Working Paper

Development and Environment
An Economic Analysis

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PREFACE

The forthcoming United Nations Conference on Environment and Development, to be held in Brazil in June 1992, has focussed increased attention upon the linkages between human development and environmental change, and the factors underlying unsustainable development. Within IIASA, the Environmental Change and Development Project has been addressing different aspects of this wide-ranging research field. Katharina Löwenthal was invited as part of the IIASA Young Summer Scientists Program (YSSP) to examine some of the economic aspects of the issue.

This paper is the result of her work. Part I deals with various approaches to development economics, and indicators of economic development. Part II deals with sustainable development, and, interestingly, draws an analogy between the concept of entropy (or unavailable energy) in physical science and that in economics (unavailable resources).

The views are of course those of the author and do not necessarily reflect those of the Project or other scholars.

DEVELOPMENT AND ENVIRONMENT - AN ECONOMIC ANALYSIS

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DEVELOPMENT AND ENVIRONMENT - AN ECONOMIC ANALYSIS

INTRODUCTION

The main purpose of the following analysis of development economics is to make evident the shortcomings of conventionally applied development theory, mainly with regard to its social and environmental implications, and to what extent economic theory can be adjusted in order to bring under control non-desired consequences of economic development.

The analysis of the above items is based on a system-analysis approach, which implies that emphasis is put on the linkages and interdependences between the economic system and the ecological and social systems.

This system-analysis approach is essential, as we live in a complex world where economic, ecological and social problems depend one on the other. The normally used scientific approach to deal with problems is to detach them from reality, and to analyse them in several fields of knowledge. But the split of reality into pieces which are subordinated to well-defined fields of specialisation leads inevitable to a loss of context; reality is a complex system where single sub-systems are often less important than the linkages and interdependences between those sub-systems. That implies that the interference in such a sub-system will lead to unexpected effects in other parts of the global system, and to feedbacks to the sub-system initially affected.

The system's view of reality implies the understanding that both the social and the economic system are sub-systems of the global natural system, the ecosphere, and that they are therefore submitted under the basic laws of this ecosystem.

However, within economics man have been ignoring this fact for the last 200 years. Rooted in the belief of the mechanistic philosophy of life human beings tried to manipulate and change the natural system according to their needs. Nowadays, however the time has come to face the fact that this interference of human beings endangers the very existence of our affluent society.

PART 1 - ORTHODOX DEVELOPMENT POLICY

The first part of this analysis will aim at demonstrating the shortcomings of traditionally applied development policy. Therefore, a short summary of orthodox development strategies and of their theoretical foundation is given. Afterwards two of the main indicators measuring the results of development policies are analysed: the terms of trade, as a measure for the ratios at which exports of one country exchange for those of its trading partner, and the national income, as a measure for economic performance.

1) THE NEED FOR DEVELOPMENT

In 1989 the Worldwatch Institute estimated that 1.2 billion people (23% of total world population) are living in absolute poverty. Absolute poverty can be defined as "a condition of life so limited by malnutrition, illiteracy, disease, squalid surroundings, high infant mortality, and low life expectancy as to be beneath any reasonable definition of human decency." (Robert McNamara, President of the World Bank, 1978) 1)

Apart from the fact that poverty should be fight against because of ethical and humanitarian considerations another aspect demands for attention: the poor became a major cause of environmental degradation in the LDC by overexploring their resource base and thereby sacrificing the future for the survival of the present. Short-term needs force landless families to cultivate marginal areas and to cut down rain forests. This leads to the destruction of land, the resource their existence depends on, thereby reinforcing the downward spiral of poverty and environmental degradation.

The only possibility to fight against both poverty and the thereby caused ecological deterioration is to enable a standard of living that makes it possible not only to be concerned about short-term survival, but also includes long-term considerations. The achievement of this higher living standard is the aim of development policy.

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1. in Worldwatch Paper 92, Nov.1989 DURNING, ALAN B., "Poverty and the Environment: Reversing the Downward Spiral"

2) DEVELOPMENT POLICY TRADITIONALLY IMPLEMENTED

Economic development can be defined as "the process by which a traditional society employing primitive techniques and therefore capable of sustaining only a modest level of per capita income is transformed into a modern, high-technology, high-income economy. The process involves the replacement of labour-intensive subsistence production by techniques that use capital, skilled labor, and scientific knowledge to produce the wide variety of different products consumed by the affluent society." 2

Traditional development policy emphasises therefore on the industrialization of LDCs, whereby the high living standards in affluent industrialized countries provide an example of what was, in principle, achievable.

Economic development usually starts with the growth of a small export sector and a linked service sector within the subsistence economy. Export proceeds are on one hand used to buy consumer goods but also to buy capital goods and semi-finished products for the expansion of the export sector. At this moment the question arises as to where the increasing supplies of the factors of production should be taken from, and how to ensure that the resulting output finds a market.

In literature various alternative Development Strategies are generally mentioned. However, emphasis will be put on the two strategies outlined below, due to their broad application in practice.

2.1) IMPORT-SUBSTITUTING INDUSTRIALISATION (ISI)

This strategy is based on the idea that previously imported manufactured goods should be produced within the domestic market by building up new industries. ISI goes together with powerful government intervention, including protectionistic trade policies as well as state enterprises directly involved in the production process. The most influential school that argued in favour for ISI was based on the Economic Commission for Latin America (ECLA), in Santiago, and was dominated by the Argentinian economist R. Prebisch.

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2. WILLIAMSEN, JOHN, "The Open Economy and the World Economy", p.251, New York: Harper International Edition, 1983

The first stage of ISI involves the manufacturing of non-durable consumer goods, like clothing, shoes and simple household goods, whose production requirements coincide with the existing structures in countries without previous industrial experience. In the 1960s the larger Latin American economies, a number of South and South-east Asian economies (e.g. India) and several sub-Saharan African economies (e.g. Kenya) pushed on to a second stage of ISI, involving the establishment of industries to produce durable consumer goods and capital intensive intermediates, such as steel.

The experience of ISI has shown the shortcomings of this development strategy. Most LDCs built up inefficient industrial sectors which cannot survive without protectionist measures such as tariffs, quotas, import licensing and exchange controls. In general the developed capitalist economies, their consumer patterns, technologies, values and tastes, served as a model for the structure of these industries. As a result the manufacturing sectors are often rather capital- than labour-intensive. Therefore, they are unable to benefit from the labour surplus in LDCs, and are heavily dependent on foreign technology and capital.

In addition, industrial production is generally directed to the demand of those consumers having a high purchasing power. In other words, it is directed in the first place to the inhabitants of industrialised countries. In the year 1987 the annual per capita GDP in developed market economies amounted to US$ 15,635 compared to US$ 960 in developing market economies. Regionally, these differences are even larger. While Japan had in 1987 a annual per capita GDP of US$ 19,471, the other East and South-East Asian countries had an average per capita GDP of US$ 428. Thereby Burnei (US$ 9,810), Hong Kong (US$ 8,289) and Singapore (US$ 7,624) rank far above India (US$ 317), Bangladesh (US$ 180) or Nepal (US$ 151). 3)

As income distribution in less developed countries is in general very unequal the second group having high purchasing power are "elites". In India, e.g., 10% of total population disposed in the year 1983 over a 24,9% share of household income, while the poorest 20% of population only had 9,3% of household income at their disposal. An even more drastic example is Brazil were 10% of total population held 46,2% of household income compared to the 2,4% held by the poorest 20% of the

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3. UNITED NATIONS, National Account Statistics: Analysis of Main Aggregates, 1987, New York: United Nations Publication, 1990

population. 4)

The undesirable outcomes for the structure of the industrial sector, did hinder the initial relatively high growth rates of the manufacturing sector which could therefore not be sustained. As ISI focuses heavily on the development of the manufacturing sector, industry often grew in isolation from other economic sectors, while other sectors, especially the agricultural, were discriminated.

2.1.1) The neo-classical critique of the ISI experience

Neo-classical trade theory states that economic welfare is maximised through the optimal allocation of scarce resources, which can be achieved by international specialisation and trade based on the principle of comparative advantage. The "failure" of the ISI strategy is therefore caused by ineffective governmental intervention which heavily distorted markets and led to economic inefficiency. To allow the market to generate "correct" price signals governmental intervention, and especially trade barriers should be reduced. Therefore the neo-classical perspective emphasis on a rigid export-led industrialisation program.

2.2) EXPORT-LED INDUSTRIALISATION

Since the mid-1960s ISI was in an increasing number of LDCs no longer regarded as a solution to the problem of underdevelopment and a shift from import substitution towards an export-oriented industrialisation strategy took place. 5)

A clear distinction can thereby be made in emphasis and approach between Latin America (Argentina, Brazil, Colombia) and South-east Asia (South Korea, Singapore, Taiwan). The latter broke with ISI more or less as soon as the first stage had been accomplished and pushed heavily an export-oriented policy with the assistance of

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4. THE WORLD BANK, World Development Report 1990 Oxford University Press, 1990

5. KIRKPATRICK, C.H.; NIXSON, F.I., "The Industrialisation of Less Developed Countries", Manchester University Press, 1983

an extensive incentive programme. Exporters were exempted from indirect taxes on both output and input and from duties on imported inputs. Profits generated from exports were given special tax concessions. 6)

However, government policy in Latin American countries favoured both the promotion of exports and domestic production. On the one hand they continued the ISI strategy, and on the other hand they selectively promoted exports by subsidising the production of non-traditional exports. This policy aimed at the overcoming of foreign exchange shortages, because the expansion of the domestic production required the import of capital goods and of intermediate inputs. As exporters were still demanded to use domestic inputs produced under protection, and the subsidies were not high enough to constitute an adequate incentive for an export-oriented production, these countries developed a continous bias towards import substitution.

Basically, there are two possibilities of export expansion: on the one hand through the increase in exports of products which the country traditionally supplied, and on the other hand through the production of additional, non-traditional export products, i.e. basically industrial products. The additional industries are normally capital intensive and require skilled labour, though both production factors are scarce in LDCs. The ensuring of the supply of inputs for the manufacturing process has to be taken into consideration.

2.2.1) Korea - an example for successful export-led industrialisation

The favorite example of neo-classical economists for the successful development of an competitive export oriented additional industry serves the Republic of Korea. In fact Korea was in 1961 one of the poorest developing countries, heavily dependent on agriculture. By 1976 it had become a semi-industrial, middle-income country, with per capita income tripled in real terms. The manufacturing sector grew at 18 percent a year in constant prices. The average growth rate of exports amounted 39.5% in the period from 1960-70 and even raised

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6. LANDSBERG, M., "Export-Led Industrialisation in the Third World: Manufacturing Imperialism", in International Capitalism and Industrial Restructuring, edited by Richard Peet, 1987 Boston: Allen & Unwinn

to 49.2% p.a. from 1970-75. The value of exports rose from US$33 million in 1960 to US$5 billion in 1975. 7)

The basic preconditions for the rapid growth of the Korean economy were:

- The agricultural sector already was well advanced, as a land reform implemented in the 1940s encouraged agricultural development. By 1961 Korea produced 92% of the country's requirements for grain, whereby the average yields were higher than those normally obtained in South-east Asia.

- The social environment was no obstacle to economic growth. There were neither firmly rooted class structures, nor strong regional or religious differences, like in other Asian Countries.

- The labour force was already well educated and disciplined.

- Besides large capital inflows through foreign grants and lendings the ratio of national savings to GNP rose from about 2% in 1961 to about 20% in during 1975-76.

- Korean policy-makers concentrated early on the expansion of the labour-intensive manufacturing sector. 8)

However, this positive example does not prove that export-led industrialisation is an overall solution for development problems. Only few LDCs have similar favourable preconditions for an export-led development, whereby a productive agricultural sector is of major importance.

Another weakness of the export-led industrialisation strategy is that LDCs depend heavily on external borrowing to finance investments in the additional industries in the period of export-led growth. As a

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7. UNCTAD, Handbook of international trade and development statistics 1989, New York:United Nations, 1990

8. for detailed information: PARVEZ, HASAN; RAO, D.C., "Korea: Policy Issues for Long-Term Development", 1979, Baltimore: The John Hopkins University Press

result, outstanding obligations and annual debt service payments increase, presenting serious debt-servicing problems.

Beyond that, the influence of transnational corporations investing in LDCs grows, which not necessarily leads to advantageous repercussions in the industrial structure of Third World economics. As a rule, transnational companies make direct investments only on the condition of gaining control over the management of LDCs firms. This involves the danger, that investments are rather used to develop in response to the demand in affluent industrial countries, and not to the needs of workers and peasants in LDCs. Export-orientated production is tied to the developed capitalist economies and reinforces the dependence of Third World countries.

