Unesco-UNEP International Environmental Education Programme

Environmental Educational Series **4**

Educational Module on Environmental Problems in Cities

Division of Science, Technical and Vocational Education

ED 83/WS/87

PREFACE

The International Environmental Education Programme (IEEP) was set up in 1975 by the United Nations Educational, Scientific and Cultural Organization (Unesco) and the United Nations Environment Programme (UNEP). Since that time it has organized and carried out national level research, pilot projects and training courses in more than forty Member States throughout the various regions of the world. This work has been undertaken with a view to contributing to the development of content, methods and materials for environmental education. The experience thus acquired has led to the elaboration of a series of experimental modules in which contemporary environmental problems are examined from an educational standpoint, following an interdisciplinary pedagogical approach that meets the methodological requirements of the different levels and modalities of formal education and teacher training in this field.

The breadth and complexity of the environmental question have revealed the necessity for identifying specific problem areas - the rational use of natural resources, pollution, health and nutrition, the urban environment, etc. - and of studying them, taking into account geographic, ecological and economic variations.

This experimental teaching module on urban environmental problems applies specifically to Europe and North America. It is just one of several different regional adaptations planned by IEEP on the theme. The same diversified regional approach will characterize the treatment of other themes, such as desertification, health and environment, and urban marginalization.

A recent survey conducted by IEEP[1] revealed that, for a majority of Member States of the European and North American region, the enhancement of the quality of the built environment - of cities in particular - is a basic priority for future environmental action. Indeed, it has been observed that in the region more than two-thirds of the population live and work in vast urban areas - traditional cities, new cities, suburbs and conurbations. This urbanization not only provokes immediate and radical changes in the natural landscape but also gives rise to specific environmental problems of a physical, social, cultural or economic nature - while amplifying the repercussions of more general problems, such as pollutions, natural resource depletion, etc. The prevention of and/or solution to these problems pre-suppose important changes in certain individual and collective ways of life coupled with the acquisition by the population of theoretical and practical knowledge, as well as the development of attitudes conducive to environmental conservation.

In this perspective, the present module, intended mainly for secondary school-level teachers and pupils, attempts to clarify certain essential scientific concepts while discussing major environmental problems such as urban growth and land use, transportation,

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1 'Progress and Trends in Environmental Education Since the Tbilisi Conference: World Survey 1981-1982'

air and water quality, noise and energy. It proposes a series of practical activities and evaluation exercises aimed at stimulating the assimilation of facts and developing the attitudes and technical skills most likely to contribute to the solution of certain environmental problems.

To facilitate its use, the module has been divided into two parts. Part I provides the teacher with the essential elements he or she will need in organizing his or her teaching (general educational objectives, lists of concepts and educational activities). Part II comprises narrative elements on each of the selected environmental problems, a series of associated educational activities which can be carried out by pupils and some evaluation instruments.

The experimental nature of the module should be emphasized. The teacher is encouraged to use the proposed content, methods and examples in a critical spirit, systematically adapting them to local conditions, and to evaluate the results obtained.

The module was conceived and designed by Unesco. Its execution was then carried out by the Institute of Urban Studies and Community Service of the University of North Carolina at Charlotte, United States of America.

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Part One

GUIDELINES FOR TEACHERS

INTRODUCTION

Only recently have we begun to recognize that a vital part of the human environment is the man-made environment, the place where people live, work and play, the neighborhood, the street and the city. Today urbanites spend as much as 80 per cent of their time in man-built structures such as residences, schools, workplaces, stores, hospitals and entertainment centres, and increasingly the built environment in which people live is the city environment.

The growth of cities is a world-wide phenomenon. Until the last century, there were fewer densely populated cities making demands on resources, and human settlements were less overwhelming because man's capacity to manipulate the physical environment was much less.

Cities today affect more than just the people who live in them. Activities in and around cities consume a large percentage of the world's resources when compared to the global population. Urban-oriented life-styles, which differ dramatically from the rural life-styles which once dominated world populations everywhere, reach far beyond the city limits. Through the mass media - television, radio, newspapers and magazines - life in communities of all sizes is becoming more urban in character.

The attraction to cities is strong. Cities offer a multitude of jobs, cultural and educational opportunities, and diversity in people and entertainment. Those who live in cities value life there for a host of reasons. They are preceived as centres of action and excitement and offer advantages not available in rural areas, including better medical care facilities and welfare programmes.

As cities grow and become more complex, life in them becomes increasingly complicated and stressful. The nature of urban problems differs from country to country for a number of reasons. First, there is an uneven distribution of resources among world populations and the allocation of natural resources and resulting economic activity from production and exchange of goods differs from country to country. Highly industrialized and urbanized countries use a greater portion of the resources, and as a result have a different set of problems. Second, non-affluent societies suffer more health-related problems and have higher death rates due to undernutrition, disease and infant mortality. Members of more affluent societies have longer life spans but are not necessarily healthier. Urban life-styles in affluent countries frequently include poor nutritional habits which lead to obesity. City stress may lead to poor mental health and sedentary living can lead to heart attacks, ulcers, increased occupational injuries, headaches and hypertension. Finally, highly industrialized societies suffer most from the by-products of technology and industrial advancement; industrial pollution, traffic, noise pollution, large volumes of wastes and degradation of water and air increase as cities industrialize.

More and more people are living in urban settings. No matter where the cities are located, the people who live in them are being subjected to crowding, sanitation problems, excessive motor vehicle traffic, noise, air pollution, etc. Such stressful conditions, when prolonged, can have a profound effect. They create tensions which result in anxiety, alienation, loss of productivity in the workplace and a host of maladaptive social behaviours: drug abuse, crime, violence and the destruction of property.

Urbanites have developed ways to cope with social and environmental stresses. Making contact with a friendly face helps. A visit to a neighbor or relative or a trip to a local entertainment facility serves this purpose. Visiting a park which lacks the usual distractions of urban activities is another solution.

At a different level, city governments are trying to grapple with the stress on man in his self-made environment. Entire networks of services have been created, including education, health services, police protection, traffic control departments and hundreds of others, but the problems associated with living in cities continue to multiply. Old solutions no longer seem to work.

The forces that determine the quality of life in cities are extremely complex. They go far beyond the design of a residence which includes adequate sanitation facilities, good lighting, heat, ventilation and soundproofing. Quality of life in the city is more than the absence of disease and infirmity. It is more than jobs. It is multidimensional. The concept of a healthy city includes not only the well-being of the people, but also the quality of the natural and man-made environment, the tension-relieving interactions of the people and the success of the activities carried on by the government.

Steps to improve the quality of the urban environment must be taken with the help and guidance of those who live in it. The starting point for improving the city is working with citizens who live there. Too often the city is planned without consideration for the needs or desires of the diversity of the residents who live there. Play areas may be good for the very young, but a quiet reading room or more neighbourhood grocery stores may be necessary to meet the needs of the elderly. Without full knowledge of the needs of various segments of society, those of differing age, social and economic groups, it is impossible to design or plan a community which will serve all its members.

> For the purpose of this module, our considerations will apply principally to urban human settlements of a relatively large size, that is, cities ranging from several hundred thousand inhabitants to several millions, and generally located in industrialized countries.

The central theme of this module is that environmental quality depends on those who live in the city and that the future depends on the involvement of informed residents who are knowledgeable about how the city works, how the city affects them and how they affect the city.

I. OBJECTIVES AND PRINCIPLES OF ENVIRONMENTAL EDUCATION

Few can dispute that cities are important and that they are part of an interlocking, interdependent global society which is becoming increasingly urban. In most countries, people are expressing concern about environmental quality and the unplanned growth of cities. At the same time, there has been increased discussion of the role of education in helping students understand, appreciate, and influence, in positive directions, their own environment. It is the responsibility of education systems to prepare students for the future and to prepare them to seek changes necessary to ensure a positive future. It is seen as the role of education to help prepare students for future changes and help create an open frame of mind regarding necessary changes.

During the past decade a new educational approach to the study of the environment has emerged: 'environmental education'. The goal of environmental education, as adopted at the World Intergovernmental Conference on Environmental Education, Tbilisi, USSR, 14 to 26 October 1977, is :

> To develop a citizenry that is aware of, and concerned about, the total environment, and its associated problems, which has the knowledge, attitudes, motivations, commitment, and skills to work individually and collectively toward solutions of current problems and the prevention of new ones.

To achieve the above goal, it was determined at the conference that environmental education should help students:

- Obtain an understanding that people are an inseparable part of an environmental system and that whatever they do alters their surroundings in both harmful and beneficial ways.
- Obtain a basic knowledge of how environmental problems can be solved, and recognize the responsibility of individuals and each segment of society to cooperate in their solution.
- Develop analytical, thinking and action skills for understanding, preventing and helping to correct environmental abuses.

In studying the complex interactions among components of any environment, understandings from the field of ecology become useful. Ecology focuses on the study of interrelationships between living organisms and their environment. It is not a traditional discipline. There are no clear boundaries of study. The scope of ecology can be a small decaying stump, a forest, a city, an ocean or the entire planet.

Human ecology is concerned specifically with people and their environment. The study of the interrelationship between man and the urban environment is called urban ecology. The study of the city then becomes the study of the urban ecosystem.

An ecosystem denotes the regularly interacting and interdependent parts of a biological community and its non-living environment, a unified system. No part of an ecosystem stands by itself; all are interdependent. Ecosystems tend to be stable, flexible, self-regulating and self-compensating and have a long evolutionary development.

Environmental education is more than the cognitive study of ecological relationships. It provides students with the opportunity to increase their own awareness of environmental problems. It is issue and problem oriented.

Environmental education focuses on the root causes of environmental degradation rather than studying the symptoms. For instance, students will discover that everyone is responsible for the quality of the environment. When studying water pollution, students may initially say that industries pollute water. After study, they will realize that it is consumers who buy inexpensive products produced by industries which have not spent sufficient money to remove waste materials from the water used during the manufacturing process. They will realize that each household adds to the water pollution problem as well.

Environmental education includes discipline orientations not generally incorporated into ecological studies. Environmental education investigations require an understanding of related psychological, sociologic, political, economic, historic, ethical and aesthetic factors.

According to the World Conference on Environmental Education, the objectives in the affective, cognitive, and skill-behaviour domain around which environmental education programmes should be developed are:

- Awareness -- to help individuals and social groups acquire an awareness of and sensitivity to the total environment and its allied problems;

- Knowledge -- to help individuals and social groups gain a variety of experiences with the total environment and to acquire a basic understanding of the total environment, its associated problems and humanity's critical responsible presence and role in it;

- Attitudes -- to help individuals and social groups acquire social values, strong feelings of concern for the environment and the motivation for actively participating in its protection and improvement;

- Skills -- to help individuals and social groups acquire the skills for working toward the solution of environmental problems and to foster a dialogue between these groups; and

- Participation -- to help individuals and social groups develop a sense of responsibility and urgency regarding environmental problems to ensure appropriate action to help solve these problems.

ENVIRONMENTAL EDUCATION PROCESS: EXPLORING ROOT CAUSES V. EXPLORING SYMPTOMS OF URBAN ENVIRONMENTAL PROBLEMS

What are some of the environmental issues facing cities?	1. Growth of cities 2. Transportation problems 3. Air pollution 4. Water pollution 5. Excessive energy consumption 6. Noise 7. Waste disposal 8. Lack of adequate planning
What are some of the major reasons for urban environmental problems?	1. Individual actions 2. Actions by industries 3. Government actions
What are some effective actions which will improve the quality of life in the city?	1. The making of sound environmental choices by any of the three listed above 2. Influencing sound environmental policies by any of the three above
What are some of the major objectives of urban environmental education?	1. Developing an awareness of urban environmental problems 2. Acquiring ecological, economic, social and technological information about the problem 3. Forming attitudes and values resulting in behaviours which enhance rather than degrade the environment 4. Identifying and evaluating alternative solutions to urban environmental problems 5. Taking action to improve the quality of life in the city

Some guiding principles of environmental education are that it should:

1. Consider the environment in its totality -- natural and built, technological and social, economic, political, moral, cultural and historical, and aesthetic aspects;

2. Be a continuous lifelong process; it should begin at the pre-school level and continue through all formal and non-formal stages;

3. Be interdisciplinary in its approach, drawing on the specific content of each discipline in making possible a holistic and balanced perspective;

4. Emphasize active participation in preventing environmental problems and working toward their solution;

5. Examine major environmental issues from local, national, regional, and international points of view, so that learners receive insights into environmental conditions in othe geographical areas;

6. Focus on current and potential environmental situations;

7. Emphasize the complexity of environmental problems and thus the need to develop critical thinking and problem-solving skills;

8. Utilize diverse learning environments and a broad array of educational approaches to teaching and learning about and from the environment with due stress on practical activities and firsthand experiences;

9. Focus on the learner's own community and relating topics being discussed to state, regional, national, and international issues and perspectives;

10. Relate environmental sensitivity, knowledge, problem-solving and values clarification at every grade level, but with special emphasis on environmental sensitivity to the learner's own community in early years;

11. Enable learners to play a role in planning their learning experiences and provide an opportunity for making decisions and accepting their consequences.

Environmental education is learner-oriented, and the role of the teacher is to create a learning environment, assist learners as they search for information and participate with the students in the learning process. Teachers are encouraged to participate in projects as team members, guides and counsellors, rather than as dispensers of information. Some points for teachers regarding the environmental education process are:

- Behaviours that are positively reinforced are most likely to recur. Desired behaviours should be reinforced by the home, school, church, youth organizations, and so on.

- The most effective effort is put forth when learners try tasks that fall in the 'range of challenge' -- not too easy and not too hard -- where success seems likely but not certain.

- Learners are most likely to throw themselves whole-heartedly into any project if they themselves have a meaningful role in the selection and planning of the enterprise.

- Reaction to excessive direction of the teacher is likely to be apathetic conformity, defiance, or escape.

- All environmental programmes should be developed systematically with application of instruction based on the learner's motivations, having due regard to his psychological development as well as the cultural environment surrounding him.

- What is learned is most likely to be available for use if it is acquired immediately preceding the time when it is needed. Learning, then forgetting, and then relearning when need arises is not an effective procedure.

- The learning process in school ought to involve dynamic methods of inquiry.

- Learning takes place through the active behaviour of the learner. It is what he does that he learns, not what the teacher does. The essential means of an education are the experiences provided, not the things to which the student is merely exposed.

- One of the keys to motivation is a sense of excitement about discovering for oneself, rather than having a generalization presented by a teacher and requiring a student to prove it.

- Helping citizens to acquire technical knowledge alone regarding an environmental problem may not increase their concern for the problem.

- Citizens are more likely to become involved in environmental issues if they personally believe they have some effect upon decision-making.

- Individual apathy can result when a person feels a lack of confidence in his/her ability to change or influence decisions. To overcome this type of apathy it is important to help an individual to see how he/she can be effective in influencing public decisions.

II. STRUCTURE OF THE MODULE

The study of the city is an important component of environmental education. THE CITY AND NATURAL SYSTEMS is an urban environmental education module. The module points to urbanization as a world-wide trend. It states that a high quality urban environment requires an understanding of, and purposeful interaction with, the complex natural and man-made environments in the city.

1. OVERALL OBJECTIVES OF THE MODULE

- Increase understanding of man's relationship to the city environment, natural and man-made, emphasizing how he affects it and is affected by it.
- Use the total city, the natural and physical resources of the schools, the surrounding community and the city as an educational laboratory.
- Serve as a basis of an interdisciplinary course of study which relates all subjects to a comprehensive study of interactions within the city.
- Provide a forum for the discussion of aspects of city life which individuals value.
- Go beyond the study of symptoms of environmental problems by exploring root causes of urban degradation.
- Develop skills to enable students to become involved in the solution to urban environmental problems.
- Motivate students to become involved in the solution of community problems.
- Develop behaviour patterns that will endure throughout life.
- Improve the quality of life in the city.

1.1 Development of Problem Solving Skills

The module aims to help students understand and influence changes in the city. The module strives to create an open frame of mind toward becoming involved in community problems to help reduce feelings of frustration, de-personalization and anonymity frequently experienced by urban dwellers. Active involvement in one's community increases the individual's sense of belonging. Therefore a primary objective of the module is to help students develop skills necessary to work toward the solution of current and projected environmental problems in the city.

Problem solving skills which will be emphasized throughout the module are:

1. Recognizing environmental problems
2. Defining environmental problems
3. Listening with comprehension
4. Collecting information
5. Organizing information
6. Analysing information
7. Generating alternative solutions
8. Developing a plan of action
9. Implementing a plan of action

1.2 Emphasis on Values

Examining and analysing what we value is a major factor in making decisions every day which affect the environment. Therefore, the module emphasizes the exploration of individual values. Activities are designed to help students become aware of their own beliefs, attitudes, values and actions related to environmental problems. The module guides students through valuing processes which allow each student to explore the consequences of his or her own actions and then generate ideas about alternative actions, thereby bringing them into a way of living more compatible with the urban environment.

The steps in the valuing process are that the students:

1. Are presented with an issue
2. Suggest alternative solutions
3. Consider the consequences of each alternative
4. Express their feelings about each alternative
5. Make a choice regarding their own behaviour

2. SPECIFIC OBJECTIVES OF THE MODULE

The text provides general background information on the interrelationships within the city. Upon completion of each sub-section, the student should be able to do the following:

The Urban Environment

1. Describe elements of the natural and man-made environment in the city.
2. List activities carried on by the city.
3. Locate major above-ground networks through the city.
4. Describe environmental changes in the city initiated by man.
5. Describe consequences, environmental, social and economic, of each of these changes.
6. List natural resources which are brought into the city daily.
7. Describe how natural resources reach the city from their sources.

8. List natural resources and man-made products which leave the city daily.

People and the City

1. Discuss a number of differences between urban and rural behaviours and ways of thinking.
2. Describe how urban life can result in an individual feeling alienated in the city.
3. List deviant behaviours which are more common in cities than in rural areas and discuss reasons for the higher rate of deviant behaviours in the cities.
4. Describe a healthy city neighbourhood.

City Growth Patterns and Land Uses

1. Explain why the city is located where it is.
2. Describe the natural site, land and water formations, original vegetation and wildlife at the site.
3. List parts of the city today which were once small outlying communities.
4. Explain why growth has occurred in existing directions.
5. List suburbs of the city.
6. Locate land in the city used commercially, industrially, residentially; for transportation; owned by the government; and/or devoted to open space.
7. Describe uses of open space in the city.

Transportation in the City

1. Describe how the city makes decisions about the construction and use of city streets and freeways.
2. Explain the costs and benefits of moving people about the city in automobiles as compared to other forms of transportation - rail systems, buses, motorized bicycles, and bicycles - considering monetary, environmental and social costs and benefits.
3. List things each person can do to make the city's transportation networks a more positive part of the city.

The Urban Climate and Air Quality and the City

1. Describe how the climate in the city differs from the surrounding countryside.
2. Describe how paved surfaces affect the temperature of the city.
3. Describe how winds are altered by city structures.
4. Discuss the causes of city haze.

5. List of sources of air pollution in the city.
6. List air pollutants produced by automobiles.
7. Describe the differences in levels of air pollutants generated by automobiles with different engines and exhaust systems.

8. Describe how the city monitors air pollutants.
9. List regulations which are in effect or could be implemented by the city to control the emission of air pollutants.
10. List costs of air pollution related to human health and damage to vegetation and materials.
11. Describe emergency measures the city has, or could have, if air pollution levels were to become dangerously high.

Water Quality and the City

1. Explain how fresh water reaches the city.
2. Describe how water is disinfected and distributed to homes, businesses and industries in the city.
3. List consumptive uses of water in the city.
4. List non-consumptive uses of water in the city.
5. Describe effects of wastes added to water by major users, or groups of users such as schools or residences.
6. Discuss how the city monitors water quality.
7. List regulations which are in effect or could be implemented by the city to control the adding of pollutants to city water.
8. Describe steps used by the city to clean waste water from schools, homes and businesses.
9. List additional steps which could be used to clean city water.
10. Describe how several industries remove industrial waste from water.
11. List ways each individual can improve water quality in the city.

Urban Solid Wastes

1. Describe how solid wastes, trash, garbage and litter, are disposed of in the city.
2. Describe alternative disposal methods for city wastes.
3. List solid wastes disposed of by the school and homes each week.
4. List solid wastes disposed of by several industries.
5. Describe ways individuals can help reduce the amount of wastes in need of disposal in the city.

City Noise

1. List sources of noise in each of these locations: the school, a residence, businesses, a busy street, a less frequented street and a park.
2. List ways each of the city noises listed above could be lessened, at the source, as the sound is transmitted, or by protecting the receiver of the sound.
3. List industries in your city which expose workers to constant noise levels.
4. Describe regulations which are in effect, or could be in effect, to reduce noise levels in the city.
5. Describe the effects of noise on those who live in the city.

Nature in the City

1. Describe benefits of vegetation in the city.
2. List species of wildlife, other than domesticated or zoo animals, which live in the city.
3. List species of wildlife, excluding insects, well-adapted to city life which are considered pests and describe why they thrive.
4. Describe types and uses of gardens and lawn in the city.
5. Describe types of parks, open space, or natural areas and the uses of each in the city.

Energy and the City

1. Explain the difference between non-renewable and renewable fuels.
2. Discuss the differences between energy use in high and low-energy consuming countries.
3. Describe the merits of relying on each of the three conventional fossil fuels - coal, petroleum, and natural gas - to meet future energy needs world-wide.
4. Describe environmental problems related to relying on each of the three conventional fossil fuels - coal, petroleum, and natural gas - to meet future energy needs world-wide.
5. Discuss several sources of energy which may become more widely used in cities in the future.
6. List ten ways individuals can conserve energy in the city.

The chapters in the student module may be used independently or in combinations related to Study Topics. Chart I indicates chapters which might be used to study pollution, natural resources, the history of cities or human health. It also indicates which chapters are companion, or corollary, chapters, and which chapters best stand independently.

3. ACTIVITIES

The activities are the core of the module. They provide students with opportunities to develop environment awareness, identify environmental issues in the city, solve problems, clarify values and conduct research related to the natural and man-made environment and related psychological, sociological, historic and economic, political, ethical and aesthetic factors. They are designed to be integrated into traditional courses of study in the natural and social sciences, the humanities or the arts. The role of the teacher is that of the facilitator of the student's own exploration of the urban environment.

Activities range from lengthy investigations of the city to short exercises which allow students to explore feelings about the urban environment. Learning will be most significant if the explorations have direct meaning to the student. Students should play a part in choosing the environmental problem in which they wish to

CHART I : USE OF THE MODULE CHAPTERS

Study Topics

	Independent chapters	Recommended corollary chapters	Pollution	Energy	Natural resources	Urban planning	History of cities	Human health
URBAN ENVIRONMENT		II				●	●	
I. PEOPLE AND THE CITY						●		●
II. CITY GROWTH AND LAND USE		I				●	●	
III. TRANSPORTATION AND THE CITY		IV, X		●		●		
IV. THE URBAN CLIMATE AND AIR QUALITY IN THE CITY	●	III	●	●	●			●
V. WATER QUALITY AND THE CITY	●		●		●			●
VI. URBAN SOLID WASTES	●		●		●			●
VII. CITY NOISE			●					
VIII. NATURE IN THE CITY					●	●		
IX. ENERGY AND THE CITY	●	III, IV	●	●	●			

become involved. There are enough problems in the city for everyone to work on something that is seen as important to the individual student.

Activities are rated according to recommended age levels to assist teachers in choosing appropriate exercises for class use:

Elementary:	9-13
Middle:	12-15
Senior:	14-17
All:	9-17

Most exercises can be easily adapted by the teacher for use by age level.

An important consideration for the teacher in helping the students explore the city is assisting them in the establishment of reasonable expectations for success. Sound environmental practices in the home and school are much more easily influenced by student involvement than are city-wide practices. It would be unrealistic to expect an elementary class to change the policies of a polluting industry during several weeks of study. A better contribution to the solution of the problem might be the dissemination of facts about the problem to parents and community leaders. An elementary class might expect success in the implementation of a waste paper recycling project at the school or in the immediate neighborhood, but not in the entire city.

The student module contains one activity for each chapter which can be implemented by students with little assistance from the teacher. Activities requiring preparation by the teacher are included in the teacher's manual only.

4. EVALUATION

Evaluative instruments fall into two basic categories: student activities, and objective questions (multiple choice, matching and true-false). It is suggested that when activities are used for purposes of evaluation, teachers require summary student reports and evaluation based on evidence of understanding of the problem-solving skills discussed on page 12. Answers for objective questions appear at the conclusion of each chapter.

SUMMARY TABLE OF THE TEACHING-LEARNING MODULE

CHAPTER	ACTIVITIES	LEVEL	EVALUATION	LEVEL
Introduction : THE URBAN ENVIRONMENT	(1) Micro Urban Investigation	All	Evaluation activity :	Adaptable to all
	(2) Twenty Things You Like to Do in the City	All	- Government service inventory	
	(3) Brainstorming on Environmental Topics	All		
	(4) Deciding If You Agree or Disagree	Middle-Senior		
	(5) The Disappearance of an Early Civilization	Senior		
	(6) Progress and Historical Mistreatment of the Environment	Senior		
I. PEOPLE AND THE CITY	(1) The Urban Environment and Poor Neighbourhoods	All	Evaluation test :	Adaptable to all
	(2) Forced Choices	All	- Multiple choice - True/false	
	(3) Rural, Suburban and Environmental Problems			
II. CITY GROWTH AND LAND USE	(1) Population Sticks	Elementary	Evaluation test :	Adaptable to all
	(2) Population Trends	Senior	- Multiple choice - True/false	
	(3) Beautifying a Shopping Area	Elementary -Middle		
	(4) Land Use Study	All		
III. TRANSPORTATION AND THE CITY	(1) School Site Traffic Planning	Elementary	Evaluation test :	Adaptable to all
	(2) Survey of Use of Motor Vehicles in the City	Elementary	- Multiple choice - True/false	
	(3) New Expressway Simulation	Middle-Senior		
	(4) Local Hearing on Transportation Alternatives in the City	Senior		
	(5) Improving Public Transportation	All		
IV. AIR QUALITY AND THE CITY	(1) Investigating Industrial Air Pollution	All	Evaluation tests:	Adaptable to all
	(2) Investigating Air Pollution Caused by Automobiles	Elementary-Middle	(1) Urban Climate - Multiple choice - True/false	
	(3) Automobile and Air Pollution Research Project	Middle-Senior	(2) Air Pollution - Multiple choice - True/false	
	(4) Investigating Air Pollution in the City			
V. WATER QUALITY AND THE CITY	(1) Exploring Drinking Water in the City	Elementary	Evaluation test :	Adaptable to all
	(2) Exploring Wastewater Treatment in the City	Elementary-Middle	- Multiple choice - True/false	
	(3) Investigating Water Pollution in a River	Senior		
	(4) Protecting Water in the City	All		

CHAPTER	ACTIVITIES	LEVEL	EVALUATION	LEVEL
VI. URBAN SOLID WASTES	(1) Exploring Solid Wastes Generated by the School (2) Man's Impact on the Environment	Elementary All	Evaluation test : - Multiple choice - True/false	Adaptable to all
VII. CITY NOISE	(1) Noise Survey	All	Evaluation test : - Multiple choice - True/false	Adaptable to all
VIII. NATURE IN THE CITY	(1) The Value of Trees in the City (2) Investigating Signs in the City (3) Investigating a Parcel of Land for Recreational Use (4) Investigating the Relationship of an Urban Community to Certain Birds and Small Animals	All Elementary Senior Senior	Evaluation test : - Multiple choice - True/false	Adaptable to all
IX. ENERGY AND THE CITY	(1) Electrical Survey (2) Investigating a Fossil Fuel Power Generating Plant	All Senior	Evaluation test : - Multiple choice - True/false	Adaptable to all
			General Evaluation Activities : (1) Who Solves Environmental Problems (2) Individual's Contribution to Pollution (3) Solutions to Environmental Problems in the City (4) An Environmental Pie (5) Force Field Analysis (6) Urban Environment	 Elementary-Middle Elementary All Elementary-Middle Middle-Senior Adaptable to all

III. GLOSSARY

AEROSOL - a substance consisting of small particles typically having diameters that range from 1/100 micrometer to 1 micrometer.

ATMOSPHERE - the predominantly gaseous envelope that surrounds the earth.

ATTITUDE - the degree of positive or negative effect associated with some thing, person, or situation; an enduring learned readiness or predisposition to act toward or against some thing, person, or situation; there are three components to an attitude -- knowledge, feeling and the action tendency.

AWARENESS - consciousness of a situation or object, without direct attention to it or definite knowledge of its nature.

BELIEF - an inference made by an observer about an underlying state of expectancy, which may or may not be consistent with the observer's verbal reports.

BIOCHEMICAL OXYGEN DEMAND (BOD) - a measure of pollution of water by organic nutrients that recognized the rate at which the nutrient matter uses up oxygen, as well as the total quantity that can be consumed.

BIODEGRADATION - the process of decomposition by living organisms.

CLIMATE - the composite pattern of weather conditions that can be expected in a given region. Climate refers to yearly cycles of temperature, wind, rainfall, etc., and not to daily variations.

COMMITMENT - an overt (written, spoken, demonstrated, etc.) public indication or affirmation to others that one has the interest, the feeling of a need, and the willingness to act out a specific function relative to some problem.

COMPONENT - a segment or group of a population that shares certain characteristics; the grouping is attained by specifying criteria and is done for a specified purpose.

COMPOSTING - the controlled, accelerated biodegradation of moist organic matter to form a humus-like product that can be used as a fertilizer or soil conditioner.

CONCERN (environmental) - any dissatisfying perception of, and/or feeling toward, the environment held by an individual, group, organization, society, or culture which frequently motivates them to address that dissatisfaction with some form of action.

CULTURE - the collection and interaction among a common set of social, political, economic, scientific, technological, philosophical, and educational systems or organizations; a given

people's way of life, as distinct from the life ways of other peoples.

DECIBEL - a unit measure of sound energy intensity.

DECOMPOSERS - organisms such as bacteria, mushroom and maggots that feed on the remains of plants and animals.

ECOLOGY - the study of inter-relationships among organisms or groups of organisms and their biological, chemical and physical surroundings.

ECOSYSTEM - any spatial unit that includes all of the organisms in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity and material cycles within the system.

ELECTROSTATIC PRECIPATORS - a device that removes particulates from an industrial effluent air stream by inducing an electric charge.

ENVIRONMENT, BIOPHYSICAL - the synergistic sum of the biological (living), chemical and physical (non-living) influences upon an organism (plant or animal).

ENVIRONMENT, TOTAL - the synergistic sum of all influences upon an organism (plant or animal). For man, this includes all biological, chemical, physical, social, psychological, economic, philosophical, aesthetic and unknown surroundings.

ENVIRONMENTAL ETHIC - a human value system based on biophysical facts: the test of the value system is the survival of the human ecosystem.

ENVIRONMENTAL PROBLEM - a perceived dissatisfaction with a condition or state of any or all parts of the total human environment.

ENVIRONMENTAL SOLUTION - a perceived satisfaction with the consequences of a completed course of action which has led to a certain state or condition of any or all parts of the total human environment. What is called a 'solution' may vary from the real to the imaginary, from the immediate to the long-term, from local to global, or from person to person. Environmental problem-solving should ideally aim towards solutions which are scientifically real, long-term, global and satisfying to a maximum number of people affected by the problem.

ENVIRONMENTALLY SOUND - consistent with biophysical facts, principles and laws.

EVAPORATION - the change from a liquid state to a vapour.

FOSSIL FUELS - remains of once-living plants and animals that can be burned to release energy.

GEOTHERMAL ENERGY - energy derived from the heat of the earth's interior.

GOAL - a direction toward some abstract end which is used to guide programme design, implementation and evaluation. A goal is derived directly from what one believes. It is broad, all-encompassing and usually not as specific as an objective. A goal is difficult to measure directly; its attainment is usually inferred from the attainment of a number of subordinate, specific objectives.

GREENBELT - a belt of parkways, parks or farm lands that encircles a town or community and is designed to prevent undesirable encroachments.

GUIDELINES - a set of guiding principles designed to give direction to the activities of, or approaches to, a specific programme. Guidelines usually contain the word 'should'.

HINTERLAND - a region remote from cities and towns.

HYDRO-ELECTRIC POWER - electric power generated by turbines using water flow.

INFORMATION - facts told, read or communicated which may be unorganized and even unrelated.

KNOWLEDGE - an organized body of information, or the comprehension and understanding consequent of having acquired and organized a body of facts.

LIFE-STYLE - a mode or manner of existence; the personal, group or cultural behavioural events or patterns that interface with the surroundings or total environment.

LIQUEFACTION - producing a liquid fuel from a solid fuel.

MIST - an airborne substance that consists of liquid droplets typically having diameters greater than 1 micrometer.

MOTIVATION - a general term referring to energizing states of the human organism which direct it toward goals.

OBJECTIVE - a specific and measurable statement of an end in view; an objective is derived from general goals or subgoals and is guided by them; an objective is written with an action verb which denotes a measurable process. If an objective is rewritten in such a form that it becomes an urged and advised course of action, then it becomes a 'recommendation'.

OIL SHALE - rock material from which a petroleum substitute, kerogen, can be extracted.

OPINION - a verbal expression of some belief, attitude, or value.

PARTICULATES - consisting of particles; the particle component of air pollution.

PATHOGENIC ORGANISMS - organisms that cause disease.

PERCEPTION - the process by which we obtain a notion of how the world is at any particular moment. Perceptions are directives for action in that they define for the beholder what constitutes appropriate behaviour at a moment of acting. Perceptions are constructed not only from external environmental stimuli, but also from internal states, habits or drives.

PETROLEUM (CRUDE OIL) - thick, dark-colored liquid obtained by drilling and used as a fuel, generally after separation by distillation (refining) into gasoline, naphtha, benzene, kerosene, etc.

PHOTOCHEMICAL - produced by chemical action of radiant energy, especially light.

PLANNING - a systematic and rational method of solving problems, which usually includes identifying the problem, studying and analysing it, bringing together the relevant interests in the community, designing a plan of action, implementing the plan and monitoring and evaluating the results.

POLLUTION - the presence of one or more contaminants or combinations thereof in such quantities and of such duration as may be, or may tend to be, injurious to plant or animal (including human) life, or property, or which unreasonably interferes with the comfortable enjoyment of life, or property, or the conduct of business.

POPULATION EDUCATION - educational programme aimed at all citizens that will foster an understanding and action-guiding perception of the causes and consequences of human population characteristics and changes.

PRECIPITATE - verb, to cause to separate as a precipitate; noun, an insoluble solid which separates out because of a chemical reaction.

RADIATION - spontaneous emission of atomic materials or rays.

RECYCLING - the recovery and re-use of resources.

RURAL - country areas.

SEWER - a series of pipes that carry water. An integrated sewer system is designed to carry waste water and human wastes away from buildings and people.

SKILL - a mental or physical ability to do something with ease and precision in a variety of similar situations.

SOLAR - pertaining to the sun.

SUBURBAN - an area spreading out from the city proper.

TAR SANDS - sandstone filled by congealed petroleum.

TEMPERATURE INVERSION - a temperature profile in the atmosphere characterized by an increase of temperature with altitude.

TIDAL POWER - power from the semidiurnal rise and fall of oceanic tides.

URANIUM - a radioactive, metalic element used as a nuclear fuel in power reactors.

URBAN - of, relating to, characteristic of, or taking place in a city.

URBAN HEAT ISLAND - a region of relatively warm air centred over an urban-industrial area.

VALUE - an abstract ideal, positive or negative, not tied to any specific attitude object or situation, representing a person's beliefs about ideal modes of conduct and ideal terminal goals.

VAPORIZATION - process of changing from a liquid to a gas.

WATERSHED - the geographical region drained by a river or stream.

IV. GENERAL BIBLIOGRAPHY

Berry, Brian J.L. The Human Consequences of Urbanization. New York, St. Martin's Press, 1973.

Boughey, Arthur S. Man and the Environment: An Introduction to Human Ecology and Evolution. New York, Macmillan, 1971.

Bryson, Reid A.; Kutzbach, John E. Air Pollution. Washington, D.C., Association of American Geographers, 1968. (Association of American Geographers, Commission on College Geography, Resource Paper No. 2)

Cook, Earl Ferguson. Man, Energy, Society. San Francisco, Calif., W.H. Freeman, 1976.

Crouch, James E. Functional Human Anatomy. 3rd ed. Philadelphia, Pa., Lea & Febiger, 1978.

Detwyler, Thomas R.; Marcus, Melvin G. Urbanization and Environment: The Physical Geography of the City. Belmont, Calif., Duxberry Press, 1972.

Greenwood, Ned H.; Edwards, J.M.B. Human Environments and Natural Systems: A Conflict of Dominion. North Scituate, Mass., Duxbury Press, 1973.

Hodges, Laurent. Environmental Pollution. 2nd ed. New York, Holt, Rinehart & Winston, 1977.

