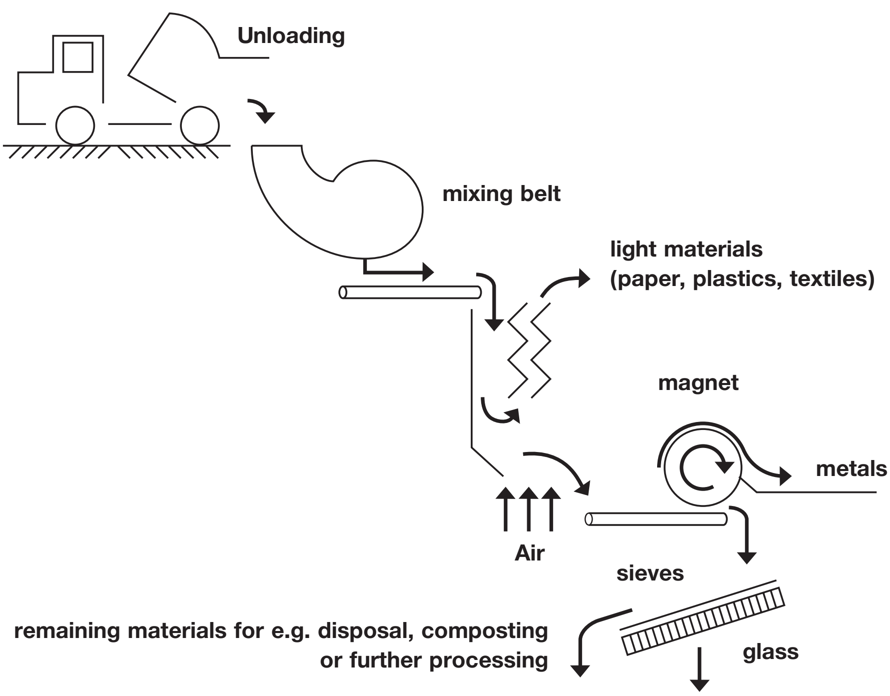
Mechanical separation involves a number of methods, including shredding, manual removal of big items, magnetic separation of metals, separation of light fractions from the heavy ones using air, screening, and washing. During these processes the materials travel along a conveyor belt and the specific fractions are gradually seperated. Metals may be extracted using magnets. Paper is usually combined with plastic, textiles, etc. to produce RDF, a fuel used to produce energy (e.g. for cement plants) or they may be buried.

As for the materials to be recycled, they are separated and 're-generated', applying different techniques, as follows:

- metals and glass are heated at high temperatures and may be further reprocessed into new products or back into the original product,
- plastic materials recovered from waste is converted into granulates or pellets which are used in the manufacture of recycled or partly recycled plastic products,
- paper is pulped and shredded for the production of recycled paper or is used as an additive to the raw material for used new paper.

Some materials such as aluminium and glass can be recycled indefinitely, as the process does

FIGURE 12 Diagram representing the mechanical separation of waste.



not affect their structure. Other materials, such as paper, always require a mixture of recycled paper with raw material to manufacture a new product.

To be economically viable, mechanical separation should be systematically implemented in cities that generate large quantities of waste. Increasingly, municipalities and private refuse-collection organizations require those who generate solid waste to keep bottles, cans, newspapers, cardboard and other recyclable items separate from other waste. Special trucks pick up this separated waste and cart it to transfer stations or directly to recycling facilities, thus lessening the load of incinerators and landfills.

The level of awareness of the local communities and their active engagement in the recycling process is the most crucial parameter for the success of the process. In general, attention should be paid in order not to 'contaminate' the materials that are meant to be recycled with other substances. This means that one needs to be cautious not to mix recyclables with other irrelevant materials, or place them in the wrong bin, or leave the bottles unwashed, etc.

Recycling is one of the tools available to us to help use resources better and reduce the environmental impacts associated with generation and disposal of wastes. It reduces the amount of waste that will be finally buried or incinerated, as well as the demand for raw materials by extending their life and maximising the value extracted from them. It can also save energy, and reduce emissions to the air and water, in the production process. Last but not least, recycling is an applied form of education which helps us to become more aware of environmental issues and encourages us to take personal responsibility for the wastes we create.

Today, recycling systems are in function in many Mediterranean cities by both formal and informal sectors and mainly for paper, glass, plastics, aluminium and other metals. More information about the recycling of various materials is presented in Chapter 2.

FIGURE 14 Starting from broken porcelain items (tubs, sinks toilets) and glass as raw materials (a) these may be transformed to terrazzo surfaces (b) that can be used as durable floors, kitchen or bathroom counters (c), (d) (case from USA).

FIGURE 13 The list of recycled products found in the market is endless. One can find recycled furniture, clothes, carpets, floor coverings from tyres, computers, art or even cars.

1.5 *Disposal of bulky waste*

The term *bulky waste* refers to large items of waste material such as electric appliances, furniture, cars (end of life vehicles), trees, etc. The management of these types of waste varies from country to country.

1.5.1 *Construction & demolition waste*

This type of waste arises from activities such as the construction of buildings and public infrastructure, total or partial demolition of buildings, road planning and maintenance. In some countries even materials from land levelling are regarded as construction and demolition waste. In many Mediterranean countries construction and demolition waste is still dumped in uncontrolled landfills causing many environmental and some health problems and risks. This is due to the hazardous substances which may be present in significant proportions in old buildings that are demolished or renovated (i.e. asbestos lead piping, old paints, etc.). For instance, cement, a basic construction material used for housing two-thirds, is rather polluting and can be recycled.

FIGURE 15 “Don't throw in the Sea” Poster of the 'AMWAJ of the Environment' national campaign aimed to stop dumping into the sea the huge amounts of debris from the thousands of destroyed buildings caused by the last conflict in Lebanon. The safe handling of the debris is one of the major challenges of the recovery process. Existing dump sites have become overloaded with conflict-related demolition rubble, exacerbating existing problems with solid waste management, and numerous additional dump sites have been created hastily, sometimes in inappropriate locations to cope with the excess debris.

Its recycled components, iron, secondary gravel and sand, have the potential to replace up to 10% of raw materials. Major infrastructure projects, such as the construction of roads, generate huge amounts of inert waste. Lately in the wider region around Athens (Greece), inert material generated by infrastructure works is sporadically being used for the ‘filling’, remodelling of old quarries or for harbour extensions.

EU directives, which state that from 2003 on all recyclable materials from construction and demolition activities must be collected. The remaining waste can either be disposed of in landfills or used for the rehabilitation, restoration of old quarries.

1.5.2 *End-of-life vehicles*

Every year, all around the world, the number of cars entering the roadways is increasing. Obviously, the number of cars reaching the end of their ‘useful lives’, either because of age or due to accidents, is also increasing. These, so called, end-of-life vehicles are usually stored in ‘car cemeteries’, which occupy large areas of land. Quite often, particularly for the Mediterranean countries, old vehicles are abandoned in fields, sideroads and various other places, constituting a potent pollutant and aggravating space limitation in crowded cities. Municipalities or the producer companies may be potentially responsible/competent for the removal of these old cars.

TABLE 7 Scrapping of passenger cars (in thousands) in some European Mediterranean countries. (Source: EEA, 2001)

Country/Year	1990	1995	2000	2005
France	2 117	1 885	2 117	2 247
Greece	24	39	70	91
Italy	1 590	1 820	2 335	2 476
Portugal	38	54	85	121
Spain	785	879	1 223	1 349

The composition of a typical car has changed substantially in recent years. For example, ferrous metal content has decreased significantly as lighter, more fuel-efficient materials such as plastics have been incorporated into vehicle design. In any case, about three quarters of a car's weight is steel and aluminium, which are recyclable, but not always easy to separate from the other material.

End-of-life vehicles also contain dangerous liquids (e.g. anti-freeze, brake fluids, etc.) that are harmful to the environment if not disposed properly. Finally, especially old generation cars, may contain materials such as lead, mercury, cadmium, hexavalent chromium, asbestos and other environmentally harmful substances.

The European Community approach to management of end-of-ife vehicles is based on two complementary strategies: (i) waste prevention by improving product design; and (ii) increase of the recycling and re-use of waste.* The estimated number of scrapped cars in the EU is projected to grow from about 1,3 million in 1995 to slighty less than 17 million in 2015. At present, the main strategy in the shredder industry is to recycle the steel and a few components such as lead from batteries and aluminum (totalling around 3/4 of a car by weight).

BUS vs CAR: *A single public bus carrying 60 passengers is equivalent to 40-50 passenger vehicles or taxis. It consumes 4 times less energy per passenger; it emits between 2.5 and 35 times fewer pollutants. Also, per passenger, 12 times less space is needed for parking it.*

METALS

The reclamation of metals is not a new trend. Metals have traditionally had a high value, either in terms of reuse or recycling and cars have been for many decades a common, rich in metals product. Of course, nowadays, there are many items from vehicles that can be recycled, from the oil and its filter, to plastic bumpers. According to relevant EU Directive (2000/53/EC), at the moment, the metal content of 75% of end-of-life vehicles are recycled in the EU. Obviously the proportion of metal from end of life vehicles currently being recycled is rather high, nevertheless there are still a lot of materials left and usually end up in landfills, such as plastics, rubber, glass, dirt, carpet fibres and seat foam.

A car no longer in use is normally sold or given to a vehicle dismantler, who will remove the parts that can be sold for reuse, remove the potentially environmentally polluting materials (operating fluids and batteries), and then sell the remaining frame or chassis to a shredding operation. Shredders are high capacity hammer mills that break the chassis into fist-sized parts. Ferrous metals are separated from the non-ferrous ones by magnetic separation.

FIGURE 16 Car tyres represent a type of waste that is rather thorny to tackle.

CAR TYRES

Tyres, representing around 3.5% of the mass of an average car, are a thorny type of waste to tackle. Due to their shape and size they require large storage spaces. They need 50-80 years to decay and even more to break down completely. They also present an important fire hazard, whereas their uncontrolled burning causes serious air and soil pollution.

In the UK whole tyres are being reused in landfill engineering. Specifically, they are used in the construction of landfill sites, as leachate draining systems. Tyres used for this purpose are exempt from landfill taxation.

* The Directive 2000/53/EC, or the "End of Life Vehicle Directive" stipulates environmental standards to car manufacturers (calls for measures such as reduction or elimination of hazardous substances; vehicle design that facilitates dismantling and therefore easy separation of material, re-use, recovery and recycling; and in order to create the 'market' for the recycled product: use of recycled materials in new cars).

The manufacture of a new car tyre requires about 32 litres of petrol.

Various methods are suggested for the environmentally friendly disposal of old tyres such as:

- *Recycling through retreading*: This refers to the process of replacing the worn rubber (adding a new layer) over the outer surface of tyres. The method allows for a considerable amount of fuel to be saved. Car tyres can undergo this process only once while truck tyres can be retreaded up to three times.
- *Recycling through grinding*: Grinding is a widespread recovery process through which a range of rubber crumb sizes is produced. Rubber crumbs have various uses such as in sports and playground surfaces, production of insulation materials, mixed with road asphalt, carpet underlay, shoe soles, etc. A small fraction (~5%) can also be used in combination with virgin rubber. Grinding also produces steel wires that can be recycled.
- *Energy & materials recovery*: The combustion of one tonne of tyres generates the same amount of energy as 0.8 tonnes of petrol and if done through a controlled process (pyrolisis) it allows the recovery of 150 kilograms of steel wires. Tyre combustion is widely applied in cement factories for energy production. The SO_2 produced by oxidation of sulfur (an important component of 'vulcanised' rubber used for tyre manufacturing), can be trapped by calcium particles (forming $CaSO_4$), limiting air pollution significantly. To understand the energy potential, suffice it to say that one car tyre can serve to produce enough electric power to heat an average house for 24 hours.

CAR LUBRICANTS

One of the areas of greatest concern regarding the waste stream of motor vehicles is the management of their lubricants. And this applies not only to end of life vehicles, but also to the fluids removed regularly during servicing. Lubricants are oil product mixes used for the lubrication and cooling of engine components in motor vehicles. They are also used in engines of industries, ships, etc. One litre of lubricant can pollute up to 1,000,000 litres of water, while its spillage on to the soil has a strong impact on its fertility.

In Italy, in 2003, approximately 600,000 tonnes of lubricants were consumed. According to a specific law (No.691 DPR of 23/8/82), a 'Consortium for used oils' was formed with the obligation to assure the collection of lubricants and to guarantee their appropriate disposal and/or recovery.

The methods applied today for the disposal of lubricants is either through regeneration or through combustion, or a combination of the two. In the first case, the oil filters are removed and squeezed out through presses, removing thus the undesirable retained oil substances. Then the used lubricants are filtered, cleaned, tested for crucial properties and 'corrected' (*viz* mixed) with virgin ones to produce new base lubricants. They may also be mixed with crude oil and treated in appropriate refiners.

On the other hand, large amounts of used lubricants are mixed with fuel and then used as combustibles by heavy industry, power plants and ships. Another option is their combustion in special plants in order to produce electric power. The combustion of 8L of used lubricants generates enough electric power to operate average household appliances for a whole day!

From the abovementioned it is clear that the preferred option for lubricating oils is regeneration for reuse as a base lubricant, but this is not yet a very common practice in many Mediterranean countries. While the production of 2.5L of engine lubricant demands 170L of crude oil, the same quantity of equal quality can be produced by regenerating only 4L of used lubricants!

One litre of waste oil is sufficient to contaminate one million litres of water; and oil poured onto the ground will affect soil fertility.

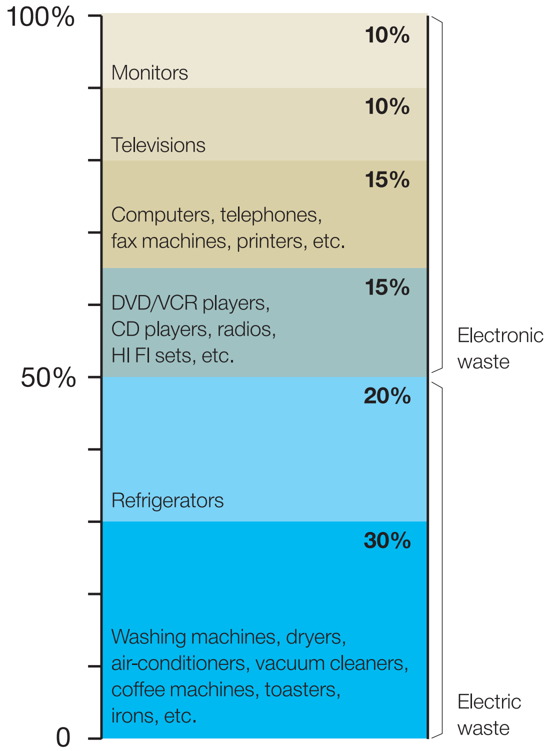


FIGURE 17 The catalogue of e-waste is rather long. Additional categories include lighting equipment, toys, sports & recreational equipment, tools, surveillance equipment, medical instruments, automatic ticket machines... (Source: Vital Waste Graphics II)

1.5.3 *Electric and electronic appliances*

In recent years, as a result of technological progress, an enormous amount of electric and electronic appliances are introduced in the market daily. In order to cope with increased needs and dysfunctions, and also due to consumerist life styles, many people tend to replace their old appliances with new ones quite frequently. Dealing with this waste is an important issue as electronic goods are becoming increasingly short lived and cheaper and so ever increasing quantities of obsolete and broken equipment are thrown away. Electronic and electrical equipment makes up on average 4%-6% of European municipal waste (2004), and is growing three times faster than any other municipal waste stream.

The main component of this waste stream is large household appliances such as refrigerators, washing machines, electric stoves, etc., followed by IT equipment. When their materials are not recycled, raw materials have to be processed to make new products causing a significant loss of resources and energy. Another major problem is the toxic nature of many of the substances, including arsenic, bromine, cadmium, chlorofluorocarbons (CFCs), lead, mercury and PCBs. Therefore, the disposal of electrical waste together with household waste may cause severe pollution. Finally, the great volume of such appliances requires large storage spaces.

The current trends for the sustainable management and disposal of electric and electronic appliances are based on the following principles:

- Reduction of the consumption and replacement rate of electric and electronic appliances when they are not seriously damaged. This will require efforts also on behalf of the manufacturers to increase the lifetime of their products.
- Drastic limitation or even complete ban of toxic metals in the manufacturing of electric goods.
- Development and implementation of recycling and reuse systems for electric and electronic appliance parts.
- Separate collection systems for waste electric and electronic equipment.
- Recovery systems set up by producers of electric and electronic equipment, including separate collection, recovery and recycling techniques.
- Access of users to information on the appropriate management of electric and electronic appliances (e.g. meanings of symbols on packaging, options for separate collection, etc.). Ultimately, consumers should realise their role in waste recovery, as well as on the effects of such waste on the environment and health.

1.6 *Problems arising from improper household waste management*

The improper management of household waste leads to a series of environmental and health problems. Such problems are quite evident in the Mediterranean area, and among them, the most commonly observed risks are the following:

- Pollution and contamination of surface and underground waters from waste leachates. Solid waste rich in organic matter dumped in riverbeds and coastal areas leads also to indirect water pollution through the development of anoxic conditions. Decomposing microorganisms consume oxygen dissolved in water in order to break down the biodegradable components of waste. Lack of oxygen leads to fish kill and loss of biodiversity.
- Dangerous atmospheric emissions because of poorly managed waste incineration.

Solid waste makes history in Saida, Lebanon

The story of Saida dump in so many ways represents the case of unplanned solid waste management in Lebanon and many other Mediterranean countries. Approaching the country from the sea, one can clearly notice the small 'artificial' mountains boardening with the cities of Beirut, Tripoli and Saida, those being mountains of solid waste! The following gives a general background on the waste dump of Saida, which has attracted great attention in the last few years, and has awakened emergency for national planning for solid waste management in the small and crowded country which has suffered also from armed conflicts.

Saida, the largest city in the South of Lebanon, is a busy commercial center situated by the coast. It is a well known city since ancient times and its castle, soap factories, old markets and Echmoun temple (Phoenician god) make it a true attraction for visitors. Is the solid waste dump at the southern borders of Saida part of the modern history of the city? Well, what stops it from being so? It has got the years of existence and the special events that give it all the reasons to be integrated in the city's history...

The dump was initially established more than 30 years ago, as a 'temporary' site for the disposal of solid waste generated by the city and its neighboring villages. The outbreak of fires often disturbed the residents of Saida because of smoke and smell, especially as the city began to expand towards the dump due to population increase. It is estimated that by 2003, the dump was 27m high, occupied an area of 29,000m^2, with a volume of 431,530m^3 of waste. Its height reached 40m in 2004! The dump receives not only municipal waste but also waste from hospitals, industries, markets, tanneries, and slaughterhouses, making its content very dangerous and highly polluted with heavy metals and contaminated with pathogenic material. The dump is believed to have largely affected the marine ecosystem in its vicinity and contaminated the ground waters in its surrounding.

Proper attention was not given to the dump, until the outbreak of a big fire in November 2002, when the sky of Saida was covered with heavy smoke for many days. Only after this incident did the authorities and the public start to realize how crucial the problem of solid waste management is, nationwide. The story of Saida highlighted the need for better waste disposal throughout Lebanon.

