LEARNING FROM THE PAST WHEN FACING THE FUTURE OF SOIL SCIENCE.

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ABSTRACT

Continued economic growth, rapid technological development and a steady increase in the flow of information in a globalizing world with networks of interacting people, challenges researchers to fundamentally reshape the way in which they work and communicate. This also applies to soil science. Lessons can be learned by revisiting experiences of the past but a plea is also made to tap old sources of wisdom defining the struggle of mankind to cope with the complexities of life, starting with Plato's *logos, ethos* and *pathos.* When applied to soil science this relates to: (i) the study of soil as an object (the *true* soil: "it"); (ii) its place in society as institutionalized by rules and regulations (the *right* soil: "we"), and (iii) the way soil is experienced by individuals (the *real* soil: "I"). A plea is made to pay more attention to the *real* and the *right* soil in future by interdisciplinary and interactive work, fitting into the "experience society" as an expression of future trends. This can, however, only be successful when basic soil research on the *true* soil will be continued and is interjected into and inspired by the interactive processes. Expressing risk and uncertainty is particularly relevant in our risk society and a strategic combination of pedology and hydrology in *hydropedology,* as recently proposed, is expected to be most effective in

communicating the character of dynamic soils in a landscape context. Soil scientists need, moreover, to become more aware of the diverse requirements for policy research by considering different policy functions, such as *signaling, preparation and implementation* and by focussing research accordingly. To tap the vast reservoir of fascination of soils in society and to mobilize support, possibilities of the internet should be much better utilized in future, establishing virtual *communities of practice* for different major types of soils, combining existing and tacit knowledge as well as results of computer simulations of possible dynamic soil behaviour.

INTRODUCTION

Society is changing rapidly: continuing economic growth, rapid technological developments and a steady increase of the flow of information leads to often unpredictable and bewildering transformations.(e.g. Castells, 2000). Such transformations contribute to a flexible, modern network society that does not match with the more traditional and hierarchial relationships between government and its citizens that dominated society in earlier times. Old principles of hierarchial democratic government are increasingly being challenged as alienated citizens feel that their interests are not well represented by their elected representatives, as evidenced by low voter turnouts and the success of protest parties. Changes in society have, of course, always occurred in history. After the rather static agrarian economy before the nineteenth century, the industrial economy brought fundamental changes in the ninetieth and early twentieth century that were transformed again as the service economy developed after the eighties of the last century . Now there is increasing awareness of the “experience economy” (Pine and Gilmore, 1999). Three reasons may be given to explain this latest development. The first is the material wellbeing in our western world: basic needs of life are met for many people and there is money to spare for luxury. The second is individualization: the unimpeded freedom to follow one's individual tastes and desires. (e.g. Giddins, 1991). The third reason, globalization, appears contradictory at first sight with the second one but does play a significant role. Processes and events all over the world have more and more in common, if only because of evermore effective global communication. Traditional institutions, such as the nation-state become less important than cultural communities, which are networks, from global to local scale, organised around particular values and interests.

Do these changes affect science? And more particularly soil science? To answer that question it is important to avoid the trap of making an exclusive analysis from our own perspective without trying to really comprehend and integrate visions by others, be it colleague scientists, citizens, stakeholders, planners or politicians. This inward looking attitude does not create mutual understanding and often leads to a sterile debate. Better ways have to be explored. We need help here and philosophy and sociology can offer valuable insights into the processes involved and their context. To come to grips with the challenge to realistically articulate different visions and approaches as to what is perceived to be the future role of science in society, Habermas (1984) distinguishes three basic human abilities to cope with the mysteries of life: (i) creating knowledge by using objective standards; (ii) having joint experiences of groups of people, as codified in social norms and values, and (iii) enjoying and cherishing individual experiences. This three-fold distinction is helpful to articulate the relationships of scientists, within a group and individually, with their professional colleagues and with society at large.

Such relationships are particularly important for soil science because it deals with land and its use. This appeals to many because it visibly affects their lives. Changing times became visible in the Netherlands when recently a new government program on innovation research was initiated at the tune of 800 million euros. These funds were not provided to Universities or Research Institutes but to consortia consisting of researchers, industrial firms, governmental agencies and citizens groups. Science Institutions by themselves are no longer the logical exclusive recipient of research funds.

