The role of the science of ecology in the sustainable development debate in Europe

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Synopsis

A tentative analysis of the role of the science of ecology in the sustainable development debate is given. The science of ecology can considerably contribute to the underpinning of the concept of sustainable development. For the solution of complicated environmental problems the application of holistic ecological concepts is needed, which means a break with the tradition of reductionism. At the same time the European dimension of the debate on sustainable development, which is at the moment strongly masked by cultural and language barriers, should be enhanced. An ecological research strategy towards sustainable development is outlined. The European Ecological Federation should play a prominent role in conveying the process of ecological sustainability in Europe.

Ecology, sustainable development, ecological sustainability, European dimension

1 Introduction

The concept of sustainable development recently evoked worldwide discussions among scientists and policymakers. The sceptic comments of scientists that the entire discussion is »old wine in new bags«, should be considered. But it is better to accept the worldwide momentum sustainable development has got since Rio 1992, and the implementation in the Agenda 21 action programme, than endlessly discuss, as ecologists sometimes do, the flaws and weaknesses of the concept. The question than is: given the sustainable development debate, how might the science of ecology contribute to the underpinning of the concept ? And the second question is: is there a European dimension in the application of ecological knowledge in the sustainable development debate ? The aim of this paper is to contribute to an answer on the questions posed. The paper starts with some definitions of ecology and sustainable development; it further discusses the theoretical ecological framework of sustainable ecosystems. Some thoughts on the relation between ecology and economy are given, and the concept of ecosystem health, suiting the discussion on sustainable development in a proper way, is elaborated. Finally the European dimension of the role of ecology in the sustainable development debate is explored.

2 Ecology, ecologists and ecosystems

Studying the role of the science of ecology in the sustainable development debate is trying to solve an equation with two unknown factors. The definition of »ecology« varies between ecology as a straightforward natural science to »ecology« as a normative social movement, in which »eco« stands for healthy, not polluted and close to nature. The definition used in this paper is: ecology is a biological science dealing with the study of the relations between organisms and their environment, including the abilities of the organisms to adapt to their environment (derived from BAKKER & al. 1995).

The definition of »sustainable development« varies between the original Brundtland paraphrase on the one hand and a sort of synergism between (weak) ecology and (strong) economy on the other (TURNER 1993). Starting from ecological, as well as economic and social arguments the Brundtland Commission (1987) defined sustainable development as follows: Sustainable development is the development which meets the needs of the present (people) without compromising the ability of future generations to meet their own needs. The definition of SCOPE (Scientific Committee on Problems of the Environment), used in her »Sustainable Biosphere Project« is the following: sustainable development is the development supporting human activities without jeopardizing the ability of ecosystems to support future generations. This definition suits ecologists better than the Brundtland definition, because »the ability of ecosystems« at least invokes on sound ecological knowledge.

»Sustainable development« is a broader term than »Nachhaltige Entwicklung«, stemming from forestry practice, indicating that the natural resources from the woods should not be overexploited. »Ecosystem« appears to be a key-concept in the definition of sustainable development. The British Ecological Society interviewed her members which concepts in their opinion reached the highest score in thinking about ecological theory; 645 ecologists responded to the questionaire. Remarkably the concept »ecosystem« had farout the highest score, followed by the concepts of »succession«, »energy flow«, »conservation of resources« and »competition« (CHERRETT 1990).

According to ODUM (1971) the ecosystem is the basic functional unit in ecology, since it includes both organisms (biotic communities) and abiotic environment, each influencing the properties of the other and both necessary for the maintanance of life as we have it on the earth. From the functional standpoint an ecosystem may be conveniently analyzed in terms of the following: (1) energy circuits, (2) food chains, (3) diversity patterns in time and space, (4) nutrient (biogeochemical) cycles, (5) development and evolution, and (6) control (cybernetics).

