The unifying power of sustainable development

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Towards balanced choices between People, Planet and Profit in agricultural production chains and rural land use: the role of science

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ABSTRACT

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Preface: The Main Challange

Wageningen University and Research Centre (Wageningen UR) seeks to make an essential contribution to people's *quality of life* through its research and education in the fields of *health and nutrition, sustainable agricultural systems* and *a viable environment*. The present paper seeks to direct and focus the debate about the role of Wageningen UR on issues related to sustainable development. The challenge is how to develop a sustainable agriculture encompassing the entire production column - from seed to consumption and beyond - and how to support a sustainable and efficient use of the various resources of rural areas.

Our focus is to assess how research can contribute to the various goals of sustainable development within society. This requires reflection on the position of scientific institutions in society and their role in clarifying problems and challenges and sustaining creative processes leading to innovations. Wageningen UR has a world-wide reputation in practice-oriented research, as well as a great potential to adapt its research strategies and its methods for translating research results into ultimate objectives of sustainable development. Research scales range from the sub-cellular level to global systems, while outcomes extend from genetic modification to integrative designs of rural areas on a supranational scale. The disciplines involved include philosophy, a variety of social studies, natural sciences and technology. It is, however, not easy to forge a synthesis between the various fields of research to achieve the central goal: to encourage a more sustainable green world. What we need is a clear view and an open mind to deliver integrative insights instead of giving partial solutions for one-sided and short-term goals. Unmasking treacherous 'blinding insights' amidst a complex and sometimes chaotic discussion of interest groups and impatient governments is sometimes unavoidable. The identification of such insights requires further reflection on basic concepts and paradigms.

Wageningen University's 85th anniversary in March 2003 presented a good opportunity to organise a debate with opinion leaders on the present role of Wageningen UR. Those invited to this debate are independent thinkers, some of them having the status of Distinguished Professors of Wageningen University, others representing the business community or NGOs.

The basis for the debate was a draft position paper and related propositions, which have been combined with the outcome of the debate in the present paper. This paper addresses the core of the problem of sustainable development, often symbolised by the People-Planet-Profit triangle and the key question how different value domains can be interlinked. It consequently considers how to combine extremely different scientific insights and how to communicate these to the scientific world as well as to policy-makers and decision-makers. Decisions have to comply with the best available balance between the 3 P's. The acceptability of such decisions to stakeholders and decision-makers depends on thorough discussions and creative, long-term thinking in society and politics. That is where science comes in, which is to recognise or predict

problems, present data, insights, uncertainties and risks, suggest innovations and make alternatives comparable to reveal their positive and negative aspects. Clarification is what is needed primarily. Commitment from science to societal problems is essential, but should not be overdone: science should sit alongside the driver in policy-making, not in the driver's seat! On the other hand, scientific insights partly set the policy agenda. Though societal problems form incentives for mission-driven research, the research agenda should certainly not depend on political views alone.

Although the 3 P concept has gained considerable support in recent years, getting from a selling concept to operational research questions and their answers is still a major challenge. Our paper explores promising avenues as well as those that are unlikely to be valuable. Its objective is to clarify, to deepen the debate, to broaden the perspective, to demystify prejudices and to reveal misconceptions. The paper introduces theories, concepts, states of the art and unsolved questions. This can be regarded as the foundation for the debate that was fuelled by the propositions. The draft position paper and the final paper were prepared under the auspices of the Working Group on Sustainable Development and System Innovation (DOS Working Group).

This paper and its conclusions and recommendations will be used to identify fields that Wageningen University UR should focus on in its future research programme. The paper also aims to contribute to the policy agenda for governments, agencies and corporate organisations.

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Outline of the paper

This paper starts by clarifying the position of science towards societal problems and decision-making (section 1). Because sustainability and sustainable development are the key issue, a short history of sustainability (or the lack of it) is provided (section 2), set against the background of man's changing perception of and attitude towards nature (section 3). The original concept of sustainability and sustainable development and the triple P concept (People-Planet-Profit) are explained, including a discussion of the question whether the primacy of one P over the others is desirable or justifiable (sections 4 and 5, respectively). If bridges are to be built and strengthened between the three value domains represented by the three P's, some reflection is required on the basic concepts of ecology or environmental studies, economics and socio-cultural studies that represent related fields of study (sections 6.1 - 6.3). These can be used to define unifying features or concepts in order to find ways of sustaining a better communication between these scientific domains (section 6.4). We present three cases which clearly show the various aspects of sustainability or unsustainability and ways of putting matters in the context of the three P's (sections 7.1, 7.2 and 7.3). Decision-making aimed at sustainable development, whether in companies or governments, requires a transparent and creative process of balancing advantages and disadvantages of the various fields. Negative and positive interactions, uncertainties and risks have to be addressed by adequate methods such as scenario studies and risk assessments (section 8). The outcome of the debate on a number of propositions linked to the above topics (section 9) is used to draw conclusions and present recommendations to direct the research agenda for the coming years (section 10)

Abstract

This position paper presents an overview of the origin and meaning of the concept of sustainable development in various domains and their interrelationships, sometimes expressed as the People-Profit-Planet triangle. The role of Wageningen UR and its position in society is clarified. The paper also deals with central concepts of several scientific disciplines related to the three P domains, such as ecology, economics and social and cultural disciplines. This leads to a number of unifying concepts that enable common ground to be identified and bridges to be built between disciplines. Three case studies, involving fisheries, pig production chains and a regional study in the Pantanal area, illustrate the difficulties and possibilities of achieving threefold sustainability. A preliminary paper was used as input for a debate with opinion leaders during the Dies Natalis (foundation day) at the 85th anniversary of Wageningen University on 7 March 2003. Conclusions from this debate are included, as well as suggestions for research and its organisation.

1 Introduction: The position of science

For a mission-driven scientific institution like the Wageningen University and Research Centre, it is of pivotal importance to review and specify its position in the societal debate, as was stated explicitly in the above Preface.

The question remains how this position can be properly implemented in the current situation. With the overwhelming acceptance of sustainability and sustainable development as guiding concepts, there are distinct roles to play. Let us define them briefly.

* We are dealing with *complex problems and multiple goals*. Science cannot afford to operate in disciplinary isolation: intensive communication between disciplines is required to gain added value in integrated approaches and to provide insight into complex problems. Theories, concepts and the jargon of a highly specialised and fragmented community hamper communication and collaboration, creating a need for unifying concepts.

* Science has to be *aware of its own paradigmatic position and traps*, especially as different scientific domains seem to be rooted in different paradigms. Since Wageningen UR has a long tradition in natural sciences and agro-technology, special attention is required when trying to link these to social sciences.

* Problems tend to manifest themselves at *ever higher scale levels*, although many mechanisms and solutions are to be sought at low levels as well. Science therefore has to consider many scale levels, choose the relevant level(s) of interest and apply these choices in upscaling/downscaling and aggregation procedures that help to communicate the insights to the public and to decision-makers.

* Problem solving is a challenge to society as a whole: *groups of stakeholders, governments and scientists will have to collaborate interactively*. Interactive science is the new catchphrase, and communicative skills are now a prerequisite for science. Science should be able to translate societal questions into scientific ones and scientific answers into societal ones.

* The status of science in our modern world has become paradoxical. It is generally accepted that modern society has come to depend on science more than ever, but the historical view of the infallible scientist has faded. *The days of the highly regarded, unquestioned authority of science are over*. Citizens are now well organised in interest groups, they are well informed themselves and they are increasingly critical of formal science. Science should therefore regain its role in society, for instance by demystifying prejudices and clarifying the ultimate outcomes of pursued interests.

* Handling complex problems and trying to aim at a much longer time horizon of generations instead of years *necessitates the acceptance of many uncertainties*. The inbuilt

difficulties and inabilities to predict the future may disappoint scientists and decision-makers alike, but are nevertheless a reality.

Science has to redefine its position in society: the days of infallible authority and a technocratic paradigm are over; science has to cope with complex systems and processes at multiple temporal and spatial scale levels, whereas higher scale levels in space and time ask for greater attention. In trying to link natural and social sciences, it has to overcome paradigmatic differences. Science has to collaborate with critical and emancipated stakeholders in an interactive manner. And science and the users of scientific knowledge have to accept inherent uncertainties in the outcome of results and to be able to assess risks.

2 Sustainability and unsustainability in history

Innate harmony or unavoidable ignorance?

Many people tend to think that unsustainable use of resources is a product of modern, industrial times, in which alienation, selfishness and short-sightedness have replaced a long history of balanced and respectful lifestyle. They assume a picture of people picking fruits or hunting in complete harmony with nature and in later stages creating Arcadian landscapes where extensive agriculture just added scenic value to existing landscapes full of biodiversity. In the eighteenth century, Rousseau developed the idea of the 'noble savage'. Arcadian landscape paintings suggested a peaceful and prosperous marriage between man and nature. These pictures are still attractive for some less informed modern people but are both romantic and unjustified. In the more primitive pre-historic times, man's role as hunter, fisher or gatherer of fruits forced him to make limited use of his environment, but where such harmony existed it was more often due to man's own limitations than to deep insights or noble motives. Quite often, man succeeded in driving his prey extinct if he had the power to do so. Clive Ponting (1991/93) in his famous 'Green history of the world', gives many examples of such disasters throughout history. On Eastern Island in the Pacific, for example, man's religious zeal led to the erection of the famous tall stone statues, which was however accompanied by intensive deforestation ending in ecological breakdown and eventually social collapse. In the ancient world appropriate irrigation techniques in semi-arid areas led to the destruction of fertile areas by salinisation. Plato referred directly to the environmental problems in Attica (Greece) due to inexpert land management. In many areas, as well as in many periods and in all cultures, deforestation and destructive erosion by wind or water have been widespread. Even a small country like the Netherlands has produced examples in a wide variety of landscapes and land-use systems. Overexploitation of sandy areas led to massive sand blow and losses of cropland and villages. Peat extraction for fuel or salt mining in mediaeval and post-mediaeval times led to loss of land, and even larger losses occurred where peat areas subsided due to reclamation and artificial drainage and were then overcome by the sea. History also reveals, however, that man sometimes learned to live with his environment and found ingenious ways of using it sustainably over the centuries (Ostrom, 1990). Learning from experience, passing knowledge on to new generations and finding ways to ensure continuity through social order, laws and regulations or anchored in religion allowed man to succeed. A good example of both socially and technically sustainable systems is the sawah system on the Indonesian mountain slopes (Geertz, 1963). Thus, history teaches us to put things in a realistic rather than romantic or cynical perspective: we see failures as well as successes. Successful cases show what might be called co-evolution between man and society. The key question facing us today is to find a modern and effective version of this co-evolution for our present day problems.

Modern times: globalisation and industrialisation

Looking at Modern times, between the 17th and 20th centuries, it is useful to realise that many simultaneous changes occurred in society. First of all, the 'Old European World', after the great discoveries of the late Middle Ages, took control of much of the rest of the world. This expansion brought about social disruption, exploitation and localised devastation of resources on a massive scale. It led to the onset of a general scaling-up process that encompassed mental, economic and political aspects of society. Secondly, industrialisation led to new economic growth, allowing a higher level of wealth and purchasing power in industrialised countries. Some of the processes were definitely beneficial, as exemplified in certain large areas where the several stages of the Green Revolution helped to overcome massive food problems in poor countries. The acceleration of production and consumption was, however, associated with a very rapid exploitation of natural resources and the risk of their depletion. It also led to the production of large amounts of waste, causing pollution of soil, water and air. In conjunction with the expansion of the European influence, the process of industrialisation has had an impact at a global level. New technologies, sharply increased mobility and communication techniques represented additional forces driving in the same direction. Present-day examples of unsustainability include nitrate pollution of drinking water in the Netherlands, emission of greenhouse gases contributing to global climate change, erosion as an effect of deforestation for timber in the rainforest areas and the dumping of radioactive waste in salt mines or oceans. Both industrialised countries and developing countries contribute to global climate change as greenhouse gases are emitted by industry but also by flooded rice fields (methane) and by cooking food on wood fires (carbon dioxide). There is no doubt that the large and ever increasing population of the world and the internal rationale of economic growth, together with periodic accelerations due to new technologies, increase the scale and pace of unsustainable use of natural resources.

Lessons?

As we have seen, unsustainable use has occurred in all eras, all regions and all cultures, although it manifests itself in varying shapes. Its origin can be found in any conceivable mixture of climate change, population pressure, uncontrolled greed, lack of social order, and … serious lack of insight. Nevertheless, it is unjustified to see man's endeavours as a sequence of wrong decisions and a lack of responsibility, as there are examples of sustainable systems as well. Globalisation may be a new phrase for a new phase, but these processes basically started centuries ago. What is relatively new for our modern times is the scale and pace of many problems. This increases the need for appropriate and timely solutions based upon sound predictions and risk assessments (early warnings) and requires an adequate response from administrations in a more anticipatory manner and on a larger scale than has been the case so far.

Unsustainable use is often associated with the problems of the rich, causing overexploitation and consequently a huge amount of pollution of any form. This picture is too simple. Unsustainability in terms of decreasing productivity, ultimately leading to the complete breakdown of ecosystems, less vitality and flexibility, may be due to riches as well as poverty (Rabbinge, 2001). In spatial terms, unsustainability due to poverty is far more common and has far more impact than that due to riches,

affecting millions of hectares against thousands of hectares per year. It is evident that tackling these problems will require different strategies.

Science as well as governance is forced to reframe their way of observing and thinking to enable them to move through the various temporal and spatial scales. They could learn from success stories of sustainable use in history.

Unsustainable use of natural resources has always existed, but the scale and pace have increased in modern times. History can teach us through cases of failure as well as successful sustainable use. The role of science is to analyse and clarify the underlying causes and to reveal risks and promising avenues to avoid trial and error and to facilitate a more conscious decision-making.

Sawah systems that have proved to be sustainable over long periods versus erosion due to unsustainable land use

3 Changing relations between man and the environment in a developing society

The nomadic guest at nature's table?

A brief history is not complete without a discussion of the various changes in man's perceptions of and attitudes towards nature. These perceptions have shown a close interrelationship with changes in society. Our current view is that in prehistoric or primitive cultures, where hunting, fishing and gathering predominated, man's perception was mainly functional: nature could and should be used. The dominance of natural forces and man's lack of understanding of nature created the basis for animist religions where natural phenomena in the abiotic as well as the living nature were considered to be related to gods. Using nature was possible as long as these gods approved. Possessing nature (as private or communal property) was out of the question. Rules, taboos and other regulations were aimed at stability serving the survival of man, although there were also examples of unsustainable use, as discussed in the preceding section. Experience and knowledge were mixed with religion and passed down through the generations by word of mouth. Although we have no written sources from these times to support or contest this view, we can find analogies in present day tribes living in more or less the same conditions.

The first revolution: transition to agriculture

One of the first major revolutions in land use was the transition from hunting and gathering to permanent agriculture, especially among sedentary communities. Circumstances changed drastically: land ownership was introduced and the original natural environment was adapted to growing crops. Land cultivation, seed selection, the domestication and raising of animals, storage of surplus food and seeds were the exponents of the transition to a sedentary way of life. Handling and controlling nature in agricultural production systems demanded more knowledge and a culture of annual or longer-term investments. There was a quantum leap in production of food per area of land, which at the same time took less time to procure. Furthermore, food could be stored and traded, providing opportunities for other skills and professions (division of labour), which seems to have accelerated technical developments. This also created the conditions for cities to develop. Still, as far as we know, the general attitude towards nature remained mainly functional. Cultures largely rooted in agriculture were dominant for millennia in various countries from east to west and north to south and in various religious traditions. In the western world, the Jewish or Christian religions were actually functional or even authoritarian towards nature. They claimed that people had the right to fill the world and use its resources for their own satisfaction, albeit by the standards of good stewardship. When nature brought disasters such as famines, pests, floods or droughts, these were primarily seen as God's punishments.

Nevertheless, philosophers, economists and scientists developed their own ideas of nature, society and the relation between man and natural resources. In societies dominated by agriculture, population growth was often seen as the greatest threat to

survival and the sustainable use of resources. One issue was how many people the earth could feed (i.e., what was its carrying capacity). Malthus (1798) foresaw that human population increase would lead to increasing demands on natural resources and the depletion of their finite stocks, eventually causing a collapse of society. He already thought at a global scale and can be seen as a first representative of a scientific way of thinking producing 'early warnings' according to a specific scenario.

Enlightenment and techno-centrism

The next socio-economic revolution, preceded by the great post-mediaeval 'voyages of discovery' around the world by Western countries, led to a massive expansion of their influence, world trade and social and cultural impacts in the newly colonised areas. Our perception and knowledge of the world changed dramatically. At about the same time, the age of Enlightenment started, where science, arts and religion each went their own way after having been intertwined for centuries. This was not an easy process, as Galileo's case showed, when he had to bow his scientific head to the power of a Church, which did not welcome his and his colleagues' astronomical findings. Another challenge to religion was the theory of evolution published by Darwin (1859). He denied man's unique position above all other creatures, which had been held to give him a privileged position as steward over nature. Darwin stated that man was just an animal species developed from the same origin as other primates. In his view, evolutionary developments are dominated by genetic mutations in interaction with the environment. The leading concept is the 'survival of the fittest' in which the best fitting 'mutant' survives and becomes dominant over less suitable ones. No one is in control; the process directs itself. These philosophical and scientific developments meant that the supremacy of the Earth in the solar system and that of mankind in the world were toppled in just a few centuries. Nature as God's creation was subjected to further profanation. In agriculture, Liebig provided major new insights explaining the rules of chemistry in plant nutrition, while Mendel elaborated the genetic laws. Science, once given independence, proved to prosper, creating a rich offspring in disciplinary branches and many technological successes. The Cartesian attitude, named after René Descartes, who founded rational thinking in its strictest form, dominated nearly all sciences. Its influence was enormous, and the resulting perceptions in the natural sciences led to many mechanistic views of the world, such as those of Newton on the physical world.

Nothing creates success like success and … nothing leads more easily to persistent blinding insights (Röling, 2000: Gateway to the global garden). The still prevailing techno-centric attitude towards present-day problems stems from the previous centuries, which were dominated by natural sciences and related technologies. Admittedly, they brought a wealth of knowledge and extremely useful technical devices in agriculture (e.g. the Green Revolution in several stages), medicine, industry, transport and communication. Of course some problems became apparent over the years, but welfare and technological successes fed optimistic visions as well: problems were there to be solved and man's creativity and resources were virtually infinite. In line with this view, Boserup (1965) was much more positive than Malthus. She believed that in a situation of population growth, mankind would invent other

methods and techniques that would be far more efficient in using natural resources and detecting new stocks or in developing alternatives and substitutes.

Industrialisation: a multiple de-coupling, the discovery of the limits to growth

The coming of industrialisation brought a new revolutionary advance in the world's capacity to sustain a growing population. Industrialisation offered opportunities for increased production and associated consumption but also provided new opportunities for the exploitation of natural resources. In the eyes of many in the modern Western world, nature had been largely brought under control, as would eventually be the rest of the natural resources. Functionalism towards nature turned into techno-centric dominance - or even arrogance towards nature - in thinking as well as actions. Industrialisation also led to further division of labour, rapid urbanisation and changing social order. We could characterise the shift in perceptions and attitudes as alienation - as described in the extremities of technocratic and bureaucratic systems by George Orwell (*Nineteen Eighty-Four*, 1948) and Aldous Huxley (*Brave New World*, 1932). A manifold and massive de-coupling has progressively occurred between the logic and rationale of production and consumption on the one hand and the environment on the other. The environment was expected to provide the resources, to deal with wastes and to reproduce itself constantly in its living components.

Of course, there were always alternative thinkers and groups exerting pressure on governments. Environmental legislation started in the early 20th century, and nature conservation developed in the same period, with the ideas of men such as John Muir leading to the setting up of national parks in several continents. The above-mentioned optimism of Boserup and the belief in the benefits of technology were tempered by Ehrlich (1969) and especially by the Club of Rome (*Limits to growth*, Meadows *et al.*, 1972). They postulated a rapid population growth and even higher consumption levels, confronted with limited stocks of resources, which together predicted an undesirable outcome in terms of the depletion of minerals, fossil energy and food and severe problems of pollution and decreasing biodiversity. In fact, their line of thinking was Malthusian but their predictions were unfounded because their estimates of stocks were very conservative and they substantially underestimated man's ability to innovate the exploitation of natural resources and industrial processes.

