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# Developments and trends in soil science: 100 volumes of Geoderma (1967–2001)

Alfred E. Hartemink [a,*], Alex B. McBratney [b], Julie A. Cattle [b]

[a] *International Soil Reference and Information Centre (ISRIC), PO Box 353, 6700 AJ Wageningen, The Netherlands*

[b] *Department of Agricultural Chemistry and Soil Science, Ross St. Building A03, The University of Sydney, Sydney NSW 2006, Australia*

**Abstract**

Between September 1967 and March 2001, Geoderma published 100 volumes containing 2079 papers covering 31,637 pages and filling 191 cm of shelf space. No doubt that is a lot of paper, but what is in it? This paper starts with a brief history of the journal and an overview of editors and a geographic breakdown of the editorial board. The contents of the 100 volumes is presented including an overview of the geographic origin of the research and authors, and an analysis of soil science subjects over time. Furthermore, the impact factor and the most frequently papers are discussed. The average length of the papers increased from 12.9 pages in the 1970s to 16.4 pages in the 1990s. Number of authors per paper increased faster so the pages per author have decreased over time. European authors account for about half of the papers but less than 40% of the research was conducted in Europe. The number of authors from North America has increased over the years and about one-fifth of the papers is from research in North America. More than half of the research reported in Geoderma was conducted in the temperate regions, whereas the tropics and subtropics account for about 30% of the papers. In the 1980s, 53% of the papers were descriptive but it decreased to 31% in the 1990s with a higher percentage of papers focussing on methodology. One of the intriguing trends is that 29% of the papers in the 1970s were based on field studies whereas only 18% of the papers in the 1990s were field based. Laboratory studies decreased from 60% in the 1970s to 49% in the 1990s. Over the same period, desk studies increased from 11% to 33% of the published papers. The majority of the papers in Geoderma has had no strong focus and only in recent years papers had an increased focus (i.e. agriculture, environment etc.). There has been a strong increase in soil physics papers whereas the share of soil chemistry steadily declined over time. Typical pedological papers cover about 30% of the journal and little change was found with time, except for the advent of papers in pedometrics.

* Corresponding author. Tel.: +31-317-471-711; fax: +31-317-471-700.
*E-mail address:* Hartemink@isric.nl (A.E. Hartemink).


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Papers on soil mineralogy have sharply declined from 25% in the 1980s to less than 10% in the 1990s. Over the same period, a doubling in the number of papers on soil and environment occurred. Papers containing information on soil classification increased from 30% in the early 1970s to around 50% in the late 1990s. Alfisols had received most attention followed by Inceptisols. Papers are based on a larger amount of soil samples and in recent years an increasing number of papers are based on existing data. The impact factor of Geoderma has steadily increased since the mid 1970s and in particular in the late 1990s. This review has shown important trends in Geoderma papers that likely reflect some of the major changes that have occurred in soil science as a whole. 

*Keywords:* Soil science; Soil science impact; Bibliometrics; History of soil science; Trends in soil science

## 1. Introduction

Soil science became a solid scientific discipline when agro-geologists (pedologists) and soil chemists combined their research efforts. This occurred at the beginning of the 20th century and was largely encouraged by international congresses (van Baren et al., 2000). The necessity for a special periodical on soil science was first understood by the founder of pedology, V.V. Dokuchaev, but it was P.V. Ototskii, soil hydrologist at the University of St. Petersburg, who established the first journal solely dedicated to the publication of soil science. The journal was named Pochvovedenie (Russian for soil science) and first appeared in 1899. Although Dokuchaev was not formally among the founders of Pochvovedenie, his devotion to soil science was so convincing that the journal became the propelling engine of his principal ideas. In the early days, Pochvovedenie had the status of an international journal and editorial board members were from 20 different countries (Zonn, 1999).

Several agricultural and soil science journals were established in the first half of the 20th Century. In 1905, the Journal of Agricultural Science was published by Cambridge University to accommodate the growing correspondence on agronomic investigations. Soil Science was established in 1916 and the Soil Science Society of America Journal (first published as the Soil Science Society of America Proceedings) was founded in 1936. Most soil science journals established prior to the Second World War had a national focus (i.e. UK, USA) and only the agricultural journals like Tropical Agriculture (founded in 1924) and the Empire Journal of Experimental Agriculture (founded in 1933) had a strong international scope. Directly after the Second World War and up to the 1960s, a considerable number of soil journals emerged reflecting the rapidly growing knowledge base in soil science (Hartemink, 2000). The increase in soil scientific knowledge largely contributed to the great post-war reconstruction and development of production agriculture (Tinker, 1985). The journals became more international in their focus following soil investigations in African and Asian colonies. Most of the journals were established and published by national soil and agronomic societies.

In the mid 1960s, it was perceived that a new international journal of soil science was needed to fulfil the growing need for more space to publish research papers and reviews on the many diversified aspects of soil science (van Baren, 1967). This ideas met with approval during the International Society of Soil Science (ISSS) council meeting at the 8th Congress in Bucharest in 1964. However, at that time no way was seen to take action because the ISSS could not accept direct responsibility for the implementation of such a project. About a year later, an opportunity arose when the Elsevier Publishing Company started studying the feasibility of adding a soil science journal to their existing series of earth-science periodicals. This was facilitated by the fact that the ISSS Secretary General, F.A. van Baren (1905–1975) was a friend of the geologist A.A. Manten from student days. Manten headed Elsevier's earth-science division. Geoderma was chosen as the journal's name and as was written in the editorial in the first issue: "... the journal will be devoted to the study of, and the presentation of, information on the skin of the earth, the soil: the indispensable basis of human life" (van Baren, 1967). Geoderma was the first ISSS cooperating journal with Elsevier followed by Soil Biology and Biochemistry, which was initiated by J.A. Waid and edited by E.W. Russell (van Baren et al., 2000). A number of other cooperating journals followed.

The world has changed dramatically since 1967. Its population has nearly doubled and scientific output has grown enormously. This is particularly the case for soil science. There were about 3500 publications annually in the 1960s but the number of soil science publications increased to over 11,000 per year in the late 1990s. Since the 1960s, the annual increase in soil scientific publications has been about 5% per year. Studies tracing developments in soil science and identifying changes in views have been conducted in various branches of soil science but no systematic efforts have been undertaken. One way of unravelling developments in soil science is to investigate what has been published through bibliometric studies and this was attempted, for example, in "The Literature of Soil Science" (McDonald, 1994). Greenland (1997) reviewed what was published in the 11 editions of "Soil Conditions and Plant Growth", which appeared between 1912 and 1988, whereas Young (1991) reviewed what was published in the first 10 volumes of the journal Agroforestry Systems. Dobrovol'skii (1999) briefly discussed the contribution of Pochvovedenie to the development of soil science, but as far as we know there has been no systematic effort to analyse what was published in an international soil science journal over time. This study analyses what has been published in the 100 volumes of Geoderma between September 1967 and March 2001, and the study has the following objectives: (i) to give a historic and geographic overview of the number of papers published and authors per paper, (ii) to analyse number of papers in terms of soil science's subdisciplines, and (iii) to discuss the impact of Geoderma in the soil science literature.

## 2. Editors, editorial board and publishing policies

### 2.1. Editors

When the first issues of Geoderma were published, there was no editor-in-chief. During the first five years of publication of Geoderma, copies of each manuscript submitted to the journal were sent to a pair of members of the editorial board for reviews and recommendations. If the two referees agreed in their recommendations, a manuscript was accepted, rejected or returned for revision and later consideration. If the two were split in their recommendations, the manuscript was sent to a third member of the board and his recommendation would then tip the scale one way or the other (Simonson, personal communication, 2000). Problematic papers were sorted out by F.A. van Baren who acted as editor-in-chief (Manten, personal communication, 1999). Nevertheless, some editorial board members complained to Elsevier about the calibre of the papers being published and urged the selection of an editor-in-chief. The point was taken and in May 1971, Elsevier invited the American pedologist Roy Simonson to become editor-in-chief of Geoderma and his name first appeared on the cover in 1972 (vol. 7). Simonson remained in charge up to 1989 (vol. 45), and under his editorship, 823 papers were published—that is exactly 40% of all the papers published in the 100 volumes of Geoderma.

During Simonson's time, the journal greatly expanded and papers from many different parts of the world were published. He encouraged authors in countries whose native tongue was not English and who were not so familiar with publishing in international journals. Simonson was a helpful editor and put a considerable effort in the editing and improvements of manuscripts. The current Geoderma office manager, Frans Koning, recalls that Simonson would write a seven page-review report with recommendations for a paper, which he considered relevant but which was poorly written. In his farewell editorial (September 1989), Simonson was rather modest about his dedicated editorial activities and provided the following deeper motivation: "... revision, ranging from little to much, has been required for a majority of the manuscripts received. The intent has been to improve the manuscripts on several counts, including the validity of the data, their interpretations and their presentations. Revising manuscripts provides practice in writing, which is the only way to improve the skill. There is no substitute for such practice." We can all confirm this.

When Simonson stepped down in 1989, he was made honorary editor for all the excellent work he had done for the journal. He was succeeded by two editors: the soil physicist Johan Bouma (Netherlands) and the pedologist John

McKeague (Canada). The new editors wrote in the preface of vol. 45: "As contributors to Geoderma, we appreciated Dr. Simonson's thorough treatment of our manuscript and his fair and professional judgement. We hope that he derives some personal satisfaction from the decision to appoint two editors to replace him." The Bouma/McKeague joint editorship lasted up to March 1994 when the soil biologist Ted Elliot and soil chemist Donald Sparks (both from the USA) joined them. Total papers published in the Bouma/McKeague period were 368. In 1995, the soil scientist Alex McBratney (Australia) joined the editors-in-chief. In July 1996, Ted Elliot stepped down and the pedologist Kevin McSweeney from the USA joined as new editor-in-chief followed 6 months later by the Austrian soil microbiologist Heribert Insam with the aim of attracting more soil biology and microbiology papers.

In summary, Geoderma started without an editor, then there was one (Simonson), followed by two (Bouma, McKeague) and currently there are four editors-in-chief (Insam, McBratney, McSweeney, Sparks). The increase in the number of editors reflects the further specialisation in soil science and the much larger number of papers submitted and published (see Section 3.2).

### *2.2. The editorial board*

Since its inception, Geoderma has had an international board of consulting editors. When J. Schelling of the Dutch Soil Survey Institute (Stiboka) reviewed the first issues of Geoderma he noted that "...the editorial board consists of a group of outstanding soil scientists, especially in the field of soil classification, soil survey, soil genesis and micropedology" (Schelling, 1968). Although pedologists have always been well represented on Geoderma's editorial board, the number of members from other branches of soil science was increased over the years. In the late 1960s and early 1970s, there were in total 30 members but the number increased to around 50 in the late 1970s. The largest number of editorial board members was in 1993 when there were 54. After 1993, the number decreased to less than 45.

A geographic breakdown of editorial board members is depicted in Fig. 1. Up to the early 1970s, most of the editorial board members were from Europe, but the number of North American members increased sharply thereafter. This probably reflects the appointment of Simonson as editor-in-chief. More than 45% of the editorial board members in the mid 1980s were from North America, compared to 33% from Europe. Ten years later this situation had reversed and currently more than 50% of the board members are based in Europe whereas less than one-third are based in North America. The number of editorial board member from Oceania (i.e. Australia and New Zealand) has been fairly steady except for a rise and fall in the early 1990s. It ranged from 8% of the total members in 1990, to 17% in 1994 and 1995, and currently 10% of the editorial board members are from Oceania. When Geoderma started in 1967, there were

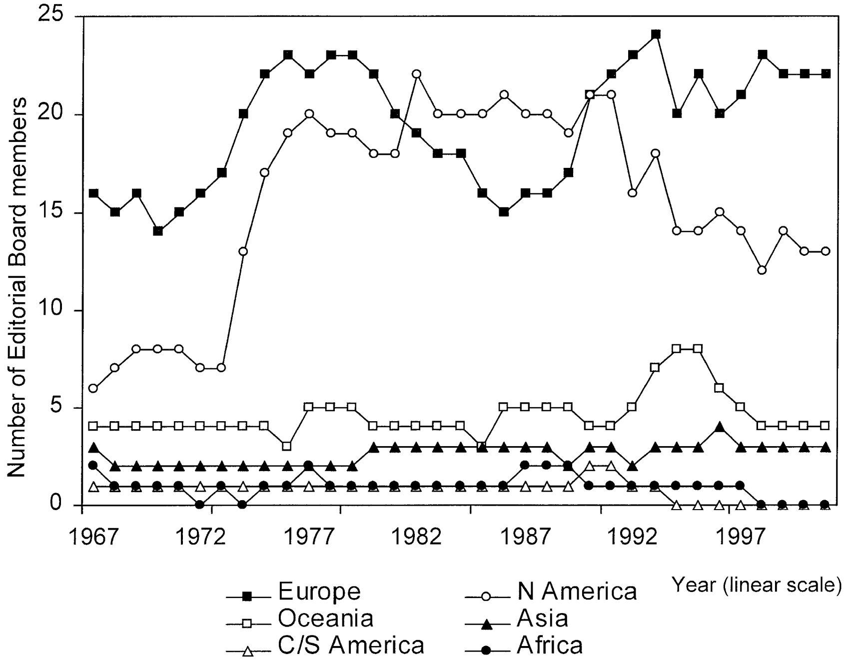


Fig. 1. Regional distribution of editorial members between 1967 and 2001.

nine editorial board members based in Africa and Central and South America. At present, there are no members from those two continents despite continuous efforts to have an even geographic presentation of the editorial board. Editorial board members from Asia have ranged from 4% to 9% of the total members and is currently 7%.

In summary, the editorial board has fluctuated in the past in both geographic distribution of its members and also in its total, but Geoderma remains to have a fairly international board compared to other soil science journals. One thing has not changed, Roy Simonson and Dan Yaalon were editorial board members in 1967—and they still are today.

Table 1 summarises some of the information for 1999 and shows that half of the board members were from Europe whereas more than 60% of the authors originate from Europe. About 14% of the institutional subscriptions were in Asia whereas research conducted in Asia and by Asians contributed only 7% to 8%. The data further show that only 13% of the research originates from North America whereas a quarter of the institutional subscriptions are from North America. So this seems to suggest that Geoderma is being read in North America but that North Americans prefer to publish elsewhere. The relation between origin of the research and origin of the authors is presented in detail in Section 3.2.

Table 1
Geographical breakdown (in %) of editorial board, institutional subscribers, origin of research, and origin of authors in 1999

| Region | Editorial board | Institutional subscribers | Origin of authors | Origin of research[a] |
|---|---|---|---|---|
| Europe | 51 | 41 | 62 | 45 |
| North America | 33 | 27 | 19 | 13 |
| South and Central America | 0 | 5 | 2 | 6 |
| Africa | 0 | 4 | 4 | 6 |
| Asia | 7 | 14 | 7 | 8 |
| Oceania | 9 | 6 | 8 | 6 |

[a]About 16% of the papers in 1999 had a global focus.

### 2.3. Publishing policies

In 1967, Geoderma had no clear scope. On the inside cover of the journal, it was mentioned that the following contributions would be considered: reviews, original research work, short communications, book reviews, announcements, congress and symposium reports and news. In the early 1970s, the following scope was defined: “The primary intention of the journal is to stimulate wide interdisciplinary cooperation and understanding among workers in different fields of pedology. Therefore, the journal tries to bring together papers from the entire field of soil research, rather than to emphasize any one subdiscipline. It is hoped that with its international coverage the journal will contribute to the sound development of soil science.” In the late 1980s, the scope was slightly changed and the last sentence was replaced by: “Interdisciplinary work should preferably be focused on occurrence and dynamic characterization in space and time of soils in the field.” The scope of the journal has not changed since the late 1980s. In an editorial in 1995, the editors-in-chief added that areas of intense interest include remediation of contaminated soil, transport and fate of metals and organic chemicals in soil, urban soil science and site-specific management. It was further stressed that papers on a broad range of environmental and ecological aspects of soil were welcomed as were quantitative papers on pedology and field soil physics.

Papers in French and German appeared infrequently up to the late 1980s but thereafter papers in Geoderma were in English only. This had a number of causes. Firstly, the older German and French soil scientists were not so familiar with English and preferred to write in their native language, whereas the younger generation grew up in a world where English became the *lingua franca* of science. Secondly, the Elsevier editorial office discouraged manuscripts in other languages for it became increasingly difficult to find suitable referees (Koning, personal communication, 2000).

In the late 1960s, rejection rates were relatively low and some of the editorial members had complained about the inconsistent quality of the published papers. The rejection rate increased, however, when Simonson became editor-in-chief and at least a third of the manuscripts received were rejected without any suggestions that they be revised. There were also other papers that failed publication because authors did not want to make the major revisions called for as a result of the reviews. Simonson had the impression that the proportion of submitted manuscripts rejected decreased slowly with time, but did not keep tabulated data (Simonson, personal communication, 2000). The editorial office of Geoderma has kept records since 1991 and rejection rates of papers submitted to Geoderma ranged from 30% to 44% between 1991 and 1999. The average rejection rate is 34% and no clear pattern with time was found. Total papers submitted annually between 1991 and 2000 ranged from 100 to 150. Although the data are few, it seems that the total number of papers submitted to Geoderma is on the increase and linear regression (graph not shown) showed an average increase of about five papers per year ($r^2 = 0.58$). This follows the approximate annual increase in soil science publications.

