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ENVIRONMENTAL
MANAGEMENT
IN
SRI LANKA

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REPORT OF A SUB - COMMITTEE

NA-142

IN COLLABORATION WITH
NATIONAL SCIENCE COUNCIL OF SRI LANKA

ENVIRONMENTAL MANAGEMENT IN SRI LANKA

Report of the Sub-committee
appointed by the Ministry of Planning
and Employment to study
Environmental Management in Sri Lanka
1973

National Science Council of Sri Lanka

1978-03-23
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PREFACE

The Prime Minister, Mrs. Sirimavo Bandaranaike, in a directive dated 2nd November 1972, to the Secretary, Ministry of Planning and Employment, has taken the initial steps to initiate action, concerning Environmental Management in Sri Lanka. I give below, an extract from the letter sent by the Secretary to the Prime Minister to the Secretary, Ministry of Planning and Employment.

“Many countries have already taken steps to set up the necessary machinery to improve and protect the quality of their environment by controlling air and water pollution, regulating the use of pesticides, fungicides, insecticides and toxic substances and improving their open spaces, parks and places of scenic beauty. Although we do not have in our country the problems of highly industrialized countries, the Prime Minister considers that it would be prudent to act now and adopt such measures as are necessary to protect and improve the quality of our environment. This question impinges on the functions of a number of Ministries and other organizations. The Ministries of Health, Communications, Agriculture & Lands, Irrigation, Power and Highways, Industries and Scientific Affairs and the Water Resources Board, are some of the organizations that will be interested in the problem. The Prime Minister thinks that, in course of time, we will have to set up a single authority to tackle this problem, but for the present, she proposes to assign the subject of Environmental Pollution to the Ministry of Planning and Employment.

The Prime Minister suggests that a Standing Committee be set up in your Ministry with representatives of the other Ministries concerned to study the problem of Environmental Pollution in so far as it affects us and to recommend to Government what steps should be taken immediately, legislatively or administratively to arrest any deterioration in the quality of our environment”.

As a result of this directive, the Secretary, Ministry of Planning and Employment, Dr. H. A. de S. Gunasekera, convened a meeting on Environmental Pollution/Management at the Ministry of Planning on 4th April 1973. This meeting was attended by representatives from a number of Ministries and other organizations concerned with the Environment. At this meeting, among the decisions taken were the following :—

- (1) A Standing Committee was to be established at the Ministry of Planning, consisting of the following members :—
 1. DR. G. H. P. DE BRUIN — Assistant Director, Fisheries.
 2. MR. LEEĀNANDA DE SILVA — Senior Assistant Secretary, Ministry of Planning and Employment.
 3. MR. P. L. N. DE SILVA — Deputy Director, Ministry of Agriculture and Lands.
 4. DR. R. C. DE SILVA — Assistant Secretary, Ministry of Industries and Scientific Affairs.

5. MR. U. T. K. GAMAGE — Secretary, Water Resources Board.
6. MR. N. GURUSAMY — Senior Assistant Secretary, Ministry of Irrigation, Power and Highways.
7. DR. G. C. N. JAYASURIYA — Secretary-General, National Science Council.
8. MR. A. S. A. PACKER — Deputy Director, Department of Wild Life Conservation.
9. MR. D. RAJENDRA — Senior Assistant Secretary, Ministry of Public Administration. Local Government and Home Affairs.
10. DR. (MRS.) P. C. RODRIGO — Assistant Director, Ministry of Planning and Employment.
11. MR. M. B. C. SILVA — Assistant Secretary, Ministry of Communications.

- (2) A Sub-Committee was appointed under the Chairmanship of Dr. G. C. N. Jayasuriya, Secretary-General, National Science Council, to study and report on the problems of Environmental Pollution/Management in Sri Lanka.

The terms of reference and the composition of this Sub-Committee is given in the body of the report. The Sub-Committee met on six occasions in the Board Room of the National Science Council during the period May to August 1973. In addition to this, several informal meetings of members of the Sub-Committee took place inbetween the formal sessions. The present report is the outcome of all these deliberations.

The subject of the Environment is a complex one. We have been given rather broad terms of reference and within the limited time available to us, we have endeavoured to produce as comprehensive a report as possible on the state of the Environment in Sri Lanka. There are bound to be shortcomings, for which, we make no excuse.

The Environment is a theme which has attracted global attention during the last decade or so. The problem was highlighted at the U.N. Conference held in Stockholm last year. A couple of years back, the British Government set up a Ministry for the Environment and other governments are following suit.

In a developing country like Sri Lanka, we face a real problem. On the one hand, we have to develop quickly, while on the other we have, at the same time, to protect our Environment. As such, decisions have to be made very carefully lest we end up in a situation like that facing some of the highly developed countries.

I should like to take this opportunity of thanking all the members of the Sub-committee, those who were co-opted and others who contributed towards this effort. It has been my privilege and indeed my great pleasure to chair this group of very enthusiastic persons.

I should also like to make special mention of the hard work put in by Dr. M.W. Ranjith N. de Silva, Scientific Officer, National Science Council, who functioned as Secretary to the Committee and without whose dynamism, we would not have been able to produce this report so soon.

The Prime Minister has so rightly stated that "it would be prudent to act now and adopt such measures as are necessary to protect and improve the quality of our environment". Finally, I would sincerely hope that this report will be the beginning of an effort made by Sri Lanka, to conserve and properly maintain her Environment, so that future generations may not blame those of us living in the country at the present time.

The Prime Minister has so rightly stated that "it would be prudent to act now and adopt such measures as are necessary to protect and improve the quality of our environment". Finally, I would sincerely hope that this report will be the beginning of an effort made by Sri Lanka, to conserve and properly maintain her Environment, so that future generations may not blame those of us living in the country at the present time.

G. C. N. Jayasuriya

Chairman

Sub-committee on

Environmental Management/Pollution

(Secretary-General)

National Science Council

National Science Council,
47/5, Maitland Place,
Colombo 7.
30th July, 1973.

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I. MEMBERSHIP AND TERMS OF REFERENCE

I.1 MEMBERS

DR. G. C. N. JAYASURIYA (*Chairman*)

Secretary-General, National Science Council

DR. A. W. R. JOACHIM

Member, Water Resources Board

DR. L. N. RAJENDRA

Assistant Director, Environmental Health and Education, Department of Health

DR. G. H. P. DE BRUIN (Alternate—DR. P. CANAGARATNAM)

Assistant Director (Research), Department of Fisheries

DR. (MRS.) P. C. RODRIGO

Assistant Director, Ministry of Planning and Employment

MR. K. M. ABEYSINGHE (Alternate—MR. D. RAJENDRA)

Assistant Secretary, Ministry of Public Administration, Local Government and Home Affairs

DR. L. S. K. B. HERATH (Alternate—MR. P. L. N. DE SILVA)

Deputy Director of Agricultural Development, Ministry of Agriculture and Lands

DR. M. W. RANJITH N. DE SILVA (*Secretary*)

Scientific Officer, National Science Council

I.2 CO-OPTED MEMBERS

MR. C. SATKUNANATHAN

Deputy Government Analyst, Government Analyst's Department

DR. P. V. C. PINNAGODA

Research Officer (Occupational Health), Division of Occupational Health, Department of Labour

MR. CHANDRA GUNASEKERA

Deputy Commissioner of Labour and Chief Inspector of Factories, Department of Labour

MR. M. Y. M. THAHIR
Director/Development, Sri Lanka Tourist Board

MR. M. W. J. G. MENDIS
Engineer/Acting Assistant Government Town Planner, Town and Country
Planning Department

I.3 THE SUB-COMMITTEE WISHES TO THANK THE FOLLOWING FOR ASSISTANCE

MR. E. CARLO FERNANDO
Engineer, Water Resources Board, for article on "Hydro-power develop-
ment in Sri Lanka,"

MR. J. H. HENSMAN
Senior Engineer, Water Resources Board, for article on "Sri Lanka's water
resources and their conservation,"

MR. D. B. PATTIARATCHI
Director, Geological Survey Department, for article on "Conservation of
Minerals in Sri Lanka,"

MR. J. S. GUNASEKERA
Soil Conservation Officer, Department of Agriculture, for article on "Review
of studies on soil erosion and conservation over the past hundred years,"

DR. K. A. DE ALWIS
Assistant Soil Chemist, Land Use Division, Irrigation Department, for article
on "The soil as a resource in Sri Lanka,"

THE COLOMBO PORT COMMISSION
for circular on "Sea Erosion,"

THE DEPARTMENT OF NATIONAL ARCHIVES
for certified copies of Gazette notifications,

THE FOREST DEPARTMENT

THE DEPARTMENT OF WILD LIFE CONSERVATION

MISS S. W. LEE
Steno-typist of the National Science Council, for typing this document.

I.4 TERMS OF REFERENCE

TO STUDY AND REPORT ON THE PROBLEMS OF ENVIRONMENTAL MANAGEMENT/
POLLUTION IN SRI LANKA.

2. INTRODUCTION

Need for the Study of problems of Environmental Management/ Pollution in Sri Lanka.

“Man is both creature and moulder of his environment, which gives him physical sustenance and affords him the opportunity for intellectual, moral, social and spiritual development. In the long and tortuous evolution of the human race on this planet, a stage has been reached when through the rapid acceleration of science and technology, man has acquired the power to transform his environment in countless ways on an unprecedented scale. Both aspects of man's environment, the natural and man-made, are essential to his well-being and to the enjoyment of basic human rights, even the right to life itself”.

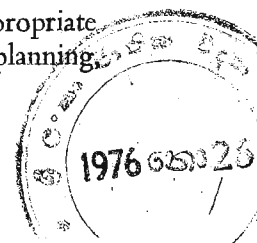
In his quest for better living, man has increasingly exploited the natural resources. Although the earth's natural resources are vast, they are not limitless. Due to over-exploitation on the part of man at least some of these resources are no more and some others are fast disappearing, one such being the whale. Examples of similar over-exploitation which has led or would lead to the extinction of some animals and plants are innumerable. Further, this is not limited solely to biological resources but applicable to every natural resource. Only proper environmental management and timely action can prevent a catastrophe.

Scientists have for a long time realized that all life is inter-dependent. Any change that seriously interferes with any living or biogeochemical cycle can have a major impact on life as a whole.

Paul Ehrlich states that—“We are in grave, grave trouble. There are 3.6 billion human beings on the face of the earth. According to our best estimates, there are somewhere between three and seven times more people than this planet can possibly maintain over a long period of time. We are able to sustain so large a population (mostly living in misery) at the moment because we are burning our capital, a process that does not seem to appeal to industrialists in conducting their business, but seems perfectly acceptable on a global scale. Non-renewable resources are being exhausted at a horrendous rate and we are destroying the capability of the planetary ecosystem to renew the supply of renewable resources”.

As a developing country, development of industrial resources is crucial for Sri Lanka, and pollution control may seem an unjustifiable cost. Industrialized nations are just now realizing that this traditional approach is short-sighted as they begin the massive and costly clean up of their air, land and water resources.

Although environmental problems in Sri Lanka have not assumed unmanageable proportions, it is advisable to act now, since preventive action can be incorporated into social and economic planning. The time is ripe for Sri Lanka to have appropriate machinery for environmental planning, management and evaluation.



Since environmental pollution/management covers a very wide field, it would be best to start within defined limits, while leaving flexibility for future expansion.

Priority should be given to problems at hand and to precautions necessary to prevent future degradation of the environment through the impact of industrial and agricultural development. It is essential not only to identify environmental problems, but to formulate a mechanism by which effective control could be achieved. Legislation alone will not be sufficient if the machinery to enforce such legislation is not clearly laid down.

Environmental studies undertaken in Sri Lanka, so far have been ad-hoc. Little concrete information is available as to the true state of the environment. The different aspects of environmental

management are governed by separate legal enactments and administered by different government agencies. Many laws pertaining to environmental management are not enforced effectively.

We considered the problems of environmental management under the following main topics :

- (a) Conservation of Natural Resources
- (b) Pollution of Land, Water and Air
- (c) Beach pollution
- (d) Problems of Human Settlement
- (e) Landscape preservation

In addition, we considered it essential to carry out a survey of legislative enactments and to obtain data on the equipment and instrumentation available for monitoring of environmental pollution in Sri Lanka.

3. CONSERVATION OF NATURAL RESOURCES

We consider that one part of Environmental Management is the management of our natural resources. As pointed out earlier, over exploitation on the part of man has led to the disappearance of some of the world's natural resources and some others are hovering at the brink of extinction.

At a time when Sri Lanka is at a juncture where her natural resources will have to be exploited to its fullest extent, we must point out strongly that unplanned exploitation of our natural resources is not advisable on a long-term basis. We include the following under our natural resources:

- 3.1 Soil
- 3.2 Water
- 3.3 Energy
- 3.4 Forests
- 3.5 Fauna and flora
- 3.6 Living aquatic resources
- 3.7 Minerals

3.1 Soil

Soil is one of the most important natural resources of Sri Lanka. It is a renewable resource unlike oil, iron ore, graphite, ilmenite and other mineral deposits which are non-renewable resources. Like any other resource, however, soil should be inventoried i.e. the quality, quantity and distribution

of the different soils and the potential for their exploitation should be catalogued. This is the principal task of the National Soil Survey Programme of the Land Use Division of the Irrigation Department.

The most important use of soil as a resource is in agriculture. The economy of Sri Lanka is still largely agricultural. A large part of the Gross National Product and over nine-tenths of the foreign exchange earnings are obtained from agriculture. Most of the capital for future development will have to be generated by agriculture. Sound information on the nature, extent and distribution of the soils and their management for optimum crop production is, therefore, of utmost importance.

The soil provides anchorage to plants and acts as a store-house for moisture and nutrients while allowing for proper aeration of the roots at the same time. The characteristics of the soil are therefore important in locating agricultural projects, formulating cropping patterns for different areas, selecting lands for irrigation, predicting irrigation and fertilizer requirements and practices, recommending farm layout plans and general land use planning. A good knowledge of the soil resources is, therefore, a sine qua non for any kind of agricultural activity.

The proper utilization of forestry resources is also dependent on a good knowledge of soil conditions for the reasons outlined above. The growth potential of different species in natural forests is highly dependent on soil conditions. Also, in the case of forest plantations, the soil properties have to be taken into account in selecting suitable species for any given locality.

Although agriculture and forestry constitute the main uses of soil, there are many other less obvious uses to which this resource is put. Thus, it is widely used in this country as a construction material for buildings either directly as earth and sand or in processed forms like bricks and tiles. Different types of soil materials are also used in reservoir and channel construction, road construction and in the production of ceramics, glass and cement. The soil may also be mined for gems and other minerals. In these uses, however, it has to be regarded as a non-renewable resource rather than a renewable resource. Soil is used as a medium for waste disposal and for transmission of water, power, gas, etc. It serves as the support for foundations of many buildings and is important in selecting and landscaping recreation areas.

Planning the exploitation of the soil resources of Sri Lanka should, as mentioned above, be preceded by an inventory (i.e. soil survey) because different soils may have very different properties and potentialities. Such a preliminary inventory is already available in the form of the 'Soil Map of Ceylon' published by the Land Use Division* in 1971. In combination with similar information regarding climate, land-forms, water resources, biota and location, this map should help in formulating rational schemes of development. In all such schemes, however, it should be borne in mind that, although soil is generally a renewable resource, unscientific exploitation without proper conservation measures could result in the permanent destruction of much of this valuable resource.

The subject of erosion and soil conservation has not received the recognition and importance it should have since it was first brought to the notice of the authorities nearly 100 years ago by the studies, references and pronouncements of that eminent scientist and naturalist Hooker in 1873. This is so in spite of such significant statements on the subject as "Your Island is slowly being washed into the sea" by the Director of the Royal Botanical Gardens, Kew in 1928 and "Whatever the future economic prosperity of the country will be, it is dependent on the few inches of top soil" by the Minister of Agriculture and Lands in 1951. Nevertheless, erosion and soil conservation has received low priority in the Island's development programme. Whatever the reason, good results cannot be expected whenever an activity receives this treatment. However, the silent creeping power of erosion is being felt as it continues and escalates, being overlooked under programmes of land clearing, settlement and production in the name expediency. This is no doubt a short-sighted policy that will adversely effect sustained production.

Since the first reference in 1873 to this subject by Hooker who initiated and was instrumental for the memorable land order prohibiting clearing of forests over 5,000 feet, a number of scientists have written or referred to the subject. They are Thwaites (1878) on the effects of deforestation, Vincent (1892) on forest policy and reservation, the Kelani Valley Railway Commission (1895) on the effects of soil erosion and siltation on the navigability of the Kelani River, the commission on Soil Denudation in

* Irrigation Department

Kelani Valley (1905) on soil denudation, effect on crops, floods due to faulty opening of land, Strange (1909) on damage to irrigation works due to erosion and siltation, Lushington (1921) on productive value of forests, Norris and Eden (1930) on the physical properties of soil as influencing erosion, and Joachim and Holland (1933) on green manures and cover crops and erosion and an investigation on silt in Ceylon rivers. Against this background comes up the question of large scale forest and land clearance for potato farming above an elevation of 5000' which is underway at present.

From 1935, there seems to have been a period of lull with little activity or attention to the subject till 1947 when it was included as a special item in the post-war development proposals. On the investigational side, the work of Joachim, Kandiah and Pandithesekera on the physical and physico-chemical properties of Sri Lanka soil showed, however, that the dry zone soils of non-lateritic character, were more erodible than the laterite and non-lateritic soils of the wet zone. The humic patana soils are most water stable while the cultivated calcic Jaffna soils are least so. In 1951, the soil conservation act was promulgated. The declaring of erodible areas and soil conservation regulations applicable to these were passed in 1953, 1959 and 1961.

The second phase in regard to work and studies on the subject was started by Gorrie and associates (1950) with the Land Reconnaissance Survey of the Gal-Oya Valley—an investigation on land use, erosion and related aspects, and the first of its kind to have been undertaken in Sri Lanka. This was followed by a series of land use

surveys in the Kotmale Valley sub-catchment and villages of Mawela, Madakumbura, Dunukedeniya and Tispane by Gorrie, Gunasekera and Saravanamuttu.

