To the Minister of Housing, Spatial Planning and the Environment
P.O. Box 30945
2500 GX The Hague

TCB S62(2000) 11 December 2000

Subject: Framework for ecological input in the policy areas of soil protection, biodiversity and land-use planning in relation to NEPP-4 and the Fifth Policy Document on Spatial Planning

Dear Minister,

In your letter of 30 March 2000, reference DBO/ 2000031932, you asked the Soil Protection Technical Committee (TCB) for advice on the role and significance of soil ecosystems. The Committee decided to issue its advice in parts, starting with a brief report covering the main points, followed by a survey and analysis of the problems and ending with a report on the options for policy-based steering instruments in the area of ecological soil quality. On 7 June 2000 the Committee responded in general terms to the questions in the request for advice (reference TCB S33(2000)). The enclosed report (reference TCB A29(2000)) is a survey and analysis of the problems, and describes a strategic framework for ecological contributions in the policy areas of soil protection, biodiversity and land-use planning. It gives me great pleasure to present this advisory report to you.

The Committee recognizes that an attempt is being made to link soil protection to biodiversity and land-use planning. This is expected to be reflected in the NEPP-4 and the Fifth Policy Document on Spatial Planning. The Committee considers soil ecosystems as the common denominator, in terms of both time and scale, in soil protection, biodiversity and land-use planning. This link can be used to create a cohesive policy.

Environmental policy is divided into a number of specific environmental problems (fragmentation, acidification, toxic and hazardous pollutants, disturbance, eutrophication, groundwater depletion). It was clear from the last National Environmental Outlook that solving these problems, particularly in rural areas, requires a long-term approach. The approach based on the above problems, which is designed to prevent compartmentalization, has resulted in a different form of compartmentalization. All problems have a major impact on chemical, physical and biological soil quality; the combined effect of these problems and hence the combined approach are not sufficiently taken into account at present. Soil ecosystems are affected by almost all the specific environmental problems mentioned above. Policy research into the quality and active quality management of soil ecosystems has resulted in an integrated approach to problems associated with environmental management, land-use planning and water management.

Even in the first biodiversity action plan the importance of so-called 'cryptobiota' [1] was emphasized, partly in view of their important role in ecological processes. There is more and more scientific evidence that biodiversity in the soil ecosystem is particularly high. At the same time, however, the role of this very diverse soil life in ecological processes is still largely unknown. In the Committee's view, more attention should therefore

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[1] 'Hidden' organisms living in the soil.

be paid to these ecological processes.[2] It is generally recognized that biodiversity benefits both from good environmental quality and from a varied landscape. Biodiversity can be improved by imposing requirements on land use and by implementing measures in relation to physical development above and below ground.

Physical development above and below ground is placing increasing demands on the soil. It must be possible to switch quickly and easily between different types of land use, for example from agriculture to nature conservation or a residential area. What is more, land-use planners believe interweaving various forms of land use and using underground space could help solve the shortage of space. The emergence of agricultural habitat management, the focus on biodiversity in towns and cities and the combination of water holding capacity and agriculture or nature conservation are examples of this. The soil ecosystem should not be so severely affected by specific uses that it is unable to sustain a subsequent or additional type of use. Otherwise, rapid transitions and interwoven uses cannot take place at a reasonable cost and within a short space of time. By a short space of time we are thinking in terms of a few decades. It is clear from this that requirements must be imposed on the local use of land on the basis of the dynamics of physical development both above and below ground.

The detrimental effects of human land use on soil ecosystems depend on the scale on which that land use takes place. Local land use should first of all be assessed on the basis of the local effects of the land use itself, expressed in terms of the seriousness of the impact and the scale on which the local land use takes place. A second but no less important assessment arises from the relationship between the present land use and the quality of the surrounding area. The longer the effects persist, the larger the scale of local use and the

[2] Ecological processes are also sometimes referred to as 'life support functions', and the diversity of these processes as 'functional biodiversity'.

poorer the quality of the surrounding area, the more severe the consequences will be and therefore the more difficult remediation - and hence the transition to a subsequent function - will be.