Whereas the Club of Rome was preoccupied with the depletion of natural resources on a global scale, others drew attention to the problems of pollution by pesticides causing enormous harm in ecosystems. Carson's *Silent Spring* (1963) and Briejèr's 'Zilveren Sluiers' ('Silver veils', 1967) were among the first to identify such problems. Their predictions and warnings proved to be excessive in some respects, since their warnings led to feedback mechanisms such as controls on pesticide use and the search for other (e.g. biological) methods. Furthermore, *Limits to growth* had a major impact on society and politicians and gave an impetus to ecological and environmental interest groups, leading to new policies and technologies for the exploration and exploitation of natural resources. The positive effect of all this was that their postulates could not be maintained, let alone the predicted outcomes; they

can, at least partly, be classified as self-denying prophecies. Necessary transitions in society and business were helped by other unforeseen circumstances. The 1973 oil crisis gave an impulse to a more modest consumption of fossil energy and stimulated new, less wasteful technologies, though these have as yet probably only reached a fraction of their potential.

Goodbye to innocence: mainstream and countercurrents - the search for balance

Despite powerful warnings and various environmental disasters, it took a long time before the many problems affecting the environment and biodiversity caused by human overexploitation were fully acknowledged by the broader public and in mainstream policy-making. A scientific, ethical or just intuitively inspired countercurrent against unlimited growth and its side effects had always existed among pressure groups. The public's new views allowed them to grow in size and force, as shown by the success of Greenpeace and Friends of the Earth, which were still marginal in the 1970s, but now have a major political impact. People realised the limits of natural systems and resources, and became aware of their manifold immaterial values next to the materialistic values that had dominated post-war thinking. More people were able to imagine the crash course the world would take if humans were to go on exploiting nature in a destructive manner. At the same time, various problems on a really global scale manifested themselves, like the degradation of the ozone layer or global climatic change. Lovelock's Gaia (1987) presented the Earth itself as a vulnerable and partly living system or even an organism. These insights first appeared in regions where people had reached a state of prosperity and had access to adequate information, and where certain problems manifested themselves earlier and more severely. The role of science in providing early warnings and predictions and influencing people's attitude is not to be underestimated. As a result, society experienced a powerful surge of interest groups warning against the effects of an unaltered course on the environment, biodiversity and food safety. As a result, the last decades of the 20th century were marked by a rather widespread awareness of environmental problems, which was reflected in policy-making, legislation and international treaties, all expressing serious worries. Recently, this way of thinking was criticised fundamentally by Lomborg (*The skeptical environmentalist*, 2001) who showed that many assumptions and predictions were biased towards a pessimistic picture. Whatever the outcome of this ongoing debate will be, it is a fact that many problems are extremely serious due to their irreversibility or long-term impacts (loss of biodiversity, climate change, desertification, water shortages). They demand an anticipatory attitude and 'no regret policies' rather than a 'wait and see' attitude establishing who was right or wrong afterwards.

This bird's eye view of the history of mankind's relationship with nature thus reveals a widespread, though not always decisive change in perception and attitude. The disadvantages of the multiple de-coupling between unlimited economic growth and the carrying capacity of the environment have led to a need to re-establish such connections in thinking as well as actions. Such a major shift could be compared with shifting the course of a giant tanker, which takes time, especially when forces such as population and consumption growth, driven by an almost autonomous and global

economy, act as strong waves and currents keeping the ship from finding and holding its new course in time.

In just a few decades, major and influential parties in society, as well as some leading politicians, seem to have understood the message and become convinced of the need to alter the course of development by creating new laws and regulations at nearly all levels of government: local, regional, national and international. An interesting development can be observed in the shifts of power and the perception of responsibilities among consumers and producers. As people become more aware of the side effects of consumption and production and also become better organised, we see a rapid growth in the number and influence of groups sharing serious concerns. These include concerns about food quality, environmental quality, ethical aspects of food production or social or ecological effects (ecological footprints) elsewhere in the world. The challenge is to find a way to deal with these concerns in society and to re-connect the logic of production and the environment that sometimes has a limited resilience to recover from adverse effects. Moreover, the manoeuvrability of governments and societies is poor, because many driving forces that seem to play at a larger scale are not checked and balanced.

De-coupling as an overarching feature; in search of re-coupling

In summary, the major trends accompanying the above developments all come under the process of multiple de-coupling. De-coupling is a catchword that covers many aspects. We can observe a separation between rationality, emotion and ethics in our individual or collective perception of the world as well as in our actions. De-coupling can be observed from a psychological as well as from a physical point of view. Let us discuss some of its aspects briefly. We are witnessing an increasing division of labour and related specialisation of people, leading to a de-coupling of responsibilities. The fact that people live in cities, hardly aware of the properties of the rural and natural areas, leads to a mental de-coupling, manifesting itself in alienation expressed either in romanticism or unconcern. Some examples of de-coupling are essentially geographical in nature, when some remote areas are exploited to deliver raw materials or products for countries in even other continents (the well-known ecological footprint). Other aspects are temporal, when resources are used in large quantities without taking into consideration that depletion could be a problem for the coming generations. These various de-coupling phenomena are closely related to unsustainable use of resources. They are the more difficult to tackle as many processes (trade, governance, communication and transport) act on large spatial scales, whereas man's ability to understand these processes is limited, as is his willingness and ability to take measures to tackle the problem.

After a long history in which man had a functional but dependent attitude towards nature and in which knowledge and religion were interwoven, the 17th and 18th centuries brought major changes in man's mental and physical world. Natural limits seemed to be less decisive, while science and technology created more and more successes until the limits of growth manifested themselves. Science had strong roots in a technocratic paradigm embracing the functionality of natural resources and man's desire of ultimate control over them. The almost total de-coupling between production and economic growth on the one hand and environment on the other is largely responsible for the unsustainable use of natural resources. This has both mental and physical aspects. Today, science needs to deal with the non-economic values of the environment and with feedback by the environment on man's activities. At the same time, scaling up processes necessitates new ways of thinking and acting that match the nature and scale of the problems. Decision-making should incorporate environmental concern in an otherwise profit-driven and technocratic society. Such changes require new ways of thinking and negotiation, inspired by re coupling in more than one sense of the word.

4 From sustainability to sustainable development: an old wise lady in a new dress?

Some backgrounds and history

After the introduction by Brundtland *et al.* (1987) in their report *Our common future*, the concept of sustainability, or rather sustainable development, became a major topic of debate. It started from the concerns about multiple unsustainability. The concept tried to restore the links between environment/ecology, economy and socio-cultural aspects. The text underlined the dangers of crossing thresholds in a way that would cause irreversible damage to ecosystems and stressed the responsibility for current and future generations. If unsustainability is compared with a disease, then it is necessary to formulate a state of healthiness and associated preconditions to achieve certain objectives.

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their needs. The tripod on which sustainable development rest is formed by the following elements:

1. the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given (economic goals);
2. protection and optimal utilisation of the environment (environmental/ecological goals);
3. empowerment of groups and communities (social goals).

Box 1

An example of the Brundtland tripod in practice

To explain the impact of the tripod of sustainable development as introduced by the Brundtland commission, let us consider the exploitation of rainforests for timber for the export market. Governments of developing countries need the exploitation of forests for timber to generate money to pay local development.

Governments of industrialised countries may oppose this exploitation because forests are needed to counteract global warming (international treaties). Organisations such as NGOs focusing on environmental issues oppose exploitation of timber because it leads to side effects such as destroying natural habitats for endangered species and unnecessary destruction of less valuable trees. The local communities living in and off the forest mostly have no say in the debate, although their resource base is exploited and partly destroyed without any financial benefit to them. Brundtland points at the empowerment of these groups. Solving the issue requires looking into all the needs.

The success of this concept can be explained as follows: it was appealing because of its broad, overarching span, it was launched when the time was ripe for it, at an appropriate occasion by a highly reputable group and it was embraced in a formal, world-wide setting. Furthermore, it challenged various target groups to assume their responsibility for current and coming generations. It bridged a gap by defining sustainability in terms of reduction of pollution in the industrialised world and in terms of more socio-economic security, negotiating power and economic growth for people in the developing countries. It also created the opportunity to establish sustainability as a stable end-state and to see it as a guiding principle for preferred development, that is, a dynamic concept rather than static one. The connotation of a common future, the positive and optimistic sound of sustainable development and the defining of goals that could be reached were ingredients that no-one could really be opposed to. At least politicians could not afford to oppose to these ideas openly.

On the other hand, some interest groups felt the concept was flexible, but ill-defined and without positive reward. For example, the World Bank (Serageldin) tried to give some more cutting edge to the concept, as can be seen from the following (abridged) quotes: 'Sustainability is to leave future generations as many opportunities as we ourselves have had, if not more…! How to measure opportunity? One could use the concept of capital. In economics and finance one does not deplete one's capital. We recognise that there are at least four kinds of capital: *natural capital* [environment / biodiversity], *man-made capital* [usually considered in economy/finances of companies], *human capital* [investments in education, health and nutrition of people] and *social capital* [the institutional and cultural basis for a society to function]'. The general idea of capital and its related idea of *stocks and flows* is elaborated below. Flows are regarded as sustainable yields that could be used without jeopardising the source of wealth, symbolised by the words capital or stock.

From a selling concept to an operational concept ?

As a *selling concept,* the concept of sustainable development worked very well. Environmental groups and Non-Governmental Organisations (NGO's) committed to social and cultural values and the more enlightened part of the business community all found inspiration in the concept. The same was true for governmental institutions, whose main responsibility it was to find a balance between the various interests. The fact that the time horizon was stated in generations rather than years created a common ground for creative collaboration rather than being stuck in the defence of territorial interests or short-term goals. The concept was taken on board by many and sometimes rephrased in catch-phrases such as the *triple P concept* (People, Planet and Profit), an almost acronymic summary of the same ideas. Still, it was - and often still is - primarily a selling concept rather than a practical concept. Before it can be understood and practised, its precise contents and consequences need to be explained and elaborated. Converting a highly appealing, but abstract concept into actual policy decisions and research agendas requires careful thought and sometimes the acceptance of a reality that is less ideal than what had been desired. The expectation that all sustainability problems could be solved by a threefold win-win-win solution is seldom fulfilled in practice. In the next section, we explain the 3 P

concept and touch upon some points that explain a few difficulties. The role of science should be to clarify the choices and consequences in all three P dimensions.

The concept of sustainable development must be interpreted as a sign of raised awareness and an attempt to create a state of mind that links thoughts, values, responsibilities and decisions that became separated in the last (19th & 20th) centuries. It connects the here and now to the elsewhere and later, as well as to various values. Sustainability also underlines the opportunities to create new solutions that are beneficial to all interests. It does not consider static states or finite stocks, but stresses positive evolution and development pathways. It promotes a dynamic and creative approach.

5 Planet, Profit and People

Origin and meaning

Attempts to rephrase the general idea of sustainable development and sustainability, and to further specify its basic foundations, led to the *triple P concept*: *Planet, Profit and People*. One of the attractive features of the triple P concept is that it has been related to sustainable development of countries and regions, as well as businesses and industries. Within a public policy context, government officials are increasingly required to evaluate the impact of a specific proposal on the sustainable development of a specific country or region. In order to facilitate this evaluation, public policy analysts first defined the idea of environmentally sustainable development (ESD) by a *triangular* framework, which distinguishes economic, social and ecological aspects of sustainability (Serageldin *et al*., 1994).

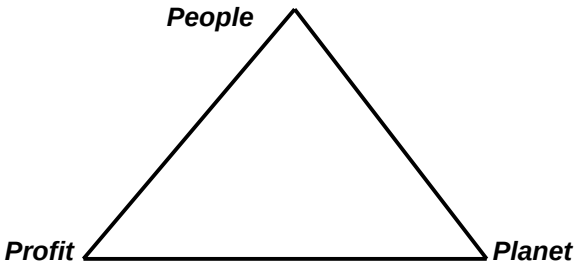


Figure 1. The 3P triangle, representing economic, ecological and socio-cultural values

A proposal has to be economically and financially sustainable in terms of economic growth, physical capital maintenance and efficient use of resources and investments. But it also has to be ecologically sustainable, in terms of ecosystem integrity, carrying capacity and conservation of natural resources, including biodiversity. Equally important is the social side, which involves equity, social mobility, social cohesion, participation, empowerment, cultural identity and institutional development (Serageldin, 1996). More recently, sustainability has been analysed in terms of a situation that leaves future generations as many opportunities as we ourselves have had, if not more. The concept of opportunities is then operationalised in terms of *capital stocks and flows* (Serageldin, 1996). The Dutch government prepared a document for the UN World Summit on Sustainable Development in Johannesburg (September 2002) in line with this conceptual development. In this document it describes sustainable development in terms of the balanced and coherent management of financial-economic, socio-cultural and ecological stocks, not merely in the 'here and now', but also relating to 'elsewhere' (across national borders, especially developing countries) and 'later' (coming generations) (SER, 2002; VROM, 2002).

After the introduction of the '*triple bottom line'* concept for business, the three P's reappeared as the title in the second sustainability report produced by Shell Oil Company over the year 1999 (Elkington, 1998; Shell, 2000). For business

organisations, sustainable development -like building an economically successful business - requires 'taking a long-term view and the integration of social, environmental, and economic considerations to make balanced judgements for that long-term' (WBCSD, 2000). In a business context, the economic dimension is specified in terms such as cost-efficiency, market orientation, innovation, knowledge management and profitability. The environmental dimension encompasses issues such as the prevention of pollution by waste, the economic use of natural resources and actively maintaining a balance with nature. The social dimension involves not just acceptable working conditions for employees, but also the more general aspects of responsibility for maintaining and enhancing the living conditions for employees, suppliers, customers and local communities (in terms of experience, skills, trust and social cohesion). In analysing the underlying issues in a business context, the capital metaphor is considered useful. Triple bottom line performance is based on sustainable management of economic, natural, human and social capital (Elkington, 1998). Within the business environment, the triple P concept is closely related to the concept of *corporate social responsibility* (CSR). The World Business Council for Sustainable Development, a coalition of 120 international companies, defines CSR as 'the commitment of business to contribute to sustainable economic development, working with employees, their families, the local community and society at large to improve their quality of life' (WBCSD, 2000). In an effort to conceptualise the building blocks for CSR, Wood defines corporate social performance as 'a business organisation's configuration of principles of social responsibility, processes of social responsiveness, and policies, programmes, and observable outcomes as they relate to a firm's societal relationship' (Wood, 1991). Breaking down corporate responsibility into *principles* (as a basis for action), *processes* (the actions as such) and *outcomes* (visible effects of actions) seems a promising approach to analysing triple P performance in business sectors like the agri-food business (Ten Pierick *et al*, 2003). Increasingly, attention is also being drawn to the process quality of business decision-making and achieving and maintaining sustainability (Van der Schans et al, 2002). Evidence suggests there is a positive relation between triple P performance and corporate transparency, stakeholder involvement and HSEQ (health, safety, environment and quality) management. The Social and Economic Council of the Netherlands, the Dutch government's highest advisory board on social and economic issues, representing both employers and employees, defines the social responsibility of business in terms of their focus on contributing to societal welfare. Two elements can be distinguished: (i) the conscious efforts of businesses to contribute to societal welfare in the long run, for the dimensions of people, planet and profits; (ii) maintaining a relation with stakeholders on the basis of transparency of dialogue, in order to respond to justified societal demands (SER, 2002).

The triple P concept is a popular translation of the ideas of the Brundtland Commission within the business environment. Translated into long-term goals for companies and into precise targets, it can help to focus the societal responsibility of companies on other goals than their own immediate profits.

P-primacy or a level playing field?

There has been some debate on how the 3 P concept could be made less vague and multi-interpretable and could gain further influence. It is here that we see several attempts to link a certain primacy to one of the three P's over the others. Each P domain could claim some sort of extra weight. The P of Planet might seem to have the 'overriding rights' because of the original concept of the Brundtland Commission. Moreover, it is evident that any thoughts of sustainable development for the dimensions of People and Profit fully depend on the state of the global environment supporting life on Earth. That is why the WRR (Netherlands Scientific Council for Government Policy, 2002) has recommended returning to this historic primacy. Others, however, for primarily short-term pragmatic reasons, put Profit before Planet. They state that most decisions in our current society relate to economic factors, even when nature conservation is included, and that these depend on sufficient money made available by a vigorous economy. This perception, this state of mind and this decision-making practice are often found in business circles. Lastly, support can be found for a primacy of the People aspects: it is people who are able and empowered to assess the various positive and negative sides in the debate (on, e.g., Planet and Profit) and to decide what to do or not. This could include a revival of social and cultural values that sometimes seem to be forgotten in the vehement debate between economists and ecologists.

In this debate on primacy questions, our opinion is that, whilst all standpoints have a certain value, a generic primacy is hardly fruitful in cases where there is still room for debate. This does not deny that there are situations in which irreversible and fatal actions towards nature or people have to be considered, that is, cases where certain bottom lines should not be crossed. The challenge is to formulate the bottom lines for each of the domains and see where remaining conflicts exist that need negotiation or where win-win situations can be developed. This is context-dependent and not helped by an academic primacy discussion.

There is no good reason to attribute a primacy to one of the three P's. Planet should have overriding precedence and represents the baseline for all life, whereas Profit reflects the main current trend in thinking. People should always have a decisive place. Yet - apart from essential baselines that should be respected - it is fruitless to claim such primacy because debates and decisions always have to be supported by good insight: it is preferable to consider profits and disadvantages without prejudice.

6 Central concepts and unifying concepts to overarch them?

Building bridges between various value domains, scientific fields and interest groups requires mutual understanding that does not arise spontaneously. Language and concepts are the carriers of understanding. It is necessary to consider three scientific and societal domains that represent:

I. biophysical, socio-cultural and economical systems with their own *content*;
II. spatio-temporal *dynamics* of a certain size and rate, such as stocks and flows;
III. different *value domains* and *valuing criteria*.

Understanding the basics and bringing them to a level of communication requires a return to central concepts and 'system laws' that have to be respected. From there, it is possible to look for common ground or to decide that there are essential differences or unbridgeable gaps. The former can be regarded as the field where unifying concepts can grow. Below, we discuss central concepts relating to:

- Planet - environmental and ecological sciences
- Profit - economics
- People - socio-cultural sciences

We will then try to identify concepts that are unifying and promising to sustain integrated approaches.

6.1 Planet

Stocks and flows

The Planet domain encompasses the *biophysical systems* on earth, consisting of a-biotic components (water, air, rock or soil) and biotic components (vegetation, animals) forming vital resources for life in the broadest sense. *Abiotic and biotic components* are closely interrelated, as living nature depends on abiotic conditions, but the opposite is also true. An aerobic atmosphere is the product of oxygen-producing green plants, and a fertile soil is kept in good working order and prevented from being removed by a sufficient plant cover and sound soil biology. In view of their evolutionary and functional interwovenness and manifold interactions these are often referred to as ecosystems. The concept of ecosystems is independent of scale; it can vary from a small pond to an entire taiga ecozone. Even the whole planet, including the atmosphere, can be seen as an ecosystem. Or it can even be regarded as a huge 'organism', representing the world as a large living system named Gaia, as put forward by Lovelock (1987) at the end of the 20th century. (In fact, the Gaia concept can be retraced to Baas Becking, who used the same term in the thirties). It is relevant that abiotic and biotic components form the *natural resources* of man: water, air, soil, minerals, fossil and renewable energy, food and fibres. In fact, they represent more than that. Natural resources enable human life by regulating so-called *life support processes* such as climate regulation, the production of oxygen, the maintenance of the

life-protecting ozone layer and the decomposition of organic matter and waste. Apart from these conditions, which are essential to our very life, nature delivers much more, by inspiring artists, scientists and inventors, by creating space and time for leisure and by fulfilling spiritual and emotional needs (see Box 2). Only some of nature's products or services can be assessed in economic or monetary terms, as has been attempted by De Groot (1992) and Costanza *et al.* (1997). Many of the present or future interests or significances for mankind are and will be priceless in both senses of the word. This is elaborated in some more detail in chapter 6.2 (Profit).

Sustainable use of natural stocks and flows

The key question in the context of sustainable use is to what degree man can exploit ecosystems without damaging them beyond repair or using them in an economically inefficient manner. In other words: what can nature perform by delivering capital (stock) or yields (crops, harvests, energy) that can be harvested regularly (flow) without the machinery becoming degraded or stopping? Are such resources - set against the rate of consumption - finite and depletable or are they so vast (e.g., the total amount of sand in the world) that depletion is not an issue?

