Social cost-benefit analysis of the soil remediation operation in the Netherlands

A.P. van Wezel et al, 2007. The Netherlands Environmental Assessment Agency, MNP report 500122002/2007 (Dutch).

Summary

Do the benefits of soil remediation justify the costs?

Do the anticipated costs of soil remediation in the Netherlands – using various alternative scenarios – lead to greater prosperity? This is the central question in this report on a social cost–benefit analysis (SCBA) of the soil remediation operation in the Netherlands. This report defines the soil remediation costs, and compares them to the benefits for health, real estate, drinking water supplies, perception and the ecosystem. The health, real estate and drinking water benefits can also be expressed in monetary terms. The costs and benefits of soil remediation are calculated over a period of 100 years.

This cost–benefit analysis demonstrates the efficiency of various policy alternatives. In addition to cost efficiency, justice for individual stakeholders and future generations also plays a significant role. Differentiating between efficiency and justice is primarily a political decision. This study does not compare the efficiency of achieving health benefits via soil remediation to the possible benefits of other (environmental) policies.

Choice of value-loaded discount rate: how far should one consider future benefits or uncertain returns?

Use of a discount rate is necessary in order to allow costs and benefits to be compared between various years. The discount rate used affects the results: lower rates have more effect on benefits in the future (e.g. health and clean water supplies). A low discount rate can be debated from the desire to have future benefits weighed more heavily and thus not restrict opportunities for future generations. On the other hand, the return on investments is uncertain for benefits that are fraught with uncertainties, where one could argue for a premium load, and thus for a higher discount rate. This SCBA on soil remediation assumes a discount rate of 4% for both costs and benefits, as per the OEI Guideline. Assuming such factors as value-loaded effects of this decision, a sensitivity analysis has been implemented for the discount rate (1-7%).

Locations with possible serious soil pollution, particularly in the western and southern regions of the Netherlands

This cost–analysis is based on the updated national information concerning soil pollution, including data on point sources from historical soil pollution and remediation costs. Information on specific substances has also been added. Soil is possibly seriously polluted at around 400,000 locations in the Netherlands, primarily in the western and southern regions of the country. Most of these locations are within built-up areas, although there are also many polluted locations in agricultural areas. If past decisions by the competent authorities are taken as an indication of future remediation projects, then there are around 56,000 remediation locations with risks to human health, the ecosystem or distribution to groundwater during current or future soil use. Around 11,000 locations involve some kind of risk during current use: the so-called 'emergency locations'. These are primarily located in and around the large towns.

Three alternatives for future investments

In addition to the 'zero alternative', this study on the Dutch soil remediation operation also includes three alternatives for future investments in soil remediation.

- In the 'zero alternative' the government ceases to contribute to soil remediation. Since (legal) stimuli do not change, private parties continue with soil remediation at a rate that is similar to today's levels. In total, this amounts to 10,000 remediation projects up to the year 2030.
- In the alternative 'current policy' scenario, measures are taken (before 2015) to reduce or manage the risks at all 11,000 emergency locations, Up to 2030, the government facilitates urban and economic developments at remediation locations where soil pollution leads to stagnation. In total, this concerns 25,000 remediation sites.
- In the second policy alternative, the soil remediation policy is limited to remediation of the 11,000 emergency locations, as well as the continuing private remediation projects, as per the zero alternative. In total, this concerns 20,000 remediation projects.
- The third policy alternative focuses on all remediation locations, including those where there is no stagnation. In total this concerns 56,000 remediation projects.

Costs of soil remediation up to 12 billion euro by 2030

The estimated remediation costs for the 56,000 aforementioned locations amount to almost 12 billion euro by 2030. The 11,000 emergency locations are expected to cost around 3 billion euro up to 2015. The median remediation costs amount to 16 euro per m^2, while the average costs are considerably higher (145 euro per m^2) due to a

distorted distribution of the remediation costs. Former gas plants, military camps and chemical laundries are relatively expensive to clean.

Health benefits uncertain, but possibly considerable

The uncertainties, particularly in health effects, of the total soil pollution, and thus the benefits of soil remediation, appear to be considerable. However, current scientific methods do not allow a more accurate assessment to be given. This analysis factors in the health effects of being exposed to cadmium, lead and carcinogens (other than cadmium). However, it is not possible to quantify the effects of non-carcinogens: these are probably considerably less, and thus are not included in the health benefits. In total, the benefits studied provide a good estimate of the total health benefits that can be achieved.

A Belgian epidemiological study reports an association between an increased risk of lung cancer and increased exposure to cadmium in the soil. If this study is applied to the Dutch situation, then this possibly leads to hundreds of lung cancer cases each year, at locations with soil pollution from cadmium throughout the Netherlands. However, this study is subject to criticism. Applying such epidemiological studies to other areas introduces uncertainties; furthermore, the scope of the study was relatively small. Sickness monitoring and specific studies to exposure in the Netherlands area of Kempen do not show increased incidents or excessive exposure. Thus it can be concluded that the health benefits of remediation at all emergency and remediation sites containing cadmium can vary from zero to several hundreds of avoided cancer patients each year.

There are no epidemiological studies available for the other substances. Health benefits for other carcinogens are determined via exposure models, per substance, per location category, and per soil use, taking into account the number of exposures. Soil remediation at all emergency and remediation locations could mean around 80 avoided cancer cases per year, mostly due to benzene at locations polluted by petrol stations and other fuels.

The health benefits of soil remediation at all emergency and remediation locations as a result of exposing children (0-4 years) to lead in the soil, expressed as ‘loss of IQ’, are considerable (3550-8900 IQ points per year). The most important losses concern locations with storage tanks, and the category known as ‘non-specified large-scale or small-scale polluted locations’.

A considerable number of health benefits seem to be achieved outside the 11,000 emergency locations

Based on the information concerning pollution contours (substance data), more emergency locations (health risks at current soil use) have been calculated (40,000)

than the 11,000 emergency locations that are calculated by extrapolating to the future, on the basis of past decisions by the competent authority. A significant percentage of the health benefits can therefore be achieved outside the aforementioned 11,000 emergency locations. However, it is important to note that the information available on pollution is possibly not representative, due to an over-representation of locations with intervention-value exceedances, and thus possibly an overestimate of the health benefits.

Benefits for drinking water facilities depend on the choice of alternative extraction or purification process

The Netherlands has 194 water extraction areas, with 79 of these located in one or more possibly seriously polluted areas. The annual gross benefits are estimated at 0.02 to 1 million euros per remediated water extraction area, depending on the choice of alternative water extraction or purification. The benefits of stopping the spread of pollution in groundwater (such as corporate premises or achievement of heat/cold storage) cannot be expressed in monetary terms. Pollution can destroy the quality of the groundwater, but can also affect the surface water and sediment.

Real estate benefits for new housing at inner-city remediation locations

The real estate benefits of soil remediation concern the influence on the price of new housing, the impact on surrounding housing and the influence on the price of land. These benefits are all calculated for real estate in new (not yet built) inner-city areas at emergency and remediation locations, since these areas have considerable spatial pressures, with few opportunities for construction at cleaner locations. The net benefits from added-value of the land, the value of the housing that can be built, and the radiation effects on the surrounding housing areas are considerable. At certain locations the benefits of economical spatial use can be significant, but this is not further expressed in monetary terms within this national analysis: this also applies to the possible benefits of remediating existing housing.

Ecological damage, increased vulnerability of around 160,000 hectare

The benefits for the ecological effects and perception are well quantified, but not expressed in monetary terms, and are thus not included in the cost–benefit analysis. Ecological effects are considerable where serious cases of soil pollution are concerned. A comprehensive research programme showed the ecological effects of soil pollution in water meadows, the Biesbosch and a peat meadow area. More tolerant plant types will occupy the open niches, with the result that ecosystems will be more vulnerable and diversity reduced. Soil pollution can also form a hindrance to nature development. The environmental toxicological standards are exceeded on around 160,000 hectares of land; only a limited amount of this land is located in

nature areas. Of the substances PAH (polycyclic aromatic hydrocarbons), copper, arsenic, zinc, lead and cadmium, the first two result in problems over a large surface area and at many locations: the negative effects are greatest for lead and zinc.

Much of the Dutch population is concerned about soil pollution

Over 1200 Dutch citizens were asked about their concerns with respect to environmental risks, including soil remediation. Relatively few people were found to be seriously concerned about soil pollution compared to the extent of their concern for air pollution, yet soil pollution is classed higher than other environmental risks. Around 8% of the Dutch population indicated during this survey that soil pollution applies to their individual living situation, while in fact 45% of those surveyed live close to one or more possible soil remediation locations. Respondents consider primarily the probability and the seriousness to be important. Other factors that influence the perception of environmental risks (one's own management, trust in the government, number involved and effectiveness of measures) are considered less serious.

This SCBA does not indicates a robust preferred sequence for one of the alternatives

The analysis as reported here does not provide a robust preferred sequence for one of the alternatives studied. The choice of discount rate, monetary value of physical benefits and the way the analysis handles cost/benefit uncertainties determine for this preference.

A 4% discount rate leads to a - slightly - negative balance in all policy alternatives

Assuming that each year of life lost is valued at 70,000 euro, the discount rate is 4% and only the top levels of the health benefits are included, then all policy alternatives result in a - slightly - negative balance over the next 100 years (net present value, Table A) in the sequence: alternative 2 (-580 million euro), alternative 1 (-600 million euro) and alternative 3 (-750 million euro). There are considerable uncertainties with respect to the costs and benefits, and thus the possibility of achieving a positive or negative balance. The benefits that are expressed in non-monetary terms (ecology, dissemination, more efficient spatial use) can cause a shift in weighing the pros and cons.

Since an important part of the health benefits can be achieved outside the emergency locations, the alternative that includes all remediation locations achieves the best net results, despite the higher costs.

Table A. Costs, benefits and balance per alternative, at a discount rate of 4% and 70,000 euro valued for each year of life lost (net present value in millions of euros, period 2007-2107)

	Zero alternative	Alternative 1 Current policy	Alternative 2 Emergency locations	Alternative 3 All remediation locations
Costs				
Remediation costs	1,400 (530-1,600)	4,500 (1,700-4,900)	3,800 (1,400-4,200)	8,500 (3,200-9,400)
Benefits				
Health	210-1,000	870-2,800	790-2,300	1,400-5,800
inc. lung cancer cadmium	0-630	0-1,500	0-1,200	0-3,500
Inc. other cancers	100	600	570	780
Inc. IQ loss	110-280	270-680	210-540	620-1,550
Drinking water	1-40	2-100	2-80	6-220
Real estate	270 (-10 - +540)	950 (-30 - +1,900)	830 (-30 - +1,700)	1,700 (-50 - +3,400)
Other benefits (ecology, dissemination, more efficient spatial use)	Pm	pm	pm	pm
Net balance	**-90 + pm** **(-1,400 - +1,100)**	**-600 + pm** **(-4,100 - +3,200)**	**-580 + pm** **(-3,500 - +2,700)**	**-750 + pm** **(-8,000 - +6,300)**

A lower discount rate results in the net–benefit policy alternatives being higher than the zero alternative

If the benefits are weighed more heavily in the future, the policy alternatives result in a positive balance for the top levels of health benefits. A discount rate of 2% or less means that the three policy alternatives result in a positive balance, compared to the zero alternative (Table B). However, a discount rate of 7% would result in a net negative benefit for all alternatives over the next 100 years. When each lost year of life is valued at 20,000 or 10,000 euro or when the health benefits are lower than the top levels indicated here, the net benefits for all alternatives and all discount rates quickly fall into the negative.

All alternatives show the health benefits to be higher than the real estate benefits and the benefits for drinking water supplies. The benefits for these latter two together

cannot compete against the costs involved – in any of the alternatives and at any discount rate.

Net benefits of soil remediation vary from one case to another

This analysis was implemented for the entire soil remediation operation. As also shown by the SCBA studies of individual cases, the comparison of costs and benefits for parts of the operation, or individual locations, produces varying results. The net benefits of soil remediation depend on the historical cause and the type of pollution, the remediation method used, current soil use and the density of residents in the area. It is also possible to be more specific about which cases achieve the largest health benefits: lead (military camps, petrol service stations), benzene (petrol service stations) and cadmium (large-scale industrial clusters). Further study, with more extensive information on pollution levels, would be useful in defining further differentiation.

Table B. Net balance at various discount rates (net present value in millions of euros, top levels with uncertain health benefits, period 2007-2107)

Discount rate	Zero alternative	Alternative 1	Alternative 2	Alternative 3
1%	1,800 + pm	4,400 + pm	3,500 + pm	10,000 + pm
2%	760 + pm	1,700 + pm	1,300 + pm	4,100 + pm
3%	210 + pm	210 + pm	90 + pm	970 + pm
4%	-90 + pm	-600 + pm	-580 + pm	-750 + pm
7%	-410 + pm	-1,500 + pm	-1,300 + pm	-2,600 + pm

Table C. Benefits expressed in physical units

	Zero alternative	Alternative 1 Current policy	Alternative 2 Emergency locations	Alternative 3 All remediation locations
Cadmium[1]	0-500	0-1,200	0-900	0-2,900
Carcinogens[2]	80	400	400	600
Lead[3]	400-1,000	1,400-3,600	850-2,100	3,600-8,900
Relevant water extraction areas	2	5	3	13

1) Increased lung-cancer incidents, annually avoided DALY loss with complete remediation implementation

2) Increased cancer incidents, annually avoided DALY loss with complete remediation implementation

3) Loss of IQ points in exposed children