This is too much of a good thing for practical managers and engineers. The ecosystem concept is dimensionally undefined: it may be a pond, a catchment basin, the earth's biosphere, or (quoting ODUM) a window flower box. That is the reason why in landscape ecology, environmental engineering, physical geography, etc. the term »ecotope« coins far better. An ecotope is part of a physical landscape, a spatially separated unit that can be delineated in the landscape. A landscape, and an ecotope as the smallest unit that can still be called a landscape, is a concrete, spatial system. An ecosystem is an abstract, functional system. It is a pity that the functional strength of the ecosystem concept never made a big hit into the literature of engineers, the people responsible for habitat restoration, and nature development. Statement: The key-concept in ecology is not applicable in every days practice of sustainable nature restoration.

It is illustrative in this respect that two prestigious conferences, partly overlapping in time, held in Amsterdam and Copenhagen, last August 1996, and labeled respectively »Challenges of sustainable development« and »Ecological Summit 96« were not organized by proper ecologists. »Challenges of sustainable development« was convened by the International Network of Engineers and Scientists for Global Responsibility (INES). The »Ecological Summit 96« was organized by applied ecologists, viz. the International Societies for Ecological Economics, Ecological Modelling, Ecological Engineering and Ecosystem Health. The »true« fundamental ecologists were almost lacking. EcoSummit 96 (quoting the organisers) should, first of all be of interest to all ecologists in the world, to continue the discussion on the application of ecology and how a more holistic approach can be fashioned from the ecological principles. The tentative conclusion is that »true« ecologists have placed themselves beyond the mainstream of the discussion on sustainable development.

Is the statement all the same correct that ecology is too important to leave it to the ecologists? Academic ecologists work in a broad array of subdisciplines ranging from autecology, via population ecology to system ecology. The less holistic the level of integration in ecology is, the more reductionistic and fundamentalistic the ecologists approach is. Ecophysiologists, populationgeneticists and microbial ecologists regard the discussion on the role of ecology in the societal debate on sustainable development a mere waste of time, or at the best favourable terms a topic for their leisure time. The explanation for that behaviour is to be found in the rat race which scientists, including ecologists are doomed to run, focused on short-term performance of individual scientists constrained by science citation frequencies and peer reviews. Stepping beyond this path is like cursing in the church. The tradition of reductionism in ecology has been a mere handicap to more holistic research needed to understand the functioning of the entire biosphere.

This tendency of reductionism among ecologists is in strong contrast with the larger environmental research programmes, as e. g. launched by the European Commission, to generate contributions for the solution of our large-scale and long-term environmental problems. These programmes ask increasingly for application of ecological knowledge, for the integration of ecological, economic and societal aspects. Statement: the »true« ecologist being a reductionist operates beyond the main focus of the societal discussion on the restoration and conservation of the environment.

3 Sustainable ecosystems: the theoretical ecological framework

3.1 Ecological theory and practice

A prime character of an ecosystem is the continuous change: changes in species diversity, changes in population size of the contributing species, spatial and temporal changes over day and night and over the seasons, long-term changes (succession) from the pioneer stage to the mature stage, changes following disturbance and stress. These continuous changes make it difficult to determine the sustainability of an ecosystem. Natural ecosystems evolved over millions of years, the human frame of mind however tends to regard a period of 10 years already as long. This requires careful and intensive long-term monitoring, as well as reconstruction of the past, in order to differentiate the influence of human activities from natural background variability.

Objective validation of ecosystems is virtually impossible, as it involves subjective choices. Biodiversity is often used by nature conservationists as the ultimate parameter to validate an ecosystem. Maximizing biodiversity, or creating environments for as much species as possible, or the opposite reasoning, avoid the extinction of species, becomes than a goal in itself. Assessing the development of the number of animal and plant species over time, as well as the recovery time after disturbance, gives insight in the structure of an ecosystem. Following the Rio 92 biodiversity treaty the very numbers of species composing »biodiversity«, may easily be overestimated while the underlying processes, the functioning of ecosystems, and the management question, what is the minimal structure under which the ecosystem still fully operates, is far more important (cf. PICKETT & al. 1989).

The »minimum structure« concept is closely connected to another functional concept, the »complete ecosystem« concept (DEKKER 1990). A complete ecosystem in this context is an ecosystem containing all trophic levels, especially larger carnivores. This considers the ecosystem as a static unit, constant over time and space, and is per definition a non-concept. Another opinion is that the ecosystem is an abstraction; the reality is the ecotope, the geomorphological and physico-chemical framework, in which a dynamic pattern of co-existing species occurs, changing over time, in which species populations migrate in an individualistic and non-predictable way (HENGEVELD 1992).