Gorrie reviewed the Soil Conservation Act and also studied and wrote on Drainage Basins Management and on Land Slides (Trop. Agric. Vol. cviii, 1952).

Investigations and studies on erosion in the Dry Zone were also initiated at this time and plans, designs and layouts prepared by Gorrie and Abeyratne. These were subsequently followed by studies by Alles—on run off and infiltration.

Investigations initiated in the up-country were followed by Wickremasinghe (1953—56) with a detailed land use survey of the Kotmale area and the Dimbulla/Dickoya Planting Districts and the formulation of a land suitability classification for these areas. He also made studies on the run-off and infiltration of the soils referred to in an article "Some aspects in planning essential for soil-conservation measures" (Trop. Agric. Vol. cxiv, 1957).

Investigations on erosion problems and conservation needs of the upper catchments of the 3 major rivers—Upper Walawe, Upper Kelani and Mahaweli Uva basins were carried out by Gunasekera and Sinniah in 1962/1963.

In 1962/64, land capability studies and land classification studies in respect of tobacco and tea lands in the Kandy District were undertaken by Gunasekera and associates.

A review of soil conservation studies and work in the upcountry region was made by Krishnarajah (Govikam Sangarawa Vol. V—2, 1962).

In 1965, Hassele carried out studies on erosion and soil loss in tea (Journal of the N.A.S.C. Vol. 2. No. 1/1965). Arumugam and Associates (1969/70) carried out investigations on watershed management in Kumbalwela tank, and land and water resources in Hanguranketa area (Water Resources Board Publication).

The latest studies and investigations in the field were by Smith, Somapala and Gunasekera (1970—Land capability specifications for the wet zone lands. Surveys in Atabage, Nilwala catchments).

A report comprising far-reaching proposals for the re-organization of the work on soil and land conservation has recently been submitted to the Government for consideration.

Sea Erosion

Since 1964, coastal protection has been the responsibility of the Colombo Port Commission. Since then, within the limited resources available, the department has executed protective works on an annual planned programme whilst also tackling emergency works as and when necessary. Since 1964, a sum of approximately Rs. 1 million has been spent annually on such works.

It is well known that beach erosion in Sri Lanka has been aggravated by sand and coral mining, rock blasting for navigation of fishing crafts, and uncontrolled coastal adjustments by various organizations. It is obviously futile to permit such operations to continue and then spend large sums of money on the protection of the coast. In addition, the existing legislation was weak and the punishment woefully inadequate, and this to some extent explained the reluctance of the Police

and the Government Agents to launch prosecutions. Allied to the control of this illegal activity in the coastal areas was the socio-economic problem.

In view of these difficulties, the Port Commission and the Ministry of Shipping and Tourism proposed in 1971 the following measures to protect the coasts of Sri Lanka:

(1) The creation of a single authority to control and co-ordinate all coastal activity in Sri Lanka and to conduct research on coastal engineering problems.

(2) Framing separate legislation with provision for severe punishment, for safeguarding the coastline.

The Cabinet approved these recommendations in 1972 and it is expected that legislation will be enacted during the course of the year. With the implementation of the proposed legislation alternative sources (which are readily available) will have to be tapped for commercial requirements of lime and sand.

It must be mentioned that protective works constructed in the last decade minimised the problem of sea erosion in a number of coastal areas, and the planning and execution of these works today can be carried out at a steadier pace and on a more scientific basis in the light of past experiences. Action is also being taken by the Colombo Port Commission to conduct a comprehensive coastal investigation programme in order to ascertain further the causes of sea erosion in Sri Lanka.

The Port Commission has brought to the notice of the law enforcing authorities these illegal activities on several occasions in the past, but no

effective action has been taken probably for reasons stated earlier. It is conceded that new legislation by itself, however strong it be, cannot successfully control the damage to our coastline without the voluntary participation of the people. A complementary course of action would appear to be the organising of a programme to educate the people on the long-term effects of damage to the natural protection of our coastline.

3.2 Water

Source & Cycle

Rain precipitation on the land surface of our Island, in extent 25,332 sq. mls. or 16.25 million acres, is our only source of water. The long term average rainfall of the Island varies from nearly 40" at Mannar to 225" at Ginigathena. The rainfall pattern divides the Island into three zones viz. the wet, the intermediate and the dry zones. The precipitation in these three zones vary between 125" to 225", 75" to 125" and 40" to 75" respectively. In terms of water, this precipitation amounts to 103 million acre feet or 6.25 ft. depth of water over the whole Island.

This large volume of water is distributed between the three undermentioned links of the hydrological cycle of rain-cloud formation and precipitation. A part of the precipitation runs off to the sea as surface and lateral flows, another part infiltrates into the earth's crust to recharge the ground water reservoirs and maintain the flow in rivers and streams, and the rest is evaporated and transpired back into the atmosphere to maintain the cycle. The distribution of water between the three links of the cycle depend on factors like topography,

extent of land surface, soils, rainfall, temperature, humidity, wind velocity, vegetation and land use.

Surface Run-off

Taking the first link, surface run-off, the total quantity of water drained into the sea from the land mass of the Island is estimated to be 39.7 million acre feet or 38% of the total volume of the precipitation.

The estimated long term average yield from the 83 rivers of the *dry* zone is 18.2 million acre feet per annum. Of this, the contribution from the Mahaweli Ganga, Sri Lanka's largest river, is estimated to be 7.2 million acre feet. It has been estimated that of this large volume of water, about 10.3 million acre feet could be regulated for utilization by man. Though these rivers are classified as dry zone rivers because they flow through this zone, most of the larger rivers like the Mahaweli Ganga, Walawe Ganga, Gal Oya, etc. have their sources in the wet and intermediate zones.

The long term average yield of the 20 rivers of the *wet* zone is estimated to be 21.5 million acre feet. The contribution from Kalu Ganga, the largest river of this zone, is estimated to be 6.4 million acre feet. This large volume of water is drained from an area of only 4,712.5 sq. mls. or 18.6% of the total area of the Island. Therefore, floods and water logging are common features in this zone.

Conservation of this "wealth" would involve the construction of reservoirs to store, regulate and divert it for utilization by man and for prevention of floods.

Ground Water

The second link, the water infiltrating into the ground to recharge the water bearing formations of the earth's crust is termed "ground water". Wells, both the open shallow type and the bore wells, intercept this water and make it available to man for domestic and other uses. No comprehensive survey of the ground water resources of the island has been done and therefore its potential is not known.

However, ground water investigations and studies have been done and are in progress along the North-Western coastal belt and in the Jaffna Peninsula. Both these areas are nearly completely underlain by limestones and their highly permeable cavernous and karst structures form good underground reservoirs to absorb and store the infiltrating water. It is estimated that the 20 sq. miles of the North-Western belt encompassing the Vanathivillu limestone and Moongil Aru formation areas have a ground water storage capacity of more than 60,000 acre feet.* The flow net analysis of this area indicates the movement of 11,000 acre feet of water a year through the limestone belt of which about 4,500 acre feet is planned for extraction for agricultural purposes. Similarly, studies have shown that of the precipitation on the 400 sq. miles of the Jaffna Peninsula in an average rainfall year of 53.11", the recharge is estimated to be nearly 90,000 acre feet. The annual water consumption for domestic and agricultural uses is estimated to be 40,000 acre feet and therefore the balance is probably discharged to the sea.*

Another facet of the ground water reservoirs is the existence of natural springs. Springs could be described as the natural over-flow of water from the underground reservoirs or aquifers. It appears on the ground surface as a current of flowing water emerging from vents. Depending on the capacity of the underground storage and the rainfall, the flow of these springs is either perennial or seasonal. Hence, springs are an important source of water and are popularly used for domestic and agricultural purposes in this country. For maintaining and building up this natural source, proper preservation is vital.

Evaporation and Evapo-transpiration

The last link of the chain is largely dependent on nature's conditions. However, destructive and improper use of our land and water resources could increase these losses and cause other adverse effects. For example, indiscriminate clearing of forests would increase surface run-off and reduce the ground-water recharge. This in turn would deplete the lateral and ground-water flows and therefore affect the discharge of rivers, streams and springs. Ground-water infiltration could be effected in cultivated land by taking effective soil erosion and control measures.

Conservation

Water is one of our vital resources indispensable for sustaining all forms of life. The expanding population of our nation makes more and more demands on it. Therefore, it is essential that proper conservation measures be adopted to prevent depletion and waste.

* 'Ground Water in Ceylon' by V. S. Balandran, Geological Survey Department, 1970.

3.3 Energy

Sri Lanka's major power resource at present and for some years to come will be the hydro-potential of her rivers. The theoretical potential which can be calculated by the mean annual surface run-off and the mean gross head upto the mean sea level is called the gross potential. But the technically exploitable potential is only a fraction of this. Again, the economically exploitable potential which finally is considered for implementation depends on many factors such as:—

- (a) the country's priorities—irrigation or power or flood control, etc.,
- (b) the other sources of power,
- (c) the development of the reservoir area, and
- (d) the economy of the country.

Over the years, several organizations have studied this subject, and due to the factors above, their figures vary very widely. Moreover, some studies have been done by formidable teams of experts covering many years, whilst some others sometimes by only one expert. In general, the more comprehensive the study, the more power that can be found. For example, in 1958, one expert concentrated on eight major plants in the Mahaweli

and arrived at a figure of 745 mw installed and 3,240 million kwh ruling out the Mahaweli diversion. Later in 1968, a team of experts studied this basin and estimated the economical installed potential with the Mahaweli diversion to be about 950 mw and 4,700 million kwh out of 43 power plants.

Apart from this, the team has expressed the view that many smaller hydro-power plants can be constructed on the other streams in the basin not included in their report.

The proposed Kukule reservoir in the Kalu Ganga basin is a clear example of the influence of the country's need on the economical potential. If Kukule water is used purely for power, it could be dropped to Pelang and have an installed capacity of 702 mw. But on the other hand, if the trans-basin diversion from this reservoir is carried out as has been suggested, this power potential will be reduced to zero as the technically feasible 25 mw installed capacity en-route may be ruled out, as it is said to be not justifiable.

Given below are the wet zone rivers on which power studies have been made. The remarks show the degree of these investigations, some fairly comprehensive, while others are insufficient. The economic potential of the basins revealed by those studies are also shown.

River	Remarks	Installed Capacity mw	Units kwh 10 ⁶
Mahaweli	Good	745 — 950	3,240 — 4,700
Kelani	V.fair	510	2230
Walawe	V.Fair	75 — 126	320 — 382
Kala	Fair	120	350 — 580
Gin	Fair	45	200
Nilwala	Fair	10 — 65	50 — 338
Maha Oya	Poor	15	70
		<u>1,520 — 1,831</u>	<u>6,460 — 8,500</u>

Hydro-power development on a commercial basis started only after the completion of the Laxapana Power Plant in 1950, though some small hydro-power stations existed before that time. Since 1950, five hydro-power plants have been constructed with a 50 mw thermal station—

Kelanitissa, which serves as back up for hydro-power during the dry season.

The following table indicates the parameters of the hydro-power plants already constructed and of those plants which are under construction —

<i>Power Plant</i>	<i>Year Completed</i>	<i>mw Installed</i>	<i>m.kwh</i>
Laxapana (Kelani)	1950	50	273
Inginiyagala (Gal Oya)	1959	10	60
Norton (Kelani)	1962	50	120
Uda Walawe (Walawe)	1969	6	22
Polpitiya (Kelani)	1970	75	313
Polgolla (Mahaweli) under construction		40	237
New Laxapana (Kelani) under construction		90	337
Bowatenne (Mahaweli) under construction		40	200

We should remember that the installed capacity of the above power plants is about 20 percent of the potential of the seven river basins referred to earlier.

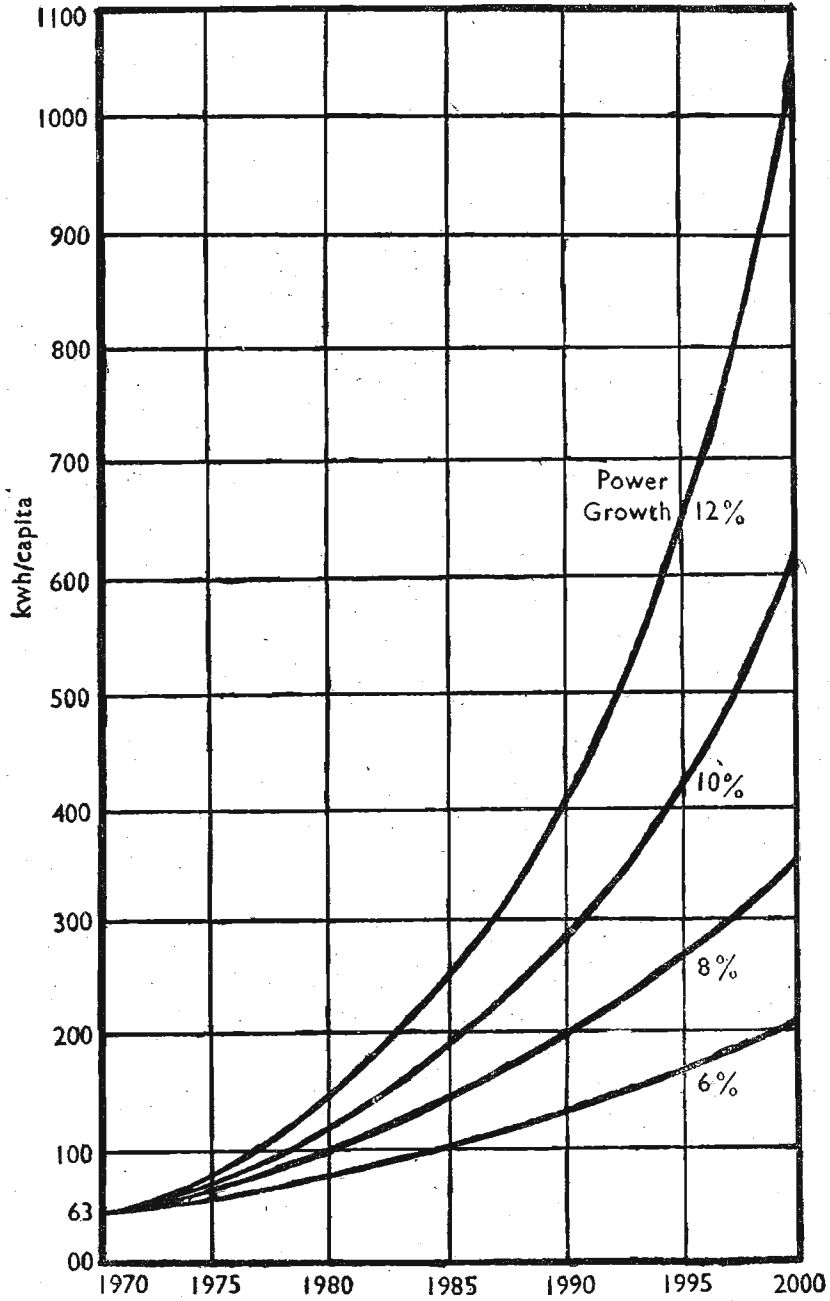
A recent economic study of the existing power plants has revealed the 1972 cost of a kwh unit from Laxapana to be 5.85 cents ; Polpitiya 6.05 cents ; Inginiyagala 9.15 cents. The Inginiyagala Station had worked at a low load factor of 38 per cent. But a load factor of 55% would have brought down the unit cost to 6.3 cents. On the other hand, in the same year, the fuel cost alone of a kwh from Kelanitissa Steam Station is 6.95 cents and from Chunnakam Diesel Station is 8.5 cents.

This study indicates that the construction of a hydropower plant in general even without firm power can be very conservatively justified, if the capacity factor of a hydroplant be such that its unit cost is less than the fuel cost alone, leaving aside all the other costs of a thermal power plant. Run off the river plants and turbines

fitted to irrigation sluices come under this category. They can be firmed sometimes by parallel thermal sets or by other plants in the grid. It is based on such economic analyses that advanced countries have hundreds of small hydro-power plants constructed in their streams. For instance, over 950 small hydro-power plants are operated by private power utilities of Classes A and B in the U.S.A., an industrial giant, rich in oil, coal, gas and nuclear technology. About one-half of the number of these stations are of less than 2 mw capacity. But this little Island considers even a quantum of 10 mw of hydro-power is not worth considering although in terms of energy, she has only a hydro-power potential.

In our planning, we cannot remain blind to world price trends—OPEC, the Organization of Petroleum Exporting Countries has doubled the per barrel price over the past three years (Time, May 28, 1973). If we fail to plan with foresight, we would find ourselves trapped by rising world market prices.

PER CAPITA GENERATION RELATED TO POWER GROWTH



Average annual increase in population from 1970 - 2000 is assumed at 1.75%

$$\begin{aligned} \text{Per Capita generation in 1970} &= \frac{785 \text{ mkwh}}{12.5 \text{ m}} \\ &= 63 \text{ kwh} \end{aligned}$$

As the commercial development of electricity started in Sri Lanka rather late, the load developed at 13% from 1950 to 1960 and at 11.5% from 1960 to 1970. The official forecast for the period 1970 to 1980 is at 10%. The per capita production of electricity in 1970 was 63 kwh units. The curves in the attached figure show that the per capita production would be for load growths from 6% to 12% and at a population increase of 1.75%. By the year 2000, at a load growth of 10%, the per capita production would be only 640 kwh units. This is a very low figure for the year 2000 as in 1966, countries like Argentina had 678, Denmark 1939, Portugal 600, Singapore 650, Yugoslavia 871, Taiwan 588. By the year 2000, these countries would be in the 6000 kwh/capita range if they maintain the same growth rates assumed for Sri Lanka. To maintain these assumed growth rates, the installed capacity, including standby capacities, will have to be about 1800 mw by 1995 and 2900 mw by the year 2000.

Though our per capita production of electricity is very low, electrical energy represents only 4% of the total energy consumption in the country. The balance 96% of the energy is met mostly from imported fuels, such as, kerosene oil, diesel oil, coal, etc., resulting in a drain of foreign exchange (*Sessional Paper XXII—1966*)*. These figures show that this country has the potential for an electricity growth of 12% or even more. In this respect, railway electrification and the change-over of existing thermal loads in the plantation sector to electricity should be the first step. This will result in a saving of foreign exchange and in turn will enable new industries to be

financed. Only if our industrialisation is developed in this manner, will our plans for progress become meaningful for we are truly utilising one of our natural resources—our water for power.

