Chapter 1
Introduction

Environmental pollution and ecological destruction are one of the major social problems for mankind to face. In the development process of modern society, many countries pay a high price due to improper handling of environmental problems, resulting in that ecological environment, people's health and social economy suffer great damage. Nowadays, with the rapid development of the global population, industrial and agricultural production and scientific technology, the relationship among population, resources and environment becomes sharp and prominence. The environment problem has increasingly aroused widespread concern and attention, become an important global problem.

But what is environment and environmental problems? In this chapter, some important definitions the main aftereffects of environmental problems, and the research contents of environmental science will be introduced.

1.1 IMPORTANT DEFINITIONS

Environment is the physical and biotic habitat which surrounds us, which we can see, hear, touch, smell, and taste. It includes physical environment and social environment.

Physical environment is the sum of various natural factors surrounding humans. It had existed before human beings appeared, and has experienced a long process of development. The physical environment is composed of non-biological factors and biological factors. The former includes air, water, soil, sunshine, and all kinds of mineral resources etc., without which life-form cannot survive, and the life-form refers to animals, plants and microorganisms. The "environment" in this textbook mainly refers to the layer called biosphere in the physical environment.

Social environment is the result of human production activities over a long period of time. In the long-term development process, people constantly improve the level of material life, science and technology, and cultural life, meanwhile, they create the city and country, industry

and traffic, scenic and cultural entertainment and cultural relic, which form the social environment.

Environmental problems refer to the deterioration of the global or regional environmental quality caused by inappropriate human production activities, which is not conducive to the survival and development of mankind.

According to different causes, environmental problems can be divided into two categories, namely, **natural environmental problems** and **man-made environmental problems**. The former, natural environmental problems or the first environmental problems, refers to environmental damage caused by natural disasters, such as volcano eruption, earthquake, typhoon, tsunami, flood, drought and, endemic etc. The latter called man-made environmental problems or the second environmental problems, which refers to the environment pollution, ecological destruction, the rapid increase in population and resources destruction and depletion, caused by inappropriate human production activities, and it will be mainly discussed in the textbook.

System, according to Webster's dictionary, is defined as "a set or arrangement of things so related or connected as to form a unit or organic whole, such as a solar system, an irrigation system, a supply system, the world or universe".

Pollution can be defined as an undesirable change in the physical, chemical, or biological characteristics of the air, water, or land that can harmfully affect the health, survival, or activities of humans or other living organisms.

When the goal of improving environmental quality is taken to be improving human well-being, the word "environment" broadens to include all kinds of social, economic, and cultural aspects. Such broadness is unworkable in many real situations and impractical in a textbook designed for a one-semester course. Our examination of environmental problems is therefore limited by our definition of "environment".

1.2 DEVELOPMENT OF ENVIRONMENTAL PROBLEMS

Environmental problems occur and develop with the emergence and development of human beings. In an agrarian society, people lived essentially in harmony with nature, raising food, gathering firewood, and making clothing and tools from the land. The wastes from animals and humans were returned to the soil as fertilizer. Few, if any, problems of water, land, or air pollution occurred (Figure 1.1). For the small settlements which grew up, the supply of food, water, and other essentials and the disposal of wastes had to be kept in balance with the changing community, but no serious environmental problems were created.