Box 2

The system of environmental function evaluation

An important aspect of nature is that it delivers services for society. From the 1970s on, several authors have tried to classify these services as functions of nature for society. Van de Maarel and Dauvellier (1978) and De Groot (1992) worked out a system of ecosystem functions that combines an ethical and utilitarian approach towards nature in assigning function – or services – to nature. As a common framework for function, evaluation functions are divided into four groups:

- **Regulation functions**: this group of functions relates to the capacity of natural and semi-natural ecosystems to regulate essential ecological processes and life support systems, which, in turn, contribute to the maintenance of a healthy environment by providing clean air, water and soil.
- **Carrier functions:** natural and semi-natural systems provide space and a suitable substrate or medium for many human activities such as habitation, cultivation and recreation.
- **Production functions:** nature provides many resources, ranging from food and raw materials for industrial use to energy resources and genetic materials.
- **Information functions:** natural ecosystems contribute to the maintenance of mental health by providing opportunities for reflection, spiritual enrichment, cognitive development and aesthetic experience.

If we use stocks that are finite, can we recycle used materials easily and economically? Is human exploitation of abiotic or biotic resources harmful to other vital or valued elements (biodiversity)? Where can we find 'flows' that can be harvested without depleting stocks or obstructing the natural processes (slaughtering the hen with the golden eggs)? If so, are there certain limits or thresholds that should not be crossed? Can we indicate biological stocks that reproduce themselves so as to allow continuous use of a sustainable yield (catch, harvest)? Can we specify where abuse leads to irreversible losses, for instance, when biodiversity is lost forever by anthropogenic extinction? *The majority of these questions cannot be answered in a generic sense but require specification, since the variety and properties of ecosystems lead to specific conditions of vulnerability*. Some ecosystems are very *robust* and can be exploited without harm; others are vulnerable, but show great *resilience* in that damage is restored by nature effectively and rapidly, and still others are extremely *susceptible and prone to c*ollapse as soon as a critical limit has been exceeded. Such questions necessitate being specific about ecosystems, their spatial scale, their varying dynamics and 'natural laws' connected to these dynamics acting at a variety of time scales. Box 3 discusses some essentials of these subjects, showing that ecological processes involve time scales ranging from many millions of years to less than a year, whereas the spatial scale of such processes may vary from 1000 km or more to well below a metre. Disturbances can also be expressed in a combination of temporal and spatial scales.

Geographical specification is also required. There is a need to indicate the locations of natural resources or conditions that differ from area to area, while defining human demands that vary from region to region. Global budgets are seldom relevant: it is regional or local surpluses or shortages that should be specified. This can be illustrated by the example of fresh water (rivers, lakes, groundwater, atmospheric water), which seems to be present in enormous quantities that cannot be depleted in an absolute sense. Nevertheless, fresh water is becoming a limiting factor to agriculture, industries and households in vast regions. Depletion on a global scale is difficult to imagine, but regional shortage is a real problem. Apart from quantitative problems, the lack of sufficient water quality due to salts, toxins or surplus nutrients can represent a serious problem. Other natural resources, such as rare minerals and fossil energy (coal, oil, gas), are on the whole less abundant and easier to deplete. Fossil energy is a stock that - despite huge reservoirs - is depleted rapidly due to massive consumption, whereas natural replenishment is a question of geological timeframes of the order of tens of millions of years. Its use causes many adverse side effects such as global warming due to greenhouse gases.

Some other valuable resources from nature can be regarded as renewable sources, such as solar energy, hydro-energy, wind energy and biomass (all of them indirectly representing solar energy). Although harvesting these energy flows by man is already common practice, its contribution is a mere fraction of the energy produced from fossil fuel. Biomass might seem to represent a huge amount of energy, but overexploitation leads to the immediate decrease of what can be harvested. When exploiting living systems, man has to respect basic laws of growth and reproduction that have specific limits.

Box 3

Time-space dimensions of processes and impacts

When considering stocks and flows in ecosystems, it is relevant to be aware of the space and time dimensions of natural processes. Evolutionary processes generally take place within time frames of up to 10^8 years. Speciation in mammals and seed plants is estimated to occur at a time-scale of about 10^5 years. Speciation occurs on various spatial scales, mostly on a continental scale but also on a rather local scale in case of insular environments.

The spatial scales on which ecosystems can develop and survive differ considerably. The most demanding species, including large top-predators like the Siberian Tiger and the Lynx, need large habitat areas, in some cases over 2000 km^2, to sustain a minimum viable population of 50 reproductive units.

Succession or restoration after a major disturbance can require several decades in pioneer communities such as coastal dunes or salt marshes to many thousands of years in climax situations in tropical forests, raised bogs or coral communities, if restoration is at all feasible. Some raised bogs originated 6000 years ago and it takes several hundreds of years to redevelop a small living raised bog. Some ecosystems are very fragile and have a very low resilience. Restoration processes depend on whether species have the opportunity to return from elsewhere. Recolonisation processes are determined by the vicinity of source habitats and viable populations that function as source areas. Some species have problems recolonising habitats due to barriers or large distances between the source area and the areas to be colonised.

In short, ecosystems have specific boundary conditions in space and time; vulnerable and less resilient ecosystems require a long restoration time of sometimes thousands of years after disturbance. More demanding species need large areas. Impacts and sudden accidents can happen over much shorter periods of time. Drought periods in the Sahel last several years to decades. El Niño, a disruption of the ocean-atmosphere system in the tropical Pacific has important consequences for weather around the globe. It occurs every 4 to 6 years and its impact lasts for about one year. It has major consequences for the development of ecosystems and the use of natural resources. Sudden events include storms, flash rains and floods, which may last for hours or days. Ecosystems are adapted to both the long-term development as well as the sudden events, by inbuilt strategies at the species level as well as at the ecosystem level, where more species and their interactions play a role.

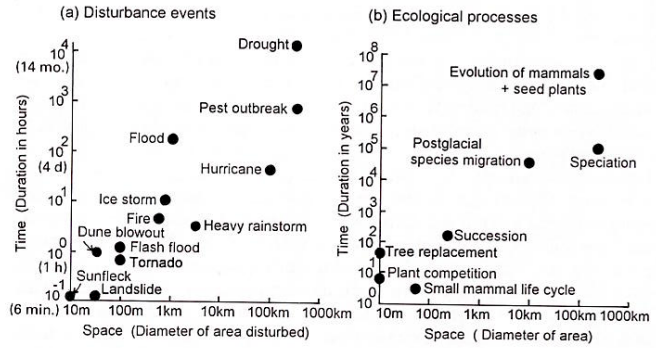


Figure 2. Space-time graphs for environmental and biological changes. Dots represent the approximate centres of the ovals within which most examples are found (Forman, 1995)

Optimum biological production is determined by rather narrow margins, and below and above some critical values nature's performance decreases rapidly or stops. These conditions are partly external, such as climate, soil and water, and partly internal and related to the availability of the full range of species and in-built genetic variation, as in the case of biodiversity or the gene pool. *The genetic information stored in the plant and animal kingdom may be the richest and at the same time most vulnerable capital on earth.* Taxa such as fungi, plants and animals form the outcome of evolutionary processes over many thousands or even many millions of years, processes that are unique, irreversible and not repeatable. This means that such resources are essentially vulnerable. *Once destroyed, their retrieval is impossible*, whatever films like *Jurassic Park* may suggest. The development of new species adapted to changed conditions takes a very long time and cannot be seen as compensation for the current rate of extinction (Wilson, 1992).

After this short overview of essentials, such as the importance of stocks and flows and spatio-temporal scales related to the Planet domain and the systems involved, let us turn to some other concepts that can be seen as relevant in the context of sustainability against the background of human use of nature or human symbiosis with nature.

Ecosystem development, stability and disturbance

Ecosystems are subject to many changes, due to both internal and external factors, either in the form of natural disturbances or human-induced. Ecosystem development is the process of natural changes taking place in a given ecosystem. These may be gradual transitions of newly colonised areas where pioneer plants invade, creating opportunities for other species of intermediate and eventually mature ecosystems by changing microclimate or soil conditions. The time required for this so-called succession differs greatly: some ecosystems develop in a matter of decades, while others need thousands of years or even longer. Ecosystem restoration times also differ by comparable orders of magnitude or may be shorter in some cases (Box 3). *Awareness of time scales is therefore fund*amental in understanding nature's behaviour.

Catastrophic events such as fires can destroy ecosystems partly or even largely, after which they are able to renew themselves gradually. Contrary to the views held by conservationists of some decades ago, and still counterintuitive for most people, these 'disasters', provided they are small and infrequent, can have positive effects on the longer-term survival of ecosystems and their inhabitants (Turner, 1987). There is always a creative as well as a destructive element in the development of ecosystems, as is shown in figure 3 (after Holling, 1986). A cycle of four stages can be distinguished: building up energy, biomass, species or organisms (stage 1, named exploitation of resources), followed by a conservation or consolidation stage (2), followed by a period of (partial) destruction (stage 3), which creates opportunities for renewal (stage 4) and so on. Holling's 'pretzel', simple as it may seem, stresses the experience that nature itself is not stationary, nor gaining from purely stationary situations. In the long run, ecosystems need some minor catastrophic events to

adjust to changes and renew themselves. It helps to preserve a full arsenal of species and processes, to facilitate adjustments to changes due to come anyhow.

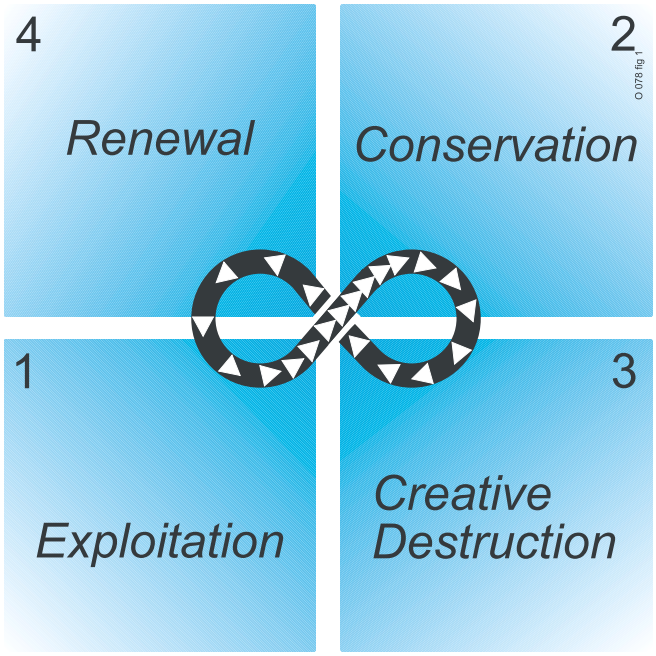


Figure 3. Four stages of ecosystem behaviour and their mutual relationships (greatly simplified after Holling, 1986)

What is essential is the ability of ecosystems to retain their components, structure and behaviour, or their ability to return to their former state after disturbances caused by natural events (e.g. fire, floods, severe frost) or by human impact (e.g., cutting down forests, drainage, polluting air, soil and water). These abilities differ from ecosystem to ecosystem. Ecologists (Mc Arthur & Wilson, 1967; Grime, 1979) have distinguished various *strategies* for individual species or for ecosystems as a whole: robust, fragile or resilient (Holling, 1986). Ecosystems are called *robust* when disturbances do not easily affect the essential conditions or cause massive destruction of communities. Resistance to change is due to in-built buffers or adaptations to cold, drought, fire, damage or shortage of food. Thus, redwoods are resistant against low forest fires after they have reached a certain height. Species or ecosystems with such a strategy are called *K-strategists*. Ecosystems are *fragile* when they are easily disturbed or even collapse. They are found in conditions that are normally relatively stable. Coral reefs, which have developed over long periods in stable conditions, can for instance be extremely vulnerable to pollution. Restoration after a collapse can be very hard and take decades or centuries. *Resilience* is the ability to restore a system's former state quickly after massive destruction, a strategy often found in the more dynamic situations. Species that are effective in regaining a certain population size or return after temporary extinction by rapid reproduction and dispersal techniques are called *'opportunistic'*. A typical species of this category might be able to restore its population after a severe winter or a flood by rapid reproduction or effective re-colonisation within a few years. Species following such a strategy are named *r-*

strategists. Ecosystems that largely consist of such r-strategists are found in dynamic environments such as softwood river forests. They prevail in the so-called exploitation stage in Holling's terminology.

The above shows that the world's various ecosystems as well as their constituent species have a wide variety of properties helping them to withstand disturbances or to return to their former state, with some being extremely vulnerable while others are extremely resilient. These properties relate to local or regional circumstances to which nature has adapted itself by developing the most effective strategy. These relationships can also be seen as species being dependent on a certain amount of disturbance, on condition that these disturbances are 'known and inbuilt' in the abilities of these species to handle these dynamics. Many ecosystems actually do need regular disturbances (such as a fire or storm damage in forests) to create new opportunities for rejuvenation, leading to stage 3 and then to stage 4. These insights undermine the idea that nature in its optimum state is a harmonious system in equilibrium with a stable environment, as was supposed some decades ago. Although, of course, equilibria do exist for shorter or longer periods, they do not represent an everlasting phenomenon nor an absolute optimum. Rather, *many ecosystems are now considered to be in a more or less permanent out-of-balance situation* (Pimm *et al*., 1984) and to be more dynamic and unpredictable than was accepted in earlier ecosystem theories.

In earlier theories, the idea of succession - the gradual shift from pioneering via intermediate stages towards climax or end stages - was a uni-directional and repeatable process with one predetermined pathway. This concept has been proven to be too simplistic and mechanistic and has been adjusted (Horn, 1976). Ecosystem development is now regarded as a far more complicated and at times inherently chaotic and unpredictable process. There is abundant evidence for the existence of more than one pathway in ecosystem development. At several moments or stages in its development, an ecosystem can follow different routes: these points are called bifurcation *points*. Small causes can then have great effects in determining such development and can lead to contrasting succession events. In other words, the developmental pathway is an important feature in trying to understand the present situation.

Alternative response to disturbances

Studying equilibria and transitions in nature leads to a more complex perspective than was assumed earlier. Nature's paths have proved to be complex and full of surprises. In this context, the term '*hysteresis'* is often used to indicate the phenomenon that – to use a metaphor - the road leading from stage A to stage B can differ considerably from that going from B to A. This insight has important implications. Scheffer *et al* (2001) point out that systems showing hysteresis may respond to changing conditions without distinct changes in ecosystem functioning and species composition over a longer period, but may then suddenly shift into other stages (Figure 4). Returning to the original stage afterwards is not simply a question of following the same route in the opposite direction; it requires quite different conditions and even some more drastic measures than would be assumed on the

basis of the preceding stages. This feature seems to be quite common and has major implications for our understanding of ecosystems as well as for management strategies. Much of the traditional science and many of the proposed models do not provide answers to the questions that regard nature and society nowadays. Consequently, ecosystem management strategies, including the degree to which human exploitation can be accepted, should take into account the unpredictable behaviour in trajectories of inherent instability and the lack of resilience that is the inherent consequence. Ecosystem management should therefore maintain considerable safety margins to prevent collapse. Exceeding these safety margins means taking risks in terms of biodiversity losses and losses of biological production, and accepting the economic risks that restoration measures will require much larger investments.

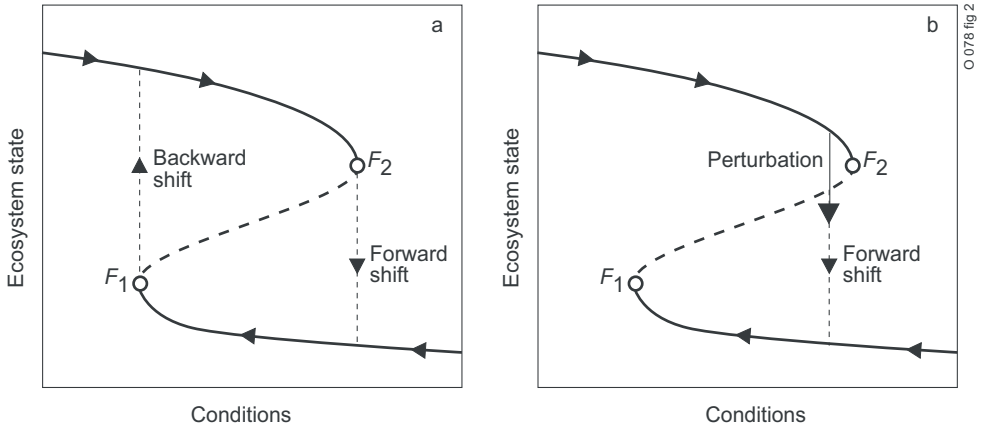


Figure 4. Hysteresis phenomenon when the bifurcation parameter first grows and then diminishes. Due to perturbation, the system jumps down from F2 without reaching F1. When the system develops beyond F1 it jumps up to a new steady state beyond F2 (Scheffer et al, 2001)

Some basic aspects of spatial relationships in landscape ecology

Nature on Earth, represented by its millions of known species and the assumed existence of many unknown species, is the outcome of hundreds of millions of years of evolution, adapted to the Earth's numerous different environments. These environments and habitats for natural life relate to geographical or spatial factors of paramount importance, including (1) the position in terms of climate zones or soil and water properties that are unevenly distributed, including their gradual transitions (gradients); (2) the size of the areas; (3) the relative isolation or connectedness of areas, enabling or obstructing the exchange of organisms; and (4) horizontal relationships between areas in terms of the transport of substances like water, sediment or nutrients. Some of these spatial or geographical topics are briefly discussed below, insofar as they are relevant to sustainable use by man.

- *Habitat differentiation,* including gradual transitions in space (gradients) is one of the key factors in explaining and safeguarding existing biodiversity.
- The *size of living areas* is important to sustain viable populations of sufficient size of those animals that demand large surfaces (e.g. large mammals), as well as to sustain the full integrity of a food pyramid, including top predators, and to ensure

an in-built buffer against outside disturbances, to absorb small disasters (e.g. fire, erosion, disease) without risking the entire area at once.

- *Isolation can be a cause of independent evolutionary development* (endemic species) and as such an asset adding to global biodiversity that should not be jeopardised: *'splendid isolation'*
- Isolation has its drawbacks in the case of *habitat fragmentation* leading to area sizes that are too small to sustain viable populations or areas that are effectively separated from each other, obstructing the recolonisation of areas after temporary extinction from nearby areas acting as pools from which migration can take place. This phenomenon is becoming more common where land use by intensive agriculture, urbanisation and infrastructure growth tends to add to the fragmentation of natural areas.
- *Other horizontal relationships in landscapes* can be equally vital. Take for instance natural flows of groundwater or surface waters (e.g. rivers, coastal currents) on which 'downstream' ecosystems (e.g. deltas) may depend. Any major influence in upstream parts, for instance due to river control or pollution by man, can be disastrous for ecosystems and their biodiversity. These upstream-downstream relationships can explain many of the ecological disasters affecting wetland areas all over the world, highlighting the fact that sustainable land use should take account of these aspects and of the behaviour of natural systems that could prevent geographical externalisation of the adverse effects of human acts.
- In general, *dispersal and migration are essential* for population survival and the functioning of biotopes. A diagram showing the essentials in such processes is shown below (Figure 5).