The municipality of Saida had started working on restoration plans for the site back in 1998, but limited funds and low political attention kept those plans unimplemented. Even after the fire, the response was not quick enough. The site kept receiving 115 tons of waste per day. Gradually, the lower parts of the dump became hollow because of waste degradation and burning of methane, resulting to a partial collapse in the sea in 2004 and a huge collapse of the dump in 2005!

A growing civil society movement to clean the site of Saida gained momentum after the incident of 2005. Local and national civil society groups actively demonstrated in the streets of Saida, in front of the dump site and outside the Ministry of Environment in Beirut requesting the clean up of the site and the establishment of an integrated plan for the solid waste management for the entire country based on waste reduction and segregation at source.

The momentum gained by the civil groups, pushed the municipality to work on an environmental impact assessment (EIA) for the clean up and rehabilitation of the site. The EIA was completed in 2006 and the Ministry of Environment has in principle accepted its content. Funds for implementation have been allocated via a donation to the municipality. Costing 5 million USD, and estimated to last 5 years, the rehabilitation plan suggests:

- ➔ Collecting the accumulated amounts of methane gas and flaring them
- ➔ Segregating the recyclable material from the pile of waste and selling it
- ➔ Composting the organic material of the waste
- ➔ Filling an old quarry in the nearby village of Zeghdraya with the soil material collected from the dump
- ➔ Safely treating and disposing the waste contaminated by tanneries

The proposed clean up and rehabilitation process is however far from a complete solution. Concerns about the transparency of the process and monitoring by civil society, as well as the marketing of recyclables and the management of the newly generated waste are still to be tackled....

(2006, Michelle Bachir, active environmentalist, Lebanon)

NOTE: The article was written before the war of 2006. Its impact on the plan is not known.

- Enhanced risk of fire outbreaks in uncontrolled landfills. Fires may be caused by i) reflection of sun rays from glass particles; ii) methane emissions when coming in contact with flammable substances from anaerobic fermentation; iii) hermetically closed plastic bags, in which fermentation is taking place (oxidation is an exothermic reaction and temperature in a closed bag can reach 60-70°C).
- Aesthetic degradation of the landscape by littering and uncontrolled dumping.
- Spread of diseases. Cavities within discharged solid waste constitute an ideal habitat for insects and rodents, especially rats. These may carry viruses, bacteria and protozoa that can be pathogenic for humans and animals.
- Inhibition of oxygenation of marine sediments due to plastics spread over the seabed which eventually may become lethal for the benthic fauna.
- Waste dumps close to the sea shore facilitate the transfer of solid wastes into the marine environment particularly during storms.

1.7 *Legal & policy frameworks on household waste management in the Mediterranean*

The Mediterranean countries that are members of the European Union have to comply with the relevant EU legislation, whose approach to waste ma-

Marine animals like fish, dolphins, whales, seals & birds are harmed by marine litter because they become entangled in it, wounded by it or mistake it for food. The results can be deadly: litter items can cause lethal cuts, hampered mobility, suffocation, drowning and when ingested may lead to poisoning, strangulation or 'forced' starvation.

the Basel Convention
An example of international legislation on waste transport

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal is the most comprehensive global environmental agreement on hazardous and other wastes. Adopted in 1989 and ratified by 145 UN Member States and by the EU, it came into force in 1992. All Mediterranean countries with the exception of Libya have ratified it. Its aim is to protect human health and the environment against the adverse effects resulting from the generation management, transboundry movements and disposal of hazardous and other wastes.

The Basel Convention regulates the trasboundary movements of hazardous and other wastes and obliges its Parties to ensure that such wastes are managed and disposed of in an environmentally sound manner. The convention covers toxic, poisonous, explosive, corrosive, flammable, eco-toxic and infectious wastes. Parties are also expected to minimise the quantities that are moved across borders, to treat and dispose wastes as close as possible to their place of generation and to prevent or minimize the generation of wastes at source.

nagement is based on three principles (europa.eu/environment/waste):

1. **Waste prevention:** This is the key factor of the waste management strategy. Reducing the amount of waste generated in the first place and reducing its hazardousness by limiting the presence of dangerous substances in products, makes the disposing process simpler. Obviously, waste prevention is closely linked with improving manufacturing methods and influencing consumers to demand greener products and less packaging.
2. **Recycling and reuse:** If waste cannot be prevented, as many materials as possible should be recovered, preferably by reuse and recycling. Several specific 'waste streams' for priority attention have been defined, the aim being to reduce their overall environmental impact. This includes packaging waste, end-of-life vehicles, batteries, electrical and electronic waste. EU directives require Member States to introduce legislation on waste collection, reuse, recycling and disposal of these waste streams. Several EU countries are already (2006) managing to recycle over 50% of packaging waste.
3. **Improving final disposal and monitoring:** Where possible, waste that cannot be recycled or reused should be safely incinerated, with landfilling only used as a last resort. Both these methods need close monitoring because of their potential for causing severe environmental damage. The recent EU directives set strict guidelines for landfill management and tough limits on emission levels from incinerators.

According to the "Mediterranean Urban Waste Management Programme" implemented for the period 2000-2002, with the support of MEDA/SMAP I, in the non-EU Mediterranean region the national efforts for addressing waste management issues vary considerably from country to country (see table 8). Many countries are in the process of reforming their waste management polices so as to be able to support the improvement of municipal solid waste collection, treatment and recycling services. Most common obstacles are insufficient cost recovery, lack of citizen awareness as well as limited capacity and commitment of municipalities.

A regional example of integrated solid waste management

The 'Regional Community Integrated Solid Waste Management Programme' was implemented for the period 2001-2002 with the support of SMAP/RMSU addressing the problem of overproduction and mismanagement of solid waste in four environmentally vulnerable areas, which generated high quantities of household waste, in Egypt, Lebanon, Tunisia and Morocco. NGOs and local communities were the basic actors of its implementation. The main objectives of the project were to raise awareness in terms of *reducing - reusing – recycling*; to identify and implement environmentally friendly methods of solid waste collection, separation and disposal, including recycling and reuse; to generate income for the households of the local communities; and to promote partnerships and cooperation among NGOs, governments and local authorities. The project's methodology included workshops, seminars, public meetings to promote the practices of sustainable waste management in households, schools, public and governmental buildings. Also, trainings of local NGO staff in order to develop appropriate techniques and possible means of waste separation, recycling at source, etc. 2000 households in total participated in the project.

FIGURE 18 Waste management throughout history as depucted in selected anecdotes. (Source: Vital Waste Graphics II)

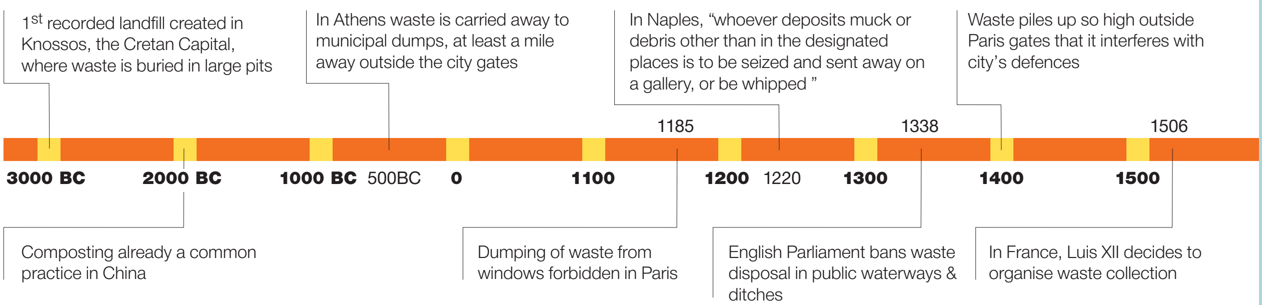


TABLE 8 Information on national solid waste management policies in some Mediterranean countries (as provided by various sources).*

Egypt, Greece, France, Italy, Spain, Portugal, Tunisia, Cyprus (under development-2000)	Have developed WASTE MANAGEMENT PLANS that relate to the type, quantity and origin of waste, as well as to its recovery, disposal and other requirements.
Algeria	A new law sets the framework for solid waste management.
Egypt	Particular legislation on solid waste management is in force. However, there is lack of legal possibilities to oblige residents to pay waste collection fees that would enable waste collection services including private ones to secure their operational expenses and achieve cost recovery. Gaps also exist in the current laws and regulations about measures for separation at source and the allocation of disposal sites.
Cyprus	The existing regulations and procedures for private companies regarding licensing, taxes and disposal expenses do not facilitate private sector participation. Till 2000 Cyprus had a lack of a legal framework for solid waste management. However, currently Cyprus is in the process of integrating and transposing a whole series of EU Directives into its national legislation which deal with solid waste, packaging waste, landfills and hazardous waste in order to harmonise with the EU policy.
Lebanon	The existing environmental laws deal with solid waste basically as a public health issue, lacking an integrated approach. New laws are under preparation.
Tunisia	The existing "polluter pays" principle- Law No.41 (1996) states clearly that *'the producer, distributor, or transporter is responsible for recovering the wastes engendered by the materials or the products they produce or distribute'*. A decree also exists, *inter alia*, with the details of a programme for the recovery of packaging waste
Syria	Till 2000 there were no laws on solid waste management. The regulations in force depend on decrees and orders from the Prime Minister and Minister of Local Administration and general recommendations. An environmental law is being proposed and discussed at the Parliament.

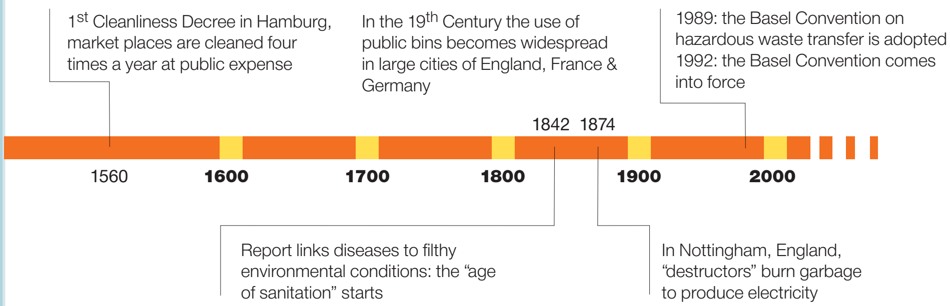
** The accuracy of the information is not guaranteed by MIO-ECSDE.*

A national example of NGO work in municipal waste management

The solid waste problem in Morocco is increasing due to a number of reasons such as: the increasing rate of waste production; the insufficient number of garbage collectors; the lack of training; the weak infrastructure and lack of adequate equipment; and, the operating of many uncontrolled dumps without proper monitoring. Organic matter is estimated to be 69% of total municipal waste. Studies of environmental NGOs (ENDA Maghreb, et al.) were carried out in order to estimate the potential profit through community composting schemes, as well as to identify the appropriate method for safe disposal of non –bio-degradable waste. Their proposed strategy relied on three main pivots:

- technical assistance,
- NGO and local community training,
- Motivation / mobilization of the civil society.

Certain technologies were used especially for producing organic fertilisers in two pilot projects which were implemented in cooperation with the local municipalities, ENDA Maghreb and other NGOs.



2. Waste Recycling

Recycling refers to the process of manufacturing materials from waste products that provide the raw material to make new ones. Although the process in itself is at a lower level than reuse in the waste management hierarchy pyramid (see figure 5), recycling helps the environment by saving space, energy and natural resources and by reducing pollution of natural resources (air, water, soil, etc.).

This process reduces the demand for raw materials, lessening the impact of extraction and transportation. Recycling also saves natural resources by economising natural gas, oil, wood or water that would otherwise be used to manufacture new products. It uses less energy than producing goods from virgin material and results in fewer emissions. In addition, recycling reduces significantly the quantity of waste that goes to landfills or for incineration.

The story and meaning of the recycling symbol

The recycling symbol, known as the Modius loop, was created in 1970 on the occasion of the first Earth Day celebration. The top arrow symbolizes the consumers' participation by means of returning the used product or packaging, etc. The next arrow is for the waste collection and manufacture entities which 'transform' waste to new products. The third arrow symbolizes the industries, which provide the market with new products made of recycled raw materials. The plain loop, either white with outline or solid black, usually indicates that a product is 'recyclable' meaning made from materials that may be recycled.

The version of the loop inside a circle (white on black or vice versa) is meant for products containing at least some materials that have been recycled, and is sometimes accompanied by a number that indicates the percentage of recycled materials thin it.

According to a recent report on solid waste management in Mediterranean countries, by Blue Plan of UNEP-MAP, in Lebanon recycling is limited to paper, plastics and glass, whereas Egypt seems to have a diversified recovery sector with recycling of materials such as metals, textiles and bones, with parallel production -at pilot scale- of compost. In Cyprus, most recycling is limited to pre-processing of paper, plastics, glass and metals before export. Tunisia has a pilot sorting and pre-processing centre in Citi El Khadra close to Tunis where paper, plastic and metals are sorted and pre-processed.

2.1 *Recycling of paper*

Paper in its primitive form, as papyrus, has been known to mankind already since 4000 BC. Nowadays, it is basically used for printing and writing and also as a packaging material because of its mechanical resistance and its environmentally friendly characteristics. Paper is made of cellulose fibre, the source of which can be pulped wood, or va-

How Cairo *zabbaleen* turn rags into riches

In Cairo the bulk of recycling is carried out by the *zabbaleen*, people who have traditionally collected and recycled garbage in Egypt. Waste collected by them is transferred to one of the seven existing settlements, where it is hand-sorted into its recyclable components: paper, plastics, rubber, rags, glass, metal and food. The food waste is fed to pigs and goats and other items are sold to special dealers and recycling centres. In this way, 80% of waste collected is recovered (864 000 tonnes/year). Typically, within the *zabbaleen* system of waste collection, treatment and trade, every family member is involved. However, the hand-sorting takes place mainly by women under unacceptable hygienic and aesthetic conditions.

TABLE 9 Environmental benefits from the recycling of various materials compared to production from raw ones (%).

Material	Air pollution reduction	Water pollution reduction	Energy consumption reduction	Water consumption reduction
Glass	20	–	4-32	50
Aluminium	95	97	90-97	–
Steel	85	76	47-74	40
Paper	75	35	23-77	58

Already since the 14th century AD it was well known that throwing away used paper was not good: in a Decision of the Venetian Council in 1336 used paper was characterised as 'raw material'. In 1774, Justus Claproth, an inventor, published his research on "a procedure for producing new paper from printed one and for removing the printing ink". This procedure was still widely used 100 years after by the Haindl enterprise in Augsburg (1889).

rious other vegetal materials such as cotton, grass, sugar cane, straw, as well as waste paper.

During the industrial recycling process, paper is mixed with water and turned into secondary paper pulp. Inks are removed from this paper pulp with the help of chemical substances. New fibres are added by mixing in primary timber paper pulp. Paper cannot be recycled more than 4-6 times, as its fibres gradually get shorter and weaker. Some virgin pulp needs to be added to maintain the strength and quality of the fibre, so no matter how much we recycle we will never eradicate the need for virgin fibre, coming from trees, or other plants. These are typically fast-growing conifers grown in managed plantations, for commercial use, while new trees replace those removed.

The advantages of paper recycling are vast: the production of one tonne of recycled paper saves 17 trees, 31.5 tonnes of water and 350L of fuel, and indirectly reduces air pollution as trees that are not cut absorb carbon dioxide from the atmosphere. Recycled paper is not necessarily re-bleached but even if so, this can be done using hydrogen peroxide rather than chlorine, which was the older relevant technology. The former is more environmentally friendly as it breaks down into water and oxygen, while chlorine, may, under certain conditions, combine with organic matter to produce dioxins, which are toxic pollutants. Although the de-inking process uses water and chemicals, it is still less harmful to the environment than the manufacturing process of new paper.

Paper recycling is still relatively expensive regarding the process of collection and storage of used paper and overall manufacturing. This is why an alternative option particularly for dirty not pre-sorted waste paper is to direct paper together with plastic to the production of RDF , which could be used in industry (cement factories, etc.). In Greece the paper recycling rate is estimated around 20%, much lower than the average rate of the EU countries.

FIGURE 19 When buying paper look for logos such as these, which indicate that no chlorine has been used in the bleaching process.

CHLORINE FREE

CL

2.2 Recycling of glass

It is believed that glass was initially discovered by the Phoenicians around 3000 BC. In ancient years it was a luxurious decorative material and even until the 18th-19th century glass was very expensive and had limited applications (i.e. jewellery, drinking cups, stained-glass windows in chur ches etc.). The

TABLE 10 Average paper recycling rate in EU (Source: www.paperrecovery.org).

Year	1998	1999	2000	2001	2002	2003	2004
Recycling rate (%)	48.9	49.4	49.8	52.1	53.4	53.6	54.6

onset of large-scale glass manufacture occurred during the industrial revolution after which mass production of containers, as well as light bulbs began. The variety of products made by glass nowadays is very rich: bottles, drinking glasses, containers and jars, windows, eye glasses, etc.

New glass is made from a mixture of four main ingredients: sand (or silica SiO_2 - 72%), soda ash (Na_2CO_3 - 14%), marble powder (or limestone - 12%) and colouring additives (metal oxides - 0,2-4%). Glass bottles and other products are characterised by imperviousness, transparency, chemical stability and they are environmentally friendly. On the other hand, their weight and fragility in comparison to e.g. plastic ones are considered as disadvantages.

Glass is 100% recyclable and theoretically can be endlessly recycled. In practice, quality non-coloured transparent and strong glass, without bubbles or 'stones' in it cannot be a product of recycled glass only. As in the case of paper, it will require some new material. Glass recycling can be applied to relatively clean glass, pre-sorted at source. An alternative option for dirty glass collected together with other garbage is to make 'sand' out of it and place it on coasts threatened by erosion or use it as building material in 'antiderapant' (non slippery) road construction, etc.

Given that a glass bottle may take up to 1 million years to disintegrate, glass reusing and recycling becomes a priority option of consumers. In addition, the advantags of recycling glass are the following:

- Recycling saves energy and reduces air pollution: for each tonne of recycled glass 135L of fuel are saved and 315kg less CO_2 is emitted (after accounting for the transport and processing needed).
- Recycling reduces the demand for raw materials: for every tonne of recycled glass used, 1.2 tonnes of raw materials are preserved.
- Recycling saves in water consumption up to 50%, compared to manufacture from raw materials.
- Recycling reduces the amount of glass that will be landfilled. Although glass is not hazardous to the environment, it will remain there indefinitely.

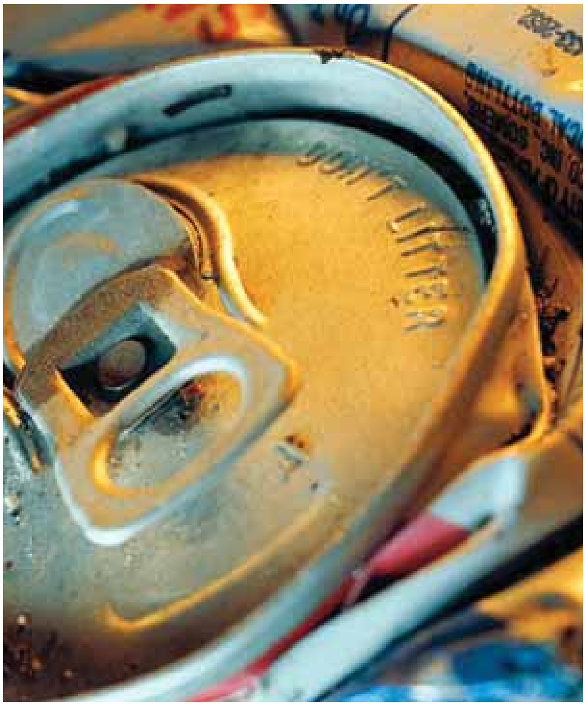


FIGURE 20 Soft drink and beer cans are the aluminium products that are mainly being recycled. But not only: aluminium foil, plates, lids and pie moulds, window frames, garden furniture and automobile components may also be recycled.