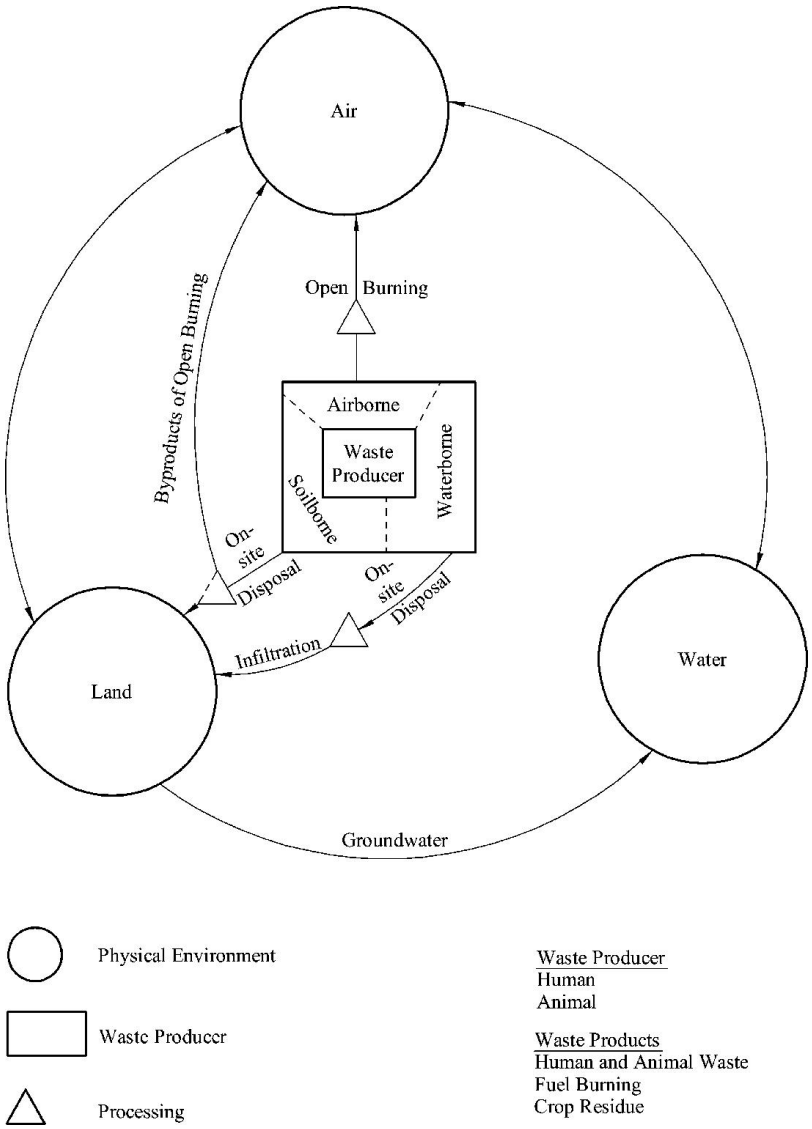

Figure 1.1 Waste cycle – agrarian society

(Source: J. Glynn Henry and Gary W. Heinke, *Environmental Science and Engineering*, Prentice Hall, 1989, P5)

The cities of ancient times had systems to supply water and to dispose of wastes. The municipal technology of ancient cities seems to have been forgotten for many centuries by those who built cities throughout the world. Water supply and waste disposal were neglected, resulting in many outbreaks of dysentery, cholera, typhoid, and other waterborne diseases. Until the middle of the nineteenth century, it was not realized that improper waste disposal polluted water supplies with disease-carrying organisms. The industrial revolution in nineteenth-century Europe and North America aggravated the environmental problems since it brought increased urbanization with the industrialization. Both phenomena, urbanization and industrialization, were and are fundamental causes of water and air pollution which the cities

of that time were unable to handle.

Rapid advances in technology for the treatment of water and the partial treatment of wastewater took place in the developed countries over the next few decades. This led to a dramatic decrease in the incidence of waterborne diseases. Figure 1.2 illustrates the waste disposal cycle for an industrialized society. Note that all wastes discharge into the environment, and thus pollute water, air, and land systems.

