Poverty, Agriculture, and Biodiversity

Rudy Rabbinge and Prem S. Bindraban

Summary

The decrease in biodiversity globally is, according to many assessments, due to the rapid decline of ecosystems and to overuse of various resources. Many studies illustrate that the ecological footprint of the average inhabitant of the U.S. is considerable larger than of the average Italian, not to speak of the average Indian. The outrageous use of natural resources and the unprecedented waste and spoilage of resources is an important reason for the overuse of ecosystems and increasing environmental pollution. Many ecosystems suffer from that greedy behaviour. Unsustainability due to wealth as described above, and defined as a decrease in productivity, flexibility and stability of ecosystems, is causing an enormous threat to ecosystems and thus biodiversity. Hundreds of thousands of hectares are affected every year. That unsustainability spiral due to wealth may be broken by advanced ecotechnological interventions.

Even more striking is the unsustainability spiral due to poverty. Millions of hectares are affected every year, and that causes an even more dramatic effect on biodiversity. The unsustainability spiral due to poverty is caused by the very low income of many farmers in developing countries in general and more specifically in Africa. The low incomes make access to external inputs impossible and cause a continuous depletion of soil, agriculture on slopes, etc., with the

ultimate effect of people leaving the land and starting a similar activity elsewhere, often on more marginal lands. That spiral of unsustainability is even more disastrous for ecosystems and thus biodiversity than the spiral of unsustainability due to wealth. Both spirals can and should be broken but require different policies, measures and actors. In all cases good scientific analyses are indispensable.

In this paper we elaborate on the two spirals of unsustainability and present a scientific analysis that explores various perspectives on sustainable maintenance of biodiversity, in relation to the claim on land by agriculture. The Millennium Assessment of the UN may contribute to further this type of analyses.

Introduction

Humankind has never dealt particularly carefully with the natural environment, but in recent decades there has been a sharper increase in awareness that current practices are very much to the detriment of nature and biodiversity. Direct exploitation for the purpose of food production, timber and other raw materials is resulting in the withdrawal of large areas from the natural environment. In addition, considerable damage is being caused indirectly by the pollution of soil, water and air. The result is a substantial change in natural conditions, in turn reflected in flora and fauna. Traces of human activity are found even in the most unspoiled areas. The scale and speed of change is unprecedented and dramatic. A halt must be called to these developments both nationally and globally. Various treaties and various international agencies (Rio, Johannesburg etc.) have declared the intention to stop this.

Since 1970 there has been a sharp increase in nature conservation areas - from 5 to 9 million km^2 or over a sixth of the total wild areas and countryside in the world. The protected area does not just concern wild areas but also landscapes that are deemed characteristic on account of a "harmonious interaction between inhabitants and land" (IUCN criteria). Nature conservation is likely to be helpful in maintaining biodiversity. It safeguards wild areas, i.e. primary nature

or areas largely untouched by human activities. But secondary nature or natural assets of particular value to humans, such as 'strokeable' animal species (seals, beavers, etc.), similarly attractive natural features (peatlands, sand dunes, etc.), and land used for farming, livestock, timber and other human activities can be managed in a sustainable way and continue to provide ecosystem services and direct economic value to humans[1]. In some cases, the maintenance of desired secondary nature may depend on human interventions, such as controlled grazing in dune valleys. In this regard, conservation of primary nature combined with sustainable management of secondary nature is indeed the best guarantee for maintenance of biodiversity.

In both cases the satisfaction of human needs arises. For the protection of both primary and secondary nature, anthropocentric motives apply since we are concerned in both cases with the assignment of value. When it comes to the protection of primary nature it is also sometimes argued that this is in the interest of nature itself, in the sense that nature has intrinsic value and deserves to be protected on those grounds. In the latter case it is of course once again human beings who form a judgment concerning the intrinsic value of nature. This distinction is therefore also arbitrary and the reason for on-going debate.

The implications of these two definitions of nature for the appropriate policies can differ widely. Although many will wish to use both criteria for protecting nature, the resolution in the case of conflict with other needs will vary widely. If the emphasis is placed on the sustainable management of secondary nature or natural assets, it will be easy to give in to the pressure to exploit as yet primary natural areas. If the emphasis is on protecting primary nature, there will be pressure for greater use of natural assets in cultivated areas.