2.3 *Recycling of aluminium*

Aluminium is a light and flexible metal that resists corrosion, conveys heat and is easy to recycle. It is widely used for packaging and for electrical and mechanical installations, window frames, etc. It disintegrates very slowly in nature, a reason why it can be considered as non-environmentally friendly, the same way as glass is.

Aluminium recycling allows saving up to 95% of energy used for the production of new aluminium products. This way the valuable raw material is economised and the total amount of garbage ending up in landfills is reduced. In 1998, over 11,6 million tonnes of aluminium were recycled worldwide, a figure almost equal to 40% of the global demand.

The electric power needed for the fabrication of 90 millions aluminium cans from raw materials covers the annual energy needs of a town of 9,000 inhabitants!

2.4 Recycling of tinplate cans and other steel products

Tinplate is steel that has been covered with a thin protective layer of tin (Sn). It is used in cans for foodstuffs (i.e. fruit, milk, meat, fish), as well as for paint and mineral oil containers, etc. Tinplate packaging is of low cost, hard, it has a satisfactory appearance, conveys heat, does not corrode easily and can take many shapes. During the past decades the average weight of steel, as well as tin coating has decreased, economising a considerable amount of resources. In the market one can also find steel sheets covered with chromium (Cr) layers that are mainly used for food packaging as well as those covered with zinc (Zn) used mostly for the construction of roofs.

As local authorities recognise benefits to be gained from including steel cans in their collection schemes, recycling rates in some countries, such as the UK, have started to rise. Owing to the reasonable price usually paid for steel, recycling collections schemes can often operate at around zero cost to the collector. In other regions tinplate recycling is still considered problematic; it offers however an important challenge for the future.

2.5 Recycling of plastic

Plastics, meaning all types of stable organic polymers, are found almost everywhere today and they have numerous applications. They are used for packaging (e.g. wraps, trash bags, containers, etc.), for construction (e.g. pipes, insulators, door and window frames, etc.), in automobile manufacture (e.g. fenders, tyres, headlights, interior panelling, seats, etc.) in electronic devices (wire casings of telephones, fans, computers, coffee makers, etc.). The world's annual consumption of plastic materials has increased from around 5 million tonnes in the 1950s to nearly 100 million tonnes today (wastewatch.org).

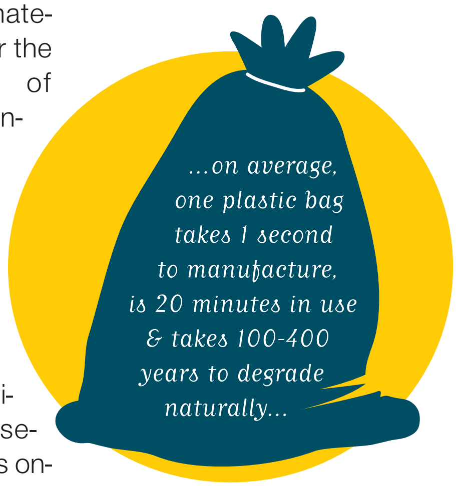
Plastics consist of polymers and a range of other materials such as plasticizers and colouring substances. They are mechanically resistant; stable in contact with oxygen chemicals; light, flexible, durable, transparent, least permeable to gases and vapour, insulating, easy to shape; and, relatively inexpensive. The table on page 45 presents the most common plastics and their use.

The main problem posed by plastics is that they decompose very slowly in nature. Because most plastics are non-biodegradable, they may even take hundreds of years to break down when landfilled, this being a rough estimation, as plastics haven't existed long enough. With more and more plastic products, produced particularly for packaging, usually disposed of soon after their purchase, the landfill space required for them is a growing concern. Therefore, reusing and recycling are absolutely necessary for minimizing environmental threats.

Recycling plastic has many advantages, such as:

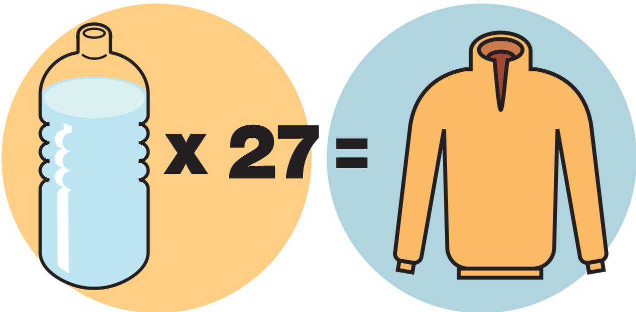
- Conservation of non-renewable fossil fuels. Plastic production uses 8% of the world's oil production, 4% as feedstock and 4% during manufacturing.
- Reduced consumption of energy. Recycling plastics saves up to 70% - 80% of their weight in crude oil.
- Reduced amounts of solid waste going to landfills.
- Reduced emissions of carbon-dioxide (CO_2), nitrogen-oxide (NO) and sulphur-dioxide (SO_2), from their incineration.

However, there are several constraints for plastics recycling: the set up of a plastic waste collection system is a costly investment; plastic packaging usually consists of two or more polymers, which cannot be easily separated; and on the other hand, raw materials used for the production of plastics are inexpensive.



From a mixture of polymers, the new 're-cycled' product is of much lower quality, used for secondary uses only. As in the case of paper, plastic disposed together with household garbage such as plastic bags containing food, etc. is not suitable for recycling but it can be collected together with paper to produce RDF. The latter is used as alternative fuel for industry, e.g. by cement factories.

One of the main trends in terms of research and technology is the production of environmentally friendly plastics. A new type of plastic was recently produced from food left-overs namely orange peels and carbon dioxide and it has similar properties to Polystyrene (PS). If its production turns out to be effective it could replace the traditional plastics from which plastic bags are made of (Journal of the American Chemical Society, 2005).



27 recycled bottles can make one fleece sweater!

The JES 'Recycling Project' in Jordan

The program promotes the idea of recycling through paper and plastic collection, as well as awareness programs in schools, factories, homes, institutions, etc., in order to motivate the public towards the segregation and collecting processes, to produce and market various products and also to encourage the use of recyclable materials. The project is being implemented since 1994 by the 'Jordan Environment Society (JES), initially on a volunteer basis, followed by expert focused work on spreading the idea of recycling to the public. Therefore, a coalition among the local community stakeholders was formed to guarantee support for the project and to provide a basis for cooperation.

It all started by putting a large paper collection container in the Shmeissani area (Orthodox National School) in cooperation with a Paper and Cardboard Factory. Since then, the idea of recycling expanded through several awareness programs. Consequently, the recycling of materials such as paper, cardboard, plastic, metals, etc., has gradually become familiar to the local communities, who now consider solid waste as an additional source of income for families.

The project aims at (i) reducing solid waste, and therefore reducing the pressure on landfills and preserving natural recourses; (ii) spreading and applying the idea of waste separation at the source; (iii) running awareness campaigns for changing people's consumption habits; and (iv) producing and marketing various recyclable products.

The project's financial viability is based on selling recyclable materials (paper, aluminum cans and plastic); funding from International Agencies, and the in kind support from the Greater Amman Municipality.

The project's components currently relate to the following:

- Use of a big truck to collect paper from designated sites (governmental institutions, departments, schools, etc.) and transfer it to specialized recycling factories and a small car for the project employees.
- Independent offices for the management at JES.
- A great number of volunteers.

JES is looking for further support in order to expand the project's activities by means of another vehicle for solid waste collection, hiring more employees for the segregation process and allocating an appropriate space to gather and segregate the solid materials.

(For more info contact JES: fadiakhzouz@gmail.com)

Recycled materials

	This symbol without a designated percentage indicates "100% recycled" content. (In some cases it can be misleading as it also indicates that the product is recyclable).
30	A number in the centre means that the product or package contains that percentage of recycled material.

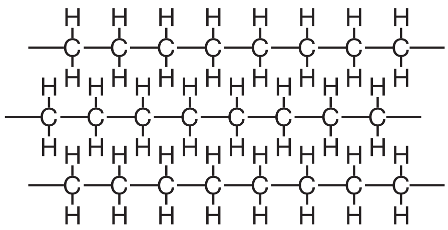
Recycled plastics

	Name of plastic	Used for	Properties	Recyclability
1	**PET** (**P**oly**E**thylene **T**erephalate)	Water, soft drink and beverage bottles	PET is a clear, tough polymer with exceptional gas and moisture barrier properties. Its ability to contain CO_2 (carbonation) makes it ideal for use in soft drink bottles.	Recyclable
2	**HDPE** (**H**igh **D**ensity **P**oly**E**thylene)	Milk and juice bottles, detergent bleach and vinegar containers, pharmaceutical packaging, various covers	Excellent protective barrier properties make it suitable for containers of liquids for drinking. Its chemical resistance properties make it ideal for containers for household chemicals etc.	Recyclable
3	**PVC** (**P**oly**V**inyl**C**hloride)	Pipes and tubes (2/3 of annual production), rain coats and shower curtains (after certain treatment that makes it flexible), films, food packaging, cable isolation		Limited Recyclability
4	**LDPE** (**L**ow **D**ensity **P**oly**E**thylene)	Supermarket & grocery bags, food wrapping, as coating film for milk cartons	LDPE offers clarity & flexibility and is used to make bottles requiring flexibility.	Limited Recyclability
5	**PP** (**P**oly**P**ropylene)	Food packaging, bottle lids, food and snack containers that need to be incubated (e.g. yoghurt). Clothing and home furnishing, especially carpeting. Automotive industry for interior trim, etc.	PP is slightly more brittle than polyethylene, but softens at a temperature of about 40°C higher. Because of its high tensile strength it is ideal for use in caps and lids that have to hold tightly onto threaded openings. Due to its high melting point, it can be hot-filled with products designed to cool in bottles, including ketchup and syrup. It can be formed into fibres of very low absorbance and high stain resistance and used in clothing, etc.	Limited Recyclability
6	**PS** (**P**oly**S**terene)	In foam form (Styrofoam): Disposable hot drink cups, eggs cartons, meat trays, etc. Also for packaging and protecting appliances, electronics and other sensitive products. In solid form: yoghurt containers, plates and utensils, video and audio cassette tapes	Noted for its sparkling clarity, hardness, ease of processing and excellent colorability, PS is a low-cost amorphus thermoplastic plastic. The most serious deficiencies are low impact strength, poor weatherability and poor chemical resistance.	Limited Recyclability
7	Other			Limited Recyclability

Activity for chemistry students!

Observe the following patterns representing the chemical structure of HDPE and LDPE. Based on the structure try to explain the physical properties of the two materials (melting point, crystallinity etc.).

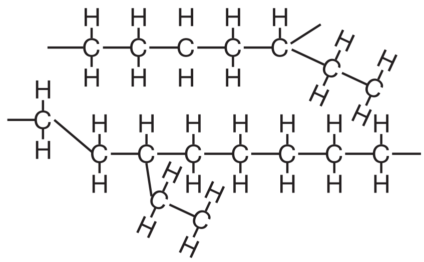
HDPE



HDPE contains less than 1 side chain per 200 carbon atoms in the main chain

- MP ~ 135 ºC
- high crystallinity
- more rigid than LDPE due to higher crystallinity
- strong as a result of regular packing of polymer chains
- less transparent than LDPE because it is more crystalline

LDPE



The main chain contains many side chains of 2-4 carbon atoms leading to irregular packing

- MP ~ 115 ºC
- low crystallinity (amorphous)
- more flexible than HDPE due to lower crystallinity
- not as strong as HDPE due to irregular packing
- good transparency since it is more amorphous

When waste recycling goes beyond lifestyles and becomes a political praxis – the Freegans

Freegans are people who employ alternative, and sometimes, extreme strategies for living, based on minimal consumption of products, resources and services and covering their needs from reusing and recycling. The word *freegan* derives from 'free' and 'vegan' (people who avoid products from animal sources or products tested on animals). *Freeganism* is a total boycott of the economic system considering that "in the modern economic system profit motive has eclipsed ethical considerations and the massively complex systems of productions ensure that all products will have detrimental impacts most of which people might never even consider". Therefore, freegans instead of only avoiding the purchase of products from one "bad" company just to support another one, avoid buying *anything* to the greatest degree possible. For this purpose, and in order to politically challenge poverty and to reduce waste going to landfills, they rummage through the garbage of retailers, residences, offices, and other facilities for useful goods. Groups like 'Food Not Bombs' recover foods that would otherwise go to waste and use them to prepare meals to share in public places with anyone who wishes to take part. Thus, they obtain food, beverages, books, toiletries, magazines, comic books, newspapers, videos, kitchenware, appliances, CDs, and just about any other type of consumer good. Freegans also reject using cars and go hitchhiking, walking, skating and biking.

More information about this 'extreme' eco-frienfdly people movement may be obtained at http://freegan.info/

3. Product packaging

Packaging refers to any material used to facilitate the containment, protection, transportation, and presentation of a product. Its purpose is to provide a physical barrier between a product and the external environment thereby ensuring hygienic conditions and reducing the risk of product wastage due to contamination also providing consumers with product information and usage instructions.

Packaging has developed, to a large extent, in response to social and economic changes affecting consumers. For example, the higher living standards in the western world have led to an increased demand for exotic goods and foods that need to be imported. Also, due to urbanisation the distance between food producers in rural areas and consumers in urban areas has increased, leading to a greater demand for packaging. An additional purpose of packaging is to make the product attractive for consumers; thus it may be colorful and luxurious.

It is estimated that a significant proportion of wastes generated per household are due to packaging materials. Although nowadays packaging seeks to be environmentally friendly and of low weight (and cost), it still contributes significantly to the increase of solid waste generation worldwide. Naturally, the cost of packaging is paid by the consumer (approximately an additional 10% for each purchase). As we shall examine in this section, in order to shift towards more sustainable products, it is not just the packaging that requires alterations, but also consumers' lifestyles and consumption habits.

3.1 *Types of packaging*

There are three types of packaging according to the use of the product:

- Primary: Packaging that contains one unit of the product on sale; it is the wrapping handled by the consumer.
- Secondary or grouped: Packaging that is used to group quantities of primary packaged goods.
- Transportation or transit: Packaging used to facilitate the transport and loading of a certain number of product units.

Packaging materials are also divided into categories depending on whether they are flexible/soft, semi-flexible/rigid or rigid. Tin cans, for instance, are considered a rigid packaging material; plastic bottles for soft drinks are semi-flexible/rigid whereas plastic membranes or paper used to wrap foodstuffs are considered flexible/soft packaging.

3.2 *Packaging materials/composite packaging*

The most commonly used materials for product packaging are paper, glass, plastic, aluminium, fabric, wood and tinplate. During the last decade, composite packaging has entered the food-packaging field. Composite packaging consists of several sheets of various materials. Such packaging is, for instance, widely used for the packaging of

EU Legislation on packaging waste

According to relevant EU legislation, *inter alia*, by 2008 a minimum of 60% by weight of packaging waste should be recovered or incinerated with energy recovery, and 55%-80% by weight of packaging waste should be recycled. Furthermore, the following recycling targets for materials contained in packaging waste must be attained (by weight): 60% glass, 60% for paper and board, 50% for metals, 22.5% for plastics and 15% for food. Three countries Greece, Ireland and Portugal, are not bound by the targets until 2011, because of the large number of small islands, the presence of rural and mountainous areas and the current lower level of packaging consumption, respectively.

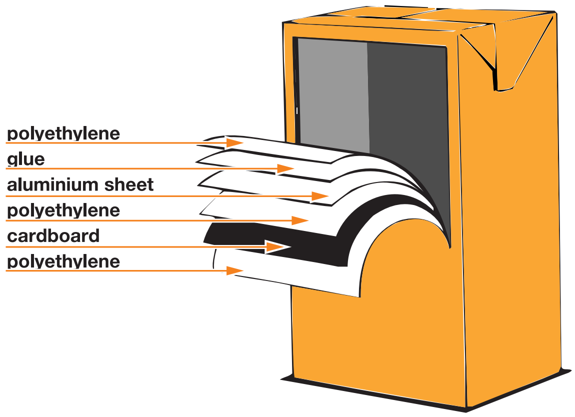


FIGURE 21 Aseptic packaging.

milk and fruit juices. Composite packaging usually has low production costs and implies low transport and storage costs. Furthermore, food is conserved for longer periods of time even without refrigeration.

The plastic film (polyethylene) is used to print information about the product, to proof and seal the packaging. Paper (cardboard) provides mechanical resistance, while the various layers are glued in between. One type of composite packaging is the aseptic packaging, which also contains a sheet of aluminium, which protects the product from light and contamination by microorganisms. This way, the product remains fresh longer without any refrigeration. Nevertheless, composite packaging cannot be reused and the cost of recycling is high and the technology required very complicated. Furthermore, it does not biodegrade easily.

3.3 *Problems related to packaging & ways to cope with them*

Pollution, cost recovery and excess packaging are problems related to the packaging of products. In general terms, excessive packaging refers to the wrapping that is not necessary for the product's safety and trade. However, given that packaging usually serves many functions at the same time, it is difficult to define the meaning of *excessive*. Packaging material is often found in coastal areas, river banks, etc., causing serious problems to fauna, apart from the aesthetic negative impact to the environment. Another issue is the cost of the packaging: manufacturing of the packaging items may be expensive, increasing in this way the cost of the final product.

Manufacturers and consumers have their responsibilities and must take responsible decisions when producing, purchasing and disposing products. Nowadays many manufacturers tend to use recyclable materials for packaging. Labels such as: 'recyclable', or 'made by recycled materials', or 'made from post-consumer recycled materials', are found on many products. A packaging material can be considered as 'recyclable' in the case that there is a widely available and viable system for collecting, processing and marketing the product/material.

By becoming aware of the unnecessary packaging involved with products people buy, they can use their power as consumers to reduce waste from excessive packaging. When buying products made of recycled materials, consumers

Neosac is a new type of plastic bag that is produced by 12 French industries in order to replace the typical plastic bags. It is completely degradable in nature through photo-degradation (degraded by the action of light, oxygen and heat) producing water, CO_2 and biomass, substances that are not harmful to the environment. This new eco-bag costs 25%-30% more than the ordinary/usual plastic bag for shopping and is already available in the French shopping malls and big markets. Similar bags, but more expensive at the time were available in the UK market already since the late 70s.