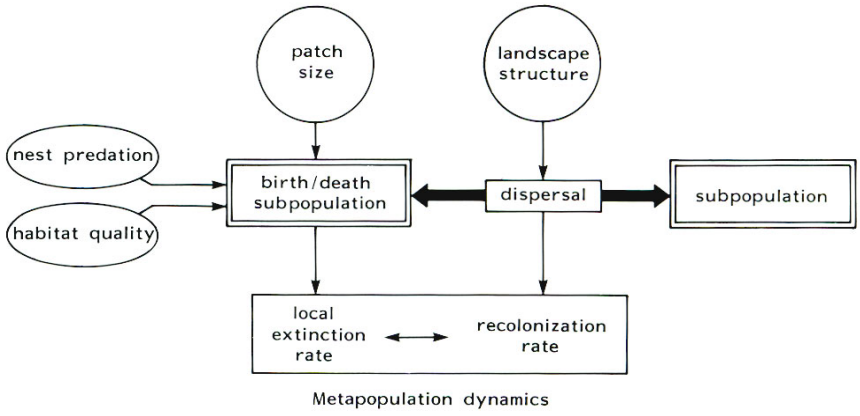


Figure 5. Dynamics and processes in a meta-population (Opdam, 1991)

The main conditions for sustainable nature and natural development recapitulated

The unique character of many aspects of nature, such as species, ecosystems or processes at the landscape level, requires that the basic boundary conditions are respected. The most important of these can be derived from the above:

- Nature presents an astonishing variation across the Earth. Because ecosystems are adapted to abiotic and other conditions (including human management), they cannot be separated.
- Ecosystems depend on the conditions to which they are adapted. Each ecosystem type has its own requirements, so that only specific regions can harbour them. It would not be possible to transport ecosystems to other places or regions without major damage, or to create them artificially the way a factory could be reallocated or new settlements for people built.
- Full development of natural ecosystems, including the most demanding species, requires a sufficiently large area to sustain a full complement of species. Areas that are too small are inclined to suffer local extinction of species.
- Areas that are too small to sustain the full spectrum of species can be improved by connecting various areas via ecological corridors to allow dispersal or migration between areas, populations and species.
- Areas designated as nature reserves should have the right environmental qualities, including the absence of human disturbances or pollution.
- Ecosystems have their own temporal boundary conditions in terms of succession or restoration time. There are no devices to circumvent these inherent properties.
- Many ecosystems are adapted to and dependent on a certain amount of disturbance such as fire and storms. These events lead to rejuvenation and create opportunities for species belonging to other successional stages. This 'law' can be translated into related boundary conditions: ecosystems should be large enough to enable such stochastic events to happen without causing irreversible changes due to localised system extinction. Depending on the ecosystems at stake and the nature of the events, a certain minimum size can be established. The rule of thumb used in the Netherlands is that the total area should be fifty times larger than the area directly affected by a disturbance.
- Sustainable use and efficient restoration of nature and its functions should take into account safety margins to prevent sudden irreversible collapses. Ecological engineers and planners could find analogies in safety margins in e.g. steel or concrete bridges that are constructed to several times the critical strength in view of expected forces.

The Planet factor represents the biophysical aspects of living and non-living nature. It is necessary to distinguish between capital (stocks), which can represent ubiquitous or rare quantities, depletable and non-depletable quantities and reversible and non-reversible losses. The functions of nature for man are numerous, whether material or immaterial. Utilising natural yields (e.g. allowable fish catches or a harvest of fruits or medicinal plants) is possible as long as vital conditions for restoration are left intact. Biodiversity losses due to extinction are absolutely irreversible. Sustainable use, especially with respect to living nature, should take into account reproductive abilities and should respect threshold values, including adequate safety margins. One should be especially aware of those processes that could endanger natural resilience. Understanding nature's capacity to deliver goods or services requires a specification per ecosystem and for temporal and spatial scales: there are hardly any generic rules. Nature and natural processes exhibit in-built unpredictabilities and domains of critical behaviour, as symbolised by the phenomenon of hysteresis. Safety margins are essential in the utilisation of nature. Conservation and restoration of basic spatial conditions (area size and connectivity) is of great importance to safeguard nature in many ways.

6.2 Profit

A. Economic theory: imperfect markets and the public sector

The market and its externalities

A discussion of triple P performance in business can hardly avoid a reference to Milton Friedman's statement that: 'the social responsibility of business is to make profit' (Friedman, 1970). This statement rests upon the assumption, first introduced by Adam Smith, that economic actors who each individually strive for their own self-interest will, as by an invisible hand, be guided such that welfare for society as a whole is maximised. The way in which the invisible hand works is through the market, an institution that matches the supply of goods and services with demand, in such way that production factors are efficiently allocated to their productive uses. Market efficiency, or in other words, maximum welfare, is defined here as the situation in which no one can be made better off without making somebody else worse off (*Pareto efficiency*).

There are several problems with this representation of economic life. The first type is that of market failures. The point is that many transactions take place in a context where economic actors do not appropriately take into account *all* the costs and benefits related to their activities. Thus, externalities exist, that is, things that are important in economic life but are not accounted for in market transactions. Very often it is very difficult or even fundamentally impossible to monetarise these externalities, such as loss of biodiversity (see also Box 4).

In scientific and societal reality, there are many cases where positive or negative effects of economic activities are not internalised in economic decision-making. External effects are especially important for the argument in this paper when they implicate the stock or flow of natural capital and/or social capital. Unlike economic or financial capital, these two forms of capital are by their very nature constituted in such a way that it is difficult to exclude people from using the resource. Because exclusion is difficult or socially undesirable, it is also difficult to institute property rights that would allow resource managers to ration the use of these resources or to ask users to contribute to maintaining the productive bases of these resources (World Bank, 2002). Appropriation of stocks would make it possible to trade them at markets, bringing their provision or maintenance under the beneficial action of the invisible hand. An example can be found in fisheries. The rebuilt stock and the increased flow of fish that is produced by that stock belongs to no one, but the fish caught belongs to the fisherman who caught it. Hence, there is an incentive for fishermen to catch as many fish as quickly as possible before anyone else does. Another example is knowledge production, an important component of human and social capital. For the purpose of this paper it is especially relevant to look at the production of socially desirable knowledge, for example knowledge that is required in order to improve the triple P performance of business or government. Building up a body of socially desirable knowledge may involve considerable investments, but once the knowledge exists it should be made freely available to as many people as possible in order to further the goals of sustainable development. But this introduces the possibility that individuals or groups do not contribute to building up the knowledge in the first place, preferring to wait until others have produced the knowledge, which they can then copy when it is available. Natural capital and social capital are therefore quite often overutilised, in the case of negative externalities, or underprovided, even though there would be positive spillovers to society as a whole.

In the neo-classical tradition, there is a prominent role for the state in developing policies to ensure that negative external effects are minimised and/or positive external effects are maximised. Traditionally, the state can do this through taxes or subsidies to bridge the gap between private costs/benefits and social costs/benefits, or through administrative rules prescribing certain socially desirable behaviours. Finally, the state can regulate behaviour through the introduction of private property rights, which allow owners of a capital asset to internalise all positive and negative effects of their actions in their economic decision-making. An example of private property rights in natural resource management would be the allocation of individual catch entitlements to fishermen, allowing them to adapt their fishing strategy to the productive possibilities of the marine ecosystem on the one hand, and to the demand characteristics of consumers on the other. An example in the field of knowledge production is that scientists or the institutes to which they belong appropriate their knowledge, which excludes others from using it or forces them to enter into licensing agreements.

Box 4

Valuation of biological diversity in economics (Van der Heide et al, 1999: 18-19)

From an economic point of view, biodiversity is an important asset. Several attempts have been made to measure non-economic effects of economic activity in such a way that they can be evaluated consistently. From the ecological side, function evaluation has been developed for a consistent inclusion of ecosystems in economic decision-making. Individual plants and animals have a value because they can be used to produce economic goods, both directly, such as fruits or nuts, and indirectly in the form of natural chemicals, fuel and compounds. Finally, the genes of species may be a source of genetic information that can be used to create new varieties of plants or animals through genetic engineering.

Biodiversity is an irreplaceable stock on a human timescale and its decline has two dimensions of irreversibility, one biophysical and the other economic. The former implies that some environments can never be restored to their original state once economic development has occurred. Economic irreversibility occurs when the costs of restoring an environment are higher than the benefits of restoration. The costs of restoring an environment will increase if economic development of this environment continues.

Several techniques have been developed to assign monetary value to the benefits of environmental quality, or damages avoided, based either on observed market behaviour or revealed preferences or stated preferences. Approaches based on revealed preferences seek to derive an explicit relationship between individuals' willingness to pay for environmental quality and the demand for a market good. Methods used in this approach include the following.

- The travel cost method (TCM) is used especially for assessing recreational values, and has been widely used for this purpose in both the USA and the UK. The underlying assumption in TCM is that the incurred costs of visiting a national park, nature reserve, open space or any other site are directly related to the benefits one gets from it.
- The hedonic pricing method (HPM) derives the value of environmental amenities, such as low pollution and noise levels, from the actual market prices of some private goods, and is commonly applied in the real estate market.

Direct methods involve monetary valuation of utility; they bypass the need to refer to market prices by asking people directly what they are willing to pay for a change in environmental quality (e.g., forest conservation or the presence of certain natural species).

- The contingent valuation method (CVM) uses such a direct approach, which basically invokes a framework of a contingent (or hypothetical) market.

Although these benefit valuation methods have been applied, none of them are perfect; each has its advantages and disadvantages. However, since nature conservation policies always entail costs anyway, policy-making may be supported by information on the expected benefits as the rationale for spending on such policies.

Transaction costs and social capital

More recently, economists have drawn attention to the fact that markets do not operate frictionless as if supply and demand are matched perfectly and at no cost. Externalities exist, so the argument goes, because there are considerable transaction costs in real life (Coase, 1960). These costs include search and information costs, bargaining and decision-making costs, and policing and enforcement costs (Coase, 1988). If transaction costs were zero or negligible, economic actors would always find ways to negotiate away the negative external effects of their economic actions or they would be able to draw up contracts such that positive external effects are properly accounted for. In the example about fisheries, fishermen would be able to negotiate an agreement among them such that they limit their exploitative action and find an acceptable way to distribute among themselves the costs this would involve, in terms of current income foregone and the benefits that might be realised if stocks are rebuilt. Scientists will make their knowledge freely available to others if they are able to conclude an agreement with those who benefit from it, forcing them to contribute to the costs.

In real life situations, however, transaction costs are considerable. This implies that parties are quite often unable to come to an agreement or to monitor and control compliance to the agreement. Hence, many externalities continue to exist, as the costs of contracting them away are larger than the benefits to be achieved.

The institutional economics analysis briefly outlined above adds to the conventional economic perspective on externalities, which says that economic actors under certain conditions are indeed able to self-organise to internalise the negative or positive effects of their economic activity voluntarily. Given that economic actors may themselves organise to solve externality problems, the state can, in principle, shift its role from direct intervention (taxes, subsidies, rules and regulations) to indirect intervention (contributions to provide institutions which reduce transaction costs). An example in fisheries management is the way the Dutch government has reduced its direct intervention in the fishing industry by handing over some quota management responsibilities to groups of fishermen, which were specifically constituted to mobilise the self-organising capacity of the fisheries sector (Van der Schans, 2001).

There is a direct link between the institutional economics perspective and the social capital concept. Many of the transaction *costs* that would have occurred if economic actors acted from a position of social isolation, as normally presumed by economists, do not exist in reality because people generally maintain or develop social ties, such that economic agreements among them are more easily concluded or maintained. In other words, economists have found - to their surprise - that people in practice do collaborate more often than one would expect, and they do not seem to be bothered to identify contract imperfections and asymmetric information problems that these economists expect on the basis of their theoretical predictions. This gap between theory and practice is explained by the fact that people live and act in social networks and that these social networks represent a social capital value in that they reduce transaction costs or facilitate informal collaboration.

A level playing field

Another problem with the invisible hand metaphor is that it presupposes perfectly competitive markets, which clear at equilibrium prices. Equilibrium prices are set by impersonal supply and demand; individual producers or consumers do not have the power to affect these prices. In reality, however, there are many situations where markets are not perfectly competitive, and/or where markets do not clear at equilibrium prices. Economic sociologists draw attention to power differences between economic actors, strategic behaviour of large economic players, coalition building between private and public actors, etc. (Perrow, 1986). Thus, economic actors do not just passively respond to the competitive pressure which is out there, but also actively try to shape the conditions under which competition is to take place (Granovetter, 1992). If there is any form of meaningful competition at all, that is, because economic, political or social coalitions often try to introduce or maintain barriers to stop newcomers from entering.

Economic theory is based, albeit often rather implicitly, on the assumption that parties exchange goods and services *non-exclusively* and *voluntarily*. This implies a set of normative principles that are in fact the backbone of economic theory but are not always practiced in economic life. One such principle is that people are autonomous individuals who have a right to freely enter or leave economic exchanges at will. This excludes social excesses such as slave labour, child labour but also unduly stressful labour relations or community relations in the industrialised world. Can a local resident, for instance, freely negotiate a compensation agreement when a local factory pollutes the air or spoils the view? Or is a company able to use its exclusively dominant position locally to force residents to accept the nuisances of production by threatening factory closure and lay-offs among the local workforce? This shows the direct link between economic principles (autonomy and non-exclusivity) and social issues (working conditions, local community relations), and to some extent also ecological issues (factory emissions). Thus, it could be argued that economic theory presupposes an institutional context involving a perfectly competitive market, which takes for granted or actively guarantees that basic social and ecological concerns would be met automatically. These concerns are addressed by economic principles such as the freedom to transact, the right to bodily integrity and the fruits of labour, the right to basic necessities of life, etc. (Van der Schans, 2001).

If we take the basic normative presuppositions underlying economic theory seriously, many of the issues that are now considered outside the economic realm would in fact re-appear on the economists' agenda. This implies for example a re-integration of basic social and environmental norms in international trade negotiations. Free trade is not only about reducing barriers to the free exchange of goods and services between nations in the World Trade Organisation (WTO). It is also and simultaneously about creating a level playing field between capital and labour in the International Labour Organisation (ILO), and between capital, labour and natural resources for instance through the International Union for the Conservation of Nature (IUCN).

Markets fail (1) because economic actors do not appropriately take into account all costs and benefits related to their activities; (2) because transaction costs inhibit effective self-organisation; (3) because the lack of a level playing field, locally or internationally, undermines basic economic principles such as autonomy and non-exclusiveness. Governmental institutions should facilitate the development of social capital (institutions and networks) because it reduces transaction costs. For markets to function properly, a global level playing field (human rights) should exist between capital (WTO), labour (ILO) and natural resources (IUCN).

B. Economic practice and the corporate environment

Ways to increase profitability

Apart from advances in economic theory, there are of course also developments in economic practice, which are relevant to a discussion of the profit dimension of the triple P concept. If we look at trends in business management, it can be noticed that there are several ways in which managers and their consultants have tried to increase corporate profitability. We have seen a shift in attention from efficiency to quality, and from flexibility to innovation in the 1960s, 1970s, 1980s and 1990s, respectively. These shifts in management attention have typically also resulted in shifts in business models (from complex bureaucracies to flexible networks), management information systems (with economic, environmental and social performance increasingly integrated) and ways in which labour relations are structured and shareholders are involved (from shareholder capitalism to stakeholder dialogue).

From shareholder capitalism to stakeholder dialogue

There are several drivers for a noticeable shift of attention in the corporate world from strict profit considerations to more fully including environmental and social concerns. One factor is that some companies have found out that not including social and environmental concerns can lead to serious problems in the short run (consumer boycotts, employee strikes). In the long term it can lead to difficulties in attracting external capital or finance, difficulties in attracting top-level management or staff, difficulties in obtaining licences from governments, or difficulties in achieving preferred supplier status in the market. Companies are, in other words, increasingly concerned that they may lose their 'licence to operate', the acceptance by society which grants them some room to manoeuvre. Thus, ethical conduct and reputation management go hand in hand. Another factor is that, due to communication technologies, internet, transport and telecommunication, non-governmental organisations and other societal groups are increasingly well-informed and well-organised, locally as well as worldwide. It is now rather easy to obtain mass support for demonstrations against international economic institutions such as WTO. NGOs are increasingly shifting from lobbying governments for regulations to addressing private business directly, because they realise that some problems cannot be properly addressed by or through governments. Multinational business operates outside national jurisdiction, and technology is progressing so fast that government

regulations are lagging behind; the capacity to make ethical judgements cannot be enforced through laws but must be internalised directly in the views and actions of company leaders. And last but not least, companies themselves increasingly find that it is difficult for them to control internal processes entirely through formal procedures and direct rules. Hence, they look for alternative ways to reduce the risk that a particular employee does not act in accordance with what is expected of him/her. Here, ethical conduct and risk management go hand in hand. This can be done through explicating value statements to employees and other interest groups or through implementing codes of conduct for which management can be held accountable.

A corporate stage model of triple P performance

The environmental management literature provides many models describing the consecutive stages companies go through in their attempt to green their business operations. Some authors distinguish three stages (Keijzers, *et al.*, 2002). The first stage is a *compliance-oriented* stage, in which companies bring their business operation in line with relevant economic, social and environmental laws and regulations. The second stage is a *control-oriented* stage, where companies actively develop initiatives to create win-win situations, such as pilot projects that show that pollution prevention pays. The third stage represents an *integrative approach*, where companies try to integrate triple P performance in their strategy and organisation, both internally as well as externally. Other authors have proposed a four-stage model, where the integrated stage is followed by a *proactive* one (Winsemius and Guntram, 2002). This shows that at the most ambitious level, environmental (and social) considerations are not just to be incorporated in a company's *normal* strategy and operations, as in the integration phase. Companies may have to look for a completely new multifaceted corporate values proposition that meets the challenges of sustainability for now and into the long-term future (Winsemius and Guntram, 2002). This approach can easily be extended to other parties, like governments dealing with the multifunctional use of a region. Figure 6 (from Klijn, 2003, based upon Winsemius and Guntram) shows the essential elements of the above four stages.

There is growing recognition at the corporate level that companies do not improve their triple P performance gradually but that the path towards more sustainable business develops through various stages, representing different ambition levels of overall triple P performance. Elkington therefore speaks of a *metamorphosis* process that companies go through in order to achieve a high positive triple P impact (Elkington, 2001). Companies may remain locusts, which implies that they combine a degenerative effect on economic, social and environmental capital with a high (but negative) impact. They may also develop into potential butterflies. They then move from a caterpillar stage to that of a butterfly by becoming regenerative to various forms of capital, but with a low impact. They may also develop into honeybees, however, which implies that they are regenerative to various forms of capital and are able to achieve a high impact. Whatever one may think of the vocabulary used, this classification shows that companies which go through several stages of sustainability have to fundamentally re-orient their mission and to re-organise themselves in the process, in terms of business value orientations, technologies, systems and structures,

processes and skills. This implies an evolutionary rather than a linear perspective on corporate social responsibility.

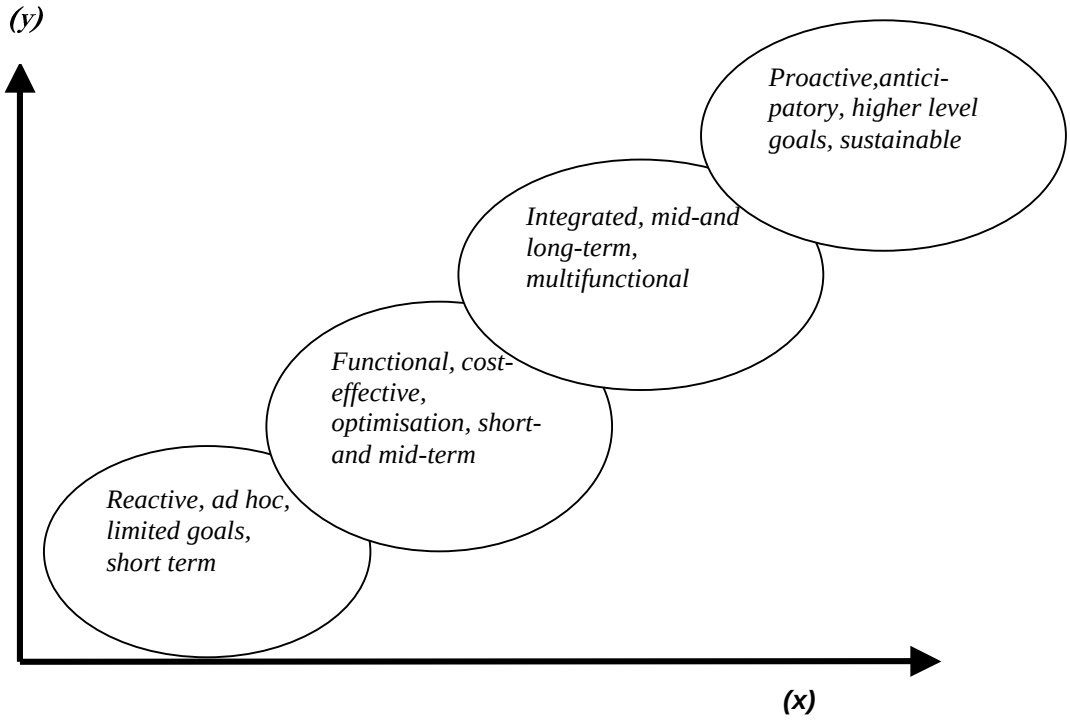


*Figure 6. How to classify decision making ? (**x-axis** : spatio-temporal scale ; **y-axis**: increasing number of values and level of integration, anticipation and balance in values; ovals show the various stages of decision-making and their main characteristics (from Klijn, 2003; inspired by Winsemius and Guntram, 2002)*

On the one hand, it can be quite difficult for a company to get from one stage to the other. On the other hand, once a higher evolutionary stage has been reached, it is rather difficult to return to a lower level, because it is assumed that the supporting business models and processes have been transformed fundamentally and irrevocably. Apart from this, the evolutionary model also implies that what may seem as an unsolvable tension between diverging societal demands in the current stage becomes a strategic opportunity if the company is able to move to the next higher evolutionary stage. More research is needed to establish the precise barriers to corporate sustainable development and the exact relationships between corporate practices and learning and corporate triple P performance and development (Cramer, 2002).