3.4 Forests

According to present estimates, Sri Lanka has approximately 6, 121, 200 acres of forests. These have been divided into :

- (a) The dry zone forest—5, 280, 200 acres
- (b) The intermediate zone forest—283, 900 acres
- (c) The wet zone forests—557, 100 acres

based on the climatic zones in which they occur.

The part played by forests in the conservation of soil and water resources as well as the amelioration of local climatic conditions cannot be underestimated. Apart from these, the forests are important as a source of timber and one should not ignore their aesthetic value. The need to preserve and maintain productive forests, especially those of the wet zone has been voiced often enough by the forest experts.

In declaring certain forests as reserves or proposed reserves, factors such as the gradient, rainfall, sources of rivers, effects on irrigation schemes, effects on flood control, elevation, siltation and local climatic effects have been considered. Therefore, it is very necessary to at least maintain those reserves, if not add to the already approved or proposed forest reserves.

* Report of the Committee on Power, Cost and Development in Ceylon.

The Conservator of Forests states in an article "A study of the protective benefits of the wet zone Forestry Reserves of Sri Lanka" appearing in the Sri Lanka Forester 1972 that:

"The total number of reserves in the wet zone is 159. Of these, 29 have either disappeared completely or been reduced to very small isolated patches rendering impossible the protection of whatever is left. The disappearance of these forests is due to releases for village expansion and to encroachments. The present extent of reserves as given in the Departmental records, i.e. the inventory figures less official releases, is 380, 340 acres. However, the actual extent of reserve forest leaving out the encroachments and illicitly cleared areas is estimated at only 334, 953 acres. There has therefore been a 14.4 per cent loss of forests from the reserves since 1956 in which year the aerial photographs on which the forest inventory was based were taken. 334, 953 acres represent a bare 9 per cent of the land area of the wet zone."

On the question of alternative crown land available for development, he states that "Besides the reserves, there are considerable extents of other crown forests and degraded forest areas which are available for development in the wet zone. The extent of such areas may be reasonably estimated at about 250,000 acres. These areas could, with proper cultivation practices, be improved and used for agriculture. For development schemes in the wet zone, therefore these areas should generally be selected in preference to reserves where release could have disastrous effects."

The present forest policy is—

- (1) To reserve and maintain adequate and suitable forest reserves for the amelioration of

local climatic conditions, conservation of soil and water resources and for aesthetic purposes,

- (2) To scientifically manage the forest resources so as to meet part of the timber requirement of the country,
- (3) To progressively build up plantation forest estates to meet future timber requirements of this country, both for internal consumption as well as for exports, and also to contribute towards conservation of soil and water.

It would be inadvisable to deviate from these accepted policies for the purpose of short-term gain. Unmanaged and unplanned exploitation of our forest reserves would be detrimental to Sri Lanka; the damage done thereby to our environment would be irreparable.

3.5 Flora and Fauna

Of the large number of medicinal plants and herbs allowed for export from Sri Lanka (Schedule I), some are cultivated, while many are collected in the wild state. Although the export potential in these plants is high, planned exploitation and constant surveys are required to prevent over-exploitation which have disastrous effects.

Seven plants in Sri Lanka are protected under the Fauna and Flora Ordinance and the subsequent acts (Schedule VII). They are the Wesak orchid, Baobab tree or Judas Bag or Money Bread tree, Foxtail or Batticaloa orchid, Primrose orchid, Daffodil orchid, Anuradhapura orchid and the Sphagnum Moss or Bog Moss.

The Department of Wild Life Conservation maintains :

1. (a) Four Strict Natural Reserves (Yala, Ritigala, Wasgomuwa and Hakgala)
- (b) One Nature Reserve at Horton Plains
- (c) One Jungle Corridor at Nelugala where the fauna and flora are absolutely protected and maintained without disturbance.
2. Five National Parks (Ruhuna, Yala East, Wilpattu, Gal Oya and Uda Walawe) where entry is permitted only for study and observation of the flora and fauna.
3. (a) Two Intermediate Zones (Wasgomuwa and Veddikkachchi)
- (b) Thirty-nine Sanctuaries (Schedule II)

Regulations may be made —

- (i) prescribing the conditions and restrictions subject to which persons may be permitted to enter any Intermediate Zone or to hunt, shoot, kill or take any wild animal therein ;
- (ii) prescribing the circumstances and cases in which the conditions and restrictions subject to which wild animals may be hunted, shot, killed or taken in a Sanctuary.

Apart from the Strict Natural Reserves, Nature Reserves, National Parks, Jungle Corridors, Intermediate Zones and the Sanctuaries which afford protection for plant and animal species, a large number of birds, reptiles and

other animals are absolutely protected by legislation under the Fauna and Flora Protection Ordinance which is effective in all other areas. Certain birds, however, are not protected during the open season from the 1st of November to the 12th of April each year. Certain animals are allowed to be hunted, shot or killed only under a special licence (see Schedule III, IV, V and VI).

A major problem of wild life conservation is the unplanned land alienation without due regard to the need for conservation of flora and fauna.

Another problem is the difficulty of preventing poaching and illicit felling of timber from the protected forests.

Authoritative sources have pointed out that the opening of the Buttala—Kataragama road along its present trace on the left bank of the Menik Ganga and the proposals for the development of Lower Uva would lead to many problems which would make wild life conservation in the affected parts of the Ruhunu National Park and the Reserve extremely difficult.

Commenting on the problems that face the Department of Wild Life Conservation, the Senior Deputy Director states thus : ‘Perhaps the most significant problem which faces this Department is the conservation of the wild elephants of Ceylon, which now do not count more than 1,500 animals. Over the years there has been an indiscriminate, sporadic and large scale clearing of jungles which are their natural habitats for various purposes. In the process many animals are being forced out of their forest abodes to cultivations where they are doomed.

Forest corridors recommended by the Committee for the Preservation of Wild Life (*Sessional Paper XI—1959*) could not be applied as planned because most of these areas unfortunately fell within areas proposed for development. It is my opinion that the present position regarding the elephant has reached rather critical proportions. Immediate effective measures should be taken to ensure their survival. As a first step towards this problem, the Department now issues licences for their capture; to start with in areas where they are trapped in pockets of forest, surrounded by cultivations and in areas where damage to cultivation is apprehended”.

3.6 Living Aquatic Resources

The aquatic resources of this Island, whether of streams or lakes, lagoons or estuaries or the sea, like those of other tropical regions, consist of a bewildering array of species, in contrast to those found in temperate climes. This makes their scientific study extremely difficult and our understanding of the inter-relationships among them and their relationships with the environment in which they live, more complicated than is generally realized. This diversity of ecological communities makes us realize that more time and effort must be devoted by scientists to unravelling these relationships than is done in temperate regions.

Fresh Water Fishery Resources

The Fresh water Fishery resources are distributed in the perennial shallow irrigation reservoirs of the low country, the villus or flood-lakes of the low country—some of which are perennial, the seasonal village tanks located mainly in the low-country, the deep irrigation and hydro-electric reservoirs of the

hills and plains, and rivers and streams. The total extent of these is nearly 250,000 acres.

Of nearly 60 species of fish found in fresh waters, only 17 species are important as food fishes, i.e., just a third. Only 8 out of 17 occur in sufficiently large numbers to be important as food fishes. It is clear now that a good proportion of the nutrients found in fresh water is utilized by commercially unimportant varieties of fish. To those accustomed to eating sea-fish, fresh water fish is dull and unpalatable. They are also, when alive, ugly to look at, which character detracts from their acceptability as food.

The natural productivity of the fresh waters, when compared with estuaries or the sea, is poor. This indicates that there is little natural drainage of nutrients from the land to the water or that the monsoonal rains being so strong, the nutrients are carried rapidly down rivers through estuaries into the sea. Which of these two is true can only be surmised, for there is a lack of consistent monitoring of the nutrient contents of these waters.

Some of the important food fishes of fresh waters are the Carps or Pethiyas; the Cat-fishes such as the Walaya and the Walapotha; and the Snakehead or Loola. Around 1950, fishes occurring in other parts of the world were introduced into our waters. These were the Common Carp, the Giant Gouramy and the Tilapia. Today, a quarter century after its introduction, Tilapia has spread widely and forms a major constituent of our fresh waters. It has spread, unchecked by natural barriers, to such an extent that the estimated production of the fresh waters is said to have increased several fold.

The living resources of the hill-streams and lakes are extremely poor compared with waters of the low and midcountry. Imported varieties of fish such as the Mirror-Carp and the "Rainbow" Trout were bred locally and distributed among the streams and lakes of the highlands with tremendous success. For a long time, they were important for the recreational facilities provided to the angler and also as food. This was especially true in these regions where fish proteins were scarce. Trout culture in other countries is lucrative and deserves more attention in our country than has been given in the last few years.

The introduction of exotic varieties has had the desired result in low-country water, but this also has its pit-falls. Future introductions of exotic varieties should be carried out with more care and control, especially since Grey Mullet and Milk-Fish forms, abundant locally, can be cultivated in these same waters. These do not breed in fresh water unlike the common Tilapia. The point to be emphasized here is that any introduction of exotic varieties could upset the balance of the environment unless it is scientifically carried out. Today, it would be almost impossible to get rid of Tilapia from our fresh waters or reduce its numbers.

In Sri Lanka, fertilizers in agriculture and pesticides and agrochemicals such as DDT and PCBB have been used increasingly since the end of World War II. In more recent times, industries such as the paper and cement industry have discharged effluents into rivers, lakes and the land. Waste oil from other industries located on the banks of rivers and lakes find their way finally into these water-bodies.

Fertilizers like phosphates and nitrates in excess are a great danger to aquatic life in rivers and lakes and can make conditions difficult for other forms of life except algae. These nutrients produce algal blooms. On dying, the algae utilize much of the dissolved oxygen in the water during decomposition, leaving very little or none to others.

Although there are still no reports of large fish kills due to pesticides, the danger from this source is ever present. Their effects are slow and difficult to determine until they become a serious problem.

Paper factories discharge sulphite wastes and lignin and sometimes mercury into water-ways. A case in point is the paper factory at Valaichenai. Here once clear water has turned a dirty brown. The sludge from the paper mills has settled at the bottom and killed off all forms of life except the most resistant varieties.

The cement factories at Puttalam, Jaffna and Galle discharge their wastes into the air. They are spread by the wind, far and wide, and settle all around the land. During heavy rains, these wastes are carried into water ways. It would be interesting to analyse the composition of these wastes and their effects on aquatic life.

Copper fungicides have been used since the beginning of the tea industry. The concentrations of these residues in fresh waters have still to be determined. Copper is well known as a toxic substance.

Arsenites from rubber estates find their way ultimately into rivers and lakes. Their effects on our fauna have still to be determined but arsenites are known to be inimical to life.

Brackish Water Resources

Shallow lagoons, tidal flats, mangrove swamps, saline marshes and deep lagoons and estuaries constitute nearly 100,000 acres of brackish waters.

Brackish water bodies are important sources of prawns, crabs and fish such as the Grey Mullet or Godaya, the Milk-fish or Vekka, and the giant Perch or koduwa. Brackish water is also the nursery ground of fish that breed in the sea such as the horse Mackerel or Parau, the Barracuda or Jeela, the Ox-eyed Herring or Ileya and the long Herring or Ranawa. Certain lagoons have large quantities of the Sprat or the Ahirava.

In the North-West or Northern lagoons, an important fishery for beche-de-mer or *Holothuria* exists. This is not eaten locally but is exported to Singapore, Hong-Kong and Malaysia and is an important earner of foreign exchange. In the more saline lagoons of the North-West, North and North-East, a very considerable amount of china moss is available. This is harvested and consumed locally on a small scale. In the past, a considerable amount was exported. This weed yields agar-agar or jelly which is used for many purposes.

Fishing in brackish waters is carried out intensively. There is no indication of stocks of fish or prawns at the present moment, although fishermen complain of scarcity. This may only be a reduction in the catch per unit effort which invariably occurs when there is a considerable increase in the fishing efforts. But the size of crab has become so small in certain lagoons like Negombo and Chilaw, that it would appear that this species has been over-fished.

Fish fry and prawns and young crabs are extremely sensitive to chlorinated hydrocarbons such as DDT and PCBB. Lagoons can also be adversely affected by eutrophication and there is indication of heavy silting of some lagoons due to deforestation and increased land-use in agriculture. Wastes from paper factories and oil from industries can also cause damage to brackish water fauna. Great care should be taken in planning new irrigation schemes, for de-salination has serious effects on brackish water life.

Marine Resources

The sea is by far the most important aquatic resource as it is the largest in area.

At the water's edge on sand-stone formation are the sea-weeds or the Algae. Approximately 315 species of marine Algae have been reported in Sri Lanka, of these 84 species belong to the Green Algae (*Chlorophyceae*), 65 to Brown Algae (*Phaeophyceae*) and 166 to the Red Algae (*Rhodophyceae*). Many countries of the world make use of this resource as food, fertilizers, fodder, and for the extraction of economically important products.

In Sri Lanka, at least some species of Brown and Red Algae could be exploited for our use and for export. Sodium alginate is a product which could be obtained from *Sargassum* (a Brown Alga) which is found in large quantities in Sri Lanka. Sodium alginate is used extensively in the paper, paint and textile industries to name only a few. Agar-Agar is obtained from the Red Algae. Two species of *Gracilaria* from which Agar-Agar could be extracted are available in quantity in Sri Lanka. Durairatnam, Gero and

Wimalasiri (Bull. Fish. Res. Stn., Sri Lanka (Ceylon), Vol. 23, Nos. 1 and 2, pp: 29—35, June and December 1972) have given details of techniques for exploiting these algae for Agar-Agar on a commercial scale. Agar-Agar has many uses.

Here again, necessary steps should be taken to prevent over-exploitation. Over-exploitation without due consideration to certain aspects such as regeneration and proper conservation has led to the loss of these resources in some countries.

On rocks at the water's edge are the edible bivalve molluscs or the Green Mussels. These are found in fair quantities in the South from Bentota to Hambantota. The Northern shore line has vast quantities of the bivalve, sand-burrowing mollusc or "matti" which is delicious eating. Care must however be exercised in the use of bivalves as food since these creatures concentrate bacteria in their gut and they can very well concentrate pathogenic bacteria and viruses which reach the sea in sewage.

Shallow muddy areas are the breeding ground of prawns. Important fisheries exist in Mutwal, Negombo and Chilaw and in recent years, new sources of prawns were discovered off Mannar, Talaimannar and Mullaitivu. These prawn fisheries yield several hundred tons a year and they can be seriously affected by DDT and PCBB which adhere to particles of silt and finally settle on these grounds. There is no indication of the serious effects of these pesticides at the moment but the future has potential hazards from these chemicals.

In the sand-stone reefs on the South-West, West and Southern coasts, vast populations of the spiny lobster were

discovered since 1958. Fishing for these spiny lobsters has increased considerably on account of the high export price that it fetches among sea-food. Today, some areas (the richest discovered) are barren, and legislation has already been drafted to control the fishery and some areas are to be declared sanctuaries for spiny lobsters.

Coral reefs abound in the North-West, North, North-East and East and South regions. They are the corner-stone of the beautiful coral fish communities and also the home of migrants from the deeper regions of the sea. Young forms which are liberated during breeding of animals living with the coral form an important food supply of other fishes. Coral lobsters also form an important part of the coral reef community. Reefs also form a natural barrier against sea erosion. Dynamiting which is practised by fishermen does some damage to these coral reefs. The removal of coral for the manufacture of quick-lime is a more serious menace. But by far the greatest danger to coral reefs is the recent population explosion of the crown-of-thorns star-fish which is a specialist coral predator. This star-fish has laid bare vast tracts of coral reef. Projects are under way to collect these star-fish manually in order to contain its multiplication.

In recent times, the collection of brightly coloured coral fish has decreased rapidly. Some areas especially on the North-West coast are devoid of coral reef fishes and skin divers are now exploring the deeper recesses of the reefs. Conservation of coral reef fishes seems an important matter in view of the rapidly increasing tourist industry. The uncontrolled removal of coral reef fishes also upsets the balance of the coral reef community and by decreasing

larvae predatory pressure could have assisted in the population explosion of the crown-of-thorns star-fish,

Coastal waters support an extensive beach-seine or "ma-del" fishery, and it is said that 25—35% of the Island's total landing of fish are produced from operation of these nets. The beach-seine exploits the young forms of many of the larger fishes such as Seer, Parau, Sharks, Skates and rock-fish which migrate into shallow water in search of food. Important fishes caught by the beach-seine are the Indian Mackerel or Kumbala, the small Horse-Mackerel or Bolla, the Ribbon fish or Savalaya, the Wolf-Herring or Katuvalla, Sardines or Salayas, Anchovies or Halmessa and the Indian Herring or Hurulla.

There is much fluctuation in the size of the catch but this may only be a reflection of the fact that fishes do not come within the range of the shore-based net rather than of an actual scarcity in the stocks of the various varieties of fish.

With the introduction of new gear, especially nylon nets, the above varieties have been caught in small meshed nylon drift-nets with a resultant decline in the frequency of operation of the beach-seine operated from the shore.

Bottom-dwelling fish such as Snappers, Breems, Groupers and Horse-Mackerel are found in fair abundance in coastal rocky areas and they are exploited mainly by hand-lines or bottom-set nets. Modern fishing gear such as trawls cannot be operated on these grounds on account of the unevenness of the terrain. The major trawl-fishing carried out by our boats exploits the Wadge Bank which lies south of Cape Comorin on the west coast of India. Another important trawl-fishing ground

lies on the east coast of India and Pedro Bank, but this has not been subject to such high fishing pressure as the Wadge Bank.

The number of fishing boats has increased enormously in recent years with the introduction of mechanized craft and the grant of loans to fishermen for purchase of boats. We do not know very much of the effects of the increase in fishing intensity on the fish stocks as adequate records of the catch and fishing intensity have not been kept. Very little can therefore be said on the subject whether there is more scope for increase of the fishing intensity and this problem requires careful consideration.

