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Solid Waste Management

Environmental Education Activities For Secondary Technical Schools

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Introduction

Everywhere people's interest in the environment is increasing. Day after day, they realize that our current methods of dealing with environmental resources must change if we want this planet to continue sustaining life. This international interest in the earth's environment is revealed in many aspects such as: conferences; international treaties and agreements aiming at organizing the use of resources, reducing pollution and adjusting technologies that are damaging to the environment; and the increased number of organizations protecting the environment, rescuing endangered species and raising public awareness as to safe environmental practices.

In Egypt, interest in the environment is witnessing a development similar to what is going on at the international level. During the last few years, the number of organizations and associations interested in the environment and in protecting natural resources and biological diversity has increased. On the official level, Law 4 for the year 1994 was issued to protect the environment. The Egyptian Environmental Affairs Agency was established to act as a coordinator between different ministries and authorities, to observe environmental practices and to enforce environmental laws and legislation. On the educational level - official and unofficial - environmental education has become one of the principal concepts taught by educational organizations to students in all levels.

In light of these developments, this book focuses on the solid waste management problem, which has become one of the major environmental problems in the cities and villages of Egypt. The reasons for this problem are not only technical, but social, legal and cultural as well. The influence of this problem affects almost all the elements of the environment - air, water and soil - as well as the health and the economy of the nation.

This book is the result of the efforts of many individuals and we cannot mention them all. However, it should be emphasized that this book is a product of the Mubarek/Gore Agreement for Egyptian/American Partnership for Economic Growth and Development. This book is one of the activities of GreenCom-Egypt, a USAID project, in cooperation with the Ministry of Education and the Ministry of State for Environmental Affairs.

Many thanks to the Environmental Education Department and the Technical Education Department at the Ministry of Education, to the Education Department in Alexandria, and to the teachers of the secondary technical schools in Alexandria who shared with us their visions and points of view during the assessment of the first draft in the 3-day workshop

held in Alexandria in July 2000. We would like also to thank the staff of the American Cultural Council in Alexandria for all their help in providing us with sources and references. Many thanks also to SEAM staff who provided us with the case studies in this book, and to AR for their efforts in publishing it.

Lastly, we would like to thank the staff of GreenCom for making our job easier, as well as the staff of Horizon for all their help and support during the different stages of making this book. We are deeply grateful to all these people.

Authors
Cairo, Egypt
September 2000

How to Use this Book

The core of this book is a collection of classroom activities for teachers and their students to carry out in classrooms, labs, workshops and outside of the school as well. These activities are addressed - especially - to students of the secondary technical schools. Due to their studies, they have a wider familiarity with the problems of solid waste that result from human activities in homes, schools, factories, hospitals and tourist buildings. The classroom activities stated in this book discuss the most important environmental issues and concepts. The book deals with global, national and local environmental problems, taking into consideration the relation between these issues and problems and the main issue of the book, which is solid waste. The classroom activities also focus on concepts of solid waste. Practical suggestions are also presented to help students explore these concepts through hands-on experiences and small projects in their school or neighborhood.

In these classroom activities, students will not feel that the problem is difficult and that they are incapable of solving it. On the contrary, the main message here is that we can do something, we can play a part in the solution, and maybe we are the main contributor to the solution.

In addition to these classroom activities, there are a number of fact sheets and background sheets that offer detailed presentation of some of the principle issues. There are also several tables and drawings. At the end of the book, there are a large number of case studies that give positive examples for dealing with solid waste problems in different situations.

The objective of this book is to help teachers in their work. The book is considered a tool to assist in explaining the subject to students.

This book is part of an integrated educational package, which also contains a video film titled "Success Story" (18 minutes) about the solid waste management issue, colored transparencies (12) for use on an overhead projector and a CD that presents -- in an interactive way -- information about the subject. This book is designed to facilitate integration between these tools. It also motivates students to question, search, study and keep looking for knowledge. We have designed the activities to be flexible, so that they can be lengthened, shortened, or edited depending on the students' level and the educational goals to be achieved.

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Chapter 1

THE ENVIRONMENT

- Elements and Components
- Environmental Education
- Renewable and Non-Renewable Resources
- Deterioration and Pollution of Resources

Sustainable Development

Sustainable development is development that satisfies the requirements of men, women, boys, and girls; is economically viable and socially acceptable; does not impose detrimental effects on the environment or deplete natural resource bases; and does not negatively threaten the income generation opportunities of other community groups.

This kind of development enables the supply of basic needs to the existing generation without eroding the rights of the next generations in enjoying the same opportunities.

Revenue from this development will be distributed fairly among all individuals -- men and women -- according to a fair and humane production relationship.

Sustainable development aims at satisfying the needs and aspirations of the present without lessening the possibility of the satisfaction of the needs and aspirations of the future.

Sustainable Development Components and Goals

The environment:	Aims to establish a healthy environment.
The economy:	Aims to improve economic welfare
The rights of the community:	Aims to treat all community sectors with justice and equality

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Ecosystems

The Environment...the System...the Ecosystem

Human beings do not live in a vacuum because we live on earth, we breathe air, and we need water, plants and animals to sustain our life. All things living and nonliving compose the environment that we live in; they affect us and we affect them. Because those things are not independent or isolated from each other, but linked together in an interrelated relationship, they form a system known as an ecosystem.

formed without any interference or alteration by man, or a modified, human-made ecosystem such as livestock pastures or crop fields. Natural ecosystems occur in numerous forms such as deserts, rainy tropical forests, and lakes. In reality these are all involved in one ecosystem, which is known as the biosphere. The biosphere is the surface layer of the globe and the lower layers of the atmosphere in which living organisms are found.

Desert Ecosystem

An ecosystem is a collection of plants, animals and other living creatures that is linked together in a permanent, interrelated relationship with its surrounding environmental circumstances. An ecosystem can either be a natural ecosystem that is

Sustainable Ecosystems

Ecosystems are similar in composition and function in spite of their different forms, and so we can select one of these ecosystems to see how it works and perpetuates its existence.

Let's start with green plants. Green plants absorb energy from the sun, and use it to transform water and carbon dioxide that is absorbed from air or water into glucose sugar, producing oxygen as a by-product. This chemical transformation is called the photosynthetic process. Using the glucose produced in this process and mineral nutrients (phosphorus, nitrogen, potassium and sulfur) absorbed from soil or water, plants manufacture the organic compounds that form and sustain their bodies. So, green plants are known as producers.

Herbivorous animals feed on grasses and green plants. Most of the plant matter that they feed on is digested, but part of it, cellulose, cannot be digested and passes through the gastrointestinal system and outside the body in the form of feces.

The food eaten by animals goes through one of the three following pathways:

1) More than 60% of the digested and absorbed food is oxidized to supply the fuel and energy needed by the animal for its biological activities. The byproducts of oxidation -- carbon dioxide and water -- are released into the environment.

2) The rest of the digested material is used in building and maintaining the body or is stored as fat.

3) Undigested matter is passed out of the body in the form of stool.

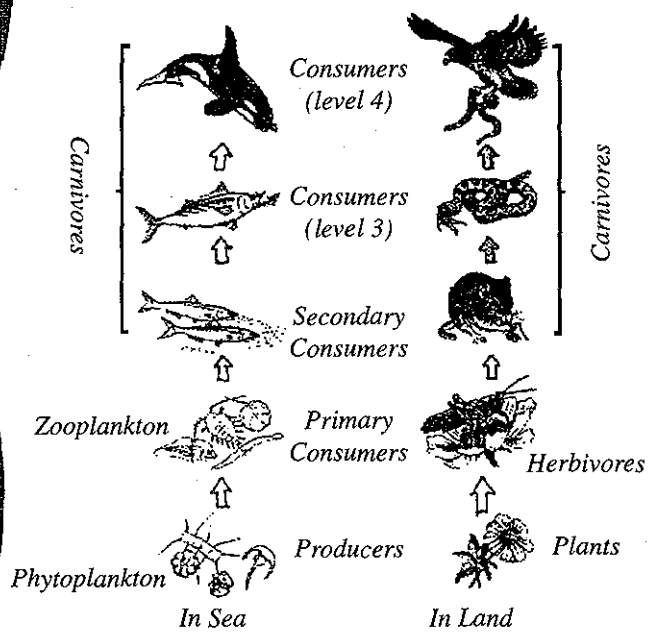
Herbivores, because they feed on other living organisms, are called consumer organisms or primary consumers. Humans and other carnivorous animals feed on herbivores. All organic wastes -- plants, dead bodies, animal feces -- eventually return to the soil. The third group of organisms, the decomposers (earth worms, scrubs, bacteria, fungi) break down those materials into substances that improve soil characteristics and plant nutrition. So, there are no accumulations of wastes in ecosystems because the wastes of one creature are a food for another creature.

Food Chains and Food Webs

Thus, from the study of ecosystems, we can observe that living creatures are related to each other through food networks. We can observe a countless number of pathways in which we find that one creature is feeding upon a second that is eaten by a third, and so on. These pathways are known as food chains. It is important to understand that food chains rarely exist as separate pathways. For example, herbivorous animals do not feed on only one kind of plant but on many kinds, and they are themselves eaten by many carnivorous animals. So, we find that food chains are networked to form numerous relationships. So, the expression "food chain" is used to refer collectively to these many chains of food relations.

Energy Pathways Through Ecosystems

Living organisms need energy to operate and maintain their biological functions (growth, mobility, and reproduction). As we know, there are two fundamental laws of energy:



Food Chain

1) The first law states that energy is neither created nor destroyed; rather, it is transformed into other forms.

2) The second law states that the transformation of energy into different forms is accompanied by a loss of the generated heat because heat always disperses to regions of lower temperature. So, the amount of energy able to be used at the end of a process is less than the original amount available at the beginning.

Green plants use the energy from the sun to form molecules of glucose sugar during photosynthesis. Glucose molecules are organic molecules that are rich in energy. The plant uses glucose for three purposes:

1) Formulating other organic molecules such as proteins and carbohydrates, sometimes in combination with other nutrients that the plant absorbs from the soil, such as nitrogen, phosphorous, and sulfur.

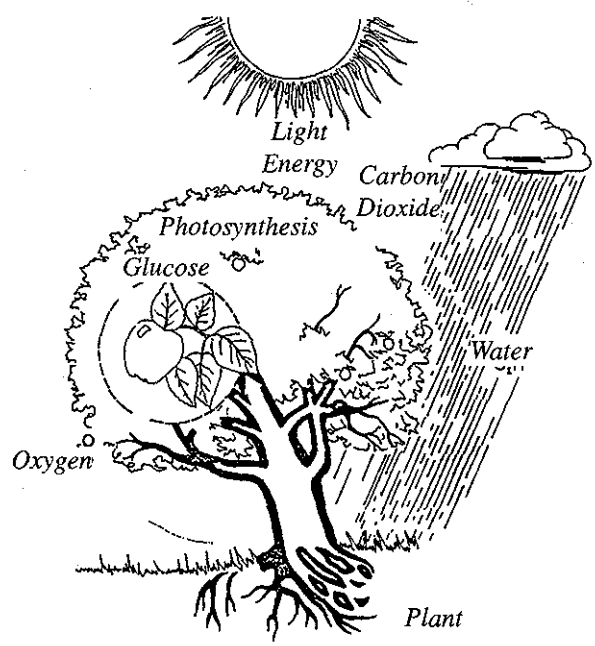
2) Providing the energy needed for the plant's biological activities such as nutrient absorption from the soil.

3) Storing some of the glucose in the form of starch, which is later used in the process known as cellular respiration. The chemistry of this process can be summarized in the following equation:

glucose + oxygen =
carbon dioxide + water + released energy

So, cellular respiration is photosynthesis in reverse.

Consumer organisms such as humans and animals gain their energy supply from the energy-rich organic materials found in the



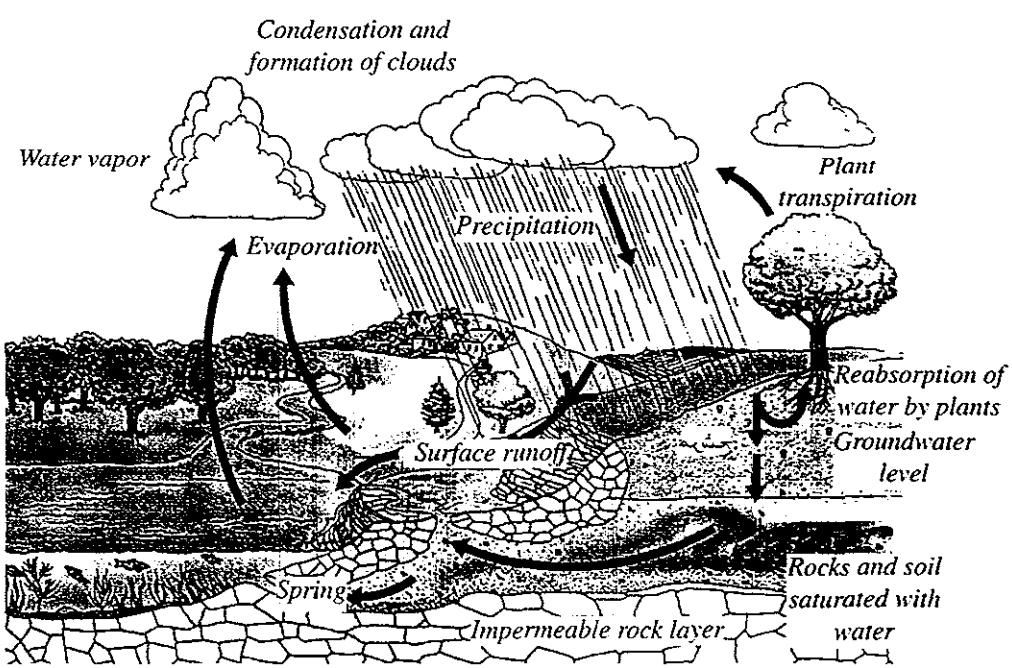
plants and animals that they eat. Then, inside the stomach of the consumer the food is digested into carbohydrates, fats, and proteins, and in the intestines these substances are transformed into simpler molecules, such as starch into sugar. These simpler molecules are then absorbed into the blood stream and transported to body cells. Inside every cell, organic molecules are broken down through the cellular respiration process described above, and the energy that the cell requires to perform its functions is released.

Most of the decomposers use cellular respiration to obtain energy from the organic wastes that they feed on. Some specific kinds of bacteria and fungi can get energy from the partial oxidation of glucose that takes place in the absence of oxygen. This kind of modified cellular respiration is called fermentation and produces ethyl alcohol, methane gas and acetic acid.

Water Cycle

If we compare an ecosystem to a living organism, the water cycle is like the blood circulation system in living organisms. The amount of water existing on earth is constant, but it circulates between the ocean, the atmosphere and the earth. This cycle can be summarized briefly as the evaporation of water into the atmosphere and its condensation out of the atmosphere in the form of rain (see diagram).

Water evaporates to the atmosphere out of water bodies and through transpiration of the plants. As the evaporated water is cold, condensation starts, water droplets form and clouds accumulate. If conditions are suitable, droplets get larger and fall in the



Water Cycle

form of rain as well as other forms (ice, fog, dew).

The water falling on the ground either gets filtered in the soil or flows on the surface, to the streams, rivers and eventually oceans.

The water filtered through the soil either stays at the ground surface to be absorbed by the plant roots and goes once more to the atmosphere via plant evapotranspiration, or it may go down to the level of ground water. The ground water eventually finds its way to streams, rivers, lakes and oceans. The cycle then starts again.

The water cycle plays a crucial role in transporting pollution. For example, rains falling on waste dumpsites can carry pollutants from those wastes into ground water. Rainfall also mixes with sulfur and nitrogen oxide pollutants in the atmosphere and becomes acid rain that endangers the lakes and forests where it falls.

Human activities affect the water cycle and rates of deforestation and desertification. Deforestation and desertification reduce the amount of water plants transpire into the atmosphere. They also reduce vegetation cover, with the result that the surface run-off is increased.

Previously we emphasized that substances circulate in ecosystems without the accumulation of wastes, because the waste of one creature becomes food for another creature. We also noted that light energy from the sun is the main source of energy in ecosystems. Finally, we observe that ecosystem components are interconnected into a whole.

Important Concepts

Studying ecosystems can enable us to understand the core of environmental problems, and then discover solutions based on this understanding.

The Ecosystem Unity

Environmental components function as one body. If one part is suffering, the other parts are suffering also. If seawater is polluted, fish and marine birds are also polluted, and human life is endangered.

Material Cycling

In natural ecosystems, materials circulate continuously and do not accumulate as wastes because the waste of one living creature is the food of another living creature.

Many human activities use materials one-way instead of cyclically. So, accumulated wastes result on the one hand and natural resources are depleted on the other hand. Recycling discarded materials is an action in which humans resemble natural ecosystems.

Maximum Limits

Ecosystems perform their functions and maintain their existence as long as they are not exposed to pressures exceeding the

maximum limits of their capability. For example, an area of green grass can regenerate what is lost due to being eaten as long as the number of animals does not exceed the area's ability to regrow. If it exceeds it, the vegetation cover of the soil will be removed, and then the soil will be eroded, resulting in loss of fertility and the breakdown of the whole ecosystem.

Similarly, bacteria living in a body of water can decompose organic wastes and purify the water, so long as the quantity of organic waste is not too large. If it is large, the decomposition process will occur until all the dissolved oxygen in the water is consumed, and fishes die due to the absence of oxygen.

Conclusion

Knowledge is power, and we can learn a lot from studying natural ecosystems. The first thing we need to learn is systems thinking.

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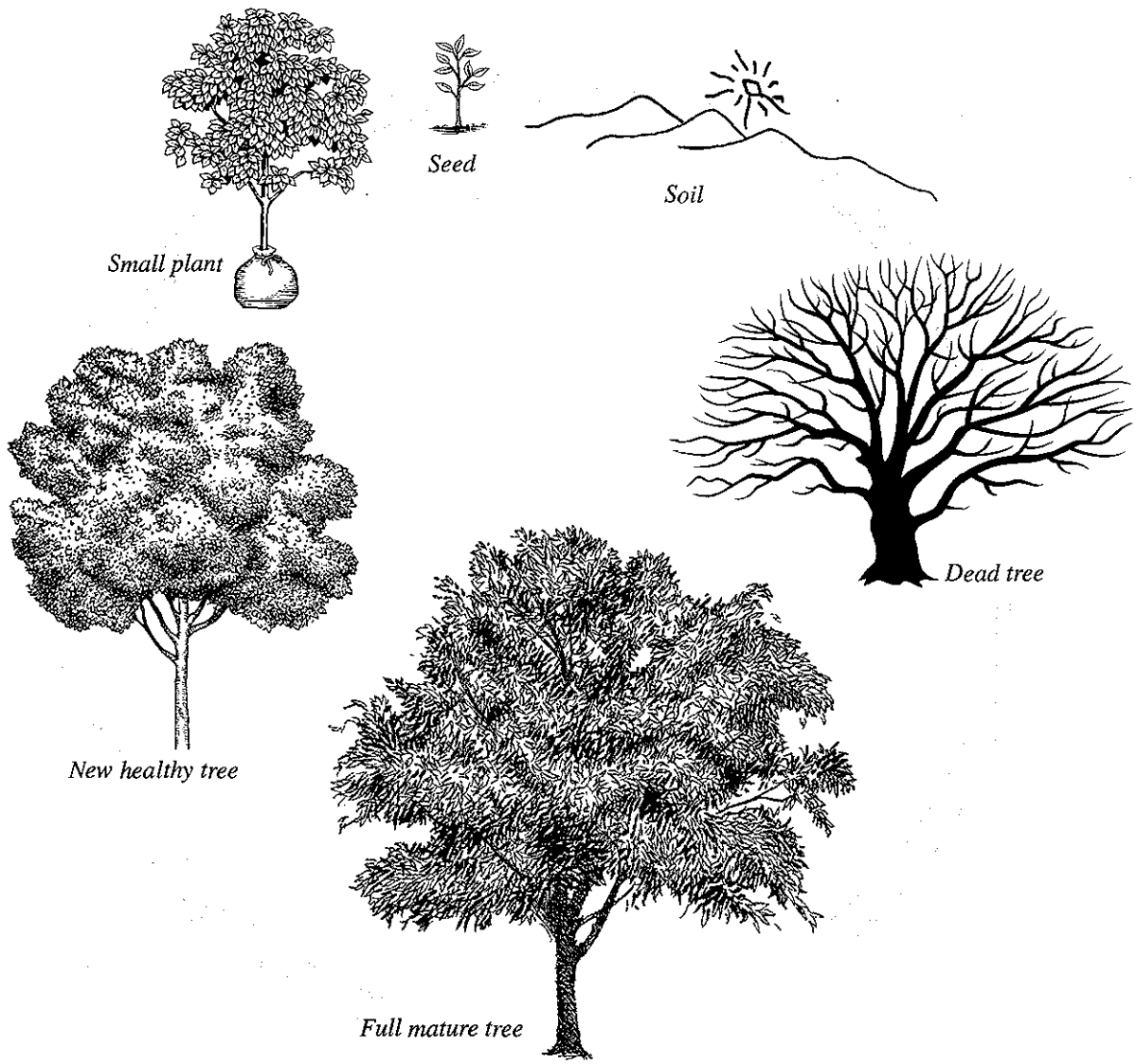
1) El Kassass, Mohammed. Man, Environment and Development, Reading Series #656. Cairo: Dar El Ma'ref, 2000.

2) Nebel, J.B. and Wright, T.R. Environmental Science, 6th edition. New Jersey: Prentice Hall Inc., 1998.

Natural Life Cycle



Human activities can also follow a natural life cycle.

Reference: Let's Reduce and Recycle: Curriculum for Solid Waste Awareness. EPA, 1990.

Activity (1)
Humans and the Environment

Concept:

Humans are an integral part of the environment where they live. They influence its elements and are affected by them. In spite of the fact that humans live in different environments, the basic elements of these environments are the same, because they are interrelated in a networked and complex structure.

Objective:

1) Encourage participants to understand that humans live in different environments as they move through the practice of their daily lives.

2) Inform the participants of the basic elements and components of the environment and the existing interrelationship between them.

Methodology:

Small group discussions, followed by a general session

Location:

Classroom or library hall

Duration:

30-45 minutes

Materials and Equipment:

Paper, pencils, chart, boards

Steps:

1) The facilitator will ask the participants to form small group discussions of 5-6 persons.

2) The facilitator will ask each group to select a specific environment to imagine living within. For example, one of the groups may imagine that it is a group of fisherfolk living in a coastal region. Another group may imagine that they are a group of grazers in the desert, farmers in a rural area, or citizens of an industrial mega city.

3) Every group discusses the kind of life that the selected group lives.
   a) What do people do in their lives?
   b) What do they need to satisfy their basic needs?
   c) From where do they get their basic needs?
   d) What are the different environments that they are exposed to or live in to do their jobs and satisfy their needs?
   e) How do they organize their lives? And what are the opportunities to meet their needs?
   f) What are the methodologies and maneuvers that they follow for transforming their natural resources into services and commodities?

4) In the end of the discussion, every group will summarize the main points on a chart.

5) In the general session, a group representative will present the main findings of his or her group.

6) After the end of the group presentations, the facilitator will moderate a discussion focusing on the following points:
   a) In spite of the different activities of the various groups, there is always a correlation between people and the environment where they live.
   b) People use different parts of the environment to satisfy their needs.
   c) These needs are satisfied through transforming natural resources into services and commodities.
   d) People live in communities formed by an interrelated number of worlds, systems, or arrangements:
      * Components of the natural and physical world: air-water-soil-energy.
      * Cultural and social organization.
      * Technologies.
      * Interactions between living creatures and the components of the physical world, which creates ecosystems.
      * Interactions between technologies and ecosystems in which humans master methods to use natural resources.
      * Interactions between the above elements and the factors of social and cultural organization that define priorities of needs satisfaction and the distribution of resources, commodities and services among people.

Interactions of humans and their environmental elements makes environmental education an interdisciplinary subject

Source: Abou Bakr, H. and Adel, H. Environmental Education Workshop, Horizon for Environment and Development. Cairo, Egypt: 2000.

Environmental Education

Environmental education is a continuous process for human beings. This process aims to communicate environmental awareness, information, behaviors and environmental values to targeted sectors in both informal and formal education. In addition, it is a commitment to act, and a moral responsibility towards the rational use of resources for sustainable development. Because the environment cannot be considered separately from other issues, environmental education must be integrated in all subjects of study. The real challenge must call for creation and innovation among teachers to incorporate a number of environmental concepts in the curricula and to integrate learning activities.

What Is Environmental Education?

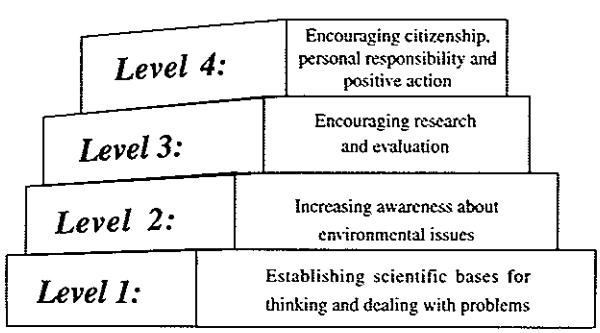
The UNEP and UNESCO conference in 1987 discussed the issues of environmental education and environmental training and resolved that:

"Environmental education must try - at the same time - to create awareness, disseminate information, teach knowledge, develop habits and skills, encourage values, offer standards and measures, and introduce guidelines for problem solving and decision-making."

So, environmental education aims to inform behavior, knowledge and skills, and thus obligates the practice of classroom and field activities. This process aims at enacting positive actions and focuses on achieving definite projects that are based on participation, develop self-confidence, and create positive behavior and personal commitment towards environmental protection. In addition to this, the application of this process requires the cooperation of individuals from different fields of expertise.

Environmental education is a process that enables the development of the skills and behaviors required to understand the relationship between human beings, their cultures, and the biological and physical world.

Thus, programs of environmental education include the acquisition of knowledge and the development of skills. But it must also encourage eagerness, motivate awareness and lead to an interest based on knowledge that will be translated into positive action.



Different Levels of Environmental Education and Their Objectives

Different Levels of Environmental Education Objectives

Example: Solid Waste Management

Level 1:

This is the basic information necessary for the initiation of a discussion about solid waste issues. This will include an introduction on solid wastes in general, the concept of solid waste management, and the components of this concept in national and local strategies for solid waste management.

In this level, the discussion may include the following subjects:
1) Definitions of solid wastes
2) History of solid wastes
3) Integrated management of solid wastes
4) Source reduction
5) Reusing and recycling
6) Organic fertilizer production (composting)
7) Waste - to energy - generation
8) Sanitary landfilling

Level 2:

This level will address the problems and various issues concerned with solid wastes and corresponding values and beliefs. In this level the students will understand points of difference in dealing with solid wastes. Instruments for analysis of such issues must be available.

In this level the following issues may be discussed:
1) Understanding the solid waste issue
2) Correlating beliefs and values to the solid waste issue
3) Analyzing solid waste issues
4) Networking different issues of solid wastes

Level 3:

Encouraging research and evaluation.

In this level students will acquire the skills and instruments necessary to collect research to answer the many questions raised in levels 1 and 2.

The following items may be discussed:
1) Listing the necessary information
2) Collecting data from secondary sources
3) Collecting data from primary sources
4) Analyzing data and presenting information collected on solid wastes
5) Studying the issue

Level 4:

This level is based on the three previous levels. It will present to the students the most important objective of environmental education -- the establishment of a responsible and positive citizen.

In this level, the following issues may be discussed:
1) Developing action plans for specific issues
2) Following up and evaluating the results of action plans

Sources: Adapted from Environmental Education Activities for Primary Schools. UNESCO, 1992. Hungerford, H., et al. Solid Thinking About Solid Waste. Carbondale, IL: Southern Illinois University, 1992.

Activity (2)
Environmental Education for Secondary Technical Schools

Concept:

Environmental education is a continuous process of promoting environmental awareness, knowledge, behaviors and values to target groups in both formal and informal learning situations.

Objective:

Achieve a common understanding of environmental education and its objectives.

Methodology:

Brainstorming, holding a general discussion and summarizing the results.

Location:

General session

Duration:

15-30 minutes

Materials and Equipment:

Paper, pencils, charts, cards, over-head projector and screen

Steps:

1) The facilitator will moderate the brainstorming session with the goal of answering the following questions:
   a) What is environmental education?
   b) What is its objective?
   c) Is there any specific age category that is the preferred target of environmental education?
   d) Should environmental education be dealt with as a separate subject, or should it be integrated with other subjects?
   e) What relationship do you see between environmental education and technical secondary schools?

2) The facilitator will record the main points on the chart. The overhead projector may be used for the presentation of transparencies that summarize environmental education and its objectives.

Source: Abou Bakr, H. and Adel, H. Environmental Education Workshop. Horizon for Environment and Development. Cairo, Egypt: 2000.

Activity (3)
Nuts Game
Demonstrating the Sustainability Concept

Concept:

Sustainability means satisfying the needs of the existing generation of people without harming the environment, over-depleting natural resource bases or taking away the rights of future generations to enjoy the resources with the same availability.

Objective:

Communicate the message that natural resources have a limited ability to be renewed, and our behavior towards natural resources will either enable this renewability or destroy it.

Methodology:

A simple game played by a group of male and female students modeling people's practices with natural resources.

Location:

Library hall or classroom

Period:

30-45 minutes

Materials and Equipment:

Big board or tablet of paper to write the goal of the game and its rules, table for recording results, jar with a diameter of 30cm, 140 nuts or small balls or big bean seeds

Steps:

1) A small group (4 or 5 people) will sit around a round table with a dish of 25 nuts. The supervisor will introduce the game and display a banner with the written objectives and rules (see the sample chart).
2) Players will read - silently - the objectives and rules of the game.
3) The game starts with a sign from the supervisor.
4) After the completion of the game, the total gains of each player and the total gains of the group will be recorded.
5) After finishing the first group game, another four to five participants will repeat the game.
6) Two questions will be asked in the general session:
   - What did you feel during the game?
   - What did you learn during the game?
7) Important points to consider during discussions: cooperation, self-control, trust, renewability of natural resources, resource depletion, total gain and fairness of the distribution.
8) In this game the jar represents the resources reservoir (e.g. soil), the nuts or balls represent the resources themselves (agricultural crops, soil fertility, etc), and the refilling of the jar represents the natural rate of renewability of the resource.

Important Note:

A) The first round: The first group of players will end the game after a few seconds, as players' response will be to collect as many nuts as possible. The jar will be

emptied and will not be refilled, as the supervisor cannot double the amount of resources (because there will be nothing left to double!!).

B) The second and the third round: These players will usually take more time and play more rounds. If they do not, and time remains, then the supervisor can initiate a discussion on the similarity between the game and real life, and can guide the discussion towards the concepts of sustainability and renewability of resources.

After the discussion, it is expected that the players will take a longer time and play more rounds so that every player should have more goals and the group should have more total scores.

Nuts Game

Objective:

Every player tries to gain as many nuts as possible

Rules:

* When the supervisor gives a sign, the players will take nuts from the jar, all of them doing so at the same time but using only one hand; this is a round.

* After each round, the supervisor will add double the number of the remaining with a maximum of 25 nuts.

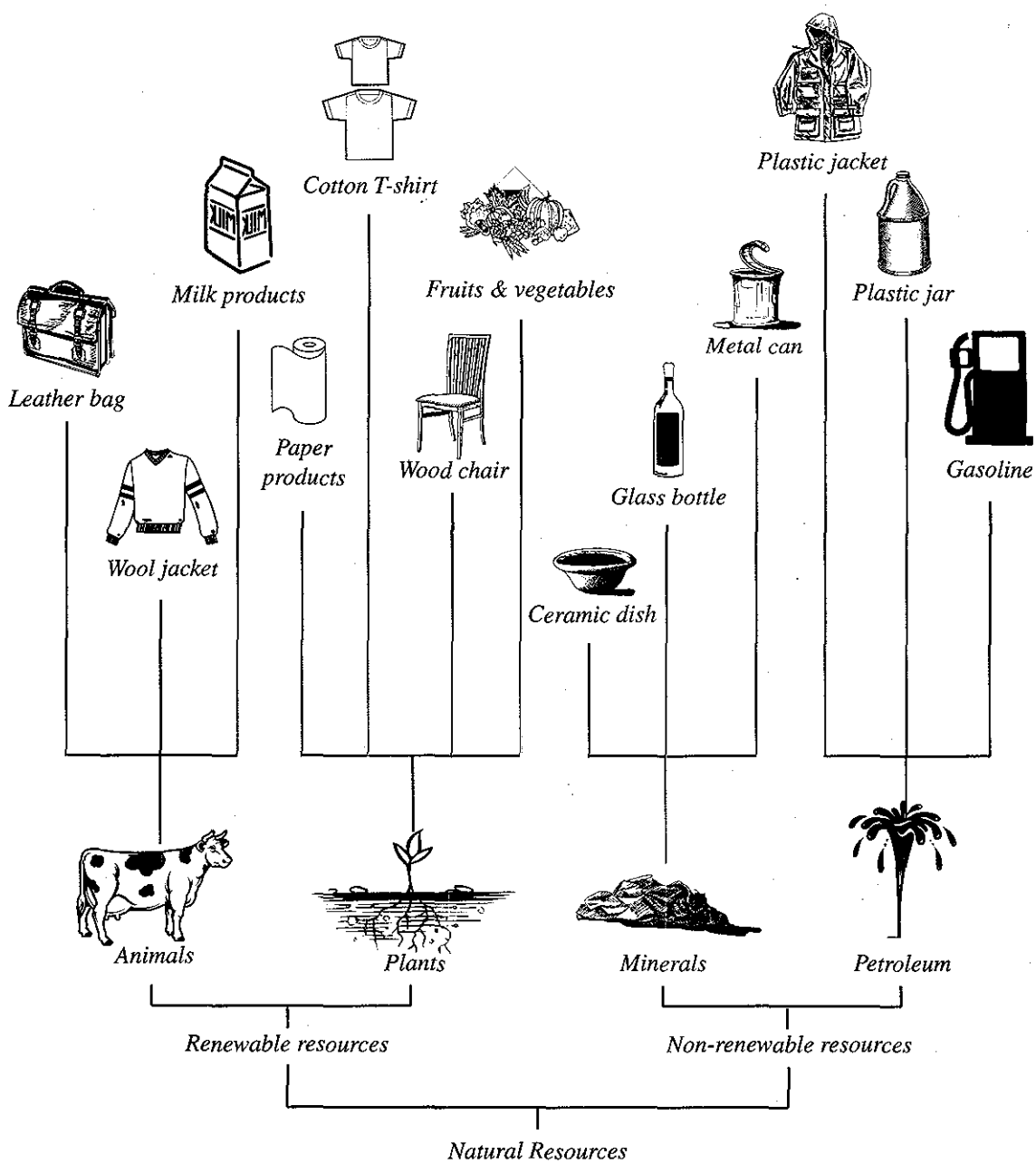
* The game will end when the jar is empty, or after ten minutes.

Score Record

Players:	1st group	2nd group	3rd group	4th group
Player 1				
Player 2				
Player 3				
Player 4				
Player 5				
Total				
Minimum score				
Maximum score				
Average				

Source: Adapted from Van Veldhuizen, L, et al. Developing Technology with Farmers. London / NY: Red Books Ltd., 1997.

Renewable and Non-renewable Natural Resources



Health and the Environment

The environment is the surrounding circumstances around species, and necessarily affects their health and safety. Any deterioration in environmental quality endangers the health of species as well as humans.

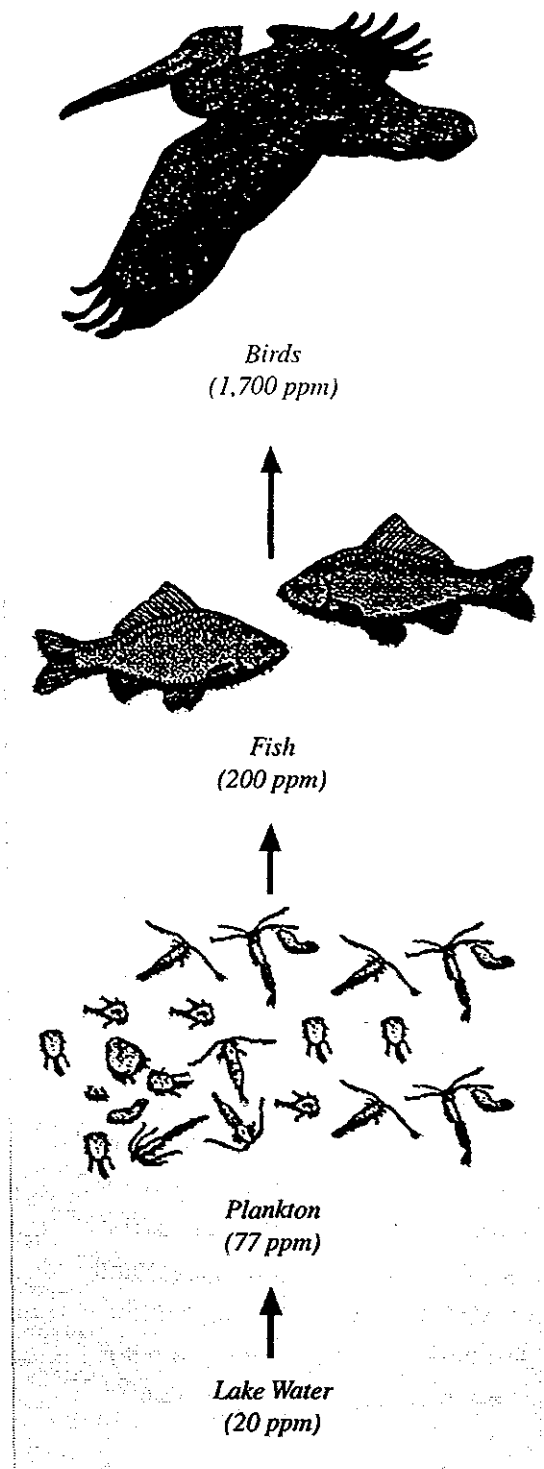
The following is a short summary of the most important materials and sources that cause health risks due to environmental deterioration.

Heavy Metals

The most dangerous heavy metals are lead, mercury, arsenic, cadmium, tin, chromium, zinc, and copper. These metals are commonly used in industry, especially in metallurgical workshops, and in the production of goods such as batteries, electronics, pesticides and medical supplies. Also, these heavy metals are used in dyes, paints, inks, varnishes and polishers because of the bright colors of some of their compounds.

As heavy metals dissolve, in ionic form, in water, the body can absorb them. When these compounds enter the body, they become linked to proteins and suppress the actions of the enzymes of living organisms.

Very small amounts of those heavy metals cause strong damage to the central nervous system and other organs of the human body. Among the famous examples is mental retardation resulting from lead poisoning, and mania and congenital malformation due to mercury poisoning.



Bioaccumulation of Pollutants

What makes these heavy metals even more dangerous is that they are accumulated in the bodies of living creatures. Due to this accumulation, small amounts that seem

harmless can reach poisonous levels when the body is exposed to them for a long time. This phenomenon is known as "bioaccumulation."

The accumulation of pollutants in the bodies of individuals is magnified through the food chain. A living creature is exposed to concentrations of pollutants through its food or environment. Then this living creature concentrates pollutants in its body. A creature that eats the first creature will have a more concentrated accumulation of pollution; thus, the accumulation of pollution in the food chain increases at each step up the chain. The living creature (such as a human) at the top of the chain is exposed to more concentrated levels of pollutants than that existing in the environment of an organism in the bottom of the chain. This concentration that happens through the food chain is known as "bioconcentration."

To avoid health risks from heavy metals, there is a requirement that organic compost of garbage or sewage sludge must not contain high concentrations of pollutants that might accumulate in plants and other organisms. The protection of irrigation canals and fisheries necessitates that municipal wastes or sewage with hazardous substances cannot be disposed of without first undergoing treatment to get rid of the heavy metals.

Non-biodegradable Synthetic Organic Materials

Synthetic organic compounds refer to the chemical structures of products such as plastics, synthetic fibers, synthetic rubber, modern paints, solvents, pesticides, wood varnish and hundreds of other products. The danger from these compounds originates from their similarity to natural organic compounds, which allows them to be absorbed inside the body. Here the compounds react with enzymes, but because synthetic organic compounds are biologically stable, the body cannot break them down or treat them like organic compounds, causing the inactivation of its functions. Swallowing large doses of these compounds will lead to acute poisoning or even death. Exposure to small doses of these materials over a long period may lead to genetic change (mutation, cancer, congenital malformation), malfunctioning of the liver and kidney, infertility, and many other dangers to the central nervous system and the other body systems (Table 1).

Synthetic organic compounds include a group of halogenated hydrocarbons that cause a lot of health problems. Halogenated hydrocarbons are organic compounds that include chlorine, fluorine, bromine, and iodine, and in their molecular structure replace one or more hydrogen atoms. Those four elements are known as halogens, and hence the name halogenated hydrocarbons. Chlorinated hydrocarbons (which contain chlorine) are commonly used in plastic materials (PVC vinyl chloride), pesticides (DDT, Merix, Quibon), organic solvents (tetrachlorocarbons), electrical insulators (chlorinated polyvinyls), fire resistant substances, and many other products. Workers in the factories that produce these

Table (1)
Examples of Poisonous Synthetic Organic Compounds Commonly Found in Chemical Wastes

Chemical Compounds	Well-Known Health Impacts*							
	Mutations	Cancers	Malformation of Newborns	Newborn Fatalities	Nervous Breakdowns	Liver Diseases	Kidney Diseases	Lung Diseases
Benzene	x	x	x	x	x	x		
Di-chloro benzene	x			x	x			
Hexachloro benzene	x	x	x	x				
Chloroform	x	x	x	x	x	x		
Carbon tetrachloride	x		x	x	x	x		x
Chloro ethylene (phenyl chloride)	x	x			x	x	x	
Di-chloro ethylene	x	x		x	x	x	x	
Tetrachloro ethylene					x	x		
Tri-chloro ethylene	x	x			x	x		
Heptachlor	x	x		x	x	x		
Poly chlorinated bi-phenyl	x	x	x	x	x	x		
Tetrachloro di-benzo- dioxine	x	x	x	x	x			
Toluene	x			x				
Chloro toluene	x	x			x			
Xylene			x	x				

Adapted from: Epstein, S.; Brown, L.; and Pope, C. Hazardous Waste in America. Sierra Club Books. 1982.
* As deduced from experimental animals.

must use protective clothes that prevent pollutants from reaching the body, and wear masks that protect the respiratory system.

Pathogens

Pathogens are defined as all organisms responsible for causing diseases in humans. These include bacteria, fungi, viruses, and parasites. The tissues, fluids and excretions of diseased persons and animals contain a large number of pathogens that can affect large numbers of creatures. Even after the symptoms of the disease disappear, the diseased person or animal still carries low numbers of pathogens. If drinking water or food are polluted with individuals' and animals' wastes, then these pathogens can reach other persons and infect them with the disease.

Untreated sewage and clinical wastes are among the main sources of pollution by pathogens (Table 2). If sewage is drained without treatment, is added to the municipal wastes and reaches a dumpsite, then surface water, groundwater and fish are contaminated, in addition to crops irrigated with polluted water. There is a requirement that manufactured organic compost be free of pathogens (produced by wastes or sludge) before its usage in fertilizing agrosoil.

Table (2)
Pathogens Carried in Sewage

Disease	Pathogen
Typhoid	Salmonella typhi bacteria
Cholera	Vibrio cholerae bacteria
Salmonellosis	Salmonella bacteria
Diarrhea	Escherichia coli bacteria
	Compylobacter bacteria
Infective hepatitis	Encephalitis A virus
Encephalitis	Encephalitis virus
Encephalitis	Shigella bacteria,
Dysentery	Entamoeba histolytica
Giardiasis	Giardia intestinalis
Other parasitic diseases	Worms

Cleaning to prevent pollution of water pathways and treatment of clinical wastes according to hazardous wastes treatment codes will lead to protection from these pathogens.

Main Air Pollutants

The following eight groups are the most well-known and hazardous air pollutants.

1. Suspended particulates and aerosols in the air. We can feel these particulates and aerosols in the form of dust, smoke and sprinkles. These particulates are always carrying other air pollutants on their surfaces or diluted in their substances. These particulates cause a lot of respiratory problems, especially to those persons suffering from chronic asthma of the respiratory system.

2. Volatile organic compounds (VOC). These include substances like benzene, paint solvents, and organic cleaning liquids. They are introduced to the atmosphere as evaporates. They also include compounds produced by the incomplete oxidation of fuel and wastes. These compounds are among the factors responsible for the formation of ozone.

3. Carbon monoxide. This is an odorless, colorless gas that is severely poisonous for humans and animals to breathe. It is toxic because it attaches to the hemoglobin site of oxygen and prevents oxygen from reaching the tissues of various organs. This gas is produced as a by-product of the incomplete combustion of fossil fuel.

4. Nitrogen Oxides. These are gases that transform into nitric acids in the atmosphere. They are the main sources of acid rain. Nitrogen dioxide irritates the lungs and may lead to acute respiratory disease in children. Nitrogen oxides are produced during the combustion of fossil fuels and solid wastes.

5. Sulfur Oxides (mainly sulfur dioxide). This is a poisonous gas for plants and animals. This gas especially affects children and elders. It is transformed into sulfuric acid in the atmosphere and thus is also a main source of acid rain. Like nitrogen oxide, it is produced during fossil fuel combustion, as sulfur is an impurity found in fossil fuels.

6. Lead and heavy metals. Lead enters the atmosphere as an emission from vehicles

that use leaded gasoline. It is added to gasoline to raise machine efficiency. Many countries have banned the use of leaded gasoline in order to prevent air pollution.

7. Ozone and photochemical oxidants. We know that ozone is present in the upper layers of the atmosphere and that it is important for the protection of living creatures from ultraviolet rays. But ozone if present near the earth's surface is harmful. It is poisonous for plants, and in animals it affects lung tissues and is correlated to many lung diseases. The presence of ozone in the lower layers of the atmosphere is an example that reinforces the definition of pollution as "chemicals present in the wrong place."

8. Atmospheric toxins and radon gas. These include toxic chemicals present in the air, such as carcinogenic chemicals, radioactive substances and other substances (asbestos, phenyl chlorides and benzene), besides traditional pollutants, emitted in the air. Radon gas is a radioactive gas produced due to natural processes in the earth's layers. All radioactive substances can harm the living creatures exposed to them.

Safe industrial processes, the use of pollution control methods to prevent pollution at its source, treatment of emitted gases, and reengineering designs will lead to reductions in pollution. This helps both protect the environment and maintain human health.

Noise

Noise is not only annoying for humans, it is a danger to health and safety. Continuous exposure to noise leads to hearing loss. Studies show linkages between noise and physiological changes in sleep, blood pressure and digestion. Also, there is a link between noise and negative genetic impacts on newborns. Noise also increases workers' risks as it reduces their attention and thus increases workplace casualties.

Experts advise that continuous exposure to a level of noise exceeding 85 decibels will weaken hearing. When defining harmful levels correlated to hearing both noise level and length of exposure are considered. When the level of noise increases, there will be quick damage to hearing. For example: a level of exposure of 95 decibels for four hours daily will lead to hearing loss. Exposure to noise levels of 115 decibels for fifteen minutes daily will gradually lead to hearing loss. A one-time exposure to levels higher than 141 decibels will damage hearing.

The National Institute of Occupational Safety and Health (NIOSH) in the United States warns that the maximum safe exposure to a level of 85 decibels is five hours, and that the maximum safe exposure to 110 decibels is 1.5 minutes. Experts recommend to those who are obligated to expose themselves to high levels of noise (Table 3) that they either limit the period of exposure or wear protective devices.

Table (3)
Some Levels of Noise in Homes or Workplaces

Home	Decibel	Work	Decibel	Outside	Decibel
Refrigerator	50	Library	40	Calm population area	40
Washer	50-70	Manual saw	85	Rain	59
Vacuum cleaner	60-85	Underground metro	90-115	Vehicle horn	110
Telephone ringing	80	Factory equipment	80-110	Thunder	120
Rotator	80-90	Plane taking off	140	Bullets	170

* **Derived from:** Noise Levels in Our Environment fact sheet, http://www.lhh.org/noise/decibel.htm, copyright 1996-1999. League for the Hard of Hearing. Updated March 19, 1999.

Owners of enterprises where workers are exposed to high levels of noise must periodically monitor the levels of noise, measure the level of hearing of workers, inform workers of the levels of noise and results of hearing measurements, and train them to use protective devices against noise.

Health Protection

Accounting for the various types of environmental pollutants and preventing them from reaching the environment is better than acting after they have polluted our environment. "Protection is better than the remedy". However, if these pollutants have already reached the environment, protection measures should be taken whether at a workplace or in public places.

References

1) Nebel, J.B. and Wright, T.R. Environmental Science, 6th edition. New Jersey: Prentice Hall, Inc, 1998.

2) Purdom, W.P., editor. Environmental Health, 2nd edition. Orlando, Florida: Academic Press, Inc, 1980.

3) http://www.lhh.org/noise/, copyright 1996-2000, League for the Hard of Hearing.

What Is Waste?

Waste is defined as materials -- either solid or gaseous -- that their owners neglect when they believe they no longer have any value.

Due to their accumulation in the environment they produce negative impacts on human health and the locations where people live.

Wastes are of various kinds and different characteristics. An inclusive list of various wastes follows.

1) Solid Wastes

Defined also as garbage or municipal wastes, and produced by houses and other locations such as hotels, schools, clubs, hospitals, commercial and industrial workshops and plants.

2) Industrial Wastes

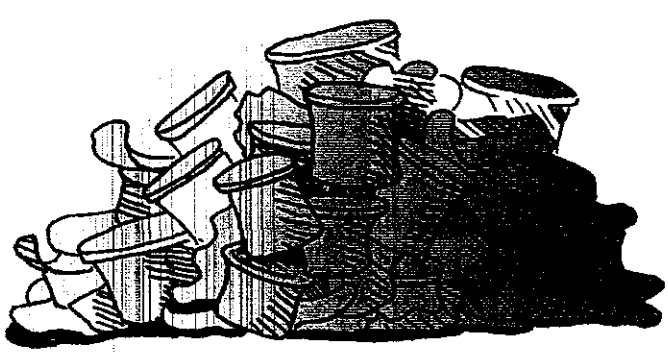
Wastes produced from all industrial activities. For example, mining wastes, petroleum production wastes, and liquid wastes from the production of oils and paints.