Considering these diverse developments, the overall objective of this paper is to explore past, current and future developments in soil science, considering the above-mentioned structural changes in society, by: (i) analysing the three basic human abilities in terms of their implications for the relation between soil science and society, and (ii) considering the possible implications for soil science in future.

THREE HUMAN ABILITIES TO COPE WITH LIFE

For a long time, mankind has recognized and distinguished three basic human abilities to cope with the mysteries of life: (i) to think and to gain knowledge; (ii) to act in a group setting with common norms and values, and (iii) to feel and imagine. The old Greek philosopher Plato was the first to make these distinctions in terms of, respectively, *the logos, the ethos and the pathos.* Kant wondered how an image of the world can be obtained and in exploring this he analysed: “phenomena of knowing, acting and feeling”. Hume (1968) in his: “ Treatise of Human Nature” distinguishes three corresponding elements: “of the understanding”, “of the morals” and “ of the passions”.

Habermas (1984) has perhaps most thoroughly analysed these three elements when characterizing communication among people: (i) statements are “true” when they can be defined according to an objective standard; (ii) statements are “right” when they agree with the established norms of groups of people., and (iii) statements are “real” when they correspond with personal, individual feelings. In short, the first statement corresponds with “It”, the second with “We” and the third with “I”. Since this paper is written from the viewpoint of a soil scientist, the “I” corresponds first with the view of a particular soil scientist, where, obviously, distinctions have to be made among scientists operating within the various subdisciplines. But the “I” also relates to the way individual citizens feel about the soil and the land. The “We” corresponds to the way in which soil science and its expertise is reflected in rules and regulations in society but also, in a more general way, to the way in which “groups of people” feel about soil. The “It”, finally, is the favorite and classic domain of the scientist: how to measure soil features and soil behavior with scientific methods that are quantitative and reproducible.

The broad sketch of developments in society, presented in the introduction, has clear and fascinating relations with the three basic abilities of man as discussed. By paying much attention to the study of soil as such (“It”), soil scientists have largely left the development of rules and regulations on land ("We") to lawyers and others, while also the personal identification of citizens with soil and land in the experience society (*their* "I") has only incidentally been nurtured. In older days, this was no problem. Research was done in splendid isolation and results were passed on to others to be applied, either technically or administratively, in rules and regulations, or to be enjoyed either by scientists or interested citizens. Each member of society occupied its particular niche with its well defined functions. As stated, the network society is fundamentally different: experiences become more important and need to be nurtured. Rules and regulations increasingly result from intensive interaction between government and its citizens. If researchers are not directly involved in that process, their well intended but independantly generated scientific contributions often evaporate. In other words, there is justification to *first* explore relations between developments in society, as discussed broadly above, and the three basic abilities of man to cope with reality and , *second,* to try to interpret the results of this analysis in terms of recommendations for future activities in soil science. We will therefore explore whether it may help to make a distinction between a "true", "right" and a "real" soil.

Soil as an object of study.

The soil as an object of study, the "true" soil, has been the favorite domain of the soil scientist: using ever more sophisticated methods to measure soil characteristics and to characterize dynamic soil processes has greatly expanded our knowledge about soils and has been a major contribution to society at large as this knowledge has been applied in many products and services. There is, however, a distinction between the soil, as such, with its static and dynamic properties and the manner in which soil is being used in many ways by people and the effects thereof. The latter is difficult to predict in an objective manner. One way is to define risks and uncertainties that are associated with particular forms of actual and possible land use and this includes indicating the limits of science. Here, the term “risk” represents uncertainty that can be quantified in terms of probabilities of occurrence. Van Asselt (2000) distinguishes seven categories describing why uncertainty occurs, of which only the first two can be quantified, the remaining are structural:

(i) Inaccurate measurement. “We roughly know” and have no technical opportunity at this time to make better measurements. We may want to invest in new technology to allow more and better measurements if this appears possible in principle.

(ii) Lack of measurements. “We could know” if only we would be willing to spend the money for measurements, using existing techniques.

