Lectures in Brno, 23r Mar to 5 April 2006 Dr Ulrich Loening

2. BIOLOGICAL RENEWABILITY: THE NATURE OF RESOURCES.

Compare "renewable" and "non-renewable" resources. Usually think of material resources, but processes are equally resources.

RENEWABLE	NON-RENEWABLE
Ambient energy	Fossil fuels
Biomasses	Minerals
eg forests	metal ores etc
soils	lime
fisheries	phosphates
biological products	etc
Biological diversity if maintained	Biological diversity if destroyed
Environmental services	
Ecological controls for stability	

Other than energy, all Renewable Resources could be depleted and become non-renewable, if used too fast. eg. most forestry in practice has in fact been deforestry. Conversely, the non-renewable resources other than fossil fuels, are not actually lost in use; mostly they are only dispersed, eg copper, and could become renewable if fully "recycled".

It is more useful to consider depleting and depletable resources in contrast to renewing and continuous.

The capacity of the environment to cope with abuses remains the most valuable renewable resource of all. Think of these environmental services as "resilient" or "elastic"; abuse too far, and stability is threatened; e.g., Excess pressures on land lead to desertification and irreversibility.

Resilience: the capacity to recover from imposed change. The spruce bud worm, devastates spruce once every few decades, allows other trees to grow, eventually spruce returns: recovery but not stability

Stability: the capacity to maintain constancy under imposed pressures. The fish in the Great Lakes could be harvested for decades; stability was great. Then as result of both over-fishing and pollution, numbers crashed. These have not recovered;

It may often be better to seek resilience than stability, because recovery is then more possible.

The effects of human intervention is often to increase "brittleness"; the sensitivity of the ecosystem to change; no change may be apparent, until is is too late to stop and stability, possibly as well as resilience, is decreased.

Complex ecological systems in which the components interact in several ways, tend to show greater stability and resilience and less brittleness. Many complex systems also show multiple benefits ro services.

Examples of renewable, but often not renewed, biological resources:

Forests provide renewable timber and inumerable other forest products , create and maintain good soil, re-cycle water between soil and atmosphere, absorb "impurities", create micro-climates suitable for a diversity of habitats. But much is lost on felling and much less usually provided by plantaions, increasing brittleness.

Soil is a dynamic balance between the materials formed from the weathering of rock and those swept away by wind and water; life maintains the soil structure and fertility, vwith all components of inorganic and organic materials, micro-organisms and plant roots, etc, interacting. Yet, soil losses: much accelerated by human activity; now about 25bn tons per year above natural; this means about 5 tons per person per year, or the soil that grows 1-3 days food!

The diversity of species in general creates resilience in eco-systems. Since the last 2 centuries and especially the last decades, mankind has threatened this resilience and changed global conditions. Gradual extinction is feature of evolution; but now man's impact is leading to high rate mainly due to habitat destruction, deforestation, desertification, agriculture, urbanisation, pollution. Also to direct destruction, mainly of large species.

Carbon dioxide balance and emmissions: C absorbed by:- photosynthesis; stored short-term in biomass, forests, humus in soil, and long term in fossil fuels; deposition in deep sea, via $CaCO_3$; ocean solubility, weathering of CaOH rocks;
C emmitted by:- respiration; burning, both living biomass and fossil fuels;
release of dissolved CO_2 if ocean warms; could lead to positive feedback.
Recall the graph of rises in CO_2 to date from 1958.
CO_2 is biologically active, and physically by absorbing infra-red. Hence leads to potential warming. About 40 other gases released through human activities, absorb infra-red, at various wavelengths; among the most important, CH_4, CFC's (also destroys ozone layer). Thus can expect many changes to stability of the planet, changes to climax ecosystems.

Acid rain: SO_2 emmitted over continental, not global scale, but 10 times natural concentrations; Sources are fossil fuels, also algal bloom at sea, giving off dimethyl sulphide. Also NO_x, complex atmospheric interaction with UV; also other toxins, like tetra-ethyl lead, converted to tri-ethyl. Many effects:- corrosion of buildings, dying of trees, acidification of water and soils; but also provision of S for agriculture.