Leadley Brown, Alison. Ecology of Fresh Water. Cambridge, Mass., Harvard University Press, 1971.

McHarg, Ian L. Design with Nature. Garden City, N.Y., Doubleday, 1971.

McInnis, Noel F.; Albrecht, Don (eds). What Makes Education Environmental? Louisville, Ky., Data Courier Inc., 1975.

Miller, G. Tyler, Jr. Living in the Environment: Concepts, Problems and Alternatives. Belmont, Calif., Wadsworth Pub., 1975.

Moran, Joseph M.; Morgan, Michael D.; Wiersma, James H. An Introduction to Environmental Science. San Francisco, Calif., W.H. Freeman, 1980.

Moriber, George. Environmental Science. Boston, Mass., Allyn & Bacon, 1974.

Raths, Louis E.; Harmin, Merrill; Simon, Sidney B. Values and Teaching: Working with Values in the Classroom. Columbus, Ohio, C.E. Merrill, 1966. (Merrills's International Education Series.)

Scientific American. Cities. New York, Knopf, 1966. (Articles originally published in the September 1965 issue of Scientific American (New York).)

Wagner, Richard H. Environment and Man. 3rd ed. New York, Norton, 1978.

Willgoose, Carl E. Environmental Health: Commitment for Survival. Philadelphia, Pa., Saunders, 1979.

Part Two

TEACHING-LEARNING MODULE

INTRODUCTION: THE URBAN ENVIRONMENT

Man has been changing and altering the physical environment for thousands of years to build cities. From the beginning of recorded time people, living in villages and towns, have clustered close to rivers and on defendable sites to share and specialize in the tasks of daily living. The very existence of cities is a sign of man's success in adapting the environment to his own desires.

However, the urbanization process as we look at it today is a relatively new phenomenon, dating essentially from the beginning of the nineteenth century.

The number of people in urban areas at the end of the nineteenth century was about 250 million in a world population of 1650 million. The urban population accounted for fifteen percent of the world total. Less than a century later, industrialized countries throughout the world are urbanized to a great extent. About 40 per cent of their population live in urban settlements and most of them in huge urban conglomerates such as New York, Moscow, London, San Francisco, Paris or Rome (see figure 1). Urbanization is accelerating rapidly, particularly in developing countries, along with the process of industrialization, the development of social and economic services, and rural-urban migrations which reflect the decay of agricultural working conditions (see figure 2). By the end of this century, it is expected that a world population of about 4,000 million will live in urban settlements. Twenty-five cities will concentrate more than 10 million inhabitants each; of these, eighteen cities will be located in developing countries such as Mexico, Brazil, India, Indonesia, Egypt, etc.

There is no universally accepted definition of 'urban'. Considerable differences exist from country to country. In some countries, places with 200 inhabitants are called urban; in others a place with less than 40,000 is not. For the purposes of this module, our considerations will apply principally to urban human settlements of a relatively large size, that is, cities ranging from several hundred thousand inhabitants to several million, and generally located in industrialized countries. Nevertheless, most urban issues and problems discussed in the following chapters, although subject to variations in extent and depth, are common to all big cities, no matter where they are located.

The study of human settlements has led to a description of a city as five components:

1) Natural Environment: the land, water, air, vegetation and animal life

2) People

3) Activities: interactions among people and with the urban environment, for example, fabrication of goods from natural resources, selling and buying of goods, teaching, leisure time activities, activities to protect health and safety, and creation of government activity to make and enforce laws.

GROWTH IN VARIOUS SIZED CITIES
POPULATION, 1976
AND
PERCENT CHANGE, 1964-1976

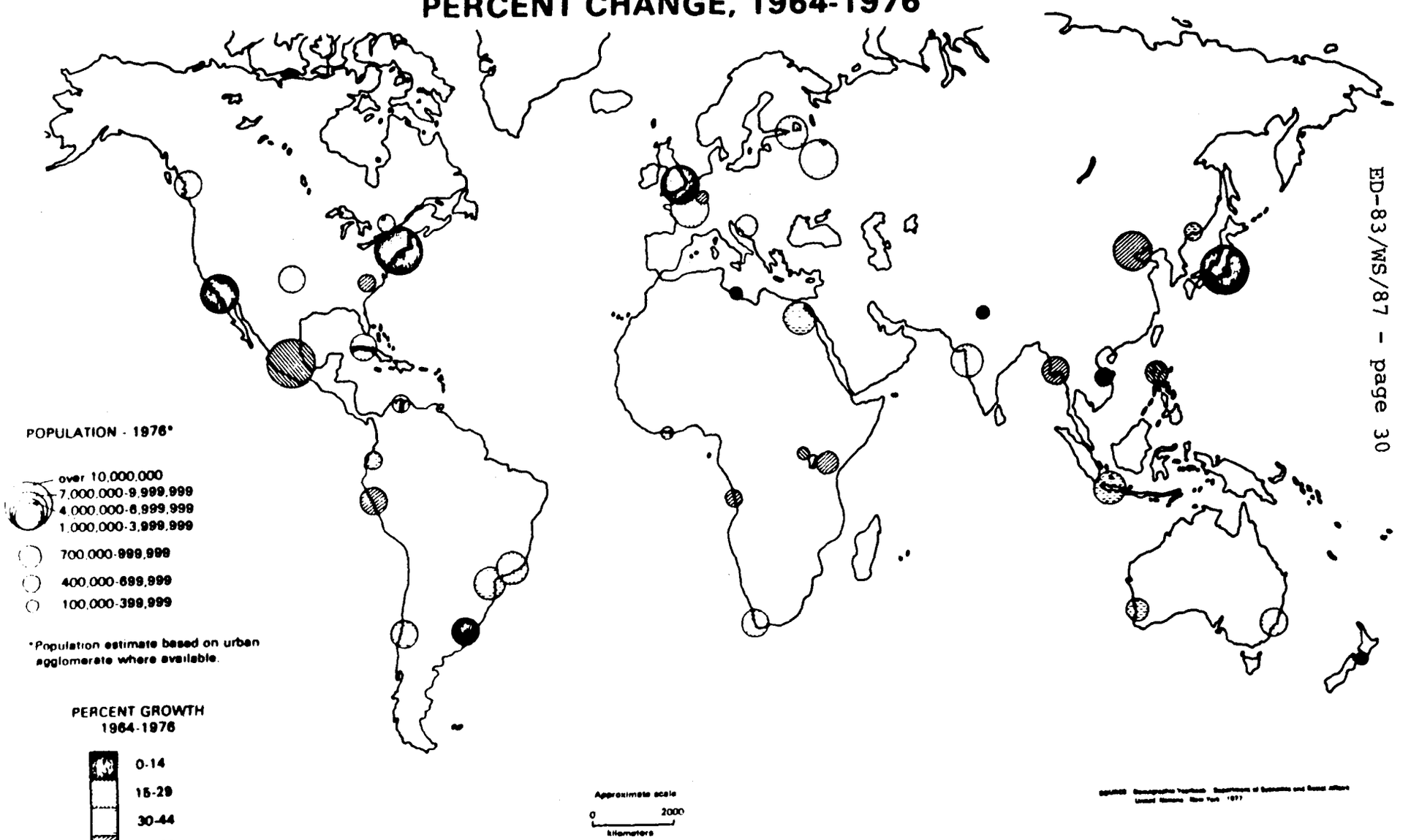
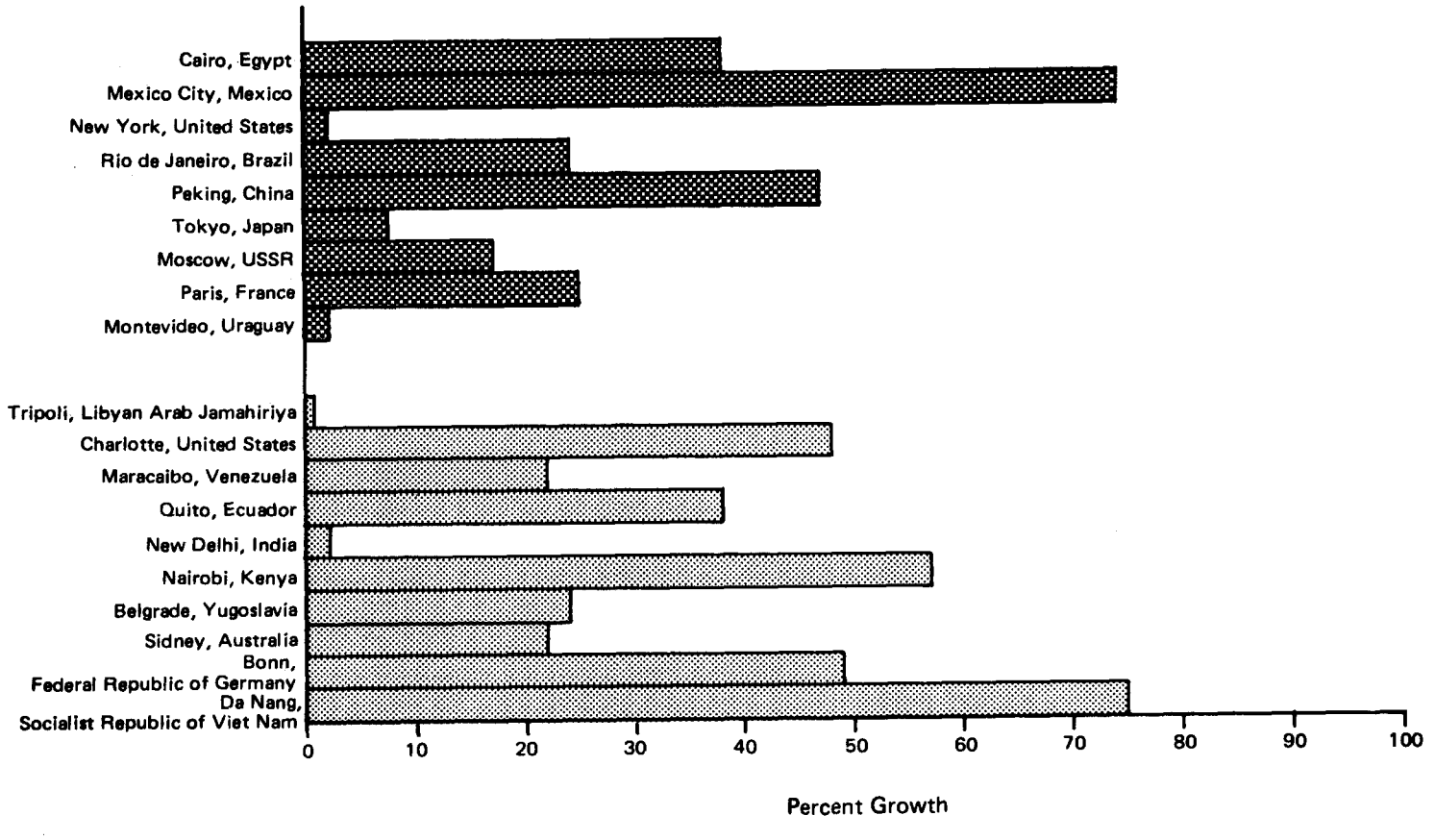


Figure 1

FIGURE 2

VARIOUS SIZED CITIES
PERCENTAGE OF POPULATION CHANGE
1964-1976



4) The Man-made Environment: buildings, homes, factories, streets, etc.

5) Networks: the systems through which everything interacts --- transportation systems, roadways, railway lines, sidewalks; communication systems including telephone, radios and television; industries for manufacturing goods; businesses for buying and selling manufactured goods; banking systems for receiving, holding and dispersing money; hospital systems; police systems; and education systems.

Urban environments differ drastically from rural environments. Cities are the place of man's greatest impact on nature. Cities alter, unrecognizably, the natural environment on which they are located, creating a new environment with unique demands.

Given the importance of cities today, it is remarkable how little is known about the interactions between man and the urban environment. One explanation for this lack of understanding is that natural scientists during the past hundred years focused their attention on natural systems not directly affected by man's activity. This approach became entrenched in the natural sciences before the environmental effects associated with modern industrial processes were significant.

With the emergence of man as a major environmental influence, why did natural scientists continue to ignore man in their studies? A partial answer lies in the fact that man is such a complicating factor when it comes to studying the environment. Man's actions cannot be reduced to simple, studyable laws. It was easier to ignore man's impact rather than re-orient investigatory approaches. As a result, the informational gap continued to grow until the middle of the twentieth century when natural and social scientists began to look at the urban environment as an important study topic.

The relationship between man and the urban environment is extremely complex. It is impossible to separate one from another the thousands of actors and processes within the city. However, there is an approach to the study of cities which helps the observer analyse them. It requires the visualization of the city, its people together with the environment, as a new kind of 'system'.

In one very important way, cities are no different from other natural systems: all parts of a city are interrelated and interpendent. A change in one part of the city results in changes in the others. For example, the construction of a new highway results in the displacement of people, the destruction of homes, alterations in water run-off patterns changes in neighbourhoods and air quality and increases in noise levels.

Cities differ from natural systems in one significant way. Man is the initiator of environmental change in the urban environment. Man removes the natural vegetation, paves the land surfaces, builds gutters and drainage systems, and releases smoke, automobile fumes and wastes from factories and homes into the air and water.

Another difference between urban environmental systems and other natural systems (excluding natural disasters) is that changes induced by man occur more rapidly and are often more difficult to reverse than those in undisturbed nature. In cities, detrimental effects are discernable in a few years, in months, in days.

Cities are 'open systems'. They are not self-contained. A city cannot function independently and in isolation from the countryside, the nation and, in many cases, the world. Cities cannot exist without exchanging two things with other environments: materials and energy.

A city can be compared to an 'island' which receives 'inputs' of energy and materials. Some inputs flow through the city with little change. Many are transformed or stored within the city. Eventually most become 'outputs'. In varying amounts of time, transformed products and wastes, along with unused energy and matter, are sent out of the city.

The tremendous quantity of material imported into and exported from modern cities was described in a 1965 study in the United States of America. The average American urban dweller used daily, directly or indirectly, about 568 litres of water, 1.8 kg. of food, and 8.6 kg. of fossil fuels. In the same report, each person in the city produced daily 454 litres of sewage, 1.8 kg. of trash, and 0.9 kg. of air pollutants.

Once materials flow into the urban system, they are subject to thousands of possible uses. Some are consumed directly by those who live in the city. Some are used by the construction industry for buildings and homes. Some are transformed into marketable products by manufacturing industries. Large quantities of air and water pass quickly through the system with only small amounts being consumed. Air and water are used primarily for the dilution of city wastes.

It is important to point out once again that the relationship between man and the urban environment is extremely complex. It is risky to oversimplify city inputs and outputs (see figure 3). Materials which enter the city are available to as many as 200 subsystems. There are systems for supplying water and removing garbage and sewage; systems for maintaining streets, parks and public places; systems to provide health services and police protection. There are education systems and systems for assisting the poor and handicapped. There are public and private systems of transportation; systems for supplying energy for heat, light and power and there are systems of communication--newspapers, radio stations and television stations. All have an impact on the urban environment.

THE URBAN ENVIRONMENT: Principal Concepts

- The world is becoming increasingly urban.
- Man alters the natural environment as he builds the city.
- Cities are composed of interacting natural and man-made components.

THE CITY SYSTEM: INPUTS AND OUTPUTS

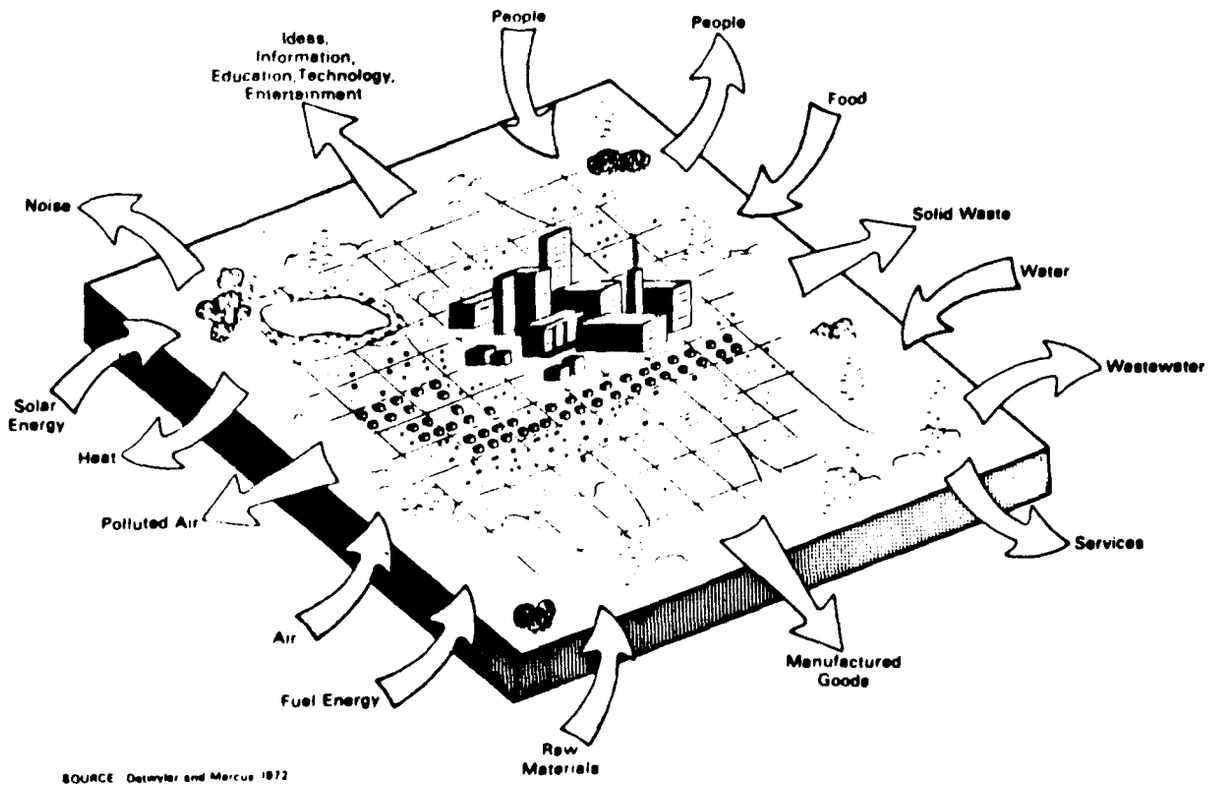


Figure 3

- The interactions between man and the urban environment are extremely complex.
- The study of man's interactions with and impact on the urban environment is relatively new.
- All parts of the city are inter-related and interdependent; a change in one component of the city results in changes in other components.
- In urban environments man is the primary initiator of change.
- Environmental changes initiated by man occur more rapidly than environmental changes in natural setting (excluding natural disasters).
- Cities are not self-contained or self-sustaining and exchange materials and energy with outlying environments.

ACTIVITIES

1) MICRO URBAN INVESTIGATION

Level: All

Emphasis: Community inventory and reporting

Time: Several days

Materials:

1. Map of the city
2. Poster paper and local newspapers

Objectives: At the conclusion of the environmental encounter, the student should be able to:

1. List (number) positive environmental qualities of a neighbourhood or part of the local community.
2. List (number) negative environmental qualities of the area.
3. Explain verbally how positive and negative aspects of an area affect the rest of the city.

Activities:

1. Visit a neighbourhood or small part of the local community. Inventory the area:
   a. Determine what kinds of people live in the area. Note signs of children and types of housing (single-family homes, apartments, two-family homes, etc.)

b. Types of businesses, parks vacant land, construction, etc. in the area.

c. List the positive aspects of the neighbourhoods, both physical and visual.

d. List the negative aspects of the environment, physical and visual. Pay attention to traffic congestion, decaying housing, quality of yards and streets, litter, etc.

2. Prepare a presentation or write a full report discussing the living environment of the study area. Consider the following:

a. What are the neighbourhood's positive and negative aspects?

b. How do the positive aspects affect the rest of the community?

c. How do the negative aspects affect the rest of the community?

d. Which environmental assets have potential for serving as building blocks to improve the livability of this community?

e. What problems exist because of other factors in the community?

f. What environmental problems in this community are related to regional environmental problems?

3. Make charts and drawings of alternative uses of buildings or land in the area. Cut ads designed to sell or rent housing in the community (in the area selected if possible) and create a large collage of the ads for display.

4. Using the report and the visuals, prepare a report of major concerns about the study area. Determine an audience which might be interested in the report. Consider a government agency, a community or church leaders. Make a presentation to the group to point out environmental improvements which could be made in the study area.

2) TWENTY THINGS YOU LIKE TO DO IN THE CITY

Level: All

Emphasis: Values clarification

Time: 15 minutes

Materials:

1. Chalk board, pencils and paper

Objectives: At the conclusion of the exercise, the student should be able to:

1. Identify and clarify what he/she likes to do in the city.
2. Describe (number) things in the city which are necessary to enjoy these activities.

Activities:

1. Ask the students to write on a piece of paper the numbers 1-20.
2. Now have them list twenty things they like to do in the city.
3. Have students evaluate their list according to the code explained below.
4. Code:
   a. Put the following code on the chalk board for the students to use in evaluating their twenty things:

      ¢ -- anything that costs over ¢20 to do (amount can be adjusted)

      P -- things that pollute or degrade the environment

      N -- things which are most enjoyable in the natural environment

      A -- things adults also enjoy

      O -- things you do or did with your parents

      T -- things which require transportation for you to do

      F -- things that you do with your friends

      E -- things that require energy

5. Several code items may be used for each of the twenty things.
6. The code provides a way to evaluate the types of things you like to do in the city.
7. The code also gives you an idea of the trends you are following in doing enjoyable things.
8. It is a good idea to do this activity at different times in the year to show the students how they might have changed during the year.

9. Declaring the things you enjoy doing provides you with a way of identifying and clarifying what you enjoy in the city.

10. Discuss parts of the city which are important for the enjoyment of preferred activities.

3. BRAINSTORMING ON ENVIRONMENTAL TOPICS

Level: All

Emphasis: Developing alternative solutions

Time: 30 minutes

Materials:

1. List of brainstorming topics

2. Chart paper and markers

Objectives: At the conclusion of the exercise, students should be able to:

1. Generate, in writing, (number) alternatives to a community environmental problem.

2. Evaluate, by discussing with a group, suggested alternatives related to the environmental issue being discussed.

Activities:

1. Form the class into groups of fours or fives.

2. Provide each group with a problem area about which to generate alternative solutions to the problem.

3. Possible problem areas (appropriate for the local area):

   a. Urban housing

   b. Community recreation facilities and programs

   c. Solid waste management (school, community, home)

   d. Urban mass transportation

   e. Community water quality.

4. Each group is provided chart paper and markers to record the alternatives generated.

5. Provide each group with 20 minutes to develop alternatives. One member of the group records the alternatives.

6. The recorders of each group share with the other groups their list of alternatives.

7. During the sharing out activity additional alternatives can be added to each group's list.

8. Discussion questions:

   a. How realistic were the alternatives generated by your group to the topic area of discussion?

   b. How might the group have functioned more effectively?

   c. Were there any new strategies gained by sharing out your group's alternatives with the rest of the class?

4. DECIDING IF YOU AGREE OR DISAGREE

Level: Middle, Senior

Emphasis: Values clarification

Time: 20-30 minutes

Materials:

1. Five chairs or desks

Objectives: At the conclusion of the exercise, the student should be able to:

1. Discuss how different individuals have different ideas about the nature of environmental problems.

2. Discuss how different individuals and agencies have different ideas about the importance of environmental problems and methods of solving them.

Activities:

1. Arrange five chairs or desks in a row, leaving several feet in between them so as to form four separate areas along a line. These chairs represent positions ranging from agreement to disagreement.

2. Explain to the class that you are going to read several value-related statements for which they are to respond by walking to the area which represents their position on the statements.

3. After each question, have a few students share out their reasons for the particular positions.

4. Continue this same procedure for other statements.

5. Let the class or yourself suggest other value statements.

Sample valuing questions:

a. More emphasis should be given to problems of environmental nature which are caused by the individual citizen instead of problems which are caused by industrialists.

b. The concept of cycles is encountered frequently in ecology. Yet, modern society is ignoring this basic law in its uses of natural resources.

c. It is primarily the responsibility of the government to control air pollution.

d. Any pollution act of a person is an infringement on the rights of another and should be so regarded by law.

e. Local organization is the key to effective environmental action; that is, battles on big national issues are based on the support of community groups.

f. There should be commuter taxes levied on persons who live in the suburbs and work in the central city, and the money used for the construction and improvement of public transit.

g. Modern technology will solve environmental problems.

h. The younger generation does not want to be involved in improving the environment.

6. Debriefing:

a. If students tend to cluster together because of peer pressures, you can have the students answer the statements on the paper.

b. A wide spread of positions usually indicates a good continuum statement, which causes critical thinking.

c. This activity is good for introducing a particular unit by making statements pertaining to that unit.

5) THE DISAPPEARANCE OF AN EARLY CIVILIZATION

Level: Senior

Emphasis: Problem solving and drawing conclusions

Time: 20 minutes

Materials:

1. Six information cards

Objectives: At the conclusion of the exercise, the student should be able to:

1. Describe (number) non-natural causes involved in the destruction of an ancient civilization.

2. Describe (number) things which might have resulted in maintaining the Tigris-Euphrates valley to present.

Activities:

1. Form the class into groups of six.

2. Pass out the cards to each group (one to each student).

3. Give the following directions for the exercise.

   a. Participants may not show their cards to everyone.

   b. Participants may read the information on the card to anyone in their group.

   c. Some of the information may be irrelevant.

   d. The holder of card one begins the exercise with the 'opening statement'.

4. Discussion questions:

   a. How might the Tigris-Euphrates valley have been a lush, fertile area yet today?

   b. Could the fate of your country be the fate of the Tigris-Euphrates valley?

   c. Were there any non-natural causes involved in the destruction of the valley?

Card Instructions:

Card 1.

YOU MAY NOT SHOW THIS CARD TO ANYONE IN YOUR GROUP. YOU MAY READ THE INFORMATION ON THE CARD TO ANYONE IN YOUR GROUP.

Opening statement -- The Tigris-Euphrates valley was once a land suggestive of the Garden of Eden, a rich, productive land whose people lived well, built flourishing cities, established governments and developed the arts.

Lands formerly occupied by Semitic peoples are now mostly desert.

The famous hanging gardens of Babylon were probably terraced slopes.

The Mesopotamians gradually died out or became nomads.

(Some of the information provided may be irrelevant.)

Card 2.

YOU MAY NOT SHOW THIS CARD TO ANYONE IN YOUR GROUP.
YOU MAY READ THE INFORMATION ON THE CARD TO ANYONE IN YOUR GROUP.

Gradually the fertility of the valley deteriorated because of forest cutting, erosion, quick runoff and overgrazing.

It takes 300-1000 years for one inch of topsoil to be created by nature.

Agricultural land was in a state of high use.

The Cradle of Civilization became a desert.

(Some of the information provided may be irrelevant.)

Card 3.

YOU MAY NOT SHOW THIS CARD TO ANYONE IN YOUR GROUP.
YOU MAY READ THE INFORMATION TO ANYONE IN YOUR GROUP.

The valley inhabitants introduced a complex and extensive system of irrigation works about 2000-1700 B.C.

Hammurabi's Code required a 2 shekel fine and restoration if an irrigation ditch was allowed to fall into disrepair, death on the second offence.

Terraces require much labour to maintain in a state of fertility and to minimize erosion.

It was a mistake to build terraces because a break on the upper levels is magnified on the lower levels.

(Some of the information provided may be irrelevant.)

Card 4.

YOU MAY NOT SHOW THIS CARD TO ANYONE IN YOUR GROUP.
YOU MAY READ THE INFORMATION TO ANYONE IN YOUR GROUP.

The Babylonian economy was basically agricultural.

Irrigation improved the production of the valley.

For several centuries after 1525 B.C. civil war was constant and the armies destroyed, plundered and deforested the region.

Babylon fell to invaders with superior weapons.

(Some of the information provided may be irrelevant.)

Card 5.

YOU MAY NOT SHOW THIS CARD TO ANYONE IN YOUR GROUP.
YOU MAY READ THE INFORMATION TO ANYONE IN YOUR GROUP.

The Sumerians and Babylonians developed an advanced agriculture.

Hammurabi's Code had an extensive section devoted to irrigation and agriculture.

Armies blocked water supplies to urban areas.

Grains, vegetables and fruits were raised plentifully in this fertile region.

(Some of the information provided may be irrelevant.)

Card 6.

YOU MAY NOT SHOW THIS CARD TO ANYONE IN YOUR GROUP.
YOU MAY READ THE INFORMATION ON THE CARD TO ANYONE IN YOUR GROUP.

Sumerians apparently took better care of their land than the Semitic Babylonians.

Enemies such as the Hitties (1600 B.C.) and Kossites (c. 1525 B.C.) wrecked and blocked the vital irrigation canals.

Deforested hilly land was preserved, as early as 2000-1700 B.C. by a system of terraces (similar to contour plowing), replenishment by organic materials and control of water to all levels.

Wars and invasions took a toll of the labour supply.

(Some of the information provided may be irrelevant.)

6. PROGRESS AND HISTORICAL MISTREATMENT OF THE ENVIRONMENT

Level: Senior

Emphasis: Discussing and writing

Time: Several days

Materials:

1. Library reference

Objectives: At the conclusion of the exercise, the student should be able to:

1. Describe, in writing, (number) ways the Industrial Revolution set in motion activities which resulted in environmental degradation.

Activities:

1. Supply students with the following statement:

   When man first came on the scene, the environment was 'right' and supported him. Something went wrong.

2. Have them list the things they feel 'went wrong'.

3. Then ask them to list the reasons why these things were allowed to 'go wrong'.

4. Show them the following chart of population growth.

5. Discuss reactions to chart as well as written responses to the original statement.

6. Around the year 1800 and following, what was responsible for the increase in the birth rate? (Suggest, if they do not, the 'progress' resulting from the industrial revolution in technology, medicine and industry.)

7. Discuss the industrial revolution, technology, medical improvements, etc., which occurred around 1800.

8. What direct reversals came out of each area?

   Suggest some of the following:

   a. Industrial Revolution: unfair working standards, misuse of the land, pollution, increased technology, larger families more desirable, modern warfare techniques.

   b. Medical improvements: decrease in death rate due to control of disease, control the growth of population, etc.

9. Write a paper on 'progress and mistreatment of the environment'.

10. Discuss as a class.

EVALUATION

1) GOVERNMENT SERVICE INVENTORY

Level: Adaptable to all

Emphasis: Community exploration

Time: Several days

Materials:

1. Chart paper

2. City directory listing government services and locations

Objectives: At the conclusion of the environmental encounter, the student should be able to:

1. Describe (number) the operations of government services in the city.

2. Discuss (number) alternative services which might improve government agencies.

Activities:

1. As a class, research and list relevant and essential public facilities and services in the city. For instance, which city agency is responsible for:

city statistics
disposing of trash
emergency medical services
fire protection
garbage collection
health and other services for the poor
helping citizens find employment
housing for the poor
inspection of buildings
jails
judicial system
libraries
mental health services
monitoring water quality
museums
noise regulations
park maintenance
planning new or redesigning old parts of the city
police protection
producing and supplying electricity
providing drinking water
public auditoriums
public transportation
schools
sewage treatment
street construction
street maintenance
traffic regulations
weather reporting

Group the facilities and service agencies listed into appropriate categories.

2. Form a research team for each category. Investigate the purpose and services of each facility.

3. Identify and interview individuals who use the public facilities and services under study.

4. Collect data and prepare a presentation about the findings including the following points.

   a. What is the basic philosophy of these organizations?

   b. Are these facilities and services designed for one segment of the population or are they broader?

   c. What are the advantages and disadvantages to facilities and services of this nature.

   d. Who makes the administrative decisions for these facilities and services? (city government, private foundation, community chest, etc.)

   e. Suggestions for improvements in the present administrative structure and decision-making of these facilities and services.

   f. Possible suggestions for new facilities and services that will meet the unmet needs of the urban communities.

5. Discussion questions:

   a. What reasons can you give for the location of each of the community facilities and services listed.

   b. What basic needs of people are being met by the existing community facilities and services?

   c. What basic needs are not being met by existing community facilities and services?

   d. What problems are associated with the quantity and quality of community facilities and services in this area?

   e. Which of the problems are related to regional environmental problems?

CHAPTER I: PEOPLE AND THE CITY

Never in human history has such a high percentage of the world's population lived in cities, and never have cities been growing at a faster rate. Approaching a city one not only notices the environmental changes but observes crowds of people hurrying to and fro, past stores, theaters and banks. An observer is struck by the contrast between urban behaviours and activities and those of people who live in the countryside (see figure 4). The urban way of life is distinctive, but distinctively urban behaviours are no longer confined to urban places, especially in countries where movies and television reach large populations beyond the city.

This chapter focuses on urban life for people who actually live in the city. The chapter is about the people of the city; the lives they live; how those lives differ from rural lives; how urban life differs for poor, middle-income and affluent residents; and how stresses associated with the city affect residents.

URBAN THINKING

The process of urbanization differs from one region of the world to another. For instance, cities in developing countries have long been centres for religion, education and government; but, with a few major exceptions, they do not resemble the large cities in industrialized countries. In fact, the seeming order of many old cities changed as they began to become industrialized. Large sections of cities in many parts of the world look like overcrowded villages, growing in disorderly ways with narrow streets, overcrowded and dilapidated buildings, congested market areas, unsanitary slums littered with filth, and inadequate water and electricity.

But regardless of a city's location in the world, and regardless of the physical condition of some parts of large cities, there are certain types of behaviour and ways of thinking associated with urban areas. In the most positive sense, we think of urbanized people as better informed, more sophisticated, technically-oriented and more global in their awareness. The modern resident of the city has more knowledge than was possible for people several generations ago.

One characteristic of urbanites is the readiness with which they, when compared with people who live in rural areas, accept change. The process of urbanization is characterized by change: changes in the physical environment as cities expand; changes in the social environment as urbanites strive to provide for themselves the amenities of urban life.

Life in the countryside is more co-ordinated with nature and its annual cycles; it is predictable and less punctuated by change. Life in the cityn on the other hand, lacks traditional involvement with nature and change is expected. City life is full of uncertainties related to jobs, moving about the city, crowds, decisions about how to spend leisure time, etc.

COMPARISONS OF URBAN AND RURAL COMMUNITIES

	URBAN AREAS	RURAL AREAS
ENVIRONMENT	Greater isolation from nature. Predominance of man-made environment over natural	Predominance of nature over human activity
SIZE	Larger	Small
DENSITY OF POPULATION	Higher	Low
POPULATION	More heterogeneous than rural communities	Compared with urban populations, rural communities are more homogeneous in racial and cultural traits
MOBILITY	More mobility in all categories.	Less moving, in and out, of the community and less job mobility.
INTERACTIONS	More numerous contacts. More impersonal, short-lived relationships.	Fewer contacts per person. Contacts are more personal and with familiar people.
BELONGING	Individuals frequently have a sense of being cut off from meaningful group associations.	Individuals have a sense of belonging to significant, meaningful groups.
GOALS	Individuals have a sense of pursuing divergent goals and feel no sense of oneness with other residents of the city	Individuals have a sense of pursuing common goals and frequently feel a oneness with other community members, particularly in a time of crisis.
INDIVIDUAL WORTH	Urbanites frequently regard each other as means to an end and value individuals less.	Individuals regard each other as worthwhile people

Figure 4

Research shows that urban residents are generally:

- more willing than rural dwellers to accept risks;
- more ready to try new ways of performing work;
- more guarded than rural residents when meeting strangers;
- more conscious of time and more punctural;
- more prepared for the unexpected;
- more inclined to think fast and talk fast;

In addition, urban residents are:

- less attached to old work ways and old tools;
- less bound by family ties;
- less all-around neighbourly;
- less inclined to join with relatives and friends in borrowing or lending things or in exchange of work;
- less devoted to customs and traditions, particularly ceremonial customs and traditions of family and neighbourhood;

Urban residents have the opportunity to learn to meet changing, unpredictable situations creatively. Far too frequently, however, they do not adjust well to life in complex, impersonal cities. Evidence of this is the high incidence of vagrancy, delinquency, crime and alcoholism associated with large cities.

Social Unbalance, Alienation and Deviant Behaviours

Life in the city is difficult. As cities become densely populated, studies show that many people tend to lose the capacity to integrate the elements of urban life into a recognizable, understandable, manageable whole. They sense a loss of control over a de-personalized environment. They cannot relate to the complex world around them and they feel alienated from it. Alienated members of society feel isolated, despairing and distrustful. They are more likely to develop mental health problems, become alcoholics or adopt deviant behaviour patterns as a solution to personal problems.

Why? The built-in conflict between those who experience the city as a good place to live and those who do not is one reason. The conflict arises out of the fact that cities are seen as places of opportunity, places to obtain good jobs and live better lives. Unfortunately, the city does not provide a satisfying life for everyone. In every city there are people who are jobless, deprived economically, trapped by lack of education, people who feel their lives are purposeless as a result of living in a crowded, de-personalized environment.