Beyond the continental shelf are resources of Pelagic fish such as the Skipjack Tuna or Balaya, the Mackerel Tuna or Atavalla, the Yellow-fish Tuna or Kelavalla, the Frigate Mackerel or Ragoduwa, the Devil Ray or Angamaduwa, Sharks and the Sword-fish or Thappara. Since 1964, these stocks have been heavily exploited by the 11 ton boats of the Ceylon Fisheries Corporation using drift nets and today the 28 ft. boats owned by local fishermen also exploit this resource. Tuna-like varieties constitute nearly 50% of the catch obtained by these drift nets. Schemes have recently been put into operation to extend oceanic fishing beyond the continental shelf especially for the Skipjack Tuna or Balaya with the use of live bait and pole and line. This method when operated from large boats requires large quantities of live bait which can only be found in quantity in waters within our continental shelf. This brings in another strain on the fish stocks of the continental waters and the effects of such heavy increases in fishing intensity should be watched very closely.

The sea is subjected to pollution not only from effluents from contiguous land masses, but also from the air. Pesticides like DDT have been found in the bodies of Arctic seals. Ocean currents also carry pollutants from distant lands and recently there has been concern about the increase in concentration of mercury in the muscle of Tuna. The sea is not a mighty septic tank. There is a limit to the amount of pollution that the sea can take and release of harmful effluents should be brought down to a minimum.

3.7 Minerals

The bond between natural resources, their utilization and industrial development is well known among those concerned with national planning. The increased mining of minerals as a natural resource is evident by world production and consumption statistics. It is also known by all those who produce and utilise mineral raw materials that the supply of mineral resources will diminish in the years to come. Industrial growth over the last two decades particularly in the highly industrialised countries has taken a heavy toll of minerals from the more accessible deposits; high-grade portions of many ore deposits have already been mined out and the mining industry today is exploiting progressively low-grade deposits of mineral raw materials; and with the development of mineral technology, sophisticated flow sheets are in operation for beneficiation of ores.

In Sri Lanka, the important minerals mined are graphite, limestone, beach sands, clays, vein quartz, silica sands, feldspar, mica rock aggregate and sand for construction.

Graphite

Mining has gone on over the last 120 years or more, and the resources of this mineral are classified as 'inexhaustible'. The exploited veins and lenses have yielded material of high-grade graphite and only hand sorting and cobbing has been necessary. However, the beneficiation of graphite-bearing material with less than 50 percent carbon (until recently considered as 'waste') is a joint programme now under-way between the C.I.S.I.R., State Graphite Corporation and the Geological Survey Department, and the objective is to up-grade this material by mineral dressing up, to grades of over 95 percent carbon. It is also possible that other useful minerals such as pyrite and molybdenite may be available as by-products during beneficiation of low-grade graphite, and the success of this work would not only aid the utilisation of low-grade graphite, but also bring into industrial use material now largely classified as 'waste'. The mining of a mineral such as graphite even in deep mines requires development in advance, in order to prepare long-term mining plans so that production will continue over the years and this aspect has to be given careful consideration.

Limestone

Sedimentary limestones of Miocene age are mined in the Jaffna Peninsula and North of Puttalam mainly for the manufacture of cement. In 1972, nearly 580,000 tons of limestone valued at Rs. 6.7 million were mined by the Ceylon Cement Corporation. Dolomitic limestones of Precambrian age are mined in various parts of the country for manufacture of lime, and to obtain fine ground dolomitic rock to correct magnesium deficiency in soils.

In 1972, from available records over 3,000 tons of dolomite were mined but this figure is an under estimate and the correct figure may be in the region of about 5,000 tons an year. In addition, coral deposits of the South-Western and Eastern coasts are mined for the manufacture of lime for building and agricultural use, but statistics are not available as to the tonnages mined.

In terms of output, the mining of limestones for cement is the largest mining activity in the Island and being of high-grade, strict conservation measures should be taken regarding exploitation of this mineral raw material. In 1971, it was proposed* that the limestone deposits of the North-Western coastal belt be conserved only for industries approved by the Ministry of Industries and Scientific Affairs. The main reasons for this proposal were as follows :—

- (a) The areas in which these limestones occur near the surface and suitable for economic exploitation are few.
- (b) The use of such high-grade limestones for road metal and building is wasteful.
- (c) Estimates made by the Geological Survey Department during survey of the Parappukadantan area alone in the Mannar district, revealed that till 1963, over 300,000 tons of limestone had been mined for road metal and similar uses. A number of meetings were held by the G.A., Jaffna regarding this proposal, but unfortunately, no action has still been taken. It is urgent that this proposal be taken up afresh as alternative

road metal as well as aggregate for building could be obtained from Mankulam or Madhu road, which will no doubt increase the cost, but if implemented would enable the conservation of our high-grade limestone resources not only for cement, but for new industries in the future.

Beach sands

Beach sand minerals such as limenite, rutile, zircon, garnet and monazite occur at a number of points along the coast, but only a few are capable of economic exploitation and one of the richest is the deposit at Pulmoddai, which is now being mined on a large scale by the Ceylon Mineral Sands Corporation. Careful mining is carried out along this coastal stretch and with expansion, apart from ilmenite, rutile and zircon, other minerals such as monazite and sillimanite will also be extracted from the tailings. Exploitation of similar deposits particularly those on the West coast at Beruwela has been terminated for the present as it may aggravate sea erosion. It is proposed to work these deposits on a small scale within the next few years, and proper conservation measures will be taken to see that the waste material after obtaining the useful minerals are left back on the beach to prevent sea erosion.

Clays

The mining of clays for cement manufacture, white-ware ceramics and the manufacture of bricks and tiles is increasing rapidly. Although no statistics of the tonnages of clay used by the cottage brick and tile industry are available, the tonnages mined in 1971 for these industries by the State Corporations was in the region of about 125,000

* By the Director, Geological Survey Department.

tons valued at Rs. 2.78 million. However, it must be pointed out that the mining of clays has not been systematic and even where the resources have been proved to depth, mining has been confined to only a few feet below the surface and in 1970, the Geological Survey estimated that nearly 250 acres of land were mined each year ; but the reclamation of the areas mined has not been given due consideration and this is a worthwhile aspect to be given serious attention as most of the land so mined is potential paddy land. Immediate conservation measures are necessary to see that the full thickness of clay proved is extracted and that steps are also taken to reclaim the land after mining.

Felspar and Quartz

About 1,500 tons of vein quartz and 500 tons of felspar are mined each year for the ceramic industry and the mining is carried out by contractors and in most cases, the mining has been

haphazard and there is considerable waste of valuable raw material at the mining sites.

It is expected that with the coming into operation of the new Mines and Minerals Law of 1973, that there would be rationalisation in mining activities and that conservation measures would have to be adopted to see that the maximum benefits is obtained from exploitation of mineral resources. Further specific uses may subsequently be found for mineral resources which now appear useless, particularly low-grade mineral deposits and those with deleterious impurities. In general, the conservation of non-renewable resources such as minerals require rational and long-term exploitation plans together with prevention of waste through poor production and treatment techniques. The recovery, for example, of by-products present in small quantities is not only a principle of conservation, but may also ensure the economic viability of a project which otherwise might have not been possible.

4. POLLUTION OF LAND, WATER AND AIR

It is only recently that environmental pollution became a major issue on a global scale. A by-product of the development and maintenance of modern civilization, it now poses a serious threat to human existence on this planet and hence it is the concern of the highest forums of the world today.

The over-all pollution problem consists in preserving the biosphere—the life-giving, relatively thin layer of soil, atmosphere and water in which replenishing cycles of living organisms take place.

There are three major aspects which have to be considered under pollution of the land, water and air. They are:

- (a) industrial pollution
- (b) pollution through agricultural activity
- (c) pollution from the exhausts of internal combustion engines

4.1 Industrial Pollution

The smoke stacks of industry and incinerators contaminate the atmosphere by discharging a wide range of noxious substances into the air. It is almost a problem of unmanageable magnitude in the highly industrialised affluent countries. In the developing countries where industrialisation is almost in its infancy, this problem fortunately is not

so acute. In our own Island, in the absence of a vast industrial complex, either here or in the neighbouring sub-continent, it is a matter for conjecture whether the concentrations of toxic substances and gases exceed the limits and impair the health of the people. However, it is not too early to begin monitoring the atmosphere for pollution.

The discharge of industrial waste and sewage in the seas and oceans is already beginning to show disturbing results in many parts of the world. The capacity of these waters to absorb waste and sewage is being stretched and will soon reach dangerous limits affecting the entire planet. These pollutants not only affect the world's fisheries, but also enter the human body through the consumption of fish.

In our own country, we can easily see the effluents of the batik and other textile industries freely flowing into drains, streams and rivers. A probe by a special committee of the Colombo Jaycees recently regarding the Wellawatte Canal, revealed that it is being polluted by the dumping of untreated sewage by the C.M.C., industrial waste by industrial concerns and faecal pollution by persons who have converted it into a public convenience. This is true for most of the beaches and water ways in the country.

The disposal of sewage is a serious problem in this country. In most urban areas, including towns like Kandy, Galle etc., their collection and disposal are almost primitive.

Demarcation of industrial and residential areas in most urban areas are equally chaotic. These are some of the problems that require urgent attention by the authorities concerned.

Some of the industries that could cause pollution of the atmosphere and water in this country are—Paper, Agro-Chemicals, Cement, Petroleum, Leather, Ceramics, Textiles, Rubber, Rice and Saw Mills, Construction industry, Asbestos and Chemical factories.

It is reported that there are three ways by which toxic substances may enter the human body, namely by

ingestion, absorption through the skin and by inhalation. It is also reported that the majority of occupational diseases is caused by inhalation as it affords rapid intake of contaminants by the body.

The following table details out some of the agents or pollutants in air and on land and their possible effect on the health of human beings.

POLLUTION AND HEALTH

<i>Agents or pollutants in air</i>	<i>Possible effect on human health</i>
Oxides of sulphur in combination with airborne particles (smoke)	Aggravation of existing respiratory diseases and contribution to their development, impairment of lung function, sensory irritation.
Airborne particles	Increase in the effects of gaseous pollutants such as sulphur dioxide, possible toxic effects depending on chemical composition (e.g. particles containing lead or asbestos).
Oxidants including ozone	Eye irritation, possible association with asthmatic attacks; impairment of lung function in diseased persons.
Carbon monoxide	By combining with haemoglobin deprives tissues of oxygen; individuals suffering from cardio-respiratory disease are more sensitive; psycho-physiological effects possible even at low concentrations; smoking is an important source, perhaps more significant than exposure to motor vehicle exhausts.
Lead	Intake through water, air and food enhances the total body burden of this element, in excessive amount it may develop poisoning.
Asbestos	A possible factor in the incidence of lung diseases along with other air pollutants and smoking—pleural calcification observed also in non-occupational exposure.
Beryllium	'Neighbourhood' cases of chronic beryllium poisoning observed near beryllium production plants.
<i>Agent or Pollutant in Land</i>	<i>Possible effect on human health</i>
Human excreta	Schistosomiasis, taeniasis, hookworm and other infections.
Sewage	Urban filariasis, flies and other disease vectors.
Garbage and vectors inhabiting it	Rodent borne disease, pollution of water and air from disposal practices.
Industrial and radioactive waste	Effects from stored toxic metals and other substances through food chains.
Pesticides	Contamination of vegetation and secondary food stuffs and entry into food chain.

Legislation relating to pollution is incomplete, ineffective and enforced by different authorities without any central responsibility and control by the State (Chapter 9). The Factories Ordinance of Sri Lanka (Chap. 128) provides for the safety, health and welfare of the workers in establishments defined as Factories. The existing ordinance does not provide for the disposal of refuse or pollutants from factories. It should be made compulsory for factory owners to provide floor charts of the process, means of disposal of waste products, and also details of the buildings, plants, etc.

Sri Lanka has been mainly an agricultural country, dependant on an agricultural economy but intensive industrialisation is now contemplated under the Five Year Plan, to improve the living standards of the people. In this effort, industry would turn out to be a polluter of the air and water. Industries are springing up all over the country without proper plans and the public are now concerned with the pollution of the air and water, which are the primary necessities of life. It is therefore appropriate that the government should now contemplate introducing progressive legislation at all levels to bring pollution under control.

The western industrial society is now paying a high penalty for its failure to take adequate precautions against environmental pollution. Sri Lanka should profit by their experience and learn to avoid the mistakes they have made. Modern technology should be made to serve our endeavour for a better standard of living as well as a pollution-free world.

Another important aspect of pollution is noise. Noise pollution by industrial factories have not reached intolerable

proportions, but noise through community activities, especially the use of loud speakers at functions does cause inconvenience to the people in the surrounding area.

4.2 Pollution Through Agricultural Activity

Environmental hazards through agriculture in Sri Lanka may arise from the following sources :

- (a) Soil erosion, whereby sediments laden with absorbed pesticides and weedicides and even fertilizers are carried into water courses, etc. and thus cause adverse effects ;
 - (b) Animal manures and waste, which when in excess of farm needs will cause pollution when leached into or carried into water courses and even groundwater ;
 - (c) Dry zone irrigation where no drainage facilities are provided resulting in the development of alkali salts in the soil and causing crop failure.
- (a) (i) *Sediments from land erosion*

Soil eroded from cultivated land is the chief source of sediment in rivers, streams and reservoirs, but road construction, stream bank and gully erosion, housing development and logging operations are also important contributory sources. These sediments contain and absorb compounds which supply plant nutrients such as nitrogen and phosphorus. These promote excessive growth of bacteria, algae and other plant life in the water. Therefore a depletion of dissolved oxygen occurs, especially on the death and decay of these organisms, and this

results in harmful effects on fish and the onset of conditions conducive to foul odours and undesirable tastes in the water. The process of enrichment of water with nutrients is known as eutrophication.

(ii) Fertilizers

Agricultural output is determined to a large degree by adequate fertilizer inputs. The two main fertilizer nutrients affecting water pollution are nitrogen and phosphorus.

Nitrogen in excess of crop needs is partly leached from the soil as nitrate to the surface and groundwater and partly dispersed elsewhere in the ecosystem. Excess nitrate in potable waters may indirectly affect human health and that of infants in particular. The necessity for restricting levels of nitrogen application to approximate crop needs is therefore obvious.

Phosphorus is the key element in water pollution. Together with nitrogen, it is the cause of eutrophic action. In the countries where the problem has been experienced, phosphates from detergents have been identified as the main cause. The possibility of phosphates applied as fertilizers being leached out into waterways should also be borne in mind.

(iii) Pesticides

These are organic and inorganic chemicals used for controlling plant pests, plant diseases and weeds, and are known respectively as insecticides, fungicides and weedicides. There is little doubt that these agro-chemicals have been responsible for very appreciably increasing the production of man's food and other requirements. Further, some of them have also been used for controlling human diseases, e.g. DDT, in the control of malaria, at low cost and with great efficiency.

The minimum amounts of pesticides should, therefore, be used, as investigations in the U.S.A. have shown that while the quantity of pesticides applied in 1967 was three times that used in 1950, crop yield per acre had only increased by about one-third.

When tested *insecticides* are used with proper care and in the concentrations recommended for agricultural purposes, obvious ill-effects on man are rarely noted. Side effects of an adverse nature may, however, occur in other sectors of the biosphere and even in man. Most of these pesticides are decomposed in the soil or changed within the plant or insect and leave little or no residues. The organo-chlorine insecticides like DDT are the important exceptions, and are widely found in the environment in varying amounts and in the tissues of plants, animals and man. Though only very slightly soluble in water and occurring in it in traces, they are readily dissolved by fats and are absorbed by sediments.

These pesticide residues are taken up selectively from the sediments by plankton or earthworms and thence by small fish which in turn may be taken up by larger fish or birds. The concentration of pesticidal residues is thus magnified at each stage of the food chain. This biological magnification is known to have harmful effects on certain species of fish, birds and wild life, and several instances have been reported from different parts of the world.

As a result of these findings, the organo-chlorine insecticides have become suspect and their use has been banned in some countries like the U.S.A. But the view positively expressed in an authentic U.K. publication on 'Toxic Chemicals in Agriculture

in the U.K.' which has been endorsed by the WHO is that "no evidence has been produced of risk to man from organo-chlorine insecticides such as DDT when applied properly or occurring as residues in the normal diet". Until such time, as further evidence on the issue is forthcoming, we could continue using the present chemicals and change them when better ones become available.

Fungicides are inorganic or organic compounds used for controlling plant diseases both in temperate and tropical regions. Chemical fungicides were first used on a large scale in Sri Lanka for the control of blister blight of tea, copper compounds being then used. The maximum copper content in made tea was fixed by regulation and fungicide applications have accordingly been related to this safe limit.

There is, in general, little likelihood of contamination of food stuffs through the rational use of fungicides for disease control, if instructions for their use are correctly adopted. Many countries have introduced legislation in regard to the sale and use of agro-chemicals so as to ensure that these products are not a hazard to public health. Such legislation is shortly to be introduced in Sri Lanka as well. But, it will be necessary in the first instance to ensure that these chemicals are safe for use. This will necessitate systematic analyses of plant material, soil and water samples from water courses in the vicinity for toxic residues, and hence the establishment of an efficient laboratory service.

Weedicides are mainly organic chemicals used for controlling and destroying weeds. They are presently applied to large areas of land in temperate countries and also being increasingly

used in Sri Lanka. In general, organic herbicides decompose relatively rapidly in the soil and do not present toxic hazards to mammals.

(b) *Animal Manures and Waste*

Cattle and other livestock manure constitute a large proportion of farm waste, especially in countries where animal husbandry is intensively practised. In the process of storage, a part of the nutrients in the manure enters the surface water through run-off or leaching and contributes to the pollution effects already referred to. Even ground-waters may be polluted thereby. The problem of animal waste is best tackled through field spreading and re-cycling of wastes.

(c) *Soil Alkali*

Alkali in the soil can become a serious problem of irrigated farming in dry areas, and is caused or intensified by the lack of soil drainage.