(iii) Cannot be measured (yet) but is felt to be real. “We know what we don’t know”. For soil science we can think , for example, of “soil quality” or “soil resilience”.

(iv) Conflicting evidence. Different types of measurements of the same feature give different results. “We don’t know what we know”. For soil science we can think of chemical measurements based on different extraction techniques that yield different numbers. Often, an arbitrary selection is made here for one particular method but that does not solve the basic problem.

(v) Lack of knowledge which can potentially be gained in future. “We don’t know what we don’t know yet”

(vi) Lack of knowledge which is unlikely to be ever gained. “ We cannot know”, and:

(vii) Experiences of uncertainty beyond knowledge:” We will never know”.

The structural uncertainties serve to illustrate the limitations of the “true” soil concept. Another important aspect dealing with “truth” was emphasized by Popper, perhaps the most important scientific philosopher of the twentieth century. He stresses that the absolute truth does not exist. Science makes progress by trial and error, by rejecting hypotheses and not by trying to confirm one favorite hypothesis, that is supposed to represent “the truth”. This constant rejection and formulation of new hypotheses, by so-called “falsification”, is the name of the game of science. “Truth”, therefore, is time-bound, at least when science has a high vitality.

The soil scientist should try to define the “true” soil as good as possible but he should be modest and know his limits. Only part of the uncertainties can be characterized. Room should be left for things we don’t know yet or things we will never know. He should, as a scientist, be guided by Popper’s approach but, at the same time, should realize that his real-life customers are allergic to scientists who “are not sure”. If, for example, a given result can be presented with a probability of 90% it may be presented to planners and politicians as “ the truth” even though a scientist knows there still is a probability of 10% that things are different and that different hypotheses are likely to arise in future.

An example may serve to specifically illustrate this important point. Sonneveld and Bouma (2003a) studied the effects of different nitrogen fertilizer applications on groundwater quality in a major sandy soil type in the Netherlands (Figure 1). They considered three types of prominent land use in the area: permanent pasture (A), reseeded pasture (B) and land previously cropped to maize (C). They used a state-of-the-art simulation model for water and solute movement, Nitrogen dynamics and plant growth and made calculations for a 30 year period, using real weather and N-fertilization data. Results were expressed as probability graphs showing the probability that the quality threshold level for nitrate in the groundwater (50 mg/liter) would be exceeded. Values were 25%, 8% and 5% respectively for the three forms of land-use, allowing the user to choose a level that he considers to be acceptable. Other scenario's could be explored with different fertilization rates offering more options. When asked for a clearcut conclusion, we would say that permanent pasture presents unacceptable pollution risks at current fertilization rates, requiring development of different forms of management, whereas the other two land uses would present acceptable risks. But note that there always is a risk. For communication purposes we set the degree of acceptability arbitrarily at 10% but other limits can be defined, of course.

When discussing the concept of the "true" soil, science faces an important principle that has been widely adopted in environmental sciences, the "precautionary principle". Adapted at the sustainability conference in Rio in 1992, the principle states:*" In order to protect the environment, the precautionary approach shall be widely applied by the States according to their capabilities . Where there are threats of irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation".* The principle is often interpreted as:" When in doubt, don't do anything". This is wrong, if only because research is always associated with doubt. An interpretation along these lines would, therefore, mean the end of research. But the principle implies, on the contrary, that lack of full scientific knowledge may not be a reason to do nothing, again emphasizing that trying to achieve absolute certainty is not realistic. Use of probabilistic approaches, as discussed above, are helpful to define different options for land use from which rational choices can be made. Simulation models are important tools to make such analyses possible.

