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Global research trends on RUSLE model: Bibliometric analysis using R Biblioshiny and VOSviewer

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Abstract: Soil erosion is an unavoidable natural phenomenon that significantly endangers soil fertility and global land management. The primary objective of this study was to perform a thorough bibliometric analysis of research

pertaining to the extensively utilized RUSLE model for soil erosion modeling, aiming to identify significant research trends, impactful contributions, and existing knowledge gaps. This study selected articles published in English from 1987 to 2024 in the Scopus database. The analysis centered on indicators including the most productive year, journals, authors, keywords, topics, countries, affiliations, and citations. We used R Biblioshiny, VOSviewer, and mapchart.net to help us with the analysis. The results showed that 2023 was the best year for publications on this topic, with Environmental Earth Sciences and Modeling Earth Systems and Environment being the top journals. Renard K.G. and Li Y. were the authors, who wrote the most papers, and “soil erosion” was the word that was used the most. China and India also came out on top, which shows that they are more affected by erosion than other countries. Furthermore, the progression of RUSLE research has been identified as occurring in three distinct phases: an initial limited phase (1987–1996), a phase of steady growth (1997–2014) propelled by the integration of GIS and remote sensing, and a highly productive phase (2015– till present moment) characterized by technological advancements and heightened global awareness, especially in 2023. These results show how modern technologies are becoming more important for making soil erosion models more accurate and scalable. This bibliometric analysis gives a full picture of how soil erosion research is changing around the world. It gives useful information for future research and supports sustainable land management and farming practices that aim to stop land degradation.

Keywords: soil erosion; RUSLE; USLE; remote sensing (RS); geographic information systems (GIS).

Глобальные тренды в исследованиях на основе модели RUSLE: библиометрический анализ с использованием R Biblioshiny и VOSviewer

Резюме: Эрозия почвы – неизбежный естественный процесс, представляющий серьезную угрозу плодородию почв и управлению земельными ресурсами во всем мире. Основной целью данного исследования был тщательный библиометрический анализ исследований, посвященных широко используемой модели RUSLE для моделирования эрозии почвы, с целью выявления основных тенденций в исследованиях, значимых вкладов и существующих пробелов в знаниях. Для исследования были отобраны статьи на английском языке, опубликованные в базе данных Scopus в период с 1987 по 2024 гг. Анализ был сосредоточен на таких показателях, как наиболее продуктивный год, журналы, авторы, ключевые слова, темы, страны,

аффилиации и цитирования. В процессе анализа использовались такие инструменты, как R Biblioshiny, VOSviewer и mapchart.net. Результаты показали, что 2023 г. стал годом с максимальным количеством публикаций по этой теме, а ведущими журналами были Environmental Earth Sciences и Modeling Earth Systems and Environment. Ренард К.Г. и Ли И. стали авторами, опубликовавшими наибольшее число статей, а в поиске чаще всего употреблялось словосочетание “эрозия почвы”. Китай и Индия вышли на первое место, что свидетельствует о более выраженных эрозионных процессах в них по сравнению с другими странами. Кроме того, установлено, что развитие исследований с помощью модели RUSLE можно разделить на три этапа: начальная фаза ограниченного использования (1987–1996 гг.); фаза устойчивого роста (1997–2014 гг.), обусловленная интеграцией ГИС и дистанционного зондирования; и высокопродуктивная фаза (2015 г. – по настоящее время), характеризующаяся технологическим прогрессом и ростом популярности модели во всем мире, особенно в 2023 г. Эти результаты демонстрируют, как возрастает важность современных технологий в повышении точности и масштабируемости моделей эрозии почв. Данный библиометрический анализ предоставляет интерес и дополнительную информацию для будущих исследований с целью развития устойчивого земледелия и эффективного управления земельными ресурсами, методов ведения сельского хозяйства, направленных на предотвращение деградации земель.

Ключевые слова: почвенная эрозия; RUSLE; USLE; дистанционное зондирование (ДЗ); геоинформационные системы (ГИС).

