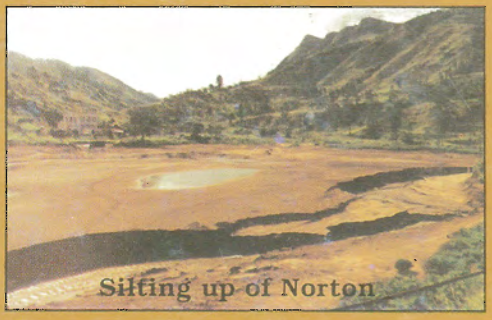
COMMONSENSE ABOUT OUR ENVIRONMENT


Silting up of Norton


Watawala

P.G. COORAY


Topaz Mining 6 - 4

COMMONSENSE ABOUT OUR ENVIRONMENT

by

P.G. COORAY

PhD, DIC, FGS, Hon.FGSAm, FNASSL

Natural Resources, Energy and Science Authourity of Sri Lanka

1997

Cover Illustrations

Top	Silting up of Norton Bridge Reservoir
Middle	Landslide at Watawala
Bottom	Land degradation by topaz mining, Rattota

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"Development cannot be carried out without conservation."
(UNEP)

"If development is not environmentally sustainable, it is doomed."
(WCED, World Commission on Environment and Development)

"Nature to be commanded must be obeyed."
(Francis Bacon, 1620)

FOREWORD

In a foreword to the Science Education Series, attention was drawn to the responsibility of NARESA to disseminate scientific information.

The Vidurava, the quarterly science bulletin contains specific articles of general interest to the schoolgoing population and the general public.

Prof. P.G. Cooray offered this material that had been originally published is a series in the Island newspaper. The Steering Committee on Science Education of NARESA examined this offer from a scientist of the callibre of Prof. Cooray and decided to publish it as a useful book for reading. It is an extension of NARESA's policy to inculcate a scientific culture beginning in school-life and extending through the life span of the general public. This book fulfills a theme that NARESA has carried in recent years viz 'Science in Everyday Life'.

Prof. Priyani E. Soysa
Director General

Acknowledgements

The author wishes to thank the following for their assistance in various ways in making the publication of this book possible:

Mr James Lanerolle, Managing Director of the Upali Group of Newspapers, for permission to use the material of the original articles which appeared in The Island, as the basis of this book;

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The Landslide Hazard Mapping Project Team, National Building Research Organisation, for kindly letting me use their picture of the landslide on the Dolosbage-Nawalapitiya road.

PREFACE

A few years ago, when I was a member of the Institute of Fundamental Studies, Kandy, I conducted a one-day session in the Schools Science Programme, which is an annual event in the Institute's yearly programme. For it, 30-40 of the island's best students, based on the results of the previous year's O-level examinations, are invited to take part in this programme, which runs for six consecutive Saturdays. In 1990, I chose the theme "The Earth Around You", which attempted to introduce the participants to various aspects of the environment of the island. The course turned out to be quite successful, and so I decided to enlarge the various topics dealt with into a series of articles for the general public through the medium of the press.

The articles appeared in The Island as a series called "Commonsense about our Habitat", and were published in the following order:

Commonsense about Water Supplies 26.5.92
Commonsense about Deforestation 2.6.92
Commonsense about the Environment 9.6.92
Commonsense about Erosion 16.6.92
Commonsense about Pollution 23.6.92
Commonsense about Landslides 30.6.92
Commonsense about Conservation 7.7.92

Those articles form the substance of this book, and they are printed here in a more logical order, beginning with an examination of the Sri Lankan environment, and ending with its Conservation.

I would like here to pay a compliment to the editorial staff of The Island for accepting for publication a series of this nature, which is largely scientific in content. That they did so without deleting a single line or a single figure, thereby giving nearly a full page to each article, is clear evidence of the enlightened policy of the paper in matters of this nature. I would also like to thank Mr James Lanerolle, Managing Director of the Upali Group, for encouraging me to continue with the series, once it began.

When the Landslide article was originally published, in 1990, it was translated into Sinhala and made into a leaflet, 15000 copies of which were printed, with financial assistance from the Central Environmental Authority and the the Association of Geoscientists for International Development (AGID). These copies were then distributed to school children in the landslide-affected areas of the island through the Department of Education.

Several friends who read the "Habitat" series when it was being published commented that they were very useful as well as interesting, and suggested that they be put together in book form. I even heard of one father who cut the articles out and had them pasted on the wall of his son's room. And when these articles were displayed at an International Conference on Geoscience Education, which was held in Southampton in April 1993, an Indian geologist made copies of them, which she was going to have translated into the vernacular of her region in Orissa State.

The bulk of the material in the book is taken from the articles, but I have since added material in the text and figures that were not in the originals. I feel that in its present form the book will provide interesting as well as instructive reading not only to the senior students in our schools, but also to adults of all ages and in all walks of life. If it influences some of its readers to become more aware of the environment around them and to take steps to take more care of that environment, I shall feel that I have achieved something useful.

P.G. Cooray

426, Mahakanda Road
Hindagala.
30 June, 1997.

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Chapter 1

THE SRI LANKAN ENVIRONMENT

What is the environment?

Everyone talks constantly and glibly about 'the environment', but what do we really mean when we talk about it? Reference to dictionaries shows that 'environment' means the objects or circumstances that surround us. Hence, we have the physical environment, the biological environment, and the social or cultural environment. In this book, we are concerned mainly about the physical environment and, to some extent, about the biological environment; but what we do to our environment is often influenced by our social or cultural environment. And so, what follows deals with our environment in all senses, in one form or another.

Environments vary in scale and in character. At one end is the mega-environment that surrounds planet earth. We call this the 'global environment', and it includes things like the ozone layer and phenomena like 'global warming' and 'sea-level rise'. We can then go down the scale through continental environments, regional environments, community environments, and local or micro-environments. In all these, whatever the scale, the 'environment' is the complex of climatic, physiological, edaphic and biotic factors that interact with each other and influence the form and life of a person or a community. Hence, you live in one environment (i.e., that around your home) and you study and work in another (i.e., that around your school or office). In my own case, my home environment is the back (south-facing) slopes of the Hantane range of hills and overlooking the wide valley of the Mahaweli Ganga. I am surrounded by patana and pinus plantations and receive strong, dry winds from the north-east monsoon that come with gale force down the Hantane slopes. My house receives the full force of the sun's rays throughout the day in the northern winter months, when the sun is in the southern hemisphere. I do not now have an 'office' environment as I am retired, but when I worked at the Institute of Fundamental Studies in Kandy, my office was on the other side of the Hantane range, on a hill slope facing north-east, and receiving rain from both monsoons.

We can recognise various mega-environments in the world, such as: the equatorial forest regions (e.g., S.E. Asia, the Amazon basin, the Congo basin); the temperate grasslands (e.g., the steppes of Russia and the pampas of South America); the polar regions, permanently covered with snow and ice and in darkness for six months or more of the year; the desert regions of the Sahara and the Kalahari; the mountain ranges of the Himalayas and the Andes; the vast lowland plains; and the coastal regions of all the continents. Each of these environments has special climatic and vegetational characteristics as well as landforms, and these determine the mode of life of the people living in that environment.

Within our own island, too, but on a much smaller scale, the environmental conditions vary from region to region, and these, in turn, influence the manner of the life of the people living in them. In the Hill Country, for example (Fig.1-1), temperatures are relatively low (10^0 to 20^0C for most of the year), rainfall is plentiful (more than 2000 mm per year), and flat land is scarce (Fig.1-2). As a result, hill slopes have to be terraced for rice cultivation and irrigation tanks are not needed. Tea, which requires much moisture for growth, is a major cash crop; and the so-called 'up-country' vegetables like carrots, leeks, cauliflower and beetroot grow well. Plentiful water for domestic purposes is available in the innumerable springs that exist, and many rivers have been dammed for the production of hydro-electricity.

Conditions in the lowlands of northern and eastern Sri Lanka, commonly called the Dry Zone, are quite different. Temperatures are generally high (over 28^0 C for most of the year), rainfall is low (below 1500 mm per year), and the land is flat or gently undulating. Terracing is, therefore, not necessary, but irrigation is essential for the cultivation of rice. Hence, thousands of irrigation reservoirs (or tanks) of all sizes are present throughout this area (Fig.1-3). Besides rice, the cash crops are tobacco and chillies, but sugar cane and cotton are also grown. Only the so-called 'low-country' vegetables like beans, yams, gourds and aubergines are cultivated. Roads are straight for long distances, and the people depend largely on wells for their supplies of drinking water, for which they sometimes have to walk for one or two kilometres. Firewood for cooking is available from the relatively 'open' forests; and salt is manufactured by solar evaporation in the driest parts of the Dry Zone, as at Puttalam and Hambantota.

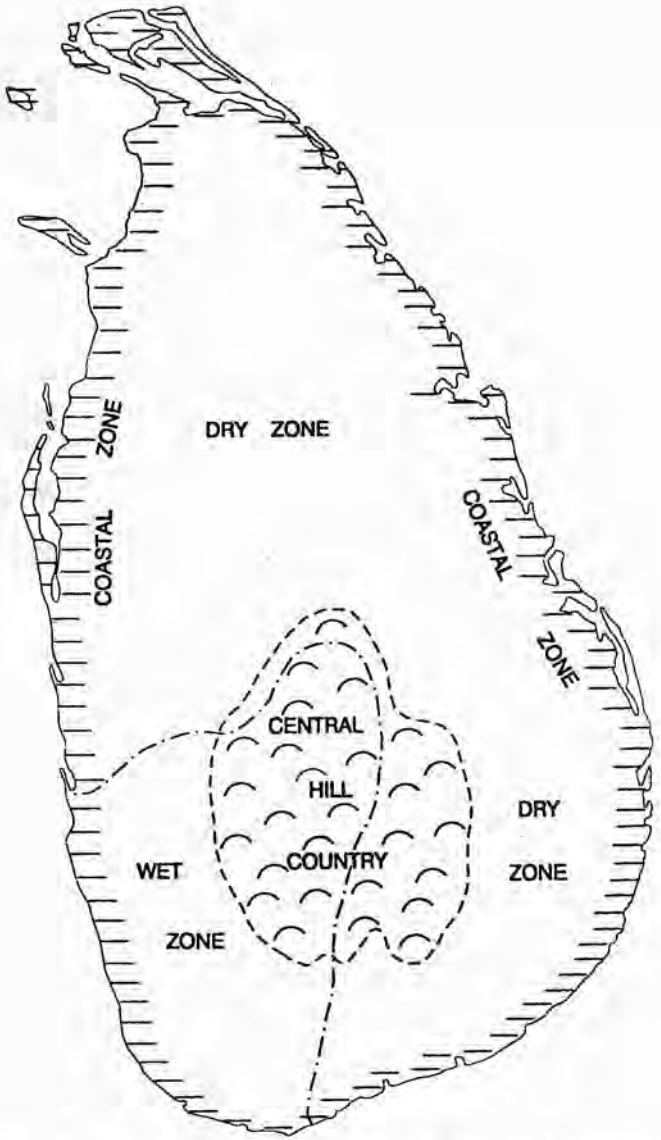

Figure 1.1: Sketch map of Sri Lanka showing the three major environmental regions, viz., the Hill country (Wet Zone), the Low Country (Dry Zone), and the Coastal Zone.

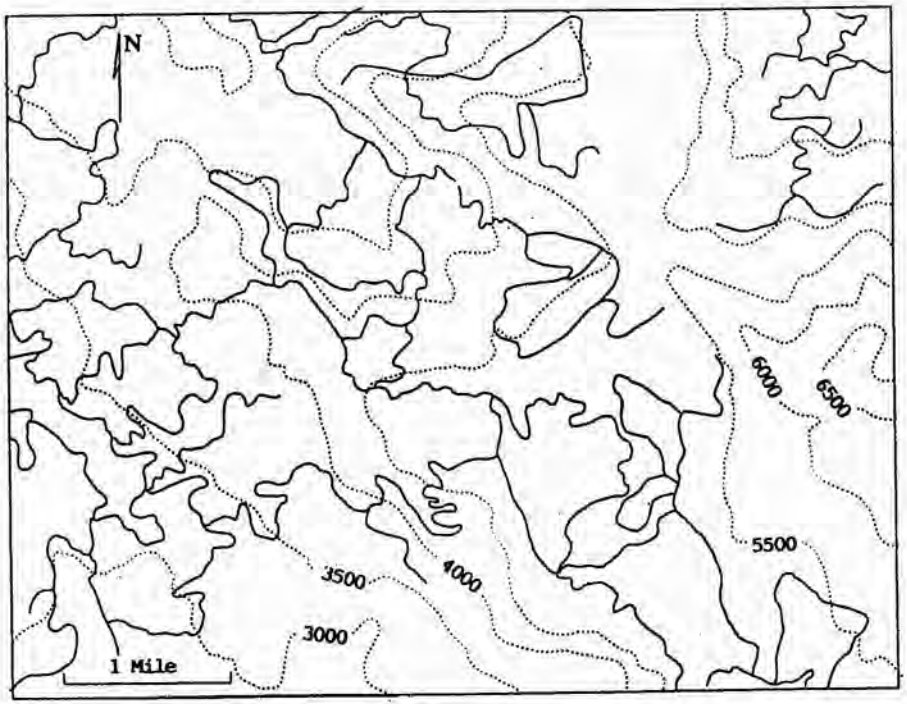

Figure 1.2: **Map of a typical area in the Hill Country, showing relief from 3000 to nearly 7000 feet above Mean Sea Level (MSL), as seen from the contour lines (dotted lines), the numerous valleys, and the winding nature of the roads (solid lines).**

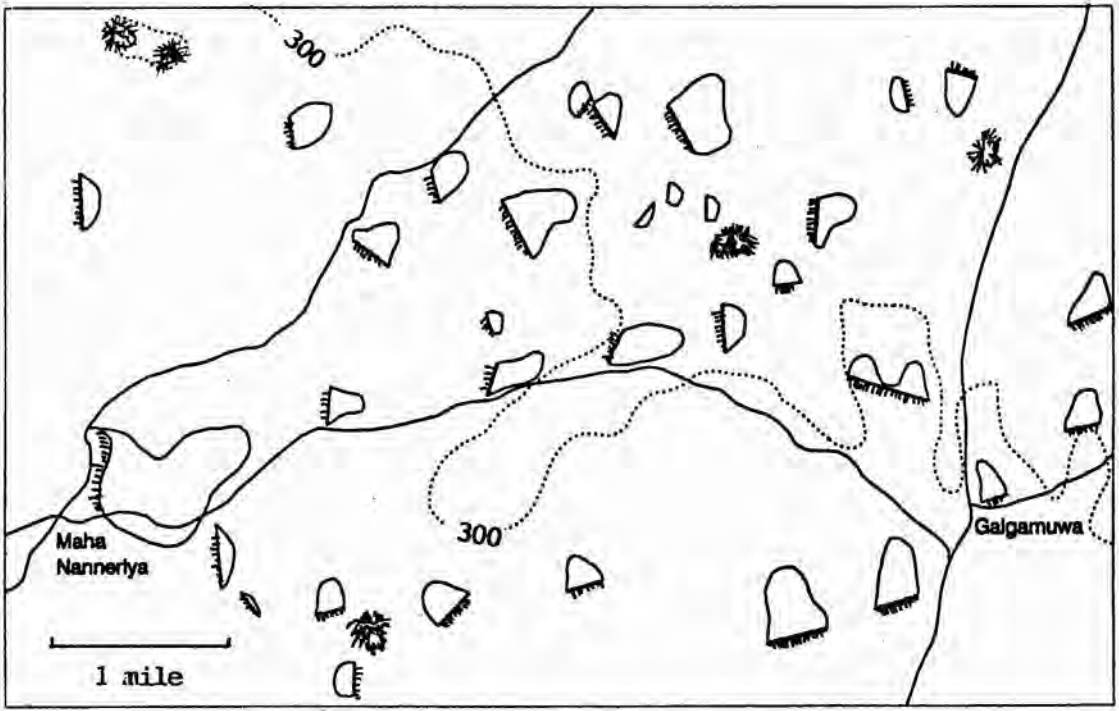

Figure 1.3: Map of typical Dry Zone country showing flattish land about 300 feet above MSL, a few scattered rocky hills or inselberge, a large number of irrigation tanks and the roads running in almost straight lines.

The western, southern and eastern coastal belts are predominantly sandy, and sand dunes, with their 'beach jungle' vegetation, are common. The sandy soils support the best coconut plantations in the island, but many other crops, e.g., gherkins, are now being grown in these sandy stretches. Sand is a good aquifer, so there is plentiful groundwater in these coastal regions, except where over-extraction has taken place. Lagoons are numerous (Fig.1-4) and provide abundant sea-food, such as crabs and prawns, which are supplied to the many tourist hotels that are strung out along these coastlines.

Furthermore, we see here an excellent illustration of how the environment (in this instance climate) can control the way people live. When the north-east monsoon was dominant and the eastern seas were too rough for fishing, the fishermen and their families used to gather along the north-western coast, from Negombo to Puttalam. Here they would establish their camps, build their *wadis* (huts) of wood and coconut thatch on the beaches, and go out to fish almost daily. Part of their catches were taken to the towns in refrigerated vans and a part was dried and salted on the beaches. When the southwest monsoon began to blow and the seas on the western side became too rough for fishing, the fishermen and their families used to migrate to the eastern side of the island, where they again established their camps on the beaches and carried on their occupation. This annual migration of the fishing population from one side of the island to the other used to take place in days gone by, but it has ceased owing to the prevailing circumstances of the present day.

It is important to understand, however, that the relationship between man and his environment is a two-way relationship. The environment influences the way man lives in that environment, but man, in turn, affects the environment in the way he makes use of it. This relationship may be a beneficial one or it may be a harmful one to either man or to his environment, or to both. We shall, in the chapters that follow, look more closely at some examples of this two-way relationship in Sri Lanka.