Finally, the effectiveness of this strategy is strongly influenced by the state of the world economy and by restrictions and access to markets. The success in the expansion of LDCs manufactured exports became a major cause of protectionistic measures in industrial countries. As a result LDCs face increasingly limitations to market their products in affluent economies. This shows that economic development following a strategy of export-led industrialisation is dependent on the performance of capitalist economies and reinforces once again the dependence of the Third World.

As mentioned above, the other possibility of export expansion is to stimulate the production of traditional export products which are intensive in unskilled labour and where technology is unsophisticated. As unskilled workers are abundant in LDCs and wage levels are low, the expansion of labour-intensive industries would be a development strategy proposed by neo-classical economists, whereby the principle of comparative advantage would serve as a justification for the need of this strategy.

3) DEVELOPMENT AND THE FREE-TRADE MODEL - A NEOCLASSICAL APPROACH

Nowadays, development strategies lay emphasis on the promotion of export-led industrialisation, whereby the free-trade model is considered to achieve optimal worldwide allocation of resources and thereby promoting the development of LDCs.

The international trade theory is, in principle, an application of the general economic theory which actually determines values, distribution and resource allocation. Hence, the following principle of comparative advantage reflects the neo-classical ideology.

3.1) THE PRINCIPLE OF COMPARATIVE ADVANTAGE

The English economist David Ricardo (1772-1823) is usually regarded as the founder of modern trade theory. In 1817 he determined the principle of comparative advantage as an explanation of how international trade could be a benefit for all nations involved in trade. It states the condition under which trade will take place between two countries, although one country has an absolute cost advantage in the production of two goods which are trade between them.

The principle of comparative advantage can best be illustrated by means of Ricardo's example of two countries, England and Portugal and two different goods, wine and cloth.

Assumption: Labour can move freely within the borders of a country, but not between countries, whereby labour is the only production factor that is taken into consideration

worker-years per unit of output

Country	Wine	Cloth
England	12o	100
Portugal	80	90

- In England 1 unit of wine will buy 1.2 units of cloth. (relative opportunity costs - costs in terms of other goods given up)

- In Portugal wine will exchange at a rate of 0.88.

- Portugal has a comparative advantage in exporting wine to England as long as 1 unit of wine can be traded for more than 0.88 units of cloth.

- England has a comparative advantage on exporting cloth to Portugal as long less than 1.2 units of cloth must be given up for 1 unit of wine.

The purpose of this example is to show that it is for both countries profitable to specialise in the production on one good and to import the other, although one country has an absolute cost advantage in both products, because the relative or comparative advantage governs profitability of trade.

Despite all the changes in economics since the days of Ricardo, the theory of comparative advantages is still a strong argument in favour of free international trade and spezialisation. It became a major component of the neoclassical general equilibrium theory.

3.2) THE HECKSCHER-OHLIN MODEL

However, David Ricardo's law says nothing about why or how a comparative advantage exists. The trade theory of Eli Heckscher (1919) and Bertil Ohlin (1933) has since become the explanation of the source of comparative advantage. Following the Ricardian assumptions, commodities are freely traded, while productive factors (capital and labour) are internationally immobile. The content and the implications of their theory can be broadly summarized by the following theorems.

3.2.1) The Heckscher-Ohlin Theorem

It states that a country will tend to export the commodity that uses relatively more of the factor of production that is relatively most abundant in the country. For example, a country with an abundant supply of capital finds it relatively cheap to produce goods whose production requires much capital and little labour, and therefore has a comparative advantage in such capital-intensive goods. This encourages spezialisation in the production of those goods requiring factors of production (labour and capital) corresponding to the endowment of these factors a country has at a given time.

The weakness of this theorem lies in the following major assumptions that are supposed to guarantee its logical validity:

- identical taste patterns in both countries,
- identical technical knowledge,
- full mobility of qualitatively equal primary inputs (which are fixed in supply) within a country but complete immobility between the two countries.
- it is based on consumption commodities and does not include capital goods

Therefore, the Heckscher-Ohlin Theorem just focuses on the factor endowment and abstracts from other influential factors determining the pattern of trade.

3.2.2) The Stolper-Samuelson Theorem (1941)

This theorem is a further development of the ideas of Heckscher and Ohlin. It states that changes in relative commodity prices have asymmetric effects on factor earnings. An increase in the domestic price of a commodity (by tariff or some other reason) raises the real return of the relatively scarce factor of production of that commodity. That means, that those who supply the scarce factor of production can gain income trough the restriction of imports, even though the society as a whole loses. The price rise will increase the real income of the scarce factor and diminish the real income of the abundant factor.

3.2.3) The Rybczynski Theorem (1955)

This theorem emphasises on the relationship between factor endowments and commodity outputs. It says that an increase in the supply of one factor of production, i.e. labour, will reduce the output of the good intensive in the other factor.

3.2.4) The Factor Price Equalization Theorem (P.Samuelson 1948)

The factor-price equalization theory states that absolutely free international trade equalizes not only commodity prices between countries, but also the prices of the factors of production, i.e. labour and capital.

The assumptions that are necessary to support this argument are:

- identical technology in both countries,
- total substitutability of the factors of production,
- the absence of factor intensity reversals.

Summing up, all these theorems are based on two-dimensional models, reflecting the neo-classical paradigm. With the objective of logical validity in the theoretical analysis economists simplify reality and exclude by the help of assumptions interference factors, thereby abstracting from the complexity of economic life.

In addition, they reduce their analysis to two factors: labour and capital. Nature as a factor of production is thereby only taken into consideration as capital in the form of land and as a resource for the economic production process.

3.3) DEVELOPMENT AND TERMS OF TRADE

The principle of comparative advantage and the thereby linked Heckscher-Ohlin model determine which goods each country is trading. It now arises the question what the ratios will be like at which exports of one country exchange for those of its trading partner. The indicator to measure these ratios are the "terms of trade".

There are a number of alternative meanings of the expression "terms of trade", but usually the "commodity" or "net barter terms of trade" are meant when the expression is used without any closer definition. The "commodity terms of trade" are calculated as change of the index of export prices to an index on import prices, relative to a base year, e.g. the quantum of imports that can be bought with a given volume of exports is measured. An improvement in the terms of trade takes place if export prices rise faster than import prices, or if they fall slower than import prices.

3.3.1) The Prebisch-Singer Hypothesis

In 1950 Prebisch and Singer published independently a hypothesis that stated a structural tendency for the terms of trades of developing countries to deteriorate in their trading with industrialized countries. This publication was one of the first that questioned

the mutual profitability of the international division of labour for developing countries on the existing lines. 1)

It states that the free-trade doctrine overlooks the unfavourable impact of free-trade on the terms of trade and on the balance of payments of LDCs which are far outweighing any advantages with respect to a more efficient allocation of resources. Prebisch-Singer divided the world into the "periphery", i.e. the developing counties with primary producers, and the "center", i.e. the developed countries with secondary producers. Free-trade is claimed to work to the disadvantages of LDCs because of the nature of the goods these countries produce under such a trade system. The comparative position of developing countries in a free market is seen to deteriorate compared to developed countries. 2)

Based on the Prebisch-Singer Hypothesis "North-South" models were developed using the following economic arguments for explaining the structural asymmetry of the two trading groups of countries, and thereby the trend towards a deterioriation of the terms of trade: 3)

- Technological superiority of industrialized countries:

  Their export products profit from the more sophisticated technology which is concentrated in industrial countries.

- Different structure of commodity and labour markets:

  The lack of an organized labour market in LDC makes it easy, that an increase in productivity does not result in higher factor incomes for the benefit of local producers, but leads to lower prices which are favourable for the overseas consumer.

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1. THIRLWALL, A.P., "Growth and Development, with special reference to developing countries", p 349ff. London: Macmillan Education LTD, 1983

2. SPRAOS, JOHN, "Inequalising Trade? - A Study of Traditional North/South Specialisation in the Context of Terms of Trade Concepts", p.21ff. United States: Oxford University Press, 1983

3. BARDHAN, PRANAB, "Alternative Approaches to Development Economics", in Handbook of Development Economics, edited by Hollis Chenery and T.N. Srinivasan, 1988, Amsterdam: Elsevier Science Publishers B.V.

- Differing income elasticities of demand for primary goods and manufactured goods:

  Elasticity of primary commodities is low. Income that is set free by a fall in the price of e.g. food will be rather spent for consumer goods than for an increase in food consumption.

- Demand for primary goods does not increase as fast as the demand for manufactured goods.

- The larger initial capital stock in developed countries makes it possible to generate higher profits which can be reinvested in the manufactoring process.

The movement of the terms of trade is one of the most important factors affecting the trade performance of LDCs. As primary commodities are contributing considerably to the export earnings of developing countries, such movements reflect to a large extent the development of commodity prices.

The critical factor determining the trade performance of Oil Exporting Countries is the price of crude oil. Hence, the oil price shocks of 1973/74 and 1979/80 led to a substantial improvement in the terms of trade of these countries. But as demand adjusts to the higher prices, the oil price fell and the trade position deteriorated.

The terms of trade index of Non-Oil Developing Countries is strongly affected by the movements in commodity prices. With rising commodity prices, like in 1973/74 and in 1980, terms of trade indices increase, with declining commodity prices, they deteriorate.

In addition to the arguments mentioned by Prebisch-Singer, the deterioration of the terms of trade for developing countries can be explained by the following trends:

- slow economic growth in industrialized countries results in lower demand for primary goods

- substitution of natural raw materials, e.g. cane sugar has been replaced by high-fructose corn syrup in soft drinks such as Coca-Cola

- increasing tendency to protectionism in industrialized countries

- debt crisis

4) TRADITIONAL INDICATORS MEASURING ECONOMIC DEVELOPMENT

4.1) INTRODUCTION

Orthodox economic development strategies focus on the industrialization of LDCs whereby developed countries are regarded as model for what is desirable. The neo-classical economic theory considers the free-trade model to achieve through international division of labour the optimal worldwide allocation of resources and therefore also the optimal preconditions for economic development of each individual country.

Apart from the general criticism of this free-trade paradigm, as mentioned above, concerning the question whether or not free-trade is really advantageous for the development of LDCs, it arises the question whether the indicators used to prove successful economic development possess general validity for the measurement of this development.

4.2) NATIONAL INCOME AND THE GROSS NATIONAL PRODUCT (GNP)

In orthodox economic theory economic growth is the major factor determining economic development. The broadest indicators of economic growth are the gross national product (GNP), resp. the gross domestic product (GDP), calculated in the System of National Accounts.

This indicator can be defined as "the total market value of the final goods and services produced by a nation's economy during a specific period of time (usually one year), computed before allowance is made for the depreciation or consumption of capital used in the process of production. It is distinguished from net national product, which is computed after such an allowance is made" (The New Encyclopaedia Britannica, 1988). Net national product is equal to national income, whereby this "income" is defined as the income available to any economy after it has set aside a part of its output for maintaining its capital stock.

The gross national product has also to be distinguished from the gross domestic product. "National product" is what is produced by the residents of a country wherever

they provide their services (labour and capital), "domestic product" is what is produced by people living in the country, irrespective of their nationality.

Three measures of GNP are provided according to whether emphasis is put on income origin, on income distribution or on income utilisation. For questions concerning development and environmental issues, the origin of national income is of major interest.

Considering the origin of national income the GNP is calculated by summing up the values of goods and services provided by the following economic units:

- the government

- private households and private organisations, as far as their goods and services are traded on the market

- the primary industry, the processing industry and the service sector, whereby the value of goods that are used as inputs for the production of other goods are not counted. 1)

4.3) CRITICISM OF THE GNP

The maximization of welfare is supposed to be the ultimate aim of economic activities. This means that scarce resources have to be used in such a way that the thereby resulting satisfaction of wants is as great as possible. In economic policy, and also in part of economic literature, an increase in welfare is regarded to as being equivalised with the annual average growth rate of national income, or GNP.

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1. WICKE, LUTZ, "Umweltoekonomie",p. 496ff. Muenchen: Verlag Vahlen, 1989

As a result the increase of the GNP is still the major target of economic policy, whereby economic policy in developing countries focuses to a even higher degree than industrialised countries on the growth of GNP. The worldwide goal of this neoclassical growth paradigm became to make the "pie" bigger, thereby enabling everyone to get absolutely more. But the conception of national income as a welfare indicator includes substantial shortcomings.

4.3.1) THE REDUCTION TO VALUES TRADED ON THE MARKET

The GNP includes only the monetary values of goods and services that are traded on the market. Consequently, all values that do not have a price valued in money and are therefore not traded on the market are not considered for the calculation of the GNP, and vice versa.

