
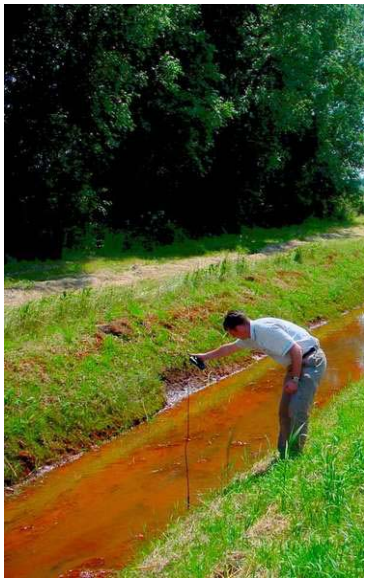


Measures and instruments for soil threats in priority areas

Interprovinciaal Overleg

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Final report
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CONTENTS

			Page
1	INTRODUCTION		1
2	SOIL EROSION		3
	2.1	Introduction	3
	2.2	No regret measures for soil erosion	3
	2.3	Additional measures for soil erosion	3
	2.4	Instruments	4
	2.4.1	Agriculture	4
	2.4.2	Nature management	4
	2.4.3	Recreation	4
	2.4.4	Water management	5
	2.5	Monitoring	5
3	ORGANIC MATTER DECLINE		6
	3.1	Introduction	6
	3.2	No regret measures for organic matter decline	6
	3.3	Additional measures for organic matter decline	6
	3.4	Instruments	7
	3.4.1	Agriculture	7
	3.4.2	Nature management	8
	3.4.3	Water management	8
	3.4.4	Climate	8
	3.4.5	Recreation	9
	3.5	Monitoring	9
4	SOIL COMPACTION		10
	4.1	Introduction	10
	4.2	No regret measures for soil compaction	10
	4.3	Additional measures for soil compaction	10
	4.4	Instruments	10
	4.4.1	Agriculture	10
	4.4.2	Nature management	11
	4.4.3	Recreation	11
	4.4.4	Water management and climate adaption	11
	4.5	Monitoring	11
5	FINANCIAL ASPECTS OF MEASURES		13
6	CONCLUSIONS		14

1 INTRODUCTION

Soil is a non-renewable resource and a very dynamic system which performs many functions and delivers services vital to human activities and ecosystems survival. Available information suggests that there has been a significant increase of soil degradation processes, and there is evidence that they will further increase if no action is taken[1].

Several EU Legislations address soil protection, but there is no specific European Community legislation on soil protection. The proposed Soil Framework Directive aims at filling this gap and has the objective of establishing a common strategy for the protection of soil functions.

Dutch provinces have a central role in water management, spatial planning and rural development. The policy letter on soil[2] (2003) and the covenant on soil policy development[3] (2009) also confirm the important role of provinces in soil management. The Dutch provinces share the concern of the EU about soil degradation process, but have reservations about the necessity of a European SFD[4].

One of the steps to be taken by the provinces may be the identification of priority areas. To be prepared for the assignment of priority areas and the selection of measures and instruments to implement these measures, the provinces developed a tool-box containing promising measures and instruments and a description of the consequences of these measures. This tool-box has the following objectives:

- Provide promising measures for soil threats and instruments to implement them.
- Create an overview of the possibilities for external integration: what can be the positive interaction of soil policy with water, climate, nature and agriculture.
- Anticipate on the SFD: be prepared for the assignment of priority areas and the selection of measures and instruments to implement these measures for the SFD.

Discussions about the SFD should not impede measures for soil threats in the Netherlands. If measures are taken now, there may be no need for additional measures on account of the SFD.

The success of measures for improving soil quality depends on the users of the soil. Farmers and managers of nature and recreational areas will have to change their land use management and invest in knowledge and machines to improve their impact on soils. For example to lower the pressure of tyres before driving on the land, use new

[1] COM 2002 179 Towards a thematic strategy for soil protection, COM 2006 0231 Thematic strategy for soil protection.

[2] Beleidsbrief bodem 2003

[3] Covenant between Central government, provinces, municipalities and water boards on the development of soil policy. Dutch title: Convenant bodemontwikkelingsbeleid 2009.

[4] VNG IPO Position Paper 2006

methods for pest and weed control or invest in GPS[5] to combat soil compaction by using permanent traffic lanes.

This report summarizes proven measures to combat soil degradation. In most cases, the wide application of these measures still needs to be realised. This report identifies policy instruments that can be used to stimulate soil users to take measures for soil erosion, soil organic matter decline and soil compaction. Measures are grouped according to the major threshold that soil users must overcome to implement the measure. Policy instruments are identified that can be used to encourage that this also happens.

Two groups of measures are identified:

- **No regret measures** are cost effective measures that can be implemented through behavioural changes or small investments. No regret measures have short term effects on soil quality and are also positive for the soil user. The thresholds for these measures are knowledge and skills.
- **Additional measures** require investments without positive effects for the soil user. The threshold for these measures is a mix of financial and technical aspects, market mechanisms and policy instruments.

[5] Global Positioning System (GPS)

2 SOIL EROSION

2.1 Introduction

This chapter describes measures to prevent soil erosion. Soil formation is a process that takes place on a geological time scale. With the exception of adding soil excavated elsewhere, it is not possible to restore eroded soil. And even then, the original soil properties are lost.

2.2 No regret measures for soil erosion

Soil erosion can be prevented by the following measures:

- Contour plowing.
- Preventing tear of grassland by keeping grasslands vital for more years.
- Using catch crops or green manure.
- Field margin management (mostly limited to arable fields).
- Covering bare soil with catch crops or green manure between crops.
- Tillage aimed at preventing soil compaction by lowering tyre pressure.

These measures can be taken as a package on the level of individual farms and nature[6] and recreation areas. They fit relatively easy into the work processes of soil users. Consequently instruments aimed at raising awareness will be sufficient. Some measures are already prescribed by existing agriculture regulations in the Netherlands (see Paragraph 2.4).

2.3 Additional measures for soil erosion

A combination of geological factors and historical and existing land use causes some areas to be very vulnerable to erosion. In these areas additional measures can be taken:

- No tillage.
- Tillage aimed at preventing soil compaction (timing of soil management, number of cattle, machinery).
- Terrace farming.

These measures have consequences for the economic position of soil users. An investment is needed in machinery and knowledge. Sometimes yields decrease because less cattle is allowed on the field or different crops are introduced in the crop rotation.

In some cases the long term effects of measures may be positive because soil fertility increases (water holding capacity, organic matter content and fertilizer efficiency). Policy instruments that stimulate soil users to make the transition will be effective (see

[6] In sand drifts, erosion is part of the process that is needed to preserve nature and not seen as a process of soil degradation.

Paragraph 2.4). Subsidies can be given during this period, but (existing) tax incentives to stimulate investments in sustainable techniques[7] can also be used.

Additionally, the government could use planning instruments to restrain land use that increases erosion or stimulate forms of land use that protect the soil from erosion. The Dutch Spatial Planning Act[8] regulates how plans are drawn up and amended. In a plan, municipalities can prescribe measures to protect spatial relevant qualities like relief in the landscape threatened by erosion.

2.4 Instruments

2.4.1 Agriculture

Erosion leads to the loss of topsoil, fertilizers and seeds. On land with severe or long term erosion, the fertile top soil is lost and the less fertile sub soil must be tilled, with higher costs for soil management (water, organic matter).

Because of the urgency for agricultural production, erosion already is a major item in agricultural extension programmes in those parts of the Netherlands that are susceptible to erosion. In these areas, the timing of land management and the choice of crops is regulated by provinces. For example, on hills with a slope of more than 18% only grassland is allowed. Note that contour plowing is no part of these measures.

National regulation for use of fertilizers[9] regulates, among other things, the tear of grasslands. Although measures are aimed at preventing the leaching or runoff of nutrients, they also have positive effects on erosion.

2.4.2 Nature management

In sand drifts, erosion is needed for nature conservation. In other areas, erosion is a threat to seed banks and biodiversity in the top soil. Eroded top soil can have a negative impact on surface water. See paragraph 2.4.4 Water management.

2.4.3 Recreation

Dust that is caused by wind erosion can be a problem for the liveability of rural areas and recreation. Dust can cause problems in areas where skating and cycling are important activities. Also, measures that cover bare soil with crops leave the landscape more interesting for inhabitants and tourists.

[7] Dutch examples are: milieu investeringsafrek (MIA) or Willekeurige afschrijving milieu-investeringen (VAMIL).

[8] WRO: Wet ruimtelijke ordening.

[9] Besluit gebruik meststoffen.

2.4.4 Water management

The Water Framework Directive (WFD) has been implemented in Dutch legislation[10]. One of the objectives is the good ecological state of surface water in 2015. Erosion contributes to clogging of waterways and increases the costs of dredging. In addition, fertilizer and chemicals in the eroded soil contribute to eutrophication and other problems with water quality. So preventing erosion contributes in certain areas to the objectives of the WFD and the Dutch Water Act. Erosion measures could be taken through instruments of the Dutch Water Act, like the Regional Water plan and Management Plans.

2.5 Monitoring

The EU Technical Working Group on Monitoring, recommends to develop a European network for monitoring of erosion. For the time being, monitoring the coverage of land by crops could be used as an indicator for the success of measure to prevent erosion in priority areas. GIS techniques can be used to study the geographic factors that identify priority areas: slope, climate and soil type.

[10] Waterwet and Besluit kwaliteitseisen en monitoring water 2009.

3 ORGANIC MATTER DECLINE

3.1 Introduction

Soil organic matter content is the balance of accumulation, decomposition and harvest of organic matter. Measures to improve soil organic matter content are aimed at influencing the result of these processes towards accumulation.

3.2 No regret measures for organic matter decline

A number of measures for organic matter management can relatively easily be fitted into the usual working process of soil users. Only small changes in behaviour or knowledge are needed:

- Field margin management of arable fields (only in areas with nature programmes, see Chapter 5).
- Use of biocides that spare the soil ecosystem.
- Leaving crop residues on the field.
- Use of compost.
- Using catch crops or green manure.

Some measures are required by legislation for manure management to prevent leaching of nutrients but also have positive effects on soil organic matter. For example, tear of grassland is limited in autumn to prevent leaching losses of nutrients. Also, farmers can receive a compensation for yield losses that are caused by measures to preserve biodiversity or surface water.

3.3 Additional measures for organic matter decline

In some areas, additional measures can be necessary. Soil users must invest in knowledge and machinery to take these measures, or change their crop rotation to include crops that add organic matter to the soil, or accept lower profits from their land. Additional measures can be:

- Field margin management of arable fields (in areas without nature programmes, see Chapter 5).
- No tillage.
- Innovative use of manure, for example separation of manure in fractions with different characteristics.
- Focus crop rotation on biodiversity and organic matter content.
- Preventing tear of grassland by keeping grasslands vital for more years.

Long term consequences of these measures are likely to be positive. Soils with low organic matter content are not very fertile and compared to soils rich in organic matter, more irrigation, biocides and fertilizer are needed for the same yields.

Additionally, the government could use planning instruments to actively restrain land use that increases soil organic matter decline or stimulate land use that accumulates soil organic matter.

- Use soil properties as planning mechanism, for example agriculture on fertile soils and objectives for the development of nature based on soil parameters.
- Mining of soils to remove nutrients before nature development instead of complete removal of fertile topsoil.

These measures influence the landscape and functionality of an area and socio-economical consequences can be high. The Dutch Spatial Planning Act[11] regulates how plans are drawn up and amended. In a zoning plan, municipalities can prescribe measures to protect spatial relevant qualities. With the exception of peat soils[12] and maybe eerdgronden[13], it is difficult to underpin the relevance of soil organic matter for the spatial quality of an area. Spatial measures may be difficult to apply.

3.4 Instruments

3.4.1 Agriculture

Agriculture and soil organic matter management are deeply intertwined and many farmers invest in organic matter management. But there always is the need to produce organic matter and sell it, for example as of potatoes, meat or sugar beets. From this perspective, farming is the process of choosing between adding organic matter to the soil or selling it.

Dutch regulation for use of fertilizers[14] regulates, among other things, the tear of grasslands and prescribes the use of catch crops after the cultivation of corn. Although measures are aimed at preventing the leaching or runoff of nutrients, they have positive effects on organic matter content (and erosion). The use of compost is also regulated by fertilizer regulation[15].

Nature conservation cooperates with farmers to increase the area of nature and semi natural land. The Dutch Conservation Program[16] consists of a number of grants to compensate farmers for yield losses caused by nature management in rural areas (biodiversity of grasslands, protection of meadow birds, field margin management). The Dutch provinces are responsible for these grants. Grants are part of a ‘catalogue for

[11] Wro: Wet ruimtelijke ordening.

[12] Decomposition of peat soils leads to changes in the landscape.

[13] Man made soils high in organic matter formed as a result of an agronomical system that over centuries led to accumulation of litter and manure on soils close the farms. Because of this accumulation, eerdgronden are higher than the surrounding land and therefore may be considered spatial relevant.

[14] Besluit gebruik meststoffen.

[15] Uitvoeringsbesluit gebruik meststoffen (quality criteria) and Meststoffenwet (amount of P and N that may be added to the soil).

[16] Programma Beheer en Subsidiestelsel Natuur- en Landschapsbeheer (SNL).

green and blue services', which means that they are allowed by the European Union competition law.

Private nature conservation organisations, drinking water companies and water boards also may pay farmers to prevent environmental problems to water and nature. Contracts are based on the same concept as the European Cross compliance policy tool, that links direct payments to farmers to their respect of environmental and other requirements set at EU and national levels. However, the ambitions are set at a higher level.

3.4.2 Nature management

Living nature depends heavily on the quality and quantity of soil organic matter. The Dutch Ministry of Agriculture, Nature and Food Quality is adapting a new method to identify the objectives for the development of nature in the National Ecological Network. Organic matter and other soil quality aspects will play a more important role in deciding the type of nature and the road map towards this type of nature.

Dutch agricultural soils are too fertile to develop a divers (semi-) natural ecosystem. Many soils were excavated to remove nutrients in the topsoil. This practice sometimes works counterproductive because also the seed bank and an important part of the sub-surface food web are removed. The alternative is mining of soils to remove nutrients before nature development instead of a complete removal of the fertile topsoil. Mining takes time and money and affects the planning of the development of the area.

3.4.3 Water management

Organic matter improves the water holding capacity of soils. Combined with measures to reduce soil compaction, organic matter management can reduce the need for irrigation to zero, which also reduces the pressure on groundwater dependent nature in the area.

During wet periods, the flush of water (and nutrients) to surface water also is lower because the land can hold more water. Provinces and water boards pay attention to these aspects in regional water plans that are used to reach the objectives of River Basin Management Plans for the Water Frame Work Directive.

3.4.4 Climate

The soil contains huge amounts of carbon. The Dutch soil contains approximately $264 \cdot 10^9$ kg carbon in the upper 30 cm (56% under grass, 32% arable land and 12% under forest soils). Depending on climate, soil type and land use, this means approximately 24.000 kg carbon per hectare in the upper 30 cm. Between 30 and120 cm the soil in the Netherlands contains approximately another $142 \cdot 10^9$ kg carbon.

Land management can have huge effects on the quality of soil organic matter and on soil properties and over longer periods also on the quantity. But because of effects of changes in weather and soil diversity, changes in organic matter content can only be measured over periods of 20 to 50 years. This is illustrated by a rule of thump that says

that changes in management can change soil organic matter by 1 weight percentage of soil over a period of 20 – 50 years.

Based on these figures, between 420 – 11,400 kg carbon, or between 1,400 and 38,000 kg CO_2 per hectare can be sequestered or lost by soil organic matter management in 20 years. The Netherlands have approximately 800,000 ha of arable land that could fix or release between 1 – 30 MTon CO_2 in 20 years. On average this is 1.5 MTon per year, less than 1% of the annual CO_2 emissions in the Netherlands in 2006 (which was 173 MTon, according to the Dutch Statistical Bureau CBS).

Soil organic matter management is important for climate adaption. Soils with adequate levels of organic matter can provide more water to crops during dry periods and are generally more resilient to extreme weather conditions. Soils in warm regions generally have lower organic matter content than comparable soils in temperate regions. If the temperature rises, farmers may have to give even more attention to soil organic matter management.

3.4.5 Recreation

Many measures that contribute to the accumulation of organic matter in the soil, also contribute to the diversity of the landscape. Field margin management of arable soils was originally introduced to prevent the drift of biocides and leaching of nutrients to surface water. A number of entrepreneurs recently started renting canoes, because the fields attracted many visitors looking for relaxation. On the other hand, conversion of agricultural fields into recreation areas, for example arable fields into golf courts or grass land into motocross arenas, leads to changes in organic matter content. These examples also show that effects may be positive or negative.

3.5 Monitoring

Local measures can have an important effect on soil organic matter quality, but the effect on the amount of organic matter must be evaluated over periods of 20-50 years because of the high spatial diversity of soils and slow structural changes compared to the short term fluctuations. In addition, weather conditions, like an extreme hot, cold, wet or dry period can partly undo the positive effects of measures of soil organic matter content.

Because of these arguments, the Dutch Soil Protection Technical Committee recommends that monitoring the risks of organic matter decline should focus on indicators for soil use (crop rotation, amount of manure, plowing strategy), rather than on soil organic matter content.

4 SOIL COMPACTION

4.1 Introduction

Measures for organic matter accumulation are also effective in preventing soil compaction. Little is known about the time that it takes for a compacted soil to recover.

4.2 No regret measures for soil compaction

The following measures are relatively easily taken by soil users:

- Tillage aimed at preventing soil compaction by lowering tyre pressure or by timing of soil management.
- Field margin management (mostly limited to arable fields in areas with nature programmes, see Chapter 5).
- Covering bare soil with catch crops or green manure between crops.

Note that: because of delivery contracts, for example for sugar beet, potatoes and unions, it may be necessary for farmers to harvest under suboptimal conditions.

4.3 Additional measures for soil compaction

Subcontractors and farmers work together to stimulate measures for soil compaction. In some areas, farmers feel the urgency to invest in measures, because they calculated that soil compaction will threaten the fertility of the soil within 5 - 15 years.
Additional measures are:

- GPS[17] to combat soil compaction by using permanent traffic lanes.
- No tillage.
- Tillage aimed at preventing soil compaction (tyre pressure, timing of soil management, number of cattle, machinery).
- Field margin management of arable fields (in areas without nature programmes, see Chapter 5).

4.4 Instruments

4.4.1 Agriculture

Soil compaction is a very relevant issue to most farmers because it can be relatively easily seen in the field and has direct influence on crop yields. Awareness can be created by comparing the amount of water on compacted land with land with good soil structure. By digging a hole in the ground, the plough pan at the bottom of the plough furrow can be easily seen and also the structure of the soil. Soil compaction is a very visible phenomenon, once you know how to recognise it.

[17] Most new tractors already have Global Positioning System (GPS) and GPS can be installed on older tractors for prices starting at EUR 1,000.

4.4.2 Nature management

Soil compaction can also be caused when agricultural land is converted into nature. Often, heavy machinery is used for the restoration of creeks that were canalised in the 70's for agronomical reasons, or to remove nutrient rich topsoil. Sometime machines are used for management, for example mowing of natural grasslands.

Governments could implement measures for soil compaction to terms and conditions for the subsidies that nature organisations receive for nature management.

4.4.3 Recreation

Soil compaction does not seem to be an item for the maintenance of large recreational areas, for example golf courts. Maybe it should be. Recreation industry organisations[18] could play a major role in raising awareness. For camping fields, it may be important that water can penetrate the soil easily to guarantee dry tents and dry feed for campers. On the other hand, the visitors of the Lowlands festival will argue that mud contributes significantly to the success of the festival.

4.4.4 Water management and climate adaption

Compacted soils can retain less water, which leads to more surface runoff. This may lead to overload of sewer systems and waterways. Because compacted soils hold little water, more irrigation is needed during dry periods. Compaction hampers the development of the root system of plants. A less developed root system means that plants can only use the nutrients from a limited volume of soil, reducing the fertilizer efficiency and enhancing the losses of nutrients to surface- and groundwater.

Based on legislation[19] concerning the use of biocides and nutrients, field margins are compulsory near waterways. The soil under field margins will be less compacted, because of a limited number of operations. The WFD and the Dutch Water act also stimulate attention on compaction in local Water plans.

4.5 Monitoring

Soil compaction is not systematically monitored in the Netherlands. Compaction is easily seen in the field, but it is difficult to measure improvement of deterioration. The degree of compaction can change within decimetres because of the heterogeneous nature of soils and weather effects.

[18] Recron: organization of recreational entrepreneurs or the Dutch Golf Federation (NFG).

[19] Lozingenbesluit open teelt en veehouderij.

It is possible to measure the acceptance of measures by soil users, for example tyre pressure, change in crop rotations or use of GPS. During wet periods areal photography could show puddles on compacted fields, the number of puddles giving a rough indication of the degree of soil compaction in a certain area. These photographs could also be used to raise awareness by soil users.

5 FINANCIAL ASPECTS OF MEASURES

This chapter presents some financial aspects of measures, based on studies of the LEI[20] on cross compliance. The studies indicate that farmers can receive a maximum of EUR 1,200 per hectare for nature management of their farms. This amount reflects a combination of compensation for loss of income and the price that society is willing to pay for ecosystem services. Note that access to grants is limited to farmers in areas appointed as 'agricultural nature management area' (SNL gebied).

LEI calculated that biological agriculture saves on average EUR 220 per hectare on measures for water purification and climate adaption elsewhere. Conventional farmers who invest in measures for sustainable soil management will save a comparable amount of money for society. This amount is an indication of the minimal advantages to society of sustainable farming.

The range of EUR 220 – 1,200 can be seen as a rough indication of the amount of money the Dutch society is willing to pay for ecosystem services provided by agriculture.

The Environmental Stewardship is an agri-environment scheme that provides funding to farmers and other land managers in England who deliver effective environmental management. Farmers can combine environmental measures into a package. Grants for a simple package vary between EUR 40 and EUR 75 per hectare, which indicates the minimum sum that the English society is willing to contribute to sustainable farming at this moment.

LEI estimates the costs of a field margin of 6 meters to be around EUR 500 per hectare, due to losses in yield per hectare. The maximum grant that farmers can receive for nature development was EUR 1,202 per hectare for the development of grassland rich in herbs in SNL areas.

In 2008, the purchase costs of ground for nature development were EUR 40,000 per hectare with a range of EUR 30,000 and EUR 60,000 per hectare. The provinces receive EUR 96,000 per hectare for the development of nature on the purchased grounds. Management costs vary between EUR 2 and EUR 3,000 depending on the complexity of the system.

[20] Economical Institute of Wageningen UR.

6 CONCLUSIONS

To be prepared for the assignment of priority areas and the selection of measures and instruments to implement these measures, the provinces developed a tool-box containing promising measures and instruments and a description of the consequences of these measures.

From this study it can be concluded that:

- Promising measures are available for soil threats.
- There are effective instruments for the implementation of these measures.
- There are possibilities for external integration based on the positive interaction of soil policy with water, climate, nature and agriculture.