Fortunately, in Sri Lanka, where rainfall conditions even in the dry zone are such as to permit the leaching out of these salts, the problem is neither general nor a serious one, as in some dry countries. Isolated patches of soil alkali do, however, occur and cause crop failure or reduction where soil drainage has been neglected or interfered with, as when drainage canals are blocked for cultivation by illicit settlers. The drainage of irrigated land is therefore essential.

4.3 **Pollution from Exhausts of Internal Combustion Engines**

Exhausts of motor vehicles, especially buses and lorries and other internal combustion engines, contaminate the atmosphere by discharging a wide range of noxious substances and gases into the air.

Special mention must be made of Ceylon Transport Board buses, many of which give out large quantities of smoke. Apart from contaminating the atmosphere, this smoke has a blinding effect on the motorists following these buses. This could cause serious road accidents. Even the smokeless exhausts of internal

combustion engines give out large amounts of noxious gases into the atmosphere. This is a serious problem which many major cities of developed countries face. Regular monitoring of the atmosphere for noxious gases would be necessary to prevent deterioration of the atmosphere, specially in and around Colombo.

5. BEACH POLLUTION

Sri Lanka is an Island blessed with a 1000 mile shoreline. A feature of the Island's shoreline is the green vegetation which skirts it by way of coconut palms or low jungle.

With the increasing complexities of economic development and the stress on social life, the community demand for recreational space and amenities would rise—a trend noticed in the developed countries consequent to the improvement of their living standards and an increase in their leisure time.

In the circumstances, the conservation of our beaches and coastal waters for local recreation purposes and as a source of income from tourism is imperative.

The Island's beaches and the coastal waters are not merely sources of recreation. They are also the means of livelihood for the local population, particularly ma-del fishing and employment in ocean-based recreational activities. It is estimated that 25% of the Island's catch of fish is from ma-del fishing.

Beach and coastal water pollution in Sri Lanka can be examined under the following headings :

- (a) Faecal pollution
- (b) Oil pollution
- (c) Waste water pollution
- (d) Industrial pollution

Faecal Pollution

Faecal pollution occurs directly as well as indirectly. Directly the beach is used for toilet purposes, and indirectly the sewage effluents are discharged into the sea and rivers without proper treatment.

Shanty settlements on the shore have added to the problem, the beaches becoming the dumping ground for disposal of garbage, sewage and domestic effluents.

Several measures have been taken to eliminate this problem. Some of the measures are the provision of toilets to the households situated in the neighbourhood of tourist areas, community education and even patrolling of the beach.

In two areas, public toilet facilities are provided, but not used. Provision of such public toilets itself is an unhealthy feature even with adequate precautions for disposal of waste matter. An adverse reaction is natural in any user of the beach who sees such facilities on the beach.

Due to lack of supervision of Town Authorities outside Colombo, conservancy labour do not hesitate to empty buckets of urine and, at times, faeces into the river or the sea.

Serious attention should be paid to the systems of sewage disposal on a national basis.

Oil Pollution

Waste oil pollution is a major problem of international scale. Although there are the 1954 International Convention and the Stockholm Convention on Pollution of the Sea, their implementation is more followed in the breach.

Examples of oil pollution of the beaches are rampant. Several complaints have been received from hoteliers, tourist groups and expert teams. Any beach, whether on the West, South or East coasts, suffers from this drawback.

Waste oil clots, travel down to the coastal waters and settle on the sea shore. They range from tiny bits to large masses. It is a major constraint on the use of the beach as well as the coastal waters. Swimming becomes difficult with the bodies of swimmers getting smeared with oil. Walking on the beach becomes a nuisance with oil clinging onto the footwear or the soles of the feet. No recreational activity is possible on such beach stretches. The waste oil also settles on the reef, rock and sandy crevices, affecting even the living environment.

In the ports, sufficient facilities of disposal of wastes, waste oil, etc. by ships coming into the ports are not available due to lack of funds. Also, any form of monitoring or surveillance of our ports requires financial outlays for personnel and equipment.

Waste and Storm Water Pollution

Waste water pollution is common in our urban areas where the domestic wastes are discharged into the coastal waters. A typical example is the stretch from Colombo to Mt. Lavinia.

Storm water too carries with it the urban wastes into the sea. Storm water outlets have become waste water outlets too. Hoteliers too are offenders in certain areas.

Local authorities do not have the finances to tackle this problem.

Industrial Pollution

The development of off-shore industrial areas and the pollution by industrial waste of waterways discharging into the sea contaminate coastal waters. A few instances are the outlet for leading coconut husk water into the sea off Coral Gardens, Hikkaduwa, waste from saw mills in Bolgoda lake, the flour mill wastes at Mutwal, and effluents from the Paper Factory at Valaichenai.

6. PROBLEMS OF HUMAN SETTLEMENT

We considered two aspects of the problems of human settlement:

- (a) Health problems
- (b) Problems other than health

6.1 Health Problems

In the development programme of Sri Lanka, new settlements are provided by the expansion and constructions of major irrigation schemes. In the recent past there have been the larger schemes like the Amparai, Rajangane and Udawalawe and now we have the Mahaweli Diversion Scheme started in 1971 and it is envisaged that new settlements will be provided for, all along its new course and tributaries. There has also been a continuing urbanization process, which is further supported by an increase in the density of the population in nearly all the principal towns. This is largely due to the progressive industrialisation, but this is somewhat reduced by the establishment of many large State Corporation industries in the rural areas. As a result, new settlements are created in areas all over the country to meet this situation. The impact of these new settlements has aggravated the existing health problems.

(i) Land Pollution

With the social and economic advancement of man, the wastes produced by him keep on increasing

and with it, methods for its safe and hygienic disposal have to be developed and enforced. The responsibility for the collection and disposal of refuse of domestic, commercial and trade origin rests with the Local Government administration. The commonest method adopted in this country for the disposal of refuse is mainly by sanitary land fill, while incineration and composting are practised on a smaller scale in certain areas. The control exercised by sanitary fill is very poor and in effect, open dumps are created which are potentially dangerous to human and animal health. Solid waste products from industrial and agricultural sources have created many problems and some of these wastes are dumped on land. It has also been observed that there is faecal pollution of land, as a good percentage of the houses are not provided with sanitary latrines. At the census in 1963, the following statistics were recorded with regard to housing units and latrines :

- | | |
|--|-----------|
| (a) No. of housing units occupied | 1,971,740 |
| (b) No. of housing units with no latrines | 699,930 |
| (c) No. of housing units where latrine facilities are shared | 192,640 |

As a result of land pollution, there has been a high incidence of bowel diseases in the country. Gastro-enteritis, dysentery, diarrhoea, parasitic infestation, etc. have been alarmingly disproportionate to the total disease spectrum. It is significant that the bowel diseases as a group have been responsible for the largest number of deaths in this country over the years.

(ii) *Water Pollution*

There is a rapidly increasing demand for urban water supplies for both domestic and industrial use with increasing urbanisation and industrial growth. The provision of pipe borne water supply is limited to towns which have only about 18% of the Island's population. The rest of the population obtain water from shallow wells, rivers and streams, tanks and irrigation channels. While the Crown Lands Act has vested in the Crown the management and control of public lakes and streams and while miscellaneous pieces of legislation do refer to the pollution of water, these provisions usually incidental to the main enactment have not dealt with the problems of conservation and pollution in a comprehensive way. As a result of the pollution of water by human wastes, pesticides, industrial and agricultural discharges, there has been an increase in the incidence of bowel diseases and epidemics of Typhoid Fever, Para-typhoid Fever and recently of Infective Hepatitis.

(iii) *Pesticides in Public Health*

Malaria has been endemic in Sri Lanka for many years and epidemics have been reported every 3—5 years. The most recent epidemic was in 1967 where there were a large number of cases. Naturalistic methods were adopted to control breeding of indicated species of mosquito, and oiling of rivers and streams were the anti-larval measures undertaken in the early years. There is a continuing need for DDT and to a lesser extent malathion for insect vector control work.

DDT became available in 1945 and was used in the programme for malaria control. In 1954, spraying in the epidemic zone was withdrawn and spraying in the endemic zone was

interrupted. However, due to increased trend of positive cases, spraying was re-established in the endemic zone. In May 1964, spray operations were withdrawn as the programmes entered the consolidation phase but were reintroduced in 1965 covering 12,000 homes with 75% DDT wettable powder at 4 monthly intervals. Towards the end of 1967, due to a serious outbreak of malaria, an emergency programme for its rapid control and a long term eradication programme were developed.

In the control of Filariasis, malathion is used as a larvicide and is confined to the coastal belt in the south western part of the Island. All new settlements have to be sprayed effectively with DDT if the malarial transmission is to be interrupted. The same will apply to Filaria if this disease is also to be controlled particularly along the coastal belt. DDT is by far the insecticide of choice in a developing country like Sri Lanka, because of its efficacy and will continue to remain so. Moreover, there is no evidence of risk to man by this insecticide as there has not been a single death due to DDT poisoning even among the sprayers.

(iv) *Air Environment*

The atmosphere is exposed more and more to various contaminants. It is imperative that safe limits should be maintained for toxic and aesthetically obnoxious gases, particulates and radiant energy due to man's activity.

At present, although there are no grave problems created, the need for surveillance by source testing, emissions from industry exists. A Clean Air Act is necessary for the reduction of atmospheric pollution from smoke, dust and grit. Preventive action could also be taken when drawing up plans for new industrial furnace chimneys.

(v) *Slum Dwellings*

These dwellings are found in all parts of the country but are seen most in Colombo, the principal towns and the suburbs. Many of the occupants do not have permanent habitations but occupy whatever crown land is available, particularly along roads and canals and build their dwellings which are usually huts with a cadjan roof and without the basic amenities like latrines or wells. These dwellings have increased over the years and are a health hazard. These dwellers dump their domestic refuse and garbage and night soil on the adjoining land or even in a canal if there is one and invariably pollute the land and the streams. As is well known, dwellers live under sub-human conditions as they do not have the wherewithal to eke out a proper existence.

It has been observed clearly that the health of the people in slum areas is inferior to that of those who live in good residential areas. Poor housing makes the individual more liable to disease or to the effects of illness. More infectious diseases are prevalent. Children, who develop the usual childhood ailments have a higher incidence of complications. Over-crowding leads to increased spread of airborne diseases such as Pulmonary Tuberculosis. Dampness causes rheumatic problems and acute bronchitis in the elderly. Poor housing can also be a contributory factor for mental illness and mental subnormality. These conditions have a stultifying effect on the proper development of the family which cannot reach its full potential. Hence it is essential that there should be slum clearance schemes and the occupants should be resettled and rehabilitated in suitable areas.

6.2 Problems other than Health

Out of a population of 12.7 million in Sri Lanka, 20% live in urban areas, but yet the problem of environmental management and prevention of pollution is worse in urban areas than in the rural areas. This may be due, most probably, to unplanned city development. There are at present 12 Municipal Councils, 37 Urban Councils, 84 Town Councils and 542 Village Councils in Sri Lanka, and only in a few of these areas are zoning schemes declared and enforced. Mapping out of particular areas into residential, commercial and industrial sectors is not undertaken at all, in rural-local authorities which cover about 4/5 of the surface area in Sri Lanka. Declaration of zoning schemes in town areas is too late a step to be taken in this direction as by the time a particular locality is developed into urban status, the problems of environmental management have already considerably increased. Any changes for better environmental management by way of creating new towns cost more money. Owing to the lack of a plan for zoning schemes, most of the development that has taken place is now seen along public roads. This system of "ribbon development" aggravates the position when slums grow up. Hence, planning of a zoning scheme should be undertaken in the initial stages of development, commencing from the country-side, where planning for better environment is less expensive to the State.

The trends of development in Sri Lanka have been to concentrate all development activities mainly in the cities and particularly in Colombo. As a result, a large rural population has continued to migrate to the city of Colombo. There are similar concentrations of population in cities, such as,

Kandy, Jaffna, Galle and Kurunegala. Rural people who have migrated to cities in search of employment and their relatives and friends who have followed them continue to encroach upon any available crown land reserved along roads, canals, etc. and to erect unauthorised semi-permanent houses which do not have sanitary conveniences. This led to the growth of slums and hawkers pitches in urban areas. The hawkers have also converted their pitches into residences without sanitary or civic amenities.

Most of those who live in slums have got themselves exempted from payment of rates to local authorities either on the grounds of poverty or on the grounds that their slums are unrateable premises as they have been put up without due authority. These slum dwellers, however, add garbage to the existing street refuse, make use of water out of the standpipes along streets, avail themselves of the recreational facilities, make use of public amenities such as public lavatories, bathing places, open spaces, parks, etc. The slum dwellers enjoy these civic amenities without payment, and local authorities are faced with a situation where additional expenses have to be incurred for maintenance of conservancy and scavenging services, public utility services and other civic amenities at the expense of the rate-payer. With the increase in the cost of providing civic amenities and maintenance services, public utility services have gradually deteriorated resulting in an insanitary and dirty environment.

It is therefore necessary as is being done now, that more and more development projects should be undertaken away from municipal areas, preferably in suburbs. This will prevent the rural labour force migrating

into towns in search of employment. Any industrial or agricultural project should also provide suitable housing and other civic amenities to the working population in close proximity to such a project. This will ensure better environmental management.

Slum clearance housing schemes are undertaken by local authorities with government grants. Invariably, owing to limited finances, housing schemes are not planned to provide accommodation to all those living in a slum. Only a few will get houses from a local authority housing scheme and those who continue to live in the slums tend to encroach upon the open land where the demolished slums once stood. Thus, the problem of slums keep on growing and is aggravated by an enormous increase in the number of slum families as time goes on.

It is therefore necessary to plan out a scheme for eradication of slums completely, at least by stages. A new programme for slum clearance is now underway in the city of Colombo, whereby sites are allotted to slum dwellers from land acquired by the State or from land belonging to the Local Authority in suburbs of the city, where civic amenities are available. Stern action is also now taken against the coming up of new slums.

Removal of street refuse, garbage and night soil has become a problem as most of the Local Authorities do not possess the necessary cleansing vehicles or modern equipment for speedy disposal of street refuse etc. Owing to lack of finances and foreign exchange difficulties, primitive methods are adopted for collection and disposal of street refuse, garbage, etc. Bullock carts and hand carts are now extensively used to clean streets, public places and open spaces.

Further, owing to lack of incinerators and modern equipment, the refuse is tipped over in open places, and most of these places are not covered with earth. These dumping grounds are later found to be breeding places for mosquitoes and flies. Provision of communal dust-bins by local authorities is seldom seen, and most of the ratepayers themselves do not co-operate with the authorities by providing their own private bins. Provision of garbage vans, incinerators, communal bins are therefore necessary to maintain a sanitary and hygienic environment. The enactment of the proposed anti-litter laws will prevent throwing of refuse at public places.

Regulation and control of the construction of buildings are now enforced by Local Authorities under the Housing and Town Improvement Ordinance. This Ordinance is enforced only within the larger Local Authorities, and in a few of the built-up areas in rural local authorities. It is therefore necessary to enforce the provisions of this Ordinance in all built-up areas.

Repairs to ruinous and dangerous buildings are required to be effected by the landlords. If the landlords fail to undertake this job then the Local Authorities concerned will effect the necessary repairs and recover the expenses from the landlords under Section 102 of H and T. I. Ordinance. But according to the New Rent Act No. 7 of 1972, authority also devolves, under Section 13 of the Act, on Rent Control Board to undertake repairs to ruinous and dangerous buildings,

through the landlord in the first instance and by the R.C.B. if necessary. As a result, there is an overlapping of duties and functions with regard to repairs to such insanitary buildings and the Colombo Municipal Council has already decided to close down its Unit for the maintenance of ruinous and dangerous buildings. There is no satisfactory arrangement to effect repairs to owner-occupied insanitary buildings as the R.C.B. is not interested in such cases. To ensure a cleaner environment co-ordination of duties and functions in this field is therefore necessary.

The problem of insanitary housing is tackled by the establishment of Housing Schemes, by the National Housing Department and construction of slum clearance houses by Local Authorities. The National Housing Department grant loans to individuals to put up their own houses but there is no system of giving loans or grants by the State to those deserving persons to effect repairs to their present buildings which are either ruinous or dangerous. Allocation of funds to meet such expenses will be a necessary step to ensure a beautiful and hygienic environment.

Preparation of town centre maps, establishment of new towns, provision of traffic free shopping centres, preservation of places and buildings of archaeological and historical value, mapping out of green belts, and restoration of derelict land are some of the steps that have to be taken in the future for a cleaner and a greener environment.

7. HIKKADUWA—AN ILLUSTRATION OF THE PROBLEMS OF THE ENVIRONMENT

Hikkaduwa was considered as a typical example where a large number of environmental problems exist. Hikkaduwa is one of the best coastal resort areas and boasts of one of the finest coral formations in the Island.

Hikkaduwa which is primarily a fishing village, is fast becoming a popular tourist resort area. The main attractions are the wide beaches, the coral and the colourful fish.

Some of the major environmental problems at Hikkaduwa are :

- (a) Faecal and oil pollution of beaches
- (b) Waste water outlets
- (c) Conservation of coral and fish

Although a number of regulations have been promulgated to prevent the removal of sand, stone, coral, fish etc., some of these regulations are not enforced, while others cannot be enforced. Some of these regulations are :

(i) *Crown Lands Ordinance*

Under Sections 63 and 66, the coastal area from the 50½ and 68½ mile posts have been declared as an area from which no sand (sand may be removed

on permits received from the Government Agent, Southern Province) stone, coral or other substances shall be removed. (Gazette Notification No. 7710 of May 24, 1929—Part I, page 1358).

This area extends from Balapitimodera (Balapitiya) to near the river mouth of Gin-ganga river at Gintota. It also includes the shoreline at Seenigama, Telwatte and Hikkaduwa from where large quantities of coral are removed from the sea to feed the lime kilns along the side of the main road. Although sufficient legislation is presently available to stop removal of coral which is in fact contributing in no small measure to sea erosion in this area, no action is apparently taken against the offenders.

(ii) *Fauna and Flora Protection Ordinance*

Under this Ordinance, the Ambalangoda/Hikkaduwa Rocky Islets have been declared as a sanctuary—Gazette No. 8675 of 25th October, 1940.

