THE ROLE OF SOIL QUALITY MAPS IN THE REUSE OF LIGHTLY CONTAMINATED SOIL

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Key words: background levels, classification, contaminated soil, GIS, governmental directives, mapping, national background values, quality of the soil, reuse, spatial planning

Summary

In 1999 the Dutch government agreed on a new policy regarding the reuse of lightly contaminated soil. From now on, lightly contaminated soil may be reused under conditions of soil-quality management. The municipal authorities supervise the reuse under this new regime. Two basic criteria need to be met before reuse of lightly contaminated soil is allowed. Firstly, the quality of the soil has to be characterised on a soil quality map. Secondly, the soil that will be reused has to be of the same - or better - quality than the topsoil already present. Both criteria require more detailed prescriptions on a national level in order to assure that the principle of 'stand still' is maintained.

In a two phased process, a guideline for the preparation of soil quality maps and for the assessment of reusability will be developed. The first phase resulted already in a provisional guideline necessary for effective implementation of the new policy. Some complex problems were not dealt with in the provisional guideline, but will be solved mid 2001. The current second phase will result in a final version of the guideline.

1 A new policy

In a densely populated country like the Netherlands, each year a vast amount of soil is excavated due to redevelopment of sites and spatial planning. At the same time there is a large need for soil to be reused, both as a building material (e.g. in dikes) as well as for raising the current soil profile in order to keep (or make) a site suitable for its (new) use (e.g. housing).

At the same time, national background levels are often exceeded for the topsoil. Existing legislation however prevents the reuse of excavated soil when it is contaminated. The potential for reusing excavated soil is therefore seriously hampered. A new policy for reusing soil was considered essential in order to enhance, or at least maintain, both the economical development and the environmental quality. Key word of the new soil policy is 'standstill': reuse of excavated soil is only possible when the quality of the excavated soil is equal to or better than the soil at the location of reuse.

In the new policy (Grond grondig bekeken 1999), the reuse of lightly contaminated excavated soil is possible when certain conditions are fulfilled. Basically the reused soil should "fit" within the local soil quality situation outlined on a soil quality map: the quality of the topsoil at the location where the soil is reused may not deteriorate due to the reuse of that excavated soil. Enhancement of the local soil quality is also possible, and even a long-term goal. This long-term goal can be facilitated by reusing soil of a better quality than the soil at the site of reuse. More information on the new soil policy is given in the paper of Wim Munters in this proceeding (Munters et al. 2000).

To facilitate the new policy in day-to-day practice, a number of problems have to be solved:

- What are the minimum (quality) criteria for the soil quality map that should be available for reusing soil within the framework of the new policy?
- In which situations is it unnecessary to investigate the quality of the soil that is to be reused, and when on the other hand should the excavated soil be investigated before reuse?
- How does one define that the quality of the soil to be reused is comparable to the quality of the soil at the location of reuse, and what does that definition mean in respect to the necessary investigation?
- At what scale do we define the location of reuse and therefore, at what scale do we want to compare the quality of the excavated soil with the local soil quality?

These questions will be answered in the next paragraphs.

2 Soil quality maps as a tool in soil-quality management

As mentioned in paragraph 1, the soil-quality management is based on comparing the quality of the excavated soil with the present soil quality at the location where the excavated soil will be reused. Therefore a tool is needed which describes the soil quality at the location of reuse.

Of course a comparison of the soil quality is possible by conducting a soil investigation on the location of reuse prior to the actual reuse, but that would not result in the desired efficient reuse of lightly contaminated soil. In fact the reuse of lightly contaminated soil would be hampered as clean soil can be reused without any restrictions. An investigation at the location of reuse would not be necessary for reusing clean soil. Reusing clean soil would also improve the soil quality, and therefore be in line with the long-term policy goal. At the same time however, efficient reuse of lightly contaminated soil is prevented, while clean soil can be reused more efficiently at locations where the local soil quality is also clean. For the large scale areas which are lightly contaminated, a simpler/more cost-effective tool is to be preferred.

