CHAPTER 1

ENVIRONMENTALLY-SOUND TECHNOLOGIES: A FRAMEWORK

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Environmentally-Sound Technologies: A Framework

Introduction

This chapter presents the three entities *Environment, Development and Technology* as a tripartite set, characterised by the interaction between the *ecological* cycles in Nature and the *economic 'cycles'* resulting from the effect of anthropogenic activities from technology use in the environment. The challenge of sustainability is postulated to lie with the ability of the humankind and the disposition of the 'economic super-cycles' to realise and promote the utilisation of environmentally sound technologies (EnSTs). Environmentally sound technologies are generically classified as 'curative' or 'preventive' with respect to *pollution and resource waste generation.* A paradigm shift from *end product focus to product life cycle* consideration is proposed, which postulates the use of a set of parameters for the (EnST) characteristic along the full product life-cycle. As constructs for eco-efficiency, the set of (EnST) parameters are perceived as integral components of the dichotomy of the "terms of exchange" between purchaser and seller of technology in the current international economic order. Eco-efficiency is predicate to play the role incorporating a measure of simultaneous effort to minimise the ecological burden while maximising the economic value of products, goods and services.

Environment, Development and Technology

In the context of environmentally-sound technologies, the term *environment* will be predicated to mean any component of the atmosphere, lithosphere, hydrosphere, or biosphere perceived as inseparable components.

Development will be taken to mean "development of human beings", namely, a process of *satisfaction of basic human needs and welfare* (Table 1.1), leading to the concept of needs-oriented development. *Technology* will be taken to mean modifier of the environment on the one hand and as a negotiable commodity with a given set of "terms of exchange" on the other.

Table 1.1: A Simple List of Basic Needs and Welfare

Material Needs	**Material Satisfiers**	**Non-Material Satisfiers**
Physiological Individual	Food, Water, Clothes, Shelter	Creativity Identity