Only a few bird species make these Rocky Islets their habitat, and as such, protection is afforded to only these birds.

(iii) *Fisheries Ordinance*

Regulations have been published under Section 26 in Gazette No. 12304 of 3.3.1961 to prevent the removal of any fish, except under authority of a permit issued by the Director or by an Officer authorised by the Director in his behalf, from a portion of the territorial waters which is adjacent to the coast of the area within the administrative limits of the Hikkaduwa Town Council, in the Divisional Revenue Officer's

division of Wellaboda Pattuwa in the Galle District of the Southern Province, and bounded as follows :—

NORTH : By a straight line drawn from the centre of the *buoy on the sea* at the North-Western corner of Lot 1 in M.S.P. 220 S.P., South-Eastwards along the Northern boundary of the said Lot 1 to the landmark at the Eastern extremity of the Northern boundary of the said Lot 1.

SOUTH : From the last-mentioned point South-Westwards, in a straight line over the sea, along the Southern boundary of Lot of 1 in M.S.P. 220 S.P. to the *centre of the buoy* at the Western extremity of the said boundary of Lot 1.

WEST : From the last-mentioned point Northwards over the sea and along the Western boundary of Lot 1 in M.S.P. 220 S.P. to the starting point of the Northern limit of the area.

The two buoys mentioned are important in defining the area and enforcing the regulation. Although the above mentioned buoys were placed in position in the early 1960's and again in late 1966, the buoys have not been able to withstand the monsoon season and have been lost. In the absence of these buoys, the regulation becomes ineffective.

(a) *Faecal and Oil Pollution*
Faecal Pollution

Faecal pollution is a major problem not only at Hikkaduwa, but at most of our beaches. This is a major drawback to the developing tourist industry. Although public conveniences are available, their number is inadequate

and they are not maintained properly, driving many people to use the sea beach as a place of public convenience. Since it is not conducive to site public conveniences on a beach, building of public conveniences, which should be maintained in a clean state, at suitable points away from the beaches and the promulgation of laws prohibiting the use of the beach as a place of public convenience may be the answer to this problem.

Oil Pollution

Two major sources of oil pollution of the beaches have been brought to our notice:

- (i) Dumping of waste oil at a distance from the coast.
- (ii) Dumping of waste oil by fishing boats even within the bay enclosed by the reef at Hikkaduwa.

It would be difficult to prevent the dumping of waste oil at a distance from the coast. Although a harbour has been built at Hikkaduwa, a number of mechanised fishing boats are anchored in the bay enclosed by the reef. A large amount of waste oil which pollutes both the sea and the beach, is dumped by these boats into the bay. In addition to the oil being a nuisance to the people using the beach or bathing in the sea, the oil is bound to affect the flora and fauna which include the coral, fish and seaweeds of this area. If this menace is not stopped immediately, Hikkaduwa could lose many attractive features.

(b) *Waste Water Outlets*

About 40—50 yards from the Coral Gardens Hotel, polluted water in which retting of coconut husks has been carried out is discharged into the bay enclosed by the Coral Reef at

Hikkaduwa. In addition to pollution a large area of the sea and beach, making it extremely unpleasant for the bathers this could also possibly affect the coral and fish in this particular area. In fact, hardly any coral or fish is available in the vicinity of the polluted water. This contaminated water will have to be diverted away from the bay to prevent inconvenience to the bathers as well as to possibly conserve the fish and coral in this area.

(c) *Conservation of Coral and Fish*

Strict enforcement of laws regarding the removal of coral and fish (with immovable land marks to mark off an area as opposed to buoys) and advertising the fact that fish and coral are protected through posters displayed in public places such as the railway stations, post offices and hotels may help considerably in their conservation.

8. LANDSCAPE PRESERVATION

The landscape of a country is as much a valuable asset as are its other resources." The country's aesthetic quality, climatic factors and social and economic characteristics constitute a priceless asset. A look at our country from this angle leads us to the inevitable conclusion that the landscape should be preserved so as to assure its benefits for the present and future generations. In fact, the Prime Minister has in her World Environment Day message, stated that "the beauty of our landscape should be safeguarded by the exercise of greater care in the use of landscape and water". (The Ceylon Daily News of 5th June, 1973).

Never in the history of man has the importance of environment been felt as in this century. Apart from the visual aspects of landscape, the economic and sociological requirements need to be considered for its preservation and conservation. The main components of the landscape are land, water and vegetation. They are closely related to each other when we think in terms of ecology which is the science of the landscape. Landscape is the appearance of man's environment whether it be in the rural or urban areas. A well preserved landscape would be a major tourist attraction and a valuable foreign exchange earner.

Soil fertility is essential for the preservation of a good landscape. This could be ensured only by proper land

use through scientific agricultural practices. Today in Sri Lanka, it is disturbing to note that these requirements are not given the consideration they deserve. In any rural environment, the agricultural land pattern and forest or wild vegetation are important features in producing a good landscape. Burning of grass land, together with the exploitation of forests through illicit and/or unplanned felling is an outrage against nature, creating an imbalance in the ecosystem of the natural environment and resulting in soil erosion and the destruction of the soil binding forest vegetation together with either the emigration of fauna to more hospitable regions or their total extinction.

Water when it occurs in quantity as in the ponds, lakes, tanks, rivers and streams is an important visual element of the landscape. But it plays its greater role below the ground surface in producing rich and luxuriant vegetation. The loss of sub-soil water enhanced by the destruction of suitable ground cover and shrub vegetation so necessary for its conservation, could seriously affect agricultural activities in the vicinity.

Even the fauna of forest land could have an effect on the rural landscape due to the predator-prey relationship. This applies equally to the insect population. The disappearance of larger carnivorous animals from a forest zone can be responsible for an increase in the number of grazing animals like the hare and deer which in turn will have its effect on grassland resulting in soil erosion and damage to agricultural crops and forestry plantations. This indicates the complexity of a wild life community, because of the diversity of factors on which the survival of the natural ecological system

depends. An unforeseen chain reaction could be triggered off by something done with the best of intention.

Mention should be made of the landscape of the sea coast of Sri Lanka which is a major attraction to an ever increasing number of tourists. It is quite evident that sea erosion takes its toll on the sea coast mainly due to the activity of man in the haphazard removal of natural vegetation and coral. On stretches of beach, where the littoral vegetation consisting of trees, shrubs and ground cover remain undisturbed, coastal erosion is considerably reduced. The planting of such vegetation on sea-side hotel sites has proved their efficacy. The soil binding properties of such humble plant material have not been given sufficient thought and deserve consideration in the preservation of the sea coasts.

Industrial estates, housing development, roads and railways to mention a few, are features of the humanised or built landscape and constitute example of disinterestedness of the authorities responsible for maintaining them in a manner that is useful to, and in harmony with, the surroundings. The humanised landscape if properly conceived and planned, can in fact be as much an asset as the natural landscape or even more so. For example, Jurong Town, Singapore's largest industrial

estate comprises large areas set apart as park-lands and green belts. Bamboo, cherry trees and a variety of shrubs and flowers are features of the landscaping. Meandering pathways, ponds and water-falls add to its beauty. Thus, while the booming industrial complex has attracted visitors intent on studying the Singapore industrial scene, it is the greening of the area that is now drawing visitors as part of Singapore's tourist attractions.

In Sri Lanka, swollen streams and rivers loaded with silt and precious top soil are common scenes in the planting districts of the hill country during the rainy seasons. It cannot be denied that this is due to soil erosion which could be minimised if more effective measures are taken than at present. Introduction of turf belts at suitable intervals may play a major part in preventing soil erosion in tea estates.

Land preservation is not a matter that should be regarded with complacency and relegated to the future on grounds that there are other matters of greater urgency. Unless this is done, in a few years' time, we will be in the same position as more advanced and industrialised countries where new landscapes are being artificially created at greater costs in the absence of natural vegetation that had been destroyed in the name of progress.

9. SUMMARY OF LEGISLATIVE ENACTMENTS PERTAINING TO ENVIRONMENTAL MANAGEMENT

9.1 Legislation to prevent pollution of rivers, streams and the atmosphere

- (a) *The Crown Lands Ordinance and Act (1947—1949)*

Give the state the power to take measures to prevent pollution of public lakes and streams.

- (b) *The Thoroughfares Ordinance and Act (1861—1953)*

Makes it an offence to throw rubbish, etc. into rivers and canals.

- (c) *The Colombo Municipal by-laws*

Forbid the "corruption" of water by chemicals.

- (d) *The River Valleys Development Board Act (1949—1965)*

Gives power to the Board to make by-laws to prevent pollution of water in its area.

- (e) *The Water Resources Board Act (1964)*

Requires the Board to advise the Minister on prevention of pollution of rivers, streams and other water-courses.

- (f) *The Nuisance Ordinance (1862—1946)*

Makes it an offence to throw unwholesome or offensive matter, liquid or thing into a stream, tank, reservoir, well, etc.

- (g) *Colombo Municipal Council Waterworks Ordinance (Chapter 208)*

Make provision to prevent pollution of streams, reservoirs, aqueducts and other water works belonging to the Council by (i) causing the water of any sink, sewer, or drain, stream engine, boiler, or other water belonging to any person or under his control to run or brought to any of the above water works. (ii) By bathing in any stream, reservoir, aqueduct, or washing, throwing or causing to enter their dog or other animal. (iii) Throwing any rubbish, dirt, filth or other noisome thing into any such stream, reservoir, aqueduct, hydrant, surface-box or other water works.

9.2 Legislation to conserve Natural Resources in Sri Lanka consist of provisions in various Ordinance and Acts as follows :

- (a) *Mines and Minerals Law (No. 4 of 1973)*

A law to provide for the vesting of the absolute ownership of certain minerals in the Republic, to regulate mining of, prospecting for collection, processing, sale and export of minerals, to provide for the health, safety and welfare of workers in mines, to enable the compulsory acquisition or requisition of immovable or movable property for any corporation established to develop the mineral industry, and to make provision for other matters connected with or incidental to the matters aforesaid.

(b) *Water*

Two draft Acts for the protection of springs, rivers, lakes and tanks and to control and regulate their water and to prevent pollution has been submitted by the Water Resources Board to the Minister.

(c) *Soil*

Soil Conservation Act (Chapter 450)—An Act to make provision for the conservation of soil resources, for the prevention or mitigation of soil erosion and for the protection of land, against damage by floods and drought.

(d) *Flora and fauna*

Fauna and Flora Protection Ordinance (Chapter 469) as amended by Acts Nos. 44 of 1964 and 1 of 1970, deals with the establishment and maintenance of:

- (a) Strict Natural Reserves
- (b) National Parks
- (c) National Reserves
- (d) Jungle Corridors
- (e) Intermediate Zones.

Protection of specified fauna and flora.

(e) *Water Hyacinth Ordinance* (Chapter 448)

An ordinance to make provision to prevent the introduction into, and dissemination in Sri Lanka of the plant known as the Water Hyacinth.

(f) *Plant Protection Ordinance* (Chapter 447)

An ordinance to make better provision against the introduction into Sri Lanka and against the spread therein of weeds, and of pests and diseases injurious to, or destructive of plants, and for the sanitation of plants in Sri Lanka.

(g) *Forest Ordinance* (Chapter 451)

An ordinance to consolidate and amend the law relating to forests and the felling and transport of timber.

(h) *Felling of Trees (control) Act* (Chapter 452)

An Act to provide for the prohibition, regulation or control of the felling of trees.

(i) *Fisheries Ordinance* (Chapter 212)

An ordinance to amend and consolidate the law relating to fisheries and to taking and protection of fish in Sri Lanka water, to provide for the registration of fishing boats, for the better regulation of the fishing industry and for purpose incidental to or connected with matters aforesaid.

(j) *Chank Fisheries Act* (Chapter 213)

An Act to make provision for regulating the taking of chanks, beche-de-mer, coral, shells, for regulating chank fisheries and the exportation of chanks and other matters incidental to or connected with the matters aforesaid.

(k) *Pearl Fisheries Ordinance* (Chapter 214)

An ordinance to amend and consolidate the law relating to the pearl fisheries of Sri Lanka.

9.3 Other legislation pertaining to the environment

- (a) *The Criminal Procedure Code (Sections 105 (i) (6), 106 and 114 (1)).*

Empowers Magistrates to order the suppression, removal or prohibition of any trade or occupation if it is injurious to the health or physical comforts of the community.

- (b) *Penal Code (Section 271)*

Makes any one who vitiates the atmosphere in any place so as to make it noxious, liable to a fine not exceeding Rs. 100/-.

- (c) *Food and Drugs Ordinance (Chapter 216)*

An Act to make provision for the regulation and control of the importation, sale and distribution of food and drugs and matters connected therewith or incidental thereto.

- (d) *Local Authorities (Standard By-laws) Act*

An Act to authorize the framing of standard by-laws for adoption by local authorities.

- (e) *Housing and Town Improvement Ordinance (Chapter 268)*

An ordinance to regulate construction of buildings, demolition of ruinous buildings etc.

- (f) *The Town and Country Planning Ordinance (Chapter 269)*

An ordinance to authorise the making of schemes with respect to the planning and development of land in Sri Lanka, to provide for the protection of natural amenities and the preservation of buildings and objects of interest or beauty, to facilitate the acquisition of land for the purpose of giving effect to such

schemes, and to provide for matters incidental to or connected with the matters aforesaid.

- (g) *Wells and Pits Ordinance (Chapter 232)*

An ordinance to provide against accidents arising by reason of wells and artificial pits being insufficiently fenced round or otherwise protected.

- (h) *Tourist Development Act. No. 14 of 1968—Part III*

Regulations may be made under this Act, prescribing a code comprising such provisions as may appear to the Authority competent to make such regulations necessary and proper for the purposes of the promotion of the safety and recreational value of public travel, and of the preservation of natural and scenic beauty.

- (i) *Municipal Councils Ordinance (Chapter 252)*

- (j) *Urban Councils Ordinance (Chapter 255)*

- (k) *Town Councils Ordinance (Chapter 256)*

- (l) *Village Councils Ordinance (Chapter 257)*

- (m) *Local Authorities (standard by-laws) Act, No. 6 of 1952*

— For Village Committees

— For Town Councils

9.4 Proposed Legislation

- (a) *Control of Pesticide Law*

A law to provide for the registration of pesticides and the regulation of packing, labelling, storage, formulation, transport, sale and use thereof.

- (b) *Coast Protection Act*

- (c) *Anti-litter Laws*

10. ENVIRONMENTAL POLLUTION MONITORING EQUIPMENT

Phenomenal advances in technology, rapid urbanisation, increasing population and mistakes of the past have produced chemical, biological and radiological contamination of land, air, food and water; destruction of natural resources; harmful physical agents like noise and radiation and a complexity of environmental changes that challenge man's adaptive ability.

As environmental change has accelerated, man cannot place his reliance on the slow process of evolutionary adaptation. Hence, he must be able to make sound judgements as to what are, or are not, permissible alterations in the environment with due emphasis on human health and welfare.

Contaminant—monitoring of the environment in which man lives, works and spends his leisure is therefore essential to (a) adopt levels of permissible alterations in the natural environment and (b) check compliance with these permissible levels. Thus, the purpose of environmental monitoring is primarily to eliminate the individual or cumulative adverse effects of various contaminants on the physical, mental and social well-being of all human beings.

In an environmental monitoring programme, the collection of samples requires a high degree of skill and

experience. The result of any subsequent analysis only has significance in relation to the method and situation of the sampling. From a chemical point of view, the method of sampling is often integrated with the method of analysis and both operations are best carried out by the same organisation.

Collection of solid or liquid samples (e.g. food or water) is fairly straight forward. However, the collection of a sample of an air-borne contaminant, that may adversely affect a person by being inhaled, absorbed through the respiratory system or skin, or ingested by contaminating food, hands and other objects, involves a new scientific discipline—Environmental Hygiene.

It is either the air contaminant or its metabolites in the body that produce the response in an individual. Further, the air contaminant may produce harmful effects in particular organs of the body. Thus, an air sampling programme for a changing environment should be based on the relationship between body—burden and air concentration of the contaminant. Therefore, air sampling instruments used in environmental monitoring have to be especially designed to suit various situations. Most of these instruments are very expensive.

The Occupational Hygiene Laboratory of the Department of Labour is fairly well equipped with air sampling instruments as well as instruments used to assess harmful physical agents in work-places. These instruments presently used for sampling the atmosphere of work-places could be used for monitoring the total environment with little or no modification as the scientific principles involved in Occupational Hygiene and Environmental Control are the same.

Sampling equipment available at the Occupational Hygiene Laboratory include instruments for collection of air-borne dusts (total or respirable fraction) fumes, gases, vapours and measuring noise, vibration, ionising and non-ionising radiations, heat, humidity, air velocity, lighting and ventilation (Schedule VIII).

Both physical and chemical methods are used in the analysis of air samples collected. However, some physical methods, such as, dust counting are outside the scope of other laboratories. Facilities for chemical analysis are available in other laboratories namely, the Government Analyst, Geological Survey, Drug Quality Control Laboratory and Medical Research Institute (Schedule VIII).

The City Analyst's Laboratory has facilities for determining the B.O.D. (Biochemical Oxygen Demand) levels of waterways; the City Microbiological Laboratory for bacteriological contaminants of food stuffs and water reservoirs. Some facilities are also available at the laboratories of the Fisheries Department and the Ministry of Agriculture (Schedule VIII).

From this survey of equipment available for monitoring the environment, we conclude that existing facilities are adequate for organizing and implementing only a modest programme of Environmental Control. An appropriate number of scientific personnel should however be appointed to man this programme.

II. SUMMARY

II.I Conservation of Natural Resources

From our study it becomes apparent that planned exploitation of our natural resources should be carried out if Sri Lanka is to make the best use of them on a long-term basis.

Erosion and conservation of soil, which have been over-looked under programmes of land clearing, settlement, and agricultural production, have not received the recognition and importance which they should have had. Sea erosion is also taking place due mainly to the removal of coral along many of our coasts.

The conservation of surface run-off water, by the construction of reservoirs to store, regulate and divert this resource for our use and for the prevention of floods, is necessary. Comprehensive surveys of ground-water resources of the Island have to be undertaken.

In the case of energy production, the main source in this country is hydro-power. Serious consideration should be given to the establishment of small hydro-power plants.