## *2.4. Special issues and discussion papers*

Geoderma was one of the first soil science journals to publish a special issue. The issue was published in 1967 and contained 14 papers on micromorphology to commemorate the 70th birthday of the Czech micropedologist W.L. Kubiëna. Between 1967 and 2001, a total of 33 special issues (out of 262 issues) have been published. They are listed in Appendix A. Some of the issues have been very influential and highly cited, like for example the one on "Transport of water and solutes in macropores" edited by M.Th. van Genuchten, D.E. Rolston and P.F. Germann in 1990 (vol. 46). Of the 18 papers in this special issue, 12 papers are in the list of the 100 most frequently cited papers between 1981 and 1999 (see Appendix C).

In April 1993, Geoderma published its first Discussion Paper with the aim of stimulating discussion on areas of major concern or on new approaches and visions. The discussion paper is judged by the editors-in-chief and sent to a number of experts for comments, which is published together with the text of the discussion paper. Finally, the authors have the opportunity for the last word. In an editorial in 1995, the editors-in-chief mentioned that the unique concept of the Discussion Paper will be further developed and new concepts or controversial matters will be presented by experts and discussion by peers and rejoinders published together in one paper with the aim of opening up new areas of soil research and encouraging fruitful discussion of issues. In total, eight Discussion Papers have been published between 1993 and 2000, and they are listed in Appendix B. Despite a number of highly interesting Discussion Papers, the number of papers envisaged in 1993 to be one or two per year, has not yet been achieved.

## 3. Contents and trends in 100 volumes of Geoderma

### *3.1. Data extraction and analysis*

All 2079 papers published between September 1967 (vol. 1, issue 1) and March 2001 (vol. 100, issue 1–2) were classified according to the following categories.

(i) General information (number of pages, number of authors).

(ii) Origin of the author(s) (Europe, North America, Central and South America, Africa, Asia, and Oceania).

(iii) Origin of the research (Europe, North America, Central and South America, Africa, Asia, Oceania and Global).

(iv) Climatic region. Five different regions were used: tropics, subtropics, temperate, arctic/boreal, or no particular region.

(v) Soil type(s) studied. We have used the 12 orders of Soil Taxonomy, and although the World Reference Base for soil resources (WRB) is the accepted system by the International Union of Soil Sciences, we felt that it was more difficult to accommodate the 30 Reference Soil Groups than the 12 soil orders. If other classification systems were used in a paper, the approximate equivalent in Soil Taxonomy was given based on look-up tables in Sanchez (1976), Isbell (1996) and other publications.

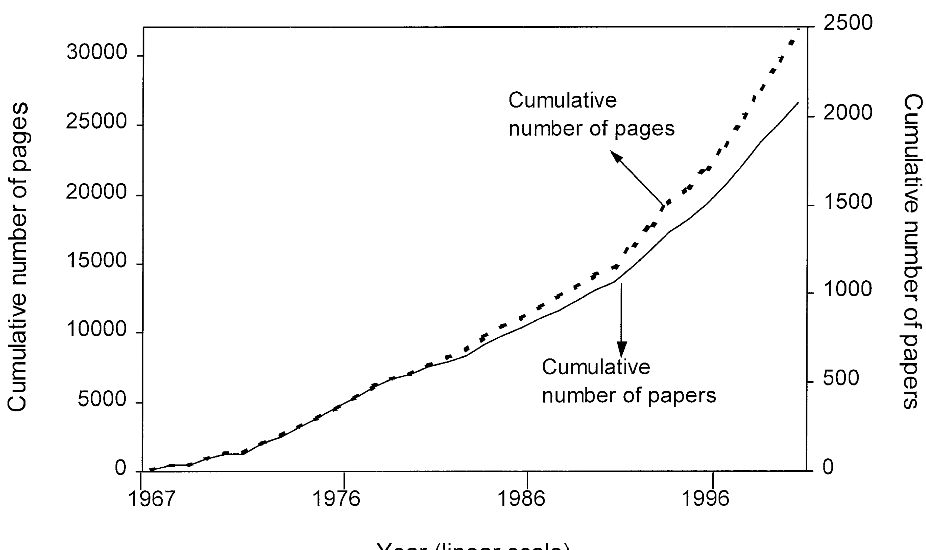


Fig. 2. Cumulative number of pages and papers published in Geoderma between 1967 and 2001.

Table 2
Breakdown (in %) of papers published in Geoderma between 1967 and 2001

| | Period | | | | 100 most cited papers (1981–1999) |
|---|---|---|---|---|---|
| | 1970s (1967–1979) | 1980s (1980–1989) | 1990s (1990–2001) | Whole period (1967–2001) | |
| Volumes | 1–22 | 23–45 | 46–100 | 1–100 | 25–93 |
| Number of papers | 538 | 463 | 1078 | 2079 | 100 |
| Number of pages | 6948 | 6956 | 17733 | 31637 | 1890 |
| Pages per paper | 12.9 | 15.0 | 16.4 | 15.2 | 18.9 |
| Authors per paper | 1.9 | 2.3 | 2.8 | 2.5 | 2.7 |
| Pages per author | 6.8 | 6.5 | 5.8 | 6.1 | 7.0 |
| *Origin of the author(s)* | | | | | |
| Europe | 50 | 47 | 52 | 50 | 39 |
| N America | 16 | 28 | 27 | 24 | 43 |
| C/S America | 2 | 1 | 3 | 2 | 0 |
| Africa | 7 | 2 | 3 | 4 | 3 |
| Asia | 14 | 11 | 8 | 10 | 4 |
| Oceania | 11 | 10 | 8 | 10 | 12 |
| *Origin of the research* | | | | | |
| Europe | 40 | 36 | 35 | 37 | 29 |
| N America | 14 | 24 | 20 | 19 | 32 |
| C/S America | 5 | 4 | 7 | 6 | 3 |
| Africa | 9 | 7 | 7 | 8 | 8 |
| Asia | 15 | 11 | 8 | 11 | 6 |
| Oceania | 11 | 10 | 7 | 8 | 10 |
| Global | 6 | 8 | 16 | 12 | 13 |
| *Region* | | | | | |
| Tropics | 20 | 13 | 17 | 17 | 8 |
| Sub-tropics | 9 | 13 | 11 | 11 | 11 |
| Temperate | 55 | 57 | 51 | 54 | 63 |
| Arctic/Boreal | 4 | 4 | 4 | 4 | 1 |
| None | 11 | 13 | 17 | 14 | 17 |
| *Type of research* | | | | | |
| Descriptive | 41 | 53 | 31 | 39 | 27 |
| Experimental | 32 | 27 | 35 | 32 | 37 |
| Methodological | 17 | 12 | 24 | 20 | 18 |
| Review | 10 | 8 | 10 | 9 | 18 |
| *Where conducted?* | | | | | |
| Field | 29 | 21 | 18 | 21 | 15 |
| Laboratory | 60 | 65 | 49 | 55 | 52 |
| Desk | 11 | 15 | 33 | 23 | 33 |

Table 2 (*continued*)

| | Period | | | | 100 most cited papers (1981–1999) |
|---|---|---|---|---|---|
| | 1970s (1967–1979) | 1980s (1980–1989) | 1990s (1990–2001) | Whole period (1967–2001) | |
| *Focus of research* | | | | | |
| Agricultural | 10 | 8 | 15 | 12 | 7 |
| Forestry | 1 | 5 | 6 | 5 | 7 |
| Environmental | 4 | 6 | 8 | 6 | 5 |
| Ecology | 1 | 1 | 3 | 2 | 2 |
| None | 85 | 80 | 67 | 75 | 79 |
| *Soil division* | | | | | |
| Soil physics | 11 | 11 | 21 | 16 | 20 |
| Soil chemistry | 34 | 30 | 25 | 29 | 30 |
| Soil biology | 2 | 1 | 5 | 3 | 4 |
| Soil fertility and plant nutrition | 3 | 3 | 4 | 4 | 5 |
| Soil genesis, classification and mapping | 32 | 26 | 31 | 30 | 22 |
| Soil technology | 1 | 1 | 1 | 1 | 0 |
| Mineralogy | 14 | 25 | 8 | 13 | 13 |
| Soils and environment | 2 | 3 | 5 | 4 | 5 |

(vi) Type of research. Four types of research were distinguished: descriptive (accounts of soil properties, could be conducted in the laboratory or field); experimental (results from planned controlled experiments in the field or laboratory); methodological (study approaches and conceptual discussions); reviews.

(vii) Application of the Research. The following classes used were: agriculture, forestry, environment, ecology or no application (pure soil science).

(viii) Soil science division. This followed the commissions recognised by the ISSS: soil physics; soil chemistry; soil biology; soil fertility and plant nutrition; soil genesis, classification and cartography; soil technology; mineralogy; soils and environment.

Fractions were used if, for example, authors were from different continents or if more than one soil type was studied.

Papers published in the uneven numbered volumes were classified in greater detail including information on the origin and number of samples, the sampling scheme and subdisciplines and subjects of each ISSS commission. For example, papers classified as having soil physics content were then further assigned to classes including water, gas, heat, solute transport/diffusion, structure, stability/erosion, scanners/sensors and modelling/simulation, all are shown in Figs. 12–16 in Section 3.3. Although it would have been desirable to have the detailed classification conducted for all the 2079 papers, time constraints did not allow this.

All trends were fitted using Laplacian smoothing splines (Silverman, 1985) with volume as the abscissa (as opposed to time), because volume number is evenly spaced in terms of number of papers and pages, and the time of publication is a little arbitrary. A smoothing coefficient, lambda = $10^6$, was used. The relation between date (time) and volume number was established so that trends could be interpreted with either as the abscissa. Most of the data are presented as the local moving average of the percentage of papers in Geoderma.

### *3.2. Papers, pages and authors*

In its 100 volumes, Geoderma has published 2079 papers and 356 book reviews. The papers fill 31,637 pages and the 100 volumes occupy 191 cm of shelf space. The number of papers increased during the 1990s compared with the number of papers from the preceding two decades. The relationship between the cumulative number of papers published in Geoderma and time is shown in Fig. 2. Data in Table 2 show this increase to be approximately double and as many papers were published in the 1990s (1078 papers) as in the in the 1970s and 1980s (538 + 463 papers). In 1990, Geoderma increased the number of volumes issued per annum from 2 to 6. There was a concurrent increase in the number of pages from approximately 590 to 1700 pages per year.

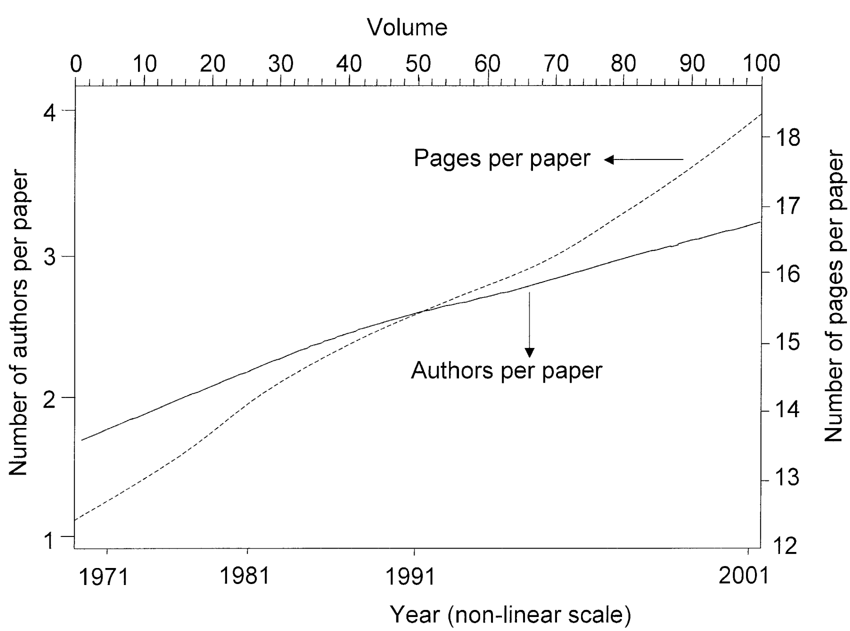


Fig. 3. Average number of authors per paper and pages per paper between 1967 and 2001.

The number of pages per paper increased from 12.5 in 1967 (vol. 1) to over 18 in 2000 (vol. 99) (Fig. 3). As the papers have become larger, so has the number of authors per paper. In 1967, a paper was written on average by 1.7 authors. This number of authors per paper had grown to 2.5 by 1990 and in 2000 there was an average of 3.1 authors per paper, representing an increase of more than 80%. Analysis of the number of pages written by each author revealed that we are contributing fewer pages than in 1967. Fig. 4 shows that the number of pages per author has dropped from about nine when the journal commenced publication to around 7.2 in 1996—a decrease of 20%.

*3.2.1. Geographic distribution*

The geographic distribution of authors has fluctuated markedly since 1967. Authors of European origin have always accounted for about half of the total papers published (Fig. 5). A large increase in papers published by North Americans was observed from the early 1970s to the late 1980s. Geoderma had a North American editor (Simonson) during this time. Currently, North American authors contribute approximately 15% of total papers published in Geoderma. A slight relative decrease in the number of papers published by Asian and African authors has occurred. In absolute terms, however, the number of papers from Asian and African authors have remained constant and on average three papers from Africa and seven papers from Asian authors were published per year in the 1970s as well as in the 1990s. The relative number of papers from South and Central America has fluctuated over time but in the 1990s on

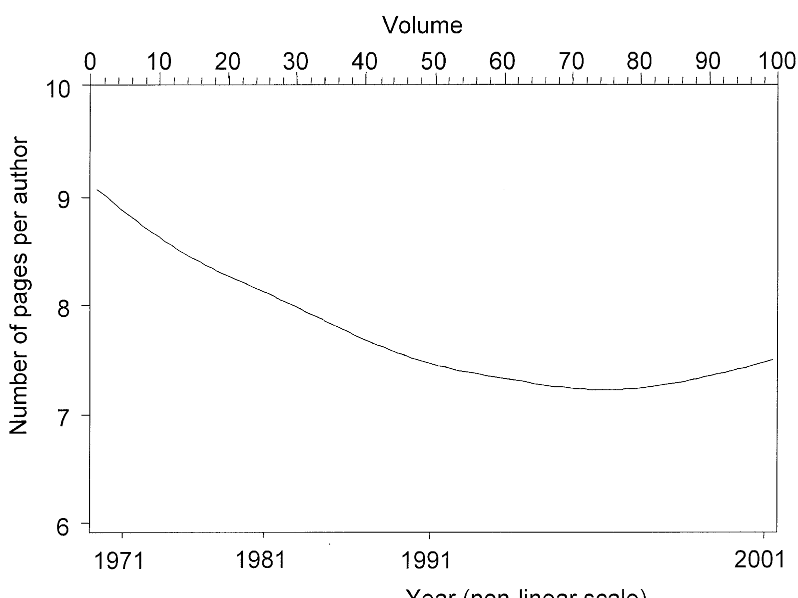


Fig. 4. Average number of pages per author between 1967 and 2001.

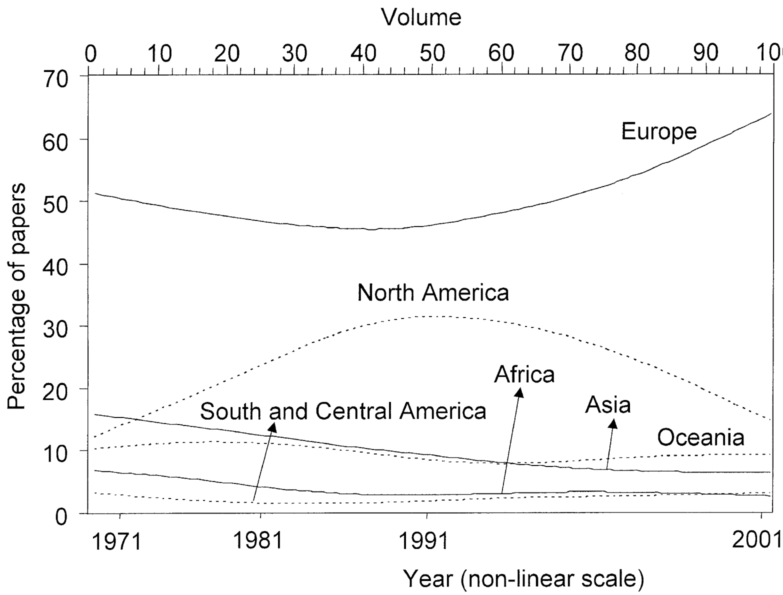


Fig. 5. Trends in the origin of the author(s) between 1967 and 2001. The ordinate is a local moving average of the percentage of papers in Geoderma.

average three papers per year are being published with authors from South and Central America. Papers with authors from Oceania showed a relative decrease from about 11% in the 1960s to 8% in the 1990s. However, the absolute number of papers increased on average from five papers per year in the 1960s, to over eight in the 1990s.