Data are needed in order to monitor the quality of soil ecosystems, ascertain the impact of land use on them and develop options for policy-based steering instruments. There are many research and monitoring programs in the Netherlands which routinely measure the quality of soil ecosystems, either in relation to land use or otherwise. Surveying and collating the results of these programs could significantly improve insights into the quality of soil ecosystems. In our opinion this task should be carried out by a planning office, which would report on the current situation and any developments in soil ecosystems related to how the soil is being used.

Yours sincerely,

The master copy of this advice has been sent to the responsible ministers(s).

W.C. Reij

Chair of the Soil Protection Technical Committee

Enclosure: Advisory framework for ecological input in the policy areas of soil protection, biodiversity and land-use planning in relation to NEPP-4 and the Fifth Policy Document on Spatial Planning (TCB A29(2000))

ADVISORY FRAMEWORK FOR ECOLOGICAL INPUT

Advisory framework for ecological input in the policy areas of soil protection, biodiversity and land-use planning in relation to NEPP-4 and the fifth policy document on spatial planning

This advisory report was drawn up at the Soil Protection Technical Committee (TCB) meeting on 15 November 2000.

CONTENTS

1 INTRODUCTION

In a letter of 30 March 2000, reference DBO/ 2000031932, the Minister of Housing, Spatial Planning and the Environment (VROM) asked the Soil Protection Technical Committee (TCB) for advice on the role and significance of soil ecosystems. The letter pointed out that views on 'the soil', as an element of environmental policy, are shifting. Demands on space are building up, under the influence of demographic, economic and socio-cultural trends. Whereas initially the aim was to protect the soil as an independent sector of the environment, attention is now being paid more emphatically and systematically to the way in which the soil is being used. The Minister stated that, in view of the different ways in which the role of ecology is currently evaluated within various policy frameworks, there is a growing need for clarity within the Ministry on the significance of the ecological function of the soil, and particularly on the implications of disruptions to this ecological function for the various ways in which the soil is used. The letter concluded with a number of specific questions to the Soil Protection Technical Committee.
The Committee decided to issue its advice in parts, starting with a brief report covering the main points in response to the Minister's specific questions. This report

was issued on 7 June 2000[1] The present report refers to the second part of the advisory process. This considers the relationship between land use and soil problems, and therefore constitutes a survey and analysis of the problems. The position of ecology in the three most relevant policy areas is also outlined. The report concludes with a recommendation for future direction and research. In the third part of the advisory process, the options for policy-based steering instruments in the area of ecological soil quality will be surveyed and described.
Section 2 of the present report considers the relationship between land use and soil problems. The idea that 'everything should be possible everywhere' and the belief that the environment can be shaped to meet human needs are not illogical in themselves, but it has become clear that they can lead to significant environmental problems. Section 3 looks at the ecological basis for soil protection, biodiversity and land-use planning. It shows that there are various ways of looking at ecology. Due to the differences between the aforementioned areas of policy, the ways in which ecology is considered also differ. This realisation is important when it comes to communication between different areas of policy. Sections 4, 5 and 6 describe the relationship between ecology and soil protection, biodiversity and land-use planning. Section 7 builds on the previous sections to make a number of overall recommendations concerning policy-based steering, and more specific recommendations are also made for research to support policy. The appendix to this advisory report contains the request for advice.