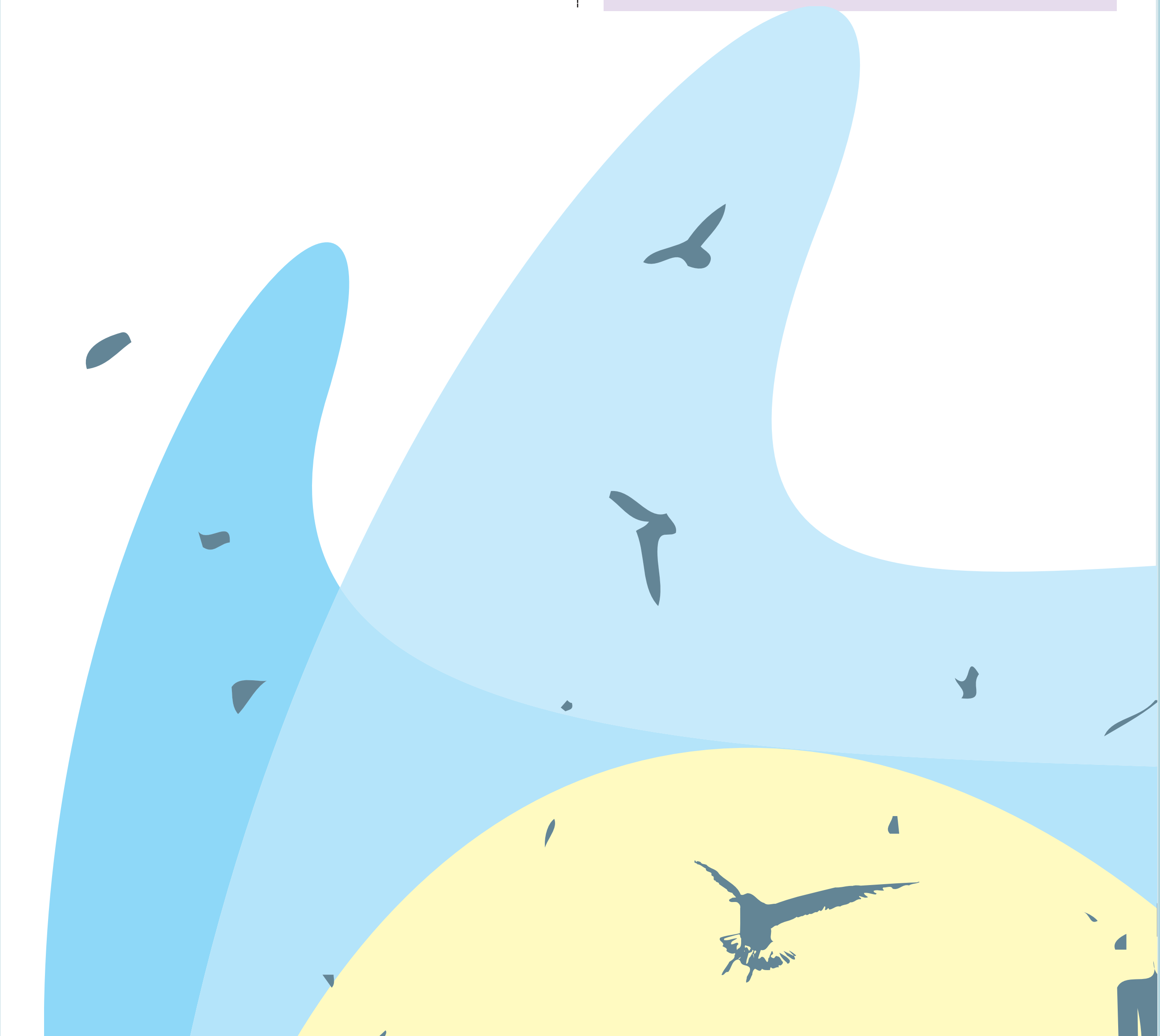
Tunisian good practice in packaging

In Tunisia, an innovative programme for recovery and reuse of old packaging materials was introduced in 1998 called *Eco-Lef* with 30 participating companies, covering packaging of bottled water, soft drinks, juice and milk products.

conserve natural resources, increase the market demand for recycled material, create jobs in manufacturing recycled products, save landfill space and contribute to the pollution reduction. Industries usually respond to consumers demands and preferences, so, why not also in the case when consumers ask for recycled, recyclable and in general, environmentally friendly products?

Edible food packaging is a fact!!!

The increased consumer demand for high quality, long life, ready to eat foods has initiated the development of mildly preserved products that keep their natural and fresh appearance longer. Edible and biodegradable polymer films (similar to those used for years in drugs) are already available and offer alterative packaging options, advantageous to the typical packaging polymers because the former do not contribute to environmental pollution. This is because edible polymers, used for food packaging, are made of renewable resources (proteins, polysaccharides, lipids, etc.) that are totally biodegradable and can be consumed by us with the enrobed food. These polymers also limit moisture, improve the food properties and function also as food additives (antioxidants, antimicrobials, etc.).



Annex 1

Introduction to a product's Lifecycle and Eco-design

'*Eco-design*' is an international concept initially developed at the Rio World Summit (1992) expressing the culmination of a holistic, conscious and proactive approach, meaning designing a product or service so as to minimise its impacts on the environment, to exploit the least possible natural resources and generate the least possible waste. Eco-design applies in all stages during a product's 'lifecycle', namely: raw material extraction, production, packaging, distribution, use, disposal, recovery and recycling. Eco-design provides enterprises with the capacity to improve their environmental profile, reducing the environmental impacts of their production procedures and services. Apart from the protection of the environment, eco-design aims at ensuring that products' good quality, durability, good functioning, appearance, as well as legislation and insurance-hygiene rules are kept. Products produced within an *eco-design* approach are labelled with a particular sign, the *eco-label*.

A product's life cycle describes all steps included in the production and consumption processes, from the raw material abstraction to its disposal:

- The first step is the raw material abstraction. For instance, timber harvesting is needed for paper and crude oil extraction for plastics.
- Next step is the raw materials manufacture which usually results in useful 'intermediate' products before the final product, e.g. oil is processed into *polymers* that are the base for the plastic production.
- Product manufacture is the formation of the final product from the intermediate materials.
- Next phase refers to product use.
- Eventual product reuse, recycling or disposal.

All the above mentioned processes involve transportation of products and materials, energy and raw material consumption, (solid and liquid) waste production and emission of pollutants.

Life Cycle Assessment (LCA) is *"a process to evaluate the environmental burdens associated to a product, process or activity"*. It examines *inputs* e.g. materials extraction, resources and energy consumption and *outputs* e.g. emissions to air and water, waste produced, etc. at every stage in a product's lifecycle in order to quantify its impacts. LCA's basic objectives are to conserve non-renewable resources, including energy; ensure that every effort is made to conserve ecological systems, especially areas subject to critical balance of supplies; develop alternatives to maximise the recycling and reuse of materials and waste; apply the

The adoption of the EU Directive for environmentally friendly design of energy-using products, (April 2005), calls for preparatory studies and impact assessments conducted by the Commission and involving stakeholders such as industry, environmental and consumer NGOs that will identify the most cost-effective solutions for improving the overall environmental performance of products.

Taking washing machines as an example, important aspects of the eco-design process would include energy, water and detergent consumption, noise and recycling ability. This analysis will identify how to achieve a high level of environmental performance for the washing machine throughout its lifecycle, while avoiding transfer of negative impact - e.g. the use of certain materials in the detergent should not lead to an increase of energy or water consumption. Eco-design requirements will then become legally binding for all products, in this case washing machines, put on the EU market, irrespective of where they are designed and produced.

most appropriate pollution prevention and/or abatement techniques.

Practically speaking, an LCA includes three steps:

- Identification of resulting emissions and waste as well as raw materials and energy consumption during the life cycle of a product.
- Assessment of the impacts of the above mentioned processes.
- Interpretation of the results of the impact assessment to concrete proposals for the improvement of the process e.g. reduction of emissions and pollution, decrease of energy required or use of alternative energy resources, etc.

Eco-design, eco-labels and Life Cycle Assessment are among the basic tools that ***Integrated Product Policy (IPP)*** uses. IPP is a relatively new EU policy that aims to ensure that production, management, use and disposal of products have the least environmental impacts, in the framework of sustainable development. IPP tries to combine market demands creating the appropriate motives that will increase demand in environmentally friendly products. The effectiveness of such a policy is heavily depended on the cooperation and active participation of all concerned stakeholders: from raw material procurers, to designers, managers, salesmen, consumers and all those working in the area of waste management. IPP has as its basic goal the continuous improvement of products and promotes research in this direction.

Let's start Integrated Product Policy in the Mediterranean

Nine organisations from Greece and Portugal participate in the programme: "*Let's start Integrated Product Policy in the Mediterranean*" that is implemented with the support of the EU (LIFE Environment). The Programme which run from October 2004 to September 2007, had as main objectives the development and promotion of a systematic approach integrating environmental protection in a product's life-cycle; the implementation of EU guidelines; the pilot implementation of IPP in products of critical importance; the gaining of experience on using IPP tools and promoting cooperation in this field.

TABLE 11 Some of the ways to apply IPP concepts and principles in products' lifecycle in order to minimise environmental impacts.

1. RAW MATERIALS	2. PRODUCTION	3. PACKAGING
Manufacturing a product means firstly exploiting raw materials. Extracting and processing these materials consumes natural resources, uses energy and is a source of pollution.	Manufacturing tends to consume large amounts of energy because of the complex processes it involves.	Bottles, boxes, cans, wrapping and other packaging currently account for over half the volume of household waste in developed countries.
SUSTAINABLE PRACTICES	SUSTAINABLE PRACTICES	SUSTAINABLE PRACTICES
Choosing the most appropriate material; reducing quantities; "transforming" waste into raw materials (recycling); prefering renewable materials and products that use only one type of material.	Optimising the production processes; assembling products so they are easily separated into their different components for repair or recycling.	Concentrating products, reducing the amount and volume of packaging to make savings along the chain, from manufacturing to waste disposal.
4. TRANSPORTATION	**5. USE**	**6. DISPOSAL & RECYCLING**
Delocated production, cost-cutting and liberalised markets all add up to one thorn issue: products usually travel thousands of kilometres before being used.	Using products, operating appliances and maintaining them in working order may require energy, water, etc. Designed to be frequently replaced, goods today are in most cases fragile and hard to repair, a practice which encourages wastefulness and generates waste.	Worn-out or damaged products may be difficult or easy to recycle. The multiple components, alloys and other combinations of materials from which they are made render disassembling and processing a complex and costly procedure.
SUSTAINABLE PRACTICES	SUSTAINABLE PRACTICES	SUSTAINABLE PRACTICES
Choosing manufacturing sites according to the products' final destination; using combined transport and alternative fuels; optimising loads.	Designing functional, energy saving products that are lasting, safe and easy to maintain or repair.	Developing reusable or recyclable products and components.

Annex 2

"Waste generators" vs. "green citizens"

Ecological footprint is one of the indicators used to evaluate the impact of our lifestyles on natural resources. It converts the products and services we use into global hectares and measures the pressure we exert on nature to satisfy our demand for production, consumption, shelter, waste disposal, etc.

Some general ways to reduce our own individual ecological footprint on natural resources are the following:

- Ask ourselves before buying a product, "*do we need this*", "*where and how was it made*"?
- Prefer solid, easily maintened, non-disposable products that can be repaired and products made from recyclable materials, if possible.
- Chose walking or using public transport instead of driving a car in cities.
- Save water during our every day activities i.e. bathing, hand washing, dish washing, etc.
- Save energy in our everyday lives by not leaving lights on, appliances on standby, etc.
- Choose products and services awarded with 'eco-labels' and companies with acceptable social and environmental policies.

Regarding our behaviour as consumers and 'waste generators' we should keep in mind the 3R motto: reduce-reuse-recycle. More particularly, we should:

- Prefer glass bottles instead of plastic ones for water, beverages, oil, etc.
- Try to reuse plastic or paper bags as many times as we can.
- Prefer a textile bag for our everyday shopping.
- Avoid disposable products.
- Chose recyclable types of packaging.
- Avoid products with too much wrapping and prefer items with bigger volumes of product.
- Use batteries that do not contain heavy metals, collect them when empty and dispose appropriety.
- Prefer products with packaging that can be returned and reused, or can be recycled by the producer company or has already been recycled.
- Prefer as packaging materials paper, glass, recyclable plastic or plastic that is biodegradable.
- Prefer electric appliances of low energy demand and if possible made of recycled material.

FIGURE 22 Childrens paintings often depict the environment ... in trouble. (Source: UNEP, FGPE, 2002)

Annex 3

*Symbols and indications of danger**

Symbol	Abbreviation	Hazard
	**E** (Explosive)	Chemicals that explode.
	**O** (Oxidising)	Chemicals that react exothermically with other chemicals.
	**F+** (extremely flammable)	Chemicals that have an extremely low flash point and boiling point, and gases that catch fire in contact with air.
	F (highly flammable)	Chemicals that may catch fire in contact with air, only need brief contact with an ignition source, have a very low flash point or evolve into highly flammable gases in contact with water.
	**T+** (very toxic) **T** (toxic)	Chemicals that at low (T) or very low levels (T+) cause damage to health, OR cause cancer or increase its incidence (carcinogens), OR induce heritable genetic defects or increase their incidence (mutagens) OR produce or increase the incidence of non-heritable effects in progeny and/or an impairment in reproductive functions or capacity (reproductive toxins).
	**C** corrosive	Chemicals that may destroy living tissue on contact.
	**Xn** (harmful)	Chemicals that may cause damage to health.
	Xi (irritant)	Chemicals that may cause inflammation to the skin or other mucous membranes.
	**N** (dangerous for the environment)	Chemicals that may present an immediate or delayed danger to one or more components of the environment.

* The iconographic symbols and indications of danger depicted here are taken from the Directive 92/32/EEC, which is an informal text of the European Union referring to classification, packaging and labelling of dangerous substances in Europe. This is actually an updated version of the original Directive (67/548/EEC), which until 2005 has been amended 9 times and adapted to technical progress 28 times.

Part II

Activities

Waste can take up a lot of space!

1 hour

Volume, landfills, waste compression, waste management

Paragraphs 1.1, 1.2, 1.6, 1.7

Objectives

- To explain the reason why waste requires so much space.
- To identify the problems resulting from not compressing waste.
- To estimate how much waste volume is reduced by compression.
- To reduce waste generated by daily activities.
- To raise the awareness of the local communities on the issue of waste volume.

The relationship between weight and volume of waste is approximately 1:4. Each ton of produced household waste occupies approximately 4 cubic meters (m^3) of space. Waste that is disposed of in traditional landfills is often not sufficiently compressed, thus leaving large cavities. Due to these 'empty spaces', waste disposal sites fill up faster. Furthermore, these cavities provide the ideal environment for insects and rats which often cause serious health and sanitation problems.

Materials & Equipment

- a newspaper
- a ruler
- 6 empty milk cartons (0.5L or 1L)
- cardboard box (A4 paper size)
- 2 rubber bands

Activity A (fig **A1**)

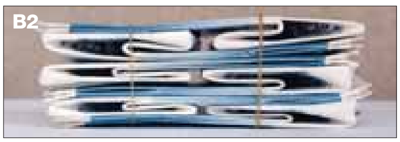

A1

1. Fill the cardboard box with folded newspapers. How many fit? Count the total number of sheets and fill in the table below.
2. Start filling the cardboard box with newspaper sheets after crumpling each one of them in your hands. How many sheets does it take to fill the box this time? Fill in the table appropriately.
3. Compare the volume of the folded newspaper with that of the separated and crumpled newspaper sheets.

Filled box	**Number of sheets**
Folded newspaper	
Crumpled newspaper	

Activity B (fig **B1**, **B2**)


B1


B2

1. Supposing that each milk box contains 0.5L or 1L respectively, calculate the total volume of the six milk boxes.
2. Fold the milk boxes as shown in the pictures.
3. Place the milk boxes one on top of the other and hold them with an elastic band.
4. Measure the approx. volume of the six folded milk boxes using the ruler.
5. Fill in the table below.

	Volume (L)
Volume of six (6) unfolded milk boxes	
Volume of six (6) folded milk boxes	

cont'd activity 1

6. Compare the volumes of the unfolded milk boxes and of the folded ones.
7. Estimate roughly how many boxes of milk and of other products (juices, etc.) your family uses in a month. What would be their total volume if you folded them? What is their total volume when you throw them in the garbage bin without folding them? The results may surprise you!
8. Brainstorm in class about the environmental implications resulting from the disposal of non-compressed waste.

More activities…

Work in groups and conduct a bibliographic research to find out the volume – quantity of waste generated in your country in the past 20 years.
Inform your family on the results of your activity regarding the consequences of non-compressed waste and the volume of waste generated in your country. You may even prepare a small poster presenting your results to inform your local society (families, local authorities, etc.) in order to sensitise them to properly manage household waste.

What did you throw away today?

⏱ 1 – 2 weeks

household waste production, mass, quantitative composition (%), consumption habits, landfills

Paragraphs 1.1, 1.2, 1.4, 1.6, 1.7

Objectives

- To take weight measurements and work out data.
- To practise in making graphs.
- To realise the impact an individual or a family has on the amount of municipal waste generated.
- To suggest ways to reduce one's own solid waste generation.
- To realise that one can reduce solid waste by changing a few daily habits.

Materials & Equipment

- a scale and a notebook

Activity

1. Start a discussion on the composition of waste you generate daily, as individuals. Give ideas on which material you assume is in greater quantity, and why.
2. Note your ideas on a flip chart.
3. Conduct a mini research in order to find out the exact composition of your wastes: Separate the garbage generated by your family every day for a week in the categories suggested in the table below. Try to record also the items you and your family throw away at places other than your home (e.g. work place, school, etc.).
4. At the end of the week, weigh them in order to calculate the total mass of waste generated and the percentage of each category (this can be done everyday if you have a scale at home). Fill in the table below.

cont'd activity 2 →

	MATERIAL							
Day	**Paper**	**Plastics**	**Food leftovers**	**Glass**	**Aluminium**	**Yard waste**	**Other**	**Total Mass** (kg)
Day 1								
Day 2								
Day 3								
Day 4								
Day 5								
Day 6								
Day 7								
Total Mass (kg)								
% of each material								

We cannot see the 'hidden' waste, i.e. the waste generated during the production of items we consume and which dramatically increases their 'real' (waste) weight. For example, if we add the 'hidden' weight of waste produced during the manufacturing process of various products we will find out that: a PC weighs 1500 kg, a toothbrush 1,5 kg, a coffee machine 298 kg and a mobile phone 75 kg!

5. Based on your activity's results calculate the total amount of garbage you and your family produce annually. How many kg/yr correspond to you?
- *Can you figure out the amount of garbage you have created since your birth? Do you see differences as you grow older?*

6. Present your findings in class and compare your results to those of others.

7. Make comparisons also with the data presented in tables 2 and 3 of the Theory section, on the composition of waste generated per capita in various countries.
- *Is your family above or below the average per capita waste generation that corresponds to your country? What could you do to decrease the waste you generate?*
- *Can you explain the differences (if any) in the composition of household wastes of your family and of the average for the various Mediterranean countries?*

8. Do you have any idea what you could do with the glass, paper, aluminium and plastic waste you have separated and measured?

9. By changing your buying and consumption habits, how many things could have not ended up in the bin?
- *How many of these things could have been reused for another purpose?*
- *How many things could have been recycled?*

Kalamata city, Greece: The sign next to the recycling bin encourages "Do not throw away energy & natural resources in the garbage".