Most of the research reported in Geoderma originates from Europe. About 37% (= 763 papers) of all papers concern European research, whereas 19% (= 399 papers) of all papers were based on research in North America. The pattern has changed over time and about 14% of the papers were from North America in the 1960s but it increased to 24% in the 1980s (Fig. 6). The relative proportion of North American research decreased in the 1990s. Number of papers increased, however, from on average 11 per year in the 1980s to 19 papers per year in the 1990s. There were on average four papers per year from Africa in the 1970s and seven papers per year in the 1990s. The number of papers per year from Asia was six in the 1970s, and eight in the 1990s. The most remarkable change that occurred in the origin of the research was the large increase in global research, which has occurred since the mid 1990s. In the 1970s, there were on average two papers per year (6% of all papers) with a global origin but it increased to on average 15 papers (16%) per year in the 1990s.

Until relatively recently, the origin of research has been closely associated with the origin of authors (Table 3). The correlations between the origin of

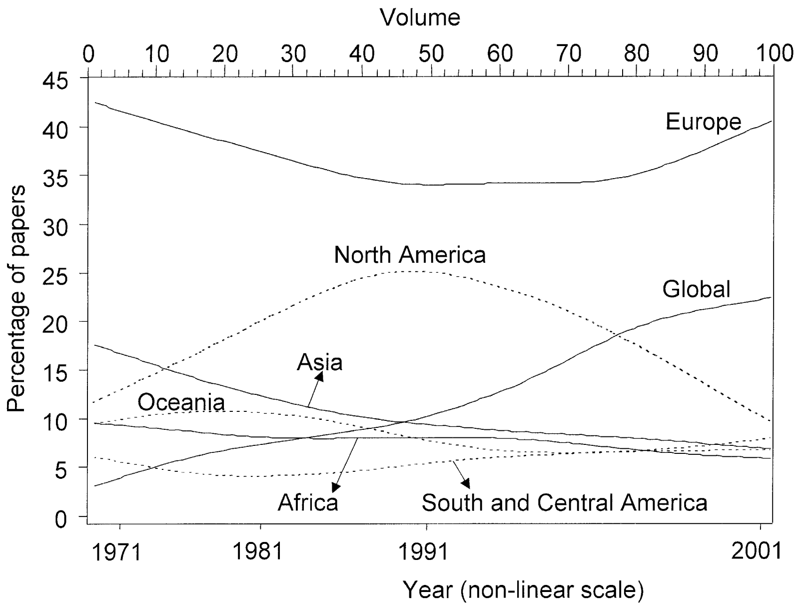


Fig. 6. Trends in the origin of the research between 1967 and 2001. The ordinate is a local moving average of the percentage of papers in Geoderma.

research and authors revealed all authors to be somewhat parochial but those from Oceania to be the most ($r = 0.86$), and perhaps this can be explained by the tyranny of distance. No confirmation of authors from Europe or North America publishing work based in other regions emerged.

The vast majority of research published in Geoderma has been conducted in temperate regions (> 50%, 1115 papers), while less then one-third originates in tropical or sub-tropical climates (Fig. 7). In the 1970s, on average eight papers per year (= 20% of all papers) was conducted in the tropics and it had increased

Table 3
Linear correlation co-efficients ($r$) between the place of origin of research and the origin of the authors. Co-efficients greater than 0.5 are shown in bold and those with an absolute value greater than 0.3 are shown in italic. Values which are not statistically significantly different from zero at the 1% level ($|r| < 0.057$, $df = 2077$) are not shown

| Origin of authors | Origin of research | | | | | |
|---|---|---|---|---|---|---|
| | Europe | N America | C/S America | Africa | Asia | Oceania |
| Europe | **0.73** | *−0.45* | | | −0.25 | −0.25 |
| N America | *−0.40* | **0.79** | | −0.11 | −0.16 | −0.17 |
| S/C America | −0.12 | −0.07 | **0.60** | | −0.06 | |
| Africa | −0.16 | −0.10 | | **0.64** | | −0.06 |
| Asia | −0.25 | −0.14 | −0.08 | | **0.81** | −0.10 |
| Oceania | −0.24 | −0.15 | −0.08 | −0.09 | −0.10 | **0.85** |

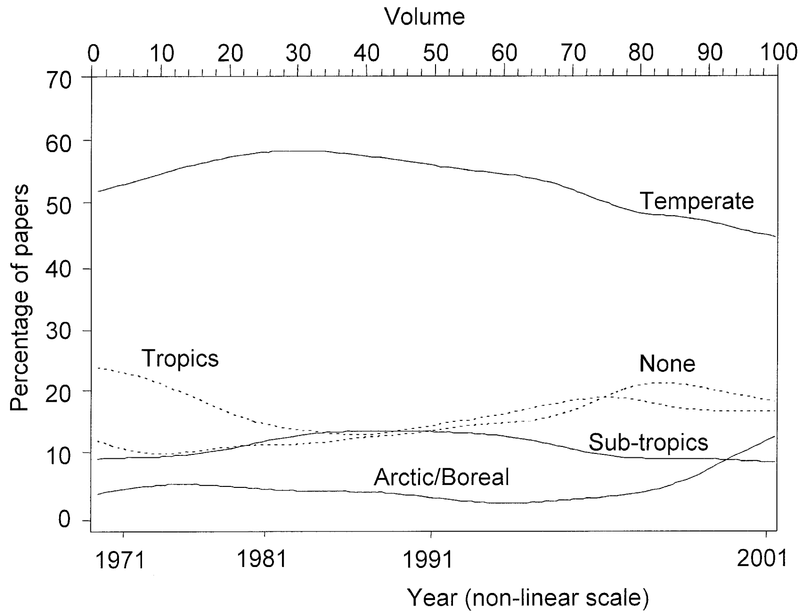


Fig. 7. Trends in the climatic region of research between 1967 and 2001. The ordinate is a local moving average of the percentage of papers in Geoderma.

to 16 (= 17% of all papers) by the 1990s. The number of papers per year from subtropical areas has increased. In its 100 volumes, Geoderma has published 28% of research originating in the tropics or subtropics and in total 580 papers have been published from those regions. A considerable increase in the modest percentage of papers in arctic or boreal areas has occurred since 1997. Little correlation was found to exist between the origin of authors and the climatic region in which their research was carried out (analysis not shown).

### *3.2.2. Focus of the research*

There are substantial changes in the type of research being conducted and there has been a swing from descriptive studies to methodological research (Fig. 8). Despite the relative decrease, the absolute number of descriptive papers per year was 17 in the 1970s and had increased to 30 papers per year in the 1990s. Number of methodological papers was 7 per year in the 1970s but it had increased to 23 papers per year in the 1990s. There has also been a relative increase in the number of experimental papers and the number increased from on average 13 per year in the 1970s to over 33 per year in the 1990s. Geoderma published about four review papers per year in the 1970s and nine in the 1990s. In the 100 volumes, there were 802 descriptive papers (39% of total), 673 experimental papers (32%), 408 methodological papers (20%) and 196 review papers (9%).

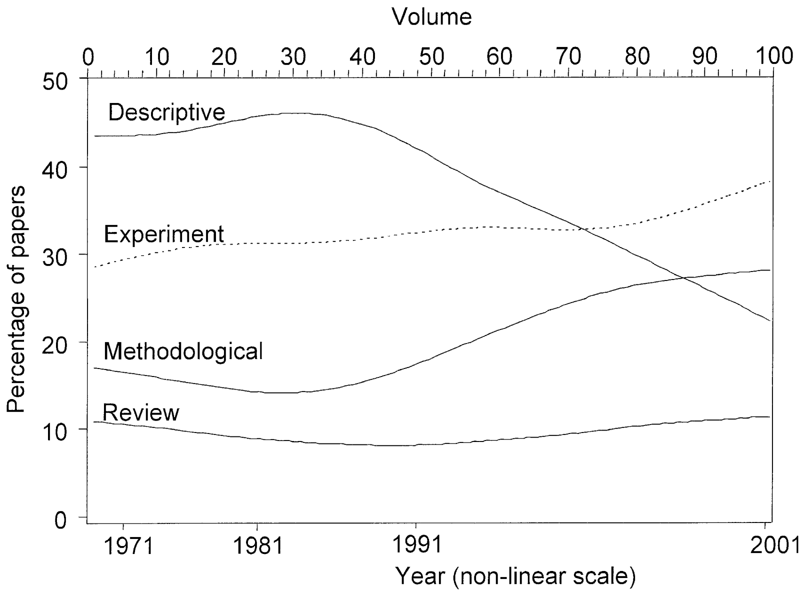


Fig. 8. Trends in type of research between 1967 and 2001. The ordinate is the percentage of papers in Geoderma.

One of the most important shifts in soil science over the last few decades is depicted in Fig. 9. There are fewer field and laboratory studies and significantly

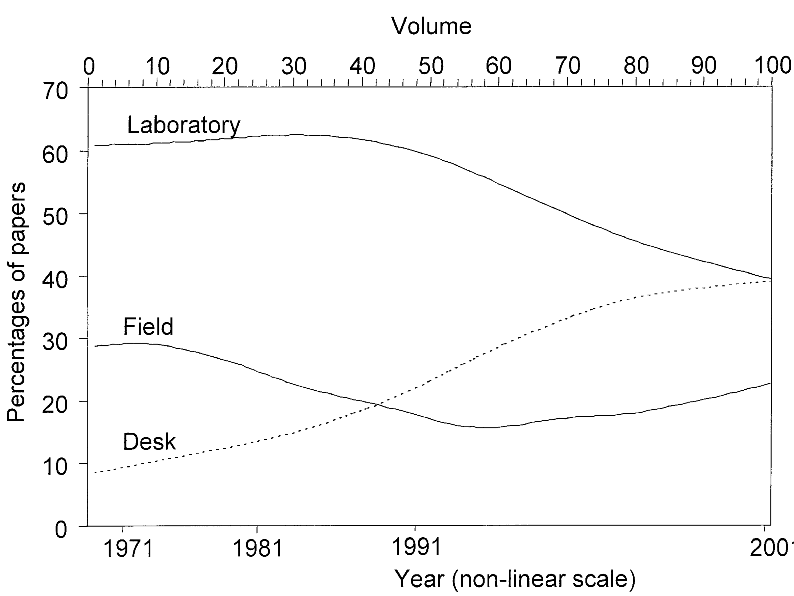


Fig. 9. Trends in field, laboratory and desk studies between 1967 and 2001. The ordinate is the percentage of papers in Geoderma.

more desk studies using existing data, which increased from 11% of all papers in the 1970s to 33% in the 1990s. The number of papers per year reporting field studies was on average 12 in the 1970s and 17 in the 1990s. The number of papers based on desk studies increased from 5 in the 1970s to 31 papers per year in the 1990s. Over the whole period, Geoderma has published 1153 papers (55% of total) based on laboratory studies, 481 desk studies (23%) and 445 papers based on field studies (22%).

Research has become more applied over time (Fig. 10). General soil science papers have been replaced with papers focussing on environmental and agricultural issues. In the 1990s, approximately two thirds of papers published in Geoderma had no particular application, and this figure has decreased from almost 85% in the 1970s. Geoderma has published 254 papers (12% of total) with a strong agricultural focus and 100 papers focussing on soils under forests. There has been a sharp increase in the number of environmental papers. In the 1970s, on average one paper per year focussed on soils and the environment and it had increased to eight by the 1990s (8% of total in the 1990s).

### 3.3. Papers per subject

Since 1967, Geoderma has predominantly published pedological research, i.e. papers on soil genesis, soil classification and mapping. Pedology papers in the 1970s and 1980s were often illustrated with X-ray diffraction curves and

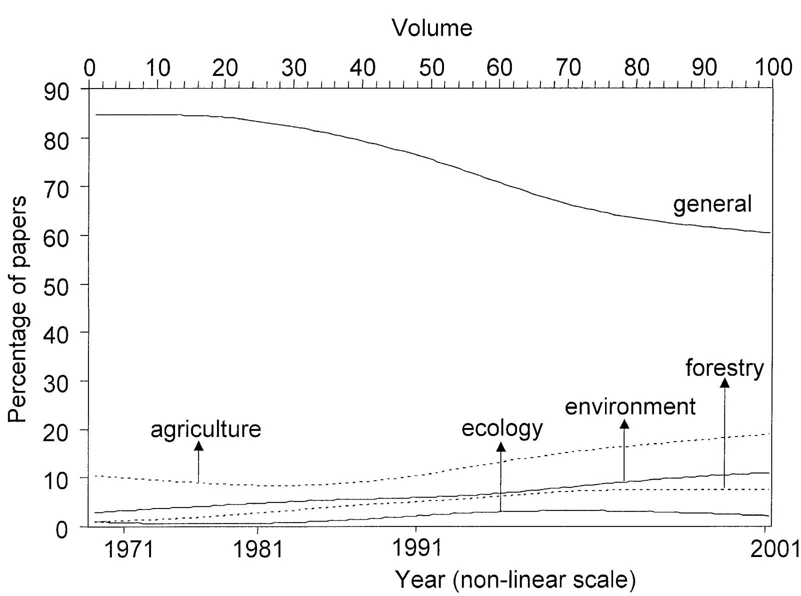


Fig. 10. Trends in the focus of research between 1967 and 2001. The ordinate is a local moving average of the percentage of papers in Geoderma.

photographs of thin sections and it is remarkable how few photographs from landscapes were published in Geoderma. Fig. 11 shows that approximately one third of published papers fall into the ISSS Commission "Soil genesis, classification and cartography". In the early years, papers on soil mineralogy and soil chemistry also comprised a large part of reported work. Over the whole period, about 29% of all papers in Geoderma were on soil chemistry, 16% on soil physics and 13% on soil mineralogy (Table 2).

In the 1990s, important shifts in the subjects of the papers in Geoderma occurred. Since 1990, there has been a large increase in papers reporting soil physics research while the number of soil mineralogy papers has plummeted to only 5%. In the 1970s, there were on average five soil physics papers per year (11% of total) but the yearly number of soil physics paper in the 1990s was 20 (21% of total).

Fig. 12–16 illustrate the trends in individual subject areas over the 100 volumes of Geoderma. Soil physics has been dominated by research into water (see paper from P.A.C. Raats in this issue), comprising about 12% of all papers published in Geoderma. Modelling and simulation studies have more than doubled in the last decade. Soil chemistry has experienced a resurgence in the number of papers published on organic matter, rising from about 8% to 12% since 1990. The percentage of papers on speciation (about 8%) is an indication of environmental awareness.

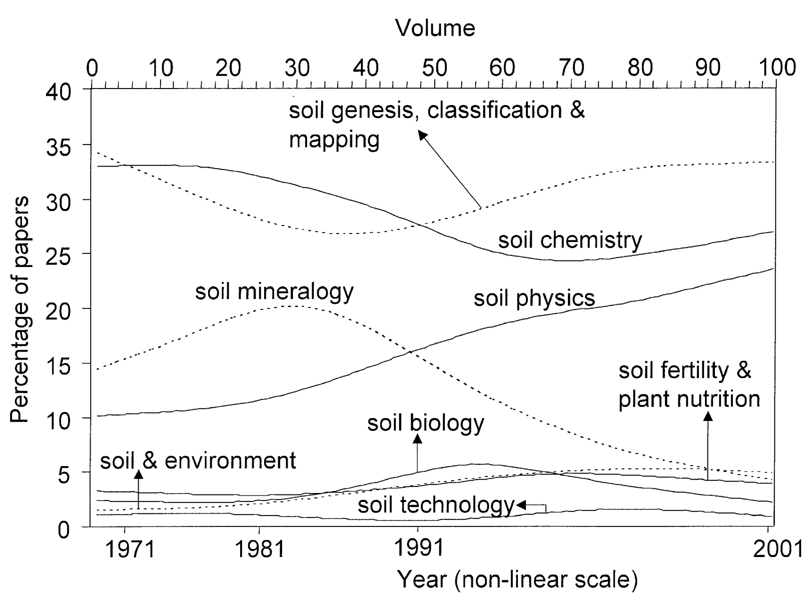


Fig. 11. Trends in soil disciplines (ISSS Commissions) reported in Geoderma between 1967 and 2001. The ordinate is the percentage of papers in Geoderma.