2 RELATIONSHIP BETWEEN LAND USE AND SOIL PROBLEMS

The soil in the Netherlands is used intensively. The population, economic activity, travel and business transactions are increasing all the time. There is a great demand for larger homes with gardens, for industrial sites and for new roads and rail connections. In order to prevent rural areas in the Netherlands from gradually becoming built up, town and country planners devote a lot of attention to the question of where large new residential developments, industrial estates, roads and rail connections should be situated. They are also considering whether it is possible to interweave different types of land use, such as agriculture and nature conservation, and 'stack' the various types of use: heat and cold storage in the subsoil, underground car parks, residential property or industrial premises above motorways.
In the past the quality of the environment and therefore also the soil played an important part in development in the Netherlands. Towns, cities and villages were located at strategic intersections of waterways and roads, on river estuaries or at places where waterways could be crossed. Given the need for drainage, arable farming mainly took place on higher, fertile land. Grasslands were situated in wetter locations. Land that could not be reclaimed for arable farming or stock farming due to the soil condition or for hydrological reasons, or that could only be used very extensively, such as calcareous heath, became what we now call nature conservation areas. The natural soil condition was the guiding principle in land development.

1 Advies Rol en betekenis bodemecosystemen in relatie tot NMP-4 en de Vijfde nota Ruimtelijke Ordening, 7 June 2000. Soil Protection Technical Committee, TCB S33(2000), The Hague.

In the nineteenth and twentieth centuries these principles were gradually abandoned. The reclamation of lakes and the areas outside dykes, the embankment and channelling of rivers, the IJsselmeer polders, the Afsluitdijk Dam and the Delta project have all drastically interfered with the hydrology of the soil in the Netherlands. The advent of artificial fertilisers and pesticides made it possible to grow crops on less suitable land. The 'creation' of the Oostvaardersplassen nature reserve also gave rise to the idea that nature can be shaped. These developments have culminated in the now prevalent attitude that 'everything should be possible everywhere'. If a site is not suited to the desired use, it is made suitable using all the resources available. Given the intensity of land use in the Netherlands, this is a logical development.

The developments described above have, however, undeniably given rise to environmental problems. The persistent demand for new houses, industrial premises and infrastructure means we now have to make choices about future development in the Netherlands. It is clear, however, that whatever choices are ultimately made, rural areas will have to be sacrificed for the sake of buildings and infrastructure. Habitats will increasingly be fragmented and disturbed as a result.

It has also become clear that influencing the water level in order to achieve the required land use also has a number of drawbacks. Examples include groundwater depletion in the summer, flooding in periods of heavy rainfall, lower ground levels as a result of settlement, and the mobilisation of metals and other substances as a result of peat oxidation.

The proposed solutions to the problem of flooding often simply give rise to other problems. Flooding could be combated by increasing water retention in brooks and rivers. Saturation, meandering and the construction of water retention basins are all measures that have been suggested. These plans often go hand in hand with nature conservation. But the sedimentary contamination that is very widely present often prevents measures of this kind being carried out.

Methods to control the water level for the benefit of agriculture, and the advent of artificial fertilisers and pesticides, have allowed agricultural production to rise to unprecedented levels. The adverse effects of this are well-known: leaching of nutrients from the soil into the groundwater and nutrient runoff into surface water, continuous input of nutrients and pesticides through atmospheric deposition, impoverishment of the soil fauna as a result of fertilisation, the use of pesticides, and tillage. Agricultural policy has led to scale expansion, as a result of which many landscape features that were impeding efficient use of the land, such as copses and hedgerows, have disappeared. This is adverse to natural pest control and biodiversity in general. The transition from agricultural land to nature conservation has its own problems. Such transitions are becoming commonplace, as the Netherlands develops a national ecological network. Agricultural land generally contains levels of nutrients and metals that are too high to allow the transition to take place without any problems.

Due to increasing activity in the subsoil, more oxygen-rich water is finding its way into the deeper subsoil. This can result in the mobilisation of metals, for example through pyrite oxidation. Pollution of the subsoil by oxidising compounds such as nitrates can have the same effect. It can lead to high levels of metals in groundwater, dredging sludge or in the soil on which the dredging sludge is spread.

In addition to the direct impact of different policies on how the soil is used or on the soil itself, there are also certain social phenomena that affect the soil. Apart from population growth and increasing mobility and all that goes with them, market forces certainly also have a significant impact on agriculture. National and global markets determine what farmers will grow, as long as it is technically possible. The question of whether the crop is a sensible choice from an environmental point of view is not usually considered.

