Evaluating sustainable remediation methods for brownfields redevelopment projects (BRPs)

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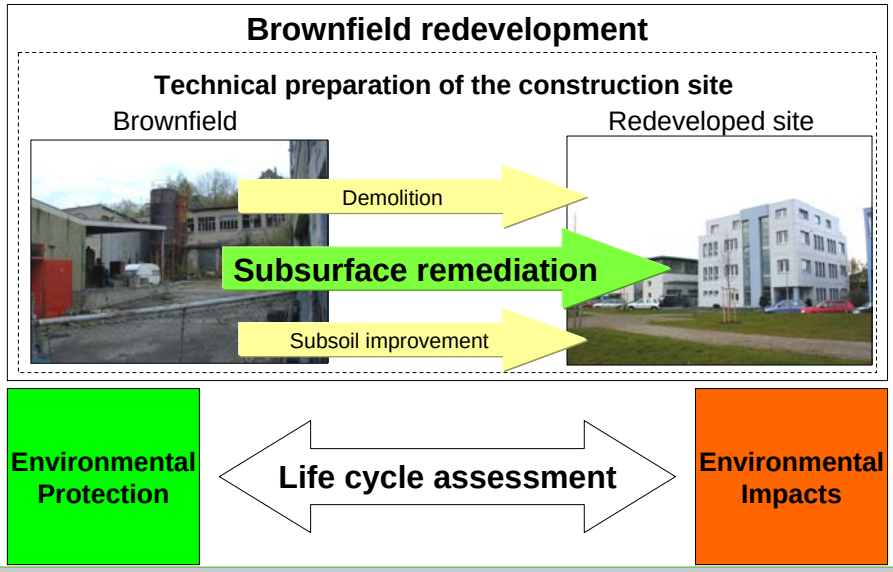
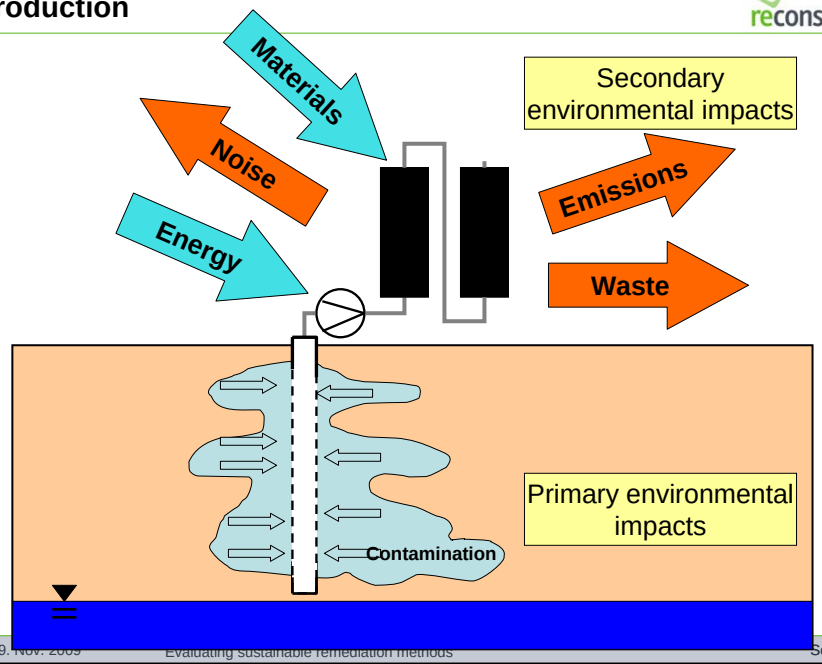
Introduction



Introduction



Research objectives

Providing
new insights and tools
on the basis of LCA in order to
minimize environmental impacts
of remediation measures

1. **Development of methods for a simplified quantitative estimation of environmental impacts**
2. **Development of new procedures for the evaluation of environmental impacts**
3. **Formulation of recommendations for a sustainable remediation management**

Basic information about remediation techniques

Overview of remediation technologies applied in NRW

	Landfill sites	Contaminated sites
Decontamination	*153*	*1,072*
Containment	*591*	*841*
Relocation on-site	*117*	*358*
External disposal	*561*	*2,389*
Total	*1,422*	*4,660*

LANUV NRW 2007

Overview of remediation technologies applied in NRW

3 remediation methods

- **Excavation and Disposal**
- **'cold' SVE**
- **Pump & Treat**

cover 2/3 of the market

	Landfill sites	Contaminated sites
Decontamination	153	1,072
Thermal technologies	8	80
Biological technologies	1	177
Soil washing or extraction	1	12
Pneumatic technologies	99	360
Soil vapour extraction (SVE)	37	360
Landfill gas extraction	62	0
Hydraulic technologies	40	443
Pump & Treat (P&T)	25	403
Others	15	40