Soils and society

How much is soil science part of our culture, our norms and values, our rules and regulations? The awareness of soil goes right back to the start of our civilization. In Genesis, the first chapter of the bible, we read:" God Yahweh formed man out of the soil of the earth …and man became a living sole". Also in other religions, soil and land play an important role (Hillel, 1991). In our technological society, the role of the soil has moved into the background. Environmental concerns focus on global change and the status of tropical rainforests and the oceans, not primarily on the land. The problem of hunger in the world is not seen as a result of the low productive capacity of soils but of poor distribution and marketing of the food that is grown and the inability of poor people to buy food. The successful "green revolution" was an exclusive triumph of plant breeding without a clear role for soil science and soil-related desertification and various other forms of land degradation are mostly seen as a result of poor management rather than as soil-related phenomena. On a more local scale, we see that environmental rules and regulations define critical contents of heavy metals and other pollutants in soils, thereby using soil data, but many other regulations tend to emphasize technical *means* rather than soil processes to define environmental *goals* for soil, air and water quality. Moreover, soils are most often considered in a generic manner, thereby ignoring the possibility to be more specific about soil behavior using stratification of soils into different soil types (e.g. Sonneveld and Bouma, 2003b).

Soil scientists have a major handicap: soils occur underground and are invisible except when excavated. Plants and animals are highly visible and this at least partly explains the viability of policies enforcing biodiversity. The new environmental and farming policy of the European Union to start in 2007 emphasizes , among other matters, the importance of cultural heritage as expressed by characteristic landscapes. That soil properties have played an important role in creating such landscapes remains under-exposed. Still, there are efforts now to define soil-charters and also the EU is working on soil policies. Recently, the Dept. of the Environment, Food and Rural Affairs in the UK published the “First Soil Action Plan for England” (Dept. EFRA, 2004). This needs support. But how can we contribute to the incorporation of soil expertise into laws and regulations that reflect concerns of society? We will address this question by briefly analyzing the policy process that underlies implementation of such rules.

The policy process

The relation between science and policy making used to be rather simple according to the old linear or hierarchial model: once a problem was identified, research was initiated and all or part of the results were later codified in rules and regulations by regulatory agencies. They were responsible for enforcement. This has led to many problems in modern society because stakeholders felt that their expertise remained unused and generic solutions to problems were difficult to implement without taking local conditions into account. One answer is interdisciplinary research where “hard” and “soft” sciences are combined and where participatory approaches are followed (see e.g. Funtowicz and Ravetz, 1993; Beck, 1992; Campbell, 1994, Roling, 2001; Bouma, 2001a, Bouma, 2001b). It is important here to distinguish different functions in a policy cycle: (i) the *signalling* function, recognizing the existence of a new problem at an early stage; (ii) the *policy preparation* function, which- once a new problem has been recognized- explores a range of possible solutions considering trade-offs between economic, ecological and social demands of various stakeholders when trying to define sustainable options; (iii) the *decision making* function; (iv) the *implementation* function where decisions are implemented. (e.g. Bouma, 2003).

Research has different functions in each of these categories. The *signalling* function is important. An example are early publications about global change that have led to a world-wide program. For soils there are publications about erosion and soil degradation but so far these signals have not led to specific, coordinated action. More recently, attention is given to soils as an important sink for carbon and this does have an impact on overall policies. *Policy preparation* requires a special approach by research. The key relation and dialogue here is the one between government and its citizens, *not* the one between science and society even though scientists may want to believe so! The relation between government and its citizens is a troubled one in many countries. The well known Dutch sociologist van den Brink

(2002) made a study of the attitude of Dutch citizens versus their government: 35% of the respondents felt threatened by their government, they were outright scared; 45% did not care and were clearly alienated, while 20% were involved but in a highly critical manner: they felt that they could do a much better job than the government. The least that can be said is that government needs a range of approaches to deal with its citizens! A generic plea for participatory approaches for policy issues is irrelevant.

The key question is how science can fulfil a facilitating and mediating role by inserting the right knowledge at the right time into the overall learning and interaction process that goes on between government and its quite diverse citizenry when preparing or implementing new policies. Scientists are not used to this and those involved with such processes need to develop a basic understanding about interaction processes and communication techniques. But let us also realize that the importance of interaction with stakeholders can be over-emphasized. Some tacit knowledge of stakeholders is clear nonsense, even though one would probably not want to say so to not endanger the interaction process. In many cases, however, input by stakeholders is very valuable. Good examples are available now for regional land use where exploratory simulation techniques have been used to produce various land-use options that help to focus the interaction process between government and its citizens. Soil science has made significant contributions in this wider context. (e.g. Kropff et al, 2001; Kuyvenhoven et al, 1998; Bouman et al, 2000).

