**New Tools and Approaches for Land Evaluation**

*Nouveaux outils et nouvelles approches pour l'évaluation*

**BOUMA J.**

Laboratory of Soils Science and Geology, P.O.Box 37, Agricultural University, 6700 AA Wageningen, Netherlands

**INTRODUCTION**

Any announcement of a discussion on new tools and approaches justifies a dose of scepticism in any science. Often, glitzy new techniques are being pursued while existing, proven approaches are ignored, even though they can be applied very successfully to current problems. Tools and approaches become easily an objective in themselves so in this invited paper I will be quite aware of this potential trap. In fact, rather than jump directly into a discussion of tools and approaches, we need to ascertain the needs of society which should constitute the very basis for our activities. Here, land evaluation has only a modest track record. Procedures have been top-down, allowing little interaction with stakeholders and colleagues from other professions, such as economists, agronomists, ecologists and many others that have an interest in the land. Of course, our definitions indicate the need for interdisciplinarity and for interaction. Unfortunately, reality has turned out to be rather different and our products tend to be pedocentric. The objective of this paper is, therefore, to discuss: (i) modern needs for land evaluation at different scales; (ii) interaction with the social and economic sciences, and (iii) promising tools and techniques. Finally attention will be paid to land evaluation in developing countries.

**MODERN NEEDS FOR LAND EVALUATION AT DIFFERENT SCALES.**

Classical land evaluation procedures (e.g. FAO, 1983) have been used successfully in many projects. However, defining relative suitabilities of different land units for defined land utilization types is becoming irrelevant. Modern land-use problems are different at different scales. For example, a modern farmer wants to know which crops to grow and how to manage them. Certainly in the so-called developed world, he is increasingly burdened with environmental regulations which force compromises between production and environmental objectives: he wants to know which tradeoffs between contrasting objectives are most attractive in managing his farm. He deals with heterogeneous fields, not single land units: precision farming is a response to such farmer's demands, requiring an innovative response from the various disciplines involved, working in a team. (Robert et al, 1996; CIBA Foundation, 1997). Soil input is crucial here but so are other data and information.

At the regional and larger scale the land evaluator deals with planners, lawyers and politicians on the demand side and, again, with a team of researchers on the supply side. The relative suitabilities of land units according to the traditional land evaluation schemes is often not of direct interest. Instead, the focus is often on developing alternative land use scenarios that satisfy different, often contrasting, objectives. Moreover, attention is increasingly focused on policy tools
that can be used to realize certain theoretical scenarios and the land evaluator is asked to contribute to the more wide ranging discussions in the interdisciplinary team and to provide relevant land data.

INTERACTION WITH ECONOMISTS AND SOCIAL SCIENTISTS.

Use of land is governed by economic and social factors in society, so economists and social scientists play an important and even central role in discussions on land use, both at the farm and regional level. For a while, the role of intrinsic attributes of the land itself appeared to be diminished as wet soils were drained, dry ones irrigated, poor ones fertilized and sick crops were treated with biocides. The recent emphasis on environmental conditions and multifunctional land use (where not only production levels are important but also quality aspects of nature and the environment) has brought the soil and, therefore, soil science once again to the fore. Every location on earth is characterized by unique physical, chemical and biological processes as induced by land conditions and the climate ("the heartbeat of mother earth"). We cannot deviate too much from this heartbeat or we will exceed environmental threshold values that define the permissible limits of environmental change. This new development provides an important impetus to land evaluation. It also imposes the challenge of defining our "land system" in dynamic terms and we should not only consider natural conditions but, also and particularly, conditions that can be created by man. This input is much needed in the interdisciplinary teams dealing with land use at different scales.

Our old position was one in which judgements on soil suitabilities were made by pedologists. The new position implies input of land data and judgements into teams that are drawn from different disciplines. It is crucial that this land-data input is effective, because it should play a central role when dealing with land use problems (e.g. Bouma, 1998).

PROMISING TOOLS AND TECHNIQUES

In our new role, dealing with land use at different scales with critical and self-assured professionals (be it farmers or regional planners), a number of modern tools and techniques can be applied at all scales:

1. Remote sensing techniques enable wide-ranging characterization of conditions at the land surface, including those of bare soil. A new generation of satellites will be launched in the near future, allowing measurements using more spectral bands. Soil scientists are in the best position to relate observed phenomena to natural conditions in the landscape (e.g. Townshend and Justice, 1991).

2. Geostatistics provides a tool to quantify natural variability in a landscape, certainly when natural subunits within that landscape are first distinguished and then characterized (e.g. Ahmed and Dent, 1997). Data provided allow more efficient sampling procedures: fewer samples in homogeneous tracts of land, more in heterogeneous tracts (e.g. Wopereis et al, 1996).