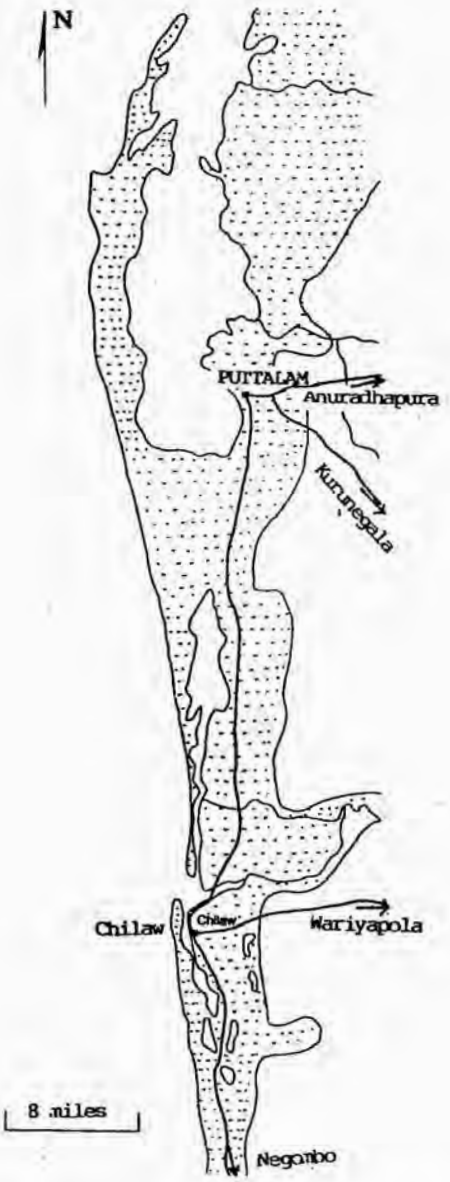

Figure 1.4: **Map of typical north-western coastal region, showing straight coastline, large extents of coastal sands (dotted) and clays and numerous lagoons and lakes.**

What does the environment give us?

As was pointed out earlier, the physical environment that surrounds us is the result of the complex interaction of several factors. These are geology - or the rocks and their structures -and climate, and their interactions give us the landforms, drainage, soils, groundwater and weather. These are what make up the environment that surrounds us.

One major element is the soil, which is what we cultivate to get our food and our commercial crops. The soil itself, which is the result of the action of climate on the rocks, varies from place to place, as it depends not only on those two factors but also on location. Some soils are rich in nutrients, others are lacking in them, and hence the need for the addition of fertilizers. Some soils are rich in humus, like those in the wet zone, whereas others, such as those on the coastal sands, are lacking in humus. Some soils have excess fluoride and others are deficient in it; this results in dental fluorosis in the former case and dental caries in the latter, in children as well as in adults living in those areas.

The soils and the climate give us our natural vegetation —our dense, tropical forests in the Wet Zone, the more open forests of the Dry Zone, our patana lands, our beach jungles —each of which has special associations of tree and plant species. The soils and climate also determine what crops grow where. For example, coconut and rubber grow mostly in the south-western sector of the island, palmyrah grows only in the extreme north, cardamoms grow in the high land of the Knuckles region, and rice grows wherever there is sufficient water for its cultivation.

A third major element in the environment is the landform. Do you live in the hills or on the plain — or along the coast? If in the hills, do you live in a valley or on a hill slope? Is you home in the very wet hills of the Hatton or Nuwara Eliya areas — or in the drier Uva Basin, with its rolling patana lands? If on the plain, do you live in a river floodplain like that of the Kalu Ganga or the Bentota Ganga in the southwest of the island, or near a village tank in the North-Central Province? If you live on the coast, is your home on the north-

western coast, with its straight coastline, its sand bars, lagoonal flats or sand dunes (Fig.1-4) or is it somewhere on the southwestern coast, with its succession of bays and rocky headlands (Fig.1-5), where the coastline is being eroded at an increasing rate? Or do you live in the Jaffna Peninsula or on one of the islands off Jaffna, where the land is flat and underlain by limestone, where all the water is underground and is 'hard', and where the predominant tree is the palmyrah palm? Wherever you live, your lifestyle will be largely governed by the landforms that surround you — the way you get to school and the time to take to get to and from it, the way you spend your leisure hours, the clothes you wear, and so on.

The environment also determines the climate and the weather we experience daily. If you life on the southwest coast, then during the monsoon your curtains will become damp with salt water, your brassware will soon become tarnished, and your furniture will be always covered with a thin film of salty moisture. Where you live in the island influences in what part of the year you get your main rainfall, and this in turn controls when you do your main cultivation. The island is divided into two main climatic zones -- the Wet Zone and the Dry Zone. If you live in the Wet Zone you will get your water from surface streams and rivers and from underground sources through springs. If you live in the Dry Zone, however, you have to store your water in artificial reservoirs and you have to depend on wells for your domestic water supplies.

Damage to the environment

Damage to the environment, which really began when man became an industrial animal, takes place in three ways. These are:

(a) by natural processes, e.g., volcanoes, earthquakes, sandstorms, hurricanes, cyclones, tornadoes;

(b) by natural processes that are aggravated by man's activities, e.g., floods, landslides, droughts; and

(c) by man's activities alone, e.g., deforestation, mining, land degradation, soil erosion, landslides, pollution, wars.

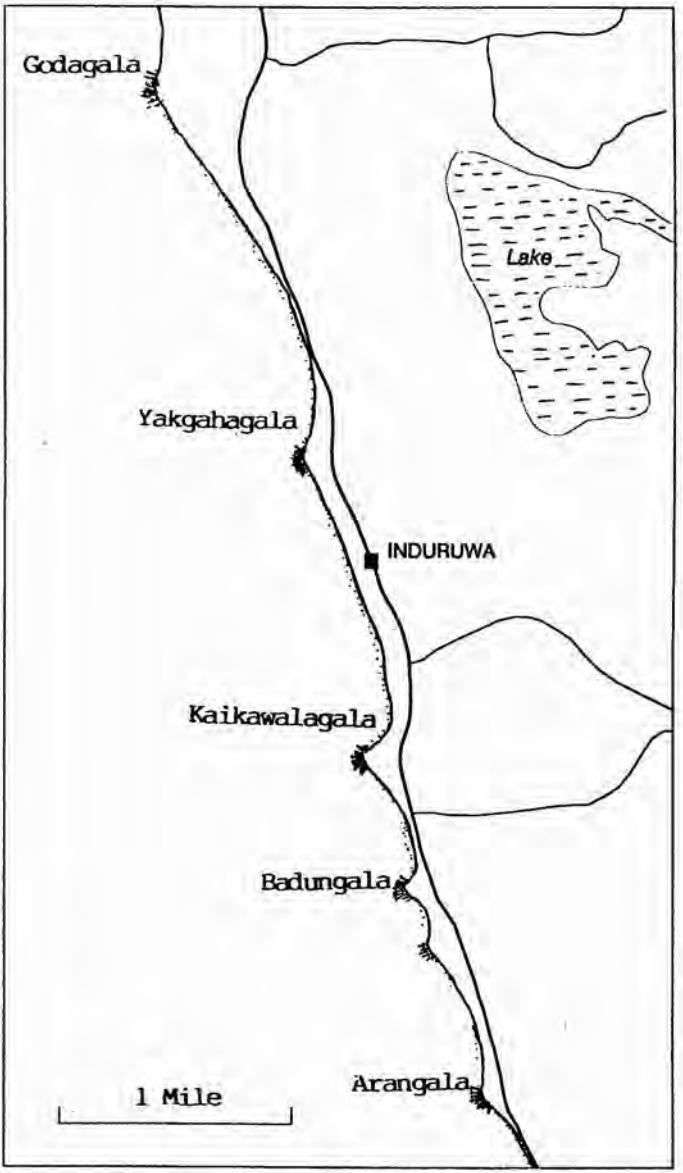

Figure 1.5: Map of typical southwestern coast, showing irregular coastline, a succession of rocky headlands and bays, and absence of stretches of sand and clay.

(a) Natural hazards are events over which man has no control, and all he can do is to try and predict when they are likely to occur and to take steps to minimize the damage. This is the reason for the present-day consciousness about 'natural hazards', the attention being paid to them through the monitoring of volcanoes and seismic activity, and the long-term monitoring and prediction of weather by meteorologists.

(b) Some natural hazards, like floods and landslides, take place because of the nature of the environment. But some of man's activities, e.g., the cultivation of very steep slopes, deforestation, which leads to the silting up of river beds and to flooding, and the disturbance of the water cycle leading to droughts, tend to bring about these hazards more frequently.

(c) It is this last group that we are most concerned about. This is because damage to the environment by man's activities has intensified to such an extent in recent decades that it is having very serious adverse effects on the environment, not only locally but globally as well. In what follows, we shall look at some of these phenomena brought about by man's actions, such as deforestation, erosion, landslides, and pollution, and end by looking at the ways in which we can halt the damage and conserve our environment for future generations.

Your own environment

Let me end this chapter by giving you a good example of a microenvironment and what is being done to it. I quote from an essay written for me by a schoolgirl as an exercise during the Schools Science Programme conducted by the Kandy School of Science at the Institute of Fundamental Studies, Kandy, in 1991.

"My Environment"

by
Ms Vidya Niyangoda
29 Kirimandala Mawatha, Nawala, Rajagiriya

"I come from Colombo and my house is situated at Nawala, which is in the suburbs of Colombo. It belongs to the coastal region and is in the Wet Zone. We usually get an equal amount of sunshine and rain every year. The highest rainfall we get is about 3500 mm each year. The temperature varies from 27° to 32°C.

"A few years ago the landscape around us was a pleasure to look at. There was lush green vegetation everywhere. About 100 metres west of my house was a big marsh land. Early in the morning and late at night you could hear frogs, and thousands of other creatures making different sounds. There were many birds there and as a kid I remember counting them each day to see how many varieties were there. The air was quite fresh and the atmosphere was so peaceful and quiet. Nature rested in tranquillity then.

"But now, due to the population explosion and upcoming industrialisation, that balance of nature has been shaken. The marshland is being filled, and the trucks which carry the soil and rock to fill it blast their horns and this causes vibration in the doors and windows. Trees, houses and all other objects that are around are covered with thick layers of dust. As the drivers of those vehicles have no civic responsibilities, they even break branches of trees near the road.

"The canal which flows into the Beira Lake goes through that marshland. Tons of garbage are dumped into this canal and the amount of waste material in it is so great that the water hardly flows at all, now. The bare stretches of land which are there as a result of land filling, have an even worse effect on the canal. The amount of silt that covers the canal is increasing because of it. The canal itself is a good breeding ground for mosquitoes and flies. Due to this, viruses like 'dengue' spread very fast.

"Nowadays when there is rainfall the land becomes water-logged. An army of mosquitoes gains life because of this. There aren't as many birds as there used to be in the good old days. The fresh air we used to have is contaminated with myriads of dust particles and fumes. The noise is sometimes really unbearable, so that you can't even hear the person who's next to you.

"Anyway, as the filling of the marshland is done with the consent of the Government, we can't do anything about it, as the rules and the punishments too are in their hands. But I always try my best to have the maximum amount of trees in my garden, and also give my best effort to try and save what is still there."

Chapter 2

COMMONSENSE ABOUT DEFORESTATION

Forests are an essential part of the environment, especially in an equatorial country like ours. They are one of our most valuable and useful natural resources as they influence climate, our river systems, provide timber and a source of energy, and are the natural habitat for the very rich plant and animal life of this country. It is said that every country needs 40 per cent of its land area to be covered in trees, but although this area of Sri Lanka may once have been forested, it is not so now. In 1966, about 44 per cent of our land surface was forested; today forests cover only about 22 per cent or less, or about half of what is needed for survival. If the destruction of the forests of the island goes on at the same rate as before, the forest cover will be reduced to about 10 per cent after another 25 years; and if deforestation is not halted, we may finally have no forests left! When that happens, our main source of energy will be gone, practically all our wild life will have disappeared, and so will all our resources of valuable timber and hundreds of species of plants and trees. That, surely, will be a sad state of affairs for this country to be in, and one which will be a disaster for our children and our children's children.

Why are forests necessary?

You may ask, "Why are forests necessary?" That is a good and relevant question, so let me try and answer it.

(a) The soil, on which we depend so much for life, derives its fertility largely from decaying vegetable matter, or humus, which is in the top few centimetres of the soil. Most of this humus is formed from the leaves that fall from the trees onto the ground, and there decay in the rain and the sun (Fig.2-1). It follows, therefore, that if we destroy the trees of the forest, we lose the leaves that fall from them, and hence, the soil loses its source of humus. When that happens, the fertility of the soil is lost and we suffer from that loss.

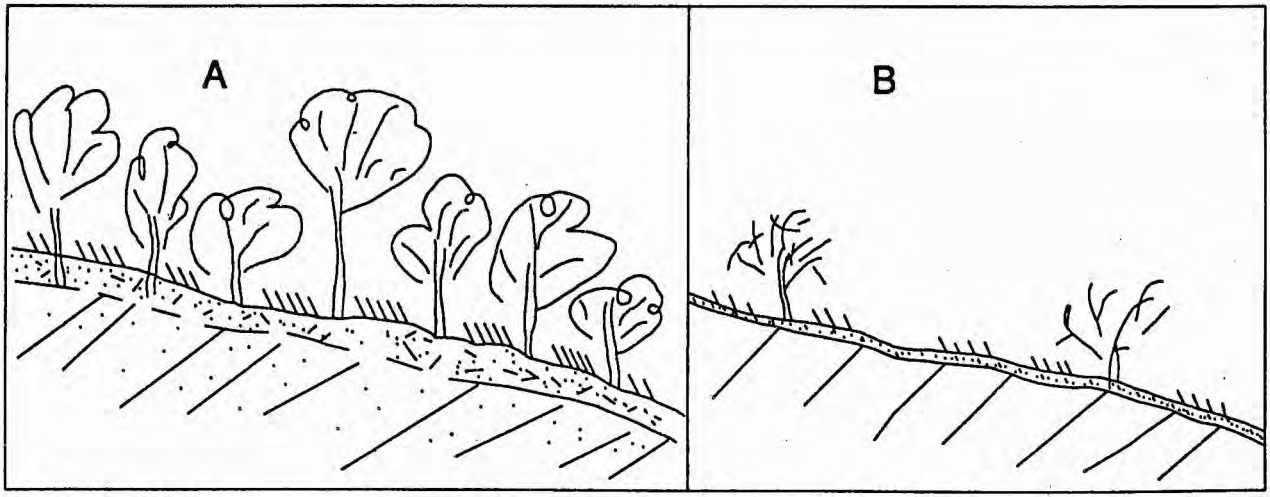

Figure 2.1: Cartoons showing loss of fertility by deforestation.
A. Forested slope with rich topsoil due to fallen leaves from trees.
B. Deforested slope with thorn shrub; topsoil removed and infertile soil remains.

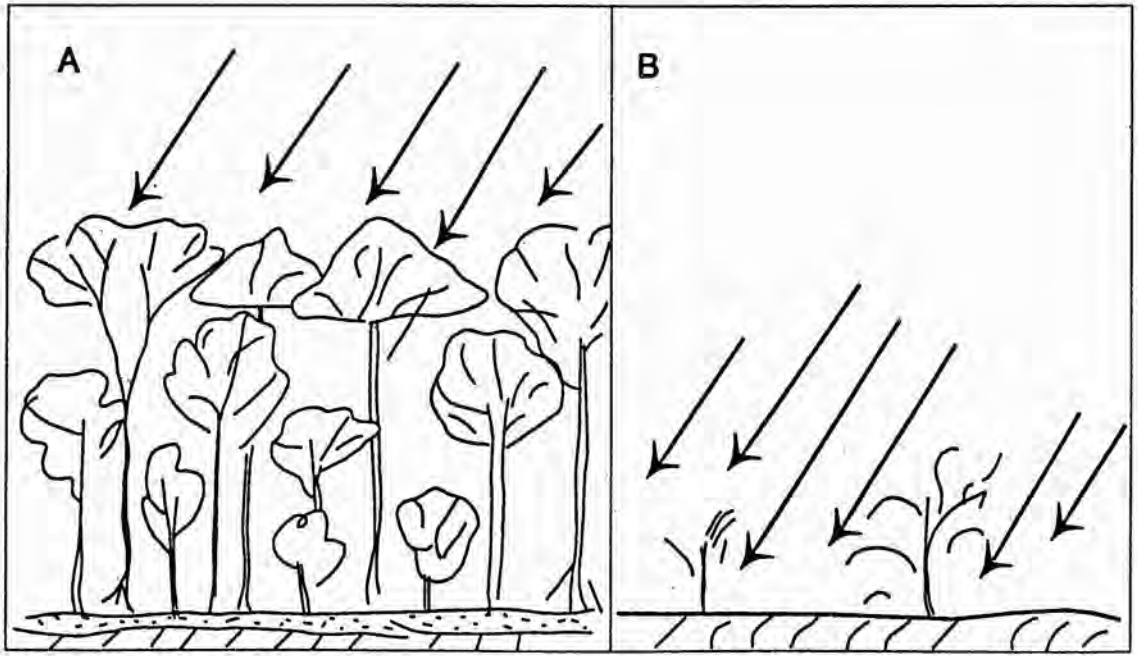

Figure 2.2: Cartoons showing soil erosion resulting from deforestation.
A. Forested land with canopy of leaves; soil protected from impact of rain drops.
B. Deforested land without canopy; soil exposed to impact of rain drops.

