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FROM ECOSYSTEM RESEARCH TO SUSTAINABLE DEVELOPMENT

Towards a New Paradigm for Ecosystem Research

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CHAPTER IV: SUSTAINABILITY - A NEW PARADIGM FOR RESEARCH?

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The challenge

The Challenges of Sustainable Development

"The real challenge of sustainability is to reframe the challenge" says Norgaard (1994). Indeed, sustainable development seems to be a concept that calls for profound paradigmatic changes in our way of looking at the world around us. Many disciplines are contributing to this change in views.

Since the late sixties the enormous success and the destructive consequences of the western industry-oriented development approach has given rise to increasing doubts about the durability of this kind of development. Mainly in the industrialised countries environmental activists and movements highlighted the need for a greater respect for the environment. Calls for drastic changes in behaviour and a stop to economic growth for the sake of future generations raised conflicts not only with the established decision-makers but also with the less advantaged who hoped that growth would bring them better opportunities, and often even with advocates of traditional cultures. Soon it became clear that the real challenge lay in the need to reconcile different aspects of development that had been looked at separately for a long time. The first most visible attempt to reconcile these different interests on an international level was achieved by the UN Commission on "Environment and Development" with the publication of the "Brundtland Report" in 1987 (WCED 1987). With this report the term Sustainable Development became an integral part of the international scientific and political vocabulary. Although "Sustainable Development" has become an important objective in many basic policy documents at all levels, it is still a very general concept far from being fully understood which gives raise to controversial discussions. However, historically this concept stands for two basic challenges:

- it tries to integrate development dimensions that have been treated separately in the development of our societies over the last three centuries.
- it tries to introduce a long-term perspective in order to ensure openness towards the future.

Sustainable Development and Conventional Science

Not by chance, these two basic aspects of the concept of Sustainable Development (SD) are difficult to handle with conventional scientific approaches. The way in which modern science has handled problems over the last two centuries has deeply shaped our societies and is intimately linked with the problems that gave rise to the discussion about sustainable development.

"Modern" science, which gave raise to the industrial revolution, has strongly based its approach on dividing problems into subproblems and looking at them separately. This approach was highly successful in detail. It corresponds to the tayloristic division of labour and to a differentiation of subsystems in society whose inability to coordinate has led to increasing problems. With increasing differentiation and specialisation, sectoral efficiency has dramatically increased, but overall, negative synergies threaten the success of individual improvements. An integrated view to prevent this has become more and more difficult. SD would need to link natural, economic and social sciences in some common framework in order to develop new tools for integration.

Modern science has largely been founded on a mechanistic world view. By identifying cause-effect relationships and combining them into simplifying models, enormous successes have been achieved in predicting single events, in constructing machines and in influencing certain aspects of nature. With the increasing pace of events, especially in the last half of our century, human impact on natural systems has become multifold, pervasive and has reached more fundamental layers of the conditions of life. While detailed understanding of nature has dramatically increased, overall predictions have not become easier and long-term perspectives as an orientation for guiding decisions involving unprecedented impacts are lacking. The attempt to control the development of complex systems over longer periods of time with the help of traditional deterministic models based on cause-effect assumptions is facing at least the following serious problems:

- The complexity of many systems is such that the amount of precise knowledge that would be required for such an approach cannot be provided in reasonable times. (E.g. the number of new synthetic chemicals that are released into the ecosphere each year is many times higher than the number of chemicals for which a reasonable environmental impact assessment is feasible in the same period.)

- Where human actions and decisions come into play, social sciences provide little uncontested assumptions on cause-effect relationships. As will be explained later, this has profound reasons. Attempts to predict the behaviour of systems that include humans have therefore been of very limited success.

Conventional scientific approaches therefore are not sufficient for meeting the fundamental challenges of Sustainable Development.

New Paradigms

In many disciplines new paradigms or new approaches have been developed that try to overcome similar difficulties.

Already in the 1920s, fundamental discoveries in physics showed the limited range of basic assumptions of “modern” science. Determinism and the idea of the independence of subject and object have been deeply challenged.

Probabilistic approaches from statistical mechanics to very pragmatic applications in pharmaceutical research have replaced the endeavour to always find precise causal explanations. Chaos theory and the analysis of turbulent processes have shown the limits to the predictability of natural processes.

Systemic approaches have been developed in a wide variety of fields, including psychology, computer sciences, biology, or political sciences. The interpretations vary from very deterministic modelling (cybernetics) to self-organisation and autopoiesis processes and those assuming some driving forces towards a coherent Gestalt.

Management approaches in organisational and social sciences have tried to optimise decision-making in uncertain environments using different kinds of scenario methods, game theory or creative processes.

A list of new approaches that have emerged in ecology, economy, sociology, organisational sciences, psychology, ethics and other disciplines in recent decades amounts to an impressive panorama of an emerging new paradigm, more and more

associated with the term of sustainability, multifold but somehow consistent, and up to now only discernible in its broad outlines. As Thomas S. Kuhn ({Kuhn 1967 ID: 6375}) pointed out, paradigmatic changes are never smooth, old and new concepts co-exist for a long time. The idea of controlling nature is still dominant in scientific research. The western culture of maxima[1] as opposed to a culture of moderation that has been predominating through most of history ({Khan 1995 ID: 5947}), still mainly drives the search for a less destructive development pattern.

Not all these ideas are new. Basic elements of the concept of sustainability can be found in many civilisations, philosophies, religions, faiths and cultures of the world, both new and old (Sumerian, Mayan, Mediterranean, North American Indian, Buddhism, Hinduism, Taoism, Sufism, Gandhism, etc.). They have been looking for wisdom in managing the relationship between humanity and nature. Today – having experienced the opportunities and the difficulties of the industrial era – sustainability can be understood as the central concept in the search for a new reconciliation between humanity and nature, a new meaning of balance and solidarity between the components of ecosystems.

Ecosystem Research

Ecosystem research includes a variety of approaches, driven by a variety of motivations. However, the dominating paradigm is coming from natural sciences, trying to establish cause-effect relationships for building complex systemic models. An essential element of most research in this field is a clear separation of the subject and the object, of the observer and the system.

Ecological systems are mainly understood as natural systems, on which human activities have impacts. Human behaviour and its complex psychological, sociological, economic and political conditions are usually not being regarded as part of the system. Changes in human behaviour are treated as externalities. The investigated cause-effect relationships usually only concern natural sciences where established methods allow stepwise scientific progress towards a consensus on single relationships of this kind. Especially with the support of computer technology impressive progress has been made in understanding complex systems by this approach.

Increasingly, ecosystem research is motivated by the need to understand pressing problems or risks caused by human activities in natural systems. Policy-makers ask researchers to forecast developments, to assess impacts and risks and to give concrete advice on how to handle arising problems. As human influence on European ecosystems has become overwhelming and pervasive, answers that can be given to these requests are limited as long as human activities are treated as externalities.

