SRI LANKA

NATIONAL CONSERVATION STRATEGY

DECEMBER 1988

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Central Environmental Authority

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Our Ref. 08/10/10/83 (vii)
December 13, 1988

Your Excellency,

SRI LANKA
NATIONAL CONSERVATION STRATEGY

In terms of Your Excellency's letter dated November 8, 1982 and on the recommendation of the Hon. R. Premadasa, Prime Minister, the following were appointed as Members of the Task Force for the Preparation of the National Conservation Strategy for Sri Lanka:

K H J Wijayadasa, Chairman
Central Environmental Authority (Chairman)

Dr R P Jayewardene, Director-General
Natural Resources, Energy and Science Authority

Dr Hiran Jayewardene, Chairman
National Aquatic Resources Agency

Lyn de Alwis, Director
Department of Wildlife Conservation

V R Nanayakkara, Conservator of Forests
Forest Department

Dr Lloyd Fernando, Director, National Planning
Ministry of Finance and Planning

Dr Walter Fernando, Director
Department of Agriculture

S R Amarasinghe, Director
Coast Conservation Department

T W Hoffman
Wildlife and Nature Protection Society

and

W D Ailapperuma, Director-General
Central Environmental Authority (Secretary)

The appointment of the Task Force was subsequently approved by the Cabinet of Ministers at its Meeting held on November 10, 1982.

The Task Force regrets the delay in submitting its report. This was necessitated by the complexities of bringing together a large number of disciplines for the purpose of integrating development and conservation, in working towards the goal of sustainable utilization of the natural resources of the country. In order to give effect to this holistic approach of development, the Task Force pursued the methodology outlined below:

(i) calling for the views of the public, on conservation and development issues, through press notices;

(ii) identification of twenty-seven sectors for the preparation of in depth background papers by specialists in the relevant fields (Annexure 1); reviewing the state of each sector; analysing the obstacles to sustainable development; identifying the inter-sectoral linkages that determine conservation and proposing ways and means of bringing about conservation-oriented development;

(iii) appointment of an Editorial Board (Annexure 2) to review the background papers and to assess the extent to which the proposals could be accepted and recommended as practical ways of achieving conservation-oriented development;

(iv) appointment of a Chief Editor and a Consultant for the purpose of developing the Strategy; and

(v) reviewing the central document at meetings of the Editorial Board to which specialists from different disciplines have been invited as and when necessary.

The Editorial Board has held over ninety meetings in the preparation of the Strategy. The background papers will be submitted to Your Excellency, as Part II of the Strategy, as early as possible.

The Task Force has the honour to submit for Your Excellency's construction, the Sri Lanka National Conservation Strategy. Forty-five copies of the Report are submitted to enable the Strategy to be tabled at the Cabinet of Ministers.

We remain,

Yours faithfully,

TASK FORCE FOR THE PREPARATION
OF THE SRI LANKA NATIONAL CONSERVATION STRATEGY

(Sgd.) K H J Wijayadasa
(Chairman)

(Sgd.) Dr R P Jayewardene

(Sgd.) Dr Hiran Jayewardene

(Sgd.) Lyn de Alwis

(Sgd.) V R Nanayakkara

(Sgd.) Dr Lloyd Fernando

(Sgd.) Dr Walter Fernando

(Sgd.) S R Amarasinghe

(Sgd.) T W Hoffmann

(Sgd.) W D Ailapperuma
(Secretary)

His Excellency J R Jayewardene
President of the Democratic Socialist Republic of Sri Lanka
Presidential Secretariat
Colombo 1

Annexure 1

SRI LANKA NATIONAL CONSERVATION STRATEGY

Sector Paper	Authors
1. Agricultural Development and Natural Resource Conservation with Special Reference to Sustained Production of Annual Crops	Dr Walter Abeygunawardena Former Deputy Director of Agriculture
2. Air, Soil and Water	Mr E E JeyaRaj Director, Environmental Protection Central Environmentat Authority
3. Alternative Systems of Land Use for Chena Lands	Dr G W E Fernando Director of Agriculture Dr S Somasiri Head, Land Water Use Division Department of Agriculture Dr M Sikurajapathy Deputy Director Department of Agriculture
4. Coastal and Marine Systems	Mrs D Sadacharm Deputy Manager, Planning Coast Conservation Department
5. Cultural Resources	Mr Pandula Endagama Assistant in Anthropology National Museums Department
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Annexure 2

MEMBERS OF THE NCS EDITORIAL BOARD

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Chairman, Natural Resources, Science and Energy Authority

Dr Hiran Jayewardene
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Mr V R Nanayakkara
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Prof A D V de S Indraratna
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Mr M S Wijeratne
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Mr R A Wijewansa
Director, Environmental Management, Central Environmental Authority
(Coordinating Editor)

The following also served on the Editorial Board:

Prof B A Abeywickrema
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Dr S T Senewiratne
Former Profesor of Agriculture, University of Ceylon

Dr G H P De Bruin
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Mr D M Fernando
Former Head, Plant Breeding Department, Rubber Research Institute

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Consultant, Janatha Estates Development Board

Prof T E J de Fonseka
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Mr A D S Gunawardena
Deputy Director, Hydraulics, Irrigation Department

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ACKNOWLEDGEMENT

The Sri Lanka National Conservation Strategy (SLNCS) was prepared by a team of specialists representing a variety of disciplines. Some members of this team were members of the Task Force appointed by His Excellency J. R. Jayewardene, the President. Others were members of the Editorial Board. The background material was provided in 27 sector papers drafted by specialists and edited by other specialists in the field.

Secretarial assistance was provided by the Central Environmental Authority (CEA). CEA staff at all levels supported SLNCS activities. The staff of the Office of the Prime Minister and of the Natural Resources, Energy and Science Authority (NARESA) helped in many ways.

The International Union for the Conservation of Nature and Natural Resources (IUCN) provided the initial inputs for the government to embark on the preparation of a National Conservation Strategy for Sri Lanka.

The United States Agency for International Development (USAID) sponsored two workshops, the first in 1983 to draft the guidelines for the preparation of the sector papers, and the second in May 1986 to review progress and decide on the format of the NCS. USAID supplied the services of one consultant for the first workshop and of two consultants for the second workshop.

The Task Force expresses its sincere thanks to these organizations and inviduals and many others who gave generously of their valuable time, their specialized knowledge and their unique experience to the SLNCS throughout the many months of assiduous researching, data collection, writing, editing typing and printing. The Task Force is deeply conscious of the special contributions made by particular individuals but regrets their inability to mention them by name.

PREFACE

Sri Lanka has been endowed with ample natural resources to enrich and sustain the lives of its people. These resources favoured the agricultural existence to which the early settlers were accustomed. Prudent forms of land utilisation were developed and handed down from one generation to the next until they became a natural way of life of the people. These practices ensured sufficient production to meet the needs of each generation whilst preserving the renewability of the resources for the future. Here then were the very foundations of sustainable development, an art which the world conservation community is striving to re-establish today.

The needs of the people then were modest. The population density was low, the principles of land utilisation were valid enough to meet the needs of the moderate population increases which occurred during the first milennium. Subsequently, however the colonial rulers stripped the land of its forest cover, particularly in the low-country and montane wet zones, to plant exotic commercial crops. Scant respect was paid to the existing land use practices, thereby causing a serious disruption of the harmony between man and his environment, which had hitherto been carefully nurtured by the people.

The spectacular advances in science and technology in the west, during and after World War II, had serious repercussions in the developing countries. Sharp increases in population and rising demands for higher living standards destroyed the balance maintained by traditional land use practices. Being so closely intertwined with agriculture, these populations set up an almost insatiable demand for more and more land to grow food. In the first flush of independence, Sri Lanka like many other nations, freely distributed forest land to satisfy each surge of population, little realising they were squandering man's most valuable natural resource.

The population of Sri Lanka which stood at 6.7 million in 1946[1] now exceeds 16 Million[2] and is expected to increase to about 20 million by the year 2000 on the assumption that present fertility rates will continue[3]. It is impossible to satisfy land hunger today or 20 years hence by the simple expedient of parcelling out land. The solution would lie in a return to the traditional skills of land utilisation greatly improved by the application of modern scientific methods.

(1) Department of Census and Statistics: Census of Population and Housing 1981 General Report–Volume 3, 1986. p. 22.
(2) Central Bank of Ceylon Statistics Department: Sri Lanka Socio-Economic Data 1987.
(3) Ref. 1, p. 33.

Man's relationship with his environment is unique. He not only lives and works in it but also causes profound changes which affect his own destiny. The extent to which a human population influences its environment depends on its demographic features and its life style. The growing needs of Sri Lanka's rising population are often being met by exploiting the country's natural resources with increasing severity, an approach which is wrong and needs correction. Unless the present careless and selfish use of resources is halted and policy-makers and conservationists become partners in reviving the kind of sustainable development which was indigenous to Sri Lanka many centuries ago, results will be disastrous.

The National Conservation Strategy is designed to restore sustainable development. It deals with the important aspects of conservation and development in later chapters, but it is well to be acquainted with the mistakes already made.

The natural resources of this country including the soil, minerals, water and air and the ecosystems such as the forests, the grasslands, the wetlands, the mangrove swamps and the coral reefs continue to be sujected to unprecedented stresses. For example, the country's dense forest cover has dwindled to 27 per cent of the land area. This is considered to be below the minimum extent required for ecological stability and for meeting human requirements of water, fuel and timber. The laying bare of the forests has caused soil erosion and siltage which have led to a considerable reduction in the dry weather flow of rivers and streams, aggravated drought damage in large parts of the island and increased the incidence of diseases like malaria, bringing untold misery to millions of people.

The inreasing use of marginal lands and steep slopes results in the unsettling of unique natural systems. Earthslips have been occurring with greater frequency and increasing magnitude in recent years. Arable land, parks, playgrounds and recreation areas are continuously being lost to building and road construction. The per capita availability of arable land had dropped to 0.2 hectare by 1981. Soil fertility is reported to be decreasing and the incidence of salinity and waterlogging increasing. The excessive application of chemical fertilisers has adversely affected both soil and ground water quality in some areas, while indiscriminate use of insecticides has led to the development of resistant strains of harmful insects.

The extensive destruction of mangrove swamps and coral reefs has adversely affected the life cycles of fish and other aquatic life forms and severely reduced their populations. The damage caused to the coral reefs has aggravated the problems of coastal erosion.

Industrial development has brought in its wake pollution of the air, water and soil. Motor vehicle exhaust emissions are also a major cause of air pollution in urban areas.

Together these many threats to the quality and productivity of the environment are indeed formidable if not frightening. Their impact on the rural population is even more alarming.

The situation is however not without hope. The careful planning, resolute implementation of conservation measure and population stabilisation required to arrest the present downward trends are well within the capacity of the people. Successive governments since independence have addressed themselves to these problems and, as will be seen later, far-reachng legislation has already paved the way for corrective action. Furthermore, Sri Lanka is perhaps unique among tropical countries in having strong non-governmental organisations (NGOO), some nearly one hundred years old, to keep the flame of nature conservation alive among the people.

But Sri Lanka is not alone in having to solve problems concerning environmental degradation. Nor are the problems confined to the Third World. Many industrialized nations, too, have to grapple with massive environmental pollution caused by toxic wastes poisonous gases and noise. The threat to the environment is no longer limited to individual nations or regions or even continents. It is global problem. Appropriately the International Union for Conservation of Nature and Natural Resources (IUCN) assumed responsibility to alert governments to the urgent need to conserve their living natural resources and prepared guidelines in a document titled "The World Conservation Strategy".

The Government of Sri Lanka was among the first to recognize the importance of the objectives laid down by the IUCN and, on the initiative of the Hon. R. Premadasa, Prime Minister, decided to prepare a National Conservation Strategy.

The Sri Lanka National Conservation Strategy (SL-NCS) is the result of the sustained effort by a multidisciplinary team composed of scientists, engineers, planners and administrators. Twenty seven sector papers, scrutinised by an Editorial Board, provided the background material for the Strategy. The active support of the wider public is crucial to the successful implementation of this Strategy.

Chapter 1

INTRODUCTION

Nations will succeed in achieving prosperity through development only when governments, economic planners, developers and people themselves recognise that the environment is intimately linked with human actions, needs and aspirations. This is because the "environment" is where people live and "development" is what people do in order to improve their lot within it.

All development influences, and is in turn influenced by, the environment which may be defined as the physical, chemical and biotic factors surrounding a living organism. Within this environment are living and non-living resources from which all living organisms derive their sustenance. Under natural conditions, plants and animals, including people, together with water, soil and air, form a harmonious system.

But this harmony is neither static nor unchangeable. It is dynamic yet fragile, for its equilibrium is maintained through the interactions and interrelationships of many component parts. These processes will ensure the continuous supply of resources essential to man, provided he does not upset the equilibrium to a degree that it cannot be restored e.g. by the large-scale removal of natural forests which exposes soils to erosion by rain and wind causing a serious reduction of soil fertility.

All living organisms and their environments are collectively termed the biosphere. The biosphere comprises the outer layer of the earth's surface, virtually all its water and the lower part of the atmosphere. Living organisms are present within the earth's zone which is accessible to sunlight and where liquid water exists. Though earlier thought to possess unlimited resources and resilience, the biosphere is now recognised as a delicate system with finite resources and limited ability to recover from misuse.

While these resources need to be used to raise the living standards of the present generation, they must continue to be available to serve the development needs of future generations. They must therefore be used rationally, economically and judiciously.

The term development is used in this document to connote not merely economic growth as indicated by the increase in Gross National Product (GNP), but more broadly, socio-economic development. Socio-economic

development is defined as the improvement in the quality of a nation, or improvement in the quality of national life as would be shown by the rising Physical Quality of Life Index (PQLI).

In these goals, development should aim at utilising the available human, financial and material resources (both natural and man-made) profitably, and in a manner which ensures their availability at optimum levels for use by future generations too. In relation to natural resources, therefore, development should be catalytic.

Natural resources are naturally occurring assets that can be used to supply an economic, social or cultural need of a people. These assets fall into two broad categories: non-renewable (exhaustible) and renewable (replenishable).

Gemstones, beach sands, miocene limestone, feldspar, graphite, apatite rock phosphate and indigenous clays are examples of the wide range of non-renewable resources of Sri Lanka. The fauna and flora, water, soil and air, constitute its renewable ones. Due to their intrinsic differences, their utilisation in development requires different approaches. Most non-renewable resources depend on technology for extraction or conversion, while the utilization of renewable resources must follow the dictates of ecological principles.

In Sri Lanka the mining sector accounted for 2.8 per cent of the country's GNP in 1987. But mineral deposits are finite.

Their exploitation has therefore to be carefully managed to derive optimum benefit without compromising the needs of the future. This applies specifically to raw materials which have an export market, such as gems and graphite. Comprehensive master plans for industrial extraction of exhaustible resources are urgently needed in order to avoid squandering them for immediate or short-term gain.

Another method of conserving non-renewable resources is recycling. For example, ferrous scrap is now being reused for making cast iron pipes, scrap brass for turning outdoor and window fittings, and cullet (refuse glass) for the manufacture of glassware.

Non-renewable resources should be used as far as possible in a way that the wealth produced by them enables the creation of alternative resources. Plastic materials of different types are partly replacing ceramics in the

manufacture of sanitaryware and tableware in other countries. Sri Lanka may consider such alternatives in a bid to conserve its naturally occurring resources.

It must also be borne in min/ ıt advancing technology may discover hitherto uncharted mineral deposits (like gold and diamonds) in Sri Lanka or uses for materials so far thought to have no economic value. Sri Lanka should therefore keep abreast of research and development in these fields.

The renewable resources of fauna and flora, water, soil and air easily over-shadow mineral deposits in importance to the well-being of people. These resources interacting with one another form natural systems known as ecosystems. A lake, a forest, a mangrove swamp or tidal pool is capable of producing adequate harvests of food and other resources to support human population and are aptly described as "life supporting systems". But misuse of an ecosystem will set in motion a series of adverse changes which may be irreversible, rendering the ecosystem totally useless to the very people who depend upon it for their sustenance.

The changes in agricultural practices illustrate this point. The fertility of the soil has been maintained, conservation - oriented methods of cultivation being handed down from generation to generation by our ancestors. But through monocultures, intensive agriculture, the injudicious and widespread use of agrochemicals and the unplanned clearing of new and even marginal lands have in this century caused greater soil degradation than in all the millennia before. Since agriculture contributes 26 per cent to Sri Lanka's Gross Domestic Product (GDP) and 45 per cent to total employment, this strategy underscores the urgent need for more enlightened land used patterns.

Other life-support systems have also been threatened through disregard for ecological balance. Some property developers treat mangrove swamps and estuaries for example, as unproductive land and fill them for use as building sites. More subtle has been the denudation of lobster breeding grounds when, in the nineteen seventies, they were swept clean of 'berried' females and young alike, to supply a lucrative export market. Today three lobster species are facing extinction.

The message is clear. Since the present generation is benefiting from these inherited life-support systems, it is incumbent on it to spare them for the use of future generations as well.

PART I
Environmental Profile

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Chapter 2

PHYSICAL CHARACTERISTICS OF THE COUNTRY

"Ceylon, from whatever direction it is approached, unfolds a scene of loveliness and grandeur unsurpassed, if it be rivalled, by any land in the universe. The Brahmans designated it by the epithet of 'The resplendent', the Buddhist poets gracefully apostrophised it as 'a pearl upon the brow of India', the Chinese knew it as the 'Island of jewels', the Greeks as 'the land of the hyacinth and the ruby".

These lines taken from Sir Emerson Tennent's epic "Ceylon" written over a hundred years ago, sum up very vividly the beauty, variety and luxuriance of this picturesque island. Mountains as high as 2500 metres, rolling hills, undulating lowlands surrounded by a warm coral - fringed sea, ample rainfall, a friendly climate and a rich bounty of flora, fauna and fertile soil made Sri Lanka one of the fairest of tropical isles.

Territory

The Democratic Socialist Republic of Sri Lanka comprises the main island of Sri Lanka and several small off-shore islands that stand on its continental shelf. The main island covering an area of 65,610 sq.km (25,332 sq. miles) lies in the Indian Ocean between latitudes 5°51' and 9°51' N , longitudes 79°41' and 81°51'E. It is separated from the south-eastern coast of India by the Palk Strait, a strip of shallow sea, a mere 40 km wide. The island's maximum length is about 43 km (272 miles) and its maximum width 225 km (140 miles) (Fig. 1).

An island state with no pretensions to being a maritime power, Sri Lanka relies only on "agreements and treaties to define and defend her territorial waters. Her rights over the neighbouring surrounding sea have been established in Marine Boundary Agreements with the Republics of India and of the Maldives. The surrounding sea now recognized as belonging to Sri Lanka, consists of:

i. The Territorial Sea, extending to a distance of 12 nautical miles from the coast of the main island ;

ii. The Contiguous Zone which extends a further 12 nautical miles from the outer limits of the Territorial Sea ;

iii. The Exclusive Economic Zone (EEZ) which extends 200 nautical miles from the coasts (and includes the Territorial Sea and the Contiguous Zone) ; and

iv. The Internal Waters, a demarcation necessary in the Gulf of Mannar and the Palk Strait where the above zones overlap with the maritime zones of India.

Physiography

The term physiography is used to include both the underlying rock formation (lithology) and the structure of the island as well as the relief of the land itself (topography).

Lithology and Structure

Although lithology and structure make interesting study, the complexity of the subject and the divergent views and theories regarding their geological history place a detailed description of them outside the scope of this strategy.

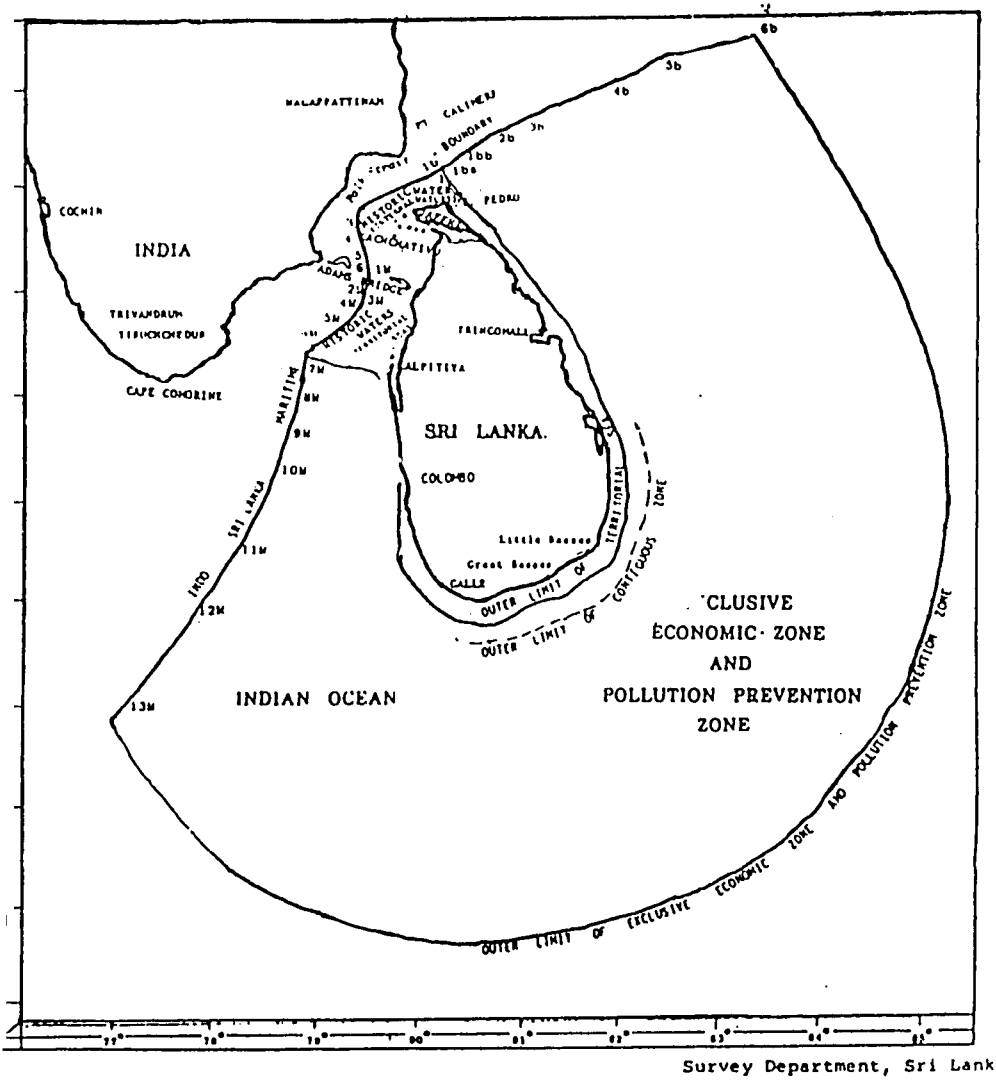
Geologically, Sri Lanka is considered along with India as an "ancient" land mass, going back to the old continental block known as Gondwanaland or the "lost continent" which existed over 1000 million years ago. Then through the phenomena of continental drift and plate tectonics, this "lost continent" became fragmented into the continents discernible today. The separation of Sri Lanka from Peninsular India is believed to have first occurred about 70 million years ago (in the Miocene epoch on the geological time-scale). This explains how the continental shelf, encircles the island of Sri Lanka and is a southern extension of the sub-marine platform upon which the Indian land mass stands.

It forms a narrow ledge with an average width of about 20 km off the western, southern and eastern coasts and broadens out to merge with the Indian Continental Shelf towards the north and northwest.

Relief or Topography

The Island of Sri Lanka consists of a mountainous area in the south-central parts and a vast coastal plain which surrounds it; the latter is rugged in the southwest but of low relief elsewhere rising from sea-level to about 300m above mean sea level. The central highlands cover only 25 per cent of the country's total area.

Fig 1



Survey Department, Sri Lanka

Territory of Sri Lanka (including maritime zones)

38

Three distinct levels, designated "peneplains" or erosion levels by geologists, are discernible. The lowest of these, the coastal peneplain rises from sea level to 120m; a second is identifiable from 300m to 760m and the third from 910m to cover 2440m. The second and third peneplains comprise the central highlands or the central massif of Sri Lanka.

Climate

In a country largely dependent on agriculture for the sustenance of its inhabitants, the people display a justifiable concern with regard to climatic variations, particularly rainfall, as the latter affect their crops and thereby their livelihood.

Wind

The two main windstreams which affect the island are the southwest and northeast monsoons. The southeast trade winds, as they blow across the equator from about mid-May to September, are deflected in a clockwise direction to become the southwest or "summer" monsoon.

The northeast trade wind system blowing from the northeast from December to February is termed the northeast or northeast "winter" monsoon.

The zone of mixing of these two airstreams is called the Inter – Tropical Convergence Zone(ITCZ). The Zone lies generally in the latitudes of Sri Lanka during March and April, when migrating northward following the apparent motion of the sun. Similarly, when moving southwards, this zone is again in the latitudes of Sri Lanka during October and November. During March to April and October to November, which are termed the intermonsoonal periods, surface winds and the winds in the lower levels of the atmosphere are generally light and variable.

Rainfall

There are four rainfall seasons during the year. These are:

i. The southwest monsoon period mid-May to September. During this period, rainfall is confined mainly to the southwestern region of the island. The heavier rainfalls are experienced along the windward slopes of the central hills, where many stations record from 1500 to 3000mm of rain during this period. However, the larger portion of the island, namely the north, northeast, east and the northcentral

region receives comparatively low rainfall, aggregating to less than 500 mm during this period. Droughts are a common feature with long spells of rainless days.

ii. The inter-monsoon period - October and November. The Inter - Tropical Convergence Zone (ITCZ) lies in the latitudes of Sri Lanka during this period. Convective afternoon and evening thundershowers are fairly widely experienced. Depressions developing mostly in the South Bay of Bengal sometimes result in widespread rain over the Island. Taking the Island as a whole, this is the wettest period of the year. The onset of the October rains is the start of the Maha cultivation season.

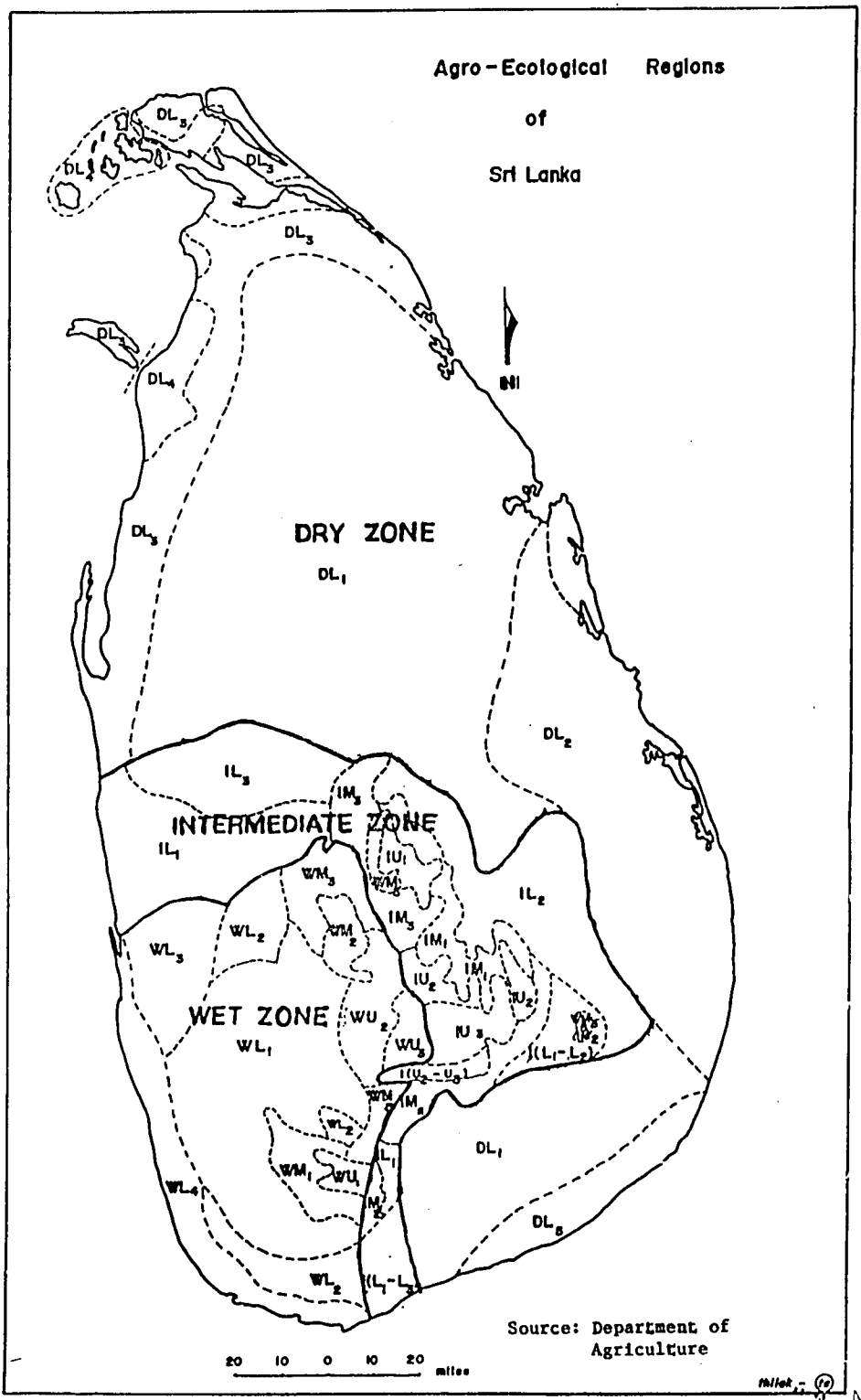
iii The northeast monsoon period - December to February. The heavier rainfalls during this season occur mainly in the north and east and over the northeastern slopes of the central hills. Most of the rain occurs in December and January, with February tending normally to be a dry month.

iv. The Inter-monsoon period- March and April.Convective afternoon and evening thundershowers are experienced, but there is less depressional activity during this period compared to the inter-monsoon period of October to November.

The three major climatic zones based on the annual rainfall are the Wet, Intermediate and Dry Zones. The boundaries between these zones are based on 75 percent expectancy of annual rainfall and are shown in Fig.2. These major climatic zones are further subdivided into 24 agro-ecological regions. Although the boundaries demarcating the Dry, Intermediate and Wet Zones do not coincide exactly with annual mean isohyets, the rainfall ranges in these three zones can be broadly classified as follows:

- the Dry Zone (mean annual rainfall less than 1900 mm).
- the Intermediate Zone (1900 - 2500mm).
- the Wet Zone (2500-5500mm).

The lowest rainfall in the Dry Zone is in the Mannar - Kalpitiya area in the northwest and the Yala region in the southeast, where the annual mean rainfall is less than 1000 mm. The highest rainfall is experienced in the Watawala- Ginigathena region where the annual mean rainfall ranges from 5000mm to 5500mm.