Hazardous substances around the house

activity 3

2 subsequent meetings of 1 hour

hazardous substances, toxic, flammable, explosive, corrosive, oxidising, environmentally friendly products

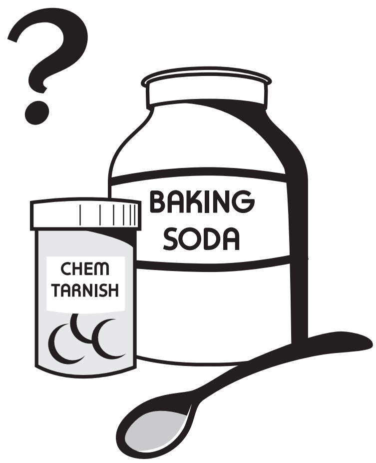
Paragraph 1.3

Objectives

- To identify and explain the meaning of a warning sign on a label.
- To be aware of the hazardous substances they encounter in their everyday life.
- To realise that improper use and disposal of household hazardous products can result in the production of hazardous waste, a threat to health and the environment.
- To classify hazardous waste according to its characteristics.
- To suggest environmentally friendly products as alternatives to household hazardous substances.
- To adopt a positive attitude towards environmentally friendly products.
- To realise that one can reduce hazardous waste generation by changing everyday habits.
- To practice in preparing informative material.

Materials & Equipment

- Several identical pieces of tarnished silverware (e.g. spoons)
- commercial product for polishing silver
- baking soda
- several pieces of cloth
- several pairs of old or plastic gloves



Procedure

1. Separate in two teams (A & B) and work in pairs to conduct the following experiment:

Team A ... the chemical way	**Team B ... the alternative way**
1. Read carefully the instructions on the label of the silver polish. **2.** Wear gloves and wipe away tarnish according to instructions. **3.** Are there any warning signs on the product's label? What do they mean?	Rub the tarnish off the silverware using a piece of cloth and a small quantity of baking soda. Repeat if necessary.

2. Each pair of students in team A joins a corresponding pair in team B. The two pairs describe the procedure each has followed and compare the results (what the spoon looks like).

cont'd activity 3

3. Discuss in class:
- Which of the two procedures do you consider less harmful to your health? Why?
- What are the generated wastes in the two cases?
- In which case does the generated waste present a greater threat for the environment?

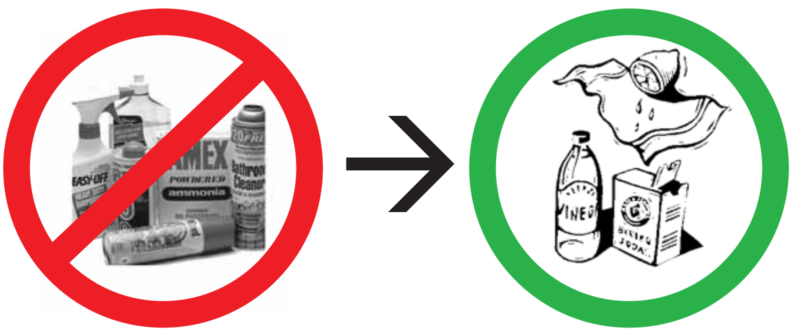
4. Brainstorm for other products you use at home that may contain harmful substances. Make a list according to the following table.

5. Ask your family and others to suggest alternative products or materials that could be used for the same purposes, but are more environmentally friendly. Fill in the table.

6. Decide on measures you will take to reduce hazardous waste generation at home.

Alternative suggestions for house keeping products

No.	Product	Alternative materials & ways
1	Silverware polish	Baking soda
2		
3		
4		
5		



Compile all your findings in a fact sheet or a poster and distribute to your family, school or local community. Present this in a form of a press release and print it in a local or school newspaper.

Warning signs on hazardous products

activity 4

1 hour

hazardous substances, toxic, flammable, explosive, corrosive, oxidising

Paragraph 1.3, Annex 3

Objectives

- To become aware of the hazardous substances that many commonly used products contain.
- To interpret warning signs on consumer products.
- To be aware of the environmental impacts resulting from inconsiderate disposal of hazardous household wastes.
- To realise that one can reduce hazardous waste generation by changing one's daily habits.
- To adopt a positive attitude towards environmentally friendly products.

Household waste is defined as 'hazardous' when it posses one or more of 15 hazardous characteristics, e.g. flammable, corrosive, infectuous, eco-toxic, etc. However this definition may differ from country to country. Such waste presents a serious risk to the environment and health if not managed and treated properly.

Hazardous waste makes up less than 1% of total waste generated in Europe. However, if not managed appropriately it poses a heavy threat to water, air and soil.

Labels indicating hazardous content

Materials & Equipment

Various packaging containers or labels from pharmaceutical and cleaning products, detergents, paints, cosmetics, pesticides and insecticides.

Procedure

1. Examine carefully the labels of the various containers. Try to find whether the following information is mentioned:
   - product's composition,
   - instructions and precautions for use
   - warning signs referring to potential risk
   - signs indicating proper disposal method.
2. Do you know the meaning of each warning sign? Refer also to Annex 3 of the Theory section to find out the symbols for hazardous substances.
3. Work in groups and conduct a bibliographic research on potential problems to human health and the environment resulting from a hazardous product's inconsiderate disposal.
4. Make a list presenting your findings, according to the table.
5. Discuss your findings in class.

Product	Warning sign	Problems caused by the product's inappropriate disposal to human health and the environment

Extension Activities

Contact the agencies and services responsible for waste management and collect information on how they dispose hazardous household waste (medicines, paints, pesticides, detergents, etc.). Is there any particular service or provisions made especially for hazardous waste? If yes, inform the local community about them.

Try to **RAISE the AWARENESS** of your family and of the local society on the issue of hazardous waste, by preparing and distributing a poster or a small leaflet about the warning signs on labels or suggested old-fashioned yet environmentally friendly alternatives to modern house-keeping products.

activity 5

Hazardous substances in various professions

1 week

Pollution, health risks, toxicity, waste residues

Paragraph 1.3

Objectives

- To identify dangerous substances used in various professions.
- To list the potential consequences of using the above identified dangerous substances on human health and the environment.
- To adopt a positive attitude towards environmentally friendly products.

- The odour at the dry-cleaner's is due to the organic solvents used for fabric dry-cleaning. Naphtha, organic compounds containing chlorine, such as 1,1,2,2, - tetra chlorine– ethylene (Perk), and chlorine-fluorine organic compounds are some of the organic solvents used. Perk is considered as carcinogenic, whereas organic compounds containing chlorine and fluorine contribute to the process of destruction of the stratospheric ozone layer. Solid waste generated by cleaning machines is toxic.
- Many paints and varnishes used in the construction business, by furniture manufacturers and printers contain substances that are toxic to humans and the environment.
- Waste residues from photographic film development contain silver (Ag).
- Mercury amalgam to the extent it is used by dentists in dental fillings is a toxic material. Amalgam residues of fillings have been disposed as waste burdening the environment with mercury.
- In order to minimize environmental pollution from toxic substances and materials, these substances as well as their containers should be treated in a responsible way. Alternative substances that have the least possible impact on the environment should be used whenever and wherever possible.





Activity

a. What is your parents' profession? Do they use harmful substances in his/her work? How do they protect themselves? If possible, discuss with an expert (chemist, doctor, etc.) the possible risks in a number of professions in your neighbourhood and compile a preliminary list.

b. With the help of the expert and your teacher, prepare a questionnaire in order to interview the employees/ staff about the possible danger of chemical substances they use, the protection measures they should apply and the management of the produced waste. Investigate also if there is any connection between the risks of their profession and their salary.

c. Separate in groups to visit the workplace of the professions that you have identified. Conduct the interviews.

d. Back in class, elaborate your findings and present them e.g. in the form of a table (see below), including suggestions on how to minimize environmental problems resulting from these particular professional activities.

Profession	**Dangerous substances**	**Purpose for using the dangerous substance**	**Safety measures applied**	**Use of alternative substances**	**Other suggestions /remarks**
Dentist					
Photographer					
Photocopier					
House painter					
Car mechanic					
Dry-cleaner					
Farmer or gardener, etc.					
Pharmacist or nurse, etc.					
Hairdresser					
Other...					

Extension Activity

Ask some elderly people to suggest ways to remove stains from clothes without using the modern cleaning products.

Stain	**Active substances in cleaning products**	**Environmentally friendly materials for stain removal**
Sweat	Bleaching agents, enzymes	
Paint	Bleaching agents	
Shoe polish	Bleaching agents	
Coffee, cocoa	Bleaching agents, enzymes	
Blood	Bleaching agents, organic acids	
Red wine	Bleaching agents	
Rust	Bleaching agents, organic acids	
Wax	Hydrocarbons	

activity 6

1 school year

Batteries, energy, heavy metals, pollution

Paragraph 1.3.3

What do I do with this used battery?

Objectives

- To identify problems resulting from the improper disposal of batteries.
- To help the implementation of relevant legislation requiring the return or separate collection of batteries.
- To adopt an environmentally friendly consumer attitude.

- Batteries contain toxic metals such as mercury (Hg), lead (Pb), cadmium (Cd), Nickel (Ni), etc.
- The manufacturing of a battery requires 50 times more energy than the energy it will provide during its use!
- Current environmentally friendly management of batteries includes the separate collection, recovery and reuse of metals contained in them.

Car batteries dumped haphazardly in Greece

Activity A

Make a bibliographic research (from chemistry books, science magazines, the Internet, etc.) to collect information on:

1. The impacts of mercury (Hg), lead (Pb), nickel (Ni) and cadmium (Cd) contained in batteries on the environment, ecosystems and human health.
2. The legislation of your country; of other Mediterranean countries; and of the EU on the disposal of old batteries.

Based on the findings of your research inform your schoolmates about the impacts of improper disposal of batteries, presenting them in e.g. a poster or a leaflet. You may present your findings on a Concept Map!

Activity B

1. Set up a “battery recycling centre” within your school premises.
2. Identify any services and/or companies that recycle batteries and operate in your region. Contact them to come and collect the batteries or find a way to deliver the batteries to their premises.
3. Make sure you involve the local community (families and neighbouring enterprises) in this recycling activity.

Waste in our neighbourhood

2 weeks

waste collection methods, eco-citizenship, local campaigns

Paragraphs 1.4, 1.6, 1.7

Objectives

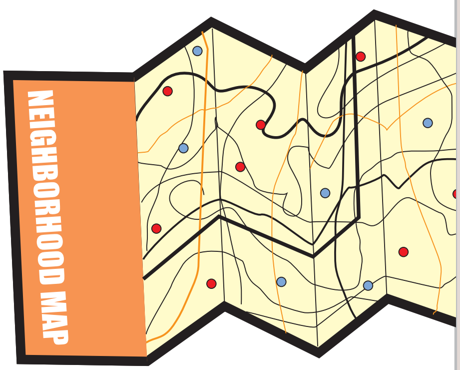
- To acess the state of cleanliness of the neighbourhood.
- To classify litter found in the neighbourhood.
- To practise in doing fieldwork.
- To adopt an attitude against littering.

Waste scattered into the streets constitutes a serious issue in urban areas as well as in the countryside, in many Mediterranean towns and cities.

In some countries of the Mediterranean the proportion of the population serviced with regular waste collection is over 95%, while in other countries it is as low as 35% in urban areas and almost absent in rural ones.

Across the entire Mediterranean region up to 25% of waste remains uncollected due to poor efficiency of waste collection services.

Activity



1. Use a city map to chose and outline the area you will investigate, preferably the neighbourhood around your school. Making successive photocopy enlargements may be necessary, prior to using the map. Mark the course you will follow.
2. Separate in groups to perform the following tasks 'in the field'. You may give names to your groups, according to the tasks:

COMMON FOR ALL GROUPS: Find the amount and types of litter in the streets as well as the distribution of garbage bins or other waste receptacles.

- **GROUP I (the interviewers):** Specify the areas with the higher frequency of pedestrians and compare these to the less frequented ones. Which are most littered? Ask passers by if they consider the garbage bins sufficient for the area. Don't neglect to ask the opinion of the street cleaner, should you meet any.
- **GROUP II (the photographers):** Take photos of the most prominent features (in terms of e.g. littering, noise, pollution, condition of garbage bins, state of existing plants and trees, etc.)
- **GROUP III (the data collectors):** Use the following table to record your findings:

cont'd. activity 7

Name of location / street	**Number containers**			**Number of litter items found**			
	big garbage containers	recycling containers	small litter bins	glass items	paper items	plastic items	other
Total							

- **GROUP IV (the graphmakers):** Based on the data collected in the above table, plot graphs showing the types and amounts of litter and the types and numbers of the garbage containers.

3. Assemble in class and discuss the things each group found most interesting during your walk. What impressed you the most and why?

4. Compile your findings by drawing a map of the area investigated (*become cartographers*). For such an activity the scale and detail may not be that important. Make sure you incorporate all useful input from the groups (photos, interview clippings, graphs, etc). Indicate the locations you consider more 'stressed' in terms of litter, noise, pollution, lack of vegetation, etc. Find the relationship between the routes and frequency of the waste collection trucks and the number of serviced shops (supermarkets, groceries, etc.).

5. Based on your research findings, prepare a report to inform the local authorities or the press about your observations and ideas to improve the cleaning facilities (e.g. asking for the installation of more containers, or for the collection of the garbage on a more frequent basis).

After a nice day spent at the beach, you are about to leave. What will you do with your garbage in case there is no garbage bin available nearby?

EXTENSION ACTIVITY

Organise a campaign in collaboration with the Municipality and local NGOs entitled "Keep it clean".
Involve other schools also, in order to raise awareness and sensitise people to contribute.
You may prepare relevant posters and leaflets; involve the local radio station, etc. to promote your campaign.

Creating a logo for your campaign can be a fun and rewarding activity. Here are some logos that have been used in various environmental campaigns:

The **National Environmental Communications Campaign**, Ministry for Environment, Jamaica

The **carbon footprint campaign**, University of Brighton, UK

The UNEP **clean up the world** campaign

The **everyone can work for the environment** campaign in Scotland, UK

The **enable environmental action for a better Leicestershire** campaign, UK

Eco schools International Programme

Construct a mini landfill

1 – 3 months

Percolate, residue, drainage liquids (leaching), biodegradation, aquifer, groundwater

Paragraphs 1.4.2, 1.4.5

Objectives

- To describe a sanitary landfill in terms of its construction and function.
- To identify some common chemical and physical properties of leachates (drainage liquids).
- To make analogies and generalisations while working on a micro-scale level.
- To understand the necessity of conducting an EIA prior to the construction of the landfill.

The rainwater that precipitates over a landfill percolates through the waste, mixes with disposed fluids and picks up a variety of suspended and dissolved materials. This is how drainage liquids (leachate) are formed. If the landfill is not carefully designed, and drainage fluids are not collected, then due to water infiltration through the landfill's layers there is a serious risk of contaminating soil and groundwater.

Materials & Equipment

- a big plastic garbage can
- a piece of transparent plastic (plexiglass), 10 X 50cm
- water resistent glue
- 5-10 kg of soil
- a screw-in plastic faucet with securing nut
- a gardeners' trowel
- a watering pot
- a thermometer
- a pH meter
- distilled water

Procedure

Prior to this activity it is advised that the students visit the nearest landfill to make observations and discuss with an employee issues like site selection, design criteria, current state and method of operation, etc.

1. Construct the landfill model:

a) Cut out from the garbage bin a vertical strip 5X40 cm, making sure you start at least 10 cm from the bottom.

b) Glue the piece of Plexiglas over the cut-out, on the inside of the container. This 'window' will allow you to view the contents of your model.

c) Insert a screw-in faucet at the bottom of the container. You may place a piece of fine netting or tulle when inserting the faucet (as a filter) to keep solid particles in the bin.

2. Fill the landfill model with waste and soil:

a) Bring to class various types of household waste like food leftovers, yard trimmings, metal, paper, plastic or cloth. Do not include meat or dairy products.

cont'd activity 8

b) Place layers of wastes and soil in your model making sure you keep a ratio of soil:waste 1:12 (*accepted ratio for a sanitary landfill*).

c) Tightly pack each layer by pressing it firmly with the trowel, *simulating a real landfill situation*.

d) Continue the layering and compacting until the container is full. The final layer should be 10cm of soil.

3. *Simulate rainfall over the landfill*, by pouring distilled water with the watering pot.

a) Find out the annual average rainfall of your area from a meteorologist and divide by 52 to calculate the average weekly precipitation.

b) Repeat simulation of the 'average weekly precipitation' to your landfill, until water begins to collect at the bottom of your model. This may take several weeks.

4. One month after starting rainfall simulation collect the drainage liquid and test its pH, its total suspended solids (liquid weight minus weight of soil), hardness and other water quality factors. Compare the results to the properties of distilled water.

5. Discuss the risks of groundwater and soil contamination by the drainage fluids.

6. Using this model make generalisations about sanitary landfills and compare to unplanned and uncontrolled dumpsites.

7. Discuss in class issues related to constructing a landfill e.g. site selection, design criteria (if any), method of operation, etc. and the necessity of conducting EIAs prior to construction.

Seeking a landfill site

activity 9

1 day – 1 week

Landfill, waste management, conflicts, environmental – economic-social impacts of a landfill, issue investigation, decision making, resolution

Paragraphs 1.4.2, 1.6, 1.7

Objectives

- To identify the advantages and disadvantages of a sanitary landfill.
- To form arguments on the conflicting issue of site selection of a landfill.
- To understand other people's viewpoits.
- To suggest possible governmental incentives that make municipalities more likely to accept the construction of a sanitary landfill.
- To participate in sound waste management.

In 2003, the inhabitants of 5 municipalities of Attica region started to demonstrate intensely against the construction of sanitary landfills in their area. Similar events take place in many other cities in the Mediterranean region. In order to find a solution with regard to waste disposal, governments usually provide municipalities with significant incentives if they accept the establishment of a waste disposal site in their area.

Activity A *(Warm up discussions)*

Work in small groups. Based on the article reflect and answer to the following questions:

- Why would inhabitants be opposed to the construction of a local waste treatment plant or sanitary landfill in their area? What is the difference between a 'traditional' landfill and a sanitary one?
- What could be the Government's arguments and, eventually, incentives towards municipalities in order to convince them to accept the creation of a sanitary landfill in their area?
- What problems will the inhabitants of Kalamata face if no solution is found to the problem of municipal waste disposal in the near future?
- What could the inhabitants of Kalamata do?

Kalamata, Greece:
"The garbage nightmare"

Garbage has become a nightmare for the Mayor of Kalamata. The composting plant is still not functioning; the old waste dump has already been shut down, whereas the attempt to dump garbage in landfills of other municipalities of Messinia has encountered the firm opposition of local population.

"Ethnos" 13/ 05/ 2003
(Greek Newspaper)

Activity B

With the help of your teacher set up a role-playing activity with the main objective of agreeing on the most appropriate and accepted solution for the waste management of the city of Kalamata. You may represent the following players:

- citizens of Kalamata
- citizens of a nearby municipality
- former workers of the old waste dump of Kalamata
- the Mayor of Kalamata and the Mayor of nearby municipalities
- environmentalists and members of environmental organisations
- representatives of the donor company that has invested in the construction of the new compost plant in Kalamata
- etc...

activity 10

Composting

7 - 8 months

Composting, biodegradable materials, biodegradation, micro-organisms, fertilizer

Paragraph 1.4.5

Objectives

- To describe the composting process.
- To name the advantages and disadvantages of composting.
- To identify the impact of compost to plants through an experiment.
- To practise in making compost.
- To be involved in environmentally friendly activities.

Biodegradation of waste containing mainly organic matter leads to a stabilized product similar to the natural organic component of soil (*humus*), which is usually called 'compost'.