THE DIFFERENCES BETWEEN HOW NATURE OPERATES AND HOW HUMANKIND WORKS; the table might help one to consider how to 'fit humanity's doings into nature's patterns." (Brundtland,1987)

	NATURE	MANKIND
1.	Driven by solar energy	Driven mainly by stored fuel, fossil or biomass
2.	Works in cycles	Works linearly
3.	All materials are recycled, there is no waste	Resources are consumed to waste
4.	Competition and Co-operation in ecosystems	Conquest by over-riding natural systems
5.	No great excesses	Large excesses
6.	Increases biological diversity	Decreases diversity
7.	Global stability	Global changes
8.	Multiple feed-back controls, mostly negative	Little feed-back control, mostly positive

1. Energy is the driving force throughout and necessarily is used linearly. The energy of the sun becomes degraded to low-grade heat. Man however is rapidly using stored energy from the burning of fossil fuels; this is non-renewable both in terms of the supply and in terms of the pollution produced. "Renewable energy," (better called Ambient energy) based mainly on solar including wind and water (and biomass) flows anyway, whether we use it or not;

2 and 3. Cycling and waste: This difference rests largely on the time scales involved. Biomass, through photosynthesers, consumers and decomposers, is largely re-cycled; man tends to harvest a resource, use it and throw out the remnants as waste. When this happens faster than natural recycling processes, pollution results. Examples from agriculture, using resources, through us to sewage; "closed cycle" agriculture is possible. Forestry, tropical forests are the most complete examples of recycling; industry, mostly linear processes. The very concept of waste is a human one: you cannot "throw your waste away", there is no "away".

4. Cooperation, competition, conquest. Frequent victorian mis-interpretation of "survival of the fittest" as refering to the toughest within the species. Nature works through the interrelations resulting from competition leading to cooperative systems; nothing else would have survived; man tries to by-pass the natural systems, in order to achieve greater productivity; eg., the addition of nitrogen fertilisers, by-passing the release of bound N by microflora and roots. We tend to be proud of our ability to overcome natural processes. Note that man's conquest is also over each other as well as over nature.

5. Excesses. There are rises and crashes of natural populations; but not usually on the scale engendered by man, both in vast increases in certain species, (including ourselves, crops and pests, weeds etc) and in dramatic decreases (including extinction). Many materials, eg antibiotics

which fulfill mutual ecological control function in nature, led to bacterial resistance within a few decades of over-use. Society tends to be proud of excesses - the biggest.... etc.

6. Diversity. Simple example shown of pasture left untended for several decades, when small number of starting species increased, eventually to bushes and trees; conversly, a rough field with many species, given some nitrogen fertiliser for a century, reduced the number to about 2. Almost all human activities, agriculture, forestry, urbanisaton, industry, reduce diversity and reduce the number of niches, (and increase "brittleness"). Now also decreasing human and social diversity, through dominance of industrial culture based from Europe.

7. Stability. All of the above points, lead in general to stability in nature and change or instability due to man. Not known how fully diversity and stability are causally related, but clearly connected. Agriculture typically increases brittleness: see quote (E. p141). Tropical forests also prime examples, stable but not resilient. Global stability (Gaia hypothesis) may now be threatened.

8. Feed-back controls. Man has largely succeeded in over-coming the feed-back controls of nature and continues to be a pioneer by continuously increasing carrying capacity. Indeed positive feed-backs have been generated, in which increases lead to further increases; the economic system operates on positive feed-back (economic growth, see below). The consequence is that man is now either obliged to instigate artificial controls to replace the natural ones which are no longer acceptable, or to submit to whatever ultimate negative feedbacks nature will provide, such as mass starvation. This raises questions about "progress", and about new ethical approaches.

6. THE CARRYING CAPACITY OF THE EARTH FOR HUMANS.

Recall graphs showing global and national population numbers and growth, and demographic transition; also S-shaped curve of growth from pioneer to climax; humans have expanded carrying capacities to continue pioneer growth. (lecture 3).

