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Waste Materials in Construction: Putting Theory into Practice

Beneficial use of contaminated sediments within the Meuse river-system[1]

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Abstract

Sediments in the Meuse valley are contaminated on a large scale by diffuse sources. The project "Zandmaas/Maasroute" aims at the enlargement of the discharge capacity. When realizing the project, a full-scale clean-up operation would not be realistic and not effective because of recontamination and the enormous scale and costs involved. However, there will be a unique opportunity to break this deadlock, if the concept of dynamic soil management is applied. This approach to remediation means putting back contaminated sediments of indigenous quality within the river system. Preconditions are determined by risk assessment and local conditions. The first aim is improvement of the environmental quality of the river system. Other objectives such as the development of natural areas, the mitigation of geohydrological effects and the exploitation of sand and gravel can be realized by several forms of beneficial use of contaminated sediments.

Dynamic soil management is a pragmatic and cost-effective solution for the problem of contaminated sediments.

1. INTRODUCTION

Large parts of the Dutch Meuse valley were flooded in December 1993 and January 1995. Consequently, a governmental advisory committee ("Boertien II") was ordered to assess the situation and to give recommendations on measures to reduce the risk of flooding. Among others, the commission recommended to enlarge the main channel of the Meuse over a stretch of about 170 km called "Zandmaas". Apart from that, the river Meuse should be adapted to improve the river for navigation. Flood risk reduction and

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navigation improvement are the main targets of the project "Zandmaas/Maasroute". A third objective is development of more natural areas in the Meuse valley.

Several alternatives to reach these three targets are being developed and will be elaborated in an environmental impact assessment (EIA) to be accomplished in 1998.

The following measures to enlarge the river discharge capacity are being considered:

- deepening of the main channel;
- widening of the main channel;
- lowering of floodplains;
- excavation of flood channels.

The realization of these measures will result in the removal and handling of the following materials:

- useful and marketable mineral resources (gravel,sand);
- clean non-marketable soil;
- contaminated sediments and dredged materials.

The management of contaminated sediments is of crucial importance for the project in terms of environmental, logistical and financial aspects. For the project Zandmaas/-Maasroute the amount of contaminated sediments and dredged sediments to be removed are estimated at ca. 5 to 11 million cubic metres.

2. DYNAMIC SOIL MANAGEMENT

Since the Roman Ages and more intensively during the last two centuries, the Meuse river system has been diffusely contaminated by upstream industrial activities [1]. The predominant contaminant is zinc. Other contaminants to be found are cadmium, PAH, PCB, DDT.

Zinc levels in the river sediments frequently exceed Dutch intervention levels. The pollution is mainly confined to the top soils in the floodplains and banks of the river Meuse which are contaminated on a large scale.

Dutch regulations prescribe that severely contaminated soils should be cleaned or properly disposed of in controlled large disposal sites. However, a full-scale clean-up operation of the river system Meuse is not feasible and not effective, because of:

- recontamination because of the ongoing industrial pollution upstream as well as erosion and redeposition of older contaminated sediments;
- the huge scale and enormous costs involved;
- general shortage of nearby existing disposal sites and public opposition against new locations for disposal (NIMBY).

Many river widening and nature development projects stagnate because of these problems. Faced with these issues and the necessity to realize megaprojects in river systems, Dutch authorities formulated guidelines for a different approach to remediation [2]. This approach is called dynamic soil management.

The main objective of dynamic soil management is to improve the actual environmental situation in the most efficient way. Where improvement is not possible, e.g. because of

recontamination, the situation should at least not deteriorate (stand still principle). The central issue is that the main part of the contaminated sediments, which are excavated due to widening of the river, are not transported to a large disposal facility but are stored nearby in the river system. The project Zandmaas/Maasroute offers the opportunity to elaborate this new approach into a design for a sustainable solution of the contaminated sediment problem.

Preconditions for a design based on dynamic soil management are:

- Environmental improvement should be achieved by concentrating and, if necessary, insulating the replaced contaminated sediments in such a way that the emission of contaminants to surface and ground water as well as dispersion by erosion is reduced. Furthermore contact possibilities for men and organisms with contaminants have to be diminished. The possible solutions depend on local conditions.