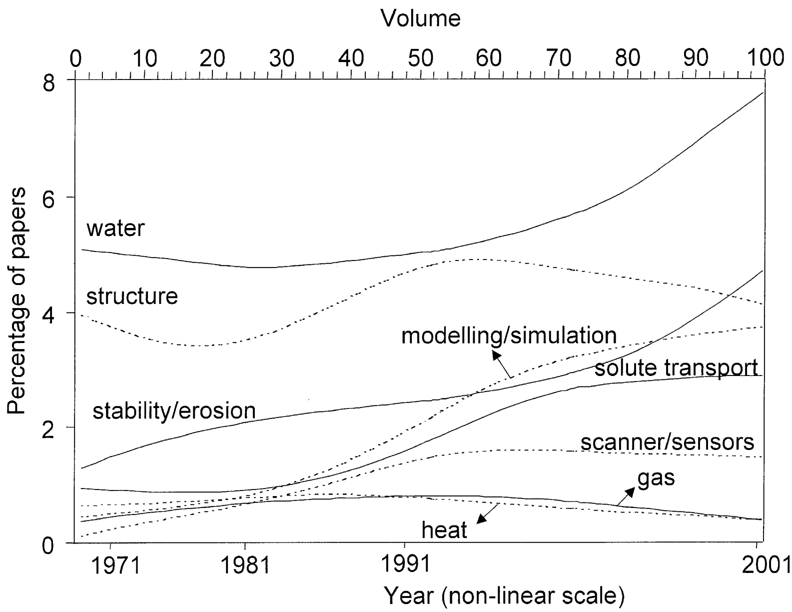


Fig. 12. Trends in soil physical sub-disciplines and subjects reported in Geoderma between 1967 and 2001. The ordinate is the percentage of papers in Geoderma.

At around 3%, soil biology (Fig. 14) is only a small component of research published in Geoderma. It peaked in the early 1990s with the special issue "Soil

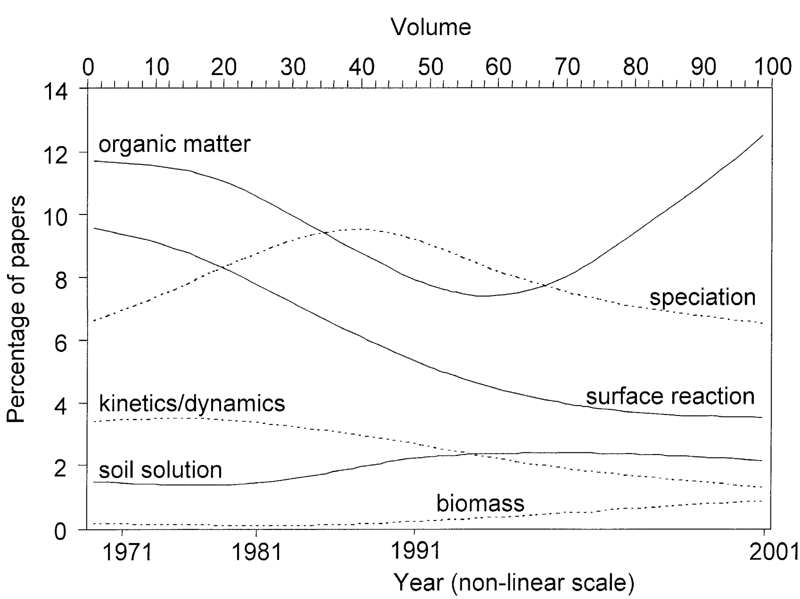


Fig. 13. Trends in soil chemical sub-disciplines and subjects reported in Geoderma between 1967 and 2001. The ordinate is the percentage of papers in Geoderma.

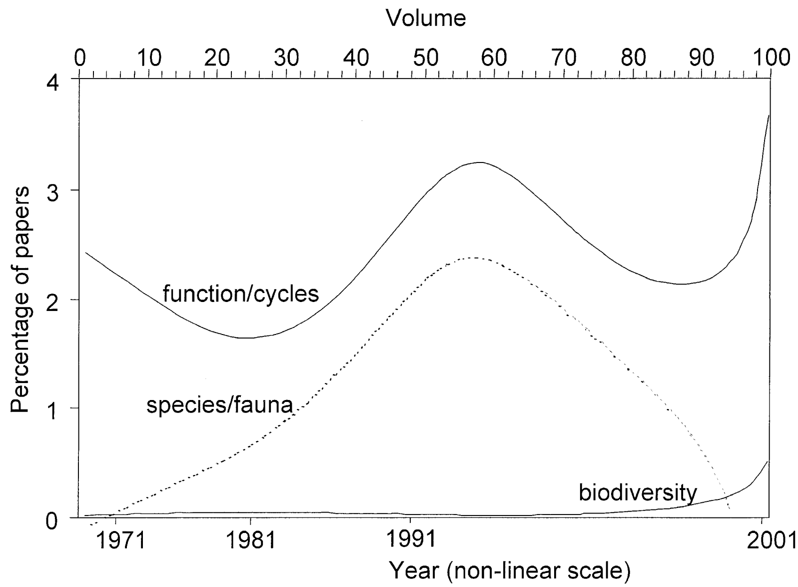


Fig. 14. Trends in soil biological sub-disciplines and subjects reported in Geoderma between 1967 and 2001. The ordinate is the percentage of papers in Geoderma.

structure/soil biota interrelationships", which contained 54 papers (see Appendix A). Currently, soil biological papers account for about 2% of papers. In

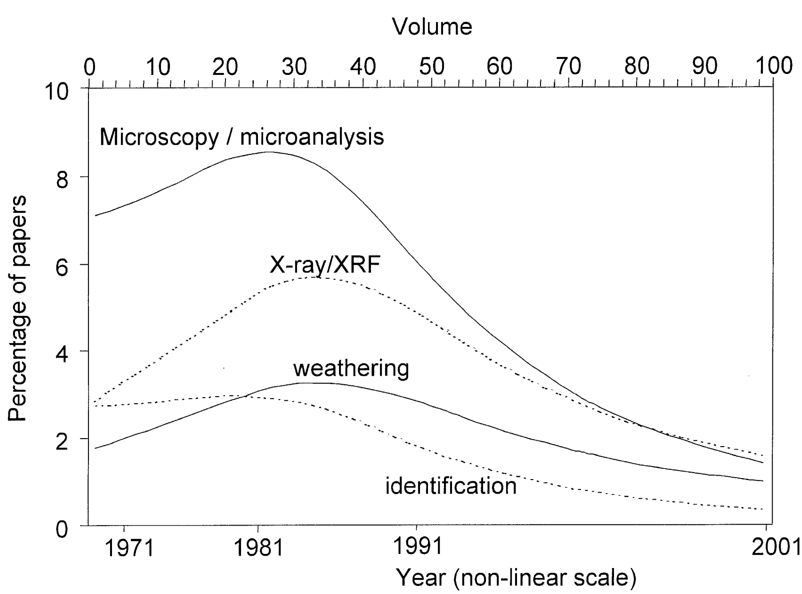


Fig. 15. Trends in soil mineralogical sub-disciplines and subjects reported in Geoderma between 1967 and 2001. The ordinate is the percentage of papers in Geoderma.

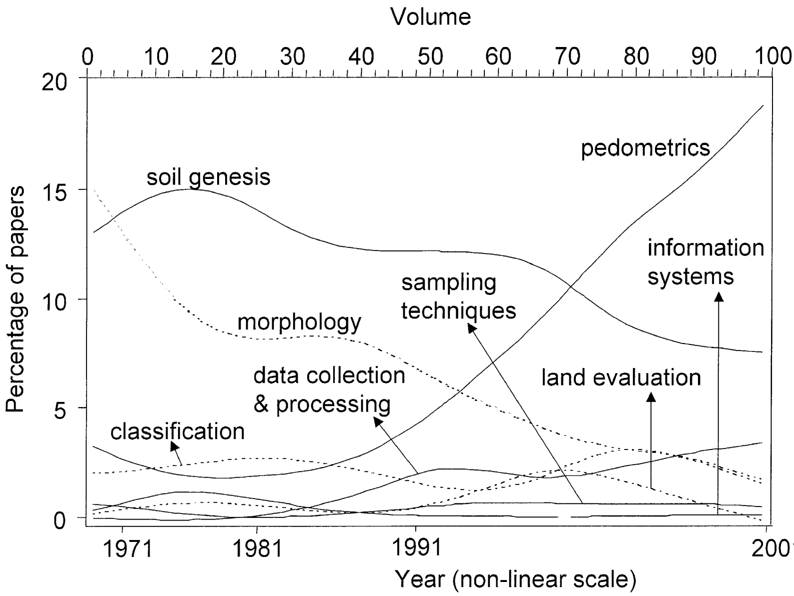


Fig. 16. Trends in pedological sub-disciplines and subjects reported in Geoderma between 1967 and 2001. The ordinate is the percentage of papers in Geoderma.

recent years, there has been an increase in the number of papers on biodiversity as the subject has begun to receive some attention in soil science. Most notable amongst the mineralogical subjects is the decline in microscopy and microanalytical research papers (Fig. 15). In 1967, these areas comprised about 7% of all papers but the figure has since dropped to around 2%. As was shown in Fig. 11, very few papers are published in soil technological subjects.

The shift from descriptive field studies to methodological desk studies is probably best seen in Fig. 16. Papers on pedometrics have risen from less than 3% in 1967 to around 18% today. It seems that more qualitative soil genesis and morphological studies have decreased to make way for the increase in more quantitative studies.

Almost without exception, papers published on environmental issues including physical degradation, salinisation, greenhouse gas sinks, acidification and urban soil, are on the increase but they form only about 2% of the papers published. Soil contamination still accounts for the majority of environmental papers in Geoderma.

We found that a considerable number of Geoderma papers were not dominated by any particular division and these papers were classified as multidisciplinary research papers. About 10% of all papers were classified as such but the multidisciplinary work peaked in 1995 (graph not shown). We are inclined to call this the "Johan Bouma effect" as he very much encouraged multidisciplinary work during his time as editor-in-chief (1989–1995). In recent years, the share of multidisciplinary papers is slightly decreasing and this is likely due to the larger number of Special Issues, which are generally more unidisciplinary.

### 3.4. Soil classification and number of soil samples

In the late 1960s and early 1970s, soil classification was only given in 30% of the papers. Therefore, Roy Simonson wrote an editorial in the first issue of vol. 9 (1973) in which he urged that the soil on which data are given in a manuscript should be identified according to: Soil Taxonomy, FAO-Unesco, or the Canadian, French or Soviet systems. The reasons were twofold: in the 1970s, two international systems became widely available (Soil Taxonomy and FAO-Unesco) and it was the editorial policy to make a special effort to ensure that the papers appearing will be useful in as many parts of the world as possible. The need for proper information of soil classification in Geoderma manuscripts was repeated in March 1978 (vol. 20) and again in August 1983 (vol. 31).

Simonson's request on the inclusion of a class name for any soil for which data had been reported had an effect. The percentage of papers that included soil classification increased from approximately 30% in the early 1970s to around 60% by 1989. This trend has since reversed with about 50% of papers currently specifying the classification of the soil under investigation. Over the whole period, 45% of the papers had not included a classification of the soil under study. The decrease in the use of soil classification in recent times may perhaps be explained by the increasing number of studies using large numbers of samples having a wide geographic distribution. Alternatively, there is an increasing number of desk studies, which make use of old data sets for which no classification of soil may have been recorded. It also shows that the use of soil classification still remains somewhat difficult despite prolonged international efforts.

Fig. 17 shows the percentage of papers that have investigated each of the orders of Soil Taxonomy. In the 1980s, most attention has been given to Alfisols and Inceptisols, but in recent years there has been a steady rise in research conducted on Spodosols, Entisols and Mollisols. Alfisols and Inceptisols account for almost 20% of all papers in Geoderma whereas Spodosols were the subject of 6.7% of all papers. Oxisols and Ultisols, which are important soils in the humid tropics, have been researched in less than 7% of the 2079 papers. Histosols have received little attention and there has been an appreciable decline in interest in these soils despite their importance as $CO_2$ sources upon cultivation.

#### 3.4.1. Soil sampling data

In keeping with the trend towards methodological research and desk-based studies, the proportion of papers researching existing data sets has increased

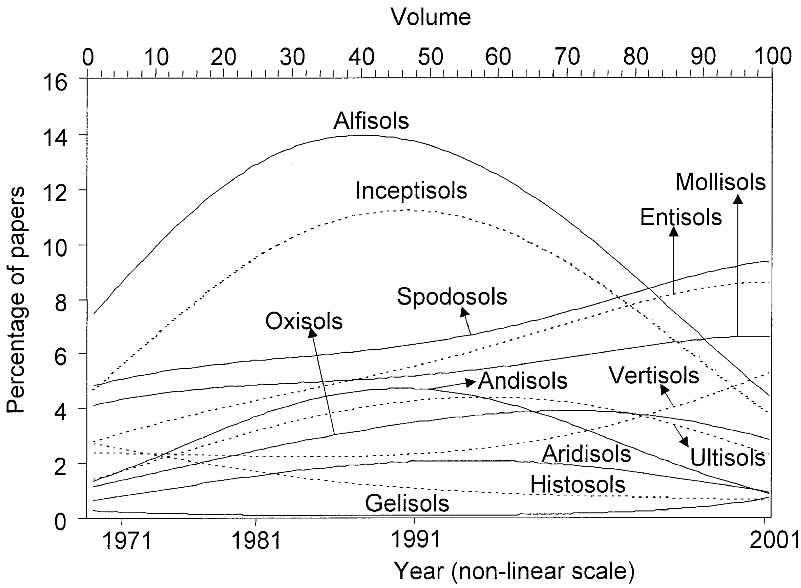


Fig. 17. Soil orders investigated in Geoderma papers between 1967 and 2001. The ordinate is the percentage of papers in Geoderma.

from 10% to 30% over the last 5 years (Fig. 18). The number of papers reporting work on specimens (samples) collected in the field peaked during the

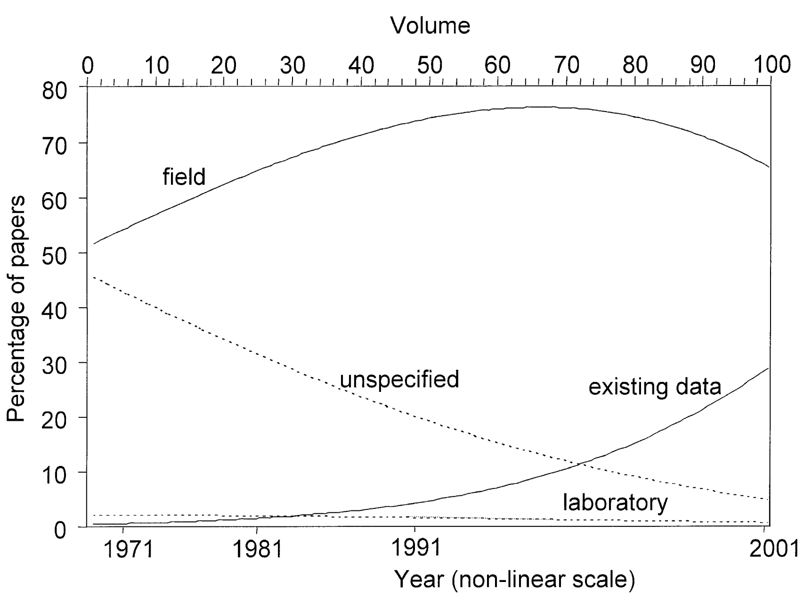


Fig. 18. Source of soil specimens (samples) or observations between 1967 and 2001. The ordinate is the percentage of papers in Geoderma.