The ultimate carrying capacity of the planet for humans: one must set up criteria: what is the material standard of living to be? What is the quality of life to be? has the carrying capacity already been exceeded? The Brundtland Report (and refs. below) lists some of the problems:-
-800m people undernourished or starving; the largest number in history, and growing by 15,000 per day.
-More people than ever before inadequately housed, and without access to clean water.
-More than ever before in history who cannot read and write.
-Major renewable resources, forests, grasslands and fisheries, now being utilised faster than their rate of natural replenishment.
-Atmospheric pollution now faster than can be contained by natural decomposition.
-Ever higher proportion of the world's more or less natural areas being converted to non-natural condition.
-Humans now about 10% of world's terrestial animal biomass; substituted for natural wildlife, with domestic animals, total of 20%.
-harvesting photosynthetic productivity about 25% from grassland, 30% from forests, 11% of land area for agriculture; plus degradation of environment, adds up to perhaps 40% of total photosynthetic production.
-large loss of species and biodiversity results.

If, by improving conditions, populations increase sufficiently to destroy land and lead to mass poverty and hunger, as has happened, one has to question the original 'good'. AV Hill: (in The Ethical Dilemma of Science, 1952): *"If ethical principles deny our right to do evil in order that good may come, are we justified in doing good when the foreseeable consequence is evil?"* What happens if, as a consequence of health care, huge numbers of people starve? Thus, the population issue raises many social and political and ethical questions, as well as biological.

One aspect seems clear: given that so many of the planet's resources are being degraded, it follows that with the present populations and the present social, cultural and technical systems, the carrying capacity of the world has been exceeded. If material resources are to satisfy needs (total land area; cultivated area; forest; grain production; wood) then 2000m seems to be near the carrying capacity for the long term future. (refs: P.E., A.E., E. and others).

All the factors, economic, social, political and technical, need to be examined and the appropriate changes made, to assess carrying capacity and how it may be enhanced.

<u>Economics</u>

Economic analysis has expanded to take in environmental issues. However, there remain at present deep divisions between economic pressures and ecological needs:
-Gross National Product, GNP, includes the sum of the nations economic activity, both good and bad; eg a car accident adds to GNP.
-The time scales differ: discounting, 5% or 10% interest, means that long-term benefits are not seen as so valuable. It becomes uneconomic for example, to grow trees.
-Natural goods are not counted or under-counted, until harvesting, Eg, timber from native forests is priced below its replacement value; the many other values provided by forests are not part of forest economics;
-Environmental services are not usually costed; they are "externalities", eg air is free! and forests, if fully accounted, might contribute several times the value of a nation's GNP!
-Many social services similarly are not counted; this leads to both social and economic exploitation. e.g., the things people do for each other, "own work", mothers bringing up children etc. Maybe half the economy rests on this.

Diagram of Henderson's economic layer cake, showing the formal economy as only the icing, overlying social and natural assets. Limitations of economics also shown by Daly's diagram, indicating the ultimate and intermediate means and ends.

Result is unrestricted growth where possible, debt, and frequent exploitation of poorer people and lands. Examples of 3rW debt, increasing interest rates and decreasing commodity prices, leading to pressures on tropical forests, soils and peoples. Cartoon of 3rd W products to Europe.

Better economic appraisal demands examining human needs; Max-Neef's matrix to help analyse relative wealth and poverty within different communities, based on fundamental needs of subsistence, protection, affection, understanding, participation, idleness, creation, identity, freedom. These are classifiable, defined, and similar for all cultures; it is the satisfiers that vary. There are many possible poverties in each of these, not only economic ones. The matrix provides a tool for thought that helps communities understand the natures of their poverties, and the means to overcome them with appropriate satisfiers.

To examine the physical possibilities of providing the satisfiers, another quantitative assessment of resources and sustainability is needed. E.g., King & Slesser for resource analyses, to appraise the physical possibilities for sustainable development: a computer model that calculates whether plans made and decisions taken, are materially possible.

<u>Summary of Human Ecological Principles</u> (Hardin 1985)

1.We can never do merely one thing.
2.Ne effects are truly side effects.
3.No system can long survive the effects of unopposed positive feedback.
4.Negative feedback can be a positive boon.
5.The "sanctity of life" must give way before the "sanctity of carrying capacity."
7.Not all elements of the human carrying capapcity are expandible.
8.Population growth ultimately makes democracy impossible.
9.Selection dictates the direction of evolution.
10.Every biocide selects for its own failure.
11.Every human law selects for its own evasion.
12.No inning is the last inning.