LANUV NRW 2007

Overview of remediation technologies applied in NRW

	Landfill sites	Contaminated sites
Containment	591	841
Encapsulation	529	767
Surface sealing	125	173
Surface coverage	297	300
Sealing for traffic or other uses	94	276
Vertical barrier	11	18
Bottom lining	2	0
Immobilization	12	10
Pneumatic containment	27	20
Hydraulic containment	23	44

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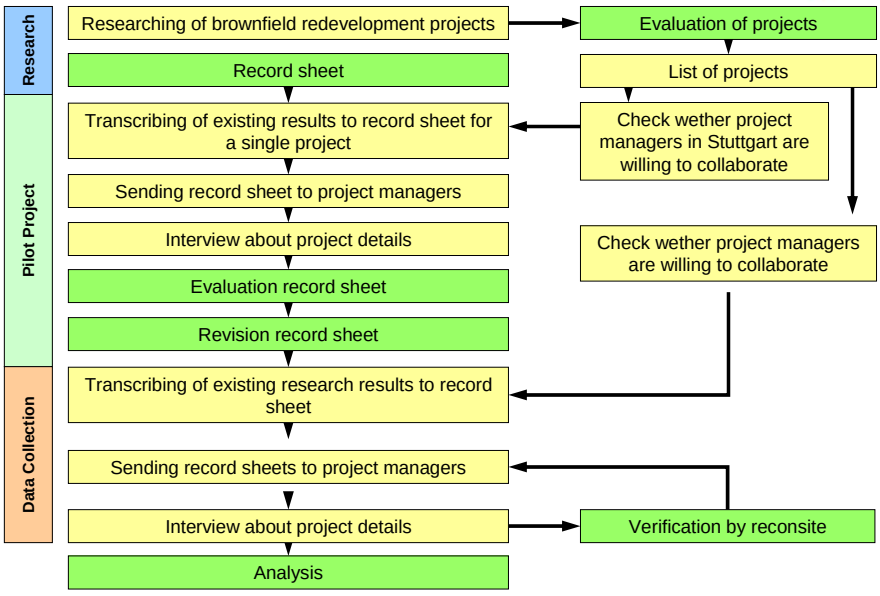
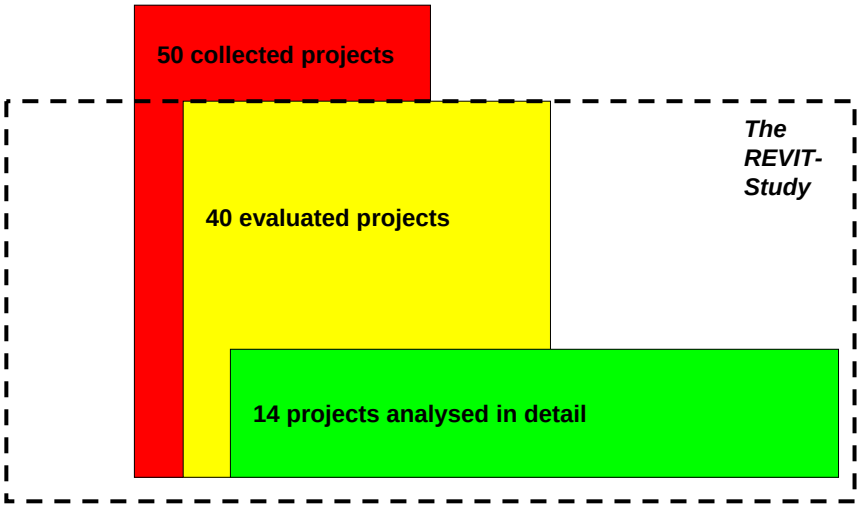
The REVIT-study

Procedure of the investigation



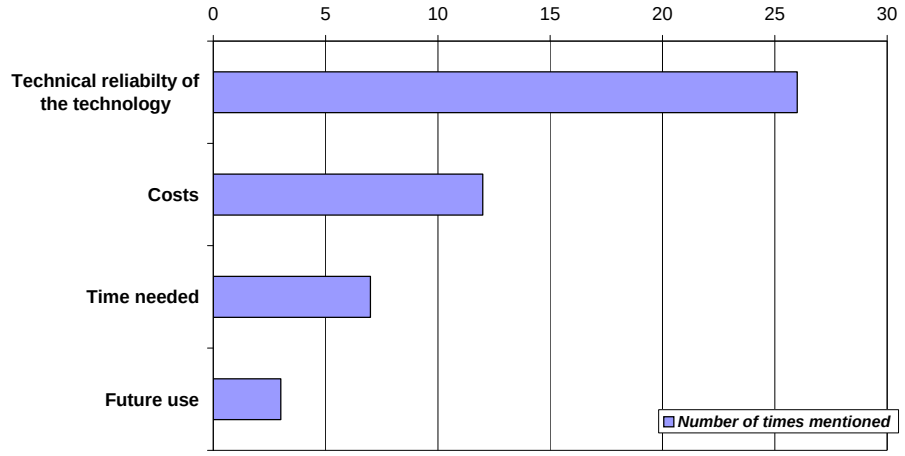
REVIT-Study: Remediation methods @ brownfield redev. proj.



