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A soil science renaissance

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ABSTRACT

The renaissance was an intellectually-rich period following a period of stasis in the medieval period. Something analogous appears to be currently taking place in soil science where novel approaches to thought are combined with a revival of ideas from the past. Renewed interest in agriculture (food, feed, fuel) and numerous publications have brought soils back onto the global research agenda. The need for up-to-date and fine resolution soil information and the revival of soil research has been highlighted and prioritised in several recent studies by the UN and other international organizations. Soil erosion, nutrient depletion and pollution are key issues that have been brought up in many recent reports – in most cases in relation to environmental degradation, climate change and world-food production. There is also an increased interest in soils in the popular press and media, and soils have entered the policy arena in many countries and several continents. We guestimate that about €3.2 billion is annually spent on soil research in Europe, North America, and some of the main countries in Asia and Oceania. For the global soil science community, there are challenges ahead to address the questions raised in these reports. There is a whole set of new techniques and methodologies in the wings waiting to take centre stage. There is a direct need to educate a new generation of soil scientists and to increase the influx of soil science students in many universities. The soil science community should benefit from the current upsurge in soil science, but the community has to deliver the goods and information that is wanted and much needed.

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1. Introduction

Soil science has always had strong ties with agriculture and soil science knowledge has made large contributions to the increase in agricultural production. A better understanding of soils has been essential for research questions on climate change, environmental regulation and ecosystem services. Reduced funding that started in many countries in the mid-1980s affected soil science and this followed widespread governmental budget cuts, and a reduced interest in agriculture. It took time before soil science departments shifted focus towards the study of soils as part of environmental and ecosystem services (Tinker, 1985). For some that shift came too late and departments were re-labelled, merged or closed, which was facilitated by a decreasing number of students (Baveye et al., 2006; Hartemink et al., 2008).

The soil science community has been somewhat inward looking and has not always providing quantitative answers to old questions in a manner that could be directly used by users of the soil or by decision makers. Soil science has suffered from communication problems within its own discipline, with other disciplines (except perhaps agronomy) and with the general public — Prof. Dennis Greenland wrote the following in the early 1990s: "…soil scientists have also been frustrated as their advice has gone apparently unheeded. This may be because the advice is couched in terms more easily understood by other soil scientists than by politicians and economists who control the disposition of land. If soil science is to serve society fully it is essential that its arguments are presented in terms readily understood by all and with both scientific and economic rigor so that they are not easily refuted." (Greenland, 1991).

There have been many ideas and reactions to the changes in soil science that were largely governed by changes in society (Bouma and Hartemink, 2002). Some searched for a soil science identity (Wild, 1989; Hudson, 1992) and there have been appeals for a new type of soil scientist (Warkentin, 1999), and a new type of soil science that is more holistic (Bridges and Catizzone, 1996). Others opined that soil science should be part of a multidisciplinary network society (Bouma, 2001), and that the discipline should be geared towards one of soil care (Yaalon, 1996). There has also been a continual call for soil science to be conducted more closely with society (McCracken, 1987; Simonson, 1991). It is difficult to asses whether all of these genuine ideas have had impact. There is some pessimism, particularly in North America, on the future of soil science (Baveye et al., 2006; Hopmans, 2007).

This paper disputes that pessimism and shows that there is increasing attention for both soils and soil research. This is part of the

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global renewed interest in agriculture as we approach a population of 8 billion. Currently, there is widespread concern about the land needed for energy (biofuels), food (hunger alleviation, increased demand) and feed (increased animal production). Oil prices are high and so is the demand for biofuels. The cultivation of biofuel crops is competing with food crops in some parts of the world and is driving-up commodity prices (UNEP, 2007a). The environmental and soil impact of the shift towards growing crops for energy or increased food production is still to be assessed (Hartemink, 2008) but it is widely realised that global soil information is not accurate or digitally available, and, certainly not up to date. The paper discusses our expanding knowledge base and impact, the fluctuating influx of students, the views in recent reports of UN and international organisations, the soil science research funding, and the development of soil legislation. From there on the rebirth of soil science is discussed and what should be done to maintain the momentum.

2. The expanding knowledge base and impact

One way to asses the vigour of a scientific discipline is the number of publications over time which is an indication of the productivity and a proxy for the amount of soil research. The trend in impact of soil science journals is an indicator for the impact of the discipline. Both the trend in the number of papers and impact factors are affected by other aspects but they are used here to illustrate that more and more is being published, and that the impact increases over time.

The total number of soil science publications was counted using ISI Web of Knowledge (Thomson Reuters) (Fig. 1). The annual increase in soil science publications is about 545 per year and there is a linear upward trend. About 16% of all soil science publications are published in primary soil science journals (Minasny et al., 2007), which means that most soil science research is being published in non-soil science journal (e.g. environmental-, chemical- or physical journals). Relatively little soil science publications appear in the top journals *Nature* and *Science*; 0.5% of all publications in these two journals have soil in the title, key word or abstract.