It is clear from the points set out above that it is not only environmental policy that is facing problems. Town and country planners are beginning to discover that the soil can be a problem in the context of land development or redevelopment in the Netherlands. They face restrictions as a result of soil contamination, hydrology and the natural soil characteristics.

Intensive land use, claims on space and the development of specific types of land use are leading to significant declines in flora and fauna. Since the Netherlands purchases a lot of raw materials and consumer goods from other countries, pressure imposed by the Dutch economy on biodiversity extends far beyond its national borders. Biodiversity was an important item on the agenda of the Earth Summit in Rio de Janeiro (1992). The participating countries undertook to draw up a policy on biodiversity.

Biodiversity is strongly linked with the 'spatial quality' of both soil and water, on various different scales. On the landscape scale, there must be adequate variation and enough open land, or land that is not intensively used by people. Furthermore, open areas must not be too small or too isolated from each other, to ensure that exchanges of species are possible. The national ecological network is based on these principles. On the local level, good soil and water quality is essential.

Soil ecosystems are a common integrating factor in the policy areas of soil protection, land-use planning and biodiversity. In the following sections, building blocks will be identified to develop an ecological basis for soil protection, land-use planning and biodiversity, and these areas of policy will be analysed in more detail from an ecological perspective.

3 ECOLOGICAL BASIS FOR SOIL PROTECTION, BIODIVERSITY AND LAND-USE PLANNING

In providing advice on the role and significance of soil ecosystems, it is useful to distinguish between two classic approaches that exist within ecology. The ecosystem can be seen either as a biotic community of plants and animals or as a process. The view of the ecosystem as a biotic community of plants and animals can be described as the pattern approach. The key questions here are: which species occur together and why, and how do biotic communities develop over time? The emphasis is on the dynamics of populations and species. Factors that can account for the dynamics include the natural cycle of matter, the abiotic environment, hydrology, and evolutionary and geographical factors. With the process approach, the emphasis is on the ecosystem as a functional whole. Scientific explanations for ecosystem processes may lie in the characteristics of essential species, as well as the abiotic environment and hydrology.

Patterns and processes are interlinked. There is a link between the structure (pattern) of an ecosystem and its functions (processes). In the Netherlands the

ecosystem is protected, at least in terms of soil protection at the functional level. This is interpreted in such a way that the target values, at least in theory, protect virtually all the species that are present in Dutch ecosystems against the adverse effects of contaminants in the soil. When the structure is fully protected, it is assumed that the functions are also fully protected. At lower levels of protection, such as at intervention values, this relationship between structure and function, pattern and process, is unclear[2].

The distinction between patterns and processes reflects what is considered to be important in various different areas of policy. Ecological requirements associated with specific land uses were referred to in the past as 'specific ecological functions'. These specific functions of the soil and protection of biodiversity fit in well with the pattern approach. For the purposes of soil protection, interactions between the soil and other sectors of the environment, geochemical cycles and effects on the climate are referred to as the general ecological function of the soil. The general ecological function of the soil, the substratum used by land-use planners (the soil characteristics and the geohydrological system) and the life support system in relation to biodiversity all fit in with the process approach. The spatial scale is an important factor here. On a local scale, designated land uses exclude the occurrence of specific plants and animals. In the area surrounding zones that have been designated for certain purposes, enough space must remain available for these species. At the local level, certain soil processes may be curbed (underneath buildings for example) as long as processes can continue to function at the desired level in the surrounding area, so that the restrictions can be lifted later on. 'Surrounding area' is an abstract concept and depends on the type of land use involved.

In the next three sections we shall look in more detail at the relationship between ecology and soil protection, ecology and biodiversity, and ecology and land-use planning.

