Soil Use and Management

EDITORIAL

40@40: Soil Use & Management, A Fortieth Anniversary Retrospective

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1 | Introduction

Soil management represents the practical roots of soil science, aiming to optimise soil use amid a changing land-use environment and society's need for increased food production. Its progression as a scientific discipline stems from the accumulation of knowledge in the natural sciences—chemistry, physics and biology—during the late 19th century. This laid the foundations for a rapid expansion in soil science across specialised branches and arguably led soil science to diverge along two related, but parallel tracks: theoretical and applied. For many years thereafter, soil science journals largely catered to the former, neglecting the latter. In the early 1980's, the British Society of Soil Science recognised the need to reconnect these strands within published research, leading to the creation of Soil Use and Management (SUM). In the inaugural issue (March 1985), the first Editor, Prof. Alan Wild of Reading University, described the Editorial Policy of the journal as 'a challenge to soil scientists, and others working with soils, to show that their research can be useful'. Today, SUM continues to publish innovative research that provides new insights into the influence of natural and anthropogenic processes, now emphasising not only agricultural productivity but also soil functions, soil health, and the long-term sustainability of managed soil systems.

This year we mark SUM's 40th anniversary with a special collection of 40 selected papers, aptly titled 40@40. These papers follow the development of applied soil research, from its traditional agricultural origins to its broader role in tackling global environmental challenges and societal concerns. Over the same period, SUM has evolved from a strong, UK-centric focussed journal to one with significant international reach, as evidenced by the global distribution of published articles (Figure 1 and Table 1) and the diverse composition of the SUM editorial team.

The first four volumes covered themes of concern to either farmers, the wider public or both:

- soil acidification,
- the management of upland soils,
- assessment of nitrogen (N) fertiliser requirements,
- problems of (soil) management under intensive use, including erosion.

In the following two years, issues alternated between those that had a specific theme and those that were 'open' to any relevant subject. The early themes were: soil water, land use and management and water management in dryland areas.

The first issue of 1987 made a new development with a series of papers on the application of technology (computers and statistics) to soil science. Throughout the four decades of SUM this 'departure' became standard practice.

The March 1988 issue reported responses to the change in priorities for agriculture that had taken place in the UK in the 1980s. The focus was no longer on increasing production, which had been achieved primarily by greatly increased crop yields, but to preserve the diversity of the landscape and the flora and fauna within. But it was clear that there was still a need for 'sound, objective and relevant data' to enable the development of robust policies to achieve these new goals, and a crucial part of that need had to be met by soil science.

A further broadening of the scope of SUM took place in March 1990 when Volume 6 incorporated the Journal 'Soil Survey and Land Evaluation', which had ceased publication the previous year.