Soil quality maps are considered to be the right tool for this comparison. However, the quality these maps themselves can vary strongly. Thus quality criteria should be defined for soil quality maps that are to be used for the reuse of excavated soil.

3 Heterogeneity of soil

The basic problem with soil is its heterogeneity. On a small scale concentrations can potentially vary largely, also when there are no obvious sources of soil contamination present. Nevertheless, by accepting soil quality maps as a tool for predicting the local soil quality in areas with lightly contaminated soil, we apparently accept a degree of uncertainty. This implicates that we are not directly interested in the quality of the soil on a small scale (e.g. 10 - 1000 m^2), but that we are interested in maintaining the soil quality at a larger scale (e.g. 1 hectare - 1 km^2). On this larger scale, there still will be some variation in the overall soil quality, but much of the variation will have disappeared. At the same time, we do not want a locally contaminated site to be part of the background level of contaminants. This implicates a sensitive process of collecting data or using already existing data. The soil quality maps should present the local background levels. These background levels may differ from national background levels that are based on investigations in non-polluted areas. In the local background levels wide spread diffuse contamination is included.

4 Making a soil quality map

A number of steps must be made to define a soil quality map, suitable for the reuse of lightly contaminated soil. These steps are given in Fig. 1. The steps should not necessarily be followed in the given subsequent order. Parallel procedures, as well as changing the order is possible in relation to a local situation. Each individual step consists of a number of activities. Hereafter only the head-

lines of these steps are given, together with the minimum quality level for soil quality maps that are to be used for the reuse of lightly contaminated soil.

In *step 1* choices on both a policy level as well as a technical level have to be made by the local (municipal) authority. The choices are directly related to the purpose of the soil quality map as a tool for the reuse of lightly contaminated soil and the kind of soil reuse aimed for by the local authorities. The soil quality map should be embedded in a soil management plan. Both policy and technical choices have to be based on a soil management plan, while the soil quality map is a translation of those choices into a practical tool. On the level of the technical definition choices have to be made like: what soil layer that will be described, which components are relevant and will be incorporated in the soil quality map, the part of the area that will be mapped, etc. The minimum quality level defines only that both policy and technical definition are reported. The actual choices are to a large degree within the freedom of policy making for the local authority.

In *step 2* the basis of the soil quality map is laid down by defining what characteristics have an essential influence on the local soil quality level. This can be a large variety of characteristics, like the geological formation of the soil, as well as the former use of contaminated sludge in redevelopment. In general three characteristics are considered most important: the soil layers present (both due to Natural formation as due to human activities), the history of the use of the area, and the (re)development of large areas (districts).

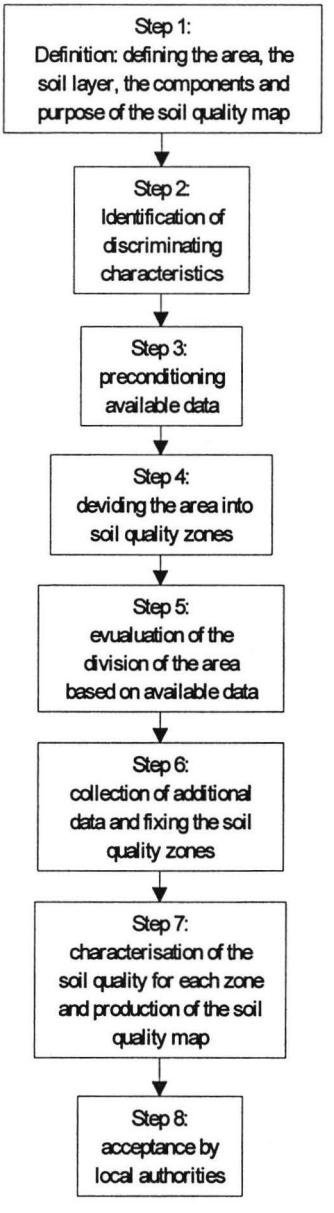

Fig. 1. Steps in making a quality map

Step 2 results in a first (rough) division of the total area into expected soil quality zones, fully based on knowledge of the history of the area. The minimum quality level defines that the relevant characteristics are chosen.