(b) The leaves and branches of the trees form a canopy (or roof) over the land. When there is heavy rainfall this canopy protects the ground from the effects of the rain-drops; it is these raindrops that cause *soil erosion*, especially on land that slopes, even slightly (Fig.2-2). If you cut down the trees you destroy this protective covering of the land, and you expose the ground to heavy rainfall. This results in soil erosion, which is one of the most damaging processes acting in our environment. You can see how damaging it is if you look at the streams in your neighbourhood after a heavy storm. The water of the stream, which is normally clear and sparkling, is now brown and muddy. The muddiness is the result of the mud and silt that has been carried down into the stream from the surrounding slopes by soil erosion. This material is finally laid down on the beds of rivers or of lakes and reservoirs, or is carried down to the sea. The cumulative effect of this deposition can be well seen in Fig.2-3. The effect of such silting up of rivers and lakes is serious; in the former it can cause easy flooding of the surrounding land and in the latter it reduces the water-holding capacity of the reservoir, and consequently, its hydro-electric capacity (see Fig. 4-6). This silting up of river beds is said to be one of the causes of the frequent floods in Bangladesh. Destruction of the forests on the lower slopes of the Himalayas has led to the raising of the levels of the beds of the Ganges and the Jamuna rivers in the delta region. This may also be the reason why a low-lying area like Ratnapura suffers from frequent floods.

(c) The most important source of energy in Sri Lanka is firewood. It has been estimated that about 8.5 million tons of firewood are burnt annually for domestic cooking only, apart from the amount burnt in the tea, tile and lime industries. In 1986, wood fuel produced 55 per cent of the energy needs of this country, most of which was used for cooking and heating. By 1991, this proportion had risen to 70 per cent or more. If, therefore, we destroy the forests around us, from which we obtain our firewood, we are destroying our main source of energy. In other words, we are only harming ourselves by the careless and

thoughtless destruction of our forests. We should mention here a recent report that, in spite of restrictions imposed by the Forest Department, deforestation is still going on in the Knuckles region to provide fuel for the 70 or so cardamom kilns that are in the Knuckles forests at heights that are prohibited by the Knuckles Conservation Plan!

(d) Rainfall is extremely important for us in so many ways. It enables us to grow our crops, with or without irrigation; it causes our rivers and streams to flow; and it recharges the water in the ground, so giving us the water in our wells. Unfortunately, we do not always realize these facts. Rainfall depends solely on the amount of moisture in the air, and part of this comes from transpiration through the pores (stromata) of the leaves of trees, bushes and grass, and part through evaporation from the surfaces of the leaves. Destroy the leaves and you destroy that particular source of moisture; and, therefore, you lessen the amount of cloud, and ultimately, the amount of rain that falls in your environment and on your land (Fig.2-4). As a result, cultivation of crops is affected, the amount of water flowing in springs, waterfalls, streams and rivers is reduced, and the wells are deprived of the recharge necessary for giving us water for our domestic uses. For example, the waterfalls of Lovers' Leap and Hospital Falls are said to be dwindling because of the destruction of the forests in the Pidurutalagala range, and many more examples can surely be found.

How are our forests being destroyed?

So far we have attempted to answer the question "Why are forests necessary?" The natural sequel to that question is "How are our forests being destroyed?" Here are some answers to that question.

(a) The population of Sri Lanka is growing fast and increasing numbers of people means that more land is needed for people to live on and to cultivate, in order to produce more food to feed more mouths! So forests are cut down, trees are burned and

land cleared for human beings to occupy; and more firewood is needed for cooking more food to feed more mouths and to warm more people living in more houses. And so this vicious circle goes on!

(b) Our forests contain valuable timber trees like teak, halmilla, jak, satin, wanasapu, and pihibiya, all of which are needed for furniture and buildings for the increasing population of the island. Some forests, like that at Dolukanda, also have rare, medicinal timber species like kuda, pathmaya and sanda raja. A certain amount of timber extraction is allowed on licence, but an enormous amount of illicit felling of trees goes on all the time. You have only to read the daily newspapers to be aware of this (See Fig. 2-5). There are almost daily reports of arrests for illicit felling and/or illicit transport of timber in the press, and such reports must surely represent only a fraction of the deforestation that takes place in this manner.

c) One of our commonest agricultural practices is chena or shifting cultivation. In this, a patch of forest is burned down and cleared of trees, the land is then cultivated for a few seasons, and is then abandoned for several years. The sad thing about this form of cultivation is that the fine trees like those that grew there before do not grow again on the abandoned land. Instead, secondary shrubs, bushes and thorny trees take possession of the abandoned land because the soil has lost its fertility. This secondary vegetation does not have the good effects on the land that earlier forest had, and so the community loses by this agricultural practice. It has been found that chena land, once cultivated, does regain its soil fertility if left alone for about ten years, but this hardly ever happens.

(d) Though not strictly 'forest', stands of coconut, rubber, margosa and cadju trees are cut down in parts of the island for use as fuel in tea factories and in brick-and-tile and lime-burning kilns. Cutting down of some of these species has recently been strictly prohibited, but it remains to be seen if this prohibition can be enforced.

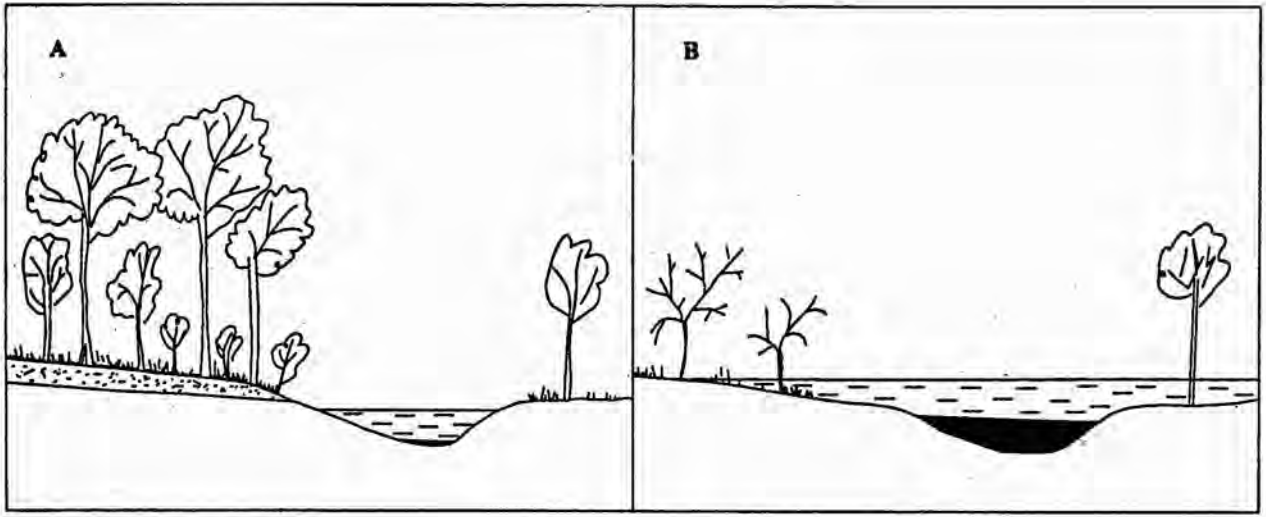

Figure 2.3: Cartoons showing flooding resulting from deforestation.

A. Forested slope has minimal soil erosion; reservoir bed free of silt.

B. Deforested slope has maximum soil erosion; silting up (i.e., raising) of reservoir or lake bed leads to flooding of banks.

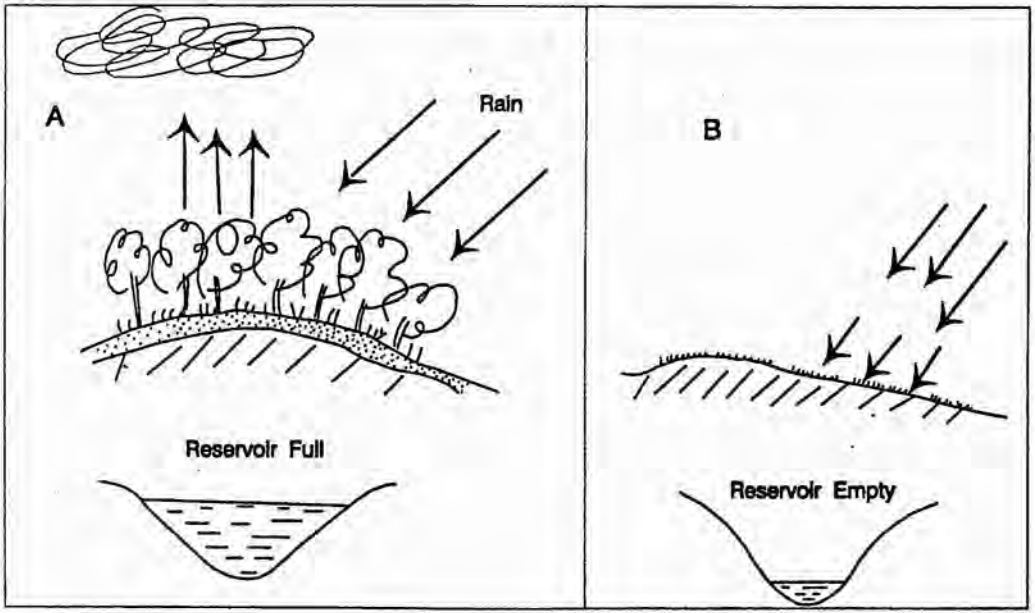

Figure 2.4: Cartoons showing drought conditions resulting from deforestation.

A. Evaporation and transpiration (i.e., evapotranspiration) from leaves of trees encourages cloud formation and rain. Reservoirs, tanks and lakes are full.

B. Deforestation leads to absence of evapotranspiration; hence no clouds form and there is little rainfall. Reservoirs, tanks and lakes are dry.

Figure 2.5: Montage of newspaper headlines on deforestation.

How can destruction of our forests be prevented?

This is the third and last question we must ask ourselves. Some things are being done, as we can see, such as the re-afforestation with pinus in many parts of the island. Teak is another species that has been extensively planted, especially in the drier parts of the country. But what can you, as an individual or a group, do to prevent this continuous deforestation that is taking place? Here are some suggestions that you might follow:

i) plant useful trees, like kohomba, in your own environment;

ii) discourage farmers from practising chena cultivation; or if they have to, show them the necessity of leaving the abandoned chena land uncultivated for about 10 years after abandoning it;

iii) form vigilante groups that will report to the authorities if illicit felling and transport of trees is going on;

iv) try and stop friends and acquaintances, generally teenagers and young people, from setting fire to dry grass, just for the fun of seeing it burn, by explaining the harmful effects of such burning, e.g., loss of humus, reduction of moisture evaporation, destruction of animal fodder and so on. This is a very bad practice that is common in the Hill Country, and the only way to stop it is by education and by talking to friends, parents, elders and others about the value of trees to us. Make them see that by destroying our forests we are only harming ourselves in the long run. Try and make them aware of the environment in which they and you live, and show them the essential part that trees play in that environment. A usful practice would be to hold an Open Day in your school at which you show the people in your community, by demonstration, posters, hand outs, photographs and paintings, the immense value of trees to us as human beings.

Many individuals and organisations are aware of the harmful effects of deforestation on the environment, and the government has taken a lead in remedying this. The Forest Department, for example, has replanted thousands of hectares with trees, mainly with the quick-growing pinus, which has some short-term benefits. Now the move is towards replacing these pinus trees with other indigenous species that have long-term benefits. We also have tree-planting days, and trees are often planted to mark special occasions. The government has also declared a large number of areas as 'reserves', 'parks' and 'sanctuaries' in order to preserve some of our important forest lands. And we have a Central Environmental Authority (CEA) as well as private organisations that keep watchful eyes on our forests, and speak out, when necessary. This is one side of the picture.

On the other side of the picture are the individuals in our society, including politicians, policemen and other public servants, who are so selfish and anti-social that they keep on destroying our forests, even trees in our forest reservations, for their benefit, using their official positions to do so. These are people who enrich themselves at the expense of the rest of the population of the island. Besides illicit felling and transport of trees, such people also engage in illicit cultivation (e.g., cardamom), and in cultivation of drugs and in illicit gemming (e.g., in Uda Walawe and Yala National Parks), to quote only a few examples. Their behaviour is a sad commentary on the degree to which our society has become a materialistic one, in spite of its deep religious foundations. It also reflects the absence of the cultivation of a civic sense among our children in our educational system.

Chapter 3

COMMONSENSE ABOUT WATER SUPPLIES

The Water Cycle

Water, like air, is essential for life, and without it we would soon die. In order to survive on this earth, what we need is not just water but clean water; dirty water, if drunk, brings disease and ultimately, death. We should, therefore, know as much as we can about where our water comes from, how it is stored, and how we extract it. It has been said that 60 per cent of our rural people suffer from bowel diseases like dysentery, diarrhoea, typhoid and hepatitis through drinking dirty water from rivers, reservoirs and contaminated wells. That is why we need to make sure that our water supplies are clean and uncontaminated. And we also need to know how best to conserve the water supplies that we have so that we do not exhaust such supplies and let them run dry. Before we do that, however, we need to know where our water comes from and where it goes to. In other words, we need to know something about the 'Water Cycle'.

We can consider the water cycle as beginning from the sky, in the form of condensation of moisture in the clouds and atmosphere as rain, snow and dew. When rain falls on the earth's surface, four things happen to it, namely, run-off, seepage, transpiration and evaporation (Fig.3-1).

a) **Run-off.** A large part of the rain falling on the earth just flows down as wash, gullies, rivulets and streamlets into streams and rivers. It is this run-off that causes soil erosion, which we have mentioned earlier, and gully erosion on bare land surfaces. This run-off eventually reaches the major rivers and is then carried out to sea or is stored in lakes and reservoirs. This is what we call 'surface water'.

b) **Evaporation.** A part of the surface water that lies in the oceans, seas and large lakes, when heated by the sun, returns to the atmosphere by evaporation, and so completes the cycle.

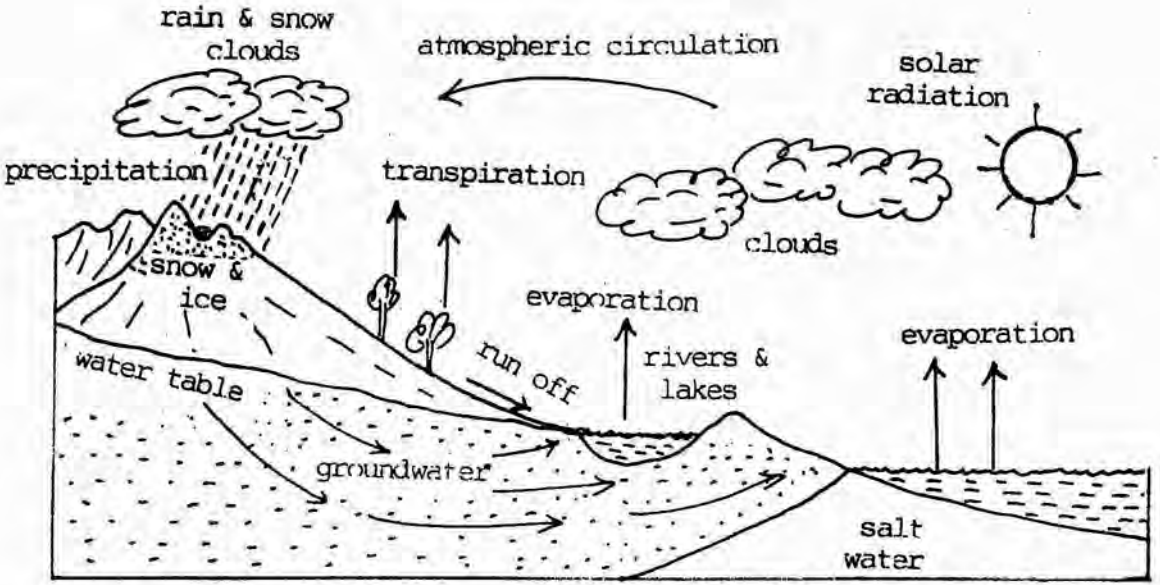

Figure 3.1: The Water Cycle.

c) **Transpiration.** Another part is taken up by plants and then returns to the atmosphere through plant leaves by transpiration. This also is part of the cycle.

d) **Seepage.** However, a part of the water that falls on the surface sinks into the soil and moves downwards as seepage. This becomes what we call 'groundwater', and it is probably the most important source of good water for human consumption. We shall spend more time on groundwater later, but let us first look at surface water a little more.

Surface water

As we mentioned earlier, part of the water that falls on the ground runs downwards along the slope into rivers and streams and finally reaches the ocean. All the streams that join together to form a major river are said to be a 'river system', and they all lie within a 'river basin' or a 'catchment'. Adjoining river basins are separated from each other by 'watersheds (Fig.3-2), and streams on either side of a watershed flow in opposite directions. Watersheds are generally forested hill or mountain ranges, and the presence of these forests on the watersheds generally induces rain to fall on them, so feeding the streams and rivers. Therefore, if we destroy these forests by burning or cutting down the trees, we are reducing the chances of rain falling on the watershed areas and, consequently, reducing the sources of our surface water.

Each little valley will have people living in it in villages and small, scattered settlements. For many people, therefore, the stream or river may be their only source of water — for bathing, for washing clothes, for toilet purposes, for cooking, and even for drinking. At their beginnings, the surface water in the streams will be relatively pure. But as one goes downstream, the surface water becomes more and more polluted as more and more people use the stream for domestic purposes, and perhaps even for washing motor vehicles and cattle (Fig.3-2).

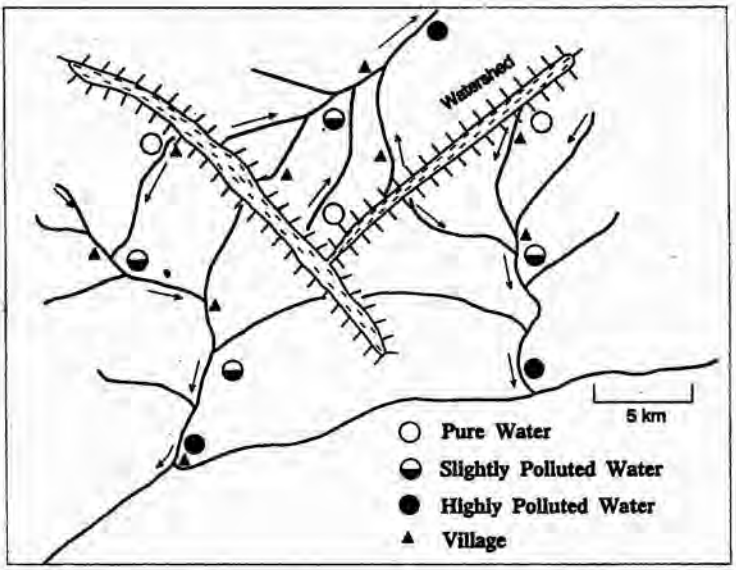

Figure 3.2: Pollution of streams and rivers in river basins. Note how the river water becomes increasingly polluted from source to mouth.

