SNOWMAN NETWORK

Knowledge for sustainable soils

SNOWMAN MCA

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SWEDISH ENVIRONMENTAL PROTECTION AGENCY

Short facts

1. Acronym and full name of the project

SNOWMAN – MCA: Multi-criteria analysis (MCA) of remediation alternatives to access their overall impact and cost/benefit, with focus on soil function (ecosystem services and goods) and sustainability.

2. Full duration of the project + at which stage of the project you are at the moment

Start: 15 January 2010 , Duration 36 month, Q4 of second year (22 months)

3. Consortium partners

Umeå University (UMU)
Chalmers University of Technology (CTH)
Umweltbundesamt GmbH (UBA-A)

4. Project funded by:

Swedish EPA, Lebensministerium (Austrian Federal Ministry of Agriculture and Forestry, Envoronemt and Water)

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NATUR VÅRDS VERKET
SWEDISH ENVIRONMENTAL PROTECTION AGENCY

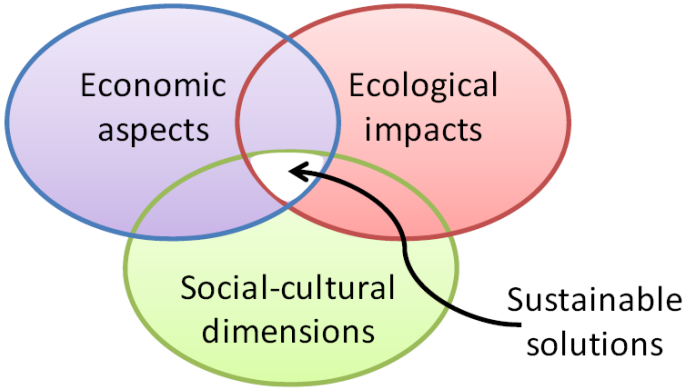
5. Total funding amount:

268 000 €, Dissemination ~ 10 000 €

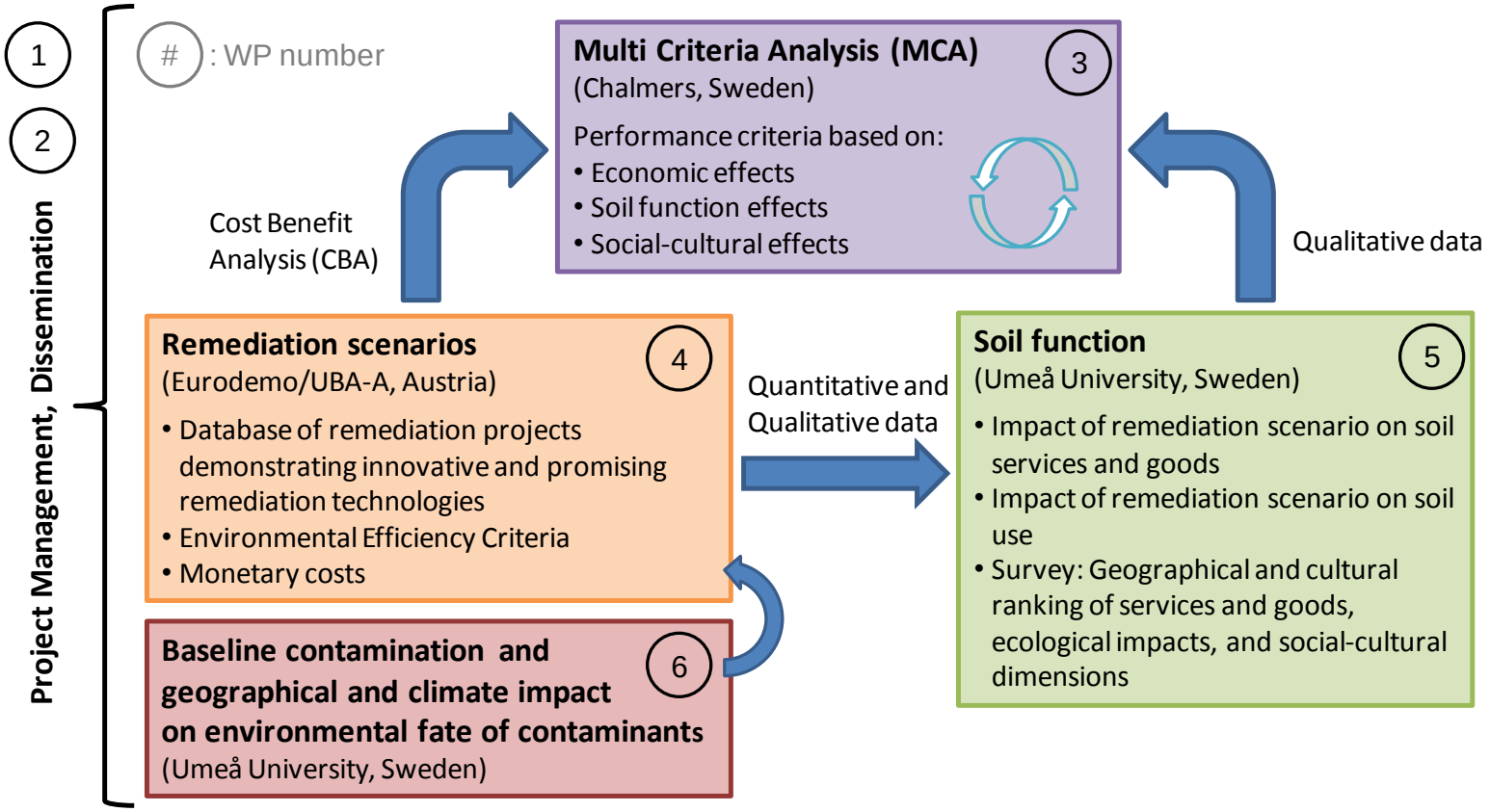
SNOWMAN-MCA

Aim / Background

- To promote sustainable remediation of contaminated soils. Specific goals are to develop a procedure for multi-criteria analysis (MCA) which can be practically applied for sustainability appraisal of remediation alternatives.
- Sustained soils is a key parameter in sustainable developments and the SNOWMAN-MCA project will demonstrate a method for including soil functions and services into MCA for assessing sustainable remediation.
- The project will be based on studies of a few representative polluted sites, and include a range of conventional and innovative remediation scenarios. The impact of the remediation strategies on soil function will be assessed and used as input during the MCA.



SNOWMAN-MCA


1
2
Project Management, Dissemination
: WP number
Multi Criteria Analysis (MCA)
(Chalmers, Sweden)
3
Performance criteria based on:
• Economic effects
• Soil function effects
• Social-cultural effects
Cost Benefit Analysis (CBA)
Qualitative data
Remediation scenarios
(Eurodemo/UBA-A, Austria)
4
• Database of remediation projects demonstrating innovative and promising remediation technologies
• Environmental Efficiency Criteria
• Monetary costs
Quantitative and Qualitative data
Soil function
(Umeå University, Sweden)
5
• Impact of remediation scenario on soil services and goods
• Impact of remediation scenario on soil use
• Survey: Geographical and cultural ranking of services and goods, ecological impacts, and social-cultural dimensions
Baseline contamination and geographical and climate impact on environmental fate of contaminants
(Umeå University, Sweden)
6

Soil Functions and Services

Soil Functions and Services (Draft Soil Directive, COM 2006)

- biomass production, including agriculture and forestry;
- storing, filtering and transforming nutrients, substances and water;
- biodiversity pool, such as habitats, species and genes;
- physical and cultural environment for humans and human activities;
- source of raw materials;
- acting as carbon pool;
- archive of geological and archaeological heritage.

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How are these related to sustainability?

WP1 - *Project Management and Coordination*

The project has been handled by a series of in person and telephone meetings, as well as by e-mail and web based tools. All meetings have been documented.

Table 1. Meetings within the SNOWMAN-MCA project.

Year	2010												2011								
Month	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9
Meeting		X			X				X		X		X		X		X				X
Type		P			T				P		T		T		T		P				T

WP2: *Dissemination and Exploitation*

A number of national and international dissemination activities have been performed.

Date	Country	Setting	Presentation /Activity
September 2010	Denmark	NORDROCS 2010 3rd Joint Nordic Meeting on Remediation of Contaminated Sites International conference	Poster: Incorporating soil services in multi-criteria analysis of remediation alternatives
September 2010	Sweden	Northern Sweden remediation centre (MCN)	Presentation: SNOWMAN – MCA
December 2010	France	Joint meeting SOLENV project	Presentation: SNOWMAN – MCA
January 2011	Sweden	FRIST competence centre (Forum for Risk Investigation and Soil Treatment): Sustainable management of contaminated sites, a workshop on future methods	Presentation: Soil function in the assessment of sustainability
February 2011	Sweden	Clean Soil Network - Workshop: Research on soil processes with potential application for contaminated soils	Presentation: Soil Functions and Services
May 2011	Sweden	The SNOWMAN-MCA International workshop on sustainable remediation and soil functions and services	Workshop organised by the SNOWMAN-MCA project (WP2: D8)
June 2011	USA	EPA/TEI International Sustainable Remediation Conference 2011	Presentation: Integrating the soil function concept and multi-criteria analysis for sustainable remediation of contaminated land

Actions in Austria (as advised during the kick-off meeting) will likely take place during the end of the project. Joint meeting with SOLENV project in December 2010 (as advised).

WP2*: Dissemination and Exploitation*

Short facts on the International Workshop:
27 Participants

Invited speakers:

- *Prof. Lars Rosén, Yevheniya Volchko (Chalmers University of Technology, Sweden):* Multi-criteria analysis for identifying sustainable remediation alternatives with focus on soil functions.
- *Prof. Paul Bardos, (r3 Environmental Technology Ltd, UK):* The SuRF-UK Sustainable Remediation Framework.
- *Bertil Grundfelt (Kemakta, Sweden / NICOLE working group on Sustainable Remediation):* Sustainable Remediation, an update from NICOLE
- *Jos Brils (Deltares, Netherlands):* Soil system services in relation to risk based land management.
- *Stéphane Vaxelaire (BRGM, France):* The SOLENV project: Integrating treatment process impacts and soil quality changes in the environmental assessment of brownfield and groundwater cleanup projects.

A short summary of the workshop may be found on the SNOWMAN website.

WP3: *Multi Criteria Analysis*

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Remediation alternative	Fulfilment of remediation goals	Cost	Environmental impact during remediation	Temporary impact on on-going activities	Benefit to society after remediation	Restrictions on landuse after remediation
1						
2						
3						
4						
5						

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The selection of criteria, sub-criteria, and indicators (i.e. measurements connected to each criteria) and ranking of the importance of each criterion is a fundamental part of a MCA.

WP3: *Multi Criteria Analysis*

WP3 (CTH) has produced a first MCA prototype (spreadsheet model) that has been demonstrated to the project but not been released to partners. Release is planned first half of 2012.

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The above is an attempt to provide flexibility and show added value of the methodology (as advised during the kick-off meeting)

WP3: *Multi Criteria Analysis*

A set of performance criteria for the MCA has been presented as a preliminary list of criteria that is updated as the project progresses (latest revision 18th may 2011). The list is subject to continuous discussion within the project and a “final” list will be presented in Q1 of 2012.

WP3: *Multi Criteria Analysis*

Ecology

Primary environmental effects

o Indicators related to contamination
• mass of contaminants removed or immobilized
• mass of treated contaminants
• (mass/volume of remediated soil/groundwater)
o Indicators related to soil functions or services
• Increase in soil quality
• Restoration of soil properties (water filtration processes, soil structure, erosion stability)
• Area of land rehabilitated
• "Quality" of land rehabilitated
o Indicators related to other eco-system services (most effects to other eco-system services are more or less included in indicators below)

Secondary environmental effects

o Indicators for total energy consumption
• amount of energy from renewable sources
• amount of energy from fossil sources
o Indicators for effects on climate
• GHG (CO_2-equ.)-emissions
o Indicators for total consumption of resources
• mass of water
o Waste related indicators
• mass of waste
• waste quality (e.g. substitution potential of primary resources, if waste is re-used)

Economy

Costs (only financial (= internal) costs included; external effects not monetized □□see environmental and social effects)

o Indicators for private costs
• Costs of remediation measures (planning, organization, operation)
• Costs of after-care measures
o Indicators for public costs
• Funding of private costs

Benefits (benefits for investors only; public benefits: see socio-economic benefits)

o Indicators for monetary benefits
• Increase in site value
o Indicators for non-monetary benefits
• Minimization of risk of legal action

Effects indirectly related to economy

o Indicators for project risk and flexibility
• Technology's state of development
• Flexibility to changes in legislation
• Flexibility to changes of (conceptual) site model
• Flexibility to incidents
o Indicators for project duration (possible interference/overlapping with indicators for private costs and intergenerational equity should be kept in mind)
• Time to meet remediation goals
• Time for after-care measures

Social aspects

Impacts on neighbourhoods and regions (negative impacts associated with remediation works)

o Indicators for impacts on neighbourhood
• Noise
• Vibrations
• Dust & odour
o Indicators for possible impacts on employees
• Occupational health and safety requirements
o Indicators for impacts on regions
• Traffic limitations
• Limitations in use of resources (land-use, drinking water etc.)

Socio-economic benefits (gained by re-use of rehabilitated land)

o Indicators for public benefits
• Restoration of local resources (e.g. groundwater as drinking water source etc.)
• Restoration of land for public use (e.g. recreational areas etc.)
• Employments effects by re-use of land

Public acceptance and equity

o Indicators for public acceptance
• Transparency of decision making process
• Public involvement in decision making process
o Indicators for equity issues
• Intergenerational equity (transfer of remediation measures to future generations; possible interference/overlapping with indicators for private costs and project duration should be kept in mind)
• Social equity (degree of balance between societal groups affected by remediation)

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Indicators related to soil functions or services (WP5)

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WP4: *Remediation scenarios*

Mix of remote and urban sites:

Site	Main contaminants	Affected receptor	Setting	Possible remediation technologies
Dry cleaner Z., Austria	PCE	Groundwater	Semi-urban	Pump-and-treat in combination with 1. Thermal in-situ treatment 2. Soil vapour extraction 3. Soil vapour extraction and partly excavation of hot spots
Shooting range T., Austria	Pb	Soil	Remote	1. Ex-situ soil treatment 2. Soil stabilization (immobilization of heavy metals by chemical means) 3. Phytoremediation (extraction of heavy metals by plants)
Gasworks S., Austria	PAH	Groundwater	Urban	1. Pump-and-treat in combination with excavation of hot spots 2. Containment by cut-off walls
Multi-industrial use, Kvillebäcken, Sweden	PAHs, metals (Pb)	Soil, Surface water (stream)	Urban	Excavation with the following considerations: 1. Mode of transportation 2. Intra-site specific guide line values
Saw mill, Marieberg, Sweden	Dioxins	Soil, Surface water (river)	Remote	1. Excavation 2. On site treatment 3. Surface cover

Started building databases with information/data for the sites

WP5*: Soil Function*

The focus of WP5 has been to suggest criteria, sub-criteria and indicators related to soil functions and services. The efforts of WP 5 have been collected in a manuscript to be submitted (Nov/Dec 2011) to a peer reviewed scientific journal (Journal of Environmental Management).

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- Present a **hierarchy** between soil functions, soil processes, soil services, and ecosystem services.

WP5*: Soil Function*

Terminology and Hierarchy:

Soil functions are defined as the individual building blocks making up the physical, chemical and biological processes that influence the soils system of both living and non-living components, i.e. what the soil does in its natural state.

Soil processes are defined as consisting of more than one soil function, e.g. purification of water which involves several functions such as filtration, degradation of contaminants.

Soil quality is, in the context of soil remediation, defined as suitability in relation to the end use of the soil.

Soil quality indicators are defined as the measurable properties of soil used to evaluate the degree to which the soil quality matches the soil functions determined by the intended end use of the soil, e.g. land use. These soil quality indicators may encompass physical, chemical and biological parameters.

A *soil service* is a soil function or soil process which has been directly or indirectly enjoyed, consumed, or used by an individual/ a society to yield human well-being

Soil service indicator is defined as a value-related measurement that indicates to which degree a remedial action contributes to human well-being by preserving, restoring and/or enhancing soil service. These value-related measurements can be expressed in: (1) community-based values which reflect attitudes, preferences, and intentions associated with a soil service; (2) economic values which reflect a direct market price of a soil good, or the willingness to pay for the service provided by the end use of the soil.

Ecosystem services are defined as the environmental, social, or economic benefits that society obtains from ecosystems. Ecosystem services include the services provided not only by soil, but also include services provided by air, water, and biota. The distinction between soil functions and services, and ecosystem functions and services may overlap, and soil function/services are used for instances where soil is the dominant component or driving force.

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- Present a hierarchy between soil functions, soil processes, soil services, and ecosystem services.
- Provide a conceptual scheme for **connecting soil functions and services with** the ecological, the economic, and the socio-cultural domains of **sustainability**.

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- Present a hierarchy between soil functions, soil processes, soil services, and ecosystem services.
- Provide a conceptual scheme for connecting soil functions and services with the ecological, the economic, and the socio-cultural domains of sustainability.
- Address specific challenges in the context of soil remediation, e.g. issues of **scale** and constrains due to **the end use** of the remediated site. **The potential negative and positive impact on soil by soil remediation** is also considered, and this is addressed by reviewing previous studies.

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- The final part of the paper **suggests a framework for how to include soil functions and services into a MCA** procedure for assessing the sustainability of soil remediation focusing on soil functions/services criteria, and providing recommendations on how already suggested criteria and indicators may be incorporated into the presented framework.

WP6*: Baseline contamination and geographical and climate impact on environmental fate of contaminants*

Two studies have been completed:

- Exposure assessment of Benzo[a]pyrene for Ho Chi Minh City residents - a CalTOX modeling approach (i.e. r*epresenting a urban scenario*)
    - To what degree are polluted soils a factor when ambient air levels (*"anthropogenic basline"*) of PAHs are high?
- Accumulation rates of POPs in a hydrological boreal forest soil gradient: implications for fate assessment and interpretation of soil survey data (*i.e. representing a remote scenario*)
    - Fate and impact of POPs from diffuse sources and how this contributes to a *"anthropogenic* basline" of POPs.

Dissemination & Communication

Targets:
Internal
Researchers
Stakeholders, Policymakers, Environmental consultants

Methods:
Workshops
Scientific conferences
Scientific journals

(Release of a spreadsheet model)

Strategy:
Dissemination and communications will target scientific community in order to gain scientific acceptance, and target stakeholders in order to improve usability

Thank you for your attention