But there have been problems. An example is the manure policy in the European Union. In 1991 the nitrate guideline was adopted, focussed on groundwater quality, and allowing a maximum quantity of N from manure of only 170 kg N per ha. This was applied for the entire Union, ignoring different soils, land uses and climates that have, of course, pronounced effects on nitrification and leaching processes of nitrates into the groundwater. Clearly, the *signalling function* had failed. A political decision was made without much input by scientists, let alone soil scientists: a big mistake that has hounded the agricultural community ever since. Researchers in the Netherlands developed a new system based on a nutrient balance for individual farms but this system was finally, after much struggle and debate, rejected by the European Court in 2003. Now we are back to the 170 kg organic N per ha which can approximately be translated into 2.2. animals /ha. This generic rule is easy to enforce and is therefore attractive for regulators but has no direct relation to the pollution potential of manure. Nitrate pollution of groundwater is governed by soil processes but soils do not play a role in the legislation. Even more seriously, the innovative capacity of farmers as expressed by making better manure with less N or using split applications all the way to applying techniques of precision agriculture, is being suffocated as the generic rules are rigidly enforced. Not the *goal* of groundwater quality guides the regulations but possible *means* to reach that goal. Having failed in their *signalling* function, soil scientists are now trying to devise a system where the water quality *goal* is central and where farmers are given the opportunity to reach these goals in their own way. In developing such a system, legal issues are more important than soil issues. Since 1991 thousands of scientific papers have been published about transformations of manure in soils, but they have ignored the political context of the problem. The EU court action in 2003 illustrates the embarrassing effects of such an elitist attitude. (see Sonneveld and Bouma, 2003a, b).

Going back to the policy cycle: *Decisions* are to be taken by government or by non governmental organizations, not by researchers. Researchers make a serious mistake when they try to play the role of decision makers. But the *implementation* of decisions taken may require again input by scientists, be it different input than before. Once decisions have been taken, considering all the available evidence, it is, however, not helpful when scientists come again with nice ideas as if the preparation process was still going on. To be effective they have to follow the policy cycle. Here, the function may be to better explain certain elements of the decisions having been taken or to help solve unexpected complications or new developments. Moreover, scientists have a particular responsibility to emphasize that implementation has operational, tactical and strategic dimensions, each with a characteristically different time frame. Policy makers often don't look beyond the short term. But short-term operational measures may not satisfy longer-term strategic objectives. Being involved in the policy making process and being recognized as a valuable partner makes it feasible to successfully stress certain more long-range interests that might otherwise disappear in everyday policy struggles. Here, science has a clear function.

Such a diversified and interactive approach, implying that scientists are members of problem solving teams, leaves lots of room for basic research which is essential to face the problems of the future. In fact, we have proposed to follow a step-by-step approach to get the interaction process going when introducing scientific knowledge into the policy process: start with simple, available input, show the limitations of this and make, thereby, a case on the basis of a cost-benefit analysis, for more sophisticated data that may require new research etc. (Bouma, 2001b). This process can be represented by knowledge chains, connecting different types of knowledge at different spatial levels (Bouma, 1997).

Be that as it may, is it realistic to expect that soil by itself can be an effective driver to incorporate more science into the policy process? I fear this is not the case. Two aspects can be mentioned here: (i) broadening our case, where water is our ideal partner, and (ii) looking for new applications and partners..

Interaction of soil and water.

Blood for man is like water for soil (Bouma, 2004). Water regimes in soils and landscapes are determined by the climate, the vegetation and by the particular properties of the soil and the underlying geologic formations and their hydraulic regimes. The recent proposal to emphasize *hydropedology* as a new discipline in which hydrologists work together with pedologists, both with knowledge about soils and landscapes in the field, deserves support (Lin et al, 2004). *Hydropedology* can provide essential input into the policy debate that goes significantly beyond input by soil and hydrology separately: water regimes in different soils and landscapes determine agricultural and ecological potentials and their environmental resilience. The more we deviate from natural water- and solute cycles, the higher the probability that the impact of man will negatively influence the sustainability of the land-use system.