Biodegradation can take place in heaps in open air or in closed containers under specific conditions of temperature, airing and humidity. Biodegradable materials should be damp, well aired, while the ratio between carbon and nitrogen they contain should be ideally 10:1.

The compost produced improves soil porosity, its ability to retain water, as well as its microbial population. Nevertheless, compost cannot be considered as a fertilizer since it contains considerably smaller quantities of nutrients (i.e. nitrogen, phosphorus).

Silos are wooden or plastic boxes with many gaps on its sides in order to permit enough air supply to its content. They can be easily made using four wooden pallets, linking these via rope or metal wires.

Materials & Equipment

- garden waste: tree branches (cut into small pieces), dry leaves, herbs, wood residue
- food leftovers: fruit and vegetable, peels, egg shells, ashes
- a hoe, dustpan, and watering pot
- a thermometer
- 4 small flowerpots
- compost
- a beaker (400mL)
- 2 daisies (plants) and lentil seeds
- a silo

Contact environmental organisations that have implemented composting activities and relevant campaigns in order to find out about their experiences (results, obstacles, etc). In cooperation with them, explore ways to initiate such a campaign involving your school and the local community.

Activity A

Try to perform this activity by involving younger students from your school as well.

1. Consult an agriculturalist to find out what biodegradable material is appropriate to be added to your compost pile, and start collecting these from your waste.
2. Choose a corner in your school garden that is flat and does not cumulate rainwater and place the silo.
3. Cut the waste collected into the smallest possible pieces and water them.
4. Place a layer of the biodegradable waste in the silo.
5. Cover the first layer of biodegradable material with a thin layer of soil.
6. Continue to apply alternate layers of biodegradable matter and soil until there is no more waste left and cover the silo.

What you expect to happen during the composting process? Take notes.

7. Measure the heap's temperature daily:

   You will find out that during the first days temperature will increase rapidly and later on it will remain stable for a short time period. Can you explain why?

8. Water the heap regularly to humidify it (pouring a relatively small quantity of water).
9. When the heap's temperature starts to decrease you should remove the material from the silo, water it and stir it with the dustpan to allow good air supply.
10. Place the material back in the silo and take temperature measurements.

    In the following days the temperature will increase again and then it will stabilise.

11. Repeat steps (8) and (9) when temperature starts to decrease again. Generally, your compost will be ready in approximately 7-8 months.

    What did finally happen? Compare to your initial expectations.

    How does the process you carried out resemble real situations in a landfill or a composting plant?

12. You should not use the compost produced immediately: wait for a couple of weeks or up to three months.
13. Use the compost you produced in your school garden or in the nearby park, after ensuring authorities' approval.

What a compost pile looks like.

Activity B: … daisies growing yellow

1. Mix equal amounts of compost and soil. Fill one flowerpot and plant a daisy in it.
2. Fill another flowerpot with plain soil (without compost) and plant the second daisy.
3. Water each daisy with 200mL of water using the beaker. Do not water again.
4. Place the flowerpots near your classroom window or in a sunny spot in the schoolyard where they cannot be reached by rain.
5. Observe how many days it takes for each daisy to start drying out.
6. Fill in the table below.

	Flowerpot WITHOUT compost	**Flowerpot WITH compost**
Number of days required for the daisies to turn yellow		

Try to explain the results and the role of the compost.

Tips for successful composting!

★ *In order to speed up the process you may use a specific mixture that facilitates fermentation. You can find it at your local nursery.*

★ *Make sure that your compost pile is provided with the appropriate supplies of air and water regularly.*

★ *Place the silo in a place protected from rain.*

★ *The initial waste should be cut into very small pieces.*

cont'd activity 10

Lentil seeds growing in compost (left) compared to plain soil (right).

Activity C: ... growing lentil seeds

1. Fill one flowerpot with plain soil and another with compost.
2. Plant the same number of lentil seeds (15-20) into each one of the flowerpots.
3. Once all the seeds have been planted, gently compact the soil to avoid trapped air in it.
4. Pour the same amount of water into each flowerpot.
5. Place the flowerpots near your classroom windows or in a sunny spot in the schoolyard where they cannot be reached by rain.
6. Water both flowerpots every second day with the same amount of water.
7. Every week write down the number of lentil seeds that have sprouted.
8. Fill in the table below with your observations.
9. Try to explain your results.

	Number of sprouted lentil seeds	
	Plain soil	Compost
1st week		
2nd week		
3rd week		
4th week		

The decomposition of materials

activity 11

2 months

organic / inorganic material, decomposition, biodegradable / non-biodegradable material, microorganisms, decomposer, biogas

Paragraph 1.4.5

Objectives

- To study the decomposition of materials in nature.
- To distinguish between organic and inorganic materials.
- To distinguish between biodegradable and non- biodegradable materials.
- To practise in conducting simple experiments.
- To adopt a positive attitude towards *reducing - reusing - recycling* the waste one creates.

Biodegradation is the decomposition (decay) of the organic material (material that contains carbon) in nature by micro-organisms that live e.g. in the soil. The wastes generated by household and commercial activities such as: food leftovers, garden waste, paper, cardboard, are biodegradable. Although 'new generation' plastics may have a reduced decomposition time, the conventional ones are not considered biodegradable.

The decomposition of material by micro-organisms under aerobic conditions (oxygen availability) produces carbon dioxide. Under anaerobic conditions, decomposition results in the production of biogas. Biogas mainly consists (> 90%) of equal parts of carbon dioxide and methane.


Decaying fruits due to fungus

Materials & Equipment

- pieces of paper, fabric, plastic bag, glass bottle
- nails, an aluminium soft drink can
- fruit and garden residues
- a hoe, water, soil, a knife

Activity

1. Dig a hole (approx. 20 cm deep) in the schoolyard (or in a big flowerpot) using a hoe.
2. Place the pieces of paper and fabric, the plastic bag, the nails, the aluminium can, the fruit skins and the glass bottle in the hole. The materials must be placed at a certain distance from each other, e.g. 10cm.
3. Cover the materials with soil and stick in two signs to indicate the exact place where you have buried them.
4. Two months later, dig out the materials and observe alterations that have occurred.
5. Write down your observations and comments in the table below.
6. Do a bibliographic research on:
   - the decomposition time of the materials that you used
   - the production and use of biogas in the various Mediterranean and European countries.

Material	Alteration - Comments	Time of decomposition
Paper		
Plastic		
Aluminium		
....		

Biodegradable municipal waste is a major contributor to the generation of leachate, landfill gas, odour and other nuisance in landfills. Alternative treatment methods such as composting or anaerobic digestion, if properly controlled, can eliminate or significantly reduce the polluting and emission potential of biodegradable waste. The EU Mediterranean countries have to comply with the EU Landfill Directive which imposes strict targets for the reduction of biodegradable municipal waste that may be disposed of in a landfill. The Directive calls for the reduction to 35% by 2016 of the amounts ending up in landfills, taking 1995 as the starting point. Source separation, separate collection, more composting combined with limits and bans on landfill use are needed to reach this target.

activity 12

Adopt a stream...

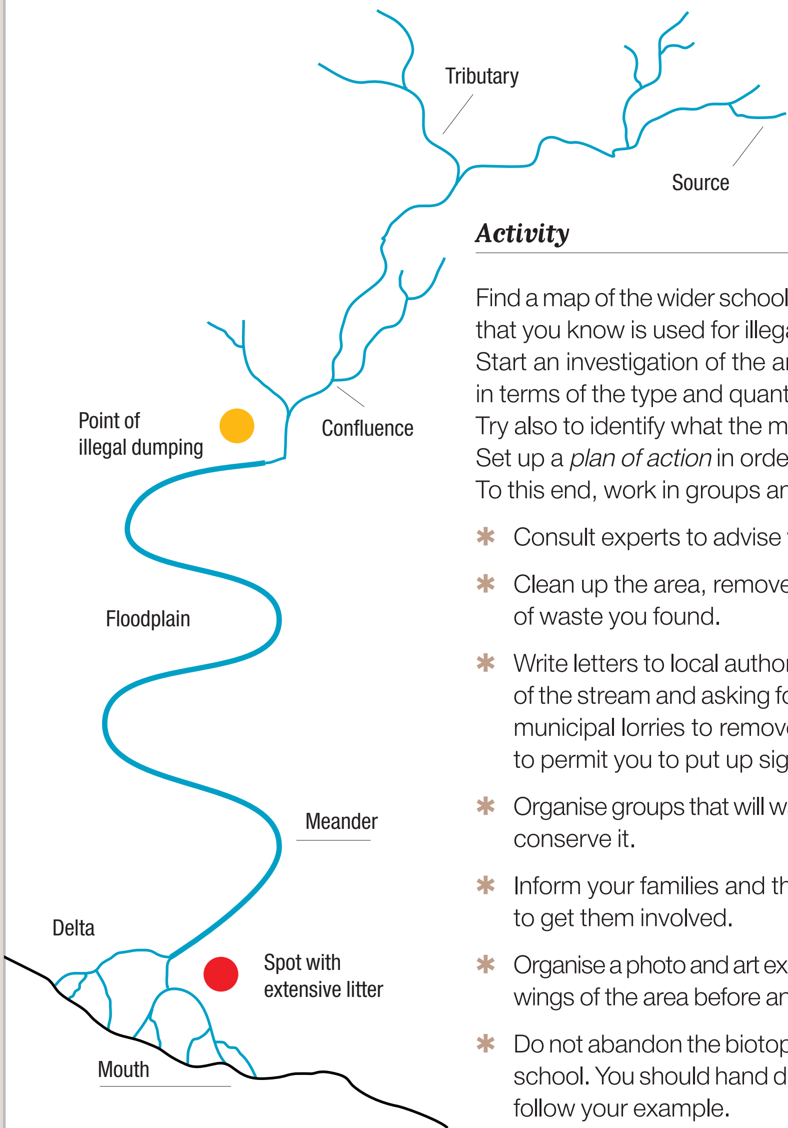
1 school year

waste management, uncontrolled dumping

Paragraphs 1.4.2, 1.6, 1.7

Objectives

- To identify and describe problems arising from the uncontrolled dumping of waste into water.
- To practise in fieldwork.
- To be involved in environmental actions and in sound environmental management.
- To adopt an attitude against disposing waste in water bodies - rivers, lakes and the sea.



Activity

Find a map of the wider school area or region and identify a stream or a pond that you know is used for illegal waste dumping.
Start an investigation of the area, take photos and write down its situation in terms of the type and quantity of the scattered solid waste.
Try also to identify what the main source of pollution is.
Set up a *plan of action* in order to clean up the area and keep it clean.
To this end, work in groups and undertake activities such as the following:

- Consult experts to advise you on the best way to protect the biotope.
- Clean up the area, remove litter and garbage and write down the types of waste you found.
- Write letters to local authorities informing them about the initial situation of the stream and asking for their contribution to your project e.g. to use municipal lorries to remove bulky wastes, to place more garbage bins, to permit you to put up signs discouraging littering, etc.
- Organise groups that will watch over the situation of the area regularly and conserve it.
- Inform your families and the local community about your action and try to get them involved.
- Organise a photo and art exhibition in your school including photos and drawings of the area before and after your action (i.e. 3 months later).
- Do not abandon the biotope at the end of the school year or after leaving school. You should hand down this tradition to the newcomers who may follow your example.

Waste issues in the Press

1 month – 1year

Press, access to information, public awareness raising, environmental issues, waste management

Paragraphs: All

Objectives

- To develop critical thinking towards the way news are presented in the newspapers.
- To value the contribution of mass media to provision of information and public awareness raising on environmental issues.
- To practice in preparing press releases.
- To practice in debating.

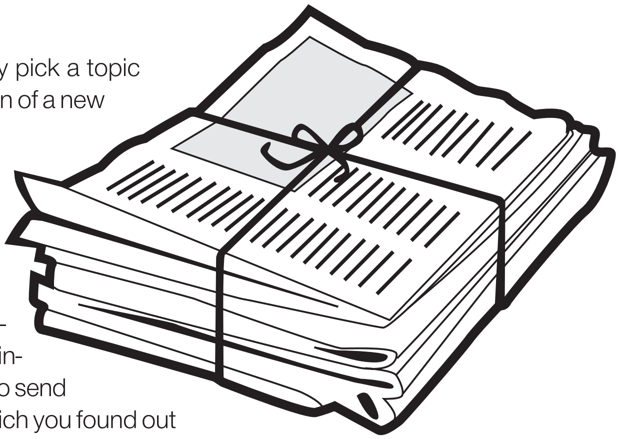
Activity

1. Work in groups and conduct an extended research on the press articles that deal with waste for a given period of time (e.g. a month, a semester or a whole academic year). Each group will undertake a particular newspaper and fill in one row of the table below. You may wish to classify the articles, as indicated in the table or use your own schemes of classification.

2. At the end of the research, hold a discussion in class, reflecting on questions such as:
   Do you think the press deals with environmental issues sufficiently?
   Do all newspapers give environmental issues the same priority?
   Is waste a popular topic? Why?

3. Based on the articles you read throughout the activity pick a topic that may cause social conflicts such as the construction of a new landfill, or a new chemical factory in a region, etc. Collect your arguments from the newspaper articles and organise a panel discussion in class to defend the positions of the various stakeholders.

4. Examine carefully the way journalists write their articles. Based on the language used in the newspapers, prepare your own press release. You may base it on the findings of this, or other waste related activity. You may also send an **ENVIRONMENTAL AWARD** to the newspaper which you found out through this exercise covers environmental topics more frequently.



Duration	**Number of articles on each of the following waste topics**				Total number of articles on waste	Percentage of waste articles on the total number of articles in the newspaper
Newspaper	Hazardous	Pollution	Landfills	Other		
Newspaper **A**						
Newspaper **B**						
....						

activity 14

Where does construction & demolition waste end up?

1-2 days

construction & demolition waste, raw materials, rehabilitation, reusing, recovery of material & energy

Paragraph 1.5.1

A fleet of tipper trucks queue at the Ouzair dump site, Lebanon. The 2006 conflict generated a massive amount of debris and building rubble, which requires appropriate management and disposal. (Source: UNEP, 2007)

Objectives

- To identify problems arising from the uncontrolled dumping of inert construction materials.
- To list disposal methods of inert construction materials.
- To be informed about the ways of reusing materials on building sites.
- To appreciate the benefits from the recovery of inert materials.

- In big Mediterranean cities, the quantity of waste generated by the demolition of old buildings and the construction of big infrastructures is increasing constantly.
- Even today, constructors and individuals keep dumping construction and demolition waste. These actions lead to pollution, aesthetic degradation, alteration of landscapes, obstruction of ravines and streams, etc.
- Inert materials from construction and demolition waste that cannot be recovered are used in the rehabilitation of old quarries, for harbour extensions, in embankment works or is disposed of in sanitary landfills.

Activity

1. Conduct a bibliographic research on the existing legislation on the management of this waste in your country and in other Mediterranean countries.
2. Work in groups. Each group will:
   - Visit the department in your municipality responsible for the collection and management of construction and demolition waste.
   - Visit a junk yard. Collect information on the quantity and the ways of disposing the demolition materials found there.
   - Visit an old quarry being rehabilitated with inert materials from excavation works. Take photos and ask people who work there about: What kind of materials are used? How are these materials disposed of? What are the impacts on the health of employees and on the environment?
3. Consult experts and find information on the impacts of mismanagement of construction/demolition waste on the environment (groundwater, air, soil, ecosystems, etc.) as well as to human health.
4. Based on your findings make a poster or a leaflet to inform the local community on the proper ways for citizens to dispose of their construction and demolition waste. You may also prepare an article for the local newspaper for raising public awareness on the ways such waste is managed in your region.

Using and 'abusing' electric & electronic appliances

2 weeks – 1 month

electric power, reusing, recycling, electricity production and consumption, heavy metals, organic compounds

Paragraph 1.5.3

Objectives

- To explore the reasons of over-consumption of electric and electronic appliances nowadays.
- To study the problems resulting from the over consumption and disposal of electric and electronic appliances.
- To suggest environmentally friendly ways to dispose of electric and electronic appliances.
- To be encouraged to use fewer electric and electronic appliances.

Heavy metals (such as lead, mercury, cadmium and chromium) and organic compounds containing chlorine and fluorine used in refrigeration systems and other toxic substances contained in devices lead to serious environmental pollution problems.

According to the European Union's legislation member-states must set up recycling and reuse systems of electric and electronic appliances. The manufacturers are the ones in charge of recycling of electric and electronic appliances. Consumers, in turn, have the duty to return old appliances to the points of sale.

Activity

A. *Do a bibliographic research to collect information about:*
- harmful substances contained in electric and electronic appliances,
- ways of disposal of damaged electric and electronic appliances (you may also find relevant information by visiting an electric and electronic appliances repair shop),
- existing legislation of your country and of other Mediterranean countries, as well as of the EU regarding the disposal of old electric and electronic appliances.

B. *Work in groups. Conduct surveys in your neighbourhoods in order:*
- to collect information about the use of various electric appliances in the past and in the present.
- to trace the 'consumerist' attitude of people in your community with regard to these products.

For your survey, you may use the table presented in the following page, checking (v) where appropriate in Columns A, C, D, writing numbers in Column B, etc.
At the end of your survey try to make a data analysis with the help of your teachers (presenting the results in tables, graphs, etc.).

a. Based on your research results, what do you think about your needs in electric and electronic appliances? Reflect on the conclusions.
b. What could you do in order to contribute to the reduction of waste produced by throwing away used electric and electronic appliances?

cont'd activity 15

Extension activity

- **Do you think that electrical energy could be conserved by your family or local community?**
- **Can you think of a way to achieve this?**
- **Who would you involve?** (contact the local authorities, NGOs, experts, etc.)

Product	A Was it used in the past?	B Number of appliances in your home	C Which one(s) could you not do without?	D Does it essentially contribute to a better quality of life?	E Alternative non-electric appliance that could be used for the same purpose
TV					
Radio transistor					
Telephone					
Mobile phone					
Video player					
Vacuum cleaner					
Small vacuum cleaner					
Electric knife					
Electric boiler					
Coffee machine					
Electric cooker					
Electric razor					
Mixer					
Hair dryer					
Washing machine					
Dish washer					
Electric thermometer					
Computer					
Electric watch					
Electric scale					
Refrigerator					
Freezer					
Hi-Fi stereo set					
Electric toothbrush					

What happens to old cars?

⏲ 1 – 2 days

Transport, traffic, air pollution, lubricants, reuse, recycling

Paragraph 1.5.2

Objectives

- To find out how old vehicles, tyres and lubricants are managed.
- To assess the benefits of appropriately managing of old vehicles, tyres and lubricants.
- Toappreciate sustainable ways of transport.

- In Athens, Greece, the ratio between inhabitants and cars is 2 to 1.
- The widespread use of cars is a source of traffic congestion in towns and of environmental pollution.
- In the European Union, old cars have to be recycled by 80% of their weight from 2006 and on.
- Recycling and reuse of old car parts helps in saving raw materials significantly. Old car tyres can be recovered and recycled / turned into other rubber products or used for electric power or heat generation. Used lubricants can be reused after filtering or used for the production of electric power.