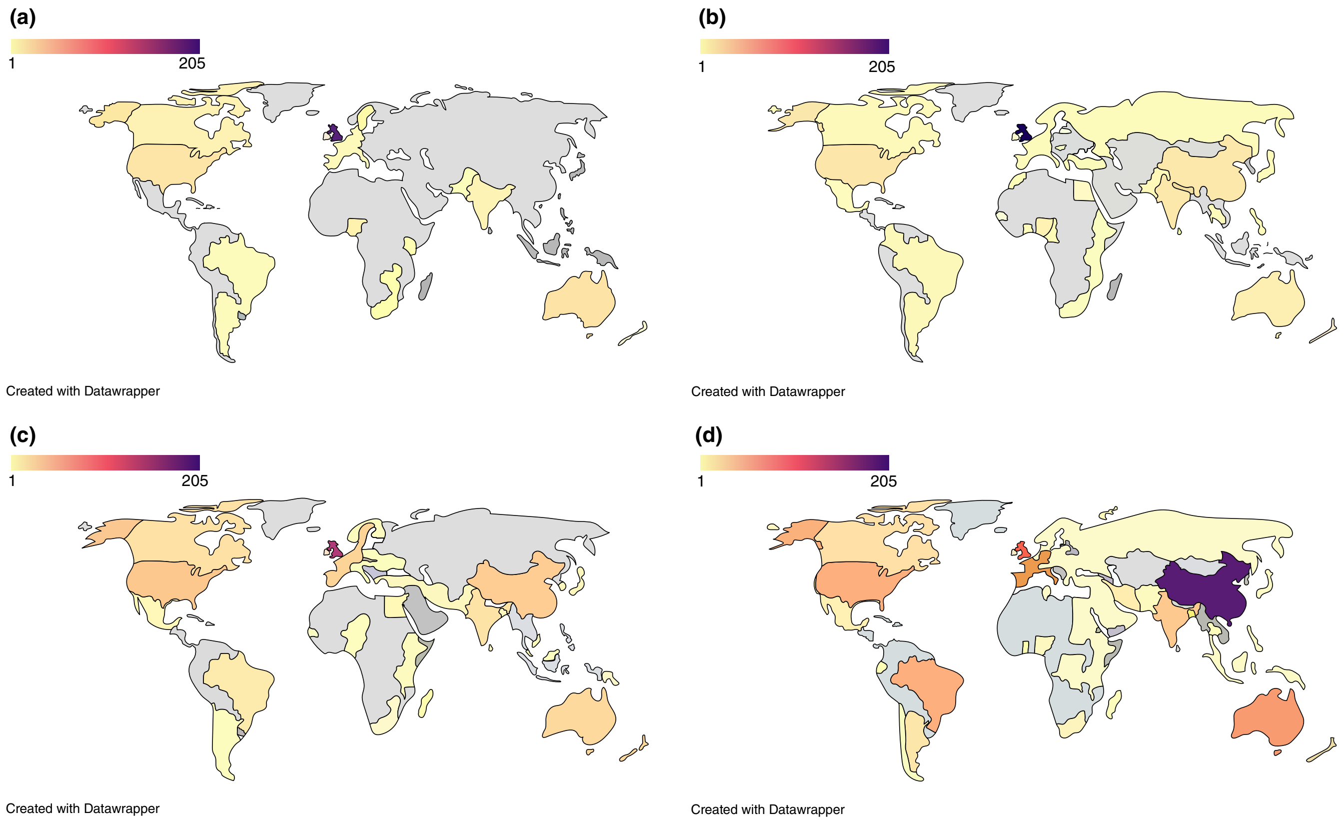

FIGURE 1 | Global Distribution of Articles Published in *Soil Use and Management*: (a) 1st decade 1985–1994, (b) 2nd decade 1995–2004, (c) 3rd decade 2005–2014, (d) 4th decade 2015–2024. Data collected from corresponding authors' institutional addresses.

TABLE 1 | Main countries of origin of papers in each decade.

1st decade	%	2nd decade	%	3rd decade	%	4th decade	%
United Kingdom	61.8	United Kingdom	45.5	United Kingdom	24.4	China	21.0
Australia	5.6	Denmark	4.2	United States	6.1	United Kingdom	10.9
United States	5.3	Spain	4.0	Spain	5.9	Australia	7.2
Netherlands	4.3	Belgium	3.8	China	5.4	Brazil	5.7
Nigeria	2.7	United States	3.3	Belgium	4.9	United States	5.7
Canada	2.7	China	3.1	New Zealand	4.5	Germany	4.5
India	2.3	New Zealand	2.7	France	4.5	India	3.9
Spain	1.7	France	2.7	Australia	4.2	France	3.6
Germany	1.3	Netherlands	2.5	Denmark	4.2	Spain	2.8
Denmark	1.3	India	2.5	Netherlands	3.1	Canada	2.1

Subsequent special editions dealt with land resource assessment and land evaluation (1989), the microbiology and chemistry of N turnover in soils, soil-borne plant pathogens (1990), modeling nitrate leaching, soil protection (1991), soil erosion (1992) and the N cycle (September, 1993).

In 1994, the departing editor (Prof. J.A. Catt) noted a decline in the 'scientific originality and quality' of papers submitted during the 5 years of his tenure, not just with SUM but with other journals in the broader area. He attributed the decline to increasing demands made on scientists to publish their work in peer-reviewed journals to boost their professional reputations, as well as the status of their employers and funding bodies, to secure funding for the next round of work. This was in the name of 'value for money' and was later considered detrimental to progress in the long term. The erstwhile Editor urged all those involved in scientific publishing to help overcome these problems by offering encouragement to under-pressure authors to ensure their work and its reporting were of satisfactory quality rather than justifying their work solely on the basis of the number of papers published.

December 1997 included a special edition on soils and the greenhouse effect, reflecting 'that the size of these emissions can be reduced by adoption of improved or alternative practices of land management or waste disposal, and in the case of carbon dioxide, the flux can be partially reversed through soil carbon (C) storage, i.e. through increases in soil organic matter'. It was considered 'timely to examine the current state of knowledge in this field'. Special editions dealt with 'phosphorus (P), agriculture and water quality', reflecting a revised understanding of the mobility of P in soils and the awareness of the harmful impacts to watercourses of even very small concentrations of P. A further special edition on this topic, providing a European perspective, appeared in 2007.

In 2000, a special edition reported progress on tackling nitrate leaching in the UK. This was followed by special editions on soil fertility in conventional and organic farming systems (2002). Among the outputs was an assessment of the adequacy of the then-current concept of soil fertility. The conclusion was drawn that, 'although nutrient management in organically managed soils is fundamentally different to soils managed conventionally, the underlying processes supporting soil fertility are not'.

The 2005 special edition was on the characterisation of contaminated land. A major driver of the work reported was UK legislation requiring the development of improved systems for identifying land that poses unacceptable risks to human health or the environment.

In 2008, an interesting perspective on the status of soil science was published as a guest editorial. Following World War II, there had been a global interest in improving what is now called 'food security'; soil science was seen as a crucial element in the drive to achieve this goal. This phase passed as agricultural production increased and, in some parts of the world, led to food surpluses. From the 1970s onward, growing concerns over environmental pollution and degradation led to a drive for sustainability; hence soil erosion, nutrient depletion and pollution became key concerns and revived interest in soil.

The year 2010 signalled the increased international emphasis of the journal by the appointment of two new deputy editors: Prof. Michael Goss from Canada and Hubert Tunney from Ireland. The year also saw the first Virtual Special Issue which drew together published papers on nitrous oxide (N_2O) emissions from soils. This initiative was developed to enhance the role of the Journal, with its focus on the application of soil science to soil management practice, as a source for teaching soil science in higher education. A special issue that year published papers on the theme 'Soil quality: does it equal environmental quality?'

In 2013, a special issue covered the topic of P in soil and its transfer to water (volume 29–1). Later that year, an editorial highlighted the growth in publications from China to 17 per year in 2011, the main themes of these papers being C and organic matter; physical, chemical and biological processes; nutrient management and soil degradation.