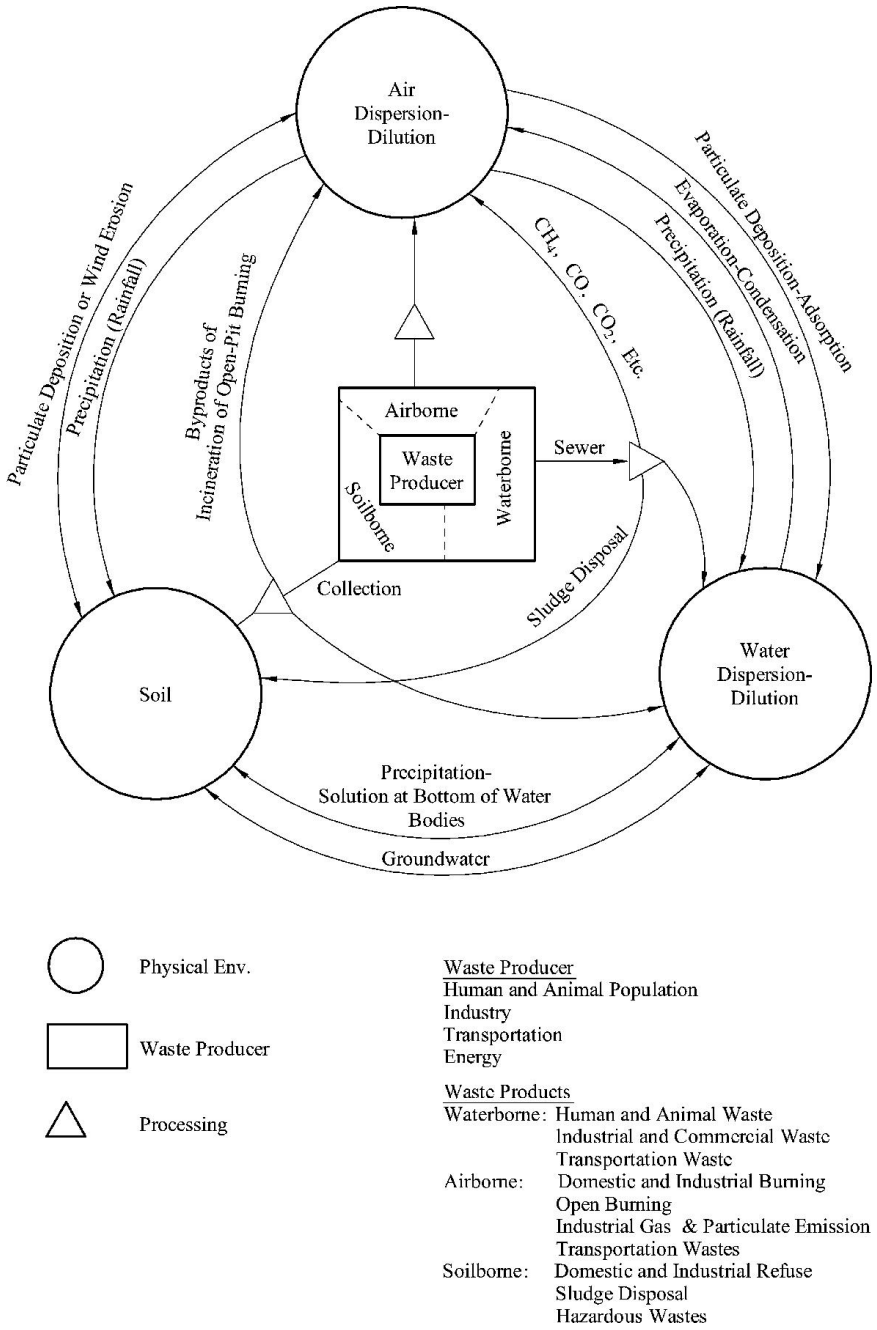

Figure 1.2 Waste cycle – industrialized society

(Source: J. Glynn Henry and Gary W. Heinke, *Environmental Science and Engineering*, Prentice Hall, 1989, P6)

Following the Second World War the industrialized countries experienced an economic boom fueled by a burgeoning population, advanced technology, and a rapid rise in energy consumption. During the 1950s and 1960s this activity significantly increased the quantity of wastes discharged to the environment. New chemicals, including insecticides and pesticides, used without sufficient testing for their environmental health effects, caused, and continue to cause, enormous problems not anticipated when they were introduced. Unfortunately, the problem is worsening as the variety and amounts of pollutants discharged to the environment increase inexorably while the capacity of our air, water, and land systems to assimilate wastes is limited. For example, around 1950's, eight famous incidents of pollution (See Table 1.1) in Belgium, America, Britain, and Japan, have shocked the whole world.

In the recent forty years, with the rapid growth of population and the unprecedented expansion of human impact on earth, there are a series of sharp contradictions among the population, resources, environment, and economic development, which has aroused attention of countries all over the world. In 1972, the first Conference on the Human Environment was held in Stockholm, which was a wake-up call of environmental problems and forced each government to make protection statutes of resource and environment in their national government's schedule. However, although people have made various efforts, the problem has not been really solved. What is more, many new environmental problems, such as the exhausting ozone layer, global spreading acid rain, the biological species reduction, population growth, and lack of resources, are threatening the survival and development of human beings. Serious global environmental realities force people to reflect on the high consumption of resources and the neglect of environmental problems seriously, and try to explore an effective boom way. Under such a background, in June, 1992, the United Nations Conference on Environment and Development (UNCED) was held in Rio de Janeiro, on which a commonly accepted human development road − the road of sustainable development was put forward.