An important statement is that the fast deterioration of ecosystems requires rapid action. This seems an open door but this is not the case. It urges the ecologist to show commitment. It is not productive to illustrate the present-day deterioration of the environment with yet another necrology documented in the grey literature only (cf. DEN HARTOG 1996). It is far better to concentrate ecological knowledge on the solution of the environmental problems, and to mobilize (existing) ecological knowledge for the restoration of ecosystems. During this process it is efficient to compile descriptive information on ecosystems and to make these data internationally accessible. Improved public accessibility of data banks avoids unnecessary data sampling and improves the quality of the data sampled. There is Europe-wide, written in dozens of languages a tremendous amount of grey literature, inaccessible for the generalist, and without any quality approval.

During the process of ecosystem conservation and restoration a number of tools is necessary: to set standards for ecosystem restoration, and to find indicators transmitting the message whether we are on the proper way and how long it takes before the goals are reached, and which risks we take underway.

3.2 Research steps towards sustainable development

In order to substantiate the role of ecology in the sustainable development debate several research steps should be taken:

(1) A valid description of the structure and functioning of the different ecosystem types in Europe should be available. Elsevier's series of books »Ecosystems of the World« offers a broad overview of the European ecosystems. When it comes to a more practical inventory of European landscapes and ecotopes, methods of biogeographers and landscape ecologists should be used, describing landscape identity, landscape diversity, scenic aspects, cultural heritage and regional economic values. Landscape is a combination, or better integration of nature and culture (ZONNEVELD 1995). This is a realistic view: European landscapes are for farout the larger parts influenced and changed by humans. Only part of Arctic areas and some remote Alpine areas are relatively untouched by man. This means that the European landscapes are a blend of nature and culture (mostly agriculture). Europe has been divided into a number of biogeographical regions, a classification of European landscapes is available. The scientific discussion on these items is hold among landscape-ecologists and biogeographers, it passes most »true« ecologists. European nature conservation policy is based on the development of an European ecological networks like the Habitat Directive Natura 2000, or EECONET, using the EC database on spatial environmental data, CORINE, Coordination of Information on the Environment (BISCHOFF & JONGMAN 1993).

(2) A quality assessment of environment and biota of European ecosystems should be available. The appreciated environmental quality is standard-dependent. A standard is a generally accepted rule based on a certain commitment of a group of people. This means that standards are changing, and bound by the national environmental policy of a specific country. This means also that although habitat restoration and nature conservation should have clear goals, the process depends on the socio-political willingness to reach the goals. The Dobris Assessment on Europe's Environment (STANNERS & BOURDEAU 1995) is the first attempt to present an objective inventory of the status of the pan-European environment and biota, which is now available for quality assessment and setting Europe-wide standards.

(3) The next step is prescription of eco-technological tools needed to restore the ecosystem, and prediction of the final status the ecosystem will reach in the process of conservation and restoration. This is an essential, but complex and extremely underexploited subject. In order to reach this aim ecological indicators should be developed to quantify the eco-

logical structures and processes during the restoration process, starting from an historical reference image of the ecosystem, and going into the direction of a future target image. According to a group of scientists having a strong believe in technological developments, the major part of the present-day environmental problems can be solved by existing technological means. According to others, and among them many scientists from Central and Eastern European countries, fundamantal ecology and technology are opposing spheres (GHILAROV 1995).

Carrying capacity seems a good concept to be used as indicator for sustainable development. The concept is well worked out in population ecology: carrying capacity, that is the population size which the resources of the environment can just maintain (carry) without a tendency to either increase or decrease (BEGON & al. 1990). There are interesting theoretical parallels between the logistic equations visualizing carrying capacity in ecology and economics (WETZEL & WETZEL 1995), including the new equilibrium reached after a major disturbance. This is theory. In practice, however, the ecological carrying capacity concept is worked out only for restricted plant- and animal-populations and not for the far more complicated communities and ecosystems. The economic carrying capacity, the earths capacity to support people, is determined both by natural constraints (resources) and by human choices concerning economics, culture and demography. Human choices are not captured by ecological notions of carrying capacity.