3) Clinical Wastes

Wastes produced by hospitals, medical labs and clinics, which include blood and its by-products, medical instruments and materials, and surgical remnants.

4) Hazardous Wastes

Wastes that require specific methodology in handling them and that threaten human health and life. The factors defining the danger of these wastes are: flammability, explosiveness, corrosiveness, and toxicity. Most of them are generated by industry and the production of nuclear energy and weapons.



Impacts of Solid Waste Accumulation

What will happen if solid wastes are accumulated?

Solid waste accumulation affects all the ecological elements, soil, water, air, and living creatures. Some examples follow.

1) Impacts of Solid Wastes on the Atmosphere

The air in the atmosphere is composed of a group of gases, of which 78% is nitrogen, 21% is oxygen, and 0.03% is carbon dioxide. Also present are water vapor and inert gases. The atmosphere is in dynamic balance over the earth's surface as its amount and component ratio is relatively constant. This balance is due to the existence of green leaves that undergo photosynthesis and absorb carbon dioxide from the atmosphere, and in the presence of solar energy produce the oxygen necessary to sustain the life of creatures on the earth's surface.

Accumulation of solid wastes, especially for long periods, will lead to air pollution because of the gases emitted by these wastes. Therefore, changes in air components take place and thus air becomes unsuitable for breathing by living creatures.

Accumulation of solid wastes will lead to the growth of many microbes, which in turn affects the health of living creatures in the polluted environment. This occurs because of the microbes' ability to decompose some components of the wastes and produce harmful gases like methane.

Air pollution will lead also to an increase in the disease incidence of allergies and ophthalmic diseases, in addition to the bad smell that affects the quality of life in the polluted areas.

Incineration of solid wastes will produce carbon dioxide, the gas that is the main reason behind the greenhouse phenomenon. In the greenhouse phenomenon, the earth catches more heat because of the physical character of carbon dioxide that prohibits heat reflected by the earth from dispersing into the atmosphere, thus increasing the earth's temperature.

Among the other dangerous gases produced due to incineration of solid wastes are the poisonous carbon monoxide, nitrogen oxide, and sulfur oxide gases; chlorofluorocarbons are released from aerosol cans and freon from refrigerators and air conditioners disposed in the garbage.

Chlorofluorocarbon gases deplete the ozone layer, which is the main atmospheric layer responsible for the protection of earth from harmful ultra violet rays coming from the sun.

All of these gases are poisonous and dangerous to the environment, causing damaging phenomena such as acid rain, which erodes buildings, kills both plants and animals, and changes soil characteristics.

The amount of gases produced from the incineration of one ton of garbage is 3000 6000 cubic meters (m^3) of gases.

The reduction in Egypt's local production due to air pollution is estimated at US$100 million annually. The public health costs due to air pollution from solid wastes are $9.6 million annually.

2) Impacts of Solid Wastes on Soil and Water

The main characteristics of water are that it is colorless, odorless and tasteless; any change in these three characteristics is pollution. Polluted water has a dangerous impact on health and the quality of life in a community.

The impacts of solid wastes on water are:

a) Changes in water characteristics, chemical pollution, and negative impacts on the water habitats of living creatures. Thus, imbalances in water composition lead to a limitation on biodiversity.

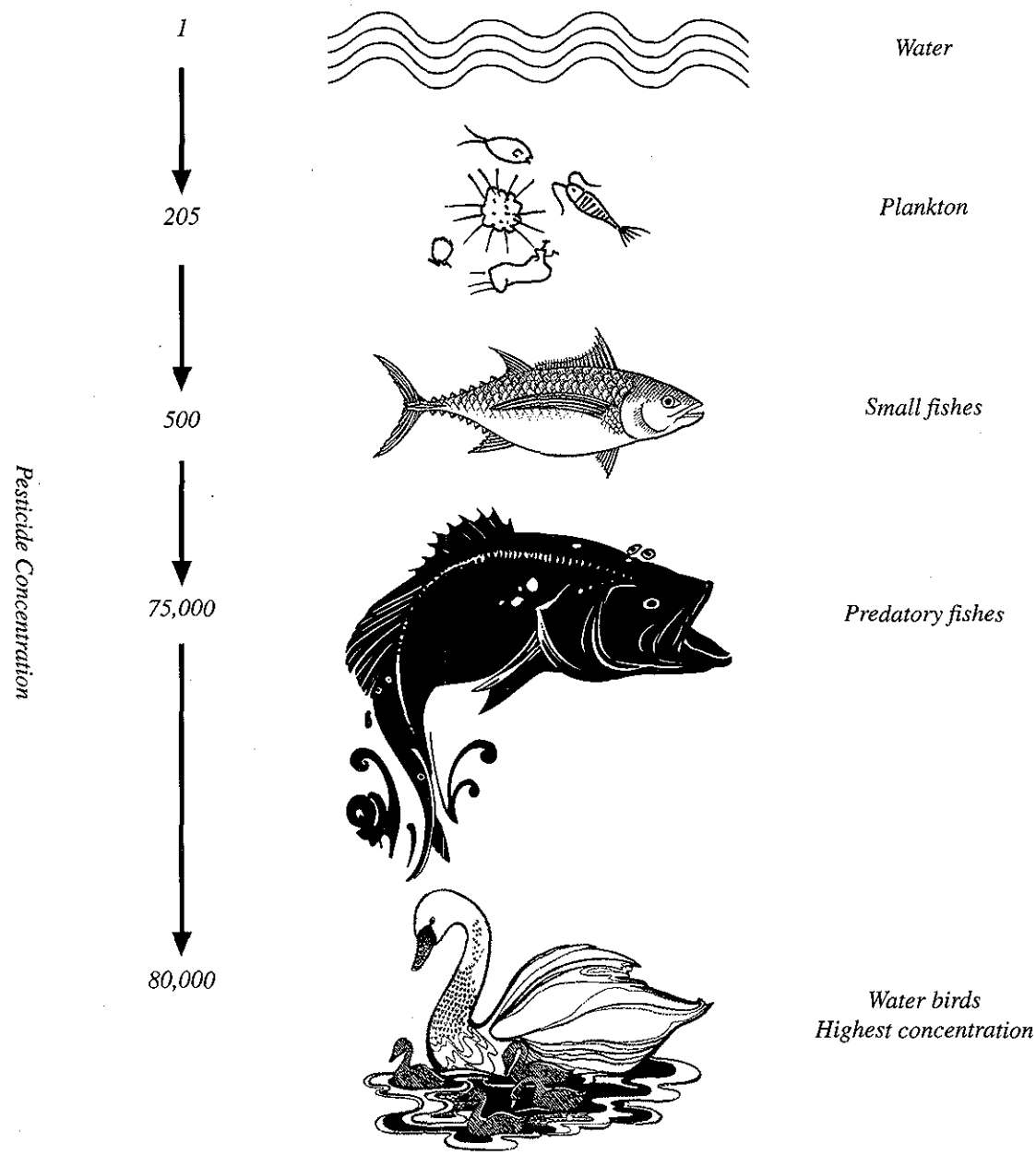
b) Water carries pollutants from one place to another, transmitting them to other creatures in contact with the water. This causes dangers like enteric diseases, cholera, dysentery, and infective hepatitis, in addition to the presence of parasites that attack human beings such as ascris, fashiola and tin worms.

c) Unsanitary garbage landfills pollute underground water -- a future water reservoir -- as seepage or leakage from the landfill will be transmitted to the surrounding soil and then change the chemical composition of the groundwater, making it unsuitable for human use.

d) Disposing solid wastes in canals obstructs the irrigation and drainage pathways, reducing the canals' drainage capability, so problems of irrigation and drainage will arise. Blockage of wastes will turn the running water into stagnant water. This will cause an imbalance in the habitat of the organisms in the water such that mosquitoes will increase along with their annoying effects and the increased transmission of pathogens. Water grasses will increase and aggravate the problem.

e) Leakage of polluted water due to wastes will change soil characteristics, and make it unsuitable for the cultivation of specific kinds of crops. In the end this will affect the biodiversity of creatures that live in or on it.

The amount of reduction in Egypt's local production due to water pollution from solid wastes is estimated at $51 million annually. The public health costs due to water pollution from solid wastes are estimated at $84 million annually.



Biological Accumulation and Concentration of Pollutants in Water

Source: Botrell, Dale. Integrated Pest Management. Washington, D.C.: Superintendent of Documents, U.S. Government Printing Office, 1979.

Activity (4)
Humans, the Environment and Solid Waste Management

Concept:

Humans are part and parcel of the environment and are affected by it. Environmental elements include air, water, soil, energy and living creatures that are interrelated into a complex web. Waste production due to human activity is negatively affecting these environmental components.

Objective:

Review the different impacts of solid wastes on the above environmental elements.

Methodology:

Open discussion in the general session about the environment and its interrelated elements. Brainstorming will follow in group discussions about the sources of solid wastes and their impacts on environmental components.

Location:

General session hall

Duration:

Approximately one hour

Materials and Equipment:

Paper, pencils, charts, colored cards, glue, stickers, and colors

Steps:

1) In the general session, the facilitator will focus the discussion around the relationship between humans and the environments where they live. (The diagram used in "Activity 1" can also be used for this activity).

2) The facilitator will raise questions such as:
   * What do humans need to live?
   * From where can they get these needs?
   * What is the relationship between the first and the second question?

3) The facilitator will encourage the participants to think about the link between human needs and natural resources. The discussion should include definitions of the five basic elements of the environment:
   * Energy / Air / Water / Soil / Living Organisms

4) The facilitator will ask the participants to form four groups to discuss the relationship between solid waste problems and the five basic environmental elements. Every group can concentrate on the following points:
   * What are the different sources of solid wastes?
   * What is the relationship between solid wastes and pollution from other kinds of wastes (gaseous and liquid)?
   * What is the impact of these wastes on energy, air, water, soil and different forms of life such as plants, animals and microorganisms?

5) Every group will select a representative to summarize the discussion outputs and to prepare for the presentation in the general session.

6) Every group will select a suitable method to present its results; for example, each group can produce audio-visual methods such as diagrams and flipcharts that demonstrate the basic ideas about the topic.

7) In the general session, the recommendations of the discussion groups will be presented, and the facilitator will moderate a discussion to link the work of the different groups with the specific problem of solid waste management, as well as with more general problems of environmental resource management.

Source: Abou Bakr, H. and Adel, H. Environmental Education Workshop, Horizon for Environment and Development. Cairo, Egypt: 2000.

Activity (5)
Keeping the Balance
What Happens When We Burn Solid Waste?

Concept:

All living organisms inhale oxygen. This is then used in the respiration process, which supplies the energy necessary for different activities. This process is like burning a fossil fuel, as it produces carbon dioxide and water as byproducts, and some energy is lost as heat. Plants undergo the process of photosynthesis in which solar energy is used to form carbohydrates from carbon dioxide and water, with oxygen produced as a byproduct. Keeping a balance between these two gases -- oxygen and carbon dioxide -- in the atmosphere is a vital imperative.

Objective:

Illustrate the unseen balance between two gases: carbon dioxide and oxygen. It is obvious that the two gases are very important and essential for life, but the production of carbon dioxide is increasing very fast and is exceeding the ability of plants to absorb it. The concentration of carbon dioxide (one of the greenhouse gases) in the atmosphere is one of the factors that raises the temperature of earth. Carbon dioxide production can be studied by burning a candle, and then changing the amount of oxygen in the surrounding atmosphere.

Methodology:

Use glass jars and candles to model oxygen consumption in the atmosphere from the processes of combustion and respiration.

Location:

The laboratory or classroom

Duration:

30 minutes

Materials and Equipment:

Glass jars of different sizes, candles of different sizes, clay, match boxes, wood cubes, bottle of vinegar, sodium bicarbonate ($NaHCO_3$), glass lamp or kerosene lamp, watch, paper, pencils

Steps to Set Up the Experiment:

1) Secure the candle on the table using clay or mud.

2) Light the candle, and cover it with the glass jar.

3) Observe how much time passes before the candle is extinguished.

Steps to Use the Experiment:

1) To simulate the impact of consuming more fuel, increase the number of candles in the jar.

2) Try to use different sizes of jars. You can measure the volume of air in each jar using graduated cylinders. Fill the jars that you are using with water to the brim. Pour the water into the graduated cylinder, and then read the volume of water that equals the volume of air in each jar.

3) Record in a table the time in which the candles remain lit in each case.

4) Consider the similarity between what happens to the candles in the different jars and what happens to people when many of them are in a closed place.

5) Raise the rim of the jar off the table using a piece of clay, a wood cube or a matchbox. Observe whether or not there is a difference in the amount of time the candles remain lit.

6) Test whether or not the candle will continue to be lit if we put a glass of a kerosene lamp on it.

Extension:

1) Obtain a small metallic barrel and make pores in its bottom.

2) Put the barrel in a safe place -- perhaps the school playground.

3) Place in the barrel assorted wastes -- food scraps, papers, plastic bottles, glass pieces, aluminum cans.

4) Set fire to the barrel contents.

5) Observe the amount of smoke emitted from the barrel, and record the answers to the following questions:

* Which objects burned, and which did not?
* Did any substances completely melt, and if so, which ones?
* How long did the fire continue in the barrel?
* Now, after doing this exercise, try to imagine the answers to the following questions:
  - i) Where does the smoke emitted from the garbage fires go?
  - ii) What is the amount of emitted gases released for eight hours each day by a plant's stack?
  - iii) What are the amounts and kinds of smokes and gases produced when agricultural wastes from rice, maize and wheat crops are burned in ten Egyptian Governorates?
  - iv) What are the amounts and kinds of smokes and gases emitted in a city where inhabitants burn garbage waste daily?
  - v) What is the effect of all the previous actions on the air that we breathe, and on our health?

Activity (6)
Measuring Air Pollution

Concept:

The atmosphere has a fixed composition of gases, including nitrogen (78%), oxygen (21%), carbon dioxide (.05%), inert gases such as helium (1%), and water vapor.

However, factory stacks and vehicles introduce other components -- some are gaseous and others are solid particulates -- into the air. While passing through the desert, winds pick up dusts that accumulate on various surfaces.

Objective:

Illustrate that suspended particulate matters are present in the air, polluting it and affecting its quality. These impurities are different from one place to another all year round. A relationship exists between the presence of those suspended materials in the air and the burning of solid wastes.

Methodology:

Simple equipment is used to monitor the solid suspended impurities in the air surrounding the school, house or club. The participants make and use the equipment.

Location:

Different places in and out of school, such as a garden, garage, carpenter's workshop, hotel or house kitchen, or textile factory entrance.

Duration:

This activity could continue for a week, with multiple thirty minute sessions to register the comments of the air monitoring group.

Materials and Equipment:

Medical cotton, filter paper, transparent plastic cups, plastic bottles, transparent adhesive strips, white paper, magnifying lenses, small microscope, notebook to register observations, pens, knife or scissors, painting brush, paper holepunch.

Steps:

1) Cut the conical ends off a number of plastic bottles and remove their covers. Turn the cones over and put them on the other pieces of the bottles.

2) Put a piece of cotton or a circular piece of filter paper in the bottom of each cone. These are the units to monitor air pollution.

3) Collect a number of leaves from the plants in the garden or in the middle corridor of the main street. Put each leaf in a plastic cup. Add a little amount of water. Pass the brush over the plant leaves to enable the removal of dust, and remove the leaves from the cup.

4) Pour the cup contents into a cone of the pollution monitoring unit, and observe the collection of dust on the cotton piece or filter paper in each cone.

5) Write down your remarks, observing what papers are more polluted. Compare the degree of pollution between leaves taken from different directions and locations and record your observations.

Alternatives/Extensions:

Simple monitoring units can also be made following these steps:

1) Take a roll of paper and divide it into many pieces, such that each piece is 10cm x 10cm.

2) Bring adhesive strips and put them on the pieces of paper that you have made.

3) Bind the edge of the paper to protect the adhesive strip until you use it. Now you have made a small air monitoring unit.

4) Do not forget to prepare a similar card with the same characteristics to use as a comparison (but keep this one closed).

5) Take the ten pieces and distribute them to various places, e.g. a garage, a public garden, a kitchen of a house or hotel, near a smelter or a burning dumpsite, a bus station.

6) Make sure that your papers are placed firmly in their places and far away from air currents that may blow them away.

7) Leave the monitoring units in place for a week or more.

8) Collect the monitoring units and go back to the laboratory.

9) Investigate monitoring units by looking at them through a small microscope or magnifying glass. What do you see?

10) Write down your observations for each unit, and note its location.

11) Compare the units from the different places where you have collected your pieces. Is there any difference?

12) Record your observations:
- Wash each monitoring unit by itself over a filter paper, using a light flow of water, and register the location of the unit
- Compare the amount of dust and particulates produced in each place
- Ask the students the following questions:
  i) Why are there particulates suspended in the air?
  ii) Where do these suspended particles and dusts come from?
  iii) What is the relation between those suspended particles and solid wastes?
  iv) Discuss with students a number of actions that may reduce the amount of suspended solid impurities in the air.

Source: Adapted from Closing the Loop: Integrated Waste Management Activities for School and Home, Part 1: Everything Ends Up Somewhere. Ohio: The Institute for Environmental Education, 1995.

Activity (7)
Greenhouse Effect

Concept:

The sun irradiates short wavelength rays that reach the earth. These waves can pass easily through atmospheric gases. The objects on earth are much cooler than the sun, and they irradiate long wavelengths that cannot pass through the earth's atmospheric gases. This energy is captured like heat in a greenhouse.

Because of carbon dioxide accumulation, the earth catches more heat, which leads to what is called the "global warming" phenomenon, or the "greenhouse effect."

Objective:

Study the greenhouse effect, in which the earth's temperature may be increasing due to the accumulation of carbon dioxide in the atmosphere from human activities.

Methodology:

Making a small greenhouse out of cardboard and plastic bags.

Location:

Library hall, classroom, or a sunny place outside

Duration:

One hour for making the small greenhouse; different times for temperature measurement

Materials and Equipment:

Adhesive, cardboard box, scissors or knife, transparent plastic bags, containers of tin or plastic, paint (black and white), soil, water, thermometer

Make It:

1) Cut the box corners from the bottom so that it has wings; leave 4cm of the base to keep the box intact.

2) Bend the wings outwards and cut out rectangular windows on both sides, leaving a frame of 3cm.

3) Bind the longer frames together at the top, then cut the other two sides and bind their edges to the rest of the box (as shown in the diagram). Secure all the parts using adhesive.

Use It:

1) Put the greenhouse in the sun, hang the thermometer from the top of the frame of the greenhouse, and record the temperature.

2) Stick the transparent plastic bags on the frames of the two windows, put the greenhouse back in the sun, and record the new temperature.

3) Compare the temperature before and after fixing the plastic on the frame. What do you observe? Make sure that the placement of the box is identical during the two readings, and that there are no unwanted air currents.

Comments:

1) This simple study can lead you to discover another factor that affects the way the greenhouse works to trap heat.

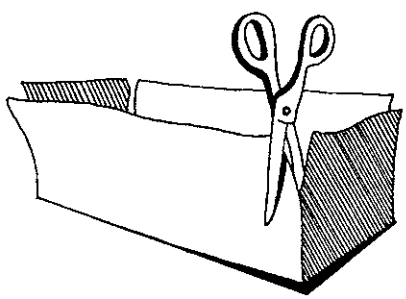
2) Bring another box, and make a greenhouse with a window on two sides. Cover the base of the greenhouse with plastic, and before its closure, make a door at one of the two ends to enable entry.

3) Now you can experimentally test another factor to see if it makes a change in the impact of the greenhouse.
   i) Try painting the box from inside with different colors. Then observe the temperature change.
   ii) Put empty tin cans, pieces of stones, gravel or water inside the greenhouse (those materials could be sources of irradiation when they store heat over a period of time, and release it gradually).

An Alternative Greenhouse:

We can develop an alternative design for the greenhouse using plastic bottles. Cut the conical part of the bottle, and separate it from the rest of the bottle. If using a bottle with a corrugated base, turn the bottle over to make the greenhouse, and put a ring of mud or clay around the border to firmly seal it. If using a bottle with a solid black cup, separate the cup from the rest of the bottle, and turn the bottle's body upside-down and place it inside the cup.

(1)



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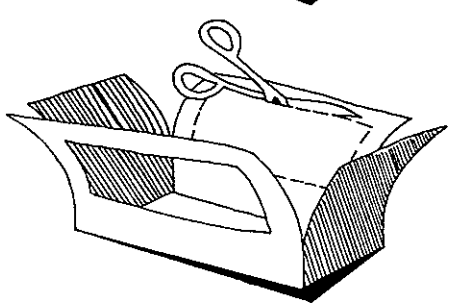

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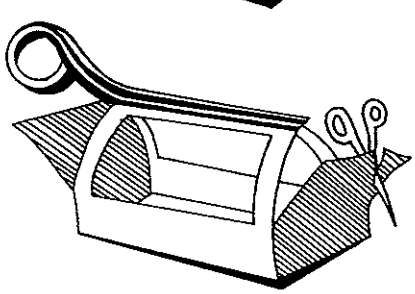

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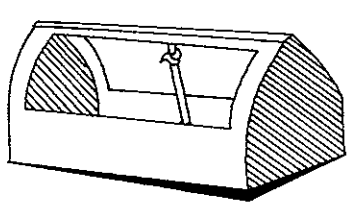

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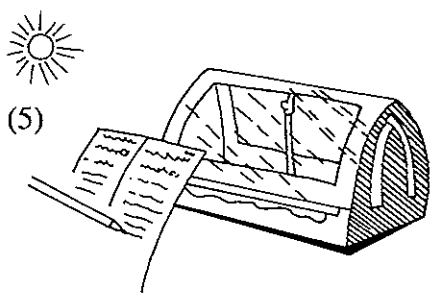
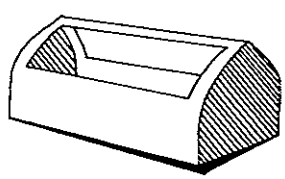
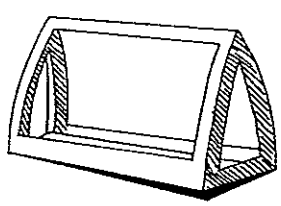
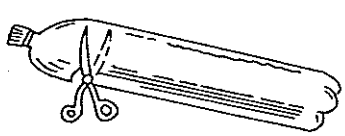
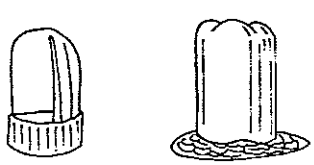










Activity (8)
Impacts of Solid Wastes on Water Resources

Concept:

The accumulation of solid wastes or their unsafe disposal will lead to the deterioration of fresh and marine water resources.

Objective:

Illustrate the impact of leakage of wastes on underground water quality as an example of water resources deterioration due to unsafe methods of dealing with solid wastes.

Methodology:

Model the filtering effects of soil layers by setting-up a filter of sand and gravel and then noticing the effect of the filter on different types of pollutants as they pass through the layers.

Location:

Classroom or school lab

Duration:

45 minutes

Materials and Equipment:

For the filter: six to eight empty plastic bottles, scissors or knife, pen, small washed stones, washed gravel, clean sand, muddy water, ink bottle (or coloring substance), salt, silver nitrate, clean test tube

For the turbidity measure: transparent plastic cups, transparent glass jars, hard papers, pencils, black ink pens

Steps to Make the Equipment:

1) Mark one of the plastic bottles at a point that is three-fourths of its height from the neck to the bottom, and then cut it into two parts.

2) Cut the conical part off a second bottle.

3) Remove the cap of the first bottle, turn it up-side down and fit it firmly in the lower part of the second bottle.

4) Make three to four other filter column units like this.

5) To make the turbidity measure or opacity measure cut a small piece of hard paper that fits exactly under the cup bottom. Write the numbers 1,2,3 ... using a pencil. Make the numbers the same size, but increase their darkness gradually, so that number 1 is written lightly, and then increase the darkness gradually and systematically with the following numbers.

Steps to Do the Experiment:

To make the filter bed:

1) Put the small stones in the bottom of the neck of the cut bottle, so that the neck's opening is fully covered but is not completely blocked.

2) Put the gravel over the stone layer, and then add a layer of sand. Finally, put small stones on the surface of the sand.

3) Pour turbid water over the small stones to pass through the bottle. It will accumulate at the bottom (keep some turbid water for comparison).

4) Compare between the turbid water and the filtered water. What do you notice?

5) What is the effect of the filter on the water? Do the stones and the gravel function separately?

6) Repeat the experiment with a longer filter column made by using more amounts of stones and sand. Compare the characteristics of the water each time it is filtered. Does the length of the filter column have an effect on water purity?

7) To measure turbidity or water opacity:
   a) Put the hard piece of paper under the cup.
   b) Add turbid water to a marked level, and leave it to settle for ten minutes. Now observe what numbers you can see. As the turbidity of the water increases, it is expected that you will see only a few numbers.

8) Add some ink or a colored substance to the turbid water, and pour this colored water over the small stones and through the filter. Observe the filtered water -- if it is still colored, what can you conclude?

9) Add table salt to the water, and pass it through the filter. Test the filtered water by putting a small sample in a test tube and adding drops of silver nitrate. What do you see?

   If a white precipitate is observed, that means that the silver nitrate interacted with the salt dissolved in the water to produce silver chloride, an insoluble salt.
   What can you conclude from these tests? Is it sufficient to filter the water through the sand layers in order to clean it? What is the analogy between this example and the disposal of solid waste in the ground?

10) Discuss with students the effect of leakage of dissolved substances from household and industrial garbage on groundwater, oceans, lakes, and canals. Ask one of the participants to write a summary of the most important impacts on the board.

11) During the discussion, initiate dialogue on the issue of biological accumulation of pollutants throughout the food chain (discussed in chapter one of this book).

12) Encourage the students to introduce proposals concerning water resources protection, and ask one of the participants to record these proposals on a big chart.

13) Ask the group to select one or more individuals to present its findings in the general session.

Other Experiments:

You can also make a small module of an unlined solid waste dumpsite in order to observe the leakage of water through its layers. Collect this water and then test its characteristics:

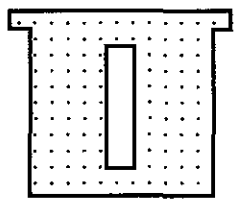
1) Make a hole in the bottom of a big tank of plastic, and insert a small tube connected to a tap (See figure). Lift the container off of the table in order to open or close the tap by putting bricks under the sides of the container.

2) Put small pieces of stones or bricks alongside the bottom of the container. Cut a circular piece of wire-mesh so that its diameter is equal or more than equal to the diameter of the bottom of the container. Fix it tightly in place, leaving a space between the bottom of the container and the garbage to allow for the collection of leakage water.

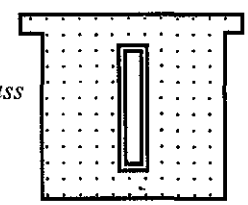
3) Fill the container with municipal garbage or school workshop wastes.

4) Model what happens in nature when rain falls or underground water mixes with dumped garbage. Water the surface of the container every two days. The water will be collected in the bottom of the dumpsite.

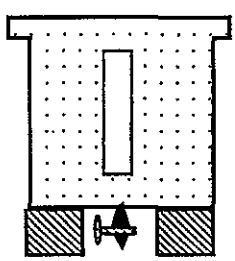
5) Open the tap and collect the water from the container. Test the water using the equipment and steps described at the beginning of this activity.



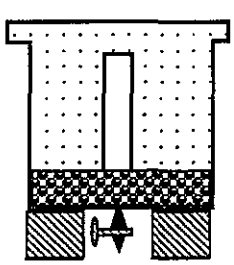
1) Make an opening that is 5cm X 60cm.



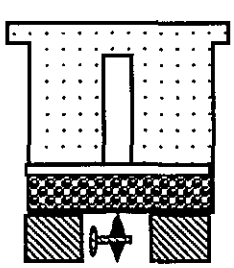
2) Place a transparent glass cover on the container.



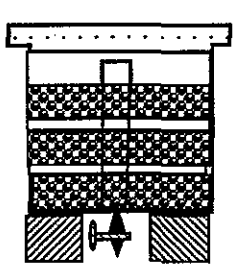
3) Put a screw tap in the bottom of the container.



4) Add the wastes.



5) Add the soil.



6) The last layer of soil is 10cm thick.

Source: Adapted from Activities of Environmental Education in Primary Schools. UNESCO, 1992.
Waste: A Hidden Resource. Take Pride in America, Tennessee Valley Authority, Environmental Education Program, 1988.

Activity (9)
Impacts of Solid Wastes on Agrosoil

Concept:

Fertile agricultural soil is a rare natural resource, but this resource is exposed to pollution from many sources, among them the dumping of solid wastes and harmful pollutants using unsafe methods.

Objective:

Illustrate the impact of pollution on soil fertility and growing vegetation.

Methodology:

Study the effect of pollutants on agrosoil using small containers with cultivated growing plants.

Location:

Classroom or garden corner

Duration:

Many days are needed to record the findings, but only an hour is needed to prepare the experiment.

Materials and Equipment:

Agrosoil; small plastic containers or empty yoghurt cups with holes in the bottom; seeds of wheat, beans, maize or helba; and various wastes, including building wastes, gypsum, cement, lime, pieces of rusty iron or tuna-fish cans, remnants of lubricant or cooler oils, leftover food from restaurants or houses, empty pesticide package, used batteries

Steps:

1) Fill the containers with agrosoil until they are approximately 2/3 full.

2) Divide the containers filled with agrosoil into units according to the number of sources of pollution available. Make sure that every unit has one container without any additives; that will be the control sample for comparison. Do not forget to put numbers on the containers and register these in the schedule as follows.

3) Add the pollution sources to be tested and then "irrigate" the different "fields" with small amounts of water.

4) Now, cultivate each field with similar numbers of seeds.

5) Register the date of cultivation, and water the containers sufficiently. Be sure that all the containers are located in one place, irrigated at the same time, and have the same fixed amount of water.

6) Document your findings:
   i) Do the seeds grow?
   ii) Are some of them delayed?
   iii) Are there vessels with no plants at all?
   iv) Are the rates of growth of plants different in different units?
   v) Do some plants die after only growing a little?
   vi) If so, in what units does this happen?
   vii) What is your explanation for this?

7) Now think about how to protect agrosoil from pollution.
   What is the importance of this? What are the benefits that we gain from this protection?

Experiment Results Registration Table

No. and Kind of Unit	Variables	Observations Dates
1. Cement	A B C	
2. Lubricant oil	A B C	
3. Pesticide cans	A B C	
4. Paints	A B C	
.....		
Comparison		

Source: Adapted from Waste: A Hidden Resource. Take Pride in America, Tennessee Valley Authority, Environmental Education Program, 1988.

Chapter 2

ENVIRONMENTAL ISSUES

- Global Environmental Issues
- National Environmental Issues
- Local Environmental Issues

Agenda 21

This agreement among the international community, in the form of sustainable development objectives for the twenty-first century, was one of the most important results of the Earth Summit -- the United Nations Conference on Environment and Development -- that took place in Rio de Janiero, Brazil, in 1992. This twenty-first century program is generally known as Agenda 21.

Nations voluntarily signed Agenda 21, and it was not obligatory for them to apply its objectives. Agenda 21 is an action program composed of forty chapters that cover many subjects pertaining to the environment and sustainable development. These subjects include health issues, access to potable water, ocean conservation, poverty and solid waste management.

Agenda 21 has been a guideline document that enables governments to manage their environments in many regions all over the world. An annual ministerial meeting is organized under the patronage of the UN Sustainable Development Committee to evaluate progress in the application of the Agenda. Many experts have criticized Agenda 21, as it is incomplete and shows many defects in issues such as wars, birth control, human rights, supervision of the multinational megacorporations, refugees, nuclear nonproliferation, control of consumption rates, media control and renewable energy sources.

Scientists and Environmental Issues in the 21st Century

Two hundred environmental experts belonging to fifty different countries were interviewed and asked what environmental issues they expect to be on the agenda of the world's governments in the beginning of the twenty-first century.

Their Responses Were as Follows:

1. Climate change	51%
2. Fresh water scarcity	29%
3. Deforestation and desertification	28%
4. Fresh water pollution	28%
5. Mismanagement	27%
6. Loss of biological diversity	23%
7. Population growth and immigrations	22%
8. Changes in social values	21%
9. Waste management	20%
10. Air pollution	20%
11. Soil depletion	18%
12. Chemical pollution	16%
13. Urban expansion	16%
14. Ozone layer depletion	15%
15. Energy consumption	15%
16. Emerging new diseases	14%
17. Natural resources depletion	11%
18. Shortages in food supplies	11%
19. Hazardous emissions of industries	10%
20. Natural disasters	7%
21. Wars and conflicts	7%
22. Emergence of new pests	6%
23. Genetically engineered organisms	6%
24. Rise in sea levels	5%

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Positive and Negative Attitudes

Many young people from different parts of the world were interviewed as to the ten most important positive environmental attitudes and the ten most important negative attitudes that they have noticed in recent times. Their responses are as follows.

The Ten Most Important Positive Environmental Attitudes:

1) Increase in the recycling of objects and wastes.
2) Attention to planting trees and reforestation.
3) Increase in attention to wildlife protection.
4) Increase in solar energy use.
5) Attention to water conservation.
6) Increase in environmental awareness.
7) Increase in pollution control measures.
8) Increase in the number and influence of environmental NGOs.
9) Emergence of many natural food supplements and products in the marketplace.
10) Increase in attention to rainforests.

The Ten Most Important Negative Environmental Attitudes:

1) Increase in pollution.
2) Continuous deforestation.
3) Intensification of wildlife hunting.
4) Increase in the air pollution of megacities.
5) Expansion of ozone depletion.
6) Complexity of water pollution problem.
7) Water scarcity.
8) Accumulation of poisonous wastes.
9) Overpopulation.
10) Increase in the amount of garbage and solid wastes.

These are the views of youth groups representing different parts of the world.

Try to Ask Similar Questions of Students of Both Sexes. For Example:

1) What have been the most important achievements in the field of environmental protection in Egypt ?
2) What are the most positive global attitudes towards the environment?
3) What are the most important environmental problems that require greater attention in Egypt?

In addition, it is possible to encourage male and female students to think positively about negative attitudes and problems.

For Example:

1) What are the causes behind the emergence and continuation of these problems?
2) How should we confront these problems in your view?
3) What we can do to eradicate these problems or to minimize their acuteness?

Encourage students to register their views and responses on a wall chart placed in the library or classroom. The wall chart should have blank areas for other students to comment, so that it will be like a forum of dialogue among the students on environmental issues.

The Most Important Environmental Issues in Egypt

1) Nile river pollution because of sanitation wastewater, industrial and agricultural drainage

2) Shortage in the per capita share of potable water because of the mismanagement of water resources and overpopulation

3) Shortage in potable water in rural areas and some urban districts

4) Soil pollution from pesticides and chemical fertilizers

5) Reduction in cultivated land due to overexpansion of buildings, land erosion, and desertification

6) Decrease of soil fertility because of intensified usage and increase of groundwater level

7) Air pollution in megacities, especially because of various industry activities and automobile emissions

8) Deterioration of the rural environment because of the overuse of pesticides and agrochemicals

9) Intense noise pollution -- in megacities especially and in the whole of Egypt generally

10) Accumulation of solid wastes and the absence of strategies to manage their disposal

11) Deterioration of the coasts of the Mediterranean and Red Seas because of industrial, mining and tourist activities

12) Risks that threaten the biodiversity in Egypt, especially illegal over hunting, agro-pesticides and destruction of habitats

13) Decrease in the level of environmental awareness and environmental education among the majority of individuals, thus influencing their dealings with the surrounding environment

14) Lack of enforcement of environmental laws that leads to further violations and aggressions

15) Occupational safety and industrial hygiene problems

16) Housing environment problems in rural and urban areas

17) Overpopulation that causes tense pressure on limited natural and non-renewable resources

18) Pollution of marine water and coastal and inland lakes with pesticides and sewage wastewater, and industrial and agricultural drainage

19) Deterioration of buildings and areas of historical and cultural value

20) Lack of environmental parameters in urban planning for new communities, resulting in architecture that is both unsuitable environmentally and unsanitary

21) Legal limitations that are obstacles to NGOs working on environmental issues

22) The land mine problem, which hinders development in various parts in Egypt, particularly in the north coast, Red Sea coast, Gulf of Suez and Sinai

Source: Abou Bakr, H. and Adel, H. Environmental Education Workshop, Horizon for Environment and Development. Cairo, Egypt: 1999.

Main Environmental Issues in Egypt

What Are Environmental Issues?

"Environment" is a commonly used word, and it is used in many contexts. For example, you may say "urban environment," "rural environment," "natural environment," "social environment" or "political environment." The environment can also mean the house, or what is surrounding an individual or community and affecting it.

Recently, the phrase "environmental problems" has been associated with pollution, which has led to differences in people's understanding of the phrase. Some people interpret it in a limited way to mean that environmental problems only have to do with pollution; others have a very broad interpretation and think the phrase refers to all community and environmental problems, including drug addiction and terrorism. Neither understanding of the phrase is suitable. The first understanding draws attention away from an important group of modern environmental problems and the second understanding mixes issues, thus complicating the solution.

Environmental issues are correlated with the deterioration and depletion of natural resources (e.g. desertification) and their effect on human health (e.g. pollution). These two categories of environmental issues are not separated. They are two faces of one coin, and they concern the quality of life of the existing generation and future generations. But this categorization enables us to analyze these issues.

Main Environmental Issues in Egypt

The following is a summary of the main environmental issues in Egypt. This survey follows the categorization mentioned above and separates the issues into two main categories:

1) Issues related to the deterioration of environmental resources

2) Issues related to pollution

This is an artificial categorization because pollution is another face of environmental deterioration.

The presentation of issues in each category will reflect their priority within these two main issues.

1. Natural Resources Issues

a. Fresh Water Resources

The population of Egypt is expected to reach 86 million by the year 2025, with a resulting water requirement of up to 100 billion m^3/year. But the current availability of water resources is limited to 75 billion m^3/year. Thus, there will be a water shortage of 25 billion m^3/year, and the resulting per capita share of fresh water will be insufficient. By 2025, the per capita share of water is expected to decrease to only 637 m^3/year, which is much less than the 1000 m^3/year defined by UNEP (United Nations Environment Program) as the minimum required per capita share of fresh water.

The way to overcome this shortage is either to increase available resources, reduce consumption, or to undertake both measures. Methods for reducing water consumption and increasing available resources include:

* Reducing water loss in the water network (refers to irrigation water, drinking water and industrial usage water)

* Reusing water

* Desalinating seawater

The reduction of losses in the network of irrigation canals, which use a large amount of water, may be accomplished by:

* Lining and covering water canals, or using pipe transport systems in irrigation. Lining of irrigation canals to prevent water leakage has other benefits, such as preventing rise of the underground water level.

* Covering the irrigation canals reduces loss due to evaporation and prevents the growth of bilharzia snails and fresh water plants such as myacin.

* Mixing agricultural drainage water with fresh water for use in irrigation. Currently 9.4 billion m^3 are used. This may lead to a deterioration of the water quality because the agricultural drainage water is exposed to agrochemical pollution and industrial wastewater, as many factories dispose their effluents into agricultural drains. Reusing polluted wastewater in the irrigation of agricultural land thus leads to its deterioration.

* Desalinating seawater is still very expensive, and so in the meantime it is devoted only to household objectives.

* Reducing water requirements through increasing efficiency. This can be done by:
  - Alternating traditional irrigation methods that waste water, such as flooding irrigation, with more efficient methods such as spraying and drip irrigation.
  - Limiting cultivation of high water consumption crops such as rice and sugar cane.
  - Using rational water consumption technologies in industry.
  - Combating overuse of water consumption through promoting awareness about the importance of rationing water use.
  - Creating economic incentives that encourage a reduction in the level of consumption (pricing policy according to consumption level).

Comparison Between Present and Future Egyptian Water Requirements and Resources

(billion m^3/year)

Year	Population (millions)	Water resources						Water requirements				Per capital share m^3/year	Water Resource Gap
		Traditional		Non traditional		Total	% Renewable	Drinking	Industry	Irrigation	Total		
		Surface	Under-ground	Desali-nization	Treatment								
1990	52	55.5	3.1	0.02	4.9	63.5	92	3.1	4.6	49.9	57.4	1221	6.1+
2000	62	57.5	7.4	0.05	9.1	74.05	84	4.5	6.1	59.9	70.5	1194	3.55+
2025	86	57.5	7.4	0.07	9.1	74.07	84	8	9.85	85.4	103.25	637	29.20-
2051	120	57.5	7.4	0.09	9.1	74.09	84	10.64	13.75	111.92	136.31	617	62.26-

b. Cultivated Land

As the per capita share of water resources is decreasing, there is a corresponding reduction in the amount of cultivated land. The current per capita share of land is 0.09 feddan, and the rate of population growth exceeds the rate of cultivated land added through reclamation efforts.

i. Urban expansion

Neighboring cities and villages are encroaching upon land that is of good quality for cultivation. In the past fifty years, Egyptian agriculture has lost one million feddans of quality land to the urban expansion of the more populous cities as well as thousands of villages. At the same time as high-quality lands are being lost forever, millions of pounds are being consumed in reclaiming desert lands, which are far weaker producers. To confront this problem, effective land use policy needs to be requested that aims at specifying best uses for various lands: fertile lands for cultivation, less fertile lands for live stocking, and arid lands for urbanization.

ii. Decreased fertility of cultivated land because of salinity

The ratio of land that has reduced fertility due to high salinity is up to 35% of the total land.

This salinity is due to shortages in agricultural drainage systems in addition to the overuse of irrigation water. The irrigation water is not drained well, and so the soil becomes over-flooded with water. Because of the hot weather, the water evaporates and leaves behind the dissolved salts, which gradually are accumulated in the soil. Correlated to soil salinization, there is another problem, water logging. The increase in the groundwater level decreases the aeration of the soil. These two problems together -- salinization and water logging -- will rapidly lead to the deterioration of the productivity of cultivated lands. This problem can be solved by establishing an efficient drainage system. Egypt currently has large projects underway to improve agricultural drainage through the establishment of a network of covered and open drains and the treatment of deteriorated lands.

iii. Pastures/overgrazing

Pasture strips on the northern coast from Rafah to Salloum are exposed to overgrazing due to the numbers of sheep and geese increasing beyond the capability of these areas. Experts estimate that the pasture area west of Alexandria until Salloum is capable of feeding 300,000 animals, but there are over one million animals in this area. Overgrazing leads to a reduction in the vegetation cover of the soil, which in turn leads to erosion by winds (weathering) and/or water (floods), resulting in desertification. The government and international aid agencies have provided livestock owners with subsidies of animal feed to compensate for the gap between the availability of natural pasture and the requirements of the animals.

2. Environmental Pollution Problems

Pollution is defined as any change in the chemical, physical, or biological characteristics of air, water, or soil such that it imposes a danger on human health, safety, agriculture, livestock, or cultural heritage.

Wastes are materials disposed of because they have no value or beneficial use.

Because wastes are always an indirect cause of pollution, we will consider pollution and waste problems together.

a. Pollution of Egyptian Cities

Many Egyptian cities are suffering from problems of air pollution, noise, and solid waste accumulation because of overpopulation problems. High population density adds to the complexity of this problem, as does the concentration of industries in the large cities and the mixture of industrial and municipal zones. A group of dangerous air pollutants are present -- lead, ammonia, sulfur and nitrogen oxides. Also accidents involving the leakage of gases can lead to temporary but dangerous pollution problems. The Egyptian Environmental Affairs Agency (EEAA) has started to take actions to improve air quality in Egypt's cities. A network for monitoring air pollution in eighty Egyptian cities has been established. Also, the agency requires petroleum refinery companies to produce unleaded gasoline to prevent air pollution from lead. Solid waste management programs and environmental awareness campaigns are also implemented by different authorities.

The accumulation of urban solid waste (garbage) is a problem in all cities. The reasons for this problem are due to a group of factors:

- Increased amounts of wastes produced by each individual as modern lifestyles are characterized by the overconsumption of materials and the overuse of disposable products and packaging.
- Shortage in collection systems for the transport and treatment of wastes. Only 10 - 15% of all garbage is collected in small and medium-sized cities; 68% is collected in Cairo.
- Negligent behaviors of some citizens.

b. Marine and Fresh Water Environmental Pollution

All water surfaces -- drains, canals, lakes, the Nile River, and the Red Sea and Mediterranean coasts -- are exposed to different kinds of pollution. This is because these surfaces are used for the disposal of sewage and industrial and agricultural drainage, which leads to deterioration of fresh water quality and fishery depletion. The tourism sector is also affected.

Legislation has been issued to regulate industrial drainage processes, and pollution prevention programs have been established to enable industrial companies to reform their waste disposal methods.

The water shortage issue is an example of the correlation between the deterioration of natural resources and pollution. Pollution of fresh water affects the quality of the resource and its suitability for use. This also is a form of depletion -- a depletion of quality.

Methods of Managing Pollution and Wastes

Methods and measures of combating pollution and wastes either mitigate the impact of those problems after their establishment -- such as installing air pollution filters on the stacks of the factories -- or prevent the problems from occurring in the first place.

Examples of New Methods:

* Prevent pollution and wastes by using various actions, among them cleaner technology in production processes.
* Recycle wastes and benefit from them by turning them into new products.

Environmental Action Plan for Egypt

Many countries prepare environmental action plans in order to achieve their optimal goals through effective use of limited available resources. The EEAA issued an environmental action plan for Egypt in 1992. This action plan showed the environmental status of Egypt and defined the most important environmental problems that Egypt is facing, citing the reasons for them and recommending policies and necessary actions required to solve them. The plan addresses these problems in six chapters:

Chapter 1: An overview of the environmental situation
Chapter 2: Pollution and natural resources deterioration
Chapter 3: Air pollution
Chapter 4: Solid waste management
Chapter 5: Egyptian heritage protection
Chapter 6: Support for environmental institutions

This environmental action plan for Egypt, according to a World Bank report, contains a thorough analysis of the problems and demonstrates the rationale behind proposed actions and measures. It also acknowledges that environmental action planning is a continuous process of review, modernization and follow up.

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Alexandria: Solid Waste Management

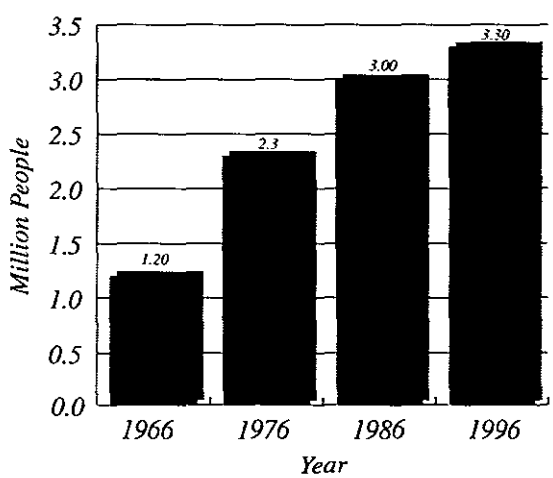
Alexandria is a mixture of histories and civilizations. It is the main port of Egypt, and its main summer resort. It has the old university and its commercial center, which involves traditional and modern industries. Alexandria is known as the "Bride of the Mediterranean Sea" as its sandy beaches, moderate weather and historic monuments have made it a popular tourism center during the last thirty years. Alexandria's population increased from 1.2 million in 1966 to 3.3 million in 1996. Alexandria receives in the summer season more than one million extra visitors. The population of Alexandria is 6% of the total population of Egypt.

Alexandria is composed of six districts in addition to the city of "Borg El-Arab". It has a high population density (1089 persons per square kilometer) on a limited strip of land (2711 square kilometers) bounded by the Mediterranean Sea on the north, the King Marriott resort on the south, Idko lakes and Abukire on the east, and desert on the west.

About 37% of all Egyptian industry is located within the governorate; and the port of Alexandria deals with 80% of the shipments in Egypt.

Solid Wastes in Alexandria

As a result of the expansion and increasing population of Alexandria, its infrastructure is suffering, its beaches are polluted, and wastes and garbage are accumulating. Alexandria produces 2000 tons of solid wastes each day, and during the summer this level reaches 2800 tons per day. The majority of Alexandria's solid wastes are organic materials, papers, plastics, glasses, and metals.



Population growth in Alexandria

How Does Alexandria Deal With Its Solid Wastes?

Solid wastes in Alexandria are a chronic problem. The following is a summary of this problem, including a description of the old system that was used to dispose of solid wastes.

1) In the old system, citizens transported garbage to containers in the street, but this system had some problems:
   a) Some citizens transport garbage to containers, but others leave garbage elsewhere, causing a problem.
   b) The containers themselves were a problem because they further congested traffic in the narrow streets.
   c) Uncovered containers attracted breeding flies, transmitted diseases, and were scavenged during the night, leaving scattered litter around.
   d) Collection was incomplete (only 85% of the garbage was collected).

2) Garbage was transported outside of the center of the city to four dumpsites: Ibis, Ameria, Montazah, and Borg El-Arab. Problems with these include:
   a) They are open dumpsites, with burning areas beside them. So, pollution and wastes were being transported from site to site, without the city really becoming clean.
   b) Wastes are rich in organic matter, and there are three composting factories in Alexandria with a total daily production capacity of 480 tons, which is much less than the amount of Alexandria's daily wastes.
   c) There is a recycling industry, but it doesn't work on a scientific basis or follow sanitary practices.

3) The strange economy of the old system:
   a) The governorate of Alexandria paid 21 million L.E. (Egyptian pounds), for the solid waste management system, including mechanical maintenance and workers' salaries, without charging citizens a service fee.
   b) Others collected fees from citizens, but did not provide them with services.

Summary of the Old System

1) It assumed that citizens would transport garbage to the containers.

2) It transported pollution from one site to another.

3) It was uncoordinated and inefficient (the provider of the collection service charged no fee, and the fee collectors provided no service).