In the private sector, companies increasingly integrate social, economic and environmental performance, re-organise in flexible networks and increase stakeholder influence. Companies tend to go through an evolutionary development process, in which consecutive stages represent ever higher ambitions of sustainability.

C. Measuring triple P performance

There have been several attempts, in the public as well as the private sector, to measure and monitor non-economic effects of economic activity such that they can be consistently incorporated into a triple P decision-making process. Earlier efforts at national level tried to modify national accounts to include environmental damages, environmental services and changes in stocks of natural capital (World Bank, 2002). This proved problematic mainly because of valuation problems. But more fundamentally, there is also a point where it is difficult to categorise expenditures and benefits in terms of positive or negative societal value. For example: expenditures on health can be an indication both of social welfare and of social problems. Unpaid household labour and voluntary work are not included in the national accounts since they do not involve a transfer of money, but they may be important in building up or maintaining economic capital. More recently, therefore, there is a tendency to develop satellite accounts, which try to link environmental and social data sets with (unmodified) national account information. Although it is in principle possible to present these data sets in terms of flow accounts and balance sheets, in practice, given the difficulty of valuation, the emphasis has often been on using information on physical quantities from environmental accounts. Social indexes are at a very early stage of development, ranging from fairly simple issues such as education to more complex issues like human rights, transparency, trust and conflict. The drawback of this approach is that it is more difficult to make comparisons across accounts in different units as well as to evaluate priorities or trade-offs. The added value of this approach is that it is more policy-relevant than the aggregated indicator approach discussed above. Using separate sets of indicators makes it easier to see the actual source of the problem that policy-makers must address, and to propose problem-specific policy measures (World Bank, 2002).

At corporate level, there has been a tendency to include intangible assets in the balance sheet. Over the last decades, a growing gap has appeared between the actual value of a company (as indicated by the value of the shares on the stock exchange) and its book value (as it appears in the balance sheet). The value of a company in the balance sheet is mainly based on the physical and natural assets that a company holds. However, the value that investors attach to a company is based on the earning potential of a company, which in turn may depend largely on intangible assets such as those embodied in human capital (knowledge, skills and experience of the employees and managers), structural capital (organisational structure and culture, including patents etc.), and social capital (company relations with suppliers, consumers etc.). Companies are increasingly trying to include the value of these intangible assets in the balance sheet, as this would result in a better representation of the real value of the company and in a better representation of the real profit earned. An example often cited in this respect is the Swedish financial services company Skandia, which makes a deliberate effort to map, measure and mobilise the intellectual capital embodied in its management and workforce (Elkington, 1988). Skandia's mission is ‘to create unique skills around the world that allow us to provide the best financial solutions to our customers and enduring value to our shareholders.

We build special relationships, engage the energy of our employees and transfer knowledge with pride.'

Figure 7. Skills around the world (http://www.skandia.com/se/about/ourmission.shtml)

If a company invests heavily in improving its reputation, in creating trust among suppliers, consumers or employees, in educating its workforce, and in maintaining the natural resource base it uses in production, this could be included as an intangible asset ('goodwill') on the balance sheet, and would result in a higher value, rather than lower profits. On the other hand, a company which neglects to maintain its good relations with consumers, suppliers, workforce or public authorities may show high profits in the short run but runs the risk of losing its 'licence to operate' in the long run.

The biggest hurdle, however, in this kind of valuation is the fact that it is very difficult to estimate a reliable value of all these kinds of (intangible) assets. In addition, the prudence principle in accounting states that under insecure circumstances, the lowest possible value of an asset, or no value at all, should be included in the balance sheet. As many of the intangible assets referred to here, or the fruits of investment in such assets, cannot be fully appropriated by the company, this puts a limit to what can appear as value in the balance sheet. In practice, companies must deal with workforce mobility in relation to educational expense, natural fluctuations and common property aspects in relation to access rights to natural resources, etc. Given these problems, the solution chosen here is again not so much to incorporate environmental, human and social capital changes in the balance sheet, but rather to include more and more non-financial indicators in annual reports of companies. Examples of these indicators include the number of new customers, workforce turnover and new drug introductions subject to public authority approval. In addition to the financial report, an increasing number of companies also publish a separate social report and environmental report, allowing shareholders and stakeholders to develop a clearer and more balanced picture of the company's triple P performance.

To measure triple P performance, at company as well as national economy level, there is a shift from aggregated to non-aggregated indexes and valuations. Non-aggregated indexes make it more difficult to compare between companies and economies, and trade-offs between concerns in the different dimensions are also more difficult to make. But they have greater relevance to triple P problem analysis and solution.

6.3 People

A. Peoples' contribution to sustainable development

People at the crossroad of problems and solutions

It is hardly necessary to stress the central role of People in the triple P triangle. The very definition of sustainable development, as proposed by Brundtland, is based on the notion that the needs of people, today and for many generations to come, should not be compromised. The Brundtland report *Our Common Future* has had a major influence in linking the 'limits to growth' debate to the world's social agenda, and in stressing the complex and many-sided interrelations between economic development, environmental degradation and social inequality. Because of their over-exploitative behaviour and consumption patterns, people are an important cause of ecological degradation. But they also depend on the life support capacity of natural resources. Hence, people and other living beings are also the first and multiple victims of unsustainable development. Interestingly, people are also the principal beneficiaries of sustainable development themselves. Hence, they may have or develop the capacity to co-ordinate their actions in such a way that ecological degradation is prevented and social inequalities are reduced. Thus, people are at the crossroads of problems and solutions. For this reason alone, it may be worthwhile to elaborate on the social and cultural dimension of sustainable development. This section first briefly outlines what people ask from sustainable development. At the same time, however, there seems to be a tendency to shift attention from the fact that people by their sheer number and basic needs draw on the planet's natural resources, to the observation that people, in terms of the human and social capital they represent, can also contribute to sustainable development. This section therefore mainly focuses on the latter aspect of the relation between people and sustainable development.

Human impact on ecosystems

The Club of Rome's *Limits to Growth* report, published in 1972, was heavily criticised in subsequent years for containing methodological flaws and resting on unduly pessimistic assumptions. There is no doubt, however, that it was quite effective in focusing public attention on the global dimensions of the environmental problem, and hence the common fate of humankind. Whereas some have drawn attention to the overpopulation problem as a source of environmental degradation (Hardin, 1968; Ehrlich, 1968), others also took into account the growth of wealth in some parts of the world, and the environmental inefficiency of technology (Commoner, 1971; Soroos, 1984). Policy measures advocated have ranged from strict birth control to

drastic reduction of consumption and fundamentally re-considering the role of technology in human development. Realising that in most democratic societies it is hard to get birth control and/or consumption reduction policies adopted, let alone implemented, people have more recently tried to picture the technological challenge that we face in order to achieve sustainable development. If it is taken for granted that the world population will double between now and 2050, and that the average per capita wealth must increase fivefold globally, we still may want to halve the human impact on the environment in order to protect its life support capacities. It is thus estimated that the efficiency with which we use environmental resources must be improved by a factor of 20 (Box 5, Van Kasteren, 2001). Reaching this level of environmental efficiency requires innovations that represent societal breakthroughs extending beyond the scope of individual companies or government agencies (*system innovations; DOS, 2001).*

Box 5 "The equation"

EI=P*W*M

EI= environmental impact
P = population size
W = wealth (per capita production)
M= metabolism, the efficiency with which we use key stocks (environmental impact per product unit)

(Source, van Kasteren, 2001).

Whatever the analysis of human impact at the global level, in order to operationalise the challenge of sustainable development, decision-makers have to translate global concerns into more concrete plans of action. An example of such an exercise at country level is the drawing up of national environmental policy plans (NEPPs) by the Dutch Government, which provide an analysis of environmental problems at the national level, select the problem areas in which the Government wants to make progress and evaluate previous environmental policies (www.vrom.nl). Companies are also trying to formulate more explicitly what their contribution to sustainable development can be. An example in this respect at the company level is Shell's decision to create a renewable energy sources business unit, which would speed up the development of technologies and markets in this field (Shell, 1998).

B. Human problem solving capacity embodied in social capital

People not only draw from the stocks and flows which sustainable development relies on, but may also contribute to their maintenance and growth. The remainder of this section focuses particularly on the way in which human and social capital may help to improve triple P performance. The human capital of a society or firm consists of the knowledge, skills and experience of individuals as members of society or organisations. Social capital resides in the quality and density of social relations

between individuals and groups. In order to explain the contribution of social relations and institutional structures to sustainable development, it could be argued that social capital in its broadest definition represents an asset or a class of assets that produces a stream of benefits. The stream of benefits from social capital - or the channels through which it affects development - includes information sharing, mutually beneficial collective action and decision-making (Van der Kroon et al., 2002). Social capital could create better output and higher productivity from other resources such as natural capital, economic capital and human capital. Collier suggests that social capital is economically beneficial because it facilitates the transmission of knowledge about the behaviour of others, which reduces the problem of opportunism. It also facilitates the transmission of knowledge about technology and markets, which reduces market failures in information. Finally, it reduces the problem of free riding and so facilitates collective action, for example to manage a common resource effectively (Collier, 1998).

Putnam defines social capital as those features of social organisation, such as networks of individuals or households, and the associated norms and values, that create externalities for the community as a whole (Putman, 1993). Putnam originally envisaged these externalities as being only of a positive nature. He and others have since recognised that negative externalities can result from interpersonal interactions, as when certain interest coalitions are able to lobby for public privileges, or when groups of established resource users are able to exclude newcomers. In such situations, social capital benefits members of the association, but not necessarily non-members or society at large. A more encompassing view of social capital includes the social and political environment. In addition to largely informal, and often local, relationships, this view also includes the level of formalised institutional relationships and structures, such as political regimes, the rule of law, the court system and civil and political rights. Institutions have a critical effect on the rate and pattern of economic development and, one might add, sustainable development in a broader sense (North, 1990; World Bank, 2002, respectively). Thus, the social capital concept is enriched with and complemented by a focus on the quality of institutions and vitality of civil society.

Good governance as a prerequisite for sustainable development

In order to analyse this more encompassing concept of social capital, it has become increasingly popular to refer to the 'governance' concept. Governance very broadly refers to the way in which power is exercised (World Bank, 1992; CEC, 2001). The World Bank, for example, has identified four areas of governance that are consistent with the Bank's mandate: public sector management, accountability, the legal framework for development, and information and transparency (World Bank, 1992, 1994). The promotion of new forms of governance is also one of the European Commission's strategic priorities. Governance is defined by the Commission as the body of rules, processes and behaviour that affect the way powers are exercised at European level, particularly as regards openness, participation, accountability, effectiveness, coherence, proportionality and subsidiarity (CEC, 2001). The Commission also made a first effort to relate the governance concept to resource management, particularly the Common Fisheries Policy (CEC, 2002). Thus, the more

'process-oriented' principles of 'governance' are linked to the more 'result-oriented' goals of triple P performance in order to provide a more encompassing perspective on sustainable development (Van der Schans, 2002).

The governance concept not only implies a more explicit normative perspective on governing, as discussed above. It also signals the idea that effective governing arrangements not only involve governments, but in fact consist of a network of actors, both public and private, each individually unable to address the issue at hand, but together constituting a partnership considered capable of doing the job (Kooiman, 1993; Schout, 2002). In relation to sustainable development, it is clear that governments on their own are unable to solve all the problems at hand, if only because government authority is limited by territorial boundaries, whereas the negative (and positive) spill-over effects of economic activity may extend beyond these boundaries. In a global economy, an ever larger share of economic production takes place abroad, even though the end-products are sold on the home market. Governments may want to regulate the social and environmental conditions under which overseas production takes place, but they have no formal jurisdiction beyond their own territory. Thus they either depend on the hosting government for the level of regulation for business and the quality of enforcement, or they depend on voluntarily adopted company-internal codes of conduct, which regulate how employees should act in different contexts in different countries.

At a fundamental level, sovereignty is customarily extended either over territory or over people (Grotius, 1646). Whereas the first type of sovereignty is embodied in the nation state, the second type exists (or existed) in tribal societies, but - one might argue - still continues today in organisational life. Members of an organisation (church, sports club, business, etc.) voluntarily put themselves under the 'sovereignty' of the organisation's leadership, and they do so regardless of the place where they are (territory is not important). To the extent that it may be very difficult to change the doctrine of territory-based public sovereignty, it is quite understandable that civil society organisations call for corporate social responsibility at private business level. In principle, multi-national businesses have the capacity to issue 'corporate laws' (codes of conduct, incentive structures, etc.) which extend territorial limits and apply to all members of the corporation alike, irrespective of the country of operation. In market-based societies, however, businesses do not have the responsibility to formulate policies that represent the interests of *all* people within a certain territory as a whole. Neither do they have the authority to formulate, adopt and enforce *mandatory* rules; in a lawful society, the use of force is generally regarded a monopoly of the state. Hence, in order to constitute effective co-governance arrangements, governments as well as businesses and civil society organisations are important; all should work in partnerships to achieve sustainable development (see also Agenda 21).

Institution building and transition management

The interest in social capital and governance is partly inspired by the fact that it may explain why co-management or self-management institutions succeed where more traditional government interventions fail, whether they are based on bureaucratic

rules or market mechanisms (Van der Schans, 2001). There is a growing literature which studies the institutional structures and the ecological and social-political conditions that enable resource users to effectively co-manage or self-manage the natural resources they depend on. There have also been efforts to develop a set of design principles of successful resource-use self-management institutions (Ostrom, 1990). Economic sociologists have, however, drawn attention to the fact that institutional development is not just a response to economic, technological and ecological conditions that pre-exist in the environment, but that institutions also actively change this environment (Swedberg and Granovetter, 1992). On this account, the set of options actors can choose from at a particular point in time depends on choices that have been made previously: institutional development is thus path-dependent. Successful self-management institutions do not develop from scratch, but self-managing resource users are limited by and make use of instruments and possibilities that already exist in practice. Institutional design and change is therefore more complex than has sometimes been suggested. It not only involves design principles that map out end results of institutional change, but must also look at guidelines indicating the successive stages which actors must go through to bring about the change (transition management). It is often rather difficult in practice to switch from one type of institutional arrangement to another, even if this would improve economic or ecological performance. Institutions are locked in a particular societal constellation, social groups have developed vested interests in existing institutions, and it may require a major crisis (economically, socially or ecologically) before a window of opportunity for change emerges. Institutional change then involves a concerted effort by many actors, both in the public as well as the private domain ('system innovation'). On the other hand, if institutional change is brought about, further development and fine-tuning of the new institutional setting may take years but no longer requires a major developmental effort by a broad coalition of societal actors.

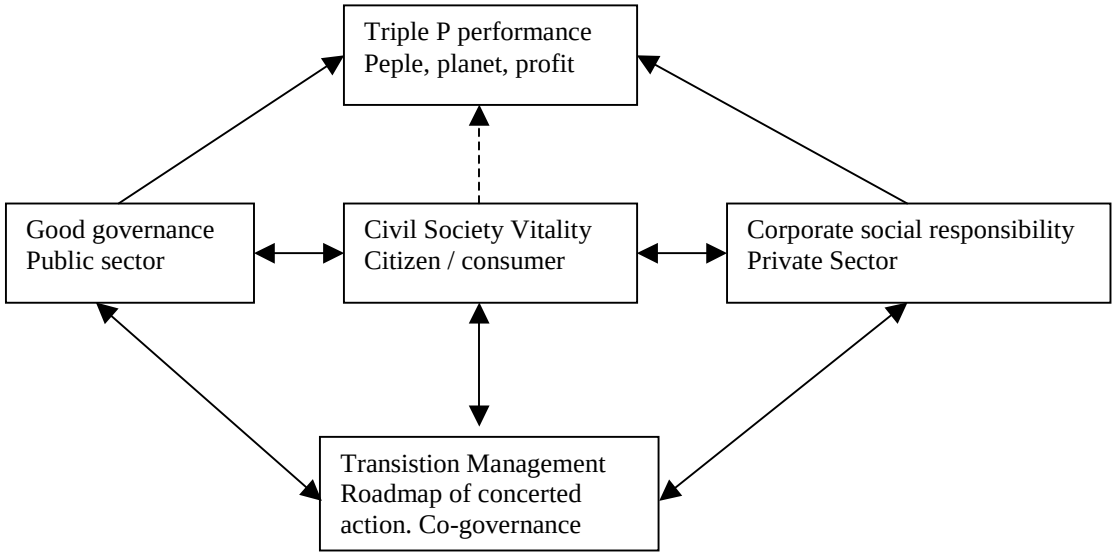


Figure 8. Relationships between various aspects of the People domain as explained in the text

Networks of public and private actors and agencies can contribute to sustainable development. They can facilitate information sharing, mutually beneficial collective action and decision-making. Good governance is seen as a prerequisite for sustainable development. Institutional change involves a concerted effort by many actors both in the public and private domain, constituting transition management.

C. Social capital: from instrumental use to embedding in a moral-ethical tradition

A degree of caution is required when looking at the role of social capital and (good) governance in relation to sustainable development. It is one thing to collect and analyse evidence that there can be a positive relation between social capital, good governance and economic growth and ecological preservation. It is quite another thing, however, to study social capital and governance *only* from this perspective, as it provides a rather instrumental, one-dimensional picture of the role and function of social capital and governance principles in economic life. From a social science perspective, social relations and political institutions are essentially social phenomena, which deserve attention in their own rights, not just as functional prerequisites to sustainable development. From a triple P performance perspective, one should of course welcome any evidence that more investment in social capital and the quality of democratic decision-making leads to more economic growth and more consideration for ecological concerns. However, even if this relation did not exist or was in fact opposite, it could still be argued from a moral or ethical perspective that social relations are important and democracy needs to be enhanced anyway.

In principle, several moral-ethical perspectives can be used to evaluate social and economic action and decision-making (Kaptein en Wempe, 2002; Van der Weele et al., 2003). From a *utilitarian* perspective, one should focus on the consequences of actions, rather than on the motives or principles behind actions. Whether or not something is valuable depends on the societal benefits and costs that can be attributed to it. This perspective is quite dominant in economics as a discipline and as a practice. Governments and businesses decide on certain policies or programmes if it can be shown that the benefits to society or to the company exceed the costs. The triple P perspective adds to this that benefits and costs are no longer just stated in economic terms but that ecological and social issues also play a role. From a *deontological* perspective, rights and duties are important concepts in evaluating economic and social action. Whether or not something is acceptable depends on the extent to which people's basic rights and duties are properly taken into account. This perspective presupposes that people are autonomous actors, who can establish moral laws to which they commit themselves voluntarily because they use basic principles that are assumed to be universally applicable. This perspective seems to gain in importance when we take into account the growing debate about principles of (good) governance in relation to sustainable development and corporate social performance.

Lastly, economic and social acts and decisions can be viewed from the *virtue ethics* perspective. Virtues are not attributes of acts or consequences but of people. A virtuous person is a person who acts and thinks in accordance with some commonly shared conception of good life. Virtues tend to be defined contextually; they do not claim universal validity, unlike the utilitarian and deontological perspectives. Virtues also develop from, and manifest themselves in, concrete action situations; they are not related to abstract principles or calculations.

Decision-making

In concrete decision-making contexts, arguments are drawn from all of these moral-ethical traditions. However, it is important in principle to distinguish between these perspectives, because the policy discourse about sustainability may be biased towards one argumentative domain. In fact, however, each perspective has its own strengths and weaknesses, but if no explicit distinctions are made, we may forget that there are alternative moral and ethical perspectives. The utilitarian perspective seems to be quite dominant in many debates on sustainable development and corporate social performance. We take into account social and ecological considerations because at the end of the day, they contribute to our economic performance. The rights and duties perspective has become increasingly popular, in that the citizens of a country or region, or the stakeholders and shareholders of a corporation, increasingly demand the right to know, and the right to participate in decision-making in relation to sustainable development. The virtue ethics perspective is not so commonly referred to in the context of sustainable development. At society level, this may be understandable because governments generally take a neutral position towards the variety of ways in which citizens under their jurisdiction try to pursue a good life. Public authorities generally confine themselves to regulating those aspects of personal lifestyles which produce negative external effects (on others or the environment). It is generally left to civil society institutions such as churches and NGOs to provide substantial criticism of the value systems on which certain ecologically or socially destructive lifestyles are based. The virtues perspective is more commonly referred to at the company level. There have always been many examples of individual entrepreneurs or associations of entrepreneurs using their businesses not just as profit-making machines but also as vehicles for expressing their personal values and opinions in relation to societal issues. An example may be provided by Anita and Gordon Roddick, founders of the Bodyshop, who formulated their company's mission as 'to dedicate our business to the pursuit of social and environmental change' (Baker, 1995).