(4) Ecological processes on ecosystem level are still highly unpredictable. The theoretical and practical implications of this lack of predictability introduces environmental risks. Risk assessment and its implementation in administrative and legal rules should be performed. An ecosystem, in general, will appear to be resistant or resilient to disturbances, until a certain threshold value will be surpassed. When this threshold is exceeded, the ecosystem becomes instable an may deteriorate within short time (ABER & MELILLO 1991). When the system is forced into an unstable situation by too much disturbance, it can turn to a new dynamic equilibrium with a more simple structure. The concept of sustainability is theoretically applicable to all steady states, but they may differ in structural complexity. The classial example of the freshwater pond dominated by aquatic macrophytes and various groups of invertebrates and vertebrates should be mentioned here. During the process of eutrophication algal blooms are going to dominate, the light climate deteriorates, the macrophytes disappear together with the vertical architecture, and an unstable impoverished ecosystem remains. Establishing the thresholds where an ecosystem in equilibrium turns into another state, and defining when they will be exceeded, i.o.w. risk assessment, is essential for the development of management systems for sustainable ecosystems. Present knowledge in the field of risk assessment for complete ecosystems is extremeley insufficient. Our knowledge in this field is mainly stemming from (humane) ecotoxicological risk assessments. In practice this regards simple dose-effect relations in single species tests under experimental conditions. There has not been much progress in multispecies experiments exposed to a combination of toxicants (e. g. PELGROM 1995). Models that have been constructed on risk assessment of a combination of toxicants on populations or communities are still highly theoretical. Considering the changing and non-predictable behaviour of ecosystems, risk analysis on ecosystem level is a challenge for the future.

Summarizing the emerging fields in the application of ecology to environmental management, we come to the following. There is an urgent need for the further development of (1) ecological standards used to set the boundaries for the conservation and restoration of (parts of) ecosystems; this is an emerging field growing beyond the assessment of a set of single target variables (characteristic species) to indicate ecosystem quality into the direction of integrated variables to indicate »ecosystem health«. (2) Ecological indicators, an emerging field growing beyond the assessment of early warning signals on the plant- or animal population level to indicators for ecosystem changes; these indicators have a high ecological relevance but as yet a low precision (MOFFAT 1994; DAHL 1996) (3) Ecological risk assessment, an emerging field growing beyond the assessment of the effects of a single impact (contaminant) on a single species to evaluating the impact of multiple stressors on an entire ecosystem. The present knowledge in the field of risk assessment for complete ecosystems is extremely insufficient.

3.3 Ecosystem health

An urgent question in the context of ecological and management discussions of ecosystems is whether indicators can be defined which are able to describe ecosystem »health« both in temporal and spatial dimensions. The obvious problem concerning health indices is their complexity, as a mirror image of the ecosystems complexity. Even the comparatively »simple« indicators like diversity, stability, productivity and resilience are composed of other ecosystem characteristics. The metaphor of »ecosystem health« is appealing because it embraces both natural and cultural values. Health is a status of functioning within a cultural context. A healthy human person in 1996 fully functioning in society, would not have been »healthy« in a primitive society, strongly focussed on physical strength.

During a workshop on sustainability of ecosystems DE GROOT (1996) presented an integrated ecosystem indicator: a circular graph to visualize in a semi-quantitative way a number of environmental characteristics (called parameters; indicators or ecosystem functions) defining a specific ecosystem, in this case a section of the Danube river basin and the High Tatra National Park in Slovakia. The problem of ecosystem dynamics can be solved by presenting a series of circular graphs embracing notions of time and space. Up to now the integrated ecosystem indicator is a useful tool that formalizes the results of best professional judgement sessions in a semi-quantitative way.

Many ecologists are of the opinion that ecosystem health indicators go far beyond the limits of ecology; instead of an ecocentric approach (as ecology should offer), an anthropocentric approach dominates, because sustainability and ecosystem health are anthropocentric paradigms (ELIAS 1995). A lot of criticism is easy to formulate, but this does not diminish DE GROOT's (1996) challenging attempt in the necessary search for composite indicators of ecosystem health.