This approach has defacto been adopted in Dutch spatial planning where the “three-layer” concept is being used: the “first” layer describes the dynamic soil and water system, the “second” the transportation networks such as roads and railways and the “third”, human settlements. Any new plan needs to consider the sequence from one to three when developing its content. Considering soil and geology and hydrology separately would not have been useful for this approach. But together they form a solid basis for planning. This needs support and soil science needs to focus in this context on issues that are particularly important for defining solute fluxes in soils and landscapes.

New applications

Traditional users of soil information become less important while new users may offer new, attractive perspectives. They have to be actively pursued. An arbitrary example was described in South Africa by the Agricultural Research Service that started to cooperate with banks and insurance firms, showing that predictions of crop yields and associated risks were commercially attractive. In these projects soil scientists worked with agronomists and meteorologists (ISNAR, 2004). Many more examples can be given that all result from the active communication of the potential of applying soil science expertise to practical problems dealing with land use or food policy.

The personal relation with soil.

How do we personally feel about soils? A distinction will be made here between individual experiences within the profession and experiences outside in society, by considering : (i) the individual soil scientist; (ii) interacting soil scientists of different subdisciplines; (iii) soil scientists interacting with colleagues, and (iv) citizens at large.

The soil scientist: from data to knowledge and beyond.

The future of soil science depends on solid but also effective research based on genuine enthousiasm and curiosity of their scientists which has to be safeguarded by a certain degree of freedom allowed for by independant government financing. The biggest threat to the profession is a continued expansion of commercialization where activities tend to be restricted to short-term projects imposed by funding agents with narrow interests. Every soil scientist will have his or her own vision and expectation for the profession. There should be room for that. Most researchers probably prefer to focus on the “true” soil. This is fine as long as others also pay attention to the “right” and the “real” soil, getting involved in interdisciplinary and interactive processes, as discussed. If this does not happen, I see a bleak future for the profession. Our system of peer review should reflect the need for an approach that goes beyond counting the number of papers in refereed journals by also rewarding successful interdisciplinarity and interaction.

Dealing with soil questions involves a sequence of considerations, starting with *data,* which becomes *information* when data obtains a certain meaning. *Information* becomes *knowledge* when it is internalized and when it becomes really part of one’s own expertise. Effective application of *knowledge* requires *wisdom* which cannot be extracted from literature and reflects an ability to judge whether or not certain knowledge should be applied in certain situations. *Wisdom* , however, can be cool and calculating. When dealing with people in defining the “right” and the “real” soil, *compassion* and *empathy* (the ability to see the world from the viewpoint of somebody else) are important qualities. I would recommend that we pay at least some attention to all these aspects in our education system and stop with looking at *data, information and knowledge* in isolation. In the past, soil scientists were often more in contact with their users than they are now: pedologists, soil surveyors and fertility experts talking to farmers and land users now find themselves often restricted to the office facing a computer screen. *Wisdom, compassion and empathy* can only thrive through real interaction with real people. Here, we can be inspired by our professional experiences of the past.

Soil scientists amongst themselves

The subcultures within soil science should merge. For example, for years pedologists have worked on Taxonomy, which was not very interesting for their colleagues in Soil Physics, Chemistry, Biology etc. Now that Taxonomy is completed, there is good reason to join the activities of Hydropedology (Lin et al, 2004) and consider solute fluxes in soils and landscapes as a unifying principle to which many other disciplinary activities in soil science can be attached and which can, together, yield a product that is attractive in a broader, interdisciplinary context. Bouma and Hartemink (2002) analysed developments in soil science in the Netherlands during the last 50 years and conclude that a first wave of supply driven science was followed by a second wave of market-driven science and that a third wave , reacting to post-modern developments in society, is still being explored. But scientists feel uneasy about this as their role appears to change quite strongly. Similar developments can be perceived in other countries. This paper intends to contribute towards establishing this third wave in everyday practice.

