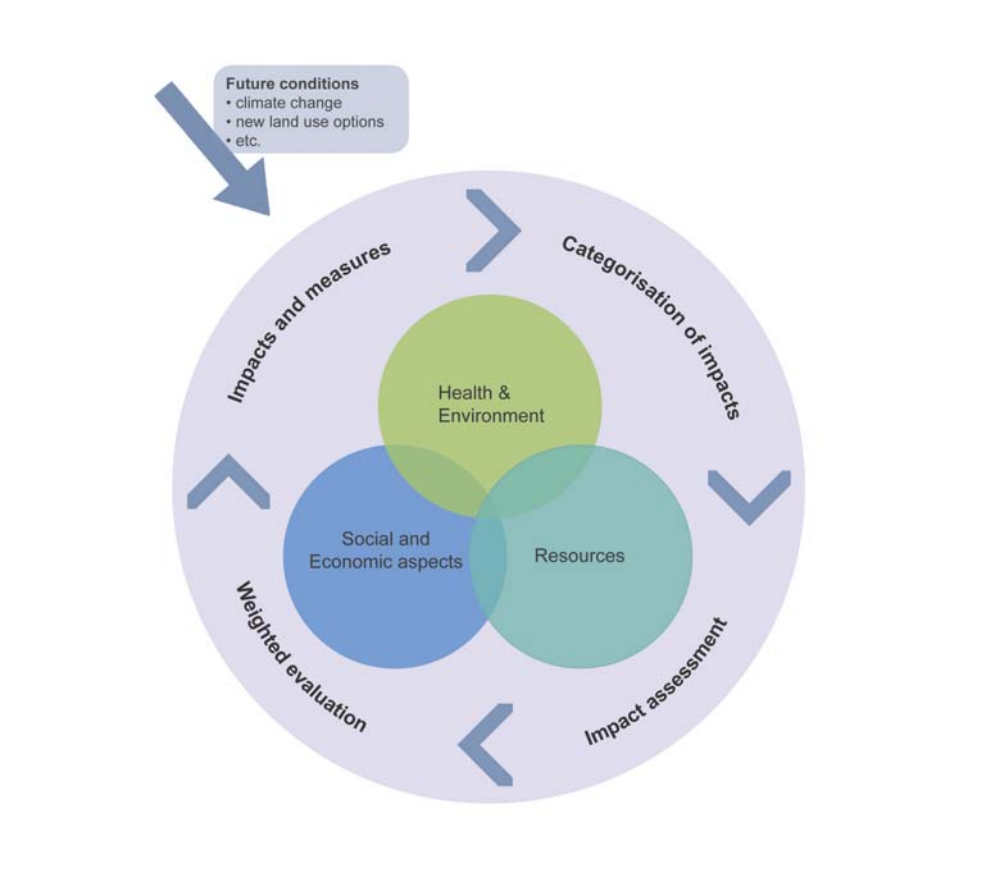
STATENS GEOTEKNISKA INSTITUT
SWEDISH GEOTECHNICAL INSTITUTE



Matrix Decision Support Tool for Evaluation of Environmental, Social and Economic Aspects of Land Use

Yvonne Andersson-Sköld
Helena Helgesson
Anja Enell
Pascal Suer
Ramona Bergman

Varia 613

LINKÖPING 2011

STATENS GEOTEKNISKA INSTITUT
SWEDISH GEOTECHNICAL INSTITUTE

Varia 613

Matrix Decision Support Tool for Evaluation of Environmental, Social and Economic Aspects of Land Use

Yvonne Andersson-Sköld
Helena Helgesson
Anja Enell
Pascal Suer
Ramona Bergman

LINKÖPING 2011

Varia | Swedish Geotechnical Institute (SGI)
SE-581 93 Linköping

Order | SGI – Information Service
Tel: +46 13 20 18 04
Fax: +46 13 20 19 14
E-mail: info@swedgeo.se
Internet: www.swedgeo.se

ISSN | 1100-6692
ISRN | SGI-VARIA--11/613--SE

Dnr SGI | 1-0706-0391
Project nr SGI | 13293, 13674, 13894

Table of Contents

Foreword

This report describes a transparent methodology, intended as a decision support tool to facilitate decision making related to land use. The tool allows for the comparisons of different proposed risk reduction measures and includes a sustainability perspective, i.e. it clarifies environmental, social and economic conditions of different measures, and it can be used in several different applications. The matrix tool can be used autonomously by a group of officials from e.g. local authorities, although there may be advantages to also bring in external help to broaden the debate and increase the basis of knowledge.

One example of an application is to support decision making for risk reduction of contaminated areas, where it can be used to facilitate decisions on e.g. specific remediation techniques or other risk reductive actions. Another example is as a structured basis for describing the consequences of a natural hazard like e.g. flooding, and the suggestions of measures that could be taken to minimise the risks, or reduce the negative consequences, of such an event.

The tool is constructed as a chain of matrices, and is thus denoted as the Matrix Decision Support Tool (MDST).

The use of the MDST should encourage to discussions that facilitate the identification and/or compilation of:

- information about the risks (or impacts) of current conditions,
- possible measures,
- consequences of these measures, and
- need for further investigations or additional decision support documents.

The MDST can be used as a check list and helps organising the decision support documents, which facilitates the comparison of different alternative measures. In addition, it contributes to increase the transparency of the decision process, and makes it easier to track the reasoning behind the decision.

The MDST has been developed at the Swedish Geotechnical Institute, SGI, by Yvonne Andersson-Sköld, Pascal Suer, Ramona Bergman, Helena Helgesson and Stefan Falemo. The report has been produced by Yvonne Andersson-Sköld, Helena Helgesson, Anja Enell, Ramona Bergman and Pascal Suer and reviewed by Anna Jonsson, Department of Water and Environmental Studies, Linköping University and Yvonne Rogbeck, SGI. Paul Frogner-Kockum has contributed on the English translation. The work has been carried out within the framework of the following projects: The Snowman ERA-NET project *Rejuvenate,* financed by Formas, Sweden, the project *Enhancing Cities capacity to manage vulnerability to climate change*, financed by Formas, Sweden, and the Interreg IVB project *Climate Proof Areas (CPA),* co-financed by SGI.

The authors would like to acknowledge the participants, as well as the financiers, of these projects.

February, 2011

Summary

There is at present a growing need for tools that could be used at an early stage of land use planning or in the daily work with environmental objectives to incorporate a sustainability perspective, i.e. a holistic approach of resources, health-, environmental-, social- and economic aspects. Thus, this report presents a tool developed to incorporate sustainability in a simple manner in the planning process of land use management. It is applicable for several different purposes, such as e.g. risk analysis of different measures suggested for contaminated sites, comparisons of different measures suggested for risk reduction of natural hazards, mitigations of risks associated with climate change or when evaluating any other land use alternatives or measures.

The aim with the tool is to provide a checklist and a methodology that promotes discussions in order to facilitate the identification and compilation of potential measures and consequences related to land use issues. In addition, it should contribute to a more transparent decision process and increase the traceability of the reasoning behind the decisions taken.

The tool is based on classic technical risk- and vulnerability analysis, comprising all steps from risk/hazard identification to appraisal of measures. The different steps can be summarised as:

- risk/hazard identification,
- risk assessment,
- risk analysis - acceptance of risk and need for measures,
- suggestions of measures,
- documentation for evaluation and prioritising of measures and
- proposal for decision of measure.

The main difference, between this risk analysis tool and many others, at least in a Swedish perspective, is the allowance of comparisons of present risks and consequences of measures early in the process. In addition, the methodology repeats the risk/consequence comparison in an iterative manner during the full process until the finial step (proposal for decision) has been reached. The tool is intended to be used by both experts and policy makers (or persons who will present the alternatives for the policy makers) in order to demonstrate all kinds of consequences and present them to the whole group of stakeholders (experts, policy makers, the public etc.).

The tool is constructed by a chain of matrices and, thus, denoted as The Matrix Decision Support Tool (MDST). The matrices can be found in Appendix 1 of this report or downloaded as an Excel spread sheet from:

- http://www.swedgeo.se/globalassets/publikationer/Varia/pdf/SGI-V613.xls

This report provides a further description of the MDST's components and gives instructions on how to use the tool.

1. Terms and Definitions

Costs – Direct cost is a cost allocated to a defined product or equal (cost unit) e.g. a special material needed for a particular product. A direct cost can be both variable and fixed. Indirect cost is a cost that can not be directly linked to a specific product (cost unit), e.g. costs for rent or indirect personal costs. The *Measure Cost* includes direct costs for the measure such as investment cost and costs for monitoring, maintenance and management for example of a structure, as well as the cost of impacts, or possible incomes due to or despite the measure. The *no measure alternative* is the case where no active efforts are made. Here the measure cost describes the direct and indirect costs of the impacts if no action is taken.

Environmental Impact Assessment (EIA) - The purpose of an EIA is to identify and describe the direct and indirect impacts of a planned activity or measure. It should include impacts on humans, animals, plants, soil, water, air, climate, landscape and historic environment, as well as management of land, water and the physical environment in general. In addition, it should take into account the management of other resources, raw materials and energy. The purpose of an EIA is to enable an overall assessment of these impacts on human health and the environment (SFS 1998:808).

Impacts – An impact can be negative or positive. A primary impact is the effect of an event (climate change / measure or other change) to a sector, environment, group of humans, housing etc. A secondary impact is the effect on the same sector, environment, group of humans, housing (etc.) that occur as a direct consequence of the primary impact. A direct impact refers to the primary impact on a sector, environment, group of humans, housing etc, while an indirect impact refers to the effect on OTHER sectors, environments, groups of humans, housing etc. (Johansson, et al., 2008).

Impact categories – The second Matrix of MDST contains four main-categories (Health and Environment, Natural Resources, Social and Economic aspects and Flexibility) and in total twelve sub-categories, defined as follows:

- Global warming (release of greenhouse gases, land use or land-changes that contributes to, or reduces, the global warming).
- Large-scale air quality (excluding global warming) including air emissions that contribute to eutrophication, acidification, tropospheric ozone, bioaccumulative air emissions, long-distance transport of particles.
- Local air quality (odour, particulates, toxic gases).
- Water quality (drinking water quality, biodiversity, ecosystems, fisheries, marine and limnological properties of high conservation value, eutrophication through leakage).
- Soil quality (pollution load, biodiversity, ecosystems, impacts on terrestrial objects of high conservation value).
- Land Resources (use of land, housing).
- Energy (energy consumption).
- Raw materials (raw material acquisition).
- Well-being / perceived welfare.
- Direct costs (costs for possible impacts and costs for measures).
- Socio-economic aspects (infrastructure, cultural, accessibility, business activity, jobs, recreation).
- Flexibility (how flexible and adaptive the measures are for possible changed circumstances).

Life Cycle Analysis (LCA) – Life cycle analysis is a generic term for analysis that aims to describe a product's or service's overall environmental impact (from the "cradle to grave").

Multi Criteria Analysis/Method – The purpose of a multi-criteria analysis is to compare different alternative measures with respect to various criteria (e.g. economic-, environmental- or social criteria).

Risk – Is here defined as a function of the probability of an undesirable event and the impact of this event (technical risk definition).

2. Background

Up till now, at least in a Swedish perspective, there has been no simple methodology or tool to evaluate environmental, social, and economic conditions of different land use alternatives, which simultaneously considers local, regional and global consequences at different time scales (Andersson-Sköld et al., 2006). *Different land use alternatives* are here defined as e.g. alternatives to reduce the consequences of climate change or remediation alternatives of contaminated sites, but it can also comprise suggestions of measures to prevent, or reduce, the impacts of natural hazards, such as flooding and landslides, at present conditions.

Additionally, lack of simple routines and tools to incorporate the work with environmental quality objectives into the everyday planning process has recently been identified (Johansson, 2008). Consequently, there is a need for a tool that could provide an overall perspective on all relevant aspects (i.e. natural resources, health-, environmental-, social- and economic aspects) at an early stage of the land use planning-process (Andersson-Sköld et al., 2006; Glaas et al, 2010; Johansson, 2008; Suer et al., 2009).

At present, when considering different land use of an area, it is common to perform an environmental impact assessment of the suggested land use alternatives. In addition, multi-criteria methods has been developed, to multifaceted describe the different consequences of e.g. different remediation alternatives. These methods are, however, often based on relatively complex cost-benefit analyses (e.g. Rosén et al., 2009). There are also still very few tools that can be used by non-experts. When facing decisions of more complex issues one may also need to request specific investigations, to obtain a sufficient decision support material.

None of the present available methods provide enough help to structure the problems and identify important gaps of knowledge. Nor are there any tools yet that systematically include natural resources, health-, environmental-, social- and economic conditions, which are intended to be used by private landowners (e.g. owners of contaminated sites) or by officials at the municipal and regional level (Andersson-Sköld, 2006; Roth et al., 2003; Roth and Eklund 2005; Suer et al., 2009).

Such, “easy to use” tool, would be of great benefit in e.g. the municipalities' efforts to:

- analyse present risks,
- identify adaptive needs and adaptation measures in a changing climate
- evaluate different strategies for e.g. remediation of contaminated sites or adaptation measures related to climate change.

Previous studies indicates that the involvement of all groups of stakeholders, affected by the decision, is crucial to how well the decision is rooted, how easy it can be implemented and how sustainable it will be (Andersson-Sköld et al., 2006; IPCC, 2007; Rosén et al., 2009). The aim with the MDST is to encourage more stakeholders to take part of the process. When representatives of an organisation are working together with the tool, either as a working group or in a form of a focus group, both better acceptance and better decisions from a holistic perspective will be achieved. The work can be carried out individually and then merged into the final results, but optimal it is carried out in discussion forums.

3. The Matrix decision support tool

3.1 Description

The tool is based on classic technical risk- and vulnerability analysis, comprising all steps from risk/hazard identification to proposal for decision on measures:

- Risk/hazard identification
- Risk assessment
- Risk analysis - acceptance of risk and need for measures
- Suggestions of measures
- Prioritising of measures

Included in the MDST

- Proposal for decision on measure
- Decision on measure and action plan
- Action
- Follow-up

The MDST is designed to incorporate sustainability in a simple manner in a decision making or planning process. It is for example applicable for risk analysis of different alternatives of measures considered for a contaminated site, for comparison of different potential measures to reduce the risk of natural hazards, to mitigate and manage the risks associated with climate change or when faced with other decisions related to land use alternatives or measures. Various aspects, such as health risks, environmental- and socio-economic conditions, can with this tool be considered in a perspicuous and transparent way at a very early stage of the analysis.

In order to monitor and evaluate a complex system, in which several different aspects have to be considered, one needs to systematically identify and document the areas with sufficient information for making relevant decision and the areas with knowledge gaps. The presented tool allows for subsequently implementation of new knowledge gained during the work process. By using this tool it is also easy to see how new knowledge may change the evaluation and to observe how this affect the overall result.

A great benefit of the here presented methodology is the consideration of several different measure alternatives already in the beginning of the process. A large number of options should be included regardless of the involved persons' intuitive feeling for the proposed measures' sustainability from economic, environmental and social perspectives, on both long- and short-terms, and from both a local and a global perspective. The overall reason for including many alternatives is to promote an open minded discussion and openness in the search for information. Through the process an alternative that initially seemed impossible can turn out to be a good option when new information comes forward.

The main difference between this tool and other available risk analysis tools is the allowance of an early comparison of existing risks and consequences of potential measures (including both environmental- and social related aspects). In addition, the tool also takes into account:

1. The time perspective for all considered aspects (e.g. Andersson-Sköld et al., 2006).
2. The consequences on different geographical scales (i.e. on local-, regional- and global scale) (Roth, 2005).
3. The flexibility of the different measure alternatives.

The work shall result in the compilation of decision support documents and the reasoning behind the priorities and the assessments. Compilation of the decision support documents as well as documentation of discussions and the reasoning behind the decisions taken is important in order to make the work process both transparent and traceable.

Furthermore, the MDST provides an application to highlight relative importance of different aspects and their impacts on the final proposal of a measure.

3.2 Purpose

The purpose of the here presented tool is to facilitate for a comprehensible compilation of input factors and to clarify how different alternatives of land use measures may affect the health, the environment, and natural resources as well as social- and economic conditions. The type of measures under consideration may range from different type of remediation techniques for contaminated sites, to measures used for adaption to climate change or other land use options.

With the help of this tool one should be able to compile:

- information on actual, perceived, or future risks (or consequences of present conditions),
- potential measures,
- identified consequences of the potential measures,
- the need for further investigations or other information.

The tool shall also:

- facilitate comparison of different measures,
- provide a useful basis for discussion, be a checklist, and support the documentation.

4. The Work Process

The work with the MDST is initiated with seven preparatory steps (Figure 1). Before going into the preparatory work one can have a first look at the actual tool to get somewhat acquainted with the matrices. However, we do recommend that the preparatory steps are conducted as separate steps before any actual work with the matrices takes place. This is because the preparatory steps include actions using the brain storm technique. This technique prescribes an open and free discussion, which can be inhibited by the requirement of completing a matrix with a definite structure.

The actual tool consists of four matrices, the pre-printed forms in Appendix 1, which are to be subsequently completed (see Section 5). The matrices also exist as Excel spread sheets (SGI, 2011), which can be used instead of the pre-printed forms.

The result, of the here described tool, is a basis for prioritising between different measures or a proposal of a decision on a measure. The aim of the work depends on the purpose of the process and who participates in it.

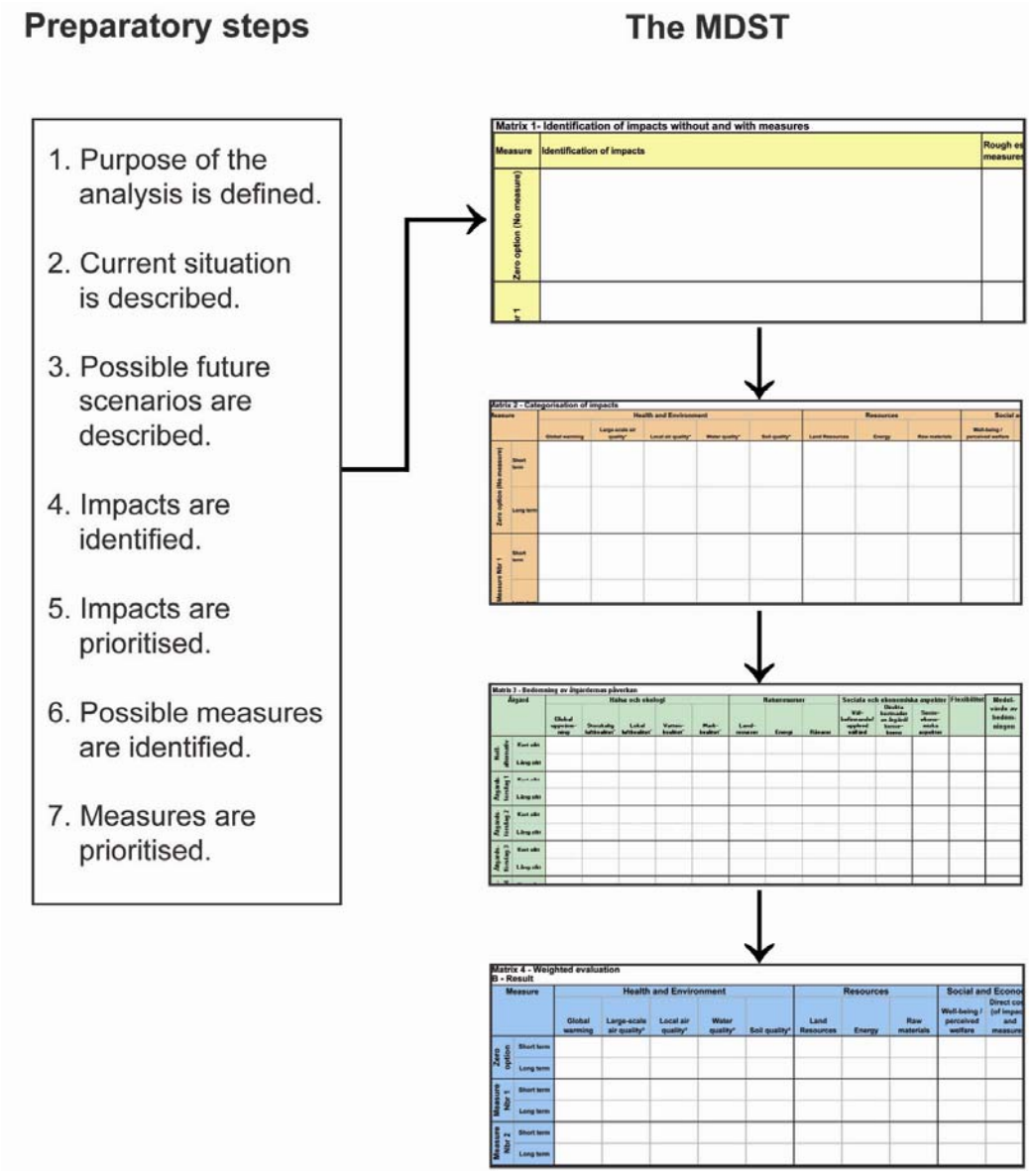


Figure 1. The MDST and its preparatory steps.

The overall process relies on the participation of multiple stakeholders, including experts in different relevant fields, policy makers and those affected by the decision (e.g. landowners or non-governmental organisations). The participation of policy makers themselves is preferable, since it will increase their understanding of the problem. However, if they are unable to participate, they can be replaced by the person(s) who will present the decision support material, and the proposal for decision, for the policy makers.

It is preferable to carry out the actual work together as a workgroup, where as many different stakeholders as possible are represented. If this is not possible, the work can be carried out individually, but in parallel steps. All steps involved in the tool can be subsequently handled, although the fundamental idea of the MDST is to create an iterative work process. This means that renewed discussions should, or must, be initiated at several occasions when new and improved information has been identified/compiled. Documentation is very important.

If the work includes handling of issues that may be controversial, the group should be chaired by a neutral moderator.

The work with the MDST will result in a decision support material that can facilitate the prioritising of alternative measures, *or* a proposal for decision on a measure. The achieved result depends on the purpose of the process (see Chapter 5) and the participants involved in it.

5. Preparation

Before the actual work with the MDST can start, the following seven preparatory steps have to be completed:

1. The purpose of the present analysis is defined.
2. The current situation is described.
3. Possible future scenarios are described.
4. Impacts of the "no measure-alternative" are identified for the current situation and for possible future scenarios.
5. The impacts are prioritised.
6. Possible measures are identified.
7. The measures are prioritised.

5.1 The purpose of the analysis

Initially, the overall purpose of the analysis has to be defined. A well-defined purpose of the analysis, and an overall agreement about the purpose within the workgroup, increase the chances of a successful process and sustainable results When the purpose is clearly defined and documented there are good chances of sustainable results and a successfully implementation.

An example of the purpose can be "to assess the impact of contaminated soil within the Real Estate XX and possible remediation actions". Another example is "To assess the impacts of expected climate change and possible measures to mitigate negative consequences". When the work is to be entitled, the title should reflect the purpose such as e.g. "*Possible risks, impacts and consequences of potential climate mitigation measures in Middling Town*".

5.2 The current situation

The next step is to define and describe the current situation. In the case of the contaminated site, the description can be formulated such as "*The contaminated area remains unexploited and the site is not remediated*". Other examples are descriptions of the present circumstances of e.g. flooding of a city district, the current traffic situation or prevailing population density.

5.3 Possible future scenarios

In many cases, but not always, there is also a need to describe one or more future scenarios. Example of such scenarios can be exploitation of a contaminated site in order to transform the site to e.g. a residential area, an industrial site or a recreation area. If the purpose of the work is to analyse adaptation measures to climate change, the future scenarios can include e.g. a rise in the sea level or an increased precipitation during the winter.

5.4 Impacts of the "no measure" alternative

The purpose of this step is to identify the risks and the consequences of the current situation and the future scenarios when no measures are taken.

The identification of consequences of no active efforts, the "no measure" option, can be carried out either as a brainstorming activity or just be based on existing data sets and previous investigations. If brainstorming activity is carried out, **all** potential impacts

(negative and positive) should be documented. Both primary and secondary impacts should be noted and if they are likely to occur in the short or long term.

If background material and investigations already exists, they should be compiled and added to the documentation (as summaries or references).

5.5 Prioritisation of the impacts of the "no measure-alternative"

In this preparatory step are the identified impacts ranked after priority. The work can then proceed with the impacts of highest rank. How the prioritisation has been made and the reasoning behind should be documented.

5.6 Identification of possible adaptation measures

Sustainable solutions, in order to meet risks or needs, can often be identified early in the process. However, new ideas about adaptation measures can be borne during the work-process. It is part of the iterative process to then be able to take care of them and incorporate them into the material.

When describing the possible measures it is important to not only consider the problems associated with the different alternatives but also to see the opportunities that they may result in. The earlier the possible measures are identified the sooner the advantages and disadvantages of the alternatives can be assessed and compared both with each other and with the "no measure"-option.

Identification of measures can be done as a brainstorming activity or could be based on existing data and previous investigations. If a brainstorming activity is performed, all potential measures shall be documented. At this part of the work, it can be useful to get help from existing compilations of examples of measures. For example, proposals for various types of measures for the remediation of contaminated sites, can be found on the Danish web page: http://jordforurening.info (Videcenter for Jordforurening, 2010). In addition, a summary of actions to reduce risks associated with climate change, especially flooding, are being developed at SGI (Bergman et al., 2011).

Already existing investigations and other background material describing possible adaptation measures should be compiled.

5.7 Prioritisation of the measures

Finally, the measures are ranked according to the most appropriate alternatives. The further work should then be focused on describing some of the alternatives of the highest rank together with "the no measure"-option, where no measures are taken. The prioritisation of the different alternatives and the reasoning behind them should be documented.

6. The work with the MDST

The tool is constructed as a chain of four forms that are subsequently completed as the work progresses. The goal is to obtain a judicious and well-documented *decision support material* and a proposal for decision on one or several *measures*. As the work progress, the group will obtain overall ratings of the alternatives that should be further studied, knowledge on further required decision support documents and prioritisation on possible measures. An example of the work process is illustrated in Figure 2.

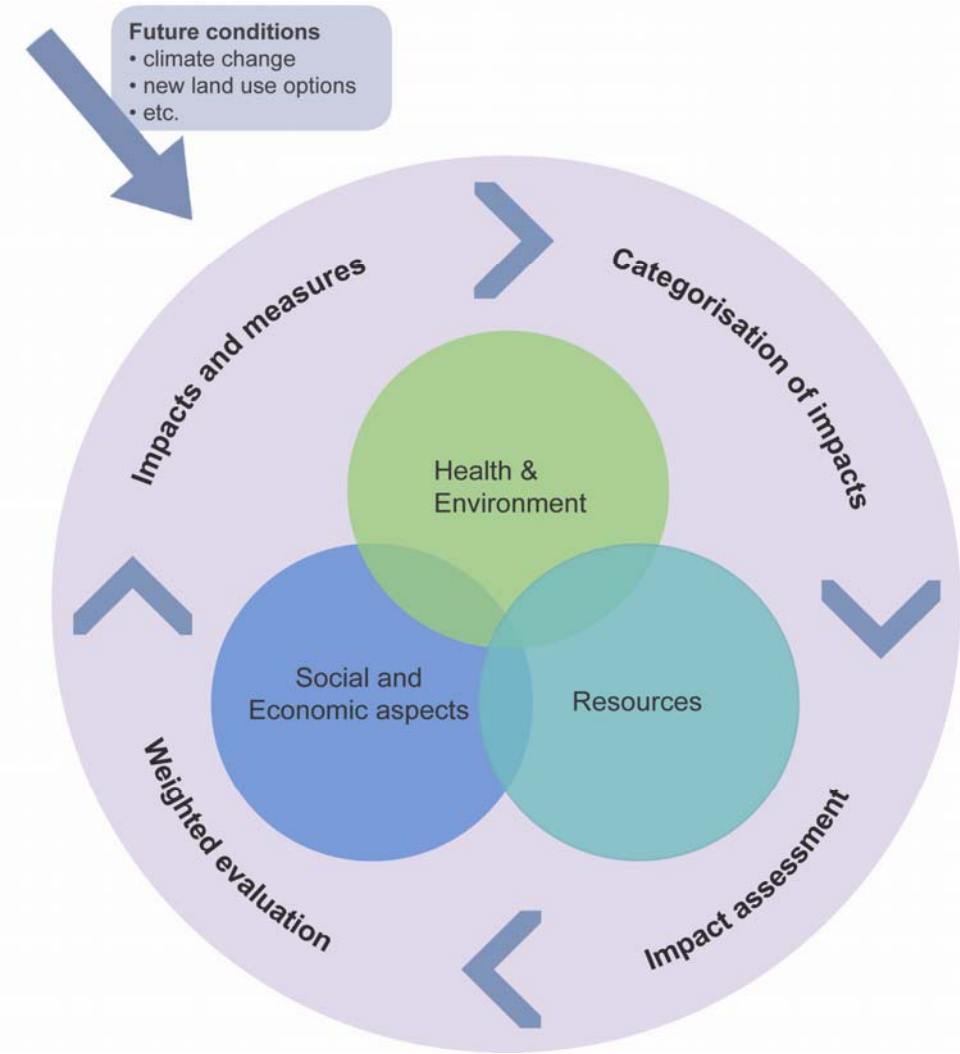


Figure 2. The MDST consists of four forms, which should be used in an iterative process. The detailed forms comprises the following steps: i) to identify impacts and measures; ii) categorisation of impacts; iii) impact assessment; and iv) weighted evaluation.

Any decision, to compile more supporting material or to proceed in the matrix-chain, should be clearly documented. To facilitate for documentation, each matrix is followed by supplementary questions to be answered about the data used (e.g. is there a need for further investigations to deepen or broaden the gathered decision support material).

These questions should be considered for each specific case to ensure that the compiled material is of sufficient quality and is informative enough to serve as an adequate basis for the decision. You may need to improve the existing material with complementary

data/documentation, which then should be processed and evaluated together with the previous compiled data.

The last form in the matrix chain (Matrix 4) does not have to be completed if Matrix 3 already provides a clear picture of what measure is the most sustainable, although, this decision has to be clearly documented.

The matrices included in the tool can be found in Appendix 1 or downloaded as an Excel-file (SGI, 2011). Below is a brief description of each step:

Identification:
Matrix 1 includes the identification and compilation of:

- **impacts** of the "no measure"-alternative,
- **possible measures** (those prioritised in the preparatory work, see Section 4),
- **impacts of measures** (both positive and negative impacts should be listed) and
- **rough estimate of costs** for each impact, and for the different measures.

Categorisation
In Matrix 2 the different impacts are sorted into four main-categories (Health and Environment, Natural Resources, Social and Economic aspects and Flexibility) and in total twelve sub-categories to these. The sub-categories are collectively referred to as impact-categories. The categorisation should be done for:

- **the "no measure"-alternative** and for
- **all prioritised measures**.

Impact assessment:
Matrix 3 includes:

- an assessment of **the significance of the impacts** of each measure on the different impact-categories.

Weighted evaluation:
In Matrix 4 the following is worked out:

- a weighting of the different impact-categories in order to clarify whether some of the categories are regarded as more important than others. It should be noted that the weighting is **case-dependent** and **site-specific**
- a mean value of the weighted evaluation for each alternative.

6.1 Matrix 1 - Identification of impacts without, and with, measures

The main task of the first part of the MDST, Matrix 1, is to identify the impacts of the "zero option" and of the proposed measures, identified in the preparatory work. By including a rough estimation of costs, at this early stage, measures that are disproportionately expensive and therefore less relevant to include in the further studies, may be revealed. The cost estimate may include both direct and indirect costs, as well as primary and secondary costs.

Matrix 1 is illustrated in Figure 3 and a description of how to complete it is given below. **DO NOT FORGET** to state all assumptions made and all supporting documentation accompanied with references.

	A	B	C
1	Object:	*Name of the site etc.*	
2			
3	Matrix 1- Identification of impacts without and with measures		Print as portrait in A3 format
4	Measure	Identification of impacts	Rough estimation of the costs of the measures/impacts
5	Zero option (No measure)		
6	Measure Nbr 1		
7	Measure Nbr 2		
	e Nbr 3		

Figure 3. Matrix 1 - Identification of impacts without and with measures.

6.1.1 Impacts of the “no measure”-alternative

On the first row of Matrix 1, under the column entitled "Identification of impacts”, all impacts identified if no measure is taken, within the context of the present situation (for example today's situation with respect to a contaminated soil, climate conditions or traffic conditions etc.) are stated. Both negative and positive impacts should be described, as well as impacts occurring in the short and long term.

6.1.2 Proposal of measures

The prioritised adaption measures, identified in the last step of the preparation process (see section 5.6), should be stated in Matrix 1. Their headings should be entered into the left most column of the spreadsheet, i.e. the predefined text “Measure Nbr1” is replaced by a more descriptive text of the proposed alternative.

6.1.3 Impacts of measures

The next step is to identify and state the impacts of the prioritised measures. Again, both negative and positive impacts should be described, as well as impacts occurring in the short and long term.

6.1.4 Identification of costs for different measures

Finally, an initial estimation of the measures’ costs is made. In addition, a rough estimation of the costs for each identified impact should be done. The costs should be entered into the most right column of Matrix 1.

6.2 Matrix 2 - Categorisation of impacts

The aim of the MDST is to evaluate the impacts of different policy options, and thus, consideration must be given to a wide range of aspects. To provide for a comprehensible result, the structure of Matrix 2 allows partitioning of impact to the following main-categories: 1) Health and Environment, 2) Resources, 3) Social and Economic Aspects and 4) Flexibility. Matrix 2 is illustrated in Figure 4 and how it should be completed is described below in section 6.2.2.

The impacts, which were stated in a broad manner in Matrix 1, will now be systematically described for all categories, from a local to a global scale and with a life-cycle perspective. This means that not only should local environmental impacts, such as impacts from applied machineries and the local environmental- and health risks be considered, but also impacts (e.g. acidification, eutrophication, global warming) and activities such as transports, production of raw materials, etc. that takes place at other locations than the area of the actual measure.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Object:		*Name of the site etc.*										
2													
3	Matrix 2 - Categorisation of impacts												Print as po
4	Measure		Health and Environment					Resources			Social and Economic Aspects		
5			Global warming	Large-scale air quality*	Local air quality*	Water quality*	Soil quality*	Land Resources	Energy	Raw materials	Well-being / perceived welfare	Direct costs (of impacts and measures)	Socio-economic aspects
6	Zero option (No measure)	Short term											
7		Long term											
8	Measure Nbr 1	Short term											
9		Long term											
10	Measure Nbr 2	Short term											
11		Long term											
12	re Nbr 3	Short term											

Figure 4. Matrix 2 – Categorisation of impacts.

6.2.1 The impact-categories

The selection of categories is based on common aspects considered in life cycle analyses, in the Swedish environmental objectives and in vulnerability analyses (e.g. IPCC, 2007), and that are relevant for sustainable development, i.e. social-, economic- and environmental aspects at different geographical scales (global-local).

Several aspects have been grouped together. For example, in the Swedish environmental objectives or in life cycle analyses, eutrophication and acidification are general considered as individual categories, while here these are included in the Category of Large-scale Air Quality. This grouping is due to the need to consider more aspects than the ones of environmental concerns, and at the same time not get too many categories

to work with. Similarly, the social and economic related sub-categories also consider several aspects.

The following 12 sub-categories, that together shall describe the social-, economic- and environmental impacts of present conditions and of potential measures, are as follows (included in Matrix 2):

- Global warming (release of greenhouse gases, land use or land-changes that contributes to, or reduces, the global warming).
- Large-scale air quality (excluding global warming) including air emissions that contribute to eutrophication, acidification, tropospheric ozone, bioaccumulative air emissions, long-distance transport of particles.
- Local air quality (odour, particulates, toxic gases).
- Water quality (drinking water quality, biodiversity, ecosystems, fisheries, marine and limnological properties of high conservation value, eutrophication through leakage).
- Soil quality (pollution load, biodiversity, ecosystems, impacts on terrestrial objects of high conservation value).
- Land Resources (use of land, housing).
- Energy (energy consumption).
- Raw materials (raw material acquisition).
- Well-being / perceived welfare.
- Direct costs (costs for possible impacts and costs for measures).
- Socio-economic aspects (infrastructure, cultural, accessibility, business activity, jobs, recreation).
- Flexibility (how flexible and adaptive the measures are for possible changed circumstances).

For all categories considered, the time aspect is of major importance. We therefore recommend that you also enter the time aspect and/or specify the impacts, both on short and long term. It is also important to define what is meant by "short" and "long" term for the specific case.

6.2.2 Categorisation

The categorisation done in Matrix 2 is based on the measures and the impacts already defined in Matrix 1. The impacts of the different measures are sorted into the new category-columns of Matrix 2. The systematic process encourages to up-date the matrix with new measures and impacts, identified during the work. Both positive and negative impacts, in the short and long term (see Section 5.2.1) should be defined. Describe how they affect each category, or if they present no impact at all.
The optimal group, for this work, is a multi-disciplinary group with experts of several different fields (economists, biologists, representatives of social sectors, etc.), who can proficiently describe how the different categories are affected by each measure.

DO NOT FORGET: To state all assumptions and documentation used accompanied with references. It is also recommended to clearly point out the categories for which relevant data are missing.

6.3 Matrix 3 - Impact assessment of the measures

Matrix 3 includes a quantitative assessment of **the significance of the impacts** on the different categories. The impacts should be evaluated on both long and short terms and graded according to a 5-graded scale (see Section 6.3.1). Figure 5 illustrates an uncompleted form of Matrix 3. The rightmost column of the matrix (column O) is given to display the mean value of the assessments (of impact-categories) for each alternative. The mean values are automatically calculated in the Excel version.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	**Object:**		*Name of the site etc.*												
3	**Matrix 3 - Impact assessment of the measures**														
4	**Measure**		**Health and Environment**					**Resources**			**Social and Economic Aspects**			**Flexibility**	**Mean value of the assessments**
5			**Global warming**	**Large-scale air quality***	**Local air quality***	**Water quality***	**Soil quality***	**Land Resources**	**Energy**	**Raw materials**	**Well-being / perceived welfare**	**Direct costs (of impacts and measures)**	**Socio-economic aspects**		
6	Zero option	Short term													
7		Long term													
8	Measure Nbr 1	Short term													
9		Long term													
10	Measure Nbr 2	Short term													
11		Long term													
12	Measure Nbr 3	Short term													
13		Long term													
14	Measure Nbr 4	Short term													
15		Long term													
16	Measure Nbr 5	Short term													
17		Long term													
18	*Including aspects of biodiversity, ecosystem services, etc., as described in Section 6.2.1 of the main report														
19															
20	Assess the impacts – use the values from the 5-graded scale to the right to complete Matrix 3.								Large positive impact	2					
21	Press 'Enter'.								Positive impact	1					
22	Click on the green button to colour the cells.								No impact	0					
23	Click on the white button to return to white colour.								Negative impact	-1					
24									Large negative impact	-2					

To colour Matrix 3, click here!

To return to white colour, click here!

Figure 5 – Matrix 3 Impact assessment of the measures.

The assessment should preferably be done as teamwork. The optimal team is composed of several experts (e.g. economists, biologists, representatives from the social sectors, etc.) who can proficient valuate the various aspects under consideration. The overall aim is that the evaluation should be based on broad expertise and knowledge. When the evaluation is done within an interdisciplinary group, other members than the expert of the specific subject evaluated, may contribute to the discussion, asking questions and thus gain a better understanding of the impact assessment. For a sustainable process and decision the group should preferably be composed by as many representatives as possible of those who will be affected by the impacts.

6.3.1 The evaluation scale

The assessment of the impacts is based on the available supporting documents and the results of Matrix 1 and 2, i.e. the identification of effects and consequences, and will be discussed by the work team. The significance of the impact is given in a 5-graded scale between -2 and +2. The evaluation can hence comprise both negative and positive impacts, indicated by plus- or minus signs. How permanent the impacts are (long or short lasting) can be indicated by giving a long lasting negative impact a more negative value compared to a short lasting.

Since the impacts can occur in a close or a distant future, each measure is given two rows in the matrix; one for short-term impacts and one for longer-term impacts.
The value of the Flexibility Category is specified in a similar way as for the other categories. A very flexible measure and adaptable to different situations will be given the value of +2, while a very inflexible will be given -2.

New information or new arguments presented at this step have to be entered into the Matrix 1 and 2. This "rewind"-process should not be regarded as a problem, but as part of the development, learning and iterative process.

Consequently, each square in Matrix 3 is given a value (a number that represents the impact assessment). To make the result more comprehensible it is also possible to highlight the impact assessment values with different colours. If you work in the Excel-version, the colouring can be done automatically, if you work on paper the selection is made manually. The colouring-scale used in Excel is shown in Figure 6.

Below is also an example of how a completed Matrix 3 may look like (Figure 6). The matrix is based on the qualitative description performed for Matrix 2 and a rough expert assessment of the extent to which the positive or negative consequence arises in the short and long term.

			Health and Environment					Resources			Social and Economic Aspects			Flexibility	Mean value of the assessments
Object:	Name of the site etc.														
Matrix 3 - Impact assessment of the measures															
Measure			Global warming	Large-scale air quality*	Local air quality*	Water quality*	Soil quality*	Land Resources	Energy	Raw materials	Well-being / perceived welfare	Direct costs (of impacts and measures)	Socio-economic aspects		
Zero option	Short term		0	0	0	0	0	0	0	0	2	0	2	0	0,3
	Long term		0	0	-1	-1	0	-1	0	0	-1	-2	-2	-1	-0,8
Measure Nbr 1	Short term		-1	-1	-1	0	0	0	-1	-1	1	-1	0	1	-0,3
	Long term		0	0	0	2	0	2	0	0	1	0	1	1	0,6
Measure Nbr 2	Short term		-2	-2	-2	0	0	-1	-2	-2	0	-2	-1	0	-1,2
	Long term		0	0	-1	-1	0	-1	0	0	1	0	-1	1	-0,2
Measure Nbr 3	Short term														
	Long term														
Measure Nbr 4	Short term														
	Long term														
Measure Nbr 5	Short term														
	Long term														
*Including aspects of biodiversity, ecosystem services, etc., as described in Section 6.2.1 of the main report															
Assess the impacts – use the values from the 5-graded scale to the right to complete Matrix 3.									Large positive impact	2				To colour Matrix 3, click here!	
Press 'Enter'.									Positive impact	1					
Click on the green button to colour the cells.									No impact	0					
Click on the white button to return to white colour.									Negative impact	-1				To return to white colour, click here!	
									Large negative impact	-2					

Figure 6. An example of a completed Matrix 3 "Impact Assessment of the measures" and its colour scale.

DO NOT FORGET to state what the assessments are based on, the documentation used and the possible need for improved documentation etc..

6.3.2 Uncertainty in the assessment

Only one value per cell can be given in the Excel version of Matrix 3, due to the automatic-colouring macro. However, if you do want to "hedge" your statement you could specifying a range, e.g. (-1) - (+2), and hence describe the uncertainty. The reason behind the uncertainty may then be entered by hand and clearly documented.

6.3.3 Results of the work related to Matrix 3

Already from the results of Matrix 3, it may be possibly to deduce which ones are the most, and least, advantageous alternatives.

However, the results of the Matrix 3 do not take into account any weighting of the impact-categories, i.e. if any of the categories are considered more (or less) important for this particular work, this will not show in the final results of Matrix 3. By making a weighting of impact categories, the most significant aspects become clearer. If your analysis will benefit from a weighting you move on to the Matrix 4 - Weighting of results.

Whether one chooses to base further work on the results of the Matrix 3, or continues with a weighting, **DO NOT FORGET** to document the basis for this decision and the reasoning behind.

6.4 Matrix 4 - Weighted evaluation

Matrix 4 is designed to allow weighting of the stated values in the Matrix 3. In this step, important impact-categories are assigned with higher weighting values and are thus attributed with a higher score in the final analysis; here denoted as the weighted evaluation. Matrix 4 has also been given a "new" column (the rightmost column of the matrix) which displays the mean values of the weighted evaluation for each of the measures proposed.

6.4.1 Determination of weights

First a valuation (weighting) of the relative importance of different categories, listed in Matrix 2, is considered. The weighting is done for all cases studied within the project and is therefore both case- and site-specific.

We have here selected a scale of three grades *(less important, important,* and *very important*). Two or more columns (categories) can of course be assigned with identical weighting. The weights are to be stated in Matrix 4A (see Figure 7).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**Object:**		*Name of the site etc.*											
2	**Matrix 4 - Weighted evaluation**													
3	**A - Determination of weights**													
4			**Health and Environment**					**Resources**			**Social and Economic Aspects**			**Flexibility**
5			**Global warming**	**Large-scale air quality^**	**Local air quality^**	**Water quality^**	**Soil quality^**	**Land Resources**	**Energy**	**Raw materials**	**Well-being / perceived welfare**	**Direct costs (of impacts and measures)**	**Socio-economic aspects**	
6	**Weight**		3	2	2	2	2	2	2	2	3	3	2	2
7														
8	Evaluate the weight of each category - use the values from the 3-graded scale to the right to complete Matrix 4A									The weight's value:		Very important		3
9	Press 'Enter'.											Important		2
10	NB! Matrix 3 has to be completed before the results of the weighted evaluation can be displayed in Matrix 4B.											Less important		1

Figure 7. Matrix 4 Weighted evaluation - Part A. Determination of weights.

To determine the value of the weights and the weighting of the categories one can proceed in several ways. One example is to develop the weightings in a workshop forum where the whole team, or a minor part of the team is represented. Another example is to interview stakeholder that will be affected by the measures or allow them to develop the weightings through a group discussion.

The documentation is very valuable also for this step. It is central for the transparency, i.e. to be able to see the importance of the "ranking". The documentation is needed in order to understand the reasoning behind, and for example, at a later date be able to update or just follow up the project.

6.4.2 Results of the weighted evaluation

When the weights have been determined for each impact category, they are entered into the first part of the Matrix 4: *Part A. Determination of weights.* These weights are then multiplied, with the numerical values of Matrix 3 and hence the importance of the weighting for the assessment is shown (see Figure 8). If you work in the Excel-version of the MDST this conversion is automatically done and the result is displayed in the second part of Matrix 4, *Part B. Weighted Evaluation, Results.* The cells are, however, not automatically coloured. The colouring is accomplished by clicking the blue box underneath the matrix.

The appearance of the Matrix 4B is then similar to the Matrix 3, but with the difference that the values given are a combination of the assessed impacts and the importance (weight) of such an impact (impact × weighting). The weighting stretches the scale to include more degrees than considered in the Matrix 3, see the example in Figure 8.

31	**Object:**	*Name of the site etc*													
32	**Matrix 4 - Weighted evaluation**														
33	**B - Result**														
34	**Measure**		**Health and Environment**					**Resources**			**Social and Economic Aspects**			**Flexibility**	**Mean value of the weighted evaluation**
35			**Global warming**	**Large-scale air quality***	**Local air quality***	**Water quality***	**Soil quality***	**Land Resources**	**Energy**	**Raw materials**	**Well-being / perceived welfare**	**Direct costs (of impacts and**	**Socio-economic aspects**		
36	**Zero option**	**Short term**	0	0	0	0	0	0	0	0	6	0	4	0	**0,8**
37		**Long term**	0	0	-2	-2	0	-2	0	0	-3	-6	-4	-2	**-1,8**
38	**Measure Nbr 1**	**Short term**	-3	-2	-2	0	0	0	-2	-2	3	-3	0	2	**-0,8**
39		**Long term**	0	0	0	4	0	4	0	0	3	0	2	2	**1,3**
40	**Measure Nbr 2**	**Short term**	-6	-4	-4	0	0	-2	-4	-4	0	-6	-2	0	**-2,7**
41		**Long term**	0	0	-2	-2	0	-2	0	0	3	0	-2	2	**-0,3**
42	**Measure Nbr 3**	**Short term**													
43		**Long term**													
44	**Measure Nbr 4**	**Short term**													
45		**Long term**													
46	**Measure Nbr 5**	**Short term**													
47		**Long term**													
48	*Including aspects of biodiversity, ecosystem services, etc., as described in Section 6.2.1 of the main report														
49															
50	NB! When Matrix 3 and Matrix 4A have been completed the results of the weighted evaluation will be automatically displayed in Matrix 4B.														
51	Click on the blue button to colour the cells.														
52	Click on the white button to return to white colour.														
53															
54															

5 & 6
3 & 4
1 & 2
0
-1 & -2
-3 & -4
-5 & -6

To colour Matrix 4, click here!

To return to white colour, click here!

Figure 8. Matrix 4B Results of weighted evaluation. In this example, we have assumed that "global warming", "well-being / perceived welfare" and "Direct costs" are more important (weight 3) than other categories (weight 2). The resulting scale is thus prolonged and now includes values from 6 to -6.

The mean value of the weighted evaluation is presented in the rightmost column of Matrix 4. The weighted evaluation is accomplished by dividing the sum of each row by twelve (for the twelve impact-categories), see Figure 8. Mathematically this is expressed as:

$$Weighted\ assessment = \frac{\sum (impact * weighting)}{12} \qquad (1)$$

where 12 stands for the number of impact categories.

When this work is completed, you get a comprehensible overview of all suggested alternatives and it will be easier to compare the possible measures with each other. This mean value of the weighted evaluation provides a clear and transparent support in a decision-making. In addition, participants in the process have been encouraged to analyse, in a structured and transparent way, the consequences of different choices in a sustainable perspective. Finally, the various participants are now aware of the issues and arguments that the other stakeholders in the group represent.

Another important result is the documentation of discussions, assessments and decisions that is such a vital part of this work. If you have any further recommendations or suggestions, or if you think there is a need to e.g. broaden or deepen the analysis, these thoughts should be summarised below Matrix 4 under the heading "*The next step - Suggestions for further work*". The comments can of course be further developed and presented in an Appendix with other accompanying support documents.

6.5 Updates and further work

The weighted evaluation can be used as a basis for the decision provided that it does not require any additional supporting material. If further investigations or information are needed, their results should be entered to the matrixes and the evaluations made in the matrices 3 and 4 have to be reconsidered. You may even need to start with the Matrix 1 or 2, depending on what additional information is available for this in-depth and updated analysis. The required additional information and how to process this material should be stated under the heading "*The next step - Suggestions for further work*".

If the result of the weighted evaluation is used as the decision support material, you should now describe what measure(s) one should proceed with. You should also develop an action plan for the future work.

7. Further application advices

One advantage of the tool is its design to allow “extensions”, even when the "primary" analysis has been completed. You can, for example, supplement or extend an earlier analysis with other alternatives of measures, resource priorities in addition to land use planning aspects, etc.

It may be worthwhile to do a cursory review of the whole matrix chain before you do (or refrain from) a more detailed work with it. This encourages to a holistic approach and prepares the participants on the issues they will face in the further work.

8. Development of the results and the work process

To further develop the result and the work process, and to deepen and improve the decision support material one can as a next step expand the work team. For example, you can extend, or replace a group of stakeholders with another. If the process with the matrix chain has already been accomplished once, and the discussion leader is familiar with the material, it is possible to perform the additional work as a single meeting-discussion or as an interview. At such a discussion you should also consider adjustments and improvements of the impact categories' evaluation, (listed in Matrix 2). By expanding the group to include many different stakeholders an extensive knowledge is gained and additionally the stakeholder's different values can be captured, which provides contributes strongly to aid decision making.

9. References

Andersson-Sköld, Y., Norrman, J. och Kockum, K. (2006). Riskvärdering – metodik och erfarenheter, Naturvårdsverket Rapport 5615. http://www.naturvardsverket.se/Documents/publikationer/620-5615-8.pdf

Bergman, R., Andersson-Sköld, Y., Fallsvik, J., Hultén, C. och Elliot, A. (2011). Preliminary title: Measures for climate change with focus on precipitation and sea level rise. Sawa publication and SGI Varia in prep.

Glaas, E., Jonsson, A., Hjerpe, M. och Andersson-Sköld, Y. (2010). Managing climate vulnerabilities: formal institutions and knowledge use as determinants of adaptive capacity at the local level in Sweden. Local Environment, 2010, (15), 6, 525-539.

IPCC (2007). Climate Change 2007: Impacts, Adaptation and Vulnerability Working Group II Contribution to the Intergovernmental Panel on climate Change Fourth Assessment Report, Summary for Policymakers. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Johansson, M. (2008). Barriers and bridges – communicative conditions in the Swedish environmental objective performance (in Swedish). Linköping Studies in Arts and Science, Dissertation No 469, PhD. Linköping University, Linköping, Sweden.

Johansson, S., Brandt, N. och Fahlberg, K. (2008). Riktlinjer för att beräkna resultat för klimatprojekt inom ramen för Stockholms handlingsplan mot växthusgaser, Stockholm stads Klimatinvesteringsprogram och Miljömiljarden. Industriell Ekologi, KTH. http://www.ima.kth.se/klimatswe

Rosén, L., Back, P.-E., Söderqvist, T., Soutukorva, Å., Brodd, P. och Grahn, L. (2009). Multikriterieanalys för hållbar efterbehandling – Metodutveckling och exempel på tillämpning (in Swedish). Swedish EPA, Report 5891.

Roth, L. (2005). Reuse of construction materials, Environmental performance and assessment methodology. Linköping Studies in Science and Technology, Dissertation No 928. Linköping University, Linköping.

Roth, L. och Eklund, M. (2003). Environmental evaluation of reuse of by-products as road construction materials in Sweden. Waste Management, 23, 107-116.

SFS 1998:808 Miljöbalk (Environmental Code). http://www.riksdagen.se/webbnav/

SGI (2011). Appendix 1, http://www.swedgeo.se/globalassets/publikationer/Varia/pdf/SGI-V613.xls

Suer, P., Andersson-Sköld, Y., Blom, S., Bardos, P. R., Track, T. och Polland, M. (2009). Environmental impact assessment of biofuel production on contaminated land – Swedish conditions in selected case studies. Swedish Geotechnical Institute, Varia 600. http://www.swedgeo.se/globalassets/publikationer/Varia/pdf/SGI-V600.pdf

Videcenter for Jordforurening (2010) Afvaerge – Oversigt afvaergemetoder. http://jordforurening.info

Appendix 1

Matrix Decision Support Tool for Evaluation of Environmental, Social and Economic Aspects of Land Use

Matrix 1 - Identification of impacts without, and with, measures
Matrix 2 - Categorisation of impacts
Matrix 3 - Impact assessment of the measures
Matrix 4 - Weighted evaluation

The matrices can also be downloaded as an Excel spread sheet from:
http://www.swedgeo.se/globalassets/publikationer/Varia/pdf/SGI-V613.xls

Definition of the **Impact Categories** used in the Matrices 2-4:

- Global warming (release of greenhouse gases, land use or land-changes that contributes to, or reduces, the global warming).
- Large-scale air quality (excluding global warming) including air emissions that contribute to eutrophication, acidification, tropospheric ozone, bioaccumulative air emissions, long-distance transport of particles.
- Local air quality (odour, particulates, toxic gases).
- Water quality (drinking water quality, biodiversity, ecosystems, fisheries, marine and limnological properties of high conservation value, eutrophication through leakage).
- Soil quality (pollution load, biodiversity, ecosystems, impacts on terrestrial objects of high conservation value).
- Land Resources (use of land, housing).
- Energy (energy consumption).
- Raw materials (raw material acquisition).
- Well-being / perceived welfare.
- Direct costs (costs for possible impacts and costs for measures).
- Socio-economic aspects (infrastructure, cultural, accessibility, business activity, jobs, recreation).
- Flexibility (how flexible and adaptive the measures are for possible changed circumstances).

CLIMATE PROOF AREAS
The Interreg IVB North Sea Region Programme
formas
The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning
SGI

Object:	*Name of the site etc.*

Matrix 1- Identification of impacts without and with measures

Print as portrait in A3 format

Measure	Identification of impacts	Rough estimation of the costs of the measures/impacts
Zero option (No measure)		
Measure Nbr 1		
Measure Nbr 2		
Measure Nbr 3		
Measure Nbr 4		
Measure Nbr 5		

Comments:

Supporting documentation and references:

CLIMATE PROOF AREAS
The Interreg IVB North Sea Region Programme
formas
The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning
SGI

Object:	*Name of the site etc.*

Matrix 2 - Categorisation of impacts

Print as portrait in A3 format.

Measure		Health and Environment					Resources			Social and Economic Aspects			Flexibility
		Global warming	Large-scale air quality*	Local air quality*	Water quality*	Soil quality*	Land Resources	Energy	Raw materials	Well-being / perceived welfare	Direct costs (of impacts and measures)	Socio-economic aspects	
Zero option (No measure)	Short term												
	Long term												
Measure Nbr 1	Short term												
	Long term												
Measure Nbr 2	Short term												
	Long term												
Measure Nbr 3	Short term												
	Long term												

*Including aspects of biodiversity, ecosystem services, etc., as described in Section 6.2.1 of the main report

CLIMATE PROOF AREAS
The Interreg IVB North Sea Region Programme
formas
The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning
SGI

Object:	*Name of the site etc.*

Matrix 2 - Categorisation of impacts

Measure		Health and Environment					Resources			Social and Economic Aspects			Flexibility
		Global warming	Large-scale air quality*	Local air quality*	Water quality*	Soil quality*	Land Resources	Energy	Raw materials	Well-being / perceived welfare	Direct costs (of impacts and measures)	Socio-economic aspects	
Measure Nbr 4	Short term												
	Long term												
Measure Nbr 5	Short term												
	Long term												

*Including aspects of biodiversity, ecosystem services, etc., as described in Section 6.2.1 of the main report

Comments:

Supporting documentation and references:

CLIMATE PROOF AREAS
The Interreg IVB North Sea Region Programme
formas
The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning
SGI

Object:	*Name of the site etc.*

Matrix 3 - Impact assessment of the measures

Measure		Health and Environment					Resources			Social and Economic Aspects			Flexibility	Mean value of the assess-ments
		Global warming	Large-scale air quality*	Local air quality*	Water quality*	Soil quality*	Land Resources	Energy	Raw materials	Well-being / perceived welfare	Direct costs (of impacts and measures)	Socio-economic aspects		
Zero option	Short term													
	Long term													
Measure Nbr 1	Short term													
	Long term													
Measure Nbr 2	Short term													
	Long term													
Measure Nbr 3	Short term													
	Long term													
Measure Nbr 4	Short term													
	Long term													
Measure Nbr 5	Short term													
	Long term													

*Including aspects of biodiversity, ecosystem services, etc., as described in Section 6.2.1 of the main report

Assess the impacts – use the values from the 5-graded scale to the right to complete Matrix 3.	Large positive impact	2
Press 'Enter'.	Positive impact	1
Click on the green button to colour the cells.	No impact	0
Click on the white button to return to white colour.	Negative impact	-1
	Large negative impact	-2

To colour Matrix 3, click here!

To return to white colour, click here!

CLIMATE PROOF AREAS
The Interreg IVB North Sea Region Programme
formas
The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning
SGI

Object:	*Name of the site etc.*

Result of the assessment

Basis for the assessment

1. Which method(s), data and other supporting information has been used?

2. If there is no supporting information available, state for which measure(s) and impact(s):

3. Is the basis for the assessment relevant? If not, which improvements are needed?

4. Is a more detailed assessment needed?

5. Comments:

Object:	*Name of the site etc.*

Matrix 4 - Weighted evaluation

A - Determination of weights

	Health and Environment					Resources			Social and Economic Aspects			Flexibility
	Global warming	Large-scale air quality*	Local air quality*	Water quality*	Soil quality*	Land Resources	Energy	Raw materials	Well-being / perceived welfare	Direct costs (of impacts and measures)	Socio-economic aspects	
Weight												

Evaluate the weight of each category - use the values from the 3-graded scale to the right to complete Matrix 4A	The weight's value:	Very important	3
Press 'Enter'.		Important	2
NB! Matrix 3 has to be completed before the results of the weighted evaluation can be displayed in Matrix 4B.		Less important	1

1. Which method has been used in the process?

2. Who have participated in this process?

3. Is there a need of improvement or should the participant group be expanded?

4. Comments:

Object: *Name of the site etc*

Matrix 4 - Weighted evaluation
B - Result

Measure		Health and Environment					Resources			Social and Economic Aspects			Flexibility	Mean value of the weighted evaluations
		Global warming	Large-scale air quality*	Local air quality*	Water quality*	Soil quality*	Land Resources	Energy	Raw materials	Well-being / perceived welfare	Direct costs (of impacts and measures)	Socio-economic aspects		
Zero option	Short term													
	Long term													
Measure Nbr 1	Short term													
	Long term													
Measure Nbr 2	Short term													
	Long term													
Measure Nbr 3	Short term													
	Long term													
Measure Nbr 4	Short term													
	Long term													
Measure Nbr 5	Short term													
	Long term													

*Including aspects of biodiversity, ecosystem services, etc., as described in Section 6.2.1 of the main report

5 & 6
3 & 4
1 & 2
0
-1 & -2
-3 & -4
-5 & -6

NB! When Matrix 3 and Matrix 4A have been completed the results of the weighted evaluation will be automatically displayed in Matrix 4B.
Click on the blue button to colour the cells.
Click on the white button to return to white colour.

To colour Matrix 4, click here!

To return to white colour, click here!

CLIMATE PROOF AREAS
The Interreg IVB North Sea Region Programme
formas
The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning
SGI

Object:	*Name of the site etc.*

Result of the weighted evaluation:

Next step(s) (suggestion on continuation):

Appendices:

Signature *Date*

---------- ----------

Statens geotekniska institut
Swedish Geotechnical Institute
SE-581 93 Linköping, Sweden
Tel: 013-20 18 00, Int + 46 13 201800
Fax: 013-20 19 14, Int + 46 13 201914
E-mail: sgi@swedgeo.se Internet: www.swedgeo.se