As there does not exist a market for the following activities they are not comprised in the gross national product, although they contribute considerably to the increase resp. to the decrease of social welfare:

- Contributions provided by private households:

  The work of a housewife, the work of a mother upbringing children and the private nursing of family-members have positive welfare effects, but are not included in the calculation of the GNP. In contrast to this, work done by professional housekeepers, charwomen, governess, educators and nurses raises the national income, although this cannot automatically be equated with a rise of welfare. The marriage of the bachelor and his housekeeper reduces the GNP, even when welfare might be increased.

- Voluntary help of charitable institutions and of the church:

  Activities of these institutions are an important factor in increasing social welfare, but not comprehended in the GNP.

- The use of common goods

- The externalisation of costs:

  In the calculation of the GNP the externalisation of costs is not taken into consideration, also this non-market phenomena reduces social welfare considerably.

Summing up, it can be said that the GNP as central indicator of economic and social policy is calculated in a way, that it rises with environmental reconstruction expenses, traffic accidents, increasing illness caused by environmental degradation (like e.g. cancer), increasing advertising expenditures, a.s.o.. In contrast to that, GNP declines with energy saving, with an increase of voluntary help not only by charitable organisations, but also by self-organised neighbourhood help, with recycling, etc.. GNP acts therefore often reversely to a measure for national welfare. 2)

"EXTERNALITIES"

The term "externalities" was first used by A.Marshall (1890) who explained thereby positive economic effects. So e.g. the advantages resulting from a regional concentration of many small firms in the same business line. A.C.Pigou (1920) used the term "externalities" in a negative sense, referring to the air pollution by english factories which was not included in private accounting.

K.W.Knapp created the term "social costs" whereby "social costs may be identified as those harmful effects of private action which, under given conditions and institutional arrangements, tend to be shifted to and borne by other sectors, third persons, or the economy as a whole. Since the entrepreneur is not held accountable for these negative consequences, output is not affected and, hence, is independent of these costs" (K.W.Knapp, 1965)

The publications of K.W.Knapp, and especially his book "The Social Costs of Private Enterprises" (1950), are

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2. SIMONIS, U.E. (Hrsg); LEIPERT,C., "Alternativen wirtschaftlicher Entwicklung" in Oekonomie und Oekologie, Karlsruhe: Mueller, 1988

widely acknowledged as a seminal work in the current discussion concerning the question how to balance the consequences of economic growth with the social and environmental issues.

In recent years social costs have been sub-summed under the concept of "externalities", nowadays interpreted only in the sense of negative effects, whereby "the externalisation of costs to society (social cost problem), to future generations (inter-generation problem), and to nature (environmental cost problem)", are distinguished (U.E.Simonis, 1990).

The complex effects of the externalisation of costs can be illustrated by the following example dealing with the "ecosystem forest":

- Part of the costs from private production is beard from nature in the form of toxic emissions; these waste products discharged by individual producers lead to a concentration of pollutants in atmosphere and in waterways; as nature has only a limited carrying capacity for toxic pollutants a concentration exceeding tolerable levels first disturbs the natural balance and thereby damages the forest; when a certain "critical point" is overstepped ecological balance is destroyed and the forest looses its capacity to renew himself.

- Part of the costs are shifted to future generations, because the costs of repairing the damages to the forest might not be carried by the generation that caused them. Also part of the depletion is irreversible, like e.g. the loss of genetic potential by the destruction of the natural habitat and the breeding stock of an animal species resulting in its extinction.

- Finally, part of the costs are shifted to third persons (in this case the owner of the forest) and to society. Profit resp. utility-maximizing individuals, like e.g. industrial plants owners or car owners, affect psychical health and overall welfare of the society.

Basically, the reason for the existence of externalities lays in the principle of profit maximization resp. in the principle of the minimization of current production costs. Participants in economy achieve cost advantages and consequently also competitive advantages by the externalisation of costs. Hence, economic systems, based on the maximisation of profits and on free competition, entail quasi system-immanent the appearance of externalities.

Nowadays, the opinion predominates that externalities are nothing else than an annoying side-effect of the economic system, and that these negative effects are widely outweighed by the positive utility-effects of the prevailing economic system. The "internalization" of externalised costs, i.e. their redistribution to those who caused them, is seen as remedy for this problem.

This solution remains in the logic of neo-classical ideology, and proceeds from the assumption, that nature is measurable and can be predetermined. But in reality human beings are not able to make evident how exactly ecological balance is affected by the interference of individuals. Hence, it is very problematic to ascribe externalised costs to producers. In the case of frontier crossing problems the "internalization" of costs becomes nearly impossible. Beyond that the process of "internalization" takes a long time, is expensive, and has the character of a fire-brigade, always running after the most evident problems, while in the meantime others arise.

This widely spread practice to deal with externalities ignores the real extent of the problem. As the economy grows in complexity, non-market interdependences become more significant, thereby magnifying the phenomena of externalised costs. Externalities are not only a side-effect of the prevailing economic system, but question the major assumptions of the neo-classical free-market model, which is seen to achieve "allocative" justice with the help of the price mechanism. As prices, and thereby costs calculated on a microeconomic level differ from those on the macroeconomic level, because they exclude externalities, free-market economies do not achieve greatest possible national welfare, the supposed ultimate aim of the economy.

4.3.2) THE LACK OF CONFORMITY BETWEEN EXCHANGE VALUE AND USE VALUE

National income accounting is based on the assumption that exchange values, i.e. market prices, reflect the real social use value of a good or service. Consequently, the gross national product is a pure monetary value, calculated by summing up exchange values. Therefore socio- and eco-political negative, neutral or positive valued goods and services are included in national income accounting only to the amount of their exchange values.

As an example the GNP includes both the values of agricultural products produced with the intensive use of fertilizers and pesticides, and of those produced without chemical assistance. In calculating the GNP it is ignored that biological agricultural products have a higher social use value with regard to their positive environmental effects than common agricultural products.

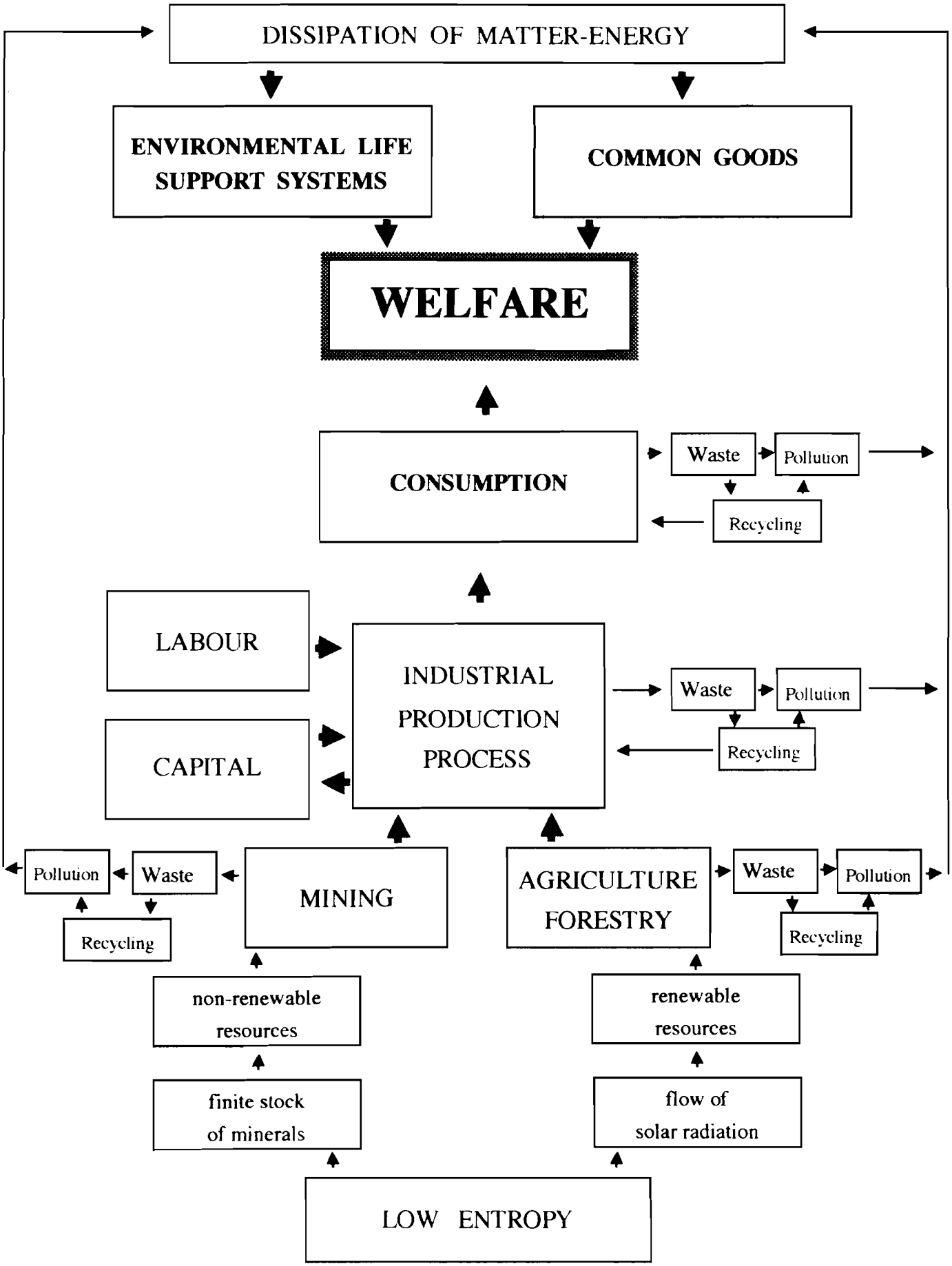
Another example for the lack of conformity between the monetary value and the use value can be given in the case of government expenditures. Public expenditures for welfare work and for environmental protection increase the GNP in the same way like public expenditures for the construction of overpayed administrative buildings, or for the construction of motorways through ecologically important areas.

This reductionism to pure monetary values has the advantage to be logically consistent in economic models with ceteris paribus assumption. But the neglect of use values for the purpose of scientific exactness reduces considerably the capability of economic theory to understand and to control the social and environmental consequences of economic activities.

4.3.3) DEFENSIVE EXPENDITURES

The gross national product registers also those expenditures needed to maintain the current level of welfare. The purpose of these so-called defensive expenditures is to equivalize those costs resulting from the industrialisation process and from economic growth. Defensive expenditures can be mainly found in

Figure 1: THE ENTROPIC NATURE OF THE ECONOMIC PROCESS



the area of environmental protection and in social and health expenses.

As an example, costs for the reduction or the elimination of environmental damages, such as the reestablishment of the ecological balance of a "dead" lake, the restoration of land eroded by intensive farming, or the cleaning of poisoned soil, increase the national income.

According to C. Leipert (1987) the defensive expenditures of the Federal Republic of Germany amounted to about 10% of GNP (155 billion DM). Taking into consideration that these expenditures do not have a welfare-effect, the national income would have to be reduced by about 10%. C. Leipert calculated that in the period 1970-85 about one fifth of the increase in GNP consisted of growing defensive expenditures, i.e of costs required to balance to negative effects of the same economic growth. For the next ten years he predicted that this trend will probably continue and become more pronounced. 3)

4.3.4) DISTRIBUTION OF INCOME AND WEALTH

The gross national product measures economic growth without considering its impact on income and wealth distribution; increasing national income is therefore able to result in declining equality of income and wealth distribution, and as a result in declining average satisfaction of needs. This problem occurs especially in less developed countries, were a rise of national income often leads to an improvement of the economic situation of the upper class.

In Argentina, e.g., per capita GDP increased from US$ 1,372 in 1975 to US$ 2,169 in 1985. However the distortion in income distribution has deteriorated in the same period as in 1975 the top 20% of total

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3. HUETING, R.; LEIPERT, C.:"Economic Growth, National Income and the Blocked Choices for the Environment", International Institut for Environment and Society (IIUG), 1987, Berlin: IIUG Report 87-10

population disposed of 43% of household income and their share increased to 49% in 1985. 4)

4.3.5) ECONOMIC GROWTH WITHOUT A WELFARE-EFFECT

The increase of the GNP only shows the improvement of the material life standard, without reflecting the real growth of welfare. This can be illustrated with the help of the following examples:

- The national income is raised when originally free goods get as a result of economic growth a market value. Thereby an improvement of welfare is pretended. As an example welfare does not rise when farm-houses cannot meet their water supply anymore from their own springs, because they are polluted with nitrates. But GNP is increased by supplying these farms with water from public utilities.

- Declining self-support of households, like e.g. the reduction of certain handicraft activities, leads to no improvement of welfare, but to an increase of national income, because these activities have to be bought on the market in the form of services.

Economic growth also can indicate growing material wealth, but have a negative welfare-effect, like in the case of an increasing cigarette and alcohol consumption.

