BIODIVERSITY – WHAT IS ALL THE FUSS ABOUT?

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The term biodiversity was coined in 1986. Since that year its use has increased steadily not only in scientific papers, but also outside the academic world. At present politicians and journalists use the word as easily as scientists do.

The term is often interpreted as referring to the global species-richness. However, it encompasses more than that. The Convention on Biological Diversity (adopted in May 1992 in Nairobi and signed at the Rio Conference on Environment and Development in the same year by 153 States and the European Community) defined biodiversity as: "The variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic systems and among the ecological complexes of which they are part, this includes diversity within species, between species and of ecosystems."

In this definition, biodiversity refers to the overall variability within nature, that is the variation which nature displays on different levels: the genetic variation within the species, the diversity of species and the diversity of ecosystems.

Loss of biodiversity

Biodiversity is decreasing at an alarming rate. Intensification of agriculture, over-exploitation of natural resources and environmental pollution have led in the 20th century to a rapidly increasing rate of destruction of ecosystems and extinction of species. At present already over 60% of the world's tropical forests have been destroyed and at the end of the hour that this lecture will take, a further 2,500 acres will have been cleared away. Closer at home: of the original extent of 300,000 ha of raised bog in Ireland presently only 10,000 ha (3.2%) remain more or less undisturbed. The species-rich fen-meadows in the Netherlands have in the course of the 20th century been reduced from 30,000 ha to a mere 30 ha (0.1%).

iIt is quite likely that on this day – November 13, 2002 – several plant and/or animal species will have become extinct. The estimates of species extinction vary, but it seems likely that each day we lose at least one and maybe even up to twenty species. The truth of the matter is that we do not know exacly how fast the rate of extinction is, for the simple reason that we do not know how many species our planet contains. Some 1.8 million species have been recorded up till now, but the total species diversity is estimated between 2-50 million.

Not only do species become extinct, the genetic variation within the surviving species is rapidly declining as well. As the area of distribution of many species is decreasing as a result of habitat destruction, the variabillity within these species decreases. Quite a number of species have been reduced to small populations with little variation in their genetic material.

In short, although we cannot give exact figures, we do know that biodiversity is decreasing at an alarming rate at all levels: ecosystems, species and variability within species. It has been suggested that unless this trend is broken, half of the biodiversity which our planet displayed in the 20th century will be lost within a hundred years.

Biodiversity as a value

But then, one may ask why that poses such a problem. Why should we be concerned when raised bogs, sedge-rich grasslands or tropical forests are lost? Why should we have a sleepless night over the extinction of some tropical spider? Why should we worry about the disappearance of some obscure moss species that only a botanist can distinguish?

In the debate on biodiversity two types of answers have been given in answer to these questions. The first answer is based on the fact that nature provides many goods and services which are of great importance to human well-being, both on the physical and the psychological level.

Nature regulates numerous processes from which human society benefits. To give an example, in February 1995 water levels in the main river systems in Holland rose to such levels that various stretches of the river dykes were seriously damaged. As a large part of the Netherlands is under sea level there was an imminent danger of catastrophic floods. Within two days tens of thousands of people and hundreds of thousands of farm animals were evacuated. The water levels went down just before the dykes collapsed and there was a narrow escape from massive flooding. But the damage that the nation suffered in two days was about half a billion Euro. The near-catastrophy did not only occur because of excessive rain fall in the upper catchment of the river Rhine but also because the wetlands in the upstream parts of the river have almost all been drained in the course of time. Excess precipitation is now discharged directly into the river as run-off. In the past a large part of the excess rainfall would have been absorbed by the aforementioned wetlands and then slowly be released to the river. In that way the wetlands would have buffered the river water levels. By this control of the river discharge the wetlands served a function to human society. Ecologists speak of a *regulation function*. Other examples of regulation functions of nature are sediment control by forests on hillsides, storage and recycling of nutrients by wetlands (the 'treatment capacity' of tidal marshes has been estimated between 365-2,700 kg N/ha/year) and pollination (without the service of wild pollination by insects, cultivation of most modern crops can only be maintained with enormous investment in artificial pollination).

Besides regulation functions ecologists distinguish *production functions* of nature. Nature produces goods which are of importance to human society. In the early 80s of the last century marine fisheries represented about 25% of the total world meat production. This is a food resource directly harvested from nature. But nature also provides products which are indirectly of great significance to the human food supply. The world food production depends almost entirely on the genetic integrity of only seven crop plant species! And three species alone – corn, wheat and rice – produce approximately two-thirds of the total world grain crop. This is rather a precarious situation as the fate of millions hangs on the balance between the genetic variability of those crops and the diseases and pests which can affect them. In order to maintain the productivity of food crop species, wild germ plasm must continouously be imported from their centres of origin to top up the domesticated species in order to reduce their susceptibility to rapidly evolving predators and diseases in their present areas of cultivation. But the natural habitats of the wild ancestors of most commercial crops are declining rapidly and so are the traditional agro-ecosystems in which most of the domesticated plants originated and became genetically diversified (primitive crops).