Attempts to include human societies in the systems considered have encountered a series of fundamental difficulties. The dominating natural sciences approach of identifying invariant cause-effect relationships and of assuming an independence of the observer and the system does not function anymore. It turns out that human behaviour and the

[1] Khan quotes the definition of the European spirit given by Paul Valery in 1922: “Wherever the European spirit dominates one sees the appearance of the maximum of needs, the maximum of work, the maximum of capital, the maximum of return, the maximum of ambition, the maximum of power, the maximum alteration of external capital, the maximum of relationships and exchanges. This set of maxima is Europe or the image of Europe”.

perception of problems are culturally shaped and in continuous evolution. Research results influence human behaviour, problem perception and political priorities change over time and space. Value judgements, perception and human behaviour cannot be considered as being independent and research itself turns out to be a part of the system.

What in science once seemed a specific problem of quantum theory and nuclear physics has ended up by challenging all kinds of macroscopic science. Suddenly, the conventional approach seems hopelessly static in an increasingly dynamic environment. Despite huge efforts, research finds itself no longer at the leading edge of "progress", but lagging behind the pressing questions of how to deal with the enormous dynamic triggered by science itself.

Ecosystem research, the most advanced approach in integrating different aspects and disciplines from natural sciences, seems to need a new paradigm for dealing with this dynamic. New bridges between natural and social sciences seem to be essential in this context.

Lessons from Research on Sustainable Regional Development

The research area "Human dimensions of environmental change" of the European ENVIRONMENT and CLIMATE programme specifically tries to approach the interaction between human activities and the environment. Within the broad spectrum of environmental research, it has some unique characteristics inasmuch as it brings together different disciplines and different cultures at the same time. Since social sciences are much more culturally shaped, real intercultural dialogue and cooperation between researchers in these disciplines is much more difficult and rare than in natural sciences.

A recent review of projects concerning Sustainable Regional Development in this programme (Schleicher-Tappeser 1998) has shown a growing convergence in views over the last few years. It seems that the intercultural character of the projects was essential in this respect. All of them not only brought together research partners from different European countries but also included regional case studies in different cultures. The resulting confrontation of different perspectives seems to have led to new insights and to increasing scepticism about straightforward conventional approaches..

The main conclusions can be summarised as follows:

- The concept of Sustainable Development stands for a profound paradigm shift which challenges century-old traditions in industrial and economic development as well as in science. Hopes for easily applicable operationalisations of the general idea of sustainable development have faded. The transition period until a general consensus about the meaning and the acceptance of this new concept will be reached may last many years.

- The emerging concept of sustainability requires new approaches for dealing with complex interrelations between different dimensions of development. Terms such as Horizontal Integration, Cooperation, Networking or Partnership are used for describing such approaches in different fields.

- Attempts to find standardised problem solutions for European wide application encounter difficulties. The meaning of Sustainability depends on the specific context.

A common language is required for describing these differences and for exchanging experiences.

- The idea of sustainability deeply challenges our way of dealing with different scales. "multi-level governance" or "shared responsibility" are new terms in the European political discussion which stand for a new interpretation of the principle of subsidiarity. In this sense the originally limited discussion about *Regional* Sustainable Development made a fundamental contribution to the general idea of sustainability.

- Changes in the perception of problems and changes in the interrelationship of actors lead to changes in human behaviour. There are no established models for forecasting such changes.

The projects reviewed have shown that there is no easy way to model and to forecast the interaction of human societies and natural systems. European policies aiming at sustainable development cannot be based on unambiguous models. They need to be flexible in two directions. Flexibility is needed over space, since problem perception, values and interaction patterns are strongly shaped by culture and vary across Europe. Flexibility is also needed over time since precise forecasting is basically impossible.

The consequences of this basic need for flexibility are:

- sustainability is a general idea that must be interpreted concretely in specific contexts

- sustainability cannot be achieved by a command and control approach since we have no adequate causal models

- sustainability can only be approached through a practical management process which includes permanent learning.

These consequences fundamentally challenge the still dominant idea, that more research and a better understanding of causal relationships in ecosystems including man will enable researchers and political decision-makers to forecast system behaviour, to identify unambiguous rules for sustainable development and to formulate command and control policies that guarantee sustainability.

Environmental policies have for a long time been based on these assumptions and have produced impressive results, especially where such an approach – including command and control policies – is culturally accepted. However, for some years this policy approach has been encountering increasing difficulties. So, both from a theoretical and from a very pragmatic point of view new approaches are needed.

The INSURED components of sustainability

A framework that tries to allow for such flexibility has been developed by the INSURED project ("Instruments for Sustainable Regional Development", see Schleicher-Tappeser *et al.* 1998) – one of the reviewed projects mentioned above.

Perception and values – sustainability as a "regulative idea"

It emerges that the concept of sustainability has two strands:

- sustainability stands for a new way of perceiving the world in which we are living,

- sustainability also stands for a shift or a new set of values and priorities in decision-making.

As perception is always conditioned by concepts and values, description and valuation cannot be completely independent. For several decades a more systemic view of our living conditions has gained in importance. In many disciplines and policy fields the way of describing and explaining phenomena has increasingly taken into account complex interrelationships between economic, ecological and socio-cultural aspects. In many instances this has resulted in an abandonment of sectoral and mechanistic approaches. This in turn has led to a different appreciation of phenomena and seems to converge to the concept of sustainability which at the same time is old and new.

Early hopes that it might be easy to find easy and generally valid rules for implementing the idea of sustainability have been disappointed. Much more than a concrete prescription, sustainability seems to be a "regulative idea" in the sense of Kant, an idea that can give a general orientation such as prosperity or freedom, which has to be interpreted in a specific manner in every concrete situation (Homann 1996, Brand 1997). For concrete orientations, it seems that we can only develop procedures in which a series of aspects have to be considered and weighted systematically. The difficulty in reaching authorative statements can be gauged if we think of the length of time that was needed to develop law systems which allow valid interpretations of what "freedom" or "justice" mean in a concrete situation. Different cultures have developed different interpretations of general values like freedom and different procedures to assess them.

The concept of sustainability can be discussed on very different levels. We can conceive of the realm of values and norms as a complex multi-level system which ranges from very general regulative ideas such as "freedom" or "respect for life" down to specified norms such as the maximum allowed NO_X emissions for cars. In between we find a multitude of intermediate norms which increase in number as the degree of concretion augments towards the lower levels. Lower level norms cannot be easily deduced from the higher ones: conflicting aspects have to be weighted, causal relationships have to be taken into account according to the present state of knowledge. Changing attitudes (such as increasing acceptance of divorce), new circumstances (such as the increase in population or in number of cars) and new insights (such as the discovery of the threat to the global climate by the greenhouse effect) continually lead to a debate and renegotiation of norms in our societies. This multi-level system of norms corresponds somehow to our view of causal relationships and to the systems (often hierarchies) of institutions which are involved in the negotiation and interpretation of these norms. At each level, at each node of this network, there is scope for interpretation and valuation.

