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An Informal Discussion:

"The Only True Definition of Environmental Sustainability !!"

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1. Definition of Environmental Sustainability

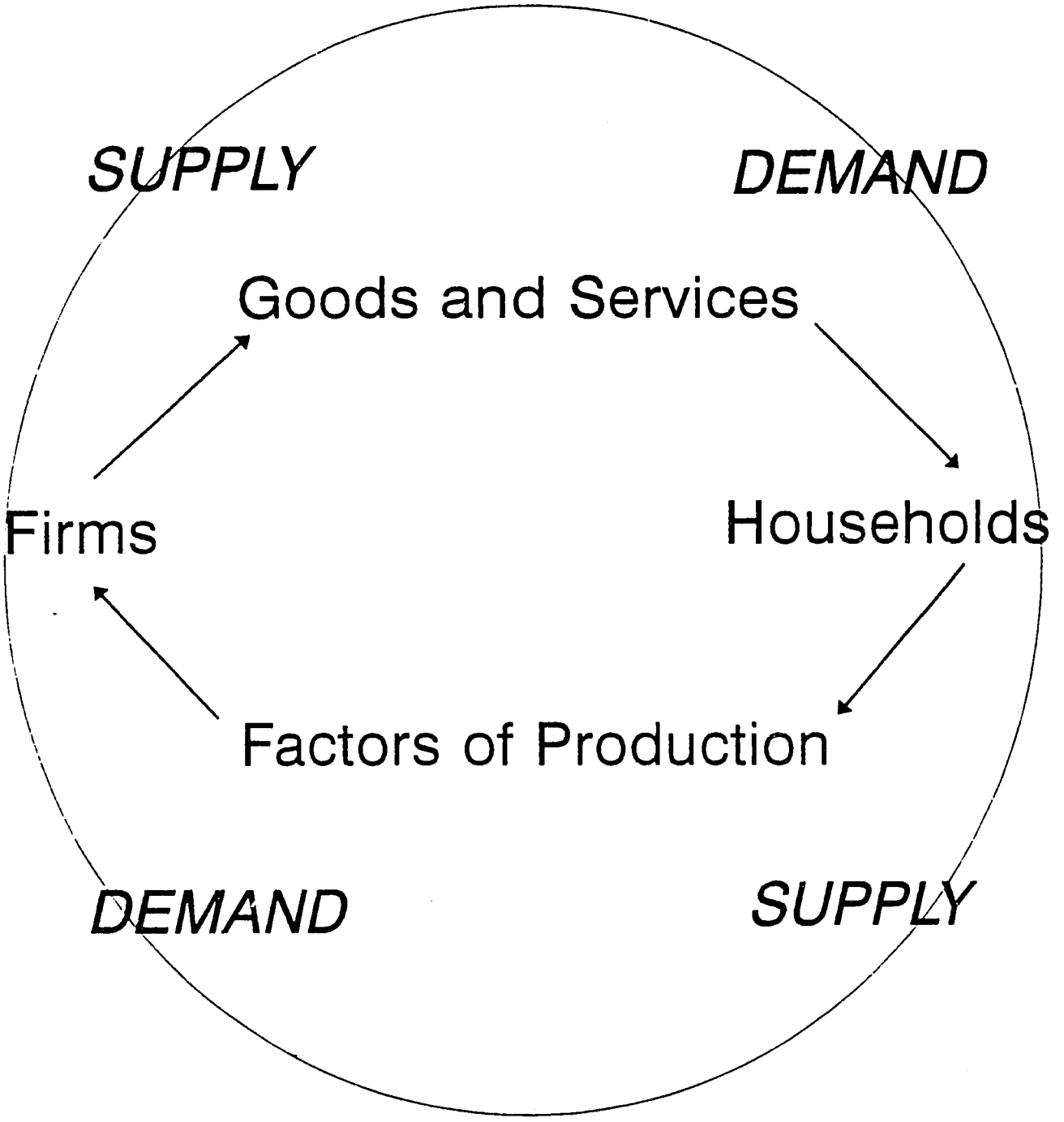
The paramount importance of sustainability arose because the world is recognizing current patterns of economic development are not generalized. Present levels of OECD per capita resource consumption cannot possibly be generalizable to all currently living people, much less to future generations, without liquidating the natural capital on which economic activity depends. Sustainability thus arose from a recognition of the inequitable and non-democratic nature of current patterns of development. The transition to sustainability is urgent because global life-support systems -- the environment -- has a time limit. We do not have time to dream of creating more living space or more environment; we must save the remnants of the only environment we have, and allow time for, and invest in the regeneration of what we have already damaged.