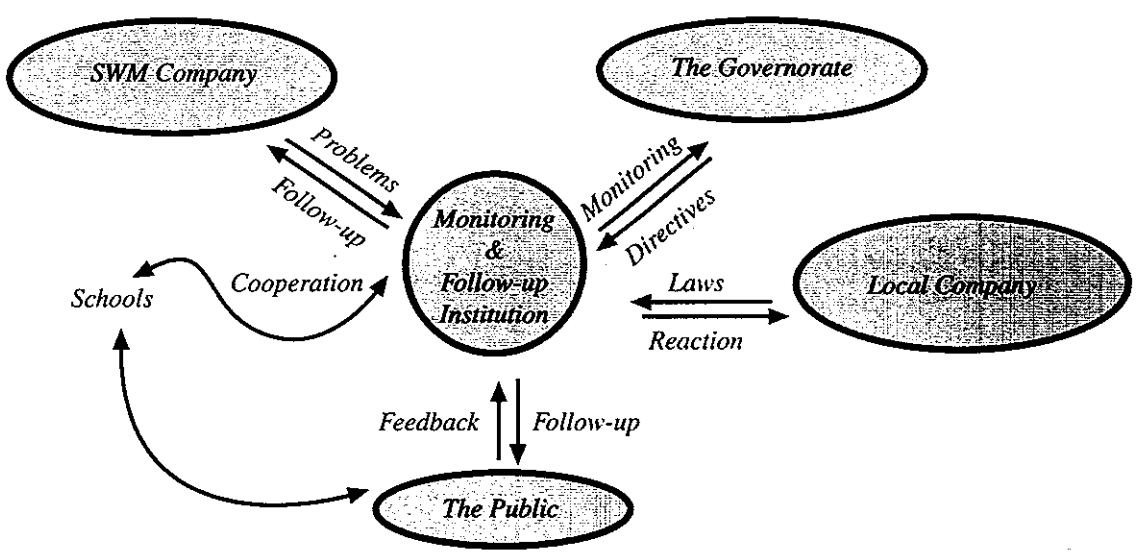
New Trend in Alexandria

The Alexandria Governorate called for international bidding among specialized companies for the creation of a solid waste management system that includes collection at the source of waste, recycling, and street cleaning. This system is funded by small fees added onto electricity bills, with staggered rates according to the amount of the bill as an indicator for consumption and socio-economic standards.

The governorate also established an institution of environmental services specialists to monitor the performance of the company chosen to implement the cleaning activities. Executive agencies of the governorate, local councils, and the general public share in this monitoring. Schools also help with the monitoring, and increase awareness among school students of the issues. It is hoped that Alexandria's pilot experiment in solid waste management will prove successful.

الأجهزة تقدم المعلومات
التي تطلب منها فقط

International Company Handles the Cleaning of Alexandria



Sources: Adapted from a lecture by Dr. A. Abou Akkudada, Workshop on Environmental Education: Solid Waste Management (Department of Education, EEAA, GreenCom) Alexandria 15-19 July 2000; Study on Solid and Hazardous Waste Management in Alexandria. CEDARE, 1996.

Activity (10)
We Are Part of the World

Concept:

Every population, regardless of its size, is directly affected by environmental issues that concern the daily lives of people. Every country has, also, its own national environmental issues that it works to solve. But the planet that all of the earth's population lives on is suffering from global environmental problems that the whole human family must cooperate to solve.

Objective:

Raise participant's awareness of environmental issues at the local, national and global level, and realize the connections between all levels of environmental issues. As we are part of the world, we are part of the problem, but we are also part of the solution.

Methodology:

Encourage participants to discuss and make a list of the most important environmental issues in their city and country, as well as the planet. List the issues according to their importance from the students' point of view.

Location:

Library hall or classroom

Duration:

30 minutes

Materials and Equipment:

Paper, paper rolls, flow master pens, colored cards, clips, pins

Steps:

1) Participants will be divided into three subgroups for discussing the following questions:
   i) First group: What are the most important environmental issues that the local people in the city or the village are thinking about?
   ii) Second group: What are the most important environmental issues and problems in Egypt?
   iii) Third group: What are the most important environmental issues and problems that planet earth is facing?
2) In each group the facilitator will write the participants answers on a big chart; participants can write answers on the colored cards -- one problem per card.
3) In this phase of the activity, the facilitator will direct the discussions so that the objective is to list environmental problems and issues, and not to consider them in detail.
4) The facilitator continues to record answers, but focuses attention on ambiguous phrases.
5) If the flow of answers stops, the facilitator may urge students to think about other topics that have not yet been discussed before. For example, ask a question such as,"What about lakes, or agrosoil?"
6) If time remains, the facilitator may ask the participants to arrange the issues and problems according to their importance or classify them according to their similarity. He or she can also ask the participants to clarify the criteria they used to choose the specific arrangement of the problems on the list. The group may agree upon a number of general criteria and standards.
7) The group will select one of its members to present the results in the general session.
8) In the general session, after the three group presentations, the facilitator will moderate a discussion inviting participants to think about the interrelated linkages and impacts that may exist between the three levels of environmental issues.

Source: Abou Bakr, H. and Adel, H. Environmental Education Workshop, Horizon for Environment and Development. Cairo, Egypt: 2000.

Activity (11)
Environmental Press File

Concept:

Environmental news is starting to frequently appear in newspapers and magazines, whether they be Egyptian or Arabic or foreign. These press materials may be an important source of information and environmental awareness.

Objective:

Encourage students to follow environmental news presented in the newspapers and magazines, and suggest how to learn from the news, and comment upon the articles.

Methodology:

Clip articles from newspapers and magazines and put them in an environmental press file.

Location:

Library hall, classroom, or student's house

Duration:

One hour weekly, to arrange press materials and file them. Students will follow what environmental news is presented in the newspapers.

Materials and Equipment:

Daily and monthly newspapers, white paper, plastic files, scissors, adhesive, flow master pen

Steps:

1) Discuss the idea of a press file of environmental news in the library.

2) Explain to the group that newspapers and magazines in homes are an important source of environmental information and news related to the city, the country (Egypt) or the world. Explain that these newspapers can be used after others finish their reading.

3) Bring a group of newspapers issued in the last week and ask the group to review its contents -- news, abstracts, photographs or cartoons.

4) Give each student one issue of a magazine or newspaper and ask him or her to point out articles using the flow master pen.

5) Participants review and discuss the topics together, and this discussion will lead to a common understanding between the members of the groups about news issues related to the environment. The group will find that there are many issues that affect, directly or indirectly, the local, national or global environment.

6) Participants cut out articles and stick them separately on a piece of white paper. Paper already printed on one side can be reused to reduce paper consumption.

7) Ask the participants to make files about specific local and international

environmental issues, such as water issues, pollution clouds, oil pollution of marine areas, sinking of hazardous wastes, NGO efforts for environmental protection, waste recycling, environmental laws, conferences, seminars, etc. Note that there are temporary events as well as long-term news items.

8) Keep these subjects in files in a corner of the library. Let the participants agree on a periodic meeting time to add collected press materials.

9) Work can be divided according to the participants' newspaper preferences. Some will prefer Al Ahram; others will select Al Akhbar or Al Ahaly or Al Wafd.

10) Encourage participants to refer to the press file when doing research or writing on the environmental issues wall chart paper posted in the library or classroom.

11) Encourage students to organize seminars, sessions, and interviews. Using the press material collected, they can invite experts or officials to discuss with them specific environmental issues concerning the city or district or that are related to the students' topic of study.

12) Discuss with students this question, "What are the benefits to be gained from doing this kind of work?"

Source: Abou Bakr, H. and Adel, H. Environmental Education Workshop, Horizon for Environment and Development. Cairo, Egypt: 2000.

Chapter 3

SOLID WASTE MANAGEMENT

- Solid Waste Management
- Environmental Auditing and Environmental Impact Assessment
- Environmental Legislation

Wastes : Sources and Types

Composition of Wastes

Wastes have many names: Wastes, trash, garbage.

Wastes are substances that their owners do not want to keep and try to get rid of as they are of no value (the owner no longer needs them or they are no longer suitable for one reason or another). For many reasons, the value of things is different from one person to another and from time to time. One person may want to have a piece of old furniture that costs thousands of pounds, and another person may not even want it for free. So, wastes can be of value for different persons in different circumstances, and thus can be defined as objects existing in an unsuitable place at an unsuitable time. Disposed wastes may cause pollution of the environment if they make unwanted changes that endanger human health and the safety of the environment in which people live.

Types of Wastes

Wastes are categorized on different bases:

a) Source: industrial, agricultural or municipal

b) Threat: hazardous, harmful,

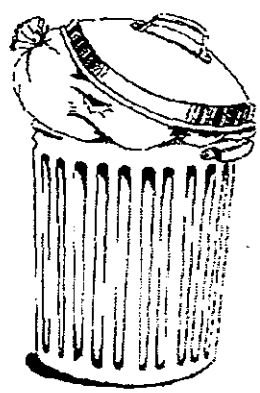
c) Form: solid, semisolid, liquid

d) Biodegradability: biodegradable, non biodegradable

Wastes include solid municipal wastes, hazardous wastes, and radioactive wastes.

Municipal Solid Wastes

Municipal solid wastes (called garbage or trash) are those wastes that municipalities are responsible for collecting and treating, as opposed to agricultural or industrial wastes. These include all wastes thrown away by houses, schools, commercial establishments and all similar institutions, i.e. wastes generated by every citizen in his or her daily life in the home, school or work. Municipal wastes include food wastes, metals, glass, textiles and plastics.



been observed that municipal wastes contain, in developing countries, a larger portion of food wastes and a smaller portion of packaging materials compared with the wastes of developed countries. Thus, wastes in developing countries are more suitable for use in composting and the generation of methane gas. But they may not be suitable if they are compressed or incinerated.

In Egypt 800 grams per capita per day of waste are generated on average. This amount varies from town citizens (the amount may reach 1000 grams per day) to rural citizens (200 grams per day), and also varies according to social class and lifestyles.

Usually municipal wastes in developed countries are dealt with by dumping in

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sanitary landfills or burning in incinerators, but in many developing countries wastes are still disposed of in open garbage dumpsites.

Hazardous Wastes

This is a legal name for some wastes that require special methods of disposal and management, because they pose a dangerous threat for human safety and the environment if they are misused or mismanaged. Usually these substances are categorized as dangerous according to the following criteria:

1) Flammability: Some substances burn quickly (e.g. benzene or alcohol)

2) Corrosiveness: Substances cause corrosion of warehouses and storage areas (e.g. acids)

3) Chemical reactivity: Unstable chemicals that may be explosive or produce toxic fumes when mixed with water (e.g. explosives, phosphorus, concentrated sulfuric acid)

4) Toxicity: Substances harmful for health if they are swallowed or inhaled (e.g. chlorine, ammonia, pesticides, formaldehyde)

Egyptian law includes clinical wastes with hazardous wastes. These involve bacterial culture wastes, tissues and body parts surgically removed, human blood and its products, injections, surgical needles, and polluted animals bodies.

Most hazardous wastes are generated in industry, but not all industrial wastes are hazardous wastes.

Radioactive Wastes

Radioactive substances are dealt with as a special and independent kind of waste as they are the most dangerous substances for the environment. Radioactive wastes are wastes that include radioactive substances or wastes that are polluted by radioactive

Some hazardous materials placards

substances.

Radioactive wastes are generated from many activities, nuclear energy generation, atomic fuel manufacture for energy generation plants, nuclear weapons fabrication, scientific research activities and nuclear medicine.

Exposure to high doses of radiation destroys body cells, and this destruction may lead to death or cancer. The most common cancers due to radiation exposure are leukemia, lung cancer, breast cancer, and thyroid cancer. Radiation will lead also to genetic damage in living cells. This destruction will lead to genetic diseases in offspring.

Dealing with Solid Wastes

How do we deal with solid wastes, as they are dangerous and have negative impacts on health? We must deal with wastes on a scientific basis, understand the nature of those wastes, manage them properly, and reap economic benefits from them by recycling them in various forms.

Solid Waste Management

Historical Synopsis of Wastes

Most people complain about the solid waste problem. In fact, wastes are as old as human beings themselves. As humans live on the earth, wastes are generated by their various activities. But early human settlements did not generate large amounts of wastes, and their components were simple, including remnants of food and primitive tools. Solid waste management consisted of no more than throwing wastes away in the large area surrounding the settlement. Then small and microscopic organisms began to decompose the wastes into simple nutrients, a process known as biodegradation, which fertilizes the soil.

Human knowledge has developed since those times, and the ability of humans to combat epidemics and diseases is increasing. So, human life span is longer and neonatal fatality has decreased, and there has been a change in the rate of population growth. When the industrial revolution occurred in the late nineteenth century, human ability developed to use natural resources and produce commodities and equipment. A change in the amounts and kinds of products occurred. Finally, the unprecedented change in the production of synthetic organic chemicals such as plastic led to changes in lifestyles. Modern communities tend to overuse disposable substances (e.g. mineral water plastic bottles) and excess packaging materials.

increase in the amount of wastes generated, but also to a change in the composition and characteristics of those wastes. Many modern consumable commodities include toxic substances. Electric batteries include heavy metals like mercury. Detergents, paints, and pesticides are dangerous and poisonous substances. Such chemicals, if present in solid wastes, require special methods to properly treat them. Many packaging materials are made of plastic, which microorganisms cannot biodegrade, so they exist for many years as wastes.

Methods of Waste Disposal

1) Burning wastes in open dumpsites. Waste is burned to reduce its size, but because of the problems caused by open dumpsites (large numbers of flies and rodents, bad odors, smog from burning wastes), this method is not often used any more.

2) Sanitary land filling.

3) Incinerators. Large ovens with high temperatures semi-combust wastes, leaving dust.

4) Waste incineration to energy generation. Incineration of wastes is used to generate energy.

In spite of the improvement in environmental circumstances and the energy gained from these developed methods, they are not sufficient to satisfy the needs of many countries all over the world. The establish-

cities, which is scarce these days. Also, landfills that are not environmentally designed or managed will cause pollution of the groundwater from leakage of wastes, including toxic substances. Sometimes fires and explosions happen in landfills due to the generation of methane gas, which is very flammable and generated by the fermentation of wastes. Also, incinerators cause problems because they were rarely designed to limit emissions into the atmosphere. Some of these pollutants are especially toxic, such as dioxin. So, citizens do not want to have landfills or waste incinerators nearby their houses. Finally incinerators and landfills, if they are properly designed or operated, are too expensive for the economies of developing countries.

All these constraints make us realize that this style of management of wastes -- although it reduces harmful impacts -- is not eradicating the root of the problem, but simply transferring it from one medium to another (from soil to ground water or the atmosphere). So, new attitudes and concepts of solid waste management have emerged to combat waste and pollution problems.

New Trends of Waste Management

1) New trends of waste management are starting to appear, such as recycling, that view wastes as useful resources that can be used another time, and not as valueless substances that need to be discarded. Wastes include organic substances, glass, metals, paper and plastics. All of these substances can be used as raw materials in new industries. The recycling approach offers environmental benefits and economic gains:
   * Reduces cost of production and waste management.
   * Supplies raw materials and preserves natural resources.
   * Preserves energy.
   * Reduces wastes.

   In spite of the many benefits of recycling, it does not solve the problem of wastes as wastes may be composed of non-recycled substances for technical or economical reasons. For example, paper cannot be recycled after a certain number of times, as every time paper is recycled, the fiber content is shortened, making the recycled paper more weak so that it cannot be used another time.

2) People's thinking is headed in the direction of finding different methods based on the well-known wisdom, "prevention is better than the cure." This idea is also referred to as preventing, limiting, or reducing waste at its source. Whatever the name, the core concept of this method is that it is safer not to produce wastes than to have to deal with them after they already exist. The philosophy of the "reduction at source" method is to produce the same amount of products without generating any -- or generating only a very small amount -- of wastes. This depends on the selection of raw materials, the rational use of those raw materials, and increased efficiency in transforming the raw materials into products. This necessitates

the prevention or reduction of any material loss that leads to less wastes and increased preservation of consumable materials.

An important question is, "What are the actions needed to prevent or to reduce wastes?" The answer is to make changes in the behaviors and attitudes of both producers and consumers. The required changes range from simple and inexpensive changes to dramatic changes that require capital investment. Examples of these include:

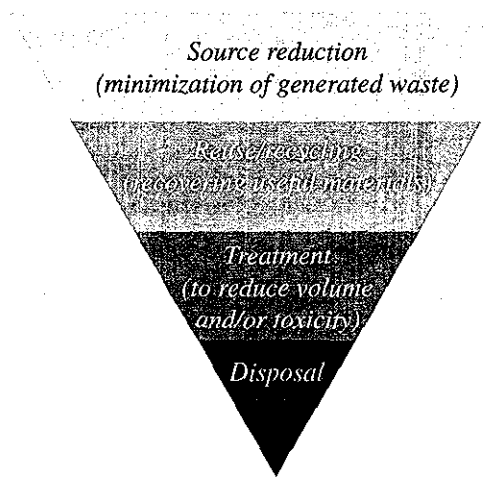
a) Improving workers' training programs to reduce defective products.
b) Improving storage systems to reduce the amount of damaged substances due to aging or bad storage.
c) Using and maintaining durable equipment so that it does not have to be replaced quickly.
d) Using raw materials which produce less wastes, and less toxic wastes.
e) Avoiding the overuse of packaging materials.
f) Using cleaner production technologies.
g) Encouraging cleaner production through more consumption of environmental friendly products by citizens.

Generally, all these changes fall under one of the following categories:

* Increased efficiency
* Replacement of raw materials
* Changes in operating processes
* Changes in product design

There is no single solution to the solid waste management problem. It is agreed upon that the best policy to deal with wastes is to follow a mixture of methods according to the specific priorities of the community and/or industries.

Hierarchy of Solid Waste Management



Modern solid waste management systems adopt a hierarchy for solid waste management. The philosophy of this system depends on mixing all available methods as suitable to the circumstances of each region, and according to the following arrangement of priorities:

1) Reduce or prevent wastes at source, but using low cost techniques.

2) Recycle in the waste generation establishment before transporting the waste.

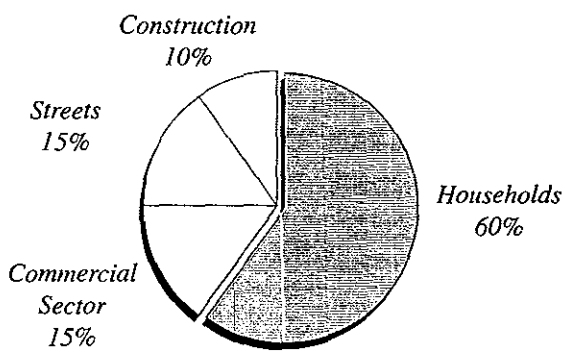
3) Use waste treatment or waste-to-energy incineration instead of burning for size reduction.

4) Build sanitary landfills in localized places.

Solid Waste Management in Egypt

Not long ago, solid waste was thrown indiscriminately, without sorting, into uncovered dumpsites. Recycling was not practiced in any official, organized or beneficial way. Now this situation has begun to change. The government, with the help of the World Bank, has sponsored many studies to understand and deal with the problem of solid waste. These studies provide waste management programs with basic, necessary information.

During the last two decades, measures have been implemented to improve solid waste management in Egypt. These activities include building safe landfills for solid waste in the Great Cairo area, and the current construction of a sanitary landfill for solid waste in the governorates of Alexandria and Aswan. In the mid-1980s, eighty small capacity waste incinerators were built. However,



Sources of Solid Waste in Egypt

they are only used for burning wastes, and they do not have the capability to regenerate energy. In addition, using these incinerators is very costly due to the large amounts of gas needed to burn the waste, which has a high humidity level. Further, the incinerators need continuous maintenance. So, for these reasons, it was decided to use them only for certain industrial and medical wastes.

Due to the high level of organic substances and humidity in the municipal wastes in Egypt, composting (producing artificial organic fertilizer) seems to be a suitable tool for waste management. Currently, there are many composting factories in some of the governorates in Egypt.

Many experiments to regenerate biotic gas (methane) from waste have also been carried out. There are some experimental reactors for generating methane in some of the new agriculture villages.

Solid waste management in Egypt is developing in a positive direction. Less waste is randomly disposed of, and in spite of the higher cost, safer waste disposal practices are being utilized, such as sanitary landfills. Before wastes are dumped, they are being dealt with in other ways -- incineration, for example. Waste management agencies are confronting the problem of the increased costs of these new practices. The next plan is to concentrate on finding uses for wastes through organized recycling programs and on encouraging waste reduction at its source, which is considered the most preferable waste management practice. The success of solid waste management programs depends on the awareness and cooperation of both the public and business associations.

This is a logical arrangement of priorities as reduction of wastes at the source is a preventive measure rather than a cure. Recycling makes use of wastes and preserves raw materials, but incineration is a method of dealing with wastes to reduce their size before they are dumped in landfills.

Conclusion

Methods and styles of solid waste management have been developed, beginning with sanitary landfills and open burning dumpsites and later including strategies such as reduction at the source. No single method up until now is without difficulties or is capable of solving the waste problem alone. So, it is agreed upon that we need to use a mixture of methods according to the environmental and economic circumstances of each region, and according to the list of priorities with reduction at the source as the first choice, and the creation of sanitary landfills as the last choice. This is logical as prevention is always better than the cure.

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Activity (12)
Wastes from Human Activities

Concept:

The produced wastes are different, as the activities are different, in the daily lives of people. So, the scope of problems will vary as will their degree of danger and appropriate methods of treatment.

Objective:

* Acknowledge the wastes resulting from different activities.
* Discriminate between wastes, pollutants, and hazardous wastes.
* Acknowledge existing methods of dealing with wastes from various activities.

Methodology:

Students discuss case studies in small groups.

Location:

Classroom, workshop or library hall

Duration:

One to two hours according to the number of working groups participating in the activity

Materials and Equipment:

Papers, pens, big chart, flow master pens

Steps:

1) Participants are divided into small groups of six to eight individuals and each group will discuss a case study from one of the following places: Urban district, tourist facility, hospital, technical secondary school, textile factory, food processing factory, mechanic's workshop, electrical workshop.

2) Each small group will do the following:
   i) Identify the size of the establishment, the number of participants involved in its activities (residents, laborers, visitors) and their categories according to age, sex, and occupation.
   ii) Identify the main activities of this establishment under normal and routine circumstances.
   iii) Identify the materials and resource inputs necessary to practice its work or function.
   iv) Identify the wastes produced by each of the activities of the establishment.
   v) Identify the existing methods followed in dealing with wastes.
   vi) Identify the sources of risk in each establishment, including electricity; fire; and caustic, corrosive, flammable, explosive, poisonous, infectious, or radioactive substances. Point out how waste accumulation can lead to an increase in these risks.
   vii) Propose safe and affordable alternatives to deal with these risks.

3) The group prepares a report on the results of the discussions and presents this in the general session. The group should present the most important points, preferably with the help of a visual aid such as charts, diagrams, or transparencies to be viewed in an overhead projector.

4) After the presentation of the main findings in the general session, the facilitator moderates a discussion to increase students' understanding of the important issue of risks from solid wastes and safe methods of disposing them.

Activity (13)
Analysis of a Bicycle's Life Cycle

Concept:

All objects, products, commodities and services that we use in our daily lives originated in nature, and passed through complex processes to be transformed into the form that we see today. After we use them, does anyone care about the final destination of these objects, and where they go?

Objective:

Encourage participants to search for and discover the origins of things, and the kinds and amounts of materials and energy that are used to transform them into the products that we use. Encourage them to think about the destiny of those products at the end of their lifecycles.

Methodology:

Analysis of the lifecycle of a bicycle, through identifying the components of its various parts, tracing them to their origins in nature, and then defining the destiny of each part after the life cycle of the bicycles reaches its final point. Note: the bicycle is just an example of a product made up of many parts, and the instructor can use another example that is more or less complex according to the age level of the participants.

Location:

Classroom, workshop, or activity hall

Duration:

One hour

Materials and Equipment:

Bicycle (borrowed from one of the participants), large wall chart to draw the bicycle, flow master pens

Steps:

1) Discuss with the group the concept of "product life cycles," giving simple examples using objects the students have with them.

2) Ask the participants to survey the various components of the bicycle.

3) Ask one or more participants who are good artists to draw a planning profile of the bicycle on a large wall chart.

4) The participants define the materials used to make each part, then define the origin of this material.

5) Participants record this on the drawing or in a table. Then the participants discuss the following:
   * What processes occur that transform the original materials into the form that we see now?
   * What are the products added to transform it into the final form that we see now?
   * What are the kinds and amounts of energy used?
   * What are the secondary byproducts of this transforming process? Where do they occur in the production process?

* What happens to these secondary byproducts?
* What are the wastes and pollutants produced during these processes?
* How are those wastes or pollutants usually dealt with?
* What environmental impacts result if the wastes are not treated in a sanitary manner? Are there any hazardous wastes? What is an example?

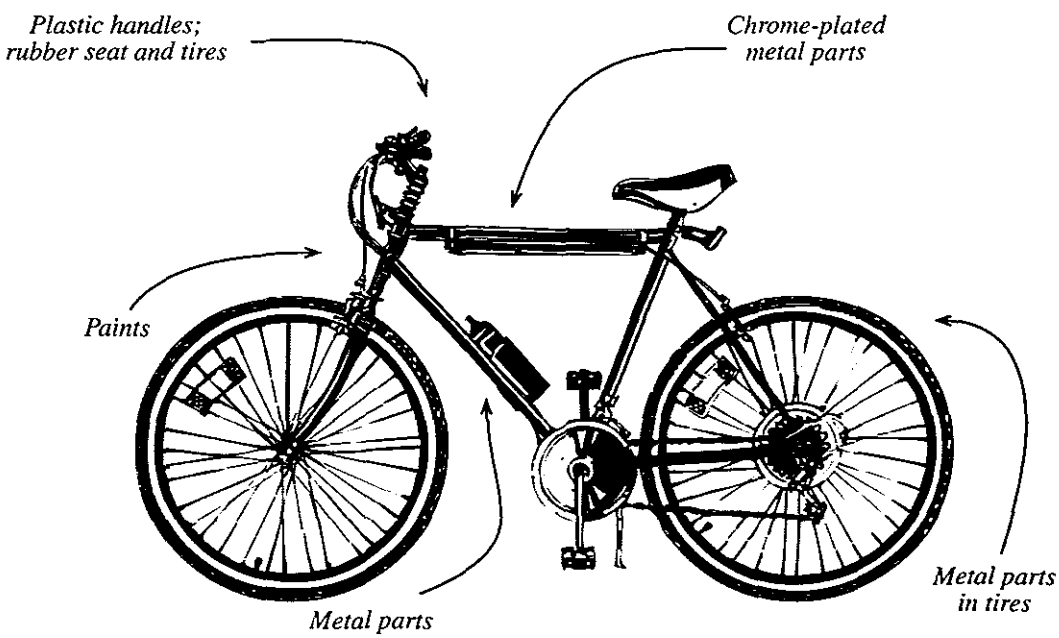
6) After finishing this analysis, the participants discuss the following:
* What are the renewable resources used in the manufacturing of this bicycle?
* What are the non-renewable resources used?

7) What are the parts that must be frequently changed? What are the parts that last the longest? How are old and unwanted parts dealt with? What is recycled? What is reused? Dumped in the garbage? What are the impacts on the environment?

8) Now, the participants can calculate the "ecological carrying capacity" of the bicycle, including its various components.

9) Participants should prepare to present their results and conclusions in the general session.

10) This method can be used with any other product.



Source: Closing the Loop: Integrated Waste Management Activities for School and Home. Part III: Everything is Connected. Ohio: The Institute for Environmental Education, 1995.

Recycling

Background

Recycling reaps benefits from unwanted objects. Instead of throwing them away as wastes, objects can be used in the production of new products.

It is important to differentiate between recycling consumer products and recycling wastes from industrial processes (such as shreds of paper remaining after cutting envelopes or from hole-punching paper used in note books) that are reused again. The second type of recycling is practiced usually due to its clear economic benefits for the industrial establishment. So, usually environmental protection programs focus on the first type.

Substances Suitable for Recycling

Glass, paper, metals, plastics, food remnants, tires and textiles

Paper: Recycled into strong and corrugated cartons, cellulose isolators, or organic compost.

Glass: Crushed glass pieces transformed into new glass bottles, or used as an alternative to gravel or sand in building materials.

Metals: Remelted and transformed into new metallurgical products.

Food wastes and plants: Turned into compost.

Plastic: Recycled into containers, boxes or artificial fibers.

Textiles: Reused in the paper industry.

Old tires: Recycled into materials that are used for road pavement.

Benefits of Recycling

1) A number of economic, social and environmental benefits are gained from recycling:

   a) Protecting natural resources for the next generation.

   b) Increasing national income by reducing costs of imported raw materials.

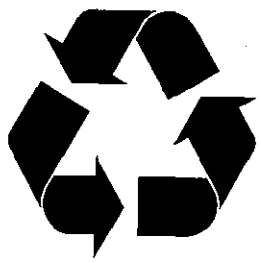
   c) Supplying industry with expensive raw materials.

   d) Preventing pollution of air, water, and soil that results from solid wastes.

   e) Reducing the need to establish new landfills and incinerators.

   f) Saving energy.

   g) Creating job opportunities.



Recycling Sign

Recycling Process

Recycling includes a chain of activities, or successive phases.

First Phase: Collection and Preparation

Methods of collecting recyclable materials are different from one community to another. In some places individuals and institutions transport materials, after sorting them in the house or factory, to special centers of collection. In some other cases, individuals leave those materials on the street in special containers, then vehicles, operated by either public or private institutions, pass by to pick up those materials.

More sorting and screening takes place in special facilities that prepare the materials for sale; these materials are now called secondary materials.

In many developing countries, the collection of recyclable materials from waste dumpsites reduces the quality and value of those materials and exposes workers to health hazards.

Second Phase: Manufacturing

Factories and workshops buy secondary materials and use them in new products.

Sometimes those materials are used in the production of the same products as the original materials. An example of this is newspapers, which are recycled into new papers. However, most objects are recycled into other products of lower quality, such as paper into paper tissues.

Third Phase: Marketing

This depends on consumers buying and using materials made from secondary raw materials. Without acceptance of, and demand for these products, recycling will not be successful.

Facts and Numbers about Recycling

1) Glass Recycling:

Every ton of glass recycled

Saves: 1.2 tons of raw materials and 9 gallons of petroleum

Reduces: 80% less wastes produced when making a new bottle

Saves: Energy, because a lower smelter temperature is required when making a new bottle

2) Paper Recycling:

Every ton of paper recycled

Saves: 17 trees

Decreases cost

Rates of recycling paper in some communities (Taiwan and Denmark): 95%

Examples of Benefits in Some Recycling Materials

Environmental Benefits	Glass %	Paper %	Aluminum %
Energy savings	4-32	40-64	95
Water savings	50	58-60	
Reduction in air pollution	20	74	95
Reduction in water pollution	50	34	95

3) Aluminum Recycling:

One can of aluminum recycled

Saves: Energy needed to make 19 recycled cans

Recycling can continue forever

4) Plastic Recycling:

* There are many types of plastic -- some of them are recyclable and others are not.
* To help citizens to differentiate between plastic types, every type is marked with a number in a recycling logo printed on the product.

* Among the recyclable plastics which are widely used are:
  PET: polyethylene terephthalate
  Mark (1): used in light cups
* HDPE: high density polyethylene
  Mark (2): used in detergents or shampoos

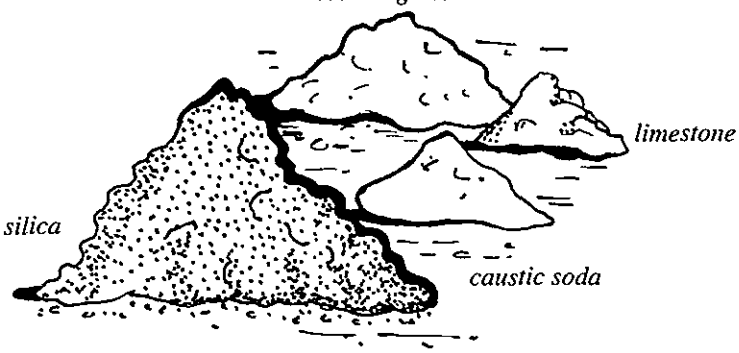
Conclusion

Many individuals consider that the recycling approach, in spite of some difficulties, is better than dumping wastes or burning them. Successful programs of recycling depend on efforts from community institutions, local councils, the business sector, and NGOs, as well as the support of citizens.

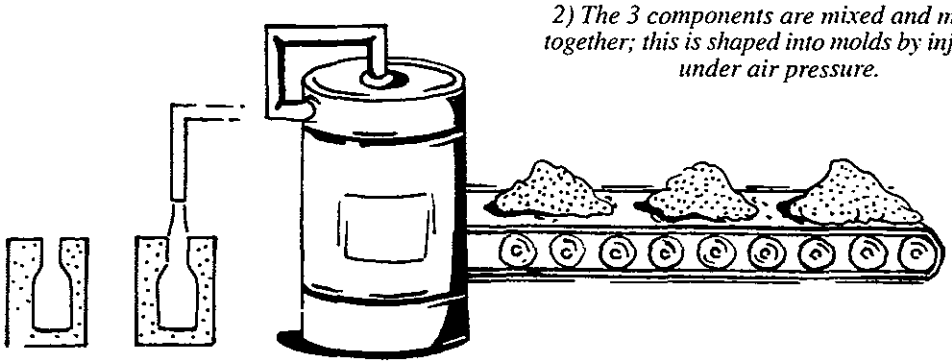
Signs and numbers for recycling types of plastics

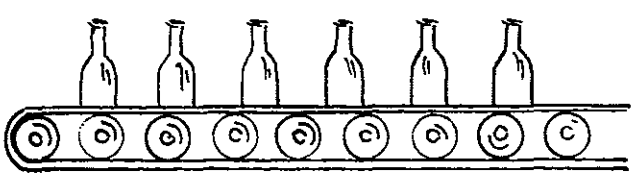
Glass Production

1) Raw materials: silica + limestone + caustic soda = glass.



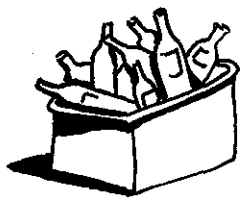
2) The 3 components are mixed and melted together; this is shaped into molds by injection under air pressure.



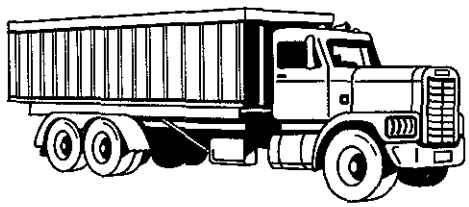


3) Molds are removed and the glass is cooled and then packed.

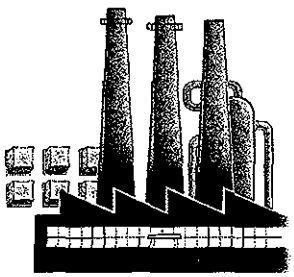
Glass Recycling



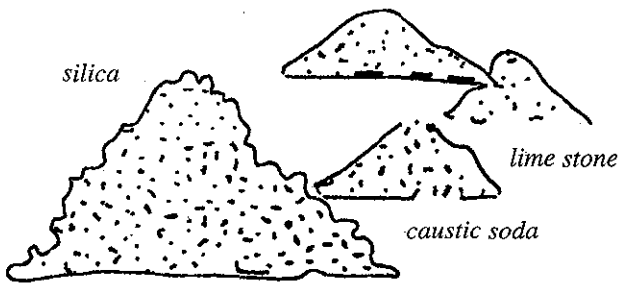
1) Empty bottles and glass jars are collected.



2) These are transported to the recycling centers.

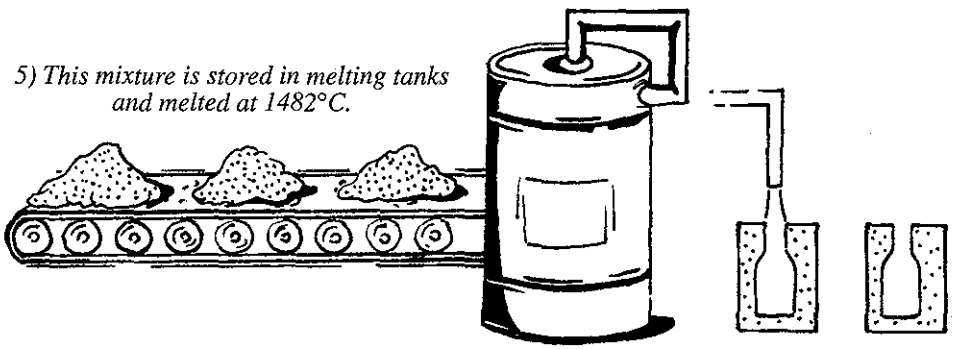


3) In the recycling centers, glasses are separated according to color and crushed into small particles called "crushed glass."

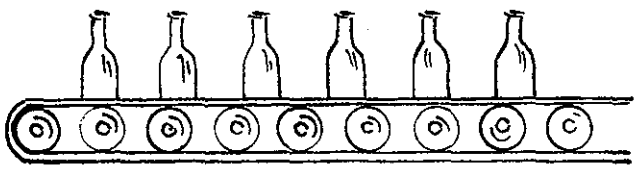


4) Pieces of crushed glass are cleaned and then mixed with silica, ammonia and limestone.

5) This mixture is stored in melting tanks and melted at 1482°C.

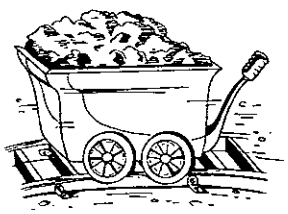


6) The melted glass is transferred to the "casting machines" and is blown or sucked according to the required shape.

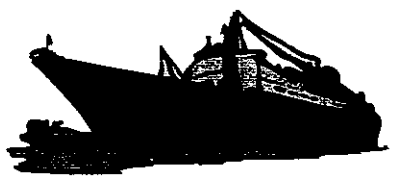


7) The molds are removed and the glass is cooled and then packed.

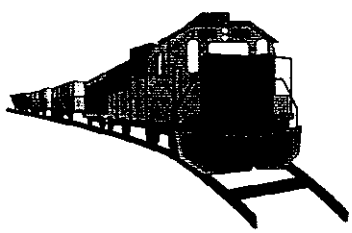
Aluminum Cans Production



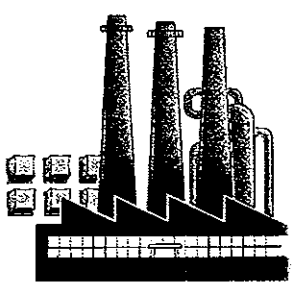
1) Bauxite is extracted from mines;



2) shipped;

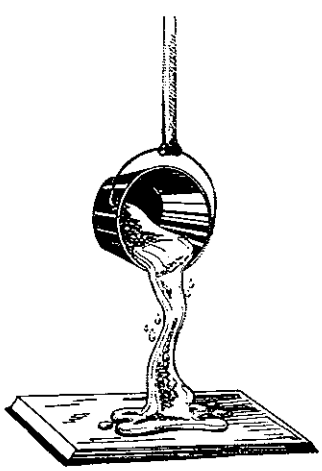


3) and then is transported to the factories.

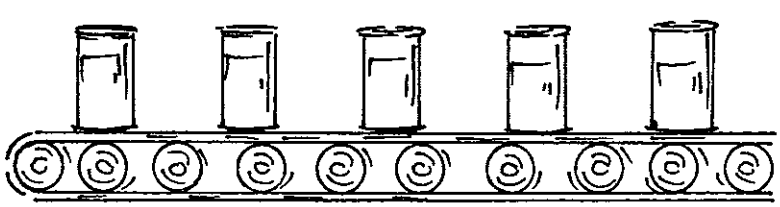


4) Through electrolysis, aluminum is extracted from the bauxite.

5) The aluminum is then melted.



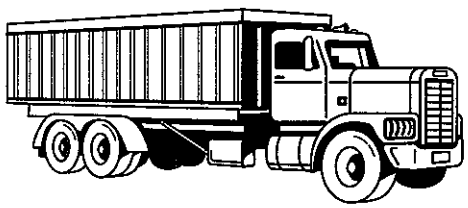
6) The aluminum is cast into slabs.



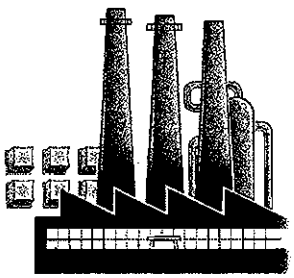
7) The slabs are formed into cans.

Aluminum Recycling

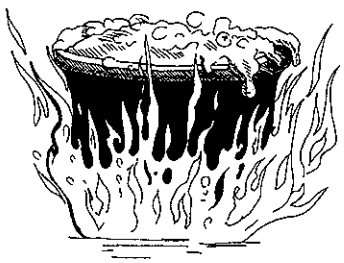
1) Various kinds of aluminum cans are collected.



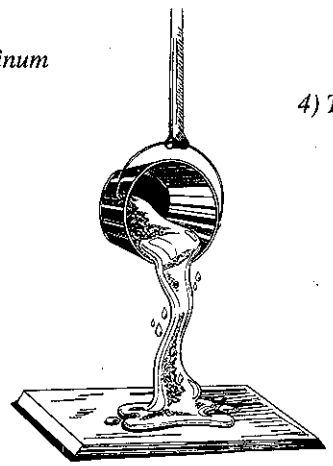
2) Cans are transported to recycling places.



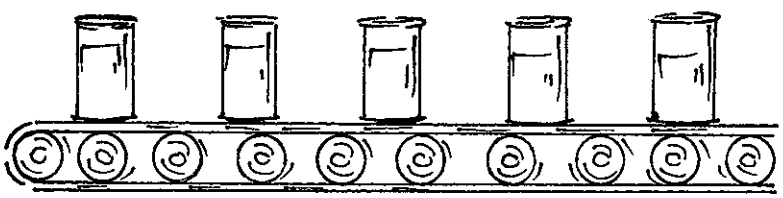
3) Cans are transported to an aluminum recycling facility.



4) The aluminum cans are melted.



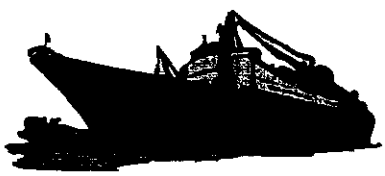
5) The melted aluminum is shaped into slabs and molds.



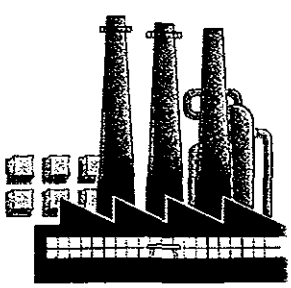
6) The aluminum is shaped into cans or other products.

Steel Cans Production

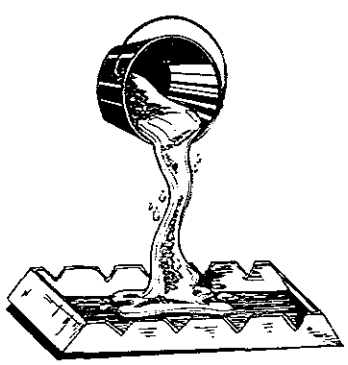
1) Iron ore (ferrous oxide) mixed with some other metals is extracted from mines.



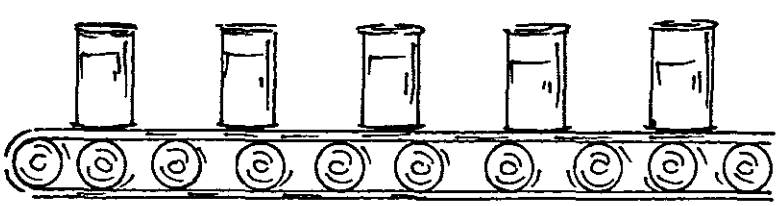
2) The iron ore is transported.



3) The iron ore is taken to steel and iron factories, where iron is extracted from the ore.



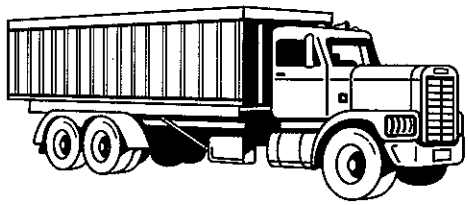
4) The iron is melted in big tanks and cast into slabs or other forms.



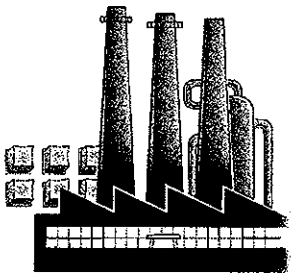
5) Sheets are covered with pewter (tin) and packed as cans.

Steel Cans Recycling

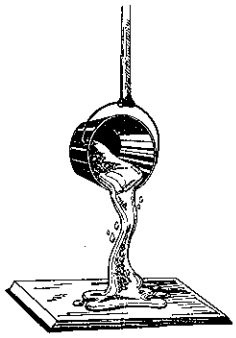
1) Empty steel cans are collected to be recycled.



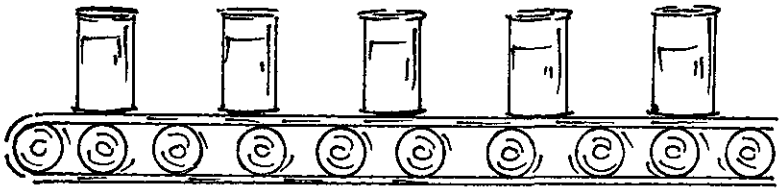
2) Cans are transported.



3) Cans arrive at the steel factory.



4) Steel cans are melted in big tanks and cast as flat sheets.



5) Sheets are covered with pewter (tin) and packed as cans.

Source: Closing the Loop: Integrated Waste Management Activities for School and Home, Part III: Everything is Connected. Ohio: The Institute for Environmental Education, 1995.

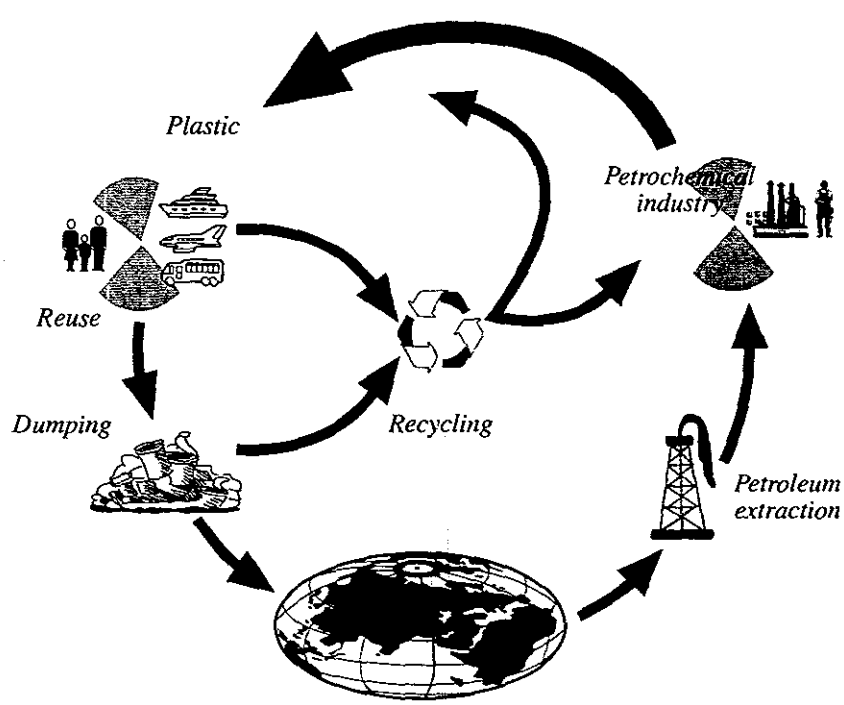
Plastic Recycling

Plastic: The Material of Modern Times

Times and centuries are known according to the materials used during those times. Plastic is one of the petrochemical products extracted from petroleum. The use of plastic is increasing due to its easy manufacture, its light weight, and its diverse characteristics and uses.

In the second half of the twentieth century, the annual production of one kind of plastic, nylon, amounted to enough material to cover the entire globe. Due to the world's increased use of plastic (150 million tons annually), scientists during the sixties were expecting that a day would come when the earth would be buried completely under plastic wastes. This is almost happening today.

The packaging industry is the main consumer of plastic (40%). It is almost the main cause of the plastic problem, as the life cycle of packaging material is usually less than one year. If the period of usage of plastic substances were to be elongated by recycling them, we would preserve our raw materials, protect the environment from pollution, and also achieve economic profit.

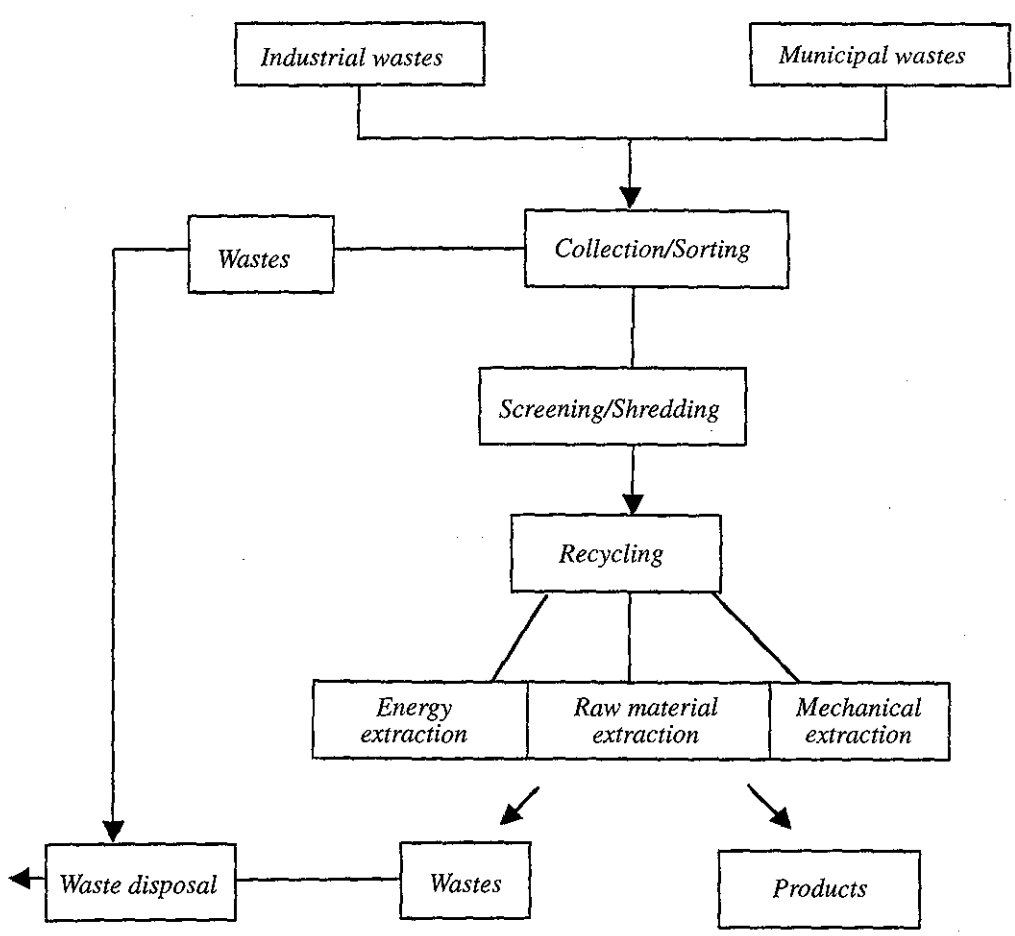


Plastic Cycle

Recycling Plastic

Recycling plastic starts from the point of collection of wastes, either after household usage (municipal wastes) or during the industrial process (industrial wastes). Wastes can be collected from houses or markets, and then transported to special collection points.