In 2015 a survey was carried out of views of members of the BSSS, readers and authors of SUM and the European Journal of Soil Science. Respondents recommended increases in the coverage of ecosystem services, sociological and policy aspects of soil management, and impacts of soil management on hydrology and biodiversity in SUM. There were requests for more papers on non-arable soils to be published in both journals. Also, in 2015 SUM published a special supplement on 'soil system science for sustainability and policy'. This comprised a collection of papers based on a series of review projects commissioned in 2009–2010 by the UK Department for Environment, Food and Rural Affairs (Defra), principally to provide a scientific evidence base to support strategic policy development in the context of ensuring the sustainability of soils. The topics were degradation threats, erosion, contamination by metals and metalloids, climate change impacts, technological opportunities to increase C storage in soils and the factors which underpin soil resilience.

A special issue of SUM was published in 2016 with the untimely death of Dr. Brian J Chambers, a valued colleague, friend and mentor to many of us in the soil science community. The edition was a tribute to the outstanding contribution he made to soil and agricultural science communities and his pioneering research on soils, nutrients and manure management.

The 70th anniversary of BSSS was in 2017 and in the anniversary issue two invited papers provided an update on the role of soil science in solving practical problems. The first focused on developments in the capability of land information systems (LIS). Combining database and metadata allows modern LIS to offer management options at a variety of scales. The second paper posed and answered the question 'Does variable rate irrigation decrease nutrient leaching losses?'. Benefits were reported in terms of N species and reactive and total P downstream of areas under variable rate irrigation compared with flood or uniform rate irrigation.

In 2019 a Special Issue of 19 papers brought together insights from Australia, the USA, and Europe about the generation, exchange and use of soil information and knowledge building for sustainable soil use and management, predominately in agriculture. Papers were grouped according to four key themes:

- Insights and implications for soil information sharing and knowledge building.
- Analysis of overarching themes for sustainable soil management.
- Soil information sharing, combining online and field activities, new audiences and evaluating use.
- Extension-building skills in soil information interpretation, audience trust and identifying learning needs.

A final section discussed collaborative approaches and farmer networks supporting knowledge building.

In 2021 the much-publicised topic of 'soil health' was discussed in several Commentaries. Reservations were expressed on whether the emphasis should be on soil health as an overarching principle around which to frame knowledge or on developing a metric to measure it, and whether it was possible to do both. To apply such terms as 'soil quality' and 'soil health' to soil without reference to a specific use or function expected of that soil has little meaning. However, it was suggested that the term—soil health—could open lines of communication between soil scientists and non-specialists, especially with politicians and policy makers.

A 2023 commentary by the new Editor-in-Chief, Deyi Hou, the first Editor from outside the English-speaking part of the world, returned to the topic of soils and food security, an issue that in recent decades has not always attracted the attention it did in the 1950s and '60s. Despite the increases in crop yields and food production the actual number of inadequately nourished people has changed little over 60 years. Managing soil resources with sustainable means remains an imperative to ensure food security.

The number of papers submitted to SUM has greatly increased over the years. Figure 2 below illustrates this increase in the number of papers. Figure 1 and Table 1 above indicate that much of this increase has arisen from the submission of papers from China and elsewhere.

2 | Introduction to Selected Papers

The Editorial team decided to select ten papers from each decade to illustrate how the topics covered by papers published in SUM over the journal's 40-year history have varied. Each Deputy Editor was assigned a decade, and their choice of papers was personal, reflecting, to some extent their own interests, but also their assessment of topical or innovative subjects in each decade. Each Deputy Editor has summarised their choices and explained the reasons for them.

As part of our assessment of changing subject matters over the years word cloud analyses were carried out for each decade (Figure 3).

3 | The First Decade, 1985–1994 (J Webb)

3.1 | Explanation of Approaches to Selecting Papers

Papers were chosen from the first decade of SUM because they included some particularly useful information and/or illustrated topics that were considered important at the time. Papers were not primarily judged by the number of citations they accrued as this is not an absolute indicator of quality. Moreover, as SUM was a new journal and one that had an intention to publish very practical work that could be of direct interest to farmers and others working in the land-based industries, a paper might be of value to them but not be cited by researchers.

The ten papers chosen mirror the most frequently published topics, but not entirely. During the first decade the most frequently used words were: N, leaching, nitrate and water (Figure 3). Key themes were: soil acidification, soil erosion, N cycling.

The dominance of UK authors reflects the authorship of the Journal's first decade.

The list includes a précis of the paper combined with reasons for choosing the paper.

3.2 | Soil Acidification

Soil acidification was of considerable interest in the decade and Hornung (1985) outlined the role of trees in soil acidification. The considerable variations in impact among species on similar soils and among sites for any given species are explained. In describing how acidification can be a process, the paper indicates that acidification is not axiomatically anthropogenic.

The acidification of soils and the subsequent mobilisation of soluble aluminium ions (Al^{3+}) to watercourses was of concern in