3. Dynamic simulation modeling of crop growth and solute fluxes is essential to explore the effects of possible alternative forms of land use (e.g. Verhagen et al, 1995; 1997 at farm level and Penning de Vries et al, 1995 at world level). Simulation results should be part of databases for major land units. To feed models, appropriate data have to be measured but development of pedotransferfunctions also needs attention. These functions relate available soil data (e.g. texture, bulk density, organic matter content) to parameters needed in simulation models (e.g. Batjes, 1996).

4. Linear or interactive multiple goal programming methods that allow quantitative assessments of tradeoffs between different options for land use, considering diverse demands made by stakeholders and society (e.g. WRR, 1992; Stoorvogel, 1995).
5. Digital Terrain Models have become important tools to simulate water, solute and sediment movement in landscapes (e.g. Dietrich et al. 1993).

6. Interactive GIS systems are proving to be invaluable in facilitating interaction between researchers and stakeholders. The development of land use options, between which choices have to be made, proceeds best when alternatives are georeferenced on a screen and when alternatives can be developed in a "game-playing" environment (e.g. Bailey and Gatrell, 1995). Having such expertise increases the effectiveness of interdisciplinary teams.

7. In trying to select the best research procedure, definition of "research chains" which visualize different methodologies used at different scales, considering a particular question or problem to be solved, has proved to be effective. (e.g. Bouma and Hoosbeek, 1995; Bouma, 1997; Bouma, 1998). Methodologies range from applying user- and expert knowledge to use of simple or increasingly complex models. Many projects can be executed with expert knowledge with, perhaps, only detailed input from simulation models for some aspects. For a soil scientist to be able to use this flexible approach in interdisciplinary teams can provide an edge, as compared with more single-minded approaches by other disciplines.

8. Distinction of a series of phenotypes for each soil genotype, as defined in Soil Taxonomy is helpful to broaden soil input into land-use studies. Phenotypes reflect significant effects of management (e.g. organic farming, conventional farming leading to degradation and erosion). Now that many soil maps are complete, let's go back to the field and find out and document what the effects of management have been on our major land units. (e.g. Droogers and Bouma, 1997; Bouma, 1998).

Will all these tools really be applied or will they remain toys of researchers, subject to limited external funding? Experience with precision agriculture (PA) (Robert et al, 1996; CIBA Foundation, 1997) indicates that modern farmers are ready to invest in new techniques as they face new demands by customers and society. PA cuts costs while yields often increase and the production system operates more nearly within environmental threshold values. The same goes for regional planners, who have good funding which is currently not adequately channeled into sciences dealing directly with land, simply because soil scientists are not often part of the interdisciplinary teams. This should change, and the the more relevant our products become, the better the chances that we will be invited to join.

DEVELOPING COUNTRIES

The tools and techniques described mostly have a high-tech focus. It is legitimate to question whether they also apply to developing countries where funding for research is often very limited and where the general level of scientific and technical skills is also low. We should, however, focus on the underlying themes: a move towards a team approach and more interaction with stakeholders. These themes are universal. Developing countries should learn from our mistakes. Single-issue disciplinary research is most effective when it is part of research chains, defined by interdisciplinary teams, that take a holistic view of the problems to be studied. There is a big role here for expert knowledge that is widely available everywhere (e.g. Bouma, 1997). Rather than jump into a new project with sophisticated models and information systems, we should first undertake a thorough analysis of the problem in close interaction with stakeholders. For precision agriculture this means that low-tech measures can be taken to overcome a high heterogeneity observed within farmers fields in Niger (e.g. Bouma et al 1997). Placement of manure and crop residues on the higher spots in a field may increase yields as compared with even applications. (e.g. Brouwer and Bouma, 1997). This same awareness of heterogeneity (that was implicitly denied by classical research approaches), is also the core of PA in so-called developed countries. What must be communicated to researchers in developing countries is the need for a research paradigm, that can be effective also in a low-tech environment. But let us not forget that many research
centers in developing countries have well-equipped laboratories and that the problem is not primarily a problem of technology but a problem of how that technology is used. The same goes for planning procedures: modern techniques produce results that allow more rational tradeoffs. Whether or not politicians like that is another matter, but this is a universal truth!

CONCLUSIONS

1. Land evaluation procedures, executed by soil scientists in a supply-oriented, top-down way are pedocentric and increasingly irrelevant.
2. Land evaluators should contribute towards interdisciplinary teams that work in close interaction with stakeholders, be they farmers or planners. Their input is crucial. Land evaluators may sometimes lead the team but this is not necessarily the case.
3. Eight modern tools and techniques, as discussed in this paper, have come of age and will make land evaluators effective members of such teams.
4. The new research paradigm focusing on interdisciplinarity and interaction is universally valid and researchers in developing countries are invited to learn from our struggles.

LITERATURE CITED


Keywords: land evaluation, approach
Mots clés: évaluation des terres, méthodologie