The process of recycling begins with the sorting of plastic components. This sorting, if it starts at the source, will be very effective for the recycling process, as will screening and sorting the different kinds of plastic materials. Labels and signs are used to discriminate kinds of plastic for easy sorting and manual screening. Some advanced technologies can also be used, such as infrared rays, for mechanical sorting and screening. The processes of screening and sorting are an essential step on the pathway of the recycling process.



After the collection, screening and sorting of the plastic wastes, the wastes are shredded and broken into a homogenous size for easy treatment. After this, the recycling process, which has mainly three paths, will start.

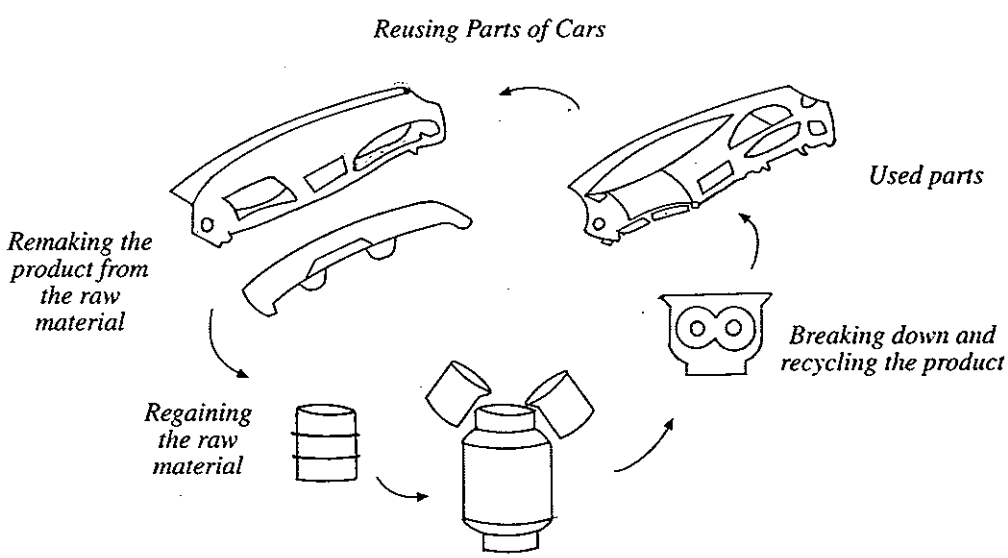
1) Mechanical Recycling

Plastic components may be recycled into new products. The new products may be of lower quality. Sometimes, raw pure plastic is mixed with the recycled plastic in a specific ratio to make new products. This kind of recycling offers an extended usage of the original raw materials. It is necessary to point out that strict standards exist for mechanical recycling. The use of recycled plastic in the production of food and medical packages (especially internal packages) is not permitted.

2) Raw Plastic Extraction

The composition of plastic is a long chain of chemical compound substances extracted from raw petroleum. If the chain is broken, either by chemical or thermal degradation, the raw material can be obtained again in the form of either petroleum or chemical compounds.

In an exciting example, the BMW Company established a production line for recycling of some of the parts of its cars. The parts are transferred back into the original raw material, and are then re-manufactured into the same product.



Some plastic parts of cars are recycled to produce the raw materials for plastics.

3) Energy Extraction

Any plastic product is originally an amount of raw petroleum borrowed from nature to be formulated and fabricated as a plastic product. After its usage, be it a short or long period, it can be burned and the energy can be extracted.

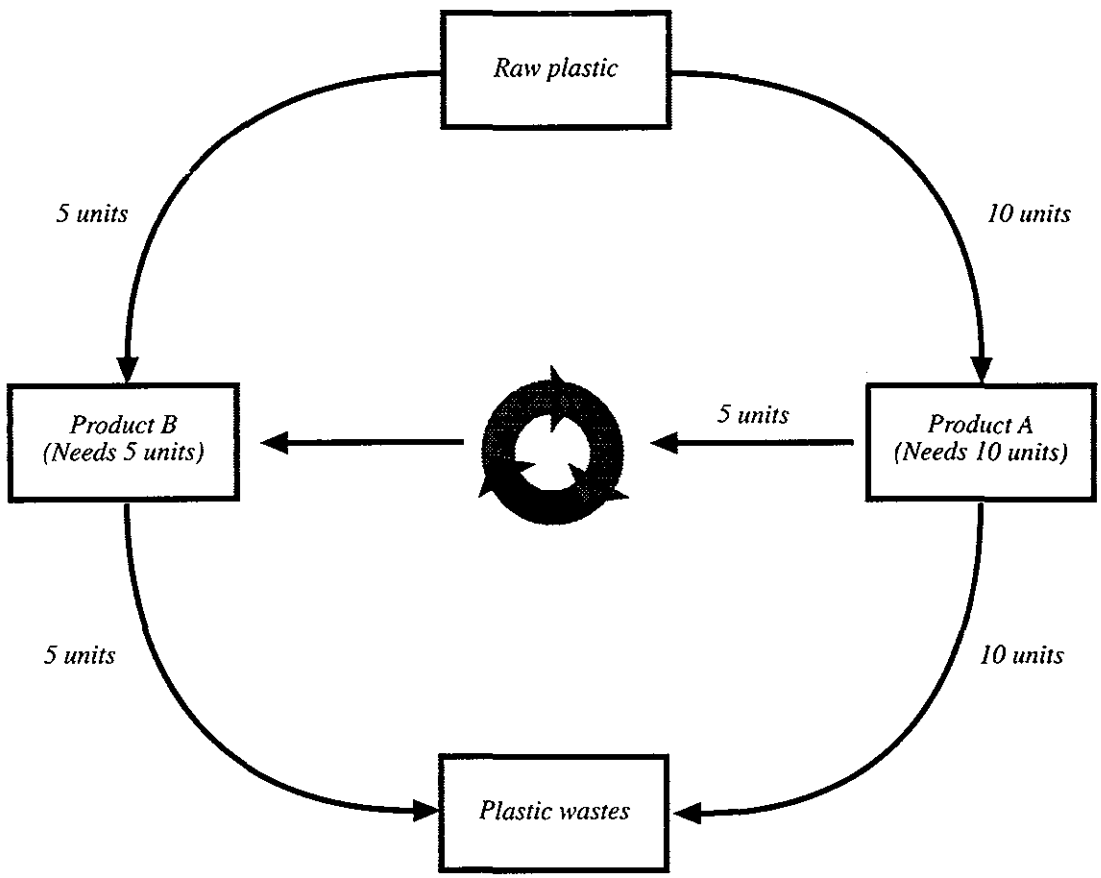
The thermal content of polyethylene is equivalent to the thermal content of petroleum itself (20,000 thermal British units per every pound of substance). But precautions are necessary, as plastic products usually include additives to acquire their specific characteristics. Thus, when burned, they may produce poisonous gases. Energy extraction of plastic wastes is done in special, technologically prepared incinerators so that the combustion of the wastes does not pollute the environment.

The process of plastic recycling is carried out on an integrated basis, as the waste screening process will affect the selected process of plastic recycling as well as the economics of recycling. The relationship between waste screening and the selection of the method of recycling to be used is illustrated in the table.

Recycling plastic also has economic benefits, as it offers a reduction in the cost of production due to the low price of raw plastic made of recycled wastes compared with the price of raw original plastic.

Type of Plastic Waste Dictates the Path of Recycling

Kinds of plastic wastes	Mechanical recycling	Raw material extraction	Energy extraction
Wastes screened into one kind	✔	✔	—
Plastic wastes of many kinds	✔	✔	✔
Plastic wastes mixed with other specific kinds of wastes	—	—	✔
Plastic wastes mixed with municipal wastes	—	—	✔



It also reduces the amount of plastic wastes requiring disposal. A formula for the economic benefit follows:

Economic benefit =
Savings on the cost of raw plastic -
Cost of recycling +
Savings from reduced waste disposal -
Cost of waste disposal

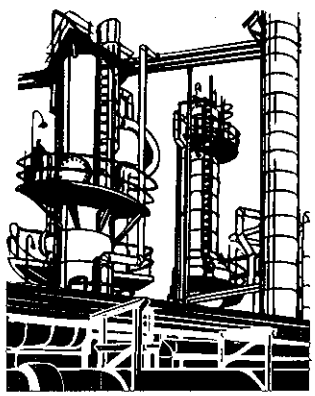
An important question arises: What kinds of packages or carrier bags are advisable to use? Plastic, paper or something else? We will find that there are some people who prefer using packages or bags made of specific materials.

We will observe that every company will introduce a justification to use those materials exclusively. Some of those reasons are logical, but all will agree that reusing and recycling, irrespective of the type of package, will save money and effort.

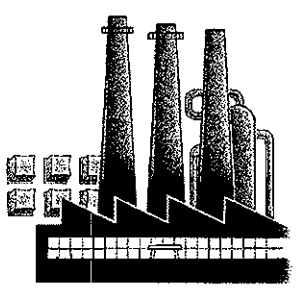
So, what you will do when you buy your commodities? Reuse them, if doing so will save raw materials and protect the environment? Or not?

Source:
Hoyle, W. and Karsa, D. R., editors. Chemical Aspects of Plastics Recycling. Cambridge: The Royal Society of Chemistry. 1997.
Augado, J. and Serrano, D. Feedstock Recycling of Plastic Wastes. Cambridge: The Royal Society of Chemistry. 1999.

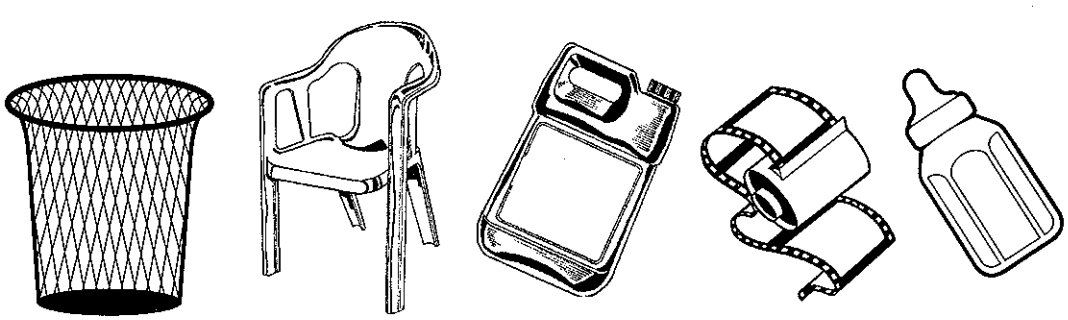
Plastic Production



1) Petroleum and natural gas, in addition to other chemicals, are mixed together to produce basic petrochemicals needed for the plastic industry.

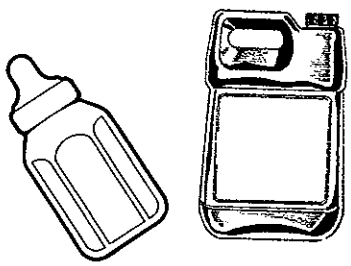


2) Petrochemicals are coverted into plastic pellets or sheets.

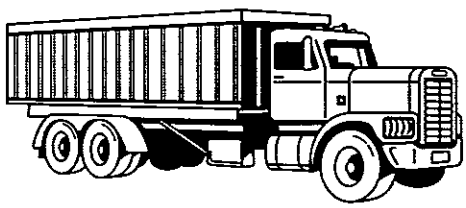


3) From melted, raw plastic various kinds of plastic products are obtained.

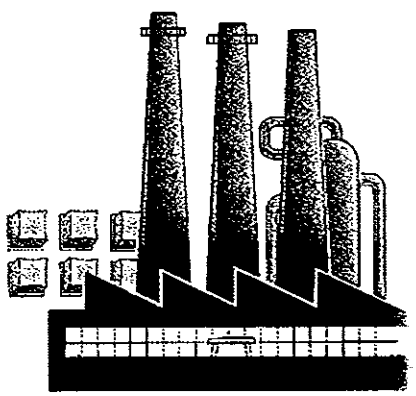
Recycling of Plastics



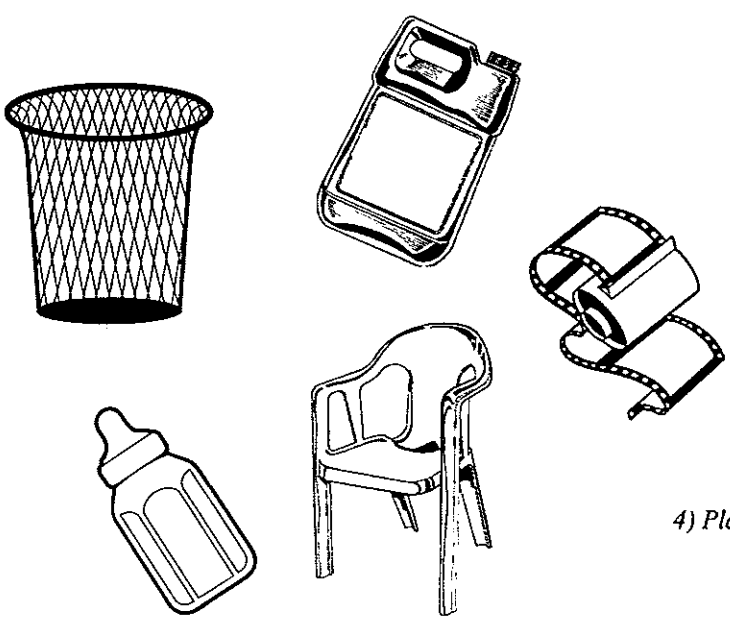
1) Plastics are sorted into their various kinds.



2) Plastics are packed and transported to the production facility.



3) Plastics are shredded and then melted and shaped into small pellets of plastics.



4) Plastic pellets are used in new products.

Composting: Transforming Wastes into Organic Fertilizers

What Happens to Wastes in Nature?

The natural environment has its own process of treating wastes. Organic wastes, such as the remains of plants or animals, are biodegraded by small creatures and microorganisms that consume most of the wastes, leaving behind parts or substances that they cannot digest. These partially decomposed remnants are called humus which is a spongy structure of black or brown color that contains mineral elements necessary for plant growth. Soil characteristics are improved if the soil is rich with manure, because unlike sand it is not too porous to keep water, nor is it too heavy like compact clay soil, which has poor aeration.

Composting

Composting is one of the methods used to make benefits of wastes (a form of recycling). The composting process provides a condition necessary to activate decomposition by microorganisms and produce humus.

The time needed for decomposition of substances depends on:
1) Carbon to nitrogen (C/N) ratio in organic wastes.
2) Surface area exposed to air (the size of the pieces of wastes).
3) Aeration (oxygen supply).
4) Humidity level.

1) C/N Ratio

Bacteria and fungi decompose organic substances into carbon, which is used by organisms as sources of energy and nitrogen needed to build body cells. A 30/1 C/N ratio, according to weight, is ideal. The decomposition will be slow if the nitrogen content is not high enough, but if the nitrogen content is too high, this will lead to the formation of ammonia, which is harmful to plants.

Plant leaves are good sources for carbon, and fresh grasses and animal wastes are good sources for nitrogen.

2) Surface Area

Decomposition of organic matter occurs when its surface comes into contact with the air, so increasing the surface area (in relation to its size) by breaking up the wastes into smaller pieces, will increase the rate of decomposition of those substances. Some insects and land worms will work to fragment organic wastes into small particles, which bacteria and fungi will then decompose.

3) Aeration

Decomposition of organic matter must occur in the presence of air, and so aeration of wastes is necessary to renew the oxygen consumed during the decomposition process. The absence of aeration will lead to anaerobic analysis, or fermentation, and will be accompanied by a bad odor.

4) Humidity

Humidity is necessary for the growth and proliferation of microorganisms. If humidity decreases to less than 40%, the activity of these organisms will decrease, but if it increases to more than 60%, aeration will be worse.

Wastes Suitable for Composting

Any wastes of plant or animal origin are suitable for co-composting, as long as they have a suitable C/N ratio and humidity level. These wastes may include:
* Household wastes (after the removal of metals, and glass and plastic items).
* Food industry wastes.
* Agricultural field wastes.
* Plant leaves and grasses cut from gardens.

Paper and wood wastes are free of nitrogen, so they cannot be composted unless the C/N ratio is controlled.

Composting of Municipal Wastes

Composting of organic wastes occurs in three stages.

1) Preparation of Wastes for Composting

* Screening of wastes to remove non-suitable materials.
* Shredding.
* Other conditions necessary for the aerobic decomposition of organic wastes.

Only 40% of municipal waste is suitable for composting.

2) Composting Organic Matter

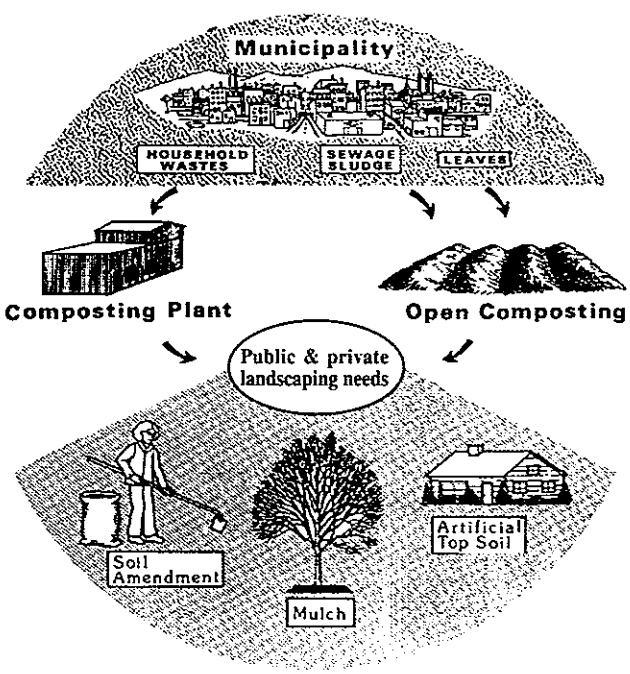
Usually, the wastes are piled into heaps with a base of about 2.5-3.5 meters, and a height of 1.75 meters. In addition to humidity, aeration must be adequate for decomposition to occur. Humidity is controlled through watering, and aeration is controlled through rotation.

3) Preparation of Compost

The quality and value of the manure is raised by sorting it so that only soft and uniform compost is used. Nutrients that plants require for growth are sometimes added. Usually 350 - 500 kilograms of manure can be produced from one ton of municipal wastes, according to the location of the factory and the weathering conditions. Good compost must be free of any pathogens, grass seeds, toxic substances such as ammonia, heavy metals, and bad odor. This will not be achieved unless sorting of the original municipal wastes takes place, and the rules of the production process are perfectly followed.

Conclusion

Using composting to transform unwanted wastes into substances necessary for the soil, as long as they contain a high ratio of organic matter and level of humidity, is better than putting them in a landfill or burning them. Compost produced to improve the soil must be free of toxic or hazardous wastes, and the production process must follow quality and safety criteria.



Composting benefits

Waste-to-Energy Generation

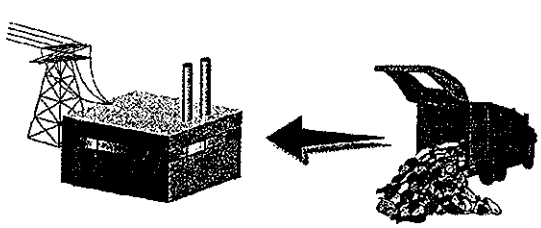
Materials and Energy

Humans have known for a long time that organic matter is rich in energy. Humans made use of organic matter as a source of energy when they discovered fire and found that plant wood is a suitable fuel to cook food. Today, humans are again using this old knowledge in the development of methods to generate energy from organic wastes.

Two technologies are now used to generate energy from wastes:
1) Burning of materials
2) Producing biogas

1) Burning to Generate Energy

For a long time, people have used fire as a way to treat wastes by burning them in open dumpsites. More recently, burning of wastes also takes place in incinerators. The purpose of burning wastes in the past was to reduce its size, and avoid problems arising from its decomposition. Recently, methods have been developed to generate electricity from the burning of wastes in incinerators that are different from the old ones that did not generate energy.



The process of generating energy from wastes takes place as follows:

i) Wastes that come to the establishment are sorted to remove large substances or recyclable materials.

ii) Wastes are passed through rotary belts with shredders that cut them into small pieces (15 centimeters).

iii) Before burning, wastes are exposed to strong magnets that remove metals, which are then recycled.

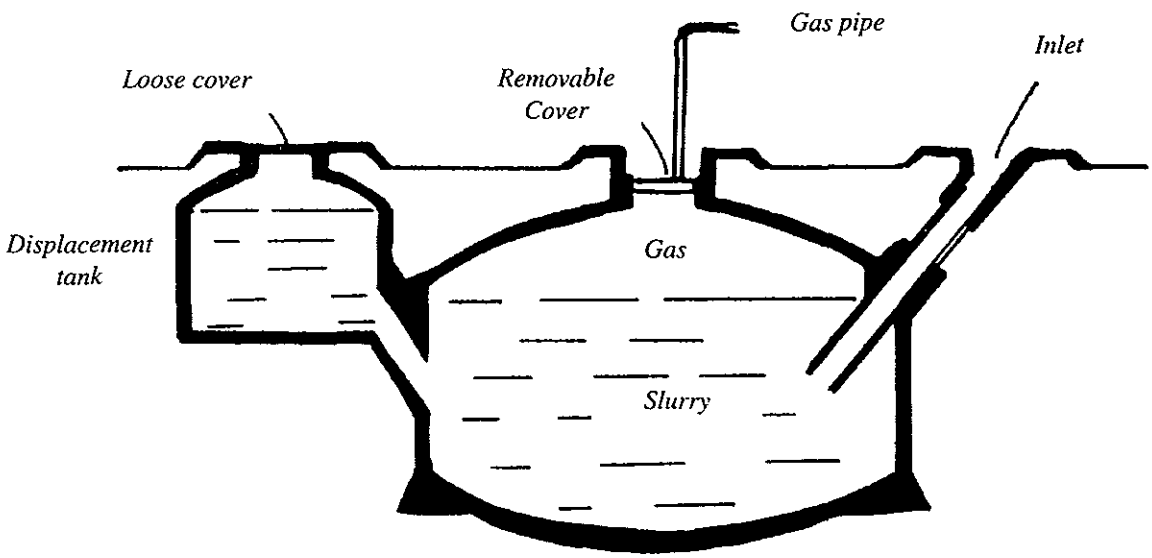
iv) Wastes are burned, and the heat generated raises the temperature of the water in boilers; the water transforms into steam that switches on turbines to generate electricity.

v) Ash is transported out of the base of the incinerator to a special facility that retrieves metals from it.

vi) Gases generated during burning are passed through lime filters to neutralize them, and then they are passed through electrostatic precipitators to remove dusts and pollutants. If operating procedures are effectively established, the level of pollution that results from the above processes does not exceed the level of pollution generated by coal or petroleum power stations.

vii) Ashes are removed and treated far away from the facility.

This process is efficient enough that in the United States, one million tons of municipal wastes are treated, 40,000 tons of metals are recycled, and 650,000 mega watts per hour (equal to 80 million liters of petroleum) of electricity are generated to supply 75,000 houses with electricity.



Chinese-type Biogas Plant

2) Producing Biogas to Generate Energy

People have discovered that during the decomposition of organic substances, highly flammable gases are generated. By studying this phenomenon, it has been observed that anaerobic digestion of organic matter is responsible for this gas generation, which is known as biogas.

Anaerobic digestion refers to the decomposition of organic matter in the absence of oxygen by a special group of bacteria (anaerobic bacteria). This anaerobic decomposition of organic matter produces biogas as well as solid and liquid byproducts.

Biogas is composed of highly flammable methane gas (55 -70%), carbon dioxide (25 -35%), and traces of hydrogen sulfide and nitrogen sulfide.

Anaerobic decomposition occurs naturally when organic matter accumulates under conditions of high humidity and the absence of oxygen. Usually this kind of decomposition occurs at the bottom of lakes, wetlands and waste dumpsites.

People have used anaerobic decomposition to generate energy for many years; the ancient Assyrians used biogas to heat bathwater in the tenth century B.C.

The sludge that remains from anaerobic analysis can be used as a fertilizer for soil.

Methane gas production results when organic wastes are present under suitable conditions for anaerobic decomposition to occur. The required conditions are lack of oxygen, the presence of high humidity, and the presence of high temperatures.

Wastes can undergo anaerobic decomposition in reactors that are impermeable to oxygen. Methane gas is generated and accumulates in the upper part of the reactor, and is then collected to be used directly as fuel for cooking or lighting. Then, sludge -- solid or liquid byproducts that are not completely decomposed -- is removed from the bottom of the reactor to be used as fertilizer for agricultural soil or to be further composted or dumped into landfills.

Biogas Reactors are common as small reactors to generate fuel for cooking or lighting from agricultural wastes. China and India use big reactors and well developed systems to generate biogas for electricity generation. Denmark is famous for its big reactors to digest animal wastes and to clean organic industrial wastes and sorted municipal wastes. During the last decade, anaerobic decomposition has also begun to be used to treat industrial wastewater, and recently, anaerobic decomposition has also been utilized to decompose solid municipal wastes.

A new system has been developed to avoid the disadvantages of anaerobic decomposition, as the process requires a large amount of time. Anaerobic decomposition of wastes is used for energy generation, and the sludge produced is used in soil reconditioning. From each ton of wastes, 75-150 kilowatts per hour of electricity are generated. The resulting bad odors, and the large amount of water required, are disadvantages of this method.

Benefits of Generating Energy from Wastes

Benefits include the following group of economic and environmental factors:

* The cost of energy generation is reduced through the use of a low-cost renewable source.
* It is an effective waste treatment method.
* The sludge byproduct is used as a soil fertilizer.
* Environmental problems associated with waste dumping are avoided.
* Less fossil fuel is consumed.

For all these reasons, anaerobic waste-to-energy generation is a much better solid waste management method than dumping or incineration.

Technological Aspects of Integrated Solid Waste Management

Integrated Solid Waste Management

Solid waste management is a special field of modern science that includes several technological aspects. This branch of science focuses on the study of solid wastes and their generation, storage, collection, transport, treatment, and disposal according to suitable health, economic, engineering and environmental standards, as well as considerations of social values and public attitudes.

The modern management of solid wastes implements a new system known as integrated solid waste management, which prioritizes reducing amounts of generated wastes, recycling, and reusing wastes before they are treated and then finally disposed.

Solid Waste Management Systems

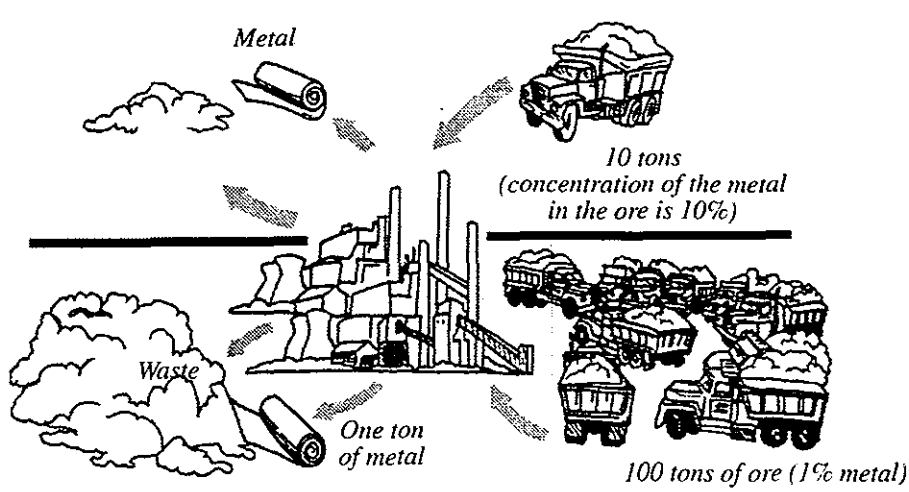
Solid waste refers to all kinds of solid substances, in addition to some liquid ones, that their owners regard as unneeded or having no further use or value. Waste management methods are developed with consideration for natural processes and the amount of wastes generated. It is possible to categorize the different activities in the solid waste management system -- starting from the generation of wastes until their disposal -- according to the following basic divisions:

1. Waste Generation.
2. Waste handling and seperation, storage, and processing at the source.
3. Collection.
4. Separation, processing, and transformation.
5. Transfer and Transportation.
6. Disposal.

1. Waste Generation

Wastes are generated when substances become unwanted and need to be disposed. Currently, waste generation is not under the supervision of any official authority.

Reducing the amount of wastes generated is the first priority of integrated solid waste management. Technologists are going

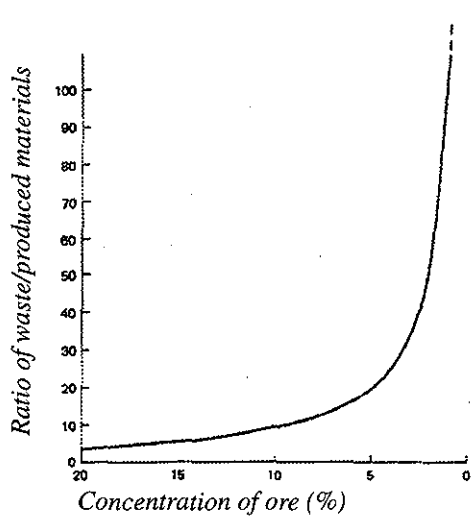


The amount of waste generated from low-concentration ore.

through a careful materials selection process, to choose the raw materials that generate minimization of waste in an industrial process. The following example demonstrates the relationship between the quality of a raw material and the amount of waste generated from its use.

a) In order to manufacture one ton of a product from a raw material with a concentration of 1 percent, you need to process one hundred tons of that material, which will generate 99 tons of wastes. However, if you select a raw material with a concentration of 10 percent, only ten tons of the raw material are needed to manufacture one ton of the product, and only nine tons of waste are generated.

b) Therefore, it is apparent that choosing the best raw material leads to a reduction in pollution. Pollution is also generated by the acquisition of the raw material and its transportation to the processing facility.



Relationship between ore concentration and waste generated.

c) Generally, using increased concentration levels of raw materials dramatically reduces the quantity of wastes generated.

2. Waste Handling and Separation, Storage, and Processing at Source

Waste management includes all the activities and processes needed to deal with wastes including its storage in garbage containers until it is collected, its transportation to a dumpsite or treatment facility, and its final disposal.

Sorting waste at its source is a very important step in a system of integrated waste management because it helps store wastes in an organized manner according to standards of cleanliness and aesthetics. It also clarifies which wastes are recyclable substances and which wastes are materials that can be reused. According to the desired standards of buyers, initial treatment of wastes may include some activities that take place in the source collection site:

* Pressing, compacting, and screening.
* Composting animal and botanical debris into organic fertilizer that can be used in farms and in the yards of houses and schools.

3. Collection

* The collection process includes collecting solid wastes and recyclable materials and transporting them to a location where they will be disposed of or reprocessed.

* This location may be a treatment building or a collection point where the materials are collected and transferred into larger vehicles.

* Well-equipped vehicles of different storage capacities are used. Usually, they lift and dump the contents of the garbage containers into the truck. The vehicles thus both collect and transport the garbage.

Models of containers for collecting sorted waste

* In large cities, transportation costs make up a large percentage (50 percent) of the total cost of solid waste management.

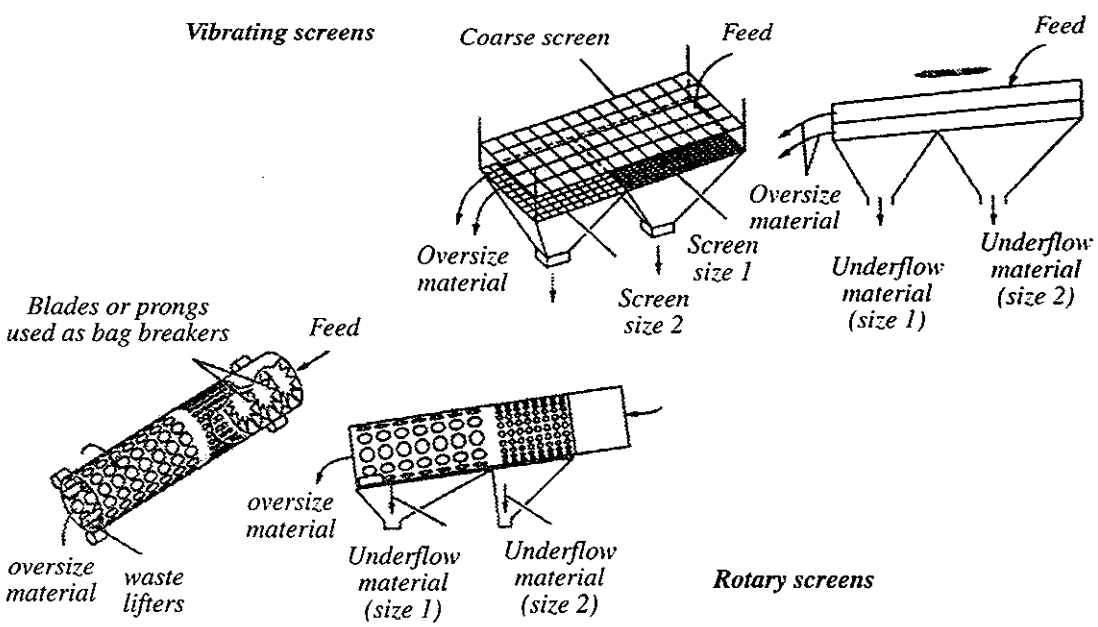
Usually municipal governments are responsible for the collection process, or they contract private firms to carry it out.

The awareness and cooperation of the public is an important step in solid waste management. For example, if people separate and place their garbage in special collection containers for each kind of waste, this will facilitate the next phase -- screening and treatment.

4. Separation, Processing, and Transformation

Collected wastes are screened and sorted to retrieve materials that can be used again. Also, materials that have initially been sorted at their source require further sorting and screening, e.g. paper wastes are sorted into paper and cardboard, glass into transparent and colored bottles, plastic into its various kinds, and metal cans into tin and aluminum.

Usually treatment includes the screening of large objects. Screeners are used to sort wastes according to size, and then the volume of the waste is reduced through compaction and burning.

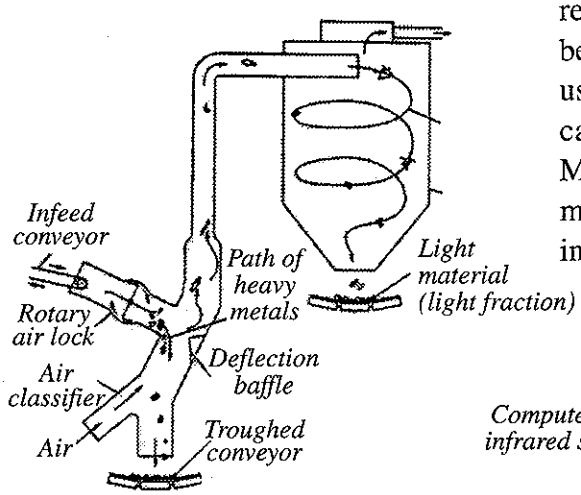


Screening

Screening is a process used to separate a mixture of different-sized materials into two or more categories. The kind of screening equipment used to deal with municipal solid wastes depends on the kind of garbage generated. As wastes are run through the equipment, similar-sized wastes are ejected from the screener.

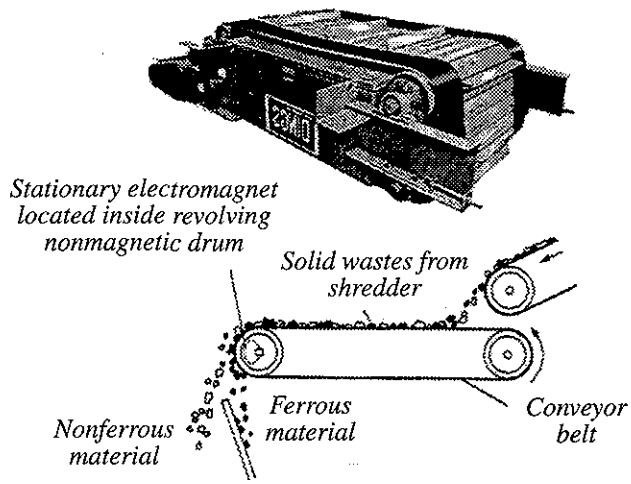
a) Density Separation (air classification)

With this equipment, materials of different weights are exposed to high-speed air currents, so that light materials are carried one away, while heavier materials move opposite to the direction of the current.



Typical air classification system

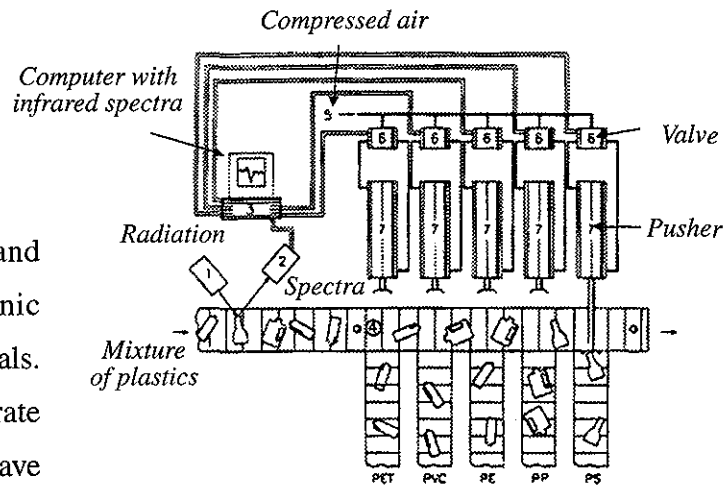
Aerobic screening is used to screen and separate relatively lightweight organic materials from heavier inorganic materials. Aerobic screening is also used to separate different kinds of glass and plastic that have been collected together.



Typical magnet separators

b) Magnetic Separation

Magnetic screening is a process by which the magnetic properties of metals are utilized to separate them from other kinds of wastes. Magnetic separation (screening) is used to retrieve metals from solid wastes that have been sorted at source; the process is mainly used to separate aluminum cans from tin cans that have been collected together. Magnetic screening is also used to remove metals from ash after wastes have been incinerated.



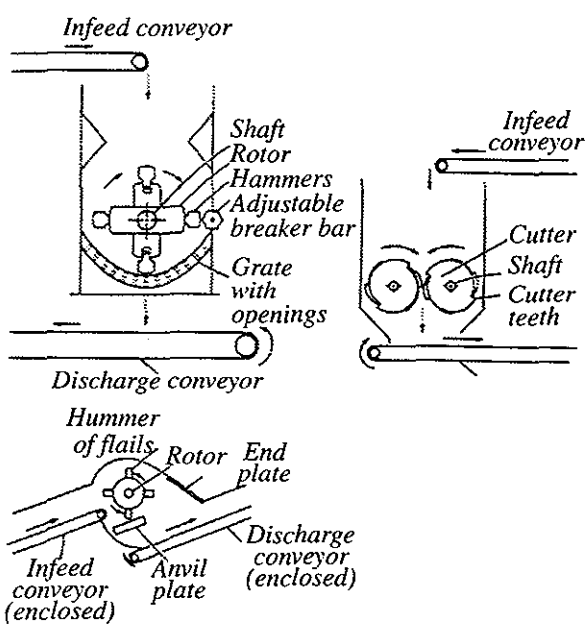
Automated sorting facility based on radiation spectra

c) Mechanical Screening by Using Photometry

Some of the advanced mechanisms used to separate plastics depend on the photo analysis of infrared rays. A computer reads the rays that are reflected off of the different kinds of plastic, and when the computer recognizes a specific ray, it opens a gate to allow the specific kind of plastic product through. This method is more accurate and less labor intensive than manual sorting.

Size Reduction

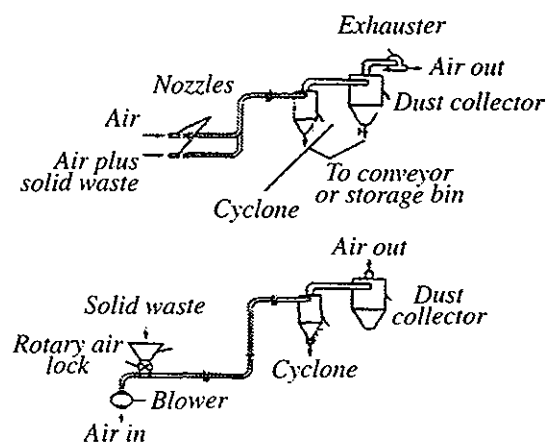
Size reduction is a process in which wastes are divided into smaller pieces. This process involves equipment such as shredders, glass grinders and wood chippers, and it creates a more homogenous mixture that is easier to deal with.



Examples of shredding equipment used to reduce the size of solid wastes

Compaction

Compaction is a process that is carried out in order to decrease the volume of waste materials. This allows wastes to be more efficiently stored and transported. It is also a phase in the waste-to-energy generation process. Examples of equipment used to compact wastes include balling equipment, glass grinders and crushers, rotators and rotating belts, compressors, loaders, and vacuum pressurized equipment; storage facilities and scales are also utilized in this phase of solid waste management.



Pneumatic conveyor system.

5. Transfer and Transportation

Transportation involves two steps:
(1) Transporting wastes from small collection vehicles into larger trunks.
(2) Transporting wastes to dumpsites or other treatment facilities.

Transportation is usually done by special trucks that are both collection and transportation stations. Although trucks are the most commonly used means for transporting wastes, trains and ships are also used.

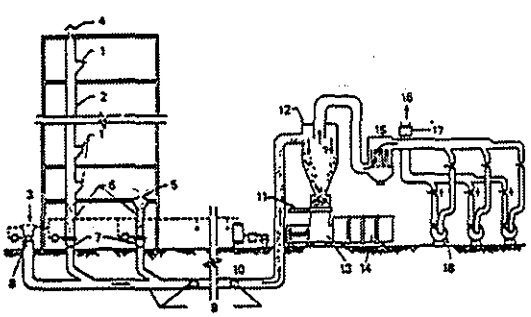
Special Collection Methods

In some housing areas, a special collection method that includes collection, screening

and transportation is used. Air pressure, controlled by various switches, directs the garbage through ducts and separates it into different containers. The wastes are compacted, and then put in containers for transport. Filters are installed to minimize air pollution, and noise pollution is also reduced by the use of special equipment.

6. Disposal

Waste disposal is the last phase in an integrated solid waste management system. Currently, many cities in both developed and developing countries continue to dump their wastes in garbage dumpsites. Sanitary landfills, or safe landfills, differ from garbage dumpsites. They are designed to contain garbage without causing any problems related to public health or environmental safety, such as rodent and insect infestation and groundwater pollution.



Collection and treatment at source

Many technological aspects must be considered in the building of sanitary landfills. Special design features include coating the bottom of the site with insulators, installing a treatment and collection system for waste leakage, and constructing a gas control system to deal with emissions that result from the decomposition of the landfill's wastes.

The plans and technological requirements needed to build a solid waste management system will differ from place to place. The selection of a suitable system to manage wastes in a location depends on several factors such as natural features, the amount and kinds of wastes generated, attitudes and behaviors of citizens, specific objectives for the solid waste management program, and cost.

We must not neglect social and human considerations, for they are essential elements in the success of integrated solid waste management systems. Research on the behaviors and habits of citizens is a necessary complement to the technological aspects of design, and both are necessary for creating an efficient waste management program that protects the environment.

References

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Activity (14)
What Were Our Families Doing?

Concept:

Egyptians have a rich heritage in the rational use of natural and environmental resources. They have effective practices for reusing and recycling. But this heritage has been neglected and is disappearing because of the new consumption norms.

Objective:

Reminding students of the traditional practices of our fathers and mothers in dealing with the environment and natural resources, and encouraging the recognition of these practices and their value as a source of positive environmental attitudes.

Methodology:

Silent session to remind participants what they saw in their houses when they were children or what they see when visiting older members of the family.

Location:

Classroom or any place for 8 - 10 persons

Duration:

45 minutes

Materials and Equipment:

Papers, pens, large pads of paper and flow master pens

Steps:

1) Ask participants to remember what the elder members of the family did during the following activities:
   * Keeping food away from flies or mosquitoes.
   * Storing food.
   * Cleaning house.
   * Making the house and clothes smell nice.
   * Protecting the house, furniture and clothes from insects and rodents.
   * Reusing consumable objects.
   * Dealing with organic garbage.

2) Ask participants to mention definite examples of the above activities, and where they took place (in rural areas or in cities).

3) Ask the students:
   * What practices are still used, and which ones have been neglected and forgotten?
   * What is their evaluation of these practices from an environmental perspective?
   * Have we lost anything from the disappearance of these practices?
   * Do they think it is important to revive these practices, or perhaps some of them? Should they be revived as they are or re-adopted with modifications and developments? What kinds of changes, if any, are needed?

4) Ask participants to present their results in front of the rest of their colleagues in an attractive way. Use colors and paints, or colored cards.

5) Ask them to select one or more of the group members to present the results in the general session.

Activity (15)
Sanitary Landfills

Concept:

The disposal of garbage and solid wastes in soil has environmental impacts on soil, water, and air. Mitigating those impacts may be achieved through proper design and improved management of the sanitary landfills.

Objective:

Alert participants to the environmental damages that result from disposing wastes in the soil (refer to activities 8 and 9) and encourage the design of safe alternatives to garbage disposal without exposing the surrounding environment to damage.

Methodology:

Design a model of a sanitary landfill considering health and environmental conditions.

Location:

Classroom, activity room or workshop

Duration:

One hour for designing the model; some weeks to monitor changes that may take place in the sanitary landfill

Materials and Equipment:

Charts, pens, big plastic tank, scissors or a knife, mud, soil, sand, small stones, a variety of garbage, big plastic bags and plastic tubes

Steps:

1) Briefly discuss with participants the most apparent conclusions of activities 8 and 9 as to the impacts of the disposal of wastes in the soil on water resources and agrosoil.

2) Encourage participants to propose ideas to avoid the risks of garbage disposal in landfills. Introduce questions such as:
   * What we can do to prevent pollution of the soil and groundwater?
   * What we can do to prevent bad odor?
   * What we can do to minimize the presence of flies, rodents, and wild dogs?
   * What we can do when the landfill reaches its maximum capacity? How can it be closed?

3) Ask the participants to draw a design or designs that satisfy the above conditions.

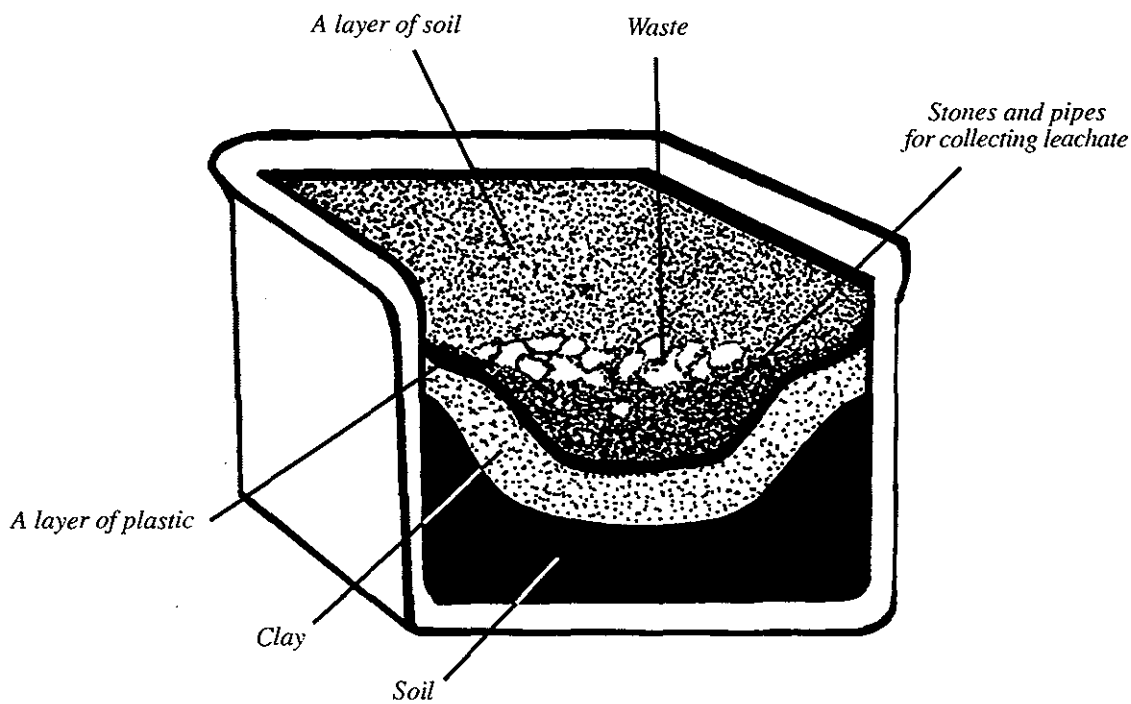
4) Discuss the different designs and ask the group to do a design that combines as many advantageous aspects as they can

5) Use the illustrative diagrams on the following pages and compare them to the participants' designs.

6) Ask the participants to make the designs using the available materials offered.

