Soil science and society in the Dutch context

J. Bouma[1,*] and A.E. Hartemink[2]

[1] Scientific Council for Government Policy, The Hague, and Wageningen University and Research Centre. Alterra - Wageningen UR, P.O. Box 47, NL- 6700 AA Wageningen, The Netherlands

[2] International Soil Reference and Information Centre (ISRIC), P.O. Box 353, NL-6700 AJ Wageningen, The Netherlands

[*] Corresponding author (tel: +31-317-474215; e-mail: j.bouma@alterra.wag-ur.nl)

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Introduction

In the Netherlands, serious soil investigations were started by W.C.H. Staring in the mid-1800s, followed by J. Van Baren in Wageningen and D.J. Hissink in Groningen in the early 1900s. Soil science rapidly expanded in the mid-1900s with university courses in Amsterdam, Groningen, Utrecht and Wageningen and the establishment of research institutes. After World War II, the number of soil scientists was very large and the knowledge base of Dutch soil science grew enormously. In 1998, there were 23 soil scientists per 100,000 ha agricultural land in the Netherlands compared with 3.0 in France, 2.7 in Denmark and 5.8 in the UK (Van Baren *et al.*, 2000).

Some of the accomplishments and developments in Dutch soil science have been documented (e.g. Buurman & Sevink, 1995; Harmsen, 1990; Knibbe, 2000) and short biographies of some Dutch soil scientists have appeared (e.g. NJAS, 1974; Van Ouwerkerk & Boone, 1990). Internationally, some progress has been made in writing soil science history (e.g. Yaalon & Berkowicz, 1997), but an authoritative and comprehensive review of historical developments in this science remains to be written – also for the Netherlands.

This paper aims to contribute to an analysis of the historical developments in soil science, confined to the broad relations between soil science and developments in society in the Dutch or Western European context. Our society has changed dramatically in the past century from an early industrial society with a dominantly rural and agricultural character to a post-industrial society where services play a key role. Soil science has changed but not as dramatic as society and this observation is point of departure for this review paper that summarizes the major developments during the past 50 years. The paper also provides some notes on the future of soil science.

Developments in Dutch society

We distinguish three broad developments that have taken place in the Netherlands and in other Western European countries since World War II in relation to the land. They are described here schematically as successive waves, meaning that they gradually come and disappear and may overlap over time.

The production wave (1945 – 1970)

The first wave represented the recovery from the devastation of World War II. Food shortage was not uncommon, which in combination with the post-war baby boom required a considerable increase in agricultural production. Fortunately, science came out of the war with high status (Tinker, 1985). There was great optimism and positivism in the 1950s and agricultural research rapidly expanded. Most research was directed towards agricultural production, which increased dramatically thanks to technological developments and major investments in agricultural infrastructure. Soil science played a crucial role in the increase in agricultural productivity, and Malthus would have been correct in predicting that population growth would outstrip food supplies but for the discoveries of soil scientists, including plant nutrition scientists (Greenland, 1991). In any other industry or discipline the record of productive and innovative research would be a matter of pride and envy – in agriculture it became a matter of criticism (Tinker, 1985). In the early 1970s, agricultural production in Europe exceeded demand for the first time since World War II, with some major consequences – success turned out to have a price.

The environmental wave (1970 – late 1980s)

Conservationists and environmental groups, inspired by popular books, drew attention to the widespread deterioration of the environment (Hartemink, 2002). These reports created public and political awareness on the state of the environment, an awareness the world had not seen before. Although most of the predictions and future outlooks in these books proved to be too pessimistic, it brought about changes to the way the public and politicians looked upon agriculture and its impact on the environment. Excessive use of agrochemicals had unwittingly polluted soil, water and air and had contributed to the destruction and deterioration of natural habitats for animals and plants. An environmental movement was established, legislation was introduced and land-related environmental research was strongly promoted.

Public opinion changed and scientists were no longer to be trusted in making recommendations affecting the public (Tinker, 1985). Agriculture was regarded as a major cause for the environmental problems and because of the large food surpluses and the associated costs, especially in relation tot the Common Agricultural Policy, it was suggested that agricultural research could be scaled down appreciably to prevent surpluses increasing still further. These agricultural surpluses were generated and supported by taxpayers' money and this, in combination with the environmental issues, caused serious damage to the farmers' image.

