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DECIDING ON SOIL REMEDIATION: APPROACHES AND TRENDS

Arthur de Groof
Grontmij Nederland BV
PO Box 119, NL-3990 DC Houten, The Netherlands
phone: +31 30 634 46 15
email: arthur.degroof@grontmij.nl

Introduction: crucial decisions in dealing with soil contamination

Two decisions can be considered crucial in every case of soil remediation: the final assessment of the contamination, and the final decision on the remediation strategy. Both decisions, while based on data gathered on site, are largely regulated almost everywhere. Policy, rules and other circumstances vary a great deal from country to country and from region to region. Still, general trends can be identified. In the decision-making process the data can be set against generic values, against site-specific criteria, or against a mix of these. This paper looks briefly at the general situation in different industrialized countries. It will be shown that in those countries all varieties (and more) are actually encountered, and that the general trend is towards more site-specific criteria.

Generic criteria generally result in the simplest decision-making model. It will be shown that this was fairly popular in the early history of dealing with soil contamination. Later on, site-specific criteria gained more ground (and still do), if only because they allow for greater flexibility. Land-(re)use is one of the most important of the site-specific criteria, or is at least one that pops up without exception: the actual use of the land is important when assessing the contamination, and the future use of the land weighs in more importantly when deciding on the remediation strategy.

A quarter century ago: a strong case for multifunctionality

In most of the countries presently dealing with soil remediation the wheels have been set in motion by major incidents. Especially where these cases received widespread media attention governments were quick to respond. The clearest example of this is probably the United States where, barely a year after Love Canal became a household name, the federal Comprehensive Environmental Response and Liabilities Act (CERCLA) came into force (1980). Perhaps most remarkable was the fact that, aside from the development of regulation, the (sometimes huge) funds needed for concrete action also came round swiftly. This was the case in the US, but also in the Netherlands, where, as in the US, a subdivision built on top of a dangerous chemical waste dump (in Lekkerkerk) was the main catalyst. The examples mentioned here had impact across national borders, as was the case with the Seveso explosion in northern Italy, which reputedly prompted other countries and the EU into action.

As the incidents were major, and obviously dangerous to human health and to the environment in general, regulations in those early days tended to be strict. Quite a few of the front running countries, especially in Europe (e.g. Denmark and the Netherlands), adopted the principle of multifunctionality, meaning to remediate all contaminated land to pristine conditions, and hence fit for all use. This also meant that the criteria did not

take into account the present or future use of the site. The obvious advantage of this approach is a relatively simple and very clear decision-making system. This was very much needed at the time, especially since it enabled quick decisions on a local level.

Revising strategies after the initial shock-effect had abated

The notion that "multifunctionality should be the ultimate aim of contaminated land remediation, as being the only truly sustainable option" (Christie and Teeuw, 1998), is certainly a defendable one. Especially if we consider the direct link that was made almost one on one in those days between soil contamination and very serious threats to human health. Actually, in the Netherlands the principle of multifunctionality has in practice been defended for a long time. Even after a study in the late 1980s (Steering Committee Ten Years´ Scenario Soil Remediation, 1989) had shown that pursuing this strategy would amount to an estimated cost of 46 billion, which is equivalent to around 60 billion or U$ 80 billion in today's value. Or, as it was translated then, even with half a billion per annum, to be borne by a population of around 15 million, it would take almost a full century for the operation to be completed. This example illustrates what generally became clear in the first half of the 1990s, and was worded by Christie and Teeuw (1998): "[multifunctionality] may not be technically feasible, nor economically viable in the short term."

During the first half of the 1990s the impression grew that (re)development was actually slowed down considerably ('stagnation' was a term often heard) by soil contamination on many urban sites, even on otherwise prime locations. This raises the question whether the policies in place influenced this 'stagnation' in any way. Looking back, this certainly seems to be the case. Research shows that high cost of cleanup is considered a (very) important, although not always decisive, constraint for developers looking at redeveloping contaminated properties (Wernstedt et.al., 2004). It is not just the actual (expected) cost, but perhaps even more "the fear and uncertainty associated with potential environmental contamination" (Bartsch et.al., undated), that kept developers away from contaminated sites. And the more stringent the policy leans towards multifunctionality, the higher the cost of remediation is expected to be, which in turn leads to a significantly reduced interest in (potentially) contaminated sites by developers (De Sousa, 2001).

Even in the densely populated areas of north-western Europe the economically best option often was, and still is, to develop a greenfield rather than a brownfield. This is a negative effect of contamination, especially in densely populated areas keen to preserve the little green that is still there. With the belief that dealing with soil contamination is mainly a public task this may not seem such a problem, were it not for the fact that no government could ever produce the means necessary to bear this task alone. Hence, there have been a great number of different responses to make brownfield development more attractive. As far as site assessment and remedial options are concerned the general response has been the introduction of "less stringent generic criteria tied to risk and future land use, and more flexible site-specific risk assessment and clean up procedures" (De Sousa, 2001). While some countries (notably Finland, the Netherlands and Switzerland) have retained, at least in theory, the ultimate goal of multifunctionality, criteria tied to land use are presently in use in almost all countries, included in this short survey.

The recent picture shows many approaches

Where almost all countries, included in this survey, now use criteria tied to land use, it is interesting to note the different ways in which they do. The models in use vary from 'comparing the concentrations measured with generic values' to 'site-specific risk-assessment', and many options in between. A summarized overview of the models that were in use around 2000 is presented below. The reason for selecting the year 2000 as the benchmark is simply that this is the most recent point in time for which extensive data are readily available, thanks mainly to the Europe-wide study undertaken by Ferguson and Kasamas (19991).