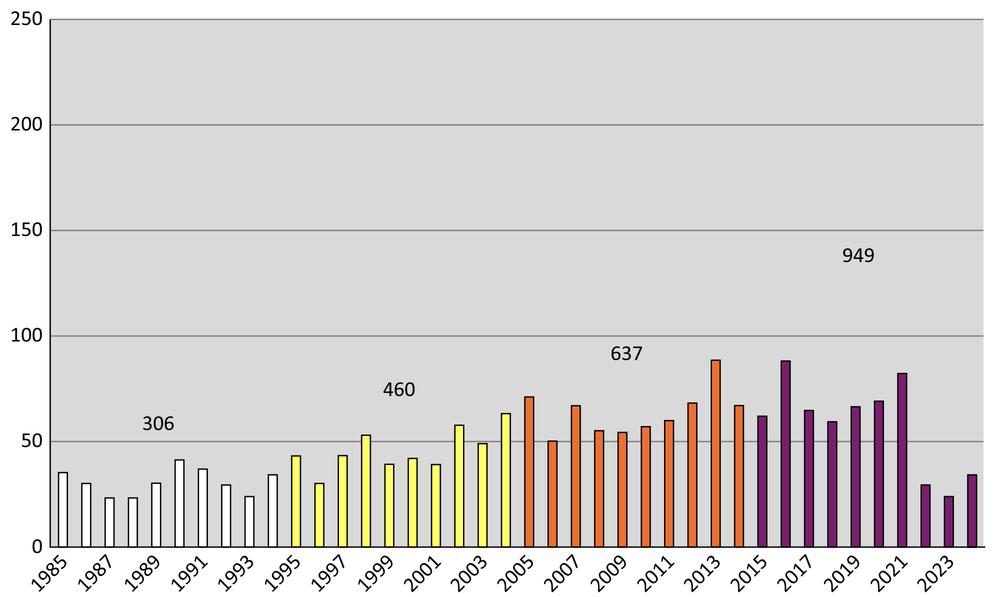

FIGURE 2 | The number of papers published in SUM each year and the total numbers for each decade.

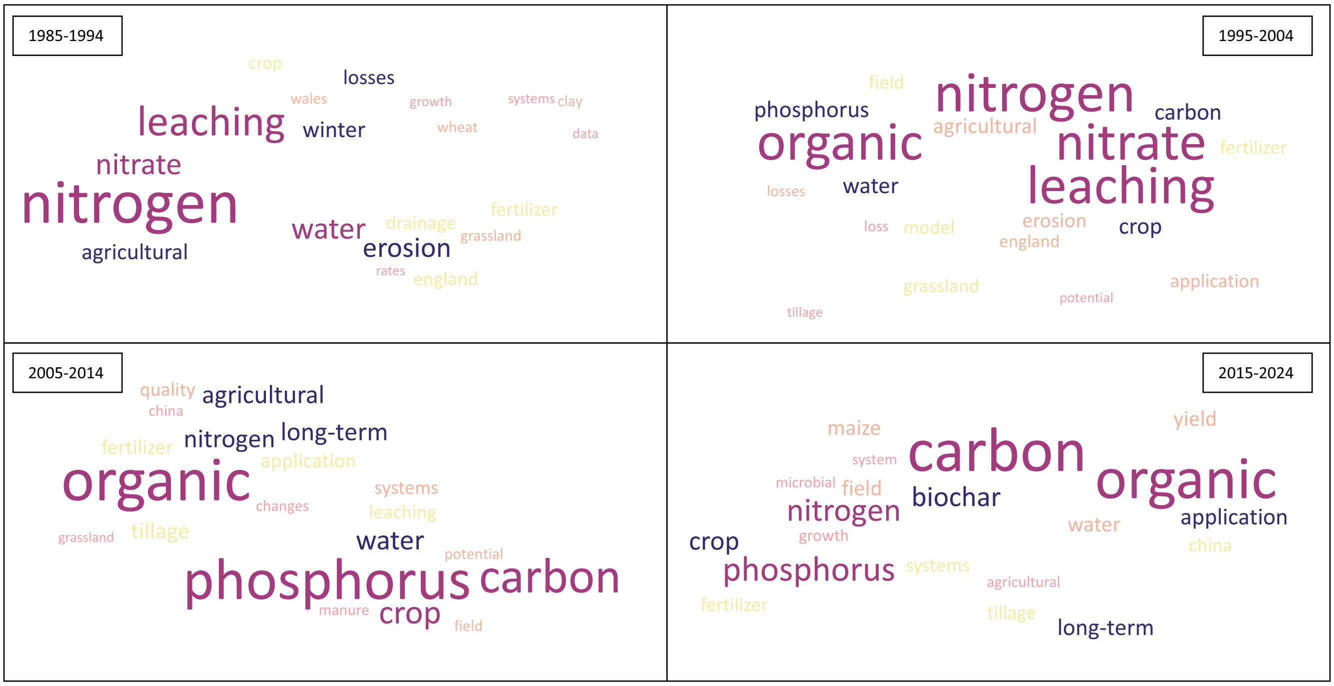

FIGURE 3 | The progression of research foci across the 4 decades; a keyword analysis.

the 1980s, being in the most frequent six of papers from 1985 to 1994. There were particular concerns that the presence of Al^{3+} in drinking water might increase susceptibility to Alzheimer's disease. Bache (1985) provided a clear summary of the mechanism of Al mobilisation in soils.

3.3 | Soil Erosion

In the 1980's there was much interest in the extent and causes of soil erosion in the UK. Morgan (1985) reported information on rainfall erosivity, soil erodibility and land capability and supplied a map of England and Wales showing areas with a risk of soil erosion at rates above the soil loss tolerance level. The study concluded that at current rates of erosion, sustained use of this susceptible area for cereal, sugar beet and vegetable production beyond the first quarter of the 21st century is threatened.

Fu (1989) was the first work from the People's Republic of China to be published in SUM. It reviewed the reasons for soil erosion in the loess plateau in China, the world's most developed region of loess in extent, thickness and depositional sequence. It is also the region with the most serious soil erosion in the world. This erosion was considered due to thousands of years of 'irrational' land use and exploitive management leading to the loss of grassland and natural woodlands.