1.3 SUSTAINABLE DEVELOPMENT

1.3.1 Relationship between Environment and Development

In the 1960s, after suffering from a series of serious environmental public hazard incidents, humans began to actively review and sum up the drawbacks of traditional economic development patterns. They found that pure economic growth did not equal to development, and for development itself, besides demanding the growth of "quantity", the more important thing was to raise and improve the overall "quality". In order to obtain freedom in nature, humans must use knowledge to build a better environment under the condition to cooperate

with nature.

Table 1.1 The famous eight incidents of pollution

Name	Pollutant	Place	Time	States of poisoning	Symptoms of poisoning	Causes of injury	Causes of the incident
Maas Valley smog incident	Soot, SO_2	Belgian Maas Valley	1930.12	Thousands of people got ill, 60 people died	cough, tachypnea, lachrymation, sore throat, nausea, vomiting, chest stuffiness	People inhaled SO_3 deep into the lungs	（1）Lots of heavy factories in the valley （2）The inversion weather （3）The accumulation of industrial pollutants （4）Foggy days
Donora smog incident		Donora town, Pennsylvania, America	1948.10	About 42% of the people were ill, 17 people died in 4 days	cough, sore throat, chest stuffiness, vomiting, diarrhea	People inhaled sulfate into the lung	（1）Lots of factories （2）foggy days （3）The inversion weather
London smog incident		London, England	1952.12	4,000 people died in 5 days	chest stuffiness, cough, sore throat, vomiting	People inhaled soot adhering to the sulfuric acid foam into the lungs	（1）The residents used high sulfur coal for heating, which discharge lots of dust with sulfur dioxide （2）The inversion weather
Los-Angeles photochemical smog incident	Photochemical smog	Los-Angeles, America	1943.5-10	The majority of the local residents got ill, 400 people who were over 65 years old died	Ophthalmocace, laryngitis	Photochemical smog created by oil industrial and automobile exhaust gas under altraviolet	(1) More than 1,000 tons of hydrocarbon were discharged into the air every day (2) The city was surrounded by mountains in three sides (3) The air flowed slowly in horizontal direction
Minamata incident	Methyl mercury	Minamata town, Japan	1953	More than 180 people were ill, more than 50 people died	lisp, gait instability, facial dementia, deafness, blindness, whole body numb, nervous breakdown	People got sick or even died through eating the poisoned fish	The waste water and residues contained toxic methyl mercury polluted the source of water
Toyama incident	Cadmium	Toyama, Japan	1931-1972	More than 280 people were ill, 34 people died	Arthralgia, Neuralgia, bone pain, bone softening atrophy, natural fracture	The rice and drinking water contained cadmium	Cadmium-tainted water was discharged into the river by factories without purification
Yokkaichi incident	SO_2, Coal dust, Heavy metals dust	Yokkaichi, Japan	1955-1972	More than 500 people were ill, 36 died of Asthma	Bronchitis, Bronchial Asthma and Emphysema	People inhaled the particles contained toxic heavy metal and SO_2 into their lungs	Factories discharged large quantities of SO_2, coal dust and heavy metal dust into the air
Rice bran oil incident	PCB	23 prefectures, including Aichi Prefecture, Kyushu, Japan	1968	More than 5,000 people got ill, 16 people died	Swollen eyelids, sweating frequently, body covered with red bumps, nausea, vomiting, liver function decline, courbature, badly cough or	Eating the rice bran oil contained PCB	In the production process of rice bran oil, the PCB, as a heating medium, was got into the oil because of poor mana- gement

					even death		

The environment is where we all live, and development is what we all do in attempting to improve our lot within that abode. Mankind is a part of nature and life depends on the uninterrupted functioning of natural systems. Environment and human activities are inseparable. Conservation of nature cannot be achieved without development to alleviate poverty and misery of hundreds of million people. Unless the fertility and productivity of the planet are safeguarded, the human future is at risk.