In *step 3* the available quantitative information of the area is gathered and made available for computerised data handling. This is an essential step as during this step data must be accepted or rejected for the definition of the local (background) soil quality. For the reuse of lightly contaminated soil at least the analytical results for arsenic, cadmium, chromium, copper, mercury, lead, nickel, zinc, sum-PAH, mineral oil and EOX should be gathered. When other contaminants are present on a large scale in the area, these should also be collected. Most often, and most efficient, the data will be stored and managed in a GIS. Data should be "labelled" when it originates from suspected or contaminated sites in order to differentiate between local sources of soil pollution and the more generally present (enhanced) background levels.

In *step 4* a first subdivision in expected soil quality zones will be made, based on the characteristics defined in step 2. Potentially it is possible that there is a form of hierarchy between these characteristics. It is therefore important to investigate if the order, in which the different characteristics are used in defining the soil quality zones, has a significant effect on the defined zones.

In *step 5* the already available data gathered in step 3 is used to check whether the first subdivision in soil quality zones is correct. This is only possible if sufficient data is available for each soil quality zone. At a minimum level, each zone should contain at least 20 analytical results for all the critical components. These are the components that are to be considered relevant for the determination of the soil quality in the zone. In general a component is considered critical when the 95th percentile exceeds the mean of target and intervention value. In addition to the number of data, the data should have an "evenly" spatial distribution within the soil quality zone.

In *step 6* additional data is gathered for soil quality zones were insufficient data is available. This is not obligatory for all zones before local government can accept the soil quality map. It may well be that in parts of the total area little soil reuse takes place, in which situation it is not cost effective to define the soil quality map for these parts. As a consequence, the reuse of soil in these parts is only possible after analysis of the excavated soil and if concentrations allow reuse. If concentrations are to high, the soil can only be applied as a building material in agreement with the Building Materials Decree (1998).

In *step 7* the now available information (both quantitative data and qualitative) is interpreted in its context. This results in a motivation for the defined soil quality zones. For each soil quality zone the mean concentration for the critical components are determined, as well as the 95th percentile. The mean was cho-

sen due to the fact that this statistical parameter is only little affected by individual outliers. In addition, when soil is reused, the mean concentration of the excavated soil will be determined (when necessary). Comparing the mean of a soil lot with the mean of a soil quality zone, results in a simple and consistent comparison. The resulting soil quality maps are reported, both as a map as in the form of the motivation. The map is not a simple one-layer map containing only the soil quality information. Although these simple maps will be presented most often, the map itself should contain several "layers". In addition to the layer with the soil quality information, at least the following layers should be present: a topographic map, a map with the sampling locations and a map with the suspected and investigated sites. More specific layers are also possible, for instance to record the former use of contaminated secondary building materials (e.g. slag).

In the final *step 8* local government accepts the soil quality map and its use. It is important to realise that a soil quality map does not describe a static situation. Due to the reuse of soil the soil quality within a zone will change. For more dynamic zones the soil quality map will potentially be outdated soon. Apart from criteria on the number of additional data when revision of the soil quality map is necessary, it is advised to use a dynamic soil quality map. New information is implemented in the GIS, and reuse of soil can be judged in line with the most actual information. In Fig. 2 an actual overview is given of the local authorities that either already have a soil quality map, or where soil quality data are already implemented in a GIS system. Fig. 2 was not based on a full investigation, but it is assumed that it will cover some 90 % of the maps and GIS systems. It should also be realised that the map is based on municipal borders. Often the soil quality map will only deal with a (small) portion of the total municipal area. In addition to the municipal soil quality maps, a small number of soil quality maps is available for large infra structural projects. These are not presented in Fig. 2.