- The environmental risks for men and ecology should be acceptable and risk assessment should be related to land use. This means different standards for agriculture, recreation, nature etc. An important finding in this respect is that zinc concentrations have no apparent relation with enviro-toxicological effects [3]. Acidity and cation binding capacity of the soil are the main parameters controlling behaviour of zinc. Leaching tests (column test NEN 7343) on zinc contaminated sediments and soils in this project and in other studies [4,5] show that even when zinc concentration levels are very high, zinc leachability can be very low. Consequently, zinc availability for organisms are likely to be low.

- For so-called "Hot-Spots" the traditional remediation approach should be followed. In case of severely contaminated sites this means removal and transportation to a regular disposal site. Hot spots may either be contaminated from local sources and contain other contaminants than indigenous to the region, or represent much higher contaminant levels than regional background value. The assessment of environmental soil quality in relation to local back-ground levels to distinguish "Hot-Spots" needs to be further elaborated.

- Within the river system zones with more or less homogeneous soil qualities are distinguished, based on frequency of flooding, soil type and land use. Displacement of contaminated soil of indigenous quality should be possible within the same zone.

- The design should lead to beneficial use dependant on local conditions (see next section).

- The measures should fit within the Dutch legal framework.

3. BENEFICIAL USE

The concept of dynamic soil management is optimized by combining environmental improvement with other benefits such as the upgrading of nature and landscape, ecological improvement and revenues from minerals. These possibilities depend on local conditions: e.g. geohydrological, hydraulic and river morphological aspects and the occurrence and depth of mineral deposits.

Possible options for replacement of contaminated sediments in combination with beneficial use are:

- re-use as topsoil for the new banks.
  After excavation and dredging activities, needed for widening and/or deepening the river, the former contaminated top soil is replaced as the new topsoil. In this way the function of the soil remains the same its new location. When reconstructing the riverbank, the development of natural habitats is promoted by a gradual and non-protected slope: a so-called ecological riverbank.

- hydrological sealing of flood channels.
  When flood channels are constructed, clayey materials are needed to seal off the channel from groundwater flows (preventing drainage). Contaminated soils released in reconstructing the river are usually quite suitable for this.

- hydrological barriers.
  The contaminated top soils, which are mostly clays with a low water permeability, are replaced in a vertical shield near the riverbanks. This clay shield functions as a geohydrological barrier for groundwater flows towards the river which causes a rise of groundwater level in the adjacent area. In this way further aridization of ecological valuable natural areas is prevented.

- exchange of mineral resources with contaminated sediments in the river channel.
  After widening of the river the contaminated sediments are replaced in a pit in the river channel, which is made for this purpose. The location of these pits is determined by the occurrence and depth of valuable gravel and sand deposits and a favourable geohydrological situation, where the groundwater flow is directed towards the river.

- ecological improvement of existing deep gravel pits
  When existing deep gravel exploitation pits can be made shallower, this may lead to an improvement of the ecosystem. Dredged materials (clean or contaminated) may very well be used for this purpose [6].

On some locations several types of beneficial use can be combined e.g. hydrological barrier and exchange with minerals.

4. PILOT PROJECT

A pilot project is planned to be carried out in 1998 in a small river section of seven kilometres. The design is based on dynamic soil management for the widening of the main river channel, which is partly completed with ecological riverbanks. The main objective is to gain experience for the project Zandmaas/Maasroute on the aspects of engineering, a design based on replacement of contaminated sediments, the acquisition of environmental permits and the prediction of effects on the river system and environment.

In suitable parts of the river section four methods of replacement of contaminated sediments in combination with beneficial use are planned:

- re-use as top soil for the new river banks;
- a clay shield as hydrological barrier;
- exchange of contaminated sediments with sand and gravel;
- ecological improvement by the filling of an abandoned gravel pit.

Three methods are displayed in figure 1.

An extensive monitoring programme will be carried out on environmental, hydrographic and geohydrological effects. Environmental monitoring comprises chemical and ecological parameters before, during and after the reconstruction. An estimation is made of potential emissions from local storage of contaminated sediments based on data from detailed soil investigations. This model will be validated by the monitoring results.