Most changes in attitudes and interpretations of reality may have minor effects on this system of values and norms. The emergence of the regulative idea of sustainability, however, is so fundamental that it can be considered as an earthquake that calls for a reconsideration and renegotiation of all relationships between values and norms on all levels. It may lead to considerable changes in the specification of norms at the lower levels. Given the enormous complexity of our system of values and norms and the fact that innumerable institutions and individuals are involved in these negotiation processes, this will necessarily take a long time. Considering the different institutions involved in this process of negotiating norms, we discover that applying the principle of subsidiarity (which we think is an essential component of sustainability, see below), will inevitably lead to different interpretations in different regions and different realms.

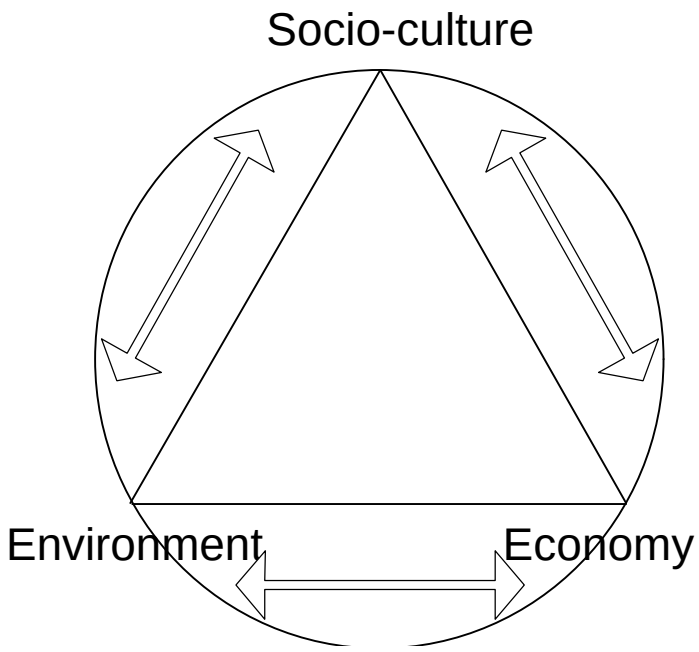
Components of sustainability

Looking at the literature we can identify not only many roots but also a large number of different interpretations of the concept of sustainability. Looking for a common systematic framework which is useful in a European context, three requirements seem to be essential:

- to develop a common language
- to develop a conceptual framework which allows the identification and the comparison of different positions
- to identify existing consensus

The widest and most accepted interpretation of sustainability has been formulated in the Rio declaration 1992. The argument presented here is based on the understanding of sustainability expressed in this document. The attempt to categorise the 27 principles of the Rio declaration shows that they concern very different dimensions. In the literature we can distinguish three basic approaches to defining sustainability. However, none of them on its own covers the complexity of the Rio approach. In essence we can characterise them by the following three questions:

Figure 1: The development dimensions



- WHAT?: What do we want to sustain?
- WHY?: Why do we bother about these issues? Which conflicts of interest are the motives?
- HOW?: How can we ensure sustainable development? Which basic approaches can help us?

The INSURED project has used them as the basis for the development of a systemic framework.

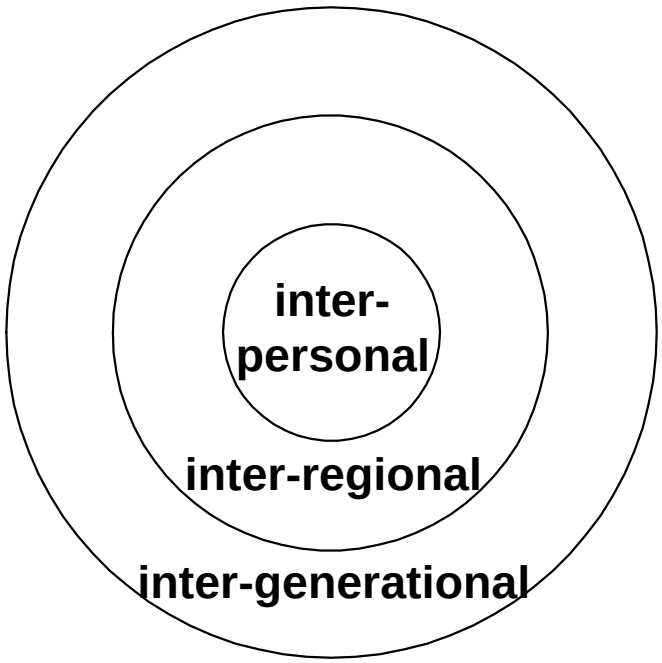
WHAT?: Development dimensions

Concerning the question "What do we want to sustain?" there is a growing consensus that besides environmental aspects, economic and socio-cultural aspects have also to be considered. In one interpretation these three aspects can be associated with the conservation and further development of natural capital, man-made capital and human/ social capital.

WHY?: Equity dimensions

Equity issues are at the origin of the concept of sustainability. Perceived inequities have led to political movements that called for another kind of development. In the last century, equity between social classes and between women and men, i.e. equity between individuals, was the main motive for the rise of the labour movement. It led to sophisticated social security systems based on solidarity between individuals. Only after World War II did equity between regions become a major political issue. Transfer systems between countries and regions were established. So the European Structural Funds are an expression of a (still?) growing solidarity between regions in Europe. And only since the early seventies, since living conditions on earth seem seriously endangered by resource depletion and environmental hazards, has the concern for equity between generations become a political issue leading to a broad debate about sustainable development.

Figure 2: The equity dimensions



HOW?: Systemic principles

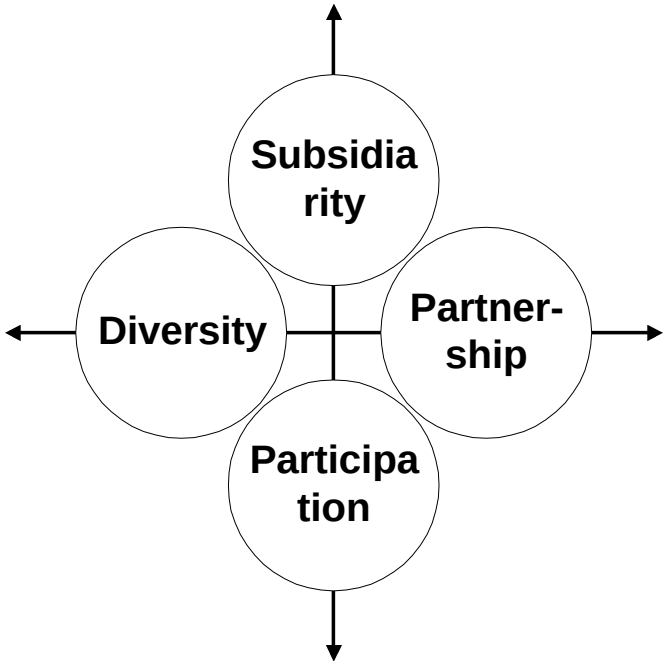
The emerging, more systemic way of looking at our world has not only sharpened our view of the problems which the dominant development model has created over the last two hundred years. It has also given indications of how to avoid mistakes and cul-de-sacs in situations of uncertainty and limited knowledge. The main shift in the perspective concerns the way of looking at interrelationships and organisational patterns. New concepts have emerged concerning systemic principles which are seen to be essential for vital systems and relationships. Different from the development aspects mentioned

above, these principles do not describe specific aspects of our life or specific development problems, rather they constitute general approaches to reality, tools for describing, understanding and structuring. In this sense they constitute important tools of perception and stand at the same time for new values.