Agro-Ecological Regions
of
Sri Lanka
N
DRY ZONE
INTERMEDIATE ZONE
WET ZONE
DL1
DL2
DL3
DL4
DL5
IL1
IL2
IL3
IM1
IM2
IM3
IU1
IU2
IU3
WL1
WL2
WL3
WL4
WM1
WM2
WM3
WU1
WU2
WU3
20 10 0 10 20 miles
Source: Department of Agriculture

Key to Fig 2- Agro-Ecological Regions of Sri Lanka

ZONE	AGRO-ECOLOGICAL REGION & SYMBOL		75% EXPECTANCY VALUE OF ANNUAL RAINFALL (Inches)	MAJOR SOIL GROUPS	TERRAIN
WET ZONE	UP COUNTRY	WU_1	> 125	Red-Yellow Podzolic Soils and Mountain Regosols	Mountainous, steeply dissected, hilly and rolling
		WU_2	> 75	Red-Yellow Podzolic Soils and Mountain Regosols	Mountainous, steeply dissected, hilly and rolling
		WU_3	> 55	Red-Yellow Podzolic Soils with dark B horizon, and Red-Yellow Podzolic Soils with prominent A_1 horizon	Rolling
	MID COUNTRY	WM_1	> 125	Red-Yellow Podzolic Soils and Red-Yellow Podzolic Soils with semi prominent A_1 horizon	Steeply dissected hilly and rolling
		WM_2	> 55	Reddish Brown Latosolic Soils, Immature Brown Loams, and Red-Yellow Podzolic Soils	Steeply dissected hilly and rolling
		WM_3	> 50	Reddish Brown Latosolic Soils, Immature Brown Loams, and Red-Yellow Podzolic Soils	Steeply dissected hilly, rolling and undulating
	LOW COUNTRY	WL_1	> 100	Red-Yellow Podzolic soils and Red-Yellow Podzolic Soils with semi-prominent A_1 horizon	Rolling and undulating
		WL_2	> 75	Red-Yellow Podzolic Soils Red-Yellow Podzolic Soils with strongly mottled sub Soils; and Low Humic Clay Soils	Rolling and undulating
		$WL_{3\&4}$	> 80	WL3-Red-Yellow Podzolic Soils with soft and hard laterite WL4-Red-Yellow Podzolic Soils with soft & hard laterite and Bog & half Bog Soils	WL3-Rolling and undulating WL4 Undulating and flat
INTERMEDIATE ZONE	UP COUNTRY	IU_1	> 85	Red-Yellow Podzolic Soil and Mountain Regosols	Mountainous, steeply dissected hilly and rolling
		IU_2	> 55	Red-Yellow Podzolic Soils and Mountain Regosols	Mountainous, Steeply dissected, hilly and rolling
		IU_3	> 45	Red-Yellow Podzolic Soils	Steeply dissected, hilly and rolling
	MID COUNTRY	IM_1	> 55	Reddish Brown Earths and Immature Brown Loams	Rolling, hilly and steep
		IM_2	> 45	Reddish Brown Earths and Immature Brown Loams	Rolling, hilly and steep
		IM_3	> 35	Immature Brown Loams, Reddish Brown Labosolic Soils and Reddish Brown Earths	Steeply dissected, hilly and rolling
	LOW COUNTRY	IL_1	> 40	Red-Yellow Podzolic Soils with strongly mottled sub Soil, Low Humic Clay Soils, Red-Yellow Podzolic Soils, with soft and hard laterite; and Regosols on Old Rock	Rolling, undulating and flat
		IL_2	> 45	Reddish Brown Earths, Immature Brown Loams and Low Humic Clay Soils	Rolling, undulating and flat
		IL_3	> 35	Reddish Brown Earths, Non Calcic Brown Soils and Low Humic Clay Soils	Undulating
DRY ZONE	LOW COUNTRY	DL_1	> 30	Reddish Brown Earths and Low Humic Clay Soils	Undulating
		DL_2	> 35	Non Calcic Brown Soils Reddish Brown Earths, Soils on old alluvium, Solodized Solonetz, Low Humic Clay Soils and Regosols	Undulating and flat
		$DL_{3\&4}$	> 25	DL_3 - Red-Yellow Latosolic DL_4 - Solodized Solonetz, Solonchaks and Grumusols	DL_3-Flat to slightly undulating DL_4 - Flat
		DL_5	> 20	Reddish Brown Earths with high amount of gravel in sub Soil, Low Humic Clay Soils and Solodized Solonetz	Undulating and flat

10

Temperature

There is little seasonal variation of temperature in Sri Lanka. The mean annual temperature in the coastal plain below 150m elevation ranges from 26°C to 28°C, while in the upper montane zone above 1500 m elevation, it ranges from 15°C to 19°C.

Highest temperatures are experienced in the eastern and northeastern low country, generally during the period May to August, when temperatures sometimes exceed 37°C (blood heat) during the afternoon. Lowest temperatures are experienced early morning shortly before sunrise. At coastal stations, lowest temperatures are recorded during December and January and range from 12°C to 24°C. Temperature decreases with altitude and at Nuwara Eliya (1890m.), the minimum temperature which is generally of the order of 7.7°C in February sometimes falls close to freezing point (0°C) occasionally. Ground frost occurs in the Nuwara Eliya region on a few days in January and February.

Surface Drainage

Depending as it does on the physical features, the surface drainage pattern of the island is a mosaic of rivulets and streams, cascades and waterfalls which fall into numerous rivers, some of which are perennial. In this beautiful country even the 1700 km of coastline are decorated by a lacework of 103 river basins which end as sand bars, deltas, lagoons and marshes.

The centrally placed mountain mass encircled by the coastal plain provides for a radial pattern of drainage to which all major rivers conform, with the exception of the Mahaweli Ganga. Typically the larger rivers orginate in the higher parts of the central highlands and flow directly towards the coast, in certain parts of the country their seaward passage modified locally by the underlying structure. These modifications, as when the river flows over a hard rocky base and over an escarpment, produce another of Sri Lanka's natural attractions, her waterfalls, of which 99 are listed. The best known among these are Bambarakanda, (the highest 263 m), Diyaluma, Dunhinda, Devon and St. Clair.

The Mahaweli Ganga originates in the inner high plateau of the highland mass. It drains the western flanks of the central massif in its upper reaches and cuts across the grain of the massif in mid-course. Then it flows through the eastern flank and toward the northeast coast to form an annular pattern of flow (as opposed to radial) in relation to the highland mass.

Natural Hazards

Cyclones, widespread floods, droughts, earthslips and coastal erosion are the major natural hazards in Sri Lanka. They cause severe damage to life and property. The losses caused by landslides and coastal erosion, though less significant in the past, are now becoming more serious threats to life and property. In terms of losses caused, they are becoming as significant as droughts, cyclones and floods. The hazards of secondary importance are gale force winds associated with thunderstorm activity and flash floods of relatively short duration affecting local areas.

Cyclones

The eastern, northern and northcentral regions are the cyclone-prone areas in Sri Lanka. The 1978 cyclone alone affected more than 1 million people, killed nearly a thousand persons, destroyed 90 per cent of the coconut plantations in the Batticaloa district and resulted in the government having to spend over Rs. 600 million on immediate releif to those affected. Three other cyclones of severe intensity had struck Sri Lanka in 1907, 1922 and 1964. On many occasions cyclones have come very near the east coast of the island but, changing track, have moved north - westwards towards India.

Floods

Almost all the major river basins in Sri Lanka are flood-prone. The increase in population and the subsequent need for land have forced more people to live and work in these vulnerable areas, intensifying the risk to life and property in the event of a major flood.

Though droughts and floods have been featured regularly in our history they have greatly increased in intensity during this century particularly in its second half. Destruction of tree cover by forest clearing especially when it is followed by chena cultivation removes first the plant debris covering the soil and then the soil itself through erosion. This leads to high runoff of rain water and silting of the beds of streams and rivers leading to flash floods.

Droughts

Every year, people experience droughts of short duration which are of local significance. Droughts of regional sifnificance however occur about once in every three to four years, and those of national significance rather less frequently.

Earthslip

Spells of heavy rain and geophysical changes in the hill country, accentuated by man's increasing land clearance of steep slopes in the mountainous areas, have increased the danger of landslides. Thus, during the past two decades, an increasing number of earthslips has occured on the mountain slopes of the central and southwestern regions of the island.

Coastal erosion

The impact of coastal erosion has been increasing. Offshore mining of corals, removal of sand from the beaches and river beds, clearing of mangrove swamps and destruction of coastal vegetation have resulted in intensified coastal erosion, mainly along the southwestern coast.

Efforts must be made jointly by the State and the people to refrain from interfering recklessly with the environment since such interference may accentuate natural hazards.

Chapter 3

DEMOGRAPHIC CHARACTERISTICS

The resources of a country can sustain only a certain size of population at a given standard of living using a given level of technology. This population is referred to as the carrying capacity of that country. Demographic characteristics such as population size, structure, distribution characteristics and rate of change, not only affect development and the environment and natural resources but are in turn profoundly affected by them. In the consideration of these interactions, population should be thought of not merely in terms of total numbers and age structure but also as people who constitute a society. Their social characteristics including education levels, health standards and family status strongly influence the process of development and its impact on the environment.

Population

Sri Lanka's population at the end of 1986 has been estimated at 16.3 million and the natural increase of population 1.6 percent. The numerical increase in population is however nearly as high each year as it was 10 years ago. The country's Wet Zone is much more densely populated than the Dry Zone. It contains 57 per cent of the total population though it occupies only 23 percent of total land area. Population densities vary from about 2,800 and 1,200 persons per sq km respectively in the Colombo and Gampaha districts to 34 and 57 persons per sq km respectively in the Mullaitivu and Moneragala districts[1]. 78.5 per cent of the total population lived in rural areas at the time of the 1981 census.

Fertility levels have been declining during the past two decades inspite of an age structure which favours high fertility. The total fertility rate, for instance, has dropped from 5.0 in 1963 to 3.5 in 1981 and then to an estimated 3.0 in 1984. However, there is scope for further reduction in fertility. The government provides incentives to individuals to practise family planning and encourages NGOO including the Family Planning Association in their programmes.

The total population is expected to increase to 20.6 million by the year 2000 if this declining fertility trend continues[2].

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(1) Central Bank of Sri Lanka - Review of the Economy 1986.

(2) Sri Lanka Census of Population and Housing 1981. General Report, Vol. 3, Department of Census and Statistics, 1986.

Mortality rates also continue to drop. Significant reductions in infact and maternal mortality have resulted in spectacular increases in life expectancy especially for women. Life expectancy at birth was 67.8 for males and 71.7 for females in 1981[1].

The age-wise distribution of the total population is: below 15 years - 35.3 per cent; 15 to 59 years - 58.1 per cent; 60 and over - 6.1 per cent. The dependency burden is therefore 72.1 per cent. Sri Lanka's age structure has been described as being in the early transition stages from a developing country pattern to that of a developed country. [1]

Education

Eighty four per cent of the 5 to 14 year old group for whom schooling is compulsory attended school. Of the 15-19 year olds only 41 per cent continued formal studies. Large numbers terminate their formal schooling after the GCE Ordinary Level and GCE Advanced Level examinations. It has been pointed out that "literacy, educational attainments and school attendance have all improved more among women than men, and more among relatively less developed districts than others. Consequently, inequalities have fast disappeared and geographic variations have converged to narrower levels."[1]

Employment

Agriculture provided about 45 per cent of total employment, but cannot offer much more. Unemployment has been estimated at 14 per cent of the available labour force in 1985 and stated to be fast rising [2].

Population Increases by the Year 2000 AD

The total population has been projected on the basis of 2.5 children per family, to increase from 15 million in 1981 the year of the last census to 20.6 million in 2001. Projections show that 37.2 per cent more rice, 42.2 per cent more fish and meat and 28.4 per cent more milk powder would be required in 2001 than in 1981[3]. The stepping up of agricultural activities to meet these increased needs is bound to cause severe stress on the environment and the natural resource base.

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(1) Sri Lanka Census of Population and Housing 1981. General Report, Vol. 3, Department of Census and Statistics, 1986

(2) Public Investment 1987-1991, Ministry of Finance and Planning, 1987.

(3) Korale, R.B.M. Effects of Population Increase in 2000 AD. Sri Lanka Population Digest, Vol. No. 2 Dec. 1986 - Ministry of State.

The school age (5 to 14 years) population is projected to increase from 3.6 million in 1986 to 4.1 million in 2001. The increased school going population would need more teachers, more schools and more facilities.

Net additions to the labour force during the period 1986 to 2000 are projected at 2.0 million. On this basis about 190,000 to 200,000 employment opportunities must be created each year from 1986 to 2000 AD to maintain a 5 per cent rate of unemployment. The task is complicated by the fact that most of the unemployed will not be satisfied with unskilled jobs, since they have studied up to Grade 10 in school.

The numbers in the over 60 age group have been projected to increase from 0.9 million in 1981 to 1.1 million in 1986 and 1.8 million in 2000 AD. This significant increase in the elderly population will necesitate the provision of welfare benefits at a level that would strain the resources of the state and of the working population.

The housing needs of the increasing population have been assessed at approximately 50,000 units per year until the year 2000. Construction of housing units leads to increased use of natural resources.

Agriculture cannot provide employment for the numbers entering the job market. Nor can they be accommodated, as in the past, in new large colonization schemes established on cleared forest lands. The threat of expanding urban slums and shanties with all the attendant problems of urbanization therefore becomes real.

Every effort is therefore needed to contain population increases. The consequences of failure to do so have been explained in the following way:

> "There is an intimate relationship between population and development and between development and peace. Excessive population pressures make it difficult to grow enough food, create enough jobs, and train enough teachers and doctors to meet the needs of the society's expanding population base. Such population pressures exacerbate hunger, unemployment, ill-health and other social malignancies so that people become angry and resentful: throughout much of the Third World there now exist political and social tensions that can only explode into violence."[1]

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(1) Gupte, Pranay: Key Note Address delivered at the Seminar on "Media and Population" organised by the Population Communication Unit, Ministry of State, 16-17 December, 1986.

Chapter 4

NON-RENEWABLE RESOURCES

Sri Lanka possesses a reasonably wide range of non-renewable resources. Some of these have already been put to good use, but many are yet to be explored and harnessed. Their utilization goes back to the ancient civilizations when each village produced the articles it needed, mostly for use in agriculture and building construction. In medieval times, iron ore was extracted in Kotmale and the Uva Basin and smelted in the Wanni with the aid of charcoal fires, as was then being done in Europe. S. F. de Silva records that the iron was fashioned into "plough shares, bill hooks, axes and knives"[1]. He continues: "Stone masons, potters, brick makers and lime burners were among the craftsmen of old Ceylon", indicating also that clays, miocene limestone and similar resources had also been discovered by that time.

Industries based on local raw materials and those that carry out primary processing of the available industrial minerals for export or domestic use contribute to the economy in several ways. The age-old brick and tile manufacture, ceramic crafts and cement represent the former, while the much improved gem industry, the extraction of mineral sands and rock phosphate are examples of the latter.

However, the reserves of non-renewable resources are finite. If they are to continue as resources in the future their management must begin now. Strategies for long-term utilisation must replace short-term exploitation, which risk depletion of a reserve to levels which make extraction uneconomical. The next generation is then denied the option of utilsing this particular resource.

Ceramics

The ceramics industry has made steady progress in recent years. It has also demonstrated the wide distribution of the various raw materials required for both improvement and specialization of ceramic products. It uses clays from the Maha Oya basin north of Negombo (Gampaha District), Weuda (Kurunegala District), Alutnuwara (Badulla District), Yatiyana in the deep south an Uda Walawe in Sabaragamuwa. Another raw material,

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(1) de Silva, S.F. - Regional Geography of Ceylon. The Colombo Apothecaries Company, Ltd. Colombo 1954, p. 285.

China clay or kaolin, is extracted from the massive Boralesgamuwa deposit bordering Colombo. The manufacture of ceramics also needs ball clays of which a 500,000- metric ton deposit occurs in Dediyawela in the Kalutara District. Feldspar, another component of ceramics is available in the Matale District (Rattota, Kaikawela) and in Koslanda, as does vein quartz of high purity (from Opanayake, Pelmadulla, Rattota, Ratnapura and Galaha). Six million tons of pure silica the sixth mineral used in the production of ceramics is available in the Marawila - Nattandiya area on the west coast.

The distribution of these minerals, shown in Fig. 3. has enabled the decentralization of the industry which is an important socio-economic aspect of resource utilization Today ceramic factories of different specialities are located in Negombo, Dankotuwa, Boralesgamuwa, Rattota and Balangoda while the best "wire-cut" bricks come from Yatiyana. Glazed pottery manufacture is practised as a cottage industry in several parts of the country.

Cement

Miocene limestone and clay with which the northwestern coastline is underlain are the principal raw materials utilized in the cement industry. The cement factories are located in Kankesanthurai and Puttalam while clinker grinding and cement packing plants have been centered in Galle and Trincomalee.

Graphite

Graphite or plumbago, as it was once popularly known, was until the ninteen fifties a lucrative industry. The situation has been changed through supplies running out. Mining has now to be carried out some metres below ground level since the present technology can only tap graphite found in veins. Operations are now economically viable only in two mines in the Dodangaslanda area of the northwestern province.

Mineral Sands

The discovery of ilmenite, zircon, rutile and monazite deposits on the northeastern beaches from Nilaweli to Pulmoddai led to the setting up of a mineral sands industry in the late 1950s. It has now developed into an impressive export-oriented operation. Recent explorations indicate more extensive depsoits of these heavy sands. There is no immediate danger of stocks running out as they are replenished annually through wave-action during the northeast monsoons.

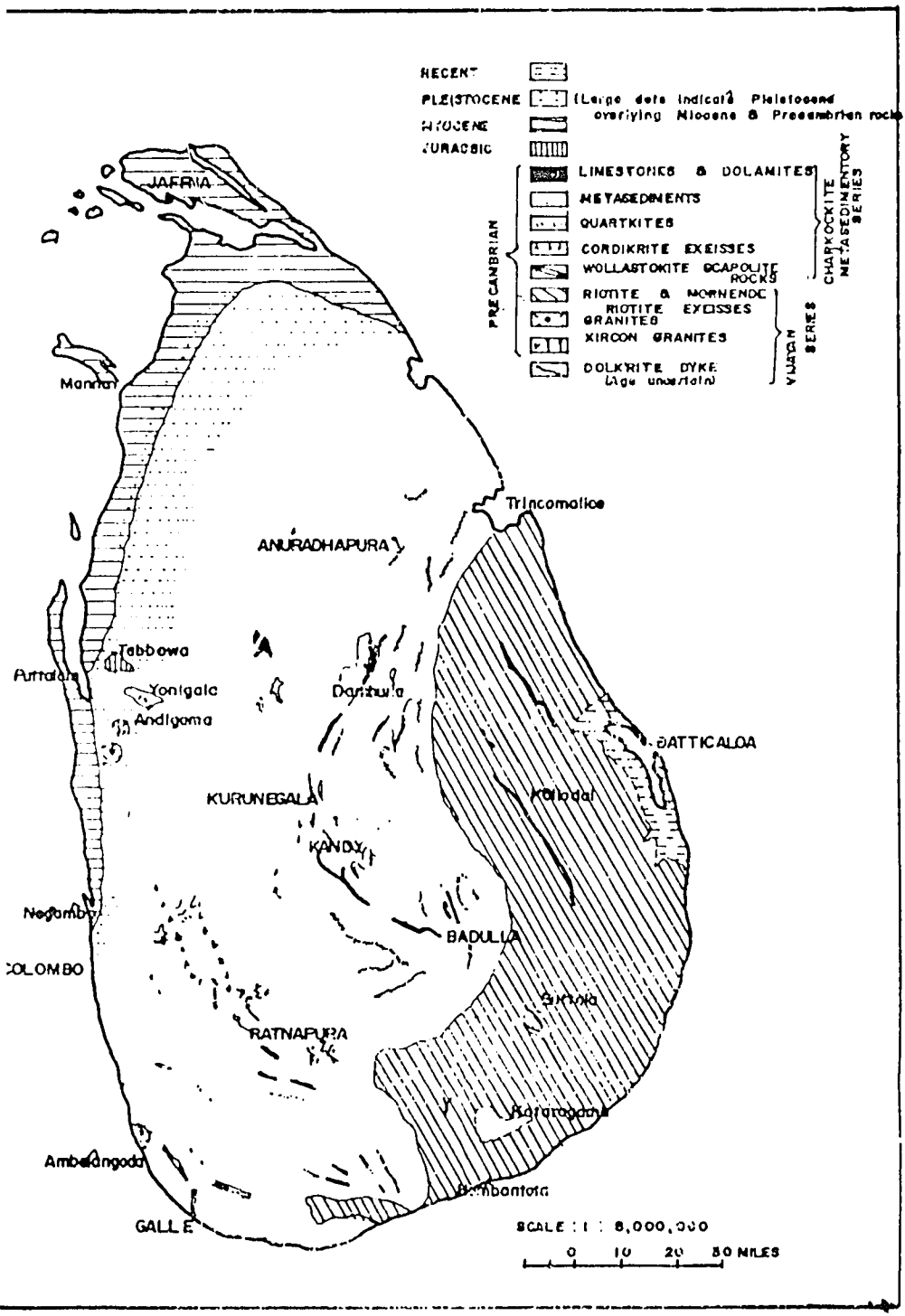

FIG.3. GEOLOGICAL MAP OF SRI LANKA

Source: Geological Survey Department.

Rock Phosphate (Apatite)

During its continuous mapping programme the Geological Survey Department made two discoveries of economic importance in the early nineteen seventies. These were the rock phosphate or apatite deposits on the Anuradhapura District and copper-magnetite in the Seruwila area of the Trincomalee District. Eppawela where the apatite was first located was then a typical village of the northwestern province. Since the discovery of a 60- million tonne deposit of this valuable fertilizer base, it has changed dramatically into a small industrial township. Within a very short space of time nearly all of the country's requirement of 20,000 metric tons of rock phosphate fertilizer was being obtained from the Eppawela deposits.

In developing this industry it is well to remember that in a small country the non-renewable resources are limited. The Mining and Mineral Development Corporation's proposed expansion into the extraction of one million metric tons of this resource annually to produce export-oriented products such as tri-sodium phosphate and di-ammonium phosphate must therefore be reviewed against the possibility of depleting the resource in less than 50 years and the country thereafter having to import rock phosphate.

The Seruwila copper-magnetite deposit, though not yet harnessed as a resource, falls into the category of future resources. It is the first base-metal ore deposit detected in the country.

Future investigations will determine whether this deposit contains available quantities of ore which make the separation of copper, nickel, cobalt or chromium commercially viable.

Gemstones

Sri Lanka is fortunate in possessing promising deposits of gem stones coveted the world over. From their wide range four are highly prized in the world gem trade. These are rubies, blue sapphires, (chrysoberyl) cat's eyes and, to a lesser extent, alexandrites. All these have the characteristics which made them very precious, desirable and expensive.

The fame of Sri Lanka's precious stones is legendary, not only on account of their beauty, variety and clarity but also because prospecting for them has been an occupation of great antiquity. Gemstones from this little island have fascinated people for centuries and have even been presented at the court of King Solomon in biblical times. To quote Sir Emerson Tennent again,

"The tales of mariners returning from their expeditions supplied to the story-tellers of the Arabian Nights their fables of jewels of Serendib", while Marco Polo wrote "the traveller of the Middle Ages on returning to Europe told of sapphires, topazes, amethysts, garnets and other costly stones of Ceylon, and of the ruby which belonged to the King of the Island's ' a span in length', without a flaw and brilliant beyond description".

But for all the romance and mystique of her gemstones, the story of Sri Lanka's gem "industry" is a sad tale of exploitation of the villager and degradation of the land, as well as of lost opportunity. The large economic chasm between the villager who toils unceasingly to "mine" river bed, marsh or buried river valleys often at the risk of his life, and the town-dweller who in comparative comfort, cuts and polishes the stones has not been bridged in the two-thousand years of "gemming". The state did little to improve the villager's lot and still less to co-ordinate the activities of mining, lapidary and export.

Not until 1971 when the state took the first steps to establish the Gem Corporation, was there an attempt to organise the activities connected with gemstones into the many faceted industry it should be. There had to be a new approach to earning foreign exchange for the country by making miner, lapidarist, entrepreneur and exporter components of a team rather than isolating them as competitors.

Although the industry is to some extent supervised by the state, a valuable contribution is still being made by the private sector. A good example is the way in which pressure was brought to bear on the Corporation to introduce heat treatment of geuda stones. The technique which was until recently in the hands of foreigners is now available to Sri Lankans. Whereas earlier a villager was happy when a foreigner paid him US $0.5 for a piece of "useless" stone, he now recognises that it may have thousands of dollars worth of sapphire in it, to be realized by heating it to the required temperature.

Lime from Coral

Slaked lime is widely used in building construction, for "plastering" brick walls. In historical times lime was mined from deposits along the coast. Later the easier and cheaper method was found of making lime from coral obtained by mutilating the beautiful fringing reef along the southern and eastern coasts.

The extraction of coral assumed such alarming proportions as to lead to coastal erosion by the sea's assault on the shoreline through yawning gaps in the reef, protecting the island. Government had to intervene, to control and later prohibit this dangerous escalation of coral destruction which set in motion many other coastal environmental problems described in Chapter 9 - Coastal Zone Resource Systems. The age-old practice of mining coral from in-shore deposits is now being given serious consideration as a means of taking the pressure off the living reefs.

Other Miocene Limestone Non-renewable Deposits

There are a few other non-renewable resources such as peat and marble including dolomite and offshore minerals, but as their deposits have not been quantified, their potential is not discussed here. There are indications that Sri Lanka has many other valuable non-renewable resources hidden among its ancient rocks and in the sea bed. Research and new technologies may soon discover them.

However, one of the disadvantages in the utilization of mineral deposits is that the act of mining directly conflicts with the conservation of other natural resources, notably land (and hence soil), plants and animals. These aspects will be highlighted later in the chapter on Constraints to Conservation. As the narrative continues into the renewable resources, the following passage from an authoritative text on Ecology is relevant:

> "The Copper Basin at Copperhill, Tennessee (USA) and a similar area east of Butte, Montana, provide impressive demonstrations of the result of absence of living organisms. In these regions fumes from copper smelters exterminated all the rooted plants over a wide area. All the soil eroded away, leaving a spectacular desert. Although modern smelting methods no longer release fumes, vegetation has failed to return, and artificial reforestation attempts have largely failed.
>
> The area is too "raw" for life to obtain a foothold and start the rebuilding process. Even the climate is different; temperatures are higher and less rain falls in the denuded area, compared with the nearby forest. Everyone should visit Copperhill as part of his general education."

Chapter 5

RENEWABLE RESOURCES

The renewable resources are the fauna, flora, soil, water and air. Two categories of renewable resources are distinguishable. Fauna and flora are living or biotic resources in contrast to soil, water and air which are non-living or abiotic. It has already been pointed out in Chapter I that the interaction and inter-relationships between them form the mechanism through which an ecosystem functions.

In other words, there is a fundamental biological link between these resources which explains their renewability. Their interplay has been described as follows:

> "Plant life is the primary source of food for all animal life and is itself substantially modified by the activity of animals. The existence of both is governed by the soil and rock upon which they live (and which in turn they affect) and by the climatic and other physical factors including the whole of the natural environment. Sunlight, air and water are necessary for soils to produce vegetation. Plant cover is needed to protect soils from erosion by wind and water and to retain water under the land. Animal life is essential to the growth of many plants, for example, for pollination and by preying on pests which destroy plants. Animals help to renew the soil by converting plants into excremental matter, and their own bodies turn into splendid compost when they die."[1]

Flora

The luxuriance of the Island's vegetation described earlier is not merely a manifestation of the lush growth of a few varieties of robust tropical trees. It is a well-balanced collection of over 3,000 species of flowering plants, ferns and allies living in climax communities spread over the country. Of the nearly 3500 species about 830, roughly 24 per cent are endemic, that is, they are found nowhere else in the world. Sri Lanka, in fact, possesses an extraordinary species diversity of great significance in an island flora.

While it is possible there may be new plant species to be identified, there is a real threat of species extinction follownig large-scale clearing of natural forest. In this situation the plant ecologist has an important part to play. His work must be coordinated with researches being undertaken in related fields, such as climatology. For instance, earlier work indicated

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(1) Robert S. Arvill: Man and Environment.

that dividing the country into three climatic regions was adequate to describe the geographical distribution of fauna in the country. But today ecological studies have shown there are actually seven vegetation zones which determine faunal distribution. Similar work has revealed the existence of 24 agro-ecological zones which are of significance in agricultural development.

The evolution of the vegetation into climax communities and particularly into forest communities makes plants both ecologically and economically important. Forests when properly managed become a steady source of good quality timber for a number of uses. Many species yield products of commercial value such as resins, essential oils and cosmetics. Today about 600 species are used in ayurvedic medicine while several more have become sources of pharmaceuticals in modern medicine. 20 percent of the fuelwood requirements of the country come from natural forests.

Four natural forest types are identifiable on the basis of annual rainfall and elevation.

i. **Tropical Wet Evergreen Forests**
Below 1,000 m Low-country Wet Zone consisting of four communities namely Dipterocarpus (S : - *Hora*); Mesua (S :- *Na*); Doona (S : - *Dun*); Camnospora (S : - *Aridda*); and Vitex (S : - *Milla*), Wormia (S : - *Diyapara*).

ii. **Tropical Lower and Upper Montane Forests**
Above 1,000 m elevation from the higher areas of Ratnapura District, Maskeliya and the Knuckles Range to the forests of Horton Plains and Hakgala.

iii. **Tropical Humid Semi-evergreen Forests** of the Intermediate Zone. The Kurunegala Group of forests dominated by Artsicarpus S : *Bedi-del* or *Val-del*), Vitex and Filicium (S : *Pihimbiya*) and the Moneragala forests (which are more dry).

iv. **Tropical Dry Mixed Evergreen Forests**
Dry Zone forests which are mostly secondary growths of Manilkara (S : *Palu*) ; Diospyros (Ebony, S : *Kaluwara*); and Berrya (S: *Halmilla*).

The Mangrove Forests must also be mentioned here although they do not belong to the above groups. They are a distinct type of natural

S - Sinhala

vegetation dominated by species whose distribution is governed by hydrological edaphic (soil) factors.

Fauna (Wildlife)

The importance of wildlife as a resource is not clear to most people. To the policy-maker and the developer they constitute a problem best dealt with by getting wild animals out of the way as quickly as possible. To them also, wildlife reserves are an anachronism in this age of "development" when in their view every inch of land must be cleared for human use or occupation.

Therefore, could this be misguided thinking in a land where the taking of life is abhorrent to the vast majority of people? It reflects more the attitude of "technically advanced societies" that tend to think of themselves as somehow separate from, beyond or above the workings of nature. The sooner this mistaken notion is corrected the better, after all, since, man is also an animal species interdependent on other species, sharing a common destiny.

Besides its role in the ecosystem and the protection it gets through religious precepts, wildlife is also of economic importance. In many countries, though not in Sri Lanka, much revenue and employment are derived from the control and management of wildlife from 'sport' and trophy hunting and from the sale of wildlife products. In Sri Lanka, the main economic use of wildlife is presently in tourism and leisure activity. Several thousands of people both local and foreign visit the numerous wildlife sanctuaries and wilderness areas each year.

The national parks of Sri Lanka have their own distinctive character where dense forests are interspersed with large open spaces affording easy observation of wildlife by day.Besides, these parks are within easy reach of principal towns. The popularity of these wildlife areas with both local and foreign visitors, has contributed to their continued existence in spite of the rush for more cultivable land.

Like the flora, the composition of the fauna also includes a noteworthy representation of the Indo-Malayan Region. It has many species in common with India, and a comparatively high incidence of endemism in the Low-country Wet Zone and in the Montane Zone. It also has affinities with ancient Gondwanaland. In zoological terms Sri Lanka possesses a 'relic' fauna. There are 84 species of mammals. The 10 endemic species among them include the Purple-faced Leaf Monkey

(Presbytis senex; S: *Kalu - wandura*); the common Toque Monkey (S: *Rilawa*) and the Golden Palm Civet (S: *Kalavedda*).

The largest of land mammals, the elephant, though relentlessly persecuted, still survives, but in greatly reduced numbers, in fragments of jungle. The total number of elephants in the wild is estimated at around 2,500. Sharing its endangered status are the leopard and the sloth bear. Four species of deer, the pangolin, several varieties of mongoose, three other species of wild cat and a host of bats, rats, mice and shrews fill almost all the ecological niches of the island.

The avifauna including the seasonal migrants, comprise about 400 varieties. Twenty one of them are endemic, the most attractive among them being the Blue Magpie, the Ceylon Jungle Fowl and the Ceylon Grackle.

Among the reptiles, of which there are 133 species, the largest are the python and the two species of crocodile. Endemicity is high in reptiles too, particularly among the burrowing snakes and the lizards of the Wet and Montane Zones.

Of the 32 species of frogs and toads which make up the amphibia, 15 are endemic.

The streams, rivers and inland waters have a striking array of fresh water fishes. Seventeen species are stated to be endemic.

Endangered species

Although adequate legislation exists for the protection of both fauna and flora, their habitats are steadily decreasing in extent. Clear felling of natural forests for human settlement, inundation of land for irrigation reservoirs and the fragmentation of other state forests for village expansion are reducing populations of both animals and plants to critical levels. Illicit felling of timber trees, uncontrolled collection of plants of economic value and the poaching of animals for meat, ivory and skin are added threats to the survival of many species.