It is remarkable that the discussion in the literature on ecosystem health is not held by fundamental ecologists, but by environmental scientists (RAPPORT & al. 1995). The metaphor is strong and inspiring. In the past five years, international symposia, new journals, the emergence of several new societies, and the redirection of environmental programs, have heralded the birth of the science of »ecosystem health and medicine«. As in medical science, a process for systematically developing a history (anamnesis) of the »patient ecosystem X« is required. If Ecosystem Health/Medicine is to become a systematic science, ecosystem diagnosis must maximize the usefulness of the data that is available, and this is most rigorously accomplished using the formal approaches of mathematical logic and statistics. Consequently these mathematical disciplines must be included in the formal training of the ecophysician and must be appropriately implemented in computer algorithms attached to large data bases of ecosystem- and laboratory-derived research (SCHAEFFER 1996).

The Dobris Assessment of the European Environment Agency (STANNERS & BOURDEAU 1995) is the first step towards an understanding of the overall status of Europe's environment. The massive compendium documents the severity and geographic extent of environmental degradation and demonstrates the need for a continent-wide integrated data collection and analysis network. The main question asked in the Dobris report is: »How healthy is Europe's environment?« STANNERS & BOURDEAU (1995) presented a description and analysis of the available environmental statistics, metaphorically along the ways of anamnesis and diagnosis, and reached the conclusion that in this stage of the process no simple answer to the question can be given. The major obstacle to set the diagnosis of European ecosystems health is the lack of comparable, compatible and verifiable data at the pan-European level.

4 Ecology and economy

In many countries the discussion on sustainable development has not been initiated by ecologists. In the Netherlands e. g., the debate has been started by environmental economists, years before ecologists put it on their agenda (e. g. OPSCHOOR 1987). The dialogue between ecologists end economists was lacking. That is the reason why the Dutch-Flemish Ecological Society took the initiative to organize a workshop in 1993 »Sustainability of ecosystems: ecological and economic factors« (ANONYMUS 1994). A substantial part of the workshop has been devoted to learn eachothers scientific languages. Further, comparative field studies, integrating economic and ecological aspects, were recommended.

A number of ecological functions can be valued in economic terms, while others cannot because of a high level of uncertainty and complexity. Taking wetlands as our example, these systems provide a wide array of functions, services and goods of significant value to society: storm and pollution buffering function, flood alleviation, recreation, scientific and aesthetic services, etc. The economic valuation of a wetland can be performed by valuing the separate characteristics of the system. But it is true that the component parts of the system are contingent on the existence and continued functioning of the whole ecosystem, which implies that putting an aggregate value on wetlands and other ecosystems is a complicated matter (TURNER 1996).

The question remains how far the ecologist in his dialogue with the economist should negociate about the »values« of ecosystems. What is common practice for decades already in the USA, the economic valuation of animals and plants, has never been fully accepted in Western Europe; in C and E European countries the monetary validation of nature is even more disqualified and regarded as prostitution of the science of ecology. The attempt to turn the values of nature into a monetary equivalent may indeed bring ecology into a rather weak position. It touches on the difference between »prosperity« (affluence), in which economic goods and services are highly ranking, and »welfare«, in which non-monetary values are ranking higher.

According to TURNER (1993; 1996) the sustainable development concept ranges between »very weak« and »very strong«, between the strict market economical paradigms on the one hand, to the bioethical criteria of »deep ecology«on the other. From the strong sustainability perspective some elements of the natural capital stock (exhaustible and renewable resources, together with environmental structures, functions and services) cannot be substituted for, except at a very limited basis, by man-made capital and therefore there is a concern to avoid irreversible losses of environmental assets. Some of the functions and services of ecosystems, in combination with the abiotic environment, are essential for human survival. These are the so called life-support services, e. g. biogeochemical cycles, and cannot be replaced. Other multi-functional ecological assets are at least essential to human well-being, but not essential for human survival, e. g. landscape, space, and relative peace and quiet. The message is that environmental degradation and loss of natural resources represent one of the main ways in which today's generation is creating uncompensated future costs. Hence restoration and conservation of natural resources and the environment is crucial to achieving sustainable development (TURNER 1993).

