

LIFE CYCLE ASSESSMENT (LCA) OF CONTAMINATED SITE MANAGEMENT



Francesca Gambazzi (EPFL), H el ene Beauchamp (VU Amsterdam)
J er ome Payet (EPFL), Kees van Gestel (VU Amsterdam)



ABSTRACT LCA is a powerful tool for assessing the environmental impact of services or products. Via the comparison of several remediation strategies for soils contaminated by metals, the study aims at identifying the main methodological gaps in modelling impacts at midpoint and endpoint levels and providing useful insights for filling in these gaps. Emphasis is placed on ecosystems (e.g. impact assessment on aquatic and terrestrial ecosystems, multiple time and space scale assessment, and biodiversity modelling). Applying the approach in a practical case study, the results highlight the importance of the ecosystem characterisation in Life Cycle Impact Assessment especially regarding the determination of the media parameters and the spatial differentiation of the impacts.

INTRODUCTION

The possible alternatives to prevent the impact of pollution should always be compared with the « No action » scenario, in order to estimate whether the management techniques result in a higher impact than the contaminated site itself.

LCA converts the amounts of substances emitted during a product (or service) life cycle into potential impacts on ecosystems.

GAPS&PROBLEMS

« No action » scenario can't be assessed with classical LCA approach as it does not create emissions due to product or services required.

Metals emitted during the life cycle of different products and services may generate damages on the ecosystems, especially the soil. However, still insufficient data is available for metal effect on terrestrial ecosystems.

MATERIALS&METHOD

Contaminated soil is considered as a « pollution reservoir » releasing amounts of metals in time. To quantify the amount of metals emitted in time, the evolution of the soil fractions that bind metals have been modelled: 1) easily soluble, exchangeable, carbonate, 2) organic matter, 3) Fe-/Mn-oxides, 4) residual fraction.

LCA is applied to two site management strategies and the impacts of the “no action” scenario are derived, based on IMPACT2002+ factors.

Terrestrial midpoints are not considered because the damage factors are incomplete. All the emissions are thus transferred to water ecosystem to derive their impact.

LIFE CYCLE IMPACT ASSESSMENT

Functional unit: Clean 162.5 m3 of Ronde Venen (NL) soil polluted with heavy metals (Dutch legislation values). **System boundaries:** the system includes the action taken on site and the disposal of the treated soil. Monitoring is considered equal for all scenarios.

Scenario 1: Soil excavation. All metals treated, time needed: few weeks

Reference flux

transport lorry 28 t/CH u	10725	tkm
Excavation, hydraulic digger /CH U	162.5	m3
New waste disposal*	178750	kg

*concentration of the entering waste modified to represent the treated soil (based on Disposal, hazardous waste, 25% water, to hazardous waste incineration/CH S)

Scenario 2: Phytoremediation for 48 years (reed) followed by « no action ». 48 years to treat Cd and Zn, remaining metals emitted later in the environment, time needed: thousand of years

Reference flux

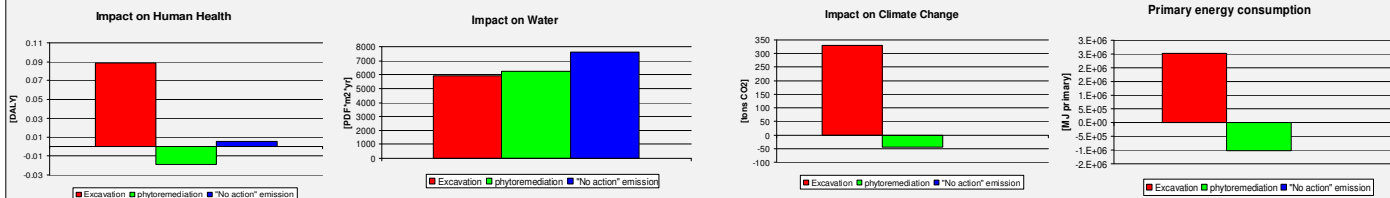
wheat seed IP, at regional storehouse*/ CH U	50	kg
Swath, by rotary windrower/CH U	3.9	ha
Tillage, harrowing, by rotary harrow/CH U	3.9	ha
Mulching/CH U	3.9	ha
Transport lorry 28t/CH U	2808	tkm
Electricity, at cogen 6400KWth, wood emission control, allocation	182000	kWh

*No data available for reed seeds in IMPACT2002+, it is assumed that wheat can approximate reed

Scenario 3: No action. All metals emitted « naturally », time needed 60 000 years (maximum limit).

Reference flux: nil

DAMAGE: « no action » showed a smaller impact on human health than the excavation procedure, but a greater for the impact on water. Phytoremediation seems to be the best option, but only thanks to the energy co-generation.



MIDPOINTS: Inorganic substances in the waste disposal have the most important impact on human health because of their effect on respiration. In all scenarios the impact on water is dominated by the impact of metals on the aquatic toxicity.

CONCLUSIONS

The most suitable (“best”) scenario depends on the target to protect (humans, ecosystem) and to compare management strategies, time should be a parameter in LCA, as well as the final site situation.

Metals generate direct and indirect impacts, especially in water. Their release, and thus their impacts, depend strictly on local conditions.

PERSPECTIVES

- Sensitivity analyses: different plant species for phytoremediation
- Long term emission pattern (until 60 000 years)
- Transfer of impact: emission of metals to soil instead of water

How should decision-makers compare unequal results of remediation strategies in terms of post-treatment ecosystem state and length of treatment time?