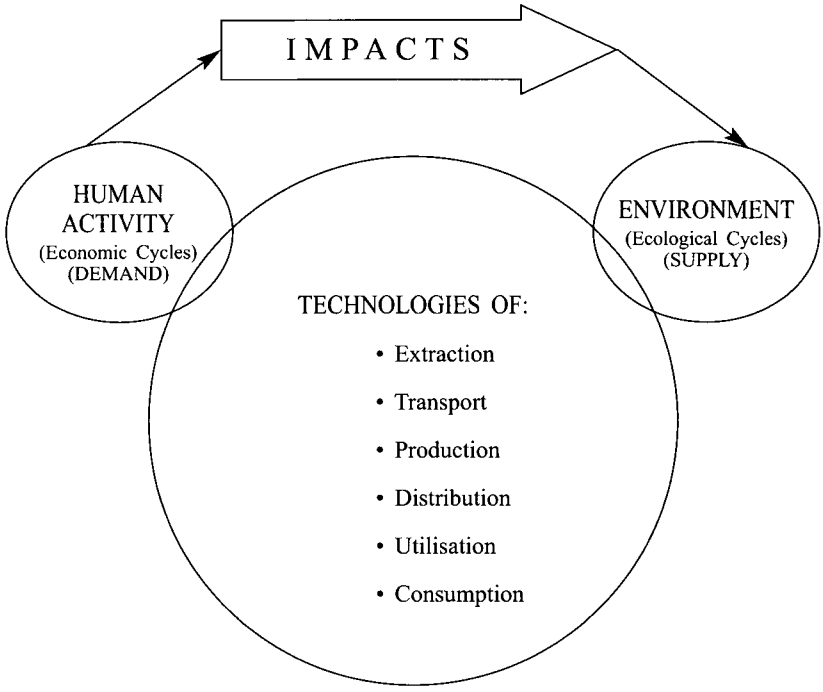

FIGURE 1
Impacts Model of Anthropogenic
Economic Cycles on Ecological Cycles

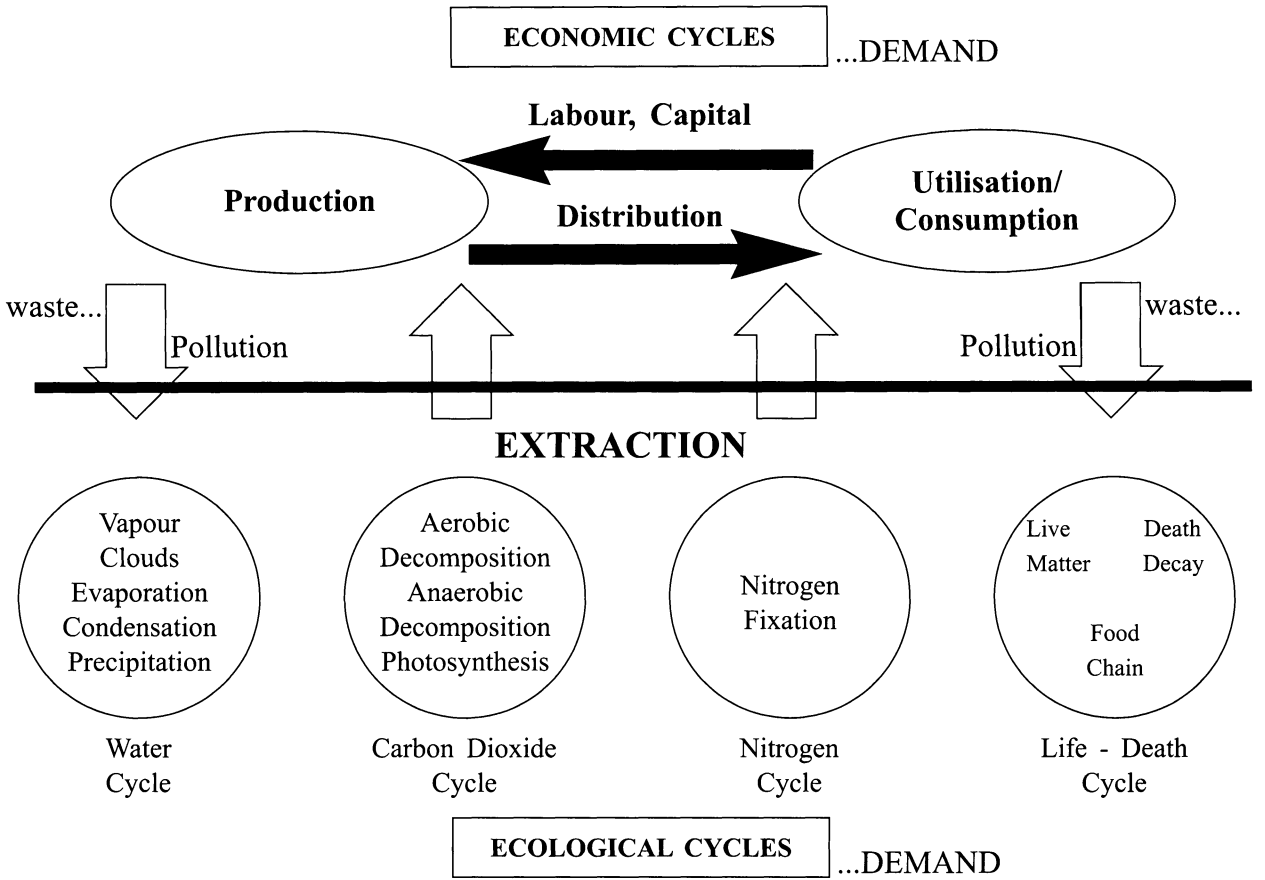

FIGURE 2
Model of Economic Cycle - Ecological Cycle Interaction

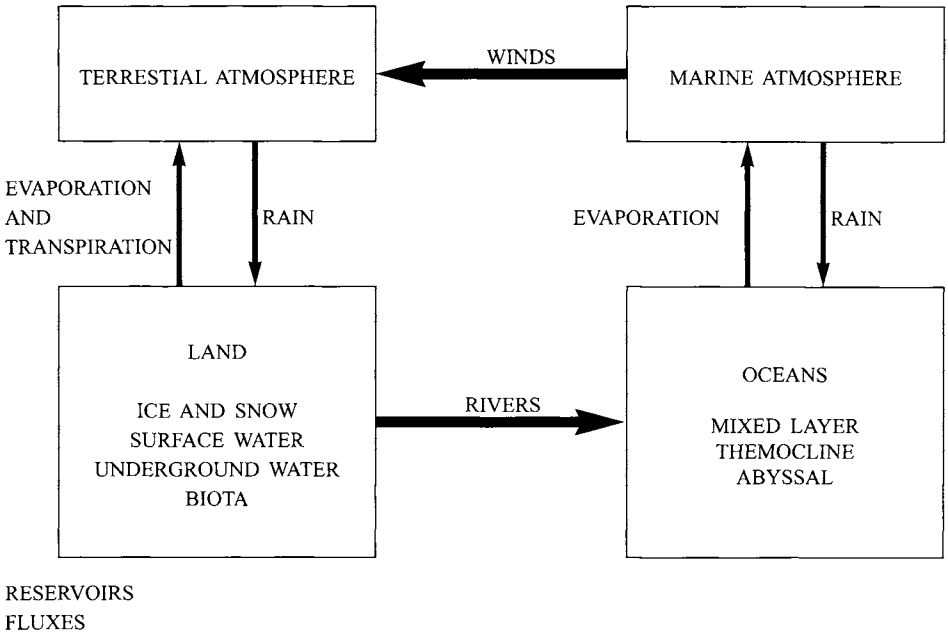

FIGURE 2 (a)(i)
Model of the Global Water Cycle

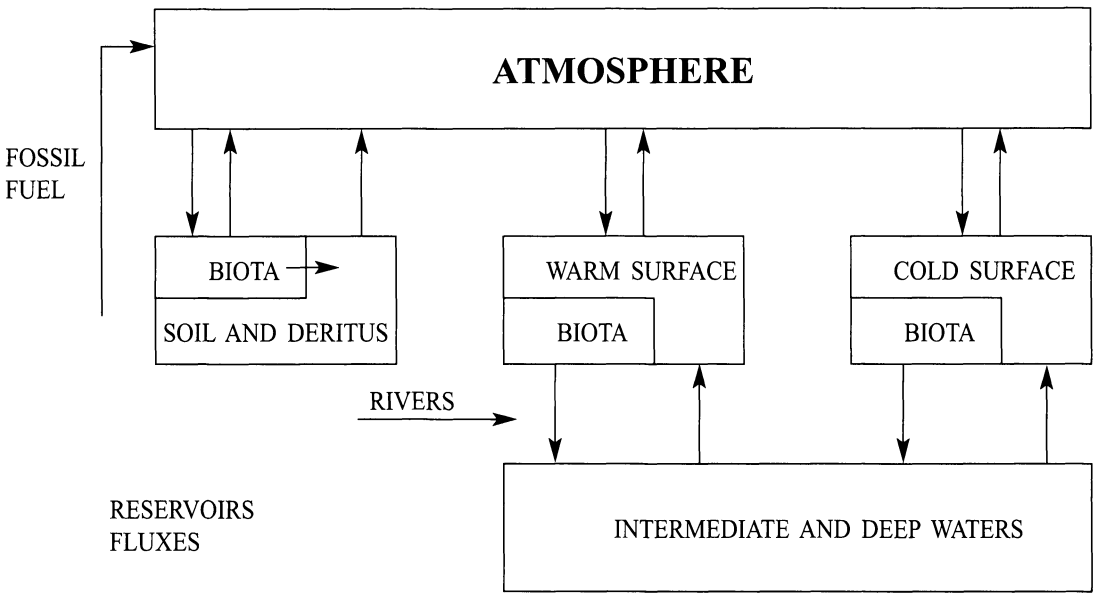

FIGURE 2 (b)(i)
Model of the Global Carbon Cycle

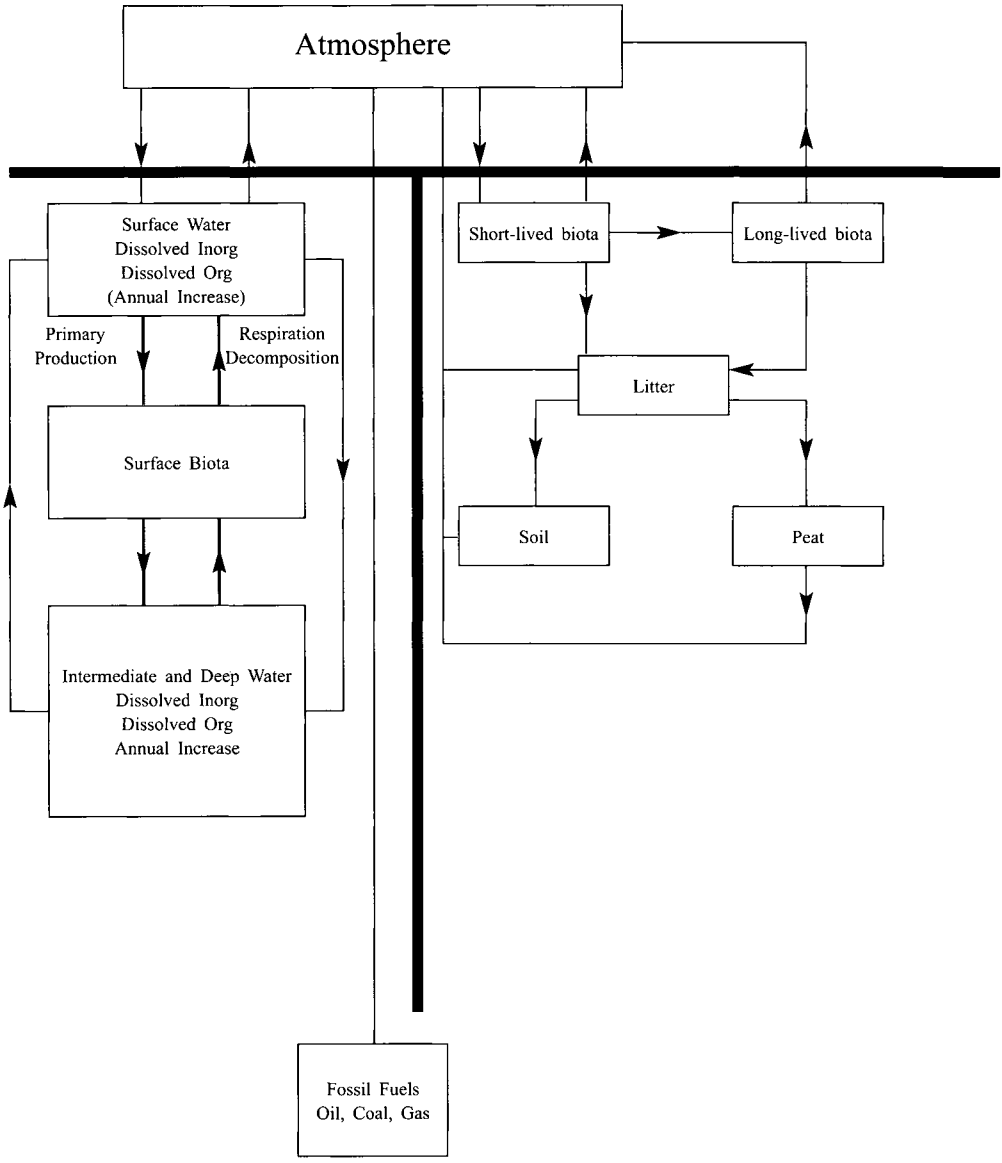

FIGURE 2 (a)(ii)
Model of the Global Carbon Cycle

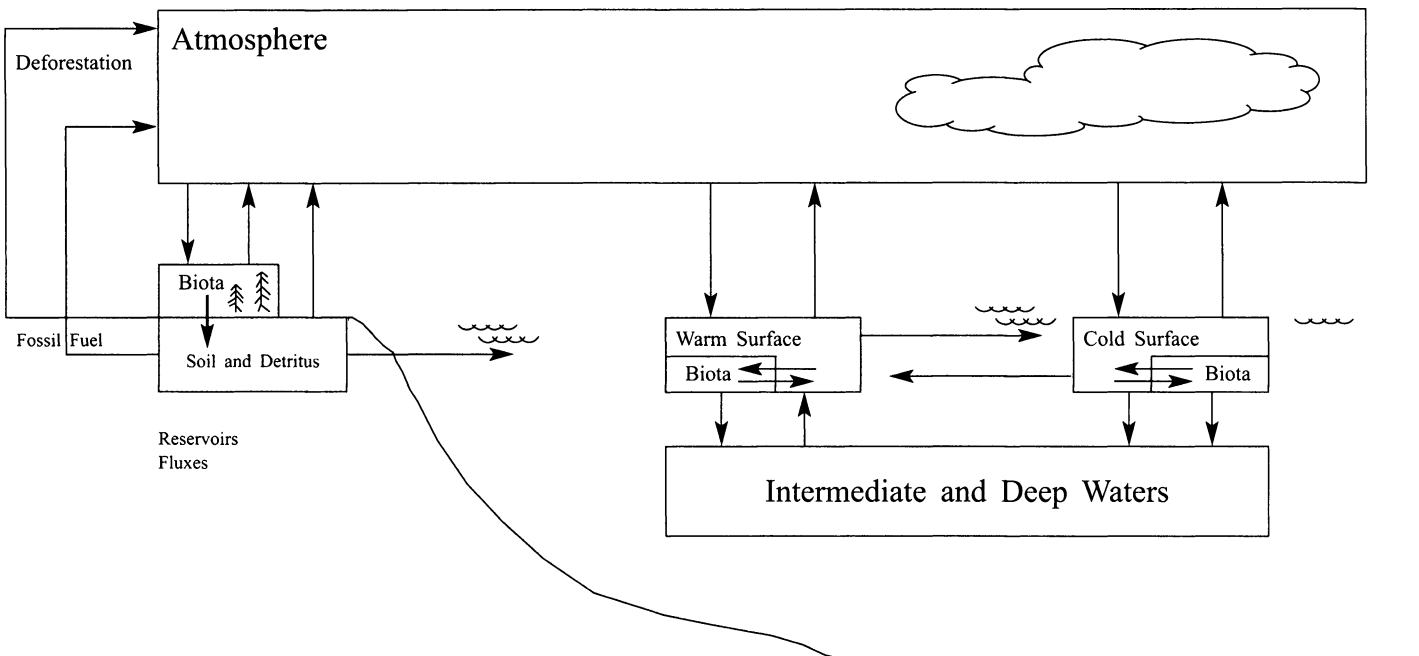

FIGURE 2 (b)(iii)
Schematic of the Global Carbon Cycle

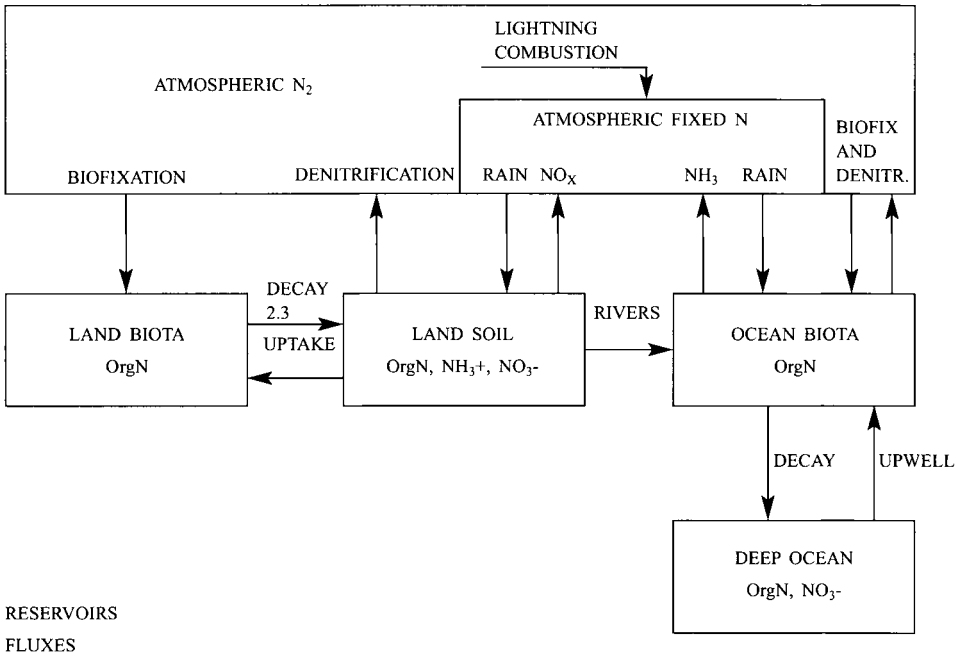

FIGURE 2 (c)
Model of the Global Nitrogen Cycle

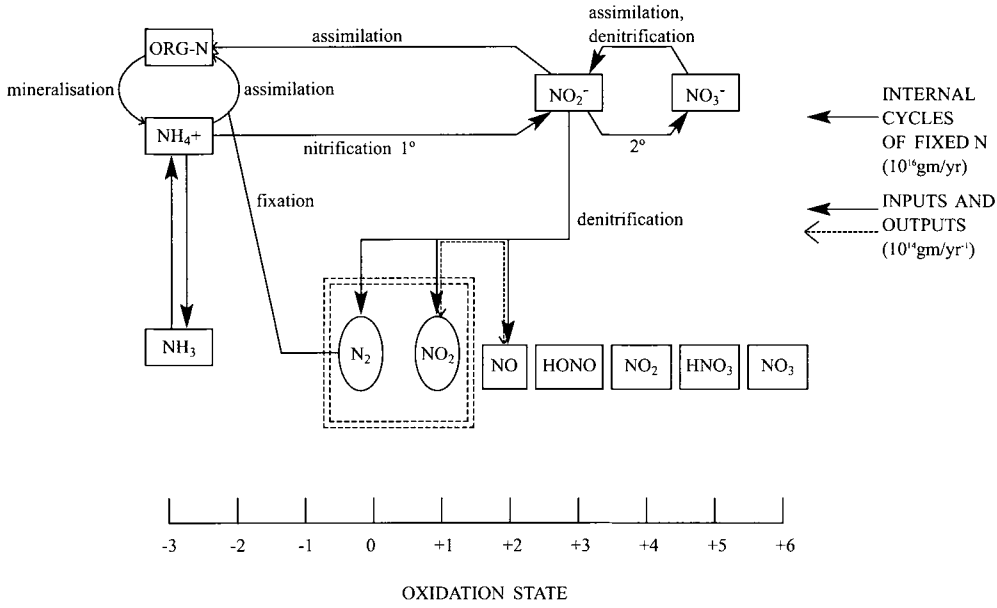

FIGURE 2 (c)(i)
Biological Transformations of Nitrogen

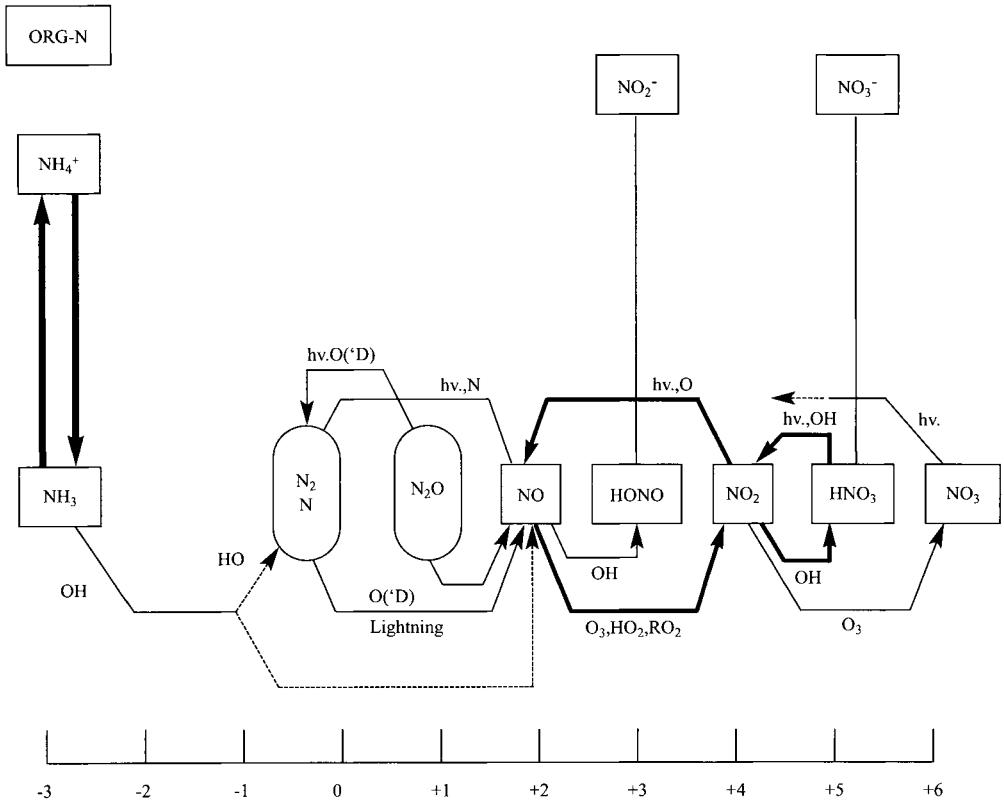