The part played by forests in the conservation of soil and water resources as well as the amelioration of local climatic conditions need not be stressed. There is no doubt that unmanaged and unplanned exploitation of our forests for short-term gain would be detrimental to Sri Lanka and the damage done thereby to our environment would be irreparable.

A large number of medicinal plants are exported from Sri Lanka. Some of these are cultivated while many are collected in the wild state. Although the export potential for these medicinal plants is high, planned exploitation with constant surveys are required to prevent their over-exploitation.

Over the years there has been an indiscriminate, sporadic and large scale clearing of jungles without due consideration for the conservation of wild life. In the process, many animals are being forced out of their forest abodes to cultivations where they are doomed. Another problem of wild life conservation is the difficulty of preventing poaching and illicit felling of timber from the protected forests.

When we consider the living aquatic resources care must be taken in the introduction of new varieties of fish into our waters, so that this would not result in an upset in the balance of the environment. In the case of brackish-water fisheries, care should be taken to prevent over-exploitation. Here it must be emphasised that the fishing industry could be the hardest hit by pollution from industrial waste. Care should also be taken in planning new irrigation schemes because de-salination would have serious effects on brackish-water life. Some species of Algae could be exploited for our use and for export, and here too over-exploitation should be guarded against and due regard has to be paid to regeneration and conservation. Not very much is known regarding fishing that takes place in the oceans around us. However, it must be said that pollution from effluents from contiguous land masses should be avoided, as there is reason to believe that there is a limit to the amount of pollution that the sea can take.

The increased mining of minerals around the world is causing concern. For example, in this country the mining of limestones for cement should strictly be conserved for this purpose. It has been found that this resource has been mined for road metal, which is to say the least, really wasteful. The mining of clay for cement manufacture, white-ware ceramics and the manufacture of bricks and tiles is increasing rapidly. However, the mining of clay has not been systematic and has been confined only to a few feet below surface even where deposits have been proved to depth. Reclamation of mined land has not been given due consideration. In general, the conservation of non-renewable resources such as minerals requires rational and long term exploitation plans together with prevention of waste through poor production and treatment techniques.

II.2 Pollution of Land, Water and Air

In the absence of a vast industrial complex, either in Sri Lanka or the neighbouring sub-continent, it is a matter for conjecture whether the concentration of toxic substances and gases exceeds the limits and may impair the health of the people and have adverse effects on our environment. However, it is not too early to begin monitoring the environment for pollution.

The discharge of industrial waste and sewage in the seas and oceans is already beginning to show disturbing results in many parts of the world. The capacity of these waters to absorb wastes and sewage is being stretched and will soon reach dangerous limits affecting the entire planet. These pollutants not only affect the world's fisheries, but also enter the human body through the consumption of fish. In our own

country, effluents of the batik and other textile industries, untreated sewage, industrial effluents and faecal pollution contribute in no small measure to the pollution of waterways and the ocean. The disposal of sewage is a serious problem in this country.

The demarcation of industrial and residential sites in urban areas is a matter that requires urgent attention. This is even more important in areas in the rural sector which are on the fringe of development into urban sites. In the latter case the costs involved would not be very great.

Industries are springing up all over the country without proper plans and the public are now concerned with pollution of the air and water, which are the primary necessities of life. It is therefore appropriate, that the Government should now contemplate introducing progressive legislation at all levels to bring pollution under control. Sri Lanka should profit by the experience of the Western industrial society and learn to avoid the mistakes they have made. Modern technology should be made to serve our endeavour for a better standard of living as well as a pollution-free world.

Environmental hazards through agriculture in Sri Lanka may arise from the following sources :

- (a) Soil erosion whereby sediments laden with absorbed pesticides and weedicides and even fertilisers are carried into water courses etc. and thus cause adverse effects.
- (b) Animal manures and wastes, which when in excess of farm needs will cause pollution when leached into or carried into water course and even ground-water.

- (c) Dry zone irrigation, where no drainage facilities are provided resulting, in the development of alkali salts in the soil and causing crop failure.

Excessive pollution from exhausts of internal combustion engines, especially from diesel engines should be prevented.

II.3 Beach Pollution

Beaches have become the dumping grounds for the disposal of garbage, sewage and domestic effluents. Serious attention should be paid to a system of sewage disposal on an Island-wide basis.

Recently, oil pollution of beaches of this country has become a factor to contend with seriously. This will be a serious handicap to the tourist industry and immediate steps should be taken to at least control oil pollution, if not eliminate it altogether.

Off-shore industrial ventures like the retting of coconut husks off Hikkaduwa, waste from saw mills on Bolgoda lake and effluents from the paper factory at Valaichenai, contribute in no small measure to contamination of coastal waters. Early action is therefore vital to prevent pollution from these sources.

II.4 Problems of Human Settlement

Here again, due to ineffective methods of disposal of refuse of domestic, commercial and trade origin and due to the fact that a large number of houses are not provided with sanitary latrines, serious problems have arisen. This has resulted in very high incidence of bowel diseases, which have been responsible for the largest number of deaths in this country over the years.

The provision of pipe-borne water is limited to towns which have only about 18% of the island's population. The rest of the population obtain

their water from shallow wells, rivers, streams, tanks, and irrigation channels. The latter type of drinking water, is not suitable due to contamination by human wastes, pesticides, industrial effluents and agricultural residues.

Slum dwelling are found in all parts of the country. This is one of the major problems of human settlement and almost every aspect of environmental management is violated in these slum dwellings, especially in the bigger cities. Already this is a serious problem and effective plans should be drawn up for the eradication of slums, at least in stages.

II.5 Landscape Preservation

The landscape of a country is as much a valuable asset as its other resources. On the one hand, steps should be taken to preserve the natural landscape so as to assure its benefits for the present and future generations. On the other hand, industrial estates, housing development schemes, roads, railways, etc. which are features of the humanised or built landscape should, if properly conceived and planned contribute in no small measure to the enhancement of the beauty of our country.

II.6 Legislation pertaining to Environmental Management

A considerable amount of legislation pertaining to environmental management is already in the statute books. Different aspects of environmental management are governed by separate legal enactments and administered by different government agencies. In many cases, the provisions dealing with environmental management are usually incidental to the main enactment and have not dealt with the problems of conservation and pollution in a comprehensive way, resulting in these laws not being effectively enforced.

12. RECOMMENDATIONS

Although for the purpose of this study, we have divided the environment into various fields, it is obvious that the subject of the environment is inter-disciplinary and embraces many fields, making all such divisions purely arbitrary. Further, the environment being a multi-disciplinary subject, should be handled in its entirety. We find that a large number of Departments and Ministries handle various aspects of the environment. There is also a considerable amount of legislation for the management of the environment. We also find that decisions made by one agency could directly or indirectly affect a large number of related or unrelated Departments or Ministries.

We recommend that steps be taken for —

- (a) the conservation and prevention of erosion of soil in programmes of land clearing, settlement and agricultural production,
- (b) the conservation of surface run-off water,
- (c) the planned exploitation of our forests,
- (d) the cultivation of medicinal plants on a systematic basis,
- (e) the prevention of indiscriminate clearing of jungles without due consideration for the conservation of wild life,
- (f) the proper management of inland fisheries,
- (g) the prevention of over-exploitation of brackish water fisheries,
- (h) the optimum utilization of non-renewable resources such as minerals,
- (i) the prevention of untreated industrial waste and sewage being discharged into waterways and the ocean,
- (j) the monitoring of pollution on land, in waterways and in the atmosphere,
- (k) the demarcation of industrial and residential sites in urban as well as in developing rural areas,
- (l) the provision of hygienic methods of sewage disposal on an island-wide basis,
- (m) the eradication of slum dwellings, at least in stages,
- (n) the preservation of both the natural as well as the built landscape,

Many of our environmental problems could be attributed directly or indirectly to an ever increasing population. Therefore, we must endorse all steps taken today to limit our population through family planning.

We feel that education with respect to the environment should best begin with children. It is heartening to know that the Government's new educational reforms include environmental studies at school level. We are also of the opinion that enforcement of many of the environmental laws are made difficult because the general public is ignorant of these. Existing institutions could be put to maximum use to

educate the general public. For example, the Zoological Gardens at Dehiwela would be the best place to educate people regarding wild life conservation laws. An eyecatching board or plaque in front of a cage of a protected animal, declaring it protected or threatened with extinction, could be one of the best methods of informing the general public that a particular animal should be protected.

We must stress that any steps taken at present to manage our environment will be cheaper in economic and social terms than action much later, which may be costly both in terms of money and life. To quote an instance, the 1952 smog in London killed an estimated 4,000 people. The first Clean Air Act of 1956 brought an 80% reduction in smoke emission and a 40% reduction in sulphur dioxide and cost US \$.35 cts. per head per annum.

From our studies, it becomes apparent that the existing machinery in various departments and institutions, although capable of handling many of the problems of the environment, will be ineffective unless co-ordinated by a suitable central organization.

Therefore we, finally, recommend that :—

A representative Central Authority for Environmental Management be established in Sri Lanka under the Ministry of Planning and Economic Affairs.

The main functions of this Central Authority should be broadly as follows :—

- (a) Co-ordination of activities with respect to the environment,
- (b) Evaluation of new development projects in terms of environmental hazards and conservation of natural resources,
- (c) Responsibility for formulation and implementation of legislation through appropriate agencies,
- (d) Responsibility for monitoring environmental pollution and determining standards for pollutants in collaboration with the various departments and institutions concerned,
- (e) Initiation, sponsorship and support of studies pertaining to the environment,
- (f) Dissemination of information pertaining to the environment,
- (g) Collaboration with international organizations interested in the environment.

This proposed Central Authority for Environmental Management should have statutory powers and not function only in an advisory capacity.

Implementation of legislation pertaining to the environment should be carried out through the various departments and institutions ; for example, laws concerned with environmental sanitation could be enforced by local authorities, pollution monitoring could be handled by the Occupational Hygiene Laboratory of the Labour Department, etc.

If, due to the present economic situation in the country a Central Authority for Environmental Management cannot be created, we recommend, for the time being, that an existing governmental agency be entrusted with the functions that we have recommended for this Central Authority.

13. APPENDIX

13.1 SCHEDULE I

LIST OF MEDICINAL PLANTS ALLOWED FOR EXPORT

1. <i>Acalypha indica</i>	— කුප්පමේනිය
2. <i>Achyranthes aspera</i>	— ගස්කරල්හැබ
3. <i>Adenanthera pavonnia</i>	— මදවිය (ඇට)
4. <i>Aerua lanta</i>	— පොල්කුඩුපලා
5. <i>Ageratum conyzoides</i>	— හුලන්තලා
6. <i>Alocasia macrorhiza</i>	— හබරල
7. <i>Aloe indica</i>	— කෝමාරිකා
8. <i>Alstonia scholaris</i>	— රුක් අත්තන
9. <i>Amarantus paniculatus</i>	— රත්තම්පලා
10. <i>Amarantus spinosus</i>	— කටුතම්පලා
11. <i>Amarantus viridis</i>	— කුරතම්පලා
12. <i>Anacardium occidentale</i>	— කපු
13. <i>Ananas sativus</i>	— අත්තාසි
14. <i>Annonia squamosa</i>	— අනෝදා
15. <i>Anthocephalus cadamba</i>	— ඇඹුල් බක්මී
16. <i>Alternanthera sessilis</i>	— මුකුණුවැන්න
17. <i>Argynea populifolia</i>	— ගිරිනිල්ල
18. <i>Basella alba</i>	— නිවිනි
19. <i>Basella rubra</i>	— රත්නිවිනි
20. <i>Bryoniopsis (Bryonia) Laciniosa</i> <i>Gucurbita maxima</i>	— වට්ටක්කා
21. <i>Cyclea burmanni</i>	— කැහිපිත්තන් - කැසිපිස්සන්
22. <i>Capparis horrida</i>	— වෙල්ලන්ගිරිය
23. <i>Calophyllum inophyllum</i>	— දොඹ (ඇට)
24. <i>Calophyllum tomentosum</i>	— කීන
25. <i>Calophyllum walkerii</i>	— පෙනෙලවැල්
26. <i>Cardiospermum halicacabum</i>	— කටරොලු
27. <i>Clitoria ternatea</i>	— තෝර
28. <i>Cassia tora</i>	— පැනිතෝර
29. <i>Cassia occidentalis</i>	— ඇත්තෝර
30. <i>Cassia alata</i>	— කහට
31. <i>Careya coccinea (arborea)</i>	— පැපොල්
32. <i>Carica papaya</i>	— කොමඩු
33. <i>Citrullus vulgaris</i>	— පිපිඤ්ඤා
34. <i>Cucumis sativus</i>	— ගොන්කැකිරි
35. <i>Cucumis trigonus var pubescense</i>	— ගොටුකොල, හීන්ගොටුකොල
36. <i>Centella asiatica</i>	— වැල් රුක් අත්තන
37. <i>Cryptolepis buchanani</i>	— සිංකෝනා
38. <i>Cinchona officinalis</i>	— ගස්පිත්ත
39. <i>Clerodendrum infortunatum</i>	

40. <i>Croton tiglium</i> (seeds)	—	ජාපාල
41. <i>Croton lacciferus</i>	—	කැප්පෙට්ටිය
42. <i>Curcuma zerumbet</i>	—	හරන්කහ
43. <i>Crinum asiaticum</i>	—	තොලබෝ
44. <i>Crinum zeylanicum</i>	—	ගොඩමානෙල්
45. <i>Datura fastuosa</i>	—	අන්තන (ඇට)
46. <i>Dillenia indica</i>	—	නොඩපර
47. <i>Dillenia retusa</i>	—	ගොඩපොර
48. <i>Dipterocarpus zeylanicus</i> (bark)	—	හොර
49. <i>Desmodium heterophyllum</i>	—	මහලඳුපියලි
50. <i>Desmodium triflorum</i>	—	හීන් ලඳුපියලි
51. <i>Eugenia jambos</i>	—	ජම්බු
52. <i>Eugenia jambos</i>	—	මාදම් (ඇට)
53. <i>Eleusine coracana</i>	—	කුරක්කන්
54. <i>Erythrina variegata</i> (indica)	—	එරබදු
55. <i>Flacourtia ramontchi</i>	—	ලගුරැස්ස
56. <i>Ficus bengalensis</i>	—	නුග, මහනුග
57. <i>Garoinia mangostana</i>	—	මැන්ගුස්ටින්
58. <i>Gloriosa superba</i>	—	නියගලා
59. <i>Hibiscus rosa-sinensis</i>	—	සපන්කුමල්
60. <i>Hibiscus esculentus</i>	—	බන්ඩක්කා
61. <i>Hibiscus fureatus</i>	—	නාඕරින්තා
62. <i>Hydrocotyle javanica</i>	—	මහගොටුකොල
63. <i>Hedyotis fruticosa</i>	—	වැරනිය
64. <i>Ixora coccinea</i>	—	රන්මල්
65. <i>Leea indica</i>	—	බුරුල්ල
66. <i>Legenaria leucantha</i> (vulgaris)	—	දියලබු
67. <i>Luffa aegyptiaaca</i>	—	නියන්වැටකොලු
68. <i>Leucas zeylanica</i>	—	ගැටතුඹ
69. <i>Lassia spinosa</i>	—	කොඹිල
70. <i>Largestroemia speciosa</i> (flosreginae)	—	මුරුත
71. <i>Lycopodium cernuum</i>	—	බඩල්වනස්ස
72. <i>Murraya koenigii</i>	—	කරපිංචා
73. <i>Melia composita</i>	—	ලුනුම්බෙල්ල
74. <i>Mucuna prurita</i> (pruriens)	—	විදුරා මැ
75. <i>Mimosa pudica</i> (Thoddal)	—	නිදිකුම්බා
76. <i>Momordica charantia</i>	—	කරවිල වැල්
77. <i>Melothria mederaspatatha</i>	—	හීන් කැකිරි
78. <i>Melothria heterophylla</i> (<i>zehneria hastata</i>)	—	කොමඩු, කැකිරි
79. <i>Melthoria heterophylla</i>	—	කඩුඩු කැකිරි
80. <i>Morinda citrifolia</i>	—	අඞු
81. <i>Mentha silvestris</i>	—	මිංචි
82. <i>Mussaenda frondosa</i>	—	මුස්සැන්ද
83. <i>Mirabilis jalapa</i>	—	හෙන්ද්‍රික්කා
84. <i>Nelumbium nuciferum</i>	—	නෙලුම් (ඇට)
85. <i>Nux vomica</i>	—	ගොඩකඳුරා
86. <i>Nyctanthes arbor tristis</i>	—	ස්පොලිකා
87. <i>Olax zeylanica</i>	—	මැල්ල

88. <i>Opuntia dellenii</i>	— කටුපතොක්
89. <i>Pandanus zeylanicus</i>	— වැටකෙයිසා (මුල්)
90. <i>Portulaca oleracea</i>	— ගෙඳ
91. <i>Pterocarpus marsupium</i>	— ගම්මාලු
92. <i>Pothos scandens</i>	— පෝටාවැල්
93. <i>Polygonum chinense</i>	— මියන් දලු
94. <i>Pipe siriboa linn</i>	— රටබුලක් වැල්
95. <i>Rejoua dichotoma</i>	— දිවිකදුරු
96. <i>Raphanus sativus</i>	— රුබු
97. <i>Streculia balanghas</i>	— නාවා
98. <i>Sesbania grandiflora</i>	— කතුරු මුරංගා
99. <i>Symplocos spicata</i>	— බෝඹු - වල් බෝඹු
100. <i>Taberna montana coronaria</i> or <i>Ervatania divaricata</i>	— වකුසුද්ධ
101. <i>Tinospora malabarica</i>	— වල් රසකිඳ
102. <i>Vernonia cinerea</i>	— මොනරකුඩුමිබිය
103. <i>Vernonia zeylanica</i>	— පුපුල
104. <i>Vinca rosea</i>	— මිනීමල්
105. <i>Zizyphus jujuba</i>	— මසන් (ඇට)
106. <i>Zizyphus oenoplia</i>	— හින් එරමිනිය
107. <i>Zizyphus naptea</i>	— යක් එරමිනිය
108. <i>Zizyphus rugosa</i>	— මහ එරමිනිය
109. <i>Zingiber zerumbet</i>	— වල් ඉඟුරු