Being an island with no possibility of wild stocks being naturally replenished from contiguous populations, several species are now identified as endangered. This situation is more applicable to the endemic species, that is species found only in Sri Lanka. Although observations are yet to be substantiated by census studies, there is little doubt that animals such as the elephant, sloth bear, dugong, marsh crocodile, several species for

birds, reptiles and fishes and over one hundred species of plants are already facing extinction. One immediate corrective measure to halt the decline would be a presidential directive that there should be no further felling of trees in the low country and Montane Wet Zone forests where 98 per cent of the endemic fauna and 90 per cent of the endemic flora are battling for survival.

Non-living Renewable Resources

The renewable resources of soil, water and air, though they are themselves non-living are vital elements for the survival of all life on earth. Without the productive layer of soil (top-soil) there would be no nutrients for plant life which provide all the food for animals, including man. Similarly, all life will perish through dehydration if there is no water. Lack of air or its pollution beyhond certain levels causes death of plants and animals alike.

Besides their inter-relationships with living organisms, soil, water and air are themselves inter-dependent. For example water, air and temperature are essential for soil formation, but if left unprotected, that same soil is just as easily degraded by these same elements, water and air through erosion. These intricate relationships will be further elucidated in the paragraphs that follow.

Soil

By definition, soil consists of the weathered layer of the earth's crust, intermingled with living organisms and the products of their decay. The soil and sub-soil form a very thin outer layer of parts of the earth's surface, which, from a human viewpoint, is the most vital element in land. Soil seldom exceeds 250 cm (100") in depth and of that, only the uppermost 25-30 cm (10-12") known as top soil, is productive.

Soil is created naturally through two very slow processes. First, the weathering action of water, air and sunlight on the earth's crust breaks it up into finely divided particles. There are important minerals, nitrates, phosphates and other chemicals in these particles which provide nutrients for plants. Plants which can grow on rock faces, and their dead matter make up the initial organic increment to soil formation. The second step is the intermingling of the organic increment with the particles to form soil. The time taken to complete these processes may be as much as several hundred years.

Gradually the soil is colonized by more complex organisms. Grasses, shrubs and trees contribute substantial amounts of moisture and organic

wastes turning soil into an attractive habitat for soil fauna. The soil fauna is made up of tiny animals such as bacteria and protozoa, small insect larvae and worms which form the micro-fauna and much larger ones ranging in size from earthworms to reptiles. In this way the soil begins to function as an ecosystem.

The soil biomass is of considerable magnitude. The activities of the fauna help also in the necessary turning over of the soil (aeration) while their excreta and dead bodies provide essential organic enrichment. It is said that the weight of living organisms below the surface of a field may exceed the weight of a herd of cattle grazing upon it.

In Sri Lanka much scientific work has been done on soils (perhaps with the exception of its conservation). A study of the systematics of soils and soil systems, indicates that there are as many as 13 soil types. There are soils to suit nearly every agricultural crop, for plantations and for house and road construction. For instance the Reddish brown Earths are suitable for maize, sorghum, legumes, chillies, fodder grasses and fruit trees, while poorly drained Low Humic Gley Soils are better suited for the cultivation of paddy. Onions, groundnut and tobacco, flourish on Red yellow Latosols.

Soils are not simply a resource. They constitute an entire life-support system, vital yet vulnerable. In nature's workshop it may take a hundred years to create an inch of top-soil by humification. Man's negligence, ignorance or greed can destroy this inch of soil in one year. A decision has to be taken immediately - whether to tend and nurture the soil as a life - giving possession or continue to misuse it and suffer the consequence of starvation and death, as currently in Ethiopia.

Water

Life begin in the water some 5000 million years ago. Without water all life ceases. Water is a transparent, tasteless liquid, a mixture of hydrogen and oxygen. It occurs in nature as a liquid, as a soild (ice), and as a gas (water vapour). It is heavy and strong enough to support an object heavier than itself. Its surface tension permits some forms of life to walk, "skate" or rest upon it. Guided by the topography, its movement over a landscape forms attractive waterfalls, streams and ravines. These are the sources of surface water, so important to man in his use of the land.

But where does water come from? Actually most of its is from the seas and oceans from where it is evaporated by the sun, carried as water vapour

and clouds in the atmosphere and condensed by changes in temperature to fall as rain. Thus the amount of available water changes very little. It is said that the water coming out of a tap today may once have slaked the thirst of an ancient cave man or a prehistoric animal.

As much as 70 per cent of the earth's surface is covered with water, but 97 per cent of that water is saline. Of the remainder, one per cent is contained in glaciers and polar ice-caps. Even the available two per cent is not evenly distributed in time or location. Hence, man has to spend considerable time, energy and money in controlling the utilization of water and transporting it to the right place at the right time and in sufficient quantity.

Nature renews water during its passage through the hydrological cycle. Salt water is converted to fresh water through evaporation and condensation. Nearly all of this water finds its way back to the sea and the process in repeated.

During this cycle water plays its vital role of sustaining all life. It is held temporally for use by living organisms, in the soil, in surface water, in trees and in animals. Some of it percolates deeper and is stored as ground water.

In Sri Lanka the naturally occurring water resources are identified as streams and rivers, lakes and villus, water-holes near the surface and deep-seated springs, soil water aquifers (permeable water-bearing geological formations) and coastal springs and lagoons. Despite this apparently even distribution over the land, the country is prone to natural hazards caused by floods and droughts bringing much hardship and economic loss to the people.

The country's Wet Zone receives rain almost throughout the year while rains are restricted in the so-called Dry Zone mainly to the period between October and January. The average annual rainfall in even the driest districts seldom falls below 1,000 mm. The Dry Zone which covers roughly two-thirds of the country has fairly heavy rain during the short wet spell of about four months. This region is called the Dry Zone because very little rain falls during the remaining 8 months of the year, when droughts are a common feature. From ancient times it has been the practice to collect the surplus rain water precipitated during the wet season in a system of reservoirs or tanks.

The larger tanks were supplied by impounding the waters of the tributaries of the major rivers. The system of distribution of water from these tanks for irrigating the rice fields was a marvel of hydraulic engineering. The small village tank, the dagoba and the paddy field were the symbols of the ancient Sinhala civilization. Post-World War II development included impounding the waters of the Gal Oya to achieve flood control, generate electricity and mainly to provide water for irrigation. The Laxapana Project saw the construction of dams across the Maskeli Oya at Mousakelle and across the Kehelgamu Oya at Castlereagh to generate hydropower.

The nineteen eighties have seen the implementation of the largest development programme in the country's history - the Accelerated Mahaweli Development Programme. When completed this programme will add 470MW to the island's electric power generation capacity with provision for future additional capacity of 275 MW. It will also provide sufficient water storage to irrigate an additional 143,000 hectares of land. Already about 50,000 families have been settled on newly irrigated land.

Water transport of goods has decreased except for the floating of logs downstream. The fine system of canals constructed by the Dutch rulers during the eighteenth century lies neglected and little used.

Development activities and population growth have led to increased demand and greater use of water, along with increased water pollution caused by unplanned development activities. These will be discussed sector-wise in later chapters.

Air (the Atmosphere)

Air has been defined as "a predominantly mechanical mixture of a variety of individual gases forming the earth's envelope, atmosphere "[1].

The basic composition of the atmosphere remains almost constant upto a height of 100 km at 78 per cent nitrogen, 21 per cent oxygen and 0.9 per cent rare gases and about 0.03 per cent carbon dioxide (percentages in dry air). The water vapour content of air varies from a fraction of 1 percent in cold dry air to 3 or even 4 per cent in moist warm tropical air. It also traces of ozone, ammonia, nitrogen and sulphur oxides, and suspended particles. Some of the minor constituents of air play an important role in

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(1) McGraw Hill Dictionary of Scientific and Technical Terms. Third Edition. Sybil Parker, Edition in Chief. McGraw-Hill Book Company, New York, 1984.

relation to plant and animal life that is much greater than their concentration would suggest. Carbon dioxide, for example, is an essential ingredient in the process of photosynthesis, which directly or indirectly produces all the food needed by animals at the same time replenishing the supply of oxygen in the atmosphere.

The atmosphere has been described as

"an important resource, which is subject to wide natural variation and human modification. It provides fresh water supply, transferring it from oceans to continents and de-salting it on the way by evaporation. It disperses pollutants, while rapidly diluting them. The atmosphere shields plants and animals from harmful wave lengths and intensities of solar radiation, moderates temperatures extremes on earth, transports heat from the equator to the poles, and moves nutrients and seeds from place to place."(1)

The atmosphere influences the lives of people, animals and plants through climatic and other changes including cyclones and severe droughts. In turn, human activities either deliberate or inadvertent, affect the atmosphere in three basic ways: changing its composition, releasing heat into it and changing the physical and biological characteristics of the earth's surface.

The composition of the atmosphere is changed when extraneous substances such as the products of burning fuelwood, oil or coal are discharged into it. Fuelwood and other forms of biomass are used for cooking in about 94 per cent of Sri Lankan households. The effects on housewives of the suspended particles, the carcinogens and the poisonous carbon monoxide in wood smoke in other countries have been vividly described.

Particulate carbon, carbon monoxide, carbon dioxide and benzopyrene are also released from motor vehicle exhausts and from oil or coalfired power plants and boiler furnaces, in addition to oxides of sulphur and nitrogen. Motor vehicle exhaust emissions also include lead compounds from the combustion of lead additives into petrol (gasoline).

Though the dangers posed by the pollution of the atmosphere by all these products of the combustion of fossil fuels have been highlighted there is as yet no firm evidence that atmospheric pollution has reached levels that pose a threat to human well-being.

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(1) The World Environment 1972-1982. Natural Resources and the Environment Series - Vol. 8 -A Report by the United Nations Environment Programme. Edited by Martin W. Holdgate et.al., UNEP 1982, p. 21.

Green leaves utilise atmospheric carbon dioxide in photosynthesis and limit its concentration in the atmosphere. The country's high forest cover has been reduced from about 44 per cent of total land area in 1956 to the present level of 27 per cent at a time when the amount of carbon dioxide emitted into the atmosphere has greatly increased. It is feared that this could result in higher levels of carbon dioxide in the atmosphere, which might hinder the radiation of heat from the earth's surface back into space and contribute to the global "greenhouse" effect. The contribution of Sri Lanka- a small island in a vast expanse of sea- to the global problem is however small.

Agriculture's contribution to atmospheric pollution is largely through the destruction of forests, the burning of vegetation and the widespread spraying of pesticides – particularly insecticides and herbicides. The insecticides used today are mostly organo–phosphates and carbamates which are toxic to humans. Malathion, an organo phosphate, has been exclusively reserved by the government for use in mosquito control. However, supplies of malathion are finding their way into unscrupulous hands and are being used in crop protection and in the preservation of dried fish.

Industrial pollution of the atmosphere is more conspicuous because the source is easier to locate. The minute fibres of asbestos released from factories producing asbestos-cement products are known to cause lung cancer. The import of the more harmful variety, blue asbestos, is now banned, though the others are also harmful. The cement factories at Kankesanturai and Puttalam have for years spewed out kiln dust over a radius of two miles. The problem of atmospheric dust common to coir and cotton spinning and weaving factories is confined to the working environment.

Two other types of atmospheric pollution are beginning to be taken notice of. They are heat pollution and noise pollution. The problem of heat pollution has been aggravated by the loss of tree cover. The ready availability of amplifiers, crackers and motor cycles has increased ambient noise levels, considerably inconveniencing people in urban areas and impairing their health.

Another environment hazard that has received world-wide attention is the threat to the ozone layer in the stratosphere which shields the earth's fauna and flora against harmful solar radiation, which even in small doses, could cause skin cancer. The possible causes of damage to the ozone layer have been identified as supersonic aircraft and chloroflurocarbons with long life times used as refrigerants and propellants in aerosols. So far however, there are no measurable effects of any damage to the ozone layer from these sources.

PART II

Management of Ecosystems for Sustainable Development

Ecosystems are systems of plants, animals and micro-organisms together with the non-living components of their environment. These components actively interact with each other giving rise to essential ecological processes, the products of which are vital for man's survival. Food, medicine, timber and fuelwood are among them. Such ecosystems are the life-supporting systems referred to in Part I.

Part II examines the principal life-supporting systems in more detail, discusses the present trends which disturb their functioning and stresses the need for their efficient management. The principal systems which are under serious threat in Sri Lanka and require immediate attention if they are to be saved from further damage are agriculture, forestry, wildlife reserves and coastal and freshwater systems. These systems which should actually support each other for sustainable development, are today locked in a hopeless conflict with each other through competition for a common resource base, namely land. Because of increasing rural population pressures, there is a demand for development activities based on agriculture (including animal husbandry) often at the expense of forests, wildlife reserves, grasslands and wetlands. At the same time, however, agricultural land is being lost through urbanisation - roads, buildings, and housing complexes are "mushrooming" on land whose soils are well suited for crops and pasture.

Unquestionably, agriculture forms the backbone of the Island's economy, In 1987, it accounted for about 20 per cent of the total GDP., about 45 per cent of total employment and around 45 per cent of the export earnings. Of the people living in rural and estate areas, (which contain 79 per cent of the country's total population) 90 per cent are either directly or indirectly dependent on agriculture for their livelihood.

An increasing population brings pressure to bear on policy makers to provide more land for cultivation. But the extent of cultivated land can be increased only by clearing even more of the rapidly diminishing forests. The heavy dependence of the national economy on agriculture together with the limited area of arable land has led to the opening of the few remaining forest lands for cultivation and the use of farming systems that cause considerable pressure on the country's ecosystem. Unless changes are made in land alienation policy, farming systems and watershed management aimed at natural resource conservation, there is the very real danger that the agricultural systems will collapse before long.

Chapter 6

FORESTS

From very early times the natural forests of this country had been carefully nurtured and preserved in their pristine form. Their importance in proper land use, especially in regard to agriculture, was well understood. Forests were only minimally disturbed and then too, only to provide simple human needs. Nanayakkara (1987) records this relationship thus

> "Man at that time achieved self-sufficiency in food, practised agro-forestry in homesteads and also lived in harmony with a neighbouring forest environment. There appeared to be a close inter-relationship betwen man and forest, man depending on the forest for a variety of forest products including medicines."[1]

The country remained almost completely covered with natural vegetation right up to the British period. This is borne out by the following observation of a British planter around 1830 in the early days of coffee, the first commercial crop, introduced by the colonial rulers.

> "Mountains... clothed with virgin forests from their bases to their summit ... the banks of rivers clothed with forests so dense that it is a almost impossible to penetrate them.. in these woods you will find timber which is almost worth its weight in gold".[2]

Unfortunately the dense forests did not remain so for much longer. Clearing of Wet Zone forests both in the low country and in the hills for plantation and export crops started soon afterwards. The dense forest cover which was estimated to cover 75 per cent of the land at the beginning of the twentieth century rapidly dwindled to around 50 percent by 1945.

The exploitation of forest resources which began under the Portuguese and the Dutch was intensified under the British rule. A separate agency of Government became necessary to supervise the extraction of timber and to prevent the local population from doing so. Thus in 1887, the Forest Department was set up. The protective role of forests became subject to their economic importance. Only during the past two decades has forest

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(1) Nanayakkara, V. R. Forest History of Sri Lanka. 100 years of Forest Conservation. Forest Department, 1987.

(2) Boyd, William: Autobiography of a Peria Durai. Reprinted from the "Ceylon Literary Register"., A.M. and J. Ferguson, Colombo, 1889, p.4.

conservation been revived and such programmes as social or community forestry and agro-forestry, re-established.

However, economists still refer to forests in term of GNP. It is their contention that the contribution of 1 per cent of the GNP being presently made by the forestry sector has to be increased considerably to justify large extents of land being set aside as forest resources. The more important role of natural forests for environmental stability and human needs has already been stressed. These uses, more than economic benefits, call for the retention of optimum extents of natural forest cover, especially in an island situation.

In order to monitor changes in natural forest cover the Forest Department carried out detailed national forestry inventories. During the past thirty years, two such inventories were compiled. The first of these covered the period 1956-60 and the other 1982 - 85.[(1),(2)] A sample estimate in mid-83 is shown in Table 1. This estimate places the forest cover at 37 per cent but the report cautions that "a great part of the forest cover is degrading, only a part is timber productive and in several regions the forest cover is considered critically low."[(2)]

It would be prudent, therefore to subject even immediate plans for large-scale timber exploitation, to a thorough environmental impact assessment (EIA). A team of scientifically trained officers should monitor the implementation of such plans particularly to implement the terms and conditions laid down in the EIA.

The country's forest types broadly correspond with its agro-climatic regions. The wet zone has tropical lower and upper montane forest; the intermediate (rainfall) zone has tropical humid semi-evergreen forest; and the dry zone, tropical dry mixed evergreen forest.

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(1) "A Forest Inventory of Ceylon" Hunting Surveys Corporate Ltd., Toronto, Canada in Cooperation with the Forest Department - Ceylon Government Press Colombo 1961.

(2) A National Forest Inventory of Sri Lanka 1982-1985. GOSL/UNDP/FAO Project SRL/79/014 Forest Department, Sri Lanka, March 1986.

Table I

EXTENT OF FOREST LAND, 1982-85

Forest Type		Extent/ha (% of total land area)
Productive natural high forests		
- in the wet Zone	120,000	
- in the dry zone	955,000	
Forest plantations older than 5 years	75,000	
Natural high forests on steep slopes	175,000	
High forests reserved for nature conservation	475,000	
Total high forest area	1,800,000	28.0
Secondary shrub and scrub forests	625,000	9.5
Fallow forest lands (mainly grass with some shrubs and trees)	300,000	4.5
Grand total of forest land	2,275,000	42.0

Source: Forest Inventory for Management Planning, SRI LANKA Terminal Report: Project Findings and Recommendations FO: DP/SRL/79/014, UNDP, FAO, Rome. 1987.

The low country wet zone forests depict the tallest tree stands, with the largest number of tree species and the greatest complexity. Unfortunately they form one of the most fragile and least resilient systems in nature. The Wet Zone climax forests are said to be primeval, having evolved slowly over a very long period of time.

Of the over 3000 species of flowering plant species, 24 per cent are endemic. Ninety-two per cent of the endemics inhabit the Wet Zone while the remaining eight per cent are found in the Intermediate and Dry Zones (Table 2). Endemic species are not merely present as a few individuals in these forests and other natural systems but they form the major component. From a biological point of view, the island's most valuable forests are those of the Wet Zone. The climax forests of the dry zone are of secondary origin.

Since 1980 the Forest Department has been carrying out a programme of reforesting watershed areas throughout the island. This programme requires to be strengthened with more funds, man-power and logistical support in order to achieve its goals, and more careful environmental assessments prior to implementation.

Table 2
NUMBER OF ENDEMIC SPECIES OF TREES, SHRUBS AND HERBS IN DIFFERENT FOREST TYPES OF SRI LANKA (PERIOD 1975)

Life Form Group / Climatic Zone	Montane Only	Common to Montane and Moist Low Country	Moist Low Country Only	Common to Moist Low Country and Dry	Dry Only	Common to Dry and Intermediate	Intermediate Only	Total in each Life Form Group
Trees	72	46	156	15	9	6	2	306
Shrubs	84	32	82	15	13	3	1	230
Herbs	128	51	88	9	12	4	2	294
	284	129	326	39	34	13	5	830

Source: Peiris, C.V.S., 1975. The Ecology of the Endemic Tree Species of Sri Lanka in relation to their conservation. Ph.D. Thesis, University of Aberdeen.

Mangrove Forests

Mangrove Forests are climax communities whose great ecological and economic importance have been realized only recently. Unfortunately in Sri Lanka even today, policy-makers failing to understand that without mangroves entire coastal fisheries will cease, approve land-filling of mangrove forests for urban development schemes.

Already many wet zone mangrove forests have been totally replaced by marginal paddy fields in the western and southern parts of the island. At the present moment an important mangrove forest not far from Colombo is being land-filled for "development", without an assessment of its impact on an important lagoon fishery nearby.

Mangrove forests are ecosystems whose functioning is still being researched. The chemistry of mangrove swamps and their importance to the fishing industry are discussed in Chapter 9 - Coastal Zone Resources. Six thousand to seven thousand hectares of mangrove forests are widely distributed along the coast of Sri Lanka in the inter-tidal zone.

The majority of mangroves, in overcoming the problem of anchorage caused by frequent movement of both water and soil, present a strong first line of defence against cyclones and strong winds. Close stands of Rhizophora, Bruguiera and Sonneratia protect the coast from strong winds and decelerate tidal flows.

Mangroves also yield useful forestry products. Local fishermen show much ingenuity in utilizing them for their own benefit or as a cottage industry in such as mat and basket weaving from the fronds of Nipa fruticans (S: *Ginpol*). The tannin-rich bark of species such as Rhizophora is used by fishermen to dye their nets and sails. Their timber is used in the construction of huts, furniture, tool handles and boats and are rendered insect resistant by the tannin in the wood. Mangroves are also used as fuelwood.

Mangrove swamps are the breeding and nursery grounds of the coastal fisheries, which produce more than 75 percent of total fish catch in Sri Lanka. Land-filling of coastal wetlands for haphazard "development" must stop. No longer can developers plead ignorance of the importance of these delicately-balance environments.

Fortunately mangrove forests along with other wetlands are receiving special protection in many other countries and Sri Lanka will do well to

join them. Sri Lanka should become a signatory to the UN-sponsored Ramsar Convention for the protection of wetlands which has helped to save mangrove forests in many other countries.

In recent years NARESA and the Forest Department have sponsored several valuable research studies to compile data on mangroves to prepare a national management plan. The state should recognize the value of mangroves as life-support systems and halt all the ill-conceived, piece-meal "development" projects planned at their expense.

Grasslands

Grasslands are natural climax communities in which grasses are the dominant species. Their position in nature is intermediate between a forest and a desert. Grasslands are delicate ecosystems which should be managed with care. They should not be classified as denuded forest lands and be subjected to reforestation.

Sri Lanka has three broad categories of grasslands, namely the montane patanas, the savannas and the villus of the flood plains.

The patanas are the most extensive among them, covering about 650sq km of the southcentral highlands but contained mainly within the triangle formed by Nuwara Eliya, Bandarawela and Badulla. Patanas have evolved naturally to suit the ecological conditions prevalent there e.g. inadequate rainfall, strong wind action and a hard pan of rock underlying the few inches of soil. Of the tree species only the Rhododendron appears to be able to establish itself under these conditions.

The validity of classifying some of the lowland grasslands as savannas has also been challenged. The "rolling" (undulating) grasslands of the Maha Oya, Bibile and Gal Oya areas distinguish them from the flat villu-type of grassland nearer the coastal plains. The regularity with which Terminalia chebula (S: *Aralu*), Terminalia belerica (S: *Bulu*) and Phyllanthus embilica (S: *Nelli*) occur in these grasslands have led to their being popularly referred to as aralu-bulu-nelli forests.

The other lowland grasslands are the talawas and villus, the former on higher land than the latter which are located in flood plains and are subject to periodic inundation.

Grasslands have much potential as pasture for livestock. But before they are improved to serve as permanent rangelands, their ecological

characteristics must be carefully studied. Being a natural vegetation climax type, grasslands are ecosystems which are governed by the principles described earlier under natural resources.

The management of grasslands therefore should be supported by careful research into their ecology.

Forest Plantations

Forest plantations on a management scale were begun around 1950 on abandoned chenas and other unproductive lands. Chena cultivators were allowed to grow cash crops between the rows of trees planted during the first three years. This system is reported to have led to the successful establishment of teak plantations in the Dry and Intermediate Zones at very reasonable costs. During the late nineteen seventies the clearing of natural forests for the establishment of forest plantations was discontinued, and fuelwood plantations are now being established in place of teak plantations. By the end of 1986, there were 179,591 hectares of forest plantations. These were mainly of teak, mahogany, eucalyptus, pines and bamboo. 75,000 hectares of these plantations are more than five years old. These forest plantations are several times more productive than natural forests.

The Forest Department has come to recognise the need to obtain people's participation in establishing such plantations. The Forestry Extension Unit in the Department performs functions comparable to those of the Extension Division of the Department of Agriculture. Social forestry and agro-forestry are receiving high priority in the Forest Department's work programme. The main activity in the social forestry programme is the establishment of farmers' wood lots to supply their needs of timber and fuelwood.

Agroforestry consists of the cultivation of a mix of plants having complementary needs, often together with small-scale livestock farming. This was the pattern of the homegarden in traditional Sinhala villages. These homegardens provided timber, fuelwood, medicines and food including milk, fruits and vegetables. They contained coconut, jak, mango, citrus, coffee, papaw, pepper, vegetables, animal fodder and medicinal plants.

The government's Forestry Master Plan recommends the following programmes for forest plantations:

- Rehabilitation of existing plantations.
- Establishment of - 10,000 hectares of new plantations each year to meet industrial demand for logs for sawing and for peeling.

- Block fuelwood plantations to be established to meet the needs of industry.

- A total of 36,000 ha of farmers' woodlots by the year 2000 to produce fuelwood, poles, posts and utility timber for the farmer's own use and for local markets.

- Protection plantations in the hill country on slopes with a gradient exceeding 30°.

Forestry Development Programmes

The forest cover in the Wet Zone of the low country and montane regions lies below the critical level, and seriously threatens hydropower generating capacity and the ability to provide water for irrigation of downstream areas. A Master Plan for Forestry Development was prepared under the Forest Resources Development Project with foreign assistance. It recommends :

i. Selective logging and scientific management of only 119,000 ha of the 278,000 ha of Wet Zone Natural Forests and the conservation of only the 517,500 ha of Dry Zone protected forests. Priority is recommended for reforestation of catchment areas and watersheds.
ii. The installation of efficient timber - sawing machinery.
iii. Setting up a Forestry Training College.
iv. Stepping up research into forestry management and timber utilization.

The catastrophic consequences of neglect of the forestry sector are highlighted in the following gloomy future painted for South and South-East Asia.

"By the year 2000 the natural closed forests of South and Southeast Asia are likely to be reduced to less than 100 million hectares. The natural forests that remain will be either in inaccessible mountainous or swampy regions, or will be protected by law, or will be so degraded as to be commercially useless. These subregions may have about 5 million hectares of plantation forests by that time.

Erosion, siltation, flooding and other problems associated with deforestation are likely to have become a severe constraint on food

production by the year 2000 in South and Southeast Asia. The ecological diversity of the region will be much lower, and populations of the remaining fauna may be expected to fluctuate much more widely, with some species becoming extinct in the low flux and other species becoming hazardous pests in the high flux.

It seems likely that some of the region's present potential to support human populations will have been irretrievably lost.

Prices and absolute scarcity will put fuelwood and charcoal out of economic reach of not only the subsistence sector but also much of the market sector of the least developed countries (LDC) populations"[1].

The complex nature of the problem of deforestation has been expressed as follows :

"Deforestation as a problem:

(i) is irreversible in nature;
(ii) is interactive;
(iii) has casual factors which are increasing in magnitude;
(iv) has a solution which is linked to socio-economic conditions which are difficult to change;
(v) involves a large number of subjects in the causation; and
(vi) is discounted by existing public administration mechanisms. [2] [3]

The most serious consequences of deforestation is seen as the loss of species and genetic diversity. "The one process ongoing in the 1980's that will take millions of years to correct is the loss of genetic and species diversity by the destruction of natural habitats. This is the folly our descendants are least likely to forgive us." [4].

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(1) The Global 2000 Report to the President: Entering the Twenty First Century. Vol. I Penguin Books, Harmondsworth England 1982.

(2) Pearce, D. Resource Scarcity and Economic Growth in Poor Developing Countries Futures Vol. 17 (1985), pp.440 to 455.

(3) Bowonder, B. Management of Environment in Developing Countries Environmenalist Vol. 7 (1987), No. 2, p. 120.

(4) Fischer A.C. Resource and Environmental Economics. Cambridge University Press, Cambridge, 1981.

Chapter 7

WILDLIFE

Wildlife is inseparable from forests. Together they comprise the biotic component of the environment and are inextricably linked to form the most basic of natural systems. The protection afforded to the forests by kings in historical times also greatly benefitted the fauna within them. With the spread of Buddhism in the country, wildlife received more specific protection in designated areas. The ancient chronicles repeatedly refer to the high priority given to the protection of animals.

Despite many attitudinal changes brought about by foreign rule, the respect for wildlife and the inherent desire to protect them have survived among the people to the present day. Sri Lanka enjoys an enviable international reputation for the positive conservation measures it has taken. It is often quoted as an example of a country which even in the face of much development, still adds considerably to its network of protected areas. For example, as recently as 1982 provision was made in the Accelerated Mahaweli Programme for the declaration of two new National Parks, the redesignation of two other reserves as National Parks and the creation of Jungle Corridors to link them.

About 11 per cent of the land area of the country is reserved for wildlife conservation. Unfortunately, too large a proportion of them falls within one climatic zone, namely, the Dry Zone. This is due to the fact that during British rule, wildlife reserves were originally established only to protect the interests of hunters. Thus the Yala and Wilpattu groups of reserves which are among the oldest, had their genesis as Resident Sportsmen's Reserves and Game Sanctuaries, managed by the then Game and Fauna Protection Society.

Since by the turn of the twentieth century the large majority of Wet Zone forests were either being removed to make way of commercial crops or exploited for their timber, wildlife continued to be given protection in the Dry Zone in which the then government had little or no interest. There was thus no scientific basis for the creation of other wildlife reserves, an omission which is still to be set right.

Of the 10 National Parks, three Strict Natural Reserves and some 45 Sanctuaries, only one National Park - Horton Plains, one Strict Natural

Reserve - Hakgala and one major Sanctuary - the Peak Wilderness are situated in the Wet Zone. These are inadequate to protect the specialized habitats therein, which harbour about 90 percent of the endemic fauna of Sri Lanka.

The most urgent need therefore is the setting up of a mosaic of protected wildlife areas in all of the seven vegetation zones of the country, which determine the distribution of both fauna and flora. These are:

A1 Monsoon Scrub Jungle - extreme north and northwest.
A2 Monsoon Scrub Jungle - extreme southeast.
B Monsoon Forest and Grassland.
C Inter-monsoon Forest.
D1 Rain forest and Grassland - below 900m. (3000 ft).
D2 Rain forest and Grassland 900 - 1,500m.
D3 Rain forest and Grassland - above 1500m. (5000 ft).

This process may even entail the abolition of certain unimportant protected areas in the Dry Zone, to obtain new important ones in the Wet Zone. For example there should be reserves specifically for fauna protection in the Sinharaja and Knuckles Ranges. These should be managed by the Department of Wildlife Conservation.

In the meantime the state, recognizing the significance of wildlife to the environment, the gene pools, their aesthetics and economic value through tourism and leisure activities, lays great emphasis on wildlife conservation. It does so in two principal ways:

a. Sets aside sufficient extents of natural forests and other habitats entirely for wildlife.
b. Enforces rigid laws embodied in the Fauna and Flora Protection Ordinance to provide protection to species which are vulnerable threatened or endangered.

The constraints to wildlife conservation are common to those of the forestry sector and other users of land. They include lack of finances, trained manpower, education and training facilities and logistical support.

The Department of Wildlife Conservation has been in existence for less than 40 years. However, it has made a remarkable contribution to conservation in general during that relatively short space of time. It has done so to a large extent with the unstinted help of non-governmental organisations. (NGOO) Particular mention must be made of the Wildlife and

Nature Protection Society which is nearly 100 years old. Considering the Department's emergence as an agency whose activities centred round the control of hunting and the export of skins and other trophies, the Department has done well to steer a course towards scientific management of natural habitats. The assistance of universities, technical and scientific institutions such as NARESA and NARA and international organizations like the International Union for the Conservation of Nature and Natural Resources (IUCN) and the World Wildlife Fund (WWF), has also been sought towards this end.

The Department's efforts in preventing the extinction of Sri Lanka's largest mammal, the elephant, have been acknowledged by international conservation organizations. The futuristic concepts of providing jungle corridors (or link forests) to distribute animals spatially and thereby prevent massive habitat destruction as occurs in Africa, merits special mention. The demarcation of Buffer Zones to mitigate the man-animal conflict in rural areas is also another progressive step.