Social deviation patterns are more common in cities than in rural areas. The areas in the city where higher proportions of crimes are frequently committed are generally characterized by physical decay and evidence of personal demoralization and deep lack of social closeness, weak family life, low incomes, deteriorating housing and unstable neighbourhood structures where people are moving in and out, high rates of vagrancy, suicide, drunkenness and narcotic use.

In cities, as compared to rural areas, young people are in closer contact with deviant behaviour. Association with delinquent gangs is more available in cities and urban offenders become involved in criminal activities at younger ages. In addition, the impersonal attitude of people in the city makes it more possible for urban delinquents to commit crimes with less fear of affecting acquaintances.

Alcoholism is higher in cities as well. One reason is that there is more social pressure and control over an individual's behaviour in small communities. Similarly, the close and generally more caring associations in small communities appear to result in lower incidences of mental illness when compared to cities.

Affluence as a Problem in the City

While poverty is usually recognized as a problem of the city, affluence usually is not. Few have considered the consequences of urban-industrial culture and the resulting dissatisfaction with life.

Affluent urbanites expect the place where they live not only to provide shelter, but also to keep them warm in the winter and cool in the summer and to provide them with interesting leisure activities. The television becomes the home theater and large living areas become restaurants when friends are invited in. Affluent urbanites expect everything to be relaxing, sanitary and effortless. They feed well-loved pets higher quality food than some people in the city eat.

Sometimes urbanites expect contradicting and impossible things from the city. They expect small cars to be luxurious and economical. They expect to be able to drive wherever they wish, whenever they want, and not be delayed in traffic. Some expect to be ever on the move, on holiday, visiting exotic places, and still be neighbourly.

Life in the city holds out tremendous possibilities of a freer life for ordinary people but many are disappointed. Urbanites can become so involved obtaining good jobs, buying homes and household goods and acquiring other amenities of urban life, that they ignore the importance of people in their lives; the importance of family, friends and neighbours. In this way, the affluent urbanite can also become isolated, unknown and alone, reduced to insignificance as a person in a large and complex city.

Never before have residents of cities been more the masters of their own environment, yet never have affluent urbanites felt more dissatisfied. It has been suggested that urbanites have come to expect more from the city than it can offer, and that positive human aspects of living in the city are being ignored.

Community in the City

Regaining a sense of belonging, a feeling that an individual has some control over the environment of the city is important. One approach to realizing this is to reduce the size and complexity of the world a person lives in; to focus one's interactions within a small part of the city or with specific groups of people. Active participation in special interest groups, religious organizations or neighbourhoods can accomplish this.

Neighbourhoods provide a small spacial area within which an individual can focus activity and spend meaningful time with people. A neighbourhood is both a place and it is people. A neighbourhood's size is such that a person can easily walk its boundaries: it is small enough to be familiar to everyone in it.

Unfortunately neighbourhoods are in trouble in many large cities. Personal friends are scattered over large areas rather than in neighbourhoods. Working adults have less time for local activities in the neighbourhood. It is the young, the old, and the jobless who frequent some neighbourhoods, often because they do not have transportation to leave.

PEOPLE AND THE CITY: Principal Concepts

- Urban behaviours and ways of thinking are distinctive and differ from rural behaviours and attitudes.
- The urban lifestyle is not necessarily confined to cities.
- Cities are complex centres of activity and change.
- Some residents of the city become isolated, distrustful and alienated as a result of living in a crowded, de-personalized environment.
- There is a built-in conflict between those who experience the city as a good place to be and those who are jobless, uneducated, or alienated for other reasons.
- The high incidence of vagrancy, delinquency, alcoholism, crime, etc., in the city is related to how life in the city affects people.
- Areas of the city which experience high rates of crime are characterized by a lack of close social ties, weak family lives, low incomes, deteriorating housing and people moving in and out of the area.
- Affluent urbanites can also experience alienation in the city.

- Neighbourhoods are important in cities as they can provide a place small enough to be familiar and friendly to the individual.
- Participation in meaningful small groups, such as families or special interest groups, is important to developing a sense of belonging in the city.

ACTIVITIES

1) THE URBAN ENVIRONMENT AND POOR NEIGHBOURHOODS

Level: All

Emphasis: Community exploration and awareness

Time: Several days

Materials:

1. Map of the metropolitan area (for each student if possible)
2. Paper and pencil

Objectives: At the conclusion of the environmental encounter, the student should be able to:

1. Describe (number), in writing, ways the poorest people in the city are affected by environmental degradation.
2. Discuss (number) problems which result in the poor being ineffective in correcting environmental problems.

Activities:

1. Get a map of the metropolitan area and mark the location of four undesirable living areas, including areas where industries or other enterprises affect the quality of the environment such as: a steel mill, auto plant, sewage treatment plant, etc. The telephone book might assist in finding them.
2. For each areas list all the disadvantages of living there, particularly the disadvantages of living close to the industries or plants.
3. For each area determine the type of housing. Indicate whether housing is single, two family or multiple family dwellings. You can visit the areas or ask someone familiar with the area.
4. Mark the areas and industries on a large map.
5. Discuss the type of housing and disadvantages of living near each location.

6. Write a paper discussing the following questions:

   a. Why do people live near industries or other enterprises which might affect the quality of their lives?

   b. What economic segment of the population generally lives in the locations identified?

   c. What educational level is generally found in this group of people?

   d. Why are these people limited in the ways they can improve the quality of their lives?

   e. In what ways do these people pay a greater cost for our way of life than others living farther away from these offending industries?

   f. What are some possible ways the quality of life in these areas can be improved?

7. Develop a plan to upgrade one area. Make a presentation on your idea to the class.

2) FORCED CHOICES

Level: All

Emphasis: Choosing and valuing

Time: 45-50 minutes

Materials:

1. Two chalk boards or large pieces of paper

2. Space for students to move to opposite sides of the room

Objectives: At the conclusion of the exercise the student should be able to:

1. Describe verbally to other students why he/she values one choice above another.

2. Discuss verbally how every person in the city is forced to make choices every day.

3. List (number) of individual choices which affect the urban environment.

Activities:

1. Place blackboards on opposite sides of a room with sufficient room to move about.

2. Place an either/or question on the blackboards; and ask Example: Which do you identify with more

   a. Asphalt? or
   b. Grass?

3. Explain to the students that they are to select one of the alternatives and move to that side of the room where it is posted.

4. Have students form triads to discuss with one another briefly why they decided on this choice. Allow two minutes per student.

5. After the six-minute triads session have students return to the centre of the room and ask another either/or question.

6. Select a student from each of the opposing views and have them relate to the entire group why they made their particular choice.

7. Repeat steps 2 through 6 with as many questions as you choose.

8. Sample Forced Choice Questions. 'Which do you identify with more:'

   a. Asphalt or grass?
   b. Clean air or dirty air?
   c. Noisy neighbourhood or quiet neighbourhood?
   d. A clean outdoor space or a littered outdoor space?
   e. Asphalt or concrete?
   f. New housing or old housing?
   g. Trees or telephone poles?
   h. Expressways or bike routes?
   i. Urban community or suburban community?
   j. Nuclear energy or solar energy?
   k. Nuclear power plants or steam power plants?
   l. Urban farming or high food costs?
   m. Cooperative living or living alone?
   n. Have group suggest other questions?

9. Debriefing:

   a. Note the importance of having individual differences and freedom to evaluate all possible alternatives to an issue or situation

   b. Participants can physically see how their values relate to the values of the group members

   c. No position or alternative is right or wrong

d. Sharing out reasons for individual choice among group members is important in clarifying individual position

e. Any two contrasting value statements can be used that apply to the group

f. Discuss types of choices individuals make which have an effect on the city

3) RURAL, SUBURBAN, URBAN ENVIRONMENTAL PROBLEMS

Level: Elementary

Emphasis: Identifying environmental problems

Time: 30-60 minutes

Materials:

1. Several popular magazines

Objectives: At the conclusion of the exercise, the student should be able to:

1. Identify (number) rural, suburban and urban environmental problems.

2. Discuss generally some causes of environmental problems.

Activities:

1. Look through several magazines and cut out selected pictures of a rural, suburban and urban scene in which several environmental problems or potential problems are illustrated.

2. Have the students view each of the pictures for a brief period of time and have them answer the following:

   a. What are three things that you like about each picture?

   b. How do the environments differ?

   c. Do the pictures illustrate any serious environmental problems?

   d. Identify any problems that you see in each of the pictures.

3. Discussion questions:

   a. How can the problems be lessened?

   b. Who or what has caused the environmental problems?

c. Why did some students identify environmental problems more readily than others?

EVALUATION (test)

PEOPLE AND THE CITY

Multiple Choice:

1. Neighbourhoods in cities:

a. can be the solution to city problems.
b. can provide a location to spend meaningful time with people.
c. are more healthy if they are large.
d. generally are dominated by one family.
e. are heterogenous.

2. Comparing urban and rural areas, there is:

a. greater isolation from nature.
b. impersonal relationships.
c. predominance of man-made environment.
d. none of the above.
e. all of the above.

3. The following is an indication that there is a conflict between what people expect in the city and what they have:

a. traffic congestion.
b. neighbourhoods.
c. becoming affluent.
d. development of delinquent gangs.
e. none of the above.

True-False

_____ 1. The process of urbanization is very similar in cities throughout the world.

_____ 2. The urban way of life and thinking is confined to cities.

_____ 3. Urbanites are better than people who live in rural areas.

_____ 4. Some residents of the city feel a alienated, isolated, and alone in the city.

_____ 5. Young people in rural areas are in closer contact with criminal behaviour than young people in the city.

_____ 6. Cities are places of opportunity and help people live better lives.

_____ 7. Alcoholism is generally higher cities than in rural communities.

_____ 8. Both rich and poor residents of the city can feel isolated in the city.

_____ 9. Areas in the city where crimes are committed generally lack strong social and family ties.

Key: PEOPLE AND THE CITY

Multiple Choice:

1. b
2. e
3. d

True-False:

1. False
2. False
3. False
4. True
5. False
6. False
7. True
8. True
9. True

CHAPTER II: CITY GROWTH PATTERNS AND LAND USE

Throughout history, cities have been compact and densely populated. Because of their relatively small population - 10,000 to 100,000 until a few hundred years ago - they were able to coexist with the natural environment that surrounded them. The rapid growth of cities during the past hundred years points to man's success in adapting the land and its resources to his own needs.

Every city has its own unique natural features. Cities tend to take their form from the nature of their site. London and Paris are located on major rivers, Istanbul on a strategic strait, San Francisco and Rio de Janeiro on superb harbours.

Early cities evolved on land which was easy to defend, on bluffs or at the mouths of large rivers. Large cities throughout the world are located on sites with access to water for industrial processing and transportation of goods and raw materials. Rich hinterlands for raising crops were also important.

In the nineteenth century, well-travelled city routes became the thoroughfares along which new growth occurred. When space became limited in the centre of the city, new nodes of growth typically appeared on the city's edge. New clusters of urbanization were linked to city centres by public transportation, usually railroads.

In the twentieth century open space has decreased inside the city and outlying nodes have become business districts in their own right. Increased wealth and the advent of automobiles have made it possible for some city dwellers to move from central areas to fringe areas. The desire to escape traffic congestion, higher taxes and fares, along with the consequent decentralization of industrial activities and jobs, as well as the search for green spaces and individual housing as opposed to rundown city neighbourhoods, have resulted in unpredictable growth patterns on the edges of large cities. The newer areas are called suburbs. Suburbs are single-function residential areas and generally are located on the most accessible land surrounding cities.

As cities grow, agricultural land and open countryside around cities disappear and with them traces of nature, fields, woods, streams, thickets and wildlife. The medieval urbanite could walk through a gate into fields, forest, or onto the shore. Today, the city dweller's contact with expansive natural areas is limited.

Urban density has been falling as a result of a higher standard of living and greater mobility of the urban population. There is growing concern about unplanned urban growth. Sprawling cities (surrounded by suburbs) are more costly in a number of ways when compared to older, more densely populated cities. They require more miles of highways, water and sewer lines. They increase fuel consumption and require higher taxes to provide adequate police, fire, health and other services.

Urban land can be used in thousands of ways, however, for study purposes division into six major categories is useful: 1) Commercial: sites for businesses which buy and sell goods; 2) Industrial: sites for the manufacture of goods; 3) Transportation: networks to move people and goods about the city; 4) Residences: sites for urban dwellings; 5) Public: primarily sites for government buildings; 6) Open space: land left open primarily for leisure activity.

Commercial Land Use

Surprisingly, businesses are small users of urban land. They appear to be large users because they are highly visible and lie along main city streets. Historically, central business districts were the major business centres. However, today's cities contain a wide variety of other commercial areas.

Secondary business areas are generally located along major thoroughfares. This development is frequently called 'strip commercial' development. Shopping centres are a major secondary commercial activity in many large cities. They are characterized by clusters of commercial enterprises located on one site, generally along a major highway. Large amounts of land are provided for the parking of automobiles. New shopping centres can divert business from central business areas and large shopping centres can become substitute city centres.

Finally, urban land is used by convenient, well-frequented stores, restaurants and entertainment establishments in residential areas.

Industrial Land Use

Historically, industrial activity was concentrated in sectors near the city centre. The past forty years have seen industry moved from cramped city centre locations to fringe locations. In suburban settings, land is less expensive and industrial complexes often resemble park developments.

Residential Land Use

Of all uses, the percentage devoted to single-family and multi-family housing is the greatest. High density housing such as apartment buildings and attached single-family homes consume less city space than low density suburban areas containing single-family residences with spacious surrounding property. Research indicates that high-density residential areas are more economical, requiring less fuel for home heating and automobile use than low-density residential areas.

Transportation Land Use

Land devoted to transportation has increased dramatically in recent years as cities have completed multi-lane freeways and constructed elaborate interchange systems connecting them to city streets. Freeway interchanges consume as much as 35 hectares of land; freeways as

much as 5 hectares of land per kilometer. Cities may devote as much as 50 per cent of the land to automobile-related activity: streets, parking lots, driveways and automobile service and sales.

Public Land Use

Publically-owned land has many uses: space for government buildings, parks or commons, schools, prisons, hospitals, green belts, etc.

Open Space

'Open space' is an ambiguous concept. 'Open space' is basically urban land not occupied by man-made structures. Most frequently, it is also public land. The most ambitious efforts to preserve urban open space have been the establishment of green belts around cities. A well-established example is London, United Kingdom. In 1931, a green belt act was passed and land was purchased to provide a large belt of permanent open space surrounding London.

Open space in the city has several purposes: 1) aesthetics, preservation of visually pleasant and beautiful places, 2) recreational sites, places for people of all ages to gather, 3) preservation of unique historic areas, 4) provision of natural areas for wildlife in the city environment, 5) reduction of urban noise and adverse effects of air pollution and heat accumulation in cities and 6) as mentioned above, as a way to shape urban growth by blocking harmful development patterns.

CITY GROWTH PATTERNS AND LAND USE: Principal Concepts

- City growth occurs along well-traveled transportation routes.
- As cities grow, fringe communities are absorbed into the city proper.
- Increased mobility of affluent urbanites has resulted in development on the urban fringe, termed suburban development.
- Some city centres are losing population as affluent urbanites move to fringe communities or suburbs.
- Uses of city land can be combined into several major categories: commercial, industrial, transportation, residential, public and open space.
- Business is a highly visible user of city land which consumes only a small percentage of the total area occupied by the city.
- Uses of land for industrial purposes is shifting from central locations to fringe areas.
- The largest uses of land in the city are residential and private and public administrative services.

- High density residential development can reduce the need for automobiles and home fuel requirements.
- Considerable land in most cities is devoted to transportation, streets, railroads, multi-lane freeways, parking lots and service stations.
- Publically-owned land is used for a wide variety of governmental services.
- Open space is an important, and frequently ignored, use of city land.

ACTIVITIES

1) POPULATION STICKS

Level: Elementary

Emphasis: Man's interdependence with the environment

Time: 30 minutes

Materials:

31 pick-up sticks (approximately 20 cm. in length) with coloured markings on them. (One for each group of 3 students.)

sticks	colour	points
1 Man	Black	60
5 Water Pollution	Blue	10
5 Waste	Green	6
10 Energy Crisis	Red	2
10 Air Pollution	Yellow	5

Objectives: At the conclusion of the exercise, the student should be able to:

1. Describe, in writing, man's role in environmental problems.

Activities:

1. Divide class into groups, three persons to a set of sticks.
2. Pass out sticks.
3. One player tries to pick up as many sticks as possible (one at a time) without moving the other sticks.
4. Two people watch and keep time.
5. Add up points. The black stick may be used to help pick up other sticks.

6. Demonstrate to the students that no matter which stick they start with or collect (water, waste, etc.) the problem centres around the black stick (man) and man is the one to solve the problem.

7. Discussion questions:

   a. Which stick is the most important to get? Why?
   b. When solving an environmental problem, what role does man play?

2) POPULATION TRENDS

Level: Senior

Emphasis: Organizing data and developing awareness

Time: 30 minutes

Materials:

1. Data gathered by each student

2. Graph paper if desired

Objectives: At the conclusion of the exercise, the student should be able to:

1. Organize population data for analysis.

2. Describe (number) factors affecting family size.

3. Discuss verbally (number) factors which affect population growth.

Activities:

1. Each student is asked to bring in the following information about his or her own family:

   a. Number of children in family including all first cousins
   b. Number of children in mother's family
   c. Number of children in father's family
   d. Number of children in maternal grandfather's family
   e. Number of children in paternal grandfather's family
   f. Number of children in maternal grandmother's family
   g. Number of children in paternal grandmother's family
   h. How many of these reached age 5?
   i. How many of these reached age 18?
   j. How many of these reached age 50?
   k. Oldest living?

2. Form the class into groups of four.

3. Give the following directions:

   a. Pool information so that all statistics represent group totals for each category

   b. Compile data so that a comparison of family size can be made, i.e., grandparents, parents, children

4. Following compilation of data, ask some or all of these questions:

   a. What is the trend in family size in the three generations?

   b. What could account for the sameness or differences in size?

   c. What comparison can be made regarding infant deaths in the last 50 years?

   d. What is happening to the family unit?

   e. Why were big families necessary in rural communities?

   f. What economic factors are affected by lowering family size (possibly amount of manufactured goods, schools, etc.).

   g. How can the population size be increasing when the family size is decreasing?

5. Variation: ask for report to include the identification of the number of girls and boys in each family so that number of survivals and longevity can be compared by sex.

3) BEAUTIFYING A SHOPPING AREA

Level: Elementary, Middle

Emphasis: Exploring the community and constructing a model

Time: several days

Materials:

1. Cardboard, miniature trees and bushes

2. Optional: camera

3. Chart paper and markers

Objectives: At the completion of a successful encounter, the student should be able to:

1. List (number) ecological and aesthetic concerns relating to the present plan of a particular shopping area.

2. List (number) improvements which could occur to minimize these problems.

3. Build a model of the shopping area with movable parts in order to show its present status and its status with improvements.

4. Plan a presentation of the ideas concerning the shopping center with an explanation of the model to the shopping centre managers and appropriate government officials.

Activities:

1. Take a field trip to the site. If possible use a camera to take pictures. Consider the following:

   a. Are there any plants?
   b. Do the signs blend in with the environment?
   c. Is there any area for relaxation?
   d. Does the area provide for the separation of people and cars?
   e. Have litter baskets been provided for waste disposal?
   f. Does water stand in the parking lot or is there good drainage?
   g. Is there good access to the highway?
   h. Is there access for mass transit?

2. Suggest ways to beautify the site. Consider:

   a. What plants could be brought in?
   b. Could they be planted directly in the ground or would they need a planter?
   c. Design an attractive sign for the store front.
   d. Could a courtyard area with benches be designed?
   e. Where could walkways from the parking rows be placed?
   f. Where could litter baskets be placed?
   g. Observe the parking lot after a rain? Does the water run off toward a drain?
   h. Where are the main roads?
   i. Is there at least one wide entrance and exit at each?
   j. Where could bus stations be placed?

3. Additional questions:

   a. What are the benefits of plants?
   b. Why is a sign that blends in with the environment more aesthetically pleasing?
   c. Why would it be beneficial to provide some recreation?
   d. What safety and aesthetic benefit is there in separating people and cars?

e. Why are litter baskets needed?
f. What are the hazards and inconveniences of a parking lot with poor drainage?
g. Why should access be convenient?
h. Would a mass transit station encourage more people to come by bus?

4. Using cardboard make a model of the building and existing areas. Small boxes could serve as benches and planters. Minature bushes and flowers could be purchased. Allow the improvements to be movable so they can be changed around in order to get the feeling of design and different points of view.

5. Try different locations for the beautification features of the improvements. Mark drain areas and road and mass transit access. Rearrange the model until the arrangement corrects the faults using the space efficiently.

6. Secure a location for display of the model in the school. Go to the office of the shopping centre with the list of problems and improvements and explain how the model was built. Ask permission to display the model to the public.

4) LAND USE STUDY

Level: All

Emphasis: Exploring the community and planning

Time: Several days

Materials:

1. Access to information on government agencies.

2. Survey material, paper, pencils.

Objectives: At the completion of an environmental encounter, the student should be able to:

1. Describe in writing (number) the natural features that should be considered in determining the particular land use of the area under study.

2. Identify the individuals or groups of individuals that have the authority to determine the use of the area.

3. List (number) criteria that should be accounted for in determining a particular use of the area.

4. Write out a plan for the use of the area showing how it improves upon the existing use.

5. Describe in writing the major actions needed in order to have the desired area use plan adopted.

Activities

1. Select a study site -- a large vacant area or an area in need of change.

2. Carry out a site inventory of characteristics of the land. Is there water present? Does it appear frequently? Is the land on a slope or level? What kind of soil is there? What is its present use? Does the area appear to have been used for another purpose at some other time? How long has it been used for the present purpose? One group could research this question. Sources of information:

   a. Interview older residents living in the area.

   b. Interview a community resource person knowledgeable in this field.

3. Report back to the class on the collected data. List the problems existing because of the present use of this area:

   a. Compatibility of use to natural characteristics.

   b. Compatibility of use to location of area (noise factor, traffic, etc.).

   c. Cause for danger or accidents.

   d. Effect on surrounding activities now taking place.

4. List present features you would not want to be destroyed.

5. Interview teachers and students throughout the building to obtain their attitudes about this area and its present use. Areas to investigate:

   a. Major concerns or complaints of present use.

   b. Suggestion of an alternate use for the area.

   Compile a list of these suggestions in order of degree of concern.

6. Obtain information regarding who has the authority to plan a new use for the area.

7. Based on collected information and suggestions, natural features, and the needs of the concerned persons, determine desired alternative uses for the area.

8. Design a plan including these alternative land uses. (This could be done by dividing into groups, each working on a particular plan of use.) Select a design the class

feels is most satisfactory in fulfilling the needs and desire of the majority of the concerned people, taking into consideration the compatibility of use of the natural characteristics of the area.

9. List reasons for deciding on the design you did and give rationale behind your reasons.

10. Choose an alternative plan and support with reasons why it could be used.

11. Present the design and plan to appropriate individuals in the community.

EVALUATION (test)

CITY GROWTH PATTERNS AND LAND USE

Multiple Choice:

1. Commercial land use in the city may be _____.

   a. food markets
   b. businesses
   c. shopping centres
   d. all of the above
   e. none of the above

2. Residential land is used by _____.

   a. apartments
   b. single family housing
   c. multi-family housing
   d. all of the above
   e. none of the above

3. Newer cities often devote as much as _____ of the land for uses related to transportation.

   a. 50%
   b. 1%
   c. 75%
   d. 20%
   e. 100%

4. What land use category represents the largest user of land in cities?

   a. industry
   b. commercial
   c. residential
   d. public
   e. parks

5. _____ housing patterns consume less city space and fuel.

a. single family residential
b. low density
c. high density
d. mixed
e. stable

6. Publicly owned land is used for _____.

a. government buildings
b. parks
c. schools
d. hospitals
e. all of the above

7. Open space in cities is most frequently _____ owned.

a. privately
b. publicly
c. industrially
d. commercially
e. residentially

8. Land used industrially in cities was historically located in _____.

a. the city centre
b. the city edge
c. the residential area
d. the rural area
e. outside the city

9. Secondary commercial development in cities is frequently located _____.

a. in the central business district
b. on preserved open land
c. in industrial areas
d. along major thoroughfares
e. outside the city

10. Sprawling cities require _____ money to maintain the same services.

a. more
b. no
c. less
d. the same amount of
e. generated

11. Higher standards of living and greater mobility of the population have resulted in _____ population in some central areas of large cities.

a. increasing
b. stable
c. decreasing
d. fluctuating
e. none of the above

12. City dweller's contact with large natural systems is frequently _____.

a. great
b. disappointing
c. extensive
d. limited
e. impossible

True-False:

_____ 1. Business uses the majority of land in the city.

_____ 2. Outlying fringe communities tend to become part of the city proper.

_____ 3. Increased affluence has stimulated many urbanites to move to areas outside the city.

_____ 4. The population in some city centres is falling because of the greater mobility of the urban population.

_____ 5. Transportation uses a relatively small amount of land in the city.

_____ 6. City land devoted to residential uses consumes the largest percentage in the city.

_____ 7. Multi-family housing uses less fuel for heating than single family housing.

_____ 8. The primary value of open space in the city is for parking motor vehicles.

_____ 9. Cities tend to take their form from the nature of their site.

Key: CITY GROWTH PATTERNS AND LAND USE

Multiple Choice

1. a
2. a
3. a
4. c
5. c
6. e
7. b
8. a
9. d
10. a
11. c
12. d

True-False

1. False (housing)
2. True
3. True
4. True
5. False (large amount)
6. True
7. True
8. False (aesthetics and recreation)
9. True

CHAPTER III: TRANSPORTATION IN THE CITY

Modern cities depend on extremely complex transportation systems for survival. Transportation systems move people and goods into, out of and through cities and connect cities with activity beyond their borders. It is these same life-giving transportation systems which are responsible for many of the problems threatening urban life in the twentieth century.

Problems related to moving people and goods about the city are not new. In the first century A.D., the government of Rome restricted vehicular traffic, with the exception of chariots and state vehicles, to night hours to relieve traffic congestion. In the 19th century, industrializing cities began to demand more rapid and efficient transportation of raw materials and manufactured goods. The transportation systems we see today began to emerge: railroads, tremways, buses and automobiles.

There is no single transportation problem in cities, but the majority of the problems can be traced to one source: the internal combustion engine as it powers private automobiles, trucks, buses and motorcycles in and about the city. These modes of transportation result in a host of urban problems: 1) air pollution, 2) excessive energy consumption, 3) traffic congestion, 4) parking problems, 5) consumption of land to construct new highways, 6) urban noise, 7) deaths and injuries due to traffic accidents and 8) high personal costs related to operating and maintaining private automobiles.

The most obvious problem in the eyes of the individual city dweller is 'traffic', congestion or overloading of city streets. The origin of traffic problems is related not only to the size of cities, but also to higher incomes and expectations of greater convenience and comfort in personal travel. Both affect the city dweller's choice of residence and mode of travel. As a result, private ownership of automobiles is increasing in cities everywhere.

The modern journey to work accounts for a large part of city traffic. Employees no longer live in the neighbourhood in which they work. They are free to choose a residence and a place to work in different parts of the city. They have the money and time to move to and from work twice, sometimes more, each day. Often workers who have moved to the suburbs continue to work in the city and owning a car becomes a necessity. Once a family owns a car, it is used frequently and daily trips to work and elsewhere increase.

As industries move to the suburbs, traffic increases and beltways or loops appear around cities. As cities attempt to build enough freeways to meet peak demands, the forces are set in motion which bring additional people into the city and more roadways are needed. It's a vicious circle and, obviously, cities have a limited capacity to absorb automobiles.

As long as we continue to increase the number of automobiles in the city, man's activities will be affected. Automobiles are noisy and produce potentially dangerous pollutants. Private automobiles are expensive to buy and expensive to operate. The price of gasoline is increasing and insurance is costing more. Hidden costs of

operating an automobile include taxes paid to the government to build freeways and maintain streets and medical bills resulting from health problems caused by air pollution.

The overwhelming presence of auto traffic limits people-oriented activity. Studies of urban neighbourhoods indicate that pedestrian traffic is important because it increases opportunities for tension-relieving interactions among residents, an important ingredient of healthy communities. Excessive motor vehicle traffic forces pedestrians to walk along narrow strips of concrete only a few feet from speeding automobiles and discourages bicyclists from using major thoroughfares.

With all of the problems caused by automobiles, why have automobiles become so popular? Partially because of the service they provide and partially because they have become a symbol of wealth. The automobile, as compared to public transit, is always ready to go; it is flexible; it can reach any destination by any route and often saves time; it involves no waiting or stopping to pick up and deliver other passengers; it involves less walking and no waiting to begin the trip; it is protection from rain, the cold and heat; it provides privacy and guarantees a seat.

Other modes of vehicular transportation can be used to move people in cities; some are more than a century old. All produce fewer detrimental effects than the automobile, primarily because dozens, even hundreds, of people share each trip. Such forms of urban transportation are called 'mass' transportation. Mass transit systems are usually owned and operated by the government. They are available to everyone for a small fee while automobiles are generally privately owned and operated by individual owners.

Mass transit systems which emphasize speed, such as underground and above ground rail systems, are called 'rapid transit' systems. Bus systems must compete with automobiles, and the emphasis is seldom on speed. The advantage of buses is that they use the same street systems constructed to accommodate automobile traffic, and consequently can serve a broader urban population.

TRANSPORTATION IN THE CITY - Principal Concepts

- Transportation systems are important in cities as they move people and goods about the city and connect cities with activity outside the city.
- Automobiles increase the mobility of residents, but result in serious traffic problems.
- Vehicles powered by the internal combustion engine cause air and noise pollution.
- The construction of more thoroughfares and freeways in and around cities increases access to the city and results in an increased number of automobiles in the city.

- Automobiles are expensive to operate and consume more fuel per passenger mile than modes of mass transit.
- Mass transit systems operated by the government produce fewer detrimental environmental effects in the city.
- Automobile traffic is a threat to pedestrian and bicycle traffic.
- Automobiles are viewed as a symbol of wealth.

ACTIVITIES

1) SCHOOL SITE TRAFFIC PLANNING

Level: Elementary

Emphasis: Planning

Time: Several days

Materials:

1. Paper and pencils
2. Recording sheets

Objectives: At the conclusion of the environmental encounter, the student should be able to:

1. Identify (number) modes of transportation used to and from schools and on the school site.
2. Identify (number) existing traffic problems that lead to and from school and on the school site.
3. List (number) ways of effectively solving traffic problems on the way to and from school and on the school site.
4. List (number) the major objectives of effective traffic pattern planning.

Activities:

1. Develop a classroom discussion on the following topics:
   a. Modes of transportation used to and from school
   b. Modes of traffic that exist on the school site
2. Organize your class into two working groups to carry out the following surveys:
   a. Group A

1) Survey the school site to determine the traffic patterns and problems that exist on the site.

2) When determining problems consider:

a) Access to:
parking areas
loading zones
driveway
others
b) Walkways
c) Bicycle paths
d) Conflict of vehicles and people
e) Others

b. Group B

1) Survey the surrounding community (within your school's boundary) to determine the traffic patterns and problems that exist on the way to and from school.

2) When determining the problems consider:

a) Congested travel routes during the school's opening and closing hours
b) Dangerous intersections
c) Dangerous walkways
d) Narrow roadways
e) Poor visibility
f) Others

3. In the classroom, share your findings with each other and record your information in a manner that will later help you develop more effective traffic patterns. Example:

a. Group A

Types of Traffic Patterns on the School Site	Existing Problems	Alternative Solutions

b. Group B

Type of Traffic Patterns -- To and From School	Existing Problems	Alternative Solutions

2) SURVEY OF USE OF MOTOR VEHICLES IN THE CITY

Level: Elementary

Emphasis: Collecting and organizing idea

Time: Several days

Materials:

1. Graph paper for tabulating data
2. Paper and pencils

Objectives: At the conclusion of the exercise, the student should be able to:

1. Collect relevant data necessary to study a community problem.
2. Organize and analyse the data relevant to automobile usage in the community.
3. Discuss, in writing, (number) facts about automobile usage in the city.
4. Discuss, in writing, (number) ways alternative uses of motor vehicles could improve environmental quality.

Activities:

1. Divide the class into four teams. Tabulate the size and number of cars, buses, motorized bicycles passing corners of the school and the number of people in each vehicle. Team will work in groups of two - one will

observe and count, the other will record. Each pair will record data as small cars, large cars and buses, the number of passengers in each. All teams use the same code: S 1 (small car and driver only), S 3 (small car, driver and two passengers), L 2 (large car and two people), BL (bus light load), B F (bus full load), etc.

2. For more accuracy, different times of the day should be used and several days ought to be used for sampling.

3. The whole class should have a briefing session before the tabulating is done so that all are in agreement on code used and how to judge the fullness of bus and size of car.

4. When teams return they will record their data on nine different master sheets. Example:

   a. Friday 8:30-8:50 a.m.
   b. Friday 10:45-11:10 a.m.
   c. Friday 12:30-12:50 p.m.
   d. Monday 8:30-8:50 a.m.
   e. Monday 10:45-11:10 a.m.
   f. Monday 12:30-12:50 p.m.
   g. Tuesday 8:30-8:50 a.m.
   h. Tuesday 10:45-11:10 a.m.
   i. Tuesday 12:30-12:50 p.m.

   On the day when organizing of data is to be done, form the class into nine groups. Each group will take one master sheet of data and organize it by counting each classification. Example: S L; S 2 or 3; S 4 or more; L 1; L 2 or 3; L 4 or more; B L; B M; B F. Total of tabulations should equal total of cars listed. When each group finishes the count and checks, the talleys can be put on squared paper and some totals can be figured.

5. Discussion questions:

   a. Can you form any conclusions about how people are using motor vehicles?

   b. Can you suggest some ways we can use automobiles and buses to economize or save gasoline?

   c. Did you have any difficulty with the collecting data? If so, can you suggest how the method can be improved?

   d. Did you meet with any reactions from people as you collected your data?

3) NEW EXPRESSWAY SIMULATION

Level: Middle, Senior

Emphasis: Role-playing

Time: Two to three hours

Materials:

1. Cards with position statements for nine students

Objectives: At the conclusion of the exercise, the student should be able to:

1. Describe (number) ways the construction of an expressway inside a city affects the residents.

2. Describe (number) ways the construction of an expressway inside a city has an impact on the environment.

Activities:

1. Introductory remarks should be read or noted on the chalk board, The City Commission has joined forces with the Government to construct an expressway through the city. The city has a population of 1,500,000. Including the suburban area, the population is 2 million. The community has a central urban core, along with a growing suburban district, surrounded by fertile farmlands. We will simulate a planning session in which various interest groups will represent their positions in an attempt to:

   a. Approve the proposed plan.
   b. Recommend an alternative paln or route.
   c. Decide against any expressway construction.

2. Pick ten students who will be representing their interests - one moderator, nine spokesmen.

3. Divide the remaining class into groups centred around each of the nine spokesmen to explore reasons to support the particular spokesman's position.

4. Reassemble the class after 15 minutes of group discussion and have the spokesmen each state their position, formed from the position statement and any suggestions from the group discussion. This part of the activity could be completed in the first class period.

5. The following class period should open once again with the spokesman stating their positions to the rest of the class.

6. Class discussion should follow to determine which policy they feel is best. Vote to make a final decision.

7. Discussion questions:

   a. Who do you feel planning normally benefits? Was this the case in the simulated session?

   b. When should planning for major constructions be started? 1 year, 2 years, 5 years, etc. before construction?

   c. Does your city have a major expressway running through or around it? If so, what types of planning do you think took place?

      1) Who benefited most from its construction?
      2) Who benefited the least?
      3) What environmental problems do you observe that are directly related to the expressway?

   d. If your city doesn't have an expressway in or around it at present, do you expect one to be built soon? What environmental considerations do you feel a new expressway in your community should take into account?

