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The Need for Policy Coherence  
and New Partnerships



**Space – the essential dimension of sustainable  
development**

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## **Abstract**

The article aims to interlink the basic elements of natural resource endowment, their utilisation and transformation in production and consumption, the waste generation and its shorter or longer term assimilation by nature. The waste may be transformed and appear as a new natural resource or it may be accumulated as waste being an obstacle for new development. If this circular process can be repeated indefinitely, the development is truly sustainable. However, sustainability involves many aspects, and most importantly the aims of development. That includes the meaning of value and hereby the moral/ethical framework for development. Development studies show us how differently the circular process has been evolving through history around the globe. Development is by definition building on anthropocentric values, i.e. the society is manipulating 'nature' for maximum utility. Natural resources - or natural capital - are through the process being transformed into man-made capital. That is physical structures in locations and infrastructure with its knowledge based institutional networks. This sets the frame for utilisation and transformation of natural resources, assimilation of waste and the use of 'nature' for creating human welfare. Whether this process is sustainable in the short term or in the long term depends on the quality of human made capital, whether it makes up for the depletion of natural resources that will allow contemporary communities around the globe as well as future generations to fulfil their needs. The article tries to illustrate how space, as the combination of natural resources, environments and man-made capital, is the basic and most important dimension of sustainability.

The article aims at giving an overview of the basic interdependence of natural resource endowment, technological, economic and social development and their impact on development of space. The structure of space or the territorial structure hereby plays an essential role in the options of further economic and social development and its sustainability. The focus is on support of livelihoods and enhancing human welfare with the environment and not against it.

## **Space and the circular process**

Basically all societies are marked by the way they utilize nature or their natural environments for their livelihood. This means how and where they produce and consume, what they do about the waste generated and how this circular process is repeated generation after generation. Pre-historic societies and remaining small groups of 'fourth-world' hunters and gatherers but also traditional cultivators still to be found in major parts of the 'third world' do not leave major traces. Their waste, mainly as biological waste, is easily absorbed or assimilated by nature. Only outstanding spectacular landmarks like the Great Chinese Wall, the Aztec monuments, the great Hindu and Buddhist temples of Southeast Asia, the Pyramids of Egypt, etc. survived the inevitable destruction by time. Other human-made capital and waste generated through production and consumption have been fully absorbed by nature and regenerated as a new resource<sup>1</sup>.

The complexity of societies in terms of utilization of resources, transformation of resources in the production process, consumption and generation of waste keeps on increasing through history. This, however, has happened in a non-linear process with epochs of progress and glory and epochs of retreat and depression. The mentioned spectacular landmarks that have survived for centuries are all landmarks of previous societies having the political and military power to draw resources from a vast territory but after losing the power, the landscape remained only with the ruins of previous glory.

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<sup>1</sup> For an account of environmental history, see: Hornborg, A., McNeill, J.R. and Martinez-Alier, J. (eds.) 2007

In the case of North-Western Europe, as in other areas where the agricultural revolution took roots, the forest cover was for centuries progressively reduced as the populations increased. Apart from this, the societies left only minimal physical footprints outside the feudal fortresses. As industrialisation took roots, the following centuries made North-Western Europe the centre for an unprecedented extraction of resources reaching even the most distant corner of the entire globe. This created a new physical structure not only in North-Western Europe but on the entire planet dominated by the resource extraction. The depletion of the natural resources as well as the waste generated by the transformation of the resources and their consumption has impacted on the future resource endowment. The consequences of this impact for future resource extraction and production will depend on the development of technologies and the deliberate political choice by society how they wish to utilise their resources.

The growth process and development of society depends on the utilisation and transformation of natural resources that generate waste that is either recycled or deposited in soil, water and air. The waste will eventually be assimilated by nature again and as such re-emerge as a natural resource. The process of extraction and transformation of natural resources, their consumption and the subsequent waste generation, which is either recycled or deposited, is a circular process (see Fig. 1) that can be repeated over shorter or longer periods, depending on its complexity. Biological degradable waste in the tropics can be transformed into nutrients in the soil in a few months while nuclear waste will pose a danger for the environment for millennia.

Each single component of the circular process, shown in Fig. 1, is bound to a physical location, apart from the waste diluted in water and air<sup>2</sup>. The natural resources are extracted in localities in space as well as the transformation of the resources take place in localities. Similarly the consumption of the commodities is space bound as well as the waste when deposited in the soil is bound to a locality. Waste deposited in the water and the waste deposited in the air will spread locally and regionally and eventually globally creating the problem of pollution knowing no borders.