It is now left to the Department to devise programmes that will benefit the people of villages close to protected areas. One successful attempt so far made has been the employment of village youth as trackers and maintenance workers.

The flow of cash into the village dissuades villagers from engaging in poaching, illicit felling and encroaching on Park land.

The formulation of a National Wildlife Policy (work on which began in 1982), the passage into the law of the new amendments to the Ordinance (also completed in 1982) and the preparation of management plans for all important wildlife areas are among the urgent actions the department must take toward achieving meaningful wildlife conservation goals.

Chapter 8

GENETIC RESOURCES

Sri Lanka, blessed with ample sunlight and rainfall, is rich in animal and plant life. Many of these plant and animal species are endemic to Sri Lanka. Of the nearly 3500 species of vascular plants growing in this country, endemics numberabout 830. As many as 92 per cent of the endemic species inhabit the low country wet zone forests and the montane zone forests. Their distribution in the principal forest types is shown in Table 1 of Chapter 6 - Forests.

Eighteen genera and 310 species and sub-species of vertebrate animals representing 6 per cent of the total number of inland vertebrates and 50 per cent of the total number of such species and sub-species found in Sri Lanka are endemic. Their numbers are shown in Table 3. The number of recent introductions has been well documented.

Widespread clearing of forests and recent monoculture practices in agriculture and plantation forestry threaten this rich diversity of life with reduction of genetic variability and even extinction of the genetic material characteristic of species (genomes). The profitable export of rare species will add to the strain on the genetic resources of this country. The introduction of exotic species into this country posses a threat to the existing species through competition for food and space. Such a threat is perceived in the establishment of Eucalyptus and Pinus plantations and in the breeding of gourami fish in reservoirs and streams.

The extensive use of pesticides and other chemicals posses a further threat to the country's genetic resources including its human resources through the generation of harmful mutations and cancers.

The advent of the green revolution in Sri Lanka and the concomitant drive to increase crop yields have caused agriculture to rely on a few improved varieties with a narrow genetic base, displacing the traditional varieties.

In the case of rice, the present extent of indigenous varieties under cultivation had dwindled to about 5 per cent of the total paddy acreage. The spread of genetically uniform varieties while helping to achieve high yields, has increased the vulnerability of crops to pests and diseases and

eliminated genetic diversity upon which crop breeding programmes depend. The presence of a wide variety of genes in wild plants enables the introduction of desirable characteristics such as resistance to pests and disease, improved yields and desirable aromas.

The conservation of genetic variability is therefore crucial to the success of future crop improvement programmes and hence assumes national importance. This was foreseen by the Research Division of the Department of Agriculture as far back as 1967. Efforts were primarily directed towards the conservation of local rice germplasm as it was threatened by the rapid spread of newly improved rice varieties. A total collection has been made of over 2000 accessions including primitive and wild species of rice. Promising sources of resistance to pest, diseases and environmental stresses have been recorded among them.

Conservation activities are currently being expanded to include gemplasm of coarse grains, pulses, fruit crops, oil crops, root and tuber crops.

Table 3

INLAND VERTERBRATES OF SRI LANKA

	Geneva	Endemic Genera No.		Species Total No.	Endemic Species No.		Species and Sub-Species Total No.	Endemic Species and sub-Species No.	
Pisces (excluding introduced forms)	32	3	9	39	16	27	6	28	45
Amphibia	10	1	10	37	19	61	37	19	61
Reptilia	68	12	19	139	72	51	159	98	62
Aves (Residents only)	165	0	-	237	20-21	8	248	104-105	42
Mammalia	51	2	4	85	10	12	114	61	54
	326	18	6	567	138	25	620	310-311	50

Note : The high percentage of endemicity shown by amphibia and Reptilia, two groups we often tend to take for granted or even sometimes forget, is mainly due to, their being confined to specific areas of isolation.

The low endemicity of Birds could be due to their mobility. An endemic species is found nowhere else in the world.

Source: Cruzy, H., (1984). Introduction to our verterbrates, quoted in March for Conservation Newsletters No. 2, Vol. I, January-March 1986.

Chapter 9

COASTAL ZONE RESOURCE SYSTEMS

The Coastal Zone may be defined as "that area lying within a limit of three hundred metres landwards of the mean high waterline and of two kilometres seawards of the mean low waterline in the case of rivers, streams, lagoons, or any other body of water connected to the sea either permanently or periodically, the landward boundary shall extend to a limit of two kilometres inland along that body of water."[1] A diagram illustrating this boundary is given in Fig. 4.

The coastal zone may also be described as an area where terrestrial and marine processes interact to produce a range of dynamic geomorphological and ecological conditions. This zone serves two invaluable functions. Firstly, it shows how nature has dealt with the problem of protecting the land from the incursions of the ocean through fringing coral reefs, sand dunes and mangrove forests. At the same time the mangrove swamps, lagoons and estuaries regulate the surface and river water runoff which would otherwise rush into the sea carrying their vast loads of silt and chemical pollutants which endanger the sea grass beds and coral reefs. Secondly, the complex of ecosystems produces innumerable ecological niches colonized by an extraordinary diversity of both plant and animal species. This biota makes these ecosystems extremely productive and economically important. They support whole fishing communities both directly and indirectly, as will be described under each ecosystem.

The coastal zone comprises five main ecosystems. They are: mangrove swamps (and forests) and mudflats, estuaries and lagoons, seagrass beds, corals reefs and beach systems.

Mangrove Swamp

Mangroves were dealt with as a forest type in the previous chapter. Here they will be considered as a resource ancillary and in relation to the productivity of the coastal zone.

Mangroves are tropical or sub-tropical halophytic woody seed-bearing plants characterized by their common ability to thrive along inter-tidal coastlines. They possess the adaptations necessary to live on shifting

(1) Sri Lanka Coastal Zone Management Plan, Coast Conservation Department, Colombo, 1987.

Fig 1

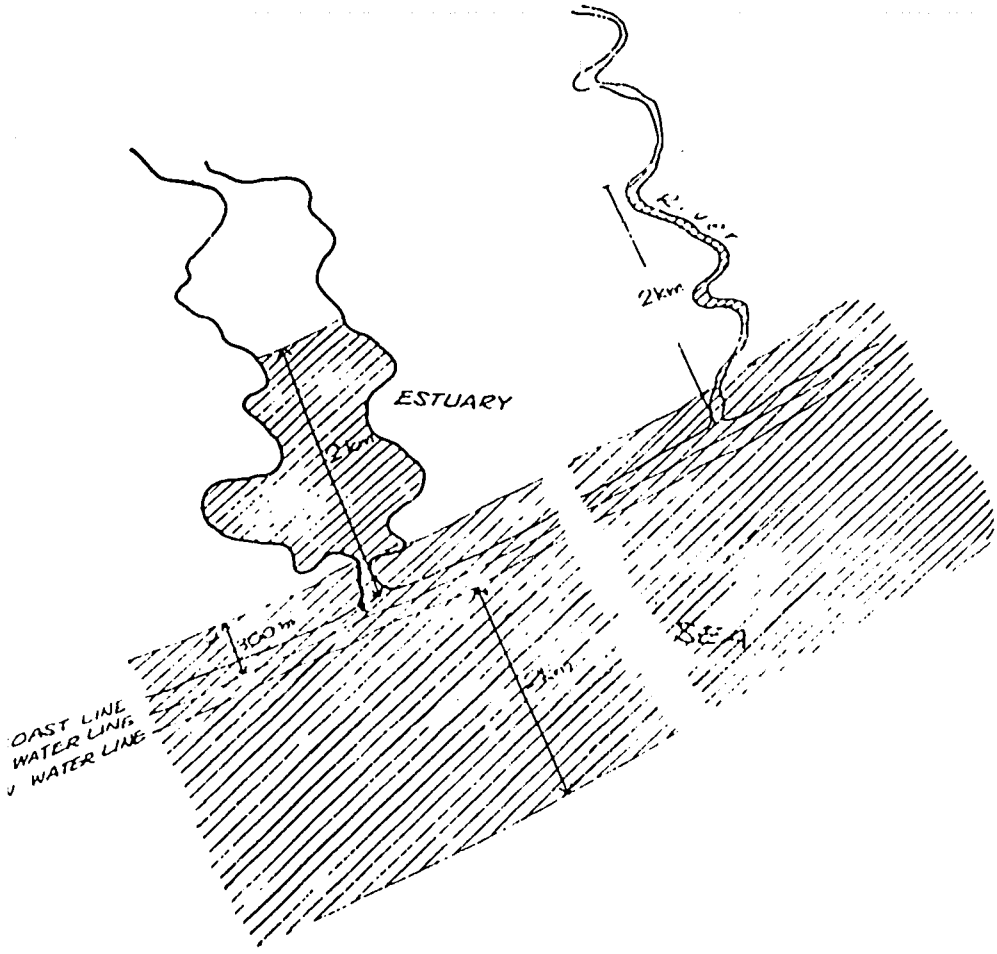

FIG. 4 : DIAGRAMMATIC PRESENTATION OF THE 'COASTAL ZONE'

Source: Sri Lanka Coastal Zone Management Plan
Coast Conservation Department.
January, 1987.

substrata that are also saline, frequently anaerobic and acidic. They range in size from tall trees (Rhizophora, Avicennia) to small shrubs (Acanthus ilicifolius)

They occur along sheltered inter- tidal coastlines and in association with estuaries and lagoons. There by they represent a unique ecosystem that has been described as follows:-

> "Mangrove swamps are flooded by the rising tide; plant litter and decomposed particles of vegetation (deritus) which is the food base for the food chains in estuarine and coastal waters are washed into the coastal zone and sometimes into the offshore areas by the ebb tides and currents. Also they receive freshwater - borne material, which include inorganic nutrients essential for plant life from landward sources by surface and river run offs."[1]

This abundance of nutrients attracts a variety of fin fish, crabs, prawns, molluscs from the sea which spawn there. The swamps serve as nursery grounds for these species for there is ample food and also shelter among the vegetation. In turn mammals, birds and reptiles from the landward side are attracted to the mangroves which provide them with food and shelter. The trees provide safe nesting and breeding sites for birds.

Some mangroves have been shown to have the ability to detoxify chemical pollutants. The water flowing into the sea from landward sources is thus rendered less harmful by them. The quality of water in the swamp itself is improved. This may be making it possible for marine for animals to migrate to the swamp for breeding and the growth of their young.

The immense economic value of mangrove communities has been highlighted. A recent publication clearly sets out the importance of mangroves.

> "The greatest contribution of mangroves to our well-being is that they enhance marine food production by supplying nutrients to the lagoons and near-shore and by serving as nursery grounds for crustaceans and fish"[2]

Mangroves are important because of the significant role they play inthe coastal fishery industry. It has been shown that the prawn catch is less in the parts of lagoons where there are no mangroves. The prawn catch is 50 per cent more in mangrove fringed lagoons.

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(1) Amarasinghe, Mala: Mangroves: a dwindling resource. Vidurava Vol 9 No. 1 (1986) p.12.

(2) Pinto, Leonard, Mangroves of Sri Lanka. Natural Resources Energy and Science Authority (NARESA), Colombo, 1986, pp. 1 and 47.

One from of in-situ fishing in mangrove swamps is unique to that environment. That is the brush-pile (s : *mas athu or athu kottu*) fish traps. Branches of Mangrove plants, particularly those of Avicennia, are arranged as a heap or pile. Fish and even invertebrates take shelter within it. The harvest is easily collected by surrounding the brush pile with a net.

Coral Reefs

Coral reefs are made from the calcium carbonate skeletons of colonial coral polyps, laid layer usually on a rock base. The reefs around Sri Lanka may attain a width of three metres, and, as they fringe the coastline play an important role in protecting the coast.

Although the reef communities are capable of building structures of great strength they are themselves quite fragile and vulnerable, thriving only under favourable environmental conditions. They do best in waters that maintain a mean average temperature about 20°C, that have a salinity near that of the open seas, that are clear with ample penetration of light and oxygen and that are free from sediment and pollutants. These conditions are met around the coasts of Sri Lanka. The good health of a coral reef is shown by the presence of a large diversity of plant and animal species. If these coral reefs are to ensure protection of the land and a sustainable yield of fish and crustaceans, punitive action should be taken against individuals or agencies that despoil the reefs by physical damage or chemical pollution.

The mining of coral for the production of lime, is perhaps the single most destructive activity. A total ban on coral mining would appear the easiest solution. But this would immediately deprive about 1,400 persons in the southwestern coastal area alone, part of their livelihood. It would be more feasible to phase out coral reef mining by encouraging the extraction of lime from inland deposits. The state should take suitable steps to attract the coral miners to this new location. Action on reef-mining when eventually enforced will not affect the economy of the dependant villages.

Coral reefs have a growth rate of only 10 cm per annum. An estimated 7000 tons of coral are mined from reefs annually. It is impossible for reef organisms to replace this off-take. The coral reefs on the southwest and the east of the island are so badly damaged as to be unable to play their defensive roles, hence coastal erosion has become uncontrollable.

Agricultutral development in the upland areas affects the flow of river water into the coastal waters both qualitatively and quantitatively. Such waters may contain silt in quantities that can choke the living coral polyps and sea grasses, and agrochemicals that can poison these polyps as well as other forms of life.

Other human activities with a direct influence on the "health" of a coral reef include the collection for export of a wide range of reef-dwellers both vertebrate and invertebrate. The depletion of such fauna upsets the fine ecological balance of the reef biota and sever important links in food chains.

Spear-fishing is a "sport" which has developed into a threat to marine life. The use of sophisticated equipment guarantee big "catches". The import into Sri Lanka of spear-fishing equipment must be monitored and controlled. The use of dynamite as a method of harvesting fish should be totally banned for obvious reasons.

It is imperative that coral reefs which are, in a sense, marine store-houses, should be strenuously protected because coastal fisheries account for about 90 per cent of the total marine fishery production.

Estuaries and Lagoons

There is considerable ambiguity in the common use of the terms "estuary" and "lagoon". Since they are almost identical ecologically they may be considered as a single component of the coastal zone resource system. One important characteristic common to both is the mixing of fresh water from the landward side (surface and river runoff) and sea water brought in by the tides, resulting in the formation of brackish water.

Lagoons and estuaries also play an important role in the migration of fishes and crustaceans to and from the sea for breeding and raising young.

There are an estimated 80,000 ha of estuaries and large deep lagoons and about 25,000 ha of shallow lagoons in Sri Lanka.

Besides the rich harvests of crabs and penaeid prawns, there are 13 species of brackish water fishes. Of these 65 per cent are migrants from the sea and five per cent from freshwater sources. Approximately 80 per cent of these species are edible, and contribute a sizeable share to the productivity of the coastal fisheries.

The sharp decline in prawn and crab harvests in lagoons and estuaries which appeared temporary and was brushed aside as such by some people, is now being taken more seriously. Scientistis have identified underlying causes as reduction in size of lagoons and estuaries due to land-filling, pollution from industrial effluents (as in Negombo and Valaichchenai) and the servicing of fishing craft in relatively still lagoons.

Seagrass Communities

Seagrass communities are another useful ecological component of the coastal zone resource system. Seagrass meadows are the most productive ecosystems in regard to carbon fixation. They occur in shallow nearshore coastal waters that are sheltered from high wave energy, most of them in estuaries and in lagoons.

The contribution made by seagrasses to the coastal zone ecosystem is similar to that of a mangrove swamp i.e. they introduce large quantities of organic material, and at times, dissolved nutrients to adjacent waters.Seagrasses are therefore linked to the coastal systems through the energy cycle. The actual quantity of nutrients contributed has not been calculated, but it may be roughly gauged from the knowledge that a square metre of seagrass bed yields a dry weight of 1300 g to 3000 g if harvested on an annual basis.

Beach Systems

A beach consists of accumulated unconsolidated material deposited in characteristic form either by waves or winds. The beach system comprises beaches, dunes and spits. The seaward limit of the system is the lowest tide while the landward margin will be a coastal cliff, a dune or, unfortunately, a man-made structure. Beach systems being unstable entities are extremely vulnerable in the face of strong winds and waves. But nature protects these beaches and consequently the land behind them by erecting barriers such as the coral reefs just described. Where man destroys these reefs, the unhappy results are seen all too quickly when the sea surges on to the land.

At first glance beaches look sterile and devoid of life but one has to only search among plants such as Spinifex, (S : *Maharavanaravula*), *Ipomoea* sp. (S : *Binthamburu*) and *Pandanus* (S : *Vetakeiya*) to discover the relative richness of animal life.

The beaches as popularly identified in Sri Lanka are best on the east coast and during the northeast monsoon in certain parts of the western and

southern coasts. However even the best beaches are generally narrow because of the frequent tidal changes and low wave energy.

The most prominent beach system is the dune, its height depending on the length of dry windy spells which blow sand on to the coast. Optimal sand dune development therefore occurs on the Dry Zone coasts such as those between Mullaitivu and Point Pedro (northeast) or between Elephant Pass and Pooneryn on the northwest. On the southeast coast too, not unimpressive dunes occur between Hambantota and Bundala and parts of the Yala National Park.

Sri Lanka's beaches are world-famous as nesting sites for five of the eight species of turtle found in the world. The largest is the leathery turtle and the smallest the hawksbill. Fortunately most of this nesting takes place on the western and southern coasts where turtle meat is not considered a delicacy. Only the eggs are consumed by the coastal inhabitants. This in itself would not have affected turtle populations to any great extent, but when commercial collectors ransacked turtle nests for profits they threatened whole populations of turtles. Laws have been enacted to prevent such commercialization but they are difficult to implement. Fortunately the Department of Wildlife Conservation and certain NGOO have succeeded in focussing public attention on this problem.

Positive steps taken include establishing turtle hatcheries. Eggs are artificially incubated in these hatcheries and the young released into the sea by hand thereby reducing destruction of nests and eggs. A national sea turtle survey is presently being carried out by the National Aquatic Resources Agency (NARA).

There was an earlier threat to beaches through uncontrolled removal of sand for building construction. Fortunately this was one area in which protective laws were enforced and today the mining of sea sand is greatly reduced.

The construction of houses and other buildings including those for tourist purposes on sand dunes has led to their destruction. Such building activities should be strictly controlled since these dunes protect the coast from storm damage.

PART III

Human Activities Involving the Environment

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Chapter 10

LAND USE

Sri Lanka is primarily an agricultural country. Its prosperity and well being therefore depend on rational land use and judicious management of its soil and water resources. The country's total land area is 6.5 million hectares of which only 5.5 million hectares are arable. With a population of 16 million in 1987, the land/man ratio is only about 0.4 hectares per person. the population is projected to increase to 20 million by the year 2000. The need is therefore urgent to achieve sustained high productivity of land.

Soil is the main component of land and the type of soil determines what crops can be cultivated. A wide range of soils spanning all 10 orders in soil taxonomy are found in Sri Lanka but only a few groups occur extensively. The predominant soil types are the well drained reddish brown earths in association with the poorly drained humic gley soils in the Dry Zone and the red yellow podzolic soils in the Wet Zone.

The present status of land use in Sri Lanka is as follows:

1.6 million ha under forest cover.

1.0 million ha under 'chena' cultivation.

1.0 million ha under tea, rubber and coconut.

0.8 million ha under paddy.

0.7 million ha under wildlife reserves.

0.5 million ha under grassland and scrub.

0.1 million ha under highland annual crops.

Competition for land is severe among the sectors using it. The major land use sectors are forestry, wildlife, agriculture and animal husbandry.

The government has imposed a ban on further clearing of forests of 'chena' cultivation. A system of permanent rainfed agriculture composed of a mix of activities including cultivation of highland annual crops, fruit trees and flowering plants (horticulture) tree species for timber and

fuelwood, and fodder species for livestock rearing is hopefully expected to replace the ecologically destructive system of chena cultivation. Plans have been prepared to reforest watersheds of reservoirs at a rate of 12,000 hectares per year.

Land degradation occurs mainly through soil erosion and loss of organic matter in the soil. Most of the stable soils in the Wet Zone occur on rolling or steep slopes which promote erosion. The soils in the Dry Zone, though occurring on gentler slopes, are of a highly erodible nature. Continuous cropping with the removal of crop residues from the land leads to decline in soil fertility which must be corrected by the application of organic manure and chemical fertilisers. Use of excessive quantities of irrigation water leads to land degradation through increased soil salinity and the raising of the water table.

Land use should be optimised by the allocation of land for different uses on the basis of the land characteristics. Land with different soils should be managed in the most appropriate way with competent guidance so as not only to preserve their desirable qualities but even to improve them.

Chapter 11

HUMAN SETTLEMENTS

The need for resettlement of people is seen in the geographical distribution of the population. The Wet Zone covering only 23 per cent of the country's total land area is inhabited by 56 per cent of the total population while the Dry and Intermediate Zones encompassing 77 per cent of the total land is inhabited by only 44 per cent. The most sparsely populated districts in the Wet Zone - Ratnapura and Nuwara Eliya, have population densities of 265 and 295 persons per sq km, respectively while population densities in the Dry Zone include 34 persons per sq km for Mullaitivu, 55 for Vavuniya and 57 for Moneragala. Colombo district has nearly 2,800 people per sq km and Gampaha about 1,200.

The country's Dry Zone, where human settlements had flourished up to the 13th century, lay neglected and mostly under jungle till the nineteen thirties. Increasing population pressure in the Wet Zone induced the government to begin resettlement programmes in the North Central Province and the restoration of the ancient irrigation tanks there. This programme gathered momentum after the mid 1940s when malaria the scourge of these areas, was suppressed with the use of DDT. In the period 1935-1970, 1975 major irrigation schemes had been completed in the Dry Zone covering 131,500 ha (about 325,000 acres). [1] In 1970 the total number of settlement schemes was 90 and 146,000 ha (361,000 acres) of irrigated land alienated to farming families.

Prior to the inception of the programme the settlements in the Dry Zone consisted of *purana* (traditional) villages often centred round village tanks and inhabited by original settlers.

"New" villages of recent origin usually located early along the main roads were often inhabited by encroachers from different parts of the country. A few relatively small urban centres included the port of Trincomalee, some administrative centres that were started as dissemination points of colonial policy and several small service centres catering to the needs of the local population.

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(1) Korale, R.B.M. Effects of Population Increase in 2000 A.D. Sri Lanka Population Digest, Vol. No. 2, Dec. 1986.

The major objectives of the settlement programme were:

(i) the provision is employment opportunities to the expanding population in the Wet Zone;
(ii) the increase of food production, particularly paddy;
(iii) the protection of peasant farmers as a class;
(iv) the increase of government revenue; and
(v) the creation of dynamic centres of production.

In order to achieve these objectives, a scheme of settlement was drawn up by which people were settled on "economic-size holdings" of irrigated land, to grow paddy.

In terms of socio-economic conditions and structure, the land settlement schemes were different from the *purana* villages. In planning these settlements the government not only attempted to eliminate major problems such as landlessness, share-cropping, exploitation, low productivity, cultivation risks and low incomes that characterized *purana* villages, but also took steps to build up new institutions to encourage people's participation and foster self-reliance.

Unlike the *purana* villages only a few of the new villages are centered round tanks. Paddy cultivation is therefore less widespread. Homestead gardening and rainfed upland ("chena-type") cultivation as practised now with short fallow periods, causes soil erosion and soil impoverishment, though it is very economical in energy usuage.

Chena cultivation is also practised by encroachers from *purana* villagers, settlement schemes and other parts of the country into state lands, including forest and wildlife reserves and stream, river and road reservations. Ownership of land other than these reserves is being vested under the swarnabhoomi scheme in the people occupying them. Nevertheless, spontaneous settlement cannot be allowed to proceed unchecked because of the indiscriminate clearing of forests and the general tendency for encroachers to adopt extensive forms of agriculture which meet the subsistence needs of the family but do not provide adequate surpluses. [1] Most encroachers are looking for a means of sustenance and not for a plot of residential land. An alternative means of sustenance must be provided for them.

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(1) Scudder, T. Evaluatory Report on Mission to Sri Lanka Settlement Project. A discussion of some basic issues. 1979.

The most ambitious programme launched in recent times is the multi-purpose Mahaweli settlement programme. In aims to clear and cultivate 130,000 ha (320,000 acres) of new (mostly forest) land, and upgrade about 32,400 ha (80,000 acres) of land already under cultivation during only one season. It also provides an additional 344 MW of hydropower, more than doubling the capacity existing at the start of the programme. The development work in the Mahaweli basin and connected areas commenced in 1972 and farmer settlement work in 1975/76. In 1978, the government decided to accelerate its implementation from within thirty to about six years. Most of the engineering work of the large projects under this programme have been completed and settlement of people in the new schemes is proceeding.

Imaginative planning of the Mahaweli settlements based on the consideration of the farmer as an individual has avoided many predicaments experienced in earlier settlement schemes. There are still some environmental issues which have to be settled, such as the following:

(i) The need to provide safe and adequate supplies of water for domestic purposes;
(ii) the need to provide for sources of fuelwood within and in proximity to settlements;
(iii) the need to control salinity and weed infestation in paddy lands; and
(iv) the need to reduce potential health hazards.

On the basis of the recent annual rate of increase in population, the Dry Zone would have to support and extra 750,000 families or 3.75 million people by the year 2000. The strategy proposed to accommodate them is not through large settlement schemes but through construction and rehabilitation of small and medium reservoirs. These may not be enough and 0.8 million ha of unirrigable land still remaining may have to be utilized. This is the last agricultural 'frontier' in the Dry Zone. Because of this limit on land availability, the development of a well managed farming system is essential.

Whatever system is adopted in the Dry Zone, large scale deforestration is inevitable. Therefore, a strategy is required that would enable the integration of agriculture and settlement with forestry in a system of agroforestry, upon which a start has already been made.

The situation in the Wet Zone will be even worse. The rural population here has increased by more than 75 per cent. This increased population has

given rise to an increasing demand for land, for purposes of food, housing, transport, industry and recreation. The increased demand in turn leads to the misuse and degradation of land manifests in -

(i) the occurrence of earthslips and landslides;
(ii) extension of settlement into hazardous areas;
(iii) clearing of hill-slopes for cultivation leading to soil erosion and contamination of underground water; and
(iv) encroachment.

This, again, underlines the urgent need to evaluate the present land issues with a view to identifying the inappropriately used and poorly managed lands and taking remedial action. There is also a need to plan the use of land so that it not only meets the present demands but also maintains its potential to meet the demands of generations to come.

The pressure on land is greatest in the urban centres of the Wet Zone. Continuous growth has put pressure on the water supply, sewage and garbage disposal systems, environmental health and maternal and child care services, with an adverse impact on the environment and conservation of resources. The Urban Development Authority has evolved several policies and strategies to minimize this impact. The creation of a land bank by the acquisition of degraded, under - utilized and under - developed urban areas and the planning and implementation of integrated development programmes in respect of several areas appear to be the most significant among the strategies. In addition, a land use policy for the urban/rural fringe along the coast is also urgently required not only to prevent the loss of valuable agricultural land but also to allocate land between competing uses such as housing, commerce, industry and services.

Chapter 12

HOUSING

Housing has a marked effect on the environment and on the health of occupants. Damp, ill-ventilated and over-crowded housing is often the cause of illness. Tuberculosis and other respiratory diseases reflect housing conditions and levels of nutrition. Diarrohoeal diseases have been found to be most pronounced in the districts where more than 70 per cent of the housing units lack any toilet facilities.

The present government policy recognizes another dimension of housing besides the purely physical one. It acknowledges and respects the personal bond between a house and its owner. It aims at a house-owning democracy achieved through maximum support by the State, but with minimal intervention. The funds available for disbursement are provided as small loans to the poor, whether living in rural, urban, estate or settlement areas. The yardstick of achievement is the number of families reached.

This thinking is expressed in the following words of the Hon R Premadasa, Prime Minister - the Architect of the Million Houses Programme:

> "Housing not only provides protection from the elements but also shelters all the factors that go to improve the quality of life of individuals, who from the families. Families make up societies and societies build up nations. Nations finally constitute the global community. That is why I consider housing to be not only a basic human need but also a key to human development. In essence, housing is central to the fulfilment of man's aspirations for a better life."[1]

Status of Housing at the 1981 Census

The following statistics summarize the housing situation in the country at the time of the 1981 Census of Population and Housing: [2]

- there were 2.8 million housing units for a population of 14.8 million people;

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(1) Ailapperuma, W.D. Reaching a Million Families. Paper presented to Sub-Regional IYSH Asian Meeting, New Delhi, December 1985

(2) Sri Lanka Census of Population and Housing. General Report, Vol. 3. Department of Census and Statistics, 1986. p. 212 et seq.

- the distribution of these housing units by location was: urban 18.2 per cent; rural 74.1 per cent and estates 7.7 per cent;
- the units were mostly (68.6 per cent) permanent structures in urban areas, while semi-permanent structures predominated in rural areas (56.0 per cent) and in estates (85.3 per cent);
- the walls in 47.8 per cent of all housing units in the country were constructed of brick, cement, stone or cabook, 43.7 per cent of mud (wattle and daub), 5 per cent of coconut or palmyrah cadjans and 2.8 per cent of wood;
- the roof was made of cadjan in 40.2 per cent of all housing units, of tile in 37.6 per cent, of sheet metal in 13.6 per cent and 7.0 per cent of asbestos;
- 49.7 per cent of all housing units had mud floors and 49.5 per cent had cement or tile floors;
- 62.1 per cent of all housing units were more than 10 years old, 10.5 per cent 5 to 10 years old and 23.3 per cent less than 5 years old;
- on the average each house has about 2-5 rooms;
- about 39 per cent of all housing units (urban 43 per cent, rural 36 per cent and estates 54 per cent) have more than 3 persons per room and are, according to a UN definition, over-crowded.

The situation regarding housing amenities was reported to be as follows in 1981:

Water Supply

- 17.7 per cent of the total population (urban - 48.5 per cent, rural - 5.1 per cent and estates - 65.6 per cent) had access to pipe-borne water.

- 72.9 per cent of the total population (urban - 47.7 per cent, rural - 84.5 per cent and estates - 20.5 per cent) used well water.

- 7.0 per cent of the total population (urban - 1.1 per cent, rural - 8.5 per cent and estates - 5.7 per cent) obtained their water supplies from rivers, streams, reservoirs (tanks), etc.

Toilet Facilities

- As many as 33.5 per cent of all housing units in the country (urban 19.7 per cent, rural - 36.5 per cent and estates - 36.6 per cent) had no toilet facilities.
- Pit lavatories predominate in the country - 37.7 per cent of all housing units (urban - 16.3 per cent, rural - 43.5 per cent and estates - 32.3 per cent).

- Flush toilets were found in barely 5 per cent of the total number of the country's housing units, including 16 per cent of urban housing units.

- Water seal toilets are found in 22.1 per cent of all housing units - nearly 40 per cent in urban areas, 17.5 per cent in rural areas and 24.2 cent in estates.

Lighting

- About 80 per cent of total households in the country are lit with kerosene lamps.

- The number of housing units having an electricity connection has increased from 9 per cent in 1971 to 15 per cent (urban - 46 per cent, rural - 8.3 per cent and estates - 5.6 per cent) in 1981.

- 34 per cent of the permanent housing units are supplied with electricity, but only one per cent of the semi-permanent units.

The 1981 Census figures reveal that the housing stock had increased by 27 per cent since the 1971 Census. The increased emphasis laid by the government on housing after 1977, contributed largely to this favourable situation.[1]

In its Hundred Thousand Houses Programme (HTHP) implemented during the period 1978 - 1983 the government played the role of "provider" of housing. The Million Houses Programme (MHP) launched in 1984 with experience gained from the earlier programme showed a radical change in the government's role to one of active support of family and community housing initiatives. The MHP is designed on the recognition that the tradition of house-building by individual families is still continued. The state supports, strengthens and complements this tradition. The broad policy framework for the MHP consists of:

- "the State playing only a supporting and motivating role;
- reaching a much larger number of families than the earlier programmes, at basic standards and minimal costs;
- decentralization and devolution;

(1) ibid

- encouraging the use of local materials and technologies ;
- recognising shelter as being central to a better quality of life and being very much a part of the productive sector of the economy"[1].

The slogan of the MHP became "Minimal Intervention, Maximal Support by the State: Maximal Involvement of the builder families".