Different systematisations of systemic principles have been discussed by various authors. The INSURED project has eventually chosen the following four:

Diversity is a concept originating from biological ecology. The diversity of subsystems and organisms is essential for ecosystems in order to be able to adapt to changing conditions and to develop new dominant patterns. The evolution of life on earth strongly accelerated when sexual reproduction allowed for greater diversity. Biodiversity is regarded as a most important indicator of the stability of ecosystems. At the Rio Conference a special convention was dedicated to biodiversity. The concept of sustainability maintains that diversity is not only a value in the realm of biology, but also in human societies. Also, in cultural and in economic development diversity is an essential prerequisite of vitality. The more technical term of redundancy can be understood as a special kind of diversity. However, according to the systemic view, diversity cannot be understood as an absolute value. As every system can be understood as a subsystem of a larger one, there is always a trade-off between autonomy and integration (Varela 1979). In this sense the concept of diversity is strongly linked to the next principle: subsidiarity, which stresses more explicitly the dialectic tension between autonomy and integration addressing the interrelationship between a series of system levels or dimensions. Whereas the concept of diversity originates from natural sciences, the concept of subsidiarity stems from the social sciences (especially catholic social doctrine). In general terms it calls for a high degree of autonomy and self-governance in the smallest possible units. This applies for policy making, social systems of solidarity and welfare, technical systems or flows of goods and resources. However, no level has to dominate all the others, neither the national nor the regional one. Finding a new balance in this sense seems to be one of the most challenging aspects of sustainability.

Figure 3: The systemic principles



The emerging more systemic, holistic view which emphasises co-evolution, complementarity and interdependence instead of fierce competition, exclusiveness, hierarchy and domination, stresses the importance of networks and partnership in human, institutional and also other relations. Networking is not only a social but also a technical and an ecological concept. Partnership has to do with trustful cooperation in a common framework and with mutual respect. Giddens has shown how much the development of modern society relies on trust. The concept emphasises the common responsibility of all parties involved. Partnership includes the striving for fair and peaceful resolution of conflicts.

Participation, finally, concerns the relationship between individuals and institutions. It means that the individuals concerned should be involved in decision-making about their future. Participation, therefore, concerns more the vertical dimension of societal relationships, the legitimacy of hierarchies. In this sense it is linked to the concept of networking and partnership which generally is perceived as concerning more than horizontal relationships.

The challenge: integration and learning

The groups of basic components of sustainability developed above represent different perspectives. They are intrinsically interrelated, but none of them is completely included in the others. An analysis of the components shows that none can be omitted without losing important aspects. In checking the 27 principles of the Rio Declaration against the ten sustainability components developed here, it was found that only the first principle, which states that sustainability is an anthropocentric approach, is not fully covered explicitly by one of the ten components alone.

The main challenge of the concept of sustainability does not lie in elaborating measures which enable us to consider every single one of the components developed above. The first five of them are not new. Special policies and institutions have been established for them for a relatively long time. The main challenge seems to lie in the way to deal with these components, a new way which is mainly expressed by the four systemic principles. In a simple formula the challenges could be summarised as follows:

- INTEGRATION
  - consider simultaneously different dimensions of development
  - look for win-win solutions
- OPENNESS TOWARDS THE FUTURE
  - conserve potentials and resources
  - improve the ability to learn, encourage innovation

These challenges are obviously present in many other fields and activities. However, trying to meet them in connection with the set of components developed above is not an easy task.

The INSURED framework

The above components of sustainability can be used as a general orientation for sustainable development. This set has proved to be very valuable for structuring interdisciplinary and intercultural discussions in a series of different projects (e.g. ARPE 1997) and for concretely assessing situations, policies and actions. With the help of a series of case studies within the INSURED project it has been further developed into a larger management framework which, in addition to these components which serve as ORIENTATION, also includes elements which make it possible to assess the POTENTIAL and to identify the DYNAMICS (see below).

Table 1: The INSURED Components of Sustainability

The development dimensions		
O1	The environmental component	The environmental component of sustainability on the one hand demands conservation of the richness and the potentiality of our environment. On the other hand, it calls on us to respect the environmental and ecological principles, to respect and to sustain the functioning of ecological systems of which man is a part. Man has strongly shaped the environment, and therefore the term environment also encompasses the man-made environment.
O2	The economic component	The economic component of sustainability on the one hand means the satisfaction of human needs, the conservation and improvement of (mainly material) well-being. On the other hand it also means respect for economic principles: efficient use of all kinds of resources is an essential aspect of sustainability.
O3	The socio-cultural component	The conservation and development of human and social potentials is one side of this component. These potentials comprise all aspects of skills, knowledge, habits, beliefs, culture, institutions of human societies and also their individual members. The cultivation of these potentials on the other hand requires respect for the principles which are considered to be essential for the good functioning of our societies, such as the guarantee of human rights, democracy etc.
The equity dimensions		
O4	Inter-personal equity	Equity between individuals, which encompasses equity between all humans regardless of their social situation, their gender or their ethnic or cultural background has been an essential demand since the French revolution and has been a core issue in the development of western societies since the middle of the last century. It remains a central issue in the concept of sustainable development. Equity is not equality (the original quest of the French revolution), the aim is not to abolish all differences, but opportunities should be equitably distributed. Solidarity is essential for improving equity.
O5	Spatial equity	Equity between different regions and countries is a more recent concept. In a world in which interrelationships between different countries are continuously intensifying, the importance of this concept is growing. Equity for all humans becomes indivisible.
O6	Intertemporal equity	The concern about future generations has been at the origin of the concept of sustainability. Equity between present and future generations, the principle of maintaining and increasing overall opportunities and options, is an aspect to be considered in all actions. However, there is no simple rule how changes in opportunities may be valued. The other SD components are needed for assessing developments in this sense.