INTRODUCTION

Soil erosion is an inevitable natural process that presents a significant threat to soil fertility and land management across the globe (Pennock, 2019; Abdi et al., 2023). This phenomenon can lead to environmental crises and jeopardize food security worldwide (Papadani et al., 2020; Al-hasn et al., 2024). To address these challenges and mitigate their impact, international organizations such as the United Nations have developed various strategies and initiatives. The implementation of Sustainable Development Goals (SDG) 2 and 15, part of a broader framework of 17 goals set to be achieved by 2030, is closely linked to combating soil erosion (Borrelli et al., 2017; Juliev et al., 2024). In order to ensure the successful application of these goals, scientists around the world are developing a range of approaches and

practices to prevent, assess, and counteract soil erosion (Borrelli et al., 2021; Wen et al., 2023). These methods are increasingly enhanced through modern technologies like remote sensing (RS) and geographic information systems (GIS), which enable more precise and effective outcomes (Abdelsamie et al., 2022).

According to data from the Global Applications of Soil Erosion Modeling Monitor (GASEMT) database, models such as RUSLE, USLE, WEPP, and SWAT are the most commonly used tools for predicting soil erosion globally (Borrelli et al., 2021). The RUSLE model, in particular, is widely preferred because it provides simple, reliable empirical calculations that are practical and effective for real-world applications (Borrelli et al., 2017; Bensekhria, Bouhata, 2022). RUSLE is an advanced version of the USLE model, which was originally developed by Wischmeier and Smith in 1965 (Ghosal, Das Bhattacharya, 2020). The USLE model was specifically designed to predict erosion in agricultural lands and low-slope areas (Ganasri, Ramesh 2016). In contrast, RUSLE integrates additional factors such as freeze-thaw and moisture-induced soil erodibility, updated approaches for calculating cover and management factors, adjustments for topography-related changes, and improved conservation strategies (Benavidez et al., 2018). This model estimates soil loss by considering meteorological conditions and watershed characteristics (Singh, 2023; Juliev et al., 2024).

GIS is instrumental in providing spatial data for various parameters such as slope, land use, and soil types, which are crucial inputs for the RUSLE model (Al-hasn et al., 2024). Remote sensing, on the other hand, aids in acquiring real-time data on land cover and vegetation, which can be used to estimate the vegetation cover factor (C) and other essential variables (Makinde, Oyebanji, 2018). Together, GIS and RS enable the creation of precise, spatially explicit models that can predict soil erosion at large scales, offering insights into environmental management and land conservation (Aiello et al., 2015). These tools have proven particularly useful in assessing soil erosion in areas with limited ground data, as they provide a cost-effective and efficient means of monitoring landscape changes over time (Singh et al., 2023; Ji et al., 2024).

RUSLE primarily relies on three key databases: 1) a climate database that provides temperature and precipitation data necessary for

calculating rain-induced erosion; 2) a crop database that contains information about the crops on the land; and 3) a soil database that includes soil properties and survey data to determine the soil erosion resistance coefficient (Kumar et al., 2022). The first database includes the Rainfall Erosivity factor (R), the Soil Erodibility factor (K), and the Topographic factor (LS). The second database covers the Cover Management factor (C), while the third includes the Support Practice factor (P) (Renard, Ferreira, 1993; Amsalu, Mengaw, 2014; Mekonnen et al., 2023). The general equation used in RUSLE is:

$$A = R \times K \times LS \times C \times P \text{ (1997).}$$

Recently, the articles written using bibliometric analysis methods has become increasingly popular in the scientific field (Juliev et al., 2024; Djanpulatova et al., 2025). Because these types of articles allow researchers to easily and quickly analyze large amounts of data in the field (Abdikairov et al., 2024; Hulland, 2024). The main goals of bibliometric analysis include identifying scientific innovations, assessing collaboration between institutions and countries, and understanding trends in academic fields (Krymskaya, 2023; Juliev et al., 2024). In the course of analyzing articles published on the topic of RUSLE, it was discovered that several bibliometric studies had been conducted on this subject. To highlight the difference between previous bibliometric studies and the bibliometric articles we are currently writing, we present Table 1 below.

MATERIALS AND METHODS

Articles published between 1987 and 2024 were downloaded from the Scopus database to study and analyze global research trends based on the RUSLE model. All types of articles published in English during the selected years from the Scopus database (www.scopus.com) were downloaded on September 27, 2024. The search query used was «rusle OR “Revised Universal Soil Loss Equation”» and the fields of science selected were Environmental Science, Earth and Planetary Sciences, and Agricultural and Biological Sciences.