All along the stream or river, therefore, people and animals are dirtying the water in various ways. We call this 'contamination', and most surface waters are highly contaminated. The use of such waters for human consumption is extremely dangerous. They can only be used for drinking if the water is boiled and, if possible, filtered. This is an important and essential step to be taken for all surface water if it is to be used for human consumption.

In large towns like Kandy, water is pumped out from rivers like the Mahaweli Ganga, subjected to a purification process, and then supplied to the people through the water mains. Although such water has been 'purified', generally by filtration and chlorination, it is always safer to boil and strain water before drinking it.

Other sources of contamination are the discharge of chemical and other toxic wastes from factories, e.g., rubber factories and saw mills, and waste from sewage systems of hotels, hospitals and homes.

One of the worst examples of this is the mid-city canal in Kandy, which is one of the most highly polluted waterways in Sri Lanka. Studies have shown that the canal contains high concentrations of the metals lead, cadmium, vanadium and iron, which seep through the sides of the canal and contaminate the numerous wells that exist close to the canal. This is a danger to the health of the people using these wells.

What needs to be stressed, therefore, is that most surface waters are polluted, except near the source of the stream or river. Mountain streams in forests and streams in uninhabited areas are, therefore, relatively pure, and the water in them may be consumed without fear. But the further down you are in the valley, the more highly polluted the water will be, and the more dangerous it is to use this water for domestic purposes, and especially for drinking.

Groundwater

The Water-table

Water that sinks into the ground and becomes groundwater behaves in certain ways that we should know about. Water will seep downwards until it reaches an impervious layer, through which it cannot pass because of lack of spaces in the material of the layer. This layer may be of clay in sedimentary rocks or solid rock in crystalline rocks. Once this happens, the water will accumulate above this layer and will so form a hidden reservoir of water. The top of this reservoir is known as the water-table, and its form follows the shape of the ground surface, more or less. The flow of water is down the top of the water-table, and two things result from this. Firstly, where the water-table intersects a valley, the water will flow into the stream running in the valley; where it intersects the ground surface, a spring will flow (Fig.3-1). Secondly, the level of the water-table rises or falls according to the climate (Fig.3-3). When it rains the water-table will rise, and when there is a drought the water-table will fall. This explains why the water level in a shallow dug well rises during the rainy season and falls during the dry season; if there is little or no rain during the rainy season, the well will run dry.

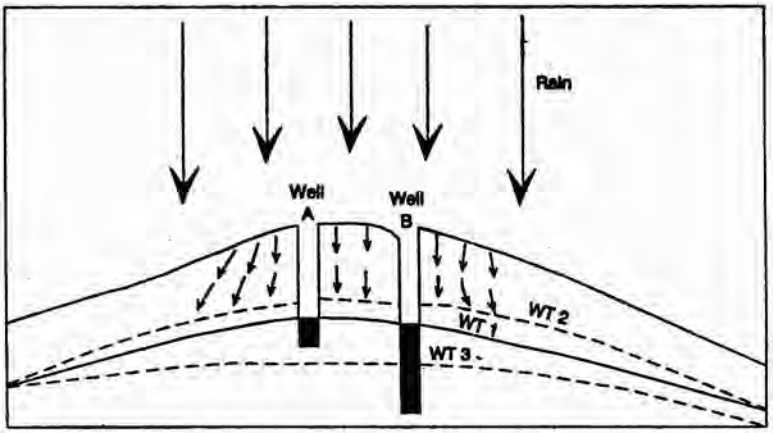

Figure 3.3: Fluctuations of the water-table. WT1, normal water-table; WT2, Water-table in wet season; WT3, water-table in Dry Season, well A runs dry.

Coastal Groundwater

Special groundwater conditions exist in sandy coastal areas. In these areas, sea water lies at the base of the sand and fresh groundwater lies on it as a freshwater lens (Fig.3-4A). Shallow dug wells in these sandy coastal areas generally tap the freshwater from this lens, and as long as it rains regularly, such water is perfectly suitable for domestic use. However, this source of groundwater must be used with care. If too much water is extracted, then intrusion of brackish water from below will take place and the water in the well will become salty and unusable (Fig.3-4B). Furthermore,if too many wells are dug, then over-extraction will take place and the water-table will be lowered to such an extent that some wells will run dry.

In the city of Bangkok in Thailand, which has a population of several million, over-extraction of groundwater has led to compaction of the sediments on which the city is built, and the consequent sinking of the city. Another danger of over-extraction is from salt-water intrusion into coastal lands, which can lower rice harvests considerably. This has happened in the Philippines, all along the coastline of Manila Bay. Here, over-extraction of fresh groundwater

has resulted in salt-water intrusion along the foreshore lands, where once there were deep pockets of fresh water. Elsewhere, the destruction of the protective mangrove belts and of bands of coral have resulted in the rush of sea water inland and the destruction of hundreds of hectares of fertile agricultural land. This has happened along some parts of the southwestern coast of Sri Lanka, where large extents of rice fields have been ruined by salt-water intrusion.

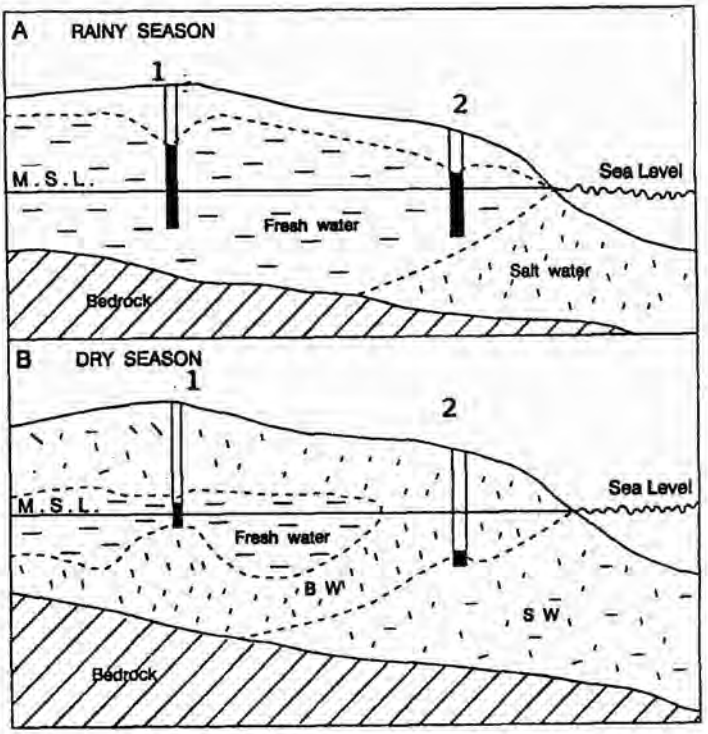

Figure 3.4: Groundwater conditions in coastal sands. 1, freshwater well; 2, brackish-water well; BW, brackish-water zone; SW, salt-water zone.

A. Conditions during the Wet Season, freshwater in both wells.

B. Conditions in Dry Season; well No. 1 has freshwater, well No. 2 has brackish water and further extraction will bring in salt water.

Groundwater in Limestone Country

The whole of the Jaffna Peninsula and surrounding islands, as well as the northern and northwestern coastal belt of the mainland, are underlain by a limestone formation, known as the Vanathivillu Limestone. This limestone is extremely soluble, as a result of which it is full of solution channels, caves, caverns and holes of one sort or another on the surface and below it (Fig.3-5). Hence, all the rain that falls on the surface goes underground through fissures and holes and forms an underground drainage system. There are no streams or rivers on the surface of this limestone country. Instead, there are large reserves of groundwater below the surface, up to depths of 212 metres or more. Some of these deep reserves of water are covered by later clay deposits, especially along the north-western coastal belt, and artesian conditions are preserved in them. Artesian tube wells in these deep basins of water yield 200 to 600 gallons per minute; elsewhere in the limestone country the yields are 200 gallons per minute or less.

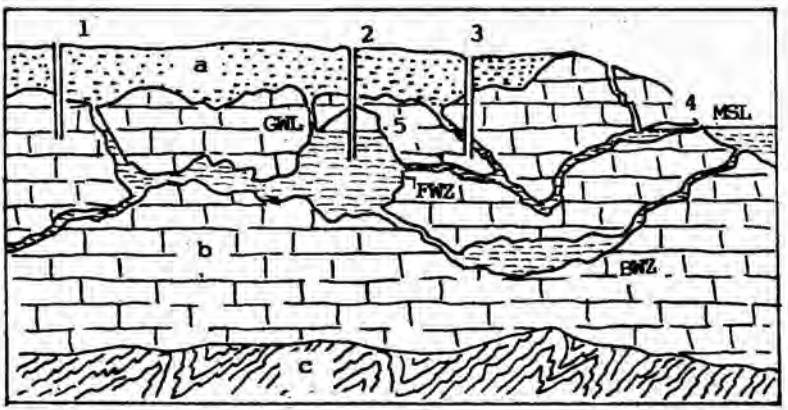

Figure 3.5: **Groundwater conditions in the Jaffna Peninsula (after C.H.L. Sirimanne, 1952). (a) Red Beds, (b) Limestone, (c) granitic gneiss; MSL, mean sea level; GWL, groundwater level; FWZ, zone of freshwater saturation; BWZ, probable zone of brackish water; 1, dry well; 2, well of Puttur type; 3, ordinary successful well; 4, spring of Keerimalai type; 5, solution cavern.**

In the Jaffna Peninsula, the water-table is 0.3 to 0.7 metres above sea level, and the fresh-water zone may be up to 30 metres thick. In all limestone areas, the fresh-water zone rests on a zone of brackish water, which itself rests on sea water (Fig. 3-5). As in the sandy, coastal tracts, therefore, over-extraction of fresh water will lead to the intrusion of salt water into the wells.

Normal groundwater yields in the Jaffna Peninsula are high (up to 100 000 gallons per day) and the water-table recovers its former level very quickly after extraction. There are two other interesting phenomena in the Jaffna Peninsula. One of these is the so-called 'bottomless well' at Puttur, which never seems to run dry. This is because the well is in the mouth of a large, underground cavern in the limestone, the floor of which is 44 metres below the surface. The other phenomenon is the presence of several fresh-water springs along the coast of the Peninsula. The best known of these is the popular bathing resort of Keerimalai, the spring at this point being the outlet of a solution channel. Because groundwater in limestone country contains dissolved carbonates of calcium and magnesium, it is said to be 'hard', meaning that soap does not lather in it. When this water is boiled in the same vessel for a long time, a deposit or crust of calcium carbonate forms inside the vessel, which is sometimes difficult to remove.

There are also limestones in the Hill Country, but these are relatively narrow bands of crystalline rock known as 'marble'. Good examples can be seen at Digane, near Kandy, and at Matale. These marbles, which are made up of crystals of calcite and dolomite (magnesium-calcium carbonate), do not dissolve easily, and although there are solution caves in them, e.g., Nitre Cave in the Knuckles region, the caves are not so extensive as the solution features of the limestone in Jaffna. Water that passes through these marbles is also hard. Place names beginning with the Sinhala word kiul, e.g., Kiulewadiya, indicate that there is hard water in that locality.

Groundwater in the Dry Zone

There is no scarcity of water in the Central Hill Country of Sri Lanka as it receives a heavy annual rainfall and there are many springs from which water flows all the year round, except in severe drought years. Conditions are quite different in the lowlands of the north and east of the island, as these areas are in the Dry Zone, where the annual rainfall is slight. Until recently, when shallow dug wells in the Dry Zone ran dry, the people suffered great hardships because of the lack of water. In recent years, however, a hitherto unsuspected source of water has been found. The crystalline rocks underlying those areas were previously thought to be without water, and only the weathered overburden in the Dry Zone was tapped for water. It has now been found, however, that there are vast quantities of groundwater stored in the fractures in these rocks, and this water is now being extracted by sinking 'tube wells' going down to 60-70 metres below the surface (Fig.3-6).

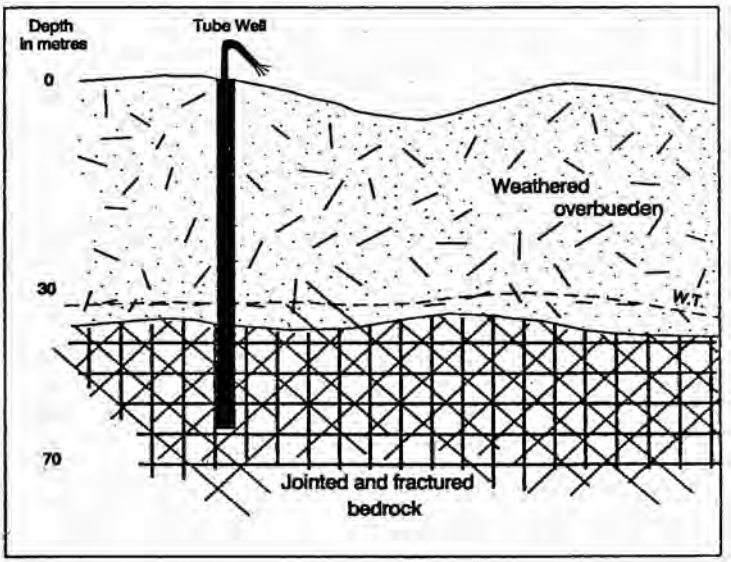

Figure 3.6: **Tube well extracting water from jointed and fractured crystalline basement rocks.**

When a tube well is located where two or more fractures intersect each other, then the tube well is able to tap a large reservoir of water, as these fractures run in several distances and are often interconnected. This water, because it comes from deep in the ground, is generally free from contamination and is relatively safe for drinking. The sinking of hundreds of tube wells in some parts of the Dry Zone areas of the island has been a great blessing to the rural peoples of those parts.

Groundwater Pollution

Groundwater is also subject to contamination in a number of ways. For instance, extensive use of chemical fertilizers leads to nitrates being carried down by seepage into the groundwater. Another common source of pollution is the siting of unlined pit-latrines above wells on sloping ground (Fig.3-7A).

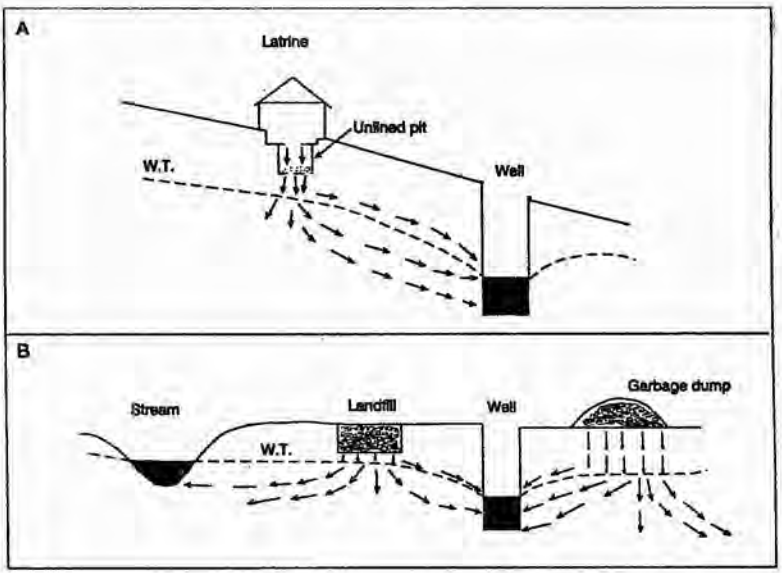

Figure 3.7: Two situations of groundwater pollution.

A. Pollution of down-slope well by faecal matter from unlined pit latrine above it.

B. Pollution of stream and well by leachates from garbage dump and landfill.

Human excreta falls on the floor of the latrine, and if the floor and walls are not sealed, the excreta can sink and seep through the ground, reach the water-table, and flow along down the slope. If there is a well on the slope below the latrine, then the water in the well will become polluted. In order to prevent this happening, latrines should always be built below wells in sloping ground, and not above them; and the floors and walls of sewage pits should always be lined with cement.

Another source of groundwater (and surface water) pollution are garbage dumps and landfill sites (Fig.3-7B). Garbage dumps are especially common on the outskirts of many of our towns and of the city of Colombo, as we still have not solved the problem of how to dispose of such garbage. Consequently, when rain falls on these large mounds of garbage, the water takes up a variety of ions from the waste and carries these down to the water-table as 'leachates'. Once in the water-table, the leachates follow the flow paths of the groundwater, polluting the wells and streams in the process.

Our water supplies, whether surface water or groundwater, depend ultimately on our climate, and specifically on the rainfall we receive through the year. Rainfall comes to us with both monsoons, namely, the South-west monsoon and the North-east monsoon, as well as through the intermonsoonal storms and showers. The central hills of the island form effective barriers to the rain-bearing winds and cause the rain to fall on the hill and mountain slopes that face these winds. One factor that induces the rain to fall is the presence of forests. If we cut down the forests growing on these hill ranges, then we reduce the chance of rain falling on those slopes. Therefore, it is essential that we conserve our forests in the catchment areas of the island.

The more rain that falls , the more our groundwater reserves are replenished. You can see this in any spring near where you live. The ordinary flow in the spring or *pila* may be small, but after a heavy shower you will see the flow increase considerably. Fluctuations in the flow of a spring are noticeable, and this, in turn, is a reflection of the amount of groundwater that is available.

Pollution of water supplies, both from the surface and from underground, is a common feature in Sri Lanka, and this water pollution is one of the worst aspects of environmental pollution in the island. It is also a major cause of sickness and disease among both children and adults.