3.4 | N Cycling

The behaviour of N in the soil was the most published topic between 1985 and 1994 accounting for *c*. 9% of all papers published. Powlson (1993) outlined the difficulties in gathering quantitative knowledge of the soil N cycle and the difficulties in making reliable measurements of many of the key processes under field conditions. While estimates of nitrate leaching using porous ceramic cups agree well with lysimeter measurements on sandy soil they are less reliable on more structured soils. Estimates of nitrous oxide (N_2O) flux from soil are subject to great spatial heterogeneity; developing long path-length measuring techniques was proposed to overcome this problem. Mineralization of soil organic matter and crop or animal residues provides much of the nitrate leached during winter under the climatic conditions of north-west Europe, because mineralization is poorly synchronised with crop N uptake. Maintenance of crop cover during winter can greatly decrease leaching but the long-term effects on the N cycle of winter cover crops or incorporating cereal straw were not yet clear.

Nitrate leaching was among the second most published topics of the decade in SUM. Thomsen et al. (1993) reported a 4-year lysimeter study in which crops were fertilised by either inorganic N or livestock. The results provided clear evidence on how the size of N additions and crop rotation influences the amount of nitrate leached overwinter thereby providing guidance for both farmers and policymakers on how nitrate leaching can be reduced.

3.5 | Soil Water Relationships

Soil water relationships were the subject of *c*. 10 papers published during the decade. Bowyer-Bower (1993) investigated the infiltration and runoff responses of degraded and non-degraded semi-arid land surfaces using rainfall simulation in the Lowveld of Swaziland. Rather than there being one final steady-state infiltration rate for a given soil type and condition (i.e., a constant of soil response), the final rates achieved were variable for each soil type and condition and depended upon rainfall intensity and antecedent moisture. The implications of this for soil use and management in terms of infiltration measurement and runoff assessment were considered. This paper is a good example of how a rigorous study of a topic may lead to practical guidance to improve soil management.

3.6 | Other Papers

Following the explosion at Chernobyl there was much concern over the impact of radionuclide deposition to land on food supplies across Europe. Bell et al. (1988) discussed the factors influencing uptake of radionuclides from soils into vegetation in relation to soil type, radionuclide, plant species and plant organ, and time since initial contamination. Gaps in knowledge were identified, particularly as highlighted by the unexpected behaviour of radiocaesium in many upland areas of Britain. The importance of resuspended soil for contamination of aboveground plant parts was also considered.

Aborisade and Aweto (1990) questioned whether tree cover maintains soil properties even when the type of tree is changed. Soil properties under 15-year-old plantations of gmelina (*Gmelina arborea*) and teak (*Tectona grandis*) were compared with logged forest soil in south-western Nigeria. The soil was significantly denser in the 0–10 cm layer of plantation soil and total porosity was less than that of forest soil. Organic C was significantly greater in the 0–10 cm layer of forest soil. Similarly, the concentrations of total N and exchangeable nutrient cations (calcium (Ca), magnesium (Mg), potassium (K)) were greater under forest soil, but the concentrations of available P were similar under all three ecosystems. The smaller organic C and nutrient content of plantation soil is mainly due to its more open organic matter and nutrient cycles and nutrient immobilisation in the fast-growing exotics. Hence it may be concluded that replacing native woodland with plantations does not axiomatically maintain soil quality.

Few papers on soil organic matter (SOM) were published in SUM during its first decade. Lepsch et al. (1994) measured topsoil (0–20 cm) and subsoil (60–100 cm) properties in agricultural and nearby natural vegetation sites in São Paulo State. Differences were related to land use and climate in order to estimate soil C storage under various ecosystems and also to study the effects of high-input agriculture on the chemical composition of soils with low activity clays. Within each land use, organic C in the topsoil was most strongly related to clay and silt content. The greatest C losses after long-term cultivation occurred in forest mineral topsoil. No significant difference in C content was found between the paired savannah-cultivated sites. Most subsoils at agricultural sites show increases in exchangeable bases (mainly Ca) and base saturation, but no significant change in soil pH.

4 | The Second Decade, 1995–2004 (Lisa Lobry de Bruyn)

4.1 | Explanation of Approaches to Selecting Papers

In choosing the 10 papers that best represent the second decade of SUM we looked at the topic areas, and it generated some well-known areas of inquiry as well as some emerging areas. Choosing the final ten papers was also difficult given the number of papers and wanting to accurately reflect the trends in research and publication over those ten years (Figure 2). Importantly we wanted to highlight those emerging areas of research, which may only have been represented by a handful of papers. These niche papers' relationship to current research topics is important to consider and how these papers may have influenced the direction of SUM in more recent decades.

The main topic areas were, soil C, soil erosion, soil monitoring, soil survey and land evaluation, while the emerging themes were indigenous soil knowledge and stakeholder analysis, soil quality, and soil biology (Figure 3).

4.2 | Soil C

Unlike the first decade of SUM, soil C was the most abundant topic area in SUM with 80 papers identified over the second decade and continues to be a prevalent topic in the journal. There was a surge in the late 1990s in the discussion of soil organic C (SOC) sequestration and its role in climate mitigation, but few empirical studies, and a reliance on modelling (Paustian et al. 1997; Falloon and Smith 2003). There were earlier studies describing the distribution of SOC using legacy soil data from various databases, and emphasis on the role of climate, soil type, particularly soil paper-size distribution and land use. Van Meirvenne et al. (1996) combined characterisation of SOC under intensive cultivation, and importantly changes over time, by revisiting 939 locations sampled previously under the Belgian National Survey 40 years earlier. The role of land management was given less emphasis and there were few long-term studies to show the impact of management on SOC sequestration. The papers chosen exemplified these types of papers and set the foundation for future empirical studies on the dynamics of SOC.