The systemic principles		
O7	Diversity	Diversity is an essential precondition for further development in all kinds of evolving systems. Biodiversity, economic diversity, and diversity of cultures all stand for the ability of a system to maintain dynamic stability. Innovation and adaptation to new conditions is possible where different approaches and solutions can be combined to form new ones. Diversification is therefore often a strategy to increase long-term stability.
O8	Subsidiarity	The principle of subsidiarity basically demands that all kinds of functions be fulfilled at the lowest possible level and within small dimensions. Help or ruling from outside shall only intervene if this really helps to improve the fulfilment of the function and if this does not diminish the autonomy of the subsystem in a dangerous way. The principle of subsidiarity originated in the catholic social teaching concerning the issue of social responsibility and social security, but it can be applied to all kinds of systems, such as politics, administration, business, technical systems, material flows in the economy etc. The principle does not give clear indications, it describes the tension between autonomy and integration into larger systems. In a world of rapidly-growing complexity it is increasingly important to be able to understand and manage shared and negotiated responsibilities between several levels and dimensions. Old concepts of (national) sovereignty will have to be replaced by concepts of multi-level governance. Subsidiarity implies empowerment of individuals and communities to actively manage and control their own life. Subsidiarity nourishes democracy, by means of governance styles which allow citizens to determine every dimension of their common life and to improve their abilities to manage equitable social interactions
O9	Networking and Partnership	The concept of networking stresses the importance of horizontal non-hierarchical relationships. A network is based on mutually agreed objectives and rules and is basically open: members can enter and leave. Networks ensure the exchange of experiences and information, organise mutual support, stabilise systems and evolve. Networks are subject to competition: members may change to other, more attractive networks. Flexibility and orientation towards the needs of the members is therefore essential for networks to survive. The concept of networking is not only relevant in social systems but also in biological and technical ones. The enormous success of the use of the networking concept in Information Technology parallel to its growing acceptance in all kinds of organisations is leading to a deep transformation of our societies.

10	Participation	All stakeholders concerned by an issue should have the opportunity to be involved in the relevant process of decision-making. In the early stages of the formulation of a problem and the identification of alternative solutions such an involvement is particularly important. Participation corresponds to basic ideas of democracy, favours a diversity of approaches and may contribute to avoidance of conflicts. Participation strengthens the sense of responsibility, motivates people to make a contribution and increases compliance with decisions taken. Participation on the other hand requires time and motivation among the participants, openness of the institutions involved and often more time and funding than exclusive hierarchical decision-making. Depending on the adopted procedures it also risks decisions being taken which contradict experts' views. Participation concerns the way of decision-making in all kinds of social systems including business. It requires respect for different kinds of interests and points of view. Therefore it also favours an approach which integrates the different dimensions of Sustainable Development.

Self-Reflexivity

In outlining the challenge of sustainability ecosystem research we have seen that the role of science seems to have considerably changed in recent decades. As a major result of the review of EU projects on Sustainable Regional Development it has emerged that sustainability can only be approached through a practical management process which includes permanent systematic learning. This would imply an abandonment of the conventional scientific approach of modelling, forecasting and control, but should not be confused with simply muddling through. Systematic tools for such an approach are needed – the INSURED framework outlined above might point in a useful direction.

For a better understanding of this change of the role of science and of the management tools needed, the concept of self-reflexivity seems to be very helpful. Giddens has described how the increased capability of our societies to communicate and to reflect the consequences of our own actions has led to an enormous acceleration of learning processes.

The success of the scientific approach has undermined its own preconditions. Conventional research has progressed by identifying reproducible phenomena neglecting minor interrelationships and by making forecasts under *ceteris-paribus* assumptions. Difficulties have appeared in applying this approach to complex ecosystems and have led to evolutionary and systems theories which seemed to provide reasonable tools for dealing with natural complexity. However, the dominant conventional approach, which concentrates on the most obvious interrelationships, has allowed for very effective interventions in natural systems – at least in the short term. With the growing extent of these interventions the natural systems have been considerably changed and intrinsically linked to social systems.

A first consequence is that new links over space and time have been established or strengthened:

- trade, travelling and research have enormously increased exchanges of all kinds between different ecosystems around the globe

- new links between different evolutionary periods have been established, e.g. by burning fossil fuels which had been deposited "safely" before the appearance of man on earth

- the standardisation of land use and the increased use of pesticides is reducing biodiversity many times quicker than it has built up in the course of evolution

- gene technology transfers genetic code between species which have evolved separately since hundred thousands of years

A second consequence is that many of these new links are subject to the control of man. Increasingly this means that they are being established and removed, strengthened or weakened not on the basis of physical, chemical or biological feedback systems, but on the basis of human perceptions, expectations and values. Whereas traditional agricultural methods evolved very slowly over centuries on the basis of unsystematic trial and error, macroscopic results, regional natural inputs and muscular forces, modern scientific methods of nature exploitation rely on models, forecasts, calculations, powerful synthetic inputs and fossil-fuel-powered machines. Changes in scientific models and forecasts, in consumer preferences, EU subsidies or stock market development may change ecosystems within a few years. Many feedback times have become shorter.

The once so successful conventional scientific approaches which started from the assumption of being able to independently observe the effects of discrete and limited interventions is no longer applicable under these circumstances. Feedback loops which are conditioned through human societies and their scientific approach to control nature must be taken into account. So, science finds itself being trapped in a feedback loop having a strong impact on its object. This results in an acceleration of change which continuously shortens the range of scientific results. In genetic engineering some strategies already take into account this phenomenon: pest-resistant crop plants are designed to be useful for only a few years until massive resistance has developed against their venom overdose which has been adapted from more flexible defence mechanisms of other organisms.

There are two consequences that can be drawn from this dilemma:

- The first is to develop management tools which give a flexible guidance without hoping to establish complete cause -effect models. This implies acknowledging that the temporal range of forecasts is diminishing and that therefore also human interventions must become more prudent.

- The second is to try to structure society-nature relationships in such a way that some structural control prevents excessive acceleration of the development of subsystems with subsequent breakdown.

Worried by similar questions, Luhmann has developed the concept of self-referential systems and has extensively described corresponding phenomena in the most varied fields, where communication in self-referential systems leads to the impossibility of communication between subsystems of society and the impossibility of integrating different dimensions of development. He ended up within a rather pessimistic world

view. Another strand in the discussion concerning autopoietic systems which can be originally associated with Varela, Maturana or Jantsch stresses the importance of looking at many different system layers and their interlinkages and of always balancing autonomy and integration. This is the challenge of subsidiarity. Today one might say that subsidiarity should not only be seen as applicable to the social realm but that it also extends to the underlying biological and chemical systems.

In fact, the idea of subsidiarity might be essential for preventing high-level systems from closed self-referential dynamics, from dissociating from their underlying foundations and from eventually destroying part of their nourishing environment. We have just witnessed such a destructive process in the Asian financial crisis. In the same sense as uncontrolled financial flows may damage the underlying economies, one might argue that uncontrolled markets for agricultural goods may damage ecosystems.