Overview of the projects

Former use	Industry – commerce – military – railway yard
Subsequent use	Housing – trade – services
Size	5000 – 320000 m²
Pollutants	LHKW, BTEX, PAH, MKW, heavy metals
Duration of brownfields	0 years to 40 years
Duration of remediation	6 month up to 20 years
Success of remediation	All of the 14 in detail examined projects were successful

Selection criteria for remediation technologies



Results – Overview (new definition)

	Technology	Number of application	Technology rating
	Excavation & disposal	29	Standard
	Soil washing (ex-situ)	1	Alternative
	Thermal treatment (ex-situ)	2	Alternative
	Biological treatment on-site	1	Alternative
	Biological treatment off-site	6	Alternative
	Soil vapour extraction	1	Alternative
	Surface sealing	6	Alternative
	Containment structures	5	Alternative
	Containment by sealing with buildings	3	Alternative
	Immobilization	2	Alternative

Results – Overview (old definition)

	Technology	Number of application	Technology rating
	Excavation & disposal	29	proven (Standard)
	Soil Washing (ex-situ)	1	proven
	Thermal treatment (ex-situ)	2	proven
	Biological treatment on-site	1	proven
	Biological treatment off-site	6	proven
	Soil vapour extraction	1	proven
	Surface sealing	6	proven innovative character: → sealing material → buildings allowed
	Containment structures	5	proven
	Containment by sealing with buildings	3	proven
	Immobilization	2	proven

Results – Overview (new definition)

	Technology	Number of application	Technology rating
	Vertical barrier	1	alternative
	Mixed-in-place vertical barrier	1	Alternative
	Microbiological in-situ methods	2	Innovative
	Groundwater circulation well	1	Alternative
	Pump & Treat	7	Standard • innovative Character: → filtration technology
	Air-Sparging	1	Alternative
	Funnel & Gate	2	Alternative

Results – Overview (old definition)

	Technology	Number of application	Technology rating
	Vertical barrier	1	proven
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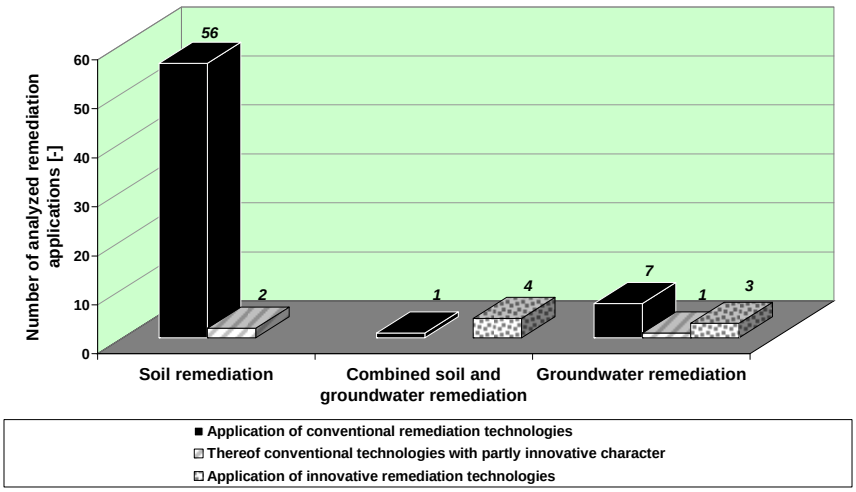
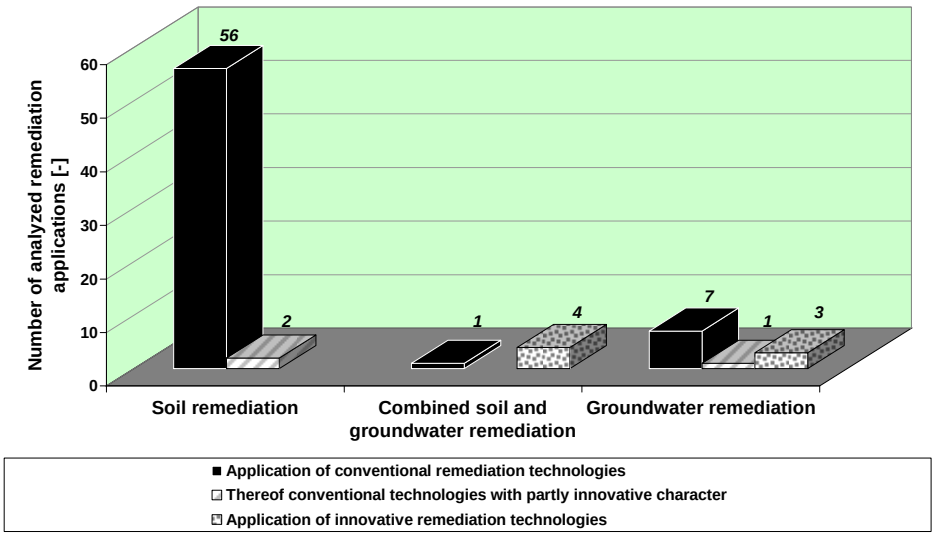
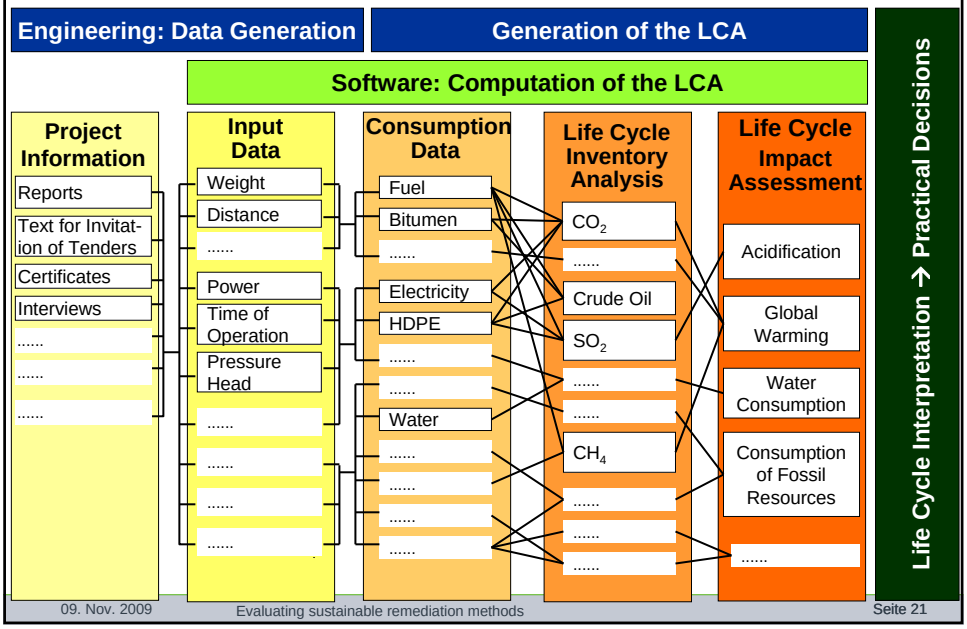