Apart from food-related products nature produces other vital resources. It has been calculated that two-fifths of the medical prescriptions in the US contain an active ingredient derived

from higher plants (25%), bacteria (13%), or animals (3%). Many unknown medicinal properties of wild plants and animals still await discovery – as was dramatically depicted in a television-appeal for nature conservation, produced by the World Wide Fund for Nature (WWF): the camera pens through a lush rainforest, then the view changes and a clear-felled plain, still smoking from recent burning of scrub, comes into focus. The camera stops moving and the following words appear on the screen:"This stretch of rainforest may have contained the cure for AIDS."

The regulation and production functions of nature are vital for our physical well-being. But nature also contributes to our mental health by providing unlimited opportunities for spiritual enrichment, cognitive development and recreation. Furthermore, it is a source of inspiration for the arts and it playes an important role in education and science. These services in the domain of the human mind have been called nature's *information functions*.

The goods and the services which nature provides to human society have a considerable socio-economic value. This value became more and more appartent in the second half of the last century, when ecosystems were damaged or destroyed at a rapidly increasing scale. The loss of certain ecosystem functions – functions which were up to then taken for granted – appeared to have negative impacts in economic terms. Therefore, in recent decades 'green' economists have developed methods by which the socio-economic values of nature can be assessed and even moneterized. In part, these methods proceed from classical economic theory (market value of goods and services provided by nature), in part they use alternative approaches such as 'shadow-pricing': *i.e*. calculating the damages to society when a function is lost, or the costs that arise when a function of nature has to be replaced by artificial devices.

The figures are quite revealing. For instance, waste treatment services provided by marshes in Massachusetts were calculated at US$ 123,000 ha/yr; crops in the USA dependant upon insect pollination represent a market value of US$ 4 billion per year (regulation functions). The world catch of marine fish and shell fish in the 80s represented an economic value of US$ 10 billion each year; in 1985 the combined retail market value of plant-based medicinal drugs in western countries was estimated at US$ 43 billion (production functions). It has been estimated that each lion in the Amboseli National Park in Afrika is worth at least US$ 27,000 per year in visitor attraction, while each elephant herd brings in over US$ 600,000 a year in tourist revenues (information function). A recent study in the Netherlands made clear that the costs of public healthcare would increase with 2 billion Euro if Holland would have no nature reserves and national parks. Outdoor recreational activities have a positive effect on general public health. Moreover, the direct revenues of outdoor recreation amount to some 7 billion Euro a year. When one considers these economic benefits of Dutch nature as the revenue from a capital at a 5% interest rate, the capitalized value of the natural heritage (based on the recreation function alone!) would be 180 billion Euros.

In order to maintain all the goods and services that nature provides, the variability in nature on all levels – within species, of species and of ecosystems – should be conserved as far as possible. In that sense, conservation of biodiversity has an ethical dimension. It serves the well-being of present and future generations.

A number of conservationists and philosophers have claimed that such an anthropocentric approach does not provide a wide enough base for long-term conservation of biodiversity. Nature will then only be treated with care as long as her functions cannot be taken over by man-made devices. Therefore, they argue, the anthroprocentric ethic needs to be broadened to

a biocentric ethic, such as voiced by Aldo Leopold in his famous *Land Ethic*: "A thing is right when it tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise." The underlying premisse of a biocentric ethic is that nature in all its variability has a value on its own independent of the value that it has for us. This has been called the intrinsic value of nature. Whether or not nature has an intrinsic value is still very much a matter of debate. There are certain theological bases for the recognition of an intrinsic value of nature. For instance, the Jewish tradition deduces from the so dramatically repeated words in Genesis "and God saw that it was good" that all of God's creation, each creature, has a value on its own as it found approval in God's eyes.

Without a theological basis, the argument for an intrinsic value of nature is not so straightforward. Some philosophers claim that it is a phallacy to attribute such a value to the natural world because the concept of value does not exist without a valuing – that is a human – consciousness. A value in nature on and of its own, therefore, is an impossibility. Others, however, state that a valuing consciousness is indeed necessary to realise an recognise nature's intrinsic value, but that it is a reality independent of that consciousness. For instance, so they argue, from nature's tendency to form increasingly complex structures or from the inherent survival mechanisms that species and individuals display it can be deduced that nature (although not aware of it herself) has a meaning and a value on an for its own.