In a similar way diversity, partnership and participation can be understood as basic evolutionary guidance principles in order to avoid too much destruction in this historical period of growing self-reflexivity.

The irritation which started with quantum physics was only the start. The observer is part of the system. Simple deterministic models become impossible. This does not only change the role of science but also the role of politics. Once the relationship of science and politics seemed so simple. The independent scientific observer analyses the system, he uses generally established norms and targets for making judgements about the situation, he proposes measures for changing the situation based on his model. Then politics, conceived as a ruler which is outside the system, sets more concrete targets and tries to implement measures. If society is no longer an unconscious object of the manipulations of experts and politicians, the whole game is going to change.

Static models become useless. Ways must be found to manage permanent change in relationships and values. Science must realise its own relative role in this process. Eco-system management may therefore be an adequate term for what needs to be developed.

Ecosystem management

Detailed plans and command and control policies under these circumstances are an illusion. However, muddling through is no alternative. Flexible management using regularly revised objectives becomes the only option. Considerable efforts will be necessary for developing orientations with the necessary degree of flexibility. New approaches and more sophisticated tools are necessary for linking in a flexible way values and objectives from some general European or even global consensus down to very concrete local development objectives for a specific context. And similarly, for linking long-term orientations with medium-term objectives and short-term targets. It seems that the concept of subsidiarity may play an increasingly important role. New skills are needed: developing common visions, negotiating, evaluating, ensuring transparency becomes essential.

Safe grounds are becoming rare. As has happened with most research in the course of this century: ecosystem research cannot escape self-reflexivity. It has permanently to reconsider its own context of use. Ecosystem research becomes a part of ecosystem management. It must continue to gather hard facts where they can be found, but it will need to develop a much more dynamic framework for the use of its established knowledge. The question “what makes the change change” becomes most interesting,

mathematically speaking: the second derivative. Parabolic or hyperbolic curves cannot be understood with linear algebra.

Sustainability is not a matter of indicators or criteria which can be easily measured and checked. Also objectives alone are not sufficient. A useful management framework should provide:

- general orientation,
- help for interpreting a specific context and assessing own forces
- a choice of general strategies
- adequate instruments for navigating in turbulent circumstances.

The following article proposes elements of a tool developed in this spirit.

Ecosystem research and sustainability

When Ecosystem research is part of the system, research programmes themselves should comply with the concept of sustainability. In the INSURED framework presented above, the systemic principles seem to be particularly interesting in evaluating research programmes.

A consequent approach for evaluating ecosystem research programmes in terms of sustainability could include many perspectives. The usual evaluation steps are: assessment of the present situation, assessment of alternative strategies, *ex-ante*, intermediate and *ex-post* evaluation of programmes considering their different internal levels. In all the evaluation steps a series of programme aspects could be evaluated in terms of the ten components of sustainability: genesis, functioning and scientific approach of the programmes, their impact on the scientific landscape, on politics, and finally on ecosystems, including human societies.

Ecosystem research is working at a focal point of the general challenges highlighted in this article. An evaluation of past and current programmes could probably give systematic insights concerning new approaches which might not only be of interest for the ecosystem research community but far beyond.

REFERENCES

American Association for the Advancement of Science (AAAS) (1997), *Human-dominated ecosystems – A special Report*, Science Vol. 279, pages 445-608.

Anderson R. E. & Carter I. (1984), *Human Behaviour in the Social Environment*, Aldine, New York

Attanasio R. M. et al. (1997), *Guida alle leggi Bassanini*, Il Sole 24 Ore Pirola, Milano

Barbault R. (1996), *L'Ecologie, une science de la nature a l'epreuve d'enjeux de société*, Natures-Sciences-Societes, 4, 4, pp. 372-380.

Beck U. (1992), *Risk Society: Towards a New Modernity*, Sage, London

Brand, Karl Werner (Ed.) (1997), *Nachhaltige Entwicklung. Opladen;* Leske + Budrich.

Cadée, N., Dronkers, J. Heip, C., Martin, J.-M. and Nolan, C. (12-14 January 1994), *ELOISE. European Land-Ocean Interaction Studies. Science Plan*, European Commission, Directorate General XII, Science, Research and Development. Roosendaal, The Netherlands. EUR 15608 EN. Ecosystems Research Report 11.

Catizzone, M, Svensson, L., Pinborg, U. & Lorenzen, H. (1998*), Report from the Brainstorming session*. In: Catizzone, M., Larsson, T-B. & Svensson, L. (1998), *Understanding Biodiversity. A research agenda prepared by the european working Group on Research and Biodiversity (EWGRB*), European Commission DG XII Science Research Development, Ecosystems Research Report 25

Catizzone, M., Larsson, T.-B. and Svensson, L. (1998), *Understanding Biodiversity, . A research agenda prepared by the european working Group on Research and Biodiversity (EWGRB*), European Commission, Directorate General XII, Science, Research and Development - 1998. EUR 18444 EN. Ecosystems Research Report No 25. ISBN 92-828-4279-7.

Clarke T. & Clegg S. (1998), *Changing Paradigms. The Transformation of Management Knowledge for the 21st Century*, Harper CollinsBusiness, London

Council of Europe-UNEP-European Centre for Nature Conservation (1996), *The Pan-European Biological and Landscape Diversity Strategy*, Published by the Ministry of Agriculture of the Netherlands, 1996. ISBN 90.802482.4.x.

De Marchi, B. (1997), *Seveso: from pollution to regulation*, Int. J. Environment and Pollution, Vol. 7, No. 4, pp.526-537.

De Tocqueville A. (1835 – 1840), *Democracy in America*, Project Gutenberg & promo.net (Feb. 1997)

Dyson, F. (1995), *"Introduction : The Scientist as a Rebel". Nature's Immagination. The frontiers of Scientific Vision*, Ed. J. Cornwell, Oxford University Press, 1995, pages 1-11. ISBN 0-19-851775-0.

Edel A. (1995), *Ethical Judgment*, Transaction Publishers, New Brunswick, New Jersey

Ehrlich P.R. and E.O. Wilson (1991), *Biodiversity studies: science and policy*, Science, 253, pp. 758-762.

Elkington J. (1997), *Cannibals with Forks. The Triple Bottom Line of 21st Century Business*, Capstone, Oxford

Esteban, J.A., Costello, M.J., Larsson, T-B., Nowicki, P.L., Svensson, L., Troumbis, A.Y. & Watt A.D. *In print*. Research and Biodiversity: A Step Forward. Report of an Electronic Conference. - Government of Catalonia. Ministry of Environment.