State intervention is limited to such support activities as granting land tenure, providing water, access, credit (small housing loans) and technical guidance.[2]

The Million Houses Programme recognises that "Housing is inherently personal and user oriented. Between housing and human beings, or between housing and families, there is the most personal and intimate relationship".[2]

The construction of houses under this programme is being done by the individuals and families themselves using the experience of previous house building and through a process of "learning by doing". Construction practices follow popular and tested local ideas. Training sessions usually of 2 to 4 days are arranged for the owner-builders of houses.

A range of choices has been developed by government for the solution of the shelter needs of the poor. These options are offered to prospective builders as a "Housing Options and Loans Package (HOLP)". They include upgrading house and latrine; new house and latrine and new house only. Each option has a loan ceiling. HOLP has helped to solve the problems of standards and designs. Its support of people using their own ingenuity and the accumulated experience of other house builders to provide shelter for themselves and their families affirms official recognition of traditional technologies of housing construction.

The MHP is conceived as a national shelter programme involving both the public and private sectors. It comprises six countrywide subprogrammes, namely those of rural housing, urban housing, plantation housing, Mahaweli Housing and other major settlement housing schemes and private sector housing.

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(1) The ABC of the Million Houses Programme. National Housing Development Authority 1986 (?)

(2) Siriwardana, Susil and Weerapana, Disa. Guidelines for the preparation of the National Housing Programme 1983.

The MHP was launched in January 1984 with the inauguration of the Rural Housing Sub-Programme (RHSP) which is expected to cover over 90 per cent of the 25,000 villages in the country. The beneficiaries under the sub-programme will be the rural poor. The RHSP is targeted to 45,000 to 50,000 rural families each year.

The Urban Housing Sub-programme (UHSP) commenced in January 1985 and is presently being implemented in all the 12 Municipal Councils and 39 Urban Councils in the country. The UHSP is targeted at the poorest of the urban poor, mainly the slum dwellers and shanty dwellers. Slums are crowded groups of permanent housing structures nearly always dilapidated, over-crowded and without the basic amenities. Shanties are temporary structures, erected by squatters on public or private land including canal and river bank reservations and road reservations. Shanties have even fewer amenities than slums. Little or no notice is taken of their occupants who have been described as shadow beings. [1]

The need to upgrade the level of housing for the urban poor is seen in the infant and maternal mortality rates which are higher than the national average as a result of malnutrition and unhygienic surroundings.

Living conditions in the line-rooms of estates have long been the subject of caustic comment. Efforts are now being made under the Plantation Housing Sub Programme (PHSP), to improve the housing for estate staff and labour grades.

The dimensions of the settlement problem under the Accelerated Mahaweli Programme necessitated a separate sub-programme under the Million Houses Programme. The major settlement schemes housing sub-programme covers settlement schemes outside the Mahaweli Programme.

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(1) Siriwardene, Susil. Some Issues of the Urban Housing Sub-Programme. National Housing Development Authority - March 1987.

Chapter 13

AGRICULTURAL SYSTEMS

An agricultural system may be regarded as an ecosystem created by man to serve his basic needs such as food, clothing and shelter. there is something primordial in agricultural activities that enabled even the earliest civilizations to develop systems which were in tune with the environment.

In ancient Sri Lanka, too, agriculture kept pace with increasing population. High productivity was achieved without endangering other natural resources. Agricultural practices could well have ameliorated the inhospitable climate of the Dry Zone. The Sinhala Kings had displayed a deep practical understanding of the "science of the environment". The kings saw in agriculture Sri Lanka's path to prosperity and greatness. Their traditions are still valid as a rationale for using land for sustainable development.

Unfortunately in a misguided "modern" belief that more land under the plough will satisfy the demands of a rapidly increasing population, policy-makers and planners seldom recognise that an optimum forest resource base is necessary to ensure sustained productivity of the land. It must be realized that there can be no sustainable development within any system without conservation of that system.

In Sri Lanka agriculture has developed along three main lines. They are:

i Peasant Agriculture;
ii Plantation or Commercial Agriculture; and
iii Livestock and Animal Husbandry.

Peasant Agriculture

As the name implies, peasant agriculure represents the efforts of rural people to grow their own food crops. It comprises the following forms of cultivation:

(i) Paddy cultivation (both irrigated and rainfed);
(ii) Rainfed chena or shifting cultivation;
(iii) Rainfed settlement market gardens; and
(iv) Irrigated farming.

Paddy Cultivation

Paddy and rice are synonymous and its cultivation in Sri Lanka is as old as its history. Paddy is still the single largest crop. It is cultivated on 34 per cent of the country's arable land area (14 per cent of the total land area). Over a million families are involved directly or indirectly in rice cultivation, processing and distribution.

The Sinhala Kings made it their prerogative to ensure that the country was self-sufficient food. They exhorted the people to participate, too, and it had not been a rare sight to see king and subject work side by side. Rituals linked with the sowing and harvesting of paddy pervade Sri Lankan culture, taking on a tinge of reverence when the clergy eventually joined in.

Even after moving into the hill country, royalty, engineers and farmers were quick to adapt to their new environment by growing paddy on terraced fields. However, today it is realized that the removal of forest cover makes hill-sides prone to earthslips.

There are an estimated 0.9 million hectares of paddy land of which about 0.75 million are cultivated annually. This land is held in about 1.6 million "parcels" and are cultivated in three ways:

- rain-fed (270,780 ha)
- irrigated by minor tanks (186,740 ha)
- irrigated by medium and major tanks (289,480 ha)

In addition 35,000 ha of "new" land are cultivated under the Accelerated Mahaweli Programme.

Rain Fed Paddy Cultivation

Rain fed paddy cultivation was first practised in the Dry Zone but is now well established in the lowland Wet Zone where it has the benefit of both the Maha and Yala rains. There is a preponderance of traditional varieties of rice in the Wet Zone.

Paddy under Minor Irrigation Tanks

There are about 30,000 minor tanks, of which about half are in use. These schemes are important in terms of rice production and of employment. The minor tanks are already pushing at the outer limits technically, socially and economically. The causes have been deforestration of catchments and population pressures. But cultivation under minor tanks is the very essence

of rural life in the Dry Zone and should not be allowed to fall into disarray. There is sufficient agricultural know-how and ecological awareness in Sri Lanka today to make it blossom again.

Paddy under Major Tanks

Paddy lands under major tanks give the highest yields in the country since assured irrigation enables the use of High Yielding Varieties (HYV). However, encroachers and illicit cultivators appear to be surreptitiously extending the irrigation schemes in a way which outstrips their design limits and water delivery systems. For example, it has been revealed that the Parakrama Samudra scheme has been seriously affected by the illicit irrigation of about 2000 ha or 22.4 per cent of the maximum irrigable area.

Therefore, while new schemes are been implemented, it is imperative that the old ones should be revitalized, maintained and operated effectively to achieve the goals of sustained production and prevention of degradation of natural resources and environmental pollution.

Other Annual Crops

Sri Lanka's agriculture is far richer, varied and successful than that of most other developing countries. Rainfall, topography, soil and to some extent temperature often determine land use patterns.

The peasant farmers though steeped in tradition are quick to cultivate varieties provided they do not call for higher inputs of labour and capital. The enthusiam with which they reached out for cowpea, soyabean and potato proves this.

At the present time the annual crops can be grouped as follows:

(a) Coarse grains - maize, sorghum and millets;

(b) Pulses or grain legumes - cowpea, greengram and blackgram;

(c) Oilseeds - groundnut, soyabeen and sesame;

(d) High cash value crops - chillies, onions and potatoes;

(e) Roots and tubers - cassava (manioc), sweetpotato and yams; and

(f) Vegetables - leaves, fruit, tubers and yams.

Coarse grains, pulses, oilseeds and high cash crops items (a) to (b) above are grown on about 310,000 hectares of land, approximately 70,000 ha of vegetables, 12,000 ha of tobacco and 10,000 ha of sugar cane are also cultivated annually.

Rainfed Chena, Slash and Burn or Shifting Cultivation
Shifting cultivation established itself easily in the Dry Zone where conditions favoured it. It was then a sensible system.

Widespread deforestation has reduced the extent of forest lands to a level where shifting cultivation can no longer be practised. The peasant farmers are now forced to keep on cultivating the same plot of land. Soil erosion and impoverishment have reduced such cultivation to the state, of subsistence agriculture. The term chena cultivation is still applied to this system of rainfed farming though shifting cultivation is only rarely practised now. The system of cultivation now practised should be termed rainfed upland cultivation.

This deep-rooted practice of rainfed upland cultivation is however of great socio-economic importance. In spite of several negative features, these chenas produce 80 per cent of food grains, pulses and vegetables. An estimated on million families eke out a livelihood from this wasteful use of nearly 1.5 million hectares of land. Although many voices have been raised against this pernicious system, it is not one which has an immediate or short-term legislative solution. There is little shifting cultivation practised today because of the non-availability of "new" land, more productive systems of rainfed cultivation are being developed to replace chenas.

Policy-makers on the advice of agriculturists are reviewing ownership problem of "chena" cultivators. It is stated that these cultivators are not willing to change to settled agriculture because they do not own the land and sometimes do not even have a permit to cultivate it.

Rainfed Settlements and Home Gardens
In the low country, another system of agriculture, unsupported by irrigation, has been practised for generations. This is the Rainfed Settlement and Home Garden. Farmers grow a mix of annuals and perennials in the rainy season, timing the harvests for the dry season.

A few industrious farmes consistently adopt soil conservation methods to prevent erosion and to improve the water holding capacity of the land. They also practice recycling of both plant and animal wastes. Hence the familiar sight of some livestock on these homesteads. These farmers are an asset.

The Department of Agriculture, anticipating the problems of chena cultivation, has compiled and experimentally tested several "packages" of

alternative systems of rainfed farming. But they have failed in the field, probably because they did not include any input from the farmers themselves. The expertise and co-operation of these farmers are essential to the success of these alternatives.

In view of these failures there is an urgent need for further research and experimentation in partnership with farmers.

Specialised Market Gardens

Market gardens or the commercial production of high value crops like potato, chilly, onion and vegetable appears to be a step in the right direction in the cultivation of annual crops. Such gardens are common in the Nuwara Eliya, Badulla, Kandy, Matale and Jaffna districts. The incentive here is the substantial margin of profit which encourages good management, more inputs such as fertilizers and pesticides, and water when most needed. The farmers have evolved intercropping, multicropping and relay cropping practices especially in the Nuwara Eliya and Jaffna districts. Effective intensification and diversification have also been incorporated by trial and error. Sometimes the land may not be kept fallow because of the demand for assured supplies of produce, but this shortcoming is balanced by good soil conservation (with stone terracing where necessary) and the application of cattle manure, compost, mulch or other organic matter supplemented with artificial fertilizers.

This is agriculture at its best. Characteristically, however, there appears the farmer who seeks a larger margin of profit by accelerating the turnover of crops. This he achieves by neglecting to conserve the soil or to replenish it with organic matter relying heavily on the spectacular short-term returns from the lavish use of agro-chemicals. Hill slopes which were rightly considered sacrosanct in terms of disturbance to the land, are brought under cultivation with water being led to them by surface drains cut across the gradient of the slope.

But Market gardens should not be altogether condemned because of the malpractices of a few. The two main threats to the environment from each cultivation have been identified as soil erosion and chemical pollution both of which should be rigidly controlled.

Irrigated Farming

Irrigated farming referred to here is not the success story of the great civilisations of the past, but a small scale system which employs common sense. In its simplest from, water is drawn from a river, manually, to a

suitable height above the bank and then allowed to flow by gravity along a network of crude channels. This **lift irrigation** which is practised very successfully during the Yala season. Chillies, onions, potatoes and vegetables are raised in this manner during the dry season. One of the best examples of this system is to be seen on both banks of the Mahaweli Ganga, below Yakkure and Somawathiya extending to Verugal and beyond. Mingling with the vegetable farmers are itinerant cultivators from the east coast who engage in extensive cultivation of tobacco.

Here again, environmental hazards have surfaced as with the earlier methods described due mostly to over application of agrochemicals. Itinerant cultivators are also a serious threat to fauna and flora particularly the large herds of swamp elephants of the Somawathiya Sanctuary.

Plantation Agriculture

Plantation Agriculture is concerned with the large scale cultivation of perennial species of plants yielding products of economic value.

Although not more than 150 years in existence, these plantations already enjoy a special place in the nation's history. The export of their produce has been the backbone of the national economy for many decades.

However, no other form of agriculture commenced with such a devastating effect on the natural environment of Sri Lanka. Where peasant agriculture was a partnership with nature, the establishment of coffee, tea, rubber and to a lesser extent, coconut, made serious inroads into prime habitats in the low contry Wet Zone, the mid-country and the hills. In less than half a century, large portions of the Wet Zone were denuded of fauna and flora. The effect this onslaught had on the soil and climate is difficult to assess today, but it is believed that the resulting disruption of the hydrological cycle can never be restored.

It has been argued that when realisation did come, conservation practices were introduced and rigidly enforced on estates. Among these were the soil erosion control methods of contour drainage and terracing and the planting of cover crops, the replenishment of soil nutrients and the retention of forest belts which also provided fuelwood for the factories. In the last century the colonial government decreed that land above 5000 feet (1500 m) in elevation should not be cleared for any purpose whatsoever. Laws protecting forests on the banks of rivers and streams were enacted in an effort to restore environmental balance.

Minor Export Crops

Still within the ambit of plantation agriculture, though on a much smaller scale, is the cultivation of nine crops, namely, cocoa, coffee, cinnamon, pepper, clove, cardamom, nutmeg, citronella and papaw (papaya).

They are know collectively as Minor Export Crops (MEC) today. Spices were the main exports of this country before tea and rubber plantations were established.

In general, minor export crops are recognized as a means of:

- augmenting the country's foreign earnings through expansion of the export base.
- diversifying the sources of foreign exchange so as to counteract effects on the economy of adverse price trends in the international market for tea, rubber and coconut.
- generating new rural employment opportunities and incomes.

An autonomous Department of Minor Export Crops was set up in 1972. In the last two decades the revenue earned through the export of these 'minor' crops has steadily increased.

Most individual species of the Minor Export Crops have survived in small monocultures, in home-gardens and in forest-gardens in well-watered districts. They have also been grown as intercrops on tea, rubber and coconut lands. The extent of land under minor export crops is estimated by the Department of Minor Export Crops to be about 67,000 ha.

It will be prudent for Sri Lanka to step up cultivation of these Minor Export Crops. They need not always remain 'minor', for crops such as cinnamon, cloves, cardamom, fruits and plants of horticultural value can be cultivated intensively on small extents of land to supply the increasing world demand.

In recent times tobacco, sugarcane and cashew, in that order of economic importance have entered the agricultural sector on a plantation scale.

Tobacco

Both production and consumption of tobacco are highly controversial subjects. Despite justifiable protests from conservationists regarding the environmental hazards of tobacco cultivation on steep hill sides and river

banks, cultivation still goes on. However, valid and frightening the medical evidence may be against smoking, that goes on too.

In Sri Lanka about 22,000 ha of land are utilized for tobacco cultivation. The best quality and hence highly prized tobacco requires a cool climate as met with in the hills of theKandy, Nuwara Eliya and Matale districts. With other agricultural crops already established on the lower slopes, there was a scramble for available land on what was remaining, namely the steep hill-sides. The deleterious effects which followed are already well known. Although cultivation of hill slopes with a gradient of over 40 per cent is prohibited, this probition appears to be observed more in the breach.

Tobacco grown on the banks of rivers, the Mahaweli in particular causes sheet erosion and consequent siltation of the rivers on a considerable scale. This is readily seen on the flood plains of the Mahaweli from Yakkure to Verugal. Further, these tobacco cultivators cut down the surrounding forest of the Somawathiya Sanctuary to provide fuelwood for their curing barns. This careless use of the villus exposes them to wind erosion as well.

Sugarcane

After several unsuccessful attempts during the past 150 years sugarcane plantations were again established about than 20 years ago. The present total extent of state owned plantations is about 10,000 ha.

From time to time governments reviewed the feasibility of expanding the industry with the intention of making Sri Lanka self-sufficient in sugar. In these reviews such factors as the economics of importing sugar and the impact on the environment were considered. Based on the findings of those reviews a firm commitment towards the goal of self sufficiency has been made.

Two multinational companies have been allocated over 10,000 ha in Pelwatte (Wellawaya) and Moneragala to grow sugarcane as a rainfed crop. Simultaneously the state Sugar Corporation will develop the Sevanagala Project to its target of 14,000 ha of plantations.

What are the environmental implications? On the credit side are two important ones. First sugarcane belongs to the grass family and has a fibrous root system which binds the soil and the leaves produce a good mulch. This combination helps combat soil erosion. Secondly, bagasse,

the byproduct of cane crushing provides sufficient fuel energy for the industry. The constraints are also appreciable. All the sugar plantations so far have been wrecked by open conflict with wildlife particularly elephants and wild pig.

On the one hand the plantations suffer heavy losses by the depredations of elephants and on the other both elephants and men are killed in regular confrontations.

Another problem is the non-availability of seasonal labour for manual harvesting. Mechanization is then resorted to. To allow free movement of machinery means wider spacing of the rows, which then exposes the intervening spaces to very severe soil erosion by wind and rain.

And finally the monoculture practices adopted for this crop tend to bring all the attendant problems such as pests and diseases. In this case, ratoon stunting disease, smut and nematodes are already causing concern.

Cashew

Although a relatively new venture, the cultivation of cashew on a commercial scale appears to have good potential. In Kondachchi in the Mannar District and Mankerni in the Eastern Province, the pilot schemes have shown good results. Cashew is also grown in the Vanatavillu area north of Puttalam.

Palmyrah

There are an estimated 11 million palmyrah palms (Borassus flabelifer) trees in the country distributed over an area of about 24,500 ha (60,000 acres) mainly in the districts of Jaffna, Kilinochchi, Mannar and Mullativu.

From the present distribution of the palmyrah palm it may be inferred that it was introduced into Sri Lanka and was first planted along the northern and eastern coasts as a protection against the full force of the northeast monsoon and to prevent wind-blown sand being driven into the coastal villages. There is no indication that palmyrah has been cultivated as an economic crop even in areas highly suitable for it.

The following paragraphs quoted in a recent report prepared by the Ministry of Regional Development shows the palm's usefulness in this aspect:

"The fact that it (the palmyrah palm) grows in sandy plains makes it very suitable for blocking erosion on the Coramandel coast of India where it fixed dunes. Many have observed it to be very well anchored in the soil; although a cyclone could rupture its trunk, the palm itself is rarely uprooted. It clearly has a very extensive and deep root system and is used consequently to demarcate rice-fields or reinforce tank bunds (Tamil Nadu, Sri Lanka, Burma, Thailand and Kampuchea). When planted in proper orientation it can serve as a convenient wind breaker, as in Burma, where dust storms are frequent in the dry season."

In time, the people of the north and eventually of the east and northwest gradually found many other benefits from this palm. In its uses it is comparable to the coconut palm.

It is said that the poorer people explored this palm at every level beginning with its tuberous root which is akin to a tap root. This was eaten boiled as a source of protein and carotene. The root was also sun-dried and made into flour. The fruit was used for its juice which is not unlike that of a very immature coconut. The embryo of the seed while still underground is uprooted and eaten either dried or boiled (kotta kelangu).

A Palmyrah Development Boad (PBD) was established in 1978 to promote the development of the palmyrah industry through improved production, processing and marketing techniques. The PDB identified several objectives among which were the stepping up of production of palmyrah jaggery and bottled palmyrah toddy, the creation of cooperatives as outlets for palmyrah based products, and the training of youth in improving the numerous handicrafts produced.

Horticulture

Horticulture has been defined as the science and art of growing flowers (Floriculture), fruits (Pomology) vegetables (Olericulture) and ornamental plants [1].

In spite of the economic benefits it can bring to the country, horticulture has been too long neglected. Its potential in producing exportable quantities of fruits, flowers and plants has been underestimated by state agencies which have neither actively encouraged nor guided the efforts of entrepreneurs to develop it. This is unfortunate, for Sri Lanka with climatic and edaphic factors to suit almost any tropical tree or plant should by now be leading the field in the export of their produce.

(1) Websters Third International Dictionary.

Singapore, for instance, earns several million dollars each year only by exporting cut flowers of orchids grown on farms occupying less than 500 ha. Sri Lanka does not lack expertise in horticulture or in any other agricultural science. There are specialists in every branch of it, including genetics, tissue culture and pathology, who can provide the necessary, advice and guidance to sustain an excellent export-oriented trade in fruits, cut flowers and exotic foliage.

Hitherto, horticulture has been nurtured by hobbyists, "explorers" (those who prospect for new plant varieties) and a few private investors.

The development of horticulture should be undertaken with the help of the Export Development Board. The export of cut-flowers and foliage plants will earn foreign exchange as well as provide increased employment opportunities.

Fruit Growing (Pomology)

The approach to growing tropical fruits in Sri Lanka is disappointing. While other countries in the region have made vast strides in the production of quality fruits on a commercial scale, Sri Lanka has done little to capitalize on its favourable conditions of climate and soil or of the available genetic diversity.

From being a sub-division of horticulture, the growing of fruits on a large scale has become a separate science, known as Pomology.

Sporadic and unplanned cultivation of fruit trees in Sri Lanka has spanned a period of over a hundred years. There are, as yet, no well-managed orchards capable of producing consistently good quality fruits to satisfy even the local consumer. Poor management of even small holdings, of, say, oranges, limes, mangoes and papaws results in wrong harvesting, storage and distribution and leads not only to spoilage but also wastage.

Lack of quality also precludes good canning of the surplus for it is almost impossible to maintain uniform quality of the canned product to win export markets.

As in the case of foliage plants and cut-flowers, a profit-oriented state agency must be assigned the responsibility of co-ordinating the pre-requisites for resuscitating fruit-growing in Sri Lanka and raising it to the status of the lucrative industry that it can become.

At present the following fruits are grown in Sri Lanka but without any serious attempt at doing so on an organized progressive or profitable scale based on the available scientific advice:

Citrus, Mango, Pineapple, Avocado, Mangosteen, Rambuttan, Banana, Guava, Passion fruit, Durian, Cherimoyer, Custard Apple, Jakfruit and Papaw.

The country has a suitable climate and soil conditions to grow all these fruits. A satisfactory partnership between the connoisseur, grower, scientist and investor is required to obtain best results.

Fruit trees being perennial come within the purview of environmental planning. Planting them in catchment areas immediately comes to mind as a good starting point, giving dual benefits. Some fruits like citrus, guava and papaw do well on hill sides in the Intermediate and Dry Zones and can be used to prevent soil erosion. Similar opportunities are available in the Dry Zone on poor soil, for example, cashew and mango which can be grown in the catchments of large irrigation tanks.

In short, the cultivation of fruit trees has so much potential as to merit immediate attention by the state.

Animal Husbandry

The third major component of agricultural systems is animal husbandry, which has close links with the agricultural practices and with the environment. Livestock, particularly cattle and buffalo depend to a large extent on pasture, and good pasture protects theland from erosion. Animal wastes provide organic matter which replenishes soil nutrients used up by crops. Draught animals provide the power required in ploughing fields, threshing and drawing carts.

Livestock is a source of essential protein for the average citizen.

In Sri Lanka, if animal production is stepped up and better quality feed ingredients are produced, some Rs. 700 million in foreign exchange can be saved annually.

The arising of livestock is not new to the people of Sri Lanka. During the colonial era, efforts were made to improve the indigenous stock of cattle, buffalo and goats through hybridization with more productive

imported breeds. More recently, successive governments have redoubled efforts to upgrade the industry and invested generously on research. These efforts culminated with the creation of an autonomous Department of Animal Production and Health in 1980.

It is clear that the industry is still unable to contribute to improving the quality of life of the average citizen. A development plan may be formulated based on the following.

- more incentives for private sector participation, such as entitlement to better breeds, availability of loan facilities and a steady supply of good quality feed concentrates and mineral supplements at reasonable prices,
- an aggressive programme of pasture improvement and a better marketing system to prevent losses through spoilage.

The livestock more widely farmed in Sri Lanka are cattle, buffalo, goats, pigs, sheep and poultry. Their populations during the years 1981 to 1985 are shown in Table 4 below.

Table 4

LIVESTOCK (INCLUDING POULTRY) POPULATIONS 1981 - 1985

	Number (1)				
	1981	1982	1983	1984	1985
Neat cattle	1,720,400	1,698,600	1,699,800	1,737,900	1,782,300
Buffaloes	898,100	879,200	910,000	951,000	966,600
Goats	512,200	511,600	519,300	535,000	539,600
Sheep	29,500	28,000	28,600	28,800	26,600
Pigs	93,700	75,100	77,000	84,800	83,600
Poultry	6,296,400	6,248,500	6,456,900	6,163,700	7,097,600

(1) *Source*: Department of Census and Statistics

Cattle and Buffalo

Wild cattle are not indigenous to Sri Lanka. The socalled wild buffaloes which inhabit natural forests are feral animals i.e. domestic animals

which have reverted to the wild. Similarly there are also isolated herds of feral cattle.

However, as agriculture spread to the mid- and up-country areas it opened up avenues for the rearing of animals more suited to moist conditions. A milder climate and the availability of water throughout the year would have made it possible to import breeds better adapted to the new situation.

Among cattle such breeds as Khillari and Kangayam for the drier areas, Jersey for the mid-country and Freisian, Ayreshire and even Swiss Browns for the hill country, were imported as the livestock industry was intensified. With regard to buffaloes, India was the best source from where the Murrah and Surti breeds were picked. Much hybridization has been done over the years and cattle and buffalo suited for a wider range of agro-ecological zones brought within reach of the average farmer.

The National Livestock Development Board was created for the promotion, processing and marketing of meat. Now however the Board is concerned mainly with dairy farming that helps to produce more milk and milk foods, and manages 800 ha of fodder and pasture land.

In 1985 the cattle and buffalo populations in the country were estimated at 1.782 million and 0.967 million respectively. Out of these about 0.9 million cattle and 0.4 million buffaloes were females. These figures are said to be below the carrying capacity of the available 700,000 ha of grazing land.

Statistics reveal that the Dry Zone has 73 per cent of the national herd of cattle and buffaloes but contributes only 39 per cent of the total milk collected by the National Milk Board through 41 of its 81 collection centres.

The average weight of a head of neat cattle in Sri Lanka is in the region of 70 - 75 kg as compared with 230 - 300 kg for those in western countries. The annual production of beef in Sri Lanka has remained more or less static at a little over 12,000 tonnes.

Goats and Sheep

In 1985 there were an estimated 540,000 goats and 27,000 sheep in the country. About 75 per cent of this number of goats and 91 per cent sheep are reared in the Dry Zone and the coconut triangle: the total production of meat, commonly classified as mutton, from these smaller ruminants is

an annual average of 1,375 tonnes. A much higher target is desirable and possible.

Pigs

There are an estimated 75,000 domestic pigs reared in the country primarily as a source of fresh pork. The production of bacon, ham and sausage locally though of recent origin has proved to be lucrative and has attracted many private investors.

With improved technology there is no doubt that the new industry will flourish. Timely action has to be taken to more than treble the production of pigs. At present only about 475 tonnes of pork are produced annually.

With the ban on firearms in recent years, the wild pig populations on agricultural land have risen so sharply as to cause much crop destruction and economic loss to farmers. The wild pig (popularly referred to as wild boar) Sus scrofa cristatus is today considered an agricultural pest which needs immediate control. Being a prolific breeder, which is unprotected outside wildlife reserves it can be subjected to controlled exploitation as a resource, provided the Department of Wildlife Conservation has the machinery to monitor the sources of supply.

Poultry

The introduction, in the nineteen forties, of the deep-litter system of raising poultry revolutionized the industry, not only through its simple technique but also because of the breakthrough in the production of infertile eggs which removed a religious bias against eggconsumption. There was every indication that broilers and layers would flourish in most Sri Lankan homesteads. This did not exactly happen because the fluctuation, mostly upward, of the cost of poultry feeds made even the smallest investment uneconomical within a short space of time.

As with other farm animals, there appears to be no reason why production of poultry and eggs should be below optimum. Both private and public sectors have improved strains of poultry as well as methods of husbandry but production targets appear elusive. Here too it is very likely due to poor quality feeds.

Pasture

The setting aside of adequate pasture for cattle grazing is an important aspect of land utilization. In this context an estimated 700,000 ha are said to be available though not actually developed for this purpose.

The 700,000 ha are made up as follows:

(a)	Unirrigated highland in the Dry Zone	325,000 ha
(b)	Villu and similar flood plain pastures	80,000 ha
(c)	30% of the land under coconut	140,000 ha
(d)	Marginal tea land in the Mid country	40,000 ha
(e)	5% of Hill country tea estates	4,500 ha
(f)	Patna land in the Hill country	55,000 ha
(g)	Herbage from paddy fields	30,000 ha
(h)	Road-sides and waste land	5,500 ha
(i)	Homesteads in the Wet Zone	20,000 ha
		700,000 ha

Only about 30,000 ha of this extent falls into the category of improved pasture, most of it restricted to government - owned farms. It will be futile to expect high yields from animals on an assortment of poor quality graze or browse, which for almost seven months of the year are dry and straw-like in texture. Indeed the 30,000 ha of paddy field herbage is stubble and post-harvest weeds.

As stated earlier, about 70 per cent of neat cattle and buffaloes are located in the Dry Zone. Due to lack of better fodder, these herds survive on wild grasses and scrub. To sustain large herds of Khillaris and Kangayams as are to be seen, say in the Eastern Province, several thousand acres are used in rotation. It is a common sight to see herdsmen driving their animals from Eravur to the flood plain of the Mahaweli in the Somawathiya - Trikonamadu area, to feed on the villu grass or from Akkaraipattu to Lahugala and Panama to graze on paddy stubble.

It could be said that this socalled available pasture of 700,000 ha is under severe threat from such processes as inundation through tank - restoration, "reclamation" for urban spread and cultivation of cash crops with increasing availability of irrigation facilities.

The improvement of pasture by planting more nutritious drought resistant grasses is imperative. This will become essential when the nomadic herdsmen find that traditional grazing grounds are shrinking in the wake of development particularly under the Mahaweli and Lunugamvehera Schemes.

Forage and Feed Ingredients

The country's total concentrate (compound feed) requirement is about 0.25 million tons per annum which is not an unattainable figure. The

ingredients for the preparation of concentrates can be grown or produced locally. Unfortunately, many of the ingredients required for animal feed are also consumed by human beings. Among these are maize, coconut, gingelly rice, ground nut *Kurakkan* (fingermillet) and sweet potato. This would mean more than doubling present output through intensive cultivation. Other ingredients which could be produced locally are fish meal, meat meal and wheat bran.

There is an obvious need to examine this vital aspect of the livestock industry. Corrective measures may result in increased production and certainly save about Rs. 60 million in foreign exchange annually.

Livestock is therefore a highly under-utilized resource. The constraints though numerous are not insurmountable. There is no dearth of know how or of research and technology but one major contributory factor is the fragmentation of the industry when co-ordination should be the theme.

Sri Lanka has so many agroecological zones, classified according to such factors as soil types, vegetation and climate. Attempts are being made in other agricultural sectors to develop crops which will make optimal use of these conditions and thereby diversify cultivation. It is worth investigating, in similar fashion, the variety or varieties of farm animals which will do best in these ecological niches. This means more research on genetic improvement of breeds which will acclimatize well, integrate with other agricultural practices and play its important role in sustainable development.

Chapter 14

FISHERIES

Fishing has been an established occupation in the south and southwest of Sri lanka for many centuries. When the southwest monsoon made fishing too hazardous, these fishermen migrated to the coasts of the north and east where a rudimentary form of fishing existed.

Fishing in Sri Lanka has traditionally been carried out on a small scale using simple craft and methods. The traditional Sri Lankan canoe has remained basically unchanged for several centuries. The following description written in 1847, is equally applicable to today's outrigger fishing canoes.

