ASSESSING ENVIRONMENTAL SOIL QUALITY IN RURAL AREAS

A base line study in the province of Zeeland, the Netherlands and reflections on soil monitoring network designs

P.F.M. VAN GAANS¹, S.P. VRIEND², S. BLEYERVELD³, G. SCHRAGE³ and A. VOS³

¹Department of Physical Geography, Utrecht University, P.O. Box 80.115, 3508 TA Utrecht, the Netherlands
²Department of Geochemistry, Utrecht University, P.O. Box 80.021, 3508 TA Utrecht, the Netherlands
³Department of Environmental and Civil Engineering, Province of Zeeland, P.O. Box 165, 4330 AD Middelburg, the Netherlands

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Abstract. A base line study into the environmental quality of soils in the rural areas of the province of Zeeland, the Netherlands, was performed. The polder-landscape in this area was developed in a complex history of floodings and land-reclamation. Samples from 67 sites, at a density of roughly one per 25 km², were analyzed for As, Cd, Cr, Cu, Hg, Ni, Pb and Zn in addition to a physico-chemical characterization by pH(KCl), dry solids, organic matter, and clay content. At about 2/3 of the sites samples were taken at more than one depth. Fluoride and pesticides were determined in partly overlapping selections of 30 samples. Four land use classes were distinguished (arable land, grass land, orchards, uncultivated), and samples were labelled by region within the province. Data evaluation was aided by a recursive statistical approach, whereby statistical tests confirm and strengthen geochemical reasoning. Single- and multivariate statistics were used both as exploratory tools and as a measure of significance and relevance of conditions and processes. In general the environmental quality of the soils is satisfactory. Exceedence of the legal standards for natural background values at more than one site occurs for Cd, Cu, Hg and the pesticides DDT/DDE, dieldrin and HCH, at most by a factor of three. High levels of Hg appear related to arable land use; enhanced levels of Cu are found in orchards. High Cd levels primarily seem to follow a regional or geological pattern; yet, a relation with arable land use and clayey soils cannot be excluded. Pesticides are not detected in grass land, incidence is highest in orchards as well as in uncultivated areas. DDT levels appear to be generally inherited from the past. Variation in soil type as described by the macro physico-chemical characteristics is essential in explaining the variation in concentration level of the potential contaminants. Variations with depth also appear largely related to concurrent variation in soil properties. For As redox conditions and hydrological regime seem of importance, in addition to the geologic history. The influence of atmospheric input is inferred for Pb. The available data do not fully resolve the causes for the regional pattern that remains when the influences of soil type, geology, and land use have been taken into account. In addition to current concentration levels, the base line study offers general insight as to what degree variations in potential contaminants are of natural or anthropogenic origin. A succession of similar studies at suitable time intervals, each with a new selection of sampling sites, may constitute an evolving, flexible monitoring system. When putting up a monitoring system, authorities should weigh the advantages and disadvantages of a network composed of fixed sites against this alternative.

1. Introduction

The environmental policy of the Netherlands with respect to the soil compartment, is aimed at maintaining the natural multi-functionality of soil (VROM, 1990; 1993a). While this policy recognizes the control that natural variability in soil attributes may have on land suitability, it states that anthropogenic influences may not impose additional restrictions. The reality of natural variability poses problems in legislation, since universal normative levels cannot easily be imposed. Potential contaminants may have locally or regionally varying natural background values, and various natural modes of occurrence with varying degrees of toxicity.

Based on concentration levels observed in soil samples from ‘unpolluted’ locations in rural areas in the Netherlands (Edelman, 1983), the “Interimwet Bodem-sanering” (IBS, provisional law on soil sanitation; VROM, 1983) has drafted a list of reference values for trace metals and organic contaminants in soil (VROM, 1983; 1988; 1993b). Since concentration levels of many constituents are governed by soil organic matter and clay content (a.o. Edelman, 1983), reference values are related to these properties (Table I). The reference values present the upper limit of what are considered natural background values for normal soils, or detection limits in case of some synthetic compounds. With all concentrations below the reference values, a soil is classified as multi-functional. Although (part of) a constituents concentration may yet be due to anthropogenic actions, the resultant level is assumed not to restrict land use. Opposedly, exceedence of the reference values not always implies anthropogenic disturbance nor loss of soil functionality. When natural causes for increased concentration levels can be identified, as for example with arsenic in bog-ore (Zuurdeeg et al., 1990), in practice the soil will not be considered polluted. Of course health hazards must still be evaluated, but treated as natural hazards.

Another, perhaps more realistic, basis for deciding upon the degree of pollution of soils (and subsequent legal consequences) is the so called stand-still principle. This of course only applies to locations and situations where the current environmental quality is considered adequate. It implies that environmental quality is monitored in time, or that at least the starting situation at some reference time is known. With respect to soil quality, the currently available data are not evenly distributed. In urban areas much information ensues from investigations made within the scope of the IBS, prior to the release of new building-sites. Although data concerning nutrient status and some relevant mineral constituents may be available for cultivated land, still little is known about background values in rural areas and nature reserves. Therefore, many regional authorities in the Netherlands are know implementing soil quality monitoring networks, which will add to already existing monitoring networks for air, surface water and ground water.

Consensus exists about the aims and scope of these soil networks. They should be able to signalize quality change and ascertain possible time trends in relation to features such as soil type and land use. They should function to check the results