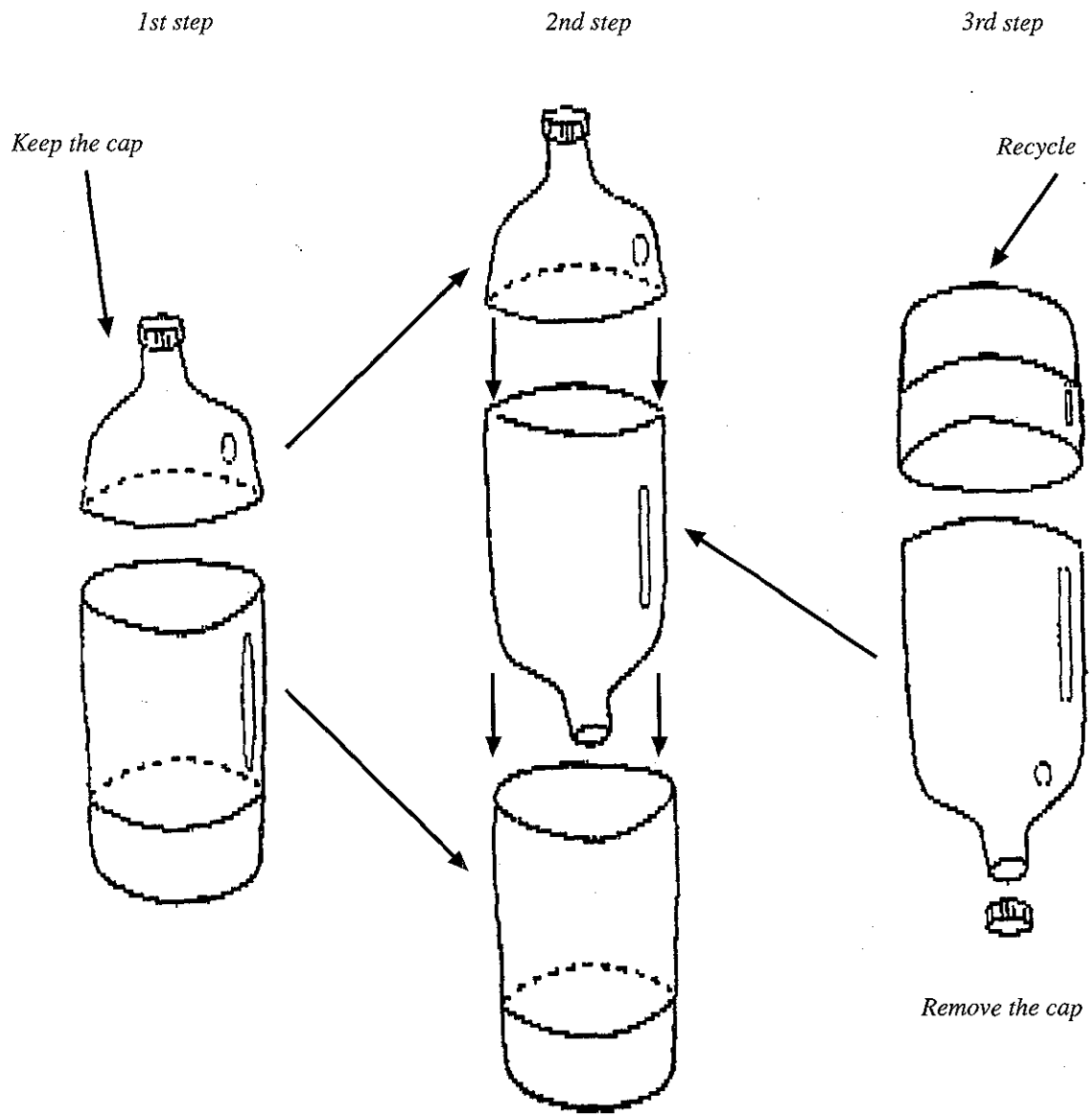
7) Ask them to have a follow-up plan to monitor the landfill every week and to record their observations.

Source: Let's Reduce and Recycle: Curriculum for Solid Waste Awareness. US Environment Protection Agency (EPA), 1980, revised 1990.

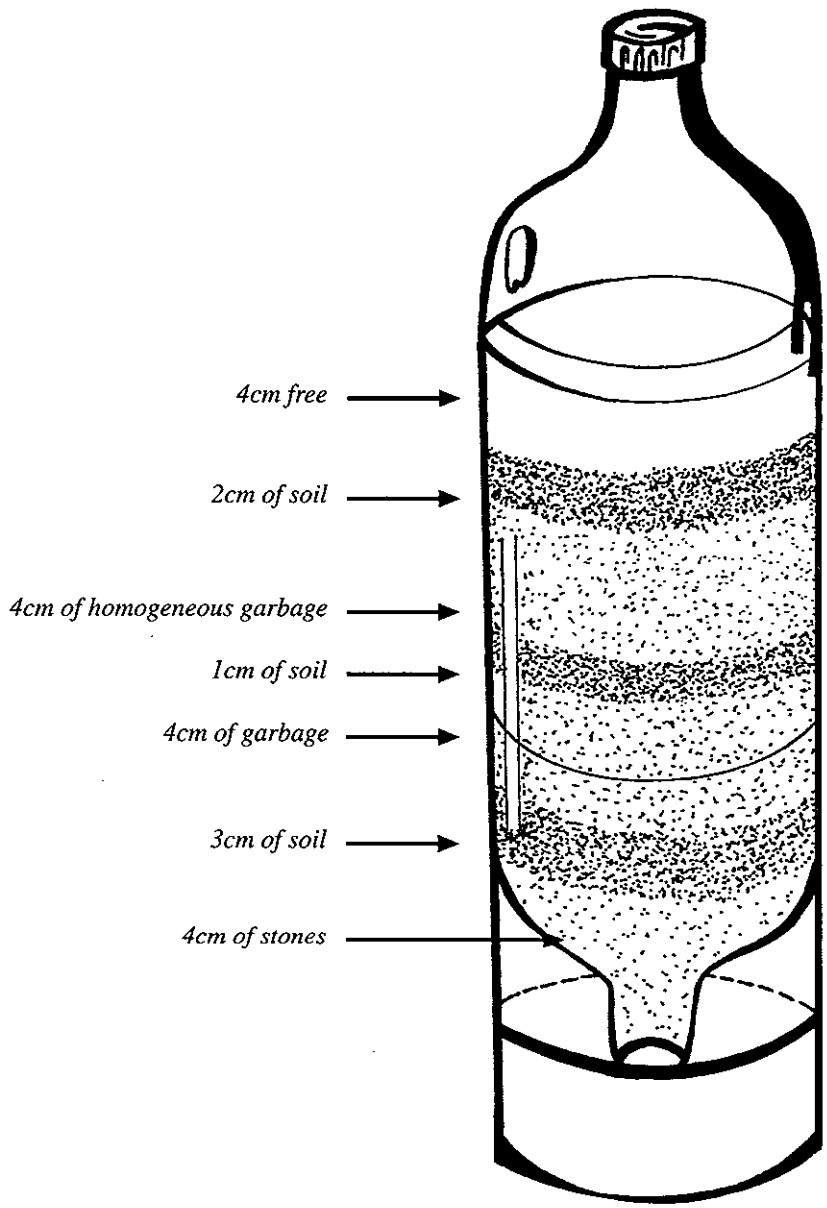


Section in a miniature model of a sanitary landfill

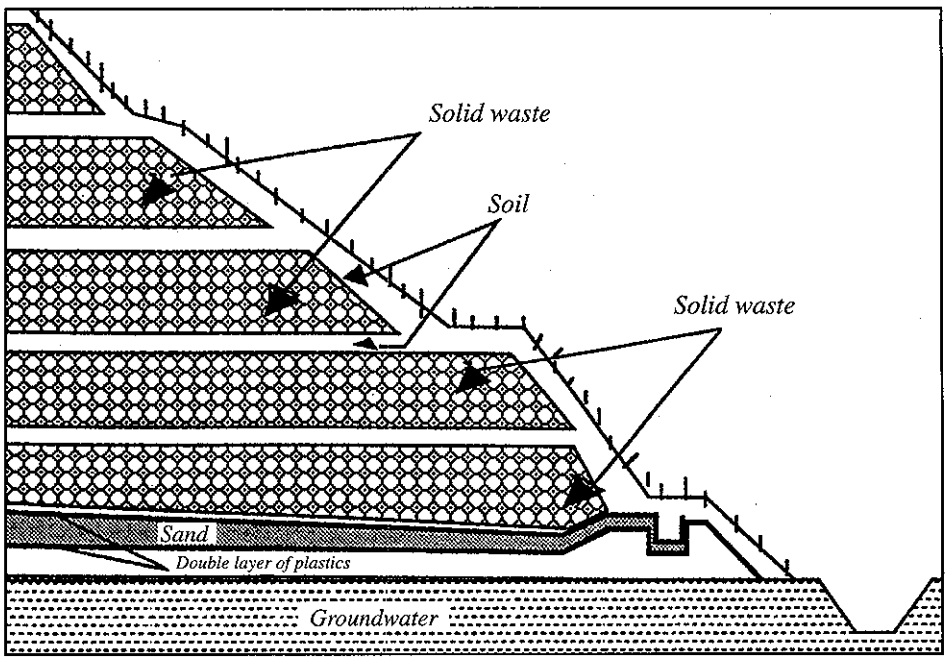
Activity (15): Sanitary Landfills



How to make a miniature model of a waste landfill using plastic bottles.



How the landfill model will finally look



Section in a closed sanitary landfill. All waste is covered with soil. After complete waste degradation, the landfill is cultivated with palm trees and used as a park.

Source: Closing the Loop: Integrated Waste Management for School and Home, Part I: Everything Ends Up Somewhere. Ohio: The Institute for Environmental Education, 1995.

Activity (16)
Composting Corner

Concept:

The decomposition of tree leaves on the forest floor is a process of recycling undertaken by microorganisms in the soil. This process produces an organic mixture of fertile soil particles and supplies vegetation with essential nutrients. All organic wastes can be recycled in the same way to produce organic compost that is necessary to improve soil characteristics and preserve its productivity.

Objective:

Demonstrate that food wastes and botanical remnants can be recycled into organic compost and used as fertilizer on agrosoil. Two objectives are achieved:

* Management of a large portion of garbage in a proper environmental way.

* Production of organic compost to replace expensive and harmful chemical fertilizers.

Methodology:

Using simple raw materials, students design a laboratory to manufacture organic compost.

Location:

An isolated corner in an activity hall, classroom, or a shady place outside

Duration:

30 - 45 minutes to build the compost laboratory; 4 - 8 weeks to make the compost

Materials and Equipment:

Three plastic bottles, kitchen wastes of food remnants and organic garbage, small amount of soil, knife and a long needle

Make It:

1) Take a bottle and cut its upper part at the widest place. You will have a conical piece that can be slipped in or out of the bottle stem as a cover. Now cut the bottle base and dispose of it.

2) Repeat the process with a second bottle, and now you have a vertical tube. Use this tube as an extension to the first bottle.

3) Remove the bottle cover and cut the bottom at the widest point. Dispose of the cap and bottom. Turn it upside down, and fit it together with bottles 1 and 2.

4) Heat the needle tip and use it to make pores in the apparatus (except the conical end of bottle 3).

5) Fill the column with kitchen and garden wastes and a little amount of soil.

6) Be sure that the wastes do not include fats, meats, or bones, as they are difficult to decompose, produce a bad odor, and attract flies. Be careful to avoid adding metals and plastic or glass items.

Use It:

1) The holes are very important and are needed to provide oxygen to the aerobic bacteria that decompose the garbage. If you have enough bottles, make a second unit and observe what happens if you leave the cover on the bottle of cone 3, or if you do not make holes.

2) You can make a useful comparison with a larger scale experiment by making a compost heap of hay and plant wastes in a garden or playground corner. Be sure that the waste is heaped on the ground in such a way that air can circulate through it. You can use this method also to compost wastes to use as garden fertilizers.

3) The liquid collected at the base of the column can be used as a liquified fertilizer. Try to compare the growth of plants irrigated by different lightly concentrated amounts of this liquified fertilizer.

4) Discuss with the students the importance of reusing organic matter in agrosoil to preserve its fertility and renew its ability to produce crops.

Activity (17)
Paper Recycling

Concept:

Each year, every individual produces an amount of waste equal to his weight. All of this garbage must be disposed of somewhere. Usually, this garbage is disposed of at a dumpsite, or it is burnt or thrown in a remote area. Today, it is difficult to find a suitable site for garbage disposal. We can help in reducing the acuteness of this problem by recycling or reusing large amounts of materials that are now thrown away.

Objective:

Demonstrate the concept of waste recycling and urge students to support local projects to recycle materials such as glass, cans, plastic and paper.

Methodology:

Collecting old papers and recycling them to be used another time.

Location:

This activity requires a place where water can be used and spilled, as the production of paper requires a lot of water.

Duration:

One hour the first day to prepare equipment and materials.

One hour the second day to manufacture paper.

Materials and Equipment:

Any paper wastes from schools or offices (except newspaper wastes), mesh with small openings, cloth to absorb water, plastic containers (must be longer than the mesh pieces), wooden spoon, dyes, plastic bags, heavy objects (bricks)

Steps:

1) Shred papers into a container of water and leave it until the next day.

2) Use the wooden spoon to stir the papers into a pulp and get rid of excess water (use an electric rotator if you have one). In this step you can add dyes if you want.

3) Put the pulp in a plastic basin, preferably rectangular, and add to it an equal volume of water; mix it well.

4) Cut a piece of mesh equal to the size of the paper to be made (make one large piece that can be easily entered into the basin).

5) Put the mesh in the basin laterally and then remove it. Now, the surface of the mesh is covered with a layer of pulp.

6) Put a piece of paper on a clean surface, and put a piece of cloth on this piece of paper. Quickly and accurately put the mesh over the textile piece so that the soft pulp roll will be completely transferred to the textile.

7) Firmly press the mesh down, and then raise it very carefully after separating it from the pulp. Put another layer of cloth on top of the pulp roll. Repeat this process six or seven times until the pulp in the basin is completely consumed. (Note: The pieces of cloth that alternate with the pulp rolls should be wet).

8) Put a newspaper cover over the pulp and cloth arrangement, and put a heavy object (clean brick) over the heap.

9) After some hours, separate the cloth and paper layers from each other. Spread the paper rolls to be dried.

10) Read the information background paper on the manual industry of paper.

11) How does the paper that you made differ from the kind that you buy?

Comments:

1) To make embedded drawings on the paper, put botanical leaves between two layers of pulp.

2) Make colored papers by adding natural liquid dyes of botanical origin (from fruits, flowers, or stems).

3) Manufacture scented paper by spraying a natural odor (peppermint, lavender, etc.) into the pulp.

Manual Paper Industry

The environmental protection society in Mokattam established a workshop to produce paper manually from reused paper, remnants of textiles and botanical cellulose. Workers are young people -- either males or females -- living in the district.

This workshop is one among other workshops that recycle plastics, glass, metals as well as textiles by using them in the production of beautiful artistic products.

In this paper workshop, production utilizing the waste takes place manually in the following manner:

i) Raw paper screening and shredding.

ii) Raw paper fermentation and processing into pulp.

iii) Fabrication of paper rolls from the pulp.

iv) Pressing the produced paper to get rid of excess water.

v) Drying the paper in the sunlight.

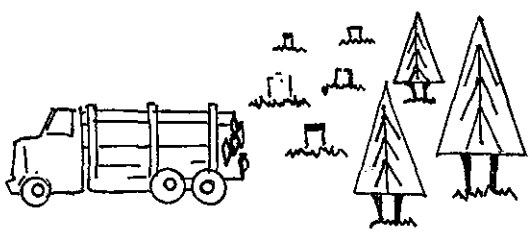
vi) Screening of the produced paper according to required standards.

vii) Coloring and dyeing of paper.

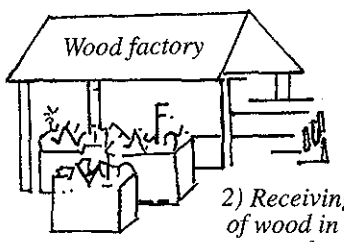
viii) Final manufacturing into bags, files, and envelopes.

ix) Registering amounts of products.

Paper Production

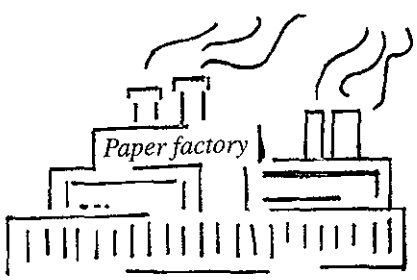


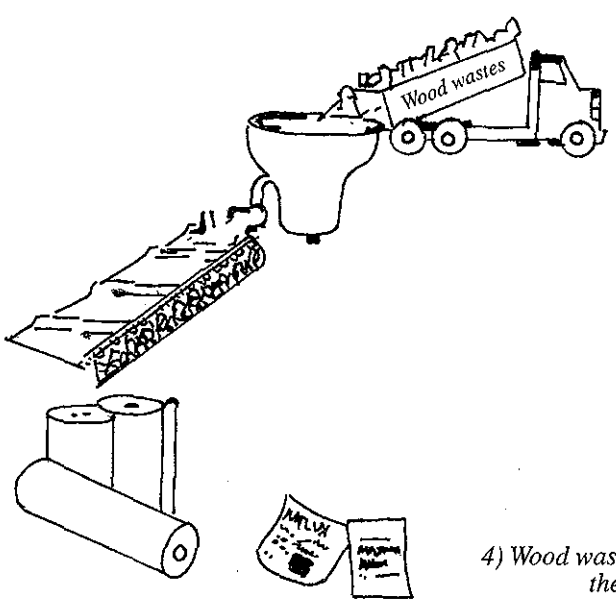
1) Cutting and transporting the trees.



2) Receiving quantities of wood in the lumber factory.

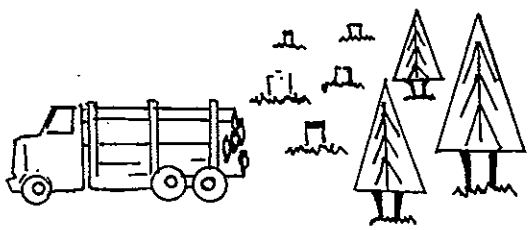
3) Wood wastes from the lumber factory are used in the paper industry.



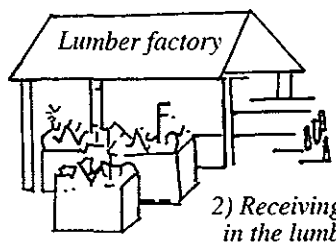


4) Wood wastes are transformed into pulp and then poured into big rolls.

Recycling Paper

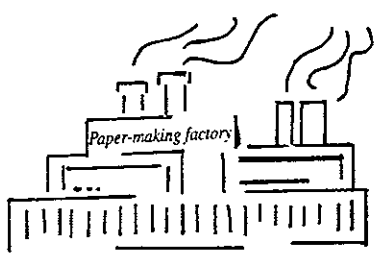


1) Cutting and transporting trees.

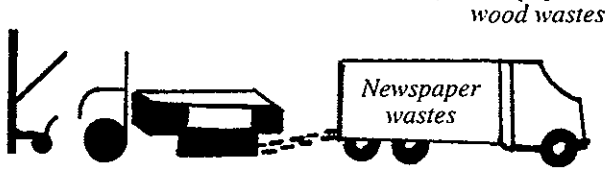


2) Receiving wood trees in the lumber factory.

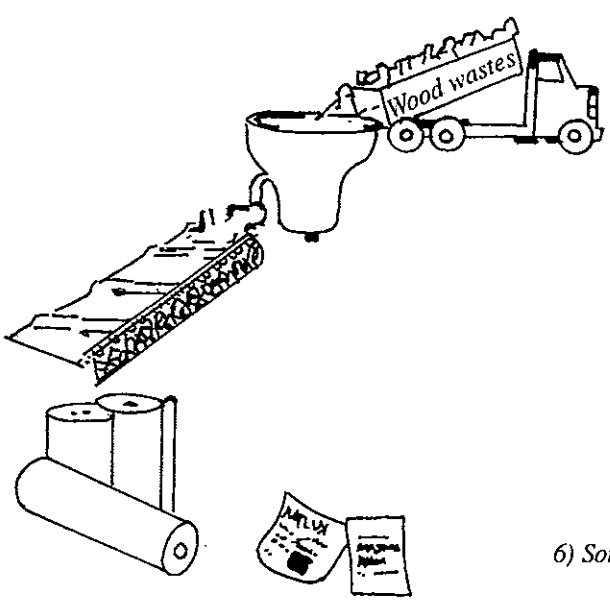
3) Wood wastes from the lumber factory are used in paper production.



4) In the paper-making factory, wood wastes are used.



5) Used paper is washed and watered in big tanks to get rid of inks.



6) Sometimes, a mixture of wood and paper wastes is recycled into new paper.

Activity (18)
Sorting Solid Wastes

Concept:

Sorting the different components of solid wastes is essential to the integrated management of those wastes. Knowing these components and their ratios will help achieve the management goals, which include reducing at source, reusing, recycling, energy generation and safe disposal.

Objective:

Encourage scientific approaches, and make use of students' information about the materials of which the solid waste is composed. Urge them to think positively and share in finding solutions to the solid waste management problem.

Methodology:

Proposing a system to sort the components of wastes, or design an apparatus to do this, depending on the various properties of those materials.

Location:

Classroom, library hall, workshop, school playground, a factory or urban district -- wherever the solid waste management problem exists

Duration:

45-60 minutes

Materials and Equipment:

Papers, pens, charts, pencils, flow master pens

Steps:

1) Identify the place that you will take as an example of this activity, such as a school, hotel or factory.

2) Identify the main activities in this place, the materials used to carry out these activities, and the expected wastes [you can use the outputs of activity (4)].

3) Brainstorm with the group about the way to sort those wastes, and try to come up with several different methods. Many characteristics could be considered, including the organic content, dryness, softness, colors, size, density, ability to float, ability to biodegrade, conductivity, and magnetism.

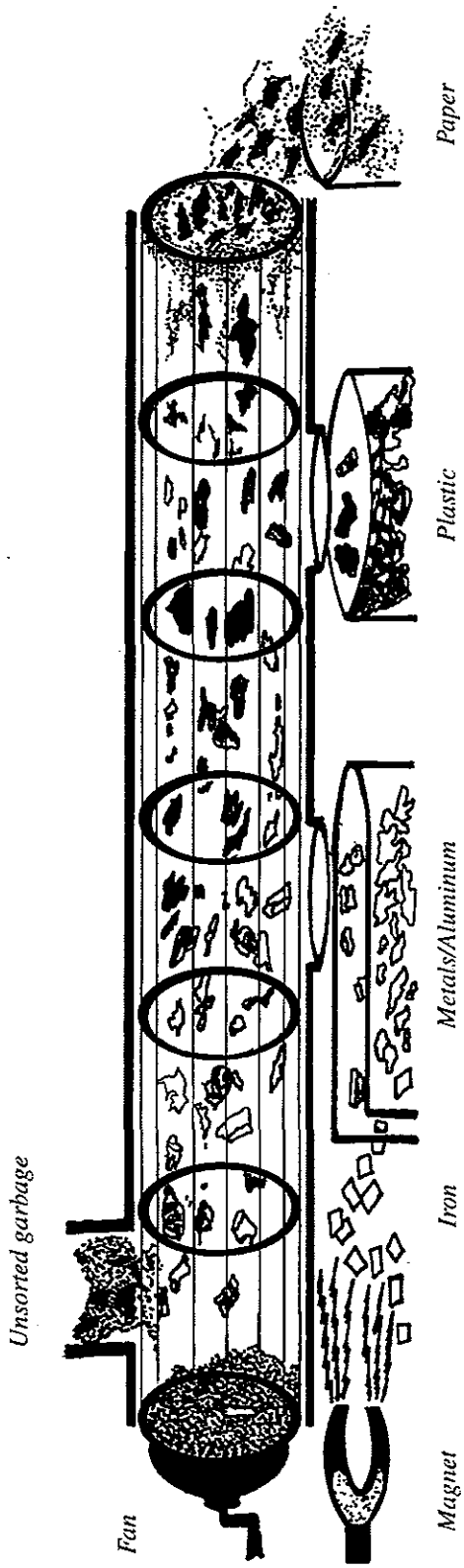
4) Make use of the sorting methods and the information about the characteristics of the materials to think practically and design a process or an apparatus to sort the wastes.

5) Write students' thoughts on a chart.

6) Select, with the group, some ideas that you think are practical.

7) Divide the group into subgroups, and every subgroup will design an apparatus or a system for sorting.

8) Be sure to introduce these designs in a clear visual form in the planning session, and explain the advantages of each one.



A model of a waste separation apparatus.

Source: Bean Fly Jones. Where Does Garbage Go? Breakthrough Strategies for Thinking. Ohio: Zoner-Bloser Inc., 1992.

Gender, the Environment and Development

Development is a process for the improvement of the existing circumstances of men, women, boys and girls in a community. It is not possible to complete a development process without using various environmental resources. So, there is a strong relationship connecting development, the environment, and men and women in their communities.

Development planners must carefully consider the ways in which development activities are implemented, asking such questions as: What are the target groups proposed to share in the benefits? What are the dominating social and economic circumstances in the community that can interfere?

So, any development process must take into consideration the environment with its resources, men and women in the community, the relationship among them, their influence on the environment and the influence that their environment has on them, as they are part of it.

First, we must agree that there is a relationship between humans and their environments. Human beings in their daily life are exposed to various environments: natural or constructed, closed or open like houses, streets, markets, public gardens, work places, beaches, transport and commercial facilities, and so on. People also use natural environmental resources for food and drink, transportation, industry, mining, agriculture and irrigation, and other life dependent activities.

So, humans and the environment cannot be separated or be two unrelated elements. But the community is not composed of one kind of human being. There are men, women, boys and girls, and so accordingly, can the relationship between these categories of people and the environment be different?

To respond to this question, and in order to satisfy different needs for each category, we must analyze the nature of the relationship between men, women and the environment, which is as different as the roles of men, women, boys and girls in the community.

Thus, there are differences in the use of available natural resources. The woman in a household uses water for dishwashing, cooking, laundry and other activities but the man uses water for car washing and garden irrigation. So, this is an example of how a natural resource is used differently by men and women because of their different roles.

As every individual has a different role in the community, he or she uses the available resources differently. So, we can expect that the wastes resulting from each activity will be generated differently in both kind and amount not only because of the sex of the person, but also because of differences in standards -- either social, economical, cultural, educational, and so on -- that differentiate one community from another, or even one family from another in the same community.

In fact, this analysis is very important for those who are involved in planning or implementing any stage of the development process. Development cannot succeed without considering these points or without recognizing the different roles that every individual plays in the concerned community, or the kind of available resources and the different needs of men, women, boys and girls in this community. This is necessary to have a plan of development that will satisfy the needs of this community.

Activity (19)
Gender and Solid Waste

Concept:

Wastes are not the responsibility of women only or men only; they are the responsibility of the whole community. But there are many different kinds of activities that men, women, girls and boys do to satisfy the various needs of each of them. Thus, every one of them will produce different kinds of wastes according to the types of resources they use and activities they do.

Objective:

Think about the various activities of men and women in different kinds of families, the resources they use to do these activities and the wastes produced by each activity.

Methodology:

Working in small groups to think about the activities of different social classes of families.

Location:

Classroom

Duration:

One hour and half, including discussions

Materials and Equipment:

Pens, papers, separate working places for the groups

Steps:

1) Divide the students into small (mixed) groups of five members each

2) Give each group a case study of one of the following families to survey:
   i) A city family in which the husband works in a metal workshop and the wife in a school
   ii) A city family in which the husband works in a restaurant, and the wife as a nurse
   iii) A city family in which the husband and the wife both work in a clothes factory
   iv) A rural family in which the husband is a farmer and the wife works in the home
   v) A city family in which the husband works in a plastic factory, and the wife in the home

3) Supply every group with a list of guidelines as follows:
   i) Every group will identify the location of the family, monthly income, number of members and their sexes and ages
   ii) Every group will identify the daily activities, including the location, of the family father and mother in a certain season selected by the group
   iii) Every group will identify the various resources that the man and woman require to carry out their different activities during the day (products, raw materials, energy sources, etc.)
   iv) Every group will identify the wastes produced by the family's daily activities
   v) Every group will identify the methods used by the family to dispose of these wastes
   vi) Every group will register their conclusions in two tables (one for the man, the other for the woman)

Example of a Table to Register Family Activities

Time	Activity	Location	Required Resources	Wastes Produced	Methods of Disposal
5:00 am					
6:00 am					
7:00 am					
8:00 am					
....					
....					
....					

4) After completing their work, ask the groups to put their findings on a large chart. Then ask them to present the results in a detailed manner, discussing every point and comparing it with the other groups' findings so that the differences will appear. During the discussions the following questions may be of guidance:
   * What are the similar and different points in the groups' outcomes?
   * What is the range of difference between the activities of the women and men in each of the five families?
   * What are the activities that only pertain to men, and what are those that only pertain to women? What activities do they have in common?
   * Do the women's activities differ among the different families? What correlation is there with the kind of work the women do?
   * Do the men's activities differ among the different families? What correlation is there in relation to the kind of work they do?
   * What are the different resources used to achieve each activity in the different families?
   * What differences are there in the resources used by women and those used by men, and what accounts for these differences?
   * What differences are there in the nature and kind of wastes produced by the

activities practiced by men and those practiced by women, and what are the reasons behind these differences?

* Are the resources used and the wastes produced by the household women different from those of the working women?
* Are the activities, resources used and wastes produced similar when the women work in the same place as the men (e.g. the third family)? What does this indicate?
* In general, are the wastes of rural and urban families different?
* What is the group's evaluation of the families' methods for disposing wastes?
* Do men's and women's methods of disposal differ?
* How many different environments are the family member's exposed to in the practice of their activities?

Note:

This part of the activity will require more time. So, two sessions might be needed -- one for tabulation and the other for discussion.

5) Finally, emphasize that men, women, girls and boys all have different roles in the community in order to satisfy their different needs. Thus, their use of resources is different, as are the kinds of wastes generated. So, wastes are the responsibility of all of the members of the community.

Source: Adapted from DPU, UCL, UK, 1996.

Activity (20)
Environmental Awareness Campaigns

Concept:

Environmental awareness is an essential element of environmental education, and environmental campaigns are a method of raising awareness about environmental issues and problems. Especially at the local level, the campaigns can achieve notable results in increasing people's trust in their ability to change their behavior and strengthen their community.

Objective:

Inform participants about the environmental campaign concept and its successful aspects, and teach the skills of designing, planning, implementing and following up an environmental awareness campaign.

Methodology:

Small groups will design the campaign to combat specific environmental problems correlated with solid waste management.

Location:

Library hall, any place suitable for 5-8 persons, and places where the campaigns will take place

Duration:

One hour for general discussion, but there will be several meetings to follow up on the various activities

Steps:

1) Define the problem and its size

a) Discuss the proposed problem, guided by the questions:

* What is the problem exactly?
* What is its environmental impact?
* What is its impact on people? What category of people are the most affected: the elderly, children, women, men, laborers, professionals?

b) Phrase the problem in a clear statement and write it on a card. Hang the card on the board and ask the participants to read it and consider if it is the real problem. What are the reasons behind it?

c) Write the reasons proposed by the participants -- each reason on a separate card. Place the cards on the board, and try to find relationships between them. What are the factors that led to the problem? Are there any other reasons? Add more cards if you need to. The group may discover that the preliminary phrasing is not exactly expressing the right problem, but is a symptom or a result of another problem that becomes clear from the discussion.

d) Discuss the following question: What are the main impacts of this problem? In other words, what are the consequences of its continuation? Write the answers on cards and hang them on the board.

2) Phrasing the main objectives of the campaign

Rephrase the problem or the correlated problems into objectives to be achieved by the campaign. The objectives must be phrased clearly, in simple words, and students must be able to carry them out within a reasonable period.

3) Identify the concerned stakeholders and campaign participants

* Concerned stakeholders:
  These people are directly involved with the problem which is the subject of the campaign -- i.e. they are the influencers and the influenced. The roles and positions of these stakeholders are different according to their involvement in the problem and the degree of their influence to continue causing it or share in its solution.
* Campaign participants:
  They are invited by the group to participate in the activity and contribute resources, ideas or other efforts during the different phases of the campaign. They may be individuals, private firms or volunteers from the NGO sector.
  i) To identify the concerned stakeholders, use the participants' answers from "step 1". Write a list of these stakeholders or write the name of each one on a card, and place the card on the board.
  ii) Identify the campaign participants; if they are also among the concerned stakeholders, put a sign on their card, or transfer their cards to another position.
  iii) Discuss with the group the desired contribution of every participant, including how to involve them and who will contact them.

4) Define the targeted groups for the campaign

These are the people that the campaign will directly target with messages asking them to do something. This step is very important because it will define the methods, locations, and duration of the campaign efforts, as well as the language used in communicating the messages.

5) Develop the message

Write out what the campaign would like to achieve or aims to change. Messages must be clear, simple, easily understood, suitable for the targeted groups, and must be phrased so that the audience feels as if it is a partner in solving the problem, and will benefit from the solution. Avoid negative phrasing that blames the audience for the problem.

6) Test the message

Test the suitability of the messages proposed for the targeted group before they are widely used. The group should discuss the method for testing the messages prepared, who will do this, and what criteria will be used to decide if any modifications of the messages are needed, or if they should be left as they are.

7) Organize the campaign and test methods of communication

This step depends on the available resources, the numbers of participants in the campaign, and if there are other efforts supporting it. At this point, participants should also discuss the timetable and duration of the campaign.

8) Identify the team members

i) Identify the team responsible for the implementation of the campaign.
ii) Identify the institutions that will help or participate.
iii) Communicate and reach clear agreements with the various stakeholders as to their responsibilities and level of commitment.

Action Plan

Objective	Activity	Method (Law)	Who	When	Cost

9) Formulate the action plan

An action plan should be made that details the team's activities to achieve its objectives, the methods to be used, the responsibilities of each member, and the timing of each part. The action plan must also include the costs of these activities and how to pay for them.

10) Follow-up and evaluation

i) Identify the team that will follow-up the execution of the awareness campaign, measure its progress in achieving the stated objectives, and select suitable methods to achieve this evaluation.

ii) Indicators must be agreed upon to use in measuring the campaign's progress in achieving its objectives; these indicators will differ depending on the nature of the campaign's objectives.

iii) Not only are evaluations beneficial at the end of the campaign, but a mid-campaign evaluation might modify the team's plans and improve its implementation as well. Selecting clear indicators will help to achieve effective evaluation, which is important because it clarifies strong and weak aspects of the activities, and points the way towards better methods and maneuvers that will lead to maximum benefits from future efforts.

Note:

Environmental awareness campaigns by themselves are not enough to make fundamental changes in the problems to be improved. Awareness campaigns are only a part of the larger efforts needed to avoid relapsing into old behaviors after the end of the campaign. A clean-up campaign targeted towards youths cannot be effective if there is no sustained system for garbage collection in the neighborhood, as the garbage will accumulate again after the end of the campaign.

Make it:

Divide the group into subgroups; each subgroup will design an environmental awareness campaign, guided by the above considerations, in one of the following subjects:

a. Reducing food loss in open hotel buffets.

b. Reducing consumption of plastic containers in markets and shops.

c. Reducing paper consumption in schools.

Performance Follow-up Plan

A performance follow-up plan is a mechanism used in planning and management and includes data collection about the performance of an institution or a specific program or defined project in that institution.

Components of a Performance Follow-Up Plan

1) Set up defined and clear results that are agreed upon by all parties involved in this program.

2) Set up detailed and reliable application indicators.

3) Collect data using proven methods, verify its sources, and keep a time-table of data collection.

4) Identify the individuals, teams or responsible firms for assuring the clearance of collected data.

5) Present the results of the follow-up plan to the concerned institution.

Steps to Develop the Performance Follow-Up Plan

1) Establish a responsible team for the design of the performance plan.

2) Define the requested data category, answering the questions:
   i) Who is the beneficiary of this performance follow-up plan?
   ii) Why do we need such data?

3) Raise many questions, as the answers could represent indicators or suitable performance measures.

4) Define where this data for the performance follow-up plan will be applied.

5) Apply the performance follow-up plan using the following steps:
   i) Determine the comprehensiveness of the data (the more detailed the data, the greater the quality, efficiency and verification of the reports).
   ii) Define the time-table requested for the follow-up plan presentation (periodic or upon request).
   iii) Allocate data collection methods (deviation ratio, sample representation ratio).
   iv) Determine costs.
   v) Define the credibility of the report (How much can we rely on it?).

6) Use information management, which is the process of data collection, storage, reuse, analysis, and presentation in a requested report.

Performance Indicators

* It is very difficult to measure performance without defining and acknowledging properly the general goal of the program, its objectives and main expected outputs.

* Indicators are instruments that enable us to measure the degree of progress in achieving the results. These indicators must be sensitive to social categories and developments.

* It is important that concerned parties agree previously upon the proposed indicators used for program or project performance measurements.

* Performance indicators may be quantitative or qualitative.

There are six standards that must be considered during the selection of performance indicators:

1) Validity (Will the indicator measure this result?)

2) Reliability (Is the indicator independent of time?)

3) Sensitivity (If the result changed, is it sensitive enough to monitor this change?)

4) Simplicity (Is it easy to collect and analyze data?)

5) Utility (Is the data valuable for decision making and learning?)

6) Affordability (Can the program or the project collect the requested data?)

Activity (21)
Suggest a Solid Waste Management Program in Your School

Concept:

Raising awareness about environmental issues in general must include positive actions towards the local environment. This is based on the all-encompassing principle, "Act locally and think globally," as the global environment is a sum of all local environments.

Objective:

Encourage students to undertake positive actions for their school's environment, and acquire planning skills necessary for creating solid waste management programs.

Location:

Classroom, library hall, and different parts of the school

Duration:

These activities can continue for many sessions, but one hour is enough to formulate the idea and lay out the general framework of the program

Materials and Equipment:

Papers, pens, paper roll, flowmaster pens

Steps:

1) Run a discussion among the students about the concept of solid waste management and emphasize that there is a difference between simply throwing away wastes and dealing with them in an integrated management system. Disposing of wastes means transferring the problem from one place to another, but integrated management includes other solutions, such as reduction at source, reusing, recycling, and deriving benefits from wastes such as energy generation, compost manufacture and safe disposal.

2) Ask students to formulate small groups. Each group will survey the different activities of each school department, and prepare a report that includes answers to the following questions:
   * What is the nature of the activities practiced in this department?
   * What are the products and raw materials (inputs) required to perform these activities? How can we categorize them and on what basis?
   * What energy sources are used?
   * What are the wastes, pollutants, hazardous wastes, and poisonous wastes produced by these activities?
   * What are the methods used to deal with these wastes?
   * How would you describe the impact of these methods on the health of laborers, students, the school environment and the surrounding environment?

3) The groups will meet again, and exchange the information that they collected.

4) The groups should discuss the following:
   * Are there any wastes from one department that another department can use?

Activity (21): Suggest a Solid Waste Management Program in Your School

* Are there any substances whose consumption could be reduced? What are they?
* What are the substances able to be reused?
* What are the substances able to be recycled?
* Are there any wastes that can be reused in energy generation, and if so, how? And what are they?
* What are the students' proposals to more safely dispose of the school's wastes?
* What changes in the existing system are required?
* Would these changes require supplying the school with other materials or equipment? What is needed?

5) Next, the group can propose an integrated program to manage wastes according to the previously answered questions.

6) The group should discuss the benefits that may be gained from the implementation of this program on the school's environment, the health of students, teachers and laborers, and the surrounding neighborhood's environment. They should also discuss the economic benefits that might result from the application of the program.

7) The group then needs to discuss the available opportunities and obstacles it may face in applying the total program or some of its parts.

8) The group can also discuss some ideas to follow-up on or evaluate the program.

Activity (22)
We Are Not Alone

Concept:

Learning about the efforts done by others to protect the environment inspires hope and feelings of trust. We feel that we are not alone, and it is also useful to know about the activities of colleagues in your location.

Objective:

Encourage the exchange of experiences with and information on environmental protection activities, improvement efforts, solid waste management programs and activities undertaken by schools, libraries and other institutions.

Methodology:

Periodic newsletter issued in different schools by students from the press groups, under the supervision of teachers.

Location:

Library hall and computer hall

Duration:

This is a continuous activity, but every two weeks or every month an hour-long editorial board meeting could be held.

Materials and Equipment:

Computer, pens, papers, photographs, drawings, newspaper clippings, e-mails addresses, camera

Edit It:

Participants in workshops always show a willingness to exchange experiences and to hear about environmental education activities in other schools and correlated institutions. Propose the idea of issuing a newsletter to be distributed among participant schools that would include news of workshops, practical and field activities, research projects, seminars, lectures, and ideas. This initiative could be introduced by the teachers in the school, but in order for the newsletter not to be an additional burden for them, the following ideas can be considered:

* The newsletter could be only four pages long.
* The time of issuance could be bimonthly.
* The editorial board could be formed of a small number of members of the press group whose duty is to collect news and suitable materials to be published by senior editors (teachers) or junior ones (students).
* Responsibility for publishing the newsletter could be the task of the Directorate of Environmental Education, or each school could take on the responsibility of issuing one edition so that the task is divided equally and periodically.
* The cooperation and participation of school computer specialists could be obtained to help in the designing and editing of the newsletter.

* The editorial board will agree on the length of articles and their contents. It is preferable that each item be short and summarized in order to publish as much material as possible.

* The editorial board may choose to ask for the voluntary help of some professional journalists. Some public figures or officials may also be invited to contribute.

* Ask the group to discuss these ideas and lay out an action plan to make the newsletter a reality.

* The group should ask one of its members to present the results of the discussion to the other participants in a follow-up session at the end of the workshop.

Activity (23)
Green Ideas

Concept:

Protecting the environment, loving nature, and respecting its living and non-living elements are activities that nourish human beings with positive values and inspire their skills and talents.

Objective:

Stimulate the spirit of creativity and innovation in boys and girls, and encourage them to practice whatever hobbies they like, enjoy their leisure time, and at the same time develop positive attitudes towards the environment.

Methodology:

Organizing individual and group competitions in many different fields, depending on the attitudes and preferences of the students.

Location:

Library hall, activity hall, classroom and home

Period:

This activity is on-going, and its length is determined by the kinds of competitions that will be organized. An hour-long session can be held in the beginning to present ideas and define competition rules.

Materials and Equipment:

Determined according to the kind of competition to be organized.

Make It:

1) In an open discussion session ask boys and girls about their favorite hobbies and ways to spend their leisure time.

2) Some of them will prefer stamp collecting, and others drawing, writing poetry or short stories, playing sports, inventing or designing machines, singing or playing music, writing or acting plays, conducting interviews for newspaper articles, and so on.

3) Divide the group into teams according to their hobbies. The activity will be more exciting if many schools participate in it. This requires coordination between school managers and the education directorate.

4) Agree with the group to organize competitions on environmental issues proposed by teachers or chosen by the students themselves. The kind of competition will be based on the hobbies of each one of the groups.

5) Some proposals and ideas for contests follow; try to come up with different and better ones.

i) Environmental stamps:

Countries issue collections of postal stamps with pictures of plants, birds, animals, and rare butterflies, as well as for environmental conferences, World Environment Day and Earth Day. Ask the group to collect as many of these stamps as they can and put them in an album. This activity can be expanded if

students collect information about the countries that issue the stamps -- their location, area, inhabitants, and environment. They can also collect information about the subject of the stamp. For example, students can research a bird on a stamp, its significance, and the threats facing it, or if the stamp is about an environmental conference, they can find out about its location, dates, and objectives.

ii) Posters:

This activity is for students who like to draw and paint. Ask the group to choose a theme or several themes for the contest, such as neighborhood cleanliness, energy generation, water issues, reusing and recycling wastes, noise pollution, and minimizing air pollutants. Provide the group with necessary materials such as paper and colors. Encourage teamwork as much as possible, as well as individual competition.

iii) Poetry, folklore, songs and short stories:

This activity is for students with literary talents. The competition can center around environmental problems in general, or be about a specific issue. A committee to judge the contest can be formed that includes a number of supervisors and library managers as well as writers or poets. The presence of poets and writers among the boys and girls will make them happy and proud of their work.

iv) Short plays and puppet shows:

Students can create short performances and invite the neighborhood and students from other schools. Two points should be taken into consideration here:

* Allow students the creative freedom to choose the format of what they would like to do.
* Help them by pointing out information available in the library, or through organizing a session with a specialist on the issues.

v) Illustrated stories:

This activity is especially for students with both writing and painting and drawing ability. The illustrated stories can take the shape of a flip chart or could be created from colored cardboard and cut and pasted onto a board. These visual stories can communicate messages about the steps in a process, manufacturing an apparatus, operating an instrument, or responding to an emergency.

Environmental Auditing and Management

In many countries, as more citizens are becoming aware of environmental issues and legislation, more companies are paying attention to the environment. The management goals of these private sector companies are not limited to gaining maximum profit for the company, but are extended to include commitment towards the community and the environment that surrounds it.

Why Do Business Institutions Care about the Environment?

There are some incentives that make an institution care about its environmental performance, including:

i) **Economic benefits:** Primarily, institutions recognize that a good environmental performance will lead to a reduction in the cost, improvement of quality and gain in the market.

ii) **Public opinion:** The public is a consumer that demands commodities or services produced by the institution, or refuses them. It is this purchasing power that influences the market place.

iii) **Legislative requirements:** Legislation is by nature a tool of enforcement, and it must be followed if the company wants to avoid sanctions and penalties.

iv) **Personal commitment:** The owners and managers of the institutions feel they have a real responsibility towards their community, and seriously try to protect it from pollution.

What Is Environmental Management of Business Associations?

Environmental management refers to the efforts adopted to reduce the negative impacts of businesses and their products. Previously, environmental management was focused on the reduction of negative impacts during production only, but it has been extended to consider the product's impact from its production to its consumption, i.e. the entire life cycle of the product.

What Is Environmental Auditing?

Environmental auditing is an environmental management tool. It is basically an organized system for evaluating the overall performance of the institution, including its impacts on environment, safety and health.

The auditing process asks such questions as:

* How is the company's current environmental performance? Is the institution committed to environmental laws, codes and licensing rules?

* Is it possible to improve this performance? Are there measures that the institution can take to reduce its harmful impacts on the environment?

* What are the costs of those measures? And what are the expected benefits from those measures?

Environmental auditing takes on many forms. According to the objectives of the auditor, this may include:

i) Commitment review: This is done to evaluate the extent of the business's commitment towards environmental policies and codes.

ii) Reduction progress review: This audit is undertaken to find out if a company can achieve reductions in wastes, used materials, emissions, and energy use.

iii) Life cycle analysis: This kind of environmental impacts evaluation considers the production, use, and disposal of a commodity.

Is Every Institution Committed to Performing Environmental Audits?

Environmental auditing is usually optional, but offers the institution and the community many benefits:

* Provides valuable data that helps evaluate environmental status on the national and regional level.
* Offers a methodology to guarantee continuous improvement of environmental management.
* Serves as a good method for environmental monitoring.
* Helps establish an effective plan for environmental protection.
* Supports sustainable development efforts.
* Informs the public about the environmental performance of the institution.
* Helps the public share in environmental management.
* Helps identify chances for cost reduction through recycling and sales of by-products.
* Assures that environmental codes are followed.
* Improves the loyalty and commitment of employees.
* Offers the management confidence and reassurance.

However, some institutions may hesitate or refuse to perform an audit, for some of the reasons that follow:

* High cost.
* Fear that commercial secrets will be exposed to competitors.
* Small institutions may not be able to perform an environmental audit due to their limited manpower and the need for help from external specialists. This may increase costs, as well as add to the fear of leaking commercial secrets.

Who Performs the Environmental Audit?

The environmental audit may be performed by a team of workers from the institution or by a team of external environmental auditors. The team should be comprised of persons who have considerable knowledge of and experience with the company, its industrial processes, and the applicable environmental laws and legislation. The size of the team depends on the size of the institution. For a small institution the team should be comprised of two persons; in medium institutions, more experts need to be involved, including a team leader, chemical engineer, industrial processes engineer, management specialist and legal consultant.

The team leader must be characterized by:

* Awareness of the company's products and production department.
* Familiarity with the waste management practices in the company.
* Familiarity with new technologies for production and waste treatment.
* Familiarity with methods for reducing production losses.
* Familiarity with environmental policies and codes.
* Awareness of the company's criteria for evaluating the quality of products.
* Ability to communicate and understand the factory engineers and administrators.

How Is the Environmental Audit Performed?

There are four phases to the environmental audit.

1) Preparation for the audit.
2) The auditing process.
3) Communication of results and recommendations.
4) Design of an action plan.

1) Preparation for the Audit

In this phase, a team is selected, a plan designating the place and time for the audit is made, basic data on the institution is collected, and the methods used to evaluate the current environmental performance of the company are identified. It is important to meet the top management of the company and have its full support. The team must be aware of the technical and financial obstacles, and how to overcome them. Effective planning and preparation will avoid loss of time and effort during the auditing process.

2) The On-site Auditing Process

An integrated environmental audit for a site includes two main components:

* Material balance
* Managerial evaluation

The **material balance** audit shows the inputs (raw materials, water, energy), consumption, and outputs (product, pollution emissions and wastes) of an operational unit, industrial process or the whole institution.

The **managerial evaluation** analyzes the managerial aspects linked to environmental performance, such as incentive systems for positive environmental performance, environmental training, emergencies, and systems of documentation and keeping environmental files.

3) Communication of Results and Recommendations

A written report is the main tool used to communicate the results and recommendations of the environmental audit to the management of the institution. All the auditing processes must be registered very carefully and promptly. So that it can be easily referred to, the final review report must be written in clear and simple language. It should be as objective and precise as possible in its presentation of the results of the audit. A suitable style and tone should be used to avoid provoking a confrontation with the management or employees of the company, as the main objective of the audit is to secure the support and cooperation of the management and staff in treating the defects and problems presented in the report.