The widely accepted definition of sustainability in economics is: "maintenance of capital", sometimes phrased as "non-declining capital". Historically, at least as early as the Middle Ages merchant traders, "capital" referred to human-made capital. The merchants wanted to know how much of their trading ships cargo sales receipts could be consumed by their families without depleting their capital. Of the three forms of capital -- human-made capital, human capital, and natural capital -- environmental sustainability refers to natural capital. So environmental sustainability is defined by two further terms, namely natural capital and maintenance or at least non-declining. These two terms are amplified below.

Natural capital is basically our natural environment, and is defined as the stock of environmentally provided assets (such as soil, atmosphere, forests, water, wetlands), which provide a flow of useful goods or services. Natural capital, or environmental assets, is distinguished from the other two forms of capital, namely human capital (people, their capacity levels, education, information, knowledge), and human-made capital (houses, roads, factories, ships). From the mercantilists until very recently capital referred to the form of capital in the shortest supply, namely human-made capital. Investment were made in the limiting factor, such as sawmills and fishing boats, because their natural capital compliments -- forests and fish -- were abundant. That idyllic era has ended. Now that the environment is so heavily used, the limiting factor for much economic development has become natural capital, rather than human-made capital. Fish have become limiting, rather than fishing boats. The subcategory of marketed natural capital, intermediate between human capital and natural capital, is "cultivated natural capital" such as pond-bred fish, cattle herds, and plantation forests.

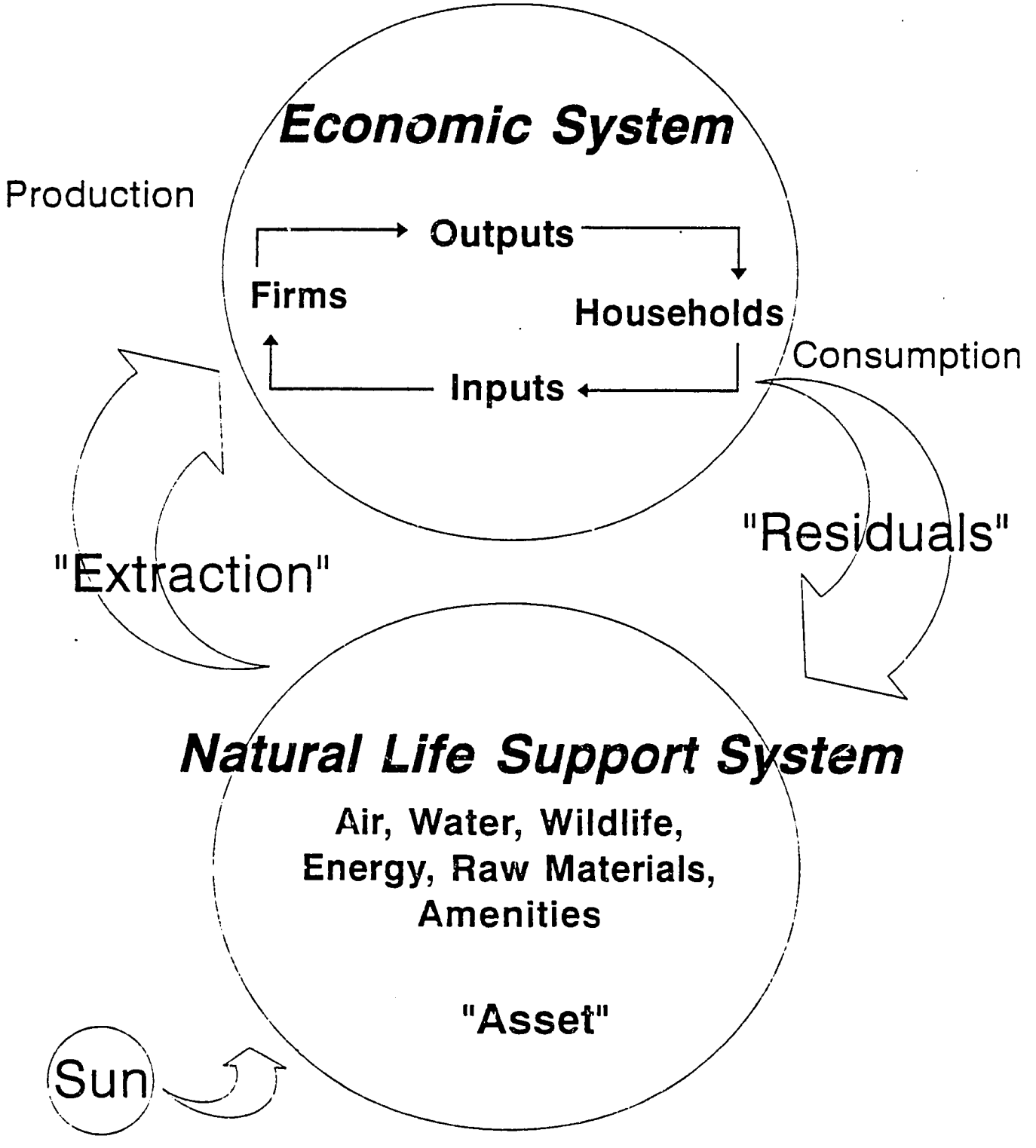
The flow of useful goods and services from natural capital can be renewable or non-renewable, and marketed or non-marketed. Sustainability means maintaining environmental assets, or at least not depleting them. "Income" is sustainable by definition: "the maximum value a person can consume during a week, and still expect to be as well off at the end of the week as at the beginning". Any consumption that is not sustainable cannot be counted as income. Prevailing models of unsustainable development treat consumption of natural capital as income. Consumption of natural capital is liquidation, the opposite of capital accumulation.