Nature conservation may, however, not be adequate to sustainably maintain biodiversity if claims on these resources for other purposes cannot be prevented. Claims on the natural resource base, including biodiversity, are affected by population and human desires or welfare. These claims differ greatly among wealthier and poorer people in the world.

Causes of Vulnerable Ecosystems and the Decline of Nature

The rich

Claims by the rich on natural resources extend over the entire planet. A healthy vegetarian diet requires approximately 1500 liters of water per day for the production of food, while this amount increases to as much as 5000-6000 liters for a meaty diet. With the import of food from developing countries a claim is therefore not only put on their land resources, but also on their water and other resources for the production the food. Also non-food items, such as cotton for clothes, leather for shoes and wood for furniture, require many resources.

In order to fulfill these desires, much progress has been made in recent decades in enhancing the productivity of agriculture, resulting in higher yields per unit of resource use. Successful increases in land and resource productivity have been obtained through specialization and intensification. Yields of major cereal crops, which account for some 80% of our diets, directly or indirectly through feed, have more than doubled globally over the past four decades. As a result, less land is required today for the production of one unit of food, thus leaving land for nature conservation and wildlife. If the yield of the major cereals - rice, wheat and maize - had remained constant at 1960 levels, additional land areas for agricultural production of approximately 1.5, 2 and 3 million more hectares, respectively, would have been needed in the year 2000 to realize current production levels.[2]

Over the past decades there has been increasing concern about degradation of our natural resource base, such as pollution of land, water and air, and loss of biodiversity due to our anthropocentric approach in agricultural production. Recently, outbreaks of animal diseases, such as foot and mouth disease and swine fever epidemics, have further deteriorated societal confidence in this approach.

The use of various inputs in agriculture, such as pesticides and fertilizers, increased to excessive amounts during the 1970s and 1980s, as our awareness of the adverse effects on nature and biodi-

versity was low. Since then, however, much effort has been made to reduce these adverse side effects by better attuning fertilizer and pesticide applications to crop requirements. The average fertilizer application rate in Europe, for instance, peaked at the end of the 1980s at 240 kg per hectare of croplands, but has since declined steadily to some 180 kg today. This overuse of inputs indeed caused problems of polluted soil, water and air, leading to eutrophication and extinction of species. Current efforts to develop advanced ecotechnological interventions can break these spirals of unsustainable use and degradation of our natural resources.

The poor

Claims on natural resources by the poor are more direct and therefore of a local nature. In sub-Saharan Africa, almost 70% of the population is still directly dependent on agricultural activities. Labor productivity has increased at a minimal rate of 20% over the past four decades, meaning that a farmer today can feed only 20% more people than four decades ago. In other words, most people were responsible for their own food production in the early 1960s, and this has remained virtually unchanged today. By comparison, labor productivity in Europe has increased sixfold over that same period; one farmer can feed six times more people today than he or she could four decades ago.[3]

One of the reasons for the lack of productivity improvement in sub-Saharan Africa is the lack of external inputs. The use of fertilizers peaked in the late 1980s at an average rate of 10 kg per hectare of cropland and has been steadily declining since to approximately 8 kg per hectare today. These fertilizer rates are not enough to compensate for the withdrawal of nutrients from the soil, even by low yielding crops. Even a cereal crop that yields just one ton per hectare withdraws approximately 20 kg of nitrogen from the soil. The nutrient balance of sub-Saharan Africa is indeed strongly negative, with long lasting negative implications because of the deterioration of the soils,[4] which are already inherently low in fertility.[5] With the rapidly expanding population, which has already increased from 200 million people in 1960 to 600 million in 2000, the pressure on natural resources will further increase with detrimental effects to agroecosystems, soils and