FIGURE 2 (c)(ii)
Atmospheric Transformations of Nitrogen

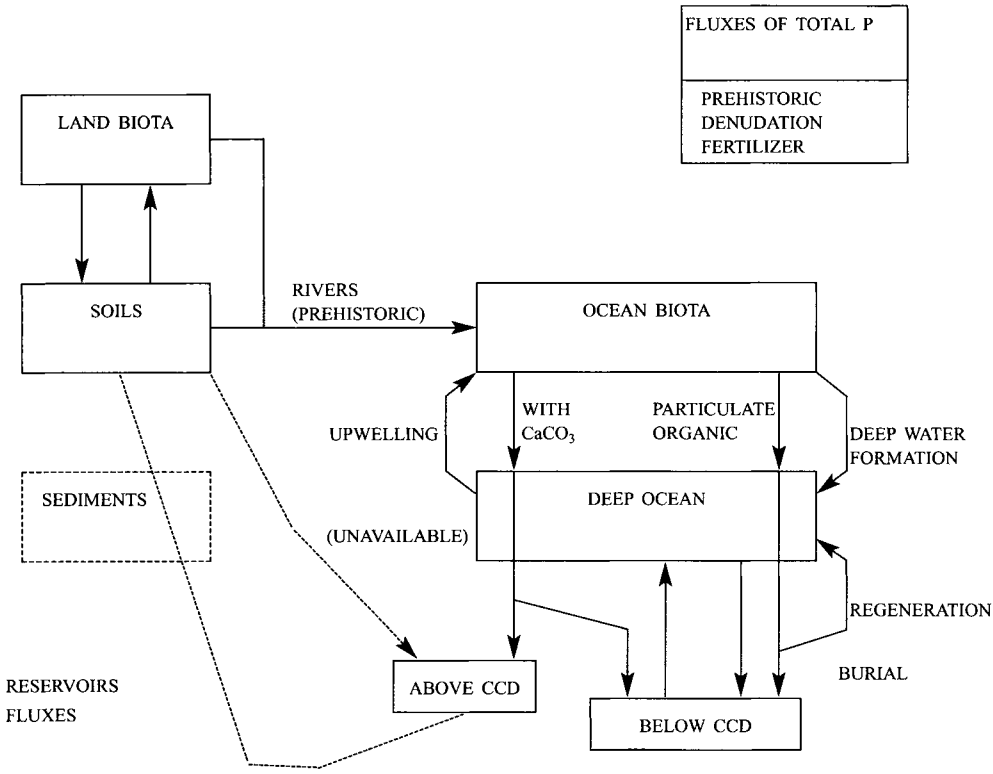

FIGURE 3
Global Cycle of Chemically Available Phosphorus

Group/Family	Medical Care	Autonomy
Health	Civil Protection	Somatic State
Safety	Schools	Non-Violence
Education	Free Movement	Schooling
Freedom/Equity		Self-Fulfilment

Ecological and Economic Cycles

Nature is replete with *Ecological Cycles*, whereby matter, organic or inorganic, is transformed from one state to another, predominantly cyclically, sometimes non-cyclically. The humankind, on the other hand, is able to construct what may be conceived as *Economic Cycles*, which almost invariably involves the extraction and transportation of raw material from nature's available natural resource; production; distribution; and consumption of the products and services from the processed raw material. This is illustrated in Figures 1.1 and 1.2, which show:

(i) Impacts Model of Anthropogenic Economic Cycles on Nature.

(ii) Model of Economic Cycle and Ecological Cycle interaction.

A model of the Global Water Cycle is illustrated in Figure 2(a); that of the Global Carbon Cycle is shown in Figure 2(b) (i) and Figure 2(b) (ii), of the Global Carbon Cycle is shown in Figure 2(b) (i) and Figure 2(b) (ii), together with a corresponding schematic in Figure 2(b) (iii)

A model of the Global Nitrogen Cycle is shown in Figure 2(c), together with the corresponding schematic for biological and atmospheric transformation mechanisms for nitrogen, Figures 2(c) (i) and (ii)

Figure 3 summarises a model on contents of major phosphorous reservoirs and transfers between them. Phosphorous is abundant in the crust of the earth where it exists principally in the form of insoluble minerals (apatite, iron phosphates) or as absorbed phosphate. These compounds are not available for biological uptake, and phosphorous is often a limiting nutrient in soils, in lakes, and in marine systems. Atmospheric transfer processes are unimportant for phosphorous, in contrast to carbon, nitrogen and sulphur. Key exchanges are with dissolved and particulate transport in rivers, with weathering processes and with diagenesis in soils and sediments.

Figure 4 summarises flux transfer mechanisms of sulphur compounds to and from the atmosphere. Sulphur compounds are present in all living materials. Reduced sulphur gases are emitted primarily as the result of biological processes in ocean surface water and in salt and fresh-water marshes and in volcanoes.