The environmental audit report components include:

i) Summary for the management of the company

This is the only part that the top management will read, and must be summarized in simple and clear writing.

ii) Introduction

This part discusses, in summary, why and when the audit was performed, the team members involved, the scope of the audit, the laws and legislation related to the institution, and the criteria used in the evaluation.

iii) Description of the institution

This part will clarify, in summary, the master layout of the institution, its main activities, the industrial processes and technologies used and the environmental measures followed.

iv) Diagnosis of the problems

This part explains the problems and possible performance improvement opportunities. This part of the report requires a high level of organization, because it is the most detailed part.

v) Recommendation

This part introduces suggestions as to what can be done to improve the environmental performance of the institution in light of the diagnosis. It should discuss proposed actions for environmental improvement, calculate the cost of implementing them and consider the time scale needed to do so. An explanation of the environmental and

International Standards of Environmental Management Systems (ISO 14000)

ISO 14000 is a set of international standards for environmental management systems. It is different from the better-known international agreements that set maximum limits for pollution emissions. Instead, it is a set of guidelines and characteristics defining basic elements of effective environmental management systems. These standards are set by the International Organization for the Definition of Standards (ISO) in Geneva, Switzerland. Its mission is to develop quality standards all over the world. As a result of the growing application of environmental management standards all over the world, ISO started in 1990 to develop standards for environmental management systems.

ISO 14000 includes a series of documents that show guidelines for environmental management:

i) First document: This document, 14001, lays out the basic elements of an environmental management system, calls for environmental policies, and increases the commitment of an establishment through improving its environmental performance.

The second, third, and fourth documents include environmental auditing standards.

ii) Second document: Document 14010 is a set of guidelines for environmental auditing and general principles for environmental auditing.

iii) Third document: 14011 contains guidelines for conducting environmental audits; Part One discusses audits for environmental management systems.

iv) Fourth document: Document 14012 recommends prerequisites for environmental reviewers.

economic benefits and the expected payback period needed to cover initial investment expenses should also be discussed. Annexes and references should also be included in this section.

4) Design of an Action Plan

The action plan is an independent document that lays out the strategy to confront the problems identified in the environmental audit. While preparing the action plan, there must be consultation with the management of the institution in order to ensure that the company has sufficient capabilities and available resources to achieve the targeted improvements.

What Is Next?

The environmental audit is a tool to evaluate environmental performance and environmental quality. It is an effective tool

Prerequisites for Environmental Reviewers (According to ISO 14012)

1) University degree, with two years experience in an environmental field.

2) Training on auditing methods, environmental codes, environmental processes, environmental impacts, and standardized parameters of environmental management.

3) Trained on no less than four reviews within twenty days, under the supervision of a senior auditor.

4) Proven efficiency in conducting audits.

5) Strong communication, social, and organizational skills; objectivity.

The senior auditor, in addition to the above prerequisites, must have conducted three other audits within fifteen days, show leadership skills, demonstrate comprehensive knowledge, have mastered training skills, follow codes and rules, continue learning new techniques and increase his or her experience in the auditing process, and periodically review previous knowledge and skills.

to guarantee continuous improvement. Thus, the environmental audit is not a transient measure that the institution is obligated to do sometimes, but must be part of a sustained effort for environmental management.

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Activity (24)
Environmental Auditing

Concept:

There is a great deal of discussion about the massive environmental problems that face the planet. But the earth is simply a combination of all the local places that make up the world. Global problems originate from local ones. If in each local place, a school or an individual recognizes the link between local and global problems, and starts reducing the local impacts on the environment, many global environmental problems will decrease.

Objective:

Teach participants how to do an environmental audit of their school, home, workshop, or other establishment. Discuss the results of the environmental audit, whose purpose is to reduce negative impacts on the environment through thinking globally and acting locally.

Methodology:

Performing an environmental audit for the school, its various departments, and the surrounding area.

Location:

School buildings and the surrounding area

Duration:

One hour

Materials and Equipment:

Notebook, papers, pens, pencils, ruler

Plan:

Every participant in the group will make a table in the notebook. The table should have 6 vertical columns divided into the following categories: very good, good, neutral, bad, very bad, don't know. Add a seventh column on the right side of the page in order to list the name of the subject to be assessed. In this column write the activities that will be documented, such as water use in the bathrooms, food wastes, heating sources, lights, paper use, raw materials use, workshop activities, and transportation methods (according to the subjects or fields you are asked to survey).

Make It:

1) Every member of the group will be assigned to survey one of the school's activities.

   i) Water evaluation group

   * Register water consumption in the bathrooms, laboratory, workshop, kitchen, garden, etc.
   * Document any water loss.

   ii) Paper evaluation group

   Ask questions such as

   * Is paper overly consumed?
   * Is stored paper reused?
   * Are paper wastes recycled?

* How is paper used?
* Is there an excessive loss of paper?

iii) Energy evaluation group

* Document when and for what electricity is used (lighting, heating, air conditioning, etc.).
* Find out if energy is being lost.

iv) Workshop evaluation group

* Record raw materials consumption, wastes and byproducts management, practices for storing raw materials, kinds of instruments and equipment.
* Are there dangerous materials (hazardous materials or equipment)? Are there special places for those substances?
* Are there fire extinguishers? Are they working? Are there instructions on how to use those extinguishers during times of emergency? Are there emergency exits? Are they open or are there obstacles in their way?

v) Transportation evaluation group

* Find out how people come to school and how they leave it. Do students use public transport, walk, ride bicycles, or come in private cars.

2) After making the survey, evaluate the activities. If there are large losses or dangerous activities, make a mark in the "very bad" column. If there are no losses or if there are protective measures in place, make a mark next to the activity in the "very good" column. If there are neither positive nor negative consequences for an activity, make a mark in the "neutral" or "don't know" columns.

3) After the group looks over the results, lead it in a discussion as to how the school or local community can mitigate any negative aspects through using resources in a more careful way. The results should be presented in many places and include proposed actions to improve natural resources usage or waste management practices that may lead to positive environmental, and perhaps economic, changes.

Alternatives:

i) The groups may decide to evaluate each of these issues alone: energy use, water use, paper consumption, raw materials consumption, solid waste management, occupational safety, industrial security, and transportation methods. Once data are obtained in a structured way, then a solution may be sought for any problem concerning loss of resources or mismanagement of wastes.

ii) Some of the ideas could also be applied for workshops, factories, or other such establishments (hospitals, governmental buildings, etc.).

iii) Students could do an environmental audit for the neighborhood surrounding the school, to monitor any environmental or health impacts that are posing a hazard to life or property.

iv) Before and after the project, students can discuss the correlations between local activities and world problems.

* There is a clear relationship between electricity usage and fossil fuel consumption, the phenomenon of acid rain, and the increasing temperature of the planet.

* The connection should be made between paper use and deforestation; local tree planting can be done to illustrate the point that lessons learned must be applied in the home and local community.

Finally, this activity can be repeated after a reasonable time, to find out if improvements have been made or not. Environmental auditing is thus an instrument of monitoring, following-up and evaluating.

Environmental Impact Assessment

Environmental impacts -- positive or negative, direct or indirect, immediate or postponed -- result from the establishment of projects and programs of development.

Environmental impact assessment is a method that offers decision makers a clearer understanding of environmental impacts, which enables them to make better decisions for community benefit. Many countries realize the importance of this evaluation and have issued necessary legislation that requires an environmental impact assessment application for proposed projects before they are licensed for establishment.

Concepts and Definitions

Environmental impact is defined as a change in environmental circumstances or the development of new circumstances -- harmful or beneficial -- due to an activity or group of activities such as those resulting from the establishment of a steel factory or a waste dumpsite. Environmental impact assessment is a method and process used to calculate and evaluate economic, social and environmental impacts expected from a proposed project, as well as to consider various alternatives. "Environmental impacts indicator" or "environmental impacts report" refers to the document that summarizes the results of the evaluation, and presents it to decision makers.

Why Environmental Impact Assessment?

The idea behind environmental impact assessment is to evaluate projects before their establishment so as to avoid many problems that may arise if the evaluation is not done. It is not meant to be an obstacle to obtaining a license; instead, it is a planning tool and a method to involve participants in the development of decisions that may affect them. Finally, it enables us to understand the relationship between the environment and development.

Elements of Environmental Impact Assessment

The environmental impact assessment process includes these basic elements:
1) Identification of impacts
2) Evaluation of impacts
3) Interpretation of impacts
4) Communication of results

1) Identification of Impacts

This includes the definition of the primary and secondary impacts expected of the proposed project. Primary impacts are those that may be directly linked to project activities. Secondary impacts are indirect changes based on primary impacts. For example, the use of heavy equipment in preparation of a location may lead to the compaction of soil, which in turn leads to the reduction of water drainage and increased water flow on the soil surface. Soil erosion is thus a secondary impact.

Expected impacts of a sanitary dumpsite project include: Pollution of underground water because of the water seepage out of the waste, pollution of air due to methane gas generated by waste fermentation, and negative affect on the neighborhood from the smell and noise caused by the movement of vehicles transporting wastes to the dumpsite location.

Example of ad hoc methods

Factors \ Impacts	No impact	Positive impact	Negative impact	Short term	Long term	Cont. term	Changing impact
Wild life			X		X	X	
Soil characteristics	X						
Noise			X	X			
Air quality			X		X		

Note: In reality, there are a larger number of factors and impacts.

2) Evaluation of Impacts

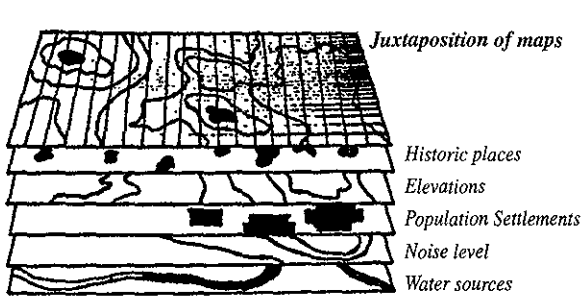
This element addresses questions such as: What is size of the impact, its time frame (i.e. when this will happen?) and its extent?

3) Interpretation of Impacts

This explanation includes a total evaluation of the meaning and importance of expected impacts, bases and principles that the introduction relies on, suggestions of maneuvers that mitigate dangerous impacts, and comparisons between advantages and disadvantages of different alternatives.

4) Communication of Results

Results of the study are objectively and clearly presented to concerned institutions and people, thus enabling decision makers to make the right decisions.



An example that illustrates a checklist that compares the expected environmental impacts of three alternatives

Impact	Explanation	Alternatives (a)	(b)	(c)
Air pollution	Concentrations of pollutants exceeding standards	-1	-2	-1
Coastal pollution	Size of liquid wastes	-2	-1	-1
Noise	Noise level	zero	zero	-1
Total impact	Deterioration of the general environment	+1	+2	zero
Total impact		-2	-1	-3

Note: In practice there are more than three alternatives and more impacts. Values presented here are based on calculations ranging from +5 to -5.

An example of the matrix method demonstrating the environmental impacts of a project's activities according to selected environmental criteria and circumstances.

Env. criteria \ Activities	Habitat changes	Road pavement	Noise and vibration	Demolition and Infilling	Traffic pathway changes	Canal digging
Soil		B	A		A	E
Climate	A					
Floods	C	B		B		
Vacant area		D	B		B	C
Pop. area		D				
Pop. density	B		A		A	

A= Little or no harmful impact
B= Visible impact that with planning and proper building is not harmful
C= Large impact which can be minimized with precautions
D= Beneficial impact
E= Dangerous impact

Methods of Environmental Impact Assessment

Many methods for doing environmental assessments exist that help demonstrate, in materialized form, to decision makers and the public the extent of environmental impacts. These methods include case studies, maps, investigation lists, matrices, and networks.

1) Ad hoc Methods

These refer to the broad parameters of the expected impacts and the general nature of those impacts. For example, impacts underground might be designated as "limited" or "harmful;" impacts on the economy of the region might be described as "fundamental" and "beneficial."

2) Overlay Methods

This method uses a group of maps that show the environmental characteristics defining the project area -- geological structures, underground leveling, land uses. Those maps are juxtaposed over each other to illustrate a full profile of the environment, and the environmental characteristics expected to be affected by the project.

3) Checklist Methods

These are lists of environmental indicators that are evaluated. Their main purpose is to define important impacts, but they may also include some evaluation of the nature and characteristics of those impacts.

4) Matrix Methods

The vertical column of the matrix has a list of the project's activities. The horizontal column includes a list of environmental characteristics that may be affected. Thus, the impacts of the project's activities on environmental parameters are considered. When the matrix is completed, it shows a full profile of the environmental impacts of the project's various activities.

5) Networks

In this method, a list of project activities is made that includes primary and then secondary impacts. The process is repeated with other projects' activities, and a network or "tree" is made to link the expected direct and indirect impacts.

Steps for Environmental Impact Assessment

There are many approaches to conducting environmental impact assessments. The following is a summary of one effective and economical method. This method, which is suitable for developing countries, is divided into nine steps.

1) Preparatory Activities

These include identifying the institutions responsible for decision-making and the selection of a coordinator to prepare evaluations and job descriptions, work proposals, and reviews of the existing legislation.

2) Scoping

An inclusive list of the expected impacts is prepared, and then this list is evaluated carefully to identify the important impacts that need further study. The objective is to increase cost effectiveness. The evaluation of the impacts is based on defined indicators such as scope, extent, and sensitivity of the proposed project area.

3) Situation Analysis

This is a registry of the existing situations in a project's area. This is not an objective by itself, but a referral point that the expected changes resulting from the project can be linked to, with descriptions of the project's effect on the current situation.

4) Estimation (Quantitative Values)

It is preferred to estimate the expected changes in quantitative values. Estimation of the impacts is the job of the experts. It is preferable that a suitable specialist studies each group of connected impacts. The audit will go no further if there are no alternatives to suggest to the proposed project.

5) Mitigation Measures

Descriptions of actions are needed to mitigate the intensity of dangerous impacts. For example:

i) Establishment of a dense green belt around a garbage dumpsite to prevent spreading and volatilization of particulates and scraps of wastes.
ii) Establishment of a pollution control system in waste incinerators to reduce air pollutant emissions up to permissible limits.

6) Evaluation (Comparison of Alternatives)

A study is done of the economical and environmental costs and benefits of various alternatives, resulting in a group of recommendations that enable decision makers to make the right choices. For example, decision makers might need to decide, among the alternatives for sanitary garbage disposal, whether to establish one big landfill or to create many small landfills all around the city, whether to establish a landfill nearby or far away from the city, or to instead use an incinerator.

7) Documentation

Two types of documentation are used in the assessment.

i) Reference documents include detailed documentation of the evaluation steps, and are meant to be referred to in the future. These documents must be written by the technical specialists who did the assessment.
ii) Work technical documents include necessary information while collecting data. These documents must be written by the coordinator.

8) Decision Making

This is a separate step from the assessment, with the objective of selecting the most accepted and practical alternative. Generally this decision is one of three types:

i) Acceptance of one of the presented alternatives.
ii) Request for further study.
iii) Total rejection of the project proposal.

9) Post-auditing

We must not forget that environmental impact assessments are based on estimations and not full facts. So, after a period of time there must be a review of the study and a comparison between actual and expected changes. This is to improve our knowledge and experience in evaluating similar projects in the future. Usually this mission will be the task of one of the national institutions

concerned with environmental monitoring. For example, a group of testing wells could be established around a garbage dumpsite. Then samples of underground water from those wells can be periodically taken and tested to assure that the water is not polluted by waste seepage.

The Report of Environmental Impacts

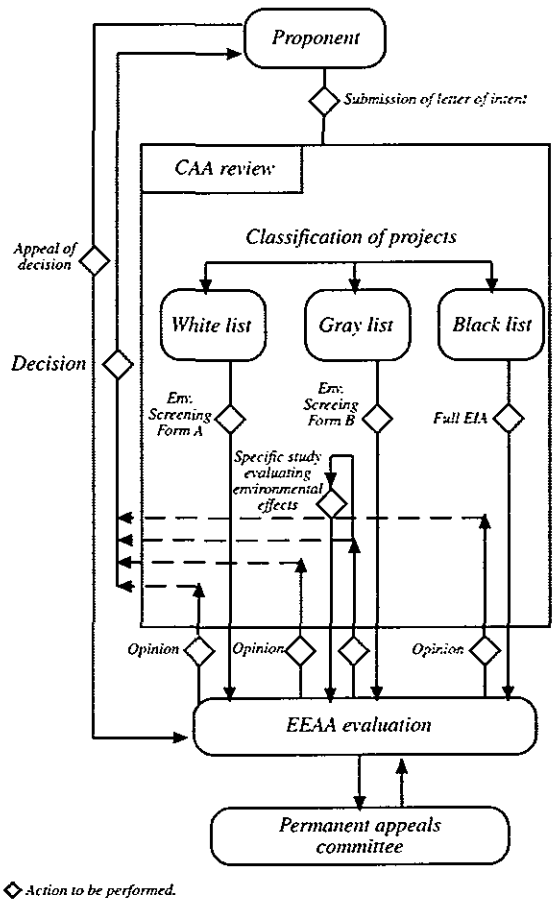
Environmental impact demonstration, or the report of environmental impacts, is the document presented to decision-makers to enable them to select between alternatives. Thus, it must present clearly the nature of the problem studied, available alternatives, advantages and disadvantages of each alternative and comparisons between alternatives. This document must be written simply in concise language. The recommendations must be phrased clearly and must include the reasons behind them. The document usually includes the following points:

1) Summary

The summary must be written in clear language, without using the sophisticated technical expressions that would be unfamiliar to non-specialists.

2) Project Description

The purpose of this chapter is to present comprehensive descriptions for decision-makers about the projects' nature, size and importance.



Environmental Impact Assessment Procedures in Egypt

3) Environmental Situation Description

It is not necessary here to fully describe all the environmental circumstances of the project area; the focus is primarily on the most important affected parameters.

4) Discussion of Environmental Impacts

This section presents expected environmental impacts, the degree of certainty as to those impacts, and the time scale of those impacts with reference to the near future.

The Egyptian Environmental Impact Assessment System

The environmental impact assessment system designed by the Egyptian Environmental Affairs Agency is based on categorization of the project according to its expected impacts. There are three categories:

a. White list: Minimal environmental impacts
b. Grey list: Significant environmental impacts
c. Black list: Dangerous environmental impacts

The system utilizes the following criteria:

a. Project activities (e.g., Mineral water factory, thermal factory, pesticide factory)
b. Technology used (e.g., Dry cement factory or wet cement factory)
c. Location of project (e.g., In or out of industrial zones)
d. Scope of the project (e.g., Mineralization in an area of less/more than 1500 feddans)

This categorization is made according to one or more indicators. The system works as follows. The owners of the project prepare an environmental impact assessment and present the required information to the administration. The administration registers documents and reviews them according to the guidelines, presenting it to EEAA to evaluate. The EEAA then reviews and evaluates the environmental impact assessment, and issues a decision to inform the administration of the results and the decision.

The administration is committed to applying the EEAA decision. The owners of the project have the right to complain in front of the permanent committee for review. This committee is formed of three experts from the Ministry of State for Environmental Affairs, a representative of EEAA, the owners of the company or some one representing it, and a representative from the specific administration. The committee is headed by a councellor from the state legal council.

5) Presentation of Alternatives and Analysis of Cost Effectiveness

The presentation of these includes an explanation of the criteria to be used in the selection of the preferable alternative.

6) Available Corrective Actions

This is a presentation of the actions that might be taken to mitigate undesired impacts of the project and the extent of expected improvements that will result from their application.

7) Plan of Environmental Monitoring

A plan of environmental monitoring will be proposed after the establishment of the project to study the usefulness of the environmental impact assessment.

8) Necessary Appendices

Data and illustrations necessary for describing the project, such as descriptive maps of the project area and planning diagrams of the activities and processes of the proposed project, are also included.

Final Conclusion

Environmental impact assessment is a method to compare different alternatives for implementing development projects. It enables the selection of the best collection of benefits for the economy and the environment. It is necessary to implement it for various projects to be more beneficial for their companies and their communities.

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Legal Framework of Environmental Impact Assessment in Egypt

Law 4, 1994 for Environmental Protection stated that the establishment of new projects or the extension or renewal of existing projects must include an environmental impact assessment before licensing is granted. The law also prohibited the establishment of any project within a two hundred meter zone along the coastline without conducting an environmental impact assessment and the approval of the proper administration in coordination with the EEAA.

Article 10 of the executive regulation of the law stated that the licensing department within a company must make sure that an environmental impact assessment of the company is conducted according to the rules, criteria, and codes issued by the EEAA. The EEAA issued guidelines for conducting environmental impact assessments in October of 1996.

Example: Alexandria Landfill

Alexandria Governorate decided to establish a sanitary landfill for garbage. The site is located 52 kilometers west of Alexandria, its length is 2.5 kilometers, and its width is 150 meters. It is expected to receive 2000 tons per day of wastes with a proposed lifetime of fifteen years. The governorate authorized an Alexandria University mission to conduct an environmental impact assessment study of this project. Based on the results of the assessment, the governorate found it suitable to use a landfill approach instead of an incineration method, as Alexandria is overpopulated. The decision was taken to create one large landfill in the west, because of the unavailability of such a location in the east. The location was selected because of the presence of a clay layer impermeable to water, which will prevent wastewater from polluting underground water in the project area. A green belt of trees will be established to avoid volatilization of particulates during landfilling. The purpose of doing the environmental impact assessment was to avoid, as much as possible, negative environmental impacts.

Activity (25)
Environmental Impact Assessment

Concept:

Ignoring environmental considerations results in the hindrance of many developmental projects, in addition to harming the environment. Thus, conducting an environmental impact assessment to evaluate a project's impacts has become a necessary part of a project before its implementation.

Objective:

Teach students the concept of environmental impact assessment and its methods, which are part of Law 4 for the year 1994.

Methodology:

Presenting case studies of applied projects and discussing, surveying and evaluating their potential environmental impacts.

Location:

Library hall or classroom

Duration:

One hour

Materials and Equipment:

Large paper pads, markers, notebooks, pens

Make It:

1) The group will discuss the expected impacts of a case study of a project to be implemented, considering all its different phases (planning, preparation, execution, operation) that will potentially impact the following environmental parameters:
   1) Air
   2) Groundwater (in various water channels)
   3) Water surfaces (lakes, seas)
   4) Soil under cultivation
   5) Biodiversity (living creatures)
   6) Noise level
   7) Social and economic impact of the project on the people in the region and in nearby regions, considering such factors as quality of life, public health, impact on job opportunities and income levels in industries such as agriculture, fishing or transportation
   * The group may decide to identify the stakeholders involved in the project (the influencers and the influenced) and define the expected negative or positive impacts of the project.
   * In order to effectively study potential environmental impacts, the group may need to ask for help from specialists familiar with the kinds of activities to be undertaken in the project.
   * The group should make a list of the inputs, outputs and activities (including commodities, services, byproducts, solid and liquid wastes and pollutants) produced in every phase of the project.
   * The group should record its results in a table.
   * Based on the above parameters, a score should be given for each of the project's impacts in its various phases.
   * The group then can make specific proposals to avoid or mitigate the project's negative impacts.
   * If the group considers that the project will pose a high risk to the environment, the group may decide to deny its approval.
   * The group may use the Environmental Impact Assessment Guidelines issued by the Egyptian Environmental Affairs Agency to help them in the assessment process.

The Law and the Environment

The Law

The word "law" means a sustained and systematically applied rule. However, the daily practice of the law is a group of behavior rules adhered to by the community. Transforming rules of behavior into required laws necessitates the existence of a legal authority that designs and lays out the laws, and a judicial authority to apply those laws, including persons who are judging the conflicts and ensuring the enforcement of those laws.

The purpose of the law is the stability of the community and the happiness of the people through the establishment of an official frame of enforcement. The law prohibits some kinds of actions like killing, thefts or throwing garbage in public places, and it introduces other kinds of responsibilities such as paying income taxes or keeping environmental records in an industrial facility. If the individuals or institutions violate these rules, they will be subject to punishments of the law -- imprisonment or financial penalties -- that they wish to avoid. The objective of the law is to ensure that people live more safely in a framework of acceptable behaviors and prohibitions.

Why Do We Need the Law?

Does the community, which is composed of sensitive, intelligent individuals, need the law? Is it possible for convictions alone -- based on moral principles and the desire for public and personal benefit -- to achieve the objectives of the law? Convincing people through non-official ways that are effective and lead to personal commitment is better than enforcement. It is far better to convince people not to pollute rivers without criminalizing this action.

But individuals may differ in their moral views, and need guidelines for their behavior. They may themselves commit to protecting their environment, but the need may arise for an authority to decide the best way to combat pollution and coordinate efforts to achieve this. In addition, there are -- in all communities -- a small number of selfish individuals. Moral persuasion alone is not enough to modify their behavior, and so official laws are needed that can punish this minority which causes pollution.

Also, official laws inform people as to exactly what actions they need to do or avoid, so that, for example, they understand the meaning and causes of pollution and can carry out the necessary steps to prevent it. If the law did not exist, how would people know which things to avoid, and how to avoid them?

The exactness of the phrasing of prohibited or required behaviors helps transfer rules into official laws. As an example, the maximum limit of lead concentrations in the gas emissions of industrial establishments is twenty milligrams per meters square (mg/m^2). This very specific requirement could not be suitably determined by individual judgment. The owners of these establishments know if they are exceeding this limit, and thus if they are

violating the law and risking facing its penalties. Moral principles or personal interests alone are not capable of setting a maximum limit of pollutant emissions.

However, in the long run, the law must be constituted on the basis of moral principles and personal interest, as the threat of penalties are not effective under many circumstances on a long term basis. Some industrial facilities may establish "symbolic" waste treatment units to avoid penalties, while still continuing to pollute the environment. In these cases, the law is not working as expected to benefit the community. Benefits from laws cannot be realized without the belief of the majority of the community, including representatives of industries, that these laws are fair and that it is worthwhile to pay for the cost of environmental protection that in the end may also prove economically beneficial as well as socially beneficial.

The Law and the Environment

For a long time, many countries have been issuing environmental legislation.

Usually that legislation is issued as a response to a new problem. The exact phrasing and approval of the legislation takes a long time. So, there is a gap between the need for legislation and the issuing of the desired law. Laws are necessary for many aspects of environmental management as they help to:

* Regulate resource use.
* Protect the environment and biodiversity.
* Moderate and resolve conflicts that arise over environmental affairs.
* Formulate agreements and conventions in a clear form.

As many environmental problems cross political borders, there is a need for a mechanism to address environmental issues at the regional and international level. The disciplines of science and international law are starting to respond to this need.

New environmental legislation or a new international convention will be effective only when the mechanisms to guarantee the successful application of this law or that convention are available.

The Environmental Laws in Egypt

Egypt has been issuing laws and legislations that address environmental concerns for many years. An example includes Law No. 58 year 1937, which criminalized throwing dead animals into the Nile River. This law also prohibited the removal or destruction of plants in public places. Law No.453 year 1954 addressed businesses that cause health hazards and disruptions in neighborhoods; Law No.271 year 1956 pertained to public shops, and Law No.21 year 1958 to the organization of industries.

Special Legislation Pertaining to Air Pollution

i) Presidential Decree No.864 year 1969: Formulated a supreme committee headed by the Minister of Health for policy design to prevent air pollution.

ii) Law No.137 year 1981: Implemented by the Minister of Labor's Ministerial Decree No.55 year 1983, which defined acceptable standards for clean air, temperature and humidity for the work place.

iii) Law No.3 year 1982: Implemented by the Minister of Housing's Ministerial Decree No.600 year 1982, which defined the specifications of industrial zones.

iv) Minister of Industry's Ministerial Decree No.380 year 1982: Required the usage of protective devices to prevent pollution resulting from the use of new technologies in industrial projects.

Special Legislation Pertaining to Water Pollution

i) Presidential Decree No.27/3 year 1966: Formulated a supreme committee for water, headed by the Minister of Health; its mandate is to oversee industrial wastewater treatment projects.

ii) Law No.48 year 1982: Pertained to protection of the Nile river and water canals from pollution, and regulation of solid waste disposal in irrigation canals.

iii) Ministerial Decree of Minister of Irrigation No.8 year 1983: Issued the executive code of Law No.48 year 1982, which set standards for wastewater treatment requirements before effluents are dumped into bodies of water (Items No. 61, 62, 65 - 69).

Special Legislation Concerning Solid Wastes

i) Law No.38 year 1967, modified by Law 31 year 1976: Organized the collection of solid wastes and the final treatment of them in public places and industrial facilities.

ii) Ministerial Decree of the Minister of Housing No.134 year 1968: Applied Law No.38 year 1967, which included definitions of solid wastes, methods of transport and collection, and standards and methods of treatment.

Various Regulations

i) Law No.21 year 1958: Pertaining to the regulation of industry, and according to the authority given by this law, the Minister of Industry issued Decree No. 91 year 1959 to regulate the using and importing of hazardous chemicals.

ii) Law No.137 year 1981: Pertained to laborers and occupational safety; Item 100 listed the conditions for the location of new projects, and Item 115 protects laborers from mechanical, physical and chemical hazards. Paragraph (B) of Item 115 deals with physical hazards such as noise; the Ministerial Decree of the Minister of Labor No.55 year 1983 detailed the permissible limits of noise.

Law No.4 Year 1994 for the Protection of the Environment

Law No.4 year 1994 is an integrated law that aims to protect the environment.

i) It established the Egyptian Environmental Affairs Agency (EEAA) to protect and develop the environment; it is under the authority of the Minister of State for Environmental Affairs (Item 2).

ii) It established the Environmental Protection Fund (Item 14).

iii) It was the first legislation in Egypt that gave incentives for individuals, institutions and establishments to undertake environmental protection projects (Items 17, 18).

iv) It required the submission of an environmental impact assessment to the EEAA for review before the licensing of any new projects (Item 19).

v) It dealt with the issues of land, air and marine pollution in an integrated manner.

vi) It gave any individual or environmental NGO the right to complain against any transgressions of the rules of the law (Item 103).

The law contains 104 items partitioned into four chapters, with a preparatory chapter in the introduction and conclusive rules at the end of the law.

Some of the chapters are divided into sections concerning specific subjects and rules dealing with various kinds of pollution.

i) Preparatory Chapter (Items 1-18)

Includes general rules and definitions of:

* The environment (unit 1)
* The EEAA and its powers and objectives (unit 2)
* The Environmental Protection Fund (unit 3)
* Incentives for environmental protection activities (unit 4)

ii) Chapter I (Items 19 - 33)

This chapter deals with the protection of land from pollution.

* Unit 1 pertains to the environment and development and the necessity of environmental impact assessments and environmental monitoring; it also calls for the preparation of an emergency plan to confront the environmental crisis, and it encourages the planting of trees, and the protection of birds and animals.

* Unit 2 deals with hazardous substances and wastes and safe methods of using them.

iii) Chapter II (Items 34 - 47)

This chapter addresses air pollution.

* It contains executive regulations for maximum limits of gaseous emissions, dusts, radioactive substances, and noise pollution.

* The law prohibits the disposal, treatment, or burning of solid wastes, except in designated places away from population centers or industrial or agricultural locations and water canals.

* The law also regulates smoking in public places, and prohibits smoking in public transport.

iv) Chapter III (Items 48 - 83)

This chapter deals with seawater.

* Unit 1 deals with pollution from different kinds of ships leaking oils, hazardous substances and liquid and solid wastes.
* Unit 2 deals with off-shore pollution.
* Unit 3 requires that each ship have an international certificate for pollution prevention.
* Unit 4 sets forth the administrative and legal procedures necessary to apply the rules of this law in the field of marine water pollution.

v) Chapter IV (Items 84 - 101)

This chapter deals with sanctions and penalties, which are usually fines. They vary according to the kind of violations, and may reach half a million Egyptian pounds in the case of petroleum pollution (Item 90). The penalty will be doubled if the violations are repeated, and the penalty may include imprisonment. This is required by some rules that concern hazardous substances and intentional violations that result in permanent handicapping (Item 95).

When the Law Goes into Effect

As the law and environmental enforcement are tools of environmental management, also personal commitment and voluntary compliance are considered main complementary tools of environmental protection. The EEAA is placing more and more emphasis on voluntary commitment, and is working for the establishment of a supportive social atmosphere by encouraging and provoking behavior changes in the community that will foster obligations towards the environment. To be effective, environmental management requires balanced environmental policy, support for legislation through education and awareness, and economic incentives for committed individuals and institutions that must follow environmental regulations and legislation.

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Some Articles of Law 4 Year 1994 For Environmental Protection

Environmental Impact Assessment for Projects

Article 19:

The competent administrative authority or the licensing authority shall assess the environmental impact of the establishment for which a license is sought by reference to the elements, designs, specifications and criteria issued by the EEAA in agreement with the competent administrative authorities. The executive regulations of the Law shall determine the establishments to which the provisions of this article apply.

Article 20:

The competent administrative authorities or the licensing authority shall send a copy of the environmental impact assessment mentioned in the preceding Article to the EEAA, to express its opinion thereon and propose measures required to be taken in the field of preparations and systems in order to treat negative environmental effects. The said authorities shall verify the implementation of the EEAA's proposals. The EEAA is required to furnish the competent administrative authority or the licensing authority with its opinion on the assessment within a maximum of 60 days from receiving this assessment, otherwise the assessment shall be deemed to have been accepted by the EEAA.

Article 21:

The competent administrative authority shall notify the owner of the establishment of the result of the assessment by a registered letter with return receipt requested. The owner of the establishment may object to the result in writing within thirty days of notification before a committee to be formed by a decree of the Minister of State for Environmental Affairs. The EEAA, the competent administrative authority or the licensing authority and the owner of the establishment shall be represented on the committee. The executive regulations shall determine the functions of the committee as well as its operating and complaint procedures.

Article 22:

Pursuant to the provisions of this Law, the owner of an establishment shall keep a written register to record the impact of the establishment activities on the environment. The executive regulations will determine the standard form of the required register, the time frame of the establishment obligation to keep it and the data to be entered therein. The EEAA is authorized to follow up entries in the register to ensure that they conform to the facts, to take samples as required and to conduct appropriate tests to determine the impact of the establishment activities on the environment and the extent of its compliance with the criteria laid down for the protection of the environment. In case of any violation, the EEAA shall notify the competent administrative authority to direct the owner of the establishment to rectify such violation forthwith. If the owner fails to comply within 60 days, the EEAA shall be entitled, in agreement with the competent administrative authority, to take such legal and judicial procedures as are necessary to stop the offending activity and claim adequate damages to redress the harm resulting from the violation.

Article 23:

Expansions and renovations of existing establishments shall be subject to the same provisions set forth in Articles 19, 20, 21 and 22 of this Law.

Environmental Monitoring Networks

Article 24:

Environmental monitoring networks with their stations and working units shall be formed, pursuant to the provisions of this Law, and shall undertake, in their respective fields of specialization, to monitor the components and pollutants of the environment on a regular basis and make the results available to the authorities concerned. For the fulfillment of the foregoing, the networks may call on the assistance of research centers and competent authorities which shall furnish the networks with the studies and information they request. The Agency shall supervise the establishment and operation of the environmental monitoring networks.

Article 25:

The Agency shall lay down a contingency plan to deal with environmental disasters which shall be approved by the Cabinet. The contingency plan will be based in particular on the following:

Gathering the information available at the national and international levels on ways of confronting environmental disasters and mitigating their harmful effects.

Identifying the resources available at the national, regional and international levels and determining how they can be deployed to ensure a swift response to the disaster.

The contingency plan will include the following:

- Identifying the types of environmental disasters and the agencies responsible for reporting or predicting their occurrence.
- Establishing a central operations room to receive reports of environmental disasters and follow up the transmission of accurate information thereon in order to mobilize the necessary resources to deal with such disasters.
- Forming a task force to follow up the measures taken to confront an actual or predicted environmental disaster. The leader of the task force shall be vested with all the powers necessary to confront the disaster in cooperation and coordination with the competent authorities.

Protecting Wild Life

Article 27:

An area of not less than one thousand square meters of state-owned land shall be allocated for the establishment of an arboretum for the cultivation of trees in each district and in each village. The output of these arboreta shall be available to agencies and individuals at cost price.

The competent administrative authorities to which these arboreta are affiliated shall lay down guidelines for the cultivation and protection of these trees. The EEAA shall participate in financing the establishment of these arboreta.

Article 28:

It is forbidden to hunt, kill, or catch the species of wild birds and animals determined in the executive regulations of this Law or to possess, transport, circulate with, sell or offer to sell such birds and animals either dead or alive. It is also forbidden to damage the nests or eggs of these birds.

The executive regulations of this Law shall determine the areas to which the provisions of this article apply and shall specify the conditions for a hunting license in these areas as well as the competent administrative authorities responsible for implementing the provisions of this article.

Hazardous Materials and Waste

Article 29:

It is forbidden to displace hazardous substances and waste without a license from the competent administrative authority. The executive regulations of this Law shall determine the procedures and conditions for granting such a license and the authority competent to issue the same.

The ministers shall, each in his field of competence, issue in coordination with the Minister of Health and EEAA a table of the hazardous substances and waste referred to in part one of this article.

Article 30:

Management of hazardous waste shall be subject to the rules and procedures laid down in the executive regulations of this Law. The executive regulations shall designate the competent authority, which, after consulting EEAA, will issue the table of hazardous waste to which the provisions of this Law shall apply.

Article 31:

It is forbidden to construct any establishment for the treatment of hazardous waste without a license issued by the competent administrative authority after consulting the EEAA. Disposal of hazardous waste shall be in accordance with the conditions and criteria set forth in the executive regulations of this Law. The Minister of Housing shall, after consulting with the Ministries of Health and Industry and the EEAA, designate the disposal sites and determine the conditions of the license to dispose of hazardous waste.

Article 32:

It is forbidden to import hazardous waste or to allow its introduction into or its passage through Egyptian territories. It is forbidden without a permit from the competent authority to allow the passage of ships carrying hazardous waste in territorial seas or in the exclusive maritime economic zone of Egypt.

Article 33:

Those engaged in the production or circulation of hazardous materials, either in gas, liquid or solid form, are held to take all precautions to ensure that no environmental damage shall occur.

The owner of an establishment whose activities produce hazardous waste pursuant to the provisions of this Law shall be held to keep a register of such waste indicating the method of disposing thereof, and the agencies contracted with to receive the hazardous waste. The executive regulations shall determine the data to be recorded in the said register and the EEAA shall be responsible for following up the register to ensure its conformity with the facts.

Protection of Air Environment From Pollution

Article 34:

The site on which a project is established must be suitable for the project activity to ensure that the permissible levels of air pollutants are not overstepped, and that the total pollution emitted by all the establishments in one area is within the permissible levels.

The executive regulations of this Law shall determine the establishments subject to its provisions, the authority competent to approve the site and the permissible levels of air pollutants and noise in the area where the establishment is constructed.

Article 35:

In carrying out their activities, establishments subject to the provisions of this Law are held to ensure that emissions or leakages of air pollutants do not exceed the maximum levels permitted by laws and decrees in force and determined in the executive regulations of this Law.

Article 36:

It is prohibited to use machines, engines or vehicles whose exhaust emissions exceed the limits set by the executive regulations of this Law.

Article 37:

It is prohibited to throw, treat or burn garbage and solid waste except in special sites designated for such purpose which are far from residential, industrial or agricultural areas as well as from waterways. The executive regulations of this Law shall determine the specifications and conditions of such sites and their minimum distance from the areas referred to herein above.

Local units shall, in agreement with the EEAA, designate the sites for burning, throwing or treating garbage and solid waste according to the provisions of this article.

Article 38:

It is prohibited to spray or use pesticides or any other chemical compounds for agriculture, public health or other purposes except after observing the conditions, regulations and safety measures laid down in the executive regulations of this Law and in a manner that will not expose humans, animals, plants, waterways and other components of the environment, directly or indirectly, now or in future, to the harmful effects of such pesticides or chemical compounds.

Article 39:

All organizations and individuals shall be held, when carrying out exploration, excavation, construction or demolition works or when transporting the resultant waste or debris, to take the necessary precautions to secure the safe storage or transportation thereof to prevent loose particles from escaping into the air, in accordance with the provisions of the executive regulations.

Noise

Article 42:

All organizations and individuals shall be held, when carrying out production, service or other activities, particularly when operating machinery and equipment or using sirens and loudspeakers, to keep the volume below the permissible sound intensity level.

Licensing authorities shall ensure that the total sounds emanating from fixed sources in one area shall be within the permissible levels, and ascertain that the establishments select the appropriate machinery and equipment to guarantee this. The executive regulations of this Law shall define the permissible levels of sound intensity and the permissible time limits for exposure thereto.

Chapter 4
CASE STUDIES

- Waste Minimization in Industry
  (Food Industries - Oils and Soaps - Textiles)

- Solid Waste Management
  (Solid Waste Collection - Waste Handling - Composting)

- Community Environmental Projects
  (Better Health, Solid Waste Collection)

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Case Study: Food Sector

Waste Reduction by Improved Quality Control and HACCP Implementation at

Edfina Company for Preserved Foods, Alexandria, Egypt

A Project Implemented By the EEAA SEAM Programme

Introduction

Waste minimization through improved quality control procedures was implemented at Edfina Company for Preserved Foods (Edfina), Alexandria. A number of interventions costing LE65,200 have yielded annual savings of LE382,622. Quality control training and the implementation of the Hazard Analysis and Critical Control Point (HACCP) system will lead to improved product quality and further savings. Although it is difficult to quantify at this stage, further savings of LE550,000 could be expected in the short term.

The Factory

Edfina is a public sector company and its factory at Montazah, Alexandria is one of the largest producers of preserved foods in Egypt. Built in 1958 on 56,000m^2 the company's workforce has been recently reduced, ahead of Government privatization plans, to its current level of 600 employees. Production is seasonal and is around 12,100 tons per year comprising: 4,600 tons of fruit juice and syrup; 3,900 tons of jam; 1,700 tons of canned beans and vegetables; 1,050 tons of frozen foods; 500 tons of tomato paste; and 350 tons of honey and other products.

Process Description

Processing of the 5 main products can be summarized as follows:

* **Fruit Juices** - fresh fruits are received, sorted, washed and squeezed. Pulp is heated, screened and mixed with ingredients. The mixture is heated, screened, homogenized, either bottled or canned, and then pasteurized. The product is incubated before final packaging and storage.

* **Jam** - fresh fruits are sorted, washed, peeled, and then cut. The fruit is then mixed with sugar, steam cooked and concentrated under vacuum. Concentrate is packed in tin cans, or jam pots, sterilized and stored.

* **Frozen Vegetables** - fresh vegetables are received, weighed, sorted, trimmed, peeled and cut manually. Peeled vegetables are sorted, blanched, frozen, sieved, and packed in pouches.

* **Canned Beans** - green beans are received, weighed, sprayed with insecticide, sieved, sorted, dip and spray washed, and soaked. This is followed by steam cooking, rapid cooling and final sorting. Cooked beans are seasoned, canned and sterilized.

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* **Tomato Paste** - raw tomatoes are received from suppliers, weighed, sorted and washed. Cleaned, sorted tomatoes are pressed for juice and screened. Seasoning is added and juice is concentrated under vacuum and heat-treated. Paste is automatically canned, sterilized, sealed, cooled and stored.

Process and Service Units

There are two canning facilities, a freezing unit, two can making plants, and a varnishing and printing facility on site. Service units include a water treatment facility, boiler station, quality control laboratories, freeze-storage and refrigerators in addition to cooling towers, garages and maintenance workshops.

Energy and Water Consumption

Annual consumption is typically:

* Electricity : 5.95 million kWh
* Fuel : 2,419 tons
* Water : 700,000m^3

Wastewater

Around 520,000m^3/year of effluent are discharged untreated into the public sewage system. The factory is in the process of installing a wastewater treatment plant.

Cleaner Production Opportunities

Cleaner production opportunities were initially identified by means of an industrial audit of the factory. An assessment was made of the different factory processes, which highlighted high product losses and recalls at around 400 tons per annum. Juice losses accounted for 204 tons (4.5%); jam losses, 58 tons (15%); tomato paste losses, 57 tons (11.5%); frozen vegetables losses, 45 tons (4.5%); and cooked bean losses, 23 tons (1.5%). Issues that needed to be addressed included:

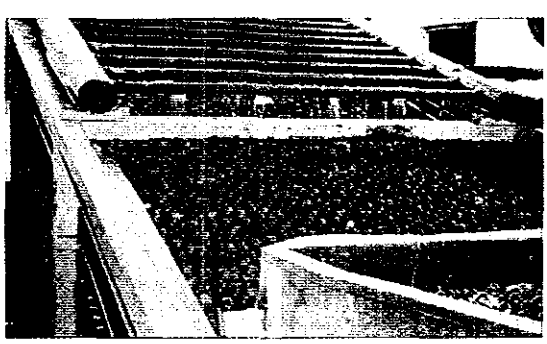
* Quality control capabilities needed strengthening through additional employee training programs.
* Product reject rates were high and could be reduced by better on-line production controls.
* Considerable amounts of jam pots were wasted due to faulty packaging.
* Manual packaging and poor handling of the vegetable paste resulted in unnecessary losses.
* For frozen food production, vegetables are washed and cooled manually. Product rejects arise due to improper handling and post blanching contamination.
* Insects were posing a problem to product quality particularly in jam production.
* Considerable amounts of packaging waste were generated, particularly tin and reject cans (1,500 tons/year) and glass bottles (22 tons/year).
* Pollution loads in discharge effluents were above permissible limits.

Cleaner Production Applications

To address the above issues a series of improvement measures were identified and implemented through the SEAM Project as outlined below. Priority was given to improvements that could entail significant savings at least cost.

Involving the Employees

An in-house team was established to identify opportunities for improvements that will minimize waste in the factory's different production lines. The team was headed by the quality control manager, and included members from other key departments. The team enhanced the communication between all levels of management and workers and facilitated cooperation between the different departments.



Improved quality control can reduce waste of raw materials and products.

Quality Control Training and Awareness Raising

A training needs assessment was undertaken with management, process engineers, production supervisors and line workers in order to tailor an appropriate employee training and awareness program. Training over 8 weeks was provided for 23 employees, mainly from the production and quality control departments, in the following areas:

* Improved quality control for food industries.
* Good manufacturing practices in food processing.
* Hazard Analysis and Critical Control Point (HACCP) Systems.
* Cleaner production principles and waste reduction techniques.
* On-line quality control monitoring and environmental measurements.
* Computer applications to improve monitoring, data analysis and reporting.

Training manuals were disseminated and on the job training was an integral part of the program.

Monitoring to Improve Process Control

To reduce product losses the factory's laboratory facilities were upgraded with partitioning, new benches and air conditioning. Additional equipment was purchased to improve on-line monitoring, including:

* Portable refractometers, pH meters, thermometers and color meters that provide quick and reliable on-line analysis of product quality.

* Turbidity meters to test process water quality.

* Computer, printer and software to improve monitoring of data and reporting of results.

LE33,230 was invested in the above equipment.

Consideration is also being given to obtaining:

* Equipment for testing coating thickness, can seams and vacuum seals, to reduce losses caused by canning defects.

* Environmental test kit and BOD (Biological Oxygen Demand) incubator to monitor effluents and final discharges.

Cleaner Production Interventions Improved Packaging of Fruit Jam

Packaging of jam in single-use foil pots was resulting in around 15% losses due to poor cutting and seal defects. During seasonal production as many as 12,000 pots (0.36 ton) were lost daily, giving rise to annual losses of 43.2 tons. Improving the design of the trimming machine has overcome the problem and led to higher quality packaging. Operational costs are marginally lower.

The new machine reduced downtime by 80% thereby increasing production capacity by 6% or 36 tons per year. Net marginal value of the increased capacity is LE16,200.

Implementation costs: LE18,000

Annual savings: LE190,056

Net margins on increased production: LE16,200

Improved Packaging of Vegetable Pastes

The blanched and chopped vegetable leaves "Molokhia" are packed manually resulting in handling and packaging losses of 17.5 tons per year. A semi-automatic packaging system made of a dispensing assemblage and a sealing device has been introduced to eliminate these losses. As a result packaging time has been reduced by 50% thereby saving labor costs and increasing productivity.

Implementation costs: LE13,950
Annual savings: LE57,750

Semi-automatic vegetable paste packing has eliminated handling losses

Modification to Vegetable Processing

The production of frozen vegetables involved a lot of manual handling that resulted in product losses and increased the risk of contamination. To minimize manual handling during cooling of the vegetables after blanching, a special sprinkler and screening system was installed.

This measure has reduced product rejects by 10 tons per year. In addition, cooling water requirements were reduced by 25% (10,920m^3/year) and labor requirements by 30%.

Implementation costs: LE10,750
Annual savings: LE49,720.

Improved food quality monitoring to reduce product losses

Improved Pest Control

The current pest control program was upgraded by installing window screens and insectocuters to control flying insects. Frequent inspection and pest surveys were also initiated. These improvements were required to bring the factory into line with international hygiene specifications and have eliminated 29.3 tons per year in product losses.

Implementation costs: LE22,500
Annual savings: LE68,986

Hazard Analysis and Critical Control Point (HACCP)

HACCP was introduced for the fruit drinks bottling line. Steps for implementation were as follows:

* All necessary quality control procedures were verified for completeness and to determine if they are being implemented in accordance with required standards.
* A Hazard Analysis was conducted to identify hazards that may be occurring in the product cycle, from farm delivery to retail, and to assess preventative measures.
* Critical Control Points (CCPs) were determined to control the identified hazards. CCP signs were then posted on the factory floor.
* Critical Limits were established at each CCP.
* An appropriate monitoring system was established for each CCP to monitor its control.
* Corrective actions were established to be taken when monitoring indicates deviation or loss of control.
* Verification procedures were established to confirm that the HACCP system is working effectively.
* Documentation concerning all procedures and records was established.
* HACCP was integrated with ISO 9000 under one management system.

Benefits and Achievements

* The main benefits of this project have been to reduce raw material waste and product rejects through better quality control. Employee training, improved process monitoring and the preventative approach of HACCP have led to greater

efficiencies and operational controls yielding benefits that are better quantified over time.

* The application of HACCP will be essential in maintaining and even expanding Edfina's export market. Pressures for quality assured products from the United States and European buyers are already evident for frozen vegetables and fruit drinks.

* The HACCP system that was implemented for bottled fruit drink production is being replicated by the factory in other production lines.

* Environmental improvements have included a reduction in water consumption, pollution loads and volume of effluent discharge.

Economics

A summary of the cost benefits that have been quantified for the four interventions is given in the table.

In addition to the above costs LE33,230 was spent on on-line monitoring equipment and a further LE40,000 was spent on quality control training and HACCP implementation. Although the direct benefits of improved quality control practices are difficult to quantify it is expected that in the short term at least a further 2% of wasted raw materials and products will be recovered yielding savings in excess of LE550,000.

July 1999

Intervention	Costs (LE)	Annual Savings	Payback Months
Improved packaging of fruit jam	18,000	206,256	1
Improved packaging of vegetable paste	13,950	57,750	<3
Modifications to vegetable processing	10,750	49,720	<3
Improved pest control	22,500	68,896	<4
Total	**65,200**	**382,622**	**2**

Case Study: Food Sector

Reduction of Milk Losses

Misr Company for Dairy and Food, Mansoura, Egypt

A Project Implemented By the EEAA SEAM Programme

Introduction

A range of pollution prevention opportunities has been identified and is currently being implemented by Misr Company for Dairy and Food in Mansoura, Egypt. To date, this has involved a total investment of LE113,250 and has resulted in annual savings of LE309,250.

The Factory

This factory is one of nine owned by the public sector company, Misr for Dairy and Food, and is one of the largest producers of dairy products in Egypt. The Mansoura factory was built in 1965 and has a workforce of around 420.

The factory annually processes an average of 7,200 tons of milk, producing mainly pasteurized milk, white cheese, blue cheese and mish. Yoghurt, sour cream, ghee and processed cheese are also produced.

Process Description

Outline of Main Processes

The main process units present in the factory include:

Milk Receiving, Preparation and Storage - raw milk is delivered from collection centers to the factory's reception area where it is tested and graded. If it is of a suitable quality it is then accepted and refrigerated prior to use.

Milk Pasteurization - the received milk is pasteurized by being rapidly heated and cooled. It is then either sent for packaging or for further processing.

White Cheese Manufacturing - white cheese is produced from the milk concentrate produced by the ultra-filtration of pasteurized milk, which is then curded, packaged and sold.

Ghee Manufacturing - initially, cream is separated from the raw milk and blended with artificial ghee and salt and then cooked. This mixture is then incubated for a day and then packed. Morta is generated as a by-product of this process (0.05%), which is also packed and sold.

Roquefort Cheese Manufacturing - the pasteurized milk is placed in basins, where it is curded, incubated, and refrigerated, followed by punching. It is stored for one month to allow the blue color to develop and then packed and stored for dispatch. Twenty percent of the milk used in this process is lost as whey.

Processed Cheese Manufacturing - Quark and Roquefort cheese are minced and cooked with skimmed milk, whey protein and some additives such as salts and emulsifiers, followed by cooling and packing.

Yoghurt and Sour Cream Manufacturing - milk and fixing agents are mixed to produce yoghurt, which is then automatically packed in small cartons, incubated and refrigerated for dispatch.

Mish (Salty Cheese Mix) Manufacturing - this is produced using dairy product rejects. These are mixed, ground and filtered to separate the solids from the whey. Preservatives are added and the product is packaged.

Service Units

Factory service units include tin can manufacturing, refrigeration and storage, a boiler station, a quality control laboratory, a warehouse and maintenance workshops.

Water Consumption

The factory uses about 37,080m^3/year of water from the Mansoura City potable water supply.

Wastewater

30,240m^3/year of industrial wastewater flows within different factory streams. There is no industrial wastewater treatment facility and the wastewater is disposed into the city sewage system.

Pollution Prevention Opportunities

Pollution prevention opportunities were identified by means of an industrial audit. This identified various improvement opportunities, the most important being:

1. Different solid wastes were stored haphazardly in open areas and roads, constituting a fire risk and impairing the general appearance of the premises.
2. Considerable amounts of milk were wasted due to overflow during the filling of storage and service tanks.
3. Milk leakages occurred in the milk packaging and refrigeration units.
4. Oils used in the car and truck maintenance facilities were drained to factory sewers, encouraging drain blockage and consequent development of foul odors.

Cleaner Production Applications

During the audit stage, particular attention was paid to those improvements that could be carried out at low or no cost to the factory. These were given a high priority, as they are easy to implement and often entail significant savings.

A brief outline follows of the measures which have already been implemented by the factory or that are currently under implementation through the Cleaner Production Demonstration Projects of the SEAM Project.

Economics

Throughout industry, pollution prevention and environmental protection measures can offer real financial benefits in terms of:

* Reduced raw materials consumption.
* Waste minimization.
* Reuse or recycling of in-plant materials.

Implementing these measures will also result in reduced environmental pollution and movement towards discharge consent limits.

Recovery solutions and better quality control of milk products and byproducts have recovered 166 tons of milk per year (2.3%), which were previously wasted. The total capital and operation costs invested in the cleaner production measures at the Mansoura factory amount to LE116,250. This has produced a total savings of over LE308,850 with an average payback period of around four months.

Factory Unit	Actions	Capital and Operation Costs (LE)	Yearly Savings (LE)	Payback Period (month)
All	Improve housekeeping and solid waste removal	13,000	120,000 ("One-off" Sale)	1
Milk Packaging and Storage	Rationalize milk packaging and increase milk refrigeration efficiency	26,500	39,600	8
White Cheese Garage	Reuse whey Collect used oil	0 500	2,000 2,500	Immediate < 3
Milk Receiving and Pasturization	Milk tank level controls Food quality valves	10,250 64,000	126,000	7
Total		**114,250**	**290,100**	**< 5**

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Case Study: Oil & Soap Sector

Oil and Fats Recovery

Tanta Oil and Soap Company, Tanta, Egypt

A Project Implemented By the EEAA SEAM Programme

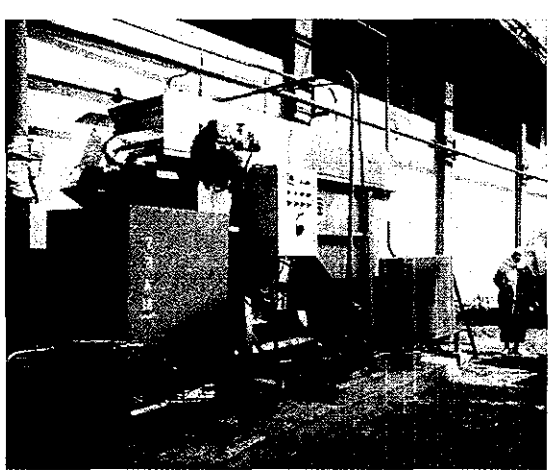
Introduction

A range of waste minimization opportunities has been identified and is currently being implemented by Tanta Oil and Soap Company in Tanta, Egypt. To date, this has involved a total investment of LE621,247 resulting in annual savings of LE637,020 and a savings in capital investment of the wastewater treatment plant of LE500,000.

A summary of how these improvements were identified and the underlying problems solved follows.

The Factory

This factory is located in Tanta city, covering an area of 35 feddans (147,000m^2) and is one of three that are owned by Tanta Oil and Soap Company. The plant was established in 1934.



Gravity Oil Separator in the Fatty Acids Unit

Tanta factory produces an average of 18,000 ton/year of edible oil extracted from cottonseeds, sunflower seeds and soy beans, and 12,000 tons/year of ghee using palm and other oil seeds. The factory also produces 9,000 tons/year of glycerine and 48,000 tons/year of animal fodder.

Process Description

Production processes in the factory include:
Seed Receipt and Preparation. Following receipt, the seeds are sent for mechanical preparation. This consists of mechanical screening and magnetic separation to remove any impurities, which may be present, followed by crushing, flaking, and cooking.

Oil Extraction. The prepared seeds are mixed with hexane in a continuous counter current system, to produce a hexane-oil mixture (miscella) and seed cake. The seed cake is separated from the miscella, dried, cooled, pressed and used in producing animal feed. The hexane is recovered from the miscella under vacuum (using direct and indirect steam) and reused in the system. The remaining crude oil is then cooled and sent for refining.

Oil Refining and Packaging. Crude oil and ghee is processed using the following steps:

Dissolved Air Flotation Unit installed in Tanta factory

- Degumming (for sunflower seeds or soybean) and neutralization - gums are removed in a batch process, using phosphoric acid. Neutralization is done by adding caustic soda to remove free fatty acids from crude oil, which produces semi-refined oil.
- Bleaching - color is removed from the oil using Fullers Earth followed by filtration.
- Deodorizing - unpleasant odors and tastes are removed from the oil by high temperature vacuum distillation.
- Packaging - the refined, bleached, and deodorized (RBD) oil is bottled in automatic filling lines.

Soap and Glycerine Production. Fats are saponified in a batch process, by mixing with caustic soda and heating with direct and indirect steam. After saponification, soap is separated from the lye solution to be dried, blended with additives, homogenized, cut, and packed. Glycerine is separated from the lye solution and distilled.

Service Units

Service units include boilers, cooling towers, pumping stations, power transformer, stand-by diesel power generators and storage and maintenance facilities.

Energy and Water Consumption

* Average annual fuel consumption is 15,000 tons of mazout and 600 tons of solar.
* Annual electricity consumption is around 10.5 million kWh.
* Average daily water consumption is 16,800m^3.

Wastewater Generation

The factory generates about 16,000m^3/day of industrial wastewater from different factory streams, including process effluents, boiler blow down, cooling water, vacuum water, and steam condensate. The wastewater is discharged to Akhnaway drain near the factory.

Pollution Prevention Opportunities

Pollution prevention opportunities were initially identified through an industrial audit of the factory, carried out by the SEAM Project. The following improvement opportunities were identified as being of particular importance:

1. Upgrade loading and unloading procedures for oil, ghee and fats to minimize spillage.
2. Improve housekeeping in the Fatty Acids Splitting Unit.

3. Recover oil from processing units' effluents, especially oil refining and packaging units.
4. Improve handling of animal fodder ingredients to prevent losses.

Cleaner Production Applications

Implementation measures for the identified opportunities are briefly outlined as follows.

Preventive Maintenance and Housekeeping

Upgrade Loading and Unloading Procedures

During the loading and unloading of oil, ghee and fatty matter from batch reactors and separators, significant levels of leakage and spillages were occurring. These losses were entirely eliminated as a result of issuing improved procedural instructions and by improving the supervision of transfer operations.

Implementation cost: 0
Annual savings: LE206,280

Ghee recovered from the Gravity Oil Separator

Product Recovery

Recovery of Oil, Ghee and Fatty Matter

Large volumes of oil and ghee are now being recovered by the installation of three Gravity Oil Separators (GOS) manufactured by the factory. The GOS are installed on the oil washing line, immediately after the water is discharged from the batch reactors of oil and ghee refining. Recovered oil and ghee was discharged and lost to the refinery effluent before the installation of the GOS.

Fatty matter is recovered from two sources: the mucilage produced during neutralization and fatty matter from refinery effluents in oil separators. The existing underground separators were found to be inefficient and were replaced with three new units. These units were installed to process effluents from the continuous refining unit, the fatty acids splitting unit and the effluent from the deodorization unit.

Implementation cost: LE273,647
Annual savings: LE203,220

Recovery of Fodder Ingredients

The animal fodder production unit was generating heavy dust emissions during the loading and unloading of the raw materials. These emissions were stopped and the ingredients recovered by installing a cyclone vacuum system, which collects the suspended matter and transfers it directly to the raw material intake system.

Implementation cost: LE127,600
Annual savings: LE107,520

Summary of Oils Recovered by the GOS Units

Type of Oil	Oil losses before improvements (% of raw oil)	Oil losses after improvements (% of raw oil)	Average oil consumption (ton/month)	Annual savings (LE)
Crude - Cotton	11.98	11.20	530	88,220
Other Oils	2.09	1.86	2,300	115,000
Total	---	---	**2,830**	**203,220**

Wastewater Treatment

Recovery of oil and fatty matter originally lost to the effluent has significantly reduced the organic load of the final effluent. This has reduced the investment required for the end-of-pipe industrial wastewater treatment plant (IWWTP) by around LE500,000.

A dissolved air floatation (DAF) unit has been installed to reduce oil content of the effluent, and prepare it for a consequent biological treatment that is to be installed to ensure that the final effluent is in legislative compliance. LE259,926 was expended on the DAF unit and at the time of writing a further LE432,530 had been spent by the factory on civil works for the new biological treatment plant.

Economics

Throughout industry, pollution prevention and environmental protection measures can offer real financial benefits in terms of:

- Reduced raw materials consumption.
- Waste minimization.
- Reuse or recycling of in-plant materials.
- Reduced use of the IWWTP.

Implementing these measures will also reduce environmental pollution and permit adherence to discharge consent limits.

The total capital and operation costs invested in the cleaner production measures at Tanta Oil and Soap factory amounts to LE621,247. This has produced total savings of around LE637,020 with an average payback period of around one year.

Benefits and Achievements

- IWWTP capital investment costs have been reduced by about LE500,000.
- Annual recovery of oil, ghee, fats and animal feed totalling LE517,020.
- Working conditions improved in the animal feed and fatty acids production unit.
- Oil and grease concentrations in the final effluent reduced by 99%.
- BOD (Biological Oxygen Demand) loads in the final effluent reduced by 85%.

Cost Benefit Summary of Implemented Improvement Measures

Factory	Action	Capital cost (LE)	Annual savings (LE)	Payback period (Years)
All	Better process control and minimization of wasted fats	—	206,280	Immediate
Refinery and Fatty acids	Recovery of oil, ghee and fatty matter from wastewater	273,647	203,220	1.3
Fodder plant	Recovery of fodder ingredients	127,600	107,520	1.2
	Total	**401,247**	**517,020**	**1.0**
Capital investment savings achieved through pollution load reduction		0	500,000	—

June 1999

Case Study: Textile Sector

Sulfur Black Dyeing: A Cleaner Production Approach

El Nasr for Spinning and Weaving Co., Mahalla El-Kobra, Egypt
Dakahleya Spinning and Weaving Co., Mansoura, Egypt
AmirTex Co., Sadat City, Egypt

A Project Implemented By the EEAA SEAM Programme

The Sulfur Black Dyeing Process

Sulfur black dyes are widely used throughout Egypt, due to their low cost, excellent washing and light fastness properties. They are by far the most economical method of producing a jet-black color in cotton fibers.

Sulfur dyes are water insoluble and must be first converted to a water-soluble form, by adding a reducing agent, traditionally sodium sulphide, so that the dyes can be absorbed by the fiber. After dyeing the fabric, the dye is converted back to insoluble form with the addition of an oxidizing agent, often an acidified dichromate. This step prevents the dye from washing out of the fabric.

However, both sodium sulfide and acidified dichromate are toxic and hazardous to handle. Their usage may leave harmful residues in the finished fabric and generate effluents that are difficult to treat and damaging to the environment. Under Egyptian Laws 93/1962 and 48/1982, discharge limits for sulfur are a maximum 10mg/l into public sewers and 0.5mg/l into canals and the Nile, and for hexavalent chromium a maximum of 10mg/l into public sewers and 0.05mg/l into canals and the Nile (<50m^3/day).

How Can the Process Be Improved?

The measures implemented by the SEAM project demonstrate how sodium sulfide and dichromate can be safely substituted without a decline in fabric quality. As a result the advantages of sulfur black dyeing can be retained, while eliminating the adverse environmental and health impacts.

This project was implemented at no capital cost and resulted in cost savings of 2-16% on consumable materials. Other benefits included the elimination of toxic and hazardous materials from the workplace and environment, reduced wastewater treatment costs, improved fabric quality and productivity. Due to reduction in the processing time and better fabric quality, the production of sulfur black dyed fabrics has more than doubled at one factory since implementation.

The Factories

El Nasr Spinning and Weaving is a large public sector factory built in 1963 and currently employing 7,000 people. It

processes an average of 8,000 tons of raw fabric per year, of which 20% are spun cotton yarns, 12% are polyester blend yarns, and 68% is grey fabric. The main products are cotton or blended yarns, white and dyed cotton and blended fabrics. Approximately 52.5 million meters of fabric were produced during 1996/7.

Dakahleya Spinning and Weaving is a public sector factory with annual production of 11,400 tons of spun yarns and ready-made garments. The factory was built in 1965 and employs 4,000 workers. It comprises three spinning departments, an open end spinning unit and a tricot plant with a weaving unit, a dyehouse and a tailoring hall. The main products are cotton yarns, cotton knitted fabrics, polyester blended fabrics, and ready made knitted cotton garments.

AmirTex is a privately owned company with around 100 employees. The factory was built in 1984 and comprises a weaving and knitting department, a printing unit and a dyehouse. The main products are cotton yarns, cotton knitted fabrics, polyester blended fabrics, and ready made knitted cotton garments. Average annual production is 720 tons of cotton, polyester and blended fabrics.

Pollution Prevention Opportunities

The following pollution prevention opportunities were identified in the sulfur black dyeing process through an industrial audit at the 3 factories.

1. High sulfur content in dyehouse wastewater of 40-170mg/l.
2. Acidified dichromate used at El Nasr, resulted in concentrations of hexavalent chromium of 27mg/l in the dyehouse wastewater.
3. Bad odor resulting from the use of sodium sulfide in the dyeing process.
4. Worker safety issues associated with the handling of toxic and hazardous chemicals.
5. Large amounts of steam, energy and water consumed.
6. Fabric losses resulting from the presence of excess sulfur on the material.

Cleaner Production Applications

Two options for reducing the problem of sodium sulfide and hexavalent chromium in the effluent are:

1. Provide adequate treatment facilities -- this incurs capital costs for precipitation tanks and sludge management and ongoing operating costs. This option does not satisfactorily address the problem as pollutants are transferred to the sludge, which still requires disposal.
2. Implement chemical substitution that reduces the problem at source and provides a cleaner production approach to the problem. The cleaner production approach has the benefit of improving productivity and at the same time it reduces the pollution load and costs of treatment.

The cleaner production approach was therefore preferred. The actions taken in this process are outlined below.

Possible Chemical Substitutes

An evaluation was undertaken to assess the viability, costs and quality of using various potential substitutes for sodium sulfide and acidified dichromates in Egypt. A summary of possible substitutes and costs is presented in the following table.

Substitute for Sodium Sulfide	LE/ton
• Glucose (75%)	1,580
• Dextrose	4,000
• Dextrine	1,500
• Hydrol (glucose waste)	0

Substitute for Acidified Dichromate	LE/ton
• Hydrogen peroxide	2,740
• Sodium perborate	3,200
• Ammonium persulfate	8,000
• Sodium bromate	8,000+
• Potassium iodate	8,000+

Selection of the Substitutes

Laboratory trials were initially used to determine the optimum combination of reducing sugars and alkali.

a) Substitution of Sodium Sulfide: In all three factories, dextrine and hydrol were rejected as they gave a poor depth of shade. Glucose and dextrose both gave good depths of shade when used with sodium hydroxide. Glucose was therefore preferred as a substitute to sodium sulfide because of its lower cost.

b) Substitution of Dichromate: In El Nasr Spinning and Weaving, sodium bromate and potassium iodate were rejected as these chemicals are corrosive, unsafe to handle and expensive. Hydrogen peroxide was also rejected, as it is not suitable for use with woven fabrics. Sodium perborate and ammonium persulfate were both acceptable; however, sodium perborate was preferred due to its lower cost. In Dakahleya Spinning and Weaving and AmirTex, hydrogen peroxide was preferred as it is particularly suitable for processing knitted fabrics.

Pilot trials were then carried out to refine the preferred laboratory 'recipe' and assess its reproducibility at production scale. During the trials it was noted that when glucose is added in stages the depth of shade was significantly improved. The successful recipes were then implemented at the production scale.

Process Optimization

In association with the substitution, processing sequences could be optimized for greater productivity and financial savings as outlined below.

El Nasr Spinning and Weaving

- The desizing and scouring processes, normally carried out in four steps, were combined.
- Temperature in the soaping bath following oxidation was reduced.

Dakahleya Spinning and Weaving

- Cold washes were used between the dyeing and oxidation steps.
- One cold wash after oxidation was eliminated.
- One hot wash after the soaping bath was eliminated.

AmirTex:

- Two cold washing steps (after the overflow washing) were eliminated.

Costs and Benefits

Direct Financial Savings

No capital expenditure was necessary for implementation, as the benefits have been principally achieved through substitution and process optimization.

Despite some increases in chemical costs, overall savings of 2-16% for all consumable materials have been achieved in the three factories for each ton of fabric processed. A breakdown of the savings is given below.

Savings in LE per ton of Fabric Processed

Factory	El Nasr		Dakahleya	AmirTex
Shade	Grey	Black	Black	Black
Savings in				
Chemical costs	12	- (80)	- (12)	60
Water use	6	6	59	17
Steam	14	14	135	120
Electricity	14	14	33	1
Labor	90	90	173	8
Total (LE)	**136**	**44**	**388**	**206**

Note: Figures in brackets indicate an increase in cost

El Nasr Spinning and Weaving

Chemical costs were reduced for grey shades but were much higher for black shades as larger volumes of glucose were required to produce acceptable results. Savings in steam (16%) and electricity (22%) resulted from combining the desizing and scouring process, which also reduced the processing time by two hours thereby saving on labor costs.

General production of sulfur black dyeing is a small proportion of the total, however with improvements to the process it is likely to increase.

Dakahleya Spinning and Weaving

A slight increase in the chemical costs was more than offset by significant savings from process optimization This included eliminating two hot washes after dyeing and optimizing the number of cold and overflow washes carried out. As a result, steam, water and electricity costs were reduced by 38-39%. Processing time was reduced from 13 hours to eight hours thereby increasing production capacity.

Around 24 tons of fabric per annum are dyed with sulfur black dyes.

Annual savings on current production: LE9,312
Annual benefits from increased production capacity: LE21,000

AmirTex

Savings of LE206 per ton were achieved; however, where hydrogen peroxide was already used as the oxidant the savings were reduced to LE46 per ton. AmirTex processes 21.6 tons per year using sulfur black dyes. Due to improved fabric quality AmirTex has increased production to 70 tons per year and reduced the use of more expensive reactive dyes at a savings of approximately LE490 per ton.

Annual savings on current production: LE2,386.
Annual savings by reducing use of reactive dyes: LE23,716.

Improved Fabric Quality

Elimination of free sulfur now avoids the past problem of 'tendering' upon storage. This used to occur when residual sulfur on the fabric progressively oxidized to form sulfuric acid, which then attacks and may eventually destroy the fabric.

At El Nasr factory, fabric strength was improved by 5% by using glucose instead of sodium sulfide.

Improved Productivity

The modified process not only improved product quality but also reduced waste by an increase in getting it "Right First Time" (RFT). A 10% improvement was achieved at AmirTex. In all factories, the modified process was shorter than the conventional process, thereby saving on time and labor costs.

Savings on Effluent Treatment Requirements

Concentrations of both hexavalent chromium and sulfur were significantly reduced in the effluent coming from the dyeing line at the three factories. BOD (Biological Oxygen Demand) levels increased due to the use of glucose; however, it is not likely to significantly increase either wastewater treatment costs or the characteristics of the final effluent.

Effluent Characteristics Before and After Implementation
(from the end of the dyeing line)

Concentration (mg/l)		El Nasr		Dakahleya	AmirTex
		Grey	Black	Black	Black
Sulfide	Before	68	117	40	103
	After	1	2.5	0.7	1.5
Hexavalent Chromium	Before	26	27	n/a	0
	After	0	0	0	0
BOD (biological Oxygen Demand)	Before	360	540	347	660
	After	1257	2150	1233	1070
TDS (total dissolved solids)	Before	3385	3900	1510	—
	After	2690	2690	1950	—

Elimination of sodium sulfide and acidified dichromate made the final effluent easier to treat, as it became less toxic and corrosive. At AmirTex savings on wastewater treatment requirements, were estimated to be around LE60 per ton of fabric processed.

Sulfur black dyed fabric using glucose as reducing agent

Improved Working Conditions

Workers interviewed at the factory were very supportive of the improvements to working conditions. The bad odors and inhalation of sulfur fumes have been removed and the substitute chemicals are much safer to handle.

Benefits and Achievements

	El-Nasr	Dakahleya	AmirTex
Electricity consumption reduced by	22%	38%	8%
Steam consumption reduced by	16%	39%	21%
Chemical costs reduced (increased) by	2%	(6%)	4%
Water consumption reduced by	13%	39%	15%
Labor costs reduced by	23%	57%	6%
Processing time reduced by	22%	38%	6%

- Improved productivity
- Improved working conditions
- Phasing out of toxic sodium sulfide and acidified dichromate

Case Study: Textile Sector

Bleach Clean-Up in Cotton Textile Processing Using Enzymes

Dakahleya Spinning and Weaving Co., Mansoura, Egypt and AmirTex Co. for Dyeing and Finishing, Sadat City, Egypt

A Project Implemented By the EEAA SEAM Programme

The Bleaching Process

Bleaching is carried out after scouring to whiten fabrics and yarns. It can also dissolve substances not removed by scouring and prepares the fibers for further finishing processes, particularly dyeing. It is normally carried out using either sodium hypochlorite (known as "chemicking") or hydrogen peroxide.

Once bleaching has been completed, the bleaching chemical must be completely removed from the fabric, so that it will not interfere with subsequent dyeing and finishing processes. This is normally done by either repeatedly rinsing the bleached fabric in water, or by neutralizing the bleach with a mild reducing agent. Chemical agents are commonly used, such as sodium thiosulphate or hydrosulphite.

This case study describes an alternative clean-up option for hydrogen peroxide based bleaching. This option uses enzymes instead of chemical reducing agents and saves water, energy and processing time.

The Factories

Under the SEAM Project, the use of enzymes in cotton textile processing has been demonstrated at Dakahleya Spinning and Weaving and AmirTex. A description of these two factories is provided below.

Dakahleya Spinning and Weaving is a public sector factory with annual production of 11,400 tons of spun yarns, knitted fabrics and ready-made garments. The factory was built in 1965 and employs 4,000 workers. It comprises three spinning departments, an open end spinning unit and a tricot plant with a weaving unit, a dyehouse and a tailoring hall. The main products are cotton yarns, cotton knitted fabrics, polyester blended fabrics, and ready made knitted cotton garments. In 1997, average monthly production was 39.4 tons of full bleached fabric and 10.3 tons of half bleached fabric.

AmirTex is a privately owned company with around 100 employees. The factory was built in 1984 and comprises a weaving and knitting department, a printing unit and a dyehouse. The main products are cotton yarns, cotton knitted fabrics, polyester blended fabrics, and ready made knitted cotton garments. Average annual production is 720 tons of cotton, polyester and blended fabrics. In 1997, average monthly production was 29.4 tons of half bleached fabric.

Identification of Problems

Conventional bleach clean-up methods have the following drawbacks:

- Higher levels of energy consumption.
- Higher levels of water consumption.
- Longer processing time.
- Release of toxic substances (sodium hydrosulfite, a toxic and hazardous chemical).
- Lower bleach clean up efficiency (bleach may not be completely removed).

Enzymetic Bleach Clean Up

Enzymes can be used in bleach clean-up as an alternative to multiple rinses or use of chemical reducing agents. In the SEAM Project, the Terminox 10L and Terminox Ultra 50L enzymes produced by Novo Nordisk were used, Terminox Ultra 50L being the more effective of the two. Both products break down residual hydrogen peroxide into non-active oxygen and water. This process is most efficient at pH 6.5-7; beyond this range, larger amounts of the enzyme are needed to achieve complete decomposition of hydrogen peroxide.

A comparison between conventional and enzyme-based bleach clean-up methods is highlighted below:

Rinsing with water:

Bleach → Rinse → Rinse → Rinse → Dye

Reduction with chemical reducing agents:

Bleach → Reduce → Rinse → Dye

Using enzyme:

Bleach → Rinse → Enzyme ! Dye

Under industrial conditions, Terminox takes 10-20 minutes to completely break down residual hydrogen peroxide and has no adverse effect on either the fibers or the subsequent dyeing process. Once bleach removal is completed, dyeing can be carried out in the same liquor, without any need for further heating.

Cleaner Production Application

Pilot scale trials were carried out using both Terminox 10L and Terminox Ultra 50L. These trials were carried out to identify optimum conditions for enzyme use, such that residual hydrogen peroxide was completely eliminated from the liquor.

Application of enzymetic bleach clean-up is very straightforward. A summary of the methodology used at both factories follows.

General Methodology

1. Drain the spent bleaching liquor.
2. Fill with fresh cold water.
3. Check that pH is in the range 6.5-7 and the temperature 45- 50°C.
4. Add enzyme.
5. Check after 10-20 minutes that residual H_2O_2 has been removed by using Merck peroxide test strips.
6. Start the optical brightening procedure without changing the liquor.
7. Assess results and optimize enzyme concentration.

Note: If the fabric is very dirty, then it is recommended that an extra overflow rinsing step be carried out once bleaching has been completed and before the enzyme is added.

The results of the pilot trials carried out at Dakahleya Spinning and Weaving, using Terminox 10L are summarized as follows:

Trial No.	Enzyme Conc. (g/l)	Liquor characteristics		
		Before Clean-up	After Clean-up	
		Residual H_2O_2	pH	Residual H_2O_2
1	1.6	25	6	0
2	0.8	5	6	0
3	0.8	10	7	0
4	0.5	25	8	5
5	0.5	25	7	0

Note: Enzyme performance is reduced where H_2O_2 concentrations exceed 1,000ppm.

In Dakahleya Spinning and Weaving, when 0.5g/l enzyme was used and pH was 8, some hydrogen peroxide was still present. When pH was corrected to 7, no residual hydrogen peroxide was detected. This demonstrates that pH is critical in fine-tuning pilot scale experiments.

Once an acceptable recipe had been developed, production scale trials were carried out to "fine tune" the pilot scale results and to check that dyeing would be of an acceptable quality. A summary of the results obtained at both factories at the production scale follows.

Dakahleya Production Trials - Optimizing Enzyme Concentrations for Full Bleaching

Trial No.	Enzyme Conc. (g/l)	Whitness index
1	0.18	96.45
2	0.16	100.78
3	0.14	98.69
4	0.12	99.94

Note: No residual hydrogen peroxide was detected once bleach clean-up had been completed.

(**Note:** in Dakahleya Spinning and Weaving, Terminox 50L was substituted for Terminox 10L at the production scale).

The recipe from Trial 4 was adopted for full-scale production, as it used the minimum amount of enzymes, while giving an acceptable whiteness index.

In the case of half bleaching, a lower level of whiteness is acceptable as the fabric is subsequently dyed. The requirements of hydrogen peroxide are also less and therefore the residual levels of hydrogen peroxide are low. The following table is a summary of the results obtained at AmirTex for the half bleaching of cotton and cotton/polyester blend.

AmirTex - Half Bleaching & Dyeing

Recipe: Terminox 50L, 137.5mg/l; acetic acid, 93.7mg/l

	Before (Conventional Process)	After (Modified Process)
a) Half bleached and dyed cotton; single jersey		
Bursting strength (kg/cm^3)	31	35.5
Washing fastness	4-5	4-5
b) Half bleached and dyed polyester/ cotton; interlock		
Bursting strength (kg/cm^3)	77.3	79.2
Washing fastness	4-5	4-5

At AmirTex, a slight improvement in the bursting strength was observed for both the 100% cotton and the cotton/polyester blend fabrics.

Process Optimization

Use of the enzymes meant that a number of stages could be combined or eliminated entirely. A summary of the optimization achieved at the two factories follows.

Dakahleya Spinning and Weaving

- Elimination of 2 hot water washes.
- Elimination of 3 cold water rinses.
- Reuse of enzyme bath for the "optical brightening" step in full bleaching process.
- Reuse of enzyme bath as the dye bath in the bleaching/dyeing process.

AmirTex

- Elimination of 1 hot wash.
- Elimination of 1 cold rinse.

Costs and Benefits

Enzyme Bleach and Process Optimization

No capital expenditure was necessary for implementation, as the benefits have been achieved mainly through substitution and process optimization.

Dakahleya Spinning and Weaving

No increase in costs was recorded, as great care was taken to identify the lowest cost recipe (while maintaining an acceptable fabric quality) and to optimize the process in terms of water and energy consumption. As a result, steam, water and electricity costs were reduced by 24-50%.

Annual savings on current production: LE112, 971.

Payback period: Immediate.

AmirTex

The biggest savings at AmirTex were made with regard to energy consumption, mainly resulting from the elimination of the hot water wash.

Annual savings on current production: LE36,359.

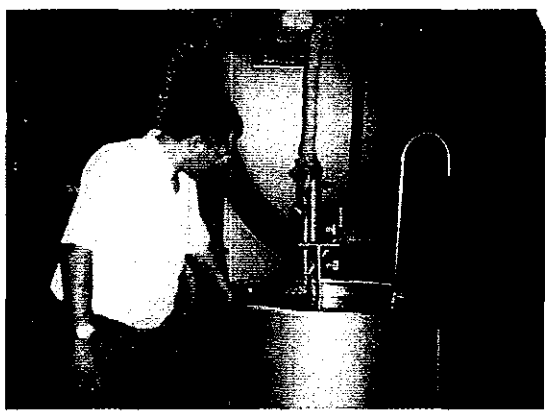
Payback period: Immediate

Saving in LE per ton of fabric processed

Savings in	Dakahleya		AmirTex
	Half bleach and dye	Full bleach	Half bleach and dye
Chemical costs	30	5	(40)
Water use	25	29	23
Energy	158	149	120
Total savings (LE/ton)	**213**	**183**	**103**
Annual prod. (tons)	124	473	353
Annual savings (LE)	26,412	86,559	36,359

Note: Figures in brackets indicate an increase in cost

Adding Terminox enzyme to jet machines



Checking for optimum pH conditions

Increased Production Capacity

Dakahleya Spinning and Weaving

Processing time was reduced by 13% per ton of half bleached fabric and 33% per ton of full bleached fabric. This corresponds to a potential increase of 1.3 tons of half bleached fabric and 13 tons of full bleached fabric per month that could be achieved.

AmirTex

Processing time was reduced from 7 hours to 5 hours per ton of fabric, thereby increasing production capacity by 29%. As the average monthly production of half bleached fabric is 29.4 tons, a potential increase of 8.5 tons of half bleached fabric per month could be achieved. These benefits are not presently quantified.

Environmental Benefits

- Effluent volume at both factories was reduced, due to the elimination of unnecessary washing steps.
- The concentration of Total Dissolved Solids (TDS) in the effluent was decreased.
  * Most of the chemical agents for bleach clean up are hazardous to handle and difficult to degrade. In contrast, enzymes are safe to handle and completely biodegradable.

Benefits and Achievements

	Dakahleya		AmirTex
	Half bleach and dye	Full bleach	Half bleach and dye
Energy consumption reduced by:	48%	24%	45%
Chemical costs reduced by:	40%	83%	—
Water consumption reduced by:	36%	50%	43%
Processing time reduced by:	13%	33%	29%

Improved productivity
Improved working conditions

February 1999

Case Study: Solid Waste Management

Remediation of Burning Dumpsite

Mansoura, Governorate of Dakahleya

A Project Implemented By the EEAA SEAM Programme

Introduction

The main municipal dumpsite for Mansoura City, adjoining Talkha and the surrounding environs was located on the outskirts of the city, adjacent to the sewage treatment works. Approximately 100-150 loads or 400 tons of waste were delivered daily to the site. There were no tipping controls and waste was dumped randomly and set on fire.

Nearby residents had complained of smoke, odor and litter nuisance and people were reluctant to occupy apartment blocks recently built in the area. Responding to a request from the Governorate, the SEAM Project implemented a program of remediation. Introducing better tipping practices, extinguishing smouldering fires and stabilizing large mounds of burnt waste were key implementation priorities. In addition, training was provided to the dumpsite workers and the role of scavengers was addressed.

Remediation was undertaken from July to September 1995 and tipping continued on other designated parts of the site till it was eventually closed in November 1996. There

Extinguishing fires at the burning garbage dumpsite

are plans by the Governorate to convert the remediated area to a public park.

Remediation cost LE105,120. A bulldozer and water pump were hired for the remediation and subsequently the Governorate purchased a bulldozer to maintain the new tipping practices.

Diverting Incoming Waste

The first stage of the program was to divert incoming waste to a new tipping area on the same site. This prevented incoming refuse from being ignited by the existing mounds of smouldering waste. An area of disused sludge drying beds immediately adjacent to the burnt waste was selected.

Groundwater impacts were assessed and considered insignificant in the light of past practices. It was reported that the old dumpsite had not adversely affected the quality of the groundwater. In view of this and the remaining limited life of the site the use of a waste liner at this late stage was considered not feasible.

Introducing New Tipping Practices

Incoming waste was dumped and spread out by a shovel loader to allow scavengers access to recover any recyclable materials. By controlling the area where scavengers could work this reduced the safety risk as previously they roamed the site often getting in the way of incoming vehicles.

The bulldozer was then used to tip, level and compact the waste in layers, or cells, between 10-20m wide and to a height of 2m. The waste cells were covered at the end of each day with a thin layer (150mm) of soil excavated at the site or by using suitable incoming construction waste. Daily cover minimizes the risk of spontaneous combustion and reduces odor, flies and the amount of wind blown litter.

Cells were planned over the available areas and were prepared several days ahead by recovering and storing available cover material. Banks, 2m high, were also prepared around the proposed cell. Tipping in successive layers on the top of existing cells was practiced up to a maximum height of 10m.

Training for the supervisors and onsite workers was provided on the new tipping procedures.

How Were the Dumpsite Fires Extinguished?

Waste that had been recently dumped and set on fire would burn out within a few days. Diverting incoming waste to a different part of the site prevented adding further 'fuel' to the existing fires.

However, there was a huge volume of burnt waste that continued to smoulder in places. These areas were doused in water by pumping treated effluent from the discharge canals of the adjoining sewage treatment works. Despite this there were still 'hot spots,' which continued to smoulder at depth. These were excavated with a back-end loader and doused.

Did Waste Disposal Continue?

In the period July to September 1995 an area of about 100m by 100m had been tipped to an average depth of approximately 3m, representing a total input of 30,000m^3. The average volume tipped weekly was therefore around 2,500m^3 after compaction on site. The total remaining area for tipping as of September 1995 was identified at 137,500m^3. At the rate of delivery of waste to the site, the tipping space identified as available gave a life span of 55 weeks. The dumpsite was subsequently closed in November 1996.

Converting the Dumpsite to a Public Park

The burnt out waste remained in unstable mounds up to 12m in height. These areas were then graded to form a gentle slope and covered with soil excavated at the site. The covering served to:

Waste transportation process to Mansoura's dumpsite

* Reduce the likelihood of wind blown ash.

* Reduce the oxygen supply to underlying areas, thereby minimizing the risk of further combustion.

* Improve the visual impacts.

With grading and top dressing the area had been beneficially upgraded and was left in a suitable condition to be transformed into a public garden as planned by the Governorate.

How Were the Scavengers Affected?

An average of 64 scavengers worked on the old dumpsite, their ages ranging from 7 to 60. Before remediation the scavengers lacked even the most basic facilities. They had no access to clean water for drinking or washing, no place to eat or rest, no shelter and no proper toilet facilities. They and their children washed in the sewage works effluent and were exposed to considerable hazards from dangerous materials on the dumpsite (particularly clinical waste).

The scavengers arrive at the tip around 8:00 a.m. in the morning and remain while there is still sufficient daylight to sort waste. This is around 8:00 p.m. in summer and 6:00 p.m. in winter. The average quantities of recyclable materials that scavengers can pick per day is estimated as: 2 tons of paper; 100kg of glass; 50-100kg of plastics; and 150-700kg of metals. The average productivity of the scavengers per day is about 40-45kg of assorted dry materials. Earnings can amount to LE7-12 per person per day, equivalent to LE175-300 per month.

A social development study was commissioned to assess how to best deal with the scavengers. A number of options were considered including banning them completely, although this would have detrimental consequences in loss of income to the individual. The favored option allowed scavenging to continue but under controlled and improved conditions, which included:

* Designated areas for scavenging incoming waste with time allowed to pick the waste before it was moved to the tip and compacted. This reduced the danger of scavengers being accidentally hit by incoming vehicles.

* Preventing waste burning, which reduced their exposure to smoke inhalation.

* Provision of protective clothing.

* Educating scavengers on health and safety issues.

* Provision of a shaded rest area.

* Provision of a first aid kit.

Due to the limited life of the dumpsite a clean water supply for drinking and washing could not be provided but was recommended for any new dumpsite.

What Are the Benefits of Remediation?

The introduction of the new tipping practices and the remedial works undertaken resulted in the following benefits:

Preparation of new garbage cells and covering of materials

* Elimination of fire and smoke and the minimization of odor nuisance to nearby residents and people working at the site.

* Reduced problems associated with wind-blown litter and flies.

* Greater operational safety.

* Better control on scavenging and improved working conditions for scavengers.

* More income for scavengers due to easier access for recovering recyclables.

* Improved visual appearance of the site by cleaning, levelling and covering the old dump areas.

* Proposed Governorate redevelopment of the remediated site to a public park.

* Capacity building of supervisors and workers to maintain and replicate the new tipping practices.

Nearby residents were very pleased with the results of the remedial actions. It was also noted that residential building activity in the nearby areas also accelerated since the site had been remediated.

What Are the Costs for Better Tipping Practices?

Equipment costs for implementation are outlined below.

Implementation Expenditures for Remedial Works and Improved Tipping

Item	Cost (LE)
D6 Bulldozer hire for 3 months	58,700
Extraction and transportation of daily cover material	31,600
Water pump rental and hose pipe	3,820
On site workers	4,600
Equipment for scavengers	2,800
Miscellaneous (spare parts, fuel etc.)	3,600
Total	**105,120**

Approximations of the increased weekly operating costs as a result of the improved tipping practices are outlined below.

Approximate Weekly Increases in Operating Costs

Item	Before (LE)	After (LE)
Staff	320	320
Bulldozer (based on LE100 per hour rental)	500	4,000
Water pump (based on LE30 per day rental)	NA	180
2 x Tractor-trailers (based on LE80 per day rental)	NA	960
Total	**820**	**5,460**
Cost LE/m^3 (based on 2,500m^3 per week)	0.33	2.18
Costs spread per household per month	0.05	0.30

February 1997

Case Study: Solid Waste Management

Solid Waste Collection, Transfer and Disposal

Sohag City

A Project Implemented By the EEAA SEAM Programme

Introduction

A waste collection service was implemented in a number of low income, densely populated areas in Sohag City. Approximately 70,000 people, or about 40% of the population of Sohag City, now benefit from the new system.

Prior to implementation, a large number of the residents had expressed dissatisfaction with the waste management service. Waste collection was irregular, collection trucks were inadequate and unsuitable for working in narrow streets and the levels of littering had reached alarming levels.

A cost effective waste collection and transfer system was developed by the SEAM Project in collaboration with the Sohag East and West Districts and residents. A fleet of 1.5 ton Micro Trucks proved ideal for collection in the narrow streets. Support was also provided by SEAM to strengthen the local manufacture of a tractor-trailer-container pick up system, which was then used for transferring waste from the collection area to the dumpsite.

Associated problems of waste disposal, vehicle maintenance and accumulated street waste were also addressed. Achieving community participation proved essential in the project's success and ongoing sustainability.

The annualized capital and operating costs for the collection and transfer equipment were LE226,138 (excluding plastic bags). Cost per household is LE1.4 per month.

Which Areas Were Covered in Sohag City?

The project was implemented in five areas as follows:

Areas in Sohag City Covered by the New Waste Collection System

		Population	Comments
Sohag West	El Makhbaz El Ally	25,000	Residential
	Kessareya	10,000	Commercial and residential
	Ghayeteya	10,000	Commercial and residential
Sohag East	Naga Abou Shagara	15,000	Residential
	El Arqam	10,000	Residential, many hospitals and clinics

The waste collection was introduced into El Makhbaz El Ally and Naga Abou Shagara and progressively extended to the other three areas. The phased approach allowed time to train staff and overcome any initial operational difficulties.

New garbage collection system at Sohag in action

How to Involve the Community?

It was recognized from the outset that the efficiency of the system would be dependent upon gaining the involvement and co-operation of the community.

An initial social survey of 945 households was undertaken to get resident's views on current problems and on how and when waste should be collected. At the same time the survey was aimed at identifying indicators that could be monitored over time to determine the success of the project (e.g. satisfaction levels, dirtiness of streets) and to gauge people's views on willingness to pay for an improved service. A follow up survey was undertaken 9 months after the service had been operating. A comparison of the key findings is given below:

Key Findings of Social Survey, Before and After Implementation

	Before July 97	After April 98
Satisfaction with waste service	32%	85%
Collection vehicles seen in the streets	40%	85%
Street sweepers pass in the street	40%	86%
Preferred collection	52%	73%
-- in plastic bags		
-- in bins	7%	NA
Preferred time for morning collection	8-10.00 (50%)	7-9.00 (97%)
Willingness to pay for improved service	70%	59%
Average monthly fee per household	LE1.40	LE1.03

Plastic garbage bags and information leaflets were distributed to residents as a part of community awareness programs

The community's views were incorporated into the design and operation of the waste system. In addition, views were sought from the waste operators on opportunities for improvement as well as preferences for vehicles that could be more easily maintained.

A range of other activities to involve the community and to raise their awareness had been developed as follows:

* 10 large resident meetings were held to raise awareness on solid waste issues and to discuss operator and community roles in introducing the new system.

* Workshops were held with other key stakeholders including the Directorates of Health, Social Affairs and Education, religious leaders and the media to encourage their active role in raising community awareness.

* Focused group discussions were also held with waste workers, residents and key stakeholders.

* Door to door household visits were undertaken by a local NGO to disseminate waste collection bags, information leaflets and posters that explained the new system.

* Resident committees were established in the East and West Districts. The committees, comprising around 30 people, meet monthly with District officials to mutually resolve any issues and to stimulate better waste practices among residents.

* Various competitions were held for the cleanest building, cleanest street, waste collection crew of the month and a children's art competition. A local musician also wrote a song that is played by the collection crew to alert residents of the collection service.

Developing Efficient Waste Collection and Transfer

* Equipment selection and the development of the waste collection system was based on the following.

* Views expressed by the community in the initial social survey.

* Views expressed by the two respective Districts and their workers.

* Ease of maneuverability of equipment in narrow, winding streets.

* Suitability of technology to local maintenance capacity.

* Practicality and affordability.

In light of the above, a cost effective collection and transfer system was designed and the equipment procured as indicated below.

Collection and Transfer Equipment

	N°	Equipment	Total Cost LE	Comments
Collection Equipment	7	1.5 ton Suzuki Micro Trucks	332,500	These small (1.6m^3) high tipping trucks are cost effective for primary collection systems where there are short haul distances and narrow streets and where they can discharge directly into larger transfer containers. They are particularly effective with a bag collection system where bags of waste can be thrown into the body. The system is suitable for use with two workers.
	21	Handcarts with bins	9,009	Work in tandem with the Suzuki trucks to sweep street waste and collect waste from very narrow passageways. Operated by 1 person and manufactured locally in the Akhmim workshop.
	4	Jawa Motorcycles	17,676	For supervisors of the waste teams.
	110	Uniforms	4,590	Provided to the 50 District workers.
	2 tons	Plastic bags	23,320	Provided free to residents for the first 4 months so that they become accustomed to disposing their waste in plastic bags. Residents are now re-using plastic grocery bags.
		SubTotal	**387,095**	
Transfer Equipment	21	6m^3 Containers	71,400	Waste is transferred to containers located in the collection areas, so that Suzuki round-trip transfer distances are ideally less than 1km. The larger containers allow loads to be 'bulked up' before transfer to the dumpsite.
	3	Tractors	116,000	Tractors are cost effective for transporting heavy loads over short haul distances. A tractor-trailer-container pick-up system was developed in association with Mabrouk Engineering of Tanta. The hydraulic trailer/container system is designed for use behind tractors of at least 60 hp and with waste densities of 400-600 kg/m^3. One tractor was fitted with a front-end loader to remove accumulated street waste. Approximately 25 x 6m^3 loads are transferred daily to the dumpsite, 4km away.
	4	Trailers	52,000	
		SubTotal	**239,400**	
		Total	**626,495**	

The new collection system operates on two shifts with the morning shift (7:00 a.m. - 3:00 p.m.) collecting waste in the residential areas. Each truck collects around five loads.

A reduced afternoon shift operates with collection principally in the commercial areas (shops and main streets). Residential users of the system put waste in the plastic

bags, which are placed on the street in front of their apartment blocks between 7:00 - 9:00 a.m. daily. This minimizes the opportunity for waste to be scattered by scavengers and goat herders. Street sweepers also collect waste from narrow passageways and place the collected waste in plastic bag lined handcarts. When full, the bags are tied and left on the street for collection by the Suzuki trucks. Waste collected in the Suzuki is transferred to the $6m^3$ containers, which are then hauled by tractor to the dumpsite, 4km away.

The system is operated by the Sohag East and West Districts and employs over 50 people. Training of waste supervisors and collectors has been an integral part of the project. The Districts have paid all labor and operating costs. There are 11,000 households, which make up 85% of all premises covered by the new service; the remainder being commercial shops, offices, clinics and market stalls.

Clinical Waste Segregation

Often clinical waste is mixed in with municipal waste and poses health risks to those who may come in contact with it.

Within the El Arqam District there are four hospitals with the following bed capacity: 1) Chest - 128 beds; 2) Fever - 64 beds; 3) Endemic disease - 20 beds; and 4) Psychiatric - 20 beds. In addition there are two health care units. A system was put in place to segregate the clinical waste with separate containers being provided for sharps, clinical waste and other waste.

Clinical waste and sharps are now collected twice a week and transported to a clinical waste incinerator at the Health Directorate's laboratory. This has a Hoval incinerator, which was recently installed and incinerates waste at 500°C in primary combustion and 900°C in secondary combustion.

Awareness raising workshops were held in each of the hospitals and health clinics to inform staff of the dangers and appropriate procedures for handling clinical waste. This was undertaken in conjunction with the Directorate of Health.

Removing Accumulated Waste

There were many areas, particularly in West Sohag but also in parts of East Sohag, where large heaps of wastes had accumulated on vacant land, between blocks of apartments and even in basements of buildings. These areas had become breeding grounds for insects and rodents and were creating health hazards to residents.

Clean-up campaigns were organised to remove the accumulated street waste, involving District workers and the community and using the tractors fitted with front-end loaders. Once cleaned the area was included in the regular collection service. In addition a major awareness-raising effort was carried out, incorporating home visits, the distribution of stickers and leaflets to all households and the organization of a 'clean building' contest. Some sites that were cleaned were planted and turned into green areas.

Burning Dumpsite Remediation

The dumpsite for Sohag City lies beside Naga El Shamendy, a village of around 6,000 inhabitants situated about 4km from Sohag City. The site is an old drainage canal that was designated a temporary dumpsite around five years ago.

The dumpsite posed serious health risks due to its deteriorated condition. As there was no real system of managing the waste at the site, garbage was dumped randomly and set on fire. Mounds of burning waste impeded access to the village and schools and the smoke caused many village residents to suffer respiratory problems. Hospital and clinical waste that had been dumped at the site also posed a health risk to children scavenging there.

A survey of village residents and dumpsite scavengers showed the following:

Naga El Shamendy Village (151 interviewed)

* 92.1% felt the adjoining dumpsite affected their health.
* 89.0% indicated they suffered respiratory disease.
* 57% preferred the dumpsite to be transformed into a public park; 49% would like a building for literacy classes.
* 95% were willing to look after the area after remediation.

Scavengers (27 interviewed)

* Average age was 11 years.
* Average income from the dumpsite was LE1.90 per day.
* 68% Suffered health problems.
* 67% Suffered skin infections
* 56% Suffered gastro-enteritis.

Remedial action was taken to:

* Extinguish the fires and introduce controlled tipping.
* Remove the piles of accumulated waste.
* Level and top dress the area with 4,000 m^3 of soils dredged from the irrigation canals.
* Transform the area into a public park and football field.

The above actions were done in conjunction with the Governorate, Sohag East and West Districts, and after consulting with residents, teachers and children of the nearby village and schools. 99% of residents surveyed

Garbage dumpsite transformed into a public park

expressed satisfaction with the remediation. 81% indicated that the positive effects were less smoke and odor.

Equipment was provided by the Districts at the dumpsite to maintain the better tipping practices. In addition a gardener has been appointed full time to look after the public park.

Upgrading of Maintenance Workshops

The maintenance facilities in the East and West districts of Sohag City were not able to provide the most basic vehicle servicing requirements in an adequate manner. Improving the maintenance facilities was essential to avoid:

* Poor vehicle utilization due to excessive downtime.
* Reduced life expectancy of vehicles and equipment.

An overall plan was developed to upgrade the workshop facilities. Construction undertaken by SEAM included renovations for maintenance rooms, improved facilities for servicing vehicles and the provision of a lube bay.

A stock of spare parts for the Suzukis and sets of workshop tools were provided to both workshops. Preventive maintenance programs are now in place and vehicle

logbooks are kept not only for the Suzukis but also for the other District vehicles.

This work has resulted in:

* Improved service areas for maintaining vehicles.
* Construction of workshops and lube bays.
* Supply of workshop tools and vehicle spare parts.
* Workshop training and the introduction of preventative maintenance schedules.
* Further work is planned by both District workshops including improving tools and spare part storage and paving workshop areas.

What Does the New Collection System Cost?

Capital costs expended on the waste collection and transfer equipment are summarized below.

Capital Costs for Waste Collection and Transfer Equipment.

Item	LE
Suzuki trucks	332,500
Handcarts and bins	9,009
Supervisor motorcycles	17,676
Uniforms	4,590
6 m^3 containers	71,400
Tractors	74,000
Tractor with front end loader	42,000
Trailers	52,000
Miscellaneous tools	4,500
Bins for segregating clinical waste	5,990
Total	**613,665**

The above costs were met through the SEAM Project. SEAM and the Sohag East and West Districts incurred additional costs on community participatory activities, workshop upgrading, dumpsite remediation and conversion to a public garden, and clinical waste segregation.

The Sohag East and West Districts have met all labor, fuel, maintenance and other operating costs, which have been recorded daily since the project's inception. To gain a better understanding of the costs for replicating the scheme a financial analysis was undertaken with capital investments being annualized at 10% real discount rate over 7 years.

The total annualized capital and operating costs are LE226,138. LE192,217 is spent on the 11,000 households, which comprise 85% of all premises covered by the service. Cost per household is LE1.4 per month (excluding the cost of plastic bags).

A summary of the financial analysis is as follows:

Replicable Costs for the Solid Waste Collection and Transfer System

Cost Element	LE
Capital costs	613,665
Annual operating costs	
Labor (on the basis of 2 shifts)	60,000
Fuel and lubricants (Based on diesel at le0.40 Per liter)	9,408
Maintenance (5% of capital costs)	30,683
Plastic bags (cost is le4.25 Per kg)	69,960
Total annual operating costs, including bags	170,051
Total annual operating costs, excluding bags	100,091
Total annualized capital costs (discounted at 10% over 7 years)	126,047
Total annualized capital and operating costs, including bags	296,098
Total annualized capital and operating costs, excluding bags	226,138
85% of annualized capital and operating costs attributable to households (with plastic bags)	251,683
85% of annualized capital and operating costs attributable to households (without plastic bags)	192,217
No. of households covered by the service	11,000
Total costs per household per month, including bags	1.9
Total costs per household per month, excluding bags	1.4

70% of residents had initially indicated a willingness to pay. The introduction of a user fee to cover the costs of operation is presently under consideration by the Governorate. There is also considerable interest in extending the service to other

parts of the city as well as replicating the system in other urban centers.

Is the New Waste System Sustainable?

The waste system implemented has proved to be sustainable in the following ways:

* Providing suitable equipment appropriate for use in narrow, densely populated areas.

* Strengthening local technology and local fabrication that is better able to support current operations and future replication.

* Selecting equipment that can more readily serviced by the local mechanics.

* Training and improving the capacity of the workers and supervisors.

* Involving the community throughout all phases of implementation.

* Delivering a service that satisfies residents as evidenced by the dramatic increase in satisfaction levels, from 32% before to 85% after.

* In comparison with the costs of running the old system the new system is about 35% cheaper per cubic meter of waste collected.

* Upgrading maintenance capabilities and introducing preventive maintenance servicing.

* Sohag East and West Districts have met all operating costs since inception, and have used existing labor.

March 1999

Case Study: Solid Waste Management

150 Ton per Day (tpd) Compost Plant

Mansoura, Governorate of Dakahleya

A Project Implemented By the EEAA SEAM Programme

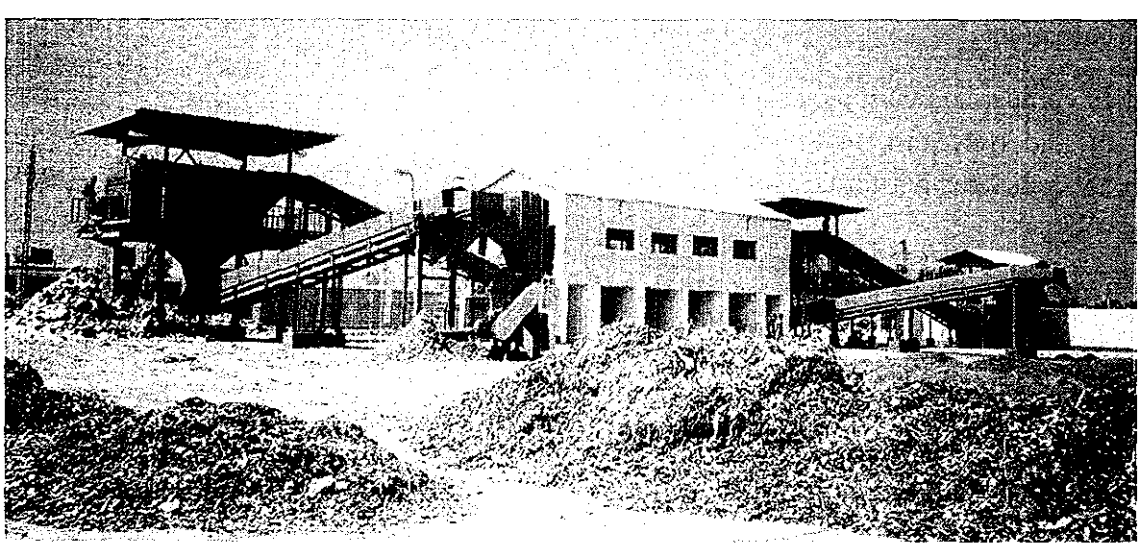
Introduction

A 150 ton per day municipal solid waste composting plant has been constructed at Mansoura to treat waste from the City and surrounding environs. The SEAM Project and the Governorate of Dakahleya jointly financed the plant, designed by SEAM. Total cost for plant, equipment and construction was LE2.4 million, significantly cheaper than similar size plants built elsewhere in Egypt. Construction time was 7 months. The quality of the compost is good and is presently sold as a conditioner for land reclamation schemes. Dry recyclables are also recovered and sold. The plant is now operated by a private contractor, under a management contract with the Dakahleya Governorate.

Why Compost?

Waste generation in the urban areas of Mansoura and adjoining Talkha is estimated to be 305 tons per day. A further 105 tons is generated in the rural districts of both areas. Typically, the organic content of urban waste is 60-70% and for rural waste, 50%. Recyclable material (paper, cardboard, plastic, glass, metal, rags) is 3-7% of urban waste and less than 2% of rural waste. All wastes had been previously disposed at the municipal dumpsite.

As much of Dakahleya is prime agricultural land, the availability of sites suitable for landfilling is severely limited. This problem can be partially addressed through



150 tpd compost plant constructed for Mansoura City

Picking belt and sorters recovering dry recyclables

composting, which will reduce the amount of material to be landfilled by 40%. In addition the demand for compost in Egypt has been rising. Within Dakahleya around 55,000 feddans of arid land in the northern part of the Governorate are being reclaimed for which compost can be used as a soil conditioner. Other desert reclamation schemes in Egypt will place further demands on available compost.

Composting is not new in Egypt, the first plant having been established more than 15 years ago. Currently there are 15 plants operating and a further 40 plants have been proposed. The purpose of constructing this plant was not only to take advantage of the economic benefits but also to demonstrate:

* Low cost technology, the capital cost being at least 40% cheaper than most other plants that had been commissioned.
* The applicability of a shredder to reduce particle size instead of the more commonly used rotary homogenizing drum.
* Commercial viability through the introduction of a 'Gate Fee' of LE5 per ton, which may in turn encourage the private sector to enter the market.

What Is the Capacity of the Mansoura Plant?

The plant was designed with a daily capacity of 150 tons, equivalent to 45,000 tons per annum on the basis of 300 operating days per year. The recovered organic content of the waste was estimated to average 50% of

the incoming waste stream and compost yield was estimated at 70% of the organic component. Recoverable recyclables (plastics, paper, metal, glass, rags and bones) were estimated to be 5% of the waste stream. A summary of the design capacity follows.

Design Capacity of the Mansoura Compost Plant

	%	Tons / Day	Tons / Year
Waste intake	**100**	**150.0**	**45,000**
Recovered dry recyclables	5	7.5	2,250
Organic matter	50	75.0	22,500
Rejects to landfill	45	67.5	20,250
Compost produced	**35**	**52.5**	**15,750**

The plant operates on two 7-hour shifts, 300 days a year. There are 50 employees, including 20 staff on the picking belt, 10 drivers and 10 general laborers.

What Is the Operating Process?

Figure 1 illustrates the process in graphical form. The process may be summarised as follows.

1. Rough Sorting

Material entering the site is first weighed at the weighbridge and then delivered to the reception area. Here large objects (e.g. lumps of concrete, tree stumps) are removed by hand and transferred to the dumpsite. Rejects in the first few months of operation averaged less than 2%.

2. Pre-screening (30mm rotary screen)

Waste material is loaded into a hopper at a rate of 10.7 tons per hour using a front-end loader. The hopper feeds a 30mm rotary screen via a chain link slat conveyor. The screen incorporates fixed blades within the drum, which facilitates the break-up of waste material. The minus 30mm component (fines) comprising mostly dust and smaller particles of organic material are collected and transported to the windrows. Fines averaged 33% of the treated waste in pre-testing.

3. Picking Belt for Removing Dry Recyclables

The picking belt is 24m long and 1.3m wide and travels at 15m per minute at waist height. There are five picking stations on either side with chutes leading to collection bays below. Pickers are assigned to recover paper, cardboard, plastics, metals, rags, glass and bones. The separated materials are dropped down the chutes and subsequently pressed into bales, except the glass and bones. The percentage of recyclables in the first few months of operation averaged less than 2%.

4. Shredder Mill

The material from the picking line passes through a magnetic separator to collect any remaining ferrous metals and then into a shredder mill. The shredded material falls by gravity onto a conveyor belt. The shredder mill breaks down the organic material to the optimal size for composting. Any plastic bags passing through the mill tend not to be shredded and are removed by subsequent sieving.

5. Rotary Screen (50mm)

The shredded material is fed into a high level rotary screen by means of a belt conveyor. The material passing through the screen is collected and transported to the windrows. This has been averaging around 30%. The plus 50mm fraction, approximately 35% of throughput, is sent to the landfill.

6. Aerobic Composting

The minus 50mm and minus 30mm fractions are laid out together in windrows, which are approximately 3m at the base, 2m high and 50m long. Water is added to the screened material to raise the moisture content to approximately 50-55%. Windrows need to be turned approximately once a week to avoid material drying and to facilitate aerobic breakdown.

Material is held in windrows for 4-6 weeks during which time degradation of the composting process results in a loss in mass of around 30-45%. During this process the temperature will range from 50°C to 70°C.

7. Final Screening and Maturation

When primary composting is complete (4-6 weeks), the material is fed onto a 20mm flat bed screen using a front-end loader. The oversize material is recycled into new windrows. The minus 20mm material is moved to a maturation pile where it remains for a further 6-8 weeks during which secondary composting takes place. At the end of this period the compost is suitable for sale and the moisture content is in the range 15-30%.

What Equipment and Infrastructure Is Required?

The total area for the compost plant is about 20,000m^2 of which about 8,500m^2 are for windrows, and 1,000 m^2 for waste reception.

Main items of equipment and infrastructure are summarized below.

1. Plant and equipment - Main Items

* Hopper and swan neck feeder and slat conveyor - 1.5m x 17.7m - 5kW motor.
* Rotary screen (30mm) - 1.8m diameter x 5.5m long - 10kW motor.
* Hand picking conveyor - 1.3m x 24m - 6.9kW motor.
* Magnetic separator - producing 600 gauss.
* Heavy duty shredding mill with vibrating feeder - 75kW motor.
* Inclined belt conveyor - 1.3m x 15m - 5.5kW motor.
* Rotary screen (50mm) - 1.8m diameter x 5.5m long - 10kW motor.
* Baling press for paper, cardboard, plastics and textiles.
* Baling press for metals.

2. Infrastructure - Main Items

* Incoming power supplies - 120KVA.
* Incoming water supplies - 100mm UPVC pipe.
* Reinforced concrete area for waste reception, buildings and fixed plant.
* Concrete area for windrow composting and maturation pile.
* Administration and maintenance buildings.
* Drainage.
* Perimeter fence.

The total cost for plant, equipment and infrastructure construction costs was LE 2.4 million.

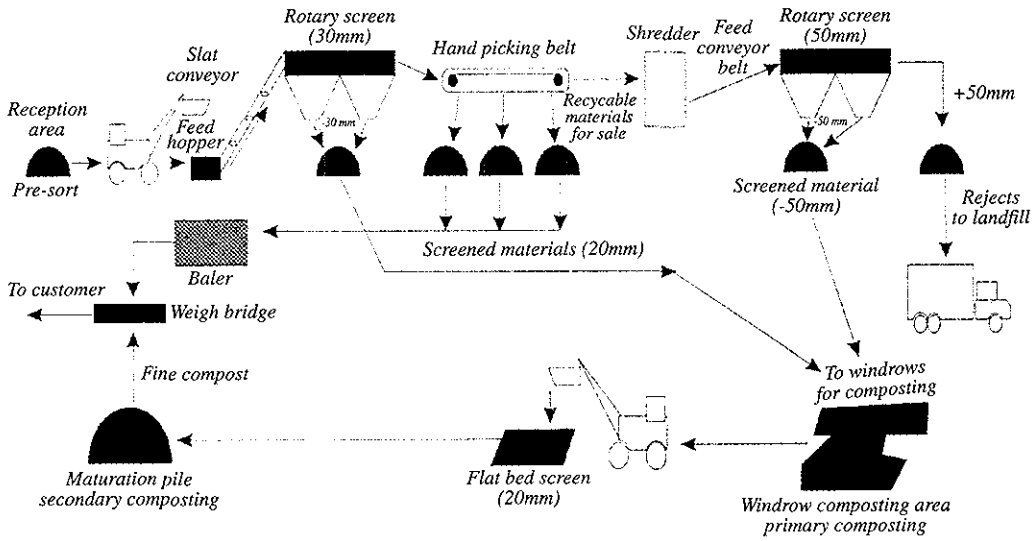


Figure 1 - Process Stages

Recovery of Recyclables and Compost

Recovery of materials for recycling and the production of compost have been assessed over a three-month operational period, from February to April 1999. Recoverable fractions are expressed as a percentage of total waste throughputs and are compared to those used in the design stage.

The lower than expected recovery of dry recyclables would seem to indicate that these materials are being scavenged before the waste is delivered to the site.

Recovered Materials as a % of Waste Throughput

	Estimated Design Stage		Actual Feb. - April 99	
	%	Selling Price Per Ton	%	Selling Price Per Ton
Compost Produced	**35.0**	**LE 18-21**	**38.0**	**LE 25**
Dry Recyclables	**5.0**		**1.6**	
Cardboard and paper	1.6	60	0.4	70
Plastics	0.7	400	0.2	415
Glass	0.7	40	0.4	50
Rags	1.0	30	0.3	15
Metals	0.7	150	0.3	60
Bones	0.3	100	negligible	300
Total	**40.0**		**39.6**	

Are Capital Costs High?

Capital costs for plant, equipment and construction were at least 40% less than other similar size composting plants that had been commissioned. A summary of costs is displayed in the chart.

In addition to these items the Dakahleya Governorate provided the land as well as vehicles for windrow turning, waste and compost handling.

Component	Costs in LE
• Mechanical works	1,585,000
• Electrical works	222,000
• Civil works	145,000
• Sanitation	39,000
• Roads	409,000
Total	**2,400,000**

What Are the Revenue and Operating Costs?

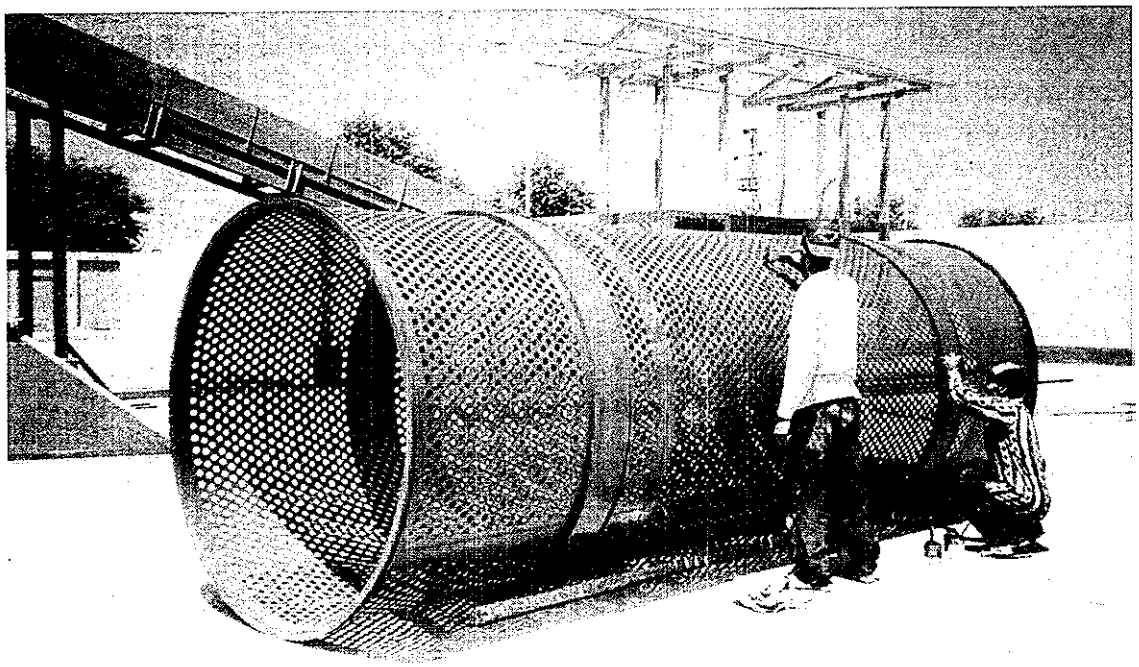
As part of the feasibility study it was estimated that the plant would hit full capacity in its third year. Capacity in Year 1 is reduced due to commissioning and inevitable problems associated with plant start up. As a result it was estimated that revenue from the sale of compost and dry recyclables would rise from LE177,000 in Year 1 to LE578,250 in Year 3 onwards. A breakdown of revenues follows.

To achieve full cost recovery a gate fee of LE5 per ton (roughly equivalent to LE0.50 per household per month) is to be imposed on waste treated at the plant. This would generate additional revenue of LE75,075 in Year 1 rising to LE224,950 in Year 3 onwards. The total projected revenue and operating costs for the plant are summarized in the table.

Estimated Annual Revenue from the Composting Plant

Item	Year 1	Year 2	Year 3 on
Waste Treated (tpa)	15,000[1]	37,500	45,000
Compost Yield (tpa)	5,250	13,125	15,750
Dry Recyclables (tpa)	750	1,875	2,250
Selling Price Per ton Compost	18[2]	18/21	21
Dry Recyclables (weighted)	110[3]	110[3]	110[3]
Revenue (LE per year) Compost	94,500	260,000	330,750
Dry Recyclables	82,500	206,250	247,500
Total	**177,000**	**466,250**	**578,250**

Notes: (1) Reduced capacity due to commissioning and plant start-up
(2) Reduced price during first year to help establish market
(3) Average price for recovered recyclables

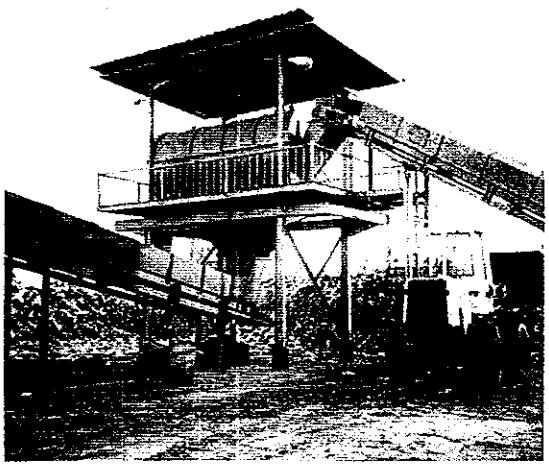


Rotary screen used for sieving material; fabricated locally

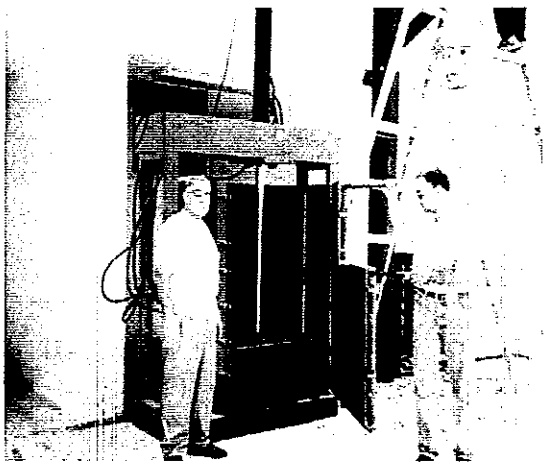
Projected Revenue and Operating Costs of the Composting Plant (LE)

Revenue	Year 1	Year 2	Year 3 on
Sales of Compost	94,600	59,875	330,825
Sales of Recovered Recyclables	82,500	206,250	247,500
Gate Fee	75,075	187,550	224,950
Total Revenue	252,175	653,675	803,275
Operating Costs & Expenses	**Year 1**	**Year 2**	**Year 3 on**
Labor	85,387	170,775	170,775
Repairs and Maintenance	66,687	100,045	133,375
Utilities and Fuel	121,687	141,906	162,250
Contingency	27,376	41,272	46,640
Total Costs	**301,137**	**453,998**	**513,040**
Income (Without Capital Depreciation)	**(48,962)**	**199,677**	**290,235**

All operating costs are born by the Governorate and plant operator.



High level 50mm rotary screen and plus 50mm rejects area



Baling press for paper, cardboard and plastics

Is the Compost Plant Sustainable?

The compost plant has been designed to be sustainable through the following actions:

* Capital costs were shared between the SEAM Project and the Governorate of Dakahleya, thus increasing local ownership.

* All operating costs have been paid by the Dakahleya Governorate and the plant management company.

* Demonstrable economic benefits have been achieved in reducing costly land requirements for final waste disposal.

* Good demand exists for the type of compost produced both within and outside the Governorate.

* Recovery and sale of dry recyclables.

* Imposition of a gate fee of LE5 per ton enhances financial viability.

* Technology deployed is straightforward and can be easily maintained.

* Local manufacture of all equipment, with the exception of the shredder, facilitates ongoing maintenance and support.

* Local recruitment and training of the workforce.

June 1999

Receiving hopper and slat conveyer leading to 30mm rotary screen and picking belt

Case Study: Solid Waste Management

Solid Waste Collection, El Kawther Industrial Zone

Governorate of Sohag

A Project Implemented By the EEAA SEAM Programme

Introduction

The El Kawther District Council is responsible for waste collection in the recently established El Kawther Urban and Industrial Development Zone. Waste generation for the District was estimated in 1997 to be 18.5m^3 per day and is forecasted to increase to around 103m^3 per day given the expected rapid development over the next 5 years.

Most wastes, except high density rejects from the tile and marble factories, had been collected by the District using a 3-ton truck. Collection methods were inefficient and unhygienic, in part due to the high loading height of 1.9m. A total crew of 6 loaders, one driver and one supervisor collect around 16m^3 or roughly 4.5 tons of waste per day, an average labor productivity of only 750 kg/man/day. This compares with a typical European rate, hand loading from bins, of 3,000 kg/man/day. In addition the one truck would not cope with the projected expansion of the area.

After consultation with the factories, the SEAM Project together with the El Kawther District Council developed a waste collection system, using a combination of vehicles and different size storage bins. Although the initial focus had been on the Industrial Zone there was sufficient capacity to cater for the rest of the District, as well as allowing for the projected increase in waste generation forecasted over the next few years. Segregation of waste at the factory, recovery and recycling of paper and plastics, and awareness raising have been integral parts of the project's implementation.

Tractor - trailer - container system used to collect waste from factories

Capital expended by SEAM on equipment amounted to LE245,465. Operating costs are born by the El Kawther District, which also levies an annual waste management fee of 0.014% of the capital costs of the infrastructure and buildings for each factory.

El Kawther Urban and Industrial Development Zone

The El Kawther Urban and Industrial Development Zone was established in 1993 to help diversify the economic base of Sohag Governorate. It covers 3,000 feddans including 600 feddans for an Industrial Zone. The remaining 2,400 feddans are in the process of being developed for educational and training institutes, retail and commercial businesses, agricultural research, recreational and residential areas.

The El Kawther District Council is responsible for solid waste collection throughout the Urban and Industrial Development Zone and had been using the same truck to service all areas.

How Much and What Types of Wastes are Generated?

A survey of 38 factories undertaken in November 1997 indicated that:

* 71% (27 factories) produced negligible solid waste.
* 16% (6 factories) produced less than $1m^3$ of solid waste per week.
* 13% (5 factories) produced between $1\text{-}10m^3$ of solid waste per week.

The number of employees in the factories surveyed ranged from 5 to 40 and averaged 16.

Based on this survey and on discussions with the El Kawther District Council, total waste generation was estimated to be $18.5m^3$ per day as indicated below.

With the forecasted expansion of the Urban and Industrial Development Zone, waste generation is expected to increase over the next five years by 6 times for industrial waste and 5 times for non-industrial waste.

El Kawther - Volume of Waste Generated Daily (November 1997)

Sources	Main Waste Type	Estimate Daily Volume (m^3)
Industrial Zone		
Small waste producers	Paper, food wastes, cans, bottles, some steel shaving	4.0
Larger waste producers		
* Tomato paste	Organic tomato residues	2.0
* Footwear	Rubber offcuts	2.0
* Tile and marble factories	High density rejects and offcuts	2.5
Residential and commercial	Food waste and paper	8.0
Total		**18.5**

100L and 170L Bins, manufactured in Akhmim Workshop, and provided to the factories for waste segregation

On this basis, typical daily waste collection by the year 2002 is expected to be:

* $68m^3$ of mixed waste for hauling to the dumpsite.
* $20m^3$ of waste paper and plastics baled down to around $2m^3$ for resale.
* $15m^3$ of high density wastes for hauling to the dumpsite.

Designing the Waste Collection System

Based on consultations with the factories and the El Kawther District Council the new waste management service was designed to:

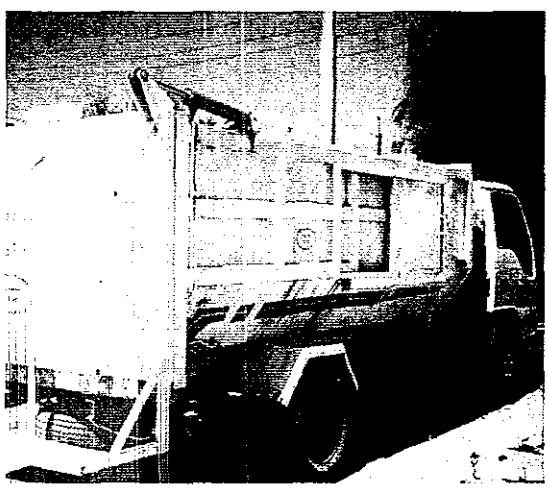
* Establish a cost-effective system for the collection of all wastes presently generated.
* Provide sufficient capacity to allow for an increase in the waste to be collected from $18.5m^3$ to $103m^3$ per day, as the El Kawther District expands rapidly.
* Segregate waste at its source in the factories.
* Recover and recycle paper and plastics.
* Improve working conditions for waste collectors.

What Equipment Is Required?

Equipment was provided for the storage, segregation, collection, and transfer of waste and for the recovery and recycling of paper and plastics. A combination of truck, tractor, trailer and container system was developed.

Storage of Waste

* 100L bins for putrescibles and 170L bins for paper and plastics were manufactured locally in the Akhmim workshop and provided to each factory for waste segregation. Maximum bin weight when full is 40kg, which is within the capacity of 2 men to lift. Putrescibles are collected daily and paper bins are collected when full. The collection frequency has been adjusted for each factory to suit the amount of waste generated.



8 ton isuzu truck used to collect waste from industrial, residential and commercial areas

* $6m^3$ containers are provided to factories and institutions that produce larger quantities of medium density waste.

* $3m^3$ containers are provided to the producers of high-density waste (e.g. tile and marble factories).

Collection and Transfer of Waste

* An 8-ton Isuzu waste collection truck with a capacity of $7m^3$ was provided for use in the industrial, commercial and residential areas. Refuse is hand loaded at the front and pushed back with a hydraulic press plate.

* A 65 hp tractor and trailer is used to collect and transfer the $3m^3$ and $6m^3$ containers. Tractors are cost effective for short haul distances, the dumpsite being only 3km away.

* A low loading trailer with a capacity of $4.5m^3$ and a low loading height, when pulled by a tractor, can be used in conjunction with the Isuzu truck for hand loaded collection.

Recycling of Paper and Plastic

* A waste paper trailer, with fully enclosed mesh sides, is used to collect and transfer paper and plastics.

* A paper press was provided with 15-ton press power that produces compacted bales of 50x70x80cm. An area in the District workshop has been prepared for paper baling operations.

In addition a Jawa motorcycle has been provided to facilitate supervision of the waste collection.

How Does the System Operate?

Wastes are segregated by the factories in the two bins provided. Paper and plastics are collected when the bins are full and transferred to the paper press for baling. Putrescibles are collected daily. For the

larger producers of medium density waste $6m^3$ containers are provided and collected when full. For the high-density waste producers, $3m^3$ containers are provided and collected every 1-3 days. Waste is collected daily from the rest of the El Kawther District.

The District collects waste in one shift, employing 6-8 people. All wastes are dumped at a site in the desert, approximately 3km away.

How Will the System Operate?

At present there is surplus equipment capacity. However, rapid future development is likely to result in more than a 5-fold increase in the volume of waste by the year 2002. Planning for this increase will result in the following collection system.

Collection of the Expected $68m^3$ Per Day of Mixed Waste

Of the $68m^3$ it is expected that $40m^3$ will be collected by hand loading and the remaining $28m^3$ will be collected in large containers using the container pick up system. The Isuzu truck should be capable of collecting the $40m^3$ in 6 loads with one shift of 3-4 employees. If necessary, the low loading trailer will provide back up.

The tractor-trailer-container system requires 2-4 workers and would be capable of moving the $28m^3$ of container waste in around 6 loads. This should be managed in one shift.

Overall, it is estimated that the Isuzu truck and the tractor with a low loading trailer will together have a single shift daily capacity of around $60\text{-}70m^3$ of waste, or up to $130m^3$ of waste on a double shift.

Collection of the Expected $15m^3$ of High Density Wastes

High-density waste will be stored in $3m^3$ containers and collected using the tractor-trailer system. Approximately 5 loads per day will be transferred and ultimately a second shift will be required to handle these wastes.

Collection of the Expected $20m^3$ of Paper and Plastics

It is estimated that by the year 2002 there will be the potential to recycle $20m^3$ or 2 tons of paper, cardboard and plastic materials per day. There is also likely to be further potential to recycle steel cans and other lightweight steel scrap. Paper wastes are presently collected and transported to the District workshop where a paper press has been installed. Paper is then baled and sold for recycling.

How Were the Factories Involved?

Prior to implementation, visits were made to most factories that were in operation at the time. Their views were incorporated into the design of the system and their cooperation was sought in the segregation of waste.

Information leaflets were prepared and disseminated. An awareness workshop was also held for all main stakeholders in the El Kawther District to discuss the new system and their respective roles.

What was the Capital Cost?

The capital cost of the equipment was funded by SEAM and cost LE245,465. A breakdown of costs is given below.

Additional costs were also incurred for preparation of the baling area, uniforms and community awareness campaign.

All labor, fuel, maintenance and other operating costs were born by the El Kawther District Council. The Council also raises an annual waste management fee equivalent to 0.014% of the capital costs of the infrastructure and buildings for each factory. Charges are in the range of LE200-400 per year per factory.

Capital Costs for Waste Collection and Transfer Equipment

Item	Number	Unit Price (LE)	Total Cost (LE)
100L steel bins	50	120	6000
170L steel bins	44	146.5	6446
$6m^3$ containers - uncovered	4	3,400	13,600
$6m^3$ containers - covered	2	4,000	8,000
$3m^3$ containers	3	2,500	7,500
8 ton Isuzu waste collection truck	1	110,000	110,000
65hp tractor	1	45,000	45,000
Low loading trailer	1	14,750	14,750
Container hauling trailer	1	9,000	9,000
Waste paper trailer	1	3,000	3,000
Paper press	1	17,750	17,750
Jawa motorcycle	1	4,419	4,419
Total			**245,465**

March 1999

Case Study: Community Environmental Projects

Improving Environmental Health Issues

Geheina and Sohag Community Hospitals

A Project Implemented By the EEAA SEAM Programme

Introduction

Geheina is a rural town with a population of around 45,000 located in Geheina Markaz in the northwestern part of Sohag Governorate. The Geheina Community Hospital receives around 200-300 outpatients daily and can accommodate 100 in-patients. The Sohag Eye Disease Hospital is a small, specialized hospital with 30 in-patients and 50-80 outpatients daily. The hospital is located in Sohag City, which has a population of 180,000.

Both hospitals cater largely for the poorer segments of the community from the city and surrounding villages. As part of the Sohag Environmental Action Plan, improving sanitation facilities and raising awareness on sanitation and hygiene practices had been ranked by the community as a high priority. To address this problem and in response to a request from both hospitals, SEAM supported a program to renovate sanitary facilities and raise community awareness. Alleviating poor sanitation conditions at hospitals providing a community service was also considered a good starting point for educating the community on environmental health issues. Community participation has therefore been an integral part of the project.

Issues

Issues that arose from consultation with hospital and local council staff were:

* Sanitation facilities in poor condition and prone to leaks and blockages.
* Limited awareness of environmental and hygiene issues among the community using the hospitals.
* Disposal of solid waste in sanitary facilities, which cause blockages.
* Poor maintenance with cleaners not being well trained nor adequately supervised.
* Inadequate segregation of hospital waste.
* Lack of awareness on the dangers of improper handling and disposal of hospital waste.

Cleaning workers also indicated that they were not highly motivated because of people's constant misuse of bathroom facilities and low salaries.

At the Sohag Eye Disease Hospital the lack of personal hygiene and incorrect garbage handling by patients, was one of the main causes of eye infections and diseases being treated. Education to prevent infections was therefore considered essential.

Implementation

Upgrading Sanitation Facilities

An assessment of the problem was undertaken in conjunction with the Geheina Hospital staff and the Geheina Council. Priority was given to:

* Upgrading four bathrooms in the patient's block.
* Upgrading the bathroom in the nurse's quarters.
* Upgrading the bathroom in the outpatient's area.
* Replacing sections of broken sewage pipe.
* Emptying and cleaning the septic tanks.

Detailed plans were prepared and the works subsequently awarded to a Geheina based contractor following competitive tender. Supervision of the works was provided by the Geheina Council and hospital management. Construction took three months. The renovations were well received by hospital staff and patients and helped lift morale of those working there.

At the Sohag Eye Disease Hospital dilapidated sewage lines were upgraded.

Hospital Clean-up Campaign

At Geheina Hospital waste was scattered around the grounds. A clean-up day was organized, involving hospital workers, local council staff and the community. Additional cleaning tools, garbage bins and protective wear were provided to the hospital so that the grounds could be maintained in the future.

Community Participation

Community Awareness Raising

Awareness raising was an essential part of the project and was designed in consultation with the hospital staff, health workers and the Directorate of Health. The main objectives were to improve the community's understanding of the need for better sanitation and hygiene practices and to enhance the capacity of hospital staff and health promoters to transfer such messages to the community.

The target groups were therefore:

* Hospital outpatients.
* Hospital in-patients and their visitors.
* People visiting the health units in East and West Geheina.
* Hospital staff and the Ra'idat (health promoters).

Improvements at Geheina hospital

* Communities visited by the Ra'idat.
* Local council workers.

Educational Material and Training

Posters were prepared by a group of young doctors for display in community areas. Information pamphlets were prepared for distribution and for use by the Ra'idat.

Awareness materials focused on the relation between sanitation and health, and between hygiene, waste handling and diseases frequently contracted.

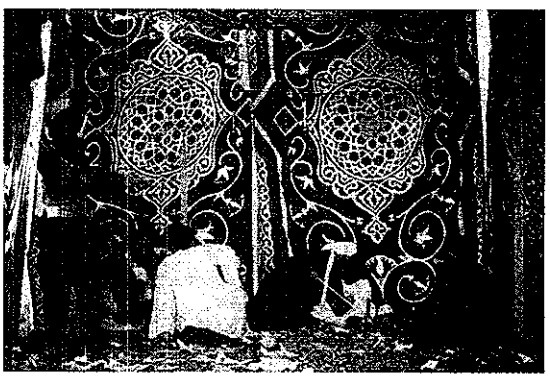
To more effectively disseminate information to the community, training was provided to the hospital staff and Ra'idat. The training, linking environment with health issues, was done with the assistance of the Sohag Directorate of Health.

The Ra'idat proved to be an effective way of reaching the community as they worked in hospitals, villages and low-income urban areas. They welcomed the training as this improved their capacity to advise the community. Prior to this, their work had focused on Family Planning issues.

Cleaning workers received training on routine and preventative maintenance issues.

Comedy Play with Environmental Theme

The Geheina Cultural Centre wrote a comedy environmental play based on issues identified by the hospital staff and Ra'idat. The humorous and lighthearted approach was centered on a married couple who wanted to divorce because of dirty habits



Environmental play developed by Geheina Cultural Center

and lack of concern for environmental and health issues. The play was performed at the hospital by local youth and was well received by the audience. At the end, the Ra'idat moved among the audience to generate a discussion on the main themes and lessons learned from the play.

The play has since been performed in three other villages, with sponsorship from the Ministry of Culture, and has appeared twice on regional TV (Channel 8). The theatre group now holds a discussion and interview session with the audience after the performance.

Segregation of Hospital Waste

The need for improved safe handling, segregation and disposal of hospital waste was discussed with the Directorate of Health, hospital staff and local council workers. The Geheina Hospital was subsequently linked to the Hospital Waste Management Program of the Technical Cooperation Office for the Environment (Egyptian Environmental Affairs Agency).

Community Roles

Community participation, focus group discussions and awareness raising were integral parts of the project. Views were sought from a cross section of key stakeholders from the beginning, which helped in prioritizing the sanitary problems and in the design of the awareness raising program.

Hospital management and staff together with the Sohag Directorate of Health and the Ra'idat played a significant role in project implementation, designing and undertaking community training and awareness raising.

The head of the Geheina Local Council was very supportive throughout the project. He facilitated a number of awareness meetings, as well as gaining the involvement of the local Cultural Center, Family Planning Unit and council workers.

Community residents were involved in meetings, awareness raising and clean-up campaigns.

Key Stakeholders and their Roles

Hospital Management and Staff:

* Plan and assess needs.
* Identify key problem issues.
* Prepare posters and leaflets.
* Provide community training.
* Organize and undertake hospital clean up.

Sohag Directorate of Health:

* Design educational material on environmental hygiene for health promoters.
* Organize and implement training for health promoters and hospital medical staff.

Ra'idat (Health Promoters):

* Identify community needs for training and awareness raising.
* Receive and provide training.
* Raise awareness in the community on environment and health issues.

Sohag Governorate:

* Direct planning and needs assessment.
* Implement projects.

Geheina City Council:

* Direct planning and needs assessment.
* Supervise contracting works for upgrading sanitary drainage system.
* Assist in clean up and removal of waste.

Community:

* Participate in meetings and needs assessment.
* Receive training and awareness raising on environment and health issues.
* Local youths staged the environmental play for the community.

Geheina Cultural Center:

* Prepare and organize the environmental play.
* Promote the environmental play to other communities.

Women leaders raising awareness with the community

Sustainability and Replicability Issues

Throughout the project the hospitals were responsible for all operating costs. Hospital staff, health promoters, the local Cultural Center and local youths have contributed considerably in labor and time to awareness raising. The Ministry of Culture sponsored subsequent performances of the environmental awareness play in other areas. The Sohag Directorate of Health is using the awareness materials in replicating similar activities in other parts of the Governorate.

In summary, the project was designed to be sustainable in the following ways:

* Gaining the involvement of the local council, the hospital staff and the community in design and implementation.
* All operating costs have been born by the hospitals. The additional costs to replicate the theater play have been met by the Ministry of Culture.
* Provision of cleaning tools in Geheina to keep the hospital and its surroundings clean.
* Provision of educational materials and training of doctors, nurses and health promoters on how to deliver environmental health messages to patients.

Achievement Highlights

* New sanitary systems benefiting community patients and hospital staff.
* Improved hygiene conditions in hospitals with positive effects for public health and for the awareness of the community at large.
* Increased awareness of relations between sanitation, hygiene and health among patients and the wider community.
* Better working conditions and reduced health risks for cleaning workers.
* Capacity building of hospital staff and health promoters.
* Enhanced cooperation between the local council, the hospitals, the Cultural Center and the Directorate of Health.

March 1999

Case Study: Community Environmental Projects

Solid Waste Collection, Bardees Village

A Project Implemented By the EEAA SEAM Programme

Introduction

Bardees is a rural village located in El Balliana Markaz in the southern part of Sohag Governorate. Population is around 40,000 with a high proportion of low-income families. Bardees had been trying to deal with a growing waste problem with old equipment in poor condition.

As part of the Sohag Governorate Environmental Action Plan solid waste issues had been ranked by the community as the number one priority requiring attention. In response to a request to assist the community of Bardees, support was provided through SEAM to improve the waste collection system. Community participation has been an integral part of the project.

Issues

Previously, waste collection was undertaken using two old Belarus tractors with box trailers having a high loading height and a limited capacity of 2.5m^3. Most of the wastes for collection are in loose heaps, which are loaded into baskets and then lifted into the trailer. Waste is transported to a small disposal site about 4km away.

Concerns and issues that arose were:

* Inadequate equipment in poor condition.
* Existing trailers have limited capacity with a high loading height of 1.9m. Workers are required to load the trailer above their heads resulting in unhygienic waste spillage.
*Insufficient coverage. Only 11% of residents in the smaller streets claimed they received a service. Service in main streets was much better.
*Community satisfaction with waste collection service is low, with only a 15% approval rating among households and 45% approval rating among non-households.
* 36% of residents regarded their streets as dirty.
*Lack of community awareness and involvement.

Implementation

Waste characteristics and community views

At the outset, an assessment was made of the waste characteristics and community's views were sought on how to improve the waste collection system.

The waste for collection was found to be 60-70% ash and dirt. Residents tend to use organics for animal feed and recycle any materials of value. Common disposal practices, by residents, of the remaining waste are:

61% burning wastes in oven
30% putting waste in collection vehicle
25% dumping in nearby empty area
8% throwing in canal
7% collection by door-to-door cleaning workers

Presumably in view of the way in which waste is disposed, only 9% of households were interested in segregating their waste prior to disposal.

On the preferred mechanism of waste collection, 72% favored collection in bins and 28% in plastic bags. Over 66% of households and 89% of shops preferred to have their waste collected between 8:00-10:00 a.m.

Waste collection equipment

In view of the nature of the waste a 'fore and aft' trailer was designed with a capacity of $7m^3$ and a loading height of 1.2m. Its application is appropriate for high-density waste and with a fully enclosed body it is more hygienic during loading and transportation. The hydraulics allow for two-way movement of the container. A large, low full width hopper at the rear is loaded with wastes and the body then tips forward to allow the wastes to fall into the front of the body. For discharge the body tips backward. Handcarts were provided to facilitate collection in very narrow streets and additional bins were provided along main streets.

The existing box trailers were upgraded by cutting doors into one side of each trailer while increasing the sides from 0.4m to 1.0m. This had the effect of reducing the loading height from 1.9 to 1.5m and increasing the capacity from 2.5 to $7.0m^3$.

Dump truck designed for use in Bardess

The 'fore and aft' trailer is capable of serving 6,870 households with a workforce comprising 2 supervisors, 17 sweepers and 1 driver. The modified trailers are used as back up and for collecting waste from outlying satellite villages.

Tree planting was undertaken along main streets and workers were provided with uniforms.

Community Participation

Community participation, focus group discussions and awareness raising were an integral part of the project.

Community views were sought from the beginning, which helped in the design of the system and enabled perceived problems to be addressed.

Consultation with the waste collection workers helped to identify environmentally unsound practices of residents like dumping of household waste, ash from ovens and construction waste in the streets and in the central canal. On the other hand, women expressed their opinion about the behavior of street sweepers, the inadequate coverage of the service, and the low standard of cleaning.

The head of the local council was very supportive throughout the project. The council organized a number of meetings and promotional campaigns.

Three Community Development Associations (CDAs) were involved in awareness raising: the Association for Qur'an Memorization and Family Care, the Muslim Youth Organization and the Soldiers of Jesus Association. The first CDA reached out to women through its literacy classes, sewing center and day-care center. Members of the second CDA, all young people from Bardees, distributed leaflets to shop owners to urge them to put their waste in garbage bins and to take care of trees. Posters were hung in their library, social club and cultural center, and meetings were organized to raise the awareness of youth. The third CDA organized awareness raising in its own building and in two churches.

Additional awareness raising activities included door-to-door discussions and group meetings organized by the local council and the community.

Some of the key stakeholders involved included:

Key Stakeholder Groups and their Roles

Community residents

* Expressed views on improvements to waste collection
* Involved in women's focus group discussions
* Participated in awareness raising
* Willing to pay for improved service

Local council

* Planning and coordination
* Operation of waste collection service
* Involved in awareness raising

Governorate

* Planning and implementation

CDAs and NGOs

* Involved in design and implementation of awareness raising
* Will be involved in operation and user fee collection

Waste collection workers

* Involved in focus group discussions
* Provide feedback on improvements to the system
* Help prepare environmental messages

Religious leaders

* Involved in awareness-raising

Institute of Social Work, Sohag

* Conducted social survey
* Facilitated focus group discussions

Tractor and 'fore and aft' trailer in operation in Bardees

Tree planting improved the visual appearance along main streets

Capital and Operating Costs

A cost breakdown of main capital items and operating expenses, excluding any overheads from the Bardees local council, are summarized below.

Capital cost	LE
Tractor - Universal 600	42,000
Fore & Aft trailer - $7m^3$	20,000
Handcarts	2,700
Worker uniforms	1,160
Total	**65,860**

Operating costs per month	LE
Fuel	420
Labor	2,290
Maintenance	254
Capital depreciation - over 7 years	784
Total	**3,748**
Cost per house per month	0.55
Plastic bags	
10 per house per month	4,492
Cost per house per month	0.65
Total cost per house per month	**1.20**

In addition to the above, additional costs were incurred for tree planting, awareness raising programs for local residents, alterations to existing trailers and spare parts.

Sustainability

Throughout the project the Bardees local government unit has met all operating costs and the service is now being provided on a more cost effective basis.

Cost recovery was assessed in the social survey. This showed that 68% of the community are willing to pay for an improved waste collection service.

It should be noted that:

* The operating cost per household of LE1.20 per month is less than the average fee of LE1.60 per month that residents were willing to pay.

* Some residents are already paying between LE1.5-2.0 per month to have their waste removed by a local person with a donkey cart.

* In focus group meetings women expressed the view that fees should be adjusted to income levels.

The introduction of a user fee had been agreed and this is likely to be implemented through a local NGO on the following basis:

* Service to be operated by the NGO.

* Fees to be collected by the NGO based on a differential between houses, shops and clinics. Household fees should not disadvantage the very poor.

* 50% income split to the Council to cover fuel, labor incentives and maintenance.

* 50% split to the NGO to cover plastic bags, fee collection and management costs.

In summary, the project was designed to be sustainable in the following ways:

* Gaining the involvement of the local council and community in design and implementation.

* All operating costs have been born by the local council.

* A user fee for cost recovery has been agreed and will be implemented through a local NGO. There has been a 68% willingness to pay among residents surveyed.

* Training of waste collection workers and their supervisors.

* Increasing awareness of residents on the need to maintain a good waste collection service.

Benefits and Achievements

* Improved waste collection service for residents that has been adapted to their needs.

* Improved environmental conditions with positive effects for public health.

* Increased environmental awareness among the residents.

* Enhanced visual impacts through less street waste and additional tree planting.

* Enhanced cooperation between the local council and NGOs/CDAs in tackling a community priority.

February 1999