Human action can be valued by its consequences (utilitarian) or by the degree to which rights and duties are taken into account (deontological). People can also value themselves with respect to the degree to which they act and think in accordance with some commonly shared conception of good life (virtues). In current debates about sustainable development and social corporate behaviour, the utilitarian perspective seems to dominate, although the rights and duties perspective and the virtues perspective do warrant attention.

6.4 Unifying concepts for the three P domains

Previous sections have highlighted some typical differences between the three domains of Planet, People and Profit, as well as some properties they share. Let us indicate some issues for which there is common ground and where unifying concepts emerge.

What can be observed in all domains is that the idea of *stocks* or *'capital' and flows or 'interest'* can be useful if handled with care. The general awareness is that stocks should be conserved and that flows can be harvested if certain limits (allowable catch or harvest) are not exceeded. In various areas, such as social capital, economic capital and sometimes ecological capital, it is evident that keeping stocks in a fit condition requires more than conservation alone. Mankind has to invest, for instance, in social structures, in learning and in adapting land use to changing conditions.

The awareness of scales in time and space is of pivotal importance in all domains. First of all, the idea of sustainability is a long-term issue as such. Thinking in terms of generations instead of short-term thinking requires a different frame of mind than is usually found in businesses or governments. Furthermore, it is clear that enhancing harmonious sustainable development in all three domains should be based upon insights into the various 'laws of scale'. For example: one cannot force nature to follow the rate of economic developments leading to rapid changes in land use, nor is it possible to maintain biological diversity or fulfil life support processes in areas that are too small. It is equally important that social processes respond to their own laws of time: many changes cannot be forced into a timeframe of less than one generation. Spatial scales are concerned when local activities such as the emission of green house gases have global impacts (climate change), or when local producers become part of international chains. The awareness of scales in time and space is even more important at present, when globalisation processes are dominating economic and social development.

In all domains, there is a growing *awareness of complexity*. Crucial relationships cannot be disregarded when trying to accomplish sustainable solutions in society. It appears that relationships are numerous both within and between domains, and are not simple but increasingly complex. There are many examples in the Planet and People domains. This awareness leads to a major challenge for science to grasp this complexity and to distinguish between more important and less important relationships. *One cannot cope with complexity by simplicity. Science has the task to understand and explain.*

Apart from complexity we have to acknowledge that *in all domains some processes are non-linear*. For many domains, *unpredictability,* certainly on time scales of the order of decades, is a fact of life. It is not only that we are unable to predict the weather for next year, but it is also impossible to predict the way technology develops. Some processes, for example in the ecological domain, are inherently unpredictable. Ecosystems show surprising behaviour, including sudden unexpected returns to less valuable stages. Concepts like hysteresis and bifurcation, as used in ecology, seem to

fit comparable processes in the economic and social domains as well. Very small events often determine which pathway will be taken in the development of natural systems, as well as in socio-cultural or economic systems. Science could identify the sources and moments of uncertainty better to indicate the probability of change, the more dangerous trajectories, and the various risks and opportunities.

In all domains, we see evidence of the fact that *system development, system adaptations and system diversity are favoured by some degree of disturbance*. The abilities of systems to adjust themselves to changing conditions and the resilience of systems, ecological, social or economic, are favoured by regular (smaller) events that disturb them. Ultimate control and conservation of systems of any kind could lead to seemingly robust, but actually fragile and less resilient systems prone to collapse.

Although an absolute, generic primacy of one P domain over the other domains cannot be claimed, as discussed in section 5, it is evident that there are bottom lines. In the People domain, such a bottom line is human rights. One aspect of corporate social responsibility is respecting this bottom line while aiming for high profit. In addition, one cannot imagine People or Profit domains functioning without complying with basic conditions belonging to the Planet domain. It is crucial to identify bottom lines or thresholds and relevant safety margins. This is a concrete part of a discussion among parties (business, governments, people) on value domains and the required degree of consensus about virtues, rights and duties.

Diversity is a common and positive feature for all domains, in ecology, at the socio-cultural level, in economies at business level as well as at government levels such as nation states. Its significance has at least two aspects: the values of diversity as such and its functional importance: diversity is an asset that helps systems to adapt and adds to their resilience. To use the metaphor of monoculture for all domains: these might be functional, easy to manage and profitable in the short term, but their vulnerability in the longer term is well-known, as is shown by the example of the current vulnerability of the banana.

The role of governance has been addressed in various domains. In the social domain, the importance of social structures, value systems and related phenomena has been stressed. When focusing on the more formal structures, such as governments at various scale levels, it is beyond doubt that these institutions are of crucial importance, although their adaptive capacity in periods of rapid developments and massive upscaling is poor. Effectiveness and efficiency of governance in accomplishing goals of sustainability should be an important item for research, including the way people are underestimating such roles in issues related to common values, as they are at the centre of sustainability.

Another common feature is the mismatch between bio-physical entities characterised by a particular scale and behaviour (e.g. watersheds), territorially bound administrative bodies and the private sector, organised in production chains on various scales that do not match the physical or administrative entities. This could be called territorial mismatch. There is also a mismatch in responsibilities, tasks and

span of control. Neither the production chain nor the territorial organisation of governments alone is able to deal with innovation processes that affect all aspects of sustainable development. There is thus a need for new arrangements and intensive collaboration in networks that could cover all necessary aspects.

Useful unifying concepts are 'stocks and flows', the latter being the crucial entity when aiming at sustainable use; temporal and spatial scales always require specification in order to link the various domains of People, Planet and Profit. All domains feature a high degree of complexity and unpredictability. A common feature for all domains is resilience, that is, the ability to recover from disturbances. This property seems to be furthered by regular smaller disturbances rather than by pure control and long-term stability. In all systems and all domains, diversity is a property that helps to avoid massive system collapses, presenting a warning against controlled monocultures in all conceivable senses in all domains. The important role of governance is invariably to watch over the balances between the three domains. Adjustments are needed in three respects: (i) to match the strong tendencies towards upscaling in the Profit domain; (ii) to create closer collaboration between business parties, governments and other parties in a network organisation; (iii) to design or maintain ecological, economic and socio-cultural systems with in-built capacities to absorb and overcome disturbances as well as to adapt to new circumstances. All this has to be situated within the framework of distinct value domains that have to be discussed and shared among discussion partners to reach agreements on virtues to be respected by all parties.

7 From theory to practice: three case studies

This chapter illustrates how the above concepts work out in reality by presenting three case studies, which reflect three different types of relationship between man and nature. In the fishery case, the fisherman is a hunter/gatherer. In the Pantanal case man is a farmer looking for the best place for controlled plant production within territorial boundaries and based on local resources. In the pig production case, the Dutch pig producer is a global entrepreneur, attracting resources from far away and selling products to neighbouring countries.

7.1 From exploitation to adaptive harvesting: fisheries

Fishery is a prime example of an economic activity which can be sustained in the long run only if ecological limits are taken into account and if social issues are addressed properly. Fishing is a hunting activity, not a farming activity; hence human effort can only be focussed on harvesting, not on enhancing the productive capacity of the resource base as such. In this sense there are some absolute ecological limits to growth in fishery. Since fishery often takes place in communities with few other means of employment, it is also important to look at the social consequences of particular actions or policies. Attempts to reduce fishing effort such that it is brought in line with available fish stocks often lead to serious social problems, since they may involve a reduction in the number of fishermen that can draw an income from the fisheries. Fisheries are traditionally a common property resource, which implies that everybody has a right to enter them. To abandon this regime in favour of a more exclusive approach may lead to local social inequalities and an increasingly skewed distribution of wealth.

A common property: respect for the biological bottom line?

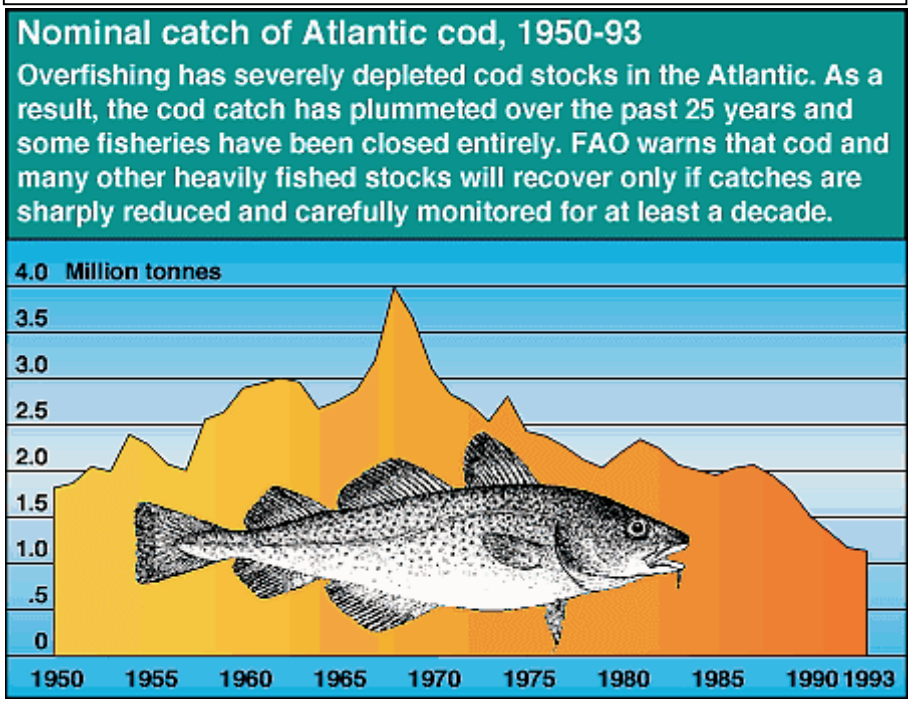
Fishery often serves as an example of the 'tragedy of the commons' in action. This metaphor, first coined by Hardin (1968), suggests that if each user of a resource held in common is free to use the resource, this will inevitably lead to overexploitation of the resource base, as it is unlikely that users will voluntarily restrict their exploitative action if they are unable to subsequently reap the benefits of their restraint. 'Freedom in the commons brings ruin to all'. Hardin therefore called for government intervention in the form of administrative rules or private property rights to restrict the use of and limit access to the resource. Preceding Hardin's analysis, Gordon (1954) more precisely showed that the lack of exclusive property rights in fisheries may not only cause biological collapse, but is also the reason that the economically optimal level of exploitation is not reached. The economic analysis of the fishery problem made clear that existing fishery regulations, insofar as they existed, generally tried to solve the biological problem to prevent stock collapse, and did not sufficiently address the economic problem of preventing economic waste and increasing economic revenues from fishery. The economic analysis of the fishery problem also made clear that fish stocks could be treated as capital stocks. The

management challenge is to optimise the net present value of the fishery, very similar to the way in which one can optimise the net present value of other capital stocks. To achieve an optimal level of fishing, all net revenues provided by the fishery in the future must be discounted to their net present value, as if the fishery was owned and managed by one rational decision-maker, endowed with perfect knowledge as to whether society prefers higher net returns now and lower returns later, or accepts lower returns today in order to gain higher returns in the future.

Private property rights to improve economic performance

Measures suggested by biologists and designed by lawyers typically included gear restrictions such as minimum mesh size and effort restrictions through closed seasons

Box 6 FAO warning *(www.fao.org/news/factfile/FF9603-E.htm)*



and closed areas. These measures may have prevented fish stocks from collapsing, but economists have argued that they did not prevent economic efficiencies and in some cases even encouraged them. An example is fishermen responding to closed seasons by over-investing in catch capacity to be able to catch as much fish as possible and as quickly as possible while the season is open. Measures suggested by economists typically include licence fees to capture the resource rent directly, or the introduction of private property rights to prevent the resource rent from dissipating. These private property rights often take the form of individual transferable quotas (ITQs), bureaucratically allocated catch restrictions that are individualised per vessel or fisherman and can be traded. These measures are perhaps theoretically superior to existing ad hoc regulations, but it has also been clear right from the start that there are political and social problems with getting the economic objectives and

instruments accepted by those involved in fishery management in practice. If there is no emergency situation such as a stock collapse, it is hard to make politicians endorse plans to govern a fishery in an economically more efficient way, especially if this involves unpopular measures. To optimise the economic situation, one would need to put vessels out of service, which may still earn a profit (although not the highest possible profit). One would need to displace people from jobs, while they still earn an income, when there are few other means of employment in the region.

Towards complex systems

In recent years, fishermen themselves, as well as more ecologically informed biologists and social scientists, have become increasingly critical of ITQs, or more generally of government-initiated Total Allowable Catches (TACs). The reason is that these output-oriented quantitative approaches assume that it is possible to predict at single species level what number of fish can be taken from the oceans and what number of fish must be left in the seas to avoid compromising future reproductive capacity. Such predictions require large volumes of numerical data about spawning stock size, recruitment success, fish mortality etc. Furthermore, this data needs to be updated continuously, because the size of individual fish stocks and the growth rate of individual fish all vary considerably from one year to another. Apart from this, the standard bio-economic model fails to take into account that fish stocks are integrated parts of complex ecosystems. More sophisticated, multi-species models do not treat stocks separately, but these models require detailed knowledge of interrelations between several species interacting with each other in various complex and dynamic ways. Given the problem of information and the lack of knowledge about ecosystem relations, quantitative assessments of fish stocks range at best within 30 to 50 % of their actual size. More often, there is almost complete ignorance of the numerical attributes of the interrelationships among species.

From quantity to quality: biomass as a resilient ecosystem

Given these problems with the standard approach, an alternative, ecologically informed perspective has been suggested which suggests that the biomass of the ecosystem as a whole is relatively stable or resilient, but the biomass of individual species varies unpredictably. Even if minor variations in quantitative inputs lead to considerable differences in outcomes at the single-species level, the qualitative behaviour of the system remains the same. Information and knowledge about basic biological processes is qualitative rather than quantitative. It does not age very quickly, unlike the numerical data required in the scientific models currently used, because the qualitative behaviour of the ecosystem is relatively stable throughout the years. Ecosystem knowledge can be obtained from direct observation by resource users themselves who, in direct interaction with the local resource base, are able to progressively refine and extend their knowledge of that resource base. From a management perspective, all of this implies that the introduction of quantitative harvesting limits for individual species should be reconsidered. Rules should focus on maintaining the basic biological processes, which constitute the long-term reproductive capacity of the ecosystem. Rules designed to allow spawning to proceed without interruption, to allow migration, and so on, are the kinds of rules that might be expected to maintain fishery yields within normal bounds. These rules emphasise

'how' and 'when' and 'where' rather than how much fish should be taken. This suggests management instruments such as territorial use rights, gear restrictions, and/or other rules that prescribe how the fish should be caught. It also suggests *adaptive* harvesting strategies that allow for switching between species when the decreasing catch per unit effort for one species indicates a relative decrease in its abundance, and it would be ecologically wise to switch to another species. This type of adaptation is impossible under a regime of assigning quantitative catch restrictions per species to individual fisherman.

If we look at fisheries management from a triple P perspective, it is clear that biological considerations have played a large role right from the start in management theory and practice: the Planet aspect dominates, Profit and People aspects are not explicitly considered. Economic considerations have gained importance in the second half of the last century, but there is a discrepancy between economic theory and economic practice. Economic theory suggests rather drastic management instruments in order to reach an economically optimal fishery; Planet and Profit theoretically go hand in hand, while People are not explicitly considered. Economic practice in turn leans heavily on social considerations, in terms of both pressure for higher returns now and accepting the risk of lower returns later; short-term Profit and People considerations prevail, at the expense of Planet and longer-term Profit and People considerations.

7.2 From erosion to flooding: land and water management in the Pantanal

In the 1970s, the government of Brazil decided to solve the problems of the poor and overpopulated southern states through an internal colonisation programme. In Planet-Profit-People terms, this was a People-Profit problem. The government founded the Instituto Nacional de Colonização e Reforma Agrária (INCRA), to lead the colonisation of the 'empty' northern states as far as Rondonia. The Planalto, the highlands around one of the planet's prime biodiversity areas, the Pantanal, were also colonised in this period. Until then, the Planalto had been mainly covered by natural vegetation. The Pantanal is sparsely inhabited by farmers, mainly living off large cattle-breeding farms (20,000-100,000 ha), and indigenous people. The farmers arrived here in the period of the Portuguese colonisation. In the present era of globalisation, their income is under threat due to rising costs and falling prices: they have to intensify and enlarge or seek alternative sources of income in eco-tourism and green labelling; in other words, they have Profit problems.

The soil of the Planalto is easily eroded and colonisation has taken place without adequate knowledge of the consequences for the rivers running west into the Pantanal. The new farming practice led to increased erosion, and rivers in the Pantanal (mainly the central Taquari river) have silted up, turning them into unstable braiding systems leading to economic and ecological problems. The silting up of the Rio Taquari is currently the major problem in the Pantanal and the Mato Grosso do

Sul, because of the nearly permanent inundation of an area of about 11,000 km^2 in the Paiaguás sub-region.

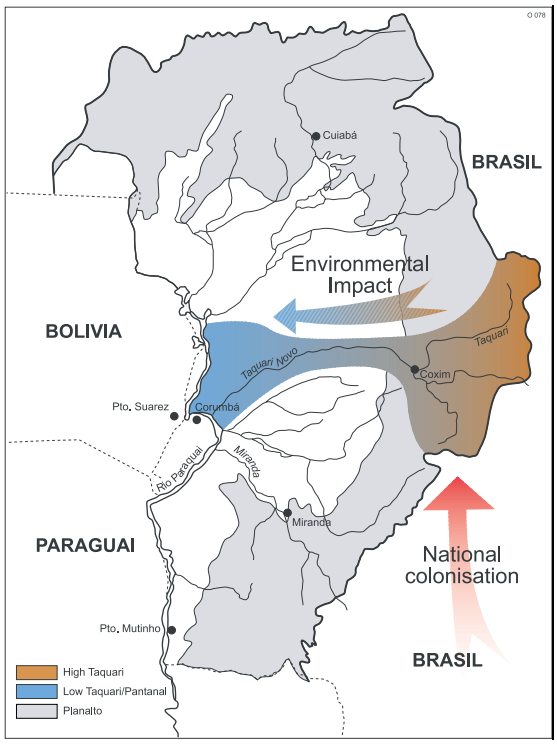


Figure 9. Spatial transference of environmental problems in the Pantanal

The solution for the economic problems of the poor farmers from the south of Brazil has been based on the economic knowledge that was available to INCRA in the 1970s. The problem of erosion and the environmental consequences for the Pantanal were not known, mainly because the focus was on colonisation of new land in a spatially different context than the regional ecological system. The farmers in the Planalto do have a problem, because they are losing their land. Another major problem, however, is not theirs, but occurs in the large downstream areas, which have no social and economic relationship with the Planalto.

Before the colonisation of the Planalto there was no need for the lowland farmers, municipalities and nature conservation agencies to interfere with the water and land management of the upper part of the catchment. Now, however, their livelihood and existence are under severe threat as a result of the entry of new inhabitants into the system. They are now in need of an institution that takes care of water and land management in the system and that will look after their interests, a need they share with the new colonisers and the eco-tourism industry. This means that economic and ecological problems have to be solved through management and knowledge of the system as a whole, which has led to the creation of a Commission of the Taquari.

The perspective for the future is that collaborative efforts to understand the system, identification of sensitive ecosystems within the basin, joint decision-making and

consistent management can solve the social and economic problems of the farmers in the Planalto and the Pantanal and can preserve the area's biodiversity. People have to create new institutions to balance the impact of Profit on Planet and aim for sustainable use. This case shows that even within one country, one jurisdiction, planning interventions and estimating their impacts does not automatically guarantee that all P domains are included. As a result, externalities create unforeseen problems. Existing institutions should be critically evaluated to avoid similar problems in the future.