4 ECOLOGY AND SOIL PROTECTION

When implementing policy on soil protection and soil remediation, ecological considerations are often not sufficiently taken into account. Although the ecological functions, i.e. the role of the soil in natural and man-made ecosystems, are recognised, there is little support for environmental measures to protect or restore those functions, particularly when they entail high costs. When it comes to weighing up the various options, it is the human impact that counts. Benefits to people and disadvantages such as effects on health, nuisance and odours carry more weight than the benefits and drawbacks for ecosystems, even though a threat to ecosystems is also a threat to people in the long term. A regulatory system is necessary in order to safeguard ecological functions.

The more people are aware that protecting the functioning of the soil ecosystem is in their interest, the more they will support a regulatory system designed to do so. To protect the ecological functions of the soil, people have to be convinced of their usefulness. Soil's ability to purify wastewater, for example, has long been known.

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[2] Advies Herziening leidraad bodembescherming I. C-toetsingswaarden en urgentiebeoordeling, June 1992. Soil Protection Technical Committee, TCB A01 (19992), The Hague

The newly rediscovered role of soil life in 'natural attenuation' and in remediation of landfill sites are good examples. The accumulation of organic material due to a lack of soil life in the immediate vicinity of a zinc factory in the Kempen region is an illustration of what can go wrong when ecological functions are disrupted. It is also necessary to indicate what risks we run if we do not take the ecological role of the soil into account. One can give examples of developments that have failed to take proper account of the reactive character of the living soil. The subsidence of peat as a result of the excessive drainage required for the intensification of agriculture, resulting in gradual contamination of the groundwater with pollutants released from the peat, is just one example.

The basic aim of soil protection is to maintain the multifunctional character of the soil, which means that current land use must not impose any limitations on its future use. All potential uses must remain possible and all the associated requirements must be met. The policy also reflects the realisation that the soil has certain functions that may be significant for different forms of land use, but cannot be specifically linked to them. This involves interactions between the soil and other sectors of the environment, geochemical cycles and effects on the climate. Adverse effects on the general functions of the soil can have major implications, including for the economy.

When the policy on soil remediation was revised, an initial survey of specific ecological functions was carried out in order to arrive at soil utility values for specific land uses. Although no scientifically satisfactory results have been achieved yet, there seems to be an underlying idea that uses such as gardens and public parks must have adequate soil quality for the species that are expected to occur there. Since these species are also dependent on a number of essential processes in the soil, certain quality requirements must also be met to protect processes. By protecting the processes at a certain level, the species involved in them are also protected, even though this is not the primary aim.

The general ecological function also involves processes, but these are considered on a rather larger and more regional scale. There is, of course, overlap with the processes that are included in the specific ecological function. The term 'life support functions', which regularly comes up in debates on biodiversity, seems to correspond to the ecological process approach to soil protection.

5 ECOLOGY AND BIODIVERSITY

Diversity of plant and animal species and micro-organisms in natural biotic communities is an important area of ecological research. A number of components of diversity have been identified, such as the number of species within a specific biotic community, the number of different biotic communities within an area and diversity on a large scale, reflected in different species compositions within comparable systems. One example of this is the differences in ground beetle fauna between pine forests in Scandinavia and the Hoge Veluwe region in the Netherlands. The concern that has been shared internationally since the Rio de Janeiro conference mainly concerns the first two components: the decline in the number of species within specific ecosystems and the disappearance of entire ecosystems. Since the diversity of 'visible' species in the tropics is orders of magnitude higher than in temperate zones, the loss of tropical rain forest is

disastrous. Some researchers, however, have argued that the biodiversity of 'invisible' species in the soil is many times higher, even in temperate zones. Although many people consider the disappearance of very large numbers of species as a result of human activity to be serious in itself, there are also certain anthropocentric arguments to be considered, such as:

- Genetic diversity, a source of biotechnological adaptations in commercially useful species, is declining;
- The diversity of biologically active materials that can serve as a basis for new products such as medicines is declining;
- Rainforests' buffer function in the climate system and in important natural cycles is being impaired. This affects the life support function of the systems in question.

Although national environmental policy in the Netherlands cannot do much about the decline of biodiversity on the global scale, we must also preserve biodiversity within the Netherlands:

- The quality of nature conservation areas will be more appreciated the more species they contain and the closer they come to the diversity that existed in similar areas in the past;
- The stability of ecological processes is generally higher the more species are involved in them. The ability of processes to cope with stress is also generally higher in systems with a large number of species;
- Pests have less chance of survival in systems that contain a large number of species. Agricultural monocultures are highly vulnerable. It has been found that simple hedgerows can form an active ecological barrier to the spread of disease and pests in agricultural systems;
- Finally, the Netherlands must set an example. Developing countries will be less willing to protect their own biodiversity if developed countries fail to do so.

The soil is a heterogeneous environment at both the micro and macro level. Partly due to this heterogeneity, the natural biodiversity of soil ecosystems is high. The intensive tillage that takes place in conventional agriculture results in a high degree of soil mixing and homogenisation. The growing and intensifying use of space for living and working, including agriculture, are making it more and more impossible for specific plants or animals to exist in certain places. These plants and animals help make the soil more heterogeneous. Other stress factors such as acidification, over-fertilisation and toxic and hazardous pollutants accelerate the decline of micro and macro gradients and the heterogeneity of the soil.

One might ask to what extent these changes can now be reversed. This question is also important from the point of view of dynamic land-use planning. It must be possible for areas designated for a purpose that allows more room for nature, such as gas works sites that are turned into parks, or agricultural land that becomes nature conservation areas, to be colonised by the organisms that one would expect to find there. In any case this means that those species must be present in the surrounding area, that there must not be too much soil contamination and that there must be a life support system, a collection of ecological metabolic processes that are important for the survival of the 'colonists'.

Species that have become globally extinct do not return, and species that have become rare on a continental scale, such as beavers, sometimes have to be imported. It therefore makes most sense to maintain biodiversity on a regional scale. There

will then be colonists in the surrounding area that can move into the designated zones that become available.
A regional pool of species is also important for another reason. Due to the increase in traffic between continents, species can be spread across the whole world. These species sometimes prove to be powerful competitors to indigenous flora and fauna, certainly if they are able to settle more quickly in areas that become available. Ecosystems on different continents are therefore tending to look more and more alike; this loss of diversity is sometimes referred to as the 'McDonaldisation' of nature.

6 ECOLOGY AND LAND-USE PLANNING

The use of space is becoming more intensive all the time. Whereas physical developments were once determined by the 'opportunities and threats' presented by the soil characteristics, it seems that many of the threats are technologically remediable and can be transformed into opportunities for new physical developments. Until recently it seemed that technology had made any type of land use possible anywhere. Flooding due to the low storage capacity of existing river courses and densely built-up areas, in particular, has led to an understanding among town and country planners that the soil and water environment do have limitations. These limitations should be seen as constraints on physical developments. In this context the so-called three-layered concept has been introduced. The soil characteristics and the geohydrological system form the so-called substratum, which is the basis for further planning. The infrastructure is the second layer. The designated land uses constitute the third layer. This layered structure is illustrated in Figure 1.
If the substratum sets the constraints, certain types of land use that are not suited to the soil characteristics may be less desirable or may not be considered to be sustainable. The substratum is also the least dynamic of the three layers. The soil is a slow environment. The designated land use layer can be very dynamic, i.e. the designated use can change rapidly. The speed with which a change of use can take place is also linked with the characteristics of the substratum. In this context the substratum must also be seen as bearing the life support system.
As we have already stated, land-use planning has a major impact on changes in biodiversity. As the substratum is increasingly criss-crossed by infrastructure, more and more barriers to flora and fauna are created, even though the quality of the substratum is sufficient everywhere for the life support system.
If all the land is designated for types of land use that are highly intensive, such as heavily built-up residential areas, industrial areas and agricultural areas, then the space for flora and fauna is limited. There are two possible ways of combating this problem: either by creating more areas 'unused by people', preferably with a different 'substratum', or by using land within designated zones less intensively, i.e. more gardens, green areas, recreational parks, hedgerows, natural ditches, stands of trees in pastureland, etc. Incorporating natural landscape features of this kind in land use plans is also important, particularly outside the national ecological network.

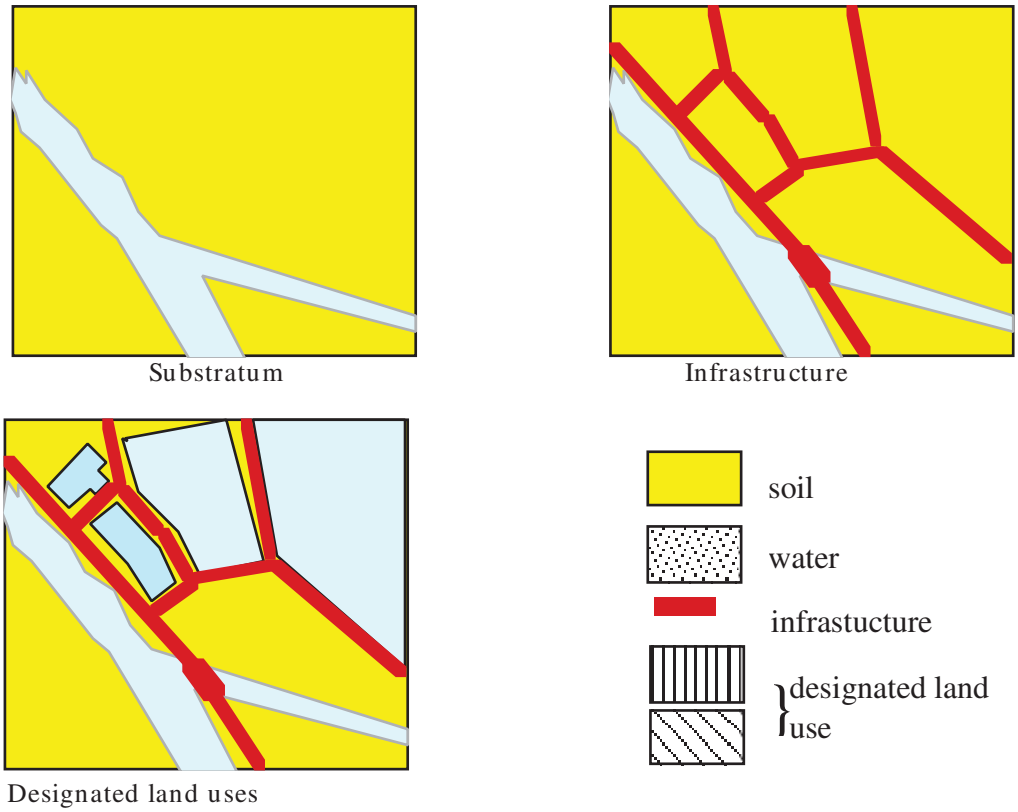

Figure 1. The three-layered model of physical development in the Netherlands.

7 RECOMMENDATIONS

The Committee drew up an inventory of soil problems that it believes merit most attention in the near future. It then analysed soil protection, biodiversity and land-use planning from an ecological perspective and established an ecological basis for these areas of policy. The Committee then drew up recommendations for policy-based steering and research into the quality of soil ecosystems.

Space and time

The effects of human land use on soil ecosystems can be evaluated in different ways, depending on the scale on which that land use takes place. The scale can be indicated in terms of time and space. In its advisory report on soil protection and pesticides[3] the Committee considered the issue of soil protection in terms of time and space. Basically, local land use should first of all be assessed on the basis of the local effects of the land use itself, expressed in terms of the seriousness of the impact and the scale on which the local land use takes place. A second but no less important assessment arises from the relationship between the present land use and the quality of the surrounding area. The longer the effects persist, the larger the scale of local use and the poorer the quality of the surrounding area, the more severe the

[3] Advies Bodembescherming en bestrijdingsmiddelen, March 1990. Soil Protection Technical Committee, TCB A89/05, The Hague.

impact will be and therefore the more difficult remediation - and hence the transition to a subsequent function - will be. The distinction between 'local' and 'surrounding area' has resulted in various policy-based steering models.

Local

Where human use of land locally tends to preclude the occurrence of certain plants, animals and processes, policy should be aimed at exploring possibilities for coexistence, and optimising and stimulating the development of this type of land use in an ecologically meaningful direction. Specific basic requirements must also be set regarding the necessary ecological quality of the soil for the specific land use in question. The policy-based steering model here is: optimisation above a base level.

Surrounding area

There must be enough spaces in the surrounding area in which plants, animals and processes that no longer occur locally in some land uses are still present. For example, the area around a farmer's field can serve as a habitat for organisms that combat pests but cannot survive in the field itself. Monitoring species and processes as indicators of diversity in ecological monitoring networks can be helpful here, particularly if the results can be related to physical developments. It will be difficult to indicate a fixed point of reference for the analysis of such trends. Indicating favourable and unfavourable developments may, however, be enough to allow adjustment of physical developments and the associated environmental impacts (i.e. the specific environmental problems referred to here and in the accompanying letter). This proposal reflects the monitoring recommendations made in the first advisory report on this subject (S33(2000)). Policy should be aimed at preserving and improving the existing situation.

Subsoil

In addition to the two-dimensional spatial scale, soil protection also involves a third dimension: depth. Human land use mostly takes place on the surface. The attention that is paid to species (pattern approach) mainly relates to the more visible parts of ecosystems which exist above ground. When it comes to the subsoil, the process approach predominates. The biological aspects of processes that take place deeper in the soil are still very much an unexplored area of science. Until a few years ago it was expected that there would not be much life in the subsoil. This impression had arisen from the fact that micro-organisms could only be shown to be present if they could be cultured in the laboratory. New molecular and genetic techniques have demonstrated that a hitherto unknown diversity of micro-organisms can occur down to considerable depths. Not only do we know little about this underground world, but processes are also very slow and so there is little scope for reversing interventions. Policy in this area is based first and foremost on the precautionary principle. If interventions are absolutely necessary, they should be carried out only occasionally and only on a local level.

Research

Instruments for policy-based steering still need to be developed or extended further. The Committee can identify a number of areas of research that may contribute towards the development and extension of the range of instruments available for policy-based steering. The research areas are classified from fundamental to applied.

1] Fundamental research into the ecological aspects of the processes that take place deeper in the soil

Little is known about this. On the basis of the precautionary principle, this lack of knowledge limits the opportunities for using the deep subsoil. We can only deal with the deep subsoil sensibly once we know more about its ecology. More knowledge is important not only on account of considerations linked to the general ecological function of the soil and its life support functions, but given the role of soil ecology in cleaning up contaminated land, the stimulation of the natural attenuation of contamination, and the recently identified favourable effects of soil ecology processes at landfill sites.

2] Monitoring species and processes as indicators of biodiversity in ecological monitoring networks and relating the results to physical developments

Data are needed in order to monitor the quality of soil ecosystems, ascertain the impact of land use on them and develop options for policy-based steering instruments. There are many research and monitoring programmes in the Netherlands which routinely measure the quality of soil ecosystems, either in relation to land use or otherwise. Surveying and collating the results of these programmes could significantly improve insights into the quality of soil ecosystems. This task should be carried out by a planning office, which would report on the current situation and any developments in soil ecosystems related to how the soil is being used.

3] Exploring opportunities to optimise and stimulate the ecological quality of the soil within the constraints imposed by specific land uses

This partly comes down to bringing about a change in attitudes among those who use the land. They should see the soil as a living entity, rather than simply as a substrate or a building material. Practical examples include identifying and applying interwoven forms of land use, such as green areas and nature conservation in the city, and nature conservation and agriculture.

4] Working out specific requirements with regard to ecological quality in relation to the use of land

These are requirements that, in human-dominated land uses, should allow the occurrence of those plants, animals and processes that are essential for that particular land use. There is also some interest in this type of research internationally (CLARINET).