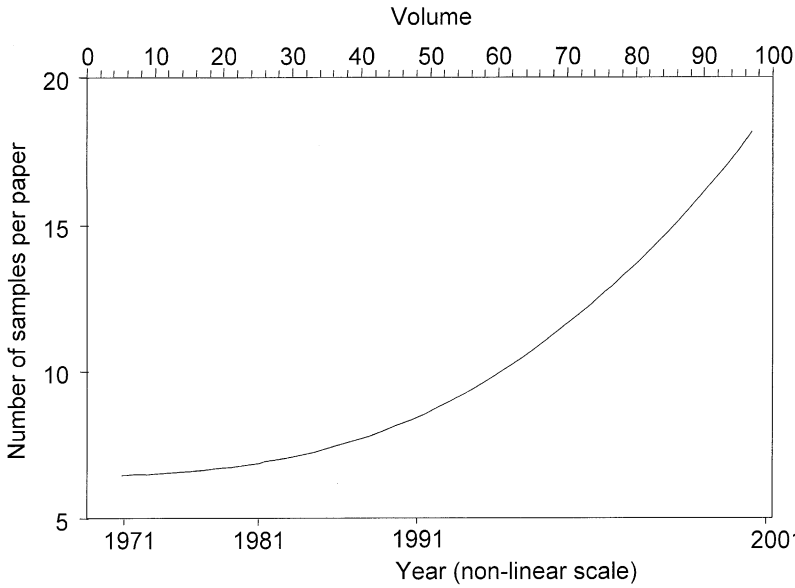


Fig. 19. Number of soil specimens (samples) or observations per paper between 1967 and 2001.

mid 1990s and are still the majority, although this has decreased since 1997. The number of soil observations (samples) per paper has also increased (Fig. 19), again reflecting the shift in the type of research being conducted. The large

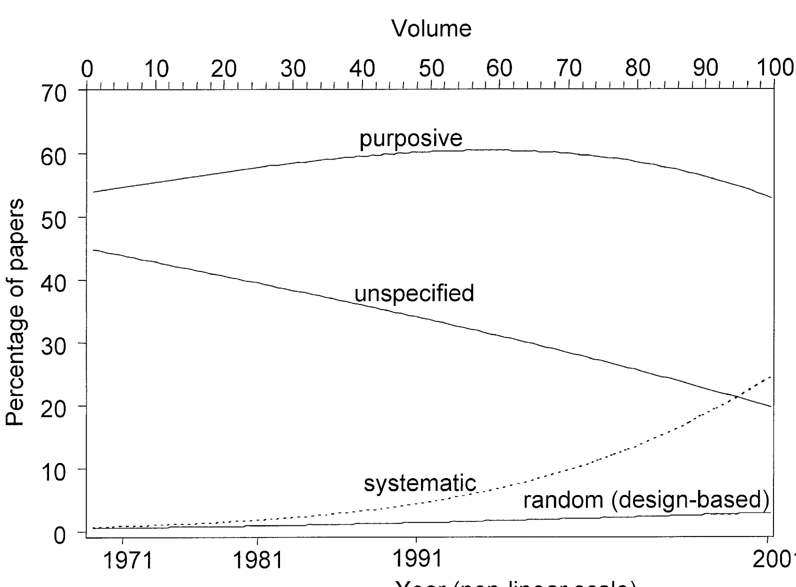


Fig. 20. Trends in sampling design reported in papers in Geoderma between 1967 and 2001.

generic soil databases built up in the 1960s and 1970s are now being utilised (often for unintended purposes). This shift has seen a decline in purposive sampling designs and an increase in systematic (model-based) designs, particularly geostatistical grid studies (Fig. 20). There has been a modest emergence of random designs, particularly since they were discussed formally in a Discussion Paper by Brus and de Gruijter (1997). Figs. 18 and 20 indicate an improvement in the reporting of details about both the origin of samples and sampling design. The percentage of papers not specifying this information has decreased considerably over time.

## 4. Impact of Geoderma

### *4.1. Impact data*

Information on the impact of Geoderma was obtained through The Centre for Science and Technology Studies (CWTS), which has been established within Leiden University (The Netherlands) as a centre for scientific research, independent analysis and advice on matters concerning scientific and technological development. CWTS obtains the‘ impact information from the Institute for Scientific Information (ISI) in Philadelphia (USA). A list of most cited papers between 1981 and 1999 was obtained as ISI holds no data in their electronic database prior to 1981. This means that the citations are skewed to papers from the 1980s, and the data presented do not show what has been the most cited and influential Geoderma paper. We have used the information to classify the 100 most cited papers in order to reveal in which areas Geoderma has published influential papers. Journal impact data were derived from the “Journal Citation Reports” that is published annually by ISI. The impact factor is based on the 2 years prior to the year of analysis and we have compiled these data since 1975 and compared Geoderma to some international soil science journals.

### *4.2. Impact factor*

Since the 1970s, Geoderma has always been in the top 10 of soil science journals although its impact factor has greatly fluctuated. The impact factor of Geoderma was about 0.5 in the late 1970s but varied around 0.7 in the 1980s. The impact factor steadily increased to over 1.0 in 1999 and Geoderma followed more or less the same pattern as the other soil science journals (Fig. 21). If the factors are indexed (1975 = 100), it appears that the impact of Geoderma increased more rapidly than the other soil science journals. Since the mid 1970s, the impact factor had increased by more than 200% and the increase was particularly large in the late 1990s.

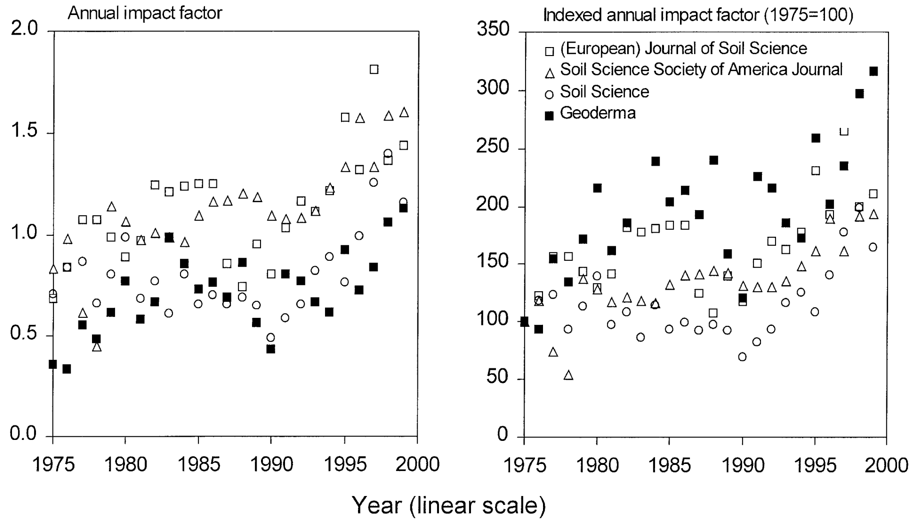


Fig. 21. Annual impact factor of some international soil science journals between 1975 and 1999.

## 4.3. Most cited papers

From the ISI databases, it was found that 1136 Geoderma papers were cited in various journals between 1981 and 1999. Citation ranged from 1 to 187 times. About 25% of the papers were cited more than eight times and 10% of the papers were cited more than 16 times. The total number of papers between 1981 and 1999 was 1404, which means that 268 papers (19%) were never cited. That is a fairly low figure as in many sciences the majority of the papers never get cited. We had no information on the papers that were never cited but it would have been interest to classify them and judge whether there is some commonality in these papers. It is more interesting, however, to discuss the most cited papers in Geoderma.

Appendix C presents a list of most cited papers between 1981 (vol. 25) and 1999 (vol. 93). Citation is skewed towards the 1980s for those papers had longer time to be cited. As could be expected, there is a number of review papers that were repeatedly cited but also some fundamental studies on solute movement and preferential flow have been often cited. The 100 most cited papers were classified as described in Section 3.1, and the outcome compared to the averages for different periods (Table 2). Although research and authors from Europe have been fairly dominant in Geoderma, there are more papers from the USA in the top 100. Likewise, papers from the temperate regions are over-represented in the top 100 and papers from research in the tropics are less cited. It seems that reviews and papers describing experimental work are well cited, whereas many of the descriptive papers have been cited less. In the top 100, there were only 15 papers resulting from a field study and more than 50 papers from laboratory studies. Almost 80% of the highly cited papers had no particular application (i.e. agriculture, forestry etc.). Soil chemistry papers were most cited followed by soil physics and general pedological papers.

### *4.4. Citation by country and institute*

A breakdown by continent of the papers in Geoderma was given in Section 3.2. Table 4 presents country data on the origin of the papers published between 1981 and 1999. During that period, 322 papers were from the USA which is 23% of the total. Papers from the Netherlands accounted for 12% of all papers published between 1981 and 1999. Institutes and universities of France, UK, Germany and Canada also contributed a large numbers of papers to Geoderma. Ranking based on citation yields quite a different ranking of countries. The list is headed by Congo followed by Niger. From both countries, a few papers were published but they have been fairly frequently cited. These were the papers were by Schwartz et al. (1986) for Congo and Valentin and Bresson (1992) and Drees et al. (1993) for Niger. As we know, these authors are not from Congo or Niger, but ISI has listed them as such.

The list furthermore shows that publications from South Africa, Ghana, Costa Rica, Jordan, Papua New Guinea and Brazil have been fairly well cited as are the papers from Israel. Although European countries have contributed most of the Geoderma papers, only three European countries were in the top 10 of citations were ranked by country. It should be stressed that this is picture from the data between 1981 and 1999, and it may look differently at present or if the data were grouped for another period.

Between 1981 and 1999, a total of 144 papers (10% of total) were published from Wageningen University and Research Centres (Table 5). On average, the papers were cited 6.7 times (University) and 7.0 times (Research Centres). The University of Bayreuth contributed 28 papers (2% of total) and these papers were cited on average 7.8 times. Most of the papers were, however, not cited (mode = 0) but the Q3 and P90 (see Table 5) showed that there were a number of papers that were frequently cited. The Universities of Sydney, Saskatchewan, Ghent, and Aberdeen all contributed more than 20 papers each, of which the papers from the University of Saskatchewan were most cited (on average 9.6 times). Overall, the table shows that most Geoderma papers came from the leading Universities and Research Centres in Europe, North America and Australia.

The top 25 of institutes based on most cited papers is quite different from what is presented in Table 5. Only four of the institutes that appeared in the list of the top 25 most published papers (Table 5) appear in the top 25 of most-cited institutes (Table 6). These were the papers from the Universities of Alberta, Colorado State, Wisconsin and California-Berkeley. The pattern emerging from

Table 4
Ranking of countries based on total number of publications in Geoderma between 1981 and 1999 and based on number of citations over the same period

| Rank | Country | Number of papers | Number of times cited | | | | | Rank | Country | Number of papers | Number of times cited | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Mean | Median | Mode | Q3 | P90 | | | | Mean | Median | Mode | Q3 | P90 |
| 1 | USA | 322 | 10.1 | 4.0 | 2.0 | 10.0 | 22.0 | 1 | Congo People Rep | 2 | 30.0 | 30.0 | 7.0 | 53.0 | 53.0 |
| 2 | Netherlands | 167 | 6.4 | 5.0 | 0.0 | 8.0 | 16.0 | 2 | Niger | 3 | 21.7 | 20.0 | 1.0 | 44.0 | 44.0 |
| 3 | France | 130 | 8.1 | 5.5 | 0.0 | 11.0 | 18.5 | 3 | Sweden | 11 | 11.3 | 7.0 | 0.0 | 12.0 | 20.0 |
| 4 | Great Britain | 125 | 5.4 | 3.0 | 0.0 | 7.0 | 17.0 | 4 | Israel | 24 | 11.0 | 6.0 | 0.0 | 18.0 | 25.0 |
| 5 | Germany | 120 | 8.8 | 5.0 | 0.0 | 10.5 | 23.0 | 5 | USA | 322 | 10.1 | 4.0 | 2.0 | 10.0 | 22.0 |
| 6 | Canada | 114 | 8.8 | 4.0 | 1.0 | 10.0 | 22.0 | 6 | South Africa | 9 | 9.4 | 1.0 | 0.0 | 6.0 | 65.0 |
| 7 | Australia | 96 | 7.2 | 3.0 | 0.0 | 9.5 | 18.0 | 7 | Canada | 114 | 8.8 | 4.0 | 1.0 | 10.0 | 22.0 |
| 8 | Spain | 49 | 4.3 | 1.0 | 0.0 | 6.0 | 11.0 | 8 | Germany | 120 | 8.8 | 5.0 | 0.0 | 10.5 | 23.0 |
| 9 | Japan | 45 | 5.1 | 4.0 | 1.0 | 7.0 | 10.0 | 9 | New Zealand | 38 | 8.7 | 5.0 | 1.0 | 11.0 | 20.0 |
| 10 | Italy | 44 | 5.7 | 4.0 | 0.0 | 8.0 | 13.0 | 10 | France | 130 | 8.1 | 5.5 | 0.0 | 11.0 | 18.5 |
| 11 | Belgium | 41 | 4.5 | 3.0 | 0.0 | 5.0 | 9.0 | 11 | Ghana | 3 | 8.0 | 11.0 | 0.0 | 13.0 | 13.0 |
| 12 | New Zealand | 38 | 8.7 | 5.0 | 1.0 | 11.0 | 20.0 | 12 | Australia | 96 | 7.2 | 3.0 | 0.0 | 9.5 | 18.0 |
| 13 | Switzerland | 29 | 6.1 | 4.0 | 1.0 | 9.0 | 16.0 | 13 | Netherlands | 167 | 6.4 | 5.0 | 0.0 | 8.0 | 16.0 |
| 14 | India | 26 | 3.1 | 2.0 | 0.0 | 5.0 | 8.0 | 14 | Switzerland | 29 | 6.1 | 4.0 | 1.0 | 9.0 | 16.0 |
| 15 | Brazil | 25 | 4.4 | 3.0 | 0.0 | 5.0 | 12.0 | 15 | Italy | 44 | 5.7 | 4.0 | 0.0 | 8.0 | 13.0 |
| 16 | Israel | 24 | 11.0 | 6.0 | 0.0 | 18.0 | 25.0 | 16 | Denmark | 23 | 5.5 | 4.0 | 0.0 | 8.0 | 12.0 |
| 17 | Denmark | 23 | 5.5 | 4.0 | 0.0 | 8.0 | 12.0 | 17 | Great Britain | 125 | 5.4 | 3.0 | 0.0 | 7.0 | 17.0 |
| 18 | Peoples R China | 18 | 3.2 | 1.0 | 0.0 | 4.0 | 10.0 | 18 | Costa Rica | 4 | 5.3 | 3.5 | 2.0 | 8.0 | 12.0 |
| 19 | Nigeria | 16 | 4.2 | 1.5 | 1.0 | 6.5 | 10.0 | 19 | Norway | 12 | 5.1 | 2.0 | 1.0 | 7.5 | 17.0 |
| 20 | Greece | 13 | 3.2 | 2.0 | 1.0 | 3.0 | 7.0 | 20 | Japan | 45 | 5.1 | 4.0 | 1.0 | 7.0 | 10.0 |
| 21 | Norway | 12 | 5.1 | 2.0 | 1.0 | 7.5 | 17.0 | 21 | Hong Kong | 2 | 5.0 | 5.0 | 0.0 | 10.0 | 10.0 |
| 22 | Philippines | 11 | 3.1 | 2.0 | 0.0 | 6.0 | 7.0 | 22 | Belgium | 41 | 4.5 | 3.0 | 0.0 | 5.0 | 9.0 |
| 23 | Sweden | 11 | 11.3 | 7.0 | 0.0 | 12.0 | 20.0 | 23 | Jordan | 2 | 4.5 | 4.5 | 2.0 | 7.0 | 7.0 |
| 24 | Argentina | 10 | 2.0 | 2.0 | 0.0 | 3.0 | 5.0 | 24 | Papua N Guinea | 4 | 4.5 | 4.5 | 1.0 | 7.0 | 8.0 |
| 25 | Austria | 10 | 4.1 | 1.5 | 0 | 6 | 14.5 | 25 | Brazil | 25 | 4.4 | 3.0 | 0.0 | 5.0 | 12.0 |

Mean = average times cited; median = middle of all citations; mode = most frequently occurring citation; Q3 = number of citations for 25% of the articles, i.e. if Q3 = 8 means that 25% of the articles were cited eight times or more; P90 = number of citations for 10% of the articles, i.e. if P90 = 17 means that 10% of the articles were cited 17 times or more.

Table 5
Institutes sorted by descending number of publications in Geoderma between 1981 and 1999

| Rank | Institute | Number of papers | Number of times cited | | | | |
|---|---|---|---|---|---|---|---|
| | | | Mean | Median | Mode | Q3 | P90 |
| 1 | Agr Univ Wageningen, Wageningen, Netherlands | 81 | 6.7 | 5.0 | 0.0 | 8.0 | 14.0 |
| 2 | Wageningen Res Ctr, Wageningen, Netherlands | 63 | 7.0 | 6.0 | 0.0 | 10.0 | 16.0 |
| 3 | Univ Bayreuth, Bayreuth, Germany | 28 | 7.8 | 5.0 | 0.0 | 11.0 | 24.0 |
| 4 | Univ Sydney, Sydney, Australia | 22 | 6.5 | 3.5 | 0.0 | 12.0 | 15.0 |
| 5 | Univ Saskatchewan, Saskatoon, Canada | 22 | 9.6 | 5.5 | 1.0 | 13.0 | 19.0 |
| 6 | State Univ Ghent, Ghent, Belgium | 21 | 3.3 | 1.0 | 0.0 | 4.0 | 5.0 |
| 7 | SOAFD, Aberdeen, Great Britain | 21 | 6.6 | 4.0 | 4.0 | 7.0 | 18.0 |
| 8 | Agr Canada, Ottawa, Canada | 20 | 9.7 | 4.0 | 3.0 | 17.5 | 27.5 |
| 9 | Univ Wisconsin, Madison, USA | 19 | 18.9 | 6.0 | 1.0 | 17.0 | 63.0 |
| 10 | Univ Adelaide, Adelaide, Australia | 18 | 13.5 | 11.5 | 3.0 | 16.0 | 40.0 |
| 11 | Cornell Univ, Ithaca, USA | 17 | 10.9 | 3.0 | 0.0 | 8.0 | 30.0 |
| 12 | Colorado State Univ, Fort Collins, USA | 16 | 19.7 | 3.5 | 2.0 | 11.5 | 53.0 |
| 13 | CSIRO, Adelaide, Australia | 15 | 10.3 | 4.0 | 3.0 | 12.0 | 33.0 |
| 14 | Univ Alberta, Edmonton, Canada | 15 | 20.1 | 5.0 | 2.0 | 16.0 | 22.0 |
| 15 | Univ Nancy I, Vandoeuvre Les Nancy, France | 15 | 8.2 | 6.0 | 12.0 | 12.0 | 12.0 |
| 16 | Univ Reading, Reading, UK | 15 | 2.3 | 2.0 | 0.0 | 3.0 | 8.0 |
| 17 | Univ California Berkeley, Berkeley, USA | 15 | 18.1 | 5.0 | 3.0 | 12.0 | 53.0 |
| 18 | Univ Minnesota, St Paul, USA | 15 | 3.9 | 3.0 | 0.0 | 5.0 | 7.0 |
| 19 | CSIRO, Canberra, Australia | 14 | 8.7 | 5.5 | 0.0 | 17.0 | 22.0 |
| 20 | INRA, Versailles, France | 14 | 6.5 | 5.5 | 6.0 | 8.0 | 16.0 |
| 21 | ORSTOM, Bondy, France | 13 | 7.5 | 5.0 | 0.0 | 10.0 | 21.0 |
| 22 | Kyushu Univ, Fukuoka, Japan | 13 | 6.1 | 5.0 | 5.0 | 7.0 | 9.0 |
| 23 | Univ Guelph, Guelph, Canada | 12 | 11.6 | 7.5 | 1.0 | 19.5 | 30.0 |
| 24 | Agr Res Org, Bet Dagan, Israel | 12 | 10.3 | 7.5 | 6.0 | 18.0 | 22.0 |
| 25 | ISRIC, Wageningen, Netherlands | 12 | 4.8 | 3.0 | 1.0 | 8.0 | 11.0 |

Mean = average times cited; median = middle of all citations; mode = most frequently occurring citation; Q3 = number of citations for 25% of the articles, i.e. if Q3 = 8 means that 25% of the articles were cited eight times or more; P90 = number of citations for 10% of the articles, i.e. if P90 = 17 means that 10% of the articles were cited 17 times or more.