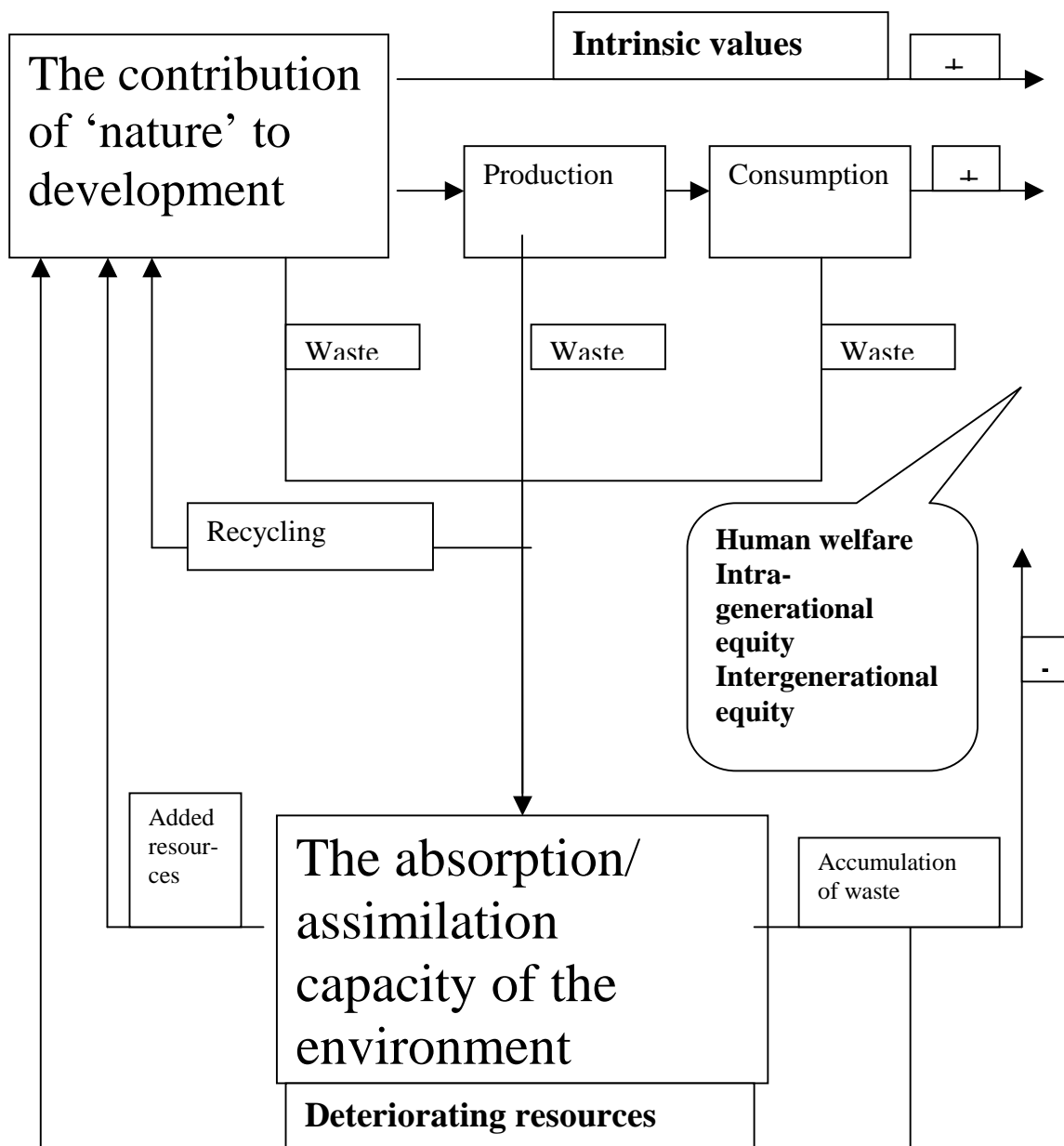
Through the societal development process, new knowledge is created about resource extraction and its transformation that is embedded as man-made experience in space<sup>3</sup>. Through this process, natural resources, or natural capital, are transformed into man-made capital that is inherited through generations adding new knowledge about the utilisation of resources and their transformation in the production process. This accumulated experience is embedded as a physical structure and a network of knowledge that might turn into a growth pole or become an obstacle for further development, depending on its progressive nature in the contemporary society. The technological, economic, social and political aspects of development have physical manifestations in space that themselves become integrated and dynamic parts of further technological, economic, social and political development. As I shall show in the following, the creation of this territorial structure is an important part of the development process and crucial in terms of securing the development process being more or less sustainable.

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<sup>2</sup> Considering a landscape where activities in the high altitudes impact on the potential for production and consumption downstream, it's important to analyse and understand the environmental implications of the activities in the physical context of a watershed.

<sup>3</sup> Economists call this for man-made capital as well as natural resources are termed natural capital. DfID has in its Guidebook on Sustainable Livelihoods, defined the whole range of community assets in terms of human, natural, financial, physical and social capitals. Critics may argue that they hereby leave all aspects of social and environmental sciences in the hands of economists!

**Fig. 1. The circular process of resources, production, consumption and waste**



Acknowledging that development is concerned with creation of utility values for improving the material conditions for human life, development studies should be concerned with how to ensure that improved material welfare for one generation should not be at the expense of future generations as well as ensuring material welfare is distributed among the present generation in a way that will allow it to pursue. A further challenge to development studies would be to incorporate nature's intrinsic values or human being's conception of how non-material factors are contributing to human welfare. We do, however, need first to define what we mean by value in economic and environmental terms. Only if we know what the society is valuing and aiming at can we assess its sustainability.

## **What is value?**

Value is basically an economic concept as a measurement of utility for the individual and the human society. However, it may be claimed that certain tree species are more valuable in avoiding soil erosion and maintaining a watershed and as such can be attached an economic value as an environmental service for providing water downstream. A special issue of the *Journal of Ecological Economics* (Vol. 41, June 2002) was devoted to a discussion of the integration of economic and ecological perspectives of values in relation to ecosystem services. Here it is also stated that 'value' is a term that most ecologists and other natural scientists would prefer not to use at all (Constanza and Faber 2002). They see ecosystems in their own right and humans, in their view, being part of nature on equal footing with other species, do not have the right to threaten other species by defining anthropocentric values. Paul R. Ehrlich in a recent article in *Environment and Development Economics* makes a powerful argument for the demonstrable failure of conventional economics to focus its attention on what will be the central issues of the twenty-first century and hence the need for ecological economics to become the central sub-discipline of economics. In doing so, the aim of this article is to contribute to what Paul Ehrlich sees as important for ecological economists - keeping the 'big picture' in view. (Ehrlich, 2008).