In conclusion, it can be said that in view of Sri Lanka's rapidly increasing population, every single person in the island must be concerned with two things. These are:

i) making sure that we conserve our sources of life-giving water by preserving our forests; and

ii) making sure that our water supplies are pure, by preventing contamination wherever we see that our water is being polluted.

Chapter 4

COMMONSENSE ABOUT EROSION

The nature of erosion

Erosion is the wearing down of the land surface by the so-called 'agents ' of erosion, which are ice, wind, running water, waves, rain and gravity. It is a natural process that has gone on all the time, throughout most of the earth's history, and is still going on.

By this process, hills are worn down to plains, valleys are carved out of mountains, and coastlines are made to recede. By this same process we have inselbergs (or erosion remnants) like Sigiriya and Yapahuwa in Sri Lanka, which are isolated rock 'islands' that have been left standing while the land around has been reduced to its present level (Fig.4-1). Similarly, we have several rocky, offshore islands, as at Beruwela and at places along the south-west coast, which were once part of the mainland, but are now separated from it by erosion of the intervening land.

Each agent operates in different environments. Ice, for example, is an agent in high mountains and in the polar regions. It acts by plucking out bits of rock and scraping away all loose material in its path as it moves down valleys as glaciers. Wind, on the other hand, operates in desert regions, where it acts as a blasting and scouring force when it carries sand grains along with it. Waves and running water have a scouring action, and gravity produces landslides and rock falls.

Although these are natural forces, it often happens that by our behaviour we either hasten these processes or make them worse. We shall, in this chapter, look at some special cases where human behaviour hastens erosion, as in coastal erosion and soil erosion.

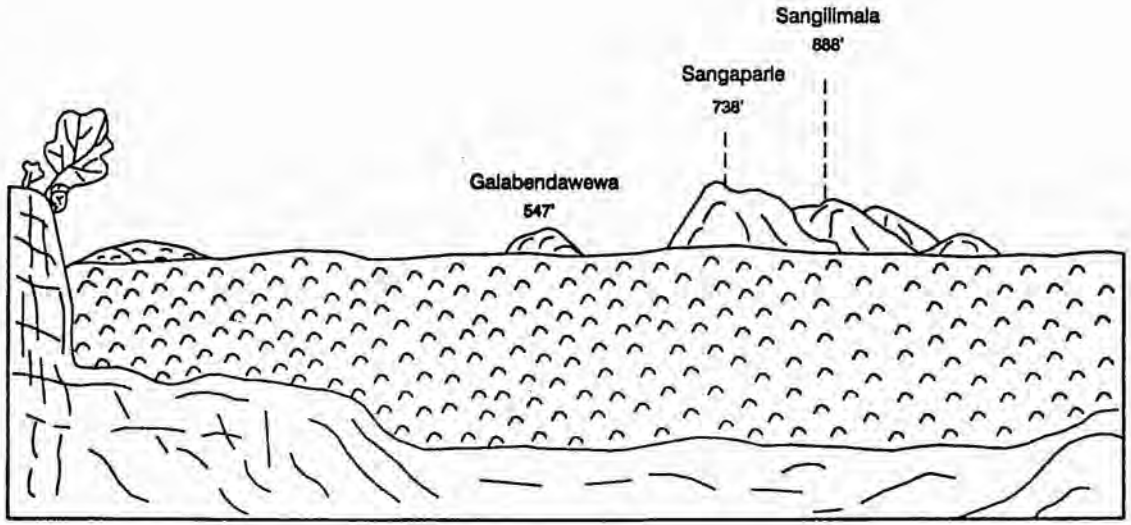

Figure 4.1: Panoramic sketch of typical Dry Zone low country west of Galgamuwa, showing erosion remnants (inselberge) standing out above the plain.

Coastal erosion

Coastal erosion along the south-western coastline of Sri Lanka has, in recent years, become a serious problem, especially during the months of the southwest monsoon, namely, mid-May to mid-August. At this time the seas are rough, the south-westerly winds are strong, and they blow the waves on to the shore where they break with great force and destroy the land (Figs.4-2, 4-3). These storm waves also wash sand on to the roads, where these run close to the shoreline.

Figure 4.2: Coastal erosion along the south-west coast showing damage to houses and to land (Picture by ANCL).

Coastal erosion takes place at many points along the south-western and southern coasts of the island, but it is especially severe at Negombo, Mutwal, Beruwela, Ambalangoda, Paiyagala, Seenigama, Akurala, Beliwatta and Weligama. The newspapers often carry pictures showing this erosion, which results in the destruction of beaches, houses, coconut trees, the main coastal road, and even the railway line that runs by the shoreline.

In order to understand coastal erosion we need to understand how waves 'break'. The movement of ocean waves is through the circular motion of wave particles. As the waves reach the shore, the sea bed shelves towards the shore, i.e., the sea gets shallower, and

the bottom of the wave is retarded by friction. When this happens, wave particle motion becomes ellipsoid, the upper part of the wave moves more quickly than the lower part, it then overrides the lower part, and the wave 'breaks'. In a gradually shelving sea floor, the waves break away from the shoreline, but where the sea floor steepens rapidly, the waves break on the shoreline itself.

Figure 4.3: Coastal erosion along the south-west coast showing damage to the main railway line to Galle (Picture by ANCL).

Although coastal erosion is a natural process, it has become much worse in recent years by man's activities, one of the worst being the removal of coral from the offshore coral reefs. Offshore coral reefs form a natural barrier to the land by causing storm waves to break on them rather than on the shore; in other words, they protect the land from the fierce action of the waves on the land (Fig.4-4A). In this way, the full force of the waves is expended on the reefs, so that when the waves do reach the shore they have much less force and do little damage. Without these reefs, the coastline has to bear the full force of the storm waves, and this brings about destruction of the land, houses, trees, and even of roads and railways (Fig.4-4B).

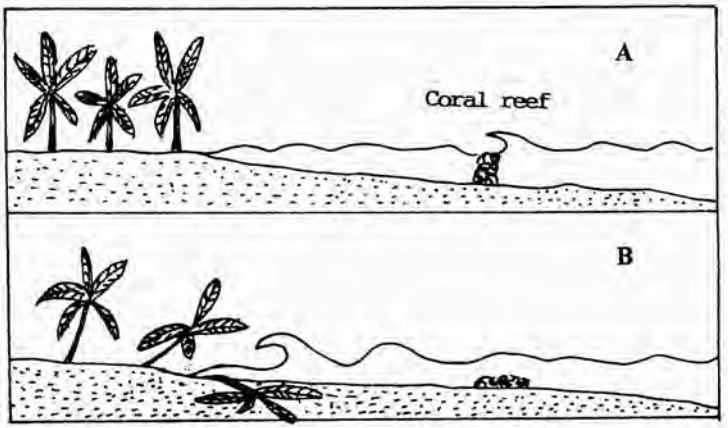

Figure 4.4: Cartoon showing the protective action of offshore coral reefs on the coast.

A. Storm waves break on the coral reef, thus saving the shoreline from the force of the waves.

B. Removal of coral reef causes storm waves to break on the shoreline, thus destroying trees, land and houses.

As recently as June 1997, one of the worst affected areas during the south-west monsoon was Seenigama, where the main road to the south became impassable because of the sea sand that was washed onto it. Buses were stuck in the sand and the traffic was held up for long periods until the sand was cleared away. So far, 600 metres of the coastline at Seenigama have been affected by sea erosion. A proposed solution is to build an embankment, 400 metres long, along the coastline here, but one wonders why the authorities have had to wait until the land was destroyed before proposing this solution. Surely it is time for the authorities to survey the entire southwestern coastline, identify stretches that are suffering erosion at present and likely to suffer erosion in the future, and take the necessary steps to prevent such erosion, at whatever the cost! Something like the 'Landslide Hazard Mapping Programme' that is being carried out by the National Building Research Organisation (NBRO) is needed here. Some appropriate authority like the NBRO itself or the Roads Development Authority (RDA) should be entrusted with the task of carrying out such a 'Coast Eerosion Hazard Mapping Programme'.

This erosion of the land at Seenigama, as in many other places along this coastline, has been attributed to the illegal removal of coral from the offshore reef, but nothing has been done to put a stop to this practice. The following headlines in the press are a stark reminder to us of what is happening to our land because of the selfish behaviour of just a few people:

"HEAVY SEA EROSION IN SEENIGAMA"

"NATURE TAKES ITS TOLL IN SEENIGAMA"

"SEA EROSION TAKES ITS TOLL IN CHILAW"

"SEA EROSION TAKES ITS TOLL UNMERCIFULLY"
"The tragic experience of sea swallowing land"

It was reported in the Daily News of 21.7.97 that a Police Post is to be established at Seenigama in order to put a stop to the dangerous practice of removing coral from the offshore reefs illicitly. That is a timely step, but the coral removers will probably move to some other point along the coast which is unpoliced and carry on their nefarious practices there.

It has been estimated that between 15 000 and 20 000 persons used to be engaged in offshore and onshore coral mining, the mined coral being the raw material for the lime-burning industry, which was a major industry along the southwest coast. Offshore coral mining has now been prohibited, but there can be little doubt that illicit mining of the offshore coral reefs still goes on. Some coral is now being transported 40-50 kilometres inland, and several lime kilns burning coral have come up by the side of the main Colombo-Kandy road near Ambepussa, half-way between Colombo and Kandy. Coral is also extracted from the reefs for sale to tourists as souvenirs.

The mining, burning or possession of coral or its transport is prohibited by the Coast Conservation Acts of 1981 and 1988. Lime kilns along the coastal strip are also banned. The banning of coral mining immediately led to an increase in its price, and the annual output from the Seenigamá area increased from 7000 kg in 1981 to

24 000 kg in 1988. In order to rehabilitate the people affected by the banning of coral mining, they were given three acres of land in the Polonnaruwa area, but they gave up the land and returned to their native places. Subsequently, they were each given an acre of rubber and coconut land in Ratgama, but they cut the trees, sold them to the lime kilns for fuel, and returned to their original places again (Daily News, 24-7-97).

Sandstone reefs (or 'beachrock') also provide a natural protection to the shoreline (Fig.4-5). These reefs occur on the shoreline itself, however, and where present, they bear the full force of the breaking storm waves. This can be seen at many points along the western coast of the island, but especially at Uswetikeyawa and Chilaw, and at points between these two places.

Figure 4.5: Beachrock on the shoreline opposite Chilaw Rest House.

Coastal erosion is brought about by other factors as well. For example, mining of sea sand from the beach results in an imbalance between sand supply and sand removal, thus causing damage to the shorelines. Again, vegetation that grows along the coast helps to bind the sand together and so prevents it from being washed away.

Removal of this vegetation exposes the sand to the force of the waves, Finally, the building of protruding structures like groynes and jetties may also cause increased erosion on the sides of such structures.

Soil erosion

Soil erosion takes place on sloping ground and is especially bad during heavy rainfalls. When these take place, the raindrops hit the ground with some force and disturb the soil, throwing some of it up and out. Heavy rainfall causes small rivulets of water to flow down the slope, carrying soil with them; these coalesce into gullies and finally into streams, and these carry away the silt and sand that once formed the soil. This is known as 'gully erosion'. When the heavy rain continues for a long time, the gullies may merge into each other and the water may move down the slope as a mass of water. This is then known as 'sheet erosion'. We have already seen the effects of soil erosion, such as the loss of fertility of the soil and the silting up of the beds of rivers and lakes and reservoirs, as at Norton Bridge after 30 years (Fig.4-6).

Figure 4.6: Accumulation of silt on the bed of Norton Bridge Reservoir after 30 years, the result of soil erosion of the surrounding slopes.

Soil erosion is a natural process. but it is greatly intensified by man's activities, such as the cutting down of forests and the burning of grasslands. Forests protect the soil by forming a cover or canopy over it and stopping the force of the raindrops from reaching the soil (see Fig.2-2). Grasses provide a binding agent to the soil, thus preventing it from being easily washed away. Remove both trees and grass and the soil becomes easily erodable.

Typical land-use on the steep hill slopes of the Hill Country are the growing of tea, tobacco, vegetables and subsidiary food crops, as can be seen in many parts of the Hill Country, e.g., Nuwara Eliya. In this system, the soil is impoverished and loses its fertility, and the soil is easily washed away unless effective preventive measures are adopted.

In the early years of the planting of coffee and tea, when large-scale deforestation took place, soil erosion was a major hazard and thousands of tons of topsoil were lost over the years. The remedy for this was contour terracing, and this became the usual practice on all sloping land. In this method, trenches, terraces and retaining walls were built along the contours. However, this method is expensive, is time-consuming, and requires a large labour force; constant maintenance is also necessary. This method of soil conservation, in spite of its high cost and other disadvantages, is still practised in many parts of the Hill Country, and can be seen on many tea estates.

Soil Conservation

In recent years, a new soil-conservation method known as Sloping Agricultural Land Technology (or SALT) has been worked out in the Philipines. It was introduced into this country a few years ago, and it is now being practised by the Ceylon Tobacco Company and by individual farmers in some parts of the island.

In this method, hedgerows of fast-growing, nitrogen-fixing trees and shrubs are planted close to each other along the contours, every 4-5 metres down the slope (Fig.4-7). The hedgerows are lopped every 6 to 8 weeks, and the loppings are used as mulch for the soil

between the hedgerows and as cattle fodder. Mulching thus prevents the soil from erosion, checks weed growth, conserves soil moisture and, upon decomposition, supplies essential plant nutrients to food crops and cash crops that can be grown in the avenues between the hedgerows.

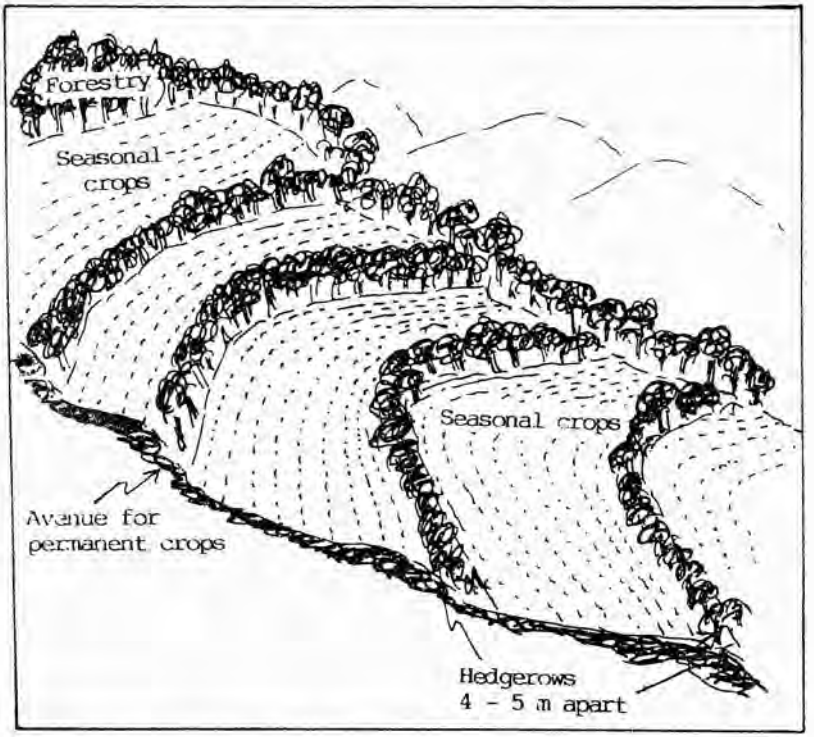

Figure 4.7: Cartoon showing grouwth of hedgerouws along contours and seasonal crops in between in Sloping Agricultural Land Technoloty (SALT). (From "Manual" published by Baptist Rural LIfe Centre, da Vas del Sur, Phillipines, 1990).

The SALT method is a low-cost method of soil conservation, something that is urgently needed in our country today. It incorporates a biological element into the conservation system and promotes good and sustainable use of the land. To quote one agriculturist: "This method is environmentally sound and is much less costly than the conventional methods of contour terracing and draining. It is also

a means of restoring degraded soils. Furthermore, it is beneficial to farmers because use of high-cost fertilizers is kept to a minimum and is eliminated altogether. In this method, the farmer produces food and cash crops, fodder for livestock and also fuel for the hearth" (Mr H. Amararathna).

Commonsense tells us that the conservation of our soils, which are among our most valuable resources and upon which all our cultivation depends, is a high priority necessity, if our economy is to survive in the years to come. By adopting all soil conservation measures possible we can:

- prevent the heavy soil erosion that is going on at present;
- reduce siltation in our rivers and reservoirs and increase the island's surface water resources;
- increase the retention of water in the soils;
- increase the water-holding capacity of the soils; and
- increase the fertility of the soils.

Figure 4.8: Montage of newspaper headlines on erosion.

Chapter 5

COMMONSENSE ABOUT LANDSLIDES

Landslides in Sri Lanka

Landslides have been with us for a long time. For example, in the thirties and forties, severe landslides recurred in the Belton-Maddecombra area of the Kotmale Valley; and a number of landslides, some serious, occurred in many places in the Hunasgiriya-Teldeniya area of the Kandy District in 1957. A disastrous landslide took place on the Kadugannawa Pass in 1947, when cars were carried away and lives were lost. In more recent years, major landslides have occurred in Gampola (1977); Agalawatte, Walapane, Hanguranketa and Kotmale (1986); Wellawaya (1987); and Watawala (1992), to mention only a few (Figs. 5-1, 5-2).

Figure 5.1: The recurrent landslide at Watawala showing the serious damage to the upcountry railway line.

Figure 5.2: The landslide at the 2nd km/stone on the Nawalapitiya-Dolosbagae road, August 1994 (Picture by NBRO's Landslide Hazard Mapping Project Team).