> "These extraordinary boats are formed of a single tree, which is either hollowed by means of fire, or scooped out by the simplest tools, and are generally from fifteen to eighteen feet in length. The velocity with which these boats skim over the surface of the water (for so light is their draught, they can scarcely be said to sail through it), surprises every beholder."[1]

Since modernization of the marine fishery commenced in the nineteen fifties a consistent objective has been the development of a highly mechanized fishing industry. However, because of rising fuel costs and other constraints, 30-40 per cent of total fishery production is still supplied by traditional canoes, mechanized canoes and shore seines (S: *madel*). In fact the profitability of the mechanized non-traditional craft (3 1/2 ton boats and fibreglass boats) rests mainly upon the subsidies provided to them. In 1985, there were about 32,600 fishing craft of six basic types in operation, of which about 13,500 (42 per cent) were mechanized.

Drift netting has been the most important method of fishing used by nearly 50 per cent of the fishing vessels.

Cast netting, shore seining, handling, trawling, pole and longlining are other popular methods of fishing.[2]

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(1) Bennett, J.W., Ceylon and Its Capabilities; An account of its Natural Resources, Indigenous Productions and Commercial Facilities Wm H. Allen and Co. London 1843, p.161.

(2) Sri Lanka Year book 1982. Department of Census and Statistics, 1983.

The coastal fishery yields 90 per cent of the country's total marine catch. The marine fishing industry may be divided into coastal (up to 30 nautical miles), offshore (30-60 nm) and deep sea (beyond 60 nm). The highest exploitation is in the coastal area, which is accessible to smaller craft.

The fisheries industry contributes only 2 per cent to the GDP. But this does not reflect the fact that 70 per cent of animal protein consumed by the population is derived from fish, or that fish has the largest expenditure value in comparison with other animal protein sources such as milk products, eggs and beef; nor that about 80,000 persons are directly employed in fishing and a further 30,000 in ancillary activities. Altogether an estimated 500,000 persons are dependent on fisheries for their livelihood.

The annual fish catch up to 1983 was estimated at about 220,000 metric tons of which about 40,000 metric tons were converted into about 10,000 tonnes of dry fish. Prices range in order from *thora* (seer), the most expensive through *paraw* (sea bream), blood fish (tuna type), mullet and shark to small fish caught in beach seines. The varieties caught in the largest quantities during 1982-83 the last normal year for the national fishery were: small (seine) fish (about 94,000 metric tons), bloodfish (34,000 metric tons) and mullet (23,000 metric tons).

The fish catch had steadily increased from 96,000 tonnes in 1970 to 217,000 metric tons in 1983. But ethnic violence erupted in 1983 and had a direct and shocking impact on fishing villages themselves in the northwest and north. The estimated total fish production in 1986 was 183,000 tons of which the coastal fisheries supplied 144,000 metric tons, the inland fisheries 35,000 metric tons and the offshore and deep sea fisheries the remaining 4,000 metric tons. The per capita consumption of fish in Sri Lanka is presently 16.3 kg which is the figure targeted for the year 2000 by FAO.

The country still imports a large quantity of fish and fish products (25,000 and 11,000 metric tons respectively in 1985) mainly as dried and canned fish. The value of imports exceeded Rs. 750 million in 1985 while exports of fish, crustaceans and molluscs which exceeded Rs. 600 million in 1984, dropped to Rs. 468 million in 1985. The main export items and the quantity and value of exports in 1985 are shown in Table 5.

Table 5

EXPORTS OF FISH AND CRUSTACEANS IN 1985

	Quantity (metric tonnes)	Value (Rs. million)
Prawns and Shrimps	1648.1	303.3
Lobsters	245.4	56.4
Crabs	973.7	33.4
Shark fins	26.2	10.2

Source : Sri Lanka Customs. External Trade Statistics, Sri Lanka, 1985.

Caution must however be exercised against hasty encouragement of an industry based on a living natural resource. The yields from these resources depend on ecological processes. The coastal fishery, at the present time, is exploited close to the maximum sustainable yield which is expected to be reached within the next five years.

An intricate food 'web' is maintained within the coastal zone. The degration of one component, say the lagoon, affects the migration of prawns to and from the sea which is necessary to complete their life cycle. Many such food webs operate to produce a sustainable fishery. For instance, over-fishing of prawns or small fishes can deprive larger fishes of their food. The population of these fishes (which may be highly edible and much sought-after) could dwindle in time either through destruction of their habitat or through over-fishing. The fishery along the western, northwestern, northern and northeastern coastal sectors rests mainly upon the productivity of the extensive seagrass beds found there. Along the rest of the coastal waters there are coral, sandstone, rock and seagrass habitats which support productivity. The productivity of these habitats as well as the nearshore coastal waters in general, is linked to nutrients and nursery habitats available in estuaries.

While removing constraints to fishing, it is necessary to remember that the catchers must be carefully monitored to ascertain whether over fishing is taking place. Over-fishing may result in the depletion of numbers which reduces the regenerative potential of the entire fishery or of specific varieties whose populations may fall below critical levels.

Population growth and reduced agricultural productivity in the future could lead to over-exploitation of living aquatic resources. Sri Lanka should therefore be prepared with quantitative analyses of productivity and the infrastructure required to regulate the fishery in its territorial waters to avoid over-fishing. It has been found that when the populations of varieties of fish are reduced below critical levels, sometimes inedible species tend to replace the depleted species and the latter are rarely able to re-establish themselves.

In order to obtain sustainable yields from our coastal waters it is very important to manage the fishery in a manner that protects the habitats and also prevents competition between the relatively inefficient traditional fishing methods and highly efficient introduced methods such as purse seining and modern trawling.

Emphasis should be laid on improving preservation of the catch, reduction of post-harvest losses both quantitatively and qualitatively and the extension of fishing activities into areas such as the deep sea, where resources are under-utilized or not used at all. The application of advanced fishery technology by the private sector should be encouraged.

Marine fisheries provide 80 per cent of the country's total fish catch. There are good resources of pelagic (open sea) and demersal (sea-bottom) species of fish in the coastal fishing area with an annual sustainable yield of 254,000 metric tons.

Inland Fisheries

Fifty-nine species of local freshwater fishes are found in Sri Lanka. They include :

- sixteen endemic species found mostly in the Wet Zone.
- about 20 edible species and
- about 30 species of Cyprinids among which are very small minnows like barbs, Rasbora and Danio.

Until about three decades ago, fishing in freshwaters was considered more a leisure activity. However, 25 species of freshwater food fishes were introduced in the nineteen fifties. They included carp from China, tilapia from Africa and gourami from the Philippines. Tilapia has caused serious ecological imbalances by successfully competing with indigenous varieties. It thrives better than other species under diverse conditions and now provides 80 per cent of the total production of inland fisheries.

The development of inland fisheries has now been extended to include :

- 123,000 ha of brackish water lagoons, estuaries and mangrove swamps;
- about 138,000 ha of freshwater reservoirs and villus; and
- 18,000 ha of perennial water bodies in the Mahaweli development area.

From modest beginnings the production from inland fisheries has increased phenomenally - from 8,200 tonnes in 1971 to 16,700 tonnes in 1978 and then to 36,000 tonnes in 1983. Improved transportation has also played an important part in increase demand for freshwater fish. Earlier, most tank catches had to be dried or salted.

Today there are 11 freshwater and 2 brackish water Fisheries Stations and 3 Fisheries Extension Centres. The Government grants generous subsidies for purchase of boats and improved fishing gear. The average yield from a tank (reservoir) is about 100 kg/ha/year but the effort needed for harvesting is great. Enterprising small scale farmers have evolved new and interesting methods of fish culture. However, aquaculture involving construction of ponds will not be an easy task. In the case of fresh water aquaculture there will be competition for land and water with paddy cultivation. In the case of brackish water aquaculture (shrimp culture) social impacts of large scale construction of ponds will be a serious constraint unless participation of the local population is involved.

In less than four decades the marine and inland fishery of Sri Lanka has developed to a level where it is making a noteworthy contribution to improving the national diet. Present priority needs are: quantitative data on the resources available in different zones, technological safeguards against over fishing and a management plan to ensure sustainable yields from the country's fisheries.

Chapter 15

ENERGY

Since energy is necessary for daily human needs, development must ensure its availability in increasing quantities on a sustained basis. Energy is derived from natural resources and therefore has a direct impact on the environment both during the processes of harnessing the resource (such as from water, firewood) and after usage (noxious fumes from motor vehicle emissions, and gases from burning coal.

The total energy consumption in Sri Lanka in 1985 has been estimated at 6 million tonnes of oil equivalent (TOE), 70 per cent of which was contributed by fuelwood and agricultural residues, 17 per cent by petroleum products and 13 per cent by electricity. Per capita consumption of commercial energy is even lower than in many other Asian countries.

The domestic sector accounted for about 67 per cent of total energy consumption during 1983 - 1985, the industrial sector about 23 per cent and transport about 10 per cent.

Electricity

The total installed capacity at the end of 1986 consisted of 746 MW of hydropower and 270 MW of thermal power, which is used to supplement hydropower. Fluctuations are caused in hydropower generation by variations in the water levels in the reservoirs. Availability of hydropower results in reduced cost of electricity to the consumer, and in less oil imports into the country.

Nearly all the sites for large hydropower projects have been exploited. Droughts in recent years have taught Sri Lanka that it is risky to depend on hydropower. During the severe drought of 1983 factories had to work reduced hours as power was not available.

Oil-fired thermal power plants are ruled out on account of low efficiency and because oil is expected to become prohibitively expensive after the year 2000.

Coal fired thermal power plants appeared the most feasible to fill the gap between power supply and demand. The Ceylon Electricity Board therefore proposed the establishment of seven such units - two of 150 MW each and five of 300 MW each in 1997, 1999, 2001, 2003 and 2005.

Transmission and distribution losses have presented major problems for the Ceylon Electricity Board. These losses have been reduced from 17.0 per cent in 1984 to 15.5 per cent in 1986 and are expected to drop to 12 per cent beyond 1989.

Imported crude oil is converted into a number of products to meet the requirements of the transport, industrial, energy, agricultural and domestic sectors. Total consumption of petroleum products estimated at one million tonnes oil equivalent of energy formed 16 per cent of national energy consumption. Demand for petroleum fuel for gas or oil turbines varies with rainfall and the availability of hydro-electric power, which depends on rainfall and also the dry weather flow in rivers.

The transport sector uses about two-thirds of the net petroleum imports. Nearly all passenger cars use petrol (with added lead compounds) while trucks, lorries and buses use auto-diesel. Bitumen is used for road paving. Heavy diesel is mostly used now instead of furnace oil for thermal power generation.

In 1981, 82.5 per cent of all housing units used kerosene for lighting. This included 51.8 per cent units in the urban areas, 89.6 per cent in rural areas and 86.5 per cent in the estate areas.

An increasing number of urban households use liquefied petroleum gas (LPG) for cooking.

Fuelwood and Agricultural Residues

Only about 20 per cent of the country's total fuelwood needs are supplied from forest sources. The Forestry Master Plan envisages that forest timber will come from forest lands cleared for agriculture and other development activities and through sustainable selective felling of Wet Zone forests. The non-forest fuelwood is provided mainly by rubber (28 per cent) and coconut (24 per cent) trees and home gardens (11 per cent).

Fuelwood and other biomass as earlier stated, contribute about 70 per cent to total energy consumed in Sri Lanka. Their greatest use is in domestic cooking. About 93 per cent of Sri Lankan households use firewood and agricultural residues. Their popularity depends on their ready availability and economy in use. It is estimated that only about 39 per cent of the firewood is purchased. Fuelwood has so far been used very inefficiently (at about 7 per cent efficiency). On the basis of 24 per cent efficiency for petroleum products and 80 per cent efficiency for electricity,

the percentage share of useful energy contributed by each source has been computed at only 46 per cent for fuelwood and agricultural residues, 35 per cent for petroleum products and 19 per cent programme for popularizing fuelwood efficient domestic cooking stoves developed in the R & D institutions.

Industrial uses of fuelwood include the processing of tea, rubber (smoked sheet) and coconut, tobacco curing and the firing of lime kilns and pottery, brick and tile kilns.

The present regional imbalances in the availability of fuelwood are predicted to worsen, especially in the Colombo and up-country areas. Fuelwood shortages are forecast in the Dry Zone after 1995 and for the country as a whole before the year 2000.

As regional imbalances in fuelwood supply increase, transport costs become more important. Charcoal which so far has found very limited use would then have better prospects since its weight is low in relation to the energy it supplies.

The establishment of forestry plantations, farmer's woodlots, block fuelwood plantations (for industrial fuelwood) and agroforestry units is recommended to meet the present and anticipated shortages of fuelwood.

Alternative (Non-conventional) Sources of Energy

None of the non-conventional sources of energy have made any considerable impact on the energy scene in Sri Lanka. Solar energy has traditionally been used in salt manufacture from sea water and in drying fish, parboiled paddy and other food items. It has recently been used for heating up boiler water. Biogas has failed to gain any wide acceptance. The seas are deep off the Trincomalee coast and suitable for generation of ocean thermal energy (OTEC) but no commercially proven technologies are available.

Nuclear Power

Nuclear power utilzation even in developed countries has lost its earlier momentum because of safety considerations. A Committee appointed by the National Science Council in 1982 saw no immediate need for installing a nuclear power plant in Sri Lanka, but indicated the need to keep this option open for future expansion of power generation. The main consideration were: availability of qualified staff, safety, economics of nuclear power and the ability of the national grid to accommodate the extra power.

Energy Conservation

Opportunities for energy conservation are seen in the design of more efficient domestic cooking stoves, in further reducing power transmission and distribution losses, in the provision of telecommunication facilities (resulting in reduced travel) and in traffic discipline. Energy conservation measures have been implemented in the public sector industrial corporations.

Energy Sources and the Environment

The demand for energy will increase because of increasing domestic consumption caused by population growth and the need for about 20 million units is projected for the year 2000. The effects on the environment of the increased energy consumption resulting from the stepping up of industrial development, should be studied.

While electricity itself is considered to be a clean source of energy in use, its generation whether from falling water, petroleum products or coal causes adverse environmental effects. For example, the impounding of rivers for the generation of hydropower results in the innundation of valuable agricultural land as well as the breeding of disease-carrying mosquitoes and other vectors in the stagnant water pools formed in the river bed below the reservoir. The resurgence of malaria in some areas has been attributed to this cause.

Environmental damage from petroleum products starts with possible oil spills at the point of discharge of the crude oil at the recently installed single point buoy mooring (SPBM).

The combustion of petroleum whether in electricity generation or in motor vehicles, releases noxious vapours containing carbon monoxide, sulphur dioxide and oxides of nitrogen, particulate carbon and in the case of petrol, harmful lead compounds too.

The environemental hazards from the use of coal for electricity generation may be summarised as follows:

- Transportation and storage problems related to risks of spontaneous combustion and the aesthetics of sea and land terminal facilities.

- Combustion problems. Flue gases from coal combustion contain mainly sulphur dioxide, nitrogen oxides, carbon monoxide, carbon dioxide, organic compounds and particulate matter such as fly ash. Used cooling

water is discharged at temperatures exceeding 35°C. This tends to disturb the equilibrium of the water body into which it is released. A major problem is created by the conversion of the sulphur acid, which is harmful to plant and animal life.

Technologies are available to reduce pollution from coal fired power plants but treatment of emissions raises the cost of power generation. Other countries are however successfully operating coal-fired power plants while maintaining environmental quality.

The collection of agricultural residues like bagasse, paddy straw and paddy hulls for use as fuels involves little or no environmental degradation.

The burning of fuelwood whether in the home or in factories causes atmospheric pollution, but no serious ill-effects of kitchen or factory wood smoke have been reported in this country.

Chapter 16

INDUSTRIES

The percentage share of manufacturing industry in GNP during each of the years 1984 to 1987 has varied from 15.1 to 16.5 made up of tree crop processing 2.9 to 3.10; factory 10.1 to 11.6, and small and other industry 2.0 to 2.1.[1]

The constraints to development in the other sectors make it imperative that the rate of industrial growth should considerably exceed the value of 5.7 per cent average during the period 1978 - 1985. It will need to contain unemployment which has been estimated to rise to 19 per cent by 1988.[2] Low demand, inadequate investment funds and shortage of foreign exchange have been identified as obstacles to a higher rate of industrial expansion.

Exports of industrial products also provide no cause for satisfaction. The relative share of manufactured products in total exports (by value) was 38.6 per cent in 1985 with petroleum products and garments accounting for 27.7 and 56.5 per cent respectively of all manufactured exports. All other manufactured products therefore, contributed a mere 15.8 per cent of total manufactured exports in 1985.[1] The value added in the manufacture of petroleum products and garments is very low. Garment exports also depend on quotas set arbitrarily by the importing countries.

Sri Lanka has often found it very difficult to establish exclusively export-oriented industries. Industries catering to both the domestic and export markets appear to be more feasible.

The 1983 Census of Industry has revealed that about 600,000 persons were engaged in industry. This level of employment is assessed as comprising "about 12.4 per cent of economy-wise employment - a far from sufficient share in overall employment creation for an aspiring developing country."[2]

The Structure of Manufacturing Industry in Sri Lanka

The public sector in Sri Lanka contains a number of large industries which include petroleum, cement, steel, tyres, ceramics, paper and mineral processing.

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(1) Central Bank of Sri Lanka - Annual Reports.

(2) Ministry of Finance and Planning: Public Investment 1987-1991 p. 63.

The functioning of state industrial corporations has been the subject of criticism and controversy. The government expects to gradually divest itself of its shareholdings in these ventures or transfer management responsibilities to independent Boards of Directors.

Freed in 1977, from constraints of regulation, especially in the importation of machinery and raw materials, the private sector has shown impressive rates of growth. Foreign participation, especially through joint ventures, is encouraged, to strengthen these units in the areas of capital, technology, managerial know-how and access to export markets. Several industrial organizations have entered into collaborative agreements with foreign partners.

Foreign investment in Sri Lanka is promoted and monitored by the Foreign Investments Advisory Committee (FIAC) of the Ministry of Finance and Planning and by the Greater Colombo Economic Commission (GCEC). FIAC aims at strengthening the local private sector while GCEC goals are increased employment and higher foreign exchange earning. FIAC has been able to raise the level of sophistication of the technologies it has been able to attract to this country.

Small and medium scale industries (SMI) form a vital segment of industry, providing an important service to the public and valuable avenues of employment.

The Government Industrial Policy Statement (1987) declares that "small and medium sized industries should be encouraged, given the capital and entrepreneurial endowments of the country" but cautions that "viability is of paramount concern because that alone will give the required stability to industries."

Cottage Industry

The 1983 census of industry defines a cottage industry as one which employs less than 5 persons. Though productivity per person is low the employment generated is high. The capital investment in such industry is also low.

Composition (Sub-sectors) of the Industrial Sectors

The major subsectors of the industrial sector are: food, beverages and tobacco; textiles wearing apparel and leather products; chemicals and petroleum, and rubber and plastic products.[1]

(1) Public Investment 1987 - 1991 Tables 3.3 (p. 67) and 3.6 (p. 70)

Food, beverages and tobacco provided the highest number of jobs (35.93 per cent) the highest share of output (37.18 per cent) and the highest value addition (46.1 per cent). Valuable all round contributions were also made by the textile, wearing apparel and leather products industries, the chemicals, petroleum, rubber and plastics industries and the manufacture of non-metallic mineral products (except petroleum and coal).

Together with the benefits it confers, industrial expansion has negative aspects to which need to be anticipated and corrected. Foremost among these is environmental pollution, which by damanging the natural resource base on which industry rests, slows the pace of development in some sectors.

The need to economically use non-renewable resources such as limestone and clay, two widely used mineral resources, has been stressed in Chapter 4 - The Non-renewable Resources. The depletion of fisheries by widespread damage to coral reefs a renewable resource, has been highlighted in Chapter 9 - The Coastal Zone Resources Systems.

Processing of raw material can also cause environmental pollution and be a health hazard. The use of (imported) asbestos fibre in the manufacture of asbestos - cement products such as roofing and ceiling sheets releases minute asbestos fibres that can cause fatal lung disease even 30 or 40 years later, not only among the factory workers but even among residents living as far as one mile away from the factory.

Industrial processing of materials needs energy, which in the case of several industries is supplied by fuelwood. The environmental ill-effects of fuelwood use are described in Chapter 15 - Energy.

Industrial processing releases noxious vapours and dusts into the atmosphere. They also release liquid effluents containing environmentally harmful substances. These effluents ultimately find their way into the ground water, waterways or the sea where they can cause extensive damage to the environment. The chemicals found in these effluents can enter the food web and increase their concentration in edible aquatic animals.

Industry is sometimes perceived as the major cause of environmental degradation in this country, because the effects are much more dramatic and the source of pollution easier to trace.

Summary of Adverse Effects of Industrial Activities on the Environment In Sri Lanka

The following are the areas in which serious environmental damage is being threatened :-

The Landscape and the Soil

Poorly planned extraction of mineral resources from the ground. Limestone and clay for cement manufacture.

China clay from Boralesgamuwa and ball clay from Dediyawala for the manufacture of ceramics.

Clay dug for the manufacture of bricks and tiles and pottery. Gem pits in prime agricultural land.

Destruction of the coral reef to produce lime for building construction has caused increased sea erosion of the southwestern coast. The number of people involved in such mining operations is estimated at only 1500. Extraction of limestone from the coral reef is now prohibited.

The dumping of waste materials disfiguring the landscape and adversely affecting the soil. These materials include coir dust, paddy husks, discarded tyres and plastic waste.

Waterways, Reservoirs and Underground Water

Rubber Factory Effluent

Effluents from the processing of rubber latex contain proteins and other organic compounds that contaminate the waterways into which they flow. The problem has worsened in recent years. Sri Lankan and Netherlands experts are working out methods of treating this effluent. The Central Environmental Authority has stipulated tolerance limits for rubber factory effluents and formulated guidelines for their discharge.

Paper Mills

The two paper mills at Valaichchenai and Embilipitiya discharge black liquor effluent with a high caustic alkali and organic matter content. An imported chemical recovery plant installed at Embilipitiya at a cost of Rs. 150 million proved ineffective and is lying abandoned. The release of black liquor into the Walawe River kills fish and other life in the river and degrades the soil in downstream fields irrigated by the river waters.

Tanneries

The Kelani *Ganga* and other waterways in the Colombo area are polluted by discharge of industrial effluents and untreated sewage into them. These pollutants include tannery wastes which contain decomposable proteins and other organic substances that use up the oxygen in the water killing the fish and plants in it.

Chrome tanning effluents contain toxic chromium salts that enter the food web and are toxic to fish, birds, human beings and animals.

Urea plant and fertilizer packing plant

Washings from the urea fertilizer manufacturing plant, (presently out of commission), were suspected of having caused the big fish-kill of September 1982. The ground water in the Hunupitiya area around the fertilizer packing plant was rendered unfit for human use through the leaching of fertilizer dumped in an open yard.

Synthetic organic dyes in the effluent discharged from batik textile manufacturing units are powerful pollutants.

Effluents from industrial units processing meat, fish and milk products have readily decomposible proteins and fats.

Atmosphere

Kiln dust from the two cement factories at Kankesanturai and Puttalam causes atmospheric pollution over a distance of two or three miles. This problem is now being successfully tackled.

Asbestos fibres released into the atmosphere during the processing of asbestos cause fatal lung diseases as stated on page 120. Government has banned the use of blue asbestos, the most malignant form. However, the other forms of asbestos are also carcinogenic.
Vapours of substances such as those of lead and isocyanates released into the atmosphere are highly toxic.

Exhaust emissions from boiler stacks are injurious to human health.

Measures to combat industrial pollution

The Central Environmental Authority is monitoring pollution of the Kelani River waters by industrial effluents, with CISIR assistance. Remedial measures are being enforced.

Aerial surveys of Colombo City and the Ratmalana - Moratuwa area have been carried out for CEA with foreign assistance using a special light aircraft. Anti-pollution measures are being enforced.

The installation of pollution control measures in existing industrial units is a much more difficult and more expensive task than doing so in new units.

Four Sri Lanka standards prepared by CEA have been approved; setting out tolerance limits relating to pollution of surface and ground waters by industrial effluents.

Interim standards have been prepared stipulating new atmospheric emission norms and typical noise level criteria.

Location of Industries

Most industrial units are located within a radius of about 30 km. from Colombo. The government is attempting to spread industries more evenly throughout the country. The 1987 Industrial Policy Statement, states that

> "in order to achieve more balanced regional growth, industries should, other things remaining equal, be dispressed widely throughout the country. It is necessary, however, to safeguard against haphazard industrial location purely for the sake of regional dispersal. Optimisation of viability should be the paramount consideration."

The Urban Development Authority is endeavouring to seperate residential areas from commerical and industrial areas by zoning according to use. Cottage industries are allowed in the residential zones but other industrial units are allowed only in the commercial and industrial zones.

Environmental Impact Assessment

An important step towards environmental conservation was taken when government decided that, from January 1984, all proposed development projects which affect the environment should be submitted for approval together with an Environmental Impact Assessment Statement or an Initial Environmental Examination. This requirement is included in the bill to amend the National Environmental Act. This decision is an affirmation that pollution control devices are an integral part of the technology itself. Their costs should therefore be born by the developer and should not be passed on to society.

Environment Impact Assessment (EIA) is at present only in its primary state of development in Sri Lanka and consists of merely pointing out the negative impacts of a project. Carried out properly, EIA requires a comparative quantitative assessment of the benefits and environmental ill-effects of the project and an estimate of the costs of developing or purchasing technology to avoid such ill-effects and the gain in monetary terms of effecting such improvements. Alternative less polluting technologies and low and non-waste technologies have to be considered. The importance of developing a capability in carrying out comprehensive quantitative Environmental Impact Assessments cannot be over-emphasized.

Chapter 17

CULTURAL RESOURCES

The Dipawamsa, Mahawamsa and Chulawamsa which document the long and continuous history of Sri Lanka are among the world's oldest historical chronicles. Their record is authenticated by rock inscriptions, ola-leaf manuscripts and the journals of foreign travellers. Most of the cultural monuments and other treasures relate to Buddhism, the religion of the majority of people or to agriculture, their principal occupation. Life in ancient Sri Lanka villages is stated to have revolved round the *dagoba* or stupa and the village 'tank' (reservoir) where rainwater was collected in the three rainy months of the year to meet the needs of the long dry period as well. Irrigation engineering and water management, and art and sculptures, are regarded as the two dominant features of the Sinhala civilization. The marvels of these ancient irrigation systems are seen not only in the giant dams and vast reservoirs (tank) but in the fine gradients of the distributive channels and in the design of the water-release regulating sluice, the *bisokotuwa*, which has been described as unique and most ingenious. Most of these irrigation works have been renovated and continue to provide the inhabitants in the Dry Zone with water for domestic and irrigation purposes even today. Several festivals, ceremonies and dances in the country are associated with paddy cultivation and harvesting.

The giant stupas, stone-sculptured Buddha images and temples spread over various parts of the country but concentrated in the North Central Province bear testimony to the religious fervour of ancient Sinhala monarchs. The main Buddhist festivals observed in Sri Lanka are: *Wesak* celebrating the birth, enlightenment and death of Gauthama Buddha; *Poson* marking the advent of Buddhism to this country; and the *Esala* pageant marked by a colourful precession including high Buddhist dignitaries in ceremonial garb, several dance troupes and over one hundred gaily caparisoned elephants. The rock caves of Dambulla and Dimbulagala have been the abode of bhikkus and places of worship for Buddhist devotees.

Hindu devalas and kovils centre round Jaffna, Trincomalee, Batticaloa and Polonnaruwa; other well known ones are situated in places as far distant as Kataragama, Munneswaram, Devinuwara and Alutnuwara. The Embekke Devale is a masterpiece of architectural woodwork. Examples of ancient secular architecture are found in the remains of royal palaces in

Anuradhapura, Polonnaruwa and Sigiriya. The moonstones, guardstones and other sculptures bear testimony to the highly developed skills of the craftsmen. The graffiti in Sigiriya, Dambulla and more recently discovered rock caves attest to the mastery of the artists. Examples of more recent secular cultural architecture are seen in the ramparts of the Dutch forts in Galle and Matara and the Dutch-style buildings in Wolfendahl and Hulftsdorp.

The movable cultural treasures include artefacts of various types - statues, relic caskets, weapons, lamps, carvings, trinket boxes, tapestries and paintings. The materials used include clay, gems, gneiss stone, marble, wood, ivory, bone, horn, bronze, iron, silver, gold, reeds, fibre and leaves.

The non-material cultural resources reflect the co-existence of Buddhism and the folk religion comprising gods and devils with assigned attributes and ritualistic practices. The origins of traditional drama, music and dance forms are traced to the cults of the folk religion. The development of painting, sculpture, architecture and literature is credited to the influence of Buddhism. Rituals of the folk religion were and even still are conducted to nullify evil influences on the community and invoke blessings on it as well as to heal ailments of individuals. Kolam or masked plays are characteristic of certain southern coastal towns, as is Nadagam which dispenses with masks. Sokara is a form of drama performed with mime and masks only in the hill country and the Vanni, but never in the low-country. Sri Lankan drama, music and other art forms have been greatly influenced by Indian culture.

Repositories of Cultural Resources

The practice of acquiring, accumulating, preserving and displaying objects of value and veneration, books and manuscripts, and unique art creations had been known in this country from ancient times. Temples and monastries which were their repositories thereby became *de-facto* art galleries. Temples have, to the present day, contained the most attractive and valuable pieces of furniture and other creations received as gifts from and offerings by royalty, the nobility and the public.

Preservation and Conservation of Cultural Resources

Monuments

The Department of Archaeology established as far back as 1867 is responsible for the excavation, protection, maintenance, conservation and restoration of monuments. Much has been achieved by this department in

many parts of the Island. Many monuments have been unearthed and restored to their original condition. Anuradhapura, Polonnaruwa, Sigiriya, Yapahuwa, Tissa and Dedigama are among the better known places where large number of monuments and sites are under the care of the Department. However, the large numbers of archaeological relics and their widespread locations have prevented the department from fully discharging its responsibilities. This department has also not been provided with adequate staff and equipment to fulfil its responsibilities.

In 1980 the Sri Lankan -UNESCO Cultural Fund was created with 60 per cent of its capital contributed by the UNESCO member countries. The establishment of this agency can be considered the most significant step taken towards the conservation and preservation of the cultural resources in this country. It is part of the UNESCO--sponsored international effort to preserve for posterity the master pieces symbolic of the world's cultural heritage. The responsibility for overall care of the cultural resources lying within the Anuradhapura - Polonnaruwa - Kandy triangle, popularly known as the Cultural Triangle, is now vested with the Central Cultural Fund. This Fund is responsible for historic cultural sites and monuments. Simultaneous excavations have already begun at several sites in Anuradhapura, Polonnaruwa, Sigiriya, Dambulla and Kandy.

Arts and Crafts

The most significant action taken to involve the state in fostering traditional culture has been the establishment first of a separate department and then a Ministry of Cultural Affairs. State patronage is most evident in the support given to the promotion of performing arts especially dance and music. These have been included in the school curriculum. Village level training centres have also been set up. The Institute of Aesthetic Studies, responsible for imparting knowledge and skills in these disciplines at higher levels to students, has now been elevated to university status. A state dance ensemble has also been organised.

A separate Government Department of Small Industries and a number of statutory bodies have been established for the upliftment of crafts and craftsmen. Crafts centres and design centres have been set up for production, training and improvement of product quality. Marketing centres like Laksala have been organised with a network of branches to provide marketing outlets for these products.

New initiatives have been taken to improve the standards of the national and religious pageants like the Kandy *Esala Perahera* and the Kataragama Festival.

PART IV

Constraints to Environmental Conservation and Sustainable Development

Chapter 18

CONSTRAINTS TO CONSERVATION

Introduction

Sri Lanka's natural resources, both living and non-living, and the vital role they play as life supporting systems have been discussed in detail in previous chapters. These chapters also stressed that conservation of the natural resource base is essential for the life-support systems to be sustainable. However, evidence placed before the Task Force indicates that there is a deplorable lack of such conservation and that the present rate of exploitation is rapidly out-stripping the renewability of these resources. Inevitably, this will lead to irreversible changes in the environment which will in turn seriously impede socio-economic development.

The reasons for this unhappy situation are many and have been identified as obstacles or constraints to conservation. These will be examined under the following headings:

i. Population Pressure
ii. Policy and Planning
iii. Legislation
iv. Institutional infrastructure
v. Trained personnel
vi. Public awareness of and support for environmental conservation.