The impact factor of the major soil science journals has steadily increased in the past thirty years as it has in several other disciplines (Fig. 2). The increase has been accelerated in the past 7 years or so suggesting some sort of hockey-stick effect possibly caused by increased electronic access and more use of soil science papers. Some journals increased faster and the annual increase for Geoderma is 7.4%, European Journal of Soil Science 5.0%, Soil Science Society of America Journal 4.2%, and Soil Biology & Biochemistry 5.2%. The impact factors of Soil Biology and Biochemistry is higher than that of more generic journals like European Journal of Soil Science and Geoderma — soil biology continues to be 'hot' in soil science. Overall, the relative increase in impact of the soil science journals is larger than the annual increase in the number of publications.

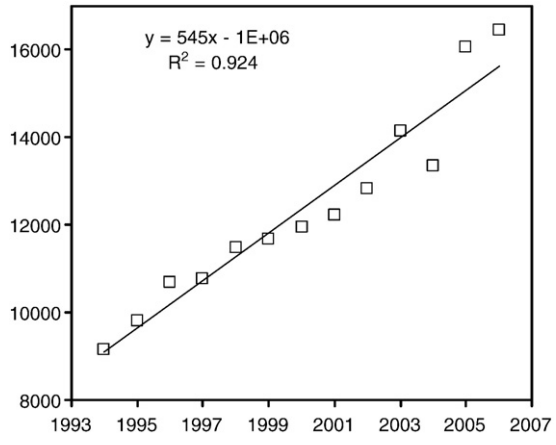

Fig. 1. Total number of soil publications (soil in Title, Keywords or Abstract) in the ISI Thomson Web of Science — 1993 and 2007.

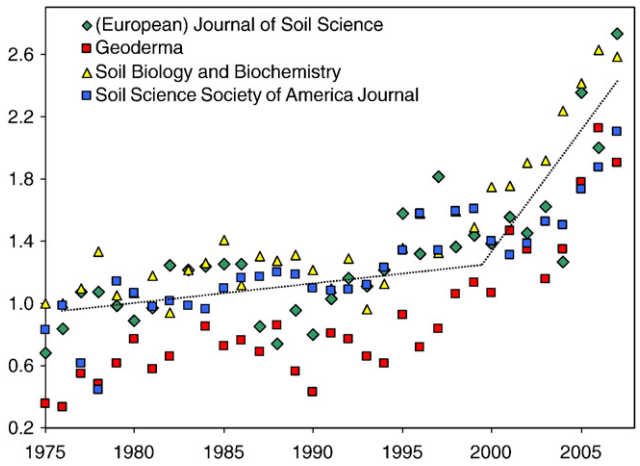

Fig. 2. Indexed impact factor of major soil science journals between 1993 and 2007 inclusive.

In addition to the increasing number of soil science publications five major soil reference works and encyclopaedias have been published in the past 8 years (Table 1). In total these works cover almost 7000 pages, with 1400 entries or subjects that have been written by over a thousand soil scientists. This is a soil science legacy that will be used for many years to come. It can be viewed as a sign of vigour of the discipline, but also as a conclusion of an era.

3. The fluctuating influx

Shifts in research foci, tertiary education and government support for the sciences have caused a reduction in the number of soil scientists and soil science departments. That happened in many parts of the world although not everywhere at the same magnitude. Recently, a dozen universities in the USA, Europe and Australia and New Zealand were surveyed and trends in student numbers was investigated (Hartemink et al., 2008). It confirmed a study from North America that soil science student numbers have considerably decreased (Baveye et al., 2006). In the Netherlands, the number of soil science students decreased and stabilised, whereas at Sydney University an increase was observed (Fig. 3) until very recently. There is a steady increase in female soil science students in many universities. Almost half of the MSc graduates in North America are now female compared to 30% in 1992. At Wageningen University in the Netherlands the number of female soil science students was less than 20% in the 1980s but is currently over 50%. Such trend has also been observed in the medical sciences and several other scientific disciplines that were traditionally dominated by men.

As many soil science departments have been merged, re-labelled or closed, the number of soil science courses has also been drastically reduced. In many universities it is not possible to graduate in soil science. The subject is often taught as part of degrees in biogeochemistry, biology, earth-system science, hydroecology etc. Although soil science is further specialising, the teaching is generalising to serve the need of students in natural resource studies. It may lead to a gap between graduate students' expertise and the work floor requirements.

4. Global studies

There have been many studies at the global level in which soils are mentioned, including the studies on global ecosystems — PAGE (Pilot Analysis on Global Ecosystems), the Millennium Ecosystems Assessment, but also in a range of conventions (e.g. United Nations Framework Convention on Climate Change, Convention to Combat Desertification)

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