Overview of models for the assessment of soil contamination (situation ca. 2000)

second tier → **↓ generic criteria**	**no**	**site-specific risk assessment due when generic criteria are exceeded**
supportive only (to site specific risk assessment)	Canadian regions France Switzerland UK USA	
for most sensitive land-use types	Austria	Norway
for certain land-use types	Germany Netherlands	
defined by land-use type	Belgium (Flanders) Sweden	Italy
basically numeric	Denmark Finland	Ireland Spain
no coordinated approach known	Belgium (Brussels Capital region) Belgium (Walloon region) Greece Portugal	

What this overview mainly shows is that there are almost as many models for the assessment of soil contamination as there are countries. Interesting are the two-tiered approaches, where generic values (in one way or another) make for the first criteria to be met, and wherever they are not, a site-specific risk-assessment is due. An advantage of these models is that they enable the user to combine the efficiency of the use of generic values, and the flexibility of site-specific risk-assessment. The US-state of Illinois uses a variety of this, leaning toward maximum flexibility. Their system consists of a tier based on generic values dependent on land use, and a tier based on site specific criteria. When planning remedial action on residential or industrial/commercial sites this tiered approach may be used, and depending on the information available, the user has a choice as to which tier(s) to apply.

Where the overview shows the situation for the assessment of soil contamination, it has to be noted that, in general, site specific criteria play a more important part in decisions on the actual remedial action.

Over ten years ago it was noted already that the approaches in use in different countries tended to come together, and that this was due to the fact that "all countries are balancing the demands of contaminated land remediation with the wider economic, social and ad-

[1] in the digital version referred to here, data for quite a few countries have been updated in 2001

ministrative framework, when developing policy" (Christie and Teeuw, 1998, indicating Visser, 1994, as a source). De Sousa (2001) reiterates "that contaminated site-related policies and programs employed to overcome each obstacle […] are converging in style and content as governments are becoming more aware of the types of costs and risks they must share in order to solve the problem effectively." The few recent data show that this trend is still continuing today. The Dutch government, for example, in December 2003 presented a vision for soil contamination in the future, explicitly including a wide range of relevant aspects into the picture (Ministry of VROM, 2003). With this it stated, in effect, that the interpretation of multifunctionality in the past had perhaps been slated too much towards the chemical aspects.

The ongoing trend summarized above shows the "general consensus that the principles of risk evaluation provide a rational framework for contaminated land management (Christie and Teeuw, 1998)" being increasingly translated into regulation.

Present issues

A larger role for site-specific criteria generally leads to a range of effects, including:

- a larger range of remediation options to consider
    - a more complex decision-making system (can lead to a longer decision-making process)
    - a greater demand for professional advice, decision making, control and enforcement
- more room for flexible solutions
    - more cases in which some of the contamination is allowed to be left behind
    - more cases that require long-term (sometimes even 'eternal') monitoring
    - need for site registration, with restrictions on land-use as long as contamination remains
- lower expected cost for remediation (the less sensitive the land-use the larger this effect is)
    - in combination with contamination allowed to be left behind, this leads to a shift of financial risks and liability issues: the actual cost for remediation is lower, but the risk for liability issues arising at a later stage grows
- higher acceptance by the general public of the need to address soil contamination

Not surprisingly, a mix of positive and negative effects. The financial aspect is, in a lot of cases, very large, and carries great importance with developers. This would lead one to expect that, overall, the listed effects lower the barriers to brownfield development. Despite the fact that contamination allowed to be left behind poses potential liability issues this seems indeed to be the case.

The effects listed above also house present issues: there is much debate on whether (or how) to invest into being in control. In many places this issue has now been translated into measures to enhance quality assurance (see also Special session 27). Contamination left behind can remain on site for decades. The need to register these sites raises the question, mainly in public institutions, of how to remain in control over the overall situation over such a time span. Developers who finally do make the plunge, going ahead on a contaminated site, in many cases decide to completely erase all potential liability issues by

simply excavating all contamination. In such cases the private parties concerned turn out to be stricter than the policy of the moment.

A peek into the future

Earlier in this paper it is mentioned that governments will try their best to get developers interested in developing brownfields, rather than greenfields. As space becomes ever scarcer, this trend strengthens all the time. More and more policies and programs are being developed and implemented, reducing costs and risks for developers, interested in developing brownfields. It has become clear that neither the public nor the private sector can go it alone. Creative solutions, in a technical sense as well as in an administrative, financial and judicial one, will continue to emerge. They can be expected to become more and more complex, taking into account more and more aspects. The (re-)use of the land will gain more ground as a factor in decision-making, as the need and the desire for site-specific solutions continues to grow.

A principal point of discussion that can be expected to come up is the degree to which the contamination should be remediated. The points of view in this discussion usually range from maximum risk reduction (often leading to the conclusion that all contamination should be removed) to maximum flexibility (which can result in limited measures to be implemented, tailored to the need of the intended user). Finding the optimum will lead to the more creative solutions.

A lot has been done already, and regulations have been, and continue to develop. There is a lot of information on strategies and regulations available, and this paper can but scratch the surface. To anybody who feels he is still near the start of this long road, it pays to bear in mind " that the principles of risk evaluation provide a rational framework for contaminated land management (Christie and Teeuw, 1998)", while still using multifunctionality as the ultimate, but theoretical, benchmark.

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