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GUEST EDITORIAL

Soil Science Education and the "Age of Money": Reflections and Concerns for the Near Future

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Soils are major players in the environment. Globally, they store more than twice as much carbon as do vegetation or the atmosphere; they contain the equivalent of about 300 times the amount of carbon now released annually through the burning of fossil fuels. Recent evidence suggests that soil carbon reserves are decreasing in several parts of the world at a much faster rate than anticipated. This is generating concern that the degassing of soils could lead to a dramatic acceleration of global warming. Concurrently, there is the possibility that large amounts of organic and inorganic contaminants, now retained by soil organic matter, may become mobilized and end up in aquifers or the oceans. At this juncture, little is known about what the future may have in store relative to any of these processes. Some computer models predict the degassing of surface soils within less than 50 years, whereas other models predict soils to act as important CO_2 sinks for many decades to come. Reliable knowledge is lacking to determine in which direction things will evolve. Undoubtedly, a major research effort will need to be initiated in the foreseeable future to deal with the relevant uncertainties, and to understand satisfactorily the effect of rising temperature and CO_2 on the dynamics of soil carbon reserves.

If current trends persist, however, it is unclear who will be carrying out this research effort, and whether the way in which it will be carried out at least initially is likely to lead to success. Institutional and student surveys carried out in 1992 and 2004 suggest that soil science education is experiencing a significant decline in the US and Canada (Baveye et al. 2006). Enrollment in M.Sc. and Ph.D. programs in soil science in US and Canadian universities was about 40% less in 2004 than in 1992. Similar trends are also manifest in other countries, like the U.K. where most university-based soil science units have disappeared in the last two decades. The fact that the number of scholarly articles published every year on soils-related issues continues to climb exponentially (Baveye et al. 2006), in spite of the drop in student enrollments in soil science departments, indicates that much of the research on soils has migrated to departments of physics, chemistry, ecology, natural resources, or environmental engineering. There, some people do excellent work, undoubtedly, but the general tendency is for researchers to view soils from the relatively narrow confines of their own discipline, and thereby to face some of the limitations encountered previously by soil scientists when they themselves were looking at soils through mono-disciplinary lenses. In recent years, a few teams of soils scientists at least have begun to appreciate the fact that soils are extraordinarily complex, self-organizing ecosystems that absolutely man-

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date a multidisciplinary, holistic approach, in which physicists, chemists, microbiologists, and mineralogists work together to unravel the maze of processes occurring simultaneously in soils. At this point, this multidisciplinary approach is embryonic. Yet it will need to be reinvented from scratch at a later date, probably with much sweat and tears, if the discipline of soil science were to temporarily disappear, for lack of combatants.

To prevent this scenario from happening, it seems worthwhile to try to understand why graduate enrollments in soil science have dropped so significantly in the last decade. Baveye et al. (2006) and Baveye (2006) analyze in detail a number of possible causes, such as the tendency of soil science education programs to keep emphasizing the agricultural side of soil science, i.e., its connection to crop production, in spite of the open intention of a majority of students to pursue careers dealing predominantly with environmental issues. Another possible cause is the fact that soil science faculty do not seem to find that their craft is really exciting any more (Baveye 2006). These perspectives suggest that measures could still be taken by soil science educators to revert the downward trend in enrollments. Unfortunately, there is another, much more sobering way to look at the enrollment numbers. In e-mails or in open discussions on the future of soil science education, various individuals have argued that at least part of the decline in enrollments at their institution is not due to a lack of faculty enthusiasm or decreasing numbers of applications by prospective students, far from it, but is caused by a significant shrinking of the size of the soil science faculty over the period considered. At first, this may appear like a "chicken and egg" type of argument, of little consequence, but upon more careful analysis, there is indeed something deeply disturbing about some of the relevant statistics, and about what they augur for the next decade.