In fact, it seems as if landslides in Sri Lanka have increased in frequency as well as in intensity in the last 25 years, and damage to property and loss of life resulting from landslides is greater now than ever before. This is probably due to several factors besides heavy rainfall, some of these being:

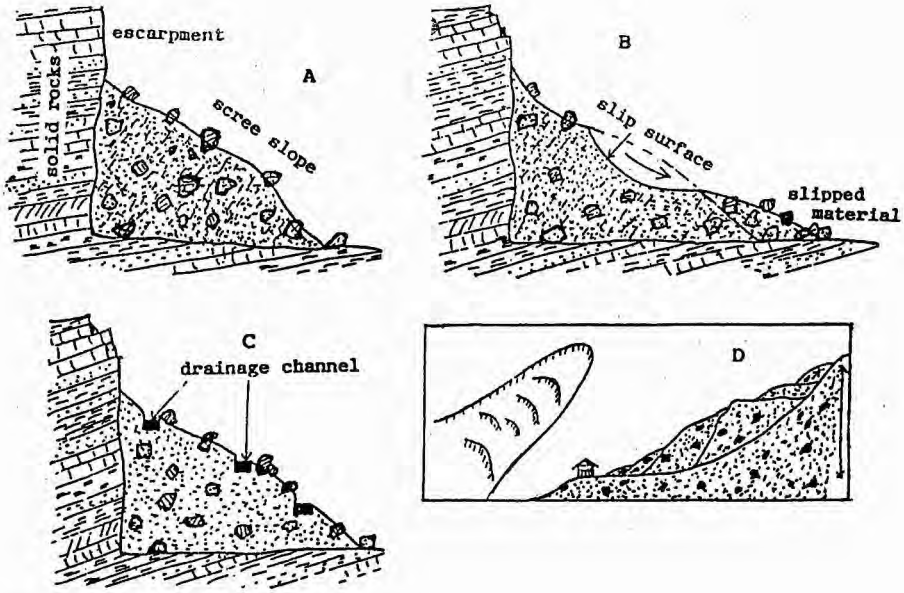

Figure 5.3: Cartoons showing landslides in scree slopes.
- **A.** A scree slope below an escarpment.
- **B.** Landslide in scree slope.
- **C.** Drainage channels on a scree slope as a preventive measure.
- **D.** Multiple landslides on the same scree slope due to absence of preventive measures; in plan (left), in section (right).

i) increasing population pressure resulting in more and more settlement and cultivation of unstable slopes;
ii) increasing removal of vegetation cover by such cultivation;
iii) extensive deforestation; and
iv) microseismic activity resulting from the impounding of large masses of water in irrigation and hydro-electric reservoirs.

Causes of Landslides

The ultimate and immediate cause of every landslide is heavy rainfall within a relatively short period of time preceding the landslide; and landslides are commonest during the rainy, monsoonal months. For example, many places in the Rangala area experienced over 500 millimetres of rainfall on December 25 and 26 in 1957; and in 1986, Katayapatana in the Maturata District had 265 millimetres in one day, January 6!

The other major contributing factor to landslides is the geological condition of the ground. Looking at this factor alone, we can simplify the picture in order to understand why landslides occur, and at the same time try and work out some remedial measures that can be easily taken to prevent and/or minimise the damage caused by landslides.

Landslides on scree slopes

In the central Hill Country of Sri Lanka, many slopes are what are known as 'scree slopes', which occur at the bottoms of escarpments (Fig.5-3A). These scree slopes are made up, not of solid rock, but of a sandy-clay matrix with blocks, boulders and fragments of rock derived by weathering of the escarpments above.

The scree slopes are made up of unconsolidated material, and if the slope is near to or steeper than what is called the 'critical angle', then that slope is in a situation of instability.

During the rainy season, the material of the scree slope becomes saturated with water; and when heavy rain falls on this saturated ground within a short period, it becomes over-saturated and waterlogged. The ground then becomes too heavy because of the weight of the water in it, a curved crack develops at the head of the mass, and the land slides down due to the action of gravity (Fig.5-3B).

When this takes place the stability of the slope is restored to some extent, but unless remedial measures are taken more slides may take place on the same scree slope in the future (e.g., Fig.5-3D). Evidence that the ground is oversaturated is often seen in the presence of springs in the ground and of cracks in the walls and floors of buildings. These are warnings that a landslide may take place in the near future if the heavy rain continues, and suitable action should be taken immediately in order to avoid disaster.

One remedy that may help in preventing landslides on scree slopes is to make sure that there is an adequate system of drainage over the entire scree slope (Fig.5-3C). In this way, the excess water that reaches the ground from the heavy rainfall will be carried away rapidly and so be prevented from seeping into the ground and oversaturating it.

Another measure would be to plant certain kinds of vegetation, e.g., ground creepers, so that:

(i) the water that falls on the ground is prevented from seeping through;

(ii) the soil is held together and prevented from moving;

(iii) the surface of the ground is protected from the striking force of the rain drops.

A third measure would be to terrace the land, and thus increase its stability.

Landslides in jointed rocks

Many of the rocks in the Hill Country are highly jointed (Fig.5-4), and this gives rise to the presence of fractures in the rocks in many directions. As a result, the jointed rocks are broken up into a large number of squarish to rectangular blocks, and this is common in quartzites and quartzo-feldspathic rocks. Several situations may arise in these kinds of rocks.

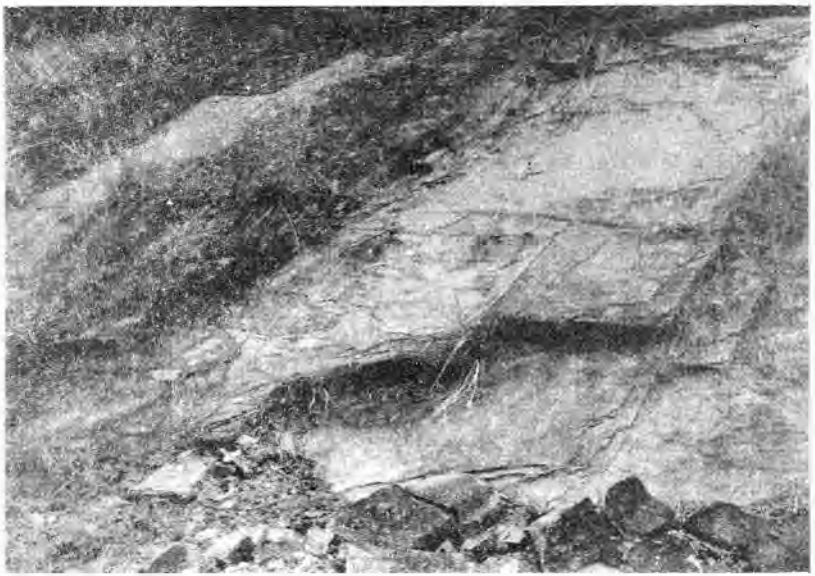

Figure 5.4: Highly jointed quartz schist in which rock slides commonly occur. Note some accumulation of rock material at foot of slope.

In one common situation, especially where the dip of the rock is against the slope (Fig.5-5), heavy rain, thunder and lightening may loosen the blocks of rock, which may already be unstable because of the roots of trees and shrubs growing in the joints. The rocks may then fall by gravity, giving rise to 'rock falls'. These rockfalls can result in serious damage to buildings, sometimes causing loss of life, and to the blocking of roads for many days. Rockfalls can also occur when large, loose blocks are perched on top of escarpments and are held in place by sand and small stones; strong vibrations, e.g., thunder, the passage of heavy lorries, rock blasting, can dislodge such perched blocks (Fig.5-6).

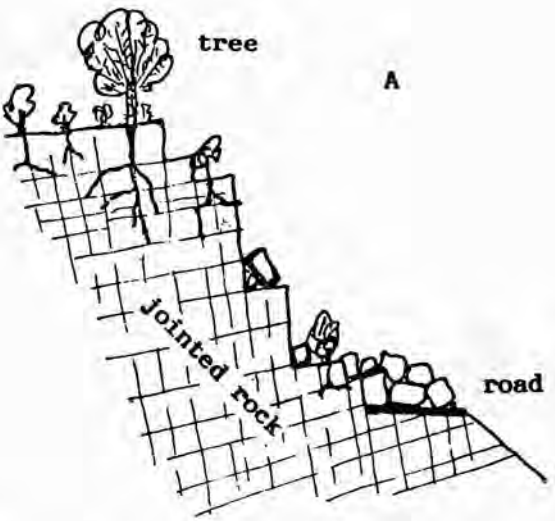

Figure 5.5: Cartoon showing rockfall in jointed rock where joints in rock are against the slope.

Figure 5.6: Cartoon showing unstable perched block at top of an escarpment. Building below escarpment is in danger from falling block.

In another situation, which is also very common, where the dip of the rocks coincides with the slope of the ground, 'rock slides' may take place (Figs.5-7A,B). This is especially common in rocks that have thin, feldspathic layers in them, which turn into clay when weathering takes place. When this clay becomes wet in the rainy season, the layers become surfaces of lubrication, down which the blocks of rock can easily slide. Very often roads are blocked when these rock slides take place (Fig. 5-7B; see also Fig.5-4).

Two safety measure can be taken in such situations. One is to clear the slope of all loose debris such as blocks of rock, stones, rock fragments and sand, until a minimally jointed layer is reached. The other is to build a retaining wall at the foot of the slope so as to keep the smaller blocks and debris away from the roads and buildings (Fig.5-7C).

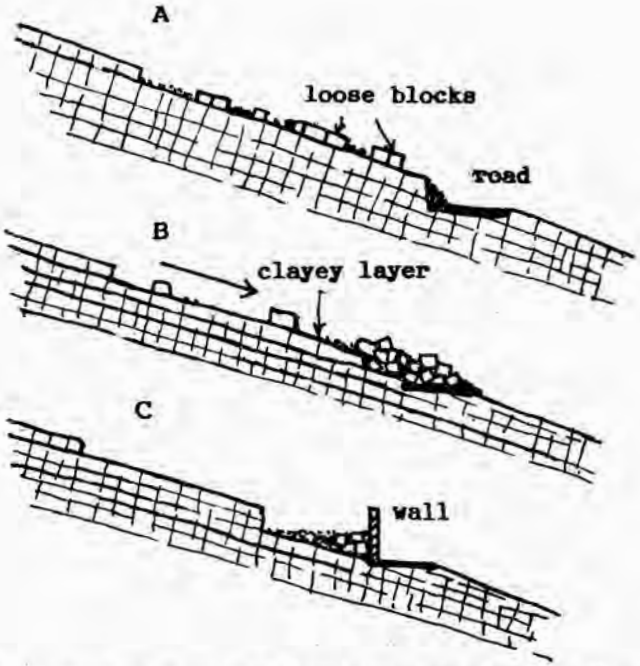

Figure 5.7: Cartoon showing rock slides in jointed rocks where dip of joints coincides with slope.

A. Loose blocks resting on joint face.

B. Rock slide on clayey layer, causing blockage of roadway.

C. Preventive wall at foot of cleared slope.

Landslides in embankments

Where there are steep to vertical earth embankments, as for example where a hill slope is cut into to provide flat land for building (a cut-and-fill situation), it is advisable to take two precautions. One is not to locate the building too close to the embankment. If it is too close, when a landslide takes place the slipped material will crash into the building and damage it and the inhabitants inside (Fig.5-8A). The embankment should ideally be about 3-5 metres away from the back wall of the building, but this depends on the height of the embankment; the higher it is the greater should be the distance between wall and embankment (Fig.5-8B).

Another precaution is to cut one or more terraces into the embankment so as to increase the total stability of the slope (Fig.5-8C). A third is to cover the bare earth surface with grass. This will, to some extent, bind the soil together and so prevent the earth from slipping.

This treatment of landslides in Sri Lanka is not a scientific treatise on landslides, but rather an explanation of the causes of some common types of landslides that occur in this country, in simple terms. What is important is that all of us should be able to recognise these dangerous situations in our own areas, identify the places that are liable to landslides, and then take the simple preventive measures that can reduce the risk of landslides. All that is needed is commonsense to do both —to recognise the danger and to apply the remedies.

Prevention of landslides

When there are signs that a landslide may take place, e.g., here are some remedial measures that can be taken:

(i) Make sure that there is an adequate system of drainage to take away, as rapidly as possible, any excess water that falls on the ground. Either enlarge the existing channels or build new drains, or both.

(ii) Plant certain types of vegetation, e.g., grasses, which will protect the surface of the land and bind the soil together.

(iii) Terrace the land and so reduce the steepness of the slope, thus increasing its stability.

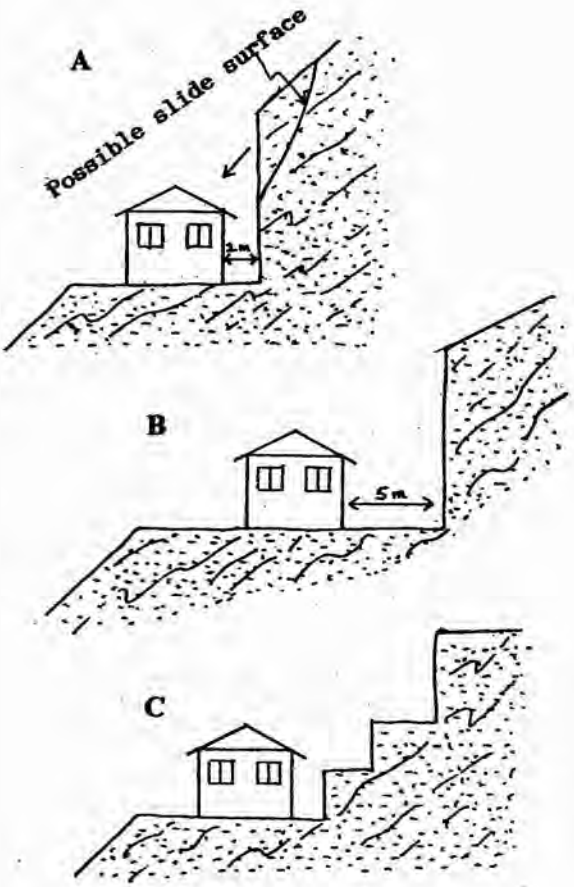

Figure 5.8: **Cartoon showing landslides in embankments.**
A. Building too close to embankment; possible damage from landslide.
B. Building at relatively safe distance from embankment.
C. Preventive terracing of embankment.

Figure 5.9: Montage of newspaper headlines on landslides.

Here in Sri Lanka, we have begun to recognise the seriousness of landslides, because of the frequency with which they seem to occur. The National Building Research Organisation (NBRO) is now charged with mapping areas that are liable to landslides (called Landslide Hazard Mapping), and to recommend plans of action when they take place.

Among the measures taken in different parts of the country to stabilize the land are reafforestation; planting of cashew, bamboo, rushes and other soil-conserving plants; control of land use on various types of slope; and monitoring (after training) of high-risk areas by students and teachers of Maha Vidyalayas and government officials close to such areas.

What you can do in the area where you live or around your school or work place is to keep a look out for signs of instability during heavy rains. When such signs appear, inform the police or the AGA of the area, and take what measures you can to minimise the danger.

Chapter 6

COMMONSENSE ABOUT ENVIRONMENTAL POLLUTION

What is environmental pollution?

The earth's environment consists of a number of spheres. These are: the **atmosphere**, or the air that surrounds us and which we breathe in order to live; the **hydrosphere**, or the oceans and seas on the earth's surface which cover most of that surface; the **lithosphere**, or the rocks that make up the solid earth, the outermost layer of which gives us our soils; and the **biosphere**, or the plant and animal life on the earth, of which we are a part. These spheres also form a part of man's environment, and by his activities he is introducing matter and energy into all these spheres in quantities and amounts that are higher than normal. This is known as **environmental pollution**, and the matter and energy causing it are known as **pollutants**.

There are four kinds of pollutants, and these are listed below (see Figs.6-1 and 6-2).

Air pollution is by gases as well as by solid and liquid particles of organic and inorganic matter that are discharged into the atmosphere in various ways and by various agencies.

Water pollution is by disease-producing bacteria and viruses (i.e., biological pollution) and by chemical elements and compounds in solution (i.e., chemical pollution); suspended solids causing turbidity are also pollutants of water.

Thermal pollution is due to the infusion of energy into the air and water, thus causing fluids to become abnormally heated.

Noise pollution is the release of energy into the environment by the emission of sound waves.

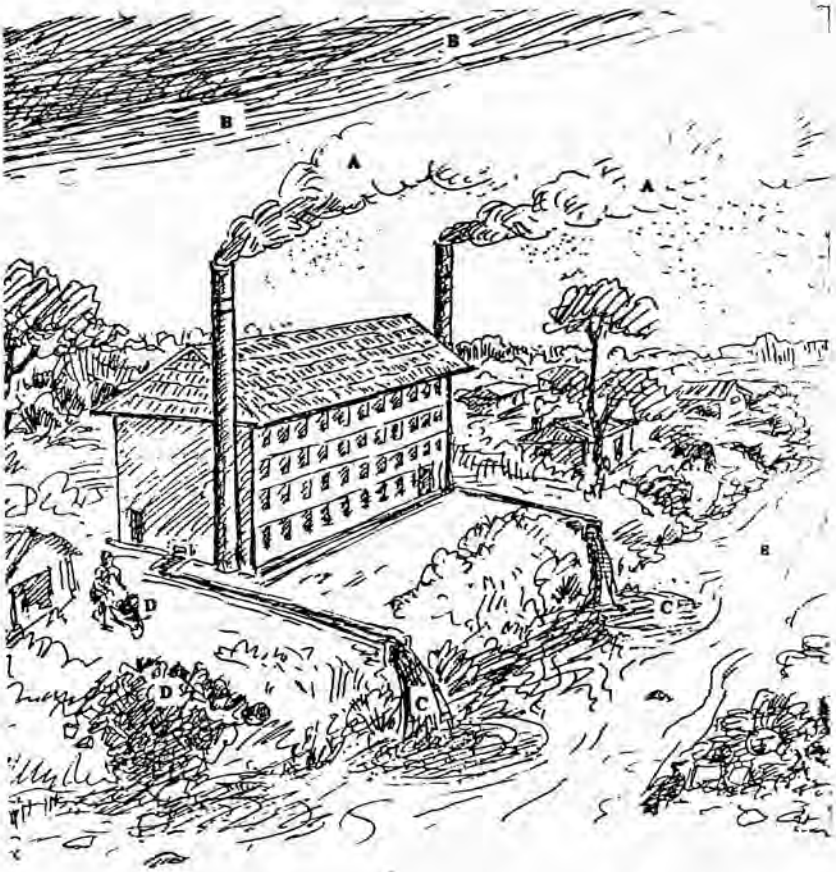

Figure 6.1: Cartoon showing different forms of pollution of the environment. A - fumes and dust particles from factory pollute the atmosphere and cover vegetation with dust; B - cloud layer with toxic fumes; C - toxic effluents from factory pollutes the stream; D - garbage dumps from dwellings on banks of stream pollute the water in the stream; E - polluted stream. (Drawn by Mr. T.B. Karunaratne from original sketch supplied by the author).