Table 6
Institutes sorted by descending average impact of their publications in Geoderma between 1981 and 1999

| Rank | Institute | Number of papers | Number of times cited | | | | |
|---|---|---|---|---|---|---|---|
| | | | Mean | Median | Mode | Q3 | P90 |
| 1 | Syracuse Univ, Syracuse, USA | 2 | 58.0 | 58.0 | 0.0 | 116.0 | 116.0 |
| 2 | US Geol Survey, Menlo Park, USA | 3 | 49.0 | 14.0 | 11.0 | 122.0 | 122.0 |
| 3 | ORSTOM, Pointe Noire, Congo People Rep | 2 | 30.0 | 30.0 | 7.0 | 53.0 | 53.0 |
| 4 | Hebrew Univ Jerusalem, Jerusalem, Israel | 4 | 28.3 | 26.5 | 16.0 | 39.5 | 44.0 |
| 5 | US Salin Lab, Riverside, USA | 2 | 27.5 | 27.5 | 7.0 | 48.0 | 48.0 |
| 6 | Fachhsch Wiesbaden, Wiesbaden, Germany | 2 | 26.5 | 26.5 | 24.0 | 29.0 | 29.0 |
| 7 | USDA ARS, Coshocton, USA | 3 | 26.0 | 30.0 | 6.0 | 42.0 | 42.0 |
| 8 | Tech Univ Munich, Freising, Germany | 9 | 25.7 | 18.0 | 3.0 | 34.0 | 65.0 |
| 9 | Va Polytech Inst and State Univ, Blacksburg, USA | 3 | 25.3 | 21.0 | 0.0 | 55.0 | 55.0 |
| 10 | Univ Kiel, Kiel, Germany | 8 | 24.4 | 25.5 | 0.0 | 45.5 | 49.0 |
| 11 | Univ Missouri, Columbia, USA | 3 | 20.7 | 20.0 | 9.0 | 33.0 | 33.0 |
| 12 | Univ Alberta, Edmonton, Canada | 15 | 20.1 | 5.0 | 2.0 | 16.0 | 22.0 |
| 13 | Univ Paris Vi, Paris, France | 3 | 20.0 | 7.0 | 0.0 | 53.0 | 53.0 |
| 14 | Univ Bar Ilan, Ramat Gan, Israel | 2 | 20.0 | 20.0 | 5.0 | 35.0 | 35.0 |
| 15 | Colorado State Univ, Fort Collins, USA | 16 | 19.7 | 3.5 | 2.0 | 11.5 | 53.0 |
| 16 | Oak Ridge Natl Lab, Oak Ridge, USA | 7 | 19.6 | 7.0 | 2.0 | 36.0 | 55.0 |
| 17 | Univ Wisconsin, Madison, USA | 19 | 18.9 | 6.0 | 1.0 | 17.0 | 63.0 |
| 18 | Ctr Pedol Biol, Vandoeuvre Les Nancy, France | 2 | 18.5 | 18.5 | 3.0 | 34.0 | 34.0 |
| 19 | Univ California Berkeley, Berkeley, USA | 15 | 18.1 | 5.0 | 3.0 | 12.0 | 53.0 |
| 20 | Griffith Univ, Brisbane, Australia | 2 | 17.5 | 17.5 | 12.0 | 23.0 | 23.0 |
| 21 | DSIR, Lower Hutt, New Zealand | 11 | 16.6 | 8.0 | 8.0 | 20.0 | 35.0 |
| 22 | Iowa State Univ, Ames, USA | 7 | 15.3 | 6.0 | 1.0 | 35.0 | 54.0 |
| 23 | Swiss Fed Inst Technol, Zurich, Switzerland | 5 | 15.2 | 12.0 | 24.0 | 24.0 | 24.0 |
| 24 | USDA ARS, Riverside, USA | 6 | 15.2 | 3.0 | 2.0 | 10.0 | 71.0 |
| 25 | Dept Agr, Adelaide, Australia | 3 | 15.0 | 17.0 | 10.0 | 18.0 | 18.0 |

Mean = average times cited; median = middle of all citations; mode = most frequently occurring citation; Q3 = number of citations for 25% of the articles, i.e. if Q3 = 8 means that 25% of the articles were cited eight times or more; P90 = number of citations for 10% of the articles, i.e. if P90 = 17 means that 10% of the articles were cited 17 times or more.

Table 7
Citations to papers in Geoderma between 1981 and 1999 and in which journal they were made

| Rank | Citing journal | Citations | as % | Rank | Citing journal | Citations | as % |
|---|---|---|---|---|---|---|---|
| 1 | Geoderma | 1466 | 18.2 | 36 | Forest Ecology and Management | 45 | 0.6 |
| 2 | Soil Science Society of America Journal | 940 | 11.7 | 37 | Geological Society of America Bulletin | 44 | 0.5 |
| 3 | Soil Science | 379 | 4.7 | 38 | Progress in Physical Geography | 44 | 0.5 |
| 4 | Australian Journal of Soil Research | 296 | 3.7 | 39 | Organic Geochemistry | 36 | 0.4 |
| 5 | Water Resources Research | 247 | 3.1 | 40 | Soil Use and Management | 36 | 0.4 |
| 6 | Catena | 238 | 3.0 | 41 | Environmental Pollution | 29 | 0.4 |
| 7 | European Journal of Soil Science | 233 | 2.9 | 42 | Journal of Arid Environments | 29 | 0.4 |
| 8 | Soil Biology and Biochemistry | 220 | 2.7 | 43 | Ecology | 28 | 0.3 |
| 9 | Journal of Environmental Quality | 213 | 2.6 | 44 | Oecologia | 27 | 0.3 |
| 10 | Journal of Soil Science | 198 | 2.5 | 45 | Pedobiologia | 27 | 0.3 |
| 11 | Plant and Soil | 195 | 2.4 | 46 | Journal of Plant Nutrition and Soil Science | 26 | 0.3 |
| 12 | Canadian Journal of Soil Science | 191 | 2.4 | 47 | Journal of Soil and Water Conservation | 26 | 0.3 |
| 13 | Biology and Fertility of Soils | 184 | 2.3 | 48 | Mathematical Geology | 26 | 0.3 |
| 14 | Soil and Tillage Research | 182 | 2.3 | 49 | Chemosphere | 25 | 0.3 |
| 15 | Zeitschrift fur Pflanzenernahrung und Bodenkunde | 171 | 2.1 | 50 | Annals of the Association of American Geographers | 24 | 0.3 |
| 16 | Journal of Hydrology | 150 | 1.9 | 51 | Agricultural Water Management | 23 | 0.3 |
| 17 | Geochimica et Cosmochimica Acta | 149 | 1.9 | 52 | Agronomy Journal | 23 | 0.3 |
| 18 | Advances in Agronomy | 143 | 1.8 | 53 | Geology | 23 | 0.3 |
| 19 | Communications in Soil Science and Plant Analysis | 128 | 1.6 | 54 | Netherlands Journal of Agricultural Science | 23 | 0.3 |
| 20 | Biogeochemistry | 120 | 1.5 | 55 | Agrochimica | 22 | 0.3 |
| 21 | Clays and Clay Minerals | 117 | 1.5 | 56 | Arctic and Alpine Research | 22 | 0.3 |
| 22 | Water Air and Soil Pollution | 115 | 1.4 | 57 | Applied Geochemistry | 21 | 0.3 |
| 23 | Science of the Total Environment | 90 | 1.1 | 58 | Ground Water | 21 | 0.3 |
| 24 | Environmental Science and Technology | 89 | 1.1 | 59 | Canadian Journal of Forest Research | 20 | 0.2 |
| 25 | Agriculture Ecosystems and Environment | 88 | 1.1 | 60 | Ecological Modelling | 20 | 0.2 |
| 26 | Soil Science and Plant Nutrition | 84 | 1.0 | 61 | Agricultural Systems | 19 | 0.2 |
| 27 | Eurasian Soil Science | 82 | 1.0 | 62 | Comptes Rendus de L'Acad des Sci-Sci de la Terre et des Planetes | 19 | 0.2 |
| 28 | Clay Minerals | 70 | 0.9 | 63 | Field Crops Research | 19 | 0.2 |
| 29 | Journal of Contaminant Hydrology | 69 | 0.9 | 64 | Reviews of Geophysics | 19 | 0.2 |
| 30 | Quaternary Research | 63 | 0.8 | 65 | Sedimentary Geology | 19 | 0.2 |
| 31 | Chemical Geology | 61 | 0.8 | 66 | Canadian Agricultural Engineering | 18 | 0.2 |
| 32 | Transactions of the ASAE | 54 | 0.7 | 67 | ACS Symposium Series | 17 | 0.2 |
| 33 | Palaeogeography Palaeoclimatology Palaeoecology | 52 | 0.6 | 68 | Earth and Planetary Science Letters | 17 | 0.2 |
| 34 | Geomorphology | 51 | 0.6 | 69 | Journal of Sedimentary Petrology | 17 | 0.2 |
| 35 | Earth Surface Processes and Landforms | 46 | 0.6 | 70 | Reviews in Mineralogy | 17 | 0.2 |

Table 6 is that some of the institutes, which have published few papers had papers that were highly cited. This applies to the paper by David and Driscoll (1984) of the State University in New York and the paper by Jennifer Harden (1982) of the US Geological Survey who wrote the second most cited paper in Geoderma (see Appendix C).

### *4.5. Where do we get cited?*

Between 1981 and 1999, almost one-fifth of all the citations to Geoderma were made in the journal itself (Table 7). More than 10% of the citations have been made in the Soil Science Society of America Journal. The bulk of the citations to Geoderma papers are made in other soil science journals although a considerable number of citations have been made in Water Resources Research. Citations have further appeared in earth science periodicals (geomorphology, palaeontology), in agricultural journals and to a lesser extent in forest and ecological journals. Overall, a wide range of bio-physical journals have referred to Geoderma papers, which reflects the different subjects covered by Geoderma.

## 5. Discussion

### *5.1. Trends*

A number of important trends emerged from the analysis of 100 volumes of Geoderma. Although we would like to distil from this analysis some trends that are universal to soil science, we are aware that the analysis is restricted to the changes in one journal only. However, as the journal has a wide scope, the period of observation was long (34 years) and the sample size large (2079 papers), we feel that the analysis of Geoderma papers probably reveals some trends that apply to developments in soil science as a whole.

#### *5.1.1. Number of papers and authors*

The most eye-catching trend is the accelerated increase in the number of papers in the 1990s compared to the earlier decades. Obviously, this reflects the policy of the publisher to issue more volumes. More importantly, it shows the increase in the publishing of soil science, and this trend is also seen in a number of other soil science journals. From this analysis, we cannot conclude that the increased quantity of papers keeps pace with real advancements in soil science. Part of the increase is the result of a recycling of ideas and manuscripts, but we think that there is a positive relation between the number of papers published and developments in soil science. We dare to postulate therefore that the increased number of papers in Geoderma has likely yielded some advancements in soil science and this shows up in the steadily increasing impact factor of Geoderma. Only the future can tell whether this hypothesis is tenable.

A concurrent trend has been the increase in the number of authors per paper, which was 1.7 in 1967 but the number had grown to 2.5 by 1990 and to 3.1 in 2000. The number of pages per paper increased from 12.5 in 1967 to over 18 in 2000, but as the number of authors per paper grew faster, authors are contributing less to a paper, and papers per author decreased from nine in 1967 to around seven in 1996.

There are several reasons why the number of authors per paper has increased over time. Firstly, we have the socio-scientific explanation, the increased number of authors per paper goes hand in hand with the high pressure to publish in many institutes and universities. So loyalty to colleagues (you are co-author on my paper if I am co-author on your paper) is likely to be one of the causes for the increase. Secondly, it may be that an increasing amount of research is being conducted by scientists with different backgrounds (i.e. soil chemists and geostatisticians) and all contributors deserve credit for their input. Increased specialisation in soil science requires such intra-disciplinary efforts. At the same time, inter- and multi-disciplinary research projects, which are increasingly undertaken, may imply more authors per paper. So it seems that soil science has become less individualised and soil scientists are more dependent on each other and are working together. Thirdly, it may be that co-authors are listed, who in previous decades would be ignored despite their contributions to a paper. This could be for example technicians and GIS or laboratory assistants. In that way, soil science is emancipating and credit is being given to all contributions to a paper. The opposite side of the coin is that responsibility of individual authors is diluted whereas some co-authors listed may have had very little input and this is a cause for concern.

#### *5.1.2. Impact*

Ranking based on number of publications per institute or country yielded a different sequence compared to ranking based on impact. In other words, some institutes had a lot of papers but relatively low impact. The same applies to some countries.

It is difficult not to deduce that quality and quantity are somewhat mutually exclusive, i.e. the more papers the less impact. However, the "more is less" thought cannot be sustained. Firstly, there are many institutes that have published few papers in Geoderma, which have never been cited. So less is not necessarily more. The data show that "more is not necessarily more", and a dilution effect may occur. It may be that in universities and institutes with a strong publication pressure quality goes at the expense of quantity but on the other hand experience (somewhat equivalent to quantity) is likely to improve the quality of papers and hence the chance for getting cited.

We have seen that papers from the USA are well cited. This could obviously be related to the quality of the science and no doubt that applies to many of the papers. Our experience says, however, that there are papers from other parts of the world that are equally good. The relatively high impact of USA papers could be related to the fact that in the USA, which is the largest “market” for getting citations, papers from other parts of the world are less well cited and thus, a sort of bias is introduced in the citation analysis. We have no data to quantitatively prove this but we think it would be interesting to investigate whether such bias still exists.

*5.1.3. Changes in soil science subjects over time*

It is difficult to write history in the making and it is easier to unravel trends in present day soil science some 100 years from now. However, the trends emerged in the subject analysis over time showed roughly that the 1970s was the era of soil description and a considerable number of field studies were reported. In the 1980s, field studies declined, the focus of the papers widened and models as well (geo)statistics entered soil science in a big way. The 1990s showed a large increase in desk studies and a slight increase in field studies and papers had a stronger focus on applications. Now let us look at some of the details in these trends.

Research has become more focused with time and general soil science papers have been replaced with papers focussing on environmental and agricultural issues. In the 1970s, on average one paper per year focussed on soils and the environment but it had increased to eight papers per year in the 1990s. There has also have been an increase in speciation papers. This shows the stronger emphasis on the role of soils in environmental research. The most remarkable change was the large increase in global research, which occurred since the mid 1990s. In the 1970s, there were on average two papers per year with a global origin but it increased to 15 papers per year in the 1990s. It is the result of a larger interest in global research related to climate change and the availability of soil metadata at the global level. There has also been a considerable increase in the number of papers from arctic or boreal areas. This has occurred since 1997 possibly because of its importance in climate change studies.

In the 1970s, there were on average five soil physics papers per year but the yearly number of soil physics paper in the 1990s was 20. These trends in subject area reflect the large changes in information technology, environmental awareness and globalisation that have occurred over the last 30 years. Rapid advances in information technology have facilitated the rise in quantitative desk studies.

In summary, the subject analysis has shown that timely topics in the study and management of natural resources have cropped up in Geoderma. In the 1980s, we have observed an increasing number of multi-disciplinary research papers (the “Johan Bouma effect”). We also noted that the information age has brought much change in the type of papers being published and is likely to do so in the future.