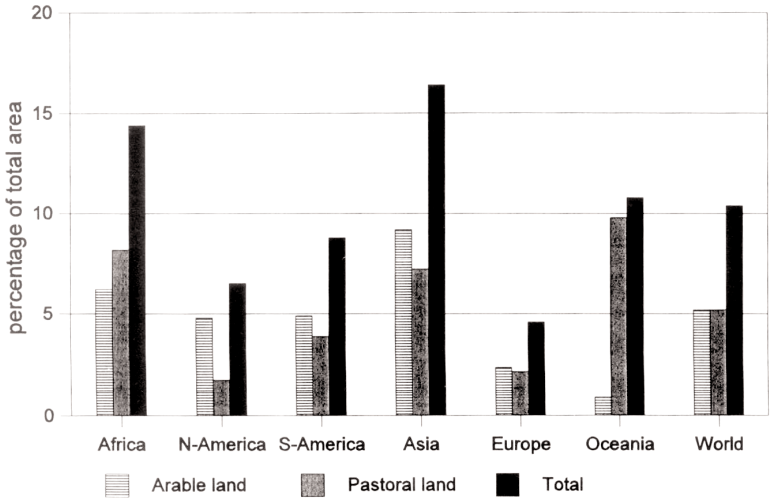
biodiversity. Sub-Saharan Africa has, not surprisingly, experienced an expansion of its cropping area of almost 40% over the past four decades in order to increase total food production.

The lack of technical inputs in activities to satisfy the primary desires of poor people places them in a spiral of unsustainability, deteriorating natural resource base and further often uncontrolled exploitation of virgin or marginal lands, adversely affecting natural ecosystems and biodiversity.

The effects

The magnitude of these two forms of threats to the natural resource base and indirectly to biodiversity is presented in Figure 1. The percentage of the land that is in jeopardy in developed regions of Europe and Northern America is approximately 4-7%. In contrast, a much larger fraction - up to 17% of the land in developing regions, primarily Africa and Asia - is threatened. In absolute terms, much larger areas are adversely affected in poor regions than in rich regions.

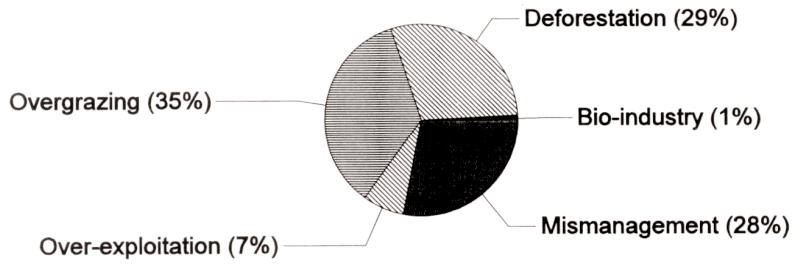
Figure 1



Two forms of threats to the natural resource base in different regions.[6]

The causes of these threats are presented in Figure 2. Mismanagement, such as the overuse of inputs, is responsible for a quarter of the lands under threat. By far the largest deterioration occurs through deforestation, overgrazing and overexploitation; these are typical activities in poorer regions, many of which are undertaken by poor people.

Figure 2



Causes of threats to the natural resource base.[7]

Current Status

All in all, both causes result in a steady decline across the board, measured in terms of both primary and secondary nature.[8] The variety of plant and animal species is declining and many species are threatened with extinction. The main cause is the disappearance of biotopes and biotopic deterioration through the over-exploitation of plants, animals and soil minerals on the one hand, and the pollution of soil, water and air on the other.

Given the continuation of present trends, the global forest cover would decline between 1990 and 2040 from 4.1 billion to 3.7 billion hectares. The area of tropical jungle - of which 4 percent is protected - is shrinking much more rapidly; between 1981 and 1990 the area contracted by around 0.9 per cent a year. If the main causes - the requirement for agricultural land by poor farmers, the need for firewood on the part of the indigenous population, and agricultural

land for exports - continue, the area of tropical forest will be substantially reduced in the next half century. Tropical rainforest accounts for 50-90 percent of all plant, animal and microbe species.

In temperate areas, the forest cover declined heavily in the 19th and early 20th century. Recently, an increase has even been discernible; planted forests are, however, much less rich in species than primeval forests. A significant proportion of the present forest cover no longer consists of primeval forest. The remaining primeval forests, such as those in Canada, are threatened by conversion to forestry and commercial exploitation.

The continued existence of savannahs, prairies, open forest areas and tundras is also threatened. An estimated one third of these natural grasslands are affected to a greater or lesser extent by cultivation, erosion, degradation and desertification as a result of overintensive use.

Of the original area of wetlands (e.g. swamps and mangrove forests) an estimated 25-50 per cent has been lost on a worldwide basis, primarily in recent decades. These wet and swampy areas are seriously threatened, chiefly by activities connected with agriculture: drainage, reclamation by the construction of dikes, and dams and barriers in or near water-bearing rivers. Only a very small proportion - 5 per cent - enjoys protected status under the Ramsar Convention. If the present rate is sustained, only a quarter of the original area of wetlands will be left in 50 years time. In densely populated areas only minimal remnants would be left.