8. Position statements: These should be on large cards.

   a. Displaced Resident - The proposed plan places the expressway directly through my neighbourhood forcing me to leave my home and move somewhere else. Wherever I move will be much farther from my job. My children will have to leave their school and friends. I won't be able to find another house to buy with my present income and will have to move into Public Housing, or rent an apartment.

   b. Dairy Farmer - The proposed plan for the expressway will go through one-half of my farm. My dairy herd will have to be reduced in half because of the loss of pastureland. I am told by other dairy farmers that my remaining cows will produce less milk because of the constant noise from the neighbouring expressway. I don't think I can make it anymore as farmer with only one-half of my herd remaining. I feel all I can do is sell my land to developers for a new shopping centre. I enjoy being a farmer, and now, although I will receive a good price for my land from the developers, I can no longer farm and must look for another kind of job. I used to enjoy relaxing on my front porch under the large oak tree in my yard. The power company informed me that they must cut my tree down to put their power lines through to the proposed apartment complex that will be built alongside the new expressway. My oldest son was planning to take over the farm a few years from now and to keep the farm going like it has now for 100 years. I used to like the quiet, easy-going life on my farm, but I guess it is all in the past.

c. City Businessman - This new expressway is just what I've been waiting for. My business will surely increase with more people coming to the city on the new expressway. I should also get more business from people coming through on weekends. I can now think of expanding my business and placing another store in one of the new proposed shopping centres that will be serviced by the expressway.

d. City Council - We feel that the new expressway will be a huge economic boom to our community. People will be able to move much easier through the city, allowing people in suburban areas a quicker way to get to the downtown business district. The construction will provide many more jobs for the people in our community and will pave the ways to more progress, more industrial growth, and more business from the neighbouring metropolis. Our community needs this link to other communities to keep it alive and growing. Without it we will continue to remain isolated from the mainstream of our progressing society.

e. Resident Living Alongside Expressway - The new expressway will be placed directly alongside my home. I have heard that the noise from the constant traffic might keep my family awake at night. My job is only a short, five minute drive from my home now, because I can travel on little-trafficked residential streets. I understand that with the proposed expressway my normal route will be blocked off, forcing me to use the expressway to get to work. I imagine during rush hours it might take me 20-30 minutes to travel to work. My children would have to cross over the expressway to get to school and I am worried about their safety. The street in front of my house is planned to be widened to four lanes to line up with the expressway. I think many of my neighbours will be moving away. I like my home and do not want to move, but I am concerned about living so close to an expressway.

f. Construction Worker - Working on the expressway construction will mean a steady, high-paying job for me several years. Maybe now I can start thinking about buying my own home. The expressway should lead to more construction in our community, which would allow me to maybe start a small construction firm of my own in the near future. I don't care where the expressway will be built, as long as it is built.

g. School Child - My parents tell me that the new expressway is planned to go right through the park next to the school. I go there often with my friends. We look at animals, go fishing, and just to sit in a nice quiet place. I don't understanding why they have to build a road through the park. No one ever asked me if I wanted it; and I don't.

h. Corner Grocery Store - I am going to have to sell my business if the expressway comes through because many of my customers will be shopping at the large supermarket that they can get to quickly by the expressway. I've run this store for 25 years and I have many regular customers who depend on my store to buy their food. Many of the older folks in this neighbourhood can't afford to drive to the supermarket, but I know I can't stay in business with only my regular customers. I need the customers that will be going to the larger stores that they can reach more easily by the expressway than they could before. I won't be able to compete. Maybe I can get a job in one of those chain-stores in the shopping centers, but I am 55 years old and they might not want to hire me.

i. Environmental Citizen Group - We feel that the proposed plan of building the expressway through our city will cause many serious problems. Just look at other cities that have done the same. Their housing situation became critical, with the expressway going through the heart of the low-income housing. These people then can't find another home they can afford, and must rent or receive assistance for the local or federal government for housing. The plan for the new expressway in our expressway in our community will also destroy a city park that adds so much to our city's environment. We are very concerned. Our city has a unique character of its own and we are afraid of losing that by placing and expressway through the middle of our city. We propose another plan for re-routing the expressway around the immediate city and preserving the quality of our city's environment.

4) LOCAL HEARING ON TRANSPORTATION ALTERNATIVES IN THE CITY

Level: Senior

Emphasis: Role-playing

Time: Several days

Materials:

1. Position statement cards for ten students

2. Chalk board to list discussion questions

Objectives: At the conclusion of the exercise, the student should be able to:

1. List (number) types of transportation available for use in the city.

2. Describe what city users are looking for in choosing each mode of transportation listed in objective number one.

3. Discuss (number) ways a city's size and population density affects transportation needs.

4. The impact of each transportation mode on the city.

Activities:

1. Read introductory remarks: Although advanced technology continues to respond to changing transportation needs, the problem of moving people is essentially a social, not an engineering issue. When making a transportation policy we must balance personal needs, particular group interests, and the needs of the community as a whole. In class, we will simulate a hearing on whether or not to make funds available for the construction of new mass transit systems and for the improvement of existing rail and mass transit facilities.

2. Questions for pre-hearing discussion:

   a. What different means of transportation are available?

   b. Who uses the various means and why? Consider characteristics of the population such as age, income level, and type and location of employment.

   c. What are the characteristics the user looks for in choosing a particular mode of transportation? Does the user always have a choice?

   d. How does the size, density and location of the population alter a region's transportation needs - especially in terms of cost, comfort, convenience, efficiency and reliability?

   e. What is the impact of each transportation mode on the community, considering questions of noise, air pollution, land use, energy requirements, safety and service benefits?

3. Give ten students cards with their position and/or speech. Allow them to study their position for several days.

4. Arrange classroom for a hearing.

5. Each speaker will make a statement. After hearing all statements, officials A, B and C will state how they feel about the issue. They are the 'decision-making' group.

6. Class discussion:

   a. What is the purpose of a local public hearing?

   b. Have any been held lately in your city? Have you attended one?

c. Do you think government officials make use of the information brought out in a public hearing? Do they have to by law?

d. What kinds of pressures might cause the public officials to ignore public opinion in a decision?

e. Is there some way of having a stronger effect on decision-makers?

f. Who do you think ought to make environmental decisions? Government? Industry? Consumers?

7. Position statements: (These should be on cards.)

a. Official A: from the capitol - wife is a staunch environmentalist.

b. Official B: from a small city - former oil company executive.

c. Official C: from a big city - co-owner of largest construction company in the region, specializing in low cost housing construction.

d. City Planner: construction of additional roads to accomodate community growth has only contributed to urban sprawl and has not reduced congestion. In the past, funds have been used not only for widening streets, but for lengthening them, which only increases the geographic area covered and the number of people using the roads. Since roads can't accomodate unlimited numbers of autos, we should use these funds to develop alternative transportation systems that relieve highway congestion and promote more rational suburban development. Ours is not the only community that is grappling with problems aggravated by changing population distribution and density. But right now, we should be spending available funds on a mass transportation system that eventually will limit and shape future residential and industrial development.

e. Promoter of Freeways: Money should be used for highway maintenance and construction only. After all, the people using the roads are paying for their use through taxes on trucks, buses, gasoline, tires, and many other goods related to cars. All this talk of limiting future highway construction and use of cars is fine, but what about transportation requirements of the less developed rural areas? The enormous cost of building and maintaining rural roads to improve access to these isolated areas cannot be underestimated.

f. Environmentalist: the social cost of car use in terms of both noise and air pollution is sufficient reason for redirecting this money toward developing alternative

modes of transportation and for improving existing systems in order to move more people more efficiently. The entire community is now obliged to pay for the privileges of those who can afford auto travel. Many people in cities are without car transportation. Rail transit is potentially faster, less expensive, and far less damaging to the environment. In fact, six times less energy is required to move a ton of freight by train than by truck. Despite a severe oil and gas shortage, car ownership and use continue to climb.

g. Housing Developer: Suburban development has occurred for no other reason than that people want the benefits of living in a less densely settled neighbourhood. They've moved to get away from crowding, to find more open space, cleaner air, less noise, etc. If mass transit extended to the suburbs, an undesirable, but certain result will high-density development along the transit routes. Also consider that highways provide the greatest route flexibility of all existing systems of transportation. Why should we put more money into rail systems when ridership is declining? Even modern subways offer no guarantee of luring people away from their cars. Public transit systems lock us into predetermined routes that may not follow the distribution and flow of people 15 to 25 years from now.

h. Citizens' Committee: Citizen A: Daily commuting from the suburbs to the city by car is an increasing hassle not only in terms of time, but because the parking shortage is more and more severe - just think of the cost of all the policemen needed to control parking violations! But what alternatives do commuters have? Bus and train service is far from adequate. Actually it is not hard to see why so little has been done to develop balanced regional mass transportation systems if you consider the lopsided allocation of transportation funds from government sources: 5 per cent for rails and 3 per cent for mass transit.

Citizen B: As a city-to-suburb commuter, dependent on existing public transit, I have to change buses three times in a one-half hour trip to reach the suburban industrial plant where I work. Owning a car would ease this trip, but the costs involved are simply too great. And moving to the suburbs is no solution: who can afford it these days? Frankly, I see a number of social injustices in the present transportation system in this country. Low income families have no cars. Older people have no cars. Without a better and cheaper mass transit system, how are these people to gain access to opportunities in the city?

i. Representative of a Motor Company: The economic effects of reducing dependence on the auto would be disastrous to the health of the economy. Just think of the many businesses and services that are related to the auto

industry. At a time when the unemployment level is high we cannot afford to alter a consumption pattern in a way that would result in robbing more people of already scarce jobs. In addition it takes from eight to fifteen years lead time for planning and constructing a mass transit system. In a decade technological advances could make existing plans completely outdated. The automobile industry is sensitive to the changing needs and requirements of our growing, dispersing population and we are spending millions of dollars annually on research to make cars safer and less polluting!!

5) IMPROVING PUBLIC TRANSPORTATION

Level: All

Emphasis: Community exploration

Time: Several days

Materials:

1. Access to public transportation offices
2. Paper and pencils

Objectives: At the conclusion of the environmental encounter, the student should be able to:

1. List (number) advantages of bus (or rail passenger) service to the city.
2. List (number) advantages that bus (or rail passenger) service provides to individuals.
3. List (number) disadvantages to individuals who use bus (or rail) transportation.
4. List (number) improvements in equipment or service of the bus (or railroad) which would encourage greater commuter use.
5. Describe a strategy to inform bus (or railroad) officials of suggested improvements in commuter service.

Activities:

1. Visit a bus company office (or a railroad station). Interview four officials and four commuters. Ask each person for their opinions on the following:
   a. What advantages does the bus (railroad) offer the city?
   b. What advantages does the bus (railroad) offer the individual?

c. What disadvantages are there to individuals who use bus (railroad) transportation?

2. Take a ride on a bus (train). Observe carefully the services provided. What condition is the equipment in, clean, neat, sanitary? Are the comfort and health needs of the passenger provided for? Obtain a complete schedule of passenger services offered.

3. Interview four (or more) random commuters as to how they feel about the bus company (railroad) services and schedules.

4. If there is more than one company providing commuter service in the area, repeat each of the first three activities for each additional company. How do the companies compare in services offered -- rationales for their services?

5. List cost factors for commuter service. What would make commuter service more profitable? Is there a possible use of equipment for profit during non-commuting hours? Are new types of equipment available which would require less expense for maintenance?

6. In group discussion, consider ideas for improvement of services, equipment, or scheduling which would result in more use of the buses (railroads) by commuters. What do commuters want? What promotional techniques would help 'sell' the mass transit idea to car-driving workers?

7. Using the facts and ideas gained in the previous activities, form a report which could be presented to bus (railroad) officials or interested groups.

8. Plan a method of presenting the report. How can it be used most effectively? Who wants the information? Who can act on the information?

9. Present the report to appropriate officials and other interested parties.

EVALUATION (test)

TRANSPORTATION AND THE CITY

Multiple Choice:

1. Internal combustion powered vehicles cause many problems of _____.

a. air pollution
b. traffic congestion
c. excessive energy consumption
d. urban noise
e. all of the above
f. none of the above

2. The most visible transportation problem in the city is _____.

   a. lack of cars
   b. air pollution
   c. noise
   d. traffic congestion
   e. freeway construction

3. Operating a private automobile is _____.

   a. cheap
   b. essential
   c. expensive
   d. inconvenient
   e. problem free

4. A hidden cost of automobile operation is _____.

   a. gasoline
   b. insurance
   c. medical bills as a result of air pollution
   d. car washes
   e. monthly payments

5. _____ accounts for the largest part of city traffic in automobile-oriented cities.

   a. recreation
   b. shopping
   c. shipping
   d. the journey to work
   e. the short trip

True-False:

_____ 1. Modern cities are dependent on complex transportation systems for survival.

_____ 2. Automobile traffic improves pedestrian traffic in neighbourhoods.

_____ 3. The majority of transportation problems in the city can be related to the internal combustion engine.

_____ 4. Private ownership of automobiles is increasing in most cities.

_____ 5. Mass transit systems produce more pollutants per passenger mile than automobiles.

Key: TRANSPORTATION

Multiple Choice

1. e
2. d
3. c
4. c
5. d

True-False

1. True
2. False (impedes it)
3. True
4. True
5. False

CHAPTER IV: THE URBAN CLIMATE - AIR QUALITY AND THE CITY

As one approaches a city, its presence can be sensed even before the skyline is in view. Housing patterns change. Traffic increases. Often streets become wider. The air is even different. Cities feel different from the surrounding countryside.

The existence of an urban climate often comes as a surprise. Research on climatic changes in cities is not abundant; however, it is clear that as cities grow, the mean temperature tends to rise, forming an 'urban heat island'. In building the city the amount of heat produced, and stored, in the city is changed as are air circulation patterns in and around the area.

The explanation of the urban climate is so simple that it is often ignored. First, city land surfaces are waterproofed with roofs, streets, and parking areas. As much as 50 per cent of the land surface in cities is impervious to water. When it rains, the water quickly drains from the paved surfaces into elaborate drainage systems.

Compare this to what happens outside the city. In natural environments, rainwater soaks into the soil. Much of the water returns slowly to the atmosphere by evaporation. The process of evaporation cools the land surface much as water evaporating from the skin cools the body. Disrupting the natural flow of water in the city disrupts this massive natural cooling system. The result is a warmer city.

A second factor affecting the city's climate also relates to its paved surfaces. In natural environments, vegetation acts as a blanket over the soil. As a result, less heat is absorbed by the soil during the day and the loss of heat at night is reduced. There is a more even temperature, day and night, in the countryside than in the city. In the city, heat is absorbed and stored by paved surfaces during the day. At night, as the surface cools, the heat flows upward, returning to, and warming city air.

A third way man has changed the urban climate is that building cities increases the roughness of the land. Roughness affects the overall air circulation above cities. As the wind moves up and down and around buildings, the effect is to decrease wind speed near the ground, thereby reducing cooling summer breezes. During periods of high winds, the problem is reversed along city streets. Tall buildings form wind tunnels through which wind gusts at high speeds.

A fourth factor in man's modification of the urban climate is production of heat in the city. Buildings, homes, automobiles, and manufacturing processes all produce heat which eventually passes into the air. Few have studied the cumulative effect of heat production in the city.

A final factor which distinguishes the city from the countryside is the amount of dust, smoke and other particulate matter in the air. Excessive particulates have a number of negative effects. They interfere with sunlight entering the city, and to a lesser degree act as a

blanket holding heat in the city at night. They decrease visibility in the city. They provide more airborne particles around which water vapour can condense, thereby increasing cloudiness and the incidence of fog and precipitation over cities.

Officially, no one ever dies of air pollution. The death certificate reads: chronic bronchitis, emphysema, lung cancer, stomach cancer, or perhaps heart disease, not air pollution. Nonetheless, air pollution is one of the most threatening of all urban problems.

Man-made air pollution is as old as fire. Over 2,000 years ago, air pollution was a problem in Rome, and the first known law to control air pollution was enacted more than seven centuries ago. In 1273 a law was passed in London prohibiting the use of one type of coal, and in 1300 a heavy tax was placed on coal to discourage its use.

Air pollution is not entirely a man-made phenomenon. Nature is a major source of pollutants. Dust, pollen, salt spray, particles resulting from forest fires, volcanic ash and hydrocarbons emitted by some trees and plants are natural pollutants and can affect plant and animal life.

As long as population densities remained low, man-made air pollution was not a major problem. However, the industrial revolution, dramatic increases in population and new methods of industrial processing have resulted in the release of tremendous amounts of wastes into the atmosphere.

Air pollution, in its acute forms, is a sickness of the cities. Almost all human activity adds pollutants to the air, either directly or indirectly. In some cities, as much as 50 per cent of the air pollutants are generated by motor vehicles. Industrial processes and fossil-fueled electric power generating plants are also heavy polluters of the air above cities.

Like other materials, air pollutants can be solids, liquid droplets or gases. Some are visible. Some are invisible. Many pollutants enter the air as a result of combustion, primarily from automobiles, but also from heating of buildings and electric power generating plants.

Other pollutants result from 'attrition', the wearing or grinding down of solid materials by friction. The wearing of automobile tires is an example. Other substances vaporize, change from a liquid to a gas, and enter the air. Vaporization is responsible for all odours in the city, good and bad.

There is a natural process for the removal of every known natural air pollutant. Some are broken down chemically into harmless materials. Some escape into space. Winds scatter many pollutants from points of emission and precipitation eventually washes many into the soil or the water.

The self-cleansing capacity of the air is limited. Urbanization has resulted in airborne substances which have an adverse effect on human health and well-being, on property and on all forms of life in the city-plant and animal.

The air pollution problem is best understood by studying air pollution in two cities, London (United Kingdom) and Los Angeles (United States).

London has been known for centuries for its 'grey air'. As far back as 1911, London air pollution is reported to have resulted in the deaths of more than 1,000 people. The doctor who reported the 1911 incident first introduced the term 'smog' as he described the mixture of smoke and fog that hovered over London. (see figure 5).

It was the London air pollution disaster in December, 1952, which showed the world how dangerous air pollution could be. Polluted air hung over London for five days and deaths climbed to 2,482 in a week while the average death rate is 945 per week.

'Grey air' pollution is associated with the burning of fossil fuels. It contains particulates, soot and fly ash, which give the air its grey cast. It also contains sulfur oxides which are produced by oxidation of the sulphur in oil and coal. Sometimes it is called industrial smog. It occurs most frequently during cold, wet weather when furnaces in residences, power plants and factories are in operation.

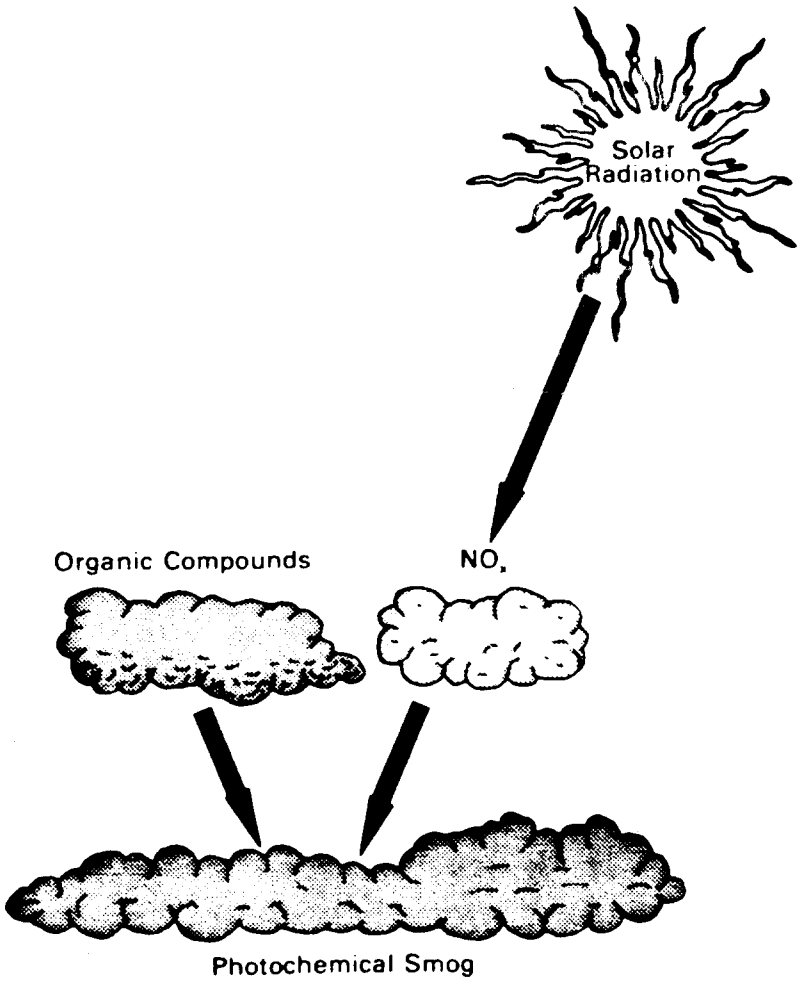
Unfortunately, even in older cities, the main problem is no longer smoke, but automobiles. This type of pollution is linked with the name of another city, Los Angeles. The first indicators that Los Angeles had a serious air pollution problem appeared about 1940. The air was frequently brownish. It was an entirely unfamiliar problem. It took more than ten years to link 'brown air' conclusively with motor traffic.

The 'brown air' problem begins with automobile exhaust which contains, among other things, hydrocarbons and nitrogen oxides. Accumulations of these chemicals are transformed by a photochemical process (triggered by the sun) into 'brown air', it contains harmful substances such as ozone, formaldehyde and peroxyacetyl nitrate.

Because heat and sunlight initiate the photochemical process, brown air pollution occurs most frequently during summer months. This relatively new type of air pollution is called photochemical smog. It is more frightening than the 'older' grey air because the polluter is millions of moving vehicles.

Even as we have come to understand air pollution in London and Los Angeles, most industrial cities of the world have begun to feel the impact of both types. Winter air pollution, fed by heating homes and industrial processes, has begun to merge almost unnoticed into summer pollution, as heat and sunlight react with automobile exhausts. In some cities, air pollution has become part of the climate. Certain climatic and geographic conditions in some cities intensify the air pollution problem.

PHOTOCHEMICAL SMOG



SOURCE Miller, 1976

Figure 5

What happens to air pollutants after emission? Winds scatter some and the general movement of air upward from the surface of the earth helps disperse others. The upward movement of air results from the fact that under normal conditions, the air is cooler at higher altitudes; light, warm air at the surface of the earth rises, much as a hot air balloon rises. Under certain conditions, however, the air near the earth's surface is cooler than that above it. The condition is called a 'temperature inversion'. (The term describes the air temperature profile, an inverse of the normal profile, i.e., the air above the earth's surface is warmer than the surface air.) Under these conditions, surface air cannot rise. It and its load of pollutants become trapped, and severe air pollution conditions may result. (see figure 6).

Cool, clear nights which result in excessive cooling of surface air cause temperature inversions. Cities located in valleys experience frequent temperature inversions as cool mountain air flows into valleys at night. (Mountains surrounding a city also limit cleansing winds.) Another type of temperature inversion occurs when large warm air masses, which are part of global climatic systems, move over an area and trap surface air and its load of pollutants below.

Major Air Pollutants

Only a few decades ago, air pollution was thought of only in terms of smoke and soot. It was termed a nuisance. Today hundreds of pollutants are known to be involved. Four-fifths of all air pollution is invisible and most pollutants are odourless.

Particulates

Particulates are the most noticeable. By definition, they are solids or liquids rather than gases. Particulates, dust, smoke and fumes, have a wide range of sizes. Under 1 micron (.00001 centimeter) in size, they are referred to as fumes, over 1 micron, they are termed dust. Dust particles over 10 microns in diameter can be seen with the naked eye. These coarse particles, including fly ash, the greyish impurities released during the burning of coal and wood, are the major cause of grey air. They settle out of the air relatively quickly when compared to the airborne life of lighter particles, liquids and gases.

Mist is made up of liquid particulates which can be as large as 100 microns in diameter. Mists result from industrial spraying, the condensation of vapour in the atmosphere or the effects of sunlight on automobile exhaust. (see figure 7).

Liquid and solid particles under 1 micron in diameter are generally referred to as aerosols because they are small enough to remain suspended in the air and move as easily on the wind as gases do.

The effects of particulates vary according to the type and size on the particulates and according to what happens to them in the air. About half, by weight, of the particles suspended in the air are small enough to penetrate deep into the part of the human lung that is unprotected by mucus, and can carry harmful chemicals with them. The

cummulative effects of such deep penetration year after year worsens existing health problems such as lung cancer, emphysema and chronic bronchitis.

Carbon Monoxide

Carbon monoxide is a colourless, odourless gas produced by incomplete combustion. In large amounts, it can be fatal. In smaller amounts, it can produce fatique, headache, confusion and dizziness. Carbon monoxide concentrations are heavy where motor vehicle traffic is heavy.

Sulfur Oxides

Burning coal and oil which contain sulfur produces gaseous sulfur oxides. Sulfur dioxide is the major oxide resulting from the combustion of sulfur-bearing fuels. It is a heavy, pungent, colourless gas that combines easily with water vapour to become a mildly corrosive acid, sulfurous acid. Sulfurous acid and compounds resulting from reactions of the acid with other materials can seriously damage the human respiratory system. Acidic rain damages crops and corrodes exposed limestone buildings and statuary.

Nitrogen Oxides

Nitrogen oxides have been jokingly called the status symbol pollutants because they have increased as cities have become more industrialized. Nitric oxide is a colourless, toxic gas formed during combustion at high temperatures from existing nitrogen and oxygen in the air. Such high temperatures are reached only in efficient combustion processes, or when combustion takes place under pressure, as in automobile engines.

During the photochemical process discussed earlier, nitric oxide oxides in the presence of hydrocarbons and sunlight. The result is nitrogen dioxide. It is considerably more poisonous than nitrogen oxide and is the only widespread gaseous pollutant which is coloured. It is yellowish-brown and is responsible for the brownish cast of photochemical smog.

Ozone

Another extremely harmful by-product of the photochemical process is ozone. It is a difficult pollutant to monitor because of its short life in the photochemical process. It causes coughing, choking, headaches and severe fatigue. It damages plant leaves and causes rubber and fabrics to deteriorate.

Hydrocarbons

Over a thousand hydrocarbons are found in petroleum, natural gas and coal. Fortunately, most are harmful only in very high concentrations. Hydrocarbons become airborne as a result of incomplete combustion of gasoline in automobiles. They are also released into the air by evaporation from gasoline tanks.

THERMAL INVERSION

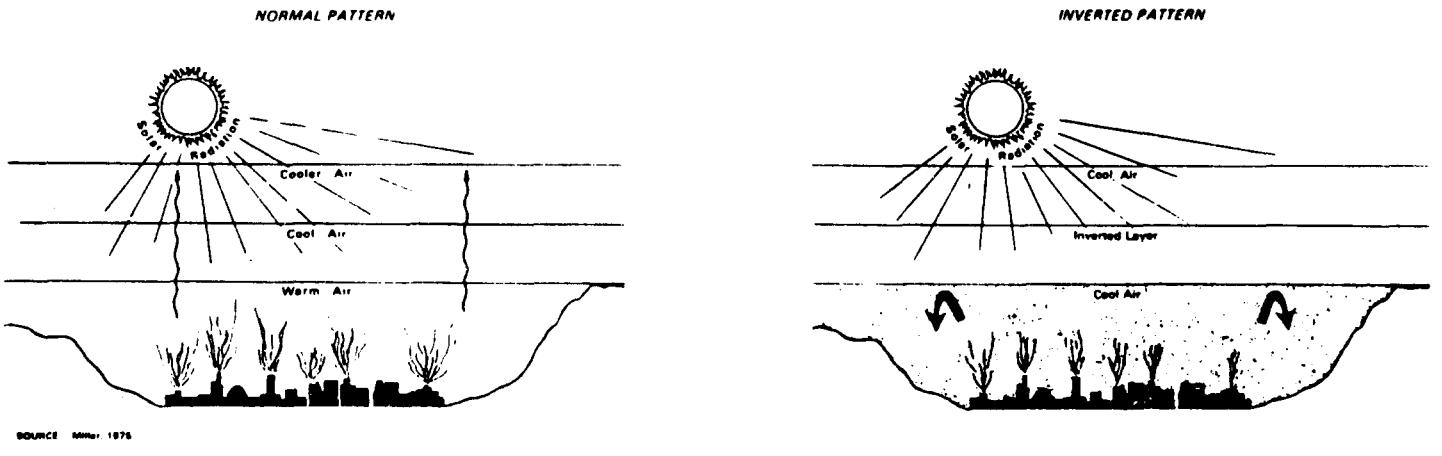


Figure 6

POLLUTION BY THE AUTOMOBILE

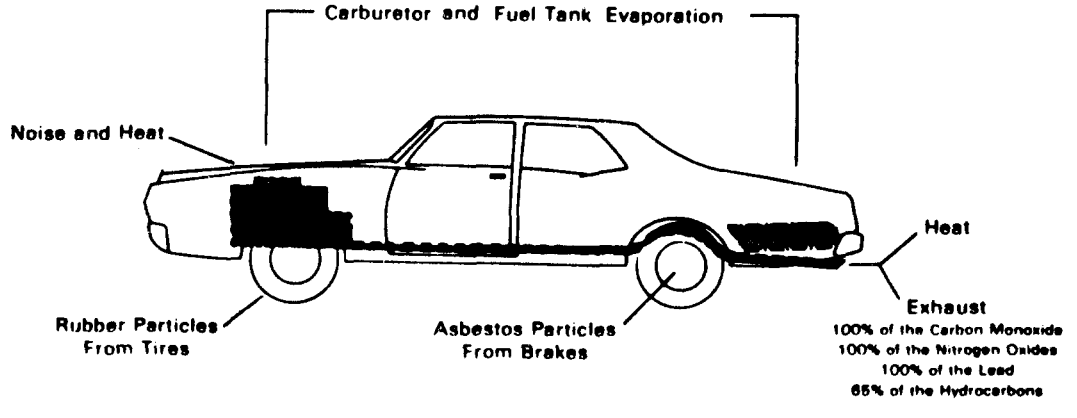


Figure 7

Air Pollution Damage

We can reject or control the sources of most of our food and water, but we cannot avoid breathing air. Each person needs approximately 15 kilogrammes of relatively pure air each day for survival.

Humans are equipped with a number of defenses against air pollution. The hairs in the nose filter out large particles. The upper respiratory tract is lined with hundreds of thousands of tiny hair-like cilia that move back and forth and sweep out foreign matter. Smoking and some air pollutants harden the cilia and slow their cleansing motion, allowing potentially harmful particles carrying bacteria and viruses deeper into the lungs.

Another natural protection against air pollutants is the secretion of mucus which washes out and dissolves impurities. When irritating air pollutants enter the nasal passages, bronchial tubes and lungs, the production of mucus increases. Coughing results as the body tries to rid itself of the pollutants and excessive mucus.

Healthy lung tissue is elastic and expands and contracts easily during breathing. Research indicates that excessive particulate matter, and perhaps nitrogen dioxide and ozone, cause lung tissue to stiffen. This reduces breathing efficiency (see figure 8).

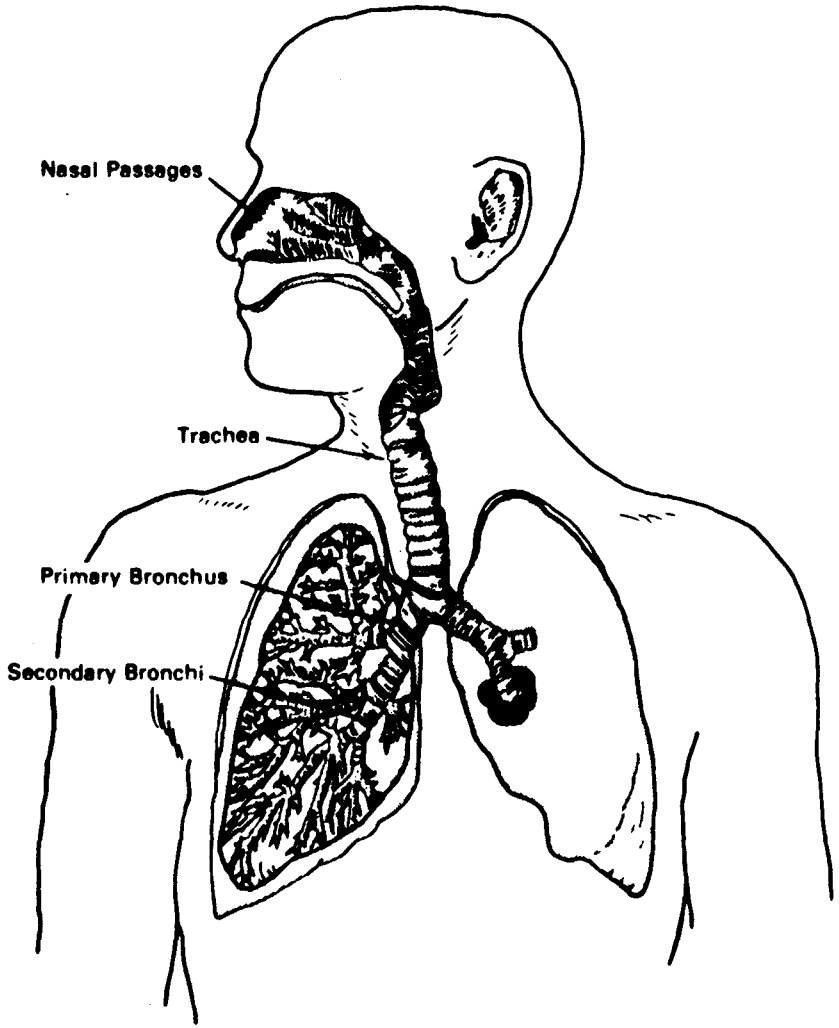
Air pollutants irritate bronchial tubes causing them to constrict, trapping air inside lung sacs. This results in enlarged lungs or torn lung sacs and less efficient breathing. Particulate air pollutants darken lung tissue in the same was as excessive smoking darkens lung tissue.

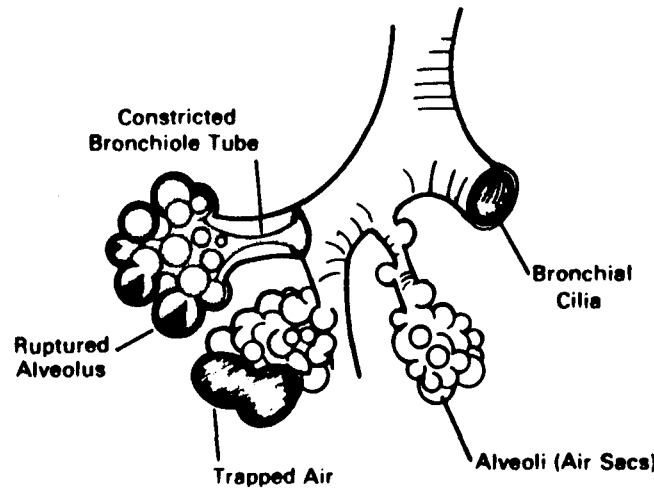
It is impossible to find simple cause-and-effect relationships between air pollutants and human health problems, but the evidence is convincing that the two are linked. During this century, as a result of the development of anti-biotics and vaccines, noninfectious causes of death - heart and respiratory ailments - have replaced infectious diseases as the major causes of death in industrialized countries. The more dramatic shift from infectious causes of deaths in industrialized areas, as compared to rural societies, is a clue to the relationship between air pollution, disease and death.

Plants are also damaged by air pollution. Sulfur dioxide and sulfuric acid discolour leaves and stunt plant growth. Ozone and other substances which result from the photochemical process damage fruits and vegetables, affecting growing areas surrounding cities. Sulfur dioxide and sulfurous acid attack metals, marble buildings, rubber, plastic, paint and some fabrics.

Air pollution is expensive. It costs billions of dollars a year in poor health, medical bills and lost time at work. It can mean repainting homes and automobiles, replacing fabric window coverings, or watching historic outdoor statuary disintegrate. Many of the costs cannot be measured in dollars. The loss of a desirable climate and clear skies has no price tag.

AIR POLLUTANTS AND THE EFFECTS ON THE RESPITORY SYSTEM





SOURCE Miller, 1975 and Crouch, 1978

Figure 8

Improving Air Quality

The only reasonable and feasible method of cleaning the air is to control pollutants before they are emitted into the atmosphere. For example, potential pollutants can be removed from fuels and other raw materials before the fuels are burned. The sulfur content of fuel oils can be reduced from 3 per cent to 1 per cent prior to use. Another approach is to substitute fuels containing fewer pollutants. Coal containing low amounts of sulfur can be substituted for high sulfur coal.

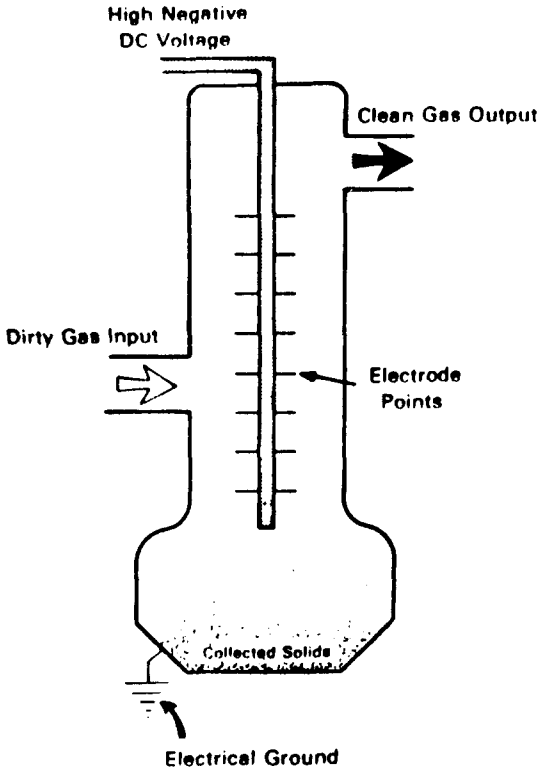
Improved industrial technology can reduce industrial pollution. Industrial smoke can be cleaned by devices, such as scurbbers and electrostatic precipatators, which trap, screen and filter fumes and particles (see figure 9). The cost of installing these devices increases the cost of manufacturing goods, but considering the costs of contaminated air, the control of harmful emissions is essential. In some cities polluting factories are shut down and the use of motor vehicles is curtailed when air pollution conditions reach dangerously high levels.