7.3 From tapioca to manure: the pig production chain

In the Netherlands, pig production has changed from a backyard activity catering for home or local demand into a professional activity of specialists aiming at national and international markets. The division of labour leads to a production chain in which each professional actor adds value to the product before passing it on to the next actor in the chain (Figure 10).

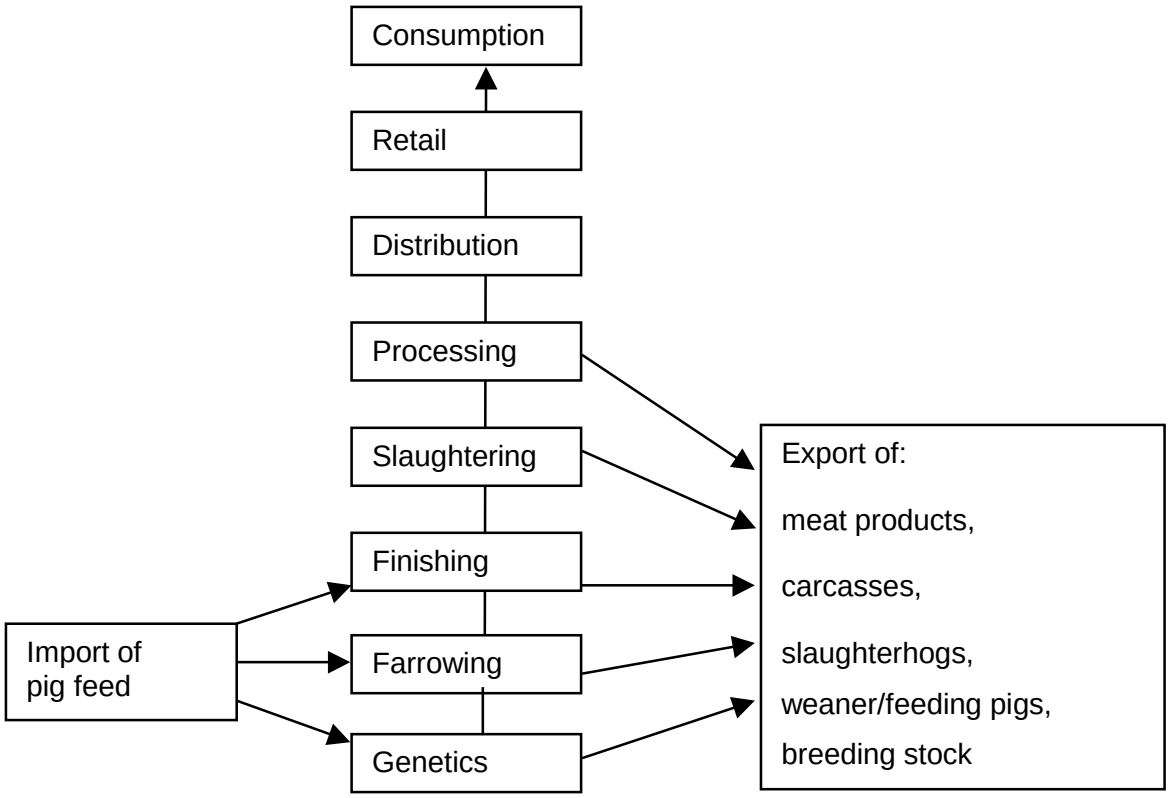


Figure 10. The Pig chain and its added economic values

Characteristics of the chain

Economies of scale lead to larger and more homogeneous batches per link in the chain. Intermediate products (including live animals) are constantly being transported to the next link in the chain. Homogeneity relates to narrow breeding goals aiming at the highest meat production against the lowest costs. As 40-50% of the costs of pig production consist of feeding costs, pigs are bred to be very efficient in conversing feed into meat. Disease resistance is only a secondary breeding goal, as it is believed that controlled circumstances in farm buildings, preventive application of antibiotics and vaccination can and will cope with this problem. However, the frequent contacts through transportation and the uniformity of batches lead to a rapid spread and large impact of contagious diseases. During the outbreak of swine fever in the Netherlands in 1996/97, 11 million of the total of 25 million pigs were slaughtered, most of them to prevent the disease from spreading.

The chain in context

The chain used to be supply-driven, allowing production in a specific region to greatly exceed local demand and leading to export of pigs and pig meat. In the Netherlands, the sector became a net exporter, with export volumes nearly twice that used for national consumption. The pigs all need to be fed while alive in the production chain. Production of feed in the Netherlands is expensive because of the high cost of land and labour, making pig production too expensive to be competitive in an export market. Importing cheap feed and transporting it cheaply via the main sea harbour (Rotterdam) and associated waterways has solved this problem, but has had major consequences. If feed is bought in developing countries, for instance tapioca (manioc/cassava) from Thailand, less food is available for consumption by the local population and the increased demand may raise the prices of the remaining food on the local market. In response to the international demand, Southeast Asian countries may decide to produce feed especially for pig production. Thus, pig production in the Netherlands means occupation of land in developing countries as an ecological footprint supporting a production branch that aims at the export of meat. On the other hand, importing pig feed leads to a pig production that is independent of, or de-coupled from holdings and land in the Netherlands. Furthermore, the amount of nutrients imported in the feed, after subtraction of the amount of nutrients exported in the meat, means a surplus of nutrients in the form of manure on farms in the Netherlands. Pig production is responsible for 20% of the manure produced in the Netherlands but contributes 67% of the excess manure. This excess leads to groundwater pollution by leached nitrate (NO_3^-) and contributes to greenhouse gases in the form of ammonia (NH_4^+), contributing to global climate change.

The feed-producing countries eventually end up with a nutrient deficit, leading to the risk of loss of soil fertility and soil degradation.

People/Profit: power relations in the chain

As long as the chain is supply-driven, the pig producer can decide on the quantity and quality of his product and can negotiate a price. If there are many buyers in the market, the producers have a strong position: the consumer has to accept the quality that has been decided upon between the producer and a professional buyer. At the

top of the chain, however, the butchers and food processing companies have now merged to form a few big players and the same has happened in the retail business. This puts producers in an unfavourable negotiating position, especially when they all have roughly the same product to sell. The bulk of the profit will end up in the hands of the retail part of the chain. A new step has been the reversing of the chain. The retailer needs to serve the citizen-consumer, who demands a particular amount of a particular quality at a particular moment, and the producer has to deliver. One quality aspect is environmental-friendly produced pig meat with attention for animal welfare. The retailer determines the price, as there are hardly any alternative markets that the producer could turn to. This reversal of the chain was temporarily slowed down because the slaughter capacity exceeded the supply of environmental-friendly produced pork, allowing temporarily traditionally produced pork to enter the chain as well against the same financial reward. Because of the way the chain is organised, the people in developing countries who produce the pig feed are unable to influence the chain, because they are scattered, unorganised and easily ignored. They will have the lowest share of the profit. Should they try to become influential, the feed import can always shift to other sources or localities.

People: consumer concerns

The role of consumers is twofold and often conflicting. Consumers are interested in low costs, but they demand quality in food and production processes. In terms of pig meat, consumer concerns may consist of

- food safety (no disease, no residues of antibiotics, no hormones);
- environmental effects of production (no water or air pollution);
- animal welfare (pigs should be able to roam about freely, pigsty floors should be lain with straw, breeding goals should be differentiated so no abnormalities are bred in);
- effects on people in developing countries (not causing degradation, fair trade).

Apart from these concerns, consumers also consider the price of meat, the time needed for shopping (supermarkets instead of 'green butchers'), the time available for preparation (convenience food), image, etc. The reversal of the chain implies that consumer demands have come to drive the production chain to a greater extent. Retailers are therefore very sensitive to these concerns. The combined consumer concerns demand that the chain ensures the supply of safe, environmental-friendly and animal-friendly meat in the supermarket, at low prices.

Profit/Planet: is environmental-friendly production more expensive?

An analysis of the supply-driven chain leads to the conclusion that the price of meat is currently very low, due to the fact that many side effects of pig production are not being accounted for. Life Cycle Analysis (LCA) would tell us that the global chain implies the use of many non-renewable resources such as energy and depletable soil qualities for feed production and transport. Other indirect costs relate to the purification of polluted drinking water. Prices should also account for the costs of regular outbreaks of diseases, during which large numbers of animals have to be destroyed, mainly to maintain the producers' export position. Another cost, which is however hard to monetarise, is animal suffering. When all these costs are taken into

account, the current traditional production methods may well be more expensive than organic pig production. The current production methods would never pass the test of sustainable production.

Options for change

Assuming that the current rationale (mode) of production cannot be changed, options for change focus on shortening the chain. Transport volumes and the risk of contamination can be reduced by applying genetics, farrowing and finishing on the same (closed) farm. The manure problem can be treated by stimulating pig farmers to enter into manure contracts with crop farmers to spread the nutrients on Dutch fields. Both changes are already taking place. In an extreme scenario, all activities could be concentrated in one huge, multi-storey pig factory on an industrial estate. In such a system, all inputs and outputs would be controlled, including those that are undesirable. Manure is seen and treated either as industrial waste or as a valuable input for fishponds located at the same site. Production and processing take place on site, reducing transport. It would be economically most feasible to concentrate pig production near a harbour, as the price of feed contributes up to 50 % of the costs of production, which is partly because of its transport costs. Although economically and ecologically feasible, the concept of such multi-storey pig factories is difficult to sell to the public, as it largely ignores animal welfare and the industrial production method conflicts with the romantic idea citizens tend to have of animal production.

An alternative is to change the rationale of production. In view of the categories and causes of costs like those of transport, excess manure and depletion of soils in developing countries, it might be better to have local pig production and consumption, based on locally produced feed. Organic farming in the Netherlands is an example of such a mode of production. Pigs can move freely, have straw in their sties and are often allowed to roam around outside. Manure can be exchanged for straw with cereal farmers. The problem is that this mode of production requires large tracts of land, which is very expensive in the Netherlands. Production for an export market would be difficult, as there would not be enough resources to sustain the 25 million piglets that are sustained with the current intensive mode of production. Even the domestic markets could not be fully catered for by organic pig production, unless the price of organically produced pork is substantially higher than the conventionally produced product.

A third option is to produce pork in the areas where the feed is grown, e.g. in Thailand. However, the consumers are still in the industrialised countries, so the meat would then have to be exported. For food-safety reasons, however, transport should be in frozen or otherwise well-conserved form. This is no option for European consumers as they prefer fresh meat, but American consumers generally accept frozen meat. Another complicating factor is the tariff system in which imports of raw materials such as tapioca into Europe are cheap but imports of meat and other end products are submitted to high import duties.

There is a wide variety in production costs among individual pig producers in the Netherlands, wider than between average pig producers of different countries.

Moving production to countries with lower costs of labour or land is therefore not necessarily a solution. On the other hand, studying the economically most efficient producers within the Netherlands can suggest options for change.

A fourth option would be to produce protein in alternative ways. Meat replacement products can be made from protein produced by legume crops or by micro-organisms, removing the need to produce meat.

7.4 Overall conclusions from the three case studies

All three cases show the externalities of a single-P approach. In fisheries, the Planet has been severely damaged by short-term Profit, sometimes aggravated in the long run by economically inefficient fishery practices. In the Pantanal and pig production cases, Profit has dominated, to the detriment of the Planet, or causing economic losses in the long run in some of the areas involved. The interests of People are seldom made explicit. Profit in terms of increased income in one place may lead to problems like flooding and economic and social losses elsewhere (Pantanal). Nutrient depletion and erosion have affected large areas far from the actual area of production and consumption. In both cases, the benefits and the costs affect different people. In the Pantanal and fisheries cases there has been some progress in combining Profit and Planet. In all cases, effects in the People domain are hard to specify. The cases show clearly that there is a need for a framework to address the three P's and their trade-offs when planning an intervention or when evaluating food chains. Many adverse effects require adequate and sometimes unpopular decisions on a higher and more complex level than is currently accomplished by the responsible authorities. Evidently, governments find the international scale of underlying mechanisms hard to tackle.

8 The role of science revisited: research agenda and policy implications

The position of science was already addressed in chapter 1. Now that we have outlined various topics of sustainable development, including the central concepts of each of the three P domains, the overarching unifying concepts, and have analysed three practical cases in their context, let us return to the role of science. By way of introduction, we develop a general classification of problems, discussing uncertainties in science in relation to the degree to which society agrees or disagrees about the course to be taken. *The central issue is the concept of risk.*

Douglas and Wildavsky (1982) state that the *concept of risk* is the product of scientific - 'objective' - knowledge about the future and consent about de preferred political-societal, normative direction. Since scientists may be certain or uncertain about particular aspects of the future, and consent may be complete or contested, this results in four combinations (Figure 11). The role of science changes according to the combination. To start in the upper left-hand quadrant of the figure: if there is scientific certainty about an issue and complete consent about the direction to take, the problem is of a technical nature and can be solved by calculating optimised solutions. An example is the knowledge about optimum conditions for plant growth that are in agreement with the desire to produce sufficient food. The lower left-hand quadrant represents a situation in which there is scientific certainty but no public consent; the problem is disagreement over facts and the solution is either debate followed by persuasion or coercion. Smoking is evidently bad for human health but the public needs to be convinced and the tobacco companies have to be controlled. The upper right-hand quadrant represents a situation of scientific uncertainty but public consent; the problem is lack of information and the solution is to do more research. People want food to be produced in an ecologically sound way because they believe this to be healthier. Science is there to demystify or to prove the point and develop better methods to achieve these goals. Finally, the lower right-hand quadrant shows a state of scientific uncertainty combined with a lack of public consent; the problem needs to be addressed from both sides. If there is room to decide that risks are large and avoidable, a temporary solution might be to apply the precautionary principle. In fact, this means making no choice with respect to the research agenda or with respect to policy. An example could have been the debate about whether genetically modified organisms (GMOs) are bad for people's health. In this situation, science and policy can easily become intertwined and both have trouble deciding which research is worthwhile. Science then runs the risk of becoming a provider of politically desirable data. A way out of this deadlock may be a public debate with all stakeholders, including scientists. Interactive problem definition and interactive research can add to both knowledge and consent and lead to solutions with higher societal acceptability.

It might be argued that scientific progress in the last decades has been enormous. Many questions have been resolved or their solutions are within reach. This would

suggest that many remaining questions should be located in the lower right-hand quadrant, where uncertainties and lack of consent prevail. The following comments can be made.

Knowledge is indeed accumulating and we now know more than ever before, yet the concern about what we do not know is greater than ever. The variety of temporal and spatial scales leads to more complex problems and more uncertainties and unpredictable processes. Simultaneously, global communication media, such as radio, television and the Internet, increase the opportunities to magnify the attention paid to local disasters, increasing the impact on people's perception. Societal actors derive knowledge from their own experience as well as from the Internet and the other media, making it easier for them to participate in the debate and increasing the risk of disagreement over facts. Some blame science for not providing any answers at all, while the real issue is lack of societal consent.

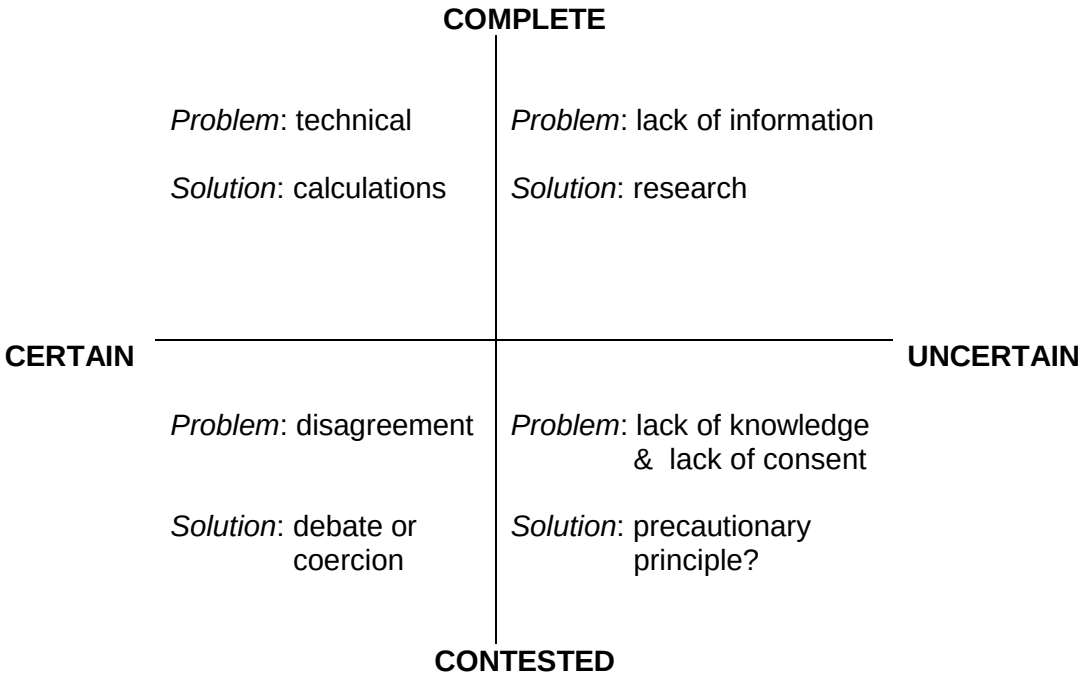


Figure 11. Problems and solutions in the dimensions of certainty of scientific knowledge and the degree of consent (after Hanekamp, 2002)

The nature of uncertainties and risks: scenario thinking

Most issues at stake are complex and have inherent uncertainties, be they natural, societal or behavioural in origin. Handling uncertainties in decisions requires insight into risks and expected damages. Thinking about risks, their identification and quantitative assessment and the means to minimise them has evolved and become generally accepted by society in the 20th century. Damage or risk of damage is no longer seen as relating solely to *individuals who are to blame*, as was common in the 19th century, but as relating to the *system that is to blame*. These issues have become matters for social institutions, commercial parties and governments. People expect their governments to take a formal position towards and assume responsibility for all

kinds of risks. The assessment of risks and ways to assess people's perceptions of and feelings about risks have become a domain in which society, governments and science find a common interest. Examples vary widely. Risks of natural disasters are quite familiar, whilst risks of imminent global change are less well-known. The acceptance of new technologies like GMO techniques might be a case in point. In situations where the uncertainties as well as the perceived negative impact of wrong decisions are large and decisions are still open, it is wise to start from the precautionary principle. This principle basically has positive as well as negative aspects: on the one hand it helps to avoid unforeseen and unnecessary damage, while on the other hand it may stifle innovation.

The task of science in these domains is to provide information on probabilities, cause-and-effect relationships, possible compensatory measures and alternatives. In this context of risks and uncertainties, scientific methods designed to develop scenarios have expanded enormously. Scenario thinking and related techniques cover various approaches, such as:

1. extrapolating current trends to predict a future situation, sometimes leading to an early warning signal for undesirable situations;
2. identifying the more extreme possibilities that can be envisaged, exploring the limits of conceivable futures;
3. designing a desirable but theoretically feasible future.

Figure 12 illustrates that three domains can be distinguished. The smaller oval (1) indicates the most probable future, more or less starting from a 'business as usual' perspective. The larger oval around it (2) represents the conceivable future, that is, what might be possible, while the lower large oval (3) represents what society or individuals may see as the most desirable situation. It is evident that some preferences lie outside the conceivable (= possible) domain. It will be clear that the most challenging situations, asking for innovative solutions, are those in which the conceivable and desirable overlap outside the probable scenario (the hatched area marked 4).

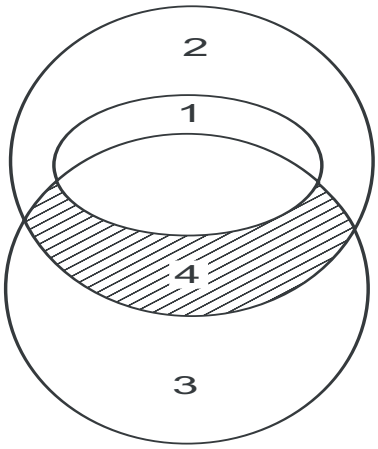


Figure 12. Three domains, representing a probable (1), conceivable (2) and desirable (3) future. The challenge for innovations lies in what is conceivable as well as desirable, but outside the probable future (4, hatched). (Adapted from De Jong, 1992)

Scenario thinking and related techniques have developed rapidly over the last decades. This illustrates the fact that decision-makers want to be informed about long-term developments and possible interventions. Various approaches are possible. The first is to stick to current trends that can be extrapolated to some point in future (*trend extrapolation*). Within this approach, it is possible to define so-called *worst case* or *best case* scenarios or something in between, the middle-of-the-road scenarios. The function of these scenarios is '*early warning*'. An example would be that of trend extrapolations for sea-level rises due to climate change, which fits in the smaller circle (the probable future). Another approach is to identify all kinds of possible future situations, starting from the least probable prior situations. This approach identifies the margins of what is possible or at least conceivable. These first two approaches involve *forecasting techniques*. It would also be possible to start from a certain desirable future (a design) and then try to reason backwards, involving a *back-casting technique*. The role of all of these scenario approaches is to provide insight into final situations as well as the pathways leading to them, and especially those decisions and measures for which interventions can make a difference.