4.4) CONCLUSION

The identification of an increase in national income with an improvement in welfare reflects a misconception of economic theory, which is based on the belief that an increase of production is supposed to be the major goal of economic activities, because the growth of production maximizes welfare. In short, under this neoclassical "growthmania" scenario society's problems, including social and environmental issues, are seen as being solved by a combination of economic growth and technological cleverness.

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4. UNITED NATIONS, Report on the World Social Situation 1989, p.39, New York: U.N. Publication

The ideology of growth thereby ignores ecological and social limitations: the fact that economic growth is seriously endangering nature which is the basis of our existence, because we live in a finite world were continual growth is biophysical impossible; the fact that some of the damages to nature are irreversible; the fact that certain production factors are absolutely scarce, because technology cannot substitute old resources for new ones without a limit and the fact that technology cannot get us out of all growth-induced problems.

The major restraint to pure material growth lies in the dependence of human beings on the "public service" functions of vital ecological systems, like e.g. the maintenance of the quality of the atmosphere, the disposal of our wastes, the generation of soil, the run of the hydrological cycle, and so on. Our civilisation cannot exist without these services rendered by ecological systems. Consequently, from the point of view of long-term human welfare the damage caused to these systems by pollution entails ecological costs of growth which will become in a non distant future higher than society can pay.

As considerable research already has been done on the undesired outcomings of the growth ideology it now arises the question how to adapt or to change our dominant economic system to enable mankind to live in peace with each other and with nature.

PART 2 - SUSTAINABLE DEVELOPMENT

INTRODUCTION

> "When a problem resists us in spite of great research efforts, we must doubt about its major assumptions. Imagination is then more important than knowledge."
>
> (Albert Einstein)

From the analysis outlined in Part 1 the dilemma of economic theory and the resulting economic policy becomes obvious.

More than 200 years ago Adam Smith first laid out the principles of classical economic theory, deeply rooted in the mechanical paradigm which claimed to explain the world with the tool of logical and mathematical principles and thereby neglected quality and emphasised only on quantity. Nature was regarded as indestructible, and it was absorbed under the variable "capital". Human beings regarded themselves as independent from natural laws and thought that nature can be manipulated according to their will.

However, it has now become clearly evident that the complexity of nature cannot be demonstrated by pure mathematical formulas and that it cannot be manipulated by man without un-desired consequences. Even though the mechanistic paradigm has lost its importance in physics and philosophy long time ago, the basic concept of the economic system as a kind of mechanical process still remains very much alive.

The center of economic models are still completely closed systems in which supply and demand functions are readjusted by the price mechanism, even though various qualifications and refinements have been added to them over the years.

1) REDEFINING DEVELOPMENT: SUSTAINABLE DEVELOPMENT

"There are many dimensions to sustainability. First, it requires the elimination of poverty and deprivation. Second, it requires the conservation and enhancement of the resources base which alone can ensure that the elimination of the poverty is permanent. Third, it requires a broadening of the concept of development so that it covers not only economic growth but also social and cultural development. Fourth, and most important, it requires the unification of economics and ecology in decision making at all levels." (Prime Minister Gro Harlem Brundtland, Sir Peter Scott Lecture, Bristol, 8 October 1986)

It arises now the question how to realise the "harmonisation" of economic and ecological principles to secure sustainable development. The purely quantitative economic theory has therefore to be adapted to a finite physical and biological world as well as to social behaviour, i.e., the biophysical and the social dimension of economic activities has to be accepted by economists.

2) THE BIOPHYSICAL DIMENSION - ECONOMICS FROM THE VIEWPOINT OF THERMODYNAMICS

2.1) THE ENTROPY LAW

As the laws of mechanics regarded physical processes to be reversible, they could not explain the irreversibility of thermic processes, i.e. that heat always moves from hotter to colder bodies, while the reverse process never was observed in nature without external intervention. Therefore, a new branch of physics using nonmechanical explanations had to be created: thermodynamics.

In 1865 the german physicist Rudolf Clausius was able to define the first two laws of thermodynamics:

- The energy of the universe (as a closed system) remains constant
- The entropy of the universe at the same time moves towards a maximum

The first law of thermodynamics, also known as the law of conservation of energy, states that energy can neither be

consumed, nor created, nor destroyed. It is only transformed from matter into energy, and from one state to the other, like e.g. from kinetic energy to heat. According to this law the quantity of energy remains the same within a closed system, and can therefore be unlimitedly used.

The second law of thermodynamics, the Entropy-Law, restricts the concept of unlimited use of a given quantity of energy. It shows the direction of transformation, and states that every time energy is transformed from one form into another, a certain amount of available or free energy to perform useful work in the future is transformed in unavailable or bound energy. As an example the energy contained in a piece of dry wood is free energy, available for useful work; when the piece of wood is burned the initial free energy becomes dissipated in the form of heat, smoke and ashes.

Entropy thereby is the measure of the amount of energy no longer available for the conversion into useful work within a thermodynamic system. As bound energy can be regarded as chaotically dissipated energy, entropy is also defined as a measure of disorder. The natural development of closed systems implies a constant shift from order to disorder, from low entropy to high entropy. The state of maximum entropy is that in which available energy has become totally unavailable. This state is the equilibrium state of a thermodynamic systems. As no free energy is available for organic life an equilibrium state means death.

2.1.1) NEGATIVE ENTROPY - THE BASIC FOR ORGANIC LIFE

The basic precondition for life on this planet is the existence of free energy, i.e. negative entropy. Living beings survive by being able to absorb this energy for building up and keeping alive their organism. Thereby, they dissipate energy and increase the entropy in their environment.

Looking at the biological evolution of ecosystems it can be observed that ecosystems in the early stage of colonization tend to maximize the flow-trough of energy. But when an ecological habitat is filled up by various species, they have to adapt to the carrying capacity of this environment by using more efficiently less energy flow-trough. This later stage in the evolution of ecosystems is called the climactic phase.

In the words of Jeremy Rifkin "homo sapiens has yet to move from a colonisation to a climactic phase. Human beings, especially in the highly industrial societies, continue to order activity in such a way as to increase energy flow-trough in both the human and the social

systems. The worldwide human crisis today is a crisis of transition. In the next age, humanity will have settled into its climactic phase, ordering its activity in such a way as to minimize energy flow-trough in the human and social process. If it doesn't, it will likely go the way of other species who were unable to make the transition in the past. Life's epic is strewn with extinct species; it would have little trouble accommodating at least one more on the long list of names." 1)

The demand for a shift to a climactic society requires the detachment from the spirit of conquest and expansion which is anchored in the concept of constant growth and in the trust in technology as a remedy for societies' problems. The transition to a climactic mode of existence would therefore depend on our willingness to live cooperatively with the rest of our ecosystem.

2.2) THE ENTROPIC NATURE OF THE ECONOMIC PROCESS

Considering the economic process from the purely physical viewpoint matter-energy enters into the economic process in a state of low entropy and comes out in a state of high entropy. Nicholas Georgescu-Roegen has formulated this more drastically: " what goes into the economic process represents valuable natural resources and what is thrown out of it is valueless waste" 2).

The economic process is therefore based on the continuous flow of low entropy. Consequently, a necessary condition for the existence of human civilisation is to have low entropy. Hence, in entropy terms economic activities always result in a deficit, because they are based on the use of available matter and energy. The increase of entropy is therefore the price mankind has to pay for going beyond biological limits.

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1. RIFKIN, JEREMY, "Entropy: A New World View", New York: The Viking Press, 1980, p.54

2. GEORGESCU-ROEGEN, NICHOLAS, "The Entropy Law And The Economic Problem", in Economics, Ecology, Ethics, edited by Herman E.Daly, 1980, San Francisco: W.H. Freeman and Company, p.51

2.2.1) THE MYTH OF SUBSTITUTION AND TECHNOLOGY

Industry and the mechanized agriculture depend on the input of natural resources. Although the scarcity of key resources is less imminent than it was feared by the Club of Rome report "The Limits to Growth", it cannot be denied that some of these resources will be exhausted in the foreseeable future. Under the assumption of 1988 production levels the known reserves of zinc and tin which could be economically extracted will secure supply for the next 21 years; those of lead and mercury for the next 22 years. 3)

Looking at the world's non-renewable energy resources the situation is even more worrying. Assuming 1988 consumption levels and reserves, coal will last for the next 200 years, while the equivalent figure for natural gas is only 58 years and that for oil 41 years. As oil provides about 40% and natural gas about 20% of world energy it is obvious that our current dependence on these resources has to fall considerably. 4)

Through the discovery of new sources, recycling and substitution, these reserves will probably last longer, but that does not change the fact that they are scarce in any case. In economic theory absolute scarcity of resources is neglected and it is argued that technology will always find a substitute for a scarce resource. In addition to that technology is regarded to be able to constantly increase the efficiency of the use of resources.

From the entropic viewpoint it can be replied that substitution within a finite stock of available energy cannot go on forever, even not with the help of the most sophisticated technology. Technology also operates under the two thermodynamic laws and can therefore be regarded as a transformer of available into unavailable energy. In this context the efficiency of technology can be defined as the ratio of useful work to total energy flow, taking into consideration the increase of entropy produced by a technological process, and the fact that technology creates islands of temporary order thereby increasing and reinforcing the disorder of the global environment. This entropic character of technologies involves that new technologies inevitably have unforeseen, and generally very negative environmental and social consequences.

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3. WORLD RESOURCE INSTITUTE, World Resources 1990-1 New York: Oxford University Press, p. 322f.

4. Ibid. p.144f.

The vision of a 100% recycling of resources is also shattered by the thermodynamic laws. Recycling also requires more free energy for input than the output on free energy can amount to. It might give the impression that obtaining a raw material by recycling requires less energy than extracting it from natural resources. But considering the energy required for collecting, separating and transporting the waste to the recycling plant, makes this impression change. The more disperse the waste is and the more complex the technology required for recycling becomes, the less the energy output will be compared to the input of free energy. This can be illustrated by the idea that the sea could in future become the source for raw materials, because it embodies a multitude of dissolved minerals. But in reality the concentration of these substances is so low that a technology efficient in entropic respects will probably never make their extraction possible. As an example the oceans contain about 7,5 million tons of gold; that is 0,005 gramme in a million litres of water. 5)

Technological processes therefore have an entropic character; the total entropy of all outputs taken together will always be greater than the total entropy of all inputs taken together. Nevertheless, there is an enormous potential for technology to develop processes enabling human beings a life nearer to reconciliation with nature. But technology will never be the remedy for all growth-related problems. To put it in other words: "There are some fixed limits to technological innovation, placed there by fundamental laws of nature, regardless of the cleverness of future inventors." 6)

Therefore the idea of unlimited possibilities in our limited world has to be reconsidered urgently. Man has to come to terms with the fact that he and his inventions are only part of the nature; he will never have the power to influence and manipulate nature according to his will.

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5. GRUHL, HERBERT, "Ein Planet wird gepluendert", Frankfurt: Fischer alternativ, 1978, S 113f

6. EHRLICH, PAUL R. and ANNE H.; HOLDREN, JOHN P., "Availability, Entropy, And The Laws Of Thermodynamics", in Economics, Ecology, Ethics, edited by Herman E.Daly, 1980, San Francisco: W.H.Freeman and Company, p.45

2.2.2) POLLUTION AS AN INCREASE IN ENTROPY

The economic production process uses raw materials as an input and transforms them with the help of energy into goods. The diffusion process of matter starts with the extraction from deposits, continues with the conversion to goods, and ends with the leave-behind of waste, thereby burdening air, water and ground in the form of pollution. Hence, pollution can be defined as the increase of disorder in a thermodynamic system and is consequently equivalent to entropy. Matter is harmless for living beings, as long as it is left in its natural deposits, and can represent a threat when it is dissipated in the atmosphere, often after having being entered into a new combination in the process of combustion.

"The industrialized human being has become a natural disaster; if he does not find a way to reduce the consumption of resources, he endangers his survival. The increasing disorder in our world forces a reflection on the concept of progress, economic growth and quality of life." 7)

2.3) A MODEL OF THE ENTROPIC NATURE OF ECONOMIC ACTIVITIES

The entropic nature of the economic process is illustrated in Figure 1. The main object of this Figure is to show the negative impact of the maximization of only one variable which increases welfare, i.e. consumption, upon two other variables which also contribute to the increase in welfare, i.e. environmental life support systems and common goods. The Figure also demonstrates that economic activities generate waste and thereby pollution not only in the sense of unwanted by-products. As matter cannot be destroyed, everything ultimately ends up as waste, and therefore returns in some form into the environment. This includes the originally intended products themselves.

