Chapter 16

MicroLEIS DSS: For Planning Agro-Ecological Soil Use and Management Systems

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ABSTRACT

The main focus of this chapter is that using soil type information in decision making is at the heart for sustainable use and management of agricultural land. The MicroLEIS decision support system (DSS) is based on the multifunctional evaluation of biophysical soil quality, using basically input data collected in standard soil inventories, and with particular reference to the peculiarities of the Mediterranean region. Its design philosophy is a toolkit approach, integrating many software instruments: databases, statistic models, expert systems, neural networks, Web and GIS applications, and other information technologies. As a case study applying MicroLEIS DSS to Cordoba Province (Spain), soil specific strategies to maximize land productivity and to prevent land degradation are predicted within two major topics: i) strategies related to land use planning at a regional scale, and ii) strategies related to soil management planning at a farm level. This DSS has proved to be an appropriate methodology for converting knowledge on land use and management systems, as estimated by research scientists, into information that is readily comprehensible to policy makers and farmers.

INTRODUCTION

To develop a new and truly sustainable agriculture that reverses environmental deterioration and at the same time augmenting the supply of food, agro-ecological innovations are necessary which consider the importance of using soil information in decision-making (Ball & De la Rosa, 2006). Soils can be used for almost all agricultural purposes if sufficient inputs are supplied. The application of inputs can be such that they dominate the conditions in which crops are grown, as can be the case in greenhouse cultivation. However, each soil unit has its own potentialities and limitations, and each soil use its own biophysical requirements. External inputs or improvements are expressed in
terms of capital, energy, or environmental costs. A main aim of sustainable agriculture is to minimize these socio-economic and environmental costs by predicting the inherent capacity of a soil unit to support a specific soil use and management for a long period of time without deterioration. Sustainable soil use and management must sustain biophysical soil potentiality and, at the same time, diversify the agricultural soil system, considering all the possible options to increase crop production: i) expansion of the agricultural land surface; ii) introduction of improved crop varieties; iii) use of irrigation techniques; iv) application of fertilizers and pesticides; and v) rationalization of soil tillage practices (Robert et al., 1993). In brief, in the design of sustainable agro-ecosystems, the challenge for the near future will be to increase the crop production on less land, and with less labor, water and pesticides.

Agro-ecological innovations are based on similar scientific principles considered by FAO in its Agro-ecological Zoning Project (AEZ; FAO, 1978) which was a milestone in the history of land evaluation. Technical guides for implementing agro-ecological approaches must be prepared in considerable detail, and localized so that they apply specifically to the soil type for which they are intended. In this way, research information produced by academic, government, and private organizations must be consistently compiled, evaluated, and formatted for use by specialists and lay people (Arnold, 2004). As the best example, the Electronic Field Office Technical Guides (eFOTG; USDA, 2004) are the primary scientific references for the US Natural Resources Conservation Service. They contain specific information about the use and conservation of soil and related resources. Appropriate parts of the eFOTG are automated as databases, computer programs, and other electronic-based elements, in order to make recommendations more site-specific. In Europe, it is now beginning to see the start of a proactive approach to soil protection strategies to promote sustainable land use and management (Stoate et al., 2001). For example, in 2002 the Commission of the European Communities issued a Communication entitled “Towards a Thematic Strategy for Soil Protection” (CEC, 2002). This was a first step towards an integrated strategy on the issue at the European level, and was followed in 2004 by the European Strategy for Soil Protection (CEC, 2004).

The new concept of soil quality as “the capacity of a specific kind of soil to function with its surroundings, sustain plant and animal productivity, maintain or enhance soil, water and air quality and support human health and habitation” (Karlen et al., 1997), based on data collected in standard soil surveys, appears to be the most appropriate framework. The soil physical, chemical, and biological quality is of manifest importance in achieving sustainable agricultural systems, which balance productivity and environmental protection. Although soil biological quality indicators are not considered in land evaluation, this agro-ecological approach can be a useful procedure for analyzing the soil physical and chemical quality from the viewpoint of long-term changes (Ball & De la Rosa, 2006).

Emerging technology in data and knowledge engineering provides excellent possibilities in land evaluation development and application processes. The application phase of land evaluation systems is a process of scaling-up from the representative areas of the development phase to implementation in unknown scenarios. The application phase—previously accomplished manually—can now be executed with computer-assisted procedures. This involves the development and linkage of integrated databases, computer programs, and spatialization tools, constituting decision support systems (De la Rosa & Van Diepen, 2002).

Decision support systems are computerized technology that can be used to support complex decision-making and problem-solving (Shim et al., 2002). Opinions are wide-ranging as to what constitutes a decision support system. A database management system could arguably be used as a