Scenario building should include assessments of the degree of predictability in view of inherent uncertainties. Predictions concerning time frames relevant to sustainability discussions, that is, those extending over many decades, are sometimes feasible, sometimes barely possible, and sometimes fundamentally impossible. Technological innovations in particular are unpredictable, while another source of unpredictability lies in society and man's behaviour, which can bring about some major surprises, as history has shown.

From scenarios to action perspectives

The Netherlands Scientific Council for Government and Policy (WRR 1995) addressed risk assessment and risk perception as a central issue, and formulated four perspectives linked to certain world views, values, ideals and expectations. Their approach actually relates to the second category discussed above, that of defining the limits of possible futures. The four perspectives are labelled utilising, managing,

saving and preserving, and differ in the extent to which they avoid or accept environmental and social risks, in the degree to which they believe that policy-makers can intervene in the production systems and levels of consumption and in the degree of confidence they have in technology.

Table 1. Action perspectives within the context of certain world views and expectations (after WRR, 1995)

	Characteristics		
Action perspectives	Confidence in resilience of environment	Aiming at adjustment of [JK56]living standards	Confidence in technology
Utilising	Yes (only action in case of calamity)	No (influence of policy is minor)	High (technology = solution)
Saving	No (growth is a threat, scarcity problems)	Yes (influence of policy is large)	Low (policy = solution)
Managing	No (risks of damage to be avoided)	No (influence of policy is minor)	High (technology = solution)
Preserving	No (risks of scarcity and damage to be avoided)	Yes (social process)	Low (social change = solution)

To what extent do people believe in the robustness of an ecosystem in terms of it being able to absorb long-term and/or severe disturbances without being damaged (resistance) or of being able to adapt to changed circumstances or recover from disturbances in such a way as to maintain its desirable functions (resilience)? When people believe that ecosystems are fragile it means that they have narrow boundaries of variation and that small disturbances for short periods easily lead to a collapse of environmental functions. An important concept in this respect is that of the threshold, being the point beyond which essential functions, such as regeneration capacity, are lost. Environmental risks include the depletion of finite resources (scarcity) and the disruption of ecosystems (damage) as a result of human activities. To what extent do people trust science to reveal the truth and to what extent do they believe that science (technology) is able to solve the currently perceived problems? To what extent are people willing and able to adapt their living standards and lifestyles (consumption patterns, distribution issues, social solidarity) to the opportunities and constraints that the environment presents them with? To what extent are they prepared to give policy a role or mandate to regulate this adaptation?

The choice of action perspectives has implications for the speed of the process and the degree of change needed.

Table 2. Degree of change

	Slow	Rapid
Limited	Utilising	Saving
Radical	Managing	Preserving

For decision-makers, whether in government or in business, it is relevant to define the goals to be achieved and the timeframe within which they are to be achieved. One could choose different positions. When such a position is not far from the current situation it is rational to aim at short-time goals and to select simple or cheap

solutions. If, by contrast, the position chosen is pro-active and innovative, it is preferable to aim at long-term goals that are far more integrative (Winsemius and Guntram, 2002; see also fig. 6 in Chapter 6). It is evident that sustainable development requires the latter position. In such cases, science should facilitate transition management, including the co-ordination of partnerships for change and network management.

To facilitate decision-making, science should assist in rendering problems and solutions explicit at relevant temporal and spatial scales. Science should provide insight in mismatches between processes at different scales and find ways to match them. The evolution of species and ecosystems, for instance, is not able to keep up with the rate of exploitation for economic purposes. The cycle of political decision-making is sometimes too slow to prevent ecological disasters. The area required for the survival of specific animal species does not correspond with the surface area of individual nature reserves. By linking ecological theory to political options, science can for instance recommend interconnecting these small patches of conservation area, thus providing a network in which species can survive. Such a network is being created in the Netherlands under the name National Ecological Network.

In non-linear systems, science should be able to determine threshold values and support policy-makers in setting relevant limits to negotiation space. Cod fishery, for instance, seems to be approaching its ecological threshold, and a collapse may be near. It is important to make policy-makers and fishermen realise that after a collapse, a gradual or even major reduction in cod fishing will no longer lead to increased fish stock. It is also important to realise that science is not the only stakeholder. Fishermen can decide to go for substitution, either by starting cod production under controlled circumstances or by catching other fish. Consumers can decide to boycott cod and thus provide additional pressure to avoid further cod fishing. The role of science is to help create windows of opportunity, for instance by identifying the biological conditions that would allow cod to increase their production, but also by introducing the concept of biological stock irrespective of species, allowing for new management structures.

Complicating factors include the fact that whilst seas and oceans do not belong to one government, the fishermen are under the jurisdiction of a particular government. Another complication is that fish are mobile and belong to no one until they are caught. This requires innovations in (international) organisation and decision-making. Science can play a role in experimenting with these types of institutions and help to develop a set of rules and regulations allowing them to function.

New societal concerns and demands need scientific input to *demystify* certain views and to clarify what outcomes are and represent at various temporal and spatial scales. People who support nature conservation may be in favour of strictly organic agriculture, thinking that this is best for nature. What they might ignore is that organic agriculture (without external inputs) leads to lower yields per unit of land, so that more land will be needed for agriculture and less will be available for nature conservation. Perhaps nature conservation will benefit much more from very

intensive agriculture, which allows sufficient food production on fewer units of land. Another myth may be that organically produced food is safer than food produced in intensive agriculture. Although organically produced food may not contain residues from pesticides, it may contain larger amounts of toxins from 'natural fungi'. Who is to decide what is healthier?

Each of the P domains shows a trend from simple towards complex systems. Science should be able to address each individual factor separately (the reductionist approach) but should also be able to integrate them (in a holistic approach) in a meaningful (ethics-driven) way. The societal debate involves not only facts and the interests of individuals and groups, but also their values. This was discussed above in the WRR action perspectives but also in the moral-ethical perspectives in section 6.3 (People). Science should be aware of these values and help render them and their implications explicit. Science should be able to distinguish between facts and opinions, but should also be able to explain the meaning and significance of scientific output to stakeholders in society. On the other hand, science should be able to translate social values and interests into scientific questions.

In conclusion, science should enlarge the body of knowledge as such and provide knowledge to support adequate decision-making. Science should also be aware that private enterprises might have totally different research needs than governmental bodies. Their spatial and temporal scales usually differ, because governments are territorially defined whereas businesses act at the level of international production chains. The articulation between these two worlds may also be a domain in which science has a role to play.

Science should be able to predict or even design a future and to assess the associated risks and uncertainties. Scenario studies are among the appropriate instruments. Science should be able to communicate with various stakeholders, including policy-makers, and relate their problems to their values, translate their problems into relevant spatial and temporal scales, and look for appropriate scale- and stakeholder-specific solutions. In addition, science should be able to render trade-offs between value domains explicit and assist in defining bottom lines (thresholds) for each P domain. Research must be interactive in its approach and contribute to new societal arrangements solving the discrepancies between administrative and business-oriented approaches to decision-making.

9 Debate

On 7 March 2003, a public debate was held at Wageningen UR on the basis of the present paper, which was summarised in seven propositions (see Box 7). The debate was chaired by Prof. Rudy Rabbinge (Wageningen UR) and involved distinguished Wageningen UR professors and invited guests. Participants included Dr Herman Wijffels (SER), Mr Kees van der Waaij (Unilever), Prof. Theo Beckers (Tilburg University), Dr Per Pinstrupp Andersen (ex-IFPRI, currently at Cornell University), Prof Patrick Morley (O2), Mr Willem Wijnstekers (UNEP-CITES) and Prof. Louise Fresco (FAO). All participants spoke in a private capacity. This chapter summarises the debate on the theme of sustainability and on the position of Wageningen UR in this debate. Topics were 3P, stocks and flows, indicators, conditions for sustainable innovation, responsibilities of society and policy, and the organisation of international institutions.

Box 7

Propositions for the debate on 7 March 2003

1. The Planet-Profit-People concept is both a holy trinity and a conceptual Bermuda Triangle.

2. Wageningen UR is optimally positioned for studies into and approaches to sustainable development, but the current organisational structure jeopardises this.

3. Stocks and flows are only instrumental for studies on sustainable development within a well-defined spatio-temporal context.

4. Indicators for all three domains expressed in one dimension (for example money, joules) mask the real debate on sustainable development.

5. Fully controlled ecological, economic or socio-cultural systems never yield sustainable innovations.

6. Sustainable development and the care of the 'commons' cannot be guaranteed in a *marriage de raison* between well-organised NGOs and business parties.

7. The present sectoral organisation structure of national and international government bodies (IMF, UNESCO, ILO, FAO, SER) is obsolete and counterproductive.

Conceptual pitfalls; the role of Wageningen UR

The preparatory paper concluded that there is as yet no strong body of interdisciplinary concepts and research effort to serve as a firmer foundation for the concepts of Planet-People-Profit and sustainable development. Planet-Profit-People questions relate to complex problems with plural goals and larger scales in space and time, as well as inherent uncertainties. Solutions come from intensive debates between various fields of science and stakeholders. This means that Wageningen UR has to adapt its role and attitude towards a more integrative, participatory approach and, if necessary, adapt its organisational structure to this.

The panel remarked that science has developed through specialisation. This has led to new technologies, more efficient production processes and prosperity. Although this development was generally satisfactory, it also created new problems of animal welfare, diseases and pollution and degradation of resources. These problems have a multitude of links in terms of causes and effects.

Organisational structures are still based on this specialisation principle, which is causing a systems crisis in terms of a mismatch between structures and needs. A developed society demands an interdisciplinary approach and a network structure. Although Wageningen UR has made some steps in this direction, much remains to be done. Dr Wijffels - later supported by Prof. Fresco - said he would be reluctant to start a new reorganisation at university level, as he felt this would be a waste of energy. It would be better to focus on collaboration between the various units. Wageningen UR should overcome the constraints of its present organisational structure by developing project and programme approaches. There are examples of such cross-boundary structures, including graduate schools and INREF. Research should be given financial support to stimulate interdisciplinary work. Since Wageningen UR currently lacks strength on the side of "people" (social sciences), it would be important to seek collaboration with groups that are strong in this respect.

Stocks and flows

For all domains at stake (Planet, Profit, and People) stocks (capital) and flows (interest) can be distinguished. A simplistic approach suggesting flow-oriented solutions would be counterproductive in situations of change. Practical solutions require a more precise definition of what stocks and flows are in a temporal and spatial context. According to Mr van Waaij the buzzword at the Unilever company is the three M's: Mensen-Merken-Maatschappij (People, Brands, Society). Unilever has taken upon itself the economic and social obligation to preserve world fish resources and to work in a sustainable manner from 2005 onwards. Despite heavy competition in industry, there is a common interest in sustainability issues. Cod and herring as threatened species show that something must be done, and something can be done respectively. Industry would like to see a Wageningen centre for sustainable food production, which could play an interactive role with regard to consumer information and questions from individual companies about sustainable supplies of raw materials.

It was confirmed that this is part of the mission of Wageningen UR and that Wageningen UR has to accept this challenge. Some initiatives are already underway, and it was stressed that there is a need for independent science to help companies in developing sustainability and bridging the emotional gap between industry and citizens: both corporate and consumer responsibility should be seen as a kind of independent 'sustainability trade mark". The view was expressed that the three P's are not restricted to companies but should also be included in the government policies.

Scientists should take stakeholders more seriously. NGOs can be approached to represent stakeholders that cannot easily enter into the debate, such as the future generations but also poor people in developing countries.

Indicators

Indicators are instruments to be used in the process of sustainable development in two different approaches. In the 'accountancy approach' (as used in the EU strategy for sustainable development), they are static data used to reach previously agreed goals (distance to targets). In the 'prospective approach', indicators are used in an integrated assessment defining goals in the future, to assess how far we have come or could yet come in reaching or even surpassing these goals. Process indicators are more important than state indicators. The view was expressed that, although we may need process indicators to understand and stimulate sustainable development, we will definitely need clear one-dimensional indicators to measure progress as well. Indicators are useful instruments to assist communication, but their importance should not be overestimated; they are simplifications/reductions of complex problems and processes. Generally, a lack of coherence is experienced between the various indicators. In addition, there is often a lack of political support, which means that indicators play only a marginal role in decision-making and learning processes.

Indicators are based on existing data, which causes availability bias: available data are from the past and do not necessarily reflect ongoing processes or the future. Indicators are generally weak in the domain of social sustainability.

Natural resilience and/or full control

Innovation and evolution in almost all domains are stimulated by some degree of stress, provided it causes no real harm. Artificial steady-state economies, such as a fully planned economy, or ecological systems such as isolated islands can maintain themselves for long periods but are fragile in the face of external influences; they lack resilience. Social or administrative systems can also be too rigid and static. In this context, planning as a control instrument is very important for future development and sustainability, where the axiom 'If it's not broken, don't fix it' does not reflect the right way to go about sustainability.

A balance has to be found between future sustainability and solving present-day problems. Environmental fundamentalism and sceptic environmentalism are both forms of conservatism leading to problems. Whilst the former has a tendency to spend money on ecology instead of poverty, and to look at the future rather than at

present generations, the latter denies the existence of present and potential problems that need an anticipatory approach to avoid disasters or the inefficient use of capital. It is, however, important to realise that money spent on the Kyoto protocol cannot at the same time be spent on clean drinking water. We have to include both. Moreover, we need to look at trade-offs and the needs of both poor and wealthier people. Science and technology can offer valuable support in repairing environmental damage or providing substitutes.

The issue of what is unsustainable development, what are the trade-offs and what is the role of science must be debated here at Wageningen. It cannot be left to economists alone, nor can we leave sustainable development to the private sector and the market. The greatest level of ecological diversity has developed in the Amazon area, in a - from a human perspective - stable system. In society, the former USSR can be seen as a socially controlled system which nevertheless produced many technological innovations. The assumption that stress is needed for innovation and evolution seems hereby falsified. The question should rather be 'under what conditions does what development occur?'

The link between science and policy is also important in the debate on sustainability, which needs to include the relevant stakeholders. Scientists are often accused of having hidden agendas. Some parties, such as the sceptical environmentalists (Lomborg), are hardly given an opportunity to enter into debates with others, because they are not accepted. Policy-makers seem unreliable, but scientists would do better to translate their findings into meaningful information for policy-makers. Scientists often provide answers to questions that policy-makers did not ask, while policy-makers ask questions that scientists cannot answer. A way to solve this mismatch is to involve policy-makers more closely in research at an early stage.

The role of business parties, NGOs and governments

In Prof. Morley's perspective, the increasing complexity, scale and speed of changes mean that the role of the major players has to be redefined. Multi-nationals and large NGOs seem to adjust their strategies more adequately than governments. This mutual interaction and collaboration between the public and private sectors can be effective and efficient and therefore attractive, but also temporary and vulnerable if they only focus on one issue. Governments have a multitude of objectives and must reassume their responsibility aiming at integration in society.

The interaction between public and private sectors is beset by many pitfalls, as is evident from the privatisation of the railway and energy sectors in the UK and USA. Public-private collaboration needs proper orchestration by governments, as well as mutual respect and awareness of each other's strong and weak points.

In the sense that the private sector wants to be quick, while the public sector wants to be methodologically correct, they have different time horizons. In education, public-private interaction seems to have had some success, but words like profit and loss are too frequently used and nobody seems to care whether students learn the right things or whether they feel comfortable.

Long-term research is increasingly being outsourced by the private sector to universities and institutions. One of the reasons is that universities generally have longer time horizons than industry. This presents an opportunity for universities.

Mr Wijnstekers recommended caution, however, questioning whether and why industry wants sustainability. If they really want it, is part of it purely a sales argument and/or reputation management? Transport of endangered species by major airlines, for instance, was stopped due to pressure groups threatening a boycott, which is effective in that it lead to reduced sales and market shares. The policy change among the larger and more reputable companies did not stop the transports; they simply shifted to cheap carriers, causing even more problems for the animals but out of sight of society.

Dr Wijffels concluded that neither companies nor NGOs nor governments alone would be able to guarantee anything. All three should engage in a joint effort to achieve progress. Interaction must consist of both collaboration and criticism to contribute to sustainability.

The role of international bodies

At present, international organisations are organised on the basis of their primary interests. This creates an attitude of defending these primary interest and ignoring those of others. Defending one-sided interests has been a valid, or rather accepted, attitude in a non-changing environment, with built-in checks and balances, but causes problems in a changing world when plural goals have to be reached and balanced. According to Prof. Fresco, international organisations are organised like national governments, in various departments. It is more important to look at functionalities than at formal structures. She did agree with the apparent lack of intersectoral collaboration but also mentioned some favourable examples, such as water management.

Changes to the present structures would have enormous consequences, because each UN organisation is made up of member states and based on constitutions. Change would require changing constituencies and concerted action by all member countries involved. Prof. Fresco also noticed an increased openness on the part of the UN towards the private sector and NGOs. Dialogue has become the preferred method.

10 Recommendations to Wageningen UR

Strengthening the Wageningen UR organisation

1. Wageningen UR is strong in terms of Planet-related research, fairly strong on Profit-related research but relatively weak on People-related research. This needs to be solved by collaboration with partners that are strong on People-related research or by strengthening the humanities at Wageningen UR.

2. Scientists should be able to communicate, translate science into societal meaning (value domains) and vice versa, and involve stakeholders from an early stage on (interactive research!). Wageningen UR should stimulate interactive research and provide training for its staff and students in this field.

3. Scientists at Wageningen UR should overcome constraints based on the disciplinary "pillar" structure by working in a project or programme approach. The organisation should stimulate interdisciplinary projects and programmes, for instance by rewarding staff and by providing adequate administrative and financial structures to support such projects.

4. Wageningen UR should do more to promote itself and its expertise relating to societal questions. Wageningen UR should also open a 'counter' or 'portal', offering people from outside the university (business parties, NGOs) easy access to the available expertise. The most suitable role for Wageningen is in areas where pro-active, long term and integrative strategies are required.

5. Sustainability is a long-term issue that is not always given high priority by business parties, governments and the public. Publicly funded science has an important role to play, because (1) the long-term goals need more attention and (2) knowledge on sustainability should be publicly available and not privatised.

Research agenda

1. Wageningen UR should initiate research into conditions that are favourable or constraining for system innovations in all sustainability domains.

2. Wageningen UR should accommodate an *intelligence unit for sustainability issues*, contributing to pro-active strategy development by companies and policy-makers rather than playing the role of an independent auditor awarding sustainability certificates. Wageningen UR should invest in long-term relationships with the private sector or in networks of which these relations form a part.

3. Wageningen UR should strongly stimulate improvements to the collaboration between 'enlightened' private companies, well-organised NGOs and

governments, with the latter orchestrating public-private partnerships related to sustainability. Wageningen UR should contribute to the *transition processes* towards more sustainability, based on the interaction between parties (*network*), by delivering data, insights and independent assessment.

4. Wageningen UR needs to do research into the development of new institutional and organisational structures to tackle complex problems in which the boundaries of one system (e.g. biophysical systems) do not coincide with those of other systems (e.g. administrative systems). Wageningen UR should complement its renowned expertise within the agri-food domain with other expertise. It should therefore initiate an acquisition programme on the overarching theme of 'How to apply corporate social responsibility to the agri-food complex?'

5. Wageningen UR has relevant expertise in the domain of land-use planning in rural areas, combined with expertise on network and transition management and interactive research. Wageningen UR is in a unique position to facilitate processes among communities, provinces and countries in Europe and to involve various stakeholders. Wageningen UR should therefore initiate an acquisition programme on the overarching theme of 'How to achieve sustainable land use in a multi-stakeholder environment'. Wageningen UR should reflect upon interventions and their (predicted) effects, by developing theoretical frameworks, process indicators, etc. This might include a framework to meaningfully link the three principles of corporate social performance, that is the principles of social responsibility, the processes of corporate social responsiveness and the outcomes of corporate behaviour.

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