The whole idea of development (and the academic discipline of development studies) is deeply embedded in an anthropocentric perception of value that may now, however, emerge as its own contradiction. With the development of production capacities and subsequent waste generation as the world has experienced during the so-called development epoch, the depletion of natural resources and deposits of waste in soil, water and air, is potentially becoming an obstacle to further development and more seriously potentially threatens the life supporting ecosystems<sup>4</sup>. This forces the human society to seriously consider sustainability. The meaning of value that I shall pursue in this article, therefore, is the anthropocentric, instrumental use value supporting economic, social and political development for present and future generations. If pursuing development for the present generations results in the risks that future generations cannot pursue development, then it should accordingly not be deemed a value. This call for an understanding of sustainable development and the role development studies could play in elaborating on this concept for the benefit of human development within sustainable ecosystems.

## **What is sustainable development?**

For the discipline of geography, as an important contributor to the academic discipline of development studies, the concept of sustainable development has been extremely useful in bridging the unfruitful cleavage between physical and cultural or social geography. Many departments of geography around the world have simply changed their names incorporating the word sustainable, signifying that they are back to the origin of geography. This, I would argue, covers the space, both in terms of the physical elements of natural resources and man-made capital as well as people who through the technological, economic, social and political processes accentuate the natural resources and create the man-made capital. The term sustainability has also challenged conventional economic thinking that has been focussing on monetary values and treated nature as an externality that only has a value when it is

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<sup>4</sup> As acknowledged by Polasky, as a conventional economist, that by the time of Adam Smith it made sense to focus attention on consumption and production of material goods as people were far less and living standards far lower. But in the twenty-first century with much larger (and growing) population and higher living standards attention needs to shift towards the larger set of consequences of economic activities...(Polasky S. 2008)

transformed into a resource that finds its monetary value (i.e. the price) at the market. To many ecological economists, the sustainable development concept is ill-conceived as it, as a political instrument, doesn't deal with the real issues of ecological sustainability (Lawn, P, 2007, p. 10). The International Panel on Climate Change and a huge variety of international institutions' assessments on resource use and climate change to a large extent build on conventional economic thinking but warn on the ecological consequences.

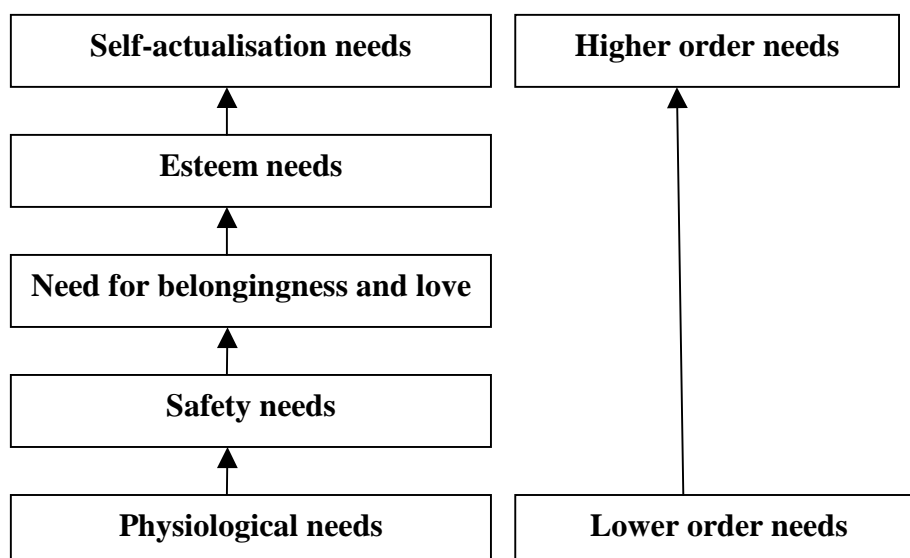
Today ecological economists like to distinguish themselves from environmental economics, resource economics or green economics who in their view are applying conventional economic methods to environmental issues, while ecological economics takes its point of departure in the laws of the natural ecosystem (Babe, R.E. 2006)<sup>5</sup>. It is, however, essential that economic analyses, calculating the price of commodities and environmental services, are based in the broader perspectives of exchanging monetary market values based in the endowment of the natural resources and its impact on the environment. Only hereby will the price reflect the real costs of all the contributions of 'nature'. According to Pearce and Turner (1990), we can divide the contribution of 'nature' to societal development into three categories, which are reflected in Fig. 1: 1. the supply of natural resources for production and consumption, 2. the capacity of 'nature' to assimilate waste and transform it into resources and 3. the intrinsic values of nature; that is the contribution of 'nature' to the wellbeing of human beings in terms of natural beauty and the wonder of the natural world. Conventional economics of exchange values do not embrace the 'real value' of 'nature' in these capacities.

Unfortunately the concept of sustainability has become a positive catch word popular among politicians and others who deliberately use it to give any political statement a positive flavour. It could all be boiled down to the US expression: 'it's like motherhood and apple-pie – who can be against it?' As the concept was defined by the World Commission on Environment and Development back in 1987, sustainable development signifies a situation where present generations around the globe can satisfy their needs without compromising future generations can satisfy theirs (World Commission on Environment and Development, 1987). The Commission certainly acknowledges growth as part of sustainable development, but by emphasising how future generations can satisfy their needs, they are pointing to the use and conservation of the natural resource endowment and how this is transformed into man-made capital.