Figure 1: ECONOMY AS ISOLATED SYSTEM
The Circular Flow of Goods & Services



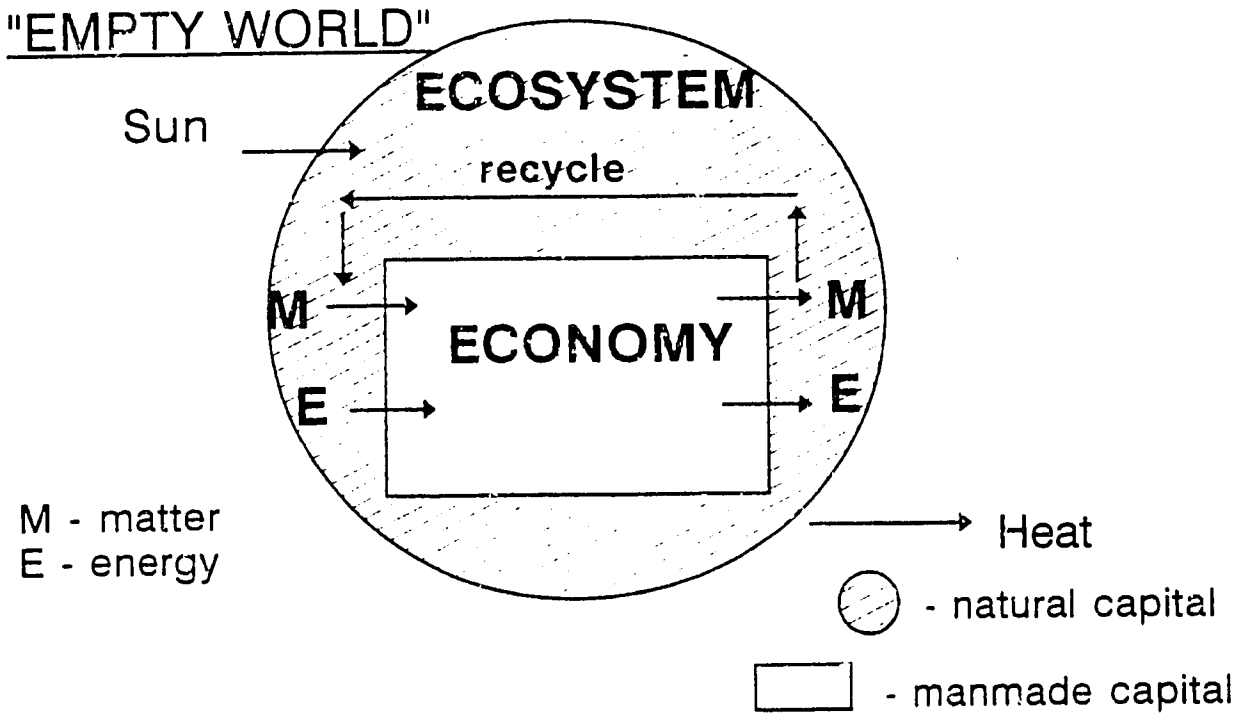
Standard "Economics 100" Chapter #1

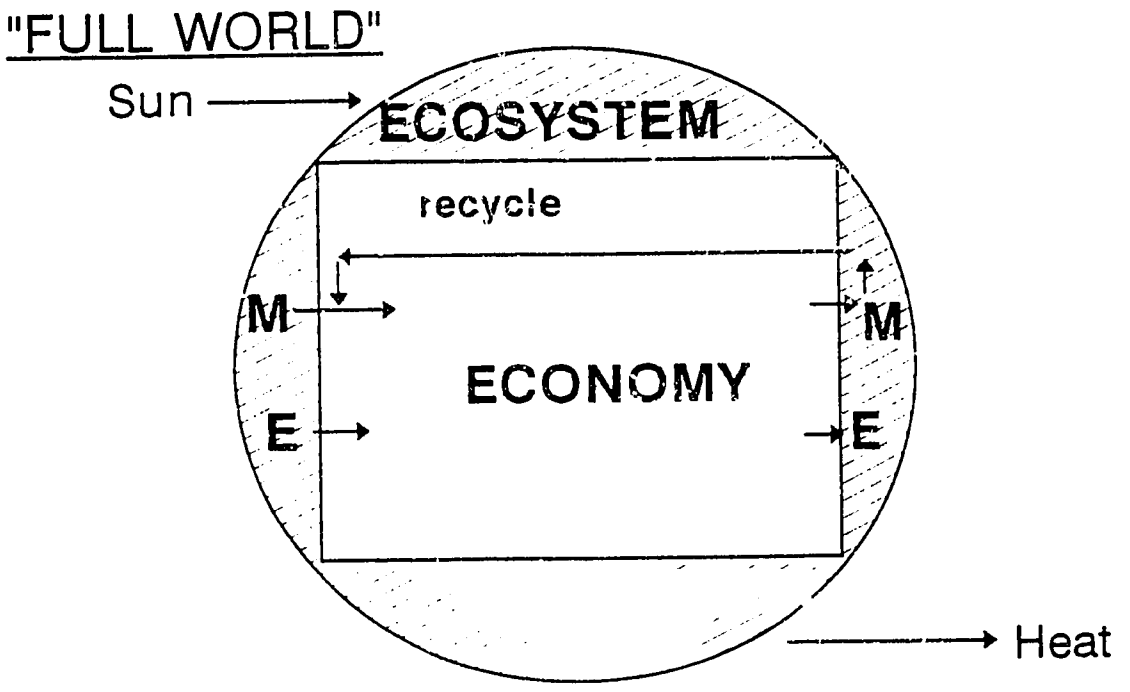
Figure 2: A More Realistic Model of the Human Economy Dependent on the Environment



[Slightly modified from: Tietenberg, 1992]

Figure 3: The Most Realistic Model Showing the Human Economic Subsystem Totally Dependent on the Global Ecosystem





Note on Fig 3: the long gone "empty world" case, the scale of the human economic subsystem is small relative to the large, but non-growing global ecosystem. In the lower diagram, the "full world" case, the scale of the human economic subsystem is large and still growing, relative to the finite global ecosystem. In the full world case, the economic subsystem has already started to interfere with global ecosystemic processes, such as altering the composition of the atmosphere (Green house warming), or the now nearly global damage to the ozone shield.

Sustainability has three levels -- weak, strong and absurdly strong -- depending on how strictly one elects to hew to the concept of maintenance or non-declining capital. Weak sustainability is maintaining total capital intact. Thus oil may be depleted as long as the receipts are invested in sustainable activities elsewhere. The sustainable receipts are income. This generously assumes that man-made and natural capital are to a large extent substitutable. Strong sustainability requires maintaining both man-made and natural capital intact separately. Receipts from depleting oil should be invested in sustainable energy production, rather than in any asset. This assumes that natural and human-made capital are not really substitutes but complements in most production functions. A sawmill (human capital) is worthless without complementary natural capital of a forest. Economic logic requires us to invest in the limiting factor which has now become natural capital, rather than the human-made capital which was limiting yesteryear. Absurdly strong sustainability would never deplete anything. It would have to be left intact for future generations. Only net annual growth rates of trees or fish could be harvested, in the form of the overmature portion of the stock.