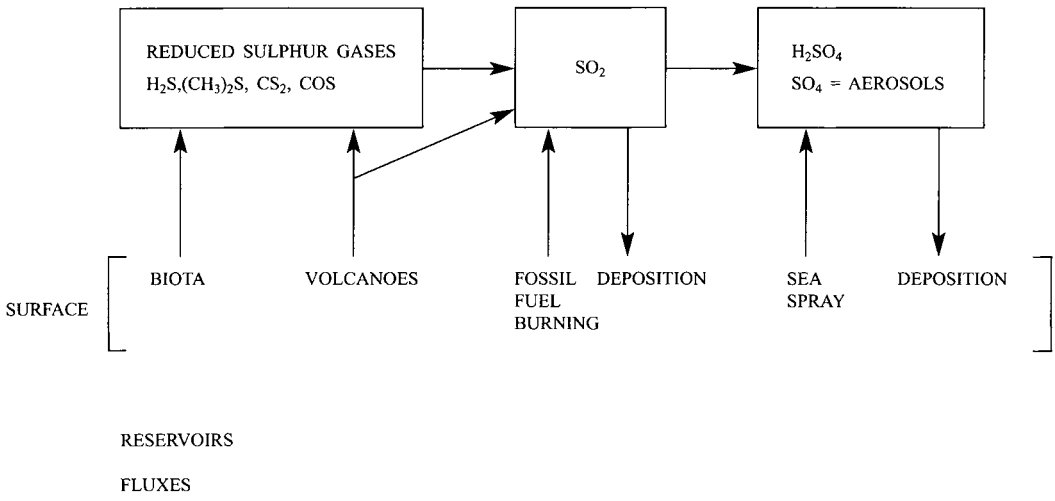

FIGURE 4
Tropospheric Sulphur Budget Model

Technology as Modifier of Nature's Ecological Cycles

Technology may be perceived to be a manifestation of the discrepancy between natural ecological cycles and anthropogenic economic cycles. A consequence of this is that the challenge of sustainability lies with the ability by both Nature and Humankind to (...) *meet the needs of the present generation without compromising the ability of future generations to meet their own needs.* A distinctive feature of the perceived challenge points to a possible relationship between technology and social challenge, namely the imperative to making and using technology to degrees that are commensurate with the social state or level of society, whether primitive, developing, developed, or emerging.

Perceived Impacts of Anthropogenic Economic Cycles

Extraction: The impacts of the anthropogenic economic cycles at extraction include the following:

- ❑ Natural Resource Exploitation, Land;
- ❑ Desertification, Biodiversity and Genetic Resource; and
- ❑ Loss and Depletion; Pollution; and Man-made Disasters.

Production,Transportation/Distributionand Utilisation/ Consumption: The impacts at these phases of the economic cycles include the following: Transborder Pollution; Global Warming; Ozone Layer Depletion; and Ecosystem Degradation.

In generic terms, the impact of anthropogenic economic cycles may be perceived to comprise the following forms:

- ❑ **Perturbance of Nature's Dynamic Eco-Equilibrium,** namely, Acceleration/Retardation of Ecological Cycles; Eco-Material Transfer and Transportation; Exploration, Degradation, Depletion and Loss.

- ❑ **Pollution,** namely, Incidence into Environment of By Products of the Economic Cycle Activities.

Other Metaphors of Technology

Many metaphors of technology exist, the various factors, depending on perspectives, beliefs, or even the nature of the social status of individuals, groups or even communities:

- ❑ Source of well-being;
- ❑ Instrument of Power to Dominate Nature and Society;

- ❑ Enslaver of Humankind;
- ❑ Destroyer of Jobs, Environment, and Social Values;
- ❑ Cause of Human-made Disaster

Environmentally Sound Technologies *(Environmental Technologies)*

Environmentally - Sound Technologies (EnSTs) may be defined in terms of the *sustainability* concept as technologies whose use or application can be said, or demonstrated to, "... meet the needs of the present generation without compromising the ability of future generations to meet their own needs" promoting the *use* **technology assessment** as a tool for the development and application of environmentally sound technologies constitutes environmentally sound technology assessment (EnSTA)

The Economic Super-Cycle

A particular aspect of the **challenge of sustainability** lies with the ability of countries in their roles as economic entities and drivers of their own destinies, for their respective future generations, to survive a phenomenon that may be described as an *economic super-cycle*, perceived to involve international control *'centres' processing problems into decisions, raw capital into investment capital, science into technology, and technology into technology transfer.* The Economic Super-Cycle can be recognised in embodiments of transitional corporations (MNCs), the Bretton Woods Systems, Donor and aid Agencies and in corresponding "networks" of bilateral and multilateral arrangements between and within countries and not least in the IGOs and the emerging Global Corporations (GCs) of the new information era.

Perceived Impacts of the Economic Super-Cycles

The Economic Super-Cycles provide an illustration of what may be termed the centre-periphery social structure, which essentially comprises an imposition, by design, by the north ("centre") on the South ("periphery") on the mode of exploitation, processing and utilisation of the natural resources of the South, perceived as the essence of the current international economic order. The result is building of a strategic alliance of imbalance of power and social reformation between the North and the South, which can be:

- ❑ *Exploitative* in the "terms of exchange"; in the context that technology is a negotiable commodity;
- ❑ Dependency-creating, in the nature of North-South relationship;
- ❑ *Fragmenting*, unless supported by a definitive environment strategy;
- ❑ *Marginalising*, unless recipient is non-succumbing to external dictates of

the economic super-cycles;

- ❑ *Dichotomous*, in the nature of differential mode of development between the North and the South.

Economic Super Cycle and Technology Transfer

Technology as a concept may be perceived to comprise the following components:

Technology = Technique + Structure,

where:

(a) Technique can be represented by combinations of the following entity types:

- ❑ Tools, Equipment, Machines, Vehicles, Physical Facilities (Technoware);
- ❑ Skills, Experience, Knowledge, Know-How, Creativity (Humanware);
- ❑ Procedures, Specifications, Standards, Guidelines, Theories, Observations (Infoware); and

(b) Structure can be represented as an Organisational Framework, a Cognitive Management Practices, Institutional Linkages, and Networks within which techniques become meaningful (Orgaware). *This component is often overlooked in the technology transfer process. It is essential that the structure that accompanies technology transfer is adequately negotiated in the "terms of transfer" to reflect appropriate and relevant organisation framework in the environment of the receiver of the technology*

It is convenient to identify the following modes of the Technology Transfer Process:

Object-Embodied *Technology (Technoware)* and transfer Human-Embodied Technology *(Humanware)* and transfer; Document-Embodied *Technology (Infoware)* and transfer; Institution-Embodied Technology *(Orgaware)* and transfer.