Activity

Work in groups. Decide which group will visit:

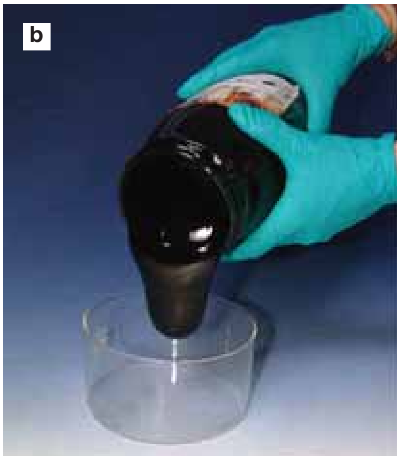
- a petrol station,
- a car repair workshop
- a tyre exchange/repair workshop
- a car cemetary

Collect information about:

- The ways used car lubricants are being disposed of in your area.
- The environmental impacts of improper disposal of lubricants, tyres and other material from old cars.

Compile your findings in a report and make an oral presentation to your schoolmates.

- *How do you go to school? By bus, by bicycle, on foot or by car?*
- *How often does your family, relatives and family friends change their cars? Investigate about it!*
- *Try to find information on car consumption rates in your country.*



Some countries -and companies- are well advanced in proper methods of managing old cars, such as using tyre scraps in new road construction (a), regenerating lubricants (b), etc. while others simply pile up cars no longer in use in so called ‘car cemeteries’(c).

activity 17

Recycling

2 hours

raw materials, reusing, recycling, recyclable & non recyclable materials, manufacture, reclamation, pollution, consumption of energy & raw materials, eco-label

Paragraphs 1.6, 1.7, Chapters 2 & 3

Examples of recycling:

- *Turning used paper back into pulp and making new paper from that pulp.*
- *Shredding old automobile tyres and adding the pieces to asphalt.*
- *Melting aluminium cans, turning the metal into sheets and using the sheets to make new cans.*
- *Melting discarded plastic items and using them to make new toys, videotapes, etc.*
- *Crushing glass bottles and jars into small pieces and melting them down to make new glass.*
- *Crushing and melting parts of old cars and using them to make new steel for new cars, furniture, etc.*

Objectives

- To distinguish between reusing and recycling.
- To identify recyclable and non –recyclable materials.
- To study the benefits of recycling.
- To be acquainted with related labels on materials & products.
- To interpret and analyse information given on product packaging.
- To be interested and motivated to participate in the recycling process.
- To adopt a positive attitude towards reducing-reusing-recycling.

Reusing means to use waste again for a new purpose or, after repair, for its original purpose e.g. we may reuse an old coffee jar as a holder for paint-brushes!

Recycling refers to the process of collecting and treating waste so that it can be used again to manufacture new products. Aluminium, glass and paper are some common recyclable materials. In addition, some plastics can by recycled into new products (as indicated in the relevant table).

Recycling usually follows four steps:

1. **Collecting:** used materials like glass, paper and aluminium are collected and taken to a recycling center. This is usually the step in which all people can be easily involved.
2. **Sorting:** the collected waste is separated by type because each material must be recycled in a different way.
3. **Reclaiming:** this is the step in which waste goes through a particular process in order for the raw material to be recovered.
4. **Reusing:** the reclaimed materials are again used as new products.

Reusing and recycling of waste help the environment by saving space, energy, raw materials and also by reducing pollution of natural resources: air, water, soil, etc.

Activity A

Collect various objects that can easily be found in school such as: paper clips, aluminium cans, old pencils, used pens, plastic bottles, pieces of cloth, paper cards, etc.

Start a discussion in class based on the following questions:

1. Would you use these objects for another purpose? Which ones and how?
2. Do you think that they could be used for another or the same purpose, if they went through a particular process? Which ones and what would the 'new products' be?
3. Do you and your family reuse any particular type of objects? Why? Why not?
3. Working in small groups and with the help of your teacher make a concept map relevant to the issues and concepts discussed. Alternatively, you may make a collage on the topic using original materials like paper, glass, cloth, etc.

Activity B … examining the labels of products

1. Bring to class packaging of various products used in our everyday activities such as: food, soft drinks, cleaning detergent boxes, spray cans, etc.
2. Work in small groups and examine their packaging to find out whether they bear a label indicating that the packaging is recycled, recyclable or environmentally friendly, or providing some other information.
3. Fill in the table below.

Product	Presence of recycling label	Material the packaging is made of	Is the packaging material recyclable?

4. Make a drawing or a poster with the recycling signs for various materials, e.g. the ones used in the EU, in your country, in other countries.

Activity C … organising an awareness campaign

Organise a campaign aiming to sensitize youth towards reducing / recycling waste. The list of themes for an awareness campaign is endless. Indicative themes might be:

- ***A campaign promoting mug use instead of disposable cups, entitled "Take your mug and drink up!"***
- ***A donation of clothes that no longer fit, or a garage sale.***
- ***A bike tour for less waste generation.***

cont'd activity 17

(a) (b)

An ECO LABEL is a seal or logo indicating that a product has met a set of environmental or social standards, which are verified by another independent inspection organization (certifier).

(a) The first eco-label ever created was the German so-called 'Blue Angel' in 1978.

(b) The European Commission awards such products with the EU eco-label.

Tips & Warnings when we collect paper, glass, aluminium and plastic for recycling

Before getting involved in recycling (of paper, glass, aluminium or plastic) you should contact the community services as well as local environmental organisations to find out whether there is a particular recycling programme, campaign or strategy taking place in your area. Identify relevant drop-off centres, recycling receptacles/bins, etc.

PAPER	GLASS	ALUMINIUM	PLASTIC
Separate paper into three groups: white office paper, newspaper and mixed-colour paper.	Most soda bottles, as well as food, beer, wine and juice containers can be recycled.	Some communities recycle foils, along with aluminum tins.	Some types of plastic can be recycled: a **number** (1 to 7) in a triangle at the bottom of most plastic containers tells us what type of plastic it is and if it can be recycled (see page 45).
Brown bags can be collected together with newspapers. Make sure you have removed rubber bands, plastic, transparencies and anything else that is not paper.	Collect and **rinse** glass bottles of any colour – most communities do not vary in the type of glass bottle they recycle unless it is of mixed colour.	Rinse the aluminium tin items before recycling.	**Rinse** the plastic items collected. It is preferable to sort them by number (in order to avoid mixing when the recycling process will start).
	Make sure you sort out anything ceramic.	Avoid collecting spay can or cans containing paint or hazardous substances. Contact the local recycling programme or relevant Community/City Department to find out where these can be recycled.	**Type 1** and **2** are usually plastic containers such as plastic bags, detergent containers, milk, soft drink or juice containers, cooking oil and bottles for water.
Mixed-colour paper might vary from magazines and flyers to junk mail.	**Avoid** mixed colour glass: It is hard to sort and recycle.		Check whether supermarkets & grocery stores in your area have bins in which their plastic bags are collected for recycling. Usually, such bags are **Type 4 or Type 2** plastic. Clean out the bags before recycling.
Carbon paper; paper that is wax coated or stained with oil; food, tissue, sanitary products; juice boxes; fast food wrappers; pet food bags are not recyclable unless noted.	Leave out mirrors, windows, pyrex, light bulbs and glass tableware.		**Type 3** (plastic food wrap, vegetable oil bottle), **Type 5** (yogurt containers, syrup bottles, some bags, some food wrap, etc.), and **Type 7** (layered or mixed plastic) can be collected together.
	Do not forget to remove the lids of bottles when sorting.		Find out, depending on the recycling programme of your community, whether you should remove the labels from the plastic products.
			Crush plastic containers to save space, whether you recycle them or not.
			(The tips provided herewith for plastic are rather "advanced" given that the plastics industry is still at an early stage of experimental recycling.

Making paper...

1 day

Manufacture, reclamation, reuse, recycling, pollution, recyclable & non-recyclable materials

Paragraphs 1.8.5, 2.3

Objectives

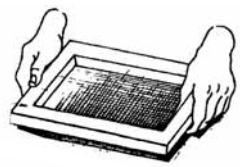
- To explore the benefits of paper recycling.
- To practise how to recycle paper.
- To conduct simple experiments.
- To stimulate students' interest and motivate them to participate paper recycling processes.
- To adopt a positive attitude towards *reducing-reusing-recycling*.

The advantages of paper recycling are huge: the production of one tonne of recycled paper saves 31,5 tonnes of water and 350 litres of oil. Furthermore, air pollution is reduced since fewer trees are cut and therefore more carbon dioxide is absorbed. However, paper recycling is relatively expensive because of the added cost of old paper collection and storage.

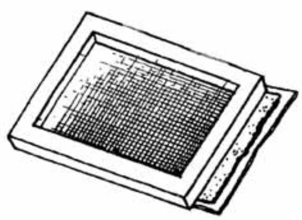
Material & Equipment

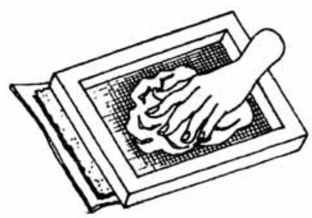
- a screen (or a net stapled on a wooden or metal frame)
- a blender
- a pan
- newspaper
- a wide spatula
- water & liquid starch (*optional*)

Activity A



1. Rip the paper to be recycled into small pieces and place it in the blender (about half full). Fill the blender with warm water. Run the blender at a slow speed and gradually increase until no more paper flakes remain. Your pulp should be smooth and well blended.
2. The more paper you add to the mixture the thicker the recycled paper will be. Add some water if needed. You may also add a small portion (two teaspoons) of liquid starch: the starch helps to prevent ink from soaking into the paper fibres.
3. Empty the blender into a pan.
4. Dip the screen under the pulp and lift it up, making sure the pulp spreads out evenly on the screen and that excess water drains into the pan. If the pulp is very thick, remove some. If it is too thin, add more pulp and spread out evenly using the spatula.
5. Flip the screen onto a newspaper. Press 'out' the new paper, using a sponge or a newspaper to soak the excesswater. Place the new paper-sheet in a safe place to dry (i.e. on a newspaper or cloth).
6. Repeat the steps above and pile your paper on fabric or newspaper sheets successively to absorb the remaining water out of the stack.
7. Gently separate the recycled paper sheets from the pile. Let them dry out in open air (1-2 days) on sheets of newspaper or by hanging them on a clothesline.





cont'd activity 18

For every **tonne of paper** that is recycled **17 trees** are allowed to live!

Activity B ... visiting a paper recycling plant

Visit a paper recycling plant. Take notes on the successive steps of the process. What are the differences and similarities with the process you followed when you made your own recycled paper?

Activity C ... setting up a recycling centre at school

Set up a paper recycling programme at school. You can either recycle the paper yourselves or decide to collaborate with a paper recycling plant operating in your area.

Try to think of ways to engage not only your fellow students but all school personnel, parents and the whole neighbourhood if possible.

What about starting an awareness campaign? ... What tools would you use to sensitize your target groups? ... Photos and facts, a theatrical performance, a campaign, or other? ...

The life-cycle of materials

Activity A: 1 month
Activity B: 3 - 4 months

Product life cycle, life cycle assessment (LCA), raw material abstraction, manufacture, reclamation, depletion of energy resources, reuse, recycling, recyclable & non recyclable materials, pollution

Chapter 2, Annex 1

Objectives

- To differentiate between renewable and non-renewable resources.
- To study the flow and conversion of matter and energy within a product's life-cycle.
- To estimate the role of reusing and recycling in the life-cycle of a product.
- To adopt a positive attitude towards purchasing products supplied in a recyclable packaging.

A product's life cycle describes all steps included in its production and consumption processes, from raw material abstraction to its disposal:

- A product or service comes into existence, usually in response to a requested need from society.
- The first step in making a product is raw material abstraction. For instance, timber harvesting is needed for paper and crude oil extraction for plastics, etc.
- Next step is the raw materials manufacture, which gives useful intermediate products, followed by product manufacture which is the formation of the final product, e.g. oil is processed into polymers which are the basis for plastics production.
- The next phase refers to product use.
- A product's reuse or recycling extends the product in life; its eventual disposal closes its life cycle.

All the above mentioned processes involve transportation of products and materials, energy and raw material consumption, (solid and liquid) waste production and emission of pollutants.

Activity A

Work in groups and conduct a survey (bibliographic research, internet, interview with manufacturers and users, etc.) on the life cycle of one or more of the following objects:


aluminium can


plastic bottle


cardboard box


tin can

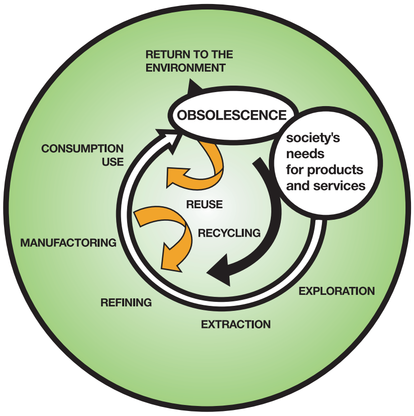

glass bottle

- For each object make a poster based on a concept map or a web chart and present it in class.
- Exhibit the posters, to sensitise your peers, on the lifecycles of 5 objects.
- You may want to extend your research to other products of your everyday life, such as a T-shirt, or a CD, etc.

cont'd activity 19

- *A* ***non-renewable resource*** *is a natural resource that cannot be re-made, re-grown or regenerated on a scale comparative to its consumption. It exists in a fixed amount that is being renewed or is used up faster than it can be made by nature. Often fossil fuels, such as coal, petroleum, and natural gas are considered non-renewable resources, as they do not naturally re-form at a rate that makes the way we use them sustainable.*
- *A* ***renewable resource*** *differs in that it may be used but not used up. This is as opposed to natural resources such as timber, which re-grows naturally and can, in theory, be harvested sustainably at a constant rate without depleting the existing resource pool and resources such as metals, which, although they are not replenished, are not destroyed when used and can be recycled.*

The following questionnaire may guide your research.



A product's typical life cycle.

Questionnaire for a study on the Life-Cycle of a product

1. What is it made of?
2. What raw materials are needed for its production?
3. Are large amounts of this material available on earth?
   Does the process of extracting these raw materials pollute natural resources: land, water, air?
4. What processes do the raw materials go through in order to produce the particular product?
   Do these processes pollute natural resources: land, water, air?
5. How is the particular product packaged and transported in order to be distributed to consumers?
   Does the process of packaging and transportation pollute natural resources: land, water, air?
6. What is this product used for?
7. How is it disposed of, after its use?
8. Are there any possible ways to reuse it for other purposes?
9. Can the product be recycled? Is it currently recycled?
   Does the process of recycling the product pollute natural resources: land, water, air?
10. How do you dispose of the product: by composting? by putting it in conventional garbage bins or in appropriate recycling bins?
    Does your disposal method pollute natural resources: land, water, air?
11. Which disposal method has the least impact on the environment and on human health?
12. Is this product necessary to you? Why?

Activity B … writing a play

Organise a theatrical play with the title: *"The story of a piece of paper or aluminium can or of a bottle glass or … "*.
Write your own scenario starting:
"In the beginning I was a grain of sand…" or
"It all started when they cut the tree…"
Present your play at school inviting your families, schoolmates and friends.

What is left …

Objectives

- To find out that often a considerable quantity of product is left in the packaging and is wasted.
- To give reasons for the large amounts of waste generated.
- To calculate the optimal packaging size for a particular product.
- To carry out simple measurements.
- To practise in conducting surveys.
- To adopt a positive attitude towards consuming less.

Activity A: 1 hour,
Activity B: 1 month

natural resources, raw material, packaging, weight, consumption habits

Paragraph 1.1, 1.2, 3.4

- The earth's population increases by 200,000 individuals per day and the planet's natural resources and raw materials are overexploited. In developed countries, people overconsume: 20% of the food bought by the average consumer is thrown away before its consumption.
- The market is full of various disposable items or products with a short life-cycle.
- Very often packaging and containers still contain significant amounts of their content when thrown away.

Buying coffee in individual pods demands ten times more packaging than a 250 gram pack!

Materials & Equipment

- 2 water or soft drink bottles (0.5L and 1.5L)
- a volumetric cylinder (50mL) and a beaker (200mL)
- a balance scale
- a clock
- olive oil

Procedure

1. Weigh an empty 0.5L bottle with its cap.
2. Add 30mL of olive oil into the bottle using a volumetric cylinder.
3. Close the bottle with the cap and shake it well in order to spread the oil over its inner surface. Avoid getting oil on the bottle's cap.
4. Leave the bottle upright for 2 minutes.
5. Remove the cap and pour the oil contained in the bottle into a beaker. When the oil starts dropping at one droplet per second, shut the bottle with the cap.
6. Weigh the bottle.
7. Calculate the weight difference between the first and the second measurements.
8. Repeat steps 1 - 7 using the 1.5L bottle.
9. Fill in the table below.
10. Discuss in class the reasons for the weight difference.
11. Do you usually buy products in small or big size? Explain the environmental consequences in each case.

cont'd activity 20

	Weight of empty bottle	Weight of bottle when olive oil is added	Weight difference (= oil left inside)	Weight of oil wasted per 1,5L of content
Small bottle (0.5L)				
Big bottle (1.5L)				

Extension activity: A tv show on packaging

It is proposed to carry out this activity after having undertaken all other activities relating to costs and benefits of packaging, i.e. when students will have gathered and examined enough material on the issue.

1. Split the class in two groups and prepare a debate entitled

Packaging: a means of protection or a means of environmental burden?

2. Organise the debate in a form of a TV show, where the two groups will defend the opposing sides and the rest of the class will be the participating audience. Don't forget to assign to one student the role of moderator of discussion.
3. The two groups should have enough material (newspaper articles, NGO and consumer group surveys etc.) and one week is time to prepare their arguments.
4. During the debate representatives from the two groups will be presenting their positions in turn. They will also be given the opportunity to present their arguements against the other group.
5. The rest of the class, taking the role of the audience, will follow the discussion and at the end they may make questions and comments, evaluate the situation and draw conclusions.
6. Finally, the whole class needs to reach consensus and propose alternatives. It may be necessary for both sides to make compromises.

Composite packaging

1 hour

recyclable packaging; types of packaging: primary, grouped; transportation

Chapter 3

Objectives

- To practise in conducting simple experiments.
- To find out whether packaging is made of composite material or not.
- To explain the purpose of the components of composite packaging.
- To pay attention to the packaging when buying various products.

Packaging is the container or a combination of materials used to wrap a product and protect it from damage, theft and decay.

Paper, glass, plastic and metal are some common materials used for packaging.

In developed, industrialised countries packaging is the prevailing component of the solid waste they produce.

Composite packaging of various products

Materials & Equipment

- Packaging of various products such as milk, juice, potato chips, photocopy paper box, aromatic hankies, etc.
- Scissors, paper cutter, water.

Activity

Work in groups and examine each packaging item in order to find out whether it consists of one or more components. In the second case, the packaging material is characterised as composite. Identify and name its component materials (paper, plastic, metal face, glass, etc.).

1. For the milk and juice boxes you may work following these steps:
   - a. Cut out a piece of the packaging.
   - b. Separate the piece into its layers using the cutter.
   - c. Pour some water on each layer.
   - d. Rub each layer with your fingers to find out whether it consists only of paper.
2. For the aromatic hankies: open it and try to separate the various materials of the packaging using the cutter.
3. For the photocopy paper box: cut out a piece, wet it, rub it with your fingers to check whether it consists only of paper.

Fill in the table below.

Packaging of...	Number of packaging components	Material of packaging components
Milk		
Juice		
Aromatic hankie		
Other...		

cont'd activity 21

Composite packaging

Work in your groups and reflect on your results.
You may use the following questions as ideas for discussion.