### 5.2. The future

Before considering some thoughts on the future of Geoderma, some anecdotes. The famous German physicist and Nobel-laureate Max Planck (1858–1947) was told in 1874 to study something else, as all fundamental laws were known and all that left was to physicists was to fill in a few remaining details. Physics, so he was told, held meager future prospects. Planck ignored this advice and in 1900 he announced his quantum assumption in his talk at the German Physical Society in Berlin. Nobody, including himself, realised that he was opening the door to a completely new theoretical description of nature. As we know now, quantum mechanics changed our view of the world in a way that was completely surprising and had unprecedented depth, and it led to an immense number of technological applications including lasers and semi-conductors (Zeilinger, 2000).

It is interesting to note that the Australian soil physicist John Philip (1927–1999) had a similar experience when he followed an engineering course in the 1940s, and he noted: "...all things were understood and all a young engineer needed to know was what handbook to use" (Philip, 1991). He added to this observation that a modern day version would be "All things are understood, and all a young engineer needs to know is what software to use". The idea that we are close to an end of science or close to finding the final theory, is a demonstration of the limitation of human imagination as was exposed in these anecdotes. There is no doubt that soil science, and thus Geoderma, will change in the years to come. Those who believe that we may know sufficient about our soil, are as wrong as those who discouraged Max Planck to study physics and John Philip to study soil physics with the argument that much was known and only the details needed to be filled in.

So how will Geoderma change? We do not know exactly but changes will occur and they will be rapid following the electronification of science and society. Consider the following: Ten years ago a publisher's note appeared in vol. 52 announcing that "From now on, Geoderma will be accepting manuscripts submitted on floppy disks. This new systems will have two distinct advantages: first it will increase the publication speed of the journal, and secondly it will reduce the likelihood of typesetting errors, thus improving the quality of the journal." Ten years later, we have almost reached the electronic submission, the electronic review and the journal is also electronically available. In the distant future, the whole journal will be electronic. Quality control will be guaranteed by the peer-review process but if we move to electronic publishing can quality be guaranteed, will we write differently, and is peer review going to be abolished? Will machines write the papers, referee them, modify them and read them leaving us free to watch cricket and football? And will it affect the way we conduct soil science and how will impact or citation be measured? Those are difficult questions, which will be unravelled in the years to come but here we attempt some discussion.

It is likely that electronic publishing will affect the style of scientific writing (Gerstein, 1999). The length of on-line articles will be less restricted and it will be possible to use hypertext and to connect to supplementary material (colour pictures, maps, videos, etc.) on other websites or in external databases. This allows a reduction in the size of the main text and to make it less technical, moving the details to linked sections. It is also likely that the internet will affect the way we conduct soil science. For example, in bio-informatics using intelligent search engines and a large number of databases on the web, new combinations of information can be made. Could something similar be done in soil science using bits of information published on the web to create some new soil metadata and meta-information? It all depends on the quality and quantity of soil information that is put on the web. It also relies on the availability of databases, soil information systems and the willingness of institutes to put it on the web. In a rapidly commercialising world where information is valuable, that willingness may be limited (Hartemink, 2000).

Free availability of information of good quality would be beneficial for the advancement for soil science and Geoderma. The analysis of the published papers has indeed shown that an increasing number of contributions use existing data. No doubt that this should be applauded but we will always need new data as our basic understanding of the soil progresses and as the soil cover changes under environmental pressures, and hopefully to corroborate our models. There is a whole set of new techniques in soil survey that are waiting to be explored (McBratney et al., 2000) and in the future we will obviously see a number of these techniques in papers published in Geoderma. Will kinetic studies at soil organic and mineral interfaces, new mathematical formulations of soil physical phenomena, DNA and pedodiversity analysis or global studies be the focus for soil science in the future? Will one of these provide the unexpected breakthrough? The other papers in this Special Issue give some clues (Heuvelink and Webster, 2001; Sparks, 2001; Chadwick and Chorover, 2001; Raats, 2001; Insam, 2001)

This review has shown that much has changed between 1967 and 2001. Geoderma is now clearly a leading global journal of soil science. It took 34 years to publish the first 100 volumes of Geoderma. With the current rate of publication, the next 100 volumes will be published in 16 years and many changes have occurred and will continue to take place. Except for the incessant publication of solid soil science, there is another thing that has not changed thus far in Geoderma. That is the cover of the journal, which really is well designed and instantly recognised. In the years to come, the journal will probably only be available in electronic format. Will the cover disappear? Nothing is forever.

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## Appendix A. Special issues of Geoderma published between 1967 and 2001

| Year | Volume number | Title | Resulting from: | Editor(s) | Number of papers |
|---|---|---|---|---|---|
| 1967 | 1 (3–4) | Micromorphology of soils | Marking the 70th birthday of Prof. W.L. Kubiëna, founder and promoter of soil micromorphology | A. Jongerius | 14 |
| 1973 | 10 (1–2) | Non-agricultural applications of soil surveys | Reports of non-agricultural applications of soil surveys assembled by the editor | R.W. Simonson | 15 |
| 1974 | 12 (1–2) | Soil science in the USSR | Papers on history, achievements and current research for the 10th International Congress of Soil Science in Moscow in 1974 | R.W. Simonson | 19 |
| 1974 | 12 (4) | Fifty years progress in soil science | Papers on the occasion of the 50th anniversary of the International Society of Soil Science | F.A. van Baren, V.A. Kovda | 9 |
| 1977 | 18 (1–2) | The nine unit land surface model. An approach to pedogeomorphic research | Monograph on contemporary pedogeomorphic processes and their response within a land surface catena framework | A.J. Conacher, J.B. Dalrymple | 1 |
| 1982 | 27 (1–2) | Characteristics, genesis and classification of strongly weathered soils of Puerto Rico | Summarizing results by soil scientist of the University of Puerto Rico and Hawaii | R.W. Simonson | 3 |
| 1982 | 28 (3–4) | Aridic soils | Papers resulting from international conference on aridic soils held in Jerusalem, March 1981 | R.W. Simonson, D.H. Yaalon | 8 |

| | | | | | |
|---|---|---|---|---|---|
| 1983 | 30 (1–4) | Submicroscopic studies of soils | Papers from the "International Working-Group on Submicroscopy of Undisturbed Soil Materials (IWGSUSM)" | E.B.A. Bisdom, J. Ducloux | 24 |
| 1986 | 38 (1–4) | Mechanisms of ion transport in soils | Proceedings from "Workshop on Mechanisms of Ion Transport in Soils" held in Zurich in May 1985 | H.M Selim, H. Fleuhler, R. Schulin | 21 |
| 1987 | 40 (1–2) | Micromorphology and submicroscopical studies of North American soils | Papers from a symposium held at the University of Saskatchewan, Saskatoon, in July 1986 | A.R. Mermut | 15 |
| 1989 | 44 (2–3) | Impact of physico-chemistry on the study, design and optimization processes in natural porous media | Extended versions of some of the papers presented at an international conference held in Nancy in June 1987 | D. Schweich, M. Sardin | 15 |
| 1989 | 45 (2) | Climatic and lithostratigraphic significance of Paleosols | Papers from the symposium on the significance of Paleosols held in Ottawa in August 1987 | K.W.G. Valentine, D.H. Yaalon | 6 |
| 1990 | 46 (1–3) | Transport of water and solutes in macropores | Collection of papers presented at the 80th annual meeting of the ASA held in Anaheim in December 1988 | M. Th. van Genuchten, D.E. Rolston, P.F. Germann | 19 |

| Year | Volume number | Title | Resulting from: | Editor(s) | Number of papers |
|---|---|---|---|---|---|
| 1991 | 51 (1–4) | Weathering and soils | Papers resulting from a symposium at the IGC Congress in Washington in July 1989 | M.J. Pavich | 12 |
| 1992 | 53 (3–4) | Digitization, processing and quantitative interpretation of image analysis in soil science and related areas | Papers presented at a symposium of the Soil Science Society of America meeting in San Antonio in October 1990 | A.R. Mermut, L.D. Norton | 14 |
| 1993 | 56 (1–4) | Soil structure/soil biota interrelationships | Papers from conference on Methods of Research on Soil | L. Brussaard, M.J. Kooistra | 54 |
| | 57 (1–2) | | Structure/Soil Biota Interrelationships held in Wageningen in November 1991 | | |
| 1993 | 60 (1–4) | Operational methods to characterize soil behavior in space and time | Resulting from papers presented at a conference of the ISSS working group “Moisture Variability in Space and Time” held in Cornell in July 1992 | R.J. Wagenet, J. Bouma | 23 |
| 1994 | 62 (1–3) | Pedometrics-92: Developments in spatial statistics for soil science | Papers from the conference “Developments in spatial statistics for soil science” organized by the ISSS Working Group on Pedometrics in Wageningen in 1992 | J.J. de Gruijter, R. Webster, D.E. Myers | 20 |
| 1995 | 67 (1–2) | Environmental soil chemistry | Collection of invited papers in the field of soil chemistry | D.L. Sparks | 8 |
| 1996 | 70 (2–4) | Fingered flow in unsaturated soil: from nature to model | Papers presented during a workshop held at the Winand Staring Centre in Wageningen in April 1994 | T.S. Steenhuis, C.J. Ritsema, L.W. Dekker | 13 |

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| 1997 | 77 (2–4) | Fuzzy sets in soil science | Papers from symposium organised by ISSS Pedometrics Working Group and the SSSA in St. Louis in October 1995 | J.J. de Gruijter, A.B. McBratney, K. McSweeney | 12 |
| 1997 | 97 (1–4) | Management of carbon in tropical soils under global change: Science, practice, and policy | Papers resulting from symposium held at ICRAF, Nairobi, in February 1994 | E.T. Elliott, J. Kimble, M.J. Swift | 10 |
| 1997 | 80 (3–4) | NMR in soil science | Proceedings of a workshop entitled “NMR in soil science” held in Wageningen in September 1996 | M.A. Hemminga, P. Buurman | 14 |
| 1997 | 81 (1–2) | Evaluation and comparison of soil organic matter models | Papers resulting from a NATO Advanced Research Workshop held at IACR-Rothamsted in May 1995 | P. Smith, D.S. Powlson, J.U. Smith, E.T. Elliott | 10 |
| 1998 | 82 (1–3) | Biogeochemistry of isotopes in soil environments: Theory and application | Papers presented at a symposium during the annual meeting of the SSSA in Seattle in 1994 | L.C. Nordt, E.F. Kelly, T.W. Boutton, O.A. Chadwick | 12 |
| 1998 | 84 (1–3) | Contaminants and the soil environment | Selected papers from the “First International Conference on Contaminants and the soil Environment” held in Adelaide in 1996 | R. Naidu | 16 |
| 1998 | 85 (2–3) | Modeling spatial and temporal variability as a function of scale | Papers presented at a symposium of the ASA-SSSA meeting held in Indianapolis in November 1996 | M.R. Hoosbeek, H.M. van Es, A. Stein | 7 |

| Year | Volume number | Title | Resulting from: | Editor(s) | Number of papers |
|---|---|---|---|---|---|
| 1998 | 87 (1–2) | Soils with gypsum | Papers presented at an international symposium held at the University of Lleida in September 1996 | J. Herrero, R.M. Poch | 8 |
| 1999 | 88 (3–4) | Fractals in soil science | Invited papers | Ya.A Pachepsky, J.W. Crawford, W.J Rawls | 14 |
| 1999 | 89 (1–2) | Pedometrics ’97 | Papers presented at 2nd international conference of the ISSS Working Group on Pedometrics held at the University of Wisconsin in August 1997 | J.J. de Gruijter | 7 |
| 2000 | 94 (2–4) | The podzolization process | Papers resulting from a joint project by researchers from Sweden, Finland, Norway, The Netherlands and UK during 1996 and 1997 | US Lundström, N. van Breemen, D.C. Bain | 14 |
| 2000 | 97 (3–4) | Pedometrics ’98 | Papers presented at an INRA meeting and the 16th World Congress of Soil Science in Montpellier in August 1998 | M. Collins, A.B. McBratney, M. Voltz, C. Walter | 14 |
| 2001 | 100 (3–4) | Developments and trends in soil science | Marking the publishing of the 100th volume of Geoderma | A.E. Hartemink, A.B. McBratney | 7 |

## Appendix B. Discussion papers published in Geoderma

| Year | Volume number | Title | Author(s) | Comments from: |
|---|---|---|---|---|
| 1993 | 57 (3) | Soils as biotic constructs favouring net primary productivity | N. van Breemen | J.E. Lovelock, L.P. Wilding and E.F. Kelly, F. Stuart Chapin III |
| 1995 | 67 (3–4) | The role of soil science in agricultural development in East Africa | F.N. Muchena, R.M. Kiome | R. Lal, P.L.G. Vlek, L.O. Fresco |
| 1996 | 72 (3–4) | A theoretical framework for land evaluation | D.G. Rossiter | J. Bouma, P.A. Burrough, J.J. de Gruijter, E. van Ranst, A.K.L. Johnson, A.B. McBratney |
| 1997 | 78 (1–2) | The role of quantitative approaches in soil science when interacting with stakeholders | J. Bouma | A. Ruellan, G.B.M. Heuvelink, R.B. Brown, B.J. Culley, R.E. White |
| 1997 | 80 (1–2) | Random sampling or geostatistical modelling? Choosing between design-based and model-based sampling strategies for soil | D.J. Brus, J.J. de Gruijter | G.M. Laslett, G.B.M. Heuvelink, N. Cressie, N.S. Urquhart, R. Webster and A.B. McBratney |
| 1998 | 83 (3–4) | Pedodiversity and global soil patterns at coarse scales | J.J. Ibanez, S. De-Alba, A. Lobo, V. Zucarello | D.H. Yaalon, L.P. Wilding and L.C. Nordt, G.M. Hudson, M. van Meirvenne, I.O.A. Odeh, M.J. Vepraskas |
| 1998 | 86 (1–2) | On the relations between complex systems and the factorial model of soil formation | J.D. Phillips | R.J. Huggett, R. Amundson, M.R. Hoosbeek, Ya.A. Pachepsky, I. Ryzhova, Yu.N. Blagoveshchensky and V.P. Samsonova, G.S. Humphreys and T.R. Paton |
| 2000 | 96 (4) | An empirical stochastic model for the geometry of two-dimensional crack growth in soil | G.W. Horgan, I.M. Young | C.J. Moran and J.M. Kirby, D. Stoyan, H.J. Vogel, B. Velde, C.E. Mullins, P.A.C. Raats |

**Appendix C. 100 most frequently cited articles published in Geoderma between 1981–1999. Data from ISI-Philadelphia. Citations were counted between 1981 and 1999 in 70 journals including Geoderma (see Table 7)**

| Rank | No. of citations | Article |
|---|---|---|
| 1 | 187 | McGill WB, Cole CV, 1981. Comparative aspects of cycling of organic C, N, S and P through soil organic-matter. Geoderma 26: 267–286 |
| 2 | 122 | Harden JW, 1982. A quantitative index of soil development from field descriptions—examples from a chronosequence in central California. Geoderma 28: 1–28 |
| 3 | 116 | David MB, Driscoll CT, 1984. Aluminum speciation and equilibria in soil solutions of a Haplorthod in the Adirondack mountains (New York, USA). Geoderma 33: 297–318 |
| 4 | 109 | Kung KJS, 1990. Preferential flow in a sandy vadose zone. 1. Field observation. Geoderma 46: 51–58 |
| 5 | 72 | Andreini MS, Steenhuis TS, 1990. Preferential paths of flow under conventional and conservation tillage. Geoderma 46: 85–102 |
| 6 | 71 | van Genuchten MT, Dalton FN, 1986. Models for simulating salt movement in aggregated field soils. Geoderma 38: 165–183 |
| 7 | 70 | Brusseau ML, Rao PSC, 1990. Modeling solute transport in structured soils—a review. Geoderma 46: 169–192 |
| 8 | 65 | Fitzpatrick RW, Schwertmann U, 1982. Al-substituted goethite—an indicator of pedogenic and other weathering environments in South Africa. Geoderma 27: 335–347 |
| 9 | 63 | Hole FD, 1981. Effects of animals on soil. Geoderma 25: 75–112 |
| 10 | 61 | Ingestad T, 1987. New concepts on soil fertility and plant nutrition as illustrated by research on forest trees and stands. Geoderma 40: 237–252 |
| 11 | 58 | Kung KJS, 1990. Preferential flow in a sandy vadose zone: 2. Mechanism and implications. Geoderma 46: 59–71 |
| 12 | 57 | Childs CW, Lee R, Parfitt RL, 1983. Movement of aluminum as an inorganic complex in some podzolized soils, New Zealand. Geoderma 29: 139–155 |
| 13 | 56 | Smeck NE, 1985. Phosphorus dynamics in soils and landscapes. Geoderma 36: 185–199 |
| 14 | 55 | Luxmoore RJ, Jardine PM, Wilson GV, Jones JR, Zelazny LW, 1990. Physical and chemical controls of preferred path flow through a forested hillslope. Geoderma 46: 139–154 |
| 15 | 54 | Troeh FR, Jabro JD, Kirkham D, 1982. Gaseous-diffusion equations for porous materials. Geoderma 27: 239–253 |
| 16 | 54 | Pennock DJ, De Jong E, Zebarth BJ, 1987. Landform classification and soil distribution in hummocky terrain, Saskatchewan, Canada. Geoderma 40: 297–315 |