Soil scientists and their colleagues

Within subdisciplines of soil science there are generally good contacts with outside professions. Soil chemists work with chemists, soil phycisists with phycisists etc. Being an effective partner in an interdisciplinary team with economists, lawyers, political scientists and sociologists – needed when pursuing sustainable development – requires much more. We need to define better what our core competences are and which areas overlap with other disciplines. If those core competences are not perceived by others as being relevant and substantial, we – and any other discipline, for that matter - will have a problem when trying to become appreciated members of interdisciplinary teams. This appreciation has to be earned: it does not come by itself. There can also be a basic conflict between freely communicating our results and by still wanting to be involved ourselves. An example are *pedotransferfunctions,* which relate, usually by regression analysis, soil data to parameters needed for simulation modeling. (Bouma, 1989; Wosten et al, 2001). For example, such functions relate texture, bulk density and organic matter content to soil permeability and moisture retention properties. When engineers use these functions, soil scientists are not needed anymore, or so it might seem. Of course they are still needed to put results in context but this is not obvious to the general user. Besides, this is not a static matter as concepts are continually being developed further in any living science as is well demonstrated by Mc Bratney et al (2002) . A similar story relates to soil mapping where off-the-shelf Geographic Information Systems offer smooth routines for non soil scientists, but where scientific probing can significantly improve the quality of the work (Mc Bratney et al, 2003). If we don't continuously extend our own scientific frontiers, we should not be surprised when others do it in a way we usually don't like.

Citizens at large

Land and soil strike a nerve in many people. We have not explored this to its potential. Aside from an occasional popular article in newspapers and magazines, and a TV documentary, much more is possible. Our former soil survey reports used to describe geology and land use in detail, the latter often in a descriptive manner that was accessible to the average reader. Reports often included illustrated "walks" through the surveyed area. Current projects hardly allow time to report such a broader context. But there is more. The explosive development of internet allows and requires new approaches. The great majority of households in developed countries are connected to the internet and the rest of the world follows rapidly. Internet cafes can be found in the most remote areas of the globe. To tap and feed a genuine interest in soils, we could use internet to present information on our major soils that not only describes their history in geological terms but also effects of use by man and, particularly, its potential for the future in view of expected economic developments and regulations. Such presentations go much beyond classical soil survey interpretations in terms of estimated limitations or suitabilities for various forms of land use and require computer simulations, of which some results were shown in figure 1. Such a specific focus on individual soils counteracts the often generic and demotivating treatment of soils in planning and legislation: "a soil is a soil is a soil". The real story is about the diverse properties of different soils, each with a unique potential where past land use can explain current properties in a given soil: Sonneveld et al (2002) showed this for the soil organic matter content which could be well predicted by regressing it with past land use. These predictions were based on visiting some 50 farms which had fields with the soil to be studied as shown on published soil surveys. New field work, including sampling soil organic matter and soil structure, was essential for this study to document changes being created as a result of different forms of soil management. Conversations with farmers and other land users yielded important tacit knowledge. Much unique soil data is still out there, waiting to be discovered. New techniques offer new possibilities to do so. The idea that field work is not necessary anymore, now that soil maps are completed, is truly mistaken and quite risky as it implies that we cut off our roots.

Much is yet to be gained by tapping and addressing the interest of our fellow citizens in soils in the context of the “experience economy”. Alerted to the role of soils in modern land use, citizens can next more easily be mobilized when soil science is needed in the policy arena. We may think of establishing *communities of practice* (Wenger et al. 2002) consisting of groups of people that share a concern, problem or passion and wish to exchange and share their knowledge and experience to deepen their understanding as a basis for action. At least some soil scientists could join such *communities* as partners in learning. Example of this approach are the Landcare Program in Australia (Campbell, 1994) and, on a much larger interdisciplinary scale, the activities of the International Panel on Climate Change (IPCC).

WHERE TO GO FROM HERE?