## **Fig. 2. Maslow's needs hierarchy. Reproduced after Lawn 2007**

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<sup>5</sup> Ehrlich, as "an ecologist who associates with economists", doesn't make that distinction, but talks of ecological economists only (Ehrlich 2008)



A major concern in using the Commission's concept of sustainable development is the definition of 'needs'. It seems beyond doubt that the globe simply can't sustain levels of consumption of fossil energy, water and other resources approaching the level of the average American citizen. There seems to be a close relationship between economic growth and human welfare until the basic needs in terms of food, shelter and clothes are provided. Using Maslow's classical needs hierarchy (Fig. 2), the higher order of needs satisfaction is not related to material welfare, unless self-actualisation needs only can be satisfied through extravagant consumption. The concept of sustainability is, however, also used in much more confined meanings, such as for example if an activity is economically or socially sustainable, meaning that it generates sufficient income to continue or whether it creates social tensions that makes it untenable. Such cases do not consider whether the activity erodes the natural resource endowment without substituting it with man-made capital that will make future generations able to fulfil their needs. An added complication with the intergenerational dimension of the concept of sustainability is that we don't know the needs of future generations and they have no 'lobbyists' to speak for them.

The developing countries have repeated at numerous international conferences that they should not be the first to cut down on the utilization of natural resources like preserving the tropical forests and the biodiversity or limiting their emission of green house gases or other pollutants threatening major ecological systems. They are just imitating what the rich part of the world has already done for centuries. With the present greed for further exploitation of natural resources to further increase production and consumption of commodities all supported by contemporary neo-liberal economics, a global consensus on the definition of intra-generational needs seems practically out of reach and is left for ad hoc partial solutions negotiated at numerous international conferences. Even more difficult though is it to define the inter-generational needs of future generations. The history of extraction and utilization of crude oil provides an excellent example of this.

Throughout the 20<sup>th</sup> century, crude oil was the main engine driving the tremendous increase in natural resources exploration, production capacity and affluent consumer societies among the rich OECD countries. It's amazing to think how generations before the invention of the combustion engine were unaware of the production potential for satisfaction of material needs were hidden underground. Think of Arab nomads who only recently realised the fortunes lying underneath the desert where they have been eking out a living from raising their camels. Today, crude oil has transformed parts of the desert into the skylines of Dubai, Doha, Bahrain and other Middle East futuristic cities.

The example illustrates that we cannot predict with any certainty which natural resources will be a precondition for the satisfaction of needs for future generations. There is, therefore, need for concern when many environmental economists with little hesitation are calculating high discounting rates for exploitation of natural resources. With rates on or above the commercial interest rate for long-term investments, they in many cases claim a scientific justification for using the resources now. Future generations have no lobbyists in international organisations supporting this brand of environmental economics<sup>6</sup>. The principle of precaution, I think, should play the role of lobbyist for future generations<sup>7</sup>.

The seemingly uncontrolled greed of modern capitalism, in some cases legitimised by environmental economists using high positive discounting rates<sup>8</sup>, is pushing the globalization of exploiting the natural resources in major parts of the developing world at an unprecedented scale. The same trend is seen in polluting the global commons, such as the atmosphere and the oceans. At the other extreme we have the claim by orthodox ecologists that human beings are like other beings and we should not use the fossil resources as they cannot be regenerated within a timeframe realistic for survival of human beings. Between the optimistic economists who stress that technological innovations have always proven to be superior to any limits to growth and the pessimistic deep ecologists who see any removal of resources that cannot be regenerated as unsustainable for future generations, the challenge is to find the middle road. The big challenge for development studies at the theoretical level that seriously needs research input is to assess what kind of man-made capital can substitute fossil natural resources that can't be regenerated. How can built-up space of man-made capital ensure future generations will not be worse off satisfying their needs, though the endowment of fossil fuels and other resources have gone down and waste has been deposited in soil, water and air? Obviously the laws of thermodynamics tell us that any development activity will increase entropy and will as such not be sustainable in the long term perspective.

This should, however, not discourage us from identifying middle term solutions. The broad definition of sustainable development given by Phillip Lawn (2007) is useful in this endeavour:

A nation is achieving sustainable development if it undergoes a pattern of development that improves the total quality of life of every citizen, both now and in the future, while ensuring its rate of resource use does not exceed the regenerative and waste assimilative capacities of the natural environment. It is also a nation that ensures the survival of the biosphere and all its evolving processes while recognising, to some extent, the intrinsic value of sentient non-human beings (Lawn, 2007, p. 29)

The remainder of this article will offer an effort to strike the balance between the optimistic anthropocentric development utility perspective and the pessimistic, orthodox ecology perspective of development depleting natural resources and ecosystems by pointing out how wise use of space can contribute to enhancing sustainability. This could be expressed in a

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<sup>6</sup> In fact there is a powerful argument for using a negative discount rate as the impact of climate change risks making access to resources even more vulnerable and unpredictable (Dasgupta 2008)

<sup>7</sup> A joke among Danish environmentalists tells about the King who after the English navy ran away with the Danish navy in 1807 ordered major plantings of oak trees to prepare for similar future events requiring the building of a new navy. As oak trees take long to mature, the Forest Department recently informed the Navy Department that the trees were now ready for use. It's difficult for foresee the technological development and the needs of future generations! For a good discussion of an ecological rationale vis-à-vis a conventional economic rationale concerning intra- and intergenerational sustainability, see Joan Martinez Alier (Martinez Alier 1994).

<sup>8</sup> Pindyck states it clearly: "with discount rates of four percent or more, it would be hard to justify almost any policy that imposes costs today but yields benefits only fifty or a hundred years in the future" (Pindyck, 2007)

short slogan version of supporting livelihoods and enhancing human welfare **with** the environment and not against it!

### **The dynamic struggle between optimists and pessimists – reserves and technological development**

Crude oil has fuelled the engine that created rapid economic growth in the Western World after the Second World War and is now fuelling an even faster economic growth in China and other parts of Asia. The question has been popping up throughout the whole period: when will the reserves be depleted and put an end to economic growth? As we shall see below, the concept of reserves of resources is a very flexible concept changing with technological development that is accentuating the possibility of new resources. But if we actually, some time in the future, deplete the reserves of crude oil without having sufficient new technology for alternative sources of energy, we will seriously have compromised future generations' ability to satisfy their needs. By using the reserves of fossil fuels, the emission of carbon dioxide will simultaneously contribute so much to global warming and unpredictable and extreme weather situations that probably by itself will demand actions to be taken. If we at the other hand develop the technologies to sufficiently tap the sources of renewable energy or we if we actually manage to safely develop the futuristic dream of a technology of nuclear fusion, which will be fuelled only by water, then we would have secured an energy resource far more sustainable than fossil fuels. Crude oil would then again be as uninteresting as it was for the Arab nomads a few generations back.