Investing in natural capital (non-marketed) is essentially an infrastructure investment on a grand scale, that is the biophysical infrastructure of the entire human niche. Investment in such "infra-infrastructure" maintains the productivity of all previous economic investments in human-made capital, public or private, by rebuilding the natural capital stocks that have come to be limitative. Operationally, this translates first, into indirect investments in conserving the remaining natural capital, second, encouraging the growth of natural capital by reducing our level of current exploitation, and third investments in projects to relieve pressure on natural capital stocks by expanding cultivated natural capital, such as tree plantations to relieve pressure on natural forests, and fourth, by increasing the end-use efficiency of products (improved cookstoves, solar cookers, hay-box cookers, wind pumps, solar pumps, manure rather than chemical fertilizer).

From the above definition of environmental sustainability, maintenance of natural capital, we can draw practical rules-of-thumb to guide the design of economic development.[1] As a first approximation, the design of the project should be compared with the input/output rules (Figure 4) in order to assess the extent to which the project is sustainable. At the next level of detail, specific indicators of environmental sustainability can be used. Figures 7 and 8 list some suggested indicators.

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[1] Environmental sustainability is a "constraint" in economic terms, rather than a maximizing criterion, such as profit or discounted utility, or present value of a future income stream. It is important to distinguish sharply between the environmental sustainability constraint, and the largely unrelated profit maximizing criterion of "sustained-yield". S-Y is often used in forestry and fisheries to determine the optimal -- most profitable -- extraction rate of trees or fish. ES counts all the natural services of the sustained resource. S-Y counts only the service of the product extracted, and ignores all other natural services. S-Y forestry counts only the timber value extracted; ES forests count all services, such as vulnerable ethnic minority forest dwellers, selectively harvested products (eg: nuts, pharmaceuticals), biodiversity, genetic values, intrinsic as well as instrumental values, climatic, wildlife, carbon balance, water source and water moderation values, including timber extracted. The relation between the two is that if S-Y is actually achieved, and this is highly doubtful now (Ludwig 1993, ITTO 1991?), and will be more doubtful in the future (Goodland et al 1990), then the stock resource (eg: the forest) will be nearer sustainability than if S-Y is not achieved. But even were S-Y achieved, that resource is unlikely to have also attained environmental sustainability. The optimal solution, such as S-Y, usually (possibly inevitably) results in declining utility or declining natural capital sometime in the future, therefore is not sustainable.

Figure 4: Operational Guidelines for Environmental Sustainability

1.	Output Rule:	Waste emissions from a project should be within the assimilative capacity of the local environment to absorb without unacceptable degradation of its future waste absorptive capacity or other important services.
2.	Input Rule:	(a) Renewables: harvest rates of renewable resources inputs would be within regenerative capacity of the natural system that generates them.
		(b) Non-renewables: depletion rates of nonrenewable resource inputs should be equal to the rate at which sustained income or renewable substitutes are developed by human invention and investment. Part of the proceeds from liquidating non-renewables should be allocated to research in pursuit of sustainable substitutes.

The world is hurtling away from environmental sustainability at present (Simonis 1990; Meadows et al. 1992). The global society is being maintained only through the exhaustion and dispersion of a one-time inheritance of natural capital, such as topsoil, groundwater, tropical forest, fisheries, and biodiversity. The rapid depletion of these essential resources, coupled with the degradation of land and atmospheric quality show that the human economy has not only exceeded its current social carrying capacity, [2] but is actually reducing future potential biophysical carrying capacities by depleting essential natural capital stocks (Daily and Ehrlich 1992). In spite of spending capital inheritance rather than income, most of the world lives in poverty, or at barely subsistence levels. Can humanity attain a standard of living which does not exceed the carrying capacity of the planet, and which is more equitable? The transition to environmental sustainability will occur. However, the ability of nations to plan for an orderly and equitable transition to environmental sustainability, rather than allowing biophysical limits to dictate the timing and course of this transition, remains in doubt.

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[2] Carrying capacity is a measure of the amount of renewable resources in the environment in units of the number of organisms these resources can support. It is thus a function of the area and the organism: a given area could support more lizards than birds with the same body mass. Carrying capacity is difficult to estimate for humans because of major differences in affluence and technology. An undesirable "factory-farm" approach could support a large human population at the lowest standards of living: certainly the maximum number of people is not the optimum. The higher the standard of living, the fewer the number of people that can enjoy it.