A. Why do you think the product is packaged in this way? For example:
To be protected from moisture, oxidation, etc?
To protect health (avoid microbial contamination)?
To prevent theft?
To promote advertising or ensure convenience in handling?
To make the product look larger or more appealing?
To provide consumer information?

B. In your opinion, is the packaging you examined essential or wasteful? Why?

C. How does the specific packaging influence the product is marketing (ability to sell)?

D. Is the packaging recyclable or reusable? Is it perhaps biodegradable?

E. How would you dispose of such packaging?

What do we pay for packaging?

Activity A: 1 hour
Activity B: 1 week

types of packaging, production cost

Chapter 3

Objectives

- To relate the cost of various types of packaging taking into account the quantity of product they contain.
- To compare the costs of a product's packaging and manufacturing.
- To shift the consumption habits towards "economic" packaging containing larger quantities of product.

Manufacturing of packaging is quite costly and, therefore, increases the cost of the final product. When consumers buy in small packs they spent more money for packaging than buying the same product in big packs. That is because, for small packs, the relative weight of packaging compared to net weight is higher.

Materials & Equipment

- Small and big packaging of the same product (e.g. potato chips, co-okies, coffee, beverage)
- Balance

Activity A

1. Weigh a small pack of potato chips.
2. Calculate the weight of the packaging (= total weight – net weight), as indicated in the packaging.
3. To calculate the cost of the packaging of your pack of potato chips you need to know the cost of 1kg of the packaging material. For example, in Greece, 1kg of potato chips packaging costs 6 euros.
   [packaging cost = packaging weight (g) X 6 (euro) / 1000 (g)]
4. Calculate the relative cost of the packaging compared the product's pri-se.
   (= packaging cost / product's prise X 100%)
5. Fill in the table below.
6. Repeat steps 1-5 with the big pack of potato chips.

Packaging	Packaging weight (g)	Packaging cost	Product's prise	Relative cost of the packaging (%)
Small				
Big				

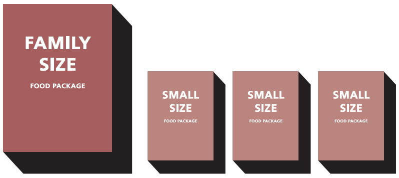
- Repeat the activity with the other products. You should first find out the cost of 1kg of each product's packaging.
- What are your conclusions with regard to the cost of packaging in relation to the quantity of product?
- In your opinion what kind of packaging should be bought to have economic benefits and to pollute less the environment?

Let's calculate!

1 *One can of condensed milk of 420g costs 0.65 Euros. One pack containing 10 portions of 15g of condensed milk costs 0.70 Euros. Calculate how much the purchase of 420g of condensed milk in portions of 15g would cost. Do we generate more waste when using cans or portions of milk?*

2 *The Athens Water & Sanitation Company charges consumers 0.50 Euros for the use of 1 cubic meter (m^3) of water. A 1.5L bottle of water costs approximately 0.25 Euros. What would the consumption of 1 m^3 of bottled water cost? How many plastic bottles would be needed? Discuss the environmental impacts of bottled water consumption.*

cont'd activity 22



Bigger is better when it comes to packaging of ordinary consumer goods. When buying in bulk you get more quantity and less packaging to throw away. Is your favourite product (i.e. breakfast cereal) available in recycled or recyclable packaging? If not write to the manufacturer and let them know you would prefer it. Or maybe you could change your preference and get a new breakfast cereal...

Activity B

Work in groups and conduct a field research in the supermarket:

a. Select a common and a concentrated detergent, which do both clean the same quantity of clothes. Compare their prices and estimate for which product a bigger packaging is needed.

b. Choose a household cleaning product. Collect information about:

- the names of the different brands,
- the packaging material used, by the various brands, for the same product
- which packaging in each brand is the cheapest one with regard to the material made of and the size of the packaging.

Product brand name	Paper packaging		Plastic packaging		Other type of packaging		Cheapest product	
	Small pack	Big pack	Small pack	Big pack	Small pack	Big pack	Plastic, paper, or another type of packaging	Small or big packaging

Investigating our consumption habits

Activity A

In the table below some examples of everyday consumption habits are given. Explore the possible motives leading people to exhibit such behaviours. What are their consequences for people and the environment?

Activity / behaviour	Possible Motives	Consequences for people & the environment
1 Throwing away a pen before it is completely used.		
2 Preferring to buy milk, coffee or juice at school, on the road or at work instead of taking breakfast before leaving home.		
3 Dumping any food or drink left after having a snack.		
4 Avoiding eating for dinner any meal left from lunch.		
5 Using plastic dishes and cups during parties.		
6 Buying new clothes to be fashionable.		
7 Buying things from the supermarket 2-3 times/week.		
8 Buying new electric or electronic appliances because the old ones need repairing which may be difficult, costly and time-consuming.		

What about you? How often do you exhibit such behaviour:
always – often – sometimes – seldom – never.
Have you ever 'caught' yourself being wasteful and using raw materials and products without consideration? Give examples.

Activity B: Conduct a survey in your neighbourhood about people's consumption behaviours and habits.

Work in small groups and make a questionnaire for identifying people's behaviour in your area regarding their consumption habits.
You may use the sentences in the table above and others you can add in order to find out how often people exhibit such behaviours.

Collect and work on your findings with the help of your teachers.
Based on your results try to draw some conclusions about the "consumer" profile of the people in your area.

Activity A: 1 hour
Activity B: 1 week

Consumption habits, consumer values

Annex 2

Before buying a new item do you ever consider issues like its recyclability, its packaging, etc?

! *in order to formulate your questionnaire you may search for previous surveys on this topic. Usually, environmental NGOs (non-governmental organisations) have worked in this field: Consult their libraries!*

Trash-Art

Trash Art in Athens

"Trash Art" is an event organised in Athens, Greece since 1997 once or twice per year aiming to present artwork of young artists made with waste.

The first Trash Art festival entitled "Creation & Recycling Fair" back in 1997 was organised by a small group of young artists in order to raise public awareness on reusing and recycling, in co-operation with the Athens municipality, as well as with cultural and environmental NGOs.

Nowadays, artists from other European and Mediterranean countries participate in the event, with paintings, sculptures, design and video art, photography, engraving and jewellery. Usually a part of the income from the sold artwork is donated to the Municipality's programme "Homeless in Athens".

Handicraft from recycled waste materials: a big trend in Africa

In many African developing countries there is no limit to the inventiveness shown in recovering and reusing waste materials. Countless decorative and useful objects (toy cars, briefcases, ashtrays) as well as furniture (tables, stools, CD racks) are crafted out of metal recovered from tins, drink cans and aerosols. More and more people in the developed world are seduced by these creations and hand crafting from recycled materials is nowadays growing into a full-fledged business.

What is eco-design?

Eco-design means designing a product using a 'circular approach' which is known as 'cradle-to-grave' analysis taking into account their entire lifecycle from creation, through use, to disposal. Main aims/principles of eco-design are:

- Utilise materials, energy and other resources more efficiently.
- Chose materials that don't come from endangered ecosystems.
- Design to prevent pollution and waste.
- Select recycled/recyclable materials and energy saving technologies.
- Optimise a product's life: make it easy to use, maintain, update, reuse, recycle, or re-manufacture.
- Keep it simple! – Use fewer materials/components and allow easy disassembly and recycling.
- Improve transport logistics.
- Avoid potential health risks. Use safe non-toxic materials.
- Respect human rights (avoid sweatshops and child labour).

Often, eco-design is not about reinventing goods. It recognises that people do not always want a product, they want solutions. If designed well, a laundrette could easily replace individual washing machines. Eco-design looks for alternative ways of performing a task with lower ecological impact and equal (or greater) efficiency. Eco-designers believe that ethics and aesthetics are not opposites but rather complement each other.

Activity

Collect in class things no longer in use and brainstorm on alternative potential uses these objects might have for you and your classmates. What aims and principles of eco-design are met (see relevant text box) by the new uses of materials?

Create artworks by using the old products and materials, such as newspapers and magazines, cardboard (e.g. egg boxes, rolls of kitchen paper, etc.), plastic bottles, old glass objects and bottles, aluminium cans, bags, broken clay cups, pieces of fabric, old electric appliances, ...
... the list is endless!!

Organise an exhibition in your school at the end of the year to present your 'trash artworks'. You may even sell your artwork in order to raise funds for your school or another social cause.

When packaging reveals pieces of the history of a society ...

In 2005, Robert Opie launched the Museum of Brands, Packaging and Advertising in Noting Hill, London, where he exhibits the world's largest collection of British packaging. Robert Opie in 1963 started collecting objects which most people used to throw away, and which many people today reuse and recycle: plastic bags, food and sweets packaging, cartons and boxes, toothpaste tubes, cleaning product packaging, bottles, tins, wrapping paper and so many other packaging items of everyday life. He was 16 years old when he kept a plastic chocolate wrapper, the first item of his collection which now accounts for more than 500 000 items. According to a relevant book he wrote "…it's more than a nostalgic trip in the world of packaging; it's a trip that helps understand the evolution of these popular products, revealing a lot of information about life-styles, attitudes, even ethics of people, as time goes by and in this way, provides a valuable source for relevant social and economic research".

(Eleftherotipia newspaper, 17/04/06)

What has been said about waste...

"...The work of garbage collectors is equally important as the work of a teacher, an artist, a politician: we cannot do without them!"
Herby Hancok, jazz pianist

"...Modern economies take from us a mountain with trees, lakes and streams, and transform it into a mountain of waste, dumps and garbage"
Edward Alby, writer

"...In my opinion, this novel is absolutely worthless to society, unless it will be recycled!"
Elen Goodman,writer

"...In Beverly Hills garbage is not dumped: TV series are made of them!"
Woody Allen, actor, director

What is the pH of a battery?

2 hours

pH, acidic or alkaline solution, soil pH

Chapter 3

The objective of this activity is to identify the changes in the soil's pH due to buried batteries and explore the impacts of disposing used batteries in the soil.

Materials & Equipment

- a car or motorbike battery, small normal and alkaline batteries
- a pipette, a beaker (250mL), a volumetric cylinder (100mL),
- pH-measuring paper
- soil, a potato, an onion, a tomato and a fruit
- hammer, metallic forceps, knife, glass rod
- water

Procedure

1. Measuring the pH of various batteries

(Demonstration by the educator)

- **a.** Open one of the lids of the car or motorbike battery. Collect a small quantity of the battery liquid with the pipette.
- **b.** Add some drops of the battery liquid on the pH-measuring paper and estimate the pH.
- **c.** Take a small alkaline battery and break its external wrapping using a hammer. Stop when a black powder or a liquid starts coming out of the battery.
- **d.** Use a volumetric cylinder to add 100mL of water in a beaker and add the damaged battery, holding it with the forceps. Stir with a glass rod.
- **e.** Use the pipette to extract a few drops of solution and add the drops on the pH-measuring paper. Estimate the pH.
- **f.** Repeat the previous steps (c – f) in order to estimate the pH of a normal battery.

2. Measuring the pH of various substances

(Experiment by the students)

- **a.** Add some drops of water to a small quantity of soil in order to humidify it. Apply a strip of pH-measuring paper on the humid soil and estimate its pH.
- **b.** Peel or cut in half a potato and apply a strip of pH-measuring paper on its flesh to estimate its pH.
- **c.** Repeat step b using an onion, a tomato, an orange, etc.

3. Fill in the table below with the results of your measurements.

Item	pH
Car battery liquid	
Alkaline battery solution	
Normal battery solution	
Soil	
Potato	
Onion	
Tomato	

4. Examine the table below with the appropriate pH values for cultivation. Discuss in class the impacts of disposing batteries in the soil regarding:

the soil's fertility,

the organisms that live on / in the soil,

the health of the ecosystem,

the plants,

the underground water, etc.

Suitable pH values of soil for the cultivation of various vegetables and fruits:

Vegetable/ fruit	pH value
Apple / Tomato	5.5-6.8
Onion	6.5-7.5
Potato	5.0-6.5
Strawberry	5.0-7.0
Lemon/ Orange	6.0-7.0

Glossary*

Aluminium • a silvery grey metal, which is light in weight, easy to shape, does not rust and is widely used in manufacturing

http://exchanges.state.gov/forum/journal/env9background.htm - aluminum

Asphalt • hard black material that is used to make the surface of roads

http://exchanges.state.gov/forum/journal/env10appendix.htm - asphalt1

Biodegradation • degradation taken place by the action of microorganisms (mainly bacteria) under natural conditions (aerobic and/or anaerobic). Most organic materials, such as food scraps and paper are biodegradable.

Biogas • gas, rich in methane (CH_4), which is produced by the anaerobic degradation of organic matter. It is used as a fuel to heat stoves, lamps, run small machines and to generate electricity. The residues of biogas production are used as a low-grade organic fertiliser. Biogas fuels do not usually cause any pollution to the atmosphere, and because they come from renewable energy resources they have great potential for future use.

Biological Treatment (of wastewater) • a process utilizing microorganisms that are stimulated to multiply, by means of aeration, in wastewater, thus removing organic substances not removed by physical and chemical treatments.

Chemical Treatment • a process utilizing chemical methods for the removal of dissolved pollutants which cannot be removed by physical treatment (sedimentation, filtration).

Chlorofluorocarbon(s) or CFCs • gases formed of chlorine, fluorine and carbon whose molecules normally do not react with other substances; they are therefore used as spray can propellants because they do not alter the material being sprayed.

Decomposition • the process during which matter decays / breaks down into component parts, small molecules, or even elements.

Degradable • material susceptible to decomposition, disintegration.

Disposable • intended to be thrown away after use.

Dump • site used to dispose of solid wastes without environmental controls.

EC Eco-label • the European Community initiative to encourage the promotion of environmentally friendly products, operating since 1992. The scheme was designed to identify products which are less harmful to the environment than equivalent brands. Eco-labels are awarded to products that do not contain chlorofluorocarbons (CFCs) which damage the ozone layer, to products that can be, or are, recycled, and to those that are energy efficient. The labels are awarded based on environmental criteria set by the EC. These cover the whole life cycle of a product, from the extraction of raw materials, through manufacture, distribution, use and disposal of the product.

Eco-label • a particular sign awarded to products (or services) with minimised environmental impacts (resources & raw material consumption – waste and emissions production) at all stages of its life-cycle.

Emission (or air emission) • discharge of gases or particles into the atmosphere from stationary sources such as smokestacks and other vents, and from surface areas of commercial or industrial facilities and mobile sources, for example, motor vehicles, locomotives and aircrafts.

Environmental Impact Assessment (EIA) • a technique used for identifying the eventual environmental effects of development projects. An EIA requires a scoping study to be undertaken in order to focus the assessment. This can be carried out in the field or as a desk study depending on the nature and scale of the project (in the EU as a result of Directive 85/337/EEC this is a legislative procedure to be applied to the assessment of the environmental effects of certain public and private projects which are likely to have significant impacts on the environment).

Eutrophication • excessive enrichment of waters with nutrients and the associated adverse biological effects.

* Many of the definitions given are based on the EEA multilingual glossary on environmental terms at http://glossary.eea.europa.eu/EEAGlossary

Garbage • any material the owner of which wants to get rid of. It is considered useless or undesired, i.e. spoiled food, used containers and broken items.

Green pricing (energy) • refers to an optional utility service that allows customers of traditional utilities support a greater level of utility investment in renewable energy by paying a premium on their electric bill to cover any above-market costs of acquiring renewable energy resources

Hazardous waste: waste that because of its chemical reactivity poses risks to human health or the environment and requires special handling and disposal procedures. May be toxic, explosive, corrosive, radioactive, etc.

Hydro-chloro-fluorocarbons • compounds used as replacements for chloro-fluorocarbons (CFCs) in various applications because they are less active ozone depleters.

Incineration • controlled process by which solid, liquid, or gaseous combustible waste is burned and changed into gases; residue produced contains little or no combustible material.

Incineration of waste • the process of burning solid waste under controlled conditions to reduce its weight and volume and often to produce energy.

Landfill • a specially engineered site for disposing of solid waste on land (buried), constructed in a simple and inexpensive way so that it will reduce hazard to public health and provide minimum safety. Most landfills are poorly managed, rather inefficient and environmentally problematic.

Life Cycle Assessment (LCA) • a process of evaluating the effects that a product has on the environment over the entire period of its life thereby increasing resource-use efficiency and decreasing liabilities. It can be used to study the environmental impact of either a product or the function the product is designed to perform. LCA is commonly referred to as a "cradle-to-grave" analysis.

Litter • siolid waste materials that have been carelessly discarded in an inappropriate place.

Manufacture • to produce goods in large quantities, especially by employing machine.

Municipal solid waste • waste produced in municipalities, coming from households, or other sources such as commercial and professional activities, office buildings, schools, etc. having similar composition to household waste. Industrial, hospital or agricultural wastes are excluded from this category.

Non - disposable • not intended to be thrown away after use.

Packaging • all products made of any materials of any nature to be used for the containment, protection, handling, delivery and presentation of goods, from raw materials to processed goods, from the producer, to the user or the consumer.

Polymer • compound of one or more large molecules formed from repeated units of smaller molecules. When synthetic polymers (not natural-produced by humans in laboratory) contain some additives (plasticizers) in order to have better properties they are called *plastics*.

Pulp • wood and other vegetable materials that have been softened and are used to make paper

Raw materials • natural substances that are used to make industrial products.

Refuse Derived Fuels (RDF) • these cover a wide range of waste materials which have been processed to fulfil guideline, regulatory or industry specifications mainly to achieve a high calorific value. RDF consists largely of organic components of municipal waste such as plastics and biodegradable waste.

Recover • to regain raw material or energy from waste through a particular process.

Recyclable • material that can be treated so that it can be used again.

Recycled • material originating from treated waste so that it can be used again to manufacture new products.

Recycling center: a place where people can bring materials they have collected for recycling.

Reusable • an item that can be used again.

Steel • iron made harder or stronger by mixing it with other substances.

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Acronyms

CFCs	Chlorofluorocarbon(s)
EE	Environmental Education
EEA	European Environmental Agency
ESD	Education for Sustainable Development
EIA	Environmental Impact Assessment
EU	European Union
IT	Information Technologies
IPP	Integrated Product Policy
LCA	Life Cycle Assessment
LDPE	Low DensityPolyEthylene
MAP	Mediterranean Action Plan
pH	*Potential of Hydrogen*
MEdIES	Mediterranean Education Initiative for Environment & Sustainability
MIO-ECSDE	Mediterranean Information Office for Environment Culture & Sustainable Development
NGO	Non Governmental Organisation
PCBs	Poly Clorinated Biophenyls ($C_{12}H_{10-x}Cl_x$)
PET	PolyEthylene Teraphalate
HDPE	High Density PolyEthylene
PVC	PolyVinyl Chloride
PP	PolyPropylene
PS	PolyStyrene
RAC	Regional Activity Centre
RDF	Refuse Derived Fuels
SMAP /RSMU	Short and Medium-term Priority Environmental Action Programme / Regional Management and Support Unit
UN	United Nations
UN DESD	United Nations Decade for Education for Sustainable Development
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environnment Programme
UNESCO	United Nations Educational & Cu;tural Organisation
WSSD	World Summit for Sustainable Development
WtE	Waste to Energy Plant