Application of remediation methods

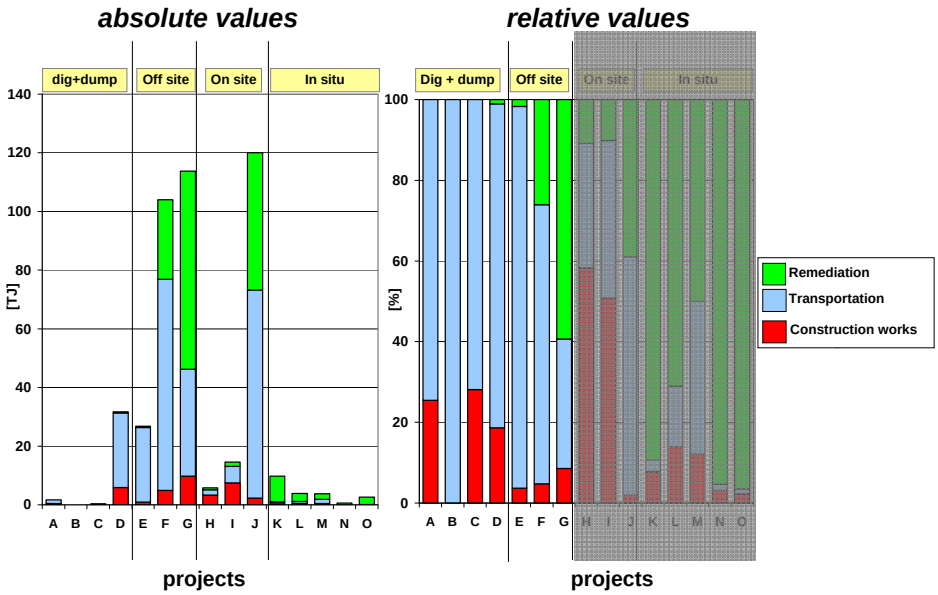


The LCA of remediation techniques

Applied LCA Method



Comparing projects: 'Cumulative energy demand'