The debate remains unresolved. Therefore, quite a number of concerned philosophers and ecologists hold that, given the present state of evolution of human civilization, there is no time to wait for a biocentic environmental ethic. Conservation of biodiversity may or may not be a duty towards nature (a question that future philosophers may ponder about), it is without a doubt a duty towards humanity which greatly benefits from nature's goods and services.

Strategies for the conservation of biodiversity

For decades it has been assumed that conserving a good set of representatives of the various ecosystems of the world would suffice to conserve nature's variability. In practice this would mean the setting aside of a certain percentage of each national territory for nature (a generally accepted figure is between 5 and 10%), while the rest of the respective territories can then be used for human activities.

In recent times, however, it has become clear that things are not that simple. This can be best explained by describing the problems in nature conservation in the Netherlands. Holland has a long tradition of nature conservation. The first private conservation organisation in the country was set up almost a century ago and in the 20s of the last century the Dutch State started an active acquisition programme of aceas to be set up as state nature reserves. By 1960 some 5% of the national territory was protected and representatives of most habitat types in the country were under conservation.

One would expect biodiversity in the Netherlands to be safe after that time. Sadly enough, that is not the case. Since the middle of the last century 30-40% of the native flora and fauna has seriously declined or become extinct. And this trend is still continuing.

The Dutch have become painfully aware of the fact that longterm survival of ecosystems and species involves more than setting aside stretches of important types of habitat as nature reserves. What happens outside the reserves is of great significance as well. What was not adequately known and understood in nature conservation untill a few decades ago, is that

ecological systems are embedded in a wider context and are linked to their surroundings by processes which operate at the level of the entire landscape. These special relationships in the landscape generally appear in the form of flow of water and air and movement of organisms. The importance of these so-called landscape-ecological relationships and processes for nature conservation becomes more and more apparent as an increasing number of ecosystems suffer damage as a result of human disturbance of these relationships and processes. The human impact in the landscape can reach over long distances in space and time and is not restricted to the region where the activity takes place.

Ecological systems are usually embedded in flow systems, that is specially connected entities of surface-water and ground-water, which operate at a large scale than the ecosystem itself. External human activities can then seriously affect the ecosystem's water quantity and quality. In the Netherlands, agricultural drainage and ground-water extraction (for drinking water and industrial purposes) has led to desiccation of most of the country's nature reserves. Moreover, impaired water quality has also become a common feature in reserve areas as the water that feeds them as often been eutrophicated by agricultural practices.

Not only water but also the air can carry undesirable substances to reserve areas. In the Netherlands, the current level of nitrogen deposition in many nature reserves has increased 10 to 40 times over the second half of the last century. The main sources are intensive systems of animal husbandry and factory farms from which large ammounts of ammonia are volatilized.

Finally, quite a number of fauna species use different habitat types for shelter and feeding or to fulfill different parts of their life cycles. Fragmentation of the landscape and isolation of habitats threatens the survival of such species. Isolation of habitat poses further risks to species survival. When dispersal and migration of plant and animal species between habitat patches is impeded, genetic erosion of the isolated populations may occur and this may eventually lead to local extinction. More- over, if in a certain habitat patch a population of a species is lost through a sudden ecological catastrophy, no repopulation will occur. In the Netherlands, many nature reserves have become islands in an intensively used agricultural landscape with absolutely no pathways left between them for dispersal and migration of plant and animal species.

Ecological connecectivity and ecological networks

In the 80s, Dutch scientists and policymakers decided that the only way to break the trend of declining biodiversity was to set up a radically new nature conservation policy which would aim at restoring the ecological connectivity in the country. For each type of ecosystem in the country a national committee of experts was formed which advised the government on long-term conservation objectives and necessary management for the special type of ecosystem. An overall plan for linking up key wildlife areas again was devised. Where such areas are at a relatively small distance from each other the ecological functions of the land in between is to be restored; in other cases 'green corridors' will be created in the agricultural landscape to allow for migration and dispersal of species. All major nature reserves will be provided with buffer zones. The restoration of the nation's 'ecological framework' started in the early 90s and will be completed by 2015. It involves major changes in land use (some 100,000 ha of agricultural land will be transferred to the nature conservation department) and large-scale technical operations to restore ecological functions (de-canalise formely canalised rivers, counteract former arterial drainage scemes, and remove enriched and polluted soils). The entire operation will cost annually about 400 million Euro during 25 years.

The maintenance and, where necessary, the restoration of ecological networks has also become the basis of the Natura 2000 programme of the European Union and of other international nature conservation programmes.

In conclusion, nature serves important functions to human society. It provides valuable goods and services. In order to maintain these functions, it is crucial that biodiversity is maintained. But biodiversity is declining at an alarming rate. And it proves extremely difficult to stop this trend. That is what all the fuss is about!

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