Reducing pollution caused by automobiles is not simple. Most automobiles are privately owned and devices which can be added to the exhaust system to reduce pollutants are expensive and must be maintained by owners to be effective. Smaller automobiles, depending on engine size and design, emit fewer pollutants. Promoting the use of mass transit, reducing the number of automobiles in the city and encouraging the use of vehicles which emit fewer pollutants will reduce urban air pollution.

Urban Climate - AIR QUALITY AND THE CITY - Principal Concepts

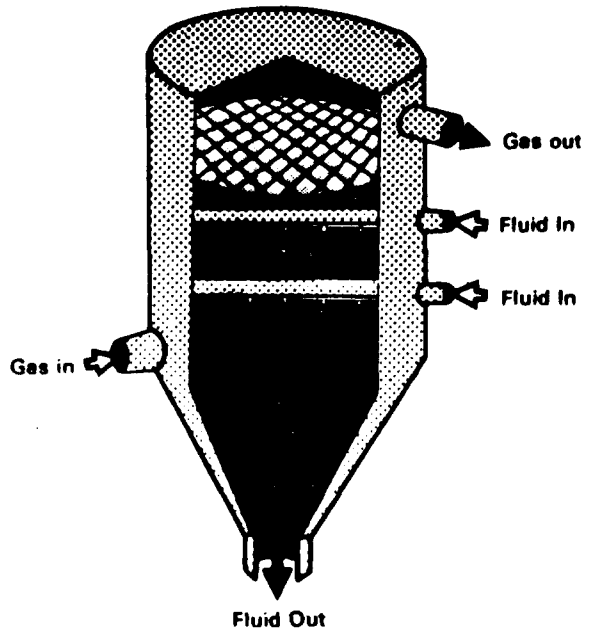
- The climate of the city differs from that of the surrounding countryside.
- The paved surfaces of the city result in higher temperatures in urban areas as compared to surrounding rural areas.
- Higher temperatures in cities result from several facts: heat is actually produced by cities in residences, businesses and industries; normal evaporation processes which cool land surfaces are reduced because land surfaces are paved and do not absorb precipitation; paved city surfaces absorb and re-radiate more heat than land surfaces in the surrounding countryside which are covered by vegetation.
- Wind patterns in the city are altered by the construction of buildings.
- Dust generated in the city increases haze, cloudiness and precipitation over cities.
- Air pollution is not a new problem for cities.

ELECTROSTATIC PRECIPITATOR



SOURCE: Miller, 1975

AIR SCRUBBER



SOURCE: Moran, Morgan and Wiersma, 1973.

Figure 9

- Motor vehicles as well as electric power generating, industrial processing, and home heating plants are the major sources of air pollution.
- Although most air pollutants are invisible, many are harmful to today's plant and animal life.
- The type of air pollution characterized by grey air is most common in the winter in cities which burn fossil fuels.
- The type of air pollution characterized by brown air, photochemical smog, is most common in the summer in cities with large numbers of automobiles.
- Photochemical smog results when a photochemical process, triggered by the sun, changes certain chemicals present in automobile exhaust into substances which are harmful to plant and animal life.
- Some cities frequently experience weather condition, termed temperature inversions, which trap air pollutants near the surface of the earth for several days.
- Air pollutants irritate and damage the respiratory system and are particularly dangerous to people suffering from respiratory ailments.
- Controlling automobile emissions is a major concern for cities.
- Damage caused by air pollution is expensive to those who live in the city.
- Improving air quality requires that pollutants be controlled before they are emitted into the atmosphere.

ACTIVITIES

1) INVESTIGATING INDUSTRIAL AIR POLLUTION

Level: All

Emphasis: Community investigation and citizen action

Time: Several days

Materials:

1. Large plates and a sticky substance such as vaseline.
2. Pencils, paper, chart paper

Objectives: At the conlusion of an environmental encounter, the student should be able to:

1. Identify an air pollution problem within the local area.

2. Identify several firms or factories which cause pollution to the area.

3. List (number) effects of air pollution on living organisms.

4. List some of the laws which have been recently passed in an effort to control air pollution.

5. Identify the agencies that enforce these laws.

Activities:

1. Locate a source of air pollution in the city, prefably a source other than the automobile, such as a plant, factory or shop.

2. What is the function of the plant? What do they produce? What are the processes used to produce the product?

3. Classify the type of air pollutants? Are they particulate, liquid or gaseous emissions?

4. To determine how much particulate matter is emitted, perform this simple experiment. Get several large plates. Cover one side of the plates with a greasy or sticky substance such as vaseline. Set one of these plates near the point of pollution with another plate a little further away and so on. After a period of time, depending on the amount of pollution, observe the particulates that have settled on the plates.

5. What effect do these particulates have on living organisms? Research the topic to find more information.

6. What does the industrial plant produce? What materials might be given off as air pollutants? What effect do these materials have on the surrounding environment.

7. In your opinion, should some type of pollution control be placed on the factory or shop? Is there a government agency which handles such matters? If appropriate, develop a plan to bring the problem to the attention of the appropriate agency, or the public. Execute the plan.

2) INVESTIGATING AIR POLLUTION CAUSED BY AUTOMOBILES

Level: Elementary, middle

Emphasis: Testing, research and citizen action

Time: several days

Materials:

1. Access to several automobiles

2. Gauze

3. Library or community contacts with information on automobiles/engine design

Objectives: At the conclusion of the environmental encounter, the student will be able to:

1. Identify (number) effects of air pollution.

2. List (number) reasons why the automobile causes air pollution.

3. Gather a sample of auto air pollutants from an automobile tailpipe.

4. Name (number) ways the automotive air pollution problem can be reduced.

5. Plan a campaign to combat automobile air pollution.

6. Carry out the campaign.

Activities:

1. List air pollution problems. Which directly affect man? Which affect non-living things? What are the sources of air pollution?

2. Perform an experiment with several automobiles. Cover the tailpipes with gauze for one day and bring the cloth to class. Describe the cloth. What caused the blackish colour? Which automobile was driven 1 to 5 miles, 5 to 12 miles, 12 to 20 miles, and over 20 miles in one day. Which is the darkest cloth? What is the dangerous colourless, ordourless gas automobiles emit? Does exhaust have a pleasant smell?

3. Can other types of engines be used in automobiles. The electric or steam vehicle? Why are these engines not used?

4. Is the internal combustion engine efficient in burning its fuel? How would keeping the car in good repair and tuned up aid in pollution control? Can we force people to maintain their cars properly? What community agency could enenforce such regulations?

5. Seek information on automobile air pollution control devices. Discuss how they recycle the exhaust for more efficient burning. Are laws needed for automobile manufacturers to install the most effective and long-lasting pollution control devices? What aid is needed for research on the use of alternative fuels.

6. Why should we support mass transit? What aid is needed for research in this area?

7. Make a poster presentation of automotive air pollution problems. Put one problem on each poster and display them in school.

8. Carry out an automobile anti-pollution campaign in the neighbourhood.

3) AUTOMOBILE AND AIR POLLUTION RESEARCH PROJECT

Level: Middle, Senior

Emphasis: Research

Time: Several weeks

Materials:

1. Library resources

2. Access to health agency personnel

3. Access to a resource person in the automobile industry (sales, repair, production, etc.)

Objectives: At the conclusion of an environmental encounter, the student should be able to:

1. Identify in writing (number) the main components of clean air.

2. Describe in writing the respiratory tract which is affected by the quality of air which a person breathes.

3. List in writing (number) health problems which medical research has linked automobile exhaust emissions.

4. Identify in writing (number) automobile exhaust emissions that are harmful to our health.

5. Name in writing (number) automobile exhaust emissions you feel are most harmful and describe the effect of each on human health.

6. Identify in writing (number) ways the government has attempted to control air pollution caused by automobiles.

7. Describe in writing (number) improvements the automobiles industry has made.

8. List in writing (number) ways the public might influence automobile manufacturers to do more towards pollution control.

9. Develop a plan of action to reduce the amount of air pollution caused by automobiles.

Activities:

1. Research information to make a circle graph showing what makes up the clean air of the atmosphere before man adds pollutants.

   a. What gas takes up the greatest percentage of space?

   b. How much oxygen is there?

   c. What are the trace gases?

   d. What are other substances?

   e. How wide is the band around the earth that holds these gases?

   f. Can any of these gases go beyond this into space?

2. Use a chart of the human respiratory system to start discussion on this topic.

   a. What is the path of air after it enters the nose?

   b. How does oxygen get into the blood?

   c. How much air is taken into the lungs?

   d. How much surface is covered by all the branches of the lungs?

3. Invite a guest speaker from the local health department.

   a. What are some harmful exhaust pollutants from automobiles, that affect human health?

   b. What are these harmful effects?

   c. Which do you feel are the most harmful?

4. Interview a resource person who sells automobiles.

   a. What regulations must the automobile industry follow in controlling automobile pollution?

   b. What are some possible future plans for further regulations?

5. Make a fact sheet of important information gathered.

   a. How are automobile exhaust emissions harmful to people?

   b. What evidence is there that people have been harmed?

   c. What are the laws controlling this kind of air pollution?

d. Has the automobile industry done all it can?

e. What can the citizen do about this air pollution problem?

6. Make a plan for reducing the pollution from automobiles.

a. How could you inform people about the problem?

b. What can the citizen do about laws?

c. What can the citizen do about purchasing automobiles?

d. What can he do about the operation of his present auto?

e. Are there other individual citizen actions possible?

7. Incorporate information into a plan which can be used to inform other about what can be done to reduce harmful auto emissions.

4) INVESTIGATING AIR POLLUTION IN THE CITY

Level: Senior

Emphasis: Environmental exploration and citizen action

Time: several days

Materials:

1. Map of city

2. Chart paper, markers

Objectives: At the conclusion of the environmental encounter, the student should be able to:

1. Identify (number) sources of air pollution in the city.

2. Identify (number) resources at the local, provincial and national level, capable of providing factual and accurate information on air pollution.

3. Illustrate (number) ways local pollution sources contribute to air pollution.

4. Illustrate (number) types of pollutants found in the local air supply.

5. Illustrate (number) ways these pollutants affect the city.

6. Describe, in writing, what local industries and organizations are doing to control their air pollution.

7. Determine the appropriate government agencies, individuals or committees responsible for enforcing air pollution control in the city.

8. Identify the local laws governing the control of pollution.

9. Describe, in writing, what is being done to enforce the existing pollution control laws.

10. Describe, in writing, the future plans for improving the control of air pollution in the community.

11. Develop a plan of action for informing the local citizens concerning air pollution in the community.

Activities:

1. Plan a field trip in the city to determine the sources of air pollution. Consider the following in your plans:

   a. areas to visit

   b. signs of pollution to look for

   c. visible effects of pollution

   d. others

2. Design a check list that will help you thoroughly investigate your community. Example:

   a. Signs of Pollution

      smoke
      odours
      others

   b. Sources of Pollution

      industry
      open burning
      electric power plants
      autos, trucks
      others

   c. Visible Effects of Pollution

      discoloration
        vegetation
        building stone
        building paint, especially white
        others

deterioration
  building stone
  statues
  others
dying or dead vegetation
particulate matter in the air

d. Others

3. Use the check list on your field trip as a means of investigating pollution in your community.

4. On a map of the city, pinpoint the areas and sources of air pollution. (This map could be used as a part of a display on pollution in the community.)

5. Identify appropriate individuals and organizations at the local, state and national level that will be able to provide you with a variety of materials on air pollution. Example:

   a. Doctors

   b. Health Department

   c. Lung Association

   d. Others

6. Interview appropriate resource people at the local level to help you obtain accurate information concerning your city. Discuss:

   a. Ways local sources of pollution contribute to air pollution.

   b. Types of pollutants found in the local air supply.

   c. Effects of these pollutants on the city.

7. Design posters that illustrate:

   a. Ways local pollution sources contribute to air pollution.

   b. Types of pollutants found in the local air supply.

   c. Effects of these pollutants on the city.

8. Visit local industries and other organizations in the community who are polluting the air and find out what they are doing to control their pollution. (Make them aware of the fact that this information will be shared with the community.)

9. Identify the power structure in your city and determine the appropriate individuals or committees responsible for enforcing air pollution control in the area.

10. Interview these individuals and committees to find out what is being done to control local air pollution. Inquire about:

    a. What air pollution control laws exist

    b. How these laws are being enforced

    c. What the fine is for breaking the laws

    d. What future plans are being considered for controlling local air pollution

11. Using all the information you have obtained, design an air pollution display that will inform your community concerning:

    a. Local sources of air pollution (Map)

    b. How these sources contribute to air pollution (Posters)

    c. Types of pollutants found in the local air supply (Posters)

    d. Effects of these pollutants on the city (Posters)

    e. Existing local air pollution control laws

    f. What is being done to control local air pollution

       by industries
       by others

    g. Future plans concerning local air pollution control

    h. What individuals can do to help control air pollution -- make a hand-out sheet of suggestions

12. Develop a plan of action for bringing this display to the community's attention. Consider taking the display to:

    a. Other schools

    b. Local community meetings

    c. Shopping areas

EVALUATION (test)

1. AIR QUALITY AND THE CITY (URBAN CLIMATE)

Multiple Choice:

1. Paved surfaces act as _____ in the city.

   a. evaporational surfaces
   b. heat collectors
   c. drainage areas
   d. impediments to water absorption
   e. all of the above

2. Cities are _____ than the surrounding countryside.

   a. cooler
   b. greener
   c. less crowded
   d. warmer
   e. higher

3. Streets surrounded by city buildings become _____ during high winds.

   a. wind tunnels
   b. wind blocks
   c. shelters
   d. wind generators
   e. all of the above

4. City buildings _____ gentle summer surface breezes.

   a. cool
   b. affect
   c. block
   d. have no affect on
   e. none of the above

5. Cities tend to have an excess of _____ in the air.

   a. pollen
   b. wildlife
   c. particulates
   d. sunlight
   e. moisture

True-False:

_____ 1. Buildings, homes, and automobiles are sources of heat.

_____ 2. City buildings affect wind circulation in the city.

_____ 3. Urban pavement speeds evaporation and cools the city.

_____ 4. Excessive particulates over a city increase visibility.

_____ 5. Urban climates are the same as rural climates in the area.

Key: URBAN CLIMATE

Multiple Choice	True-False
1. e	1. True
2. d	2. True
3. a	3. False (prevents heating)
4. b	4. False (decreases)
5. c	5. False (different from)

2) AIR QUALITY AND THE CITY (AIR POLLUTION)

Multiple Choice:

1. Each person needs approximately _____ of relatively pure air each day for survival.

   a. 30 kg
   b. 100 kg
   c. 13.5 kg
   d. 0 kg
   e. .5 kg

2. Air pollution is _____ human health.

   a. beneficial to
   b. costly to
   c. not detrimental to
   d. responsible for
   e. all of the above

3. Industrial smoke can be cleaned by _____.

   a. electrostatic precipitators
   b. stack plugs
   c. wind pipes
   d. washing it
   e. nothing

4. Urban air pollution can be reduced by:

   a. reducing the number of automobiles
   b. promoting mass transit
   c. encouraging use of non-polluting vehicles
   d. burning low sulfur coal
   e. all of the above

5. Gray air pollution is associated with the burning of _____.

   a. fossil fuels
   b. nuclear power
   c. wood
   d. plastics
   e. automobiles

6. In some cities motor vehicles may contribute as much as _____ of the air pollutants.

a. 90%
b. 0%
c. 10%
d. 50%
e. 25%

7. The self cleansing capacity of air is _____.

a. limited
b. expected
c. unlimited
d. effective
e. invisible

Matching:

1. fosil fuels
2. brown air
3. temperature inversion
4. sulfur oxides
5. nitrogen oxides
6. electrostatic precipitator
7. cilia and mucus
8. ozone
9. 13.5 kg
10. photochemical

a. help protect lungs
b. triggered by the sun
c. cleans smoke stake smoke
d. gray air
e. how much air humans need to survive
f. high sulfur fuels
g. nitric oxides
h. product of photochemical process
i. traps pollutants
j. internal combustion engine

True-False:

_____ 1. Air pollution is always expensive to prevent.

_____ 2. Nitrogen oxides are known as the status symbol pollutants.

_____ 3. Burning high sulfur coal yields sulfur oxides.

_____ 4. Air pollution helps some respiratory ailments.

_____ 5. Temperature inversions release pollutants into space.

_____ 6. Gray air pollution is triggered by a photochemical process.

_____ 7. Ozone is harmless.

_____ 8. Air pollution damages plants.

_____ 9. Most air pollutants are visible, but harmless.

_____ 10. Air pollution is a man-made problem.

Key: AIR QUALITY AND THE CITY

Multiple Choice	Matching	True-False
1. c	1. d	1. False (may be)
2. b	2. g	2. True
3. a	3. i	3. True
4. e	4. f	4. False (aggravates)
5. a	5. j	5. False (traps pollutants)
6. d	6. c	6. True
7. a	7. a	7. False (harmful)
	8. h	8. True
	9. e	9. False (invisible, harmful)
	10. b	10. False (is not entirely)

CHAPTER V: WATER QUALITY AND THE CITY

Water is the most abundant substance on earth, and in many ways the most unique. Water dissolves a great variety of materials and those which are insoluble can be dispersed by it. Water has characteristics which make it 'appear' to be a natural waste disposal system. In fact, it is. It flows easily to low places in the landscape. Waste material dumped into flowing water is quickly carried away to 'somewhere else". The problems is that 'somewhere else' may be where somebody else is trying to live and use the same water.

Early villages dumped great quantities of wastes into available streams. With few people and large streams, there was little problem. By the time waste water from one village had been mixed with clean water and carried a few miles downstream, the water was drinkable in the next village.

As villages became towns, and towns became cities, streams, and even large rivers, could no longer break down the quantities of pollutants dumped into them. Water-borne wastes from one city began to arrive at the city downstream in highly contaminated water.

In early cities, city wastes were also dumped on vacant land. City dwellers, accustomed to throwing wastes into rural fields, fouled early cities by throwing wastes directly into the streets.

Urbanites today still use the land and water for disposing of wastes. However, they prefer elaborate systems of pipes and special dumping sites to protect their city against the health hazards associated with contaminated water and open dumps.

Urban Water Supplies

Most urbanites have become accustomed to drawing water from a tap and don't think about the fact that faucets are connected by kilometers of pipes to a water supply somewhere. Cities get water from rivers or lakes or from man-made collection sites, cisterns or reservoirs.

All land surfaces catch water and as such are called 'watersheds'. The land area which collects water for use by cities is called the urban watershed. Urban watersheds may be located within a few miles of a city, or they may be located several hundred miles away. Some cities pump ground water to the surface for use or rely in some way on natural springs or artesian wells? Water actually enters buildings through pipes which are connected to the collection sites (rivers, lakes, reservoirs, etc.). What happens to water before it is collected for distribution to city users is complicated.

All water is locked into a natural recycling process called the hydrologic cycle (see figure 10). The heat of the sun evaporates water from ocean surfaces, filling the air masses above with large quantities of invisible, gaseous water called water vapour. When moisture-bearing air is cooled over land areas, some of the water vapour precipitates out and gravity pulls it down as rain, snown sleet or hail.

Most of the water that falls on the land sinks, or percolates, downward into the soil to form the ground water system. But the soil, like a sponge, can only absorb so much water. Excess water runs off the land into nearby streams, rivers, lakes or oceans. A large percentage of the water that falls on the land evaporates directly back into the atmosphere. Some, which percolates downward, is picked up by plant roots and eventually also passes back to the atmosphere from plant leaves and stems.

Water supplies for cities are but a small part of a massive natural recycling system. A secondary point is that the total amount of fresh water available on earth is fixed.

The amount of fresh water on earth, compared to all water, is very small. Approximately 97 per cent of the earth's water is salty. It is in oceans. Much of the rest, fresh water, is ice or snow. Each year less than .01 per cent of the total amount of water on earth actually falls on land surfaces where it can be collected for use by man.

With the world's population increasing at the rate of more than 200,000 every day, the demand for fresh water, particularly for agricultural uses, threatens to become a serious long-term problem in some parts of the world. Densely populated areas in Spain, southern Italy, the Dalmation coast, Greece, Turkey, all Arab states except the Syrian Arab Republic, most of Iran, southern Australia, New Zealand, Panama, northern Mexico, central Chile, the Peruvian coast and the southwestern United States are already faced with shortages of usable water.

Cities, compared to agriculture, are small direct users of water. Nonetheless, cities mush have fresh water and all cities are part of the overall hydrologic system.

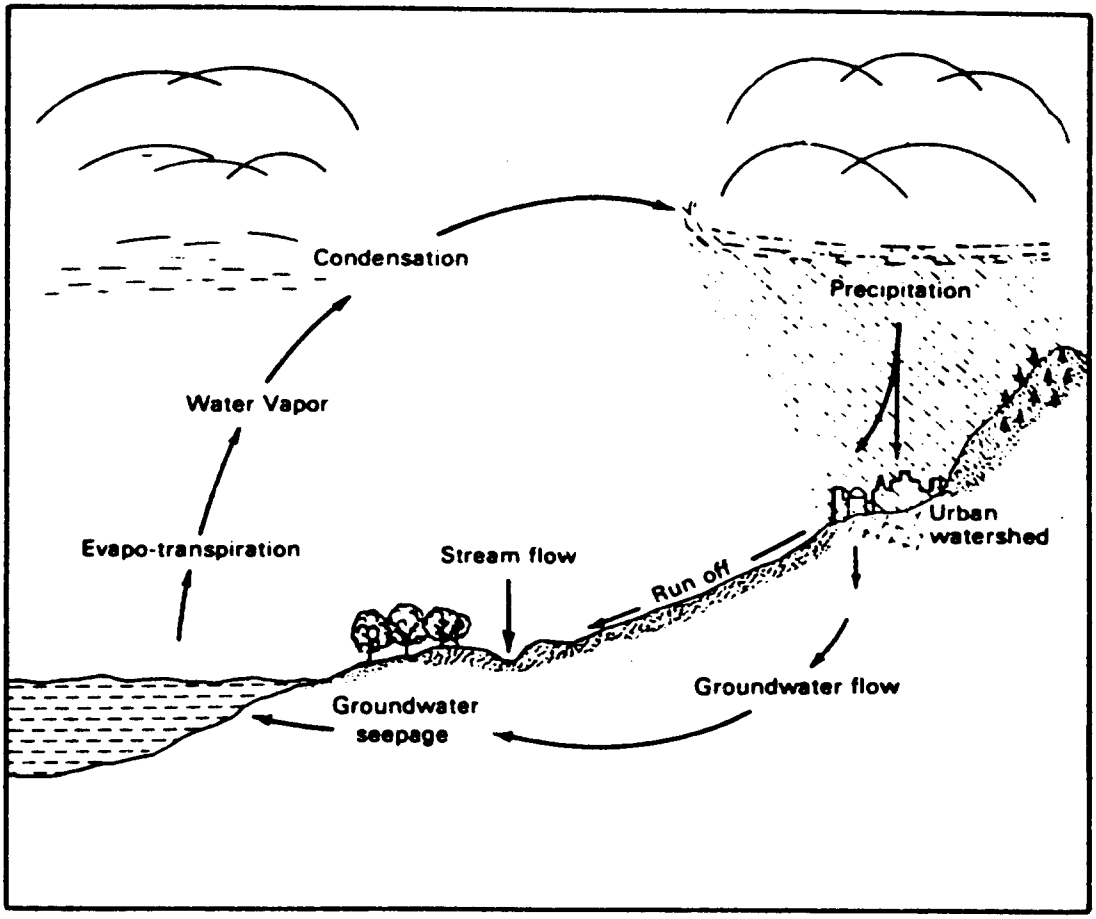
City Demand for Water

People need only a few liters of water a day for survival. Much of it is supplied by the water content of food, therefore several glasses of fresh water per person are adequate.

Despite this requirement, urban dwellers use incredible amounts of water each day. Flushing a toilet uses ten liters. A single shower can use as much as 100 liters. Food preparation, laundering and house maintenance can bring the total to as much as 500 liters per day per person.

There are two basic types of water use in the city. Relatively small amounts of water are 'consumed', and 'disappear' temporarily from the natural recycling process. For examples, beverage bottling and food processing companies and those producing lotions and beauty aids 'consume' water. Drinking water is also a consumptive use. Water used consumptively eventually returns to the system through evaporation or elimination.

THE HYDROLOGIC CYCLE



SOURCE. Griggs and Gilchrist, 1977.

Figure 10

By far the greatest use of urban water is for nonconsumptive purposes. Water is merely 'used' for cooling, cleaning, industrial processes requiring water as a solvent, for the dilution of wastes, or for recreational activities such as boating and swimming. Theoretically, such water should be returned to the system unchanged. In reality it is usually altered in some way.

Water Pollution and Biodegradation

Strickly speaking, pollution is any departure from a pure state. But in discussing the environment, it means a departure from normal rather than a pure state. Even without the effects of man, water is never pure. Natural pollution is a part of every waterway. Leaves, animal wastes, silt, minerals and gases continually fall, or are washed, into rivers, streams and lakes.

Waterways have the ability to 'purify' themselves. Water-borne wastes, leaves, dead organisms and other by-products of life, called organic materials, provide food for water-borne bacteria and fungi. Some of these bacteria and fungi, known as acquatic decomposers, require oxygen to survive as do all living organisms. The oxygen is dissolved in the water.

However, the amount of oxygen which can be dissolved in water is limited by certain physical laws. If the amount of organic materials entering the water is normal, the decomposers can readily consume the wastes. The process is called biodegradation. The organic materials are broken down, or degraded, into safe substances by natural biological processes.

If, however, the organic waste load is excessive, contained large amounts of man-generated wastes such as oil from city streets, wastes from food processing plants and sewage, dissolved oxygen is quickly depleted and pollution occurs (see figure 11).

The effects of organic pollution on water-borne life in rivers receiving overloads of untreated organic wastes is well-known. Clean water, upstream from a discharge point, usually supports a wide variety of fish, algae and other organisms. Soon after organic wastes are dumped into a river, oxygen levels drop dramatically and approach zero. Then, only sludge worms and blood red larvae survive. As the oxygen level recovers downstream, several species of trash fish, primarily carp and gar, which can tolerate low oxygen levels, appear. Eventually, further downstream, a normal aquatic community is restored.

Water is considered polluted if substances are added to it which affect fish and other biotic life or its use for drinking, washing, swimming. Polluted water may contain a variety of solids, organic materials, infectious and toxic agents, or nutrients, or its temperature and appearance may be changed.

Organic Pollution

The most common pollutants are organic. They include human sewage and animal wastes; surface run-off from city streets containing oil and other materials; cleaning materials; organic fertilizers; and

SURFACE WATER POLLUTION

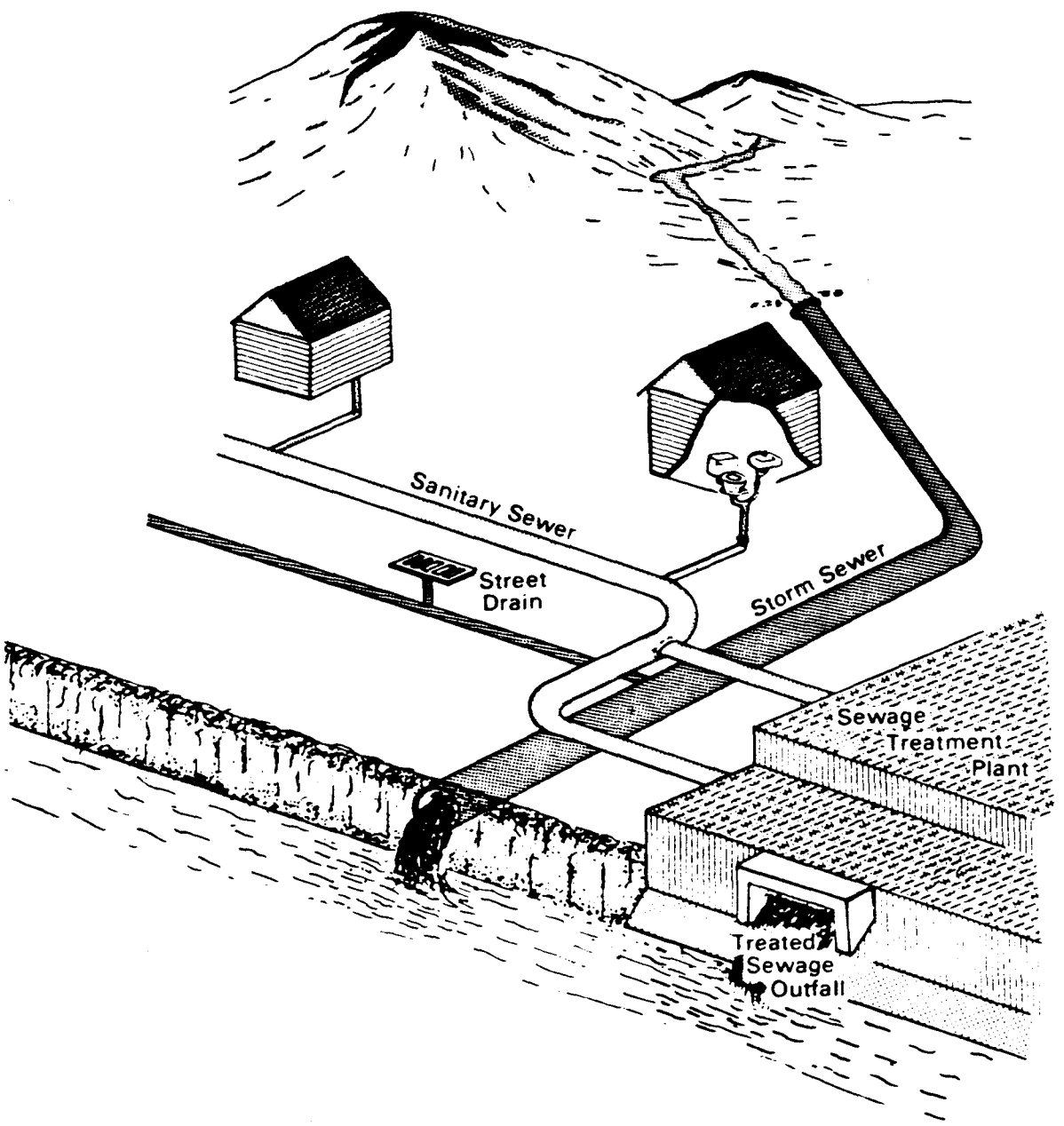


Figure 11

industrial wastes from meat, fruit and vegetable processing plants, pulp and paper mills, chemical and oil industries, textile mills, etc. Organic materials are generally not poisonous to stream life in and of themselves. Instead, they deplete waterways of dissolved oxygen as described. In addition, they create conditions favourable to disease-carrying bacteria and viruses. Human sewage, undegraded in polluted water, can carry bacteria and viruses which cause typhoid fever, endemic diarrhea, salmonellosis, cholera, dysentary and other infectious diseases. Sickness and death can result from drinking organically polluted water.

Phosphate and Nitrate Pollution

Overloading water with organic wastes can result in another type of pollution. As organic materials are broken into their components by decomposers, minerals result. Nitrates and phosphates are examples and both act as fertilizers. Under certain conditions they can over-fertilize a receiving body of water and increase dramatically the growth of algae and other aquatic plants. Phosphates are found in some detergents, nitrates in animal wastes. A sign of this type of pollution is 'algal bloom', characterized by excessive and unsightly growth of floating green or blue-green algae. In over-fertilized ponds or lakes, excessive plant life screens sunlight from organisms below and competes with decomposers for dissolved oxygen.

Biochemical Oxygen Demand

Water can be deoxygenated in a variety of ways. In order to compare the pollution potential or organic wastes, a measurement for the amount of oxygen-demanding wastes in water was developed, the Biochemical Oxygen Demand (BOD) test (see figure 12). The BOD is the amount of dissolved oxygen needed by decomposers to break down organic wastes in a given volume of water at a given temperature. For instance, waste water from homes has a BOD of 250 ppm (it is measured in parts per million) as compared to waste water from industries which process organic materials such as meat-packing plants, dairies, canneries, and bakeries which have BOD ratings of 5,000 to 15,000 ppm or even higher.

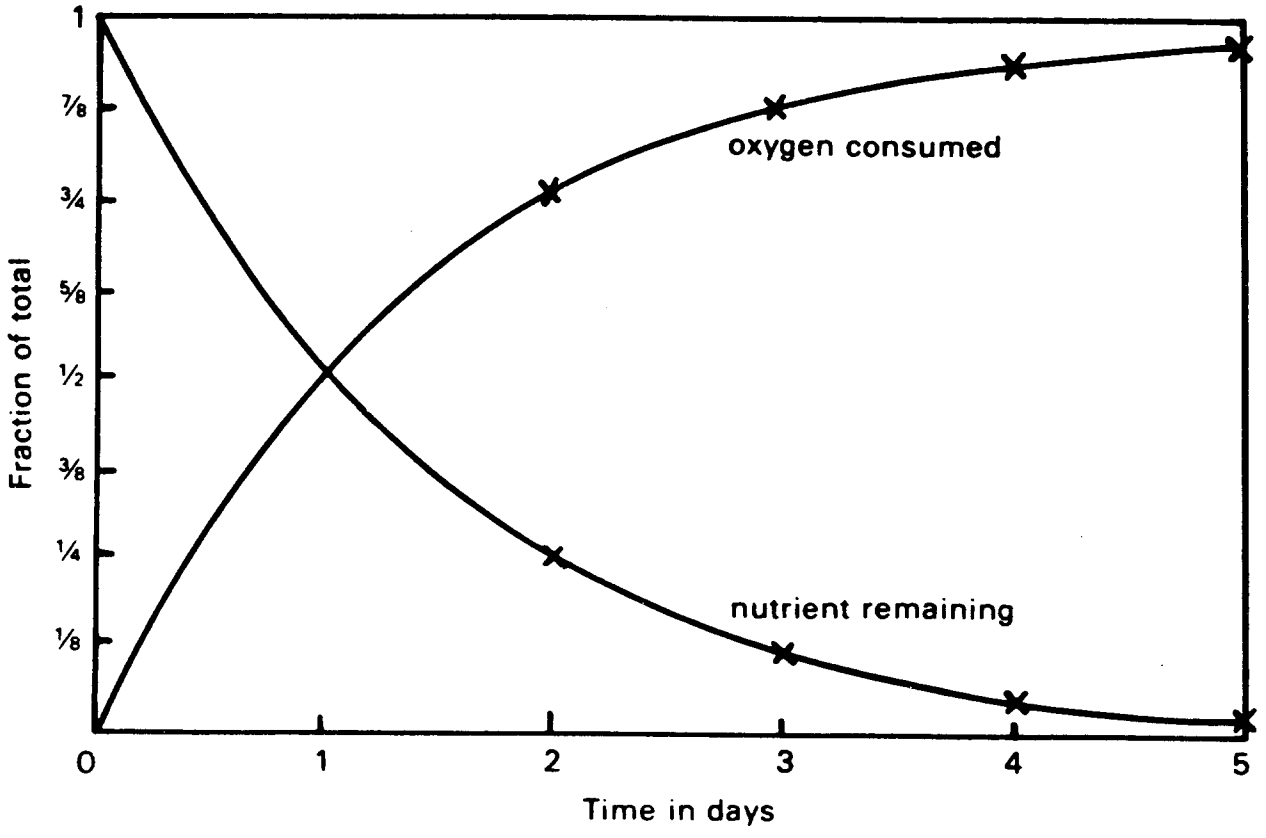
Toxic Pollution

Heavy metals such as lead, mercury, copper, arsenic and chromium used in tin plating, galvinizing and chromium plating solutions can directly affect decomposers and the respiratory and digestive systems of higher forms of life, including humans. Some toxic materials such as mercury or lead, and poisons like cyanide and some chlorinated hydrocarbons used in insecticides, can accumulate in the body and seriously affect health over time.