Environmental pollution has reached alarming proportions in the highly industrialised countries of the 'North', and also in the megacities of the world, such as Hongkong, Calcutta, Bangkok, Cairo, Lagos, Buenos Aires and Rio de Janeiro in the 'South'. Atmospheric pollution in those parts of the world is caused by fuel combustion, chemical industrial processes, smelting and refining of ores, quarrying, forest fires, dust storms and volcanic dust. By these means, carbon dioxide (CO_2), sulphur dioxide (SO_2), and lead and dust particles cause smog and haze in the air. In fact, there are certain cities in the world, e.g., Mexico City in Cental America, and Dhanbad and Kanpur in India, where a permanent haze or smog, the result of atmospheric pollution, hangs permanently over them.

We need mention only a few examples of environmental pollution and the dreadful consequences it has brought to people in all parts of the world. The release of sulphur-bearing fumes into the atmosphere by factories in Europe, causing sulphuric acid to form in the atmosphere, has led to the awful phenomenon of 'acid rain'. This acid rain has brought about the destruction of trees over thousands of square kilometres in Europe and America, and the deaths of fish in countless numbers of lakes and rivers in those countries.

The Chernobyl disaster, when radioactive matter was released from a nuclear energy plant in Russia, caused death, destruction and permanent damage to the environment and to the people living within close range of Chernobyl and also beyond. The effects of the Chernobyl disaster are still being felt.

More recently, the setting fire to hundreds of oil wells in Kuwait by the retreating Iraquis caused permanent darkening of the skies, the precipitation of 'black snow' and 'black rain', and a high rate of respiratory diseases among the Kuwaiti people, all of which were environmental disasters of the first order. In the same war, the oil spill created by the Iraquis caused the death of millions of birds and fishes, and polluted the land and sea for hundreds of kilometres along the coast. In fact, oil spills from oil tankers that run aground, occur periodically off the coasts of countries, and cause irreparable damage to the coastlines and the birds and fish that live on those coasts.

Figure 6.2: Montage of newspaper headlines on pollution of the environment.

Nearer home, the leakage of methane gas from a factory in Bhopal in India caused the deaths of hundreds of people and respiratory diseases to thousands more. And the people who suffered from this environmental disaster caused by industrial carelessness are still fighting for some form of compensation for their deaths and injuries.

Curently (October 1997), a permanent 'haze' has been covering much of Malaysia, Singapore, Indonesia and S.E. Asia for the past three months, and this is likely to continue into the early months of 1998. The haze has been caused by smoke from forest fires in Sumatra and elsewhere in Indonesia, started by logging companies, fires which in time became uncontrolled. The damage to those countries covered by the haze in terms of the health of humans and animals, to the education of the children by schools being closed, and to the ir economies in enormous, and still incalculable. This must surely be one of the worst environmental disasters in recent years to hit our part of the globe.

Water pollution is also a serious problem in the West. The release of industrial waste and sewage into rivers and seas has had disastrous results in many places. The Rhine River, for example, which flows through several European countries, became so highly polluted at one time that all the fish in it died. Similarly, the Mediterranean Sea, surrounded as it is by highly populated countries, became known as "The Sewage Pit of Europe". Fortunately, remedial measures taken in both those instances have resulted in cleaning up the pollution and preventing it happening again. The Ganges river in India, into which half-burnt corpses are frequently thrown and which has millions of people living on its banks, is one of the worst polluted rivers in the world.

We are all aware of what is happening to the earth's environment, globally. The ozone layer, which protects us from the harmful rays of the sun, is being gradually destroyed. As a result, 'global warming' is an ongoing process today, and this is leading to the melting of the ice caps in the polar regions and of the glaciers in the temperate zones. A good example of this phenomenon is the retreat

of the Bering Glacier in Alaska, which is said to have retreated by about 12 miles in the last 25-30 years. The melting of the ice caps is resulting in a gradual but sure rise in the global sea level. What this will mean at some future date is frightening to contemplate, for if this sea-level rise continues, it will eventually lead to the submergence of thousands of square kilometres of the coastal regions of many countries, including our own, and the disappearance of many populated coral islands, such as those that make up the Maldives, and thousands in the Pacific.

Here in Sri Lanka, although environmental pollution has not yet reached alarming proportions, it is going on in many places and in many forms. The government as well as many sections of the population are aware of this pollution that is taking place, and some steps are being taken to control and lessen it. But more than that is needed, as there is little monitoring of whether or not the steps are effective, or even being followed at all. We should all, therefore, adults and children, become aware of the forms that this pollution takes. If we do that, then we can and should take the necessary steps to prevent or control the pollution that takes place in the vicinity of our homes, schools and places of work. We can then ensure that environmental pollution never reaches the serious proportions that it has attained in other parts of our region. Let us now look briefly at some of the main types of pollution going on in Sri Lanka.

Water Pollution

All over the island, surface waters and groundwaters are being polluted by children as well as adults urinating and defacating on the ground because of lack of toilet facilities. Faecal pollution of the ground around tanks and reservoirs, along footpaths and on the beaches is a common sight in our country. Sometimes, pollution of the countryside takes place even when toilet facilities are available, simply because it is easier to relieve oneself in the open than looking for and going into a toilet. As a result of this habit, 65 per cent of the people of Sri Lanka suffer from bowel diseases such as diarrhoea, dysentery, typhoid and infective hepatitis. In fact, it has been said that 8 to 10 children die of diarrhoea daily in Sri Lanka!

We have already seen, in Chapter 3, how groundwater and surface waters in rivers and streams are being polluted (see Figs.3-2 and 3- 7). In addition to the ways already mentioned, groundwater and surface waters are being polluted by the uncontrolled disposal of industrial and domestic waste. Industrial waste in this country includes thousands of tons of solids like sawdust and fibre dust, and millions of gallons of affluents from mills and factories, e.g., textile, steel, petroleum, tyre, leather, paper, rubber, canning and food-preserving factories. Wastes from these factories are being discharged into rivers like the Kelani Ganga, into lakes like Bolgoda and Beira, and into canals like Ekala, Ja-ela, Wellawatte and Dehiwela. It has been reported that 77 per cent of the untreated sewage from Colombo was, at one time, dumped into the Kelani Ganga; that the mid-city canal in Kandy and Kandy Lake are some of the most polluted stretches of water in the island because of the sewage and domestic waste being discharged into them from houses, hotels and hospitals; and that the Moratuwa and Ratmalana areas are some of the worst areas for industrial pollution (see Fig.6-2).

Air Pollution

Air pollution in Sri Lanka is not so widespread or so serious in its effects as water pollution, but it certainly exists. Presently some 50 000 or more vehicles are registered each year in this country, and petrol consumption increased from 400 000 metric tons (m.t.) in 1970 to 630 000 m.t. in 1986; it must be over 750 000 m.t. now, in 1997. Vehicle exhaust emission is, therefore, very high where vehicles are most concentrated, and it is not surprising to be told that a layer of smog (smoke plus fog) is known to form over Colombo, at times, at about 1300 m above sea level.

In addition to smoke, exhaust emissions contain carbon monoxide, unburnt hydrocarbons, sulphur dioxide and oxides of sulphur and lead. All these can cause serious damage to lungs. The worst cases of vehicle exhaust emission are the black, diesel fumes from the 'belching' buses on our roads. The people who live on the sides of the roads along which these buses run (e.g., the Colombo-Kandy road and the Colombo-Galle road) must suffer badly from lung damage. Although efforts are made from time to time to ban such 'belching'

buses from the roads, such bans do not seem to be having any effect, as the number of 'belching' buses appears to be the same as before. Unfortunately, there is as yet no monitoring in Sri Lanka of the actual effects of diesel- and petrol-fume emission, and it is time such monitoring is undertaken by the proper authority.

Another form of air pollution is dust from various industrial processes in the country (Fig.6-2). The worst is probably from the cement factories in the country. The dust from these factories covers the vegetation in those areas and enters the lungs of the factory workers, so causing a lung disease known as pneumoconiosis. Several cement-factory workers are known to have died from this illness. Flour from large bread factories and dust as well as gases from rock quarries, rock-crushing plants, charcoal-making plants, pesticide factories and from burning rubber pollute the air; and the stench from open garbage dumps, polluted lakes and lime-burning plants also add to air pollution.

Noise Pollution

The sound of vehicle horns, especially in towns where 'silent zones' are supposed to exist, the noise that large vehicles like lorries and buses make when they race their engines as they come round bends, the blasting of rock in quarries, the noise of factory plants, the blaring forth of loudspeakers at public meetings, places of religious worship and from moving vehicles with loud speakers — these are all offensive to our ears and are a special form of environmental pollution. Although we in some countries of the Third World have become used to these forms of noise and accept them as part of life, they are still pollutants of the environment which should be eliminated or, at least, regulated and controlled.

In western countries you almost never hear the sounding of a car horn because drivers observe the rules of the road, thus making the sounding of horns unnecessary. We in Sri Lanka go to the other extreme and sound our horns at every corner or bend in the road, or whenever we are impatient with other drivers, motor-cyclists, cyclists or pedestrians, or whenever we overtake another vehicle.

Most drivers in this country suffer from what I call the 'overtaking syndrome', i.e., the urge or necessity to overtake any vehicle in front of them! There is, of course, an explanation for this necessity to sound one's horn so frequently. It is that most vehicle drivers in this country do not observe, or even seem to know, the elementary rules of driving. The 'Highway Code' is something they do not observe, — and most drivers probably do not know that such a 'Code' even exists. Nor have most of them ever heard of 'road courtesy'. The prevalent habit of driving in the middle of the road and of overtaking round corners, even round bends, when what is approaching cannot be seen, is the cause of most accidents in this country and is the reason why one has to sound one's horn so frequently.

Every citizen is entitled to certain privileges from the environment in which he or she lives and works, and one of these must surely be a certain amount of peace and quiet, and protection from the noisy assault on his or her ears. That is why we have 'silent zones' in our towns, and why there are road signs around certain areas in our major towns showing where horns should not be sounded. Unfortunately, very few vehicle drivers observe these signs, or are even aware that they exist. The rule of 'silence' is broken all the time, either through ignorance or an "I don't care" attitude, which shows a lack of civic sense. This is compounded by the police not bothering to enforce the law with respect to 'silent zones' or sometimes even speed limits. In fact, a civic sense seems to be sadly lacking in our present day society in Sri Lanka! The sad thing is that drivers of vehicles get away all the time with such unlawful behaviour regarding this and other rules of the road because nobody cares to — or is able to — enforce the law of the land.

Land Degradation

Degradation of the land, i.e., spoiling or destroying the land in one way and another, chiefly by man, must also be regarded as a form of pollution, and it is most evident in the mining and quarrying industries (Fig.6-3). The environmental effects of gem mining, for example, may be listed as follows:

- land degradation through deforestation and reduction of cultivable land;
- soil erosion;
- surface water and groundwater pollution;
- health hazards, e.g., malaria;
- damage to engineering structures, e.g., roads, houses, bridges;
- disruption of and changes to community life-styles.

The environmental effects of all these activities, though local, are cumulative, and are becoming a major problem in the country.

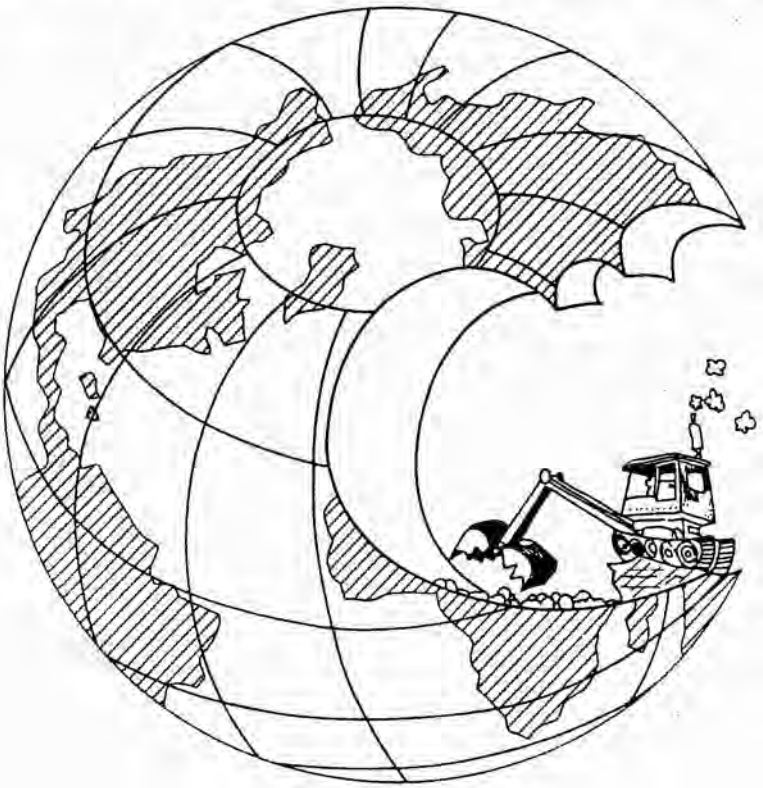

Figure 6.3: Satirical cartoon showing effect of mining on the earth (from "Ambio", 1972, Journal of Human Environment Research and Management, Royal Swedish Academy of Sciences).

In the Moneragala district, for example, illicit gemming has caused extensive damage to thousands of acres of state forest reserves, extending even to parts of the Yala National Wild Life Sanctuary bordering the Kumbukkan Oya, and also to the catchment areas of nearly 50 waterways (as reported in the Daily News of 3.12.1990). Similarly, the 'gem rush' that took place in the Elahera area some years ago, led to the destruction of roads and bridges over a considerable area. Even now, topaz mining in the Rattota area has led to the destruction of coconut land and paddy land, as well as to the creation of large, unprotected holes in the ground which remain unfilled, thus creating breeding grounds for the malaria-bearing mosquito and health hazards to little children who could easily fall into them and drown (Fig.6-4). The same situation exists along the coastal belt north and south of Colombo. North of Colombo, large areas where clay has been mined for brick-and-tile making have remained unfilled, and are now stagnant ponds of water where mosquitoes breed; and in the south, the mining of inland coral has also left large pools and ponds of stagnant water that are a hazard to the environment.

In certain mining and quarrying activities, such as apatite mining, and quarrying of limestone, quartz, feldspar, rock and clay, land is completely destroyed and lost — and cannot be renewed or replaced. Of course, this is inevitable and cannot be avoided, but we should always keep this in mind. Other effects are the large amounts of fine dust that are raised by stone crushing, which are a danger to health, and the noise of drilling and blasting, as well as the strong vibrations in the ground, when quarries are situated close to buildings and human dwellings.

Sand Mining

Sand mining in river beds is also a cause of land degradation, and it is now reaching critical and dangerous proportions. It has been estimated that over 5 million cubic metres (cu.m.) are removed each year from our river beds. Of this amount, 1.8 million cu.m. are taken from the Maha Oya, 800 000 from the Kelani Ganga, 300 000 from the Kalu Ganga, and over 2 million from all the other rivers in the island

(Dr W.P.S. Dias of the Dept. of Civil Engineering, University of Moratuwa in Daily News of 18.7.97). In fact, this amount is likely to increase in the future as increasing demands for sand are being made by our flourishing building industry.

Figure 6.4: Degradation of the land caused by mining for topaz in the Rattota area.

Let us look at what is happening in two of our major rivers, the Kelani Ganga and the Deduru Oya. We have been told that the removal of sand from the Kelani Ganga has lowered its bed, and this has resulted in: a) an influx of sea water into the river; and b) the river water as far upstream as Kaduwela becoming salty.

The most recent report, which is by the Coast Conservation Department (in Daily News of 18.7.97) says that: "indiscriminate and excessive sand mining in the Kelani Ganga has caused its water level to drop below sea level, leading to disastrous and far-reaching

consequences." These are: i) intrusion of sea water, which will affect the drinking water supplies of a large number of people; ii) loss of a vital sand layer in the bed of the river.

Sand mining in the Deduru Oya is also posing severe environmental problems. A few kilometres upstream of Chilaw, sand is being mined at 15 to 20 spots, and each loading point delivers 50 000 to 80 000 cubic feet (1400 to 2200 cu.m.), although only 4500 cubic ft (125 cu.m.) is allowed on three days in any one week. At each loading point, 15 to 20 tractors remove the sand (Fig.6-5). No revenue is being collected, and so, in addition to the damage to the environment, the government is losing large amounts of revenue through this illegal activity. (Elsewhere, the banks of the Nilwala Ganga are being dug in order to obtain clay for brick-making).

Figure 6.5: Sand mining in the Deduru Oya (Photo by ANCL).

Although a permit is needed to mine sand, a large number of persons are doing so illegally and openly. Moreover, although a limited amount of sand may be mined each month on a permit, most miners take out the permitted amount in two or three days. Therefore, unless something is done soon to control and to monitor this mining effectively, the resulting hazards to the environment and to the people will be incalculably disastrous.