Many doomsday scenarios have come up again and again speculating on the growth of world populations in relation to the capacity to produce enough food since Malthus started that debate in 1798. We must acknowledge the optimism of those claiming that new technology has always been invented for food production to follow the growth of population. The widespread hunger and malnutrition still found in the world today is rooted in an unequal access and entitlement to food, not in the global production capacity. Whether this will hold true also for the future is seriously questioned by many researchers who now acknowledge that conventional high input industrialised agriculture has peaked to be followed by a decline in output. Simultaneously the amount of arable land is decreasing and deteriorating due to soil erosion and other processes of land degradation stemming from over utilisation. This leads to further destruction of the forest cover to expand the area of arable land. The removal of forests leads locally to lower precipitation and generally contributes to global climate change. What impact this will have on global food production is too early to predict exactly. But what is certain is that those areas in the world, already most vulnerable to the vicious circle of poverty and natural resource degradation will be the ones facing another gloomy challenge imposed by climate change.

Basically the contradictions inherent in the WCED definition of the concept of sustainability might be boiled down to the dichotomy of the political science theories of realism versus idealism. In the realist interpretation of global power struggles, the sovereign nation states or corporations having the power to set the agenda are legitimized to do so. The idealist perception emphasizing intra- and intergenerational equity is fighting an uphill battle with the present global political set-up.

In an attempt to reconcile the contradictions of realism versus idealism, I shall argue that there is room for many compromises in terms of what nature can contribute to societal development and how the space or man-made capital in the territorial structure can contribute to improve

on sustainability, both in an intra- and intergenerational meaning. This may, in my mind, become the most important challenge to development studies. So far we have been concerned by the creation of utilitarian values enhancing economic growth for the benefit of social, cultural and political development. When the production of utilitarian values results in waste generation and resource depletion that becomes an obstacle to further development, the challenge is to get development back on track.

### **The contribution of nature to development**

Nature is by definition manipulated by humans as we throughout history have been eking out the needs for survival and hereby have created our environments. Nature, untouched by humans, is no longer thinkable. Even the most remote small plant on a faraway mountaintop is impacted by the changing composition of the atmosphere, acid rains, the thickness of the ozone layer, etc. Nature is transformed into ‘natural environments’, manipulated by human development.

This poses the basic moral question whether we regard the environment as a pool of resources that can be exploited for maximum economic utility or whether humans are just equals to other sentinel beings having no rights to destroy habitats for others. I, as a development protagonist, have stated my position above in defining ‘value’ as an anthropocentric concept of utility that should, however, cover utility both in an intra- and inter-generational meaning of the concept. If we regard environment as a pool of resources we choose in between two extremes: maximum exploitation here and now by those having sufficient economic, social, political or military power to exploit them, or at the other extreme, we add a moral dimension, by asking who have the rights to decide on how to share those environments. The ‘Tragedy of the Commons’ (Hardin, G. 1992) comes into mind whether humans can actually care for resources in solidarity or only under individual protection. The moral dimension of sharing among present generations in an intra-generational equity or between generations in an intergenerational equity adds to our definition of sustainability in terms of maintaining the environment and its productivity in a space and time dimension.

It is, therefore, essential, when striving for sustainability, to consider how various elements of ‘nature’ can be utilized and conserved to maintain as little disturbance of the environments as possible while still satisfying human needs now and in the future. Sustainable development must at the same time secure a transformation of natural resources into man-made capital or build-up places and infrastructure that will facilitate and not obstruct both an intra- and an intergenerational equity.

The utilisation of natural resources and the transformation of the environments are getting increasingly more complex. Figure 3 helps to generate ideas on issues that could enhance sustainability, leaving out the technical complications of inventing the necessary technologies. The basic moral/political question on how we define sustainability among present generations and between present and future generations still remains. At the end of the day, the moral/political question can be boiled down to our definition of needs for those having the power to access and utilize the resources and hence for sharing among present generations or use the principle of precaution (moral obligation!) for the sake of future generations. The problem with the World Commission’s definition of sustainability is that it has not helped us in setting the moral standards for satisfaction of needs.

### **Fig. 3. The contribution of ‘nature’ to societal development**

<b>Output capacity: Endowment of natural resources and ecosystem services</b>	<b>Absorption/transformation capacity of ‘nature’ and its potential environmental degradation</b>	<b>Options for optimizing the two capacities: Improvement of man-made capital to get more out of less and enhance recycling</b>
<u>Energy resources</u>	Emission of carbon dioxide leads to global warming that threatens plants and animals including food production and ecosystems.	Reduce on energy consumption.
<u>Fossil fuels</u>	Carbon dioxide is diluted in a diffuse form in the atmosphere.	Use of cleaner technologies. Collecting and storing carbon dioxide.
Coal	Highly hazardous waste that can’t be assimilated in foreseeable future	Even if technological development can make production more safe, depositing waste will continue to be a major threat
Crude oil	No environmental impact apart for possible aesthetic	Development of technology to fully extract, store and transport of energy
Natural gas	No environmental impact	Major challenge in developing the technology for future utilization Large potentials for ‘getting more out of less’, substitution and recycling of resources
<u>Nuclear fission energy</u>	Waste takes long time for assimilation by ‘nature’	Nutrients in vegetation recycled through composting. Possible energy production through bio-ethanol
<u>Renewable energy</u>	Waste is degradable and quickly assimilated, depending on climate.	Enhanced knowledge on the function and contributions of life supporting ecosystems. Enhanced efforts in conservation and payment for environmental services for necessary protection.
Solar power	Threatened by cultivation, industrial pollution and global warming	Enhanced knowledge and acknowledgement on the need for preservation of
Wind energy		
Hydropower		
Wave energy		
Tidal energy		
Geo-thermal energy		
Nuclear fusion energy		
<u>Fossil resources.</u> Minerals etc.		
<u>Organic resources</u>		
Soils and nutrients		
Vegetation		
Forests		
Animals		
Aquatic life		
Micro-organisms		
<u>Ecosystems</u>		
<u>Bio-diversity</u>		