5. OUTLOOK

Dynamic soil management is a practical and cost-effective remediation approach for the project Zandmaas/Maasroute. This approach will soon be formalized as the remediation policy for the floodplains of large rivers in The Netherlands. The concept of dynamic soil management is now elaborated by the competent authorities into a regional remediation policy for the river Meuse. The pilot project will serve as a first test case for this new approach. Several river reconstruction alternatives in which options for beneficial use are included will be considered in the environmental impact assessment.

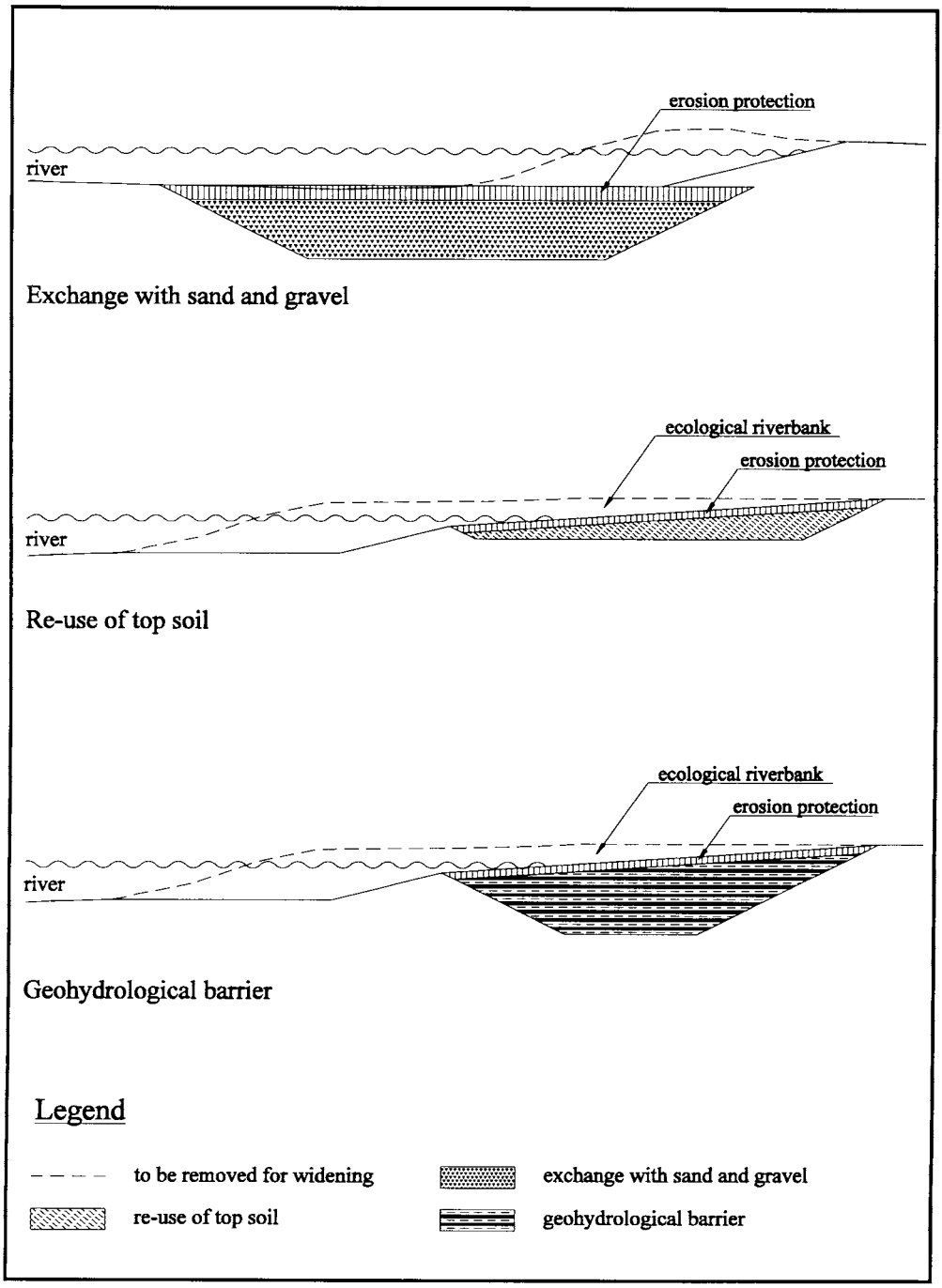

Figure 1. Options for beneficial use of contaminated sediments.

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