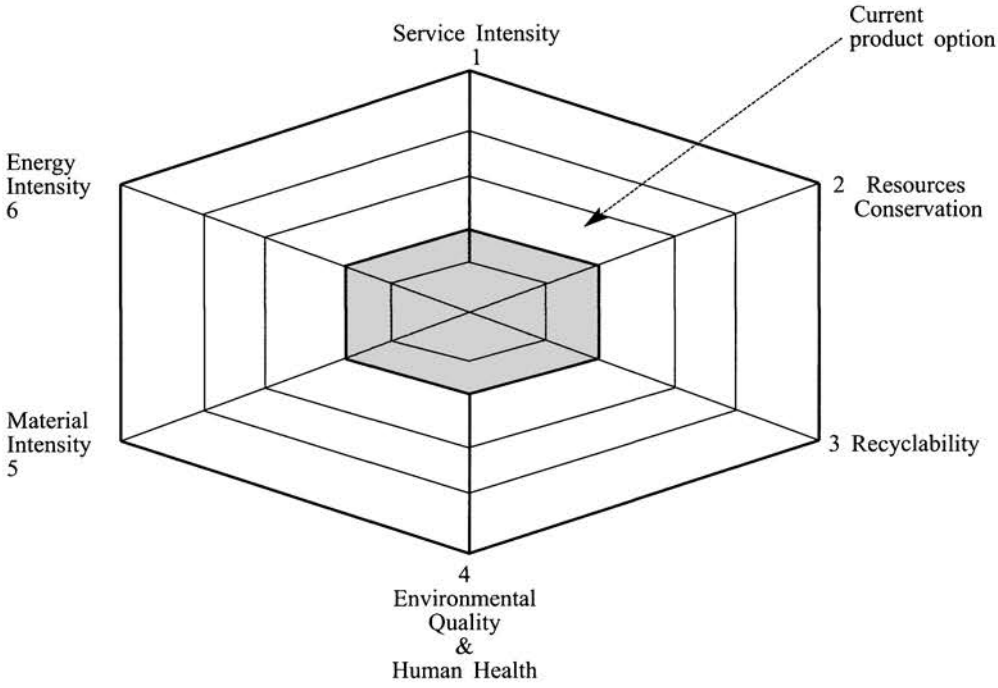

FIGURE 5
The Six Components of Ecoefficiency

Environment Technologies: Generic Classifications

"Curative" Technologies

"Curative" technologies comprise those environmental technologies whose utilisation will variously result in the mitigation of the factors of environmental pollution or resource waste generation:

- **Pollution Control/Abatement Technologies**
- **Waste Control Technologies**, including: Waste Treatment and Disposal; and Waste Recycling and Utilisation
- **Energy Conservation Technologies**, including Waste Energy Recovery; and Waste Utilisation for Energy Generation.

"Preventive" Technologies Pollution Free/Low Pollution Technologies; Energy Efficient (or Energy Saving) Technologies through the promotion of Non Conversion Sources of Energy Efficient Energy Supply through Conversion Generation of Energy.

Environmentally Sound Technology Assessment (EnSTA)

Environmentally Sound Technology Assessment (EnSTA) is based on the *sustainability concept*, perceived as a triple balance of securities:

- ***Ecological Security***, a condition on environmental resource quantity, for the current capacity of the environment to support living and non-living resources without compromising the ability of future generations to meet their own needs;

- ***Socio-economic Security***, a condition for human education, health and technological progress to meet the needs of the present generation without compromising the ability of future generations to meet their own needs;

- ***Resource Security,*** a condition on environmental resource quality, for the current capacity of the environment to sustain living and non-living resource quality.

EnSTA and Eco-Efficiency

Eco-Efficiency represents a measure of Simultaneous Effort to minimise etc while maximising the economic value of Products, Goods and Services (human needs and welfare, quality of life, among others). A result of the Eco-Efficiency concept is the need for the paradigm **shift** from the end-use product consideration in any attempt to computer Eco-Efficiency metric.

The **components** of Eco-Efficiency are varied and various and include the following:

- Material Intensity
- Energy Intensity
- Service Intensity
- Environmental Quality and Human Health
- Recyclability
- Resource Conservation

The six components of Eco-Efficiency may be represented as in Figure 5 above.

EnSTA and Eco-Efficiency Criteria in the Total Life Cycle of a Product

Production: Material Intensity; Energy Intensity; Renewable Resource Input;

Waste Intensity; Refusal Rate; Transport Intensity; Packaging Intensity; Hazardous Effluent and Intensity; Longevity; Surface properties (cleaning losses and duration due to mechanical stress); Anti Corrosivity; Repairability; Structure and Ease to Disassemble (maintenance, repair); Durability; Reliability; Likelihood of Material Fatigue; Adaptability to Technical Progress and Technology Upgradation.

Use, Consumption: Material Throughout; Energy Input; Self-Optimisation; Multi-functionality; Potential for Subsequent (different) Uses; Potential for joint (e.g. several families) Users; Size; Area Coverage; dispersive Hazardous Material Outputs.

After Use: Material Consumption and Complexity; Re-usability; Multi-purpose Usability; Remanufacturing Potential for Same Use; Combustion Potential (usable energy outputs); Potential for Composing; Impact on environment after Disposal.

Special Focus on Living Resources: Conservation Strategy Objectives

Conservation strategies for living resource in the environment functionally depend on the **renewable characteristic** of the biotic resources.

Maintain essential **ecological processes** and life support systems through rational planning, allocation, and management of biotic resources;

Preserve **genetic diversity** through the collection and banking of genetic material:

Ensure sustainable utilisation of **ecosystem** through knowledge and understanding of productive capacities and measures to ensure that resource utilisation does not exceed resource regeneration capacity.

Figure 6 depicts what is known as the *Holdridge Life-Zone Classification System* for the earth's geographical biodiversity regions.

Conservation Strategies: National Perspectives

Strategic Review: Review of national development objectives in light of the conservation strategies.