4.3 | Soil Erosion

Another area where SUM published extensively through its second decade was on soil erosion with 51 papers. Given this land degradation issue is still very prevalent and has major implications for SOC sequestration rates it is still often measured as soil erosion risk using the USLE (Auerswald et al. 2003) or now the RUSLE. To manage soil erosion risk maintenance of more than 50% cover and limiting tillage through no-till or conservation agriculture is required but across Europe adoption of no-till cultivation is still relatively small. Also, ground-breaking techniques to describe soil structure such as computed tomography were gaining recognition in this period and this paper had wider implications for other uses such as root architecture (Mooney 2002).

4.4 | Soil Nutrient Management, Particularly N and P Cycling

This topic area was well represented throughout the second decade of SUM and many papers were related to keeping nutrients in the soil and avoiding them being leached into waterways. The paper by Shepherd et al. (1996) at the beginning of the decade typified the need to manage soil nutrient levels by understanding the mechanisms of soil N dynamics.

4.5 | Soil monitoring, Soil Survey, and Land Evaluation

The earlier papers from this second decade of SUM were soil surveys of various land degradation issues such as water erosion, soil pollution and SOC. These papers also coincided with national-level soil monitoring activities in Europe, which in England have not been revisited, since 1995, with the same intensity. Interestingly with the introduction of the EU Soil Monitoring Law in 2023–2024, the availability and access to soil data are becoming increasingly important. At the end of the second decade only one paper was raising the role of digital soil information and its accessibility and scale, emphasizing the lack of fine-scale mapping of soil, and the loss of information (Rossiter 2004). However, the advances in modeling of soil properties such as bulk density have been highlighted in the third and fourth decades of SUM, making it possible to set a benchmark for national C inventories.

4.6 | Indigenous Soil Knowledge and Stakeholder Analysis

An under-represented area in the second decade of SUM yet fundamental to the management of land was knowing the level of awareness of land managers and their levels of adoption of SLM practices as soil care is largely a private undertaking rather than a public one (Oberthür et al. 2004; Sillitoe 1998). The intersection between local or indigenous soil knowledge was equally understudied and the level of privately collected soil information unknown. Two of the ten papers highlighted in the fourth decade were on the nexus between soil and human behaviour and its value for soil care and sustainable land management. Sillitoe (1998) was the only one that is cited to this day.

4.7 | Soil Quality

Given the prominence in the current literature on the term soil health, evident in the fourth decade of the journal, it was not represented in the second decade of SUM and only a few papers on soil quality. The papers that were well-cited on soil quality also featured under the soil C topic.

4.8 | Soil Biology

The influence of soil management on soil biological activity is an area with few papers in the second decade of SUM; yet there is increasing interest in the role of microbes in SOC sequestration, and soil organisms in nature-based solutions to land degradation and maintaining soil health. In the fourth decade in 2022 there was a collection of papers on microbiology and inoculation. The one we chose to highlight for the second decade was the effect of land management on earthworm abundance and impact on soils (Scullion et al. 2002).

5 | The Third Decade, 2005–2014 (David O'Connor)

5.1 | Explanation of Approaches to Selecting Papers

The third decade of SUM marked a transformative period as soil science increasingly engaged with global environmental challenges, especially climate change. Advances in electronic publishing and falling data storage costs allowed for wider dissemination and greater author support, while social media started amplifying soil-related issues beyond academia. Research addressed urgent topics such as soil degradation, erosion, contamination by metals and metalloids, impacts of climate change, and technologies to improve C storage and resilience. Although the UK contributed the largest share of papers (22%), submissions were published from 58 countries around the world (Figure 1), including a marked increase in the number of papers from Asian institutions, highlighting the global significance of these challenges.

During this decade P emerged as the joint most common subject together with 'organic' C, ranked third (Figure 3).

5.2 | Soil C and Climate Policy

Research during this decade methods advanced for quantifying SOC under diverse land uses, contributing to evidence-based C accounting and informing climate policy. The emphasis on long-term monitoring, robust data systems and modelling remains as relevant as ever.

5.3 | Soil C and Land Use Database for the United Kingdom

Bradley et al. (2005) developed a detailed spatial database that integrates soil C, land use and soil properties in a 1-km grid across the UK, supporting UNFCCC and Kyoto Protocol reporting. This provided a 1990 baseline estimate of 4562 Tg SOC in the top 1 m of the UK's soil and set a benchmark for national C inventories. Its adaptable design and standardised protocols continue to inform policy compliance and research on soil C, climate resilience, and sustainable land use.

5.4 | Potential Aerobic C Mineralization of a Red Earth Paddy Soil and Its Temperature Dependence

Zheng et al. (2012) examined how long-term fertiliser treatments influence aerobic C mineralization and its temperature sensitivity in red earth paddy soils. Their findings revealed that SOC mineralization rates in red earth depend upon its physicochemical protection, particularly by iron-oxyhydrates. This work remains useful for predicting carbon dioxide (CO_2) emissions under warming scenarios and highlights the need to manage both C input and its long-term stability in soil.

5.5 | SOC as Affected by Land Use in Reclaimed Coastal Wetlands

Bai et al. (2013) explored SOC dynamics in reclaimed coastal wetlands, showing that conversion to cropland significantly reduced SOC levels, particularly in older (>20 years) reclamation zones. Conversely, ditch marshes—receiving organic inputs from agricultural and household waste—retained or even increased C stocks. These findings highlight the importance of strategic land-use planning to balance agricultural development with C stewardship, a principle increasingly relevant to blue C initiatives and wetland conservation.