1.3.2 Definition of Sustainable Development

The concept of sustainable development has been evolving. In "Our Common Future", it was defined as the development that meets the needs of the present without compromising ability of future generations to meet their own needs (WCED, 1987). Broadly speaking, sustainable development strategy is aiming at promoting the harmony between human beings and nature; from a narrow view, sustainable development implies the sustainability of nature, i.e. the inter-generational fair distribution in resource supply and its costs and benefits, including the intra-generational fairness between regions.

The definition has remained a classic one, and this principle was universally accepted by more than 100 countries, including China, at the 1992 UNCED. The World Summit on Sustainable Development (WSSD) in 2002 made it clearer that the economic development, social development, and environmental protection be three pillars of sustainable development at local, national, regional, and global levels, which are interdependent and mutually reinforcing. In another word, it means that economy, society, and the protection of environment should be developed in a balanced way with an aim of developing economy as well as protecting the natural resources and environment, including atmosphere, fresh water, oceans, land and forests, etc. The core of sustainable development is "development", in particular, economic and social development, which could be gained under the precondition of strict control on population, improvement of population quality, environmental protection, and sustainable utilization of resources.

Sustainable development stresses fairness, equity, and integration of the above-mentioned three pillars. It took poverty eradication, changing consumption and production patterns, and protecting and managing the natural resource base for economic and social development as the overarching objectives, and essential requirements for sustainable development.

1.3.3 Measures of Sustainable Development

For different regions and different countries, even in different periods of the same country, the sustainable development measures are different. For most developing countries, economic development and meeting people's basic living needs are the premise of sustainable development. For developed countries, the emphasis should be put in the technique reform, low input, and low consumption.

Human beings must make profound changes in order to realize sustainable development. These changes will come from all areas, such as society, economy, scientific and technological education, administration, and law etc.

First, we should keep population at a sustainable development level. Population is both the most important development resource and the heaviest burden for development. For example, in China, the absolute amounts of many resources rank first in the world and the total size of the economy is also in the forefront, but because of large population, per capita possession of resources and per capita GDP lag far behind those in many other countries. Limiting family size to two children and giving support to international organizations that promote family planning in less developed nations are important ways of controlling population growth. In addition, a national education to promote the citizens' basic scientific literacy is very important. The way and degree of participation of the masses will decide the realization process of sustainable development.

Second, we should conserve natural resources which are the material basis for human survival and development. Natural resources can be categorized as non-renewable resources, such as mineral, petroleum and natural gas etc., and renewable resources, such as forest, grassland etc. To save resources, developing countries must change the traditional mode of economic growth, i.e., the extensive development mode of high input and high consumption changes to the intensive pattern of saving resources and reducing consumption. Meanwhile, developed countries need to solve the problem of high consumption. Western developed countries, whose populations account for 26 percent of the world, consume over 70 percent of the world's merchandise and labor force. But, for the developing countries such as China, it is often a case of too many people sharing too few resources. Table 1.2 largely reflects the huge gap between the developed countries and the developing countries in the aspect of consumption.

Table 1.2 The distribution of the world's consumption

Merchandise		Per capita consumption unit	Developed countries (26% of the world population)		Developing countries (74% of the world population)	
			Proportion of world consumption (%)	Per capita consumption	Proportion of world consumption (%)	Per capita consumption
Food supplies	Energy	calories/day	34	3395	66	2389
	Protein	g/day	38	99	62	58
	Fat	g/day	53	127	47	40
Paper		Kg/year	85	123	15	8
Steel		Kg/year	79	455	21	43
Other metals		Kg/year	86	26	14	2
Commercial Energy		Tonne coal equivalent / year	80	5.8	20	0.5

(Source: "Our Common Future", *World Commission on Environment and Development*, 1987.)

The Conservation of natural resources also means using resources more efficiently. Currently we waste about 50% of the consumed energy. Every day, huge amounts of water and other resources are wasted. Although this wastefulness is often viewed as one of society's greatest faults, it is also one of our greatest opportunities for improvement. By becoming more efficient we can cut waste, reduce environmental damage, and ensure a steady supply of resources for future generations.