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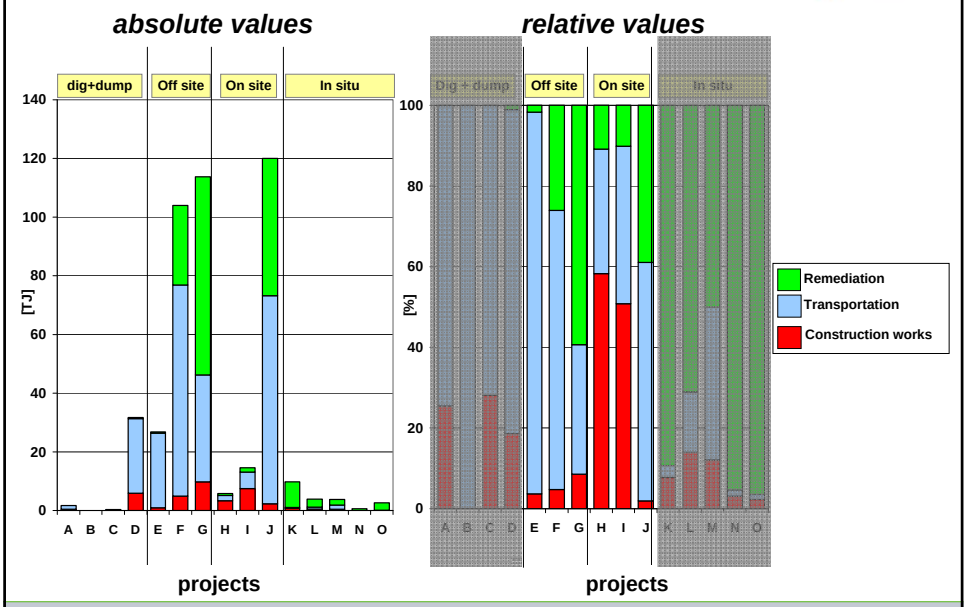

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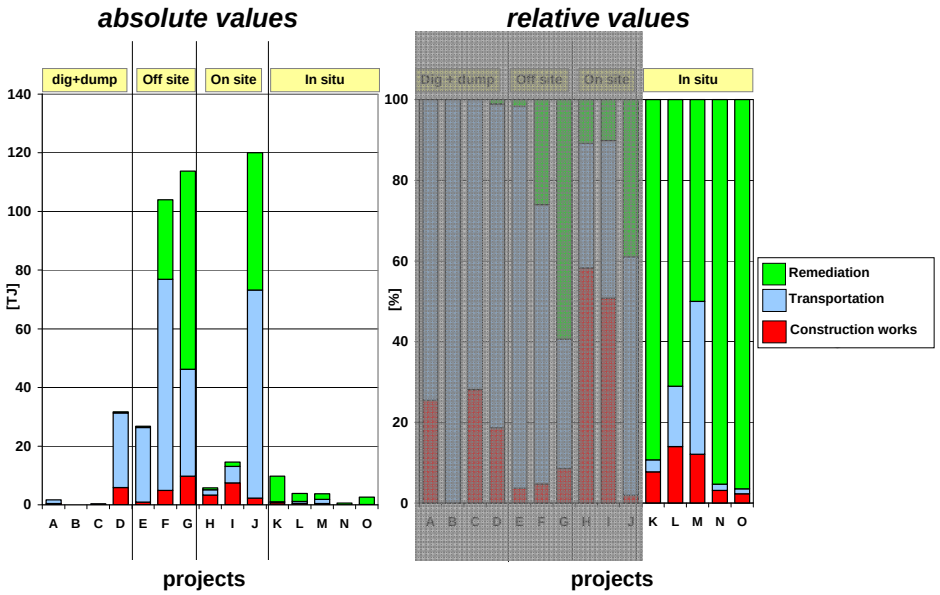

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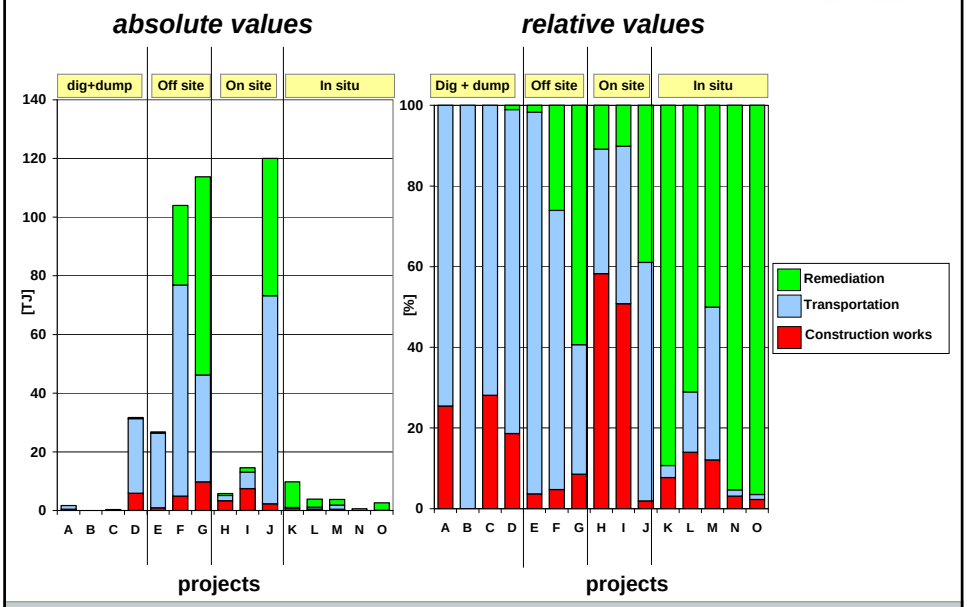


Simplification method for the LCA

Measures / actions < 5 % in the main impact categories:

- Construction site set-up
- Transportation of material
- Control trips
- Transportation of persons
- Drilling work

Identifying and neglecting!