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7. BINSWANGER, H.C.; FRISCH, H.; NUTZINGER, H.G.; SCHEFOLD, B; SCHERNHORN, G.; SIMONIS, U.E.; "Arbeit ohne Umweltzerstoerung", Frankfurt: Fischer alternativ, 1988, S 79

2.3.1) ENVIRONMENTAL LIFE SUPPORT SYSTEMS

The life of human beings and consequently their welfare depend on "environmental life support systems" which maintain the working of the ecosphere. These include the regulation of the climate, the water cycle, the carbon cycle, the oxygen cycle, the self-regulation functions of ecosystems and the maintenance of genetic diversity. By maximizing consumption to increase welfare these complex systems are more and more burdened with the waste of the industrial production process. This increasing amount of waste generated in the economic process cannot be absorbed by natural cycles of the life support systems. Hence, it is concentrated in the form of pollution, thereby negatively influencing the balance established by natural cycles and causing harmful effects on living species.

The destruction of the protective stratospheric ozone layer and acid rainfall are examples for the negative impact of human economic activities on the environmental life support systems which again directly affect the health of man, animals and plants.

Looking at the effects of ozone depletion the immediate consequences for human beings are an increase in skin-cancer. About 10,000 people are dying world-wide from skin cancer every year, whereby the incidence rates of melanoma increases steadily. In the U.S.A., e.g., the number of white-coloured people falling ill with the most dangerous cutaneous (maligant) melanoma rised over the past 35 years by some 200% and accounts for about 7,800 deaths annually. 8) In Australia over the last 50 years, deaths from melanoma in both males and females increased each year by 5%. In other countries the equivalent rate is rising by 3-7% per year. The association between skin melanoma and exposure to UV-radiation has been proved by several studies. The US Environment Protection Agency, e.g., have calculated that a 1% decrease in the concentration of the ozone layer will rise the incidence rate of basalcell and squamous-cell carcinoma by 1-3%; mortality rates caused by melanoma are predicted to increase by 0.8-1.5%. 9)

Although the immediate implications on our health might be frightening, the effects on plants and animals are even more serious for human beings because food

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8. WORLD RESOURCE INSTITUTE, World Resources 1990-1, New York: Oxford University Press, p. 63f.

9. UNEP, Environmental Data Report 1989/90, p.352 Oxford: Alden Press

production is endangered. An examination of 200 cultivated plants has shown that more than half of them were damaged by a further increase in UV-radiation which led to a lowering of crop yield. Even more serious are the effects on the phytoplankton in the oceans which are in the ecosystem "ocean" the primary energy converters and the first stage in the food chain. An increase in UV-radiation would reduce the phytoplankton and thereby also the diversity of species in oceans. 10)

Another example for the outcomes of the risky interference of human beings in ecosystems is the "greenhouse effect" which is caused by the exhaustion of the environment's waste absorption capacity. It is estimated that the global mean temperature will increase by 1 degree till the year 2025, and that it will be 3 degrees above today's before the end of the next century (i.e. about 4 degrees above pre-industrial age). The temperature increase will be faster over land than over oceans, reinforcing regional and seasonal inequalities in distribution. By the year 2030, in central north america it is estimated that the warming will vary between 2 to 4 degrees in winter and between 2 to 3 degrees in summer; soil moisture thereby would decrease by 15 to 20% in summer, which would significantly change crop production patterns 11). Even though there are those who sharply reject the actual existence of global warming, the fact remains that the continuous interference of human beings in the ecological equilibrium of the atmosphere brings about the risk of unexpected changes that destroy the working capacity of this life support system. In other words, what we should actually ask ourselves is whether or not man is willing to continue carrying out a world wide climatic "experiment" he has already embarked himself on, even if the high risk is already well known.

Nowadays, human interventions in ecological systems violate the limits imposed by the absorption capacity of natural life-support systems beyond which lies ecological disaster. Sustainability therefore requires the acknowledgement of the fact that ecosystems have a limited carrying capacity to absorb pollution produced by

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10. GRIESSHAMMER, R.; HEY, C.; HENNICKE, P.; KALBERLAH, F.; "Ozonloch und Treibhauseffect" p.15f., Hamburg: Rowolth, 1989

11. IPCC (Intergovernmental Panel of Climat Change), "Climate Change, The IPPC Scientific Assessment" edited by J.T.Houghton, G.J.Jenkins and J.J. Ephraums, Great Britain: University Press Cambridge, 1990

human beings in the economic process. The idea of carrying capacity implies that natural systems can only bear a certain amount of interventions from the outside. Beyond a certain level of burden caused by interference in the natural cycles of ecosystems there is degradation and no recuperation any more, and, of course, no sustainable utilization.

2.3.2) COMMON GOODS

The life of human beings is equally dependent on the existence of "common goods". Common goods are those goods which are publicly available for the individual use, like e.g. air, the oceans, rainwater, fauna and flora. The "tragedy of the commons" is caused by rational, utility-maximizing decisions of individual actors on a microeconomic level which seek to reduce their own costs by "externalizing" costs. Although no individual actor might deliberately intend to cause environmental damage, this might be the result of their collective action on a macroeconomic scale. As an example industry releases into the air and into the water over 70,000 different chemicals, of which at least 80% are inadequately tested for their effects on living species. 12)

The oceans are a classical example for a global common good. Most of the wastes and contaminates produced by human beings finally reach them by natural run-off from the land or by direct dumping. Oceans always absorbed large quantities of minerals washed down from the land. But the run-off caused by the economic activities of human beings is much higher than the one caused by nature: mercury two-and-a half times the natural rate, zinc, copper and lead about 12 times, antimony 30 times, and phosphorus 80 times. 13) Heavy metals and chemicals enter the marine food chains and build up their concentrations in higher species. Man often discovers to late, like e.g. in the case of DDT or mercury, the dangerous effects of ocean pollution.

A special type of common goods are the public goods. In addition to the fact that nobody can be excluded from their use, their characteristic is that they cannot be devided into separate parts, like e.g. air. In this case

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12. MYERS, NORMAN; "The Gaia Atlas of Future World", p.30 London: Gaia Books Ltd., 1990

13. MYERS, NORMAN, " The Gaia Atlas of Planet Management" London: Gaia Books, 1985, p.84f.

the "free-rider problem" occurs. Individuals want to benefit from public goods, but as they cannot be excluded to do so, they are not willing to pay for the "production" and "maintenance" of these goods.

Summing up it can be said that short-sighted considerations lead to the depletion of the common goods, having in the long run a negative impact on human welfare. Hence, a sustainable development policy has to consider the macroeconomic dimension of the decisions made by individuals on a microeconomic level. As the environmental damage caused to the commons can in general not be restricted to national territories only international agreements will bring about a solution for the present environmental problems. 14)

2.3.3) NATURAL RESOURCES

The basic input for the industrial production process are natural resources. In the beginning of the 1970's the awareness of the scarcity of non-renewable resources already began to develop. This was made evident by the Club of Rome report "The Limits to Growth". But, due to the discovery of new reserves, the substitution by other materials and recycling, many of the predictions which were made about non-renewables being exhausted have been proved to be false. Nowadays, the concern about an exhaustion of non-renewable resources stays upright, but is not seen any longer as a main constraint to economic activities. The depletion of renewable resources is regarded as a more critical issue with a more negative impact on human life, putting also serious constraints on economic activities.

The deforestation of tropical forests is an example for the depletion of a renewable resource. According to a 1980 FAO assessment the estimated annual rate of closed forest cleared in the tropics amounted 114,000 sq km. But recent studies have shown, that deforestation is much higher. These new studies estimate that up to 204,000 sq km of tropical forests are destroyed every year. In Brazil, e.g., 80,000 sq km of closed tropical forests were cleared in 1987, compared to the 14,800 sq km estimated by the FAO. 15) Only about 10% of the destroyed tropical forests are reforested, including plantation forests which are usually monocultures. Even if

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14. HOLLICK, A., "Management of The Global Commons", in "Sustaining Tomorrow", edited by F.R. Thibodeau and Hermann H.Field, London: University Press of New England, 1984

15. WORLD RESOURCE INSTITUTE, World Resources 1990-1, New York: Oxford University Press, p. 102f.

reforestation takes place tropical forests ecosystems need up to a century to regrow and several centuries to reach a new climax stage.

The widespread effects of the fast clearing of tropical forests are hard to assess. Available studies often produce contradictory data and beyond that human beings are probably not yet able to disclose all possible impacts of this deforestation. Without doubt clearing of tropical forests has a serious impact on the carbon cycle. About 450 billion metric tons of carbon are stored in the world forests; that is 20-100 times more carbon than stored in an comparable area unit of croplands. When forests are cut down their capacity to absorb carbon from the atmosphere gets lost. In addition to that it is estimated that annually 2.8 billion metric tons carbon are released into the air by deforestation. Hence, the clearing of tropical woods contributes to the "green house" effect in two different ways. 16)

With the help of their roots tropical forests bind up to 95% of precipitation in the ground and release this stored moisture only slowly. This regulates the water balance in tropical regions. Deforestation entails the loss of this water storage capacity and can therefore result in inundations. The countries at the foot of the Himalayas are the worse affected by damages produced by flooding and by the alluvion of mud and debris. India, e.g., spends every year about US$ 1 billion for the reparation of damages to irrigation systems and water reservoirs and for flooding-damages caused by the clearing of tropical forests. 17)

Another outcome of the fast clearing of tropical forest is a loss of biodiversity caused by destroying wildlife habitats. Till to the year 2000 it is estimated that 20% of all animal and plant species will become extinct due to deforestation in the tropes. Human beings thereby destroy one fifth of the genetic potential that would otherwise be available for medicine and agriculture to serve as basis for further developments. 18)

Hence, sustainability calls for an effective management of renewable and non-renewable resources. The basic approach to an effective management for renewable

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16. Ibd. 111f.

17. WICKE, L.; HUCKE, J., "Der oekologische Marshallplan" Muenchen, 1989, p.47

18. Ibid. p.41

resources lies in the concept that resources must be used on the basis of a sustainable yield. This concept implies that each unit of land or water has a certain carrying capacity, i.e., that there is a finite yield that can be derived from each unit. An utilization going beyond the carrying capacity of a certain unit seriously affects the units ability to produce further yields. In the case of non-renewable natural resources sustainability demands for a conservation policy with regard to future generations. On top of it, this implies a breaking with the dependence of our current economic system on non-renewable energy resources. It also implies the exhaustion of all possible opportunities for substitution, for effective materials utilization and for recycling.

2.3) THE REORIENTATION OF ECONOMICS

Classical economic theory has shown considerable shortcomings in dealing with the crisis in the development of the world economy. From the viewpoint of the entropy paradigm "the economic and ecological disaster of the planet" is the direct result of "not acknowledging this principle (the entropy law) and ignoring the necessity to reorient the economic policy around this ultimate truth". 19)

2.3.1) RECONSIDERATION OF ECONOMIC VALUES

Orthodox economic theory regards the economic process to transform valueless things into economic assets by man's labour (D.Ricardo, 1817). In contrast to this the two first laws of thermodynamics show that matter-energy cannot be created by human work; it is rather transformed in an inverse direction, from an useable into an unuseable form. In each stage of the economic process energy is extracted from the environment, part of it is absorbed by the goods processed, and part of it becomes unuseable in the form of pollution. Thereby human beings create islands of high entropy, like e.g. towns, at the expense of increasing entropy in the surrounding environment.

Hence, economic activity is regarded as "transformation of the amounts of existing available energy from a useable into an unuseable state, offering, however

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19. DRAGAN,J.C.; DEMETRESCU M.C., "Entropy and Bioeconomics - The New Paradigm of Nicholas Georgescu-Roegen", p.146 Milano: Nagard Srl Editrice, 1986

"temporary utilities" satisfying people's needs on the line of this transits". 20)

From the pure physical entropic viewpoint the economic process produces only useless waste. Consequently, the question arises as to what the reason for such a process could be. "The answer is that the true "output" of the economic process is not a physical outflow of waste, but the enjoyment of life." N.Georgescu-Roegen thereby argues that "low entropy is a necessary condition for a thing to have value. This condition is, however, not sufficient. The relation between economic value and low entropy is of the same type as that between price and economic value." 21) This parallelism means that nothing can have an economic value without having low entropy, but that things may contain low entropy and no economic value, like e.g. a plant that cannot be used for the satisfaction of human "needs".

2.3.2) RECONSIDERATION OF THE MECHANISM OF PRICES

In classical theory the price mechanism is regarded to solve the problem of scarcity. But as long as not all parties concerned can participate in the decision making process this mechanism is producing misleading results. First, there is nature, directly affected by economic activities, but not having a right to vote for directing the economic process. Secondly, future generations are excluded from the market of today. Consequently, they cannot stop the lavish utilization of non-renewable energy resources.