Fig. 2. Overview of "90%" of the municipal soil quality maps in the Netherlands in April 2000.

5 Conditions for reusing soil

Apart from the condition that a soil quality map should be available, the provisional guideline gives rules for the reuse of soil. The basics of these rules are:

- Reuse of clean excavated soil is always possible; the new policy does not cover the reuse of clean excavated soil.
- Reuse of heavy contaminated excavated soil is not allowed.
- The assessment of soil that originates from a soil quality zone should be based on the critical components (the components for which the 95th percentile exceeds the mean of target and intervention value).
- When the 95th percentile of the soil quality zone where the lot originates from does not exceed the mean of target and intervention value, the soil can be reused without further soil quality investigation. Due to the definition, this can only be true for the non-critical components. In this case the quality of the lot is assumed to be equal to the mean quality of the zone it originates from.
- When the 95th percentile of the soil quality zone where the lot originates from does exceed the mean of target and intervention value, the actual soil quality of the lot has to be investigated. The resulting mean concentrations for the critical components are used to see if reuse is possible in respect to the earlier rules.
- When the soil does not originate from a soil quality zone, the quality of the soil should always be determined. Reuse of the soil within a soil quality zone should be assessed in respect of the earlier rules.

6 From provisional to final guideline

The current provisional guideline had to be made within a short time due to the necessity to implement the new policy into already existing legislation. There was very little time for discussion with all actors (e.g. local, provincial and national authorities, consultants). During the development of the current provisional guideline it became clear that much more consultation with all actors is of vital importance in developing the "final" guideline. Although there was some criticism on the rules for the development of the soil quality map, the main criticism was focussed on the rules for reuse of soil. This was to be expected for three reasons:

- The reuse of soil is a new responsibility of the municipal authorities. A national guideline will by definition be in conflict with this new responsibility (i.e. curtailment of local policies).
- In general, the local authorities were already orientating themselves on this subject and where therefore reluctant to make choices that could be implemented in the national guideline.
- There was a lack of knowledge of the exact consequences of the rules for the reuse of soil, especially the risks involved in the reuse of soil lots based

on the characteristics of a much larger soil quality zone. This involves not only the environmental risks, but also the juridical risks (what are the consequences when a reused soil lot appears to be much more contaminated than expected).

It was therefore decided that the first version of the guideline could only be published as a provisional guideline and the further development of a final guideline should continue.

7 Subjects of research and further development

Based on the conclusions on the provisional guideline as mentioned in paragraph 6, a one and a half year project was defined to develop the final guideline. Six steps will be made during that period. These steps are:

1. inventory of subjects for further research,
2. research on these subject (see below),
3. report and discussion on the results of the research,
4. definition of a first version of the final guideline,
5. evaluation of the first version of the final guideline,
6. finalisation of the guideline and political acceptance.

At this moment - April 2000 - the second step is running. In the second step we concentrate on calculating the risks of the decisions based on the estimated quality of excavated soil. The estimation is, in line with the provisional guideline, that the mean quality of the lot is equal to the quality of the zone where the lot originated. The calculations are based on a number of different already existing soil quality maps. Both maps from cities as from rural areas were used in order to get a good feeling of the risks involved. Elements in these calculations are the variability within the soil quality zone, the scale on which information within the soil quality zone is (to be) gathered and the scale of soil lots originating from these soil quality zones. During the conference these results will be shown.

During the whole project, we will communicate with all involved parties in order to be able to implement their wishes as much as possible in the final guideline. It will need no explanation that part of these wishes - at least at the moment - contradict each other. Hopefully, the research in the second step will result in enough knowledge to be able to judge these contradicting wishes.

References

Grond grondig bekeken (1999) VROM, 990410/a/9-99 22669/210, (in Dutch)

Munters, Wim., et. al. (2000) New Dutch policy with respect to excavated contaminated soil (these proceedings)

Building Materials Decree (1998) Staatscourant, nr. 20 (Engl. translation available)