The previous sections have suggested a need to move beyond the study of the "true" soil – which has received most emphasis in soil science in the past - and pay more attention to the "right" and the "real" soil. But these three categories have their own identities and relations between the three are not clearcut. Besides, opinions on this are controversial. Many soil scientists find the type of discussion being presented here, irrelevant and irritating. How, then, to proceed? In view of the importance of the "experience economy" some of us may first want to start to further develop the concept of the "real" soil with particular attention to citizens at large, possibly by initiating *communities of practice* through internet. Here, selective input of "true" information by researchers is essential to fine-tune and sanitize what is perceived as "reality". Next, we have to see how we can better translate such perceptions of "reality" into rules and regulations about use of soil in the broadest sense. Again here, input of "true" soil information into interdisciplinary teams is essential . In other words, the key message would be that we need to feed our more traditional soil research more effectively into research that characterizes the way soil is experienced by a wide variety of users, which, in turn is to be codified in written and unwritten rules and regulations guiding land use in society. This would appear to be the most promising sequence of activities for the future which certainly requires basic soil research, which is, however, bound to be most effective in a broader well-defined context.

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FIGURE 1

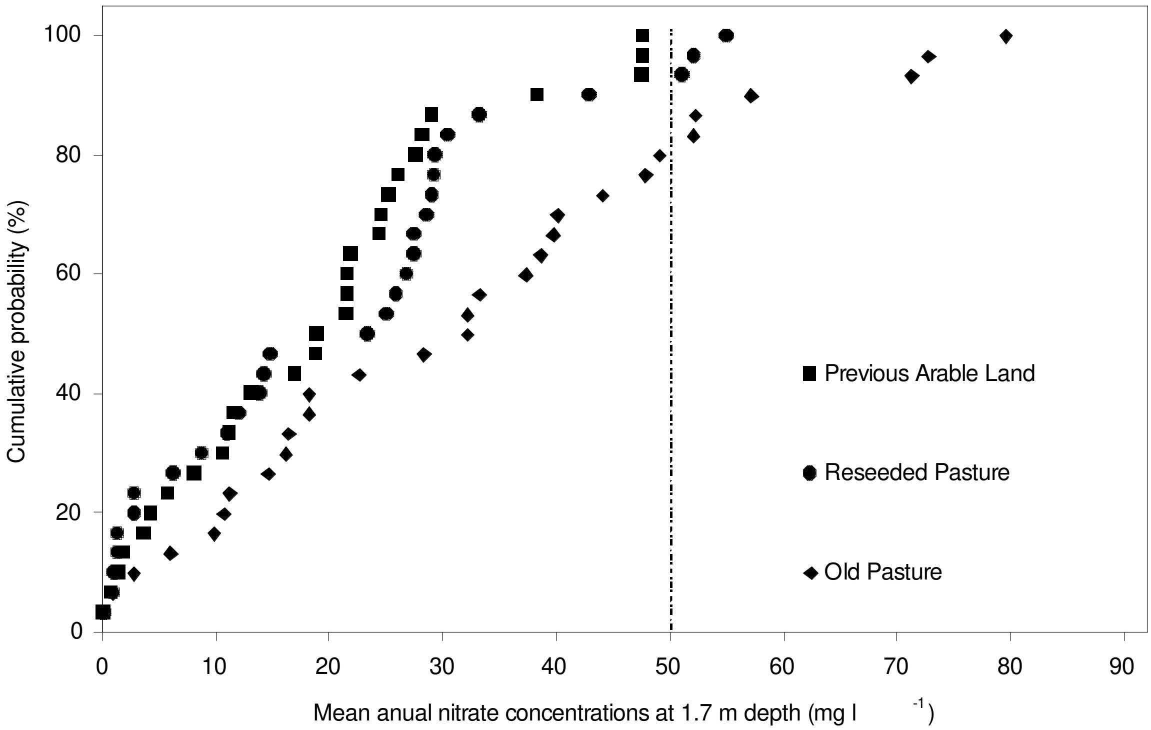
Cumulative probability (%)
0
20
40
60
80
100
0
10
20
30
40
50
60
70
80
90
Mean anual nitrate concentrations at 1.7 m depth (mg l^{-1})
■ Previous Arable Land
● Reseeded Pasture
◆ Old Pasture

FIGURE CAPTION

Figure 1. Cumulative probability curves of the mean annual nitrate concentration at 1.7 m depth for a major sandy soil in the Netherlands under grassland , considering three types of management as indicated. The EU groundwater quality standard is 50 mg nitrate per liter. (from Sonneveld and Bouma, 2003b).