7. DEVELOPMENT, SUSTAINABILITY AND THE FUTURE

"*The Conquest of Paradise"* and *"A Green History of the World"* document how European development, based on the best soil in the world, led to the industrial revolution and the import of cheap raw materials from distant lands. Result colonialism, and export of European culture and technology; almost always destroyed native cultures and resources. This continues to-day, under different economic guise. Almost never has Europe learnt from, or imported, ideas and approaches, ("culture"), from other parts.

The inequalities in the world are now extreme; tables in the Brundtland Report.(B. p.69) showing how the flow of finance with massive loans to the 3rd World ("developing world") is now reversed, with equally large net payments to the rich nations.

The Club of Rome commissioned the Limits to Growth studies. The Stockholm Conference of 1972 "Only One Earth" led the notion that development is not possible without conservation. International Union for the Conservation of Nature produced the World Conservation Strategy in 1980; three main aims:
a. to maintian essential ecological processes and life-support systems
b. to preserve genetic diversity
c. to ensure sustainable utilisation of species and ecosystems.

The United Nations instigated the World Commission on Environment and Development, (Brundtland report). It includes the challenges for:
"Sustainable development..."
"Humanity ..to fit its doings into (nature's) pattern.."
"..to break out of past patterns.... Security must be sought through change."
"Two conditions must be satisfied... The sustainability of ecosystems ..And ..that the basis of exchange is equitable;.... For many developing countries, neither condition is met."
" that global economic growth be revitalised."

One can question the last, in relation to carrying capacities. The cultural as well as economic habits of Europe and the richer countries have been crucial in their influences. Susan George, *A Fate Worse than Debt"* and Jacobo Shatan *"World Debt: Who Pays?"* have documented the problems. Environmental degradation, and with it, famine and irrevocable loss of species, will continue under the present systems; the Brundtland plea for change is therefore fundamental; the solutions are not mainly technical, but of course require the <u>appropriate</u> technologies.
The Food and Agriculture Organisation of the UN has been severely criticised for <u>causing</u> world famine by applying inappropriate economics and technologies.

The World Resources Institute, with the World Bank and the UN FAO has promoted a Tropical Forest Action Plan, but it has been criticised because it failed to address the indirect destructive forces from the rich. The large projects, like big dams, mining developments and others, financed by the World Bank and by the EEC and others, are all beginning to take ecological and social considerations more strongly into their programmes. Yet they have all been criticised for not taking account of the Brundtland challenges. So we can ask about the meaning of "development", which may not be only industrial etc. Development has equally been the basis of the global ecological problems we now face.

There are many international NGOs pointing towards solutions: eg Int. Solar Energy Society, for renewable energy; Int Federation of Organic Agricultural Movements, for sustainble agriculture; The New Economics Foundation, for alternative economics; Now in the last 2 years, national and international decision makers are taking more note.
The UNCED (Earth Summit) in June 1992 in Rio, (20 years after Stockholm, "Only One Earth") brought together more than 100 Heads of State.. Yet the poor countries cannot take on the ecological constraints that the rich are beginning to demand, and accuse the rich of a plot to prevent their development. The CO_2 arguments are typical of this.

"Caring for the Earth" is the latest from WWF/ IUCN/ UNEP as a follow-up to the WCS. It provides analyses and firm, thoroughly thought out recommendations for action. It is not afraid to criticise, for example, the TFAP.

However, not only economic changes, nor a social, but also cultural ones, including the approach to science and technologies, are needed.

The Rise of reductionist science in the 17C, Descarte, Francis Bacon, and others, created the current background. The scientific approach, to isolate the problems and solve those that can be defined and measured, is very powerful, has been very successful, but omits some vital elements- omitted externalities just like economics. The answer cannot be to despise the scientific approach; it is vital and it has told us how much humanity is threatening the survival of the present biosphere; rather the domains of science need to expand, and to be complemented with other means of thought, feeling and intuition.

Systems analysis of complex processes like ecosystems, and a holistic approach in science, is needed and is developing. Applying such a wider approach leads to different technologies - appropriate technologies, indicated above. But it is sobering to be reminded that John St. Mill, famous British economist of the 19th century, foresaw the issues:
"If the earth must lose that great portion of its pleasantness which it owes to things that the unlimited increase of wealth and population would extirpate from it, for the mere purpose of enabling it to support a larger, but not a better or a happier population, I sincerely hope, for the aske of posterity, that they will be content to be stationary, long before necessity compels them to it."

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