Faculty numbers have generally declined sharply in soil science groups in most countries. There are notable exceptions in Europe, like the SIMBIOS Centre in Dundee (Scotland), AgroParisTech in France, or the University of Bari (Italy), and in a few US institutions as well (Baveye et al. 2007), where soils groups have become larger in recent years, but by and large, especially in the US, soil science faculties have been downsizing at an alarming rate, and advertisements for new positions are rare. For example, in 1990, the soils group in the Department of Agronomy at Cornell University had 18 professors, five of whom were scientists of the US Department of Agriculture (USDA) with courtesy professorial appointments, plus five extension faculty. This coming summer, after losing two more individuals and having a refill in pedology refused by college administrators for several years in a row, the soils group, now in the Department of Crop and Soil Sciences, will have seven professors (including two USDA scientists) and three extension faculty. This amounts to a downsizing from 23 to ten individuals, i.e., by 56.5%, in the last 17 years. During the same period, the soils group at the University of Illinois at Urbana-Champaign, once one of the most prominent soil science departments in the U.S., shrunk from 17 faculty members down to seven, or a decrease by 59%. At neither institution are there clear signs that the faculty attrition is about to stop in the near future, leading to speculation that both Cornell and the University of Illinois might soon not have identifiable soil science programs at all.

It would be tempting to look at these statistics as a direct consequence of the lack of interest of students for soil science, manifested by declining graduate enrollments. However, there is no evidence that this is the case. For one thing, university administrators tend to base staffing decisions on demand for undergraduate teaching rather than graduate instruction, by virtue of the much more significant numbers of contact hours (credits multiplied by numbers of students) associated with undergraduate courses than with graduate ones. In addition, if faculty attrition were a consequence of decreasing graduate student numbers or even enrollment in undergraduate soil science courses, one would have expected some kind of a lag between the two. Staffing cuts in universities at the professorial level generally rely on not refilling positions after retirements or voluntary departures. Such cuts therefore represent a relatively slow process, which necessarily adjusts with some delay to diminishing instructional demand in any given discipline. No such lag was noticeable with the professorial attrition in soil science, which seems to have preceded, or at least coincided with, the onset of the decline in graduate soil science enrollments. Therefore, its cause must be found elsewhere. One plausible scenario, frequently mentioned in discussions, is that soil science education

fulfills part of a mission of universities and colleges that is no longer in fashion in many universities and colleges.

In recent years, a number of observers (e.g., Duderstadt 2000; Bok 2003; Triggle 2005) have expressed deep concern about the relentless quest for prestige that characterizes much of higher education, particularly in the US, about the erosion of the idea of higher education as a "public good" and the consequent plummeting of public support for it, about the commercialization and profit orientation of universities, or about the sky-rocketing tuition for undergraduate and graduate students and the million-dollar compensation packages for top administrators to which this commercialization has led. As a result of all of these trends, American higher education has been thoroughly transmogrified in the past 30 years into an institution "where everything is for sale if the price is right" (Bok 2003). In a celebrated article, Engell and Dangerfield (1998) refer to the current era as the "Age of Money," partly alluding to the dollar influx of research grants, higher tuitions, and grander capital improvements, but also to another, more symbolic, aspect of money as the secret key to "prestige," influence, and power in the American academic world. In this Age of Money, Engell and Dangerfield (1998) argue that the royal road to success for academic fields has to offer at least one of the following Three Criteria:

- *A Promise of Money*. The field is popularly linked (even if erroneously) to improved chances of securing an occupation or profession that promises above-average lifetime earnings.
- *A Knowledge of Money*. The field itself studies money, whether practically or more theoretically, i.e., fiscal, business, financial, or economic matters and markets.
- *A Source of Money*. The field receives significant external money, i.e., research contracts, federal grants or funding support, or corporate underwriting.