5 Contribution of ecology to sustainable development debate; a European comparison

What is the role of ecology as a science in the European sustainability debate? This question asks for an answer to another question: Is there an European discussion on sustainable development among ecologists? Central and Eastern European countries are facing enormous environmental problems, that became manifest after the political changes in 1989. These countries are in an economic state of transition, where economic growth has a higher priority than environmental care.

A clear analysis of the key environmental needs in Central and Eastern European (CEE) countries is given by the Regional Environmental Center for Central and Eastern Europe (REC, 1994). One of their conclusions is that all countries in transition proceed in isolation along separate lines. Although they are facing the same historical heritage, the CEE countries are not cooperating with each other to address common environmental problems. A fact is, however, that an integrated environmental policy is one of the greatests needs and challenges for CEE countries, just as it is for European Union countries.

Preservation of European biodiversity located in the CEE region is a task of international importance, in which ecologists can play an prominent role. The environmental heritage in C and E Europe has left a long list of environmental hot spots (e. g. mining areas, chemical and metalworking facilities, and power plants including obsolete nuclear installations), but also vast areas of pristine natural environment, where the values of nature should be preserved against possible economic expansion. At the moment, during the transition period more attention is being given to environmental hot spots than to environmental assets. Ecologists should be alert in keeping up the standards for nature protection. Nature restoration and conservation is a labor- and capital-intensive activity, which should benefit from the ecological knowledge and experience gained by scientists from European Union countries (REC, 1994).

Among the societal groups dealing with the protection of the environment in CEE countries the non governemental organisations (NGO's) are increasingly becoming important. Many independent scientists, and among them many ecologists, are attached to those NGO's. Elias (1995) of the Slovak Academy of Sciences explained that the topics in ecology in C. and E. European countries of prime importance are, in decreasing order: 1. Landscape planning and landuse, comprising the application of landscape ecological principles with a high level of applicability, including environmental impact assessment; 2. Restoration ecology, including the rehabilitation of habitats sich as rivers, wetlands, etc.; 3. Conservation biology and biodiversity, comprising the identification of biodiversity hot spots as a basis for landscape planning an biotope mapping. In general there is a critical approach in CEE countries to the goals of the Rio Agenda 21, of which the implementation seems far beyond the daily reality. LUBY (1996), president of the Slovak Academy of Sciences made a clear statement in this context at a recent workshop on sustainable development in Bratislava: »We as Slovak ecologists were occupied during the past 5 years by the struggle for the sustainability of science in Slovakia, since 50% of our academic staff was dismissed and 7 institutions were closed down completely«.

The suggestion might arise that the European Union member states are making more progress in implementing sustainable development than C.- and E.-European countries. This is not the case. Environmental policy in the European Union has made great progress in the eighties and comprises at the moment more than 300 legal directives, dealing with air and water pollution, sewage disposal, treatment of chemicals, nature conservation, etc. A closer look, however, learns that notwithstanding the various EC directives the implementation of the environmental policy of the Europen community occurs on a national level. The formal supranational competences are insufficient to overcome contradicting national interests. This means that »sustainable development« is the gospel, without implementation on a European scale. Talking about the Dutch environmental policy, e. g. this is a good example of virtual reality: the gospel of sustainable development is preached in a squandering economy. Many more European countries are addicted to economic growth, and the sustainable development debate is closely connected to the level of prosperity.

There is still a wide gap between the potential body of ecological knowledge available in the European Union, and the application of ecological concepts in environmental management. European countries are moving from a phase of research that enabled passive understanding of the environment to one that bears directly upon its active management; environmental sciences are now driven by the urgent need to understand and to predict environmental changes. The solutions of environmental problems towards sustainable management policies go beyond the borders of pure science. As countries move from passive understanding to active management, a stronger link to the social sciences is essential. An effective interdisciplinary interface between the natural and the social sciences is necessary for an optimal contribution to environmental decision making.