The global ecosystem's source and sink functions have limited capacity to support the economic subsystem. The imperative, therefore, is to maintain the size of the global economy to within the capacity of the ecosystem to sustain it. It took all of human history to grow to the $600-billion scale economy of 1990. Today, the world economy grows by this amount every two years. Unchecked, today's $16 trillion global economy may be five times bigger only one generation or so hence.

It seems unlikely that the world can sustain a doubling of the economy, let alone Brundtland's solution of a "five- to ten-fold increase." We feel increased throughput growth is not the way to reach sustainability; we cannot "grow" our way into sustainability. The global ecosystem, which is the source of all the resources needed for the economic subsystem, is finite and has limited regenerative and assimilative capacities. It looks inevitable that the next century will be occupied by double the number of people in the human economy consuming sources and burdening sinks with their wastes.

Figure 5: Priorities to Approach Environmental Sustainability

a) Accelerate the transition to population stability.

b) Accelerate the transition to renewable energy.

c) Human capital formation: education and training, employment creation, particularly for girls equivalent to that for boys.

d) Technological transfer: for the South and East to leapfrog the North's environmentally damaging stage of economic evolution; job creation rather than automation.

e) Direct poverty alleviation: including social safety nets, and targeted aid.

Figure 6: Environmental Sustainability Costs Less

1. Walking, biking and mass transit cost less than driving automobiles.
2. An extra blanket or sweater damages less than raising the thermostat.
3. Opening windows costs less than turning on air conditioners.
4. Insulation costs less than firing up the furnace.
5. Recycling costs less than trashing
6. One child families cost less than eight-child families.
7. Vegetarianism damages less than carnivory.
8. Village agroforestry plots cost less than agribusiness food.

Figure 7: Criteria and Indicators of Environmental Sustainability:

(1) **Population stability:** No net increase in population over some planning time horizon

(2) **Greenhouse Gases:** No net increase in concentration of greenhouse gases in the atmosphere, beyond some limit. Fossil fuel use to fall to very low levels.

(3) **Acidification:** No net increase in acidification (hydrogen ion concentration) in surface waters and soils, beyond some limit.

(4) **Toxic Substances:** No net increase in toxic chemical and heavy metal concentrations in soil and water, beyond some limit.

(5) **Soil Degradation:** No net topsoil erosion beyond some limit; no reduction of fallow period below some limit.

(6) **Aquifers:** No net depletion of aquifers beyond some limit

(7) **Natural Ecosystems:** Preservation of all or most remaining natural forests, estuarine areas, coral reefs, and other ecologically critical biomass or ecosystems.

(8) **Species Extinction:** As a general rule, no further humanly induced extinctions of other species.

Figure 8: Indirect Statistical Indicators of Long Run Environmental Sustainability:

(1) **Energy Intensity:** The energy intensity of aggregate output (energy/GNP) -- the lower the energy intensity the greater the sustainability.

(2) **Renewable Energy Proportions:** The fraction of total energy from renewable sources, assuming the renewable sources are being renewably exploited.

(3) **Material Intensity:** The material intensity of output for various basic materials and for different sectors.

(4) **Recycled Proportions:** The recycled fraction of materials, and its complement, the dissipated fraction.

(5) **Transport Intensity:** The transport intensity of output for various basic materials and for different sectors.

(6) **Water Use:** Percent use of available water supply.

(7) **Cropland Cultivated:** Percent of potential croplands in cultivation.

(8) **Pastoral Use:** Percent of rangelands and pastures being irreversibly overgrazed.

Figure 9: Institutional Priorities for Environmental Sustainability

1. **Monitor Standards:**
   Set indicators and monitor environmental standards where none exist or where inadequate.

2. **Compliance:**
   Monitor international compliance with standards, treaties and agreements. The UN Sustainable Development Commission looks highly promising.

3. **Enforcement:**
   Strengthen environmental enforcement capabilities (The UN's "Green Police" proposal).

4. **Coordination:**
   Coordinate UN's environmental work; dispute resolution mechanism needed between agencies.

5. **Mediation:**
   Mediate international environmental disputes, possibly the International Court of Justice, Hague.

6. **Institution Strengthening:**
   Foster the creation or strengthening of environmental capabilities in all relevant loci, wherever needed, such as in governments, industry, businesses, consulting firms, banks, religions, military, schools, academia.

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