Third, we must prevent industrial pollution so as to protect the environment. Industrial pollution is a major cause of environmental pollution and a major obstacle to economic and social sustainable development. In order to reduce and prevent industrial pollution, we must vigorously promote clean production technology, or clean technology in short. Clean technology is a kind of process and technology which can reduce the consumption of raw materials and energy, and effectively prevent the production of pollutants and other wastes. It requires the input of energy and resource to a minimum and the output of waste and pollutant to the lowest degree in the production process. At present, clean production technology is advanced technology in controlling the industrial pollution, and will become the dominant technology in industrial production in twenty-first century.

In addition, human beings also need to take other measures, such as carrying out ecological agriculture, planting more trees and grass, protecting biological diversity, implementing comprehensive renovation on cities' environmental pollution, improving the environmental legal system, promoting the environmental science research and education, strengthening environmental management, international exchanges, and cooperation.

1.3.4 Making Sustainable Development Work

"Developing countries are littered with the rusting good intentions of projects that did not achieve social or economic success," writes Walter V. C. Reid, a leading authority on Third World development. To making matters worse, he notes, ill-conceived projects have wrought considerable damage to the Third World. Erosion, desertified landscapes, pesticide poisoning, pollution, and deforestation are some of the results of a multibillion dollar annual budget for Third World development. Why?

There are many reasons. The first is the good intentions of the international lending agencies, the multilateral development banks (MDBs), and development agencies. There are four MDBs: the World Bank, the Inter-American Development Bank, the Asian Development Bank, and the African Development Bank. They are funded by groups of nations. The World Bank, headquartered in New York City, for example, is mainly supported by the United States, France, Germany, the United Kingdom, etc. MDBs lend billions of dollars a year to Third World nations to finance economic development projects, from road construction to farming to dam building.

The MDBs are joined by private commercial banks and international development agencies. The US Agency for International Development, for example, is a key player. It provides outright grants for development projects.

All this is well and good. Problems arise, in part, because of the types of projects the MDBs fund or support. Many projects are unsustainable. Thus, the MDBs have not only failed to stop environmental deterioration, but they have, in many cases, worsened it. Large dam projects, for example, flood productive farmland, displace people, increase the prevalence of waterborne disease, and reduce sediment that nourishes estuarine life. The costs of these projects often exceed the economic benefits gained from hydroelectric power and irrigation water. Irrigation water in arid regions leads to salinization and waterlogging, both of which can decrease productivity and render land useless. Over half of the Third World's irrigated cropland, for instance, suffers from salinization.

MDBs have helped finance deforestation and colonization projects as well. In western Brazil, forests were cut to make way for farmers and ranchers, but 80% of the people soon left because the soils were quickly washed away or lost their fertility.

Pesticide use to support large agricultural projects funded by MDBs has also proved economically and environmentally costly. In Central America, in fact, chronic and acute pesticide poisoning is among the region's most serious problems.

Volumes of horror stories could be written about well-intended projects gone awry. Fortunately, the MDBs and others are beginning to see the need for new practices for sustainable development.

Considerable gains can be made in the Third World by improving energy efficiency. Simple changes in wood cookstoves, for instance, could cut energy demand drastically and help reduce deforestation in the Third World. Energy efficiency, combined with projects to replant trees and manage forests better, could go a long way toward helping Third World nations meet their needs sustainably. Today, however, energy efficiency projects constitute less than 1% of the international aid.

Agriculture, forestry, and animal husbandry can be made sustainable, but important changes are needed. First, funding agencies must rely more on local knowledge than agricultural experts from the West who often attempt to transfer costly technology to Third World nations. Second, MDBs and other agencies agencies must begin to study the environmental, social, and political effects of proposed projects. Until very recently, the environment and the long-term sustainability of projects have received little or no attention at all. A more careful analysis will help MDBs and others avoid projects that are doomed to fail or destined to create widespread environmental damage. Third, developers must design with nature, rather than continue to