### Intrinsic values

Threatened by cultivation, industrial pollution and global warming

genetic diversity for human long term survival.  
Enhanced efforts in conservation and payment for environmental services for necessary protection.  
Enhanced acknowledgement of intrinsic values, supplementing 'cyberspace'.  
Enhanced efforts in conservation and payment for environmental services for necessary protection.

While we can't escape that moral/political question we can still do a lot to optimize the capacity of utilising the natural resources wisely and sparingly and to ensure the maximum recycling of resources through enhancement of the man-made territorial structure. For analytical purposes it makes sense to divide the contribution of nature to human society in its output capacity of resources and ecological services and its assimilative capacity of waste absorption. Figure 3 offers some suggestions to how this could be done.

### **The complexity of natural resources and the environments**

Natural resources play so many roles in supporting life on the planet which is one of the main problems when conventional economists insist of setting the market price for natural resources. Garden furniture made of tropical hardwood has become very popular and pretty cheap in Europe. But the price we pay in the furniture shop does not - by far - cover the real value the wood actually represents. It cannot be excluded that the tropical hardwood has been harvested from a certified sustainable plantation production, but by far the most wood comes from clear felling of forests in Borneo, Sumatra, Myanmar, the Amazon and other tropical forests still remaining. Greedy logging companies create space for ranching of cattle for beef production, oil palm plantations for industrial use or simply to accommodate population pressures from smallholders who just want to cultivate for survival. By clear felling the forests, the micro climate changes in most cases with less, and more unpredictable, precipitation as a result. Also the role of the forests of facilitating rainwater infiltrating in the soil that makes it end up in the aquifers and serve as a groundwater reserve is destroyed by removing the forest. Hereby the rainwater runs off, washing out soil nutrients, creating soil erosion and eventually bad lands. If the forests were covering upper mountain watersheds, the destruction of the forests will result in risk of rivers drying up, creating problems of water supply downstream. Further, the forest was the habitat of a rich biodiversity, supporting a number of plant and animal species that are essential for the survival of a broad range of genetic variety. If the forest was an old forest in balance, the carbon sequestration of new growing trees was offset by the carbon emission of dying and rotting trees. By felling and burning the forest, the carbon accounts go dramatically into negative<sup>9</sup>. On top of all this, the forest had an intrinsic value, extremely valuable for people living by and off the forest, but impossible to attach a market price.

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<sup>9</sup> It's estimated that approximately 20% of present CO2 emissions comes from burning tropical forests

Environmental economists have tried in different ways to attach a market price to many of these non-marketable values. With the Kyoto Protocol's Clean Development Mechanism, a carbon market is being created and attempts are being made to have local people benefit through economic compensation for maintaining a forest cover through various means of 'payment for environmental services'. But if the costs of all the environmental services that a tropical tree is actually contributing to could be calculated, the costs of garden furniture made of tropical hardwood would be prohibitive to the many customers enjoying the cheap tropical hardwood today.

While neoclassical economists had their hey-day during the development epoch, calculating exchange values based in market prices of production factors, neo-liberal financial economists are presently having their hey-day with financial markets and speculative capital now dominating productive capital. With the present pressure on natural resources and the assimilative capacity of 'nature' in relation to waste generation, it seems obvious that the future must be for ecological economists! If they can still make it?

### The environment as input for production and consumption and as a sink for waste

Conventionally, nature has been regarded by economists as an externality providing the necessary natural resources for production and consumption. However, from a conventional supply and demand point of view, resources were scarce and therefore commanded a price. No considerations were made to the roles of the natural resources in the life supporting ecosystem, whereby no price could be attached. Similarly with the role of nature functioning as a sink for assimilating waste. Conventionally nature was considered having an endless capacity and waste would simply 'disappear'. Only during the last three to four decades with extraordinary production capacity and endless consumers' appetite, has made it obvious that there certainly are limits to the assimilative capacity of nature. Places for depositing of waste have become a scarce resource that has increasingly got a price tag.

A better utilisation of natural resources and a better structure of space can improve immensely on the capacities for output as well as for absorbing and recycling waste that will make production and consumption more sustainable. A comprehensive approach to production and consumption that incorporate all 'real expenses', i.e. incorporating the long-term roles the resources play in the life supporting ecosystems, a so-called 'cradle to grave price', would provide the real price for sustainable development.