13.2 SCHEDULE II
SANCTUARIES MAINTAINED BY THE DEPARTMENT OF WILD LIFE CONSERVATION

Name of Sanctuary	Extent in Acres	Location	Date of Declaration
Wilpatru West	53,120	N.W.P.	7.11.41
Wilpatru North	1,560	N.P.	7.11.47
Chundikulam	27,550	N.P.	25.02.38
Giant's Tank	9,739	N.P.	24.09.34
Telwaite	3,520	S.P.	25.02.38
Wirawila—Tissa	10,290	S.P.	27.05.38
Karagamuwa	2,480	S.P.	27.05.38
Polonnaruwa	3,760	N.C.P.	27.05.38
Galway's Lands	140	C.P.	27.05.38
Tangamalai	325	Uva	27.05.38
Mihintale	2,470	N.C.P.	27.05.38
Rocky Islets (Ambalangoda—Hikkaduwa)	3	S.P.	25.09.40
Kataragama	2,070	Uva	27.05.30
Minneriya—Giritale	16,540	N.C.P.	29.07.38
Anuradhapura	8,650	N.C.P.	27.05.38
Peak Wilderness	275	C.P.	29.07.38
Kegalle	55,300	C.P. & Sab.	25.09.40
Pallemalala	240	Sab.	14.03.41
Welhella—Katagille	34	S.P.	23.10.42
Kokilai Lagoon	332	Sab.	18.02.49
Senanayake Samudra	N.P.	N.P.	18.05.51
Gal Oya Valley North East	Full Supply Level	E.P. & Uva	12.02.54
Gal Oya Valley South West	23,040	E.P. & Uva	12.02.54
Vavunikulam Tank	30,720	E.P. & Uva	12.02.54
Sagamam	37,760	N.P.	12.02.54
Padaviya Tank	12,000	N.P.	12.02.54
Trincomalee Naval Headworks	1,423	E.P.	21.06.63
Great Sober Island	16,000	N.C.P.	21.06.63
Little Sober Island	44,800	E.P.	21.06.63
Kimbulwanawewa	160	E.P.	21.06.63
Lahugala—Kirulana	16	E.P.	21.06.63
Somawathie Chaitiya	1,216	N.W.P.	21.06.63
Mahakandawwa	3,840	E.P.	1.06.66
Madhu Road	55,040	E.P. & N.C.P.	9.09.66
Bundala	around Full Supply Level	N.C.P.	9.12.66
Seruvila — Allai	65,920	N.P.	28.06.68
Maimbulkanda—Nittambuwa	15,360	S.P.	5.12.69
Paratitivu	38,400	E.P.	9.10.70
	58	W.P.	31.10.72
	46	N.P.	26.04.73

13.3 SCHEDULE III

LIST OF BIRDS THAT ARE NOT PROTECTED

English Name	Scientific Name	Sinhalese Name	Tamil Name
Black Crow	<i>Corvus macrorhynchos culminatus</i>	Kaka-Kaputa	Andang Kakam
Ceylon House-Crow	<i>Corvus splendens protegatus</i>	Kaputa, Kolamba-Kaka	Oor-Kakan
Ceylon House-Sparrow	<i>Passer domesticus soror</i>	Ge Kurulla	Adaikalan-Kuruvi, Oor Kuruvi
Spotted Munia	<i>Uroloncha punctulata lineoventer</i>	Wee-Kurulla	Nellu Kuruvi
White-Backed Munia	<i>Uroloncha striata striata</i>	Wee-Kurulla	Nellu-Kuruvi
Ceylon Hill-Munia	<i>Uroloncha kelaarti kelaarti</i>	Wadu-Kurulla	Thukanan-Kuruvi, Manjal-Kuruvi, Manjal
The Striate Weaver-Bird	<i>Ploceus manyar flaviceps</i>	Wadu-Kurulla	Thukanan-Kuruvi, Kuruvi
Baya or Common Weaver-Bird	<i>Ploceus philippinus philippinus</i>	Wadu-Kurulla or Goyyan Kurulla	Thukanan-Kuruvi, Kuruvi
Rose Ringed Parakeet	<i>Psittacula krameri maillensis</i>	Ranna-Girawa	Payatham-Kili
Purple Coot or Gallinule	<i>Porphyrio poliocephalus poliocephalus</i>	Kirtala, Kittu	Kanan-Koli
The Indian Darter or Snake Bird	<i>Anhinga melanogaster</i>	Hanseya	Pambu-Tara, Nedung-Kilathy, Nedung Kaluthathan
Pigmy Cormorant	<i>Phalacrocorax niger</i>	Diya-Kawa	Nir-Kakam
Indian Cormorant	<i>Phalacrocorax carbo sinensis</i>	Diya-Kawa	Nir-Kakam
Indian Shag	<i>Phalacrocorax fuscicollis</i>	Diya-Kawa	Nir-Kakam

13.4 SCHEDULE IV

LIST OF BIRDS THAT ARE NOT PROTECTED DURING THE OPEN SEASON ONLY AND MAY BE SHOT WITHOUT A LICENCE

English Name	Scientific Name	Sinhalese Name	Tamil Name
Ceylon Spotted-Dove	<i>Streptopelia chinensis ceylonensis</i>	Alu-Kobeyiya	Mani-Pura, Umi-Pura, Pulli-Pura
Indian Ring Dove	<i>Streptopelia decaocto decaocto</i>	Maha-Kobeyiya	Kalli-Pura, Sambal-Pura
Ceylon Wood Pigeon or Lady Torrington's Pigeon	<i>Columba toringtoni</i>	Maila-Goya	Karuppu-Pura
Blue Rock-Pigeon	<i>Columba livia intermedia</i>	Gal-Pareyiya	Mada-Pura, Malai Pura
Bronze-Winged, Emerald Dove	<i>Chalcophaps indica robinsoni</i>	Nil-Kobeyiya	Thamil-Pura
Ceylon Orange-Breasted Green Pigeon	<i>Treron bicincta leggei</i>	Bata-Goya, Sipaduwa	Pachchai-Pura
Pompador Green Pigeon	<i>Treron pompadora pompadora</i>	Bata-Goya, Sipaduwa	Pachchai-Pura
Ceylon Southern Green Pigeon	<i>Treron phoenicoptera phillipsi</i>	Bata-Goya, Sipaduwa	Pachchai-Pura
Common or Fantail-Snipe	<i>Capella gallinago gallinago</i>	Keswatuwa	Ullan-Kuruvi
Pintail Snipe	<i>Capella stenura</i>	Keswatuwa	Ullan-Kuruvi
Wood Cock	<i>Scolopax rusticola</i>	Maha-Keswatuwa	Periya Ullan-Kuruvi
Jack Snipe	<i>Lymnocyrtes minimus</i>	(No Sinhalese Name)	(No Tamil Name)
Wood Sandpiper	<i>Pringa gartola</i>	Sili-Watuwa	Kottan
Curlew	<i>Numenius arquata orientalis</i>	MahaWatuwa	Kumandy, Mussal-Kinandu, Muyal Kinandy
Whimbrel	<i>Numenius phaeopus phaeopus</i>	MahaWatuwa	Kuthiral-malai-kottan
Eastern Golden Plover	<i>Pluvialis dominica fulva</i>	Oleyiya, Rana-Watuwa	Kottan
Grey Plover	<i>Squatarola squatarola</i>	Oleyiya	Kottan
Painted Snipe	<i>Rostratula benghalensis benghalensis</i>	Ulu-Keswatuwa, Raja-Watuwa	Ullan-Kuruvi
Watercock	<i>Gallinago cinnerea</i>	Wil-Kukula	Tannir-Kili
Ceylon Bustard-Quail	<i>Turnix suscitator leggei</i>	Bola-Watuwa	Kadai
Blue-Faced Quail	<i>Excalfactoria chinensis chinensis</i>	Pandara-Watuwa, Wil-Watuwa	Kadai
Cotton Teal	<i>Nettapus coromandianus coromandianus</i>	Mal-Seruwu	Raja-Tara or Kuluppai
Pintail	<i>Anas acuta acuta</i>	Seruwu	Tara
Garganey	<i>Anas querquedula</i>	Seruwu	Tara
European Teal	<i>Anas crecca crecca</i>	Seruwu	Tara
Whistling Teal	<i>Dendrocygna javanica</i>	Seruwu, Thumba-Seruwu	Chilli-Tara

13.5 SCHEDULE V

LIST OF WILD ANIMALS (INCLUDING REPTILES BUT NOT INCLUDING BIRDS) ABSOLUTELY PROTECTED DURING BOTH THE CLOSE AND OPEN SEASONS

English Name	Scientific Name	Sinhalese Name	Tamil Name
Bear Monkey or Hill Wanduroo	<i>Pithecus vetulus monticola</i>	Maha Wandura	Periya Mundi
Grey Flying-Squirrel	<i>Petaurista philippensis lanka</i>	Hambawa or Hangu	Paravai-Anil
Small Ceylon Flying-Squirrel	<i>Pteromys layardi</i>	Hambawa	Paravai-Anil
Highland Giant-Squirrel	<i>Ratufa macroura macroura</i>	Dandolena	Malai-Anil
Hog Deer	<i>Hylephus porcinus</i>	Wil-Muwa or Gona-Muwa	Mann
Water-Lizard or Water-Monitor	<i>Varanus salvator</i>	Kabara goya	Kabaragoyen
Dugong	<i>Dugong dugon</i>	Mudu Ura	Kadal Pandi
Fishing Cat	<i>Felis viverrina</i>	Koladiviya or Handundiviya	Koddipuli
Rusty Spotted Cat	<i>Felis rubiginosa</i>	Wal Balala or Koladiviya	Kattupoonai
Delft Island Pony	<i>Equus caballus</i>		
Indian Pangolin	<i>Manis crassicaudata</i>	Kebellaya	Alangu
Leathery Turtle	<i>Demochelys coriacea</i>	Dhara Kesbewa	Dhoni Amai
Slender Loris	<i>Loris tardigradus</i>	Una Haputawa	Thevangu
Kelaart's Long clawed Shrew	<i>Feroculus feroculus</i>	Hik miya or Kunu miya	Mung'elli
Ceylon Pigmy Shrew	<i>Suncus fellowes gordonii</i>	Podi Hikmiya or Podi Kunumiya	Mung'elli Kutti or Sinna Mung'elli
Ceylon Jungle Shrew	<i>Suncus zeylanicus</i>	Kunumiya	Mung'elli
Long-tailed Shrew	<i>Crociodura miya</i>	Hik miya or Kunu miya	Mung'elli
Horsfield's Shrew	<i>Crociodura horsfieldi</i>	Podi Hikmiya or Podi Kunu-miya	Sinna Mung'elli or Mung'elli Kutti
Pearson's Shrew	<i>Solisorex pearsoni</i>	Hik miya or Kunu miya	Mung'elli
Ceylon Fruit Bat	<i>Rousettus seminaudus</i>	Wawula	Vaya
Ceylon Tube-nosed Bat	<i>Murina eilecnac</i>	Posi Wawula	Sinna vava
Malpas's Bat	<i>Kirivoula malpasi</i>	Podi Wawula	Sinna vava
Ceylon Gerbil or Antelope-rat	<i>Tatera ceylonica</i>	Wel miya	Vel-elli
Ceylon Mole-rat	<i>Gunomys gracilis</i>	Wel miya	Kurumb'elli or Viel'elli or Nell'elli or Agillarne
Ceylon Spiny-mouse	<i>Leggadilla fernan eni</i>	Miya or Podi miya	Sund'elli
Highland Coelomys or Spiny-rat	<i>Coelomys mayori</i>	Miya or Kelle miya	Yelli or Kart'elli
Bicoloured Coelomys or Spiny Rat	<i>Coelomys bicolor</i>	Miya or Kelle miya	Yelli or Kart'elli
Nillu Rat	<i>Rattus montanus</i>	Miya or Kelle miya	Yelli or Kart'elli
Ceylon Palm-civet	<i>Paradoxurus zeylonensis</i>	Kalawedda	Marum nai
Olive-backed loggerhead	<i>Lepidochelys olivacea olivacea</i>	Mada Kasbava or Eramadhu Kasbava or Parai kasbava or Batu Kasbava	Kanga mateyan amai or Sith amai
Giant brown-red logger-head	<i>Caretta caretta gigas</i>	Olugedi kasbava or Kannadi-Kasbava	Perumthale amai or Nai amai
Hawksbill turtle or Caret or Shell Turtle	<i>Eretmochelys imbricata</i>	Pothu Kasbava or Leli Kasbava or Pana Kasbava	Alunk amai
Green turtle	<i>Chelonia mydas</i>	Gal kasbava or Mas kasbava or Vali kasbava	Perr amai or Pal amai
Starred tortoise or star tortoise	<i>Testudo (Geocheilone) elegans</i>	Mayvara ibba or Hooniam ibba or Vairan ibba or Tharuka ibba	Katu amai or Katu petti amai

13.6 SCHEDULE VI

LIST OF ANIMALS WHICH SHALL NOT BE SHOT EXCEPT ON, A SPECIAL LICENCE AT ANY TIME OF THE YEAR

English Name	Scientific Name	Sinhalese Name	Tamil Name
Leopard	<i>Panthera pardus fusca</i>	Kotiya (General term) Diviya (Male) Dividena (Female) Walaha	Pulee Pulee Pulee Karadi
Ceylon Bear	<i>Melursus ursinus</i>	Hale Kimbula, Aja Kimbula	Kulathu Muthale
Ceylon Swamp-Crocodile	<i>Crocodylus palustris kimbula</i>	Pitta Gatteya, Gatte Kimbula, Gorekaya	Chem-mookan Muthalai
Marsh-Crocodile or Estuarine or Sea-Crocodile	<i>Crocodylus porosus Schneider</i>		

13.7 SCHEDULE VII

PROTECTED PLANTS

English Name	Botanical Name	Sinhalese Name	Tamil Name
Wesak Orchid or May Orchid	<i>Dendrobium Macarthisae Thw.</i>	Wesak mala	Papparappuli or Perukka or Anaippuli
Bacbab Tree or Judas bag, or Moneybread-Tree	<i>Adansonia digitata L.</i>	---	---
Fox-tail Orchid or Batticaloa Orchid	<i>Rhynchosyles retusa Bl.</i>	---	---
Sphagnum moss Bogmoss	<i>Sphagnum zeylanicum Mitt</i>	---	---
Primrose Orchid	<i>Dendrobium heterocarpus</i>	---	---
Daffodil Orchid	<i>Ipsa spectosa</i>	Rat-tha or Rasana	---
Anuradhapura Orchid	<i>Vanda tessellata (Roxburghii)</i>	---	---
---	<i>Vanda spathulata</i>	Madara	Wudacha-maram
---	<i>Cleistanthus collinus</i>	---	---

SCHEDULE VIII

ENVIRONMENTAL POLLUTION MONITORING EQUIPMENT

I. Occupational Hygiene Laboratory — Labour Department

The instruments used for environmental monitoring, and assessment of the harmful physical agents in work places can be used for Total — Environmental Control, with suitable modifications if necessary.

(i) **Air Sampling**

(a) Dusts : **Particle count**

Midget dust samplers,
Membrane filters and samplers,
Microscopes.

(b) Dusts and Fumes :

Gravimetric

Personal samplers,
Casella hexhlets,

(c) Gases and vapours

Drager tubes,
Personal samplers,
Improvised absorbing and
adsorbing devices.

(ii) **Assessment of harmful physical agents.**

(a) Thermal stress and radiation

Globe thermometers,
Kata thermometers,
Velometers,
Hygrometers.

(b) Ventilation

Hastings air thermometers
Kata thermometers
Pitot tubes and Inclined
Manometers

(c) Noise and Vibration.

Precision Sound level Metre
+ Octave Band Analyser
(B and K.)

(d) Lighting and glare.

Eel Light Master Photometer.

(iii) **Chemical analysis of collected air samples and Bio-Chemical Analysis.**

Spectro photometer (S P 500 — Unicam)
 Eel Colorimeter
 Gas chromatograph (Perkin — Elmer F 11)
 Absorptiometer (Hilger — Spekker)
 + fluorimeter
 other analytical equipment for classical methods.

(iv) **Respiratory Physiology**

Mc Dermott Spirometer.

(v) **Ionising Radiations**

Digital Rate Meter (Ekco Type M 5183)

2. **Quality Control Laboratory — Ministry of Health****Analytical Instruments**

Spectrophotometer	Hitachi—139
Spectrophotometer	
Spectrophotometer	Hitachi—EPS—3T
Fluorophoto spectrometer	Hitachi—204
Atomic Absorption spectrophotometer	Hitachi—208
Automatic Polarimeter	Shimadzu
Colorimeter	Shimadzu-Bausch and Lomb
Infra-red spectrophotometer	Hitachi EPI—G3
Gas Chromatograph	Hitachi 0063
Gas Chromatograph	Shimadzu 5AP3
CHN Automatic Analyser	Hitachi 026
Balance	Shimadzu LD
Balance	Shimadzu LM
Balance	Shimadzu LU T—100
Balance	Shimadzu LU T—3000
Automatic Titrator	Hiranuma RAT—11
pH Meter	Hitachi—Heriba

3. **Geological Survey Department**

Atomic Absorption spectrophotometer
 Absorptiometer — Hilger — Watts
 Fluorimeter — Jarrell — Ash
 Spectrophotometer — Hilger — Watts
 Eel — Flame Photometer
 Spectrograph — Emmission — Jarrell — Ash
 — ray — Spectrometer
 Portable Scintillating Counters.

4. **Government Analyst/s Department**

Gas Chromatograph (Perkin — Elmer F 11)
Spectrophotometer (UV and ordinary light)

5. **Fisheries Department**

Facilities for bacteriological work.

6. **Ministry of Agriculture and Lands**

A quality control laboratory has been established with West-German aid at Gannoruwa with facilities for evaluation of agro-chemicals.

7. **Coconut Research Institute**

Atomic absorption spectrophotometer — at the moment appropriate cathode lamps for monitoring toxic trace elements are lacking.