The third wave (late 1980s – present)

The third wave started in the late 1980s and is sometimes referred to as the 'post-modern' society in which capitalism remained the only major political system. Society increasingly individualized, governments retreated and influence of political parties diminished. This is particularly true for Western Europe, because of the continuing development and expansion of the European Union, which assumes a regulatory role in many areas. Changing coalitions of special interest groups, politicians and scientists enter the debate on specific issues, whereas non-governmental organizations become important. Broad introduction of information and communication technologies results in strong economic growth which – by some – is considered to have a structural character in terms of the 'new economy', based on services and the Internet.

There is increasing emphasis on the multifunctional character of land that should not only be used for agriculture and building activities, but also for nature and recreation purposes, providing new impulses to land research. Even though attention for local environmental issues has decreased among citizens, major international programmes on more elusive issues, such as global change and biodiversity have been established and most governments have made official commitments to participate. Here, land research and soil science may play an important role.

The third wave also introduces a changing relationship between science and society. The linear model of knowledge transfer through fundamental and basic research via strategic and applied research to the user is being replaced by a much more flexible network structure in which various stakeholders such as citizens, politicians and scientists, work together. This is certainly not yet common practice, but some successful research projects have followed this course and there is a trend to further pursue this type of approach (e.g. Bouma, 2001a; Bouma *et al.*, 1998; Campbell, 1994; Vereijken, 1997).

Developments in soil science

Trends and shifts in soil science can be distinguished on the basis of shifts in research topics, in quantity of soil research, focus of attention, or modes of operation. Here we look at developments in soil science as a reflection of general developments in society, distinguishing two waves since World War II.

The first wave: supply-driven soil science

Fundamental science thrives on the independent pursuit of the truth. This represents the science-driven wave, which is supply-oriented, and focuses on soil genesis and the characterization of soil physical, chemical and biological properties and processes. Direct use and application of the results for realization of societal objectives is not a primary concern. In the 1950s and 1960s, research funds were relatively abundant associated with an increase in the number of soil scientists and expansion of our knowledge base. Amongst other things, this resulted in identification of several subdisciplines each with its own jargon, terminology and niche. Consequently, many new soil science journals emerged to serve the need for the broadening of the subject (Hartemink, 2001). The 'publish or perish' culture in science made sure that the supply of papers was adequate for the increased number of journals. The Netherlands Journal of Agricultural Science established in 1953 was a typical first-wave journal. One of the arguments for its establishment was to make Dutch research papers accessible to foreigners as only Dutch language journals existed in the Netherlands (Schuffelen, 1953).

The second wave: market-driven soil science

Certain branches of soil science, such as soil fertility research, have always had a strongly applied character with a direct and major impact on agricultural practice (Hartemink, 2002). This also holds for soil survey and land evaluation, which defined land suitabilities for a wide range of land uses, albeit initially in a descriptive manner based on expert knowledge. The major thrust for market-driven research in soil science originated in the late 1960s when society became more critical. Research budgets from government sources started to dwindle, increasingly to be replaced by commissioned projects in a market setting. On the whole, this has limited the scope of research, because narrow objectives and deadlines for output-oriented research projects had to be satisfied. Research was sometimes subjected to restrictive conditions by those footing the bills, including possibilities to publish results. Basic research can be, and has been realized in the context of applied commissioned research even though loss of independence of researchers is a cause for concern. Also, large international programmes have been initiated such as the International Geosphere-Biosphere Programme, providing relatively abundant funding possibilities for soil scientists within excellent research groups. Overall, market orientation and the initiation of large research programmes represent clear signals from society as to what it considers relevant, at the expense of the freedom of researchers to choose their topics.

Developments within soil science differ among sub-disciplines. One of the oldest activities, mapping and soil classification, has developed into soil survey interpretations with a focus on practical problems. Soil classification as such has remained a basic supporting activity, as has micromorphology, albeit receiving less attention. Soil chemistry, physics and biology have long maintained their disciplinary character in the context of practical problems related to inorganic fertilizers, soil contamination by heavy metals and biocides, soil hydrology, soil tillage and organic farming often in the framework of commissioned research.

In the mid-1980s, sustainable use of natural resources became a major issue in soil science. Bruntland (1987) in her famous definition talks about "using natural resources more efficiently so as to better fulfil the needs of men". This represents a strongly anthropocentric view, but does not put the living earth in a central position, which is a common approach in recent years and can be associated with what was earlier in this paper called *the third wave of developments in society*.

A third wave, also for soil science?