Measures / actions > 30 % in the main impact categories:

- Excavation
- Mass transport
- Energy intensive remediation techniques

Balancing!

Unsaturated Zone

Reasons for excavation & disposal

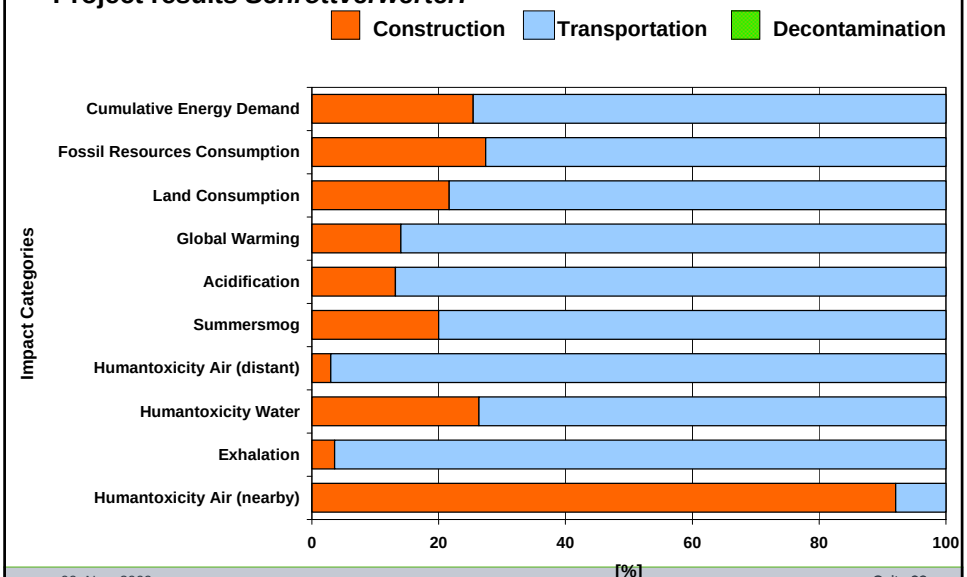
- Deadlines
- Low disposal costs
- Need for a definitely clean site
- Foundation of new buildings
- Clearly defined point sources of contamination

http://www.carrieresfeidt.lu/

- Cost of disposal
- Depths of the contaminated zone
- Accessibility
- Surroundings
- Health and safety issues

LCA-Results: Excavation and Removal

Project results *Schrottverwerter:*



Results: Excavation and Removal

- **Transportation distances** often > 200 km
- **Mass transports** dominate most of the impact categories
- Fate of **excavated material**?
- Refilling material may be necessary

Simplification of the LCA

Mass transports

Unsaturated Zone

Excavation & Soil Treatment & Disposal

www.Schmid-umweltschutz.de

Soil washing (off-site)

Biological treatment (on-site/off-site)

www.zueblin.de

www.al.fh-osnabrueck.de/14251.html

Thermal Treatment (off-site)

Results: Off site measures

- Potential environmental impact emphasis on transportation and remediation
- Transportation rate often > 50 % in most life cycle assessment impact categories
- Environmental impacts:
  Ex-situ thermal treatment > Soil washing > Biological treatment
- Disposal of decontaminated material is very important: recycling or disposal?

Simplification of the LCA

Mass transports

Remediation technique

Results: On site measures

- Potential environmental impacts caused by construction operations, transportation, and the applied remediation technique
- The influence on the impact categories is depending on the type of **remediation technique** and on the extent of **construction measures** and **mass transportation**
- Important: displacement of decontaminated material for backfilling

Simplification of LCA

Mass transports

Remediation technique

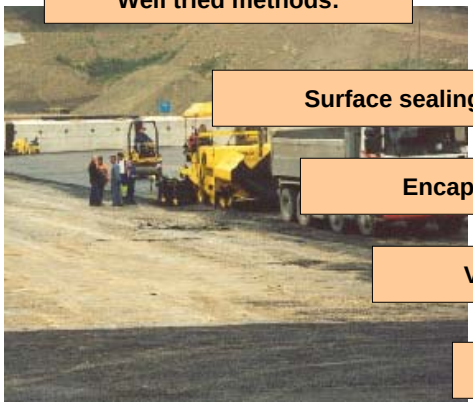
Construction measures

Unsaturated/Saturated Zone

reconsite

Containment measures

Well tried methods:

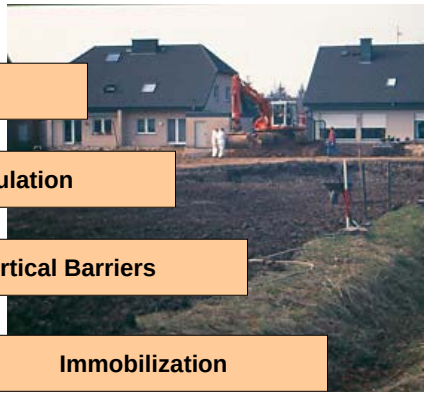


Surface sealing

Encapsulation

Vertical Barriers

Immobilization



www.walo.ch

www.al.fh-osnabrueck.de/14251.html

Saturated Zone

reconsite

Well tried methods:

Pump & Treat

Air-Sparging

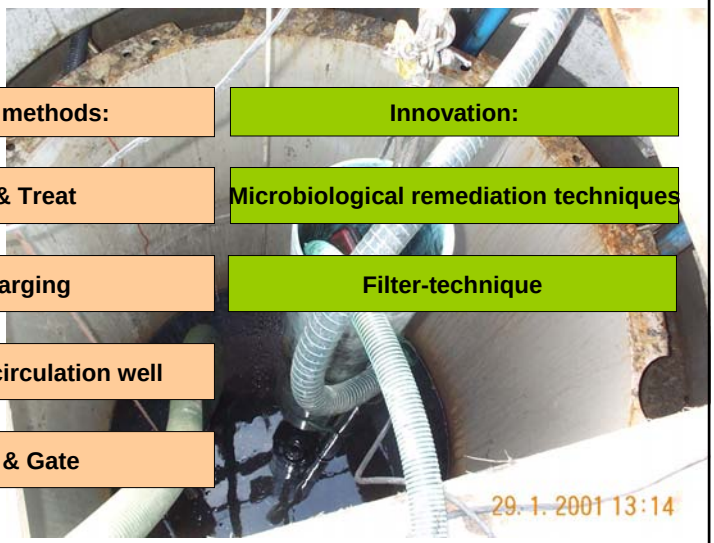
Groundwater circulation well

Funnel & Gate

Innovation:

Microbiological remediation techniques

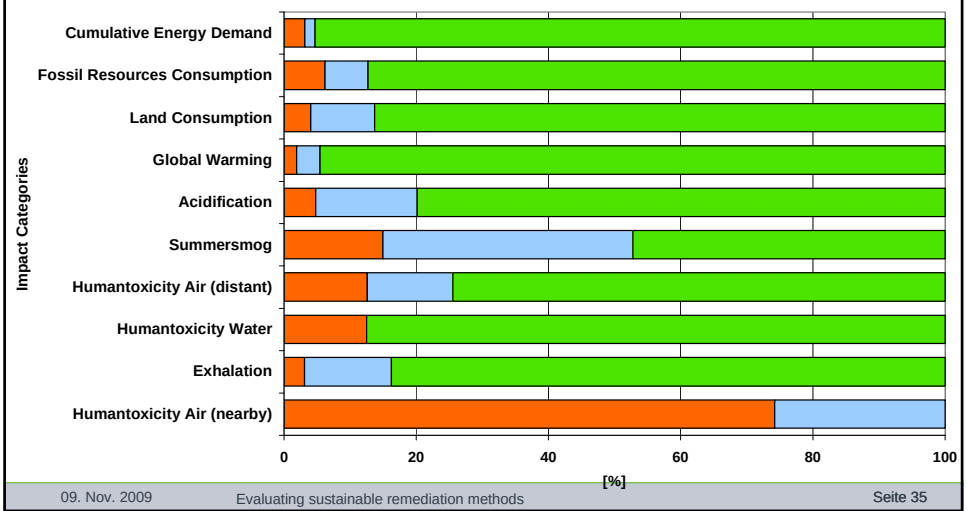
Filter-technique



http://dmi.stadtwerke-karlsruhe.de/index_public.html

LCA-Results: In situ measures

Project results *Metallverarbeitender Betrieb A: (metal processing company A)*



Results: In situ measures

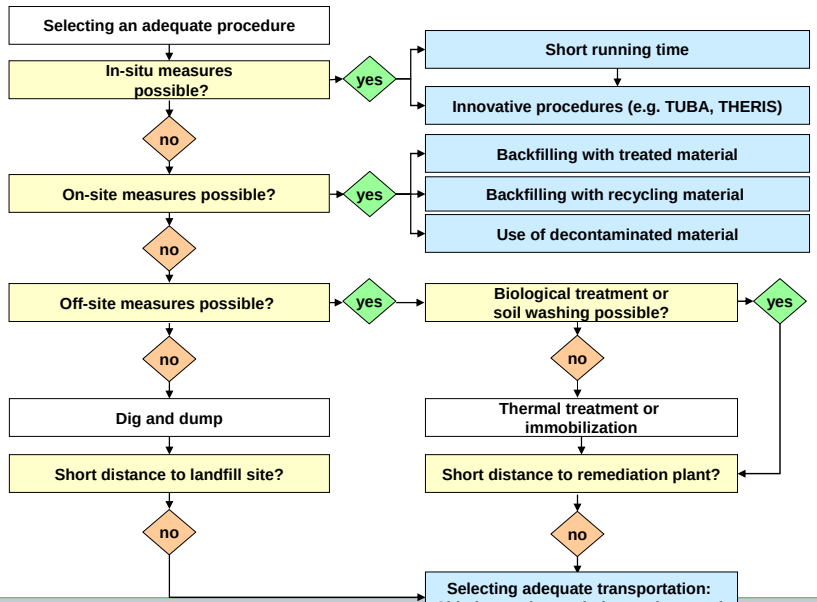
- **Remediation technique and the operation time of the facility are the driving factors**
- **Essential environmentally relevant facility components:**
  - pumps to discharge groundwater and soil-air
  - extracted air cleanup/water cleanup installations
- Transportation and construction operation are often not relevant

