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SCBA data space circular soils

Final report

The Ministry of Housing and Spatial Planning & Geonovum

Rotterdam, 23 april 2026

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Summary

Research question

In spatial challenges such as housing construction and dyke reinforcement, a significant amount of soils is released annually, ranging from clean and slightly contaminated soils and dredgings. There is an urgent need for insight into these released flows in order to reuse them in a high-quality way and to prevent unnecessary disposal.

The Buyer Group Grondstromen (a collaboration of Directorate-General for Public Works and Water Management, provinces, water boards and municipalities) has developed a market vision to accelerate more circular reuse of soils and dredgings. In this context, a national data space is being explored. This system must provide insight into the chemical and physical quality of soil through data from, among other things, soil surveys (linked to the National Key Registry for the Subsurface), and efficiently link supply and demand. Underlying Social Cost-Benefit Analysis (SCBA) looks at the (one-time) investment and structural costs for setting up the data space for circular soil management in the Netherlands and the social benefits that can be expected as a result of putting the system into operation.

The analysis compares two policy alternatives (a regional and a national system) with the zero alternative, in which data on circular soil management remain fragmented and circularity grows only marginally. The SCBA has an analysis period of 2027–2050 and a discount rate of 2.8%[1].

Results

Outcomes in outline

Table S1 shows that a data space generates significant societal benefits. Both in the policy alternative (BA) with regional systems (BA1) and in the alternative with one national system (BA2), the benefits far outweigh the costs. The national system (BA2) delivers the highest benefits, as standardisation, adoption rates and market forces act more strongly. In addition, it is plausible that these positive balances are in reality even larger as a result of the non-quantified income pro memori (PM) items.

Table S1: Total overview of social costs and benefits of policy alternatives compared to zero alternative

Variable	BA1: Regional (NPV 2027-2050 in € million)	BA2: National (NPV 2027-2050 in € million)
Costs	€91	€116
Benefits	€ 270 + PM	€ 554 + PM
Balance (benefits – costs)	**+ € 178 + PM**	**+ € 438 + PM**

The benefits come from multiple sources: reduced failure costs, better matching of supply and demand, lower logistical costs, reduction of CO_2- and other emissions, improved data quality and a more transparent market process. The PM items consist of the reuse of data, less costs for enforcement and ecological profit.

The national policy alternative reinforces these effects through scale and uniformity. As a result,

[1] According to Report Working Group on discount rate 2025

supply and demand can be better matched and more secondary soils can be deployed. The SCBA thus shows that a data space, and in particular a nationally organised system, can be an effective tool to reduce social costs and increase circular soil management.

Cost of data space

The total costs of the introduction of the data space in the regional variant amount to € 91 million (NPV) and in the national variant to € 116 million (NPV). An important part of this concerns the design and maintenance of the set of agreements and governance, with €19.5 million in BA1 and €43.6 million in BA2 respectively. In addition, there are costs for management, data provision and connection. The structural connection costs, the annual recurring costs that organisations incur for providing and updating data, amount to € 38.6 million in BA1 and € 30.8 million in BA2. Due to national standardisation, these structural costs are lower in BA2 than in BA1. Table S2 provides a clear overview of all cost items.

Table S2: Overview of total costs of introducing data space policy alternatives to zero alternative

	BA1: Regional (NPV 2027 - 2050 in € million)	BA2: National (NPV 2027 - 2050 in € million)
Set of agreements and governance	€19.5	€43.6
Coordination at regional level	€ 3.9	€ 3.9
Data space investments	€ 2.4	€4.1
Structural management costs	€13.3	€19.0
One-time connection costs	€ 2.0	€ 3.0
Soil quality maps, etc.	€11.8	€11.8
Structural connection costs	€ 38.6	€30.8
Total costs	**€91**	**€116**

Benefit items

The benefits of the data space consist of financial, logistical and environmental impacts. In total, the regional starting point (BA1) generates €270.4 million (NPV), while the national data space (BA2) generates €554.8 million (NPV) in benefits. The biggest benefits are the reduction of claims and failure costs, improved market functioning and price efficiency, and the reduction of air pollution due to reduced transport costs. Some of the benefits cannot be fully quantified. This mainly concerns the reuse of data, enforcement and ecological profit. For example, the data space creates strategic linking opportunities to better unlock data and connect it directly with other national systems, such as the National Key Registry for the Subsurface (BRO) and the Data Space Physical Living Environment (DSFL). This allows logistics and earthworks to be combined at an early stage with spatial research, such as archaeological soil research or the detection of Explosive Remnants of War, which can prevent failure costs and project delays. Better matching of supply and demand can also lead to less unwanted soil movements, which limits ecological damage. Furthermore, an increase in the use of area-specific soils leads to the preservation of local soil quality and biodiversity. Table S3 summarises all quantified benefits and PM-items.

Table S3: Overview of total benefits introduction of data space policy alternatives to zero alternative

	BA1: Regional (NPV 2027-2050 in € million)	BA2: National (NPV 2027-2050 in € million)
Alignment time/transaction costs	€ 3.4	€5.6
Claims and failure costs	€89.3	€146.2
Traffic air pollution reduction (NO_x, PM)	€ 42.9	€96.8
CO2 reduction due to less transport	€10.1	€25.6

CO2 reduction due to less primary extraction	€9.4	€26.0
Reuse of data	€0.2 + PM	€ 0.4 + PM
Market forces and price efficiency	€80.6	€ 197.9
Enforcement	€ 11.2 + PM	€ 18,2 + PM
Soil surveys	€ 20.0	€32.8
Data entry	€1.8	€2.9
Permit granting	€0.9	€ 1.5
Ecological benefits	PM	PM
Total benefits	**€270**	**€ 554**

Conclusions

On the basis of this SCBA, the following conclusions can be drawn:

- Even with a cautious approach of the SCBA, the introduction of a national data space provides society with the highest benefits that outweigh the costs to be incurred. The link with the MIRT and HWBP has a strengthening effect on the supply and demand of circular soil management. The large volumes from these two programmes ensure that investments are recouped quickly.
- The introduction of a regional system also brings benefits to society, but substantially less in size. These lower social benefits also outweigh the expected costs.
- A phased route leads, on the one hand, to cumulatively higher total costs over the duration and, on the other hand, to structurally lower total benefits compared to direct national introduction. From an economic and social perspective, the direct establishment of a nationally standardised system is therefore more effective than a phased transition.
- It therefore seems sensible to develop a national system directly, and not to opt for a regional system or a phased approach, because the additional benefits of the national system far outweigh the additional costs.
- The sensitivity analysis shows that the results of the cost-benefit analysis are robust, but also highly dependent on the future growth of the volume of released flows that are reused in a high-quality way to avoid unnecessary disposal;
- This means that the intended acceleration of the transition, as expressed in the market vision of the Buyer Group Grondstromen (a collaboration of RWS, provinces, water boards and municipalities), will have to become a reality.

1 Introduction

1.1 Reason and purpose

In spatial challenges such as housing construction and dyke reinforcement, a significant amount of soils is released annually, ranging from clean and slightly contaminated soils and dredgings. According to the UNEP report Sand and Sustainability (2022), sand scarcity[2] can lead to global market distortions and rising costs in the long term. The ministry of IenW is currently carrying out the national assessment of primary building materials. This should show whether this effect will also occur within the Netherlands – and if so, in what period and to what extent. There is an urgent need for insight into these released soils in order to reuse them in a high-quality way and to prevent unnecessary disposal.

The Buyer Group Grondstromen (a collaboration of RWS, provinces, water boards and municipalities) has developed a market vision to accelerate more reuse of soils and dredgings. In this context, a national data space is being explored. This data space must provide insight into the chemical and physical quality of soils through data , among other things, soil surveys (linked to the National Key Registry of the Subsurce), and efficiently link supply and demand. This SCBA looks at the (once-only) investment and structural costs for setting up the data space circular soils and the social benefits that can be expected.

1.2 Method and approach used

1.2.1 What is a SCBA?

The basis for determining the social costs and benefits of a project or policy proposal lies in the comparison of two future situations:

- The policy alternative, which introduces the data space for circular soil management (regional systems or one national system), and
- The zero alternative, in which the data space is not realized and the current fragmentation of the information provision remains.

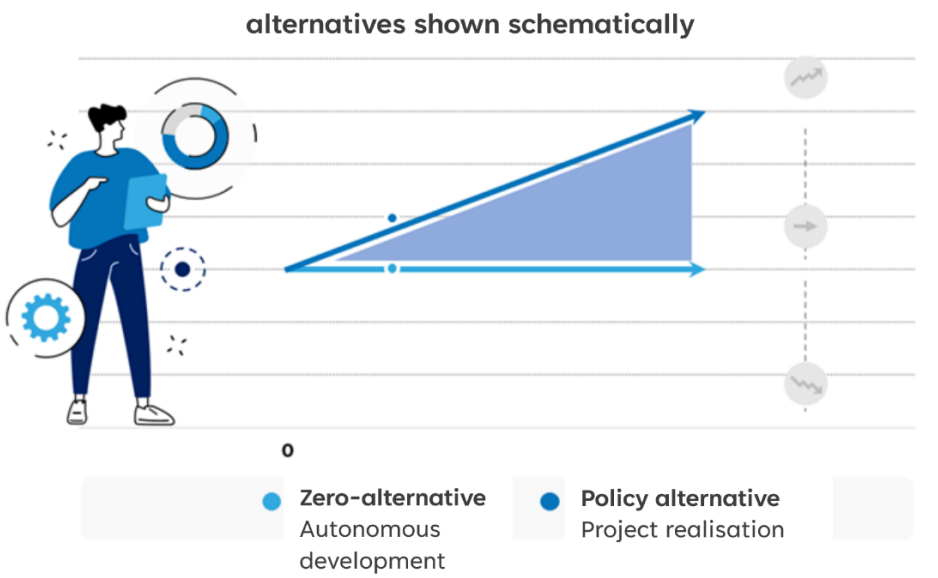
The comparison between these situations shows what effects occur when the data space is introduced. These effects can be both positive (benefits) and negative (costs). Examples are additional investment and management costs inflicting costs, and improved market functioning, lower failure costs and less transport on the benefit side.

In a SCBA, all costs and benefits are collectively considered as ‘effects, which are updated over time and discounted and expressed in Net Present Value (NPV). This provides insight into the total social value of the policy alternative (or project alternative) compared to the zero alternative. Figure 1.1 schematically shows how this equation is made. As soon as a policy proposal is realised, differences occur compared to the hypothetical situation in which the policy proposal is omitted. The extent of the benefits can increase over time, for example with

[2] Sand and Sustainability: 10 Strategic Recommendations to Avert a Crisis | UNEP - UN Environment Programme

growing circularity, wider adoption or improved data quality.

Figure 1.1: Illustration of comparison between policy alternative and zero alternative SCBA



As with other SCBAs, there is uncertainty about the development of both the zero alternative and the policy alternative. The size of the shaded triangle in the illustration shows the best estimate of social value, but the actual outcome may be higher or lower. This underlines the importance of a sensitivity analysis, in which these uncertainties are explicitly taken into account.

1.2.2 Methodology

Starting point in the design of this SCBA, is the General SCBA guidelines[3] and the Work Guide SCBA Digital Government[4]. The General Guidelines provide the generic framework for SCBAs in the Netherlands, complementary to the Working Guide guides ICT, which provides projects with guidance for monetising information benefits, standardisation effects and digital infrastructure.

In accordance with these documents, the following steps have been taken for this investigation:

1. Definition of the zero alternative: Determine how the situation develops without a data space: regional fragmentation, limited data sharing and limited growth of circularity.
2. Elaboration of policy alternatives:
   - BA1: regional data space nodes,
   - BA2: a single national data space with uniform standards.
3. Identification and measurement of costs and benefits
   - Costs: investment, management, governance, connection costs;

Benefits: reduced risk of failure costs, emission reduction, better market functioning and effcient supervision (classification into monetarisable and non-monetarisable (PM^3) effects).

[3] Leidraad MKBA. Ministry of Finance. (in dutch)
[4] Werkwijzer Digitaliseringsprojecten overheid. Ministry of Finance (in dutch)

4. Sensitivity analysis: Identification of the main uncertainties (reduced risk from cost of failure , soil management growth, price effects, transport effects). These variables are varied to determine the robustness of the outcomes.
5. Preparation and presentation of the cost-benefit overview: All effects are systematically arranged and presented in Net Present Value (NPV), with full transparency on assumptions, key figures and calculation methodology.

1.2.3 Method of operation

The costs and benefits were determined on the basis of a meta-analysis, using existing studies, available data sets, practical examples, expert interviews and the insights from the Effects Arena with stakeholders from the circular soils sector. This involves, among other things, the following sources and steps:

- Analysis of previous studies and market vision[5] of the Buyer Group Grondstromen;
- study of regional initiatives, such as 'Grip-op-Grond' Fryslân[6];
- Input from experts on soil quality, logistics, supervision and circularity;
- Model-based calculations of additional costs and benefits based on soil volumes, emissions, transport movements and price effects;
- Validation session with experts from the field, including the soil sector as experts in the current matching of supply and demand.

The assumptions, key figures and calculations are coordinated with the client and discussed in a validation session with stakeholders from different parts of the circular soil chain. On the basis of this session, various posts have been tightened, including hourly rates and logistical effects. Annex 1 contains a list of involved parties and parties that participated in the Effects Arena and/or validation session. Finally, a sensitivity analysis was carried out. This sensitivity analysis investigated how the results change if crucial assumptions turn out differently. This provides insight into the reliability of the SCBA calculations and the extent to which the final result is robust under different scenarios.

1.3 Reading guide

Chapter 2 explains the delineation of the analysis, including the policy context, the zero alternative, the policy alternatives and the expected societal impacts. Chapter 3 presents the main results in broad terms, including total costs, benefits and the balance. Chapter 4 describes the costs in more detail, while Chapter 5 explains the benefits in detail. Chapter 6 sets out the conclusions and the significance of the results for policy and implementation.

[5] Market Vision | Buyers Group Grondstromen (in dutch)
[6] Grip on Grond | Fryslan (in dutch)

2 Scope of analysis

This chapter describes the policy context and delineation of the SCBA. First, it sets out the problem analysis that leads to the exploration of a data space for circular soils. The zero alternative is then defined, after which the policy alternatives are described. Finally, the assumptions surrounding the development of circular soil management are explained and a qualitative inventory is given of the effects that the data space can bring about.

2.1 Problem analysis

A SCBA starts with an elaboration of the problem analysis. The general SCBA guideline states the following: 'The problem analysis ensures that the SCBA is in line with the current policy issue. To this end, the problem analysis focuses on the question of which bottleneck arises (or which opportunity remains unused) without government intervention, which policy issue arises from this and what promising solutions there are to achieve the policy goal.'

Analysis of policy documents and discussions shows that there are a number of structural bottlenecks in the Netherlands: a growing demand for soil, limited possibilities for primary extraction, fragmented information provision and a high societal ambition to work in a circular way.

2.1.1 (Future) scarcity of raw materials

Every year large amounts of soil are released during construction - and infrastructure projects. At the same time, increasing spatial scarcity leads to restrictions in the authorisation of new extraction of primary raw materials. Both Cascade[7], the trade association of surface mineral winners, and the Buyer Group Grondstromen signal a structural decrease in licensed sand and gravel extraction in the Netherlands. Their Circular Soil Market Vision shows that national sand extraction will fall by around 44% towards 2030 and even by 75% towards 2035 (compared to 2021), while gravel extraction is expected to come to a near complete halt.

Internationally, according to the UNEP report Sand and Sustainability (2022)[8], sand scarcity can lead to global market distortions and rising costs in the long term. The Dutch Ministry of Infrastructure and Watermanagement (IenW) is currently carrying out the national assessment of primary building materials. This should show whether this effect will also occur within the Netherlands – and if so, in what period and to what extent. The question now is whether this will lead to market scarcity and higher costs in the Netherlands in the longer term. However, it is clear that these developments reinforce the dependence on secondary soils and increase the urgency to work circularly.

2.1.2 Ambition to work circularly

The Netherlands has set itself ambitious goals: 50% circular use of raw materials in 2030 and

[7] There is a risk of resource scarcity: national strategy in our societal interest

[8] Sand and Sustainability: 10 Strategic Recommendations to Avert a Crisis | UNEP - UN Environment Programme

full circularity in 2050[9]. Without the structural availability of data on the quality, origin and application possibilities of land, these objectives will continue to be difficult to achieve.

2.1.3 *Inefficiencies and costs in implementation*

Lack of visibility on released and applicable soil creates double logistics, transport distances become unnecessarily large and potentially usable soils are sometimes transported off-site. This leads to higher costs, additional CO_2 emissions and suboptimal use of available soils.

2.1.4 *Inconvenience to residents near projects*

Lack of insight into soil demand and supply results in additional transport movements with associated noise nuisance and reduced road safety. In addition, the removal of soil leads to unnecessary environmental pressure and loss of valuable materials.

2.2 Zero alternative

In a social cost benefit analysis, a comparison is made between the developments and effects in the policy alternative (when the project is realised) and those in the zero alternative (when the project is not carried out). The zero alternative is the most likely development if no (national or regional) data space introduces circular soil management. It includes both exogenous trends and existing policies and already foreseen measures that are expected to take place anyway.

Current developments without a data space

Activities aimed at improving the reuse of released land and information sharing are already taking place in several regions. These existing initiatives are part of the zero alternative. These include:

- Existing regional or local data spaces, such as in Fryslân with ‘Grip op Grond’[10], which localise the supply and demand of soil flows;
- Growing focus on the circular use of raw materials in public policy programmes, without a national standard or coordinated set of agreements and governance;
- Slightly increasing reuse of soils, but mainly limited to ‘low-hanging fruit’ and heavily dependent on local initiatives or policy priorities.

Characteristics of the zero alternative

In the zero alternative, no data space for circular soil management is available. The rate of reuse is increasing somewhat, but:

- Is limited to relatively small volumes;
- Takes place mainly within existing regional partnerships;
- Depends on voluntary, non-standard data sharing;
- Does not lead to a national overview of released and applicable soil.

[9] The National Circular Economy Programme 2025 has another intermediate target of 55% circular use by 2035.
[10] Grip on Grond | Fryslan (in dutch)

This does not create a structural impulse in the zero alternative to increase circular reuse of soils nationally. National targets are not guaranteed and differences between regions persist.

2.3 Policy alternatives

This section outlines the policy alternatives that come on top of the developments in the zero alternative. A policy alternative is a coherent and practicable set of measures aimed at achieving the policy objectives, in this study a high-quality reuse in which released soils are reused as much as possible within the project or area. Two policy alternatives are identified in order to understand the differences in social costs and benefits:

1. Five regional data space nodes with limited data sharing, leading to partial reuse;
2. A national data space circular soils, leading to full circular reuse in 2050.

Alternative 1: Partial reuse with regional data space nodes

In this alternative, five regional data space nodes for circular soil management will be developed and operational by 2030. These are based on existing initiatives such as 'Grip op Grond' in Fryslân. Main features:

- Regional systems better match the supply and demand of soil flows, but there is no national standardization;
- It is up to each region to decide which environmental data and soil data are to be included; Uniformity is lacking;
- Reuse takes place mainly at local and regional level and to a limited extent between neighbouring provinces;
- Released land is used as high-quality as possible within the same area, with 'good reusable soil' being used almost entirely from 2030 onwards. The national target of 50% circularity by 2030 will not be met;
- Reuse is applied in new designs and projects. Existing designs will not be revised; no delay or additional design effort is assumed.

Alternative 2: Fully circular and reuse of soils supported by a national data space

In this alternative, a national data space circular soils will be operational in 2030, including the set of agreement and governance structure. Main features:

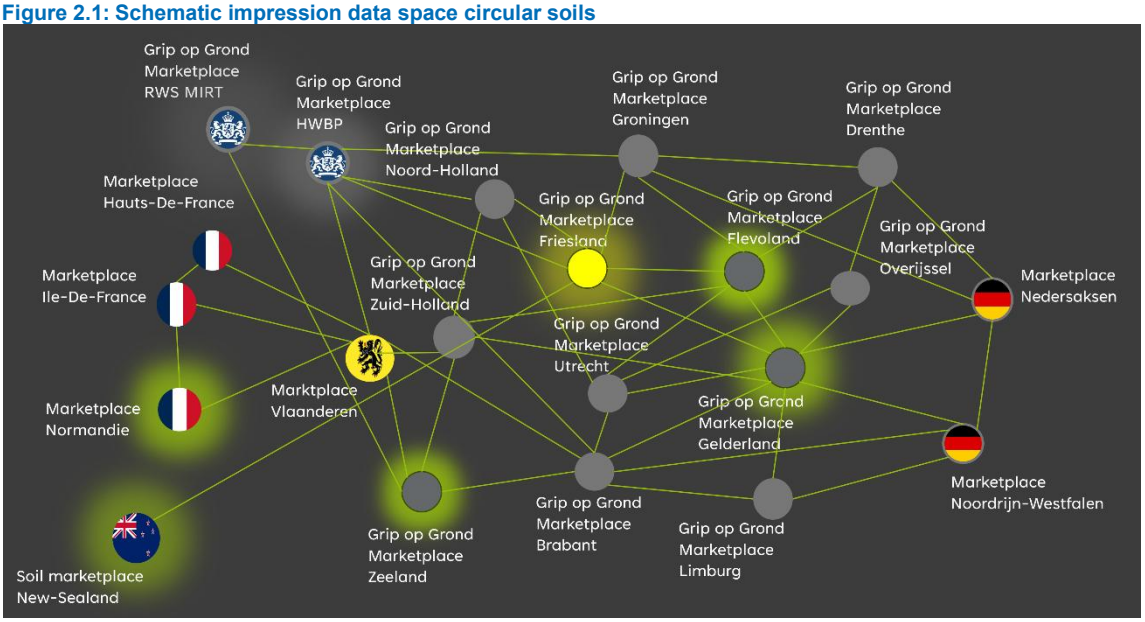
- The data space is linked to the National Key registry of the Subsurface (in dutch Basisregistratie Ondergrond or BRO)[11], which provides users with up-to-date, standardised environmental data;
- Soil researchers can gain direct insight into the quality of released soil and determine through a national marketplace where it can best be applied;

[11] Key registration subsurface of the Netherlands

- The national target of 50% circular use by 2030 is monitored through the data space; by 2050, fully circular reuse will be pursued;
- Application of reuse takes place in and between all provinces, creating optimal matching opportunities;
- The data space will also be linked to major national investment programmes such as the Multi-year Programme for Infrastructure, Spatial Planning and Transport (MIRT) and the Flood Protection Programme (HWBP). This link ensures that large-scale infrastructure and water safety projects are also included in the circular exchange, allowing significantly larger volumes of released or needed soil to be efficiently reused. This accelerates the scale-up to fully circular use of soils.

Figure 2.1 provides a schematic overview of the design of policy alternative 2. In this SCBA, only national linkages are assumed; cross-border linkages as also shown in figure 2.1 have been excluded from consideration.

Figure 2.1: Schematic impression data space circular soils



Source: Ministry of Housing and Spatial Planning (2025)

2.4 Circular soil management in the alternatives

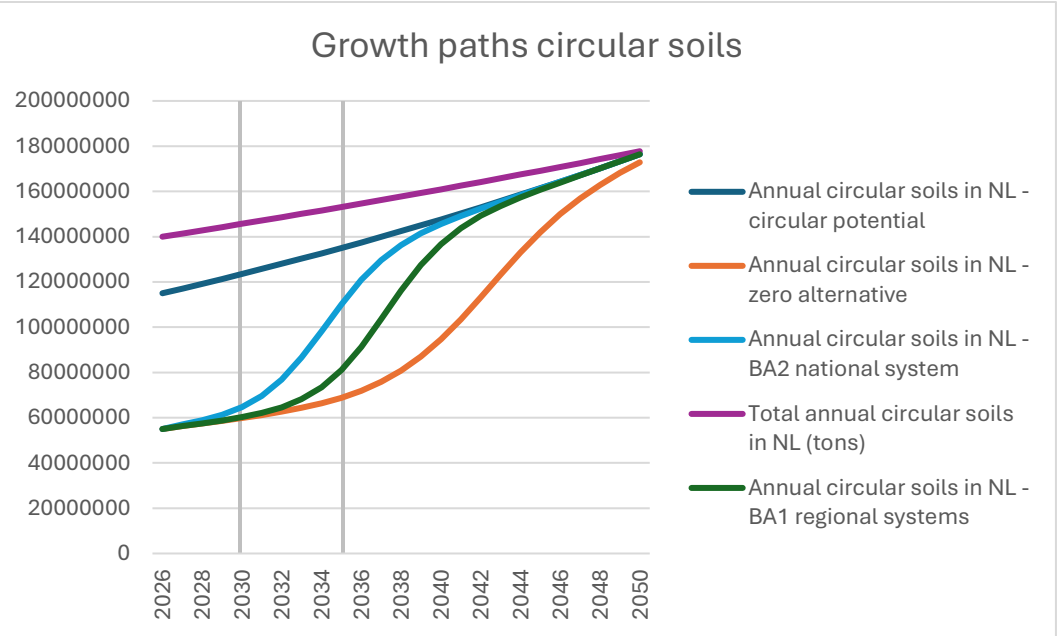
The development of circular soil management in the Netherlands is determined by both the amount of annual earthworks and the extent to which released soil can be reused in a high-quality manner. According to the Market Vision[12] of the Buyer Group Grondstromen, approximately 140 million tons of land are moved every year in the Netherlands, of which an estimated 115 million tons have circular potential. This means that a significant proportion of current soil management are suitable for high-quality or area-based own reuse, but this potential is not yet exploited in current practice. National monitoring data from the Ministry of Infrastructure and Watermanagement show that approximately 55 million tons of these are currently being directly applied, mostly locally or in low quality. This means that in the starting year (2026) 48% of the total circular potential is already used, which serves as the baseline (zero measurement) for the further calculations[13].

[12] Market Vision - Buyers Group grondstromen

[13] Waste treatment in the Netherlands, 2023 data

Against this background, a growth path per policy alternative (see Figure 2.2) has been drawn up for this SCBA for the development of the data space circular soils. These growth paths are based on the insights from the document analysis, interviews, the validation session and the analysis of potential circular volumes.
The reductions in the primary sand extraction are shown in the figure with the green and black markings. As described in section 2.1.1, national primary sand extraction is decreasing by around 44% towards 2030 and even by 75% towards 2035 compared to 2021. These years are shown in the figure below with the vertical grey lines. This development in the supply of sand reinforces the demand for circular soils. This is visible in the figure as an increasing demand for circular soils, also in the zero alternative (the autonomous development).

Figure 2.2: Future development of circular soils



Zero alternative

In the zero alternative, the circular development lags behind. Although total soil demand in the Netherlands is slightly increasing due to demographic growth and infrastructural challenges, there is no systematic incentive to link demand and supply of released soil. As a result, high-quality reuse is limited to the so-called ‘low-hanging fruit’: local exchanges within individual projects.

- The limit of 50% of circular potential will not be reached until around 2034;
- The full use of the circular potential (100%) will not be in sight after 2050.

Policy alternative 1: Regional data space nodes

This regional alternative creates regional markets in which the supply and demand of soils are better matched. Project teams can apply released soil more frequently within the region, reducing transport distances and partially replacing primary extraction.

- 50% circular potential is reached in 2031, three years earlier than in the zero alternative;
- The maximum achievable level will be reached around 2045.

Policy alternative 2: National data space

In this national alternative, the supply and demand of soil management are not only linked regionally, but also interregionally. The Market Vision of the Buyer Group Grondstromen shows that many circular opportunities are now not being exploited because circular soils stop at regional borders and organisations have no insight into supply and demand across regional borders. A national system makes these links possible.

In addition, in this alternative, the integral quality values of soil (biological, physical, chemical and functional) are also better unlocked, so that more high-quality applications can be realized.

- The level of 50% circular potential will already be reached in 2029, partly because the MIRT and HWBP are quickly linked to the data space.
- The maximum achievable level in 2042, due to early and national matching opportunities.

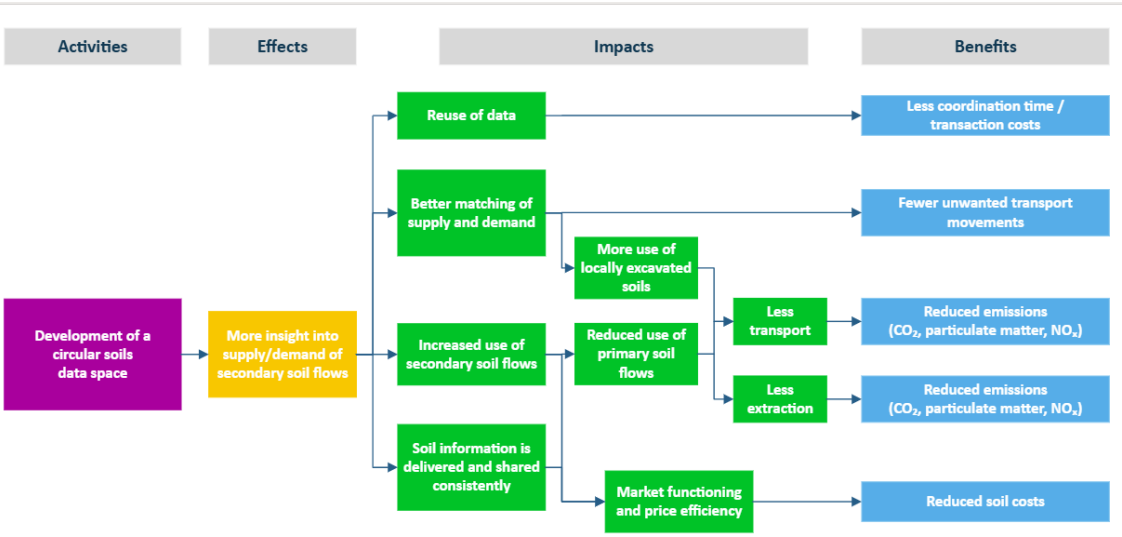
2.5 Possible effects

In this section, a qualitative inventory is made of the possible effects that can occur when a regional or national data space for circular soil management is realized. The effects are based on insights from the Effects Arena of 21 November 2025 and additional documentation. The inventory describes the relationship between the measures in the policy alternatives and the expected market , project - and environmental impacts, compared to the situation without a data space (zero alternative). It is a model-based representation that does not yet make any statements about the quantitative size of effects.

2.5.1 *Impact scheme*

The impact scheme in Figure 2.3 provides a schematic representation of how the development of a regional or national data space influences activities towards ultimate social benefits. The scheme provides insight into how an improved information position in the chain can lead to better coordination, more efficient market operation and substantial project , environment - and health effects.

Figure 2.3: Impact scheme



Main features of the effects

The introduction of a data space has the potential to affect three domains:

1. Market effects: price formation, less information - asymmetry and better matching of demand/supply;
2. Project effects: less failure costs, faster coordination and less transport;
3. Environment and health Impacts: fewer transport kilometers, less primary extraction, lower emissions and higher soil quality.

2.5.2 *Market effects*

A regional or national data space can influence different market mechanisms. The main expected effect is to increase the transparency of soil management markets by making information on origin, quality, volumes and times of availability more reliable and easily accessible. By making data more transparent and accessible, both the government and the market parties (soil and dredging companies) will have a better insight of available volumes and quality of soil. As a result, price formation can become less dependent on incomplete information and soil prices can decrease (price efficiency effects).

In addition, better matching between supply and demand can lead to better matches between projects, which can result in fewer unwanted movements, resulting in less ecological damage.

2.5.3 *Project effects*

Within projects, a data space can lead to various effects:

- Less alignment time;
- Lower failure costs.

Less alignment time

In current practice, project teams spend time on reconciliation, search costs and solving mismatches in quality or volumes. With standardized and shared data, this alignment time can decrease.

Lower failure costs

Part of the failure costs in soil projects stem from unclear quality information, wrong assumptions or late changes. The system reduces the risk of mishandling soil quality or logistics, reducing redesign, delays and cost overruns.

2.5.4 *Environmental and health impacts*

The transmission of the data space to environmental and health impacts is done through two mechanisms:

- Increased use of area-specific and/or secondary soils; and
- Reduction of transport and primary extraction.

Reduction of transport and emissions

If supply and demand are better matched, the costs of transport may decrease. Less and/or shorter transport flows potentially lead to lower CO_2 emissions, less NO_x and particulate matter emissions and a reduction in noise pollution.

Reduction of primary extraction

In addition, better use of secondary soils can contribute to a decreasing need for primary extraction. Less extraction of primary resources can result in lower environmental pressure and reduce disturbance of nature and soil areas.

Effects on the living environment

Fewer transport movements and less removal of soil can further contribute to lower disruption pressure in residential areas, which can have positive effects on quality of life and road safety. In addition, the increased use of area-specific land can improve the ecological value of the soil. However, due to the loss of soil services such as subsidence or the raising of dikes, there will probably always be a demand for primary soils in the Netherlands.

3 Key findings

3.1 Introduction

This section outlines the main outcomes of the social cost-benefit analysis. First of all, we provide insight into the general principles used. We then provide insight into the costs and benefits for society as a whole (government, companies and citizens). A sensitivity analysis has been used to determine the extent to which some assumptions and suppositions influence the results. At the same time, this provides insight into the robustness of the analysis.

3.2 General principles

We have used a number of principles for the cost-benefit analysis of the data space. The general principles are as follows:

- The time horizon of the project is 2050;
- The starting year for investments is 2027;
- The costs and benefits have the price level 2026;
- The discount rate is 2.8%;
- The costs are additional costs (the additional costs incurred in the policy alternative compared to the costs in the zero alternative);
- The starting year for a fully operational data space is January 2029;
- The starting year of the benefits is 2027 (with the introduction of the first projects). The benefits of this also take place in the same year of introduction (no delay);
- In this SCBA different hourly rates are used for project managers (€ 96/hour), enforcement employees and administrative employees (respectively € 69/hour and € 50/hour). For this purpose, the hourly rates of previous SCBAs have been adjusted for inflation and validated with stakeholders;
- The costs and benefits presented relate only to the additional effects: the difference between the policy alternative (with data space) and the costs and benefits in the zero alternative (without data space);
- The total cost estimate includes both the development and implementation costs as well as the structural management costs of the IT system and the associated organisation (such as licensing and supervision).

Specific principles:

- The adoption of the data space and the share of high-quality reuse of soils increase via an S-curve (ingrowth path) during the duration of the analysis, starting from the commissioning in 2027;
- The realisation of the benefits (such as the savings on reconciliation time, the reduction of failure costs and the reduction of emissions) follows the same line as this coverage ratio, namely the S curve;
- In our assumption, the total volume of annual earthworks in the Netherlands (approximately 140 million tons) increases by 1% per year, while the average project size as a basic starting point remains the same for the entire lead time;

- One-time (investment) costs for the government take place exclusively at the front of the project, during the construction and implementation of a national management information system (dashboard) and regional systems. The structural costs that follow mainly concern system management, governance, licensing and enforcement;
- For the connection to the regional systems, it has been assumed that the various decentralised parties (such as the regional data source holders) independently incur connection costs for their data sources. Large-scale cost reductions due to national bundling of these local ICT adaptations have not been counted here, where this applies for policy alternative 2 (national system);
- There is no retroactive input or digitisation of data; only new soil management and projects are recorded in the system from the moment of going live;
- Any autonomous, large-scale IT renovations of existing decentralised systems have not been taken into account in the cost estimate;
- In the zero alternative, the current, fragmented method remains, whereby regional initiatives such as those in Friesland continue to grow autonomously and people continue to depend on decentralised, local initiatives.

3.3 Overview of social costs and benefits

This section gives an overview of the social costs and benefits. Section 3.3.1 provides insight into the total costs. These are further elaborated and explained in chapter 4. Section 3.3.2 provides insight into the benefits. These are then further elaborated and explained in Chapter 5. Subsequently, the various cost items are dealt with separately.

To determine the costs and benefits, we used the effects (benefits and more costs) of the data space in relation to the expected development without this system (the policy alternative versus the zero alternative). In addition, the costs and benefits are presented according to two different concepts: the effects at the final year (2050) and the Net Present Value (NPV).

The effects in 2050 relate to the structural costs and benefits experienced in that year. This reference year has been chosen because in previous years adoption and growth paths (S-curve) are still being worked on, so that the full annual effect is not yet overcome in the early years. With one-off costs or benefits, there is of course no longer any effect in this final year 2050, as these have already been realised at the beginning of the term. The net present value (NPV) refers to the current monetary value of the range of amounts paid or received in the future, discounted at the discount rate mentioned above.

3.3.1 Costs

For the costs, we distinguish between the one-off investment costs for both the local authorities and the market (one-off connection costs) and the central government (IT development and project costs), and the annual recurring costs. These structural costs consist of administrative and supervisory burdens for the government (system management and governance) and the structural costs for data registration.

In this SCBA, we compare two policy alternatives with the zero alternative:

- Policy alternative 1, multiple regional systems: The total costs for the realisation and operation of the regional system amount to € 91 million (NPV). At the end of 2050, the structural costs will amount to € 5 million per year;

- Policy alternative 2, one national system: The total costs for a fully nationally controlled system are considerably higher at € 116 million (NPV). The structural costs in 2050 amount to € 6 million per year.

The main differences between the alternatives are: The national alternative is in total more expensive than the regional alternative. This difference is mainly driven by the significantly higher costs for the set of arrangements and national governance (€43.6 million NPV for BA2 versus €19.5 million for BA1). The one-time IT investments and connection costs are also higher with the national alternative.

On the other hand, a national system provides economies of scale in the operational phase: the structural connection costs for maintaining connected data space nodes and obtaining feedback are lower for BA2 (€ 30.8 million NPV) than for the more regional approach of BA1 (€ 38.5 million NPV).

Table 3.1 shows the costs for both policy alternatives compared to the zero alternative. All costs presented below are expressed over the full time horizon 2026–2050 and are discounted in cash at a discount rate of 2.8%. This concerns net present values (NPV) and not the costs per year.

Table 3.1: Overview of total costs of implementing data space circular soils

	NPV 2026-2050 (2.8%) in € million	NVP 2026-2050 (2.8%) in € million	Explanation
	Difference BA1 and Zero alternative	Difference BA2 and Zero alternative	
Set of arrangements and governance	€ 19.5	€43.6	Costs for the organization. This includes the ongoing management of standards, legal frameworks and national governance.
Coordination at regional level	€3.9	€3.9	Costs for decentralised coordination, implementation guidance and governance within the regional networks/nodes.
Investment data space	€ 2.5	€ 4.1	One-time development and implementation costs for the IT infrastructure of the data space.
Structural management burdens	€ 13.2	€19	Annual recurring IT costs for, among other things, the hosting, the technical maintenance of the data space.

One-time rule/connection costs	€ 1.9	€ 3	One-time costs for (decentralized) source holders to connect their own local systems to the system.
Soil quality maps, etc.	€ 11.8	€ 11.8	Investments needed for cleaning, harmonising and periodically (e.g. 5-yearly) updating the soil quality maps.
Structural connection costs	€ 38.5	€ 30.8	Annual recurring costs for the technical maintenance of connections, data quality checks and the processing of feedback.
Total	**€ 91.4**	**€116.2**	

3.3.2 Benefits

In this section, the expected benefits of the data space are plotted out of circular soils. These benefits are both of a financial nature (such as efficiency gains in hours and lower project costs) and of a social nature (such as environmental gains and less health damage caused by emissions).

As with the cost side, we compare the two policy alternatives with the zero alternative:

- BA1 (Regional): The total social benefits of the regional system amount to € 270 million (NPV). By the end of 2050, the annual structural income will amount to €2.8 million;
- BA2 (National): The total benefits for the national system are more than twice as high at € 554 million (NPV), with structural benefits per year also higher in 2050 (€ 3.3 million).

An important methodological nuance is appropriate with regard to the pre-existing structural benefits in 2050. Such a snapshot is somewhat biased. The benefits in this SCBA are realized per project that is carried out more efficiently and more circularly thanks to the data space than in the zero alternative. As the market adoption of the data space and the shift to circular soil management follow a gradual ingrowth path (an S-curve), the year 2050 shows the situation in which the system has reached its maximum potential. The net present value (NPV) is therefore a much purer measure of total social profit, as it takes into account the gradual build-up of the number of circular projects over the entire duration.

The main differences between the alternatives are**:** Both alternatives make a significant contribution to reducing claims and failure costs (the largest structural benefit item) and stimulate more efficient market operation.

However, the national alternative (BA2) scores substantially better on most benefit items than the regional alternative (BA1). Because a national, central system crosses local and regional borders and makes the (interlocal and interregional) circular soils much more transparent and coordinated, the expected impact on market forces and price efficiency is a factor 2.5 times greater (€ 198 million NPV for BA2 versus € 80 million for BA1). The resulting environmental

benefits (less CO_2-, NO_x- and particulate matter emissions due to more efficient logistics and less primary extraction), as well as the savings on enforcement and soil research, are also considerably higher in a nationwide system. Table 3.2 shows in detail all income items for both policy alternatives.

Table 3.2 Overview of total benefits introduction of the data space circular soils

	NPV 2026 2050 (2.8%) in € million.	NPV 2026 2050 (2.8%) in € million.	Explanation
	Difference BA1 and Zero alternative	Difference BA2 and Zero alternative	
Alignment time/transaction costs	€ 3.4	€5.6	Efficiency gains because project leaders and buyers spend less time searching, preparing and tuning data on earthmoving.
Claims and failure costs	€89.3	€146.2	Financial savings due to early identification of risks, which avoids unexpected costs, delays and errors during implementation.
Air pollution traffic NO_x and particulate matter	€ 42.9	€96.8	Health benefits (avoided social damage) due to a decrease in polluting kilometres thanks to smarter logistics.

	NPV 2026 2050 (2.8%) in € million.	NPV 2026 2050 (2.8%) in € million.	Explanation
	Difference BA1 and Zero alternative	Difference BA2 and Zero alternative	
CO2 reduction due to less transport	€ 10.0	€25.6	Climate benefits because land flows are matched more locally and efficiently.
CO2 reduction due to less primary extraction	€ 9.3	€26.0	Climate benefits due to the avoided CO2 emissions that would be associated with the extraction, processing and transport of new (primary) material.
Reuse of data	€0.2	€0.4	Time savings for designers, analysts and policy staff because existing data is immediately usable and does not have to be re-collected or processed.
Market forces and price efficiency	€80.6	€ 197,8	Financial benefits because a more transparent system better matches supply and demand, resulting in sharper prices.
enforcement	€ 11.1	€ 18.2	Savings through more efficient, risk-based monitoring (less physical checks needed) and avoided environmental damage due to a decrease in illegal movements.
Soil survey	€20	€32.8	Savings because projects have to carry out fewer new (physical) soil surveys and probes thanks to the availability of up-to-date data.
Data entry	€1.8	€ 3.0	Less time spent on data entry because the delivery of information (instead of via separate PDFs) is digital and standardised.
licensing	€0.9	€ 1.5	Savings at the competent authority (municipalities/environmental services) through faster testing thanks to first-time-right delivery and automated validation.
Total rounded	**€270**	**€ 554**	

3.3.3 *Balance & break-even*

Table 3.3 shows the final result of this SCBA. This compares the costs and benefits discussed in paragraphs 3.3.1 and 3.3.2, resulting in the final social balance.

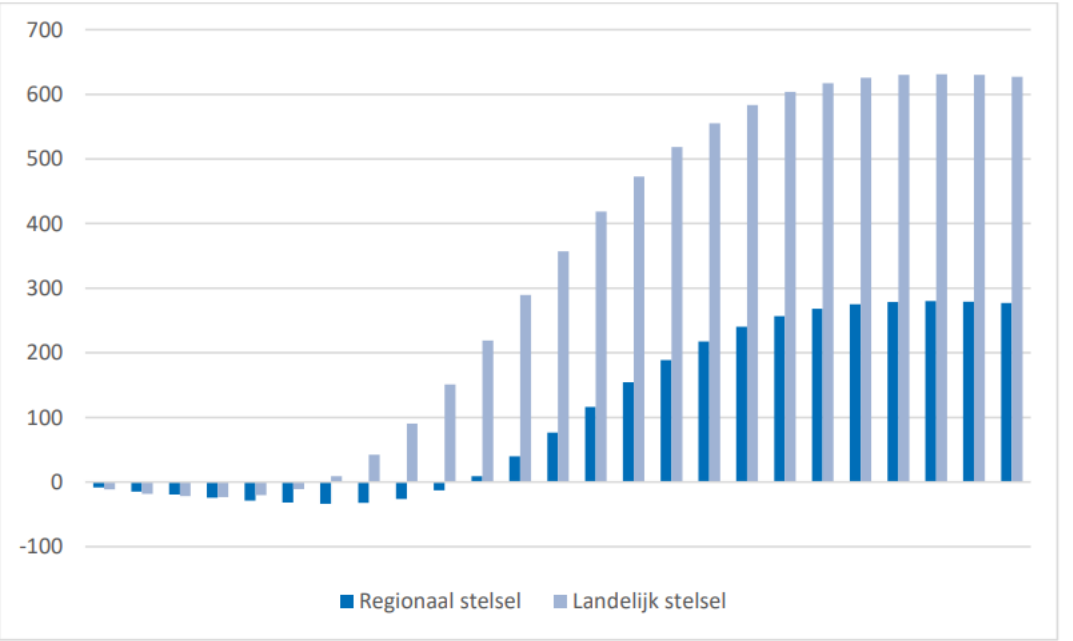
This balance is strongly positive for both policy alternatives. For the regional alternative (BA1), the balance is + € 178 million (NPV). With the national alternative (BA2), this social return is considerably higher with a balance of + € 438 million (NPV). This means that the introduction of the data space will bring significant social benefits to circular soil management in any form. In addition, it is plausible that this positive balance is in reality even greater due to non-quantified benefits (the PM-posts), such as long-term policy information, possibilities for reuse of data, better enforcement and environmental gains.

Table 3.3: Overall overview of social costs and benefits

Variable	BA1: Regional (NPV 2027-2050 in € million)	BA2: National (NPV 2027-2050 in € million)
Costs	€91	€116
Benefits	€ 270 + PM	€ 554 + PM
Balance (benefits – costs)	**+ € 178 + PM**	**+ € 438 + PM**

Figure 3.1 shows the costs, benefits and the balance cumulatively over time. Due to the cumulative nature of this figure, we see that the national system has a positive balance from 2032 onwards, followed by the regional system in 2036.

Figure 3.1: Phase of cumulative costs and benefits (nominal) over time (EUR million)



Of course, the bulk of the costs is at the front of the time horizon. The largest investment and connection costs are incurred in the lead-up to and during the first years of implementation (from 2027). Once the system is operational, costs fall to a structural level for management and enforcement.

The benefits, on the other hand, follow an S-curve: in the first years, the use and adaptation of reuse of soil in the market grows, after which the benefits increase steeply as more and more projects use the data space and reuse of soil becomes the norm.

Looking at the balance, the conclusion is that from 2032 onwards the cumulative benefits of the national data space will outweigh the cumulative costs, the so-called break-even point. In 2036, this is the case for the regional system. In other words, the social payback period is between 5 and 9 years. As BA2 has higher start-up costs, but also generates significantly larger (and faster increasing) benefits, the tipping point for the national system is expected to be more favourable than for the regional alternative.

3.3.4 Scenario: Phased transition from regional to national

Policy practice sometimes considers phasing out the development of the data space: start with regional systems (BA1) to integrate them at a later stage or scale them up to one national system (BA2). While this approach may seem intuitively logical from a risk management perspective, the analysis shows that it is likely to lead to inefficiencies and suboptimal societal returns.

In a phased introduction, two adverse effects occur:

- In the first phase, both public authorities and market players must invest in construction, governance and technical connection to the regional systems. In the event of a later transition to a national system, these parties will again have to incur one-time (IT) connection costs in order to comply with the new, uniform national standards. A substantial part of the initial regional investments should be considered as sunk costs in this scenario;
- The benefits of the data space, in particular the reduction of failure costs and the substantial improvement in market forces, only realise their maximum potential with interregional matching and national coverage. By first operating regionally, society misses the added value of the national system during the transition years. Because the adoption and the associated benefits follow an S-curve, delaying national uniformity ensures that the maximum benefit potential is reached later.

A phased route therefore leads, on the one hand, to cumulatively higher total costs over the duration and, on the other hand, to structurally lower total benefits compared to direct national introduction. The resulting social balance of this transition scenario will be positive, but will be significantly lower than the + € 438 million (NPV) of policy alternative BA2. From an economic and social perspective, the direct establishment of a single national standardised system (BA2) is therefore more effective than a phased transition.

3.4 Sensitivity analysis

A sensitivity analysis provides insight into the consequences of adjusting a number of key assumptions underlying the results of the cost-benefit analysis. In carrying out the cost-benefit analysis, some assumptions were discussed:

- The growth of annual soil management in the Netherlands;
- The potential savings rate of failure costs by the data space;
- The relative fall in soil prices through increased transparency and competition;
- The decrease in the number of kilometers driven/dangered for transport.

Therefore, around these uncertainties, four variants have been designed for the sensitivity

analysis. In each of the variants, we map the effects of this alternative assumption on the balance of costs and benefits, as well as on the payback period.

3.4.1 Variants

The four variants are shown in Table 3.4. The results of these variants are detailed in 3.4.2.

Table 3.4: Variants of sensitivity analysis

Variants	Uncertainty	Change
Variant 1	Annual growth in soil management	No growth in land demand: 0% instead of 1% per year
Variant 2	Failing Cost Savings Rate	Lower savings rate: 0% instead of 10%
Variant 3	Relative price decrease	No price effect: 0% instead of 1% (*BA1*) and 1.5% (*BA2*)
Variant 4	Decrease percentage of kilometres	No decrease in mileage: 0%/0% instead of 20%/19%

3.4.2 Effects variants

The table below shows the results of the sensitivity analysis. In these tables, for the base and per variant, the costs, benefits, the balance and the payback period for the investments are listed. Each variant is based on the basics, with only the adaptation of the variant in question carried out.

Table 3.5: Sensitivity analysis results BA1

Variants	Costs (NPV)	Income (NPV)	Balance (NPV)	Payback period
Basis	€91 million.	€270 million.	+€ 179 million.	9 years
Variant 1	€91 million.	€236 million.	+€ 145 million.	9 years
Variant 2	€91 million.	€181 million.	+€ 89 million.	10 years
Variant 3	€91 million.	€189 million.	+€ 98 million.	10 years
Variant 4	€91 million.	€217 million.	+€ 125 million.	10 years

Table 3.6: Sensitivity analysis results BA2

Variants	Costs (NPV)	Income (NPV)	Balance (NPV)	Payback period
Basis	€116 million.	€554 million.	+€ 438 million.	5 years
Variant 1	€116 million.	€493 million.	+€ 377 million.	5 years
Variant 2	€116 million.	€408 million.	+€ 292 million.	5 years
Variant 3	€116 million.	€356 million.	+€ 240 million.	5 years
Variant 4	€116 million.	€431 million.	+€ 315 million.	6 years

The sensitivity analysis indicates that the results of the SCBA are robust. The balance changes, but remains positive and the payback period differs only by 1 year from the basic variant.

Variant 1: Annual growth in circular soils

The basic variant assumes an annual volume growth of 1% in the total circular soils in the Netherlands. This growth effect affects multiple benefits, such as transport savings, avoided

primary extraction and price efficiency in the land market. Because the development of circular soils was the subject of discussion, this variant is calculated with 0% growth.

The results show that the loss of volume growth causes a marked decrease in total benefits (from €270 million to €236 million NPV for BA1 and a similar trend in BA2). This is because less volume growth means that the system 'works' on a small reuse of soil over time, resulting in less significant annual gains. Although the benefits are lower, the balance remains positive and the payback period remains unchanged.

Variant 2: Reduced Failure Cost Savings

In the basic variant, a savings of 10% has been retained for failure cost reduction. This is based on expert assessments and on experiences from other systems where standardisation and better information exchange lead to less mismatch, fewer contract changes and better coordination between stakeholder parties. Because this percentage is uncertain, a restrained scenario of 0% savings on failure costs has been used in this variant. This means that one of the most important benefits items is fully set out. The effect of this is clear: income decreased from €270 million to €181 million (BA1) and from €554 million to €407 million (BA2). As a result, the net balance decreases and the payback period in policy alternative 1 shifts by one year.

Variant 3: No price effect in soil prices

The basic variant takes into account a relative price decrease for soil due to more transparency, better data and stronger competition. In BA1 this is a price effect of 1%, in BA2 of 1.5%. Because the extent of this effect was the subject of discussion, variant 3 has no price effect (0%). The loss of this price effect results in a decrease in total income (from €270 million to €189 million for BA1; from EUR 554 million to EUR 355 million for BA2). As a result, the payback period increases by one year in policy alternative 1. Despite the lower benefits, the balance remains positive in this variant as well.

Variant 4: Decrease percentage of kilometers of road/inland waterway transport

In the basic variant, the use of the data space leads to a decrease in the number of transport kilometers: approximately 20% less road transport and 19% less inland waterway transport. Because the extent to which transport optimisation occurs is uncertain, an alternative scenario has been calculated in Variant 4 in which no reduction in transport kilometers takes place. The loss of this effect affects several benefit items. The reduction of CO_2- emissions, particulate matter and NO_x is decreasing because the number of kilometers driven and the number of kilometers on water remains the same. This can also reduce the benefits associated with lower logistic costs or less noise pollution. As a result, income in BA1 fell from €270 million to €217 million (NPV). In BA2, income decreased from € 554 million to € 431 million (NPV).

3.4.3 Adoption curves

An important assumption in the SCBA concerns the growth path of circular soils. The assumptions about how quickly circular soils are adopted differ between policy alternatives. It is assumed that a national data space leads to a faster and broader adoption of circular methods than regional systems. Because this adoption rate is uncertain, a sensitivity analysis has also been carried out for this. It looked at what would happen if both policy alternatives followed the same growth curve: once equal to the growth path of policy alternative 1 (slow), and once equal to that of policy alternative 2 (fast).

Table 3.7: Results sensitivity analysis growth path BA1

Variants	Costs (NPV)	Income (NPV)	Balance (NPV)	Difference (BA2-BA1)
Basic BA1	€91 million.	€270 million.	+€ 179 million.	-€ 259 million.
Basic BA2	€116 million.	€554 million.	+€ 438 million.	+€ 259 million.
Variant slow adoption BA1	€91 million.	€270 million.	+€ 179 million.	-€15 million.
Variant slow adoption BA2	€116 million.	€310 million.	+€ 194 million.	+€ 15 million.
Variant rapid adoption BA1	€91 million.	€488 million.	+€ 397 million.	-€41 million.
Variant rapid adoption BA1	€116 million.	€554 million.	+€ 438 million.	+€ 41 million.

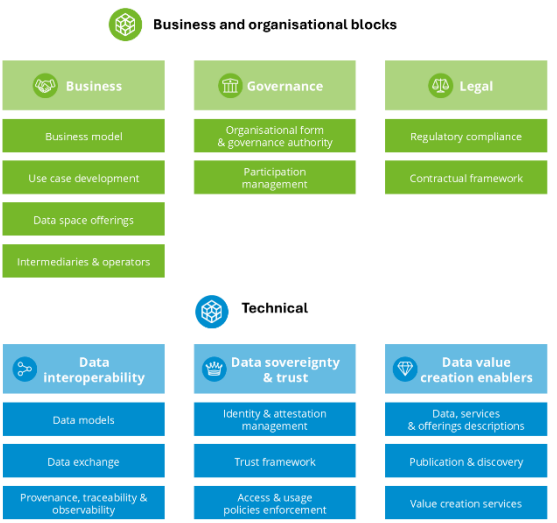
The results show that the results of the SCBA are robust. Although the balance varies by growth path, the policy alternative with a national system remains the most positive in all cases.

4 Costs in detail

4.1 Introduction

This chapter explains the costs associated with the development, implementation and exploitation of the data space for circular soils. The EU Data Space Support Centre's European building block model[13] for data spaces was used to estimate the costs of the data space (see Figure 4.1). We distinguish (1) Set of arrangements & governance, (2) coordination at regional level, (3) investments in the data space, (4) structural management costs, (5) one-time rule/connection costs, (6) soil quality maps, etc., and (7) structural connection costs. For each category, it is explained what the costs include and how they were valued in the analysis.

Figure 4.1: European data space building block model



Source: EU Data Space Support Centre

4.2 Overall overview

Table 4.1 shows the total costs (NPV) for both policy alternatives over the analysis period 2027-2050. The differences are mainly due to the size of the set of arrangements and governance, the investments in the digital infrastructure, and the annual management and connection costs.

Table 4.1: Overview of the total cost of the data space

	BA1: Regional (NPV 2027 - 2050 in € million)	BA2: National (NPV 2027 - 2050 in € million)
Set of agreements and governance	€19.5	€43.6
Coordination at regional level	€ 3.9	€ 3.9
Data space investments	€ 2.4	€4.1
Structural management costs	€13.3	€19.0
One-time connection costs	€ 2.0	€ 3.0
Soil quality maps, etc.	€11.8	€11.8
Structural connection costs	€ 38.6	€30.8
Total costs	**€91**	**€116**

4.3 Set of arrangements and governance

Description of effect

The set of agreements includes the joint set of definitions, data standards, quality criteria, procedural agreements and responsibility sharing that are necessary for the data space to function properly. The governance organisation then manages it: keeping standards up to date, assessing changes, supporting chain parties and monitoring the quality and continuity of the system. Interviews indicated that these costs consist exclusively of labour costs.

Valuation

The costs have been determined on the basis of the structural effort required to develop and maintain the agreement system.

- In BA1, a more modest central organisation is sufficient, which mainly develops frameworks and aligns them with the regional systems. The costs amount to a total of € 19.5 million (NPV).
- In BA2 there is a connection between all twelve provinces, the Multi-year Programme for Infrastructure, Spatial Planning and Transport (MIRT) and the Flood Protection Programme (HWBP). This requires the same tasks per connection, but a multitude of connections. For this reason, the valuation amounts to € 43.6 million (NPV).

4.4 Coordination at regional level

Description of effect

Circular soils are strongly area-based, which means that regional support remains necessary. This coordination includes answering substantive and technical questions, ensuring data quality at regional level and translating national frameworks into regional practice. The experiences from Grip-op-Grond Fryslân[16] indicate that these costs consist of wage costs.

[16] Grip on Ground | Fryslan

Valuation

As regional support in both variants has to be designed in a similar way, the same cost estimate has been made for both BA1 and BA2. The total cost is € 3.9 million (NVP). This post consists of structural staffing and coordination at regional level.

4.5 Investment data space

Description of effect

Setting up the data space requires one-time investments in technical and organisational components that together form the basis for a reliable and usable system. This includes developing the digital infrastructure and architecture, setting up data models and API standards, setting up security mechanisms, establishing links with existing systems and setting up tooling for data quality, validation and support.

Valuation

The costs for these investments have been determined on the basis of substantiated cost inventory of parties involved in the development of the necessary functionalities, including the Ministry of Housing and Spatial Planning, the Ministry of Infrastructure and Watermanagement, Rijkswaterstaat, Geonovum and Sogelink. It looked at the extent of the development needed to get the datas space up and running and the scale at which this development needs to be realised.

In a regional system (BA1), the facilities needed are smaller in scale and less complex, because systems do not create connections with national system building blocks. Investments consist of:

- Implementation of dataspace functionalities (catalogs, data API's, data space connectors);
- Marketplace development and regional digital twin modules;
- Regional organisation of identity management;
- Operationality of data exchange;
- Development of computational models.

The valuation includes:

- One-time investments by regional system;
- Multiplied by the number of data spaces (5);
- Divided over two years.

This results in a total investment of €2.4 million (NPV) for BA1.

In BA2, a single integrated national system is implemented that can be used by all users (twelve provinces, MIRT and HWBP). As a result, the necessary facilities are more extensive and complex. The investments include:

- National data models;
- A national policy registry, identity management and governance establishment;
- National data - exchange infrastructure (API's couplings, data space connectors);
- Development of the national digital - twin architecture for circular soils.

As a result, the investment is higher, namely €4.1 million (NPV) for BA2.

4.6 Structural administrative costs

Description of effect

The structural administrative costs consist of the annual recurring costs necessary to keep the data space running technically and functionally. This involves activities such as hosting the facilities, maintenance of software components, implementing updates, solving malfunctions, monitoring data quality and providing support to users. These tasks are carried out by the system management organisation and therefore constitute an essential cost item for the continuity of the data space.

The extent of these management costs is derived from indicative cost estimates of parties involved in the exploration of the data space, including the Ministry of Hoisin and Spatial Planning, Ministry of Infrastructure and Water management, Rijkswaterstaat, Geonovum and Sogelink. In their inventories, maintenance, management, hosting and support services are identified as annually recurring components of the system. These estimates form the basis for the valuation of this item.

Valuation

In the regional alternative (BA1), the size of the structural administrative costs depends on the number of regional systems. Each system has a fixed annual management cost, and the total annual costs increase as more regions operate. This means that the structural cost is built up by:

- A management cost per regional system per year;
- Multiplied by the number of operational regional systems in a given year.

This calculation method creates an overall picture in which the regional costs account for the largest part of the costs. Over the entire term, this results in € 13.3 million (NPV).

The national alternative (BA2) refers to regional management units and the management of the overarching data space. This fixed annual amount leads to €19.0 million (NPV) for this alternative.

4.7 One-time control/connection costs

Description of effect

The one-time control and connection costs are the initial costs that organisations have to incur in terms of standardisation, mapping and technical connections to make their internal systems, processes and data structures suitable for connection to the data space. An important part of these costs is the development and implementation of the technical connection between the systems of organizations and the data space. This requires a combination of an Application Programming Interface (API) and a so-called trusted connector. An indicative cost estimate has been included in the previous cost inventory that has been used as a basis for this valuation.

Valuation

In the regional model (BA1), organisations connect to regional facilities with a more limited set of functionalities. This results in a one-time cost of €2.0 million (NPV).

In the national model (BA2), organizations must adhere to one uniform national standard, with broader technical and organizational requirements. The initial effort is therefore greater and the costs amount to € 3.0 million (NPV).

4.8 Soil quality maps

Description of effect

For a well-functioning data space it is necessary that reliable and up-to-date soil quality data are available. Both policy alternatives assume that all municipalities must update their soil quality map so that the data comply with uniform data models and are suitable for integration into the system. For the policy alternatives, it is assumed that municipalities update their soil quality map on average once every five years. This frequency is in line with practice, where municipalities such as Haarlem[17], Heerenveen [18] and Lansingerland[19]review their maps approximately every five years. For the costs of this update, a similar cost item from an existing practice case is included, in which an amount of approximately € 10,000 is included for soil-related activities. This estimate was assessed during the validation session as a reserved and realistic estimate for the extent of work that municipalities typically carry out when updating their soil quality map.

Valuation

Since both BA1 and BA2 are based on the same national updating effort by municipalities, the costs in both variants have been determined in the same way. The work required for harmonisation, data quality and accessibility will result in a total cost of €11.8 million (NPV) in both policy alternatives.

4.9 Structural connection costs

Description of effect

Structural connection costs are the annual recurring costs that organizations incur to permanently supply data via the data space. This includes activities such as updating data and adjusting connections in case of changes to standards. In contrast to the structural management burden (paragraph 4.6), which relates to the management of the system itself, these costs are for the parties that provide data; provinces, water boards and other data source holders. The estimation of these costs is based on a previous study carried out in the context of the BRO[20].

[17] Note Soil Management and Soil Quality Map 2023-2028 | Local laws and regulations

[18] Updating soil quality map and soil management memorandum Municipality of Heerenveen | Local legislation and regulations

[19] [BR2100136] Updated Soil Note and Soil Quality Card.pdf

[20] Research into the social costs and benefits of the BRO | Basic registration subsurface

Valuation

The regional alternative (BA1) provides data through different regional systems. The variation in methods and standards leads to higher structural costs, estimated at € 38.6 million (NPV).

The national alternative (BA2) works with one uniform national standard, which requires less management effort. As a result, the annual costs are lower and amount to €30.8 million (NPV).

5 Benefits in detail

5.1 Introduction

This chapter explains the benefits associated with the use and scaling up of the data space circular soils. We distinguish benefits in terms of (1) tuning time, (2) claims and failure costs, (3) air quality and climate (emissions), (4) reuse of data, (5) market operation and price efficiency, (6) enforcement, and (7) process benefits around soil research and administration. For each category, it is explained how the benefits come about and how they have been valued over the entire life cycle (S-curve) in the analysis.

5.2 Overall overview

Table 5.1 shows the total benefits (NPV) for both policy alternatives over the analysis period up to 2050. The benefits are substantially higher in the national alternative. This difference is driven by a greater impact on claim and failure costs as well as the effect on market forces, because interregional and crossregional circular soils in a national system can be connected much more efficiently.

Table 5.1: Total benefits

Post	BA1: Regional (NPV 2026-2050 in € million)	BA2: National (NPV 2026-2050 in € million)
Less reconciliation time/transaction costs	€ 3.4	€5.6
Fewer claims and failure costs	€89.3	€146.2
Air pollution traffic NO_x and particulate matter	€ 42.9	€96.8
CO_2 reduction due to less transport	€ 10.0	€25.6
CO_2 reduction due to less primary extraction	€ 9.3	€26.0
Reuse of data	€0.2	€0.4
Market forces and price efficiency	€80.6	€ 197,8
More efficient enforcement	€11.2	€18.2
Saving soil research	€ 20.0	€32.8
Data input efficiency	€1.8	€2.9
Authorisation efficiency	€0.9	€ 1.5
Improved soil quality on site	PM	PM
More efficient use of space (depots)	PM	PM
Total (calculated)	**€ 270 + PM**	**€ 554 + PM**

5.3 Less reconciliation time and transaction costs

Description of effect

In the zero alternative, project leaders, consultants and buyers spend a lot of time on the work for preparation and the coordination around circular soils. The search for suitable outlets or reusable soil lots is a manual, fragmented process. With the introduction of the data space, the provision of information improves considerably, which directly leads to a reduction in the number of hours required at the front of a project.

Valuation

Based on assumptions from the internet consultation for environmental performance in the construction and civil engineering sector, the preparation in current practice takes an average of 40 hours per project. The system reduces this by an estimated 20% (up to 32 hours). With an average all-in hourly rate of approximately € 96, - this results in structural savings.

- In BA1 (Regional), this yields a NPV benefit of € 3.4 million over the entire term.
- In BA2 (National), this amount is € 5.6 million.

5.4 Fewer claims and failure costs

Description of effect

Failing costs and claims in the Construction and Civil Engineering sector[21] often arise from a mismatch between supply and demand, unexpected soil quality or consequent contract changes during execution. Because the data space ensures a more transparent and reliable information position in the tender and design phase, these unforeseen delays and costs can partly be avoided.

Valuation

The average size of a Construction and Civil Engineering sector project in the Netherlands has been estimated at around € 3.6 million, with the share of failure costs in the zero alternative estimated by experts at an average of 5% (approximately € 200,000 per project). It is estimated that the system can reduce the costs from failure by an estimate of 10% (or 4.5% minimal). With more than 2,500 projects per year, this is the second largest benefit item in the SCBA.

- In BA1 (Regional), the savings amount to € 89.3 million (NPV).
- In BA2 (National), this rises to € 146.2 million (NPV).

5.5 Environmental benefits: emission reductions NO_x, PM , CO_2

Description of effect

Circular earthworks and better coordination through the data space lead to smarter logistics. Soil is more often moved directly ('from work to work') or via shorter routes. This leads to a decrease in the number of transport kilometers driven. In addition, high-quality reuse partially

[21] Grond-, Weg- en Waterbouw (GWW) sector in dutch

prevents new primary soils (such as sand) from being extracted, processed and transported. Together, this leads to a direct reduction of air pollutant cleaning (NO_x and particulate matter or PM) and greenhouse gases (CO_2).

Valuation

The savings were calculated on the basis of the emission factors of CE Delft (STREAM model) and national chain analyses for primary extraction, combined with an expected reduction of 20% in transport distances by road. The emission reductions have been monetised through the official OEI shadow prices for environmental and climate damage. Because the fleet is greening towards 2050 (electrification), the financial benefit of this item decreases in later years.

- In BA1 (Regional), the total combined environmental benefit (NO_x, PM and CO_2) is €62.3 million (NPV).
- In BA2 (National), the logistical profit across provincial borders is greater, resulting in an environmental benefit of € 148.4 million (NPV).

5.6 Market forces and price efficiency

Description of effect

The data space ensures more transparency in the soil market. Where supply and demand still depend heavily on fragmented, local networks, a digital system makes the playing field transparent for all market parties. International studies show that increased transparency and data space access in public procurement leads to more bidding and sharper price formation.

Valuation

A prudent assumption has been made for the calculation; a price reduction on the annual Construction and Civil Engineering contract volume of 1% for the regional scenario and 1.5% for the national scenario (where the playing field is wider). In accordance with the OEI guidelines, only 50% of this price reduction can be counted as pure welfare gains.

- In BA1 (Regional), this results in a welfare gain of € 80.6 million (NPV).
- In BA2 (National), this profit amounts to € 197.8 million (NPV), which makes this the largest separate revenue item of the national system.

5.7 More efficient enforcement

Description of effect

Monitoring and required enforcement of soil quality and earthworks is labour intensive in the current situation. Inspectors of environmental services have to physically visit many locations. The system can be more explicitly 'risk-driven': data analysis in the system detects suspicious movements, which reduces the number of enforcement actions required and the amount of time spent per action.

Valuation

The reduction in required enforcement actions is proportionally linked in the model to the increase in circular projects (the S-curve). Combined with an hourly rate of € 69, - for

enforcers, this results in savings.

- In BA1 (Regional), this benefit amounts to € 11.1 million (NPV).
- In BA2 (National), this benefit amounts to € 18.2 million (NPV).

5.8 Process benefits: soil survey, data entry and licensing

Description of effect

In addition to the large macro items, the digitalisation and streamlining of processes directly benefits both the market and the competent authorities. The efficiency impact is particularly visible in the following three operational process steps:

- Soil survey: In the current situation, soil lots are often inspected several times or unnecessarily, because previous research data are not transferable or are lost between successive projects. Thanks to data sharing within the data space, a historical overview of the soil quality per lot or location is created. As a result, reuse or physically overlapping projects, require less re-drilling or new batch research.
- Data input & reuse: Digitally reviewing and reusing Construction and Civil Engineering data in one central location takes the contractor and designer less time than manual searching.
- Authorisation: Examination of a permit application or notification for land resistance is a labour-intensive process. Thanks to the consolidation of relevant soil lot information within the data space, the licensee has a complete file much faster.

Valuation

These administrative and operational process improvements may seem modest at individual project level, but add up to a substantial social amount over all thousands of annual Construction and Civil Engineering projects in the Netherlands:

- BA1 (Regional): In the regional alternative, the combined savings on these three process steps amount to approximately € 22.7 million (NPV). This benefit largely consists of avoided costs for physical soil research (€ 20.0 million), supplemented by the saved hours for data entry by market parties (€ 1.8 million) and faster licensing by governments (€ 0.9 million).
- BA2 (National): Because a nationwide system applies more quickly to a large number of projects, the benefits for the avoided soil research increase to € 32.8 million, for data entry to € 2.9 million and for permit granting to € 1.5 million. In total, this combined saving amounts to approximately € 37.2 million (NPV).

5.9 Non-quantified income (PM items)

Description of effect

Not all benefits of the data space circular soil management can be expressed in a reliable monetary value. Nevertheless, these so-called PM-items contribute to the social added value. From previous chapters, expert interviews and the Effects Arena, the following qualitative benefits emerge:

- Ecological gains from area-specific soils: By better regional matching of circular soil management, the use of area-specific soils is stimulated. Preventing the introduction of foreign material in the soil protects the local soil quality, the dense flora and fauna and biodiversity.

- Less ecological damage (counteracting unwanted movements)**:** A more transparent chain and better registration reduce the risk of procedural errors or unwanted activities. This reduces the chance that (slightly) polluted soils ends up in clean or vulnerable locations (such as nature reserves or floodplains).
- Strategic linking opportunities and policy making: The wide, up-to-date and standardised availability of data provides local and regional governments and water boards with valuable insight into future flows and allows direct links to other spatial challeges. Concrete examples of these linking opportunities are the integration with related National Key Registry of the Subsurface (BRO) and the data space of the physical living environment (DSFL). This allows the logistics of earthworks to be combined at an early stage with risk analyses or spatial studies. This includes the timely fitting of archaeological soil research or the detection of explosive war remnants.
- Liveability and road safety: Reducing the number of transport movements (see section 5.5) not only brings environmental benefits, but also directly relieves the pressure on the direct living environment around projects. Less heavy freight traffic in residential areas leads to less noise, fewer vibrations, a decrease in bloating dust and an improvement in road safety for local residents.
- More efficient use of space (depots): When supply and demand of soil are better matched ('work-to-work'), there may be a reduced need for long-term temporary storage in soil depots. These unlocked square meters can be used more usefully for nature, housing or business. Conversely, better alignment of supply and demand (and especially visibility of this) can also lead to more regional depots to temporarily store soil while awaiting use that does not match in time with its release.

Valuation

While these effects are expected to be positive, their valuation in an SCBA is too uncertain to monetise. The effects are highly location- and project-dependent. These qualitative social benefits are therefore not included in the total financial sum in Table 5.1, but are included as substantial Pro Memori (PM) items in the decision-making process. Both the ecological gains and the improved information provision (such as the just mentioned linking opportunities with regard to the BRO, DSFL, archaeological research and war unexploded remnants are logically greater for the national alternative (BA2) than for the regional alternative (BA1). In the national data space alternative, data can be more easily exchanged via national APIs with other national government systems, whereas in BA1 regional systems this would be more fragmented and thus lead to more costly and time-consuming customisation.

6 Conclusions

6.1 Positive impact on society

The results of this SCBA show that the introduction of a data space for circular soil management leads to a clear social added value. In both policy areas, the benefits outweigh the costs by far. The regional alternative (BA1) generates a positive balance of € 178 million (NPV), while the national alternative (BA2) generates significantly higher benefits with € 438 million (NPV).

The benefits come from multiple sources: reduced failure costs, better matching of supply and demand, lower logistical burdens, reduction of CO_2 and other emissions, improved data quality and a more transparent market process.

The national policy alternative reinforces these effects through scale and uniformity. As a result, supply and demand can be better matched and more secondary soils can be deployed. The SCBA thus shows that a data space, and in particular a nationally organised system, can be an effective tool to reduce social costs and increase circular soil management.

On the basis of this SCBA, the following conclusions can be drawn:

- Even with a modest approach of the SCBA, the introduction of a national data space provides society with the highest benefits that outweigh the costs to be incurred. The link with the MIRT and HWBP has a strengthening effect on the supply and demand of circular soil management. The large volumes from these two programs ensure that investments are recouped quickly;
- The introduction of a regional system also brings benefits to society, but substantially less in size. These lower social benefits also outweigh the expected costs;
- A phased route leads, on the one hand, to cumulatively higher total costs over the duration and, on the other hand, to structurally lower total benefits compared to direct national introduction. From an economic and social perspective, the direct establishment of a nationally standardised system is therefore more effective than a phased transition;
- It therefore seems sensible to develop a national system directly, and not to opt for a regional system or a phased approach, because the additional benefits of the national system far outweigh the additional costs;
- The sensitivity analysis shows that the results of the cost-benefit analysis are robust, but also highly dependent on the future growth of the volume of released soils that are reused in a high-quality way to avoid unnecessary disposal;
- This means that the intended acceleration of the transition, as expressed in the market vision of the Buyer Group Grondstromen (a collaboration of Directorate-General for Public Works and Water Management, provinces, water boards and municipalities), will have to become a reality.

6.2 Sensitivity of results

The sensitivity analysis shows that the results are robust. In all variants, the benefits remain

higher than the costs, despite changes in assumptions about important uncertainties such as:

- Volume growth of circular soil;
- Savings on failure costs;
- Price effects in the soil market;
- Reduction in transport kilometers;
- Speed of adoption.

Variations in these assumptions reduce the benefits, but the balance remains positive and the return period changes marginally (up to one year compared to the zero alternative). This applies to both BA1 and BA2.

This result indicates that the social added value of the data space circular soils is not dependent on one dominant benefit item, but is supported by a broad spectrum of effects. This does not change the order of precedence between policy alternatives: the national system remains the most socially positive in all sensitivity variants.

Annex: consulted parties

Table B.1: List of consulted Parties

Organisation	Interview	Effects Arena	Validation session
Boskalis			x
Buyer Group Grondstromen	x	x	x
Copernicos	x	x	x
DAGnl			x
Municipality of Lelystad (Flevoport)	x		x
Geonovum	x	x	x
Municipality of Amsterdam	x		x
Grondbanken Netherlands	x	x	x
Grip op Grond Province of Fryslân	x	x	x
Project Meanderende Maas	x		x
Ministry of Infrastructure and Watermanagement	x		x
Ministry of Housing and Spatial Planning	x	x	x
Environment department Arnhem Region			x
Province of Gelderland			x
Rijkswaterstaat	x	x	x
Sogelink	x		x
TNO - Geological Service Netherlands	x	x	x

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