Few activities in soil science appear to correspond with the third wave as described for developments in society. Such activities require an interdisciplinary, non-traditional and flexible approach. An example is the 'Landcare' programme in Australia (Campbell, 1988) and New Zealand in which concerned citizens supported by policy makers designed programmes for combating soil degradation due to salinization and inappropriate land use. In these programmes, soil scientists were involved but not necessarily so. They were invited to supply specific contributions in the broad interdisciplinary context. Rather than present their 'solutions' to problems observed in the traditional 'problem-solving' mode of operation, soil science input was derived from discussions in the team and was part of a joint learning experience. A comparable approach was followed in the design of innovative farming systems in the Netherlands by prototyping, in which farmers worked directly with scientists, using a systems approach to reflect the complex interactions among disciplines (e.g. Aarts *et al.*, 1999; Hilhorst *et al.*, 2001; Vereijken, 1997). This approach, in which soil scientists have participated, could be revolutionizing agricultural research.

In the third wave the living earth is placed in a central position, from which are derived the limits within which human society can develop. In doing so, soils play a key role in defining fluxes of water, solutes and energy between land and sea and land and atmosphere. The magnitude of such fluxes strongly depends on land use, which therefore is an important driver for global processes. In dealing with these processes, we can build on our experience and knowledge from the past 150 years. Soil properties do not vary at random across landscapes but certain natural soil patterns occur (Heuvelink & Webster, 2001). One should use soil maps, in full awareness of all variability, and consider taxonomy as a tool for stratification of soils in a landscape context, each soil with characteristic dynamic properties: living soils in dynamic landscapes. Each soil type can thus be a 'carrier' of information, presenting a characteristic 'window of opportunity'. Thus, we can identify carrying capacities and more clearly define the natural limits that the earth presents.

Rather than either basic research as described for the first wave or problem-solving research as described for the second wave, soil scientists should play a role in support of different visions on a problem, as negotiator acting as an intermediary, and as problem identifier and clarifier (Bouma, 2001a). This clearly reflects the character of post-modern society where scientists play a role in teams consisting of members of non-governmental organizations, business groups, citizen groups and policy makers. We therefore distinguish only two waves in soil science and conclude that while the waves described for society are clearly successive in nature, the two waves for soil science still exist next to each other: many (very good) papers are still supply driven. We advocate development of a third-wave soil science with an open eye for future needs of society and incorporating elements of the first and second wave.

Soil-related issues in natural resource management

For a number of environmental issues international treaties have been signed as many of the environmental problems cut across borders of countries and continents. These treaties deal with global climate change, reduction in biodiversity, and global shortages of fresh water resources. Soils play a major role in these environmental problems. Other issues are the degradation of land and future food security as the world population is expected to reach 8.7 billion by the year 2050 (Lutz *et al.*, 1997). This is of particular importance in the developing world where 95% of the population increase takes place. In Western Europe the demographic problem will be much more the ageing of its population and associated health concerns and hence food safety. A major additional issue will be future land use. In the Netherlands approximately 70% of the land area is currently used by agriculture. Due to increasing pressure by urban citizens and a decreasing economic importance of agriculture in relative terms, different land use patterns will develop in future. Whether soil patterns and soil properties will play a role in determining these new land-use patterns remains to be seen, but these trends may present a huge challenge to the soil science profession. More contacts between soil scientists and geologists and hydrologists are being established as subterranean construction becomes increasingly attractive and feasible.

Research programmes should be interdisciplinary in character and follow comprehensive systems approaches. The high political visibility of these programmes calls for various forms of interaction with stakeholders, including planners and politicians. Bouma (2001b) has advocated a step-by-step approach in presenting soil information into the scientific and social discourse, starting with simple approaches based on expert knowledge and by showing how additional specific scientific input can improve the ultimate result. Whether the more advanced methodologies will be applied, depends on the type of questions being raised and the sophistication of input by other disciplines, as it is not effective to combine highly specialized soil input with strongly generalized input from other disciplines. Existing expert knowledge is often adequate to answer questions (Bouma, 1993). The step-by-step approach implies that a problem is first studied by simple means, identifying gaps needing further research, which can be increasingly sophisticated depending on the type of questions being raised. This versatile approach contrasts with the all too common condition that a soil scientist tries to apply his or her favourite model or method. Basic research is needed when existing knowledge or simple modelling is inadequate to answer the disciplinary questions emerging from systems analysis by interdisciplinary teams. This way, basic research is part of research chains that have a relation with real-world problems. Of course we should realize that there will always be a need for curiosity-driven research that may result in new insights and system innovations in unexpected ways.

Conclusions

We think that the future for soil science is bright, but much depends on the willingness and ability to interact with colleague researchers in other fields and with various other stakeholders, while preserving our scientific vitality. The future of soil science may well depend on our ability to react in a creative and professional manner to the challenging third wave of developments in society in which stakeholders, such as citizens, politicians and scientists, work together.

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