5.6 | Innovative Soil Amendments

Biochar emerged as a major focus during this decade, recognised for its potential to improve soil fertility, structure, and nutrient dynamics, particularly in challenging soils. The featured studies underscore the importance of the regional soil environment as well as feedstock type and production conditions in determining biochar's performance. At the same time, research on liming and mineral amendments highlighted practical strategies for addressing soil acidity and nutrient imbalances. Collectively, these studies emphasise that amendment effectiveness depends on the nature of the amendment material properties, application context, and long-term management goals.

Uzoma et al. (2011) demonstrated that cattle manure biochar significantly improved maize yield, nutrient uptake, and water use efficiency in arid sandy soils, with optimal results at 15 t/ha. Improvements in soil pH, C and N content, cation exchange capacity, and hydraulic conductivity highlighted biochar's role in rehabilitating coarse-textured soils with poor nutrient retention.

Wang et al. (2014) evaluated low temperature biochars from wheat, rice, and peanut crop residues as amendments for strongly acidic tea garden soils. The biochars raised soil pH, reduced exchangeable acidity and aluminum saturation, and increased base cation levels—addressing acidification driven by excessive N fertilization. This research supports biochar's dual role in improving soil quality and contributing to C sequestration in acidic soils.

Morales et al. (2013) investigated biochar's influence on P dynamics in degraded tropical soils. They found that low temperature biochars exhibited greater P sorption capacity, while fast-pyrolysis biochars buffered soil solution P levels. These findings reinforce that biochar is not a one-size-fits-all amendment for P management; its effectiveness depends on both its chemical properties and the soil context.

Higgins et al. (2012) assessed the agronomic and practical benefits of pelletized dolomitic lime applications on permanent grassland in Northern Ireland. While pelletized dolomitic lime was no more effective than ground lime in altering soil pH or improving grass yield over three years, its ease of application using standard fertiliser equipment offers operational advantages. Importantly, the dolomitic composition significantly increased soil and herbage Mg levels, reducing the risk of grass tetany. These findings remain relevant amid growing interest in enhanced rock weathering and sustainable soil amendments.

5.7 | Soil Physical Properties and Soil Conservation Management

Research during this decade provided robust evidence that conservation practices and organic inputs can restore degraded soils, enhance aggregate stability, and improve water and nutrient retention—even in semi-arid regions and landscapes subject to freeze–thaw cycles. At the same time, advances in modelling soil physical properties addressed long-standing challenges in predicting key parameters such as bulk density, which underpin modern soil monitoring and modelling efforts.

He et al. (2009) presented a decade-long study in the farming–pastoral transition zone of Inner Mongolia, an area severely impacted by historic land use change and intensive ploughing. Their findings demonstrated that no-tillage combined with straw cover significantly improved soil organic matter, N, P, macroaggregate stability, and porosity. These improvements led to greater crop yields and a 14% increase in water use efficiency compared with conventional tillage. This research remains highly relevant as climate variability and land degradation continue to threaten food security in semi-arid regions like Inner Mongolia.

Chai et al. (2014) investigated how freeze–thaw cycles influence soil structure and nutrient retention in North-Western China, a region where structural degradation risks soil erosion and nutrient loss. They found that long-term N fertilisation, when combined with green manure or straw treatment, helped maintain macroaggregate stability and enhanced SOC and N enrichment ratios despite the damaging effects of freeze–thaw events.

Tranter et al. (2007) tackled a persistent challenge in soil science: predicting bulk density accurately and efficiently. Their model separates bulk density into soil mineral packing (ρm) and soil structure effects ($\Delta\rho$), with SOC identified as a key driver of variability. In today's context—where soil data underpin climate modeling, precision agriculture, and land degradation assessments—this approach remains influential.

6 | The Fourth Decade, 2015–2024 (Adrian Unc)

6.1 | Explanation of Approaches to Selecting Papers

The decade's publication record exemplifies the expanded subject matter coverage (Figure 3) and geographic diversity (Figure 1); the most clear evidence of the positioning of SUM as a soil-centric interdisciplinary journal. The ten articles highlighted here are but 1% of the total published during the decade, a clear under-sampling of a wide-ranging pool of research foci (Figure 2).

6.2 | Soil Database Modelling

Advancing analytical capacity leads to increased emergence of the availability of large datasets prompting the development and testing of data-based tools in relation to management (i.e., to identify landscape scale variability neural-network classification centred). Yet, as soil science is accelerating its forays into data-pattern identification-based research, one must consider both the advantages and caveats of such approaches and, importantly, be reminded of the enduring value of the hypothesis-testing method of inquiry.

Rivera et al. (2015) describe effectively the rationale, development and verification of a self-organising map, a classification exercise based on Soil Quality Database (SQDB) indicators. It is also a direct assessment of the limitations of such approaches and recognises the necessity to treat that neural-network classification as a tool for testing hypotheses rooted in theory rather than a tool for hypothesis-free pattern recognition. It also describes jargon-free, as much as possible, the underlying concepts—an advantage for non-data scientists.

6.3 | Conceptual Treatment of Soil Quality Parameters

Schröder et al. (2016) summarise the emerging concern that standard soil quality parameters do not necessarily correlate well with nutrient cycling, might not accurately describe resilience, and must be carefully interpreted when informing on soils' contribution to ecosystem services "The same soil property can simultaneously strengthen and weaken the performance of one or more functions." It is an example of the drive to re-evaluate the paradigms that underpin our approach to soils research.

