Chapter 15
3D Modelling of Geology and Soils – A Case Study from the UK


Abstract Developments in GIS based technology have greatly aided the routine production of three-dimensional geological maps. Similarly the continued development of airborne remote sensing, geophysics and infrared measurement now provide tools that can assist in the mapping of soil structure and properties rapidly in 2D, 3D and even 4D. Whilst the combined use of such techniques have grown popular for performing site investigations and developing conceptual models of contaminated sites their use in determining and mapping soil has been restricted.

In this paper, we describe ongoing work at the British Geological Survey in which we have combined a variety of remote sensing, soil, geological and geophysical survey techniques to assist in the production of site specific, 3D digital soil models and geological maps. We were particularly interested in investigating (a) to what extent do methodological differences between the UK’s soil and geological communities hinder the development of an integrated near surface model (b) whether technologies to map geology in 3D can be used to develop spatial models of the soil; and (c) can technologies used in digital soil mapping assist in reducing uncertainties associated with such models at a range of scales.

To date we have found clear evidence that differences in terminology do hinder the development of linked models of the near surface environment; but that such differences can be resolved by dialog between field surveyors from each discipline at an early stage in the process. The GSI3D software used in this work performed well in this, relatively simple usage and a successful 3D model of the Brakenhurst surface environment was obtained. However our attempt to use digital soil mapping techniques was compromised by the relatively poor contrast in soil properties across this specific site. Further investigations across representative soil landscapes are being carried out that should address this issue and provide more insight into the adoption of digital soil mapping techniques at a local scale.

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15.1 Introduction

Digital soil mapping (McBratney et al., 2003, see also Chapter 1) is a rapidly expanding field that has similar aims to those being developed by the wider Earth science community. For example both soil science and geology rely on the use of a variety of digital techniques (e.g. satellite and airborne remote sensing and geophysical surveys) coupled to, spatial and numerical analysis and observational data. In addition, developments in portable GIS and computing technology within soil science and geological science communities allows interactive capture of field notes and development of spatially attributed maps and models in the field rather than on return to the laboratory (BGS, 2002).

Following its completion of the 1:50,000 digital geological survey of the UK (Jackson and Green, 2003) BGS began the development and subsequent licensing of 3D geological models across a range of scales (BGS, 2005a). This undertaking was commensurate with the commissioning of the BGS sustainable soils programme (BGS, 2005b, Chapter 14) whose aim, in response to drivers from existing and prospective European Union Framework directives (DEFRA, 2004), was the provision of better and more relevant geological information for soil science and survey. The simultaneous development of these two areas led to the hypothesis that both near surface pedological and geological information could be incorporated into future 3D geological models. In testing this hypothesis we were particularly interested in investigating (a) to what extent do methodological differences between the UK’s soil and geological communities hinder this (b) whether technologies developed to map geology in 3D can be used to routinely develop spatial models of the soil environment at a site specific and catchment scale; and (c) can technologies used in digital soil mapping assist in reducing uncertainties associated with such models at a range of scales.

The first issue that we considered when testing our hypothesis was the potential impact of differences in classification that might prevent the effective use of existing field information. The basis for these concerns were that the Soil Survey and Geological Survey of the UK, have emerged into the 21st century with significant differences in methodology, nomenclature and scientific rationale about the genesis of the shallow subsurface. For example, in the UK soil maps have traditionally portrayed information for the agricultural community and other land based industries where topsoil (A-horizons) and Subsoil (B-horizons) and their properties were of most interest. Consequently, the majority of investigations were restricted to 1.5 m depth (Hodgson, 1997). Because of this interpretation, process orientated research and derived products have tended to focus on customers interested in nutrient and water availability, workability and soil erodibility.

Geologists in the UK, on the other hand, have investigated the shallow geosphere in a different manner. The aim of a geological survey is to map, describe and characterise the material that makes up the Earth, through survey and process orientated research. In the 19th century the BGS was mainly concerned with mapping the bedrock in order to find resources. However, in the latter part of the 20th century quaternary deposits and water resources became the dominant interest, but only in