Again we ask the question: is there an European discussion on sustainable development among ecologists? One of our collaborators used the internet connection »Infoterra« to ask the approximately 1300 subscribers wordwide, all interested in discussions on sustainable development, on 11 July 1996 their opinion on the role of ecology in the sustainable development debate, and specifically the viewpoints of ecologists in the different European countries. He got 5 answers, 3 from the USA, 1 from Canada and 1 from Australia. After these reactions he asked again in an explicit and provocative way for European answers. Result: no further answers. Although our sample is small and certainly not significant, our pilot experiment asks for a better check of our hypothesis: the debate on the relation between sustainable development and ecology is mainly pursued on a national level, strongly masked by cultural and above all language barriers.

The discussion among ecologists occurs mainly on a national level. We have access to the Dutch (e. g. DUIJNHOUWER & al. 1994; ANONYMOUS 1996), the German (e. g. ANONYMOUS 1995; KASTENHOLZ & al. 1996) and the English (e. g. O'RIORDAN 1995) literature. And there is certainly a discussion on sustainable development in the French, Spanish and Italian literature, but these sources have not been explored by us. There is no Europe-wide discussion on sustainable development among ecologists. We are lacking the European dimension in the discussion on the role of our field of study in the sustainable development debate. Our colleagues in the USA took their Sustainable Biosphere Initiative, and drew an ecological research agenda (LUBCHENCO & al. 1991). Their research recommendations comprise a major new integrated programme of research on the sustainability of ecological systems. The programme focuses on understanding the underlying ecological processes in natural and human dominated ecosystems in order to prescribe restoration and management strategies that would enhance the sustainability of the Earth's ecological systems.

The environmental problems in Europe differ considerably from the problems in the United States of America. The problems in Europe are historically much older, and certainly more intense and site specific as in America (STANNERS & BOURDEAU 1995), and there is no need to mimic the initiative of the Ecological Society of America. But on the other hand should we explore ways in which ecologists can expose their expertise more fully, and can become more responsive to the solution of critical environmental problems. European countries are facing specific environmental problems that should challenge ecologists in the various European areas to work unanimously at solutions. Multi-langual European ecologists should use the unifying »language of ecology« to convey their knowledge, in order to solve environmental problems.

6 Final remarks

The subject of sustainable development is not popular among natural scientists, and consequently not among ecologists; it is beyond their main interest, it does not »score« in terms of personal records, it is interdisciplinary, it is vague. Yet the positive attitude of ecologists concerned about the immense environmental problems created by mankind, is preferred. Anthropogenic changes have occurred in the biosphere as long as man is active on earth. The new prospect is that the summation of all human impacts in the biosphere is nowadays larger than it was ever before, and that never before we have had the possibilities to study the environmental changes so intensively and on such a wide scale and to prescribe and predict what is going on, in order to influence (restore) the ongoing processes. This loads a responsibility on ecologists to feed the political process towards sustainable development with proper and accessible information.

The science of ecology can considerably contribute to the underpinning of the concept of sustainable development. For the solution of complicated environmental problems, the application of holistic ecological concepts is needed, which means a break with the tradition of reductionism. At the same time the European dimension of the debate on sustainable development, which is at the moment strongly masked by cultural and language barriers, should be enhanced.

The European Ecological Federation (EEF) should play a prominent role in conveying the process of ecological sustainability in Europe. Almost all European countries, including C. and E. European countries have their own national ecological society. EEF is the umbrella federation, which has easy access to the member societies and their member ecologists. Two initiatives will be taken: (1) An academic discussion will be started among ecologists from all over Europe, in order (a) to reach a common definition among ecologists about ecological sustainability; (b) to define the role of the science of ecology in the sustainable development debate, approached from the national ecological, economic and social experience; (c) to reach a European synthesis (consensus) on the relation between ecology and sustainable development. (2) Besides the academic debate on the concept of sustainable development, comparative research projects will be proposed to bring the concept in practice, and to integrate reductionistic ecological principles into holistic standards, integrated indicators and risk assessments on ecosystem level. The European nature conservation policy is based on the development of European ecological networks. The data bases of these superstructures are available via the European Commission and other organizations. This information can be used to set up comparative ecosystem studies on a regional scale, e. g. sections of lowland river basins or areas with high mountainous forests, as was suggested at the Bratislava workshop on sustainability in 1995 (SPRENGERS & al. 1996).

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