6.4 | Soil Science and Policy

Cao et al. (2017) offered a unique large-scale survey-based analysis of policy on land ownership and C stocks in China. They examined land ownership structure, single vs. common, and its effect on land management. Counterintuitively, community management of fenced grasslands was found to result in greater C stocks and healthier soils, thus not supporting the view that common ownership fails to maintain the resource—a central tenet of the Tragedy of the Commons. It is a direct example of the linkage between policy and soil C stocks and soil functional state. While Cao et al. (2017) do not clearly postulate it, we are taking the liberty to suggest that this raises the question of the need to consider the value of community management of lands in other non-conventional economic systems, such as indigenous communities.

6.5 | Long-Term Experimentation

While, for practical reasons, much of recent research is derived from short-term experimentation, soil responses to changes in land use and management occur over a longer time period. It is thus essential to objectively know to what extent soil questions can be answered by short- vs. long-term experiments. Sandén et al., (2018) verify this for critical recommendations in management changes, including tillage, fertilisation and cover cropping. The data is collected at a European continental scale. Their work is also a reminder that no practice can equally support productivity, environmental quality and greenhouse gas emission (GGE) control, at all times: there is always a trade-off to be objectively considered in management decisions. Another example of the value of long-term experimentation comes from Holland and Behrendt (2021). They assessed the economics of liming in arable crop rotations; an analysis uniquely possible due to the 35-year Rothamsted and Woburn liming experiments.

6.6 | Decision Support Tools

Several papers published in 2019 might be considered as examples of stakeholder-driven science in support of decision tool development. Soil management is ultimately decided by soil managers namely the farmers. Knowledge exchange is critical for homogenization of soil decision making, while addressing local variability on natural and cultural conditions. Bampa et al. (2019) asked how the understanding of soil quality (perception and practice implementation) related to decision priorities. Information has been collected through workshops across several European countries. Results highlight the need for better knowledge transfer e.g., through direct advisory activities rather than using IT tools. The paper is a timely reminder that agriculture and its impact on soil properties, is local, requiring local solutions and locally adapted support. They also placed into sharp focus that applied soil research must ensure research results are made accessible to knowledge users.

6.7 | Landscape Assessment

Grassland is probably one of the most heterogeneous land managements; it varies across jurisdictions, ecosystems and climate gradients and cultures. While one cannot easily find a paper addressing all this, Huang et al. (2020) provide a competent assessment of the role of land use along a climate gradient on soil C and nutrient status. It completes a sound assessment of integrating confirmatory data with discovery.

6.8 | Organic Fertilisers for Sustainable Agriculture

It is often argued that the transition from conventional to organic agriculture is hampered by the limited standardisation of the local availability of organic fertilisers. An obvious question is the material-specific mineralization rate and thus its behaviour post-application? Levavasseur et al. (2022) report a first attempt to answer this question at scale; 663 exogenous organic materials were incubated for periods matching annual cumulative day degrees for central France (i.e., annual average 12°C) and the rate of C and N mineralization monitored. Mineralization was modelled (STICS model, 5 C pools) and validated against the data. While this was done for one climate and at constant field capacity, an obvious limitation, it does offer a strong baseline for in-field hypothesis testing across diverse farmland conditions.

Organic-based farming also requires rethinking of fertilisation schedules. Manuring-only based fertilisation leads to a nutrient availability profile that does not match crop requirements, possibly reducing yield or increasing nutrient losses and contamination beyond farm boundaries. To overcome this managements that mix organic and mineral fertilisers are already being considered. Salinas et al. (2024) stay within the all-organic fertilisation while verifying the integration of manure (slow release) with soluble organic fertiliser (organic soluble amino acid fertilisers). The experiment is sufficiently comprehensive (productivity, soil parameters, GHG) and does have the right controls (urea vs. liquid organic fertiliser), and two distinct crops, melon and maize. It concludes that manure + drip irrigated liquid organic fertiliser might offer equivalent productivity with reduced GHG losses.

6.9 | Classical Soil Science

Mattila et al. (2023) examined the relationship between N availability and farm practices, arguably the oldest question in agronomy. Considering the emphasis on management it is essential to be able to quantify its impact versus the significance of soils' intrinsic properties. The variability in Protein-N, Illinois soil N test –N and non-recovered soil N (the latter after also eliminating water soluble and mineralizable N) pools across cropping models in the agricultural region of Finland could be well described by clay, C and the C:clay ratio. The labile pools could not be described by the same. This is a sensible confirmation that farm management does affect and govern labile N but has a comparably minor impact on the stable N pools.

7 | Conclusion

For 40 years the journal addressed fundamental soil sciences questions while evolving to include the significance and application of the current major topics in soil science, which together with the submission of papers from soil scientists across the globe demonstrate that SUM has met the challenge laid down by Professor Alan Wild and has become a vehicle to enable soil scientists to show their science is relevant and useful.

List of Editors 1985–2025:

1. Professor Alan Wild, Department of Soil Science, University of Reading, UK. 1985–1986.
2. Dr. R. Webster, Soils Division, Rothamsted Experimental Station, UK. 1987–1989.
3. Dr. John A. Catt, Rothamsted Experimental Station, UK. 1990–1994.
4. Dr. Bryan Davies, ADAS, Cambridge, UK. 1995–2009.
5. Professor Donald A. Davidson, University of Stirling, UK. 2010–2013.
6. Professor Michael J. Goss, University of Guelph, Canada. 2014–2019.
7. Professor Deyi Hou, Tsinghua University, China. 2020–2024.
8. Distinguished Professor Leo Condron, Lincoln University, New Zealand. 2025–.