EU Commission (1996), *Mandate for a European Working Group on Research and Biodiversity (EWGRB),* May 1996-December 1997. – EU Commission DG XII Contract ENV4 CT96 6140

European Commission, *Proposal for a Council Decision. COM(98),* 305 Vol. I. Office for Official Publications of the European Communities, Luxembourg. 1998. ISBN 92-78-36330-8.

EU Commission (1996), *Mandate for a European Working Group on Research and Biodiversity (EWGRB),* May ´96-December ´97. - EU Commission DGXII Contract ENV4 CT96 6140.

EU Commission (1998), *Communication of the European Commission to the Council and to theParliament on a European Community Biodiversity Strategy* - EU Commission DG XI & DG XII.

EWGRB (1996), *The European Working Group on Research and Biodiversity* (EWGRB). http://www.ettnet.se/~ewgrb

Fisher L. (1982), *The Life of Mahatma Gandhi*, Granada, London

Funtowicz, S.O. and Ravetz, J.R. (1990), *Uncertainty and Quality in Science for Policy*, Kluwer Academic Publishers, 1990, Dordrecht.

Funtowicz, S.O. and Ravetz, J.R. (1991), *A new scientific methodology for global environmental issues*, in Costanza, R. (Editor), Ecological Economics, Columbia University Press, New York, pp.137-152.

Funtowicz, S.O. and Ravetz, J.R. (1993), *Science for the post-normal age*, Futures, Vol.25, No.7, pp.735-755.

Funtowicz, S.O. and Ravetz, J.R. (1994a), *The worth of a songbird: ecological economics as a post-normal science*, Ecological Economics, Vol.10, pp.197-207.

Funtowicz, S.O. and Ravetz, J.R. (1994b), *Uncertainty and regulation*, in Campagnari, F. (Editor) Scientific-Technical Backgrounds for Biotechnology Regulations, ECSC/EEC/EAEC, Brussels and Luxembourg, pp.133-142.

Gandhi M. K. (1982), *Villaggio e autonomia*, Libreria Editrice Fiorentina, Firenze

Garrat B. (1994), *The Learning Organization*, Harper Collins Publishers, London

Gasparini A., Strassoldo R. (1996), *Tipi ideali e società*, Franco Angeli, Milano

George S., Weimerskirch A. (1994), *Total Quality Management*, John Wiley & Sons, New York

Gouillart F. J., Kelly J. N. (1995), *Transforming the Organization*, McGraw-Hill, New York

Grove-White, R., Macnaghten, P., Mayer, S. and Wynne, B. (1997), *Uncertain World: Genetically Modified Organisms, Food and Public Attitudes in Britain*, research report by the Centre for the Study of Environmental Change (CSEC), Lancaster University, Lancaster, March 1997.

Hammer M., Champy J. (1994), *Reengineering the Corporation*, Nicholas Brealy Publishing, London

Hays S. (1994), "Structure and Agency and the Sticky Problem of Culture", in *Sociological Theory*, n. 12

Homann, Karl, (1996), *Sustainability: Politikvorgabe oder regulative Idee?*, In: Gerken, L.: Ordnungspolitische Grundfragen einer Politik der Nachhaltigkeitp. 33-47. Ordnungspolitische Grundfragen einer Politik der Nachhaltigkeit. Nomos: Baden-Baden. EURES-RST.

Holling, C.S. (1998), *The Renewal, Growth, Birth and Death of Ecological Communities*, Whole Earth, Summer 1998. pages 32-35.

INES (1995), *Annual Report 1995 of the International Network of Engineers and Scientists for Global Responsibility*, INES Office, Dortmund, Germany.

Jantsch, Erich (1979), *Die Selbstorganisation des Universums. Vom Urknall zum menschlichen Geist*, München: Hanser.

Kammen, D.M. and Dove, M.R (1991), *The virtues of mundane science*, Environment, Vol.39, No.6, pp.l0-l5.

Kay, J.J. (1994), *Some notes on the Ecosystem Approach*, Available at the URL http://www.fes.uwaterloo.ca/u/jjkay/pubs/nac/index.htm.
A version was also published as :
Kay, J. (1997) *The Ecossytem Approach: Ecosystems as Complex Systems*; in Murray, T., Gallopinn, G., (eds) *Proceedings of the First International workshop of the CIAT-Guelph Project "Integrated Conceptual Framework for Tropical Agroecosystem Research Based on Complex Systems Theories"*, Centro Internacional de Agricultura Tropical, Cali, Colombia, 26-28 May, 1997. pp. 69-98.

Ketteler W.E., Freiherr von (1924), Corsivo, ausgewählt und hrsg. von Johannes Mumbauer, 2. aufl., J. Kösel & F. Pustet, München

Khan, Adil, (1995), *Sustainable Development: The Key Concepts, Issues and Implications*, In: Sustainable Development, p. 63-69.

Kuhn, Thomas S. (1962), *The structure of scientific revolutions*. Chicago, University of Chicago Press

Kuhn, Thomas S. (1967), *Die Struktur wissenschaftlicher Revolutionen*. Frankfurt.

Laanbroek, H.J., Maltby, E., Whitehead, P., Faafeng, B. and Barth, H. (1994), *WATER. Wetland and Aquatic Ecosystem Research. Science Plan*, European Commission, Directorate General XII, Science, Research and Development. EUR 17452. EN. Ecosystems Research Report 23. ISSN 1018-5593.

Lawton, J.H., J.M. Moreno, and S.Struwe, (editors) (1998), *Ecosystems research and the European Union environment policy needs*, Report of TERI-CA Workshop, Toledo 29 April-1 May 1998. University of Toledo Universidad de Castilla-La Mancha, EU/DG XII, 41 p.

Lubchenco, J. (1998), *Entering the century of the environment: a new social contract for science*, Presidential Address to the American Association for the Advancement of Science, 15 February 1991, published in Science Vol.279, 23 January 1998, pp.491-497.

Luhmann, Niklas (1984), *Soziale Systeme. Grundriß einer allgemeinen Theorie*, Frankfurt am Main: Suhrkamp

Matthews, R. (1998) *Hidden perils*, New Scientist, 21 February 1998, pp. 1~11.

Menaut, J.-C., Struwe S. (1994), *Terrestrial Ecosystem Research Initiative (TERI). Science Plan*, (Eds.) Ecosystems Research Report 17. European Commission, Directorate General XII, Brussels, 1994.

Maturana, Humberto R./ Varela, Francisco J. (1987), *Der Baum der Erkenntnis. Wie wir die Welt durch unsere Wahrnehmung erschaffen - die biologischen Wurzeln menschlichen Erkennens*. (=Originalausgabe 1984) Bern, München, Wien: Scherz.

Milton K. (1996), *Environmentalism and Cultural Theory*, Routledge, London

Morin E. (1994), *Terra-Patria*, Raffaello Cortina Editore, Milano

Naiman R.J., J.J. Magnuson, D.M. Meknight and J.A. Stanford, (editors) (1995), *The freshwater imperative. A research agenda*, Island Press, Washington.Norgaard, Richard B. (1994), *Development betrayed. The end of progress and a coevolutionary revisioning of the future*, London.