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| 17 | 53 | Schimel DS, Coleman DC, Horton KA, 1985. Soil organic-matter dynamics in paired rangeland and cropland toposequences in north Dakota. Geoderma 36: 201–214 |
| 18 | 53 | Schwartz D, Guillet B, Lanfranchl R, Mariotti A, 1986. C-13/C-12 ratios of soil organic-matter as indicators of vegetation changes in the Congo. Geoderma 39: 97–103 |
| 19 | 49 | Tiller KG, Brummer G, Gerth J, 1984. The relative affinities of Cd, Ni and Zn for different soil clay fractions and goethite. Geoderma 34: 17–35 |
| 20 | 48 | Tiller KG, Brummer G, Gerth J, 1984. The sorption of Cd, Zn and Ni by soil clay fractions—procedures for partition of bound forms and their interpretation. Geoderma 34: 1–16 |
| 21 | 48 | Dalton FN, van Genuchten MT, 1986. The time-domain reflectometry method for measuring soil–water content and salinity. Geoderma 38: 237–250 |
| 22 | 46 | Oades JM, 1993. The role of biology in the formation, stabilization and degradation of soil structure. Geoderma 56: 377–400 |
| 23 | 45 | Piccolo A, Stevenson FJ, 1982. Infrared Spectra of Cu-2 + , Pb-2 + , and Ca-2 + complexes of soil humic substances. Geoderma 27: 195–208 |
| 24 | 45 | Schwertmann U, Murad E, Schulze DG, 1982. Is there Holocene reddening (hematite formation) in soils of axeric temperate areas. Geoderma 27: 209–223 |
| 25 | 44 | Magaritz M, Kaufman A, Yaalon DH, 1981. Calcium carbonate nodules in soils—O-18–O-16 and C-13–C-12 ratios and C-14 contents. Geoderma 25: 157–172 |
| 26 | 44 | Valentin C, Bresson LM, 1992. Morphology, genesis and classification of surface crusts in loamy and sandy soils. Geoderma 55: 225–245 |
| 27 | 43 | Bronger A, Heinkele T, 1989. Micromorphology and genesis of paleosols in the Luochuan loess section, China—pedostratigraphic and environmental implications. Geoderma 45: 123–143 |
| 28 | 42 | Brummer G, Clayton PM, Herms U, Tiller KG, 1983. Adsorption desorption and/or precipitation–dissolution processes of zinc in soils. Geoderma 31: 337–354 |
| 29 | 42 | Edwards WM, Shipitalo MJ, Owens LB, Norton LD, 1990. Effect of lumbricus-terrestris I burrows on hydrology of continuous no-till corn fields. Geoderma 46: 73–84 |
| 30 | 40 | Shanmuganathan RT, Oades JM, 1983. Influence of anions on dispersion and physical properties of the a horizon of a red-brown earth. Geoderma 29: 257–277 |
| 31 | 40 | Norton LD, 1987. Micromorphological study of surface seals developed under simulated rainfall. Geoderma 40: 127–140 |

| Rank | No. of citations | Article |
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| 32 | 40 | Stein A, Hoogerwerf M, Bouma J, 1988. Use of soil-map delineations to improve (co-)kriging of point data on moisture deficits. Geoderma 43: 163–177 |
| 33 | 38 | Sanchez PA, Buol SW, Couto W, 1982. The fertility capability soil classification-system—interpretation, applicability and modification. Geoderma 27: 283–309 |
| 34 | 36 | Jardine PM, Wilson GV, Luxmoore RJ, 1990. Unsaturated solute transport through a forest soil during rain storm events. Geoderma 46: 103–118 |
| 35 | 36 | Crawford JW, Ritz K, Young IM, 1993. Quantification of fungal morphology, gaseous transport and microbial dynamics in soil—an integrated framework utilizing fractal geometry. Geoderma 56: 157–172 |
| 36 | 35 | Wieder M, Yaalon DH, 1982. Micromorphological fabrics and developmental stages of carbonate nodular forms related to soil characteristics. Geoderma 28: 203–220 |
| 37 | 35 | Senesi N, Testini C, 1982. Physicochemical investigations of interaction mechanisms between s-triazine herbicides and soil humic acids. Geoderma 28: 129–146 |
| 38 | 35 | Parfitt RL, Orbell GE, Russell M, 1983. Weathering sequence of soils from volcanic ash involving allophane and halloysite, New Zealand. Geoderma 29: 41–57 |
| 39 | 35 | Groenevelt PH, Grant CD, Kay BD, 1984. Physical assessment of a soil with respect to rooting potential. Geoderma 34: 101–114 |
| 40 | 34 | Kluitenberg GJ, Horton R, 1990. Effect of solute application method on preferential transport of solutes in soil. Geoderma 46: 283–297 |
| 41 | 34 | Jeanroy E, Guillet B, 1981. The occurrence of suspended ferruginous particles in pyrophosphate extracts of some soil horizons. Geoderma 26: 95–105 |
| 42 | 34 | Higashi T, de Coninck F, Gelaude F, 198. Characterization of some spodic horizons of the campine (Belgium) with dithionite-citrate, pyrophosphate and sodium hydroxide-tetraborate. Geoderma 25: 131–142 |
| 43 | 33 | Schwertmann U, Latham M, 1986. Properties of iron-oxides in some New Caledonian oxisols. Geoderma 39: 105–123 |
| 44 | 33 | Anderson SH, Peyton RL, Gantzer CJ, 1990. Evaluation of constructed and natural soil macropores using X-ray computed-tomography. Geoderma 46: 13–29 |
| 45 | 33 | Brimhall GH, Lewis CJ, Ford C, Bratt J, Taylor G, Warin O, 1991. Quantitative geochemical approach to pedogenesis—importance of parent material reduction, volumetric expansion, and eolian influx in lateritization. Geoderma 51: 51–91 |

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| 46 | 33 | Ladd JN, Foster RC, Skjemstad JO, 1993. Soil structure—carbon and nitrogen-metabolism. Geoderma 56: 401–434 |
| 47 | 33 | Cross AF, Schlesinger WH, 1995. A literature review and evaluation of the Hedley fractionation—applications to the biogeochemical cycle of soil-phosphorus in natural ecosystems. Geoderma 64: 197–214 |
| 48 | 32 | Ross GJ, Ozkan AI, Rees HW, Wang C, 1982. Weathering of chlorite and mica in a New Brunswick podzol developed on till derived from chlorite mica schist. Geoderma 27: 255–267 |
| 49 | 32 | Amacher MC, Iskandar IK, Kotubyamacher J, Selim HM, 1986. Retention and release of metals by soils—evaluation of several models. Geoderma 38: 131–154 |
| 50 | 32 | Bouma J, 1990. Using morphometric expressions for macropores to improve soil physical analyses of field soils. Geoderma 46: 3–11 |
| 51 | 32 | Desjardins T, Andreux F, Volkoff B, Cerri CC, 1994. Organic-carbon and c-13 contents in soils and soil size-fractions, and their changes due to deforestation and pasture installation in Eastern Amazonia. Geoderma 61: 103–118 |
| 52 | 31 | Russell JD, Fraser AR, Jones D, Vaughan D, 1983. An ir spectroscopic study of soil humin and its relationship to other soil humic substances and fungal pigments. Geoderma 29: 1–12 |
| 53 | 31 | Kampf N, Schwertmann U, 1983. Goethite and hematite in a climosequence in southern Brazil and their application in classification of kaolinitic soils. Geoderma 29: 27–39 |
| 54 | 31 | Guggenberger G, Zech W, 1993. Dissolved organic-carbon control in acid forest soils of the fichtelgebirge (Germany) as revealed by distribution patterns and structural composition analyses. Geoderma 59: 109–129 |
| 55 | 30 | Shipitalo MJ, Protz R, 1989. Chemistry and micromorphology of aggregation in earthworm casts. Geoderma 45: 357–374 |
| 56 | 30 | Hoosbeek MR, Bryant RB, 1992. Towards the quantitative modeling of pedogenesis—a review. Geoderma 55: 183–210 |
| 57 | 29 | Topp GC, Davis JL, 1981. Detecting infiltration of water through soil cracks by time-domain reflectometry. Geoderma 26: 13–23 |
| 58 | 29 | Muhs DR, 1982. A soil chronosequence on quaternary marine terraces. Geoderma 28: 257–283 |

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| 59 | 29 | van Kuilenburg J, Bouma J, de Gruijter JJ, Marsman BA, 1982. Accuracy of spatial interpolation between point data on soil-moisture supply capacity, compared with estimates from mapping units. Geoderma 27: 311–325 |
| 60 | 29 | Gregorich EG, Anderson DW, 1985. Effects of cultivation and erosion on soils of 4 toposequences in the Canadian prairies. Geoderma 36: 343–354 |
| 61 | 29 | Zech W, Hempfling R, Haumaier L, Schulten HR, Haider K, 1990. Humification in sub-alpine rendzinas–chemical-analyses, IR and C-13 NMR-spectroscopy and pyrolysis-field ionization mass-spectrometry. Geoderma 47: 123–138 |
| 62 | 29 | Wilson GV, Jardine PM, Luxmoore RJ, Jones JR, 1990. Hydrology of a forested hillslope during storm events. Geoderma 46: 119–138 |
| 63 | 29 | Monrozier LJ, Ladd JN, Fitzpatrick RW, Foster RC, Raupach M, 1991. Components and microbial biomass content of size fractions in soils of contrasting aggregation. Geoderma 50: 37–62 |
| 64 | 29 | Murphy EM, Zachara JM, 1995. The role of sorbed humic substances on the distribution of organic and inorganic contaminants in groundwater. Geoderma 67: 103–124 |
| 65 | 28 | Hassink J, Bouwman LA, Zwart KB, Bloem J, Brussaard L, 1993. Relationships between soil texture, physical protection of organic-matter, soil biota, and c-mineralization and n-mineralization in grassland soils. Geoderma 57: 105–128 |
| 66 | 28 | van Breemen N, 1993. Soils as biotic constructs favoring net primary productivity. Geoderma 57: 183–211 |
| 67 | 28 | Hutchinson MF, Gessler PE, 1994. Splines-more than just a smooth interpolator. Geoderma 62: 45–67 |
| 68 | 27 | Pena F, Torrent J, 1984. Relationships between phosphate sorption and iron-oxides in Alfisols from a river terrace sequence of Mediterranean Spain. Geoderma 33: 283–296 |
| 69 | 27 | Birkeland PW, 1984. Holocene soil chronofunctions, southern alps, New-Zealand. Geoderma 34: 115–134 |
| 70 | 27 | Janssen BH, Guiking FCT, van der Eijk D, Smaling EMA, Wolf J, van Reuler H, 1990. A system for quantitative-evaluation of the fertility of tropical soils (QUEFTS). Geoderma 46: 299–318 |
| 71 | 27 | Petach MC, Wagenet RJ, Degloria SD, 1991. Regional water-flow and pesticide leaching using simulations with spatially distributed data. Geoderma 48: 245–269 |

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| 72 | 26 | McKeague JA, Kodama H, 1981. Imogolite in cemented horizons of some British-Columbia soils. Geoderma 25: 189–197 |
| 73 | 26 | Lal R, 1981. Soil-erosion problems on Alfisols in Western Nigeria 6. Effects of erosion on experimental plots. Geoderma 25: 215–230 |
| 74 | 26 | Smettem KRJ, Collis-George N, 1985. Statistical characterization of soil biopores using a soil peel method. Geoderma 36: 27–36 |
| 75 | 26 | Ambrosi JP, Herbillon AJ, Nahon D, 1986. The epigenetic replacement of kaolinite by hematite in laterite-petrographic evidence and the mechanisms involved. Geoderma 37: 283–294 |
| 76 | 25 | McBratney AB, Webster R, 1981. Spatial dependence and classification of the soil along a transect in northeast Scotland. Geoderma 26: 63–82 |
| 77 | 25 | Agassi M, Morin J, Shainberg I, 1982. Laboratory studies of infiltration and runoff control in semi-arid soils in Israel. Geoderma 28: 345–356 |
| 78 | 25 | Tippkotter R, 1983. Morphology, spatial arrangement and origin of macropores in some Hapludalfs, West-Germany. Geoderma 29: 355–371 |
| 79 | 25 | Davies BE, 1983. A graphical estimation of the normal lead content of some British soils. Geoderma 29: 67–75 |
| 80 | 25 | Bresson LM, Boiffin J, 1990. Morphological characterization of soil crust development stages on an experimental field. Geoderma 47: 301–325 |
| 81 | 24 | Tarchitzky J, Banin A, Chen Y, Morin J, 1984. Nature, formation and effects of soil crusts formed by water drop impact. Geoderma 33: 135–155 |
| 82 | 24 | Stumm W, 1986. Coordinative interactions between soil solids and water-an aquatic chemists point of view. Geoderma 38: 19–30 |
| 83 | 24 | Schulten HR, Hempfling R, Zech W, 1988. Discriminating horizons in a moder profile by field-ionization mass-spectrometry and pattern-recognition. Geoderma 41: 211–222 |
| 84 | 24 | Sudicky EA, 1990. The laplace transform galerkin technique for efficient time-continuous solution of solute transport in double-porosity media. Geoderma 46: 209–232 |
| 85 | 24 | Scheidegger A, Borkovec M, Sticher H, 1993. Coating of silica sand with geothite-preparation and analytical identification. Geoderma 58: 43–65 |
| 86 | 24 | Chenu C, 1993. Clay polysaccharide or sand polysaccharide associations as models for the interface between microorganisms and soil-water related properties and microstructure. Geoderma 56: 143–156 |

| Rank | No. of citations | Article |
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| 87 | 24 | Addiscott TM, 1993. Simulation modeling and soil behavior. Geoderma 60: 15–40 |
| 88 | 23 | Cabrera F, Dearambarri P, Madrid L, Toca CG, 1981. Desorption of phosphate from iron-oxides in relation to equilibrium pH and porosity. Geoderma 26: 203–216 |
| 89 | 23 | Preston CM, Dudley RL, Fyfe CA, Mathur SP, 1984. Effects of variations in contact times and copper contents in a C-13 CPMAS NMR-study of samples of 4 organic soils. Geoderma 33: 245–253 |
| 90 | 23 | Mctainsh G, 1984. The nature and origin of the aeolian mantles of central Northern Nigeria. Geoderma 33: 13–37 |
| 91 | 23 | Arduino E, Barberis E, Franchini M, Marsan FA, Zanini E, 1986. Iron-oxides and clay-minerals within profiles as indicators of soil age in Northern Italy. Geoderma 37: 45–55 |
| 92 | 22 | Fox RL, 1982. Some highly weathered soils of Puerto Rico: 3. Chemical-properties. Geoderma 27: 139–176 |
| 93 | 22 | Courty MA, Fedoroff N, 1985. Micromorphology of recent and buried soils in a semiarid region of Northwestern India. Geoderma 35: 287–332 |
| 94 | 22 | Haynes RJ, Swift RS, 1985. Effects of air-drying on the adsorption and desorption of phosphate and levels of extractable phosphate in a group of acid soils, New Zealand. Geoderma 35: 145–157 |
| 95 | 22 | Mucher HJ, Chartres CJ, Tongway DJ, Greene RSB, 1988. Micromorphology and significance of the surface crusts of soils in rangelands near Cobar, Australia. Geoderma 42: 227–244 |
| 96 | 22 | Fine P, Laven R, Verosub K, Southard RJ, Singer MJ, 1989. Role of pedogenesis in distribution of magnetic-susceptibility in 2 California chronosequences. Geoderma 44: 287–306 |
| 97 | 22 | Hantschel R, Horn R, Kaupenjohann M, Zech W, Gradl J, 1988. Ecologically important differences between equilibrium and percolation soil extracts, Bavaria. Geoderma 43: 213–227 |
| 98 | 22 | Juma NG, 1993. Interrelationships between soil-structure texture, soil biota soil organic-matter and crop production. Geoderma 57: 3–30 |
| 99 | 22 | Smith P, Smith JU, Powlson DS, Mcgill WB, Arah JRM, Chertov OG, Coleman K, Franko U, Frolking S, Jenkinson DS, Jensen LS, Kelly RH, Kleingunnewiek H, Komarov AS, Li C, Molina JAE, Mueller T, Parton WJ, Thornley JHM, Whitmore AP, 1997. A comparison of the performance of 9 soil organic-matter models using datasets from 7 long-term experiments. Geoderma 81: 153–225 |
| 100 | 21 | Crampton CB, 1982. Podzolization of soils under individual tree canopies in Southwestern British Columbia, Canada. Geoderma 28: 57–61 |