### The continuum from fossil to renewable resources

Fossil fuels like crude oil or coal can only be regenerated within a geological time scale, while firewood is renewable. It is, however, wrong to consider the two as a dichotomy. In between the two there is a continuum where, as an example, hardwood takes several centuries to regenerate, and some low value coal has a shorter timeframe of regeneration than has high value coal. Bio-ethanol has recently become popular as a renewable source of energy. The risk, however, is that plantations for producing bio-ethanol for rich peoples' cars will substitute the production of essential foodstuff for the poor. An even bigger risk is an increased destruction of remaining forests, wetlands and other life supporting ecosystems for creating utility values from bio-ethanol<sup>10</sup>. The ultimate renewable energy resources are the resources of solar power and the power that can be extracted from the basic physical laws, such as wind energy, wave- and tidal energy, hydropower, etc. These sources will not dry up

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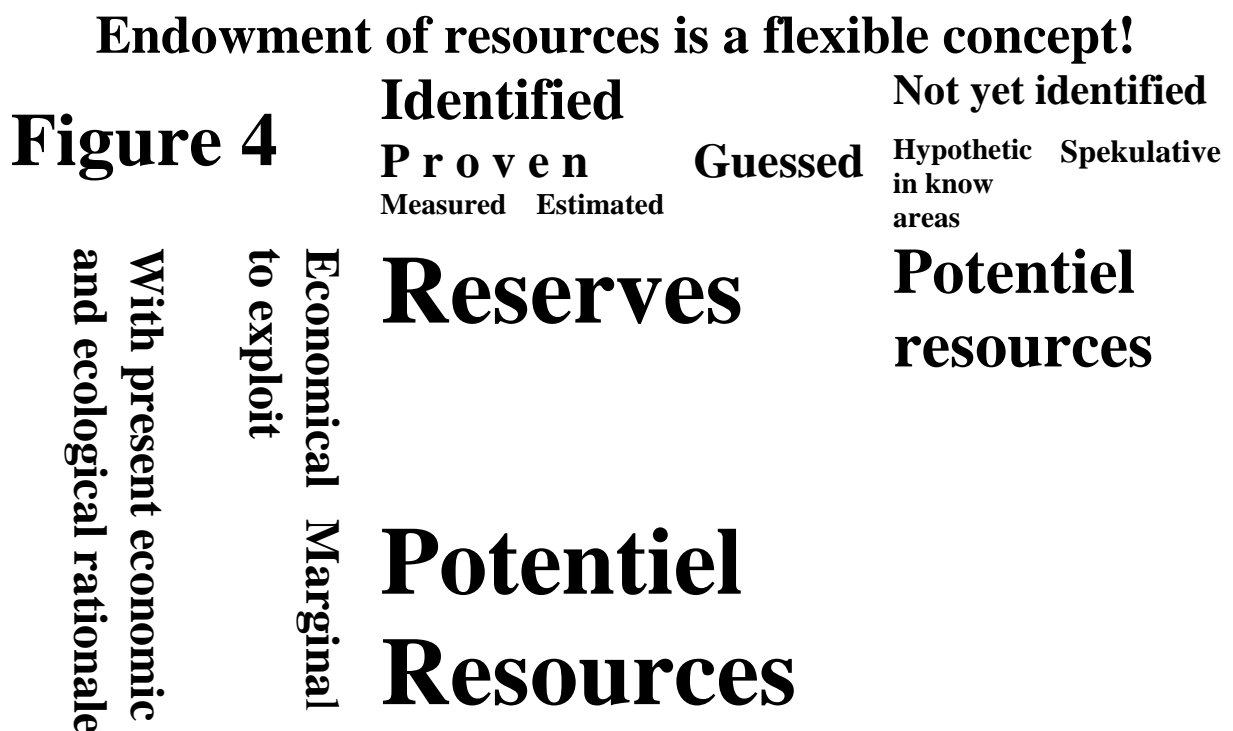
<sup>10</sup> Second generation bio-ethanol produced on biological waste products is a much more promising venue.

and the challenge is to develop technologies to capture, store and transport the energy. The challenge is to build the territorial structure of man-made capital that will support renewable energy production and recycling of resources that will keep waste within nature's assimilative capacity and simultaneously extend the lifetime of reserves of known resources.

The dynamic concept of reserves of natural resources

The magnitude of resources actually available for development is first of all dependent on the economic and ecological rationale of the society, which again to a large extent rely on the moral/political question of intra- and intergenerational equity. Secondly, the volume of resources available depends on the technological capacities. The drilling of oil illustrates both. Within the last decades, oil exploration is possible at ever greater depth at sea. Recently oil explorations were technically possible also in arctic seas. This, however, accentuates the potential risks of contamination of the arctic seas where oil spill will have disastrous consequences for all biological life, including human life.

As shown by Fig. 4, the endowment of natural resources is a very flexible concept depending on the demand for resources. With a high demand, as presently for crude oil, it becomes economic feasible to go at ever greater depths at sea and under other extreme conditions to extract the oil. This accentuates the fact that the marginal and possibly even the sub-marginal resources as well as hypothetical and speculative resources will be explored. Estimating reserves of resources, therefore, must take into account whether the reserves are proven, estimated, guessed, hypothetical or even speculative and at what level of demand will make them economically feasible to exploit.



(After McKelvey, 1974)

## Life supporting ecosystems

As tropical forests gradually disappear they no longer protect the soils that in most cases are extremely vulnerable to heavy tropical downpours. The result might easily be soil erosion and washing out of nutrients from the top soils with serious effects on its capacity to sustain the vegetation cover. The land may in the worst case scenario turn into useless bad land. If the forest happens to be in the mountainous uplands, its capacities of protecting the infiltration of rainwater into the aquifers and hereby protecting watersheds that are critical for water streams and rivers, will be affected. Not only does the missing forest impact on the local climate, probably resulting in less precipitation but also in less infiltration of water into the soils and subsequently ending up as run off rainwater, creating soil erosion and drying up of rivers and water streams. On top of this comes the loss of biodiversity the forest was supporting and subsequently the loss of genetic resources for present and future use.