The estimates of the number of species faced with extinction range from a few to 140 a day. It is, however, difficult to provide a complete picture of the extinction or threatened extinction of species in various parts of the world. The total number of plants, animal and micro-organism species on earth is unknown. If the speed at which species are dying out is estimated at 10 to 100 species per day, this will result over the next 50 years in a loss of some 200,000 to 2,000,000 species. In the latter case this would even exceed the number of known species today.

Solutions to Protect Nature

Against the background of the deterioration of the natural environment there is every justification for asking what a sustainable relationship with nature would involve. The notion of sustainability means that account needs to be taken not just of what currently needs to be safeguarded or managed for use but also of what needs to be passed on to future generations.

It is impossible to work with objectively fixed elaborations of sustainable development with maintenance of biodiversity as one of the components. However, it is necessary for normative choices in relation to the identified risks and uncertainties to be made explicit. These can be made explicit in action perspectives, i.e. ideal-type constructions that seek to bring out potential differences in practical implementation. In practice, policy processes do not imply a once-and-for-all action perspective, but an on-going process of adjustments with increasing insights and developments. Obviously, the two generic causes of the decline in biodiversity, wealth and poverty, require different strategies and interventions for their solution.

Action Perspectives

Four scenarios are presented based on action perspectives that differ primarily in their definition of what should be aimed for in terms of nature. The aim of the *Preserving* and *Saving* action perspectives are the preservation of a primary natural environment, of all unspoiled nature under *Preserving*, and of representative ecosystems under *Saving*. The *Managing* and *Utilizing* action perspectives seek to use and sustain specific natural features of interesting nature, in natural areas under *Managing* and interesting nature in cultivated areas and towns under *Utilization*. In other words, the aim is to preserve as large an area as possible of primary nature; the actual extent of that area depends greatly on whether this basic principle means "the total area which is still primary" (*Preserving*) or "all current options for the natural environment must be kept open" (*Saving*). On the basis of the principle that important natural fea-

tures must be sustained, a distinction is also made between action perspectives which seek to realize these features primarily in cultivated areas (*Utilizing*) or mainly in natural areas (*Managing*).

Preservation of the existing wealth of species and ecosystems will not permit further domestication and resultant reduction in the present area of primary nature. The 'hardest' consequences of the action perspectives relate to the use of space. The amount of space available on earth is fixed. If part of it is reserved for nature, the question arises of how much space is left for other purposes, in particular for the other activity which demands large amounts of space, namely agriculture. In the table below, the current agricultural land available per person is given along with the areas remaining for agriculture and other human activities in 2040 under the four action perspectives for a low and a high population scenario.

Table 1

Region	Use of space per capita (in hectares)						
	Present	Population growth up to 7 billion			Population growth up to 11 billion		
	Agric./ capita	U	S/M	P	U	S/M	P
World	0.91	1.61	1.53	0.68	1.10	1.05	0.47
Africa	1.68	1.81	1.71	0.76	1.14	1.08	0.48
N.+C. America	1.50	3.88	3.67	1.63	2.73	2.59	1.15
S. America	2.09	3.46	3.28	1.46	2.51	2.38	1.06
Asia	0.37	0.59	0.56	0.25	0.41	0.38	0.17
Europe + former USSR	1.05	3.38	3.20	1.42	2.61	2.87	1.10
Oceania	18.69	25.00	23.72	10.53	17.8	16.87	7.49

Current space per capita for agriculture and space remaining per capita for agriculture and other human activities under various action perspectives in 2040; U= Utilizing, S= Saving, M= Managing, P= Preserving.

The four scenarios sharply illustrate the consequences of the various sizes of the areas to be set aside for nature. The numbers in the table indicate the area left over for food production and other human activities, such as living and working.

Comparison with the space currently available for food production shows that in the *Utilizing* scenario, with its small acreage of protected natural areas, more space than is currently available for, say, food production will be available only if there is low population growth on all continents. The gain in space for agriculture in Asia and Africa is very limited even in this scenario, however, because of the high population growth; the present diet in these regions is already very modest, but a better diet would still have to come mainly from an increase in productivity. High population growth will lead to an increase in the food production problems in both these continents.