Analysis: In-depth analysis of practices and identification of areas for change.

Action Planning: Proposal of means of supplying the economic, social, and political resources necessary to meet the conservation objectives. It is important that conservation strategies aim to do the following, among others: integrate conservation and development goals; compensate for knowledge gap by retaining options including information data on absorptive capacity and productive regenerative qualities of environment; address prevention as well as cure options; and address causes as well as symptoms.

"The Road to Sustainability Is Long"

The road to sustainability is long. Sustainability by nature is a long-term process and can only be realised after a long time horizon. This is rendered manifest by the realisation that as an international agenda, *sustainability as a* **concept** in the international area has existed for quite some time. Below **(Table 2 on page 26)** is **listed** a number of international initiatives since the late 1960s that may be considered pertinent to sustainability.

A number of the initiatives can be perceived as precursor in relation to sustainability.

For individual countries and groups of countries, the realisation of sustainability will be continent upon the ability of the political agenda of the countries to effect a *paradigm shift* out of the *status quo*, namely, the ability to develop a vision which is supported by commitment in the form of allocation of adequate financial resource to provide the necessary drive for the vision.

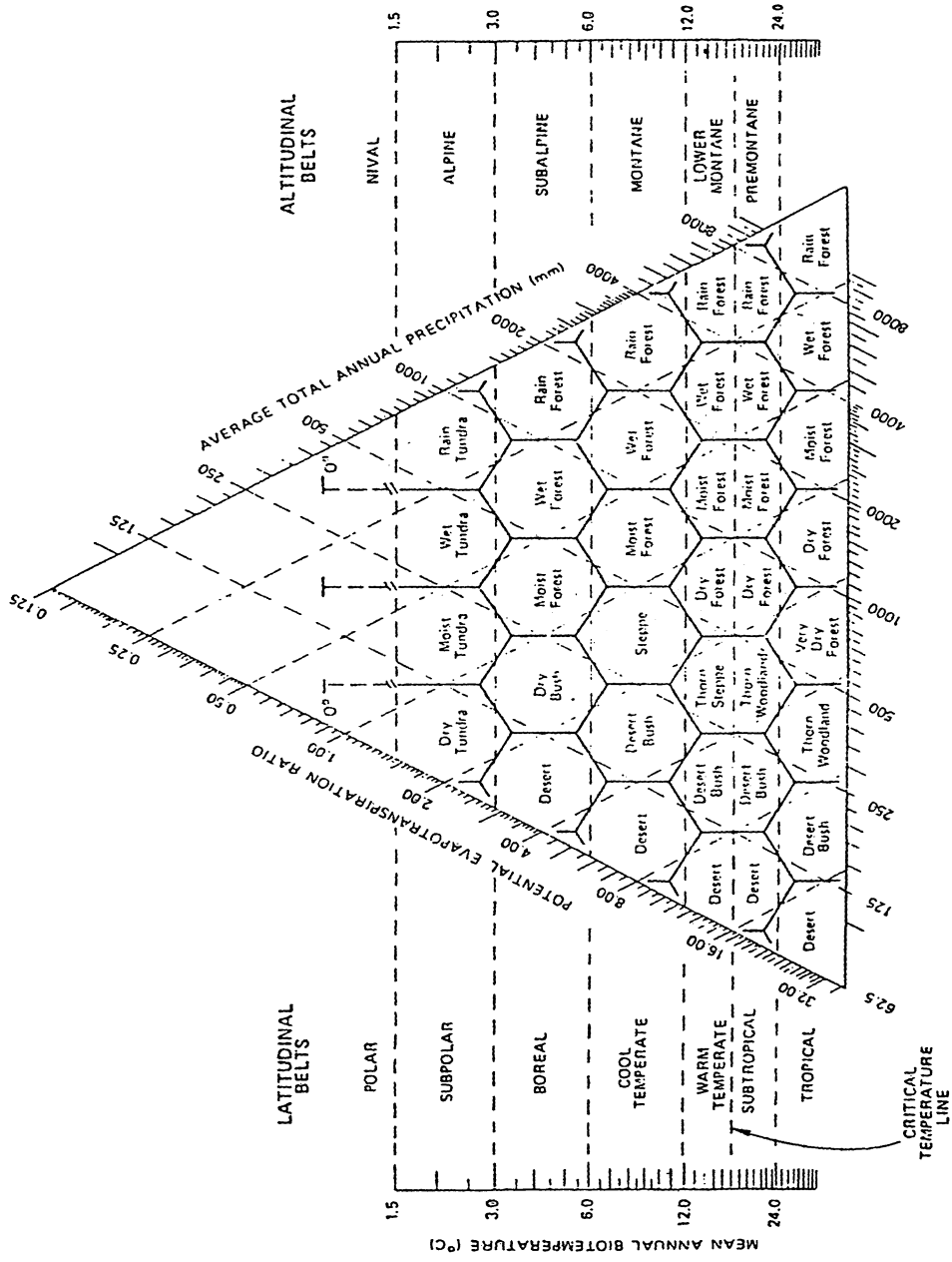

FIGURE 6: The Holdridge LifeZone Classification System

Table 2: A Chronology of Initiatives on the Environment

1968 Paris **Biosphere** Conference – **Environmental** Education first fully recognised.

1975 Belgrade – Belgrade Charter – framework for **environmental education**.

1977 Stockholm UN Conference on **Human Environment**

1977 Tbilisi First InterGovernmental Conference on **Environmental Education**

1987 Moscow - Another Conference on **Environmental Education**

1987 Bruntland report. "Our Common Future", an exposition heralding marriage of **Economy and Ecology** on planet Earth.

1992 Rio Earth Summit. "Agenda 21", a consensus action plan for 21st century – commitment to realising **sustainable** development.

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Volume I: Section 1: *Social and Economic Dimensions of Agenda 21.*
Volume II: Section 2: *Conservation and Management of Resources for Development of Agenda 21.*
Volume III: Section 3: Strengthening the Role of Major Groups of Agenda 21.

Section 4: *Means of Implementation of Agenda 21 and the Non-Legally Finding Authoritative Statement of Principles for Global Consensus on the Management, Conservation and Sustainable Development of all Types of Forests.*

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