The assumption of orthodox economic theory that the price paid by a purchaser reflects the production costs is defeated because externalities are excluded. The price mechanism used in orthodox economic theory represents the preferences of the current generation and does not consider the questions of intergenerational equity and of our responsibility for future generations. 22)

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20. Ibid. p.147

21. GEORGESCU-ROEGEN, NICHOLAS, "The Entropy Law and the Economic Process", p.282, U.S.A.: Harvard University Press, 1971

22. For detailed information see the recent paper of NORGAARD, RICHARD B., "Sustainability as Intergenerational Equity: The Challenge to Economic Thought and Practice", Berkeley, California, 1991

2.3.3) RECONSIDERATION OF ECONOMIC DEVELOPMENT

Human beings dispose of two sources of low entropy which differ from each other considerably: first, the finite stock of mineral resources in the earth's crust, and second, the flow of solar radiation. Mineral resources in the crust of our planet are finite, and the rate at which we use these resources depends largely on our own decision. In contrast, the flow of the sun's radiation will continue for another five or six billion years and is thereby relatively infinite; but the rate at which solar energy reaches the earth is strictly limited. Consequently, these two sources of low entropy are scarce. Orthodox economic theory would argue in the inverse direction: a general scarcity of resources is neglected, because technology is considered to be able to find always new substitutes.

Agriculture and mining can therefore be regarded as the basis of the economic process. Agriculture, because it transforms solar energy into food, and mining because it extracts mineral resources needed as an input for the industrial process. As time went on traditional agriculture became mechanized and supported by chemical fertilizers and pesticides. In this way agriculture itself became an entropic process, with energy no longer being obtained only from the sun. Without doubt the mechanization of agriculture and also the progress made in biology resulted in an substantial increase in productivity. However, this advantage is not free of charge; the price is the permanent diminution of the low entropy stock available on earth. It may be right that with the help of a well-organised mechanized agriculture a world population up to 11 billion people can be fed 23); but the question is: For how long?

This can be illustrated by a study of the IUCN (International Union for Conservation of Nature and Natural Resources) which estimated that if current rates of land degradation continue, one third of the world's arable land will be destroyed in a period of twenty years (from 1980-2000). In the same period the remaining area of tropical forests will be halved, and world population will increase by almost 50% 24).

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23. WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT: "Our Common Future", p.98f., Oxford: Oxford University Press, 1987

24. DASMANN, RAYMOND F., "An Introduction to World Conservation", in Sustaining Toworrow, p.19 edited by Thibodeau, Francis R., Field, Hermann H. Hanover: University Press of New England

Not only the productivity of agriculture is limited by the scarcity of the earth's resources, but also industrial growth. If really every single land would somehow manage to build up a modern industry we would soon realize that mineral resources are to scarce to maintain this immense industrial capacity in the long run.

"If divested of all the obstructive grab donned on it by the growth models now in vogue, economic development boils down to only two elements: development proper, i.e., the innovation of finer sieves for the sifting of low entropy so as to diminish the proportion of it that inevitably slips into waste, and pure growth, i.e., the expansion of the shifting process with the extant sieves." 25)

Summing up, it can be said that the transition of free energy to bound energy by the economic process results in the fact that less energy is available to be used by others in the future. As a consequence, economic development as it is usually practiced nowadays may be beneficial for us and for those who might enjoy it in the near future. But for future generations and therefore mankind as a whole this development will definitely have a negative impact.

However, it must be considered that human beings, even if they would be aware of the consequences of the reduction of free energy by economic activities, might not be willing to renounce at the luxury provided by the current economic system for the benefit of the future generations. It arises the question if it is "perhaps the destiny of man to have a short, but fiery, exciting and extravagant life rather than a long, uneventful and vegetative existence". It is our own decision if we "let other species - the amoebas, for example - which have no spiritual ambitions inherit an earth still bathed in plenty of sunshine." 26)

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25. GEORGESCU-ROEGEN, NICHOLAS, "The Entropy Law and the Economic Process", p.294, U.S.A.: Harvard University Press, 1971

26. GEORGESCU-ROEGEN, NICHOLAS, "Selections From Energy And Economic Myths", in Economics, Ecology, Ethics, edited by Herman E.Daly, 1980, San Francisco: W.H. Freeman and Company, p.74

7) THE SOCIAL DIMENSION

7.1) INTRODUCTION

"Growth chestnuts have to be placed on the unyielding anvil of biophysical realities, and then crushed with the hammer of moral argument. The entropy law and ecology provide the biophysical anvil. Concern for future generations, subhuman life, and inequities in current distribution of wealth provide the moral hammer." For cracking the "nut of growth mania" it is not sufficient to "hammer from above with moral arguments" 1) because there remains enough room to escape provided by optimistic biophysical assumptions. But only placing the "growth chestnut" on the "anvil" supplied by natural science is also not sufficient to smash it. In order to tackle the shortcomings of our economic system, the biophysical dimension, as well as the social dimension have to be taken into consideration.

Nowadays, human beings find themselves on a kind of crossroad were they are free to choose the direction. They can either choose the from a short-term viewpoint, more convenient way of a "business-as-usual" growth mania scenario; or they choose the pretentious way of a sustainable society scenario whereby human beings would have to accept that nature puts limits to economic growth and adapt their values, their social behavior, and their economic structures to this fact.

Which way mankind decides to pick out is not so much a question of the lacking evidence of environmental degradation, but rather a moral and social question. Everybody who seriously occupies himself with the consequences of human interference in biological systems is perfectly aware of and understands the destructive nature of these interventions. Even in politics there is nowadays a general consensus about this fact and there seems to be willingness to execute changes of current structures. To what extent the changes of social and economic structures towards an ecological adjustment will be actually implemented remains to be seen.

The main obstacle for choosing the right way on the crossroad lays in the human nature itself. Human beings of the 20th century are mainly short-term planners, in

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1. DALY, Herman E., "Entropy, Growth, and the Political Economy of Scarcity", in Scarcity and Growth Reconsiderd, p.72 edited by V.Kerry Smith, 1979 Baltimore: The John Hopkins University Press

general materialistic and egoistic, and follows the neo-classical principle: "In the long run we are all dead". The protection of the environment, it is feared, might require a reduction of the "high" living standards to which the affluent societies in industrialised countries have get used to and which are eagerly aspired and pursued by developing countries.

However, when environmental damage is ignored, there will come the time when the depletion of resources, the impairment of life support systems and the exceeding of the absorptive capacity of common goods will force human beings to readapt their consumption patters whether they want or not. At present we still have the choice to implement ecological programmes step-by-step giving way to a gradual evolution.

This, however, will not be a choice for much longer, as the time will unforcedly come in which it will become imperative to adapt current social and economic structures to the boundaries imposed by the environment. As long as we have this choice we should make use of this unique chance in order to steer a shift towards a sustainable society. To wait until environmental constraints force us to do so, will certainly be the more painful path.

To what extent people will really make use of this chance will depend to a large extent on the awakening of their environmental awareness. How now to push ahead the process which leads to a strengthening of the awareness with respect to environmental issues?

7.2) STANDARD OF LIVING AND QUALITY OF LIFE

7.2.1) DEFINING THE STANDARD OF LIVING AND THE QUALITY OF LIFE

Usually, the term "standard of living" is equated with disposable income and is measured by economists by using average gross domestic product per capita. This narrow interpretation implies that private consumption alone is responsible for the well-being of human beings. It ignores that every individual benefits from the collective consumption of both public and environmental services.

Public services, such as education, health care and public security, are financed by taxes and duties. They also contribute considerably to the personal well-being of every individual. Therefore, a comparison between the

per capita GDP of two nations is not sufficient to find out where the standard of living is higher. In 1987, the per capita GDP of, e.g., the Netherlands amounted to US$ 14,792, the equivalent number of the United Arab Emirates to US$ 16,200; but while public health expenditures totaled at US$ 540.40 per capita in the Netherlands, the United Arab Emirates only spent US$ 185.00 per year for each individuals' health. The educational expenditures are with US$ 319 per capita in the United Arab Emirates also much lower than the US$ 691 spent annually for each individual in the Netherlands. 2)

For assessing the living standard of a nation it is therefore necessary to include per capita spendings for public services. In practice, these expenditures for social security and welfare are used to calculate the living standard in a broader context.

However, this interpretation of the living standard does still not take into account the use of environmental services on which the welfare of our society ultimately depends. The deterioration of the air quality, the growing burden by noise pollution and water pollution, the destruction of the beauty of the landscape and the extinction of animal and plant species, will make feel people that their standard of living is declining even if their disposable income is increasing.

The growing awareness that individual welfare cannot be reduced to pure material human needs, and can consequently not be equated with consumption levels has led to a discussion concerning a new-definition of political objectives. The term "quality of life" has been implemented in common usage for expressing those needs of human beings which are essential for individual welfare, but which cannot be satisfied with the help of the disposable income being available to each individual. These are common goods, such as air, environmental services, like the water cycle, and non-material goods. Although a general accepted definition for the term "quality of life" does not yet exist it has become a keyword for political measures and a large number of scientific publications have been written about this topic. 3)

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2. KURIAN, Georg T., "The New Book of World Rankings" Oxford: Facts On File, 1991, p.234, p.248

3. LEIPERT, C.; SIMONIS, U.E., "Alternativen wirtschaftlicher Entwicklung" in Oekologie und Oekonomie, p.105 edited by U.E.Simonis, 1989 Karlsruhe: Mueller

The broadest interpretation of the standard of living would now have to include the "quality of life" concept. Hence, the standard of living would comprise:

- the private consumption made possible by each individual's disposable income,
- the collective consumption of public services,
- the consumption of common goods, of environmental resources and services,
- and of predominantly non-material components of the standard of living, like e.g. the satisfaction of cultural, psychical, social and ethnic needs.

Considering the complex needs of human beings, such a broad definition of the living standard is more reliable for measuring the welfare of a nation than the pure monetary indicator of GDP per capita which simply reduces human needs to consumption.

7.2.2) THE INVERSE RELATIONSHIP BETWEEN DISPOSABLE INCOME AND THE QUALITY OF LIFE

Programmes which aim at the reparation of environmental damages and at the protection of nature require in general either public or private financial support.

This can be illustrated by a study undertaken by the International Institute for Environment and Society (IIES) of the Science Center in Berlin has which calculated the total expenditures for environmental protection in West Germany. In 1984, these expenditures amounted to DM 10.9 billion in industry and to DM 11.8 billion from the government. In 1985, the sum increased to nearly DM 13.6 billion in industry and to DM 13.2 billion from government. For the other economic sectors, i.e. primary production and services, it was estimated that at least 0.7 billion went into investments for environmental protection and the same amount into operating expenses. Hence, total environmental expenditures for waste disposal, water and air pollution control, and noise reduction amounted in West Germany to about DM 24.1 billion in 1984, and to DM 28.1 billion in 1985. 4)

This calculation of total environmental expenditures includes only estimates about environmental protection expenditures in primary production and in services,

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4. LEIPERT, C.; SIMONIS, U.E., "Environmental Protection Expenditures, The German Example" p.15 Science Center Berlin, 1988, 1989

because there is no adequate data available. The costs of environmental protection activities of private households are not comprised.

Even though environmental protection expenditures in West Germany amounted to DM 28.1 billion in 1985, the annual damage inflicted to the environment in that country exceeded considerably this figure. According to a study of Wicke et al. the estimated annual damage to the environment amounts to DM 103.5 billion, that is almost four times the amount spent on environmental protection, or roughly 6% of the country's GNP. The estimation of the environmental damage was based on quantifiable environmental damage. Air pollution ranked first with approx. DM 48.0 billion, followed by noise with more than DM 32.7 billion and by water pollution with DM 17.6 billion. Soil contamination ranked with DM 5.2 billion on the last place. 5)

This study makes clearly evident that the annual damage to the environment is still much higher than the annual amount spent for environmental protection and that the securing or the improvement of our current "quality of life" will make it necessary to raise over the following years even larger amounts of money.

The protection of our environment is usually financed either by public expenditures or by investments undertaken in the primary, manufacturing and service sector. This, however, implies that private households are the ones who ultimately will have to bear the additional costs required to carry out environmental protecting measures. Public expenditures are financed by taxes and duties which are charged to individuals; environmental protection investments undertaken by the industrial sectors will to a large extent be transferred to consumers in the form of higher prices. Hence, the protection of our environment which is in general consumed collectively without adequate payment will lead to a smaller amount of income available for the private consumption of each individual.

The extent to which people are willing to sacrifice disposable income available for private consumption for the collective consumption of the environment, depends primarily on their environmental awareness.