The forest is an example of a coherent ecosystem that is essential for supporting life on Earth. When species from that ecosystem are removed they impact on the rest of the ecosystem that will have to adjust to the new situation. Ecosystems are never in balance but constantly in a dynamic process of change. There is, however, a threshold for how much ecosystems could be disturbed before they cannot regenerate. Some ecosystems are more resilient than others. But clear felling a forest or draining a wetland of course will change the ecosystem radically and change its ability to support life. This is also the case where huge areas of mangrove forests have been drained for agricultural and construction purposes or for creating shrimp farms in many parts of the tropical regions.

## Nature and environments as intrinsic values

Apart from nature's tangible value as input for production and consumption, its value for assimilating waste gets increasingly important with enhanced capacity for production and subsequent increased generation of waste. Similarly, nature's value for protecting biodiversity and maintaining the essential pool of genetic resources for future food production is increasingly appreciated. Much less regarded is nature's value in itself as being nature or what is termed, intrinsic value, i.e. the appreciation of the natural world. What's the value of enjoying the wonders of nature in terms of a viewing a beautiful landscape, enjoying a bird singing or by swimming among colourful fish at a coral reef? Intrinsic values are obviously relative to individual choice. Individuals value differently the wonders of nature and some even claim that they are happy in cyberspace!

Nature's intrinsic values are most clearly finding their market price in the differentiation of land prices depending on the lands location in relation to natural attractions like a panoramic view of a landscape, nearness to the sea, rivers or forests or decreasing prices by nearness to garbage dumps, motorways, airports etc. This 'willingness to pay' principle, as illustrated by

the differentiation in prices in the real estate market according to location, is used by economists to attach a price on nature's intrinsic values. By asking how much people are willing to pay to visit e.g. Grand Canyon, the 'value' of this marvellous natural phenomenon can actually be compared to a Disneyland. How much are people willing to pay to visit Grand Canyon compared to how much they are willing to pay for a visit to Disneyland? The very serious danger in doing these kind of economic calculations are first of all that Grand Canyon might not be re-established if once partly destroyed. Secondly, comparisons based on the 'willingness to pay' principle only take into account the preferences of the present generations without knowing the preferences of future generations. The potential risks of depreciating the intrinsic values should (a moral obligation again!) be met with the principle of precaution - at least - on behalf of future generations.

If we, as an indicator for the destruction of the 'original'<sup>11</sup> nature, use the rate of extinction of biological species, we get an idea of the decline of intrinsic values. The rate of extinction of biological species has been high ever since colonialism and the inclusiveness of 'virgin land' in Africa, Asia and the Americas in the mode of production dominated by North-Western Europe. The rate accelerated with industrialisation from the late nineteenth century and during the 'development epoch', starting after Second World War. The rate of extinction of species increased again to further accelerate during the epoch of 'letting the market forces free' under globalisation from the late 1980s. Nature's intrinsic values and the market price people are willing to pay to enjoy it, therefore, probably will increase drastically in the decades to come.

## **Conclusions**

As already acknowledged by Karl Marx, nature is the material foundation of any society and the technological development to transform nature into commodities determines the level of economic development. As technological development, or what Marx called the productive forces, were not very developed in Marx's time, he didn't acknowledge or foresee the consequences of possible depletion of natural resources and the magnitude of waste generation threatening the resilience and productive capacity of the planet's major ecosystems. Marxist and neo-liberal economists alike have up to recently continued perceiving nature as an abundant externality that only was assigned a market price as it became a scarce resource in the production process.

The extraordinarily rapid technological development with increasing capacity for natural resource extraction and waste generation that occurred in the United States after the Second World War triggered the environmental movement. Suddenly it became obvious that there are limits to the capacity of the rivers, seas, soils and air to assimilate the waste generated and the relationship between human health and the environment became an issue. The term environment was spreading from the US and became internationally recognized, especially after the UN Conference on Environment and Development in Stockholm in 1972. Our Common Future published by the World Commission on Environment and Development in 1987, helped in reconciling the cleavage between the various popular movements for the protection of nature for its own sake and the increasingly concerned international scientific and political community concerning the sustainability of contemporary global development. At the UN Conference on Environment and Development in Rio de Janeiro in 1992 they were hammering out the message: Development for the present generations as well as for future

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<sup>11</sup> 'Original nature' of course is a nonsense concept as nature is dynamic and keeps on changing also without human interference. However, the conversion of forests or wetlands to arable land or build up physical structures, most likely is a non-reversible process.

generations is dependent on how we utilize the natural resources and take care of the environments. Sustainable utilization of the environments had become a much bigger issue than protection of the pandas.

In eking out a living, human societies are transforming nature to manipulated environments. This article has tried to show how the main contributions of nature to the development of the human society could be designed to achieve a higher level of sustainability. The utilization and transformation of natural resources into man-made, build up capital or the structure of space is an essential dimension in enhancing sustainable development. This article is not offering the technical solutions how to enhance the output capacity of the endowment of natural resources and ecosystem services. Neither is it offering the technical solutions on how to enhance recycling of resources and thereby bring the magnitude of waste within nature's assimilative capacity. The aim of the article is to show a way for striking a compromise between the 'optimistic' developers, little concerned with the environmental consequences of production and consumption or with the intra- and intergenerational equity on the one hand and the concerned 'pessimistic' voices who perceive sustainability in its strong version calling for absolute protection of natural resources and the environments on the other. Development and development studies, by definition build on the anthropocentric concept of utility and material use values, but if development should be possible also for future generations, the concept of sustainability should be further developed and refined – and eventually adhered to.

Deliberate emphasis on technological development to organise space and design man-made capital in built-up structures to enhance sustainability can certainly enhance both intra- and intergenerational equity. Everyone concerned with development, not least development studies, must contribute to that, However, we will never escape the moral/political question on how to define needs for the present generations and ensure equity around the world nor avoid the principle of precaution to care for future generations. We should focus on supporting livelihoods and enhance human welfare **with** the environment and not against it!

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