Simplification of the LCA

Operation time of pumps

Consumption of activated carbon

Practical advice for a sustainable remediation management



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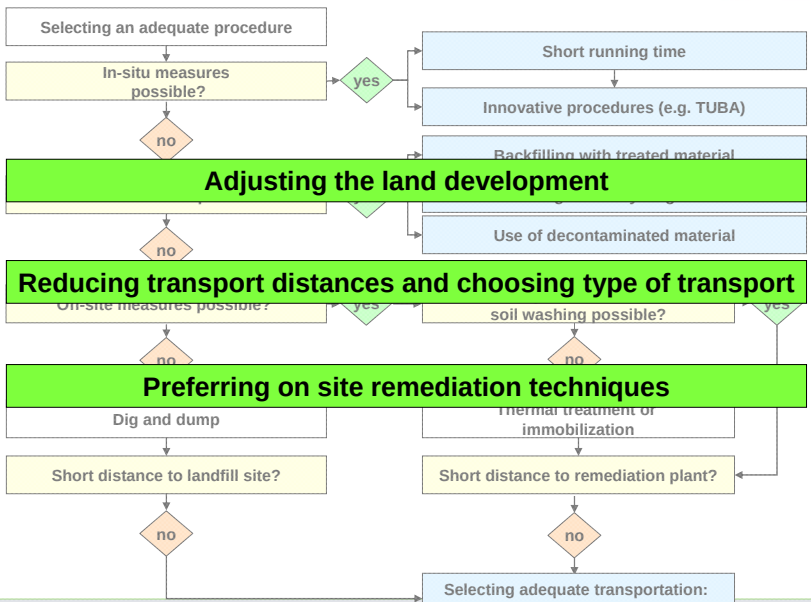
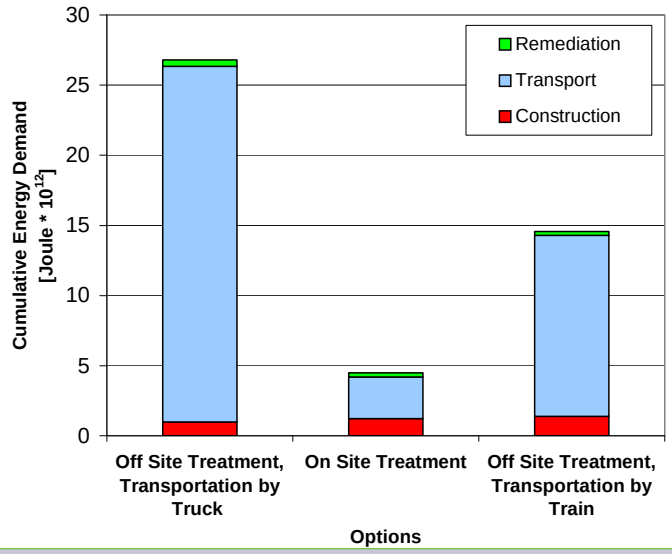


Optimisation



Requirements for remediation technologies

- ***Cost efficiency***: Techniques have to be at least equal to the standard technologies or preferably more favorable with respect to cost and efficiency
- ***Remediation goals should be reliably obtainable in a certain period of time:*** Assessable of remediation time
- ***Interfaces:*** between remediation technologies and other construction processes in a brownfields redevelopment project should be controllable.

Scale in the unsaturated zone: Excavation & Disposal

Conclusions (1)

1. ***The application of innovative remediation technologies in brownfield redevelopment projects is not commen***
2. LCA should focus on main parameters of remediation measures
3. ***Excavation & disposal*** *in 70* % of all examined cases, because:
   - only 15 % of the examined remediation were groundwater contaminations
   - decontamination was the main goal
   - combination with the demolishing of buildings and other construction actions
4. **Mass transportation** often **dominates** the environmental impacts

Conclusions (2)

5. **Saturated zone:** pump & treat and the use of **alternative remediation technologies**:
   - Funnel & Gate
   - Microbiological remediation methods
6. Impacts of in-situ remediation measures depend on the running time
7. Formulation of **requirements for the application of other remediation technologies instead of excavation & disposal or pump & treat**
   - cost-efficient
   - reliable reaching of remediation goals