Table 1. A comparison between the current study and previous research

Research	Objective of the research	Results and findings
Ghosal, Das Bhattacharya, 2020	In this paper, researchers attempted to review the soil erosion studies conducted throughout the globe using Revised Universal Soil Loss Equation (RUSLE). They searched the SCI, Scopus, Web of Science, Google Scholar database and various theses for this study.	Though RUSLE is the most widely used model for estimation of soil erosion, the factors, namely rainfall erosivity, soil erodibility, slope length and steepness, cover management and conservation practice; vary greatly over different climatic zones, soil properties, slope, land cover and crop phase, respectively. Depending upon those variations, researchers have developed various sets of equation for different factors of RUSLE. These equations can be useful to map soil loss for many places on this planet.

Table 1 continued

Research	Objective of the research	Results and findings
Benavidez et al., 2018	The goal of this paper is to review the Universal Soil Loss Equation (USLE) and its various versions (RUSLE, RUSLE2, and MUSLE), focusing on their sub-factors, strengths, limitations, and adaptations to different local conditions. It aims to provide guidance for researchers working with these models by discussing the uncertainties and limitations of the equations, particularly in relation to climate, spatial resolution, and temporal scales.	The review highlights the various adaptations and applications of the Universal Soil Loss Equation (USLE) and its variants (RUSLE, RUSLE2, MUSLE) across different geoclimatic regions. It identifies the strengths and limitations of each model, particularly in relation to climate types, spatial resolution, and temporal scales. The analysis emphasizes that while (R)USLE is widely used, it has several limitations, such as: Empirical Nature: The models rely on simple empirical formulas, which introduce uncertainty, especially in regions where data quality or availability is inconsistent. Inability to Account for Specific Erosion Types: The models fail to adequately estimate soil loss from gully erosion or mass wasting events, and do not predict sediment yield to streams. Unit Mismatches: Different studies use varying units, which can lead to confusion and errors when applying the model.

Table 1 continued

Research	Objective of the research	Results and findings
Kumar et al., 2022	The purpose of the article is to evaluate the performance of the Revised Universal Soil Loss Equation (RUSLE) model in various global conditions. The article examines how the RUSLE model performs under different topographic and climatic conditions and aims to identify the most suitable conditions for its reliable application.	Despite its widespread use, the RUSLE model has limitations and challenges, particularly in large and unmeasured areas due to the lack of availability and quality of the necessary data. The paper found that further research is needed to assess when the model works well and where it falls short.
Negese, 2024	The objective of this review is to examine the remote sensing methods utilized and identify the critical aspects that have been overlooked in previous studies in Ethiopia when estimating the RUSLE C-factor value using remote sensing techniques. Specifically, it focuses on the use of uniform C-factor values derived from literature after classifying remote sensing imagery into various land use and land cover categories, as well as the application of the Normalized Difference Vegetation Index (NDVI), both of which are widely employed approaches in Ethiopian studies for estimating the RUSLE C-factor.	The study identified several critical oversights in previous RUSLE-based studies in Ethiopia, which may lead to inaccurate soil loss predictions. These included: Inadequate consideration of the seasonal variation of cover and management factors (91.89%). Underestimation of the effect of management practices (89.19%). Underestimation of the spatial variation of cover and management factors (81.08%). Inadequate consideration of the impact of vegetation and crop canopy cover on soil erosion (76.67%).

Table 1 continued

Research	Objective of the research	Results and findings
Ezeh et al., 2024	The article aims to review and analyze the application of the Revised Universal Soil Loss Equation (RUSLE) model in soil erosion studies, with a specific emphasis on Nigeria. For this analysis, the researchers examined approximately 50 articles from Google Scholar and 4 articles from the ScienceDirect database.	The results from various studies across Nigeria showed notable differences, which were attributed to the varying methods used to estimate key factors in the RUSLE (Revised Universal Soil Loss Equation) model. Based on these findings, the study recommends that the Ministries of Agriculture and Environment prioritize soil erosion research by adopting proactive soil conservation and management strategies. The use of ensemble models, including machine learning approaches, is suggested rather than relying solely on structural interventions. Additionally, the study advocates for a harmonized look-up table for the cover management factor and conservation practices factor, ensuring they fairly represent the different ecoclimatic regions. The study also highlights the limitations of the model and proposes a way forward for improving its application.

Table 1 continued

Research	Objective of the research	Results and findings
Phinzi, Ngetar, 2019	The purpose of this paper is to provide an overview of recent developments in the use of geospatial technologies, such as Geographic Information Systems (GIS) and remote sensing, for deriving the individual factors involved in the Revised Universal Soil Loss Equation (RUSLE).	Advancements in Geospatial Technologies: Recent developments in geospatial technologies, particularly GIS and remote sensing, have significