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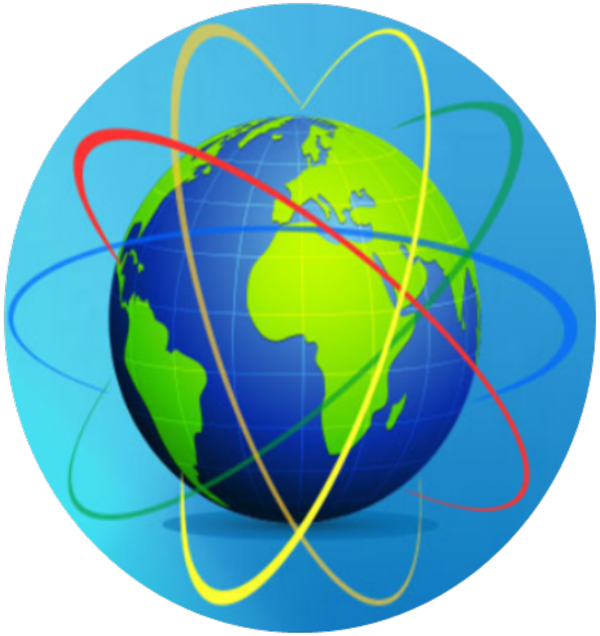
The 3rd International conference on Sustainable Remediation



Theme 2 TOOLS, METRICS AND INDICATORS

Use of social and economic indicators for the selection of sustainable site remediation options

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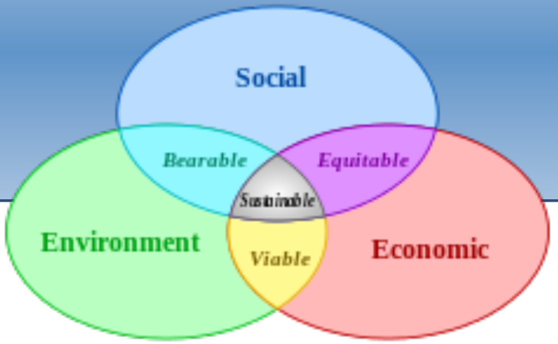
Selection of site remediation alternatives

- Multicriteria analysis
- Cost-effectiveness analysis
- Cost benefit analysis
- Sustainability indicators

- Lifecycle analysis
- Ecological footprint - Carbon footprint- Carbon balance
- Risk assessment- Environmental impact assessment

3P?



- Several methodologies have been developed to evaluate and select the most optimal remediation options for a contaminated site, taking into account economic, social and/or environmental aspects

- Lot of attention for environmental aspects of site remediation: LCA, carbon footprint, etc.

- need to include more social and economic aspects in the selection of site remediation options

Environmental impact of site remediation

Cappuyns V, (2013). LCA based evaluation of site remediation, Opportunities and limitations, Chemistry Today 31(2), 18-21

Ref	Case study	Impact assessment method or tool
[22]	-	REC (uses value functions method for assessment of environmental merit)
[23]	Site contaminated with Pb, As, Cd, PAH's	Calculation of potential impact indicators
[8]	Analysis of 6 generic remediation options	Multimedia Maclkay model Solid Waste Burden (SWB) + useable land area
[17]	Site contaminated with mineral oil, PAH and Cr	Use of disadvantage factors
[24]	-	pollution factor (PF) is calculated, and expression of environmental impacts in dimensionless environmental impact units (EIUs
[21]	Industrial site contaminated with sulfur	No impact assessment but ranking of productivity resources
[18]	spent pot lining (SPL) landfill contaminated with Cd en Cu	EDIP97 + simulation of contaminant transport in groundwater, using site-specific data
[2]	Diesel-contaminated site	EDIP97
[20]	Landfill sites in Switserland	Procedure for estimating heavy metal transport in soil within a current LCAI
[25]	Old landfill	Specify method for impact assessment transport of heavy metals
[26]	former manufactured gas plant site	Characterization method adopted from UBA (2000),
[27]	Mixed industrial-residential-commercial area	IPPC Tier Two methodology

Environmental impact of site remediation

Ref	Case study	Impact assessment method or tool
[28]	Brownfield contaminated by human activity in railway sector	IMPACT2002+
[10]	Diesel-contaminated site	US-EPA TRACI
[29]	Industrial site with 300 industries involved in chemical and petro-chemical productions	DEcision Support sYstem for REhabilitation of contaminated sites (DESYRE).
[19]	Outdoor shooting range and gasoline station	Decision support tool (DST) based on REC
[30]	Site contaminated with chlorinated ethenes	GaBi4 LCA softwareand EDIP97 impact assessment method Lemming et al (2010)
[16]	Site contaminated with diesel	Global warming potential (GWP), acidification potential (AP), eutrophiation potential (EP) and photo oxidant creation potential (POCP)
[13]	Agricultural fields contaminated with dieldrin	RN_{soil} and economic input-output LCA
[31]	Dioxin and furan Contaminated sediments in a Fjord	ReCiPe impact model
[15]	Area of 700 km^2 contaminated with Pb, Cd and Zn	Global warming potential (GWP) of CO_2
[12]	Previous oil depot	ReCiPe- EPD
[11]	Industrial site with distribution center for cars	REC

Research questions

Which indicators, assessment methods, criteria, … are available to evaluate social and economic aspects of soil remediation projects?

Use/ application of social and economic indicators in different countries (Flanders, UK, US, Austria, and The Netherlands)?

Methodology

- Starting point: indicators of the SuRF framework
- Use of these indicators in practice for the selection of soil remediation alternatives in the US, UK, The Netherlands and Flanders
    - Analysis of Research reports, Guidance documents and legislation (RIVM, OVAM, DEFRA, EA, SuRF, NICOLE, CLARINET…),
    - Interviews with experts from soil remediation sector in Flanders

Sustainability indicators

Sustainability indicators from SuRF

Social	Economic
1. Impacts on human health and safety; 2. Ethical and equity considerations; 3. Impacts on neighbourhoods or regions; 4. Community involvement and satisfaction; 5. Compliance with policy objectives and strategies; 6. Uncertainty and evidence.	1. Direct economic costs and benefits; 2. Indirect economic costs and benefits 3. Employment and capital gain; 4. Gearing; 5. Life-span and 'project risks'; 6. Project flexibility.

S1: Impacts on human health and safety

⇒ Human health and safety are taken into account when a choice between different remediation techniques has to been made

- Regulatory requirements (obtaining a license or permit);
- Guidelines for environmental risk assessment
- Safety of site workers

- Potential quantification in DALY or QALY=> can also be translated in monetary value

S2: Ethical and equity considerations

- Polluter Pays principle
- Liability versus responsibility
- Remaining contamination is an aspect in MCA in Flanders => intergenerational equity

Other concerns, not fully considered:

- Impacts/benefits proportionally divided between different groups?

S3 : Impacts on neighborhoods and regions

Impacts/benefits to local areas:

- Effects from dust, light, noise, odor and vibrations during works and associated with traffic, including both working-day and night-time/weekend operations
- Wider effects of changes in site usage by local communities
- architectural conservation, conservation of archaeological resources

⇒ **better fine-tuning between soil remediation activities and site redevelopment plans**

S4 : Community involvement and satisfaction

- *Changes in the way the community functions and the services they can access (all sectors – commercial, residential, educational, leisure, amenity)*
- *Quality of communications plan*
- *Effect of the project on local culture and vitality*
- *Inclusivity and engagement in decision making process*
- *Transparency & involvement of community, directly or through representative bodies*

⇒ In general communication mainly after the soil remediation options have been approved, only information, no stakeholder involvement in decision process

Communication and stakeholder participation

- Good practices from US
- Communication and participatio ... on projects
    - implementation of different ways of ... every stage
    - Transparency: all decisions are doc...
    - Technical information and explanati...

=> collaboration with (local) commu... remediation to a happy conclusion

C1-2 : Direct and indirect costs and benefits

- *Direct financial costs and benefits of remediation*
- *Changes in site/local land/property values*
- *Increase in site value => future development or divestment*
- *Liability discharge*
- *Health benefits through decreased soil, air and groundwater contamination*
- *Consequences of an area's economic performance*

⇒ Can be quantified (# euro's, # hectares of clean soil, # avoided sick persons)

⇒ More attention should go to (in)direct benefits (incl. quantification)

Cost-benefit analysis

⇒ costs and benefits are converted into monetary values for comparison

⇒ considers a diverse range of impacts, such as the effect human health, the environment, the land use, and issues of stakeholder concern and acceptability

⇒ by assigning values to each impact in common units.

Cost-effectiveness analysis

⇒ Aim is to determine ". . . the least cost option of attaining a predefined target. . ." without a monetary measurement of benefits (Environment Agency 1999)

⇒ Costs are calculated conventionally and benefits are scored individually. An aggregate score for benefits is then divided by cost to provide a measure of "cost effectiveness"

⇒ **Austria**: a 'modified' cost-effectiveness analysis is mandatory when requiring resources from the National remediation Fund

CBA: existing studies

Reference	Subject-major findings
Bonnieux et al. (1998)	basic economics of contaminant flows from both private and public perspectives
Hamilton and Viscusi (1998)	First comprehensive assessment of the cost-effectiveness of Superfund cleanups demonstrates the importance of explicitly calculating the trade-offs embodied in environmental cleanup decisions
Postle (1999)	CBA including human health, water supply, land value
Hetterschijt (2000)	financial risks of soil remediation projects can be assessed and evaluated by a team of remediation experts using commercially available software.
Kent (2001)	"Treating contaminated groundwater at the point of extraction when needed, may be more practical and cost effective than attempting to restore aquifers to background conditions at the point of contamination"
Efroymson et al. (2003)	framework for Net environmental benefit analysis (NEBA), with special application to petroleum spills in terrestrial and wetland environments. "Primary information gaps related to NEBA include: non-monetary valuation methods, exposure-response models for all stressors, the temporal dynamics of ecological recovery, and optimal strategies for ecological restoration"
Hylander (2006)	Quantification of remediation costs for different case studies and compare these costs with preventive measures
Van Wezel (2007)	described the benefits of soil remediation for health, drinking-water supply and housing are expressed in monetary terms extent to which these benefits will weigh up to the true (financial) cost of the remediation will depend partly on the value-taxed discount rate chosen Focusing on non-material benefits, like for example environmental benefits, can result in a positive balance
Irivinne and Denn (2010)	CBA of the proposed National Environmental Standard (NES) that would define an acceptable level of protection for human health CBA was not able to provide a strong conclusion as to whether or not the NES is likely to generate a net benefit to society
Forshlund (2010)	if environmental health risks are to be reduced, there are probably other areas where economic resources can be used more cost-effectively
Barton et al. (2010)	WTP for remediation. discusses how to better inform local stakeholders about the potential and limitations of the contingent valuation method and how to improve communication of economic valuation results.
Guerrirro (2011)	overview of the major steps necessary to conduct a cost-benefit analysis of cleanup interventions
Bartke (2011)	Investigation of drivers of risk perception and introduction of a novel valuation method for the assessment of market-perceived risks for sites polluted by earlier use
Lavee (2012)	increase in the land value of the contaminated site, and indirect benefits, arising from the increase in nearby property value
Morio et al. (2012)	investigations on brownfields re-use optimization using a weighted sum aggregate multi-criteria objective function

Possibilities of CBA

Examples

- ⇒ **Costs/benefits for drinking water supply**
- ⇒ **Costs/benefits for industrial water quality (loss of supply, increased treatment cost)**
- ⇒ **Reductions in values of affected properties**
  - ⇒ **Influence of perceived economic risks and stigma**
- ⇒ **Changes in values of adjoining properties**

Applications of cost-benefit analysis

⇒ Quantification of remediation costs and comparison of these costs with preventive measures

⇒ Cost of potential health effects (damage function approach)

⇒ e.g. CBA based on the avoidance of cancer

Methods for valuing health

Basic approach	Main subsets	Evaluation methods
Human capital		Cost of illness
Willingness To Pay	Revealed Preferences	Hedonic wage method
		Averted expenditures
	Stated Preferences	Contingent Evaluation
		Stated Choice

Source: Enhealth 2003

⇒ **Willingness to pay for remediation**

Cost-benefit analysis

⇒ difficult to attach a strictly monetary value to many effects of a remediation project.

⇒ Most studies limit themselves to the estimation of the increase in land value after remediation

⇒ Concerns exist about discounting future effects to net present value (long-term effects of some remediation projects)

⇒ e.g. monetary valuation for less tangible environmental values e.g. biodiversity?

⇒ UK: no formally prescribed cost benefit analysis (CBA) procedures, but guidance has been produced by the Environment Agency.

⇒ assessments can involve a *combination* of qualitative, formal cost benefit analysis (CBA) and multi-criteria analysis (MCA) methods

Economic appraisal

⇒ financial risks of soil remediation projects (e.g. Cappuyns and Kessen, 2013)

⇒ net environmental benefit analysis (NEBA) = gains in environmental services or other ecological properties attained by remediation or ecological restoration, minus the environmental injuries caused by those actions.

⇒ Possibilities of Life Cycle Costing (LCC) to quantify environmental costs and benefits (Steen et al., 2006)

- ⇒ impacts on human health, ecosystem health and natural resources have to be considered (ISO 14042).
- ⇒ Issues like work environment, economic impacts, impacts on cultural values and social impacts are sometimes also included as externalities

Conclusions

- Improvements to be made with respect to social and economic aspects of 'sustainability evaluation' of site remediation

- More attention should go to benefits of site remediation

Benefits of sustainable remediation

- More rational use of energy and resources
- More intelligent remediation design
- More equitable solutions

Conclusions

- Economic valuation techniques offer opportunities for quantification of (in)direct benefits
- Involvement of/communication with stakeholders can be improved: lots of good examples exist!

However, we can save 700 lire and two months by not doing a geotechnical investigation

Thank you for your attention!

Questions?

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