Physical Pollution

Many materials which find their way into rivers and streams are relatively inactive, but they can be environmentally hazardous and aesthetically displeasing. Trash of every description, plastic wrappers, glass bottles and metal cans, find their way into waterways. Their effect is physical, not chemical. The most common example of physical

BIOCHEMICAL OXYGEN DEMAND CURVE



EQUATION FOR THE CHEMICAL OXIDATION REACTION

$$\text{nutrients} + \text{dissolved oxygen} \xrightarrow{\text{microorganisms}} CO_2 + H_2O + \text{oxidized inorganics}$$

Figure 12

SOURCE Turk and Wittes, 1978

pollution is silt which washes into rivers and lakes. It causes waterways to become cloudy and change colour. This reduces the sunlight available to aquatic organisms. The china clay industry pollutes water. Raw clay is washed to remove grit and fine grit remains in the waste water. The steel industry is another example. Hot-strip mills produce very fine particles which result in red or black waste water. Textile mills wash fabrics and excess dyes colour the water.

Eventually most suspended particles settle out and smother life in the bottom of the body of water. One pollutant which does not settle out is oil which has been emulsified by detergents. It results in persistent milky water which is relieved only by further dilution.

Thermal Pollution

Thermal pollution simply means the addition of hot water to a stream or lake. Water temperature profoundly affects aquatic life; increased use of water as an industrial coolant can, therefore, result in profound effects on aquatic life. Power generating plants and manufacturing industries use tremendous amounts of water for cooling. The water is usually taken from a river or lake, passed through the cooling system, and returned at a temperature 5° to 10°C higher.

There is much controversy about the extent of the damage caused by thermal pollution. Some animals are killed outright by the hottest water, but mixing occurs rapidly and the major damage is caused by warm water. Heating water significantly reduces the water's capacity to hold dissolved oxygen. The importance of dissolved oxygen in water has been discussed. Warm water also inhibits the normal reproductive capacity of cool-water species such as trout, bass and salmon.

Waste Water Treatment

Water used by urban households, businesses and industries leaves the city via sewer pipes buried under city streets. Eventually waste water is dumped into nearby rivers, lakes or the ocean. Most is treated before it leaves.

Other city water, run-off from rain and snow, also finds its way to waterways. Run-off from city streets, sidewalks and roof tops cannot be absorbed into paved city surfaces. Instead it drains into large storm-water sewer pipes carrying with it oil, asphalt and heavy metals such as lead, mercury, copper and zinc as well as trash washed from city surfaces. The water flows, unnoticed and untreated, under city streets as it returns to rivers and lakes.

Some cities use a single system of pipes to transport both storm water and sewer water. In such systems, storm water is treated before it leaves the city. Problems arise in combined systems when rainfall is heavy and treatment plants are unable to process the volume of water received. In such cases, raw sewage is frequently discharged into streams and rivers.

SEWAGE TREATMENT PLANT

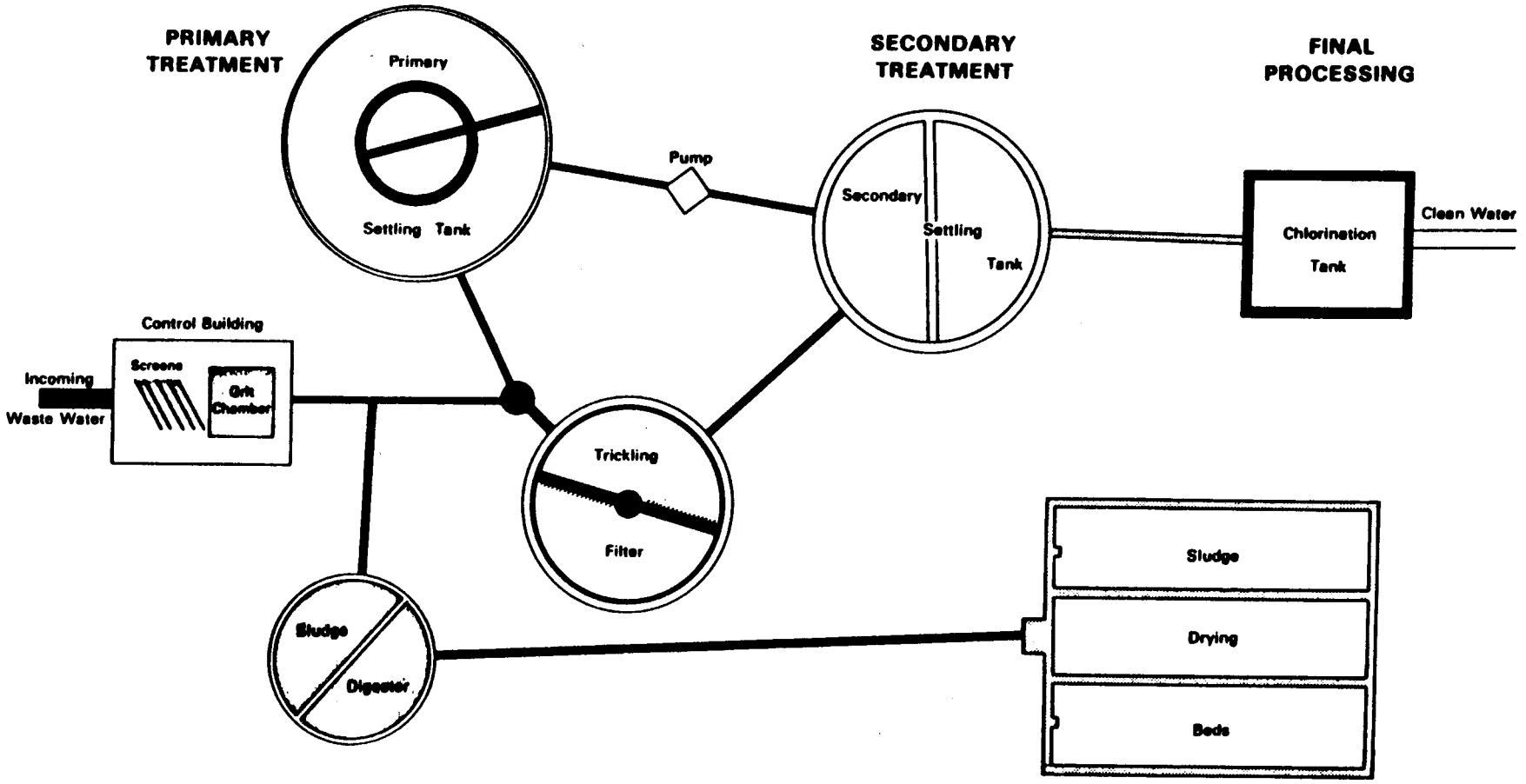


Figure 13

Where it exists, sewage treatment can be divided into three processes. Most pollutants can be removed if treatment is thorough. Unfortunately, complete treatment is expensive and rare (see figure 13).

Primary sewage treatment is a physical process that removes only the substances in sewage that can be screened or settled out. Large objects such as sticks, stones, and cans are screened out. Then, in a second tank, suspended organic material is allowed to settle. A final step in sewage treatment (primary, secondary, or tertiary) is disinfection usually by the addition of chlorine or ozone. Processing sewage with primary treatment alone is grossly inadequate, yet many cities do just this and dump the waste water into rivers and lakes where untreated wastes are diluted. The water may or may not purify itself naturally. If it does not, chronic water pollution results.

Secondary sewage treatment is a biological process. Specially cultured decomposers feed on the organic material in sewage. As the decomposers die they settle to the bottom of the tank as sludge. Air is continually bubbled through the water to furnish the organisms with oxygen. In some types of treatment plants, colonies of decomposers are grown on bed of rocks, and the waste water is trickled over the rocks, allowing the decomposers to feed on the organic material.

The disposal of the accumulated sludge is a major problem for sewage treatment plants. Generally it is taken to landfills; broken down in sealed tanks by anerobic bacteria which produce small amounts of methane gas used as a fuel to operate the plant; or in a few instances, sludge is used as fertilizer or in the production of organic fertilizers.

Treatment plants using primary and secondary processes are efficient in removing organic wastes, suspended solids and in killing infectious organisms. Other substances, particularly phosphates, require tertiary treatment for removal.

There are many tertiary treatment methods. For example, phosphates can be removed by adding chemicals that cause them to precipitate out of the waste water. Filtering waste water through activated charcoal removes organic chemicals that resist biodegradation during secondary treatment.

The technology is available to remove most pollutants from water, but tertiary treatment is costly and complex. Improved and less expensive methods of treating waste water are being tested in laboratories around the world.

Municipal sewage treatment plants routinely treat waste water from households and businesses. Some industrial wastes are treated at plant-owned treatment plants, some are treated by city facilities for a fee, and some are treated by the city system without additional fees. A few industries which use large volumes of water are realizing that improvements in industrial waste water treatment will allow them

to re-use water. Tight water supplies and high government standards for water quality increase the attractiveness of the recycling of industrial water.

Recycling of city water has also been considered as a method of increasing supplies, improving water quality and curtailing the demand for additional water. This sounds distasteful as we like to think that water comes out of the tap in a pure state. In reality, most cities draw their water supplies from rivers that have already recycled waste water discharged by a city upstream. The water is merely disinfected before it is piped to homes and businesses for consumption.

WATER QUALITY AND THE CITY: Principal Concepts

- Cities located near water have historically used water for the dilution and disposal of city washes.
- All water used in the city is part of the natural hydrological cycle.
- There could be a shortage of clean, fresh water for city use in some parts of the world in the future.
- Most water used by city dwellers enters and leaves the city in engineering works, pipes, pumps, canals, etc.
- City dwellers use large amounts of water for purposes other than drinking water.
- In natural environments, water purifies itself.
- Dumping excessive amounts of wastes into water can overpower water's natural ability to purify itself.
- Water is considered polluted if substances are added to it which affect its use for drinking, washing, swimming, fish or other biotic life.
- The amount of dissolved oxygen in water determines how much organic waste material can be degraded by aquatic organisms known as decomposers.
- Human sewage is the major source of organic water pollution in cities.
- Organically polluted water carries bacteria and viruses which cause infectious diseases.
- Dumping wastes into water containing chemicals which act as fertilizers can result in polluted conditions as excessive growth of algae blocks.

- Dumping toxic materials into water can destroy aquatic life.
- Inactive materials dumped into water can reduce sunlight available to aquatic organisms.
- Using water to cool industrial equipment results in thermal pollution which reduces the water's capacity to absorb dissolved oxygen and disrupts the life processes of cool water organisms.
- City waste water should be cleansed before it leaves the city.
- Most pollutants can be removed from waste water if treatment is thorough.

ACTIVITIES

1. EXPLORING DRINKING WATER IN THE CITY

Level: Elementary

Emphasis: Exploring the community

Time: Several days

Materials:

1. Access to city health information

Objectives: At the conclusion of the environmental encounter, the student should be able to:

1. Describe the source of drinking water in the city.
2. State (number) reasons why health standards are set for drinking water in the city.
3. List (number) potential sources of contamination to city drinking water.

Activities:

1. Have a health official discuss the sources and quality of drinking water in the city.
2. Ask about the history of health problems of the area pertaining to drinking water when talking to the health department official and/or to older residents of the city.
   a. When did the health department start checking drinking water?
   b. Why was there a need for checking water?
   c. Were there any epidemics as a result of contaminated drinking water?

d. Could a visit to the graveyard prove that there were epidemics? How could this be determined?

3. Are there other sources of drinking water in the area? What are they?

4. If possible, have samples of drinking water (in clean containers) checked by the health department.

5. What contaminants does drinking water in the city often contain? Where do the contaminants come from? Where is it becoming contaminated?

6. How could contamination of drinking water be prevented? What sort of action would this require?

7. Develop a plan to solve water contamination problems in the community.

2) EXPLORING WASTE WATER TREATMENT IN THE CITY

Level: Elementary, Middle

Emphasis: Community exploration and action

Time: Several days

Materials:

1. Access to information on waste water treatment

Objectives: At the conclusion of an environmental encounter, the student should be able to:

1. List (number) major problems associated with treatment of city waste water.

2. Diagram the local sewage treatment plant and briefly describe how it treats sewage at each stage.

3. Describe a more efficient sewage treatment plant that could be used.

4. List alternative solutions to one of the sewage treatment problems noted in objective one.

5. Identify (number) different ways of financing an improved sewage treatment plant.

6. Develop and implement a plan of action to solve one of the problems identified in objective number one.

Activities:

1. Plan a field trip to the local sewage treatment plant to find out how sewage is broken down and put back into the environment.

   a. What are some of the problems of this plant?

   b. How does the plant work?

   c. How complete is the treatment?

   d. Where does the effluent go?

2. Examine the regulations at the city.

   a. List the regulations that pertain to sewage treatment.

   b. List the advantages and disadvantages of the different regulations to the students.

3. Use local resource people to talk on the functions of different sewage treatments that can be used --- primary, secondary, tertiary, other.

4. Work in groups to draw up alternative ways of treating sewage. What improvements would this make to the environment?

5. Interview individuals responsible for sewage treatment problems. Find out if they are working for improvements.

6. List different ways of financing needed improvements and the costs of improvements.

7. Develop and implement a plan of action to resolve one of the problems of the treatment of sewage in the city.

3) INVESTIGATION WATER POLLUTION IN A RIVER

Level: Senior

Emphasis: Measuring pollution

Time: Several days

Materials:

a. Access to a nearby stream or river.
b. Glass or clear plastic collecting jars.
c. Masking tape.
d. Markers.
e. Secchi disc and cord (see directions).
f. Dissolved oxygen test kit (optional).
g. Plankton net (see directions).
h. Bottom sediment scoop (see directions).

Objectives: At the conclusion of the environmental encounter, a student should be able to:

1. Describe cause of turbidity.
2. List (number) causes of turbidity which can be attributed directly to human acitivity.
3. Describe how dissolved oxygen affects aquatic life.
4. Describe (number) characteristics of the water in the river tested.
5. List industries which use water in the city and possible pollutants added to the water they use.
6. Describe, in writing, the city's water quality standards.
7. Discuss whether or not the standards are enforced.

Activities:

1. Have the students construct materials which are not available (see directions).
2. Choose for examination a stream or river that runs through or past the city.
3. Travel as far upstream as time permits and take samples at intervals of one kilometer for as far downstream as time permits.
4. At each sampling location, have each student keep a record of:
   a. Degree of water turbidity.
   b. Results of dissolved oxygen test (if used).
   c. Odour of water sample.
   d. Amount and kind of predominant shore vegetation.
   e. Kind of human activity taking place in the area (housing, industrial, farms, woodlot, etc.,).
   f. Amount and kind of aquatic vegetation ('water weed', algae, etc.) present.
   g. Observable aquatic animal life present.
   h. Overall aesthetic quality of the water.

5. Obtain a sample of the water and the bottom sediment at each location. Label these carefully according to location with masking tape and a marking pen.

6. Upon returning, make up a large 'river quality' table showing results of the tests and observations from site to site going downstream.

7. Arrange the water and sediment samples on a table in the order in which they were taken.

8. Have the students make careful observations about each water and sediment sample on the following inputs:

   a. Order

   b. Overall clarity of water.

   c. Amount and kind of animal life present in water and sediment sample.

9. Have the students graph dissolved oxygen test results (if used) with dissolved oxygen content at test sites on the vertical axis and distance from the first test site on the horizontal axis.

10. Have them graph Secchi disc results with disc measurement on the vertical and distance from first test site on the horizontal axis.

11. Discussion questions:

    a. How did the Secchi disc and dissolved oxygen test results change as they were taken farther downstream?

    b. What makes water turbid?

    c. Which of those turbidity causes can be attributed directly to human activity?

    d. What is the relationship between degree of turbidity and aquatic plant growth?

    e. If dissolved oxygen test results differed from point to point, how can you account for the differences?

    f. What effect would varying degrees of dissolved oxygen have upon aquatic animal life?

    g. Did the variety of animal life in the water change as you went downstream? Why or why not?

    h. Does the sediment appear to change in some ways as one goes downstream?

i. At any one test site, did the quality of the water appear to change significantly?

j. Identify the points along your tested area of the river where industry or other human activity might alter water quality.

k. Do your tests and observations suggest any relationship between human activity and altered water quality?

l. What businesses or industries along your river can be identified as having significant impact upon local water qualtiy?

m. In what ways does the recreational value of the river increase or decrease as it flows along?

n. In what ways does your city make use of the river?

o. Are some of those uses in conflict with others? Which use dominates?

p. Does your city have a policy regarding water quality standards?

q. Are those standards enforced? Why or why not?

Directions for Construction of Testing Equipment:

SECCHI DISC

Materials: metal disc 12-13 cm. in diameter cut from lightweight metal, metal washers, heavy string, black paint, white paint, eyebolt, nuts.

Procedure:

a. Cut disc from lightweight metal.

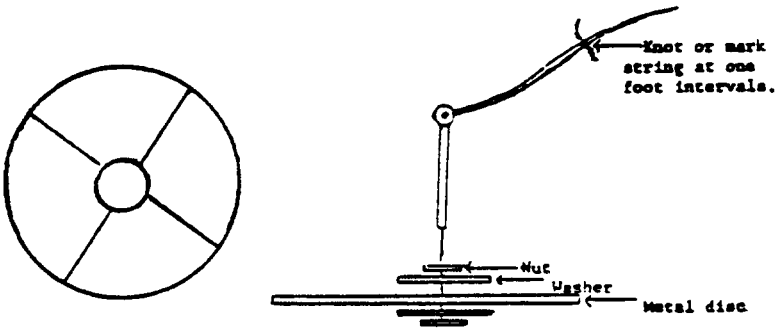
b. Drill hole in centre for the eyebolt.

c. Place a metal washer and nut on the eyebolt, on both sides of the disc. Add more washers if extra weight is needed.

d. Paint disc black and white for contrast.

e. Attach a heavy string to eyebolt and mark it at one foot intervals.

f. Lower the disc into water until it disappears and take a depth reading at this point. Lower it a few feet deeper then raise it until it becomes visible. Take a depth reading at this point. Average these two readings. This is called the limit of visibility.



g. The Secchi Disc can be lowered into streams from a boat, an overhanging branch, or a bridge.

SEDIMENT SCOOP

Materials: A large can (approximately 20 cm. tall, 10 cm. in diameter), broom handle, nuts and bolts, hammer and nails, drill.

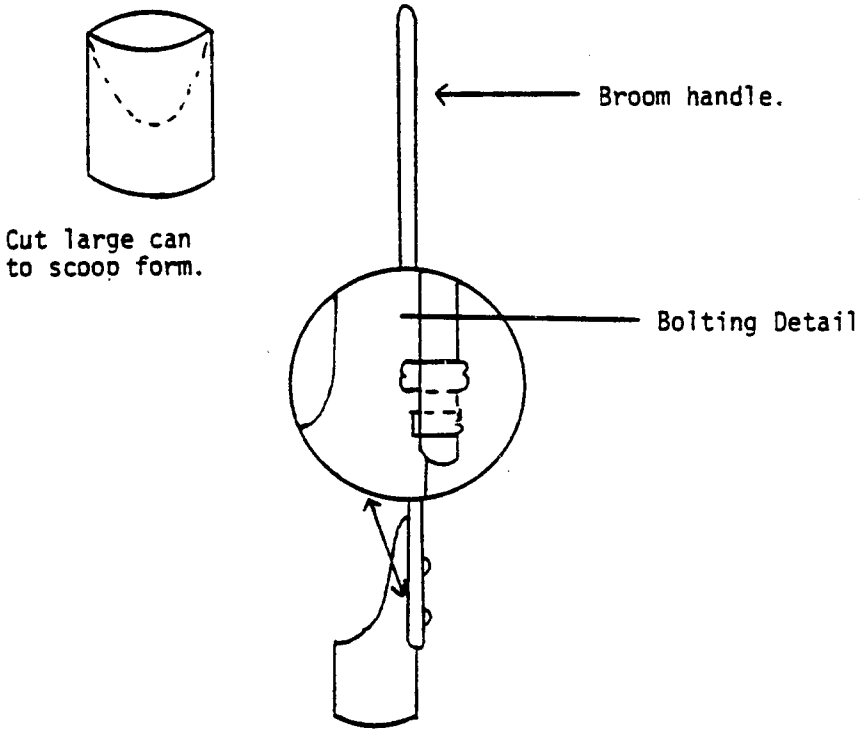
Procedure:

a. Using tin shears, cut the can into a scoop as shown.

b. Punch several small nail holes in bottom of can to allow water to drain.

c. Drill two holes through the broom handle and can.

d. Bolt can securely to the end of the handle.



4) PROTECTING WATER IN THE CITY

Level: All

Emphasis: Organizing individual action projects and exploring the community

Time: Several weeks

Materials:

1. Reference books
2. Chart paper and markers
3. City map

Objectives: At the conclusion of the environmental encounter, the student should be able to:

1. List (number) ways water is used.
2. List (number) ways water is polluted and how the pollution affects its use.
3. Describe, in writing, how water is treated before it is delivered to homes.
4. Describe, in writing, how waste water is treated after it is used.

Activities:

1. Make a list of as many uses as possible for clean water. Put the list on poster paper. Mark the list with the following:
   a. Put an 'S' next to human uses of water necessary to support life.
   b. Put an 'E' next to human uses for enjoyment.
   c. Put an 'N' next to human uses not related to supporting life or enjoyment.
2. Make a list of as many ways as possible that humans pollute water. Research the question if necessary.
   a. Put an 'S' next to pollution that affects human survival.
   b. Put an 'E' next to pollution that degrades the environment.
   c. Put 'N' next to pollution that does not affect human life.

3. Make a list of ways to reduce water pollution.

4. Choose one way (for each student) to improve water quality; something the school can do, something the family can do, or something the individual can do.

   a. Make an individual check list for the anti-pollution campaign covering four weeks.

   b. Implement the project and evaluate the results individually with the teacher after two weeks.

   c. Modify or change the project, if necessary, and continue for two more weeks.

   d. Evaluate the project and report the results to the class.

5. Obtain a map from the city water department showing the source of the local water supply and the location of waste water disposal facilities. If possible, visit both a water supply treatment site and a waste water treatment facility.

   a. How much water is used per person each day in the city?

   b. Where does the city get its fresh water supply?

   c. Where is waste water for your part of the city treated?

   d. If possible, visit the fresh water treatment facility or the waste water treatment facility Make a report on the method used for one or both processes.

6. Make a presentation to the class on 'Improving Water Quality in the City'.

EVALUTION (test)

WATER QUALITY AND THE CITY

Multiple Choice:

1. The land area which collects water for use by cities is called a(n) _____.

   a. artesian well
   b. urban watershed
   c. reservoir
   d. sewer
   e. run-off

2. The natural global recycling process for all water is called the _____.

   a. reservoir
   b. evapo-transpiration
   c. hydrologic cycle
   d. urban watershed
   e. sewer

3. Of the total amount of water on earth the percentage of fresh water is _____.

   a. very small
   b. lots
   c. half and half
   d. large
   e. nonexistent

4. Most urban dwellers use, directly or indirectly, _____ amounts of water each day.

   a. very small
   b. medium
   c. low
   d. large
   e. no

5. Industries such as beverage bottling, food processing and cosmetic lotions use water _____.

   a. consumptively
   b. non-consumptively
   c. sparingly
   d. infrequently
   e. by recycling

6. The process by which decomposers break down organic waste is called _____.

   a. garbage disposal
   b. biodegradation
   c. putrification
   d. pollution
   e. BOD

7. A by-product of biodegradation of organic waste is _____.

   a. cholera
   b. BOD
   c. garbage disposal
   d. phosphate pollution
   e. physical pollution

8. The amount of dissolved oxygen needed by decomposers to degrade organic wastes in a given volume of water at a given temperature is the _____.

   a. waste water potential
   b. pollution potential
   c. oxygenation
   d. BOD
   e. biodegradation

9. Physical pollution is _____.

a. chemically inactive debris
b. environmentally hazardous
c. aesthetically displeasing
d. all of the above
e. none of the above

10. Water which runs off city streets is often removed through a system of underground _____.

a. highways
b. storm sewers
c. gutters
d. sidewalks
e. sanitary sewers

11. The physical process that removes substances in sewage that can be screened or settled out is _____.

a. tertiary treatment
b. storm sewers
c. gutters
d. biodegradation
e. secondary treatment

12. Secondary sewage treatment is a(n) _____ process.

a. biological
b. physical
c. toxic
d. none of the above
e. unimportant

13. Most methods of tertiary treatment of waste water are _____.

a. important
b. expensive
c. for phosphate removal
d. all of the above
e. none of the above

14. _____ has been considered as a method of improving water quality and reducing further demand for water.

a. biodegradation
b. recycling
c. activated charcoal
d. tertiary treatment
e. chlorination

Matching:

1. BOD
2. biodegradation
3. toxic pollution
4. watershed
5. decomposers
6. organic pollution
7. thermal pollution
8. tertiary sewage treatment
9. phosphate pollution
10. physical pollution

a. salty
b. removal of chemical pollutants
c. food processing industries
d. biochemical oxygen demand
e. natural recycling process for H_2O
f. aquatic bacteria and fungi
g. biological sewage treatment process
h. lead, mercury, insecticides

11. primary sewage treatment
12. consumptive water use
13. 97% of earth's water
14. hydrologic cycle
15. secondary sewage treatment

i. settling out sticks, cans and other large objects
j. hot water discharge
k. human sewage, disease organisms
l. process whereby decomposers break down organic materials
m. algal bloom
n. land area that collects water for city use
o. physical not chemical effect

True-False:

_____ 1. The land area which collects water for use by cities is called the urban open space.

_____ 2. A small part of city water is locked in the hydrologic cycle.

_____ 3. Water supplies for cities are a major part of the massive recycling system.

_____ 4. Most of the earth's water is fresh water.

_____ 5. Many places in the world are faced with shortages of usable water.

_____ 6. The greatest use of urban water is nonconsumptive.

_____ 7. Organic materials are degraded into simple substances by biodegradation.

_____ 8. Organically polluted water is safe to drink.

_____ 9. Dissolved oxygen is needed for decomposers to break down organic waste.

_____ 10. Toxic pollutants increase the effectiveness of decomposers.

_____ 11. Physical water pollution is uncommon.

_____ 12. Physical pollutants are environmentally safe.

_____ 13. The extent of damage from thermal pollution is controversial.

_____ 14. A major problem with thermal pollution is that it reduces the water's capacity to dissolve oxygen.

_____ 15. Primary sewage treatment is a physical process.

_____ 16. Primary sewage treatment is adequate.

_____ 17. Secondary sewage treatment is a physical process.

_____ 18. Disposal of sludge from secondary treatment is a problem.

_____ 19. Tertiary sewage treatment can remove most pollutants.

_____ 20. Recycling of city water can curtail the demand for additional water.

Key: WATER QUALITY AND THE CITY

Multiple Choice	Matching	True-False
1. b	1. d	1. False (watershed)
2. c	2. l	2. False (all of city water)
3. a	3. h	3. False (minor)
4. d	4. n	4. False (salty water)
5. a	5. f	5. True
6. b	6. k	6. True
7. d	7. j	7. True
8. d	8. b	8. False (dangerous)
9. d	9. m	9. True
10. b	10. o	10. False (decrease)
11. c	11. i	11. False (is common)
12. a	12. c	12. False (harmful)
13. d	13. a	13. True
14. b	14. e	14. True
	15. g	15. True
		16. False (not adequate)
		17. False (biological)
		18. True
		19. True
		20. True

CHAPTER VI: URBAN SOLID WASTES

When one considers all of the solid materials that urban dwellers use, only food and fuel are actually consumed. Materials used in residences, clothing, tools, furnishings, decorations, automobiles, etc. are constructed for use, not consumption. Raw materials, metals, lumber, petroleum products (used in plastic), chemicals, etc., are taken from the earth, fashioned into consumer products and, when each product's useful life is over, generally thrown out. In this manner, the raw materials are returned to the earth.

Virtually all human activity creates waste. Our earliest ancestors, inhabiting caves, threw wastes 'over their shoulders'. When resulting piles became offensive, they were covered up. After a few hundred years, a cave would fill up, forcing the occupants to find new homes.

In early cities few improvements had been made. Discarded materials were thrown around city dwellings or outside city walls. Interesting records of the daily life can be pieced together by studying waste piles.

Concern over the health hazards created by accumulated heaps of trash along streets forced improved collection. Garbage and trash were hauled from city streets to farms for feed, to open dumps or to nearby rivers. Where cities were located near the ocean, trash was barged out to sea. The solid waste problem was not solved, it was merely moved.

Disposal Methods: Dumping, Burning, Sanitary Landfills

Today's solutions to urban wastes are not much improved. Modern waste disposal techniques, similar to ancient methods, include open dumping and burning. Open dumps are unsightly and smelly and become the home of disease-carrying vectors, flies and rats and pathogenic organisms.

Open burning merely swaps one environmental problem, land waste disposal, for another, air pollution. When anything burns, particularly something as impure as urban trash, smoke is produced in great quantities. Burning indoors, in incinerators, helps little. Nonetheless, if proper pollution control devices are installed, incinerators can be designed to burn large amounts of trash safely. Heat generated from incinerators can be used to heat buildings.

A modern hazard of burning trash is that it contains man-made products new to the twentieth century. For instance, plastics containing polyvinyl chloride produce a highly corrosive compound, hydrogen chloride, when burned. It errodes metallic containers, including incinerators.

One step beyond the open dump is disposal in a sanitary landfill. Landfills differ from open dumps in that wastes are 'sanitized' by covering them quickly. As each truckload is dumped, a bulldozer covers the wastes with earth. The advantage of a properly maintained sanitary landfill is that prompt burial prevents trash from blowing

away or attracting unwanted organisms. Unfortunately most landfills are not properly maintained since wastes are usually covered only once a day, often less frequently. Another safety precaution related to landfills is their location. Landfills must be sited so that rainwater seeping through buried wastes will not contaminate underground city water supplies.

Good sites can accommodate a great deal of trash. When a site is filled to capacity, the last layer of waste materials is covered with several feet of earth and the land can be used for certain types of development. Because wastes will settle for years, construction of buildings is extremely unwise. Commonly the land is used for parks or other recreational facilities.

A possible by-product of old landfills is fuel. Large sites that have been receiving wastes for many years can be tapped for the collection of methane gas. The fuel, a smelly gas associated with decaying organic matter, is produced as decomposing organisms in the soil feed on buried organic wastes. The gas can be cleaned and used for heating buildings.

Problems and Solutions

In burying wastes, we rely on the earth's natural recycling capacities to decompose wastes. The problem is that solid wastes of today are quite different from those of the past.

Natural materials have a rather short life in the natural environment. Organic materials, including paper and paper products, are decomposed by organisms in the soil. This natural recycling process is similar to the natural decomposition of wastes in water. Tin cans, which are actually steel can thinly coated with tin, rust away in a few years. Glass bottles are reasonably destructible in that they are easily crushed.

But many modern materials do not decompose. Buried or not, plastic bottles and aluminum cans will last indefinitely. No natural process decomposes plastic or aluminum.

Highly poisonous waste materials present another problem. Insecticides, rodenticides and herbicides need special treatment, even in minute quantities. The numbers and types of toxic materials are increasing as are disposal problems related to ridding cities of hazardous materials.

The many terms used to describe urban wastes are not precise. 'Litter' generally refers to ignored wastes indiscriminately discarded by urbanites on city streets, in vacant lots and in public places. 'Rubbish' commonly refers to dry wastes including paper, glass, cans, plastics, etc. 'Garbage' describes wet wastes resulting from food preparation. Other urban wastes include building materials, dead animals, sewage (discussed earlier) and industrial wastes. Air pollution and water pollution result from disposal of urban wastes. This discussion focuses on consumer-generated wastes rather than industrially-generated wastes. The latter is a huge topic by itself.

Population growth and the packaging revolution have increased the amounts of solid wastes in cities around the world. As much as a third of household wastes can be disposable paper products and discarded packaging: household wrappings, boxes, tissue, napkins, diapers, etc. While the volume of disposable household goods varies from country to country, the use of throw-away items is increasing everywhere.

Safe and economical waste disposal is possible. One alternative is the construction of a solid waste pipeline similar to sewage pipelines running from residences under city streets to centralized collection sites. A housing development in Stockholm, Sweden has a pilot system which collects solid wastes from 500 apartments in a pipeline (over 50 cm in diameter). An air stream pushes the wastes along the line to an incinerator more than a mile away. Heat generated by the incineration supplies heat to the apartment in the winter.

As innovative as new technologies for waste disposal may be, a better solution to the problem is not disposal, but recycling. Billions of dollars of useful resources are thrown into city dumps or are burned each year. In the long run the solution is to abolish the idea of 'waste' in favour of 're-use'. Organic materials, for instance, can be eliminated from the waste stream by composting garbage for use in gardens. Consumer goods can be designed for practical recycling. Paper trash can be collected separately and reprocessed into new paper. Used aluminum cans can be made into new cans. Bottles can be reused. In the long run, the elimination of unnecessary packaging would result in a more waste-free system.

URBAN SOLID WASTES: Principal Concepts

- Open dumps are a poor method of disposal of wastes.
- Burning city wastes produces air pollutants except burned in incinerators equipped with proper emissions controls.
- Sanitary landfills provide an adequate disposal site for urban wastes if they are properly maintained.
- Many modern materials do not decompose when buried.
- Increased use of disposable products and excessive packaging of consumer products results in increased amounts of wastes in need of disposal.
- Recycling and reusing waste materials is preferable to burying or burning used materials.

ACTIVITIES

1) EXPLORING SOLID WASTES GENERATED BY THE SCHOOL

Level: Elementary

Emphasis: Survey, organization and interpretation of data

Time: Several days

Materials:

1. Map of school and grounds

Objectives: At the conclusion of the exercise, the student should be able to:

1. List (number) sources of solid wastes generated by the school.

2. Describe, in writing, (number) ways each category of solid wastes identified by objective one could be reduced.

Activities:

1. Divide students into groups. Each group should select one type of waste and determine its sources at the school.

2. The collected data should be discussed and compiled within the groups. (Some data ideas are: location of trash collection, amounts of trash and times of pick-ups, sources of trash, methods of disposal, use of disposable materials, recycling).

3. Each group should submit to the class a written summary of its data and one or two practical means of lessening the amount of waste. They may also have ideas about recycling wastes.

4. Discussion question: Are there comparable waste problems in your homes or neighbourhoods?

2) MAN'S IMPACT ON THE ENVIRONMENT

Level: All

Emphasis: Awareness and providing alternative solutions

Time: Several days

Materials:

1. Chart paper and markers

2. Paper, or small cards, and pencils

Objectives: At the conclusion of the exercise, the student should be able to:

1. Describe (number) ways man alters the environment as he develops new materials and constructs buildings.
2. Describe (number) ways these activities have a negative affect on the environment.
3. Suggest (number) ways negative results of the activities in objective number one could be reduced.

Activities:

1. Divide into groups of approximately six students each. Each group constructs a chart similar to the following:

MASTER CHART

PROBLEM (As people needed or made more:)	ACTION (People did:)	IMPACT (Results:)	REMEDY (Cures:)
homes	cut down trees	errosion, animals moved	plant trees
food	used more land	-	-
to kill insects	used poison	-	-
materials	built factories	-	-
cars	made more	-	-
litter	waste materials	-	-
energy	-	-	-
gas	-	-	-
etc.	-	-	-
etc.	-	-	-
etc.	-	-	-

2. Discuss the charts. Individually rank five problems considered most important by numbering them one through five. Tally class results and discuss.
3. Make individual cards similar to the model below for specific environmental problems. These cards should provide space to outline 'impacts' and 'remedies' in some detail.

SPECIFIC AREA CARD	
PROBLEM (More People Needed:)	More cars.
ACTION (People Did:)	Made more cars.
IMPACT (Results:)	Fumes put pollutants into air. Trees and plants died. More noise. Abandoned cars unsightly, etc.
REMEDY (Cures:)	Engineers work to design better motors. Cleaner air helped plants and animals. More people riding bicycles, etc.

4. Discuss individual cards.

EVALUATION (test)

URBAN SOLID WASTES

Multiple Choice:

1. Solid waste mineral is disposed of by _____.

   a. dumping
   b. burning
   c. burying
   d. littering
   e. all of the above

2. In sanitary landfills, urban wastes are sanitized by _____.

   a. spraying with disinfectant
   b. covering with dirt
   c. burning
   d. pathogenic organisms
   e. all of the above

3. A possible by-product of old landfills is _____.

   a. useless land
   b. pathogenic organisms
   c. fuel
   d. none of the above
   e. sulfuric acid

4. When buried, organic materials _____ quickly.

   a. do not decompose
   b. recycle
   c. become useful
   d. decompose
   e. stabilize

5. The disposal of insecticides, rodenticides and herbicides requires _____ treatment.

   a. no
   b. special
   c. biodegradation
   d. tertiary
   e. little

6. A(n) _____ amount of household wastes are disposable paper products and packaging.

   a. insignificant
   b. increasing
   c. decreasing
   d. negligible
   e. zero

7. An environmentally sound alternative to the disposal of wastes is:

   a. not wasting
   b. re-using wastes
   c. using fewer disposable items
   d. recycling
   e. all of the above

Matching:

1. composting	a. reusing waste materials
2. Stockholm, Sweden	b. does not decompose
3. plastic	c. innovative solid waste disposal
4. burning waste	d. air pollution
5. methane gas	e. organic wastes
6. open dumps	f. unsanitary
7. litter	g. produced when organic materials decompose
8. recycling	h. improperly discarded trash

True-False:

_____ 1. Burning trash containing plastics may produce a highly corrosive compound.

_____ 2. Modern wastes decompose more readily than earlier materials.

Key: URBAN SOLID WASTES

Multiple Choice	Matching	True-False
1. e	1. e	1. True
2. b	2. c	2. False
3. c	3. b	
4. d	4. d	
5. b	5. g	
6. b	6. f	
7. e	7. h	
	8. a	

CHAPTER VII: CITY NOISE

From earliest times, noise has been part of the urban environment. In ancient Rome, the poet Horace complained of the noise made by heavy wagons on roads. Caesar barred chariots from certain parts of the city at certain times of the day and night. Much later, Marcel Proust lined his study with cork panels to keep out the noise of the Paris streets.