When environmental expenditures are used in such a way that each individual is immediately aware of the positive impact on his "quality of life", like e.g. in the case of

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5. WICKE, L, et al., "Die oekologischen Milliarden" Muenchen: Koessel, 1986, p.123

noise abatement or water pollution control, these improvements in the quality of life will probably be valued higher than the loss of disposable income required to pay for them. The interrelationship between the willingness to sacrifice part of the private disposable income and the thereby achieved improvement in the quality of life gets more complex when environmental problems are not seen or felt in daily life, like e.g. the depletion of the ozone layer. In such a case science has the task to provide sufficient information to the general public in order to increase their environmental awareness and to make evident the dangers of human interference in natural systems. As environmental degradation, especially in the form of pollution, endangers human health information might be an adequate means to build the required consciousness for valuing higher the improvement in the quality of life than the loss in private wealth.

However, the problem gets even more complex when environmental expenditures are directed towards people living overseas or towards future generations. In this case those who restrict themselves by reducing their disposable income do not enjoy a direct improvement in their "quality of life". Therefore, it will become essential to make people aware that the economic wealth of the affluent industrialised societies has been achieved partly at the expense of both geographically distant and future societies.

In the era of imperialism and colonialism, the European great powers, Japan and the United States subjugated and exploited "under-developed" societies overseas. The division of the world at the expense of the non-white population was justified by pseudo-scientific theories such as the socialdarwinism and by the ideology of missionaring "under-developed" societies.

Nowadays, most of the colonies became independent and the former imperialists distanced themselves from the atrocities towards the autochthonous population. However, the mere declaration of independence did not bring about their desired change in world wide power distribution. Less developed countries remain weak in economic performance and have therefore a comparably very low per capita income. The superiority of industrialised countries is nowadays expressed by economic dominance and pressure resulting in a further profitable utilization of the natural resources of LDCs. This short term policy does not take into consideration that our "quality of life" depends also on the living conditions in the poor countries. The deforestation of tropical forests, e.g., has ecological effects that cannot be restricted to the countries cutting down the forests. The contribution to

the "green house" effect and the loss of biodiversity are only two of the best known global consequences. The time has now come for the industrialised world to recognise that their quality of life is affected by the economic fate of the developing countries and that it is therefore necessary to introduce long term policies considering the negative ecological effects of our modern form of "imperialism" and balancing international inequality.

8) MEASURING NATIONAL WELFARE

As outlined above (Part 1, Chapter 4) the gross national or gross domestic product is a too narrow indicator for measuring the welfare of a nation. Equating an increase in welfare with the growth of production ignores, from the ecological point of view, both the rapid exhaustion of the life support services provided by our environment and the depletion of common environmental goods. From the social point of view the GDP or GNP is not a sufficient welfare indicator, because it does not consider income distribution and other indicators which provide information about a nation's social situation.

Efforts which aim at a fundamental reformation of the GNP-concept have to be based on the fact that nature is the basis of the economy, because economic activities are only transformations from natural raw materials into products which finally become waste.

8.1) The "Environmental Adjusted" GNP as Measure of "Sustainable Income"

The GNP or GDP as it is in general calculated within the System of National Accounts (SNA) does not take into consideration the increasing pressure economic activities put on the environment. In this context the GNP as a measure for the economic success and thereby also for the income of a national economy has three major shortcomings: first, the treatment of environmental protection costs, second, the handling of the degradation and depletion of natural resources, and third, the disregard of the limited carrying capacity of

ecological systems. In policy making GNP serves as a key-indicator for planning economic policy. This indicator, however, is misleading to the extent that GDP does not reflect environmental degradation.

An "environmental adjusted" GNP has to be corrected for environmental losses caused by the economic process. It will than become a more adequate indicator for measuring economic performance, for guiding policy decisions and for making judgements as to how successful policies are.

8.1.1) Defensive Expenditures

Defensive expenditures, as already outlined above (Part 1, Chapter 4), are those parts of the national income which are used on preventive, restoratory and compensatory measures. Since they do not cause an increase in welfare, but just contribute to maintain a certain level of welfare, they have to be isolated and subtracted from GNP. In the case of the environment this implies that the GNP has to be reduced by all expenditures undertaken for measures with the purpose of preventing or clearing up the damage caused by the industrial production process, because these defensive expenditures do not add well-being; they just keep the environment in a state it has been before the production process started. The isolation of these items discloses the interactions between industrial production and the thereby caused environmental damage.

The calculation of defensive expenditures, however, faces several problems. The correction of the GNP can only be made to the extent defensive expenditures are undertaken. That implies that environmental degradation that does not lead to financial outlays for restoratory and compensatory measures is not reflected in the adjusted GNP.

An other drawback of the calculation of defensive expenditures is that they are hard to isolate. Leipert does not only include financial outlays required to balance the environmental degradation caused by the industrial production process, but also expenses in the fields of health, security, traffic and housing in his concept of defensive expenditures. 6)

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6. HUETIG, R.; LEIPERT, C., "Economic Growth, National Income and the Blocked Choices for the Environment", IIUG Report 87-10, Berlin, 1987, also C.LEIPERT, "Die heimlichen Kosten des Fortschritts: Wie Umweltzerstoerung das Wirtschaftswachstum foerdert", Frankfurt: Fischer, 1989

In the case of environment related defensive expenditures their isolation is relatively easy when "end-of-the-pipeline" technologies are added to the existing equipment. But how to estimate the defensive expenditures contained in the costs for integrated technologies used in the industrial production process? An even more serious problem occurs for spendings in the fields of health, security, traffic and housing. It is impossible to demarcate, e.g., spendings on health care made necessary by economic activities from spendings that would be required without those economic activities. 7)

A further disadvantage of the concept of defensive expenditures is that opportunity costs of shifts in production or consumption patterns induced by environmental considerations are not reflected in the GNP.

Summing up, the calculation of defensive expenditures is, despite its imperfections, a very useful approach to adapt the GNP or GDP. Especially in the field of environmental related expenditures it would thereby be possible to show the amount of financial outlays needed to avoid and repair environmental damages caused by economic activities.

8.1.2) The Depletion and Degradation of Natural Resources

In addition to the subtracting of defensive expenditures it has to be considered that part of the GNP is generated by depletion and degradation of natural resources. This loss of natural assets entails no charge in the SNA which reflects the decrease in the potential of future production. Hence, the misleading idea is supported by the view that economic growth can be obtained by the exploitation of a diminishing natural resource base. In reality the income gained by economic growth on the costs of environmental exploitation represents a permanent loss of wealth. In literature there are two approaches which try to find a way to compensate the depletion of natural resources within the SNA: the use of depreciation and the concept of user costs.

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7. LEIPERT, C.; SIMONIS, U.E., "Umwelt und Volkswirtschaftliche Gesamtrechnung" IIUG Report 87-6, Berlin, 1987

8.1.2.1) The Use of Depreciation

The first approach to consider environmental degradation in the SNA is to calculate a depreciation for natural capital analogous to the depreciation of man-made capital. The concept of the Net National Product (NNP) is thereby taken as a model. NNP is computed by subtracting from the GNP an allowance for depreciation, i.e. the amount of money that is reinvested to maintain the actual capital stock intact. This concept takes into account that income achieved by the consumption of the capital stock leads, sooner or later, to the exhaustion of this capital which therefore can no longer produce any income. As the degradation of natural resources is also a form of capital consumption it reduces future income possibilities, and should consequently be considered as deprecation. 8)

In contrast, current accounting practice treats revenues generated by the depletion of natural capital as value-added that has to be included in the GNP, or its counterpart the GDP.

For practical purposes, natural capital can be divided in two categories: renewable and non-renewable natural resources, which are both affected by depletion. The calculation of the depreciation of natural capital can equally be applied to the consumption of both types of resources. The basic idea underlying the concept of measuring a depreciation for natural capital losses is to generate during the exploitation of a natural asset an allowance which permits the replacement of the asset at the end of its useful life.

For renewable resources, such as forests, the natural capital loss can be balanced by replacement. This replacement cost could be charged in the form of depreciation to the gross income gained from natural resource depletion to obtain the net value-added actually generated. The main impediment this concept of "shadow projects" has to face is that natural depletion can easily be irreversible. Human beings e.g. contribute every year through their economic activities to the extinction of an increasing amount of higher order species, an environmental damage that cannot be repaired.

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8. DALY, H., "Toward a Measure of Sustainable Social Net Product"; HARRISON, A., "A Possible Conceptual Approach to Introducing Natural Capital into the SNA", in Ahmad, El Serafy, and Lutz, " Environmental Accounting for Sustainable Development", Washington: The World Bank, 1989

In the case of non-renewable resources current accounting practice calculates gross operating surplus by subtracting the costs directly related with the extraction of natural resources from the market value. Net operating surplus takes into consideration a depreciation only for the consumption of man-made capital. If non-renewable resources were treated as natural capital, part of the gross operating profit would be exposed to be generated by consuming natural capital and would therefore have to be subtracted in order to calculate net operating profit. If such a correction in the form of a depreciation would be based on the full value of the exploitation, the net national product would be adjusted up to the amount of the entire proceeds gained from natural assets' sales.

The calculation of the depreciation of natural capital involves a number of problems. Depreciations of man-made capital are based on different lifetime assumptions for different assets in different industries, laid down in general accounting principles. For natural capital a comparable approach for valuing the depletion is not available. Information of the depletion of natural resources is expressed in physical units and has to be valued somehow in monetary terms before it can be integrated into the SNA. Valuation thereby can by based either on the principle of replacement costs or on the discounted value of the willingness to pay, i.e. on the monetary amount a society would be willed to pay for a service or good that has no adequate market value.

8.1.2.2) The User Cost Approach

The second approach dealing with an integration of natural resource depletion in the SNA is the user cost approach. The objective of this approach is to identify a tool for taking into account the depletion of mineral resources. The method considers only the fraction of total reserves which are liquidated within an accounting period and does not aim at valuing total mineral reserves. 9)

The basic idea underlying the user cost approach is that the gross revenues resulting from sales of depletable natural resource stocks can be split into true income which adds value and a capital element, the user costs. This user costs should be set aside each year and

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9. EL SERAFY, S.; LUTZ, E., "Environment and Natural Resource Accounting" in Environmental Management and Economic Development edited by Gunter Schramm and Jeremy J.Warford, Baltimore: John Hopkins University Press, 1989

invested to secure that the same level of true income can be maintained both during the life-time of the resource and after the resource has been exhausted. For the calculation of the ratio of true income to user costs El Serafy (1981) developed the following formula 10):

$$X/R = 1 - 1/(1+r)^{n+1}$$

X = true income
R = total receipts
r = discount rate (interest rate to invest receipts)
n = life expectancy

In order to calculate R-X, the user cost factor, which has to be set aside as capital investment and is therefore excluded from GNP, one has to decide on a discount rate, r, and on the time period, n, over which the resource will be extracted.

I order to avoid the valuation problems of depreciation for natural capital the calculation is based on the conscious assessment of current rates of extraction of the available stock measured in physical terms. This avoids the need for a more complex valuation of the natural resource stock. Current market prices serve as adequate valuation. The ratio of user costs to true income depends on the chosen life expectancy of the resource measured in years and on the chosen discount rate.

The relationships between life expectancy, discount rate and true income are shown in Table 1. A country that, e.g. decides to exploit his stock of a certain natural resource in 10 years at a discount rate of 5% will obtain only 42% of receipts as true income. The rest are user costs which have to be reinvested for securing the capital stock. With a higher life expectancy and/or a higher discount rate the proportion of true income to user costs increases.

10.EL SERAFY, S., "The Proper Calculation of Income from Depletable Natural Resources", in J.Ahmad, S.El Serafy, E.Lutz "Environmental Accounting for Sustainable Development", The World Bank 1989

Table 1: Income Content of Mineral Sales (X/R)

Life expectancy of of the resource (N) (years)	Discount rate (r) 1	2	3	4	5	6	7	8	9	10
5	2	4	6	8	9	11	13	14	16	17
10	10	20	28	35	42	47	52	57	61	65
15	15	27	38	47	54	58	66	71	75	78
20	19	34	46	56	64	71	76	80	84	86
30	27	46	60	70	78	84	88	91	93	95
40	34	56	70	80	86	91	94	96	97	88
50	40	64	78	86	92	95	97	98	99	99
60	46	70	84	91	95	97	99	99	99	100
80	55	80	91	96	98	99	100	100	100	100
100	63	86	95	98	99	100	100	100	100	100

Source: El Serafy

In contrast to the depreciation approach were the NNP is corrected, the user cost approach changes the GNP itself, because user costs are excluded therefrom. This has the advantage that the GNP or GDP itself become "environmentally adjusted" and could maintain its leading role as an indicator for economic performance.

The concept of an "environmentally adjusted" GNP, however, cannot be equalised with sustainable national income. Environmentally adjusted GNP just aims at maintaining the last years' level of natural capital and does not take into account that current environmental capacities may not be enough to secure sustainability, like e.g. in the case of deforestation. In addition to that neither the calculation of a depreciation nor the user cost approach can guarantee that investments are actually made in such a way that the maintenance of environmental capacities is secured. An accounting method can only lay down the theoretical foundations for a policy that has to lead in practice to sustainability.

Another main impediment to the consideration of environmental degradation within the SNA is that environmental damage has to be valued in monetary terms so that it can be integrated in the GNP or GDP. This entails the whole spectrum of valuation problems, such as inter- and intragenerational claims. R.Hueting developed for the valuation of environmental resources and functions the concept of "shadow prices", but this

concept only includes the preferences of today's living generation. As intergenerational aspects are excluded "shadow prices" are in general too low. 11)

In order to measure sustainability of economic performance in addition to the GNP alternative indicators have to be used.

8.1.3) Physical Indicators - Environmental Accounting

Taking into account that the monetary valuation of natural resources and services is very complicated and not always possible it is very helpful to use physical indicators for making evident the direction and the rate of changes in environmental capacities.

Based on this idea several countries already have developed environmental accounts which should provide useful physical data for an efficient management of natural capital. In "stock accounts", the amount of environmental features available at a given time is recorded in physical units. The use that is made out of these stocks is registered in so called "flow accounts". They show extractions, additions and other impacts economic activities have on environmental capacities.

In Norway, France and Canada, accounting systems have been developed to record environmental capacities in separate physical accounting frameworks. The Norwegian Government thereby did the pioneer work by introducing a system of natural resource accounting and budgeting in 1974. Four years later the French Government decided to implement the "Comptes du Patrimonie Naturel". In the year 1986, the Canadian Government adopted a similar system. 12)

These physical accounting frameworks are very useful in detecting the impact human economic activities have on environmental capacities. They are an important tool for those responsible for managing natural resources in a sustainable way. Physical indicators can disclose the limits within which economic activities have to be restricted in order to avoid a violation of the carrying capacities of ecosystems. An "environmental adjusted" GNP or GDP that would be created within the limitations

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11. LEIPERT, C.; SIMONIS, U.E., "Umwelt und Volkswirtschaftliche Gesamtrechnung", IIUG-Bericht 87-6, Berlin, 1987

12. PEARCE, D.; MARKANDAYA, A.; BARBIER, E.B., "Blueprint for a green economy", London: Earthscan Publication Ltd,

imposed by a system of physical indicators could therefore be regarded as sustainable income.

However, the, at the moment, used physical accounting systems are more or less simplified and are therefore only a first step to an overall assessment of the entire environmental resource base. The main impediment in implying a more complex system demonstrating the complex impact of human activities on environmental capacities is that such an accounting system requires the existence of a very well-developed monitoring and data collecting capacity.

8.2) SOCIAL INDICATOR SYSTEMS

In order to measure national welfare the "environmental adjusted" GNP or GDP is no sufficient indicator, because it does not include the social implications of our current economic system. The growth of GNP has shown to be often associated with increasing social inequalities, with a worsening of the situation of the poorest and with a growing dependence on industrial countries markets and capital. Therefore, "social indicators should record the results of socio-economic, social and political processes that fall outside the areas normally covered by economic indicators" 13), i.e. they should provide a guideline concerning the social dimension of economic development.

Social indicators aim at modifying the way of thinking in politics which is predominated to a large extent by economic objectives. First, they can serve as indicators to show improvements and/or deteriorations in the social situation of a nation's residents. Thereby the development of the social situation does not have to correlate directly with the development of GNP, i.e. that it can happen easily that GNP increases while social indicators like e.g. income distribution deteriorate or vice versa. Secondly, social indicators can be used as early warning signals for potential problems in social, economic and also environmental areas. In the following concepts of several more complex social indicators will be presented.

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13. SIMONIS, U.E., " Beyond Growth, Elements of Sustainable Development", p.77, Berlin: edition Sigma, 1990

8.2.1) The Physical Quality-of-Life Index (PQLI)

The PQLI is used as a measure of social progress. It was developed by the US Overseas Development Council and first publish in 1977. The calculation of the PQLI is based on three social indicators: child mortality, life expectancy and literacy, which are given the same weight in determining the PQLI.

In the year 1985, Australia, France and Iceland were with an PQLI of 100 placed first in the list of world ranking. Immediately beyond those countries ranked Finland, Japan, the Netherlands, Norway, Sweden and Switzerland with an PQLI of 99 and Canada, Cuba, Denmark, Italy, Spain and the United States with an PQLI of 98. Ethiopia, with a PQLI of 25, and Afghanistan, with a PQLI of 21, were placed last in the list of world ranking. 14) The Physical Quality-of-Life Index provides an important tool for development planning. A direct correlation between GDP per capita and PQLI (see Table 2) can not be observed which makes once more evident that GDP or its counterpart GNP is no adequate indicator for measuring the welfare of a nation.

Table 2: GDP per capita and PQLI

Country	GDP per capita in US$ (1985)	PQLI (1985)
Afghanistan	219	21
Ethiopia	113	25
Nepal	143	36
Angola	607	37
Uganda	158	51
Zaire	96	55
India	276	55
Saudi Arabia	7,782	56
Indonesia	512	63
Peru	925	71
United Arab Emirates	20,045	74
China	230	80
Burnei	14,351	90
Uruguay	1,728	91
Ireland	5,220	96
United States	16,581	98
Australia	10,527	100

Source: Kurian, World Rankings, 1991;
U.N.National Account Statistics, 1990

14. KURIAN, G.T., "The New Book of World Ranking", p 232, New York: Facts On File, 1991

The PQLI has the advantage to be relatively easy to calculate and became therefore an indicator frequently used to measure national development in addition to GNP or GDP.

However, in literature this concept of valuating human development is criticized sharply. The weighting of the different components creating the PQLI is regarded as a crass simplification. It is also argued that the index is flawed by the, especially in the case of literacy, used data. Finally, the lack of distribution matters within the concept of the PQLI is criticizes, although there it can be replied that the three used social indicators used for calculating the PQLI can be used for revealing inequalities in income distribution. 15)

8.2.2) Concepts of Multi-dimensional Social Indicators

Looking for a single indicator which measures human welfare it has to be realized that welfare is influenced by too many factors for being expressed in a single figure. This shows once again the divergence between complex reality and the simplification assumed in science. No doubt that a certain degree of simplification has to be undertaken in science because all interrelations and interdependencies occurring in reality cannot be disclosed. Nevertheless, the extent to which these simplified images can claim to reflect reality has to be reconsidered.

Concepts of multi-dimensional social indicators try to approach a real measure of human welfare. They analyse with sometimes more than 100 different indicators all areas of human activities which are of importance for human well-being. Economic activities are thereby only one area of importance. Out of the multitude of social indicator systems two will be presented in the following.

8.2.2.1) The Drewnowski-Model

The Drewnowski-Model was developed at the United Nations Institute for Social Development (UNRISD). Its objective is to quantify social and economic goals and to provide thereby a tool for socially-oriented development planning which aims at the improvement of the living conditions of people.

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15. MILES, I., "Social Indicators for Human Development", p.51, London: Frances Pinter, 1985

In order to quantify quality of life Drewnowski used in his model stock variables as well as flow variables. Stock variables are combined in an index of the state of welfare. This index shows the specific characteristics of a population that were formed by the flow of welfare over a substantial period of time.

Flow variables are combined in an index of the level of living. Within the Drewnowski-Model the level of living is determined on the one hand by the degree of satisfaction of needs made possible by the consumption of goods and services, and on the other hand by non-economic components. This reflects the intention to make evident the interdependence between economic performance, measured by economic indicators, and other components of the quality of life, measured by social indicators, which are both important for living conditions.

The index of the level of living consists of nine components whereby these components are made operational by altogether 27 indicators as it is shown in the following overview.

COMPONENTS:	INDICATORS:
Nutrition	Calories intake; Protein intake; Percent of non starchy calories in food intake
Clothing	Cloth consumption; Footwear consumption; Quality of clothing
Shelter	Service of dwellings; Density of occupancy; Interdependent use of dwellings
Health	Access to medical care; Prevention of infection and parasitic disease; Proportional mortality ratio
Education	School enrollment ratio; School output ratio; Teacher/pupil ratio
Leisure	Leisure time
Security	Security of the person; Security of the way of life
Social environment	Labour relations; Conditions for social and economic activities; Information and Communication; Recreation: cultural activities, travel, sport and physical exercise

Physical environment	Cleanness and quietness; Public amenities in the neighbourhood, Beauty of the environment

8.2.2.2) The OECD Concept

The OECD developed an extensive system of social indicators to quantify measures of individual well-being in the OECD-countries insofar as these appear to be quantifiable. Although this ambitious system of social indicators includes more than 100 single indicators "the indicators in the OECD List of Social Indicators in fact cover only some of the social concerns and cannot therefore be used alone to gauge the 'quality' of life in a country or of a particular population group. However, within certain limits and because they have been constructed precisely for the purpose, the social indicators can usefully reveal real situations and movements towards change, thus enabling the analysis of the conditions of individual well-being." 16)

The OECD List of Social Indicators is divided in eight subdivisions: health, education and learning, employment and quality of working life, time and leisure, command over goods and services, physical environment, social environment and personal safety. Each of these subdivisions is analysed by several social indicators.

The extensiveness of the OECD-indicator system can be demonstrated by a comparison with the Drewnowski-Model. While within the latter "physical environment" is made operational by three indicators the OECD-system uses thirteen:

- Trends in average number of persons by room
- Distribution of the population, by density of occupation of dwellings
- Percentage of households with more than one person per room
- Percentage of households with access to an outdoor space adjacent to the dwelling
- Percentage of household having access to an area of open space within 20 minutes
- Percentage of population with basic amenities inside the dwelling
- Percentage of households lacking some of the basic

16. OECD: Living Conditions in OECD Countries, A Compendium of Social Indicators, p.3, Paris: OECD 1986

amenities in the dwelling
- Percentage of population within walking distance to selected services:
  - Percentage of population having access to
    - a store satisfying daily needs in the vicinity
    - a primary school in the vicinity
    - a post office in the vicinity
    - a public transport stop in the vicinity
- Total emissions of traditional air pollutants
- Percentage of population exposure to transport noise

Although extensive social-indicator systems such as the OECD indicator system are a very valuable approach to assess welfare they are confronted with a main impediment that occurs by the calculation of social indicators: the shaky statistical base. Data which is collected by different institutions is in general not comparable with each other and actual data is often not available at all. In addition to that the data does not permit any direct comparison between countries owing to differences in the actual nature of the data and/or methods of collection used.

Nevertheless social indicator systems are an important tool for determining the welfare of a nation.

9) CONCLUSION

In order to get closer to solutions for nowadays problems science is challenged to overcome the generally used method of analysing problems in several fields of knowledge. By the subordination to well-defined fields of specialisation the potential for problem solutions is restricted because context is lost and linkages are ignored. Human beings had to make often enough the experience that by passing over interdependences problem solutions can only be part-solutions. So e.g. orthodox development strategies considered the increase of the national income of less developed countries as primary goal. This pure economic viewpoint of development ignored ethical, mental, social and environmental issues which contribute equally to the development of a nation. In order to approach to a solution for such a complex question like development scientist out of different fields of knowledge should work together which would allow to tackle a problem from different viewpoints and to make evident linkages.

Development policy that claims to be beneficial for "less" developed countries has to supply more complex development strategies than the praising of world-wide industrialisation. Scarcity of natural resources, increasing damage to environmental life support systems and a rapid growing world population challenge alternative development concepts which enable LDCs to develop in accordance with the principles of "sustainability".

New development strategies have to offer in the place of development "aid" real partnership, with fair prices for raw materials and access to the newest technologies. This implies, without doubt, measures which are expensive and "painful" for the economies of industrialised countries, and which are therefore unpopular because people are not yet willed to accept a redistribution of wealth. It will become the major task of the future to animate and to direct a change in the consciousness of each individual which leads to the understanding that the damage to the environment caused by human beings will precede to an extent were it is irreversible and were each individual itself is affected badly. As LDCs have to develop to an extent were their population can afford the "luxury" of environmental protection the only possibility to avoid a further environmental degradation is the redistribution of wealth. In order to put this to work a world-wide general political consensus will have to be created because the distribution of welfare has always been a political decision. Nevertheless, each

individual himself has still to go through a long learning process which makes him realise long term considerations until wealth distribution can be effectively carried out.

A basic precondition for tracing out sustainable development policies are adequate indicators. The environmental adjusted GNP or it's counterpart the environmental adjusted GDP, physical indicators and social indicators are important tools which permit the quantification of development strategies and goals.

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