Population Pressure

Although the rate of population growth has declined in recent years, the annual increase in numbers remains high. This is due to the large population base. Increasing numbers tend to consume resources at a speed which overtakes their renewability. The environment's 'resource capital' becomes threatened, thereby compromising the ability of the state to provide food security, health care and education. Improvement of the populations living standards also becomes difficult.

The chapters on **Environment Profile** have already identified the areas in which environmental degradation is rampant. The spread of agriculture into the cultivation of marginal lands, the filling of mangrove swamps and other wetlands for human settlements, and the destruction of coral reefs for the extraction of lime are examples which merit mention again.

Another problem arising from population pressure in an agricultural economy is the limited employment opportunities. This is especially so in the absence of industrial growth. Socio-economic problems become acute in such situations where governments attempt to solve them by recourse to further exploitation of resources already on the verge of collapse.

In the past, rural over-population in the Wet Zone was largely mitigated by migration into new colonization schemes established by clearing forest lands in the Dry Zone. This has also greatly checked mass migration into the cities. However the establishment of state-aided colonization schemes on a large scale will not be possible in the future as it was in the past. The Mahaweli Development Programme is one of the largest programmes of this type and may be the last of this type.

Though migration from villages to towns has not been a major cause of urban environmental degradation, the natural increase in the urban population has led to pressure on land, housing and civic amenities. Slums and shanties are continuing to grow in most urban areas. It has been estimated that nearly half the population of Colombo City live in slums or shanty dwellings without any basic amenities.

Policies and Plans

Lack of Conservation Consciousness and Understanding at the Policy-making Level

For a country whose people lived in harmony with the environment for many centuries, it is difficult to understand their neglect of it today. Perhaps the reason may be that in historical times the rulers as decision - makers realised that for agriculture to flourish they had to instil in their people a respect for the land and the importance of tending and nurturing it. With each succeeding generation these attitudes, handed down from father to son, became a way of life with the people. The rudiments of sustainable development were thus established. The kings, their engineers and advisers, were aware of their responsibility to support agriculture, especially the cultivation of paddy, the staple food. The need for storing water when it was in plenty, and releasing it when most needed, was foremost in their minds. This gave the impetus for the construction of the huge reservoirs and dams and extensive irrigation systems, which remain unsurpassed 2000 years later.

The farmers for their part practised soil and water conservation methods to the best of their ability. They used organic manure in the form of leafy matter and dung of village cattle to replenish the soil. In this way they

improved their land, produced sufficient food for the commuity and were able to keep resource bases intact. The first disruption of this harmonious partnership was undoubtedly the introduction of commercial crops in the early nineteenth century. Not only was agriculture neglected, but also, large extents of the magnificient forest cover of the wet and montane zones were removed to accommodate first coffee and later tea, rubber and coconut plantations. Conservatioan practices were at first ignored because the objectives was to extract maximum revenues from these crops.

Not until disease and uncontrolled soil erosion adversely affected the productivity of plantations did governments realize the environmental damage that had been caused. They were compelled to introduce stringent conservation oriented measures in order to arrest the depletion of soil and its nutrients. But these practices did not compensate for the earlier removal of forests whose protective canopy was the best safeguard to the environment in general and the soil in particular.

The tendency to cut down forests and to exploit other resources too in the short term, continued even after independence in 1948. Two key factors fuelled the further assault on the natural resources. First the sharp increase in population (from 6.7 million in 1945 to 16.4 million in 1987) demanded more land to raise food crops. Secondly, most decision makers who apparently had no knowledge of the dangerous consequences of short-term exploitation, approved haphazard alienation of the remaining forested lands.

What was more dangerous was the erroneous impression created in the minds of the people that the road to progress lay in combating "the jungle and its ferocious wild beasts". The warnings of scientists and conservationists were treated with scorn and branded as being against the country's progress. Such erroneous thinking exists even today.

The government in 1978 included two important clauses in the Constitution which should have contributed to a reversal of attitudes.

(i) "The State shall protect, preserve and improve the environment for the benefit of the community;

(ii) "The exercise and enjoyment of rights and freedoms is inseperable from the performance of duties and obligations and accordingly it is the duty of every person in Sri Lanka to protect nature and conserve its riches."

However, in practice these objectives were not followed by approving and implementing agencies. Adequate emphasis was not given to environmental conservation in the approval of new projects. Sri Lanka's National Industrial Policy Statement as recently as 1987 fails to mention, let alone warn against, pollution.

The environment does not find a place even in Sri Lanka's Cultural Policy. This is all the more disturbing for the natural environment has had a profound influence on people's lives and produced a vibrant culture.

However during the past 4 or 5 years, environmental concern is reflected in some sectoral master plans such as those for Coast Conservation, Urban Development and Plantation Industries. A decision has been made by the Cabinet of Ministers that all applications for approval of development projects should be supported by an Environmental Impact Assessment reports.

Lack of Environmental Planning and of Rational Allocation and Use of Resource

In the final analysis conservation hinges on the utilization of the most important natural resource, namely land. Since it forms the resource base for all social, economic and cultural development, land is the environmental component most extensively altered by man and hence runs the greatest risk of unplanned use.

Of the country's total land area of approximately 6.5 million hectares, only 5.5 million can be used for productive purposes such as agriculture, forestry, animal husbandry, human settlements, buildings and roads. Fifteen ministries and over 50 government agencies are involved in its utilization, either directly or indirectly. The state sector is justifiably blamed for lack of planning and of rational allocation and use of land. Many of the constraints are traceable to an absence of cross-linkages and co-ordination between the various agencies. For example, the filling of mangrove swamps and mud-flats by property developers should not be allowed by the Ministry of Fisheries because the coastal fishery, which accounts for about 90 per cent of total fish production depends on the fishes and crustaceans that breed and begin life in the security of these swamps.

Nor should the encroachment of marginal lands for cultivation of subsidiary crops be condoned by the agency responsible for protecting these lands which have highly erodible soils. Consequently tons of silt find their

way into streams and rivers. Land above the 1500 metre (5000 feet) contour is today ravaged with impunity.

The Tourism Development Plan did not take into account the impact that the construction of large hotels virtually on the beaches, would have on beach ecosystems. Ironically this process led to the almost total disappearance of the beaches which were to have attracted tourists. Other such contradictions are too numerous to detail here, but will be mentioned when proposals are made to overcome these constraints.

Lack of Adequate Base-line Information

Lack of adequate base-line information greatly hinders environmental planning. Such information which is specific to each country must be obtained by research studies.

Three broad overlapping areas in environmental research have been identified[1]. They are: (i) Inventory Research which includes research on the distribution of ecosystems and species. (ii) Functional Research which includes research on ecosystem dynamics and relationships, the effects of human activities on ecologial processes and vice-versa, baseline monitoring, and other basic ecosystems, species and population studies and (iii) Management - oriented Research which includes research into standards, techniques and technologies that will improve the planning and management of living resource use.

However, there is very little on-going research in these areas, even though the rich genetic diversity found in the country's tropical rain forests and in its fresh water and marine habitats offers a fruitful field of research for identifying hitherto unknown varieties of fauna and flora.

Legislation

Many of the laws relating to environmental conservation are outdated or scattered in a large number of legislative enactments and/or have glaring inadequacies[2]. They fail to give the recognition due to resource conservation and sustainable development. There are large gaps in legislation relating to the environment. For instance there is no legal provision for enforcement of Environmental Quality Standards for the protection of river catchments and watersheds or for monitoring the unauthorized use of land in vulnerable or fragile areas.

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(1) World Conservation Strategy op. cit. Section 12. Improving the capacity to manage: training and research.

(2) Wijayadasa, K.H.J. and Ailapperuma, W.D, Survey of Environmental Legislation and Institutions in the SACEP Countires, - Sri Lanka A Joint SACEP - UNDP Project - Published by Central Environmental Authority, 1986.

The shortcomings in environmental legislation include also limitations in the areas of application of the law. For example legislation on housing covers only the 15 per cent of the country's total land area that are designated urban or built up areas. Institutional support for implementing environmental legislation is also inadequate. This wil be discussed under "Institutional Infrastructure."

The enforcement of laws has been rendered difficult as responsibility for doing also has been distributed among a number of government ministries, departments and other agencies.

This would help by reducing the number of laws so that enforcement can be co-ordinated and made effective. Law enforcement is also hampered by lack of funds, trained staff and transport.

Institutional Infrastructure

Exploitation of the natural resource base took pride of place over its conservation during the past 150 years. The framing of legislation and establishment of institutions had this bias. Wider concern for conservation developed only within the last 15 years. The lack of environmental consciousness at the policy formulating and planning levels has already been pointed out. The weaknesses in the institutional framework can be clearly illustrated by reference to the case of land. More than 50 government agencies and departments belonging to ten ministries utilize land. Sri Lankan soils span the whole classification of soils and each type of soil is suitable for particular purposes and unsuitable for others. Yet there is no central organization to plan control and monitor land use. The responsibilties of the different organization for land are not clearly spent out. The result is considerable overlap in the responsibilities of these organizations that caused friction among them. The Department of Agriculture is entrusted with the task of enforcing the Soil Conservation Act, but is not provided with adequate authority staff or funds to implement it. Staff and funding are continuing problems for all or nearly all orgnizations.

The industrial sector provides another example. The responsibility for the subject of industries is shared between the Ministries of Industries and Scientific Affairs, of Rural Industrial Development, of Textile Industries and of Finance and Planning as well as the Greater Colombo Economic Commission.

The institutional framework is also woefully inadequate in supportive services. For instance, the Pesticides Act mandates numerous far-reaching controls, but adequate facilities are not available for regularly analysing toxicological data and monitoring toxic residues.

A number of NGOO devote their energies solely to the cause of environmental conservation. While co-ordination among them has proceeded to the stage of establishing a common umbrella organization, liaison between them and government institutions is as yet weak.

Inadequate budgetary provision to maintain let alone improve basic infrastructure and logistics often brings into question the justification for continuing with certain institutions. The subject of soil conservation was recognised, an Act was promulgated in 1950 and a separate Soil Conservation Division was created in the Department of Agriculture. But due to inadequate financial, staff and logistical support it became defunct during a period when it was most needed at national level.

Lack of Trained Personnel and of Training facilities

Lack of trained and experienced personnel at all levels is the most severe constraint to all environmental conservation activities. Many of the trained technical personnel have accepted more remunerative employment abroad. The Central Environmental Authority, Natural Resources Energy and Science Authority (NARESA), the National Aquatic Resources Agency (NARA), the Universities, government departments and corporations and research institutes are among the institutions suffering from a dearth of trained personnel. The Department of Forestry, Wildlife and Agriculture and the Institute of Plantation Management are conducting in-servicing training courses largely to meet their own needs. These courses are also hampered by the lack of qualified teachers.

The universities do not turn out graduates with a sound understanding of the environment. There are no first degree courses in environmental science. Particular aspects of environmental science are incorporated in different courses without any attempt at integration of the course contents or at dialogue between teachers. Lack of linkages with government departments, industry and other institutions involved with the environment isolates university education from real life environmental situtaions. Lack of facilities for long term field studies is another major drawback.

Lack of Public Participation in Environmental Conservation Activities

A serious constraint to obtaining public participation particularly those in rural areas in a lack of understanding between officers charged with the task of implementing the law and the villager who, in trying to satisfy a basic need may be guilty of infringement of the law. There are instances where people who have enjoyed the benefits of a natural forest or a river for generations are apprehended for collecting firewood, extracting cane

or for fishing. Not only is the villager denied the use of the resources, he is also charged in court. It is not possible to talk of participation to such people. They will only try to avoid detection, for their need may be great.

Villages also feel a sense of injustice and frustration when perhaps to that same forest, outsiders come in gangs and fell timber on a large scale. It is more than likely that even after arrest those offenders will not be punished because of the 'influence ' they wield.

The activities of migrant fishermen who take over entire fishing grounds to the exclusion of the resident population is another example of inequality in resource utilization.

A failure by each administration to give the local inhabitants first preference in all conservation or resource utilization activities which bring socio-economic benefits is a severe constraint to their participation in protecting resources for sustainable use.

PART V
The Strategy

Chapter 19

REMOVAL OF CONSTRAINTS TO CONSERVATION

Environmental Conservation and Socio-Economic Development

The increasing population pressure and the efforts to provide a reasonable standard of living within the limits of the resources available have already been identified as the main causes of environmental degradation. The solution of serious and immediate long-range planning in most developing countries. This has forced upon people and governments of countries like Sri Lanka the erroneous notion that conservation is contrary to development. The first obstacle that has to be removed is therefore this misconception of what conservation connotes. The idea must be imprinted in people's minds that conservation only aims at ensuring continuous development at an optimum level. Without conservation, development tends to cause ecologial damage which invariably leads to economic losses and social stresses. It is therefore imperative that conservation considerations be integrated into the development process at every stage from policy formulation to planning and project implementation. A strong political will is essential to forge such links between conservation and development.

Policies

Political will is translated into action through policies, plans and programmes. In their anxiety for quick results, governments as policy-makers have chosen and continue to choose the option of formulating short-term policies for development. Plans and programmes based on this option have met with limited success. Utilization of a natural resource without a simultaneous increase in productivity cannot meet the demands of a rapidly growing population. In other words, development without conservation of resources can neither sustain populations nor improve the quality of life. A firm political commitment to sustainable development is the most urgent need.

The following cardinal principles of conservation - oriented development must be borne in mind in future policy formulation:

(i) Only ecological processes can assure the ability of a natural resource to produce harvestable amounts of food and other basic necessities of life.

(ii) Over-exploitation of any one component of an ecosystem, specially a life - supporting ecosystem, upsets the equilibrium of the whole ecosystem and thereby endangers its productivity. Development which disregards this proven fact runs counter to the attainment of the socio-economic goals which the development activity sets out to achieve.

(iii) The needs of an increased population can be met by making the country's natural resources more productive by recourse to science and technology.

Co-ordination and Cross - Linkages

One of the weakest areas in the planning process in Sri Lanka has been the lack of adequately strong cross-linkages between the different government agencies managing different development sectors. Activities in one sector, as already shown, often adversely affect productivity in another sector. For example, fisheries have suffered from the reclamation of mangrove swamps, the mining of the coral reefs for limestone, the discharge of silt by rivers and industrial pollution. Suitable mechanisms should therefore be devised to ensure sufficiently strong linkages between the organizations in charge of the different sectors. Particular attention has been drawn to the need for the optimum use of land, with allocation for different purposes being determined on the basis of suitability. The setting up of a national organization for land use planning under the Ministry of Lands and Land Development is therefore recommended.

Baseline Data

Lack of baseline data is a severe constraint to proper environmental planning in many sectors. Three types of environmental research, namely inventory, functional and management (research) have already been described. Such research would provide training for undergraduate and postgraduate students as well as baseline data for environmental planners. The compilation of a Baseline Data Handbook has been recommended [1]. It is expected to include basic information on the natural resources, consumption patterns, population growth and development projections - the important environmental, social and economic factors.

Another recommendation is the establishment of a national environment reference centre for disseminating information between government agencies and departments, non-governmental organizations, individuals, inter-national organizations and other countries[1].

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(1) Hubbard, F.E. : Strategy for Environmental Protection and Management in Sri Lanka. Central Environmental Authority, Colombo, 1982.

Legislation

The legislation relating to the environment presently found scattered in a number of different statutes should be reviewed and revised in order to ensure that:

- they are adequate to effectively meet present day needs of resource management;
- the laws are applicable in all areas where they are needed;
- the authority and responsibilites of the Central Environmental Authority are considerably enhanced, and provision made for delegation of such powers;
- Environmental Quality Standards and Environmental Impact Assessment of development programmes and projects can be enforced; and
- penalties are adequate for breaking environmental laws.

The infrastructure for the implementation of environmental laws, such as testing laboratories and logistics in the form of transport should be provided. Above all, adequate trained staff should be provided to enforce the laws and provide the back-up services.

Implementing Agencies and Infrastructure

The Central Environmental Authority (CEA) has been established as the policy - formulating and co-ordinating agency for the protection and management of the environment. Its administrative and regulatory responsibilities have been kept to a minimum. Amendments to the National Environmental Act of 1980 have been proposed to Parliament increasing its regulatory authority, which it expects to execute through delegation to other state agencies capable of exercising the delegated authority. These agencies include the Forest Department, the Coast Conservation Department and the Tourist Board. The CEA as well as the implementing agencies have been severely constrained by lack of experienced trained staff.

District environmental agencies (DEAA) have so far been the implementing arm of CEA programmes. The establishment of Provincial Councils makes it necessary that DEAA are responsible to these Councils for a major part of their work. The responsibilities of the Provincial Council vis-a-vis the central government have been spelt out generally but fairly clearly. These relations in respect of environmental activities can be developed as experience increases.

Government departments, state corporations and other statutory bodies should be provided with adequate funds for them to be able to recruit, train

and retain the services of competent staff and to procure equipment and other necessary facilities. The savings from environmental activities are several times greater than the investment but it will take time to appreciate the benefits which will accrue.

The existence of a number of government departments and other institutions sharing responsibility for activities in a particular area has lead to overlapping of authority. Authority must be clearly defined and responsibility pinpointed. Even where several organizations are involved in a particular area such as forestry, mechanisms for coordination must be established among them.

Another constraint is that government agencies are more concerned with exploiting natural resources than with conserving them, because performance is judged by output. This is particularly ill-advised in the case of non-renewable resources.

Environmental education including exposure to field studies must from an integral part of training institutes such as the Sri Lanka Institute of Development Administration, and Government Teacher Training Colleges.

It is a sad fact that much environmental degradation and abuse of natural resources are caused by public sector organizations. There should be severe penalties for both public and private institutions that are found guilty of neglecting the environment and sometimes even causing irreparable damage to it.

Trained Personnel

Lack of technically trained personnel is a problem with almost all institutions, whether big or small in both private and public sectors. Besides the agricultural sector, there are occupations such as fishing and mining which underplay environmental considerations. Training in universities and other institutions should emphasize the environmental aspects of such subjects. Such institutions should liase closely with government departments, industry and other organizations involved in environmental activities.

In view of the urgency of removing constraints the availability of trained personnel in every department activity is a sine- qua-non. Immediate measures must be taken to provide training in environment institutions and universities. The argument that the intake to such courses is not sufficient to make these courses viable will cease when more and more

'openings' are created as adherence to terms and conditions of EIA applicable by law.

Environmental Education

Formal System

Environmental education (EE) should be planned to provide an understanding of the complex nature of the environment resulting from the interaction of its biological, physical, social, economic and cultural aspects. Practical experience must be an important part of EE so that skills and knowledge are imparted at the same time that attitudes and values are being imparted. The training of teachers is particularly important in EE and needs special attention at teacher training colleges. High quality text books and other reading material on environmental subjects must be made available especially in the national languages.

A basic bachelor's degree course in environmental science at university level is a pressing need. Until such a course is established efforts should be made to integrate the environmental elements which are scattered in different subjects. A holistic approach is needed. Each university should have its own field study centre. Facilities must be provided to university students for long duration field work and for community social work concerned with environmental activities.

Non-formal educational activities in schools and those organised by non-governmental organizations should be supported. Newspapers should view environmental topics from an educational point of view rather than from their news value. Greater interest must be shown by radio and TV in environmental subjects, more attention than now being paid to accuracy of facts and of translation.

Public Participation in Environmental Activities

Healthy signs are already appearing of government and non governmental organizations (NGOO) seeking and obtaining public support for conservation activities. There is now greater appreciation of the pressures that force people towards clearing of forests for chena cultivation or for mining the coral reef. Alternative systems of rainfed farming and security of tenure are being considered.

The NGOO have played a valuable role in conservation activities, both in training programmes and in studies on environmental aspects of different activities. Closer cooperation between them and government organizations will be mutually beneficial.

Chapter 20

PLAN OF ACTION

The relationship between development and environmental conservation has been explained. Also, the objectives of conservation have been set out, the strategic principles outlined, the constraints to conservation identified and the plans for overcoming such constraints indicated. This chapter spells out the specific measures that need to be taken at sectoral level to conserve the environment and the natural resource base in Sri Lanka.

Specific Action At Sectoral Level

Land use

Proper land utilization is the key to successful resource conservation and development. In Sri Lanka, the per capita availability of land has declined sharply to a critically low level of 0.4 ha making it imperative that land be used to maximum human benefit. This can be achieved by planning for sustainable development. Land should be allocated to a sector only on a carefully evaluated priority basis.

One criterion for deciding priority should be the suitability of the land for the sector requesting it, and the sector's capability of contributing to the socio-economic improvement of the people. For example a decision may have to be made whether a mangrove swamp should be subjected to landfill for a hotel project.

In the past, decisions on land use had been taken on an ad hoc basis where the activity may not only have destroyed a life-support system but where the economic venture which replaced it, may also have been subsequently abandoned. Such lop-sided "development" occurs because a multiplicity of ministries, departments and other state agencies compete for land. Some of these institutions make serious attempts to contribute to national development. Clear policies and perceptions are lacking in many instances.

The Task Force, therefore, recommends, as the immediate and most urgent need, the establishment of a separate national organization for land-use planning staffed with competent technical personnel.

The proposed organization (Authority) should be responsible for the following:

a. Land use planning carried out on the basis of identification of objectives, inventorizing of land resources and selection of best use for each land category.
b. Strengthening of data acquisition and processing capacity.
c. Intensified research on land management practices.
d. Review of existing legislation with a view to formulating a Legislative Enactment to regulate land use.
e. Strengthening of education, extension and support services.
f. Preparation of zoning plans for integrated crop and animal husbandry enterprises.
g. Siting of nature reserves to include all ecological systems for the conservation of fauna and flora.
h. Monitoring and management of land use activities in catchments of irrigation and hydropower reservoirs to reduce siltation rates and thereby increasing the lifespan of reservoirs.

The Task Force views with grave concern the far-reaching consequences of soil erosion and recommends the following urgent remedial measures:

1 Replacement of the present Soil Conservation Act by a comprehensive "Land Use, Soil and Water Conservation Act" with wider scope and authority for effective control of land use and enforcement of proper management practices.
2 Development of a land use plan for the whole country based on an ecological understanding.
3 Giving high priority to soil conservation as a matter of policy in all land use activities.
4 Conducting research in integrated watershed management so as to provide the basis for all soil conservation work.
5 Conducting research in appropriate farming systems including the concepts of mixed home gardens and conservation farming.
6 Taking necessary measures to minimise urban and construction site erosion.
7 Establishment of soil conservation units in other agencies with the development and/or use of land.
8 Emphasising soil conservation in the school curriculum.

The creation of divisions in the Tea, Rubber and Coconut Research Institutes dealing specifically with conservational aspects, institution of a

research programme on physical planning of estates and setting up gene banks as necessary, is recommend.

Since the public sector plantations are managed by different agencies, it would be prudent to create divisions in each of them to deal specifically with the subject of environmental conservation on state plantations.

The dissemination of research findings to the private sector is carried out by the extension services of the Department of Agriculture and of the crop research institutes. It is recommended that their officers be further trained in matters related to the National Conservation Strategy, so as to enhance their capability to implement such a strategy.

Water Resources

Land is an important resource, but life cannot exist without water.

As a resource, water is utilized in two principal ways: potable water for drinking and general domestic use, and raw water for agriculture, industry and the generation of power. The natural source of water is the hydrological cycle. Utilization of water resources, therefore, should not jeopardize this cycle.

The Task Force recommends the following actions which are designed to manage the resource to maximum human benefit:

1 The existing legislation on stream and river bank reservations should be revived and strictly enforced by Government Agents and the Departments of Irrigation, Forest and Wildlife Conservation. All settlements which have encroached on land within 2-chain stream reservations should be phased out. No new settlements on such land should be permitted.

2 The Forest Department with the assistance of other institutions such as the State Timber Corporation, the Mahaweli Authority and the Plantation Sector, should step up the reforestation of degraded watershed and denuded catchment areas.

3 As in the case of land, a number of ministries have jurisdiction over water supplies. The many uses of water must be identified and prioritised to avoid conflict and competition.

4 A single ministry or institute with wide powers and trained personnel must be entrusted with the responsibility of establishing cross-linkages in water utilization and management and in laying down policy. The functions of the existing Water Resources Board may be examined with a view to expansion to encompass these new responsibilities.

5 The Irrigation Department should demarcate the limits of catchments of all irrigation reservoirs, including their feeder streams and rivers. These catchments should be designated Nature Reserves under the Fauna and Flora Protection Ordinance, or Forest Reserves under the Forest Ordinance to underscore their importance.
6 Continuing research and monitoring of land utilization should be carried out.
7 A review of land reform and a study on fragmentation of holdings would be desired to formulate a solution to this problem.

Forestry Resources

Sri Lanka's natural forests besides providing a large variety of material benefits - timber, fuelwood, food, medicines and ornamental plants - play a major role in stabilizing the environment. Unplanned removal of forests to critically low levels is the first step towards desertification. The following actions are recommended to ensure sustainable utilization of the remaining forest resources:

1 The Forest Department, the State Timber Corporation and the Ceylon Plywoods Corporation should be brought under one Authority.

2 Lands for protective natural forests should be identified and be made inviolate by statute. These areas should be selected on a scientific basis using such criteria as the ecological range of plant species and their densities, the diversity of ecosystems and the heterogeneity of the terrain.

Similarly land for economic exploitation should be demarcated and scientifically managed.

Man and Biosphere reserves which are recognized internationally, should be declared permanent forest reserves, in Sri Lanka.

3 The staff of the Forest Department should be increased substantially at all levels to improve its administrative and management capacity at both the central and regional levels.

Training should be made compulsory for all grades of officers in the Forest Department. Facilities for training at the Forest College should be improved and the College should be provided with an adequate number of qualified instructors and lecturers. In addition to the initial training, in-service training courses should be regularly conducted for

middle level staff. Training facilities should also be made available to other agencies such as the Mahaweli Authority and the state and private plantation sectors.

4 It is recommended that a separate unit manned by staff with appropriate training and aptitude be created to combat illicit felling and encroachment.

5 Adequate funds should be made available to the Forest Department for implementing its various capital projects, especially those of reforestration, forest management and forest protection.

6 The present research unit in the Forest Department should be upgraded to a separate Forest Research Institute under the proposed Forest Development Authority.

7 Extension services should be further developed as an urgent priority. Officers should be given special training to develop new attitudes in forestry extension work. Other government departments as well as NGOO at the rural level should be co-opted into the Forestry Extension Programme.

8 Management of plantations and natural forests should be intensified. Sufficient numbers of adequately trained staff and resources should be made available at the regional levels to prepare and implement management plan for all plantations and productive forests.

9 If the present trend of deforestation continues, there will be serious shortages of timber and fuelwood by the year 2000. Reforestation programmes should be initiated immediately to produce industrial wood and fuelwood to mitigate such shortages. Natural grasslands should not be reforested as they are distinct natural systems.

All degraded agricultural land especially those in the mid-and up-country areas should be converted into forests or agroforests. Land presently under agriculture, but unsuited for it should be allowed to revert to forest or be brought under the agroforestry programme.

10 There is an urgent need to promote an efficient timber harvesting system. The timber utilization rate, which at present is 25 per cent to 35 per cent, can be doubled thereby effectively increasing the timber resources:

11 Ex-situ Conservation of Forest Genetic Resources

Denudation of natural forests effectively destroys the habitats of fauna and flora causing a rapid decline in their population densities. Already the list of threatened and endangered species in Sri Lanka is disturbing. Extinction causes a reduction in the diversity of species in a country and through it, the genetic material. This is particularly true with plants used as medicines and food crops, which can be useful to man, now or in the future. It behoves governments to take action to prevent species extinction.

It is therefore necessary, in addition to protection under natural conditions, to select threatened, endemic and endangered species and protect them outside their habitats. This is best done in botanic gardens. It is recommended therefore, that botanic gardens be established in the seven agro-climatic zones of the country.

Wildlife

It is evident that the importance of wildlife to the environment has been grossly underestimated. On the contrary, the conflict which arises from development failing to provide alternate areas for the needs of wildlife, is given undue prominence. That such conflict can be avoided is well demonstrated in the Accelerated Mahaweli Programme which reserved more land for wildlife than for development. This contrasts sharply with the planting of sugar cane on elephant migration routes.

The Task Force is convinced that wildlife conservation should be further strengthened on the lines recommend under the forestry sector particularly in relation to training of staff, increasing the department's capability to implement its aims and objectives through more inputs of staff, logistics and funds.

In addition immediate action should be taken to -

(a) complete the formulation of a national wildlife policy;
(b) publish the new Amendments to the Fauna and Flora Protection Ordinance;
(c) set up a mosaic of inviolate protected areas in all the seven vegetation zones of the country;
(d) appoint a committee to examine the need to set up a Board of Wildlife for Sri Lanka.

Agriculture

Agriculture has been and will continue to be the cornerstone of the country's economy. Nearly 45 per cent of total employment is met by the agricultural sector. It ensures food security as well as earns foreign exchange through exports of produce from commercial crops. Undoubtedly agriculture should receive priority in national planning. However, agricultural systems unless carefully monitored can develop at the expense of other resources, particularly forests, natural vegetation, soil and water. It is therefore, necessary to have a balanced approach when expanding agricultural activities.

The Task Force therefore recommends the following:

1 A large number of farm families obtain a substantial part of their livelihood by engaging in rainfed highland cultivation. With very little assistance from the state these families produce over 80 per cent of the subsidiary food crops required by the country. But lacking as they do in financial resources to invest in and practice conservation methods such as the control of soil erosion, these farmers cause environmental degradation.

2 The Ministry of Agricultural Development and Research should therefore, direct that immediate steps be taken to remove environmental constraints caused by rainfed agriculture by developing an alternate "package". It is essential that such a package, though based on scientific research, should incorporate the practical knowledge of the farmers who are expected to implement the new methods.

Whilst employing scientific advances in crop production the package should aim at reviving the concept of ecological balance which was inherent in homesteads of past eras. The Forest Department's programmes of agro-forestry, farmers' woodlots and community forestry should form an integral part of the new programmes.

The Ministry of Agricultural Development and Research should, in consultation with the Ministry of Lands and Land Development, extend the laudable concept of "*swarnaboomi*" or ownership to the highland cultivators.

This will remove another serious constraint in improving rainfed agriculture which stems from a lack of ownership, and hence, security of tenure.

3 A subsidy scheme should also be intiated, payable either in cash or food aid to encourage farmers to construct soil and water conservation earthworks.

4 Minor and major tanks and the irrigation delivery systems should be rehabilitated, water management improved and land tenure reforms introduced to stimulate and sustain agricultural productivity.

5 Efforts should be made to diligently collect and preserve germplasm of traditional varieties especially of paddy which is an invaluable genetic resource.

6 Research must focus on sustaining productivity of high yielding varieties and on cost-reduction technologies for both production and processing.

7 Cultivation of annual crops on hill slopes without soil conservation measures should be discouraged.

Cultivation on slopes greater than 40 per cent should be totally prohibited. Laws should be framed to conserve the environment in such situations where soil erosion is a major hazard.

8 Measures should be taken to minimize pollution of surface and ground water through excessive or careless use of fertilizer and agrochemicals. A strong extension-education programme must be launched simultaneously with rigorous enforcement of the law.

9 Government policies and priorities must contribute to income generation and the alleviation of poverty and should aim to producing food, so that there is adequate intake of calories and protein to maintain good health of the population.

One aspect of agricultural development that has been neglected is the development of animal husbandry. This is difficult to understand in the context of the opportunities available in Sri Lanka for animal husbandry. Animal production when properly managed enriches the soil with organic matter, besides producing nutritious food and providing a source of income. Pasture lands must be developed and utilized sustainably for the rearing of animals.

Animal production should also be incorporated into integrated systems of farming.

10 The minor export crops including cocoa, coffee, cinnamon, pepper, cloves, cardamom, nutmeg, citronella and papaw should be supported by;

1 strengthening the infrastructure needed to implement the Minor Export Crops Assistance Scheme;
2 increasing subsides for the construction or repair of essential oil distillation stills and cardamom barns;
3 providing rural credit;
4 establishing export promotion villages;
5 introducing a scheme of compulsory auctions;
6 providing subsidies for replanting old plantations.

Tobacco cultivation must be subject to the following conditions:

1 no cultivation on slopes with more than 40 per cent gradient;
2 strict enforcement of soil conservation laws;
3 the industry must grow its requirements of fuelwood;
4 soil fertility must be maintained by practices such as crop rotation and mulching;
5 restoration by the industry of already eroded tobacco lands.