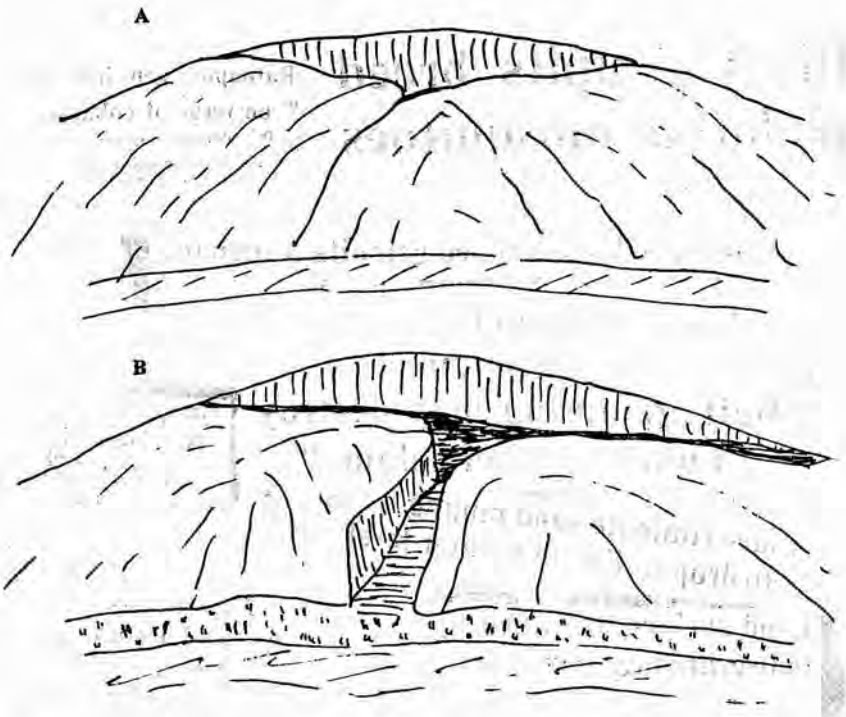

Figure 6.6: Cartoons of the abandoned stone quarry above Victoria dam, showing how nature conservation can be achieved by intelligent quarrying.

A. View from the approach to the dam from the Teldeniya side, in which no sign of the quarry is visible.

B. View of the quarry, seen only from the entrance to it.

Removal of sand from some of our beaches is also taking place at various points along the coast. This is upsetting the the coasal sand balance, and this, in time, will affect the growing coastal zones in the northwestern, western, southern and eastern coastal regions.

Quarrying for earth and for stone is also a feature of land degradation. Most quarries and earth-cuts are an eyesore and are offensive to the eye, especially when they become the sites for hideous and vulgar advertising billboards. One of the worst instances of this offensive advertising is near the bottom of the Kadugannawa

Figure 6.7: Montage of newspaper headlines on land degradation by mining.

Pass, and I shudder every time I pass that spot! Abandoned quarries are also an eyesore, especially when they are on the sides of the main roads. The remedy for this would be for the Roads Development Authority to encourage villagers and quarry owners to grow creepers so as to hide the earth cuts and quarry faces.

Let me end this chapter by describing a quarrying operation that had a regard for the environmental effects of its operation and could be quoted as a fine example of 'environmental conservation'. When the Victoria Dam was being built, the enormous amounts of stone that were required were quarried from the hill on the other side of the dam. Today, as you approach Victoria Dam from the Teldeniya side, you can see, in the distance, an expanse of bare rock rising over the top of a hill (Fig.6-6A). But when you cross the dam and drive to Adikarigama on the other side, you pass an opening in the hillside; and when you look in you see a huge, abandoned quarry. It is obvious that when quarrying, the operators made a passage into the hill, and then started quarrying, as a result of which the quarry is not visible until you actually come to the opening in the hill. I call this a very great respect for the environment for which the operators should be thanked and congratulated. Would that more of our quarry owners and quarry operators had the same respect for our environment!

Chapter 7

COMMONSENSE ABOUT CONSERVATION

What is Conservation?

We often hear about the conflict between 'development' and 'conservation', and in this chapter we shall look at the demands that development makes on the environment on the one hand, and the need to protect the environment from damage and harm on the other. In that sense, therefore, conservation means preserving the status quo, or leaving the environment as it is with a minimum of change. With a rapidly growing population, however, that is just not possible, as we can see all around us. If you drive along the Kandy to Colombo road, you will see land being cut into and levelled for houses, and large extents of estates being parcelled out for sale as building plots every few kilometres. In this context, therefore, conservation means making sure that the environment suffers a minimum of damage and change, and where possible, seeing that the damage is rectified (Figs.7-1, 7-2).

We are surrounded by our environment, and as I look out of my window at home in Mahakanda while writing this, I see many of the elements of my environment. I see the air I breathe, the wind that cools my room, the cultivated soils on the hillside, the patana-covered slopes, the forested hilltops, the stream in the valley and the landscape that gives me so much pleasure and satisfaction. At the same time I can see some of the damage that is being done to those very elements of the environment that sustain our lives. I see the grasses periodically being wantonly and senselessly burned, forests being cut down, steeply sloping land being cleared of vegetation and soil erosion taking place, recurrent earthslips occurring, and a stone quarry across the valley defacing the landscape and causing a noise disturbance by frequent blasting of the rocks.

It is obvious, therefore, that we have damaged — and continue to damage and even to destroy — the elements in our environment that are beneficial to us. How we do this, and how we hurt ourselves in the process is shown in the accompanying table. So we need to ask ourselves: "Why should we protect our environment?" And if we agree that the environment should be protected, the question that follows is "How should we protect our environment?"

Why protect the environment?

The environment in which we live is essential to our very lives because it gives us:

a) the air we breathe, which brings us our winds, our clouds, our rain and our dew;
b) the rivers, lakes and seas, which give us our plentiful supplies of fish and our water for irrigation, our waterfalls for hydroelectricity and for scenic beauty, our beaches that attract the tourists and give us much foreign exchange, which in turn enables us to import many of the things we need;
c) the soil on which we grow our food crops that enable us to eat in order to live, and our commercial crops that enable us to trade with each other and with the rest of the world;
d) our hills, which give us slopes to cultivate, which cause rain to fall, and which give us aesthetic pleasure to look at and which bring us our cool climates;
e) our valleys and plains, which give us large extents of cultivable land, and provide routeways for our roads and railway lines, give us land on which to build our homes, our schools, our villages, and which provide playgrounds for us;
f) our minerals like sand, clay and rock, which we use as building materials, the crushed stone for our roads, a variety of clays for our industries, and minerals like gemstones, graphite and mineral sands which we trade internationally;
g) our forests, which house our rich vegetable and animal life, which give us firewood, which protect our soils, and which encourage rain to fall by providing moisture to the air;
h) our pure water from the ground, which we use for drinking and cooking.

Figure 7.1: Satirical cartoon, 'Conservationists at Work' - I (source unknown).

Figure 7.2: Satirical cartoon, 'Conservationists at Work' - II (source unknown).

The Environment gives us.	Environmental damage results in
Atmosphere	
Air we breathe	... Lung diseases
Wind and rain	... Climatic changes
Ozone layer	... Global warming, skin cancer
Hydrosphere	
Food from rivers, seas..	.. Reduction of food supply
Rivers for irrigation..	... Reduction of cultivation
Rivers for hydropower..	... Increased imports of coal & oil
Beaches	... Loss of tourist trade & of foreign exchange
Groundwater	... Bowel diseases, loss of water for domestic use
Lithosphere	
Soil, food, commercial crops	... Loss of soil fertility Increased import of fertilisers
Hills, rain, cool climate	... Landslides, warmer climate
Valleys, plains - land for cultivation, building	... Loss of land for cultivation, building
Routeways for communication.....	... Blockage by landslides
Minerals for building and trade.....	... Degradation of the land
Forests - fuel.....	... Loss of fuel resources
timber.....	... Loss of timber resources
rainfall.....	.....Lowering of moisture, rainfall; droughts
Life.....	... Loss of animal & vegetable life

Surely these are enough reasons why protection of our environment from damage and destruction is essential if we are to continue to live in the environment in which we find ourselves. Let us look at some of the things that may happen to us if we do not protect our environment but allow the various elements of our environment to be damaged or polluted.

i) We may pollute the air we breathe and so damage our lungs.
ii) We may destroy part of our food supplies that come to us from rivers and seas, reduce the water flowing in our rivers and so reduce our hydroelectric resources, making it necessary for us to import more coal and oil, and so increase the cost of our electricity.
iii) We may continue to lose our fertile topsoil, and so make it increasingly difficult to cultivate our crops without adding more and more artificial fertilizers at more and more cost to us; this, in turn, will lead to silting up of river and lake beds, which may lead to more flooding.
iv) We may destroy our beaches by more erosion of the coast, and we may pollute our beaches to such an extent that tourists will cease to come here and our foreign exchange earnings will go down considerably.
v) We will cause more and more landslides to occur, so destroying more and more land and homes and causing more and more loss of life and limb.
vi) We will lose our sources of firewood, our sources of valuable timber, our sources of moisture in the air, and ultimately, our rainfall.

And so we could go on and on, listing many more bad effects on our lives if we do not take immediate steps to put a stop to the damage to and pollution of our environment.

How can we protect the environment?

Much has recently been said about conserving or protecting the environment, and in October 1991, a global programme called 'Caring for the Earth' set out nine principles by which to live in order to avoid destruction of the Earth.

Here in Sri Lanka, the government has been conscious of the problems of environmental damage and the need for conservation, and has taken several steps to remedy the situation. Some of these steps are listed below.

1) We had, until recently, a Ministry of Transport, Environment and Women's Affairs, but that has now been replaced by the Ministry of Forestry and Environment.
2) We have a Central Environmental Authority (CEA) whose duty it is to formulate policy and to coordinate the various efforts that are being made by governmental and non-governmental agencies of the Environment.
3) We have a 'National Heritage Wilderness Act No. 3 of 1988', which is for the declaration, protection and preservation of areas of 'wilderness' or areas with 'unique eco-systems, genetic resources or any outstanding natural features'.
4) We have provision for an Environmental Impact Assessment (EIA) of every new project proposal that affects the environment; and no project proposal can go ahead without EIA clearance.
5) We have the Sri Lanka Environmental Congress.
6) We have the CEA hoping to set up environmental protection societies at village level in order to help conserve the environment.
7) At the World UN Conference on the Environment held in 1992, we presented a 'National Report on Environment and Development'.

There are also Non-Governmental Organisations (NGOs) that are watch-dogs of our environment, raising their voices whenever development and other projects, private and public, are likely to damage or seriouly affect the environment. Unfortuntely, such voices are sometimes ill-informed or are motivated by other than environmental concerns, and by their objections may prevent essential development work in some public spheres.All this shows that the conservation of our environment is very much the concern of people in many walks of life in Sri Lanka, from the highest levels of the government to village level, and of state and private organisations. Unfortunately, the checks and balances do not always work, as in the

glaring example of the determination of the Ceylon Electricity Board to go ahead with the Upper Kotmale Hydroelectric project, in spite of the prohibition placed on it by the CEA and the numerous objections by many organisations and individuals. Fortunately, wiser counsels have prevailed and the scheme appears to have been dropped. The uncertainty and unpredictability of the rainfall that this island receives from year to year should be reason enough for us to depend less and less on hydro-electric power and more and more on alternative sources of energy.

This has now been recognized by the government, and steps are being taken to use alternative sources of energy for the country's power requirements. One such source is coal, but there is difficulty in finding a suitable location for a coal power plant. We are now seeing something that has recently arisen and will continue to arise in our society — the conflict between environment and develpment. In the case of the coal power plant, the conflict is between the siting of the powr plant in Kalpitiya Peninsula and the people who live there; elsewhere in the island the conflict is between the human population and the elephant population. Owing to the development process and the increasing population of the island, the elephant lands are being gradually lessened, and the elephants are encroaching more and more on the lands occupied by humans. How these conflicts will be resolved we do not know, but it is likely that, as in other parts of the world, the environment may have to give way to the demands of a growing population.

What can I do to protect the environment?

The question that each one of us should ask ourselves is: "What can I, as an adult or as a schoolboy or schoolgirl, do to help to protect and look after my immediate environment?" There are many ways in which we can do this, and some of the ways are listed below.

a) Educate yourself about the environment, and learn about it in whatever ways you can. Ask your teacher to have discussion sessions about the environment around the school. Or you can form an Environmental Conservation Club in the school, or in the village, or for all the schools in the neighbourhood. One project of such a club could be to make a large-scale map of the area around the village, and

on it mark the topography, drainage, soils, wells, springs, buildings, quarries and mines, forests, vegetation, cultivated fields, waste disposal sites, landfills, and anything else you can think of. You could start with a one square kilometre area — say half a kilometre on all sides of the school — and map it on a large scale, such as 30 cm = 1 km.

b) Another project would be for all the schools in your town or group of villages to establish a field centre, where you could go or be taken on weekends and public holidays to learn about your environment.

c) A third project would be for you, or a group of you, to be on the look-out for signs of pollution or damage, e.g., dumping of waste into streams, illicit felling of trees, to your environment. If you see such signs, bring them to the notice of your teacher, school principal, grama sevaka, police or Asst. Government Agent. However, you must be careful that you are not reporting to the very person or persons who are responsible for the pollution or damage. You might be in danger if you do! So if you are making such a report, go in a group because, as the saying goes: "there is safety in numbers."

d) A good project for your class would be to keep a scrap book of cuttings from newspapers and magazines about environmental matters. This would be a good way of educating yourselves about environmental matters not only in Sri Lanka but also globally.

e) Above all, make sure at all times that what you, your classmates, your parents, your brothers and sisters and your friends and neighbours do is not causing pollution and/or damage to the environment. It is definitely better and cheaper to prevent environmental pollution and damage than to find remedies for them.

f) Finally, here are some positive acts that all of us, whether children or adults,can do to conserve the environment:

- plant trees wherever they have been destroyed,
- do what you can to avoid soil erosion,
- observe sanitary habits, and always use a lavatory instead of relieving yourself in open ground or on the banks of streams or on the beach,
- do not dump garbage and waste on open ground or in streams,
- observe correct principles in siting wells and lavatories,
- do not break coral from the reefs to sell to tourists or for making lime.

The need for Environmental Education

I earnestly hope that 'environmental education' will one day become a part of the normal curriculum of primary and secondary education in Sri Lanka. At present, school children are taught something about the earth in the 'Science' and 'Social Studies' courses up to 'O' Level standard. but much more 'Earth Science' is needed in those courses in order to make children of all ages better aware of their environment.

Earth science, which includes the study of the atmosphere and of the oceans as well as of the earth itself, is the best way to introduce the concept of the environment to children. The atmosphere, the oceans and the earth are the main elements of the environment, and it is the interactions of these elements that give us not only the micro-environments in which we live, but also the biosphere, of which we are a part.

I feel strongly that more and more earth science should be included in primary and secondary education, and that geology, which is the study of the solid earth, should be a core subject in all tertiary education. It is just as basic as chemistry, physics and zoology, and as relevant and useful, perhaps even more so, than those subjects, to adult life in a community. Unfortunately, our present educational system is geared and oriented to turning our professionals, rather than to turning out individuals who are educated for living as adults in a community. If we want to achieve the latter end, then geology should be taught as a subject in the last two years of secondary education (i.e., at GCE Advanced Level). It is a curious system of education that teaches much Earth Science in the years up to GCE Ordinary Level, and then drops the subject altogether in the last two years of the system! It is unfortunate that this anomlay is being continued in the present revision of the Advanced Level subjects to be taught, and that those responsible for the education of our youth have still not seen the importance of Earth Science being an essential component of our entire system of education. For the same reason, Geology should also be taught in all our universities,

not just in one or two. Only then will be able to produce an enlightened community of individuals who could be legislators, administrators, planners and others who will clearly understand the obligations and duties imposed on us as citizens of the earth.

Environmental conservation should become part of the learning process from the primary level right up to secondary, and even tertiary levels of education. This has already been done in our south-eastern Asian neighbour, Malaysia. It is a lead we should follow without delay.

If we do not learn to look after our immediate environment from a young age, we will find it hard to look after it when we are older. If we do not look after our environment now, it will be damaged beyond repair and living in it will become impossible in the future. When that happens we will have nowhere else to go, and we, like the rest of the human race, will perish on the earth that once was ours.

About this Book

One of the topics that occupies many people's minds today is the environment in Sri Lanka and what is happening to it. We see it being destroyed by landslides, floods and coastal erosion, being damaged by soil erosion and pollution, and being degraded by mining activities of many kinds. These various happenings to Sri Lanka's environment are vividly brought to our notice by the written word, by newspaper headlines and by pictures in the press. They should make us stop and think about what we ourselves, as inhabitants of this island, are doing to destroy out own environment, the environment in which we live, work, and play. This book attempts to survey, in commonsense terms, many aspects of this damage that we are doing to our own environment, e.g., deforestation, erosion, landslides, water supplies and pollution. And although the subject of environmental consevation and protection is an extremely large one, the book ends by giving us some useful hints of what we ourselves can, and should, do to take care of our own environment. The book is based on a series of articles which appeared in The Island some years ago, under the general title "Commonsense about our Habitat".

About the Author

After his graduation from University College, Colombo, Prof. P.G. Cooray spent 20 years as a field geologist in the Geological Survey of Sri Lanka, and a further 20 years as an academic in universities in Nigeria, Zambia and Saudi Arabia. He returned to Sri Lanka in 1986, and has been a Consultant Geologist since then. He was on the staff of the Institute of Fundamental Studies in the period 1988 to 1992, and since then a Visiting Lecturer in the Department of Geography (1992-1996) and of the Department Geology (1996-) of the University of Peradeniya. He has, since 1993, been a Member of the Board of Management of the Geological Survey and Mines Bureau of Sri Lanka. He now spends much of his time writing, lecturing and conducting workshops in scientific writing in Sri Lanka and countries of the SAARC region.

Professor Cooray holds degrees in Geography and Geology, and is a Fellow of the Geological Society of London and of the National Academy of Sciences of Sri Lanka. He was recently honoured by the Geological Society of America by being elected an Honorary Fellow of that Society. Dr Cooray is the author of several books and scientific papers, and besides the present title, two others are soon to be published. These are: "The Knuckles Massif — A Portfolio", to be published by the Forest Department, and "Geological Field Notes and