Nonaka I. (1991),” The Knowledge-Creating Company”, in *Harvard Business Review*, November - December

O'Connor, M. (1994a) *Complexity and coevolution methodology for a positive treatment of indeterminacy*, Futures, Vol.26, No.6, pp.610-615.

O'Connor, M. (1994b) *Thermodynamique, complexite et codependance ecologique: la science de la joie et du deuil*, Revue Internationale de Systemigue, Vol.8, Nos.415, pp 391Ä4~3.

O'Connor, M. (1994c) *Entropy, liberty and catastrophe: on the physics and metaphysics of waste disposal*, Economic Analysis, Kluwer, Dordrect/Boston/London; pp.119-181.

O’Neill J. (1995), *The poverty of postmodernism*, Routledge, London

Papa E. R. (1995), *Discorso sul Federalismo*, Giuffrè, Milano

Pastori G. (1997), *La redistribuzione delle funzioni: profili istituzionali,* paper, Convegno nazionale “Nuove funzioni e riforma delle autonomie locali nella prospettiva federalista”, Firenze 3-4 Luglio 1997

Pitelka, L.F. (1993), *Biodiversity and policy decisions*. In: E.-D. Schulze and H.A. Mooney (editors), *Biodiversity and ecosystem function*, Springer.

Pius XI (1931), *Quadrigesimo anno*, in “Enchiridion delle Encicliche”, Edizioni Dehoniane, Bologna 1995Pauly, D. (1995) *'Anecdotes and the shifting baseline syndrome of fisheries,* TREE, Vol.10, No.10, October 1995, p.430.

Ranchor P. (1994), *Hinduism and Ecology*, Motilal Banarsidass, Delhi

Ravetz, J.R. (1996), *'The microcybernetic revolution and the dialectics of ignorance*, in Ravetz, J. and Sardar, Z. (Editors), Cyberfutures, Pluto Press, London, pp.42~0.

Reale L., M.Nori and G. Ferrari, (editors) (1995), Holistic approach to sustainable development: intera

Reid, T.S. and D.D. Murphy (1995*), Providing a regional context for local conservation context*, Bioscience, Supplement Issue, pp. S-84-S90.

Schleicher-Tappeser R., Strati, F., Thierstein A., Walser M. (1997), *Sustainable Regional Development. A comprehensive approach*, EURES, Freiburg

Schleicher-Tappeser, Ruggero, (1998), *Progress towards Sustainable Regional Development: Results form the EU Research Programme on Human Dimensions of Environmental Change*. In: Anonymous, Symposium: Regions – Cornerstones for Sustainable Development, Graz, 28.-30.10.1998

Schleicher-Tappeser, Ruggero, Robert Lukesch, Filippo Strati, Gerry P. Sweeney, Alain Thierstein (1998), *Instruments for Sustainable Regional Development, The INSURED Project*, Final Report, EURES Report 9, Freiburg i. Br.

Seligman A. (1993), *L’idea di società civile*, Garzanti, Milano

Senge et al. (1994), *The Fifth Discipline Fieldbook*, Nicholas Brealey Publishing, London

Serageldin I. (1993), *Developmental Partners: Aid and Cooperation in the 1990s*, SIDA, Stockholm

Smith N. I. (1994), *Down-to-earth strategic planning*, Prentice Hall, Sydney

Stevens, W.K. (1990), *New Eye on Nature: The Real Constant is Eternal Turmoil*, The New York Times, 31.07.1990, pages B5-B6.

Sutton M.A., Beier C., van Breemen N., Byrne C., Cernusca A., Christensen T., Ekschmitt K., Heads P., Huntley B., Kertesz M., Lawton J.H., Moreno J.M., Mulder J., van der Putten W., Schulze E.D., Struwe S. and Wolters V. (1998*), Transects for European research in ecosystem functioning: site based measurement strategies in the Terrestrial Ecosystem Research Initiative (TERI),* Institute of Terrestrial Ecology,Edinburgh,UK.

Troumbis, A. Y. (1998), *Descriptive analysis of the Biodiversity Research Questionnaire*, Prepared by A. Y. Troumbis in collaboration with the Student Discussion Group on Biodiversity: E. Binos, B. Emmanouilidi, P. Fappas, A. Ganouri, G. Gatidou, M. Giannelli, H. Horiatelli, A. Kalfagianni, M. Koulouri, H. Kourletaki, G. Kralis, E. Papadatou, I. Papadopoulou, G. Papamihail, M. Salomidi, K. Siragaki, I. Tsikos, P. Tukikoglou, A. Vergangi, K. Ververidis and A. Vourdouba. In: Catizzone, M., Larsson, T-B. & Svensson, L. (1998), *Understanding Biodiversity. A research agenda prepared by the european working Group on Research and Biodiversity (EWGRB),* European Commission DG XII Science Research Development, Ecosystems Research Report 25.

UN-Economic Commission for Europe (1995), *Environment for Europe – Some key Documents*, 23-25 October 1995, Sofia (Bulgaria). United Nations, New York and Geneva, 1995.

United Nations (1972), *Declaration of the United Nations Conference on the Human Environment,* 3-16 June 1972, Stockholm, Sweden.

United Nations (1992*), Report of the United Nations Conference on Environment and Development,* 3-14 June, 1992, Rio de Janeiro, Brazil.

UNSEC (1998), *Report of the Secretary-General prepared by the UN Social and Economic Council on Capacity Building, Education and Public Awareness, Science and Transfer of Environmentally Sound Technology* (Chapters 34, 35, 36 and 31 of Agenda 21), for the 6th Session of the Commission on Sustainable Development, United Nations, New York.

Varela, Francisco J. (1979), *Principles of Biological Autonomy*. New York/ Oxford: Elsevier North Holland.

Waltner Toews, D. and Wall, E. (1991), *Emergent perplexity in search of post-normal questions for community and agroecosystem health,* Soc.Sci.Med., Vol.45, No 11, pp.1141-1149.

WCED, World Commission on Environment and Development (1987), *Our Common Future*, Oxford: Oxford University Press.

Welford R. (1995), *Environmental Strategy and Sustainable Development*, Routledge, London

Wheeler D., Sillanpää M. (1997), *The Stakeholder Corporation*, Pitman Publishing, London

White, G.F. (1994), *Reflections on changing perceptions of the Earth,* Annual Reviews Inc. Energy Environ. 1994. Vol 19, pages 1-13.

Wilson, E.O. (1998) *Consilience – The Utility of Knowledge*, Ed. A. Knopf, New York 1998. ISBN 0-679-45077-7 Science 52600.

Wolfe A. (1989), *Whose Keeper? Social Science and Moral Obligations*, University of California Press