The *Saving* and *Managing* scenarios portray a doubling of the protected area, though with major differences in accessibility. Hence, the area available for food production is the same in these scenarios, however the way in which nature objectives are achieved is considerably different. The problems in Asia and Africa prove to be even greater in these scenarios; with a high population growth, the per capita area available for agriculture on both continents even falls below its present level - in Africa by a large margin. Competition between nature conservation, agriculture, forestry and other functions which demand space is high. Large tracts of currently primary natural areas will have to be used for food production in both these scenarios.

The conflicts are most pronounced in the *Preserving* scenario. The area used in this scenario could be realised only in Europe and the former USSR. In almost every other continent, however, problems would arise, once again being most pronounced in Africa and Asia, where much less land would be available for food production than at present. This conclusion can also be formulated differently: If agricultural productivity remains unchanged and the population continues to increase, it will be absolutely impossible in large parts of the world to sustain the present acreage of primary natural areas. The only way of making this scenario possible is through far-reaching increases in agricultural productivity. This is of itself not an impossible task; in Asia, for example, a tripling of the yield per hectare is by no means impossible, while the possibilities in Africa,

given the present low level of production, are often much greater - though the relatively poor soil does present a problem.

Evaluation

These scenarios highlight important directions for choices. The continuing impoverishment of nature and interesting natural features forces a stand to be taken on whether this process should be allowed to continue unchecked. If not, the question unavoidably arises as to what sort of protection is needed. Policy makers will have to make the choices themselves; scientists can elucidate the choices which have to be made, but cannot make them.

The scenarios suggest the consequences of the choices assumed here. However elementary, it would appear impossible to rule out completely the realization of any of the scenarios. The problems, particularly in Asia and Africa, will be enormous, especially in the case of the Preserving scenario. The assumed amount of space set aside for nature is greatest in the Preserving scenario and, given the population growth on these continents, there will be a need for an enormous increase in agricultural productivity. If self-sufficiency and food production is the aim here, productivity will need to increase by a factor of between four and six.

The competing claims on land and other resources for various functions are intense, especially in densely populated and poor regions in the world. Maintenance of biodiversity and the insurance of adequate food in these regions can only be achieved by breaking the current unsustainability spiral due to poverty. With agriculture as the main source of food and income to the largest part of the population, the most promising option to sustainably maintain biodiversity is the increase of agricultural productivity in terms of land, labor and other inputs.

Notes

[1] E.g., McNeely, A. and S.J. Scherr, 2001, Common ground, common future: How ecoagriculture can help feed the world and save wild biodiversity; IUCN-The World Conservation Union, Switzerland.

[2] FAOSTAT data, http//faostat.fao.org/ (last updated February 2004).

[3] InterAcademy Council, 2004. Realizing the promise and potential of African agriculture. Science and technology strategies for improving agricultural productivity and food security in Africa. InterAcademy Council. Amsterdam, the Netherlands. http://www.interacademycouncil.net/

[4] Nandwa, S.M., Bekunda, M.A., Research on Nutrient Flows and Balances in East and Southern Africa: State of the Art; Agriculture, Ecosystems, and Environment 71 (1-3), 5-18, 1998.

[5] Voortman, R.L., Sonneveld, B.G.J.S., Keyzer, M.A., African Land Ecology: Opportunities and Constraints for Agricultural Development; CID Working Paper No.37, 2000.

[6] Based on Oldeman, L.R., R.T.A. Hakkeling, W.G. Sombroek, World map of the status of human-induced soil degradation: An explanatory-note; Wageningen, International Soil Reference Information Centre, 1991; and World Resources Institute, World Resources 1992-1993; New York, Oxford University Press, 1992.

[7] Based on Oldeman, ibid.

[8] Van der Meij, T., J.H.W. Hendriks, C.J.M. Musters et al., Developments in nature: visions on the living nature in the world and scenarios for its preservation; Background studies, V87. Sdu Publishers, The Hague, The Netherlands, 1995.

[9] WRR, Sustainable risks: A lasting phenomenon; Reports to the Government, No. 44, Netherlands Scientific Council for Government Policy, Sdu Publishers, The Hague, TheNetherlands, 1995.