redesign nature. “Modification of the environment to fit the needs of a production system,” writes Walter Reid, “is much less likely to be sustainable modifications of the production system to fit the environment.” That’s because most environmental modifications have serious repercussions. Fourth, development should preserve genetic diversity whenever possible. Extractive reserves in Brazil and other countries are a case in point. They can provide sustainable income at a far lower cost than traditional development practices like clearing and cutting forests. Fifth, inappropriate laws and policies must be removed. Subsidies for pesticide use and for ranching in cleared tropical rain forests are two examples of ruinous policies. Sixth, widespread participation among locals should be encouraged. Planners have long ignored the input of people who will be affected by their projects. They have also ignored knowledgeable local experts, who better understand the people’s needs, cultures, beliefs, and the environmental constraints of areas being affected. “Planners should not assume that they know people’s needs,” writes Walter Reid. Development is unlikely to be sustained unless the needs of people are identified and local residents support the project. Seventh, MDBs and other agencies must be more flexible, allowing projects to shift as problems arise. Inflexible bureaucracies often impair projects by refusing to allow for changes, even in the face of serious problems. By funneling money through smaller, non-governmental organizations, the large bureaucracies can be separated from the management of projects, allowing greater flexibility and ensuring greater success.

These changes can help the Third World develop along a sustainable path, operating within the limits posed by the earth. They can also be applied to the developed countries in future development.

1.4 WHAT IS ENVIRONMENTAL SCIENCE?

What is environmental science? To understand the term, we need take each word separately. The word “environmental” refers broadly to everything around us: the air, the water, and the land as well as the plants, animals, and micro organisms that inhabit them. Science, of course, refers to a body of knowledge about the world and all its parts. It is also a method for finding new information. Science seeks exactness through measurement, insight through close observation, and foresight through its theories.

Environmental science comes into existence as a recognized discipline to cope with the vast problems spawned by overpopulation, resource depletion, and pollution. It has become a key tool for our survival.

Modern environmental science is aimed at helping us control our own actions in the natural world to avoid irreparable damage. In this sense, environmental science means learning to master ourselves.

To solve the highly complex problems of overpopulation, resource depletion, and pollution requires a knowledge of many scientific fields. Environmental science calls on chemistry, biology, geology, and a great many other disciplines, including sociology, climatology, anthropology, forestry, and agriculture. Spanning this wide range of knowledge, environmental science offers an integrated view of the world and our part in it. Environmental science takes on the colossal task of understanding complex issues. It is an often awkward melding of science, engineering, and liberal arts that requires broadly educated men and women in the age that leans heavily toward specialization.

Environmental science differs from the traditional "pure", or "objective", science, which seeks knowledge for its own sake. Instead, it offers a great deal of urgent advice and reaches many conclusions that challenge cherished beliefs and practices. You may find this true as you read this book. In contrast to the astronomer in a mountaintop observatory or the cell biologist in a laboratory, environmental scientists are often in the thick of things, and at the heart of today's hottest debates.

Environmental science is the study of the environment, its living and nonliving components, and the interactions of these components. By choice it focuses on the ways that humans affect the environment and the ways our actions come back to haunt us. Crossing many traditional boundaries, it attempts to find answers to complex, interrelated problems of population, resources, and pollution, problems that threaten the welfare and long-term survival of humanity.

Changing our ways will be a colossal task, a process that will take generations to complete. It will involve arduous work in many fields. The moon landing is a weekend home-improvement chore compared with the job ahead. The study of environmental science is a cornerstone of change.

1.5 WHAT IS ENVIRONMENTAL ENGINEERING?

Environmental engineering is an important branch not only of environmental science but also of engineering. The Environmental Engineering Division of the American Society of Civil Engineers (ASCE) has published the following statement of purpose:

Environmental engineering is manifest by sound engineering thought and practice in the solution of problems of environmental sanitation, notably in the provision of safe, palatable, and ample public water supplies; the proper disposal of or recycle of wastewater and solid wastes; the adequate drainage of urban and rural areas for proper sanitation; and the control of water, soil, and atmospheric pollution, and the social and environmental impact of these solutions. Furthermore, it is concerned with engineering problems in the field of public health,

such as control of arthropod-borne diseases, the elimination of industrial health hazards, and the provision of adequate sanitation in urban, rural, and recreational areas, and the effect of technological advances on the environment.

Thus, we may consider what environmental engineering does not. It does not concerned primarily with heating, ventilating, or air conditioning (HVAC), nor is it concerned primarily with landscape architecture. Neither should it be confused with the architectural and structural engineering functions associated with built environments, such as homes, offices, and other work places.

There are mainly two aspects in res environmental engineering, from is to protect the environment from being damaged by the human unadvisable activities, and the other is to protect humans from being injured by the adverse environment so as to enable people to live healthily and cosily.