Academic fields that offer one (or more) of the Three Criteria thrive. Any field lacking all three languishes. For example, Engell and Dangerfield (1998) worry that the humanities in their entirety fall squarely in that category and therefore face a very uncertain future. With these criteria, it is relatively straightforward to understand that soil science, and indeed most fields that deal with the environment, cannot thrive in the current era, even within the context of colleges of natural and life sciences. Soil science education neither promises money, like biology programs (educating pre-medical or pre-veterinary school students), or provides a knowledge of money (like the departments of Agricultural Economics, now reincarnated as the booming departments of Applied Economics). As a source of money, in absolute terms, soil science does not necessarily fare much worse than it did 20 or 30 years ago, in spite of increased competition from other disciplines like environmental engineering or ecology. Many soil science professors in the US, Canada and Europe, are able to attract sizeable grants, generating appreciable overhead (indirect costs). In past decades, university administrators would have been satisfied with that financial picture. But this is no longer the case. Not only should scientific projects provide overhead to the university, but increasingly their merit seems based on how much additional money, beyond overhead, they can bring to administrators in the form of revenues from patents, or donations from wealthy alumni. In some cases, as with genomics, the promise of revenues may eventually turn out to be an illusion, in particular once legal expenses are factored in. Nevertheless, it is clear that relative to a number of other fields like biotechnology, genetic and biomedical engineering, or nanotechnology, with their prospects of bounty-generating patents, soil science appears sickly since the Bayh–Dole act (act of US congress passed in 1980, allowing universities and individual researchers to benefit financially from patents resulting from federally-funded research), which may explain why at least some university administrators seem intent on eliminating soil science programs at their institution. For the same reason, other environmental programs, dealing with air and water quality, are also threatened.

Can anything be done at this stage to change this situation? Yes, with a two-step strategy. A first step is for soil science faculty members, worldwide, to convince themselves, more clearly than seems to be the case now, that their discipline addresses issues that are crucial for the well-being of humanity, issues about which research urgently needs to be supported financially before most topsoil has eroded away, most soil carbon has volatilized in the atmosphere, or most

groundwater resources are irreparably polluted by organic or inorganic contaminants now retained by soil ecosystems. Then, the second step is to convince others. One should probably approach this second step differently at universities and colleges where "service to society" still resonates for top administrators as one of the fundamental missions of academia, and at institutions of "higher learning" where the race for prestige currently overrides any consideration of the "public good" or of the welfare of humanity. In "service-minded" universities, soil science professors simply have to make as convincing a case as possible to their campus administrators that serious attention needs to be devoted to soils rapidly. Experience shows that these administrators are then likely to take the message forward to state or government officials, to philanthropists, or to anyone else in a position to influence funding allocations. At the prestige-driven institutions, unfortunately, efforts to convince the powers-that-be might be largely pointless since they are unlikely to take things to the next level. Lamenting about the "Age of Money" is not likely to get very far. In these institutions, the only way to effect change might be to bypass administrators entirely and to go to the public directly with a clear message about the urgency of soils-related issues, in a way that will, indirectly, also benefit researchers at the "service-oriented" universities.

Far more, and with far more conviction than has been the case in recent years, soil scientists should write newspaper and scholarly articles targeting the general public and policy makers, to alert them about the looming threats associated with soil carbon losses and massive soil erosion in the years ahead. The concerted goal of these efforts should be to encourage funding of a research initiative similar in scope to the Manhattan project during WWII, or the recent Human Genome project. As with these large-scale projects, uncertainties are significant, not the least of which because some of the questions about soils that urgently need to be addressed will require a full-fledged multidisciplinary approach, which largely remains to be invented. Yet, as with the Manhattan project, failure is not an option, if in 20–30 years we want to leave to our children and grandchildren a planet earth in half-way decent shape.

References

Baveye, P. (2006). A future for soil science. *Journal of Soil and Water Conservation, 61*(5), 148A–151A.

Baveye, P., Jacobson, A. R., Allaire, S. E., Tandarich, J., & Bryant, R. (2006). Whither goes soil science in the US and Canada? Survey results and analysis. *Soil Science, 171*(7), 501–518.

Baveye, P., Jacobson, A. R., Allaire, S. E., Tandarich, J., & Bryant, R. (2007). Reply to a comment on "Whither goes soil science in the US and Canada? Survey results and analysis" by A. Hartemink. *Soil Science, 172*(2), 168–171.

Bok, D. (2003). *Universities in the marketplace: The commercialization of higher education*. Princeton, NJ: Princeton University Press.

Duderstadt, J. J. (2000). *A university for the 21st century.* Ann Arbor, MI: The University of Michigan Press.

Engell, J., & Dangerfield, A. (1998). Humanities in the age of money. *Harvard Magazine*, 48–55, May–June.

Triggle, D. J. (2005). Patenting the sun: Enclosing the scientific commons and transforming the university – Ethical concerns. *Drug Development Research, 63*, 139–149.