Horticulture

State assistance should be provided for the development of horticulture through a profit-oriented state agency like the Export Development Board. The export of cut-flowers and foliage plants should be encouraged as a means of earning foreign exchange and providing employment opportunities.

Fruit-growing should be raised in a similar manner to the status of the lucrative industry it can become.

Population

Convincing evidence was placed before the Task Force to demonstrate the negative impact on the environment of rapid population increases. The population which was 6.7 million in 1946 rose to 16 million in 1986. The projected figure for the year 2000 A.D. is 20 million but the amount of natural resources available to sustain population, improve the quality of life and eliminate mass poverty remains finite. Therefore, the following

actions have been recommended to maintain the population within the limit of the carrying capacity of these natural resources:

1 Intensification of formal and non-formal education to increase awareness and knowledge of the importance of family limitation and also enlarge the number of motivated couples seeking family planning.

2 Further expansion of employment opportunities available to women.

3 Reduction of infant mortality rates. This would make it unnecessary for couples to feel they should have larger families.

4 Provision of more effective incentives for having smaller families.

5 Identification and catering to groups seeking contraceptive knowledge.

6 Assignment of gaps in service delivery programmes to different NGOO on a geographical basis in order to avoid duplication. The District Population Committees could delineate the areas for various NGOO so that the peripheral areas in a district could also be adequately covered.

7 Review of the role of external funding agencies and NGOO in specifying targets of acceptors in definite time periods. This can lead to listing non-acceptors as acceptors or relisting of clients who had come to clinics earlier in a desire to reflect statistical success in progress reports.

8 The need for a planned and unified communication effort involving extension services and the mass media is a paramount.

Human Settlements

In the sphere of human settlements, the Task Force has had to differentiate between the problems of adaptation to new environments by settlers in colonizing schemes and those concerning the upliftment of the traditional or *purana* villager. Urban settlements formed a third category. However, since all categories are entitled to certain common facilities such as health, food, energy and employment, recommended actions cannot be too rigidly separated. Further, these services and requirements necessitate co-operation and co-ordination to ensure their availability on an equal basis to all citizens. The actions are therefore listed in order of current importance and urgency.

Health

1 Adequate supplies of safe drinking water must be provided to settlers.
2 More diversified, and therefore .ess vulnerable, long-term control measures of vector-borne diseases must be incorporated into settlement schemes at the planning stages, rather than postpone them until there is a disease outbreak.

Agriculture

1 Traditional farming methods which produce the larger share of subsidiary food crops, must be improved to ensure wise usage of resources as well as provide more employment opportunities.

2 To prevent encroachment, radical changes in land tenure must be effected, particularly with regard to ownership.

3 Following on these two recommendations, the Task Force urges that serious consideration be given to availability of rural credit to encourage investment by farmers in soil conservation and other development-oriented practices which will increase productivity on their lands.

Irrigation

Technical personnel in the field must be instructed to educate settlers on the correct and economical use of irrigation water. Irrigation officers should also pay early attention to removing whenever possible the causes of salination of irrigation water and to take suitable measures to control weeds.

Energy

The practical knowledge of officers of the Forest Department must be utilized in the improvement of fuelwood resources. Settlers should be encouraged to participate in the agro-forestry and social forestry programmes of the Department in order to be self-sufficient in fuelwood.

Industry

The establishment of agro-based industry must receive serious attention either as a source of permanent employment or one which would supplement family income. This will in turn reduce pressure on the demand for more land.

The Task Force also draws attention to the special situation in the Wet Zone. There, population density is highest, with some 600 persons per sq.km. The natural forest cover has diminished and only 9 per cent of land is unexploited. It is recommended that no further development takes place in the Wet Zone without a comprehensive plan for land use.

The planning of human settlements in clusters is strongly recommended in order to facilitate the provision of basic amenities as well as to prevent interference with adjacent agricultural and forest lands.

1 Zoning of urban areas into residential, commercial and industrial areas has already begun.
2 In the construction of houses, the use of timber should be minimal.
3 Mud-based technologies should be promoted for housing construction.
4 Urban over-crowding and proliferation of slums and shanties are being tackled through planned urban development. Land use planning is central to such development to save valuable arable land on the outskirts of cities and towns from being swallowed up by urban growth.
5 Civic amenities such as water supply, sewerage, electricity, parks and playgrounds should be expanded.

Energy

Since fuelwood and agricultural wastes (collectively referred to as biomass) comprise 70 per cent of the energy requirements, careful attention has been paid by the Task Force to assess the impact of energy consumption on the natural resources which produce them. Eighty-four per cent of biomass energy is consumed by the domestic sector, chiefly as firewood for cooking in rural households. With no immediate possibility of providing these households with cheaper fuel, action has to be taken to ensure increased biomass production without compromising natural forests, to meet the needs of a population of 20 million predicted for 2000 A.D.

With regard to the approximately 30 per cent energy presently produced from petroleum products and hydro-electricity, the environmental concerns arise chiefly from pollution from the atmosphere. From an economic stand point, it is apparent that energy from coal would be a cheaper alternative to petroleum after all sources of hydro-power have been utilized. But there is evidence that emissions from coal-fired power plants constitute a serious environmental hazard. It is evident that energy produced by nuclear power plants are in this respect the "cleanest".

The Task Force recommends the following actions:

1 The issuing of a Presidential directive addressed specifically to the Ministries of Lands and Land Development and of Agricultural Development and Research that no land in any part of the Wet Zone, both low country and montane, be cleared for any development. The directive should also draw attention to the strict enforcement of existing "laws" regarding the protection of stream reservations and the prohibition on development of lands above 1500 m. (5000 ft.) elevation, both of which date back 100 years, but are still of the utmost significance and importance.

2 In addition to the above and in order to further improve water flows throughout the year into streams and rivers and from there to irrigation and hydro-power reservoirs, it is recommended that much larger inputs of manpower, logistics and finances be made to the reforestation programmes of the Forest Department. The State Timber Corporation, all sections of the plantation industry (including the JEDB and the SLSPC) should be directed to reforest all degraded land which comes under their jurisdiction. A simultaneous monitoring system to evaluate both the speed of reforestation and its effectiveness should be established.

3 Forest management should be improved to ensure sustained yields of fuelwood and forest products while protecting the environment.

4 Roads should be properly maintained to provide many effective lanes of traffic, including lanes for bicycles. The improvement of traffic flow through better road, updated traffic regulations and their strict enforcement could lead to significant savings in fuel.

5 Mass transit systems such as the railway should be improved in order to use fuels more efficiently, reduce congestion on roads and provide a quick mode of transportation to commuters. Incentives should be provided for transport of goods by rail as this will reduce overall fuel consumption.

6 The rural electrification programmes should be extended to provide electricity to many more rural households, but attention should be paid to the consumers' ability to meet cost of supply.

7 Technologies for more efficient use of fuelwood and agricultural residues, and more efficient cooking stoves in particular, should be developed by the R & D and popularised through the media.

8 Thermal electricity generating plants recommended by the electricity generation expansion plan from 1993 onwards should be implemented.

9 The national telecommunications system of Sri Lanka which is in a very poor state should be improved. This could lead to energy conservation through reduced travel.

10 Rehabilitation of mini and small hydro-projects should be encouraged, as they are eminently suitable in the industrial sector which now consumes 16 per cent biomass energy.

11 The need to use technologies that generate electricity from fossil fuels more efficiently are of paramount interest to Sri Lanka in the longer-term.

Mineral Resources

Minerals are an exhaustible resource. Besides, many of them, though economically important are available in limited quantities and should be exploited frugally. Activities related to mining have been shown to cause a number of environmental problems. Disturbance of the soil profile leads to erosion; excavation creates depressions and pits in which water stagnates, providing breeding grounds for vectors of diseases such as malaria, a serious thread today; mineral dust is a health hazard to those engaged in processing minerals. There also appears to be other side effects such as the destruction of fossil deposits or of archaeological objects in mining activities.

The Task Force recommends the following action to minimize environmental hazards stemming from mining activities, while permitting the utilzation of important mineral deposits through which income and employment are generated.

1 In order to effectively implement any national environmental strategy in the mining and mineral resource sector, there should be continuous and effective interaction between the various sectoral agencies engaged in mining and related activities. The Geological Survey Department should act as the lead agency in such interaction. For this purpose the Department should be provided adequate qualified personnel, infrastructure and funds.

2 The main priority for action in the mineral resource sector is to effectively implement the Mines and Minerals Law, No. 4 of 1973, by framing the necessary regulations. Further, the present law should be amended to make provision for ensuring the conservation of natural ecosystems.
3 An effective Environmental Impact Assessment System should be formulated to ensure that physical, chemical, biological, socio-economic and other changes are taken into account when large scale mining, mineral processing or mineral sector industries are planned.
4 No serious consideration is presently given by the state sector organizations engaged in mining activities for the protection of the environment. These organizations should be compelled by law to carry out Environmental Impact Assessments at their own expense prior to any development of a mineral resource, before the necessary approval is granted.
5 Immediate remedial measures should be taken to check the environmental degradation that has already taken place in the mining sector.
6 It is recommended that a register of all mining activities within the Island should be compiled with the assistance of the local authorities. Once such a register is available, the Geological Survey Department should initiate studies into the adverse impact on the environment, of mining and related activities.

Tourism

Tourism has become an important foreign exchange earner, created employment opportunities and catalysed the development of other sectors. It has, at the same time, caused socio-economic and environmental problems which have been described earlier. The following actions are proposed for the healthy development of tourism.

1 The tourism "product" must be diversified.
2 The present zoning schemes should be enforced and also revised from time to time.
3 All tourism development projects must be accompanied by Environmental Impact Assessment (EIA) by the appropriate authorities.
4 Tourism related socio-cultural issues should be identified and resolved.
5 Environmental "carrying capacities" must be indicated in the next master plan for Tourism.
6 Procedures must be formulated to regulate activities of unauthorised tourism dependent establishments.

7 The Hikkaduwa tourist development plan prepared by the Urban Development Authority must be implemented.
8 Building moratoria must be declared on "saturated: tourist areas".
9 Waste water and sewage disposal systems of Sri Lanka's hotels and other tourist facilities must be inventorised. Standards must be established and remedies for shortcomings must be sought through the existing Tourism Act.
10 Persons employed in the tourist trade must be educated on the need to conserve natural resources.

Cultural Resources

There is close and intimate relationship between culture and environment. Since culture is the man-made part of the environment a proper balance between the natural and man-made environment is a desirable goal. The following actions are proposed for the conservation of the country's cultural resources:

1 The formation of a National Cultural Policy should be undertaken immediately. This policy should give due recognition to all the cultures and religions which enrich the country.
2 Action should be taken to identify cultural resources, presently assigned to several ministries and brought under one umbrella organization. Such a step will promote an appreciation of each other's cultures in this multi-racial, multi-religious and multi-lingual society.
3 Adequate legislation should be provided to give effect to these policies.
4 Cultural impact should be given due regard in the planning and implementation of development projects, new settlement schemes and the development of tourism.
5 Action should be taken at village level to create an awareness of the cultural resources in that village and seek the participation of the local people in conservation of such resources.
6 In such case the government should provide assistance and expertise to programmes which will bring economic benefit to the village.
7 Adequate funds should be allocated in the annual budget for conservation programmes identified as requiring the highest priority.
8 Public awareness through the media and through publications should be intensified with a view to inculcating a sense of pride in their unique cultural heritage, among the people. This is paticularly necessary in order to solicit public co-operation in protecting cultural artefacts and preventing their illicit export.

9 Action is also urgently required to make children of school-going age aware of the history and culture of Sri Lanka's multi-national, multi-religious and multi-lingual population with a view to fostering a healthy understanding of the different components which have hitherto enriched society.

Coastal and Marine Resource Systems

The six coastal habitats which play a vital role in the productivity of marine resource systems are coral reefs, beach systems, estuaries, lagoons, mangroves and seagrass communities. The following actions are proposed for their conservation:

1 A fuller understanding of coastal and marine resource systems is a pre-requisite to any proposed management plan which may be considered. In view of the general lack of data, it is suggested that comprehensive studies be undertaken. The preparation of an atlas is essential for identifying threatened and critical areas that need urgent attention.
2 Environmental impact assessment requirements should be strictly adhered to in any development which may affect the coastal zone.
3 The recommendations of the Coastal Zone Management Plan is a step in the right direction and should be implemented immediately.
4 It is necessary to identify habitats which require special attention, either because of their vulnerability or special value, as a matter of priority.
5 There is a need to identify legal and administrative responsibilities among the different agencies utilizing coastal and marine systems.
6 The conservation/protection needs of the different coastal and marine ecosystems should be assessed in order to classify them in relation to existing and proposed development.
7 The systems that do not come under the purview of the Coast Conservation Act, such as parts of estuaries, mangroves and adjacent lands, should be immediately identified for purposes of management.
8 The provisions of the Coast Conservation Act, should be reviewed in view of the difficulties experienced in enforcement, due mainly to the associated socio-economic problems. Particular attention must be paid to the control of destructive activities such as mining of the coral reef, dynamiting fish, collection of varieties of ornamental fish, shells, other organisms, corals and sand and the uncontrolled use of spear-guns.
9 The inland activities that have the potential to alter or degrade the coastal environment, such as by soil erosion and agro-chemical pollution through discharge waters should be regulated.

10 At present there is no programme for the regular assessment and monitoring of coastal water quality, as a result, the pollution loads are not quantified. Such a programme should be established without delay.

Natural Hazards

In Sri Lanka, droughts, cyclones, widespread floods, earthslips and coastal erosion are the major natural hazards causing severe damage to life and property. Although there is a growing awareness of the need for disaster preparedness, there is much more to be done. The following actions are proposed:

1 The present disaster-preparedness plans of government and non-governmental organizations (NGOO) have to be reviewed, revised and updated as a matter of urgency. To implement this, it is absolutely necessary that a central authority or a co-ordinating Office operating under an inter-ministerial committee, be formed without delay. This authority should have adequate representation from government and NGOO concerned with disaster preparedness and the Defence Services.

2 A disaster-preparedness programme requires an on-going commitment at two levels, firstly at central government level and secondly at provincial and district levels. The central authority being the national level organization, should form a committee in each administrative district under the chairmanship of the Government Agent. There should be similar committees set up in all AGA's divisions. Voluntary groups should also be established at the district level and in the major towns.

3 A programme of action must be launched to make the public aware of the damage caused to the physical environment by clearing natural vegetation on hill slopes, destruction of coral reefs and beach vegetation, which help in disaster mitigation. The media - radio, television, films, posters and newspapers - could be used for this purpose. As a long term strategy, lessons in natural hazards should be developed and incorporated into the school syllabus, so that children acquire an awareness of the dangers of natural hazards.

4 Planning authorities must pay due regard to disaster preparedness in economic planning and allocate necessary funds for implementation. Also, physical planners should take note of the need to provide contingency plans for disaster mitigation when planning new townships

and settlements, particularly in cyclone-prone areas. As far as possible, all new buildings in these areas should conform to the specifications given in the following reports:

(i) Construction and Preparedness in Cyclone Prone Areas of Sri Lanka. Sri Lanka Foundation Institute, Colombo 1980.

(ii) Technical Assistance to Sri Lanka on Cyclone Resistant Construction. Commonwealth of Australia, Department of Housing and Construction, for Australian Development Assistance Bureau, October, 1979.

Genetic Resources

The study of the genetic or hereditary make-up of a living organism has assumed importance in recent years. Such phrases as gene pools, gene banks and genetic resources are in common usage today. Genetic material becomes a resource when an organism or a species provides potential for a more productive human use. This is best illustrated in the development of domestic food crops either from existing varieties or more significantly, from a wild species. For instance only recent studies are bringing to light the pharmacological properties of certain plants which are invaluable to medicine.

Sri Lanka is rich in species diversity of both plants and animals. They are already being used by the people in numerous ways. However, the rapid denudation of natural habitats which harbour these species are threatening their continued existence. Similarly, replacement of traditional paddy varieties which are resistant to drought, flooding or pest attack, with high yielding varieties will make the gene pool poorer.

The Task Force therefore recommends that sufficient attention be paid to the conservation of genetic resources through the following actions:

(a) All known and available genetic strains of all economic crops should be preserved either in gene banks under refrigeration (as is being already done for rice strains) or maintained as continuing crops in the field.

(b) Similarly, forestry resources must be protected when introducing new plants species. Introduction of new species should be done only with the greatest circumspection and the careful evaluation of all possible consequences.

(c) Forest and wildlife management must be co-ordinated and intensified in order to preserve all the wild flora and fauna. "Man and Biosphere Reserves" have been demarcated and are intended to serve as in situ conservation stands in order to preserve the natural forests and other natural systems in the different climatic zones in their original state as gene pools.

In addition, *ex-situ* conservation should be carried out on valuable commercial species which are undergoing genetic impoverishment in their natural habitat.

Medicinal and other economically important plants should be conserved, both *in-situ* and *ex-situ*.

A national strategy to preserve germplasm of wild species at both macro (arboreta, biosphere reserves, wildlife parks) and micro (seeds, pollen, meristem etc.) levels is an urgent task.

(d) Hazardous chemicals must be constantly monitored for harmful, mutagenic and carcinogenic effects on the human gene pool. The human genetic resources are the most fundamental resource to be preserved.

(e) Legislative and legal procedures should be enacted to provide teeth to the conservation methods discussed above.

(f) Adult and student educational facilities should be extended to create conservation awareness in the whole population.

Industry

The industrial development of the country has to play an increasingly an important role in providing employment for the large numbers of young people entering the labour force and for raising or even maintaining at present level the standard of living of its people. Industrial growth requires increasing quantities of both renewable and non-renewable natural resources as raw material. This would, however, result in the release of greater volumes of wastes into the environment. The following strategies are proposed in order to minimise the resultant environmental degradation and ensure sustainable industrial development:

1 Environmental conservation should be made an integral part of economic development and within its industrial growth.
2 Chambers of industry and commerce must be made to accept the urgent need for environment conservation during industrial expansion.

3 A capability must be developed for the assessment of environmental impacts of technological and product development. Such development should include training of the necessary personnel and the design of techniques for environmental monitoring. This assessment should cover the physical, biological and the social environment, namely, working and living conditions welfare and health as well as pollution control and resource utilization.

4 Cleaner, low-waste technologies should be used in industry. Government should consider the advisability of setting up a technology transfer centre that could also assist in the selection of such technologies.

5 Industry should be required to hire the services of environmental scientists.

6 Pollution control measures must be made compulsory and incorporated both in new industrial plant and operational units where discharges from the plant constitute a threat of serious damage to the environment.

7 The grant of incentives to industry for the installation of pollution control measures should be considered.

8 Recycling of materials should be promoted.

9 An industrial counselling service should be established.

10 Environmental science should be a component of the curriculum of study courses of industrial engineers and scientists.

Living Aquatic Resources

The marine and inland fisheries share the major part of Sri Lanka's living aquatic resources. Although in terms of GDP they contribute only a little over three percent, these resources provide 70 percent of the animal protein of the people. Besides, over 100,000 people are employed in the fishing industry supporting about 500,000 persons. Evidence was placed before the Task Force to indicate that both marine and inland fisheries could be expanded to increase production as well as employment. The following actions are recommended to achieve this objectives as well as protect the resources themselves:

1 A comprehensive survey of the available off-shore and deep sea resources should be undertaken without delay.

2 Adequate investment should be made for sustainable exploitation of deep sea living aquatic resources identified by the above survey. This would help conservation of these resources in the off-shore areas for small scale fishery.

3 The present open-door policy should be changed to one where the country's off-shore and deep sea areas are exploited only under strict regulations.

4 Greater surveillance should be exercised against the entry into the country's Exclusive Economic Zone of unauthorized fishing vessels. The provisions of the Fisheries (Regulation of Foreign Fishing Boats) Act No. 59 of 1979 should be strictly enforced.

5 The development of inland fresh water fisheries should be expedited.

6 People should be educated in the nutritional value and other beneficial characteristics of the less popular varieties of fish.

7 Pollution of the fresh water or marine environment by industrial and other effluents must be strictly controlled.

8 Tourism must be developed in a manner that minimise adverse effects on the fishing industry.

9 The export of lobsters and prawns is a lucrative trade but one which can deplete their populations. Several lobster breeding grounds have already been destroyed. Urgent action should be taken to enforce regulations covering lobster fishing. The established of farms in which both lobsters and prawns are raised should be encouraged.

10 The habitats of other living aquatic resources must be also conserved.

Environmental Education

Environmental conservation programmes succeed to the extent that there is public participation. Environmental education is a vital component of a national conservation strategy. The following recommendations are made to improve environmental education:

1. **Formal and Non-formal Education at Primary and Secondary Levels**

Primary level students should be introduced into the study of the environment mainly through field studies which provides them with first-hand experience that enables them to make their own observations and draw simple conclusions.

The main consideration in the environmental education of middle level school children should be academic study (to gain information and comprehension of the subject) backed by field experience.

The students in the highest level at school should be helped to develop a sense of critical judgement and a sound decision-making capability.

Environment should be taught as a single integrated holistic subject and not as a collection of separate sections in a number of subjects. This approach is necessary at university level too.

Environmental education should be imparted by teachers trained for the purpose. The selection of the trainee teachers is most important. A system of recognition must be devised for schools, teachers and students, for good performance in Environmental Education.

The publishing of books, journals and other reading material on the environment for students and the public, especially in the national languages, should be given high priority.

2. **University Education**

A bachelor's degree course should be started in Environmental Science or Natural Resources. There should be greater interaction between university departments concerned with the study of the environment.

Interaction should also be fostered between the universities and government institutions concerned with the environment and with similar institutions in the private sector.

The present courses of study in the universities dealing with the environment should be less specialized, more practical-oriented and should have greater bearing on the environmental situation in the country.

Every university should have at least one field study centre attached to it.

3. Non-formal Environmental Education

The laudable efforts being made by NGOO in providing non-formal education through lectures, workshops and seminars, excursions and in many other ways should be given every encouragement.

Public libraries should strengthen their sections on the environment.

Environmental Centres should be established to provide information about the environment and natural resources.

Natural history museums should be established at the provincial and district levels.

Radio and television programmes on the environment should be supervised by a panel of specialists to ensure high quality.

PART VI
Implementation

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Chapter 21

IMPLEMENTATION OF THE STRATEGY

Environmental conservation is multi-sectoral and multi-faceted. It is a way of life that must be made a part of the national ethos. At government level it pervades every activity from policy planning to implementation. Therefore, implementation of conservation measures should be carried out in a manner that serves the interests of all sectors.

The following recommendations are made to enable speedy and effective implementation of the actions recommended in this National Conservation Strategy :

1 Priorities should be assigned in the allocation of resources and in the implementation of recommendations. Actions which require allocation of little resources but are likely to have a big impact on environment, the development of a land use plan for the whole country or the prohibition of the reclamation of wetlands should receive immediate attention.

2 Since resources are limited, they should be so allocated as to ensure maximum sustainable use.

3 The success of most environmental conservation programmes, projects and activities depends on the degree of support at grassroot level. Therefore, every effort must be made to secure active public involvement. The promotional campaigns should emphasize the benefits that would accrue to the individual as well as to the community.

4 The institutions recommended in this report should be created without delay.

5 Adequate funds should be immediately allocated for the training of staff needed to man the agencies and institutions involved in the conservation of natural resources.

6 Environmental training and research, should be accorded high priority and the techniques of Environmental Impact Assessment (EIA) should receive special attention in such training programme.

7 A permanent mechanism must be established for co-ordination between agencies responsible for policy formulation.

8 A Ministerial-level National Environmental Council on the lines of the National Health Council should be established. It will function under the chairmanship of the Prime Minister. It shoul d be adequately

representative of relevant Ministries, special interest groups (NGOO) and Provincial Councils. The National Environmental Council should set national policies and strategies for conservation. It should also monitor and evaluate their implementation and impact.

9 The Central Environmental Authority (CEA) should be designated to service the National Environmental Council.

10 The agencies implementing conservation programmes and projects should be identified and their responsibilities clearly defined.

11 Machinery should be installed to ensure close coordination and cooperation between organizations concerned with the conservation of natural resources. The World Conservation Strategy, emphasizes that the basic unit of management should be the ecosystem.

12 The degree of devolution of responsibility and authority to Provincial Councils should be clarified. This would naturally have to be decided within the framework of the Provincial Councils Act, No. 42 of 1987 and the 13th Amendment to the Constitution. Further delegation of duties and powers to district and local authorities should be decided upon.

Monitoring

Environmental monitoring should include not only areas where action has been taken to arrest degradation but also those areas where signs of degradation are beginning to appear. This would allow early corrective action which will cost much less than action taken later. Local monitoring can be done at the district or provincial level, and the reports collated to describe the national situation.

While the National Environmental Council should be mandated to monitor and evaluate the implementation and impact of national policies and strategies for environmental conservation, the CEA would have to shoulder the burden of this work as it is charged by law to formulate and enforce Environment Quality Standards.

The annual report of the National Environmental Council should be presented as the Annual Report on the State of the Environment in Sri Lanka. This would be a valuable document not only for national planners but also for students of the world environment.

Appendix I

SECTOR PAPERS

1. Agricultural Development and Natural Resources Conservation with Special Reference to Sustained Production of Annual Crops
2. Air, Soil and Water Pollution
3. Alternative Systems of Lnd Use for Chena Lands
4. Coastal and Marine Resource Systems
5. Cultural Resources
6. Development Issues
7. Energy
8. Environmental Education
9. Forestry
10. Genetic Resources
11. Health
12. Human Settlements
13. Industries
14. Land Utilization
15. Living Aquatic Resources
16. Livestock Production
17. Mineral Resources
18. Minor Export Crops
19. Natural Forests
20. Natural Hazards
21. Physical Setting
22. Plantation Agriculture
23. Population
24. Soils
25. Tourism
26. Water Resources
27. Wildlife

Appendix II

GLOSSARY OF TERMS

Age structure	- the age composition of a population i.e. the relative numbers of people in different age classes. (7)
Agroforestry	- a combination of forestry programmes, cropping, livestock breeding and pasture management on the same land. (7)
Aquifer	- a subsurface zone that yields economically important amounts of water to wells. (9)
Arable	- ploughed land, or land suitable for ploughing on which crops can be grown. (7)
Biogeochemical cycle	- the chemical interactions that exist between air, water and soil and living organisms. (7)
Biosphere	- the integrated living and life-supporting system comprising the peripheral envelope of planet earth together with its surrounding atmosphere so far down, and up, as any form of life exists naturally. (4)
	- the thin covering of the planet that contains and sustains life. (8)
Biotic environment	- portion of the environment that includes all living organisms. (7)
Carrying capacity	- the number of persons sharing a given territory who can, for the foreseeable future, sustain a given physical standard of living, utilizing energy and other resources (including land, air, water and minerals) as well as enterprise, skills and orgnizations. (2)

Catchment area	- the area from which rainfall flows into a river. (7)
Conservation	- the planning and management of resources so as to secure their wise use and continuity of supply while maintaining and enhancing their quality, value and diversity. (2) - the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations. (8)
Corals	- the skeleton of certain solitary and colonial anthozoan coelenterates, composed chiefly of calcium carbonate. (9)
Coral reef	- a ridge or mass of limestone built up of detrital material deposited around a framework of skeletal remains of molluscs, colonial coral, and massive calcareous algae. (9)
Deforestation	- the removal of trees or the clearing of forests. (7)
Desertification	- the destruction of the biological potential of the land leading ultimately to desert like conditions. (7)
Development	- a process of socio-economic change involving the transformation of society in order to reach an agreed set of goals based on capacities and of people. (7) - the modification of the biosphere and the application of human, financial, living and non-living resources to satisfy human needs and improve the quality of human life. (8)
Ecology	- the science which deals with the relationship between all living things (including human populations) and their environment. (7)

Ecosystem	- the total components of an immediate environment or recognizable habitats including both the inorganic and dead parts of the system and the various organisms which live together in it as a social unit so far as its characteristic dominance or influence-sphere extends. (4)
	- a functional system which includes the organisms of a natural community together with their environment. (7)
	- a system of plants, animals and micro-organisms together with the non-living components of their environment. (8)
Environment	- the sum of all external conditions and influences (both biotic and abiotic) which affect the development and life of organisms. (7)
Evolution	- the process by which the genetic composition of plant and animal species changes with time. (7)
Fauna	- animals, the animal life characteristic of a particular region or environment. (7)
Flora	- plants, the plant life characteristic of a particular region or environment. (7)
Fossil fuel	- fuel formed in geological past *e.g.*, oil and coal. (7)
Gene	- unit of hereditary material represented as a small section of a chromosome. (7)
	- the basic unit of inheritance. (9)
Genes	- physical units of inheritance transmitted from one generation to another and responsible for controlling the development of characters in the new individual. (1)
Genetic	- of or relating to biological inheritance. (7)

Genetic diversity	-	the variation of genetic material within and between species and sub species of animals and plants. (7)
Germplasm	-	the generative or germinal part of a plant or animal cell. (7)
Habitat	-	the locality or living place of a plant or animal. (7)
Hydropower	-	energy generated by falling water.
Indigenous	-	existing and having originated naturally in a particular region or environment. (7)
Life-support systems	-	the main ecosystems involved in providing food, health, water and shelter for human survival and sustainable to degradation. (7)
Monoculture	-	the cultivation on a large scale of a single crop to the exclusion of other crops on a piece of land. (7)
Natural resources	-	any raw material, either renewable or non-renewable, obtained from nature. (7)
Nutrient	-	an element or compound that is an essential raw material for organism growth and development of living organisms. (7)
Optimum yield	-	the amount of material that can be removed from a population (source), that will maximise growth on a sustained basis. (7)
Organic matter	-	carbon-containing matter, usually derived from living organisms. (7)
Pesticide	-	any substance or mixture of substances intended for preventing, destroying or controlling any pest, including vectors of human or animal disease, unwanted species of plants or animals causing harm or otherwise interfering with the production, processing, storage, transport or marketing of food, agricultural

commodities, wood and wood products or animal feedstuffs, or which may be administered to animals for the control of insects, arachnids or other pests in, or on, their bodies. (5)

Pollution - Reduction of the purity of the environment by the release of gases or vapours, liquids or solids into it. (1)

Recycling - the recovery and re-use of materials from wastes. (1)

Renewable energy - energy obtained from a source that can be replenished such as fuelwood or bagasse, (in contrast to fossil fuels available only in finite quantities).

Resources - a means that is available for supplying an economic want (*e.g.* land, labour etc.) (1)

Salinity - degree of salt concentration.

Shifting agriculture - a system of agriculture which involves moving to a new area, clearing trees and bush for planting, and moving on to another area when the soil fertility is depleted. (7)

Species - Endangered Species: Taxa in danger of extinction and whose survival is unlikely if the casual factors continue operating. Included are taxa whose numbers have been reduced to a critical level or whose habitats have been so drastically reducted that they are deemed to be in immediate danger of extinction.

- Vulnerable Species : Taxa believed likely to move into the endangered category in the near future if the causal factors continue operating. Included are taxa of which most or all the populations are decreasing because of over-exploitation, extensive destruction of habitat or other environmentl disturbance; taxa with populations that have been seriously depleted

and whose ultimate security is not yet assured; and taxa with populations that are still abundant but are under threat for serious adverse factors throughout their range. (3)

- Rare Species : Taxa with small populations that are not at present endangered or vulnerable, but are at risk. These taxa are usually localised within restricted geographical areas or habitats or are thinly scattered over a more extensive range. (8) (1)

Subsistence agriculture - a form of agriculture in which communities grow or collect only enough food and raw materials for their own immediate survival and use. (7)

Sustainable environment - a system of development that can persist for many years without depleting resources or degrading the environment. (7)

Sustained yield - the principle of managing a plant or animal population in which there is a balance between those individuals removed and those replaced by natural growth so that the population is not depleted. (7)

Taxon - a taxonomic group (*e.g.* species) plural - taxa. (7)

Urbanization - move to city or make rural area more like a town or city. (7)

Wetland - an area covered permanently, occasionally or periodically by fresh or salt water up to a depth of 6m. (1)

- areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres. (3)

Watershed - the drainage area of a stream. (9)

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