Accelerated population and industrial growth, especially during the last fifty years, has been accompanied by a steady increase in the noise level in cities. As cities have crowded more and more services into less and less space, urbanites spend more time surrounded by noise. Realization of the effects of increased city noise has been slow.

It is extremely difficult to define noise. Generally it is 'unwanted' sound. But one person's noise may be another person's pleasure. For example, rock music may be enjoyable to one person, nerve-wracking to another. Some sounds, while generally acceptable, become annoying when loud. The louder a sound, the more likely it is to be considered noise.

Sound, pleasant or unpleasant, has two dimensions: loudness (intensity) and pitch. Intensity is the amount of sound energy reaching the eardrum. Highly intense sounds can be painful and cause damage to the eardrum. Continual exposure to loud sounds can result in permanent hearing losses. Victims of hearing loss caused by environmental noise are seldom aware that they have a problem.

The intensity, or loudness, of a noise can be measured by the amount of power that strikes the eardrum. The most common unit for measuring power is the watt. The power of the average human voice is only a few millionths of a watt. The power range between the faintest sounds the human ear can hear and the most intense, painful sounds is about 2 million million units. But because loudness to the human ear does not increase exactly as intensity changes, a special scale was developed to measure loudness: the decibel scale. One decibel (db) is the smallest change in loudness that the average human ear can detect. The decibel scale conveniently translates the relationship between the intensity or power of a sound and the perceived loudness.

It is impossible to establish a dividing line between sound and noise. Below 40 to 50 db, sound is rarely called noise. Above 80 to 90 db, sound is almost always called noise. In between whether or not a sound is considered noise depends on pitch and other characteristics of the sound. High-pitched sounds are usually more annoying than low-pitched ones. Irregular or intermittent sounds are considered noise more frequently than steady sounds. Sound is irregular when there are frequent changes in the loudness or pitch.

City dwellers are bombarded by noises, indoors and out-of-doors. The sound level in a quiet neighbourhood may be 40 db, a busy street 90 db, a factory over 100 db. Indoor noises are found in households, offices and industrial plants, and sites of special city activities

such as discotheques and amusement parks. Household noises include voices, radio, television, plumbing, household appliances, etc. Many modern apartment buildings are constructed with very little muffling in the walls and sounds carry easily from one apartment to another. Household noises, while annoying, seldom result in hearing losses. Industrial noises, on the other hand, frequently fall in the 80-110 db range, and can cause both temporary and permanent hearing losses. Reduction of industrial noise can be achieved through the installation of quieter equipment and mufflers made of sound absorbing materials. Industrial workers continually exposed to high levels of noise should be required to wear ear plugs or muffs which can reduce noise by 40 to 50 db.

Outdoor sources of urban noise fall into five broad categories: transportation; construction; industrial operations; noises produced by people, shouting or loud playing of radios; and miscellaneous noise such as clanging metal garbage cans or air-conditioning units.

Community noise surveys have been conducted in major cities around the world. There is general agreement that streets are the greatest source of outdoor noise. Although aircraft noise is more intense, exposure time is less. As high as the 16th floor in New York City, traffic noise levels were up to 100 db. The noisiest surface vehicles are trucks, generating as much as 90 db at high speeds. Following closely behind trucks are buses, motorcycles, sports cars and passenger cars. Railroads, subways and elevated trains are noisy because metal wheels run on metal rails. Continuously-welded rails or the use of rubber wheels softens the noise. Aircraft, railway and freeway noise cause a decline in a neighbourhood's attractiveness.

Construction and demolition noises generate intense and intrusive noise. Construction equipment is operated by loud diesel engines and air compressors. An air compressor rates more than 100 db.

The effects of noise fall into four categories: 1) annoyance, 2) disruption of activity, 3) partial or total loss of hearing, and 4) physical or mental deterioration.

Annoying noises interfere with normal activities such as rest and sleep, reading and concentration, studying, talking, etc. Sudden noises not only interrupt activities, they cause blood vessels to constrict, pupils to dilate, muscles to contract, increased heartbeat, wincing, suspension of breath and stomach spasms. Urban noise contributes to a general atmosphere of stress and tension. Medical experts believe that excessive noise can be a triggering agent for allergies, ulcers and mental problems. A study in the United Kingdom discovered that people who lived close to a major London airport required treatment for mental illness at a higher rate than people living elsewhere.

The most studied effect of over-exposure to noise is hearing loss. Hearing loss is not deafness. It is a decreased ability to hear sounds in the 'normal' range of pitch and loudness, in other words, an inability to hear sounds heard by most people. The most serious impact occurs on those occupations continually expose them to noise levels exceeding 80 db and almost all workers in such situations are affected unless proper ear plugs or mufflers are worn. Gradual

hearing losses lower worker productivity, increase accident rates and cost employers billions of dollars in lost output.

As with air pollution, it is difficult to link noise directly with specific physiological and mental disorders, but there is little doubt that it is a contributiong factor.

Controlling Noise

From a technological and economic standpoint, noise pollution is easier to control than water and air pollution. Air and water pollution are best controlled at the polluting source. Noise can be controlled: 1) at the source, 2) as it is transmitted, or 3) by protecting the receiver.

Cities have been slow to insist on reductions in the sources of urban noise. A handful of cities have established maximum day and night noise levels in certain parts of the city. The USSR limits factory noise to 85 db and residential noise to 30 db. Some cities have developed building codes which insure that apartments are constructed with sound absorbing materials between units. Noise control standards can also be established for automobiles, motorcycles, trucks, airplanes and home appliances. Street sounds can be muffled by planting natural sound absorbers, trees, between streets and residences.

A final line of defense is to protect oneself. Some people mistakenly associate noise with power and choose noisier home appliances, and other items such as motorcycles, with the mistaken idea that louder devices are more powerful and work better or faster. Carpets, drapes, upholstery, etc., absorb and reduce noise within homes and apartments. Consciousness that noise is an increasingly serious urban problem and that specific action can produce meaningful results is important.

CITY NOISE: Principal Concepts

. Sounds considered to be offensive vary as one person's noise may be another person's pleasure.

. Loud, high-pitched and irregular sounds are more likely to be unpleasant than soft, low-pitched, regular sounds.

. City dwellers are exposed to thousands of sources of noise, indoors and out-of-doors.

. Sudden and loud noises can cause physical reactions in the cardiovascular respiratory, nervous and muscle systems.

. Physical stress and mental disorders are affected by excessive noise.

. Exposure to sounds over long periods of time can result in severe hearing losses.

. Noise pollution can be controlled at the source as it is transmitted or by protecting the receiver.

ACTIVITIES

1) NOISE SURVEY

Level: Elementary

Emphasis: Surveying and values

Time: Several days

Materials:

1. Survey sheets made by students: (example)

SOUNDS	LIKE	DON'T LIKE	LOUD BUT NEEDED
School bells			
Wind blowing			
Car brakes squealing			
Birds singing			
Police sirens			
Children playing			
Soft music			
Noon whistle			
Rock music			

Objectives: At the conclusion of the exercise, the student should be able to:

1. Display visually, the results of a survey.

2. Discuss verbally, how to conduct a survey.

Activities:

1. Divide class into small groups.

2. Have students make a list of sounds they like to hear.

3. Make a list of sounds they don't like to hear, and a list of loud but needed sounds.

4. Develop a survey list from the students' lists. Be sure to mix up like, don't like and loud lists. Include a place for the people being surveyed to add their own sounds.

5. Take a survey of parents and other students.

6. Make a graph to show results of survey.

7. Analyse data.

8. Discussion questions:

   a. What sound was liked and disliked by most people? Why?

   b. Are some sounds problems?

   c. Does our survey represent the feelings of most people?

   d. Does our survey list all the sounds?

   e. Can we improve our survey?

   f. What should we do with the data we have gathered?

EVALUATION(test)

1) CITY NOISE

Multiple Choice:

1. Continual exposure to loud sounds can result in _____.

   a. permanent hearing loss
   b. inability to hear sounds normally heard by people
   c. hearing problems
   d. all of the above
   e. none of the above

2. The most common unit for measuring power is _____.

   a. centimeter
   b. loudness
   c. watt
   d. decibel
   e. erg

3. A special scale to measure loudness is the _____ scale.

   a. watt
   b. decibel
   c. metric
   d. intensity
   e. centigrade

4. Sounds above _____ are almost always termed noise.

   a. 40-50 db
   b. 1-10 db
   c. 60-70 db
   d. 80-90 db
   e. 100-110 db

5. Urban noise contributes to _____.

   a. tension and stress in people
   b. health and well-being
   c. air pollution
   d. economic well-being
   e. city power

6. The noisiest surface vehicle is the _____.

   a. bicycle
   b. car
   c. truck
   d. airplane
   e. compressor

7. _____ is the most studied effect of over-exposure to noise.

   a. mental illness
   b. annoyance
   c. physical deterioration
   d. hearing loss
   e. health

Matching:

1. watt	a. 80-110 db
2. noise	b. noisiest surface vehicles
3. sound intensity	c. sound level in quiet neighbourhood
4. decibel scale	d. power of average human voice
5. hearing loss	e. unit for measuring power
6. industrial noise	f. unwanted sound
7. 40 db	g. sound energy reaching eardrum
8. a few millionths of a watt	h. noise
9. above 80-90 db	i. decreased ability to hear sounds
10. trucks	j. measures loudness

True-False:

_____ 1. Noise has been steadily increasing in cities.

_____ 2. Loud home appliances are more powerful.

_____ 3. Noise pollution is more difficult to control than air or water pollution.

Key: CITY NOISE

Multiple Choice	Matching	True-False
1. d	1. e	1. True
2. c	2. f	2. False (not necessarily)
3. b	3. g	3. False (not difficult)
4. d	4. j	
5. a	5. i	
6. c	6. a 9. h	
7. d	7. c 10. b	
	8. d	

CHAPTER VIII: NATURE IN THE CITY

Man, in building the city, alters the natural site drastically. Development techniques require that natural vegetation be removed. With it, wildlife disappears. Vegetation, except for imported food, is no longer perceived as a necessity. Rainwater that would have been available to plant roots, runs in gutters and sewer pipes. Ground water supplies are altered by the sewer system. Soil is compacted, rivers are enclosed in concrete, and great areas of shade are created by multi-storey buildings. Modern engineering capabilities make almost any alteration in the natural environment possible. Urbanites often seek relief from the tedious, frenetic life-style of the city by visiting a place where the sense of sight sound, touch, taste and smell are calmed. Places outside the city where nature is evident and unaltered by man can re-energize the visitor. The smell of trees and the taste of spring water, the sound of waves pounding onto a beach are uncomplicated, predictable and calming. In the same way nature in the city, unpolluted water or well-planned open spaces can have a calming effect.

The history of urban gardening reveals that vegetation inside the city was important in ancient cities and has taken many forms: large formal, geometrically planned gardens and pools; smaller gardens in courtyards, on patios, balconies or roofs; indoor gardens; exotic gardens; and gardens which are mostly grass.

Space for city vegetation clearly has value. Parking lots and plazas can provide space, but open space alone is not enough. Space softened by trees, greenery, water and different textured surfaces mitigates harshness. The interplay of natural and artificial features in the city softens and harmonizes the man-made environment.

Dense concentration of residences and apartments stacked one above the other limit the indoor tension-reducing space available to urbanites. Streets, sidewalks, parks and plazas become additional living space and these shared spaces take on special meaning. Among other things, parks and green areas are places where urbanites can envelop themselves in nature without the usual distraction of urban activities. For many, it is their only contact with nature.

In recent years studies have shown that vegetation improves the quality of the urban environment in measurable ways. Large parks, such as New York City's 341 hectare Central Park, dilute gaseous pollutants. A strip of green foliage is three to six times more effective in trapping dust than a smooth flat surface of the same size. Trees are effective in helping to settle out particulate air pollutants. A study of London's Hyde Park (259 hectares in area) revealed a 25 per cent reduction in the concentration of smoke passing through. City vegetation clearly has value and space for nature in the city and is too important to be an after-thought.

Trees and large bushes are the most conspicuous elements of city vegetation. They not only filter out dust and other airborne particles; they also serve as windbreaks, reducing wind velocities on city streets as wind rushes between tall buildings. They modify the local climate by providing shade and regulating moisture content of the air.

They absorb reflections from concrete and asphalt, minimizing heat and glare. They serve to delineate property lines and as median dividers separating pedestrian traffic from vehicle flow. They beautify landscape by softening building lines; they provide a variety of colour, sizes and patterns to the urban landscape, emit pleasant odors and provide a sense of privacy and solitude.

The city, as compared with natural settings, is hostile to plant growth. Urban vegetation is subject to a number of environmental stresses that are absent or less severe in the countryside. These stresses limit the kinds of plant life that can survive in the city.

Urban trees must withstand reduced supplies of water and oxygen. Pavement prevents normal water absorption by the soil.

Nutrient minerals in the soil are often limited because leaves, grass and other organic materials are not recycled in the soil. Dead organic material is raked and collected for disposal elsewhere.

Man-introduced substances, which are harmful to vegetation, find their way into urban soil: pesticides, herbicides and run-off from city streets. Toxic materials and road salt kill urban vegetation. Some air pollutants severely reduce plant food production even in low concentrations. Sulfur dioxide and ozone cause bleached spots to appear on leaves and other pollutants cause discolouration.

Activities in the city can cause mechanical damage to vegetation. Tree roots are frequently injured during construction work. Trees are vulnerable to vandalism and accidents which allow entry of disease organisms.

During the construction of cities, native vegetation is largely destroyed. City dwellers bring new species into the city and take care of them. Vegetation is found along city streets, in gardens and parks, in private yards and on unused land. Gardens may be ornamental or they may produce food. Urban vegetable gardens are appearing not only in privately owned gardens, but in vacant lots and on unused public land.

Disturbed land which is left vacant is quickly taken over by unwanted vegetation, aggressive invaders termed weeds. In natural environments, such invaders have a purpose. In cities, they are viewed as pests.

The use of grass in the cities originated in moist climates where grass could be grown with little care. Early expanses were maintained by animals (sheep, goats or cattle) grazing around the home. Lawns have become increasingly popular in some countries during the past fifty years, but today, they require constant care, watering and moving.

City parks and green areas are located on open land which is relatively uninterrupted by man-made structures, buildings, streets, etc. Historically parks were privately owned and rather formal. Vegetation was reduced to simple and comprehensive geometry, an idealized nature. In today's parks, trees, lawns and gardens may be

interlaced with pathways and playing fields. Parks are more frequently publicly owned and serve multiple leisure uses. During the last two centuries, there has been a recognition that all of nature is a garden. There has been a movement away from stylized, ornamental gardens toward allowing nature to be the gardener. Natural vegetation, inside or outside the city, requires less care, provides the city dweller with opportunities for contact with the natural environment and food and nesting sites for wildlife.

The types of city plantings vary. Some cities have systematically planted trees along streets, creating an 'urban forest'. Natural forests contain a wide variety of trees, bushes and ground plants and provide a home for equally as many species of animals. They are characterized by complexity and diversity - healthy systems balanced by thousands of interdependent natural processes.

Urban forests, on the other hand, are frequently dominated by one species. Such a forest is vulnerable to disease. One diseased tree quickly results in a second diseased tree, and a third. There have been instances where entire stands of trees have disappeared from cities, wiped out by a single disease. Such an occurance is improbable in a natural forest. Natural diversity is a buffer against calamity.

All cities contain a surprising amount of wildlife. However, with a few exceptions, wildlife in cities is not integrated into healthy natural communities. Useful habitats for small animals and birds exist along streams and lakes, in parks, both forested and open, in private gardens and yards, in cemeteries, dumps and neglected areas of the city such as railroad right-of-ways and vacant lots where vegetation has established itself.

Birds and mammals that once inhabited the land which the city occupies frequently continue to be found near the urban edge. The purposeful reintroduction into the city of berries and shrubs preferred by certain species frequently results in their return to the city. Diversity of vegetation permits diversity in animal life. Vegetation is a direct source of food and it supports the insects and other invertebrates that serve as food for birds and animals. Vegetation also provides sites for nesting, dens, and protection from enemies.

Speaking primarily of non-domesticated animals, three groups can be identified: animals adapted to life in the city which are at least partially dependent on people or man-made structures for food, shelter and nesting sites; those that tolerate urban life; and those that usually shun cities because the small natural living spaces provided inside the city are inadequate.

The most successful non-domesticated species in the city are those whose life in the wild pre-adapted them for life in the human community. The Norway rat, cockroaches, the rock dove or common pigeon and the house sparrow are examples.

NATURE IN THE CITY: Principal Concepts

- The type of vegetation and wildlife changes dramatically when a city is constructed on a land site.
- Vegetation has been an important part of cities throughout history.
- Vegetation inside the city provides an opportunity for contact with nature and provides an escape from city stresses.
- Vegetation in the city provides shade and minimizes heat and glare from paved surfaces and buildings.
- Vegetation baffles city noises and helps remove particulates from the air.
- Urban vegetation is subject to environmental stresses that are not present in natural settings.
- The most successful non-domesticated species of animals and plants in the city are those whose habitat in the wild pre-adapted them for life in the city.

ACTIVITIES

1) THE VALUE OF TREES IN THE CITY

Level: All

Emphasis: Community exploration, planning and citizen action

Time: Several days

Materials:

1. Access to information on trees
2. Large drawing paper and pens

Objectives:

1. List (number) ways trees can benefit a community.
2. Identify (number) environmental factors influencing the selection of street-trees.
3. Design an appropriate street-tree planting plan for the community.
4. Identify existing laws and ordinances governing community beautification.
5. Identify (number) ways a tree planting ordinance can benefit a community.

Activities:

1. Take a field trip to survey the existing trees to determine the need for a street-tree planting programme. Observe the following:

   a. Healthy trees that should be preserved.

   b. Dead trees that should be removed.

   c. Diseased trees that need attention.

   d. Areas where new trees are needed.

2. Make a street-tree map of your area of the city and record the following information:

   a. Location of various site factors:

      width of streets
      width of planting strips
      set back of buildings
      location of utilities

   b. Location of survey facts:

      healthy trees that should be preserved
      dead trees that should be removed
      diseased trees that need attention
      areas where new trees are needed.

3. Gather a variety of informational materials concerning trees.

4. Identify professional resource people who are knowledgeable concerning trees. Consider:

   a. Landscape planner
   b. Soil expert
   c. Biologist

5. Research or ask professionals about the following:

   a. Value of trees in the community (shade, separation of cars and people, microclimate improvement, beauty, boundary, others).

   b. Ecological factors influencing the selection of appropriate trees (soil conditions, climatic conditions, moisture, light, etc.).

   c. Environmental factors influencing the selection of appropriate trees (salt splash, pollution, limited space, heat, others).

6. Design sketches illustrating the effective use of street trees in the community.

7. Use these sketches to design an appropriate street-tree planting plan for your community. Consider:

   a. Location:

      near a building
      near utilities
      in a planting strip

   b. Suitability:

      size
      shape
      growth pattern
      root system

   c. Variation of species

   d. Environmental factors

   e. Ecological factors

   f. Width of street

   g. Aesthetic value and others

8. Identify any existing laws and ordinances governing community beautification.

9. Evaluate findings and determine how a tree planting ordinance might benefit the city. Consider:

   a. Care and protection needed for existing trees

   b. The tree planting plan you want to implement

   c. Proper planting of new sub-divisions

10. Organize a tree planting committee to serve as an action group for:

   a. Implementing your stree-tree planting plan

   b. Adopting a street-tree ordinance

   c. Enforcing the ordinance

11. Determine and carry out the responsibilities of tree planting committee.

    a. Seeking assistance from influential citizens

    b. Circulating a petition as a means of gaining support for adopting a street-tree ordinance

    c. Determine the provisions that should be included in a tree planting ordinance. Example:

       care and protection of existing trees
       ensure new trees will be planted
       ensure sub-divisions will be properly planted
       hiring of a trained individual as a tree warden
       ensure public hearings when important trees must be cut
       set standards concerning size, shape, variety, manner of planting, location, spacing, quality of stick used, care after planting, etc.
       enforcement of regulations

    d. Based on the knowledge you have gained, develop a plan of action for adopting a tree ordinance in the community that will include your plan for implementing a street-tree planting programme and present your plan to the appropriate individuals and committees for approval.

2) INVESTIGATING SIGNS IN THE CITY

Level: Elementary

Emphasis: Exploring the community and city ordinances

Time: Two days

Materials:

1. Access to information on government regulations
2. Optional: camera

Objectives: At the conclusion of the environmental encounter, the student should be able to:

1. Describe in writing (number) ways signs affect the city.
2. Discuss whether or not the city has ordinances regulating the use of signs.
3. Describe (number) sign ordinances which would be beneficial to the city.

Activities:

1. Go on a field trip to a local business district along a major street in your community. If you have access to a camera, have the students take pictures of the different types of signs. Take pictures looking down the road, as if you were traveling along the road.

2. Have students make a list of the different signs, such as:

   a. Large signs near the road
   b. Large signs away from the road
   c. Especially distracting or irritating signs
   d. Signs on buildings (flush with the building)
   e. Number of signs for one business
   f. Especially appealing or non-distracting signs

3. Compare to streets (or pictures from magazines) where signs are limited in size, number, closeness to road, and in general, functional but not distracting.

4. Discuss the visual appeal of both types of streets. Consider safety and aesthetics.

5. Contact an appropriate government official to find out if there is any sign ordinance in your city.

   a. If your city has no sign ordinance, what suggestions for such an ordinance can you make?

   b. If your city has such an ordinance, what violators of the ordinance can you witness?

6. Discussion Questions:

   a. Why do you think large, lighted signs are used?

   b. Do you think businesses should limit the size, number, and locations of their signs? Why? Are laws and ordinances the only way of limiting signs?

   c. Compare traveling on rural roads to traveling on streets lined with businesses. How do you feel about looking around? What are the most dominant things to see?

   d. Do signs play any part in drivers becoming distracted or irritated when they drive?

   e. What ways can people make traveling through a city more relaxing and less eye-straining, realizing that businesses want to advertise?

   f. Observe how many billboards are along the street (or in your pictures).

1) Can billboards be appealing or aesthetic?

2) Are they safe?

3) Are they really necessary for businesses? Do you feel billboards deteriorate the quality of your environment?

g. When does private advertising infringe on the public's right to quality, appealing environment?

7. The activity can be designed for noise ordinances also.

3) INVESTIGATING A PARCEL OF LAND FOR RECREATIONAL USE

Level: Senior

Emphasis: Community exploration and planning

Time: Several days

Materials:

1. Access to information on government regulations and local history.

Objectives: At the end of an environmental encounter, the student should be able to:

1. Draw on a map of the community in which the parcel of land to be studied is located, identifying any unusual physical or ecological features.

2. Describe in writing the history of the land use of the area, bringing it up to the present time.

3. Describe in writing the existing laws governing the use of the land.

4. Draw up a plan for recreational use of the land, and identify reasons for decisions.

5. Determine who influences land policy for area government officials, realtors, etc.

6. Identify four points that must be considered and accounted for in implementing a land use plan for the area.

7. Describe the major actions (in writing) needed in order to have the desired recreational plan adopted.

Activities:

1. Visit the land area in question.

   a. Carry out site inventory-size, terrain, ground cover, water availability, soil type, unusual features.

   b. If possible, take slides of the area and features.

2. Obtain information regarding zoning laws and ownership of land from appropriate government agency.

3. Determine who makes laws concerning zoning for area, and how much control residents have over these decisions.

4. Identify community interest groups and determine if their objectives are similar or opposite. Support might be gained by working with another group.

5. Obtain the history of land and its use -- library resources, local histories, interviews with long-term residents.

6. Determine regulation size of playing fields and courts desired to determine what could fit practically into space available.

7. Conduct survey of immediate neighbourhood and other close residential areas to determine recreational needs.

8. Draw up plans of recreational development, including placement of trees, shrubs, etc.

9. Determine approximate cost of converting area to suitable recreation area.

10. Interview local government officials to determine who would be responsible for grounds upkeep, replacement of equipment, safety, and enforcement of any necessary regulations.

11. Present plans to local government for consideration.

12. Obtain backing of influential members of community to implement plans -- fund raising campaign, voters' approval on bond issue -- or both.

13. Obtain publicity in local papers to gain voters' approval and general public support.

14. This activity is easily adapted to planning the use of any parcel of land.

4) INVESTIGATING THE RELATIONSHIP OF AN URBAN COMMUNITY TO CERTAIN BIRDS AND SMALL ANIMALS

Level: Senior

Emphasis: Biological study and citizen action.

Time: several days

Materials:

1. Biology reference books
2. Chart paper, markers

Objectives: At the conclusion of the environmental encounter, the student should be able to:

1. Identify one or more ecological communities within the study area.
2. Identify (number) species of birds and numerous small animals within each of the ecological communities mentioned in objective number one.
3. Describe the interrelationship of one of the animal's (identified in number one) to the environment.
4. Describe how unbalanced environmental conditions can result in production of others.
5. List (number) ways in which man has upset predator-prey relationship within any or all of the ecological communities identified in behavioural objective number one.
6. List (number) ways in which small animal life is directly and indirectly beneficial to the total urban community.
7. List (number) ways in which urban problems can cause deterioration of small animal life.
8. Identify at least (number) ways in which the ecological communities described in behavioural objective number one can be preserved.
9. Identify the land owners and managers and influential citizens of the local community regarding the preservation and maintenance of ecological communities in this local community.
10. Develop a plan of action for preserving and maintaining ecological communities in the local community.

Activities:

1. Identify and classify plants found in one urban ecological study area, i.e., a park, a wooded area, lake, etc.

   What seems to be the relationship of these plants to soil type and moisture content of the soil?

2. Prepare a field survey to determine the numbers and varieties of different insect and lower animal species inhabiting the study areas. Are certain animals confined to certain ecological niches?

3. Prepare a field survey to determine the numbers and varieties of different bird species inhabiting the area. (Concentrate on non-migratory types.)

   a. Do certain species of birds seem to be confined to certain ecological communities within the study area?

   b. Are nesting habits directly or indirectly related to the ecological niche which the bird occupies?

4. Construct one food-chain for the ecological community.

   a. Are these food-chains overlapping from one ecological study area to another?

   b. Have any of these food chain links been altered? If so, prepare a chart showing where the links have been altered and how.

5. List ways in which animals in each of the study areas protect themselves.

   a. Do any depend on each other for protection?

   b. What are some means of protection employed other than shelter?

   c. Prepare a list of the ways urban development may have altered the scheme of protection for certain animals.

6. Prepare a list of animals which seem to be over-abundant.

   a. What is the supply of food for these animals?

   b. From observation, what do the conditions of these animals appear to be?

   c. What is one natural enemy of each animal in question?

   d. Are the enemies found in good numbers in the study area? If not, why?

7. Make a chart showing ways small animals directly and indirectly benefit the ecological community of study area and also the surrounding urban area.

   Compare numbers of insects to numbers of other kinds of animals. What seems to be the relationship, if any?

8. Identify certain environmental problems within the urban area.

   a. Which one problem or problems seem predominant?

   b. Do they affect all of the ecological study areas, or just specific ones?

   c. Do certain animal species seem to be more affected than others?

   d. What is the relationship between the affected animals and the rest of the ecological community?

9. Outline a plan for active preservation and improvement of ecological environments with the urban community.

   a. Contact the proper authorities, i.e. government council, township supervisors, planning commissions, zoning commissions, private land owners.

      1. Make them aware of the ecosystems and their benefits.

      2. Clearly present by means of charts, drawings, slides, films, etc. the geographic areas in question.

      3. Outline your plan for preservation or improvement or both for the areas in question.

   b. Contact civic groups and repeat the procedures outlined in (a).

   c. Contact the mass media so that the public can become aware of the action plan and may thereby insure the success of the programme.

10. Follow-up activities which can be carried out directly by classroom students.

    a. Establish new habitat areas for certain animal species, i.e., brush piles, artificial nesting areas, etc.

    b. Cutting, thinning, separation, etc. to insure health of resident species and to encourage arrival of new species.

c. Introduction of new (imported) species to balance an area.

d. Installation of nature trails to facilitate observation and enjoyment.

EVALUATION (test)

NATURE IN THE CITY

Multiple Choice:

1. Vegetation improves the quality of the urban environment in _____.

   a. no way
   b. measurable ways
   c. immeasurable ways
   d. indescribable ways
   e. one way

2. City vegetation which affects the climate most is usually _____.

   a. flowers
   b. container gardens
   c. large bushes
   d. trees
   e. grass

3. Vegetation modifies the city climate by:

   a. providing shade
   b. changing moisture in the air
   c. insulating the ground
   d. absorbing reflections
   e. all of the above

4. The urban environment is _____ to vegetation.

   a. beneficial
   b. indifferent
   c. irrelevant
   d. hostile
   e. none of the above

5. Man-introduced substances resulting in air and water pollution _____ vegetation.

   a. fertilize
   b. harm
   c. help
   d. stimulate
   e. none of the above

6. Urban forests, when compared to natural forests, are dominated by _____.

   a. one species
   b. many species
   c. trees
   d. complex systems
   e. a few species

7. Wildlife in cities is _____ into healthy natural communities.

   a. integrated
   b. forced
   c. not integrated
   d. gradually moving
   e. none of the above

8. Birds and mammals that once inhabited the land which the city occupies frequently continue to be found _____.

   a. in the inner city
   b. along city roads
   c. in school yards
   d. near the urban fringe
   e. in man-made houses

Matching:

1. diversity in vegetation	a. weeds
2. rats, pigeons, sparrows	b. trees and bushes
3. urban forests	c. destroys original vegetation
4. unwanted vegetation	d. flowers and food
5. large parks	e. pre-adapted for urban life
6. most conspicuous city vegetation	f. provide shade and regulate moisture
7. trees and bushes	g. dilute gaseous pollutants
8. city construction	h. lack diverse species
9. urban gardens	i. diversity in animal life

True-False:

_____ 1. Space for city vegetation is valueless.

_____ 2. Cities foster development of natural vegetation.

_____ 3. Large parks dilute gaseous pollutants.

_____ 4. Parks are frequently publicly owned and serve multiple leisure uses.

_____ 5. Trees and bushes absorb reflections from asphalt and concrete.

_____ 6. City vegetation baffles heat, ameliorates the urban heat island and provides a habitat for wildlife.

_____ 7. Disturbed land is quickly taken over by weeds.

_____ 8. Wildlife in cities is usually not integrated into healthy natural communities.

_____ 9. The Norway rat, pigeon, house sparrow and cockroaches are successful urban wildlife.

Key: NATURE IN THE CITY

Multiple Choice	Matching	True-False
1. b	1. i	1. False (has value)
2. d	2. e	2. False (hostile)
3. e	3. h	3. True
4. d	4. a	4. True
5. b	5. g	5. True
6. e	6. b	6. True
7. c	7. f	7. True
8. d	8. c	8. True
	9. d	9. True

CHAPTER IX: ENERGY AND THE CITY

Energy and the power it produces is such a pervasive part of the lives or residents of the city that it is often taken for granted. Homes, businesses, industries and governments depend on energy and the availability and use of energy is a strong determinant of a city's character and quality of life.

Highly industrialized countries have built great urban areas based on abundant, cheap, safe sources of energy. Realization during recent decades that world energy supplies are limited has caused cities to begin to examine their uses of energy. Questions are being asked. Where does the city get its energy? How much energy is used in the city? How much is wasted? What are the environmental and health effects of the city's uses of energy? How do the high, rising costs of petroleum affect cities? Are there cheaper or safer forms of energy which could be used?

The World Energy Picture

Energy can be studied from two basic perspectives: energy available for use (energy supplies) and energy used (energy consumption). Midway through the 1970s, the world consumed energy equivalent to approximately 8,000 million tons of coal: 33 per cent in the form of hard coal, brown coal and peat; 44 per cent in oil; 20 per cent in natural gas; and 3 per cent in nuclear and hydro-electric power (see figure 14). Amounts of other forms of energy were either very small (such as geothermal energy, tidal power and solar power) or not recorded (such as wood and animal wastes).

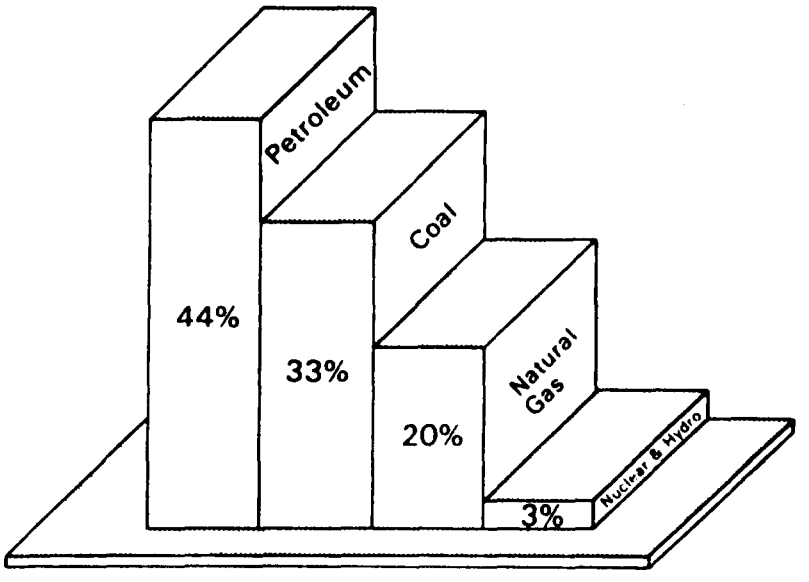
While energy consumption is heavily concentrated in highly industrialized countries, particularly in Europe, North American and the USSR, energy supplies (major reserves of conventional fuels for future use), are concentrated in the Middle East, eastern Europe and large parts of Asia for oil, and North America, Asia and Poland for coal.

Non-renewable/Renewable Fuels

Sources of energy, (coal, crude oil and natural gas) are 'non-renewable' energy sources because once they are used, they are gone. Hydro-electric power, wood, solar, and tidal power, and animal wastes are examples of 'renewable' sources of energy, because they can be replenished in a relatively short period of time when compared to non-renewable resources. Nuclear fuels - uranium and thorium - are also non-renewable.

Coal, crude oil and natural gas are fossil fuels, formed over periods of hundreds of thousands of years. They were formed from decaying organic material left by plants and animals which died millions of years ago. Covered by earth, the decaying plant or animal material accumulated. Eventually, under immense pressure of earth and water caused by oceans which later covered the the earth, the rotting material became the fossil fuels of today. Certainly the process continues today, and fossil fuels are still being created. However, these fuels will not be available for use for thousands of years.

RECORDED WORLD ENERGY CONSUMPTION PATTERNS FOR FUELS (1975)



Small uses geothermal, tidal and solar
Unrecorded uses wood and animal wastes

Figure 14

ENERGY CONSUMPTION PATTERNS IN HIGH ENERGY CONSUMING COUNTRIES

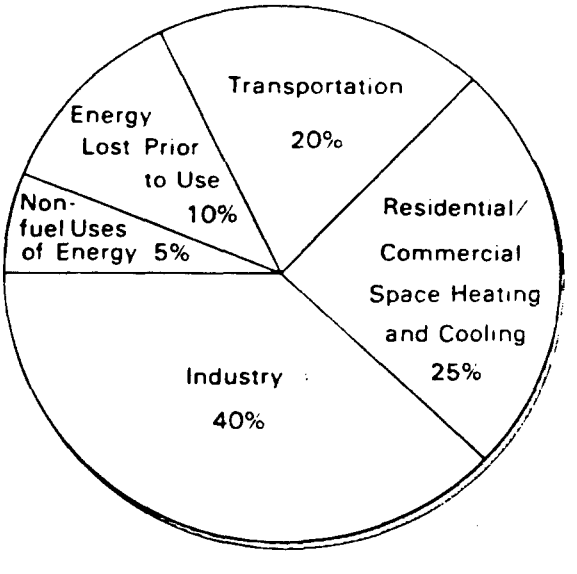


Figure 15

Energy Supplies

Our knowledge of world fossil fuel supplies in the form of reserves which are economically recoverable is incomplete. It is difficult to measure with accuracy the quality and quantity of fuels which can be extracted from the earth's surface at affordable rates. It is also difficult to predict how fast fossil fuels will be consumed. Based on: 1) information regarding world fuel supplies which are considered recoverable, and 2) predicted rates of future world energy consumption, natural gas supplies will be largely depleted by the year 2000; crude oil will last several decades into the next century, and coal reserves will last for several hundred years.

Energy Consumption

Predicting how much energy will be consumed during coming decades is difficult. A known factor is that the price of energy affects the amount consumed. Lower prices result in higher rates of consumption. Higher prices reduce rates of consumption.

During the fifties and the sixties, crude oil prices were low. Each year world consumption of oil increased at a rate well over 4 per cent. At such a rate, the total amount of energy consumed annually would double in approximately eighteen years. Energy consumption patterns began changing when the price of oil increased dramatically in 1973. It is predicted that rates of energy consumption will increase more slowly in the future as a result of continuing price increases. Switching to non-conventional fuels will also slow the rate of consumption of conventional fuels.

It is important that urbanites understand three things about energy consumption: 1) world supplies of conventional fuels are limited and will eventually run out, 2) world population and new uses of energy have dramatically increased consumption of existing world supplies during the past fifty years, and 3) activities in the city consume energy. Heating, lighting and transportation consume energy directly while purchasing processed food and manufactured goods (which use energy in the production process) consume energy indirectly.

A number of things affect energy consumption patterns in cities. Highly industrialized countries consume energy at rates (per person) ten to twenty times that of developing societies (particularly countries which do not rely on manufactured fertilizers). Affluence affects the amount of energy consumed. People in affluent areas become accustomed to driving automobiles any time and anywhere they choose. Where summer heat may have called for an afternoon rest years ago, work can now be done each afternoon in artificially cooled buildings. Homes in high energy-consuming countries tend to be larger and more frequently heated and cooled with centralized systems. And finally, the habit of buying luxury appliances such as electric knife sharpeners, can openers and throw-away food containers contributes to high rates of energy consumption.

It is difficult to develop a detailed, accurate outline of the uses of energy in the city. Information is more readily available

on a country-by-country basis, particularly for industrial, high energy-consuming countries because energy consumption statistics are recorded (see figure 15).

In high energy-consuming countries, approximately 40 per cent of the total amount of energy available is used industrially in the manufacture of goods. Residential and commercial heating (and cooling) uses, depending on climate, consume 20 to 25 per cent. Use by various modes of transportation accounts for another 20 to 25 per cent.

A major category of 'energy consumption' is 'energy lost' (as heat) when primary fuels (coal, oil, natural gas, or uranium) are converted in power generating plants to electricity. This loss of energy accounts for 10 to 15 per cent of the total amount of energy consumed. The loss is significant, not only because of the percentage, but also because industrializing societies are increasingly using electricity, which is perceived to be a clean, flexible source of energy to meet energy demands.

Some fuels are used as a raw material (rather than as a source of energy) in the manufacture of such products as petrochemicals, asphalt, lubricants and steel. This fuel use category varies greatly from one country to another. In highly industrialized countries, it may account for 5 to 10 per cent of the energy consumed.

Sources of Energy

The next sections discuss sources of energy focusing on: 1) fossil fuels, 2) generating electricity from fuels and alternative technologies for generating electricity, 3) solar energy, 4) traditional fuels and 5) future technologies. It focuses on the growing worldwide concern regarding the undesirable consequences of widespread and rapid growth of energy consumption in the face of dwindling supplies and increasingly high prices; the impact on the environment of extracting, transporting and using various forms of energy, and the impact of technologies which produce power.

Fossil Fuels: Coal, Petroleum, and Natural Gas

Coal

Coal has been the backbone of industrializing societies during the nineteenth and most of the twentieth century. However, during the past thirty years, coal has fallen from prominence as other energy sources which are more flexible and cleaner, particularly natural gas, have been developed. Today, because of vast world coal reserves, it is being re-examined for its potential to help meet the needs of high energy-consuming countries.

Coal is extracted from both underground and surface mines. Surface mines are attractive due to lower investment and operating costs and because they are not subject to the health and safety problems associated with deep mining.

Underground coal mining creates conditions which affect the health of miners. 'Black lung' disease, which affects only underground coal miners, is an example. Accidents are high in underground mining. Acid mine drainage from underground mines can seriously pollute water. Above-ground coal mining (strip-mining) can result in long-lasting erosion, and scars, if the land is not properly restored when mining activity is completed.

Air pollution caused by burning coal, especially coal with a high sulfur content (as discussed in the chapter on air quality), has in the past accelerated the trend toward substituting cleaner-burning gaseous and fluid fuels for coal. However, emphasis has turned in recent years toward technologies for converting coal itself into cleaner gaseous and liquid fuels. The process is expensive and prospects for commercial application of coal conversion technologies are difficult to predict.

Petroleum

The versatility of liquid fuels derived from petroleum has made them increasingly popular fuels during the past forty years. Petroleum products are easily transported and can be used in a wide range of ways: for heating homes and offices, powering automobiles and airplanes and in industrial production. Petroleum versatility goes beyond uses as a fuel and it is an important component of plastics, medicines, fabrics and other 'man-made' materials. After refining, petroleum provides a host of useful fuels, including gasoline and kerosene.

Another benefit of petroleum is that it can be found and extracted from the ground with very minor expenditure of energy as compared to coal. As a flow resource, petroleum will move itself when channeled through under or above ground pipes.

Since 1945, petroleum and natural gas have replaced coal as the primary fuel source in industrialized societies. The reasons are not difficult to understand. The railroads increasing use of diesel engines resulted in a major substitution of petroleum for coal. New discoveries of oil and gas in Africa and Asia and the development of large tankers and pipeline networks increased the supply of petroleum available to population centres and reduced the cost of petroleum and natural gas at a time when the cost of extracting and transporting coal continued to rise.

Petroleum is unique in the world scene today in that since prices escalated dramatically during the seventies, the control and use of petroleum has become a major factor in world economics and politics.

Natural Gas

Natural gas is a highly valued fuel. It can conveniently flow from extraction fields to homes and industries in cities. Unfortunately, it has been wasted in the world since production first began. It is found in underground traps, along with crude oil in which it was dissolved. For years, natural gas was separated from the oil in the oil fields and allowed to escape into the atmosphere. As a precaution against explosions, the 'waste' gas was ignited and 'flared' into the

air. This process goes on today in some major oil-producing countries. This happens because it is not economical to transport natural gas from remote oil fields to heavily populated parts of the world. Natural gas pipelines must be large and stronger than pipelines for petroleum. Even when the natural gas is compressed, natural gas contains less energy than the same volume of crude oil. Therefore, the investment in large pipelines is practical only in countries where fields are located near population centres, primarily in Europe and North America.

Another way to transport natural gas is to liquify or convert it to another fuel, methyl alcohol, before transporting it to population centres. Both processes are expensive, and consume energy in the conversion process.

Electricity

Energy from fossil fuels can be delivered to consumers directly by truck, gasoline pumps and through underground pipes, or it may be delivered indirectly to consumers by converting the fuel energy to electrical energy. In recent decades, consumption of electricity has increased more rapidly than the demand for energy in general because it is so versatile, clean and convenient.

Demand for electricity depends on a number of things. The amount available in a country and the income of residents are two determinants of demand for electricity. The price of electricity, when compared to substitute forms of energy, is also important. Highly industrialized nations tend to use more electricity and have more uses for electricity, including air conditioning and thousands of types of home appliances.

Electrical energy is generated by using a fuel (coal, oil, gas or nuclear) to heat water to produce steam. Steam propels turbine blades which turn a generator to produce electrical energy. Electrical energy is transmitted through wires, at high voltages, to substations, where it is transformed into low voltages suitable for distribution to homes, offices and industrial plants in the city.

The best electric generating plants convert only 40 per cent of a fuel's energy into electrical energy, which means that approximately 60 per cent of the fuel is wasted (as heat). Most waste heat is discharged into the generating plant's cooling water and enters nearby rivers and lakes. The effects of waste heat disposed of in this manner (thermal pollution) are discussed in the chapter on water quality. Fossil fuel electric generating plants can also be major contributors to air pollution unless proper equipment is utilized.

Nuclear Power

Nuclear power plants function much like fossil fuel electric generating plants. Both use steam to drive the turbine generator that produces electricity. The main difference is that fossil fuel plants burn coal, oil or natural gas to heat the water which produces steam. In nuclear power plants, 'nuclear fission' produces the heat.

Nuclear energy is controversial. Many believe that generating electricity with nuclear power is an answer to future fossil fuel shortages. Others see nuclear power as a threat to public safety because large doses of radiation can seriously affect plant and animal life. Normal radiation levels from nuclear power plants are considerably lower than the levels to which plants and animals are exposed from other natural and man-made sources. However, even small additional doses can cause genetic damage and carry a low cancer-causing probability. The concern of those who question generating electricity with nuclear fuel focuses on two things: nuclear wastes and accidents.

The radioactivity from nuclear waste material is potentially more dangerous than from a nuclear power plant itself because wastes must be: 1) transported from the site, 2) processed for storage, and 3) stored for hundreds of years. Over time, the potential for exposure to radiation is increased manyfold.

The vulnerability of nuclear power plants to accidents, due to technical malfunctions or human errors, has raised questions in every country using nuclear power to generate electricity. The risks from even the lowest levels of radiation contamination as a result of an accident are so great that they must be weighed carefully as countries evaluate future energy needs.

In additon to replacing or supplementing dwindling fossil fuels, the benefits of nuclear power include reduced air pollution (caused by fossil-fuel electric generating plants) and the provision of electricity for areas which have little or no access to fossil fuels.

Hydro-electric Power

One of the earliest forms of energy used by man was the energy of flowing water. Modern hydro-electric plants generate electricity as falling water propel turbines. The development of hydro-electric power depends on the availability of good sites to build large dams. Sites must have sufficient height for the water to fall, large storage capacity and be located near population centres where the power will be used. All hydro-electric power dams have a limited life span, up to a maximum of perhaps 400 years. This is due to 'sedimentation', as silt is washed into reservoirs from land surfaces upstream. There are other environmental limitations. Reservoirs constructed to hold water frequently cover valuable agricultural land. In dry climates, water evaporates from reservoir surfaces, wasting great quantities of water. Dams and reservoirs disrupt natural or animal life cycles, resulting in the proliferation of undesirable organisms. All of this is unfortunate, because hydro-electric power is probably the most efficient and cleanest major source of power yet developed by man.

Geothermal Power

Where natural hot springs exist, hot water and steam (geothermal energy) have long been used to heat buildings. The first electric power plant using steam from hot springs to propel turbine blades was completed in Italy in 1904. Despite this fact, the total amount of electricity generated by geothermal energy today is very small.

Geothermal heat is tapped by drilling wells into the area where the heat is trapped. The process is similar to that used in drilling for oil. Insullated pipes lead the steam to the power plant. Geothermal steam commonly contains impurities which corrode the turbine blades. Geothermal heat traps have been found in the USSR, Italy, Iceland, New Zealand, Japan, Mexico and the United States. Like oil and natural gas, geothermal energy sources are considered non-renewable since long periods of time are required for the earth to regenerate geothermal heat caps.

Wind Power

Windmills have been used for centuries to pump water. Despite the fact that winds are erratic and undependable, the use of wind to produce electricity is increasing. Such use depends on whether or not it is necessary to have power during any specific time period. In windy areas, windmills can be used to propel the moving components of small electric generating systems and the surplus electricity can be stored in batteries. For large-scale power productions, suitable batteries are expensive and, as yet, cannot compete with other available sources of energy.

Tidal Power

Places with extremely high and low tides have long fascinated engineers because of the possibility of developing substantial amounts of electrical power by harnessing the tidal flows. The principle is simple. Flowing water, in this instance, tidal flow, turns turbines which generate electricity. While the basic idea is simple, construction and operation of such a facility is expensive and very little of the world's energy supply to date is supplied by tidal power.

Solar Energy

Solar energy refers to the useful heat or power obtained directly from the sun's radiation. It can be harnessed by man for two purposes: heating or the generation of electricity.

Other than the fact that most countries are not in the habit of using solar energy for heating (water or homes), there are no serious barriers to greater use of solar energy for heating and cooling in areas where the number of cloudless days is high. Buildings must be sited properly and they must be designed and constructed to utilize and hold solar radiation. From a larger perspective, solar energy equipment needs to be standardized and mass produced so that the costs will be lower and comparable to present heating equipment.

Generating electricity from solar energy is quite another matter. It is technically feasible to convert solar radiation to electricity, but existing technology is expensive and inefficient. The practical potential of solar power is impossible to calculate at present, but experimentation is extensive in all parts of the world and hopefully where sunny days abound, its use will increase significantly during the next decade.

Traditional Fuels: Organic Wastes, Wood

In countries where oil, coal, gas and wood are limited, animal excrement and vegetable wastes from many sources are gathered and dried for fuel. For example, as much as 40 per cent of the total energy consumption in India is supplied by such material; it is not included in world energy statistics primarily because the information is difficult to obtain. In high energy societies, much animal and vegetable waste is discarded. Only recently have corncobs, and wastes from potatoes, sugarbeets, orange-juice processing plants, etc. been considered as sources of fuel, substances from which methanol or ethanol can be produced. Wastes from large animal feedlots are still regarded as a disposal and pollution problem rather than as a source of energy or fertilizer. Animal wastes, such as fat (and bone) which is used in some societies for lighting and heating, is discarded in high energy consuming societies.

Trash and garbage from residences and industries is being burned to produce in some cities. The major problem in such experiments is separating the organic material which will burn, from inorganic components which will not burn.

Wood

Wood was probably the first fuel used by man. Where forests covered the land, fuel wood was an important source of energy in industrialized societies until a century ago. Pressure on forests came not only from fuel needs, but from shipbuilding and wood-burning steam engines. Eventually forests in some heavily populated countries disappeared. Except in a few heavily forested area, there is relatively little demand for fuel wood today in most high energy societies. Nonetheless, there is some indication that burning wood as a fuel to heat homes in cities will increase during the next decade where wood fuel is readily available.

New Technologies: Tar Sands and Oil Shale, Fuel Cells, Hydrogen, Fuel-to-Fuel Conversion

Thousands of technologies are being explored to provide the world with safe, clean sources of fuel for the future. Unfortunately, almost 90 per cent of the world fuel reserves (considered technically and economically recoverable by the year 2000) will require extensive treatment to reduce adverse effects on environmental quality.

Tar Sands and Oil Shale

Oil trapped in roch (oil shale) and sand account for one-third of the world's supply of recoverable petroleum reserves. A number of different methods can be used to treat sand to remove petroleum products. Extraction from oil shale is accomplished by blasting, crushing and heating the rock, a process which destroys miles of natural terrain and disrupts natural wildlife. The cost of land restoration is expensive, and restoration to natural conditions is impossible. Great quantities of water are required in extracting oil from oil shale and the potential for water pollution is high.

Fuel Cells

Electrical energy can be produced directly from chemical energy (produced by the oxidation of a gas). Current use is primarily in the space exploration industry. Continued research may lead to increased use in the future.

Hydrogen

Hydrogen is a highly explosive fuel which can be produced by the electrolysis of water. The fuel is too dangerous to use directly in automobiles or industries; however, the development of new technologies, including the use of hydrogen in fuel cells (described above) indicates that it may be widely used in the future in industries and homes.

Fuel-to-Fuel Conversion (Coal Gasification and Coal Liquifaction)

As the price of crude oil increase, and supplies dwindle, interest grows in 'fuel-to-fuel' conversions in countries which have large reserves of solid fuels, primarily coal. Converting coal to a liquid or gaseous fuel is appealing because pipes necessary to transport such fuels are already in place in high energy consuming countries.

Several different kinds of gas can be made from coal. 'Synthetic natural gas' will likely be used in the future to replace decreasing supplies of natural gas. The wide-scale production of synthetic crude oil will become commercially practical only when the cost of preparing it becomes lower than the price of natural crude oil. Producing liquid fuels is even more complex, and costly, than producing gaseous fuels.

Energy Conservation

Reducing world-wide energy consumption by conserving energy is our best energy option for the future. It has been estimated that energy conservation could result in a 25 per cent reduction in consumption during the next ten to fifteen years. Energy conservation always begins with individual energy users -- individuals driving automobiles, heating homes, or operating industrial machines.

Homes and offices consume approximately 25 per cent of the total world energy supply each year. Wasted energy in the home can generally be attributed to one of the following: carelessness, lack of proper insulation, or the need for proper maintenance of heating equipment.

Reducing energy waste in homes and offices in most climates begins with reducing heat lost through doors, windows, and ceilings (as heat rises). Air leaks out through cracks, around windows and doors, through attic stairway doors and fireplaces and around light fixtures and plumbing vents or pipes. Leaky hot water faucets waste energy as well.

The greatest potential for energy savings at home and in offices is through improved insulation. Proper insulation can cut in half the energy required to heat a single-family home and can result in substantial savings in attached homes, apartments, and office buildings. Poorly insulated homes and apartments reflect a period of cheap energy and expensive insulating materials. With the rapidly increasing energy prices of today, city dwellers who live in under-insulated residences realize they cannot afford to ignore the energy-savings potential of adequate insulation.

Sealing or caulking all spaces around doors and windows and adding 'weatherstripping' around doors will seal out cold air and reduce the loss of warm air. Double thicknesses of glass (or plastic) over windows will cut heat losses through windows by half.

In industrialized countries, the use of electric home appliances has increased dramatically during recent decades. Not only do homes have hot water heaters, refrigerators and stoves, but radios, televisions, washing machines, clothes dryers, air conditioners, electric coffee percolators, rice cookers, electric knives, can openers and electric hair curlers.

Reducing the use of home appliances and using appliances which are 'energy efficient', conserves energy. Until recently, manufacturers of home appliances placed emphasis on producing inexpensive appliances with little consideration given to how much energy each item would consume in its life time. This trend is changing. Many manufacturers now carry labels which include an energy efficiency rating, a notation of how much energy will be required to operate the appliance in the home.

Other energy conservation measures can be undertaken at home. Home lighting can be reduced by lighting only spaces which are actually being used. Using natural daylight whenever possible saves energy. Neon lights consume about one-fourth as much energy to produce the same amount of light as an incandescent light.

New homes and offices can be designed with energy conservation in mind. For instance, a well-insulated (30 cm. of insulation) home built to capture solar heat in the winter in relatively sunny climates can reduce energy consumption by as much as 75 per cent. Utilizing 'waste heat' in homes can reduce energy consumption. Capturing used shower water in a bathtub will heat a bathroom for a short period of time. Venting a clothes dryer inside, rather than outside, will heat more than one room. Because great amounts of heat are lost when doors are opened, homes with vestibules or small double-doored entrance halls conserve energy.

Some governments and utility companies provide loans to home and building owners to encourage them to make energy saving improvements in old residences. Savings in monthly fuel and electric bills repay the loans automatically over a period of several years.

Transportation consumes as much as 25 per cent of the world energy supply each year and unfortunately there has been a shift during the past decade away from energy efficient modes of transportation (railroads, and buses) to private automobiles. In spite of this, there are ways to realize energy savings in countries where a large percentage of travel is by automobile. For instance, speed limits can be reduced. Automobiles consume as much as 25 per cent less fuel at speeds of 80 kph as compared to 110 kph. Maintaining automobile engines properly and inflating tires properly reduces energy consumption. Purchasing automobiles which carry energy efficient labels encourages manufacturers to develop more efficient automobiles. Car pooling, or sharing rides in automobiles, and switching from private automobiles to public transit reduces energy consumption.

Industries consume approximately 40 per cent of the world energy budget. The use of more energy-efficient machines, increased use of energy audits to determine where energy is wasted in factories, hiring energy engineers to monitor and improve energy use in factories and promoting energy conservation among employees are ways energy consumption can be reduced in the industrial sector.

ENERGY AND THE CITY: Principal Concepts

- Energy is an input into the city; virtually all energy used by cities is imported.
- Highly industrialized countries use more energy per person than less industrialized countries.
- Major energy users in cities are: industries; residences and businesses for heating (and cooling); and transportation.
- World supplies of conventional fossil fuels (such as coal, petroleum and natural gas) are limited.
- Using coal as a fuel can result in a number of undesirable environmental effects such as: air pollution, lung disorders and accidents (associated with underground mining) and the destruction of land surfaces (surface mining of coal).
- Petroleum is easier to extract from the earth and transport than coal.
- Electricity is viewed as a clean source of energy by the consumer.
- Energy is wasted (as excess heat) when fossil fuels are burned to generate electricity.
- The controversy regarding using nuclear fuel to generate electricity focuses on: 1) accidents which might release damaging levels of radiation and 2) transporting and storing used nuclear fuels which contain radioactive materials.

- The use of solar energy to heat (and cool) homes and businesses and to heat water is increasing.
- Sources of energy in the future will likely include materials which are not familiar to us today, and a return to traditional materials and processes.

ACTIVITIES

1) ELECTRICAL SURVEY

Level: All

Emphasis: Surveying and drawing conclusions about a problem

Time: One class period plus work at home

Materials:

1. Survey forms.

Objectives: At the conclusion of the exercise, the students should be able to:

1. List (number) home appliances using electricity which are unnecessary.
2. Explain how the amount of electricity used in residences is measured.
3. Discuss (number) ways to reduce electric consumption.

Activities:

1. Design survey forms similar to below. Design separate surveys for the home and the school.

Identify all the things in your home (school) that use electricity and put them in the appropriate categories below.

---

1. Couldn't do without	2. Could do without with some difficulty	3. Are not necessary

---

2. Survey home uses of electricity. Place each electrical appliance in the appropriate column. Survey school uses on a separate survey form.

3. Find out where the electricity entering the school and home is measured and record amounts for several days. Calculate how much electricity an average home uses in a day, month, year. Do the same for the school.

4. Select a discussion leader and discuss electrical uses in the school and home.

5. Discuss what people did before electricity was used extensively.

6. Make a list of practical ways to cut down on electrical consumption in the home and at school.

7. Design a campaign to cut down on energy use. Implement the plan.

2) INVESTIGATING A FOSSIL FUEL POWER GENERATING PLANT

Level: Senior

Emphasis: Environmental investigation and citizen action

Time: several days

Materials:

1. Plates and vaseline.

2. Reference materials on air pollution or contact with individuals/agencies knowledgeable in the area.

Objectives: At the conclusion of the environmental encounter, the student should be able to:

1. Identify what type of fuel is used to furnish power for the generators of a local power plant.

2. Identify what type of pollution is present.

3. List three things adversely affected by the air discharge from the power plant.

4. Determine an alternative fuel that could be used.

5. Compare the cost of the regular and alternative fuel.

6. Describe in writing two benefits that would result from the use of an alternative fuel.

7. List the standards for clean air in this area.

8. Identify the type of equipment used by the plant to reduce pollution.

9. Develop a plan of action to reduce the amount of pollution created by this power plant.

Activities:

1. Visit a local electric generating plant using fossil fuel. What type of fuel is being used for a power sources? Why is this fuel used in preference to other types?

2. Inspect the discharge from smoke stacks or obtain information from the proper authority.

3. Determine the degree of 'fall-out' by distributing vaseline smeared plates in the vicinity of the plant.

4. Based on observation determine the effect of pollutants on (a) vegetation, (b) paint and homes, (c) lung disease rates, (d) visibility.

5. Investigate to find out the cost per unit of other available fuels. Will the use of other fuels result in less contamination?

6. Correspond with authorities to determine what standards have been established for clean air. Are regulations being ignored and why?

7. Interview the company engineer to find what type of abatement device is used for smoke control. Is this type adequate for the emissions and work load?

8. Research various air pollution abatement devices and their effectiveness. Make a presentation on two or more alternative abatement devices and their effectiveness. Present these alternatives to the power plant and the regulatory agency.

9. Develop a plan of action to help the power plant acquire a more adequate abatement device if one proves needed. Carry out the plan.

EVALUATION (test)

ENERGY AND THE CITY

Multiple Choice:

1. Conventional fuels generally do not include:

a. solar power
b. oil
c. natural gas
d. wood
e. coal

2. The following is not a major use of energy in urbanized countries:

   a. manufacture of goods
   b. transportation
   c. agriculture
   d. heating and cooling
   e. industry

3. One of the following is not true about coal:

   a. underground mining affects the health of miners.
   b. surface mining is attractive due to lower operating costs.
   c. supplies are very limited world wide when compared to other fossil fuels.
   d. can be converted to gaseous and liquid fuel.
   e. a fuel associated with gray air pollution.

4. All hydroelectric power dams have a limited life span due to:

   a. political stress.
   b. evaporation.
   c. proliferation of undesirable organisms.
   d. drought.
   e. sedimentation.

5. Oil trapped in rock and sand:

   a. accounts for one-third of the world's supply of recoverable petroleum reserves.
   b. can easily be removed for use.
   c. exists only in remote, uninhabited parts of the world.
   d. is potentially hazardous due to low levels of radiation.
   e. none of the above.

True-False:

_____ 1. Coal, crude oil and natural gas were formed from decaying organic material left by plants and animals which died millions of years ago.

_____ 2. Cities produce energy sufficient for the needs of residents.

_____ 3. World fossil fuel supplies will last for thousands of years at present consumption rates.

_____ 4. Affluent countries generally consume more energy per person than less affluent countries.

_____ 5. Forty per cent of a fuel's energy is lost when it is converted to electricity in power generating plants.

_____ 6. Petroleum is an important component of plastics, medicines and fabrics.

_____ 7. Transporting natural gas to cities through pipelines is practical all over the world.

_____ 8. The total amount of electricity generated by geothermal energy today is very small.

Key: ENERGY AND THE CITY

Multiple Choice:

1. a
2. c
3. c
4. e
5. a

True-False:

1. True
2. False
3. False
4. True
5. True
6. True
7. False
8. True

ANNEX: General Evaluation Activities

General Evaluation Activity

1) WHO SOLVES ENVIRONMENTAL PROBLEMS?

Level: Elementary, middle

Emphasis: Role-playing

Time: 30 minutes

Materials: Task cards with the following information should be made up ahead of time: (Use local issues.)

Pick one of the following problems which occurs in communities:

a. mosquito control problem

b. where to locate a housing development

c. locating a new freeway through an existing urban area

d. locating land for a new recreation area near a city

e. where to build a solid waste plant for a large city

f. conflicting use controversy over local body of water (dumping mine wastes, recreation or wildlife?)

The following people are available to help with the community problem you have chosen. On paper, explain what each of them might be able to contribute to solving the problem the most beneficial way to the community.

artist	engineer	philosopher
economist	sociologist	agriculture expert
lawyer	doctor	recreation specialist
ecologist	chemist	government official

Objectives: At the conclusion of the exercise, the student should be able to:

1. Describe (number) how community professionals can contribute to improving environmental quality.

2. List (number) ways citizens can interact with community professionals to improve environmental quality.

Procedure:

1. Pass out task cards to groups of three students. Use local community problems if possible.

2. Groups follow directions on the cards. Have one person be the secretary.

3. Ask them to add two more people to the list and tell what their role would be.

4. Call groups together for general discussion during which someone from each group should explain what they did.

Discussion Questions:

1. Did you find people on the list that did not play a role in the problem solving?

2. Did some people listed play the same role in several problems different groups worked on?

3. Who played a different role, depending on the problem the group picked?

4. What part would you most like to play? Do you think you would enjoy doing it for a living?

5. What about ordinary citizens? Are they listed? Do citizens have anything to do with making decisions?

2) INDIVIDUAL'S CONTRIBUTION TO POLLUTION

Level: Elementary

Emphasis: Awareness

Time: 30 minutes

Materials:

1. Paper and pencils

Objectives: At the conclusion of the exercise, the student should be able to:

1. List (number) ways students contribute to environmental problems.

Activities:

1. Each student should draw a line across his/her paper.
2. Make light marks, one centimeter apart across the line.

   Example: _____
   1 2 3 4 5 6 7 8

3. By each mark write in a pollution problem you contributed to in each grade level in school.

   Example: 1st grade - waste paper

4. Do this for grade levels one through eight, or as appropriate for student's present grade level.
5. On the other side of your paper, mark five lines across one horizontal line 2 centimeters apart. This represents future years.

   Example: _____
   1 2 3 4 5

6. Now write in five pollution problems, one for each year. (One that may be most common for that class).
7. Below the line write five ways, one for each pollution problem, that they could be prevented or lessened.
8. Discussion questions:

   a. What are some of the problems to which we contribute?

   b. What can we do to help lessen them?

   c. Who is the real problem?

   d. What are some of the problems in the future?

3) SOLUTIONS TO ENVIRONMENTAL PROBLEMS IN THE CITY

Level: Adaptable to all

Emphasis: Evaluation of solutions

Time: Several days

Materials:

1. Ten environmental problem cards.
2. Six solution cards.
3. Optional: library and government reference materials.

Objectives: At the conclusion of the exercise, the student should be able to:

1. Discuss (number) positive and negative aspects of solutions to environmental problems.

Activities:

1. Make ten 'environmental problem' cards and six 'solution' cards:

   Environmental problem cards

   a. Decay of a housing area.
   b. Air pollution caused by automobiles.
   c. Pollution of water caused by inadequate sewage treatment facilities.
   d. Pollution of air caused by factory wastes.
   e. Littering of city streets.
   f. Disruption of neighbourhood by excessive traffic.
   g. Pollution of water by industrial wastes.
   h. Disposal problems resulting from proliferation of disposal products.
   i. Littering of streets and alleys by trash.
   j. Noise caused by large airlines.

   Solution cards

   a. Pass a law to help solve the problem.
   b. Pass a local tax to pay for elimination of problem.
   c. Make each individual pay for and eliminate the problem himself.
   d. Receive assistance to solve the problem.
   e. Forget about it - it's not a serious problem anyway.
   f. Enforce present laws.

2. Post the 'solution' cards where they can be seen by the class.

3. Select a student teacher who will display the 'environmental problem' cards one at a time. Each student chooses the solution which he or she thinks is best.

4. Discuss each 'environmental problem' as a class, comparing alternative solutions.

5. Make a chart which indicates how many students chose each solution, showing the results in percentages.

6. Write a report solving one of the environmental problems. Stage a debate between two different solutions to the same problem.

7. Discussion questions:

   a. Is there only one solution to each problem?

   b. What factors must be considered when developing alternative solutions to a problem (i.e., social, economic, technological)?

4) AN ENVIRONMENTAL PIE

Level: Elementary, middle

Emphasis: Values

Time: 45-50 minutes

Materials:

1. Chalk board or chart paper.

2. Worksheet with a drawing of a large circle to be used in diagramming an environmental pie.

Objectives: At the conclusion of the exercise, the student should be able to:

1. Describe (number) things that affect choices in the way organizations spend money and time in the solution of environmental problems.

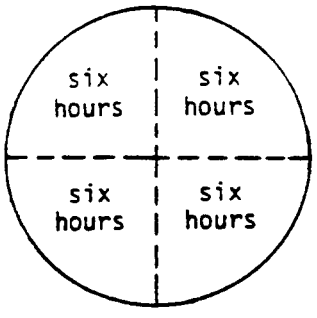
Activities:

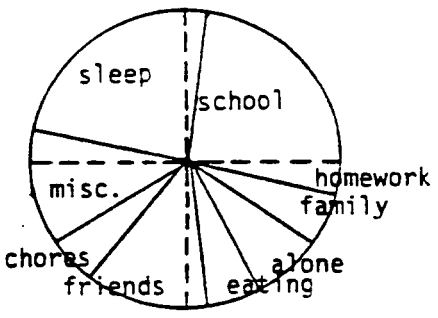
1. Explain to students that this activity is designed to have them investigate how time or money is allocated for activities.

2. Group class into teams of four or five students. Explain that these teams are for the purpose of having individual and group decisions on how time, money, etc. can be used more efficiently.

3. The teacher draws a large circle on chalk board/chart paper or on worksheets. Students divide their circles into four quarters using dotted lines.

4. An example for the question, 'How do you spend your day?'





5. Examples of categories that could be used in the environmental pie:

   a. How does city government spend its money?

   b. What agencies are involved in cleaning up the environment?

   c. How much money is spent on cleaning up the environment?

   d. How much time is spent by people destroying the environment?

   e. How do urban children spend their time daily?

6. After students have completed individual pies (about 10-15 minutes) have the group work toward a group pie with the same categories. Have students take about 10 minutes to do this and then have groups share out their results to the rest of the teams.

7. Discuss what the pies reveal about government or individual priorities.

5) FORCE FIELD ANALYSIS

Level: Middle, Senior

Emphasis: Developing problem-solving skills

Time: 45-60 minutes

Materials:

1. Blank Force Field Analysis sheet for each team

Objectives: At the conclusion of the exercise, the student should be able to:

1. Discuss, in writing, the process by which the central issue of a problem can be determined.

2. Discuss, in writing, how to develop and evaluate alternative solutions to an environmental problem.

Activities:

1. Divide the class into groups of four or five.

2. Have students identify a problem and a goal on a blank force field analysis sheet.

3. Have groups identify the driving forces related to their goal. (e.g. self, others and situation)

4. Have each group identify restraining forces (self, others and situation) related to their goal.

5. Have groups determine possible actions that can be taken.

6. Have each group identify the resources that are available and have access to and in need of.

7. Discussion questions:

   a. What are the possible advantages of using a strategy of this type in solving everyday problems? What disadvantages?

   b. Who assumed the leadership role in your group? Did this cause you to participate more freely? Why or why not?

   c. How did your group decide upon a topic for the problem during this activity? Was everyone in agreement with the selection and its major goal?

   d. Did you have a sense of security while being a member of your group? Why or why not?

   e. What were the major issues thrown around during the brainstorming period that your groups came up with?

   f. Were you able to communicate your thoughts clearly?

   g. Was there any difficulty in listening to other members of the group? Why?

Force Field
ANALYSIS SHEET

(Sample by a teacher concerned about the city)

Problem	Goal
A major environmental problem in the city: high school student's total disregard for the conservation of the urban environment	To develop and help urban high school students acquire a basic understanding of the biophysical environment in order to improve the quality of life in the city

Driving Forces	Restraining Forces
Self	
My dedication to the preservation of urban environments - and the instructing of young and old alike in the understanding and importance of maintaining the urban ecology.	Societies - acceptance of habitual behaviours, societies' close-minded view to change, lack of information.
Others	
Community leaders who share the same basic understandings, that in order for the quality of life and environment of urban poor people to improve they must take part in the revitalizing and change of the urban community.	Many individuals in the urban communities don't want to become included because they feel it's not their duty to take part in improving the city.
Situation	
Urban environmentalist working in a major urban community.	Lack of financial aid to implement education programmes.

Possible Actions

Form student coalitions to start defining and correcting the behaviour of most young people about urban environments. Massive re-education efforts by public schools.

Resources

Have access to:	Needed:
UNESCO booklets	Community planning booklets, additional names of community leaders

EVALUATION (test)

6) THE URBAN ENVIRONMENT

Multiple Choice:

1. Urban environments _____ rural environments.

   a. are the same as
   b. are very similar to
   c. differ dramatically from
   d. are more important than
   e. are simpler than

2. The relationship between man and the urban environment is _____.

   a. extremely complex
   b. extremely simple
   c. moderately complex
   d. insignificant
   e. non-existent

3. All parts of a city are _____.

   a. inter-related
   b. interdependent
   c. important
   d. none of the above
   e. all of the above

4. In the urban environment man is _____ of environmental change.

   a. victim
   b. observer
   c. beneficiary
   d. initiator
   e. all of the above

5. Man-made changes in the urban environment tend to be discernable _____.

   a. rapidly
   b. very slowly
   c. never
   d. instantaneously
   e. in moderation

6. Eventually 'inputs' into the city become _____.

   a. stationary
   b. inputs again
   c. outputs
   d. useless
   e. none of the above

True-False:

_____ 1. Cities are one of the places of man's greatest impact on the natural environment.

_____ 2. The relationship between man and the urban environment is simple.

_____ 3. All parts of a city are separate and independent.

_____ 4. Cities are self-contained, 'closed systems'.

_____ 5. Materials flowing through the urban system are subjected to thousands of possible uses.

_____ 6. In the city air and water are used for the dilution of wastes.

_____ 7. The study of man's impact on the urban environment has always been recognized as important.

_____ 8. There is a universally accepted definition of urban.

_____ 9. Man does not alter the natural environment as he builds the city.

_____ 10. The interactions between man and the urban environments are simple.

_____ 11. In urban environments man is the primary initiator of change.

_____ 12. Cities are not self sustaining as they exchange materials and energy with other environments.

_____ 13. The world is becoming increasingly urban.

Key: URBAN ENVIRONMENT

Multiple Choice

1. c
2. a
3. e
4. e
5. a
6. e

True-False

1. True
2. False (ver complex)
3. False (inter-related and inter-dependent)
4. False (cities are open systems)
5. True
6. True
7. False (not)
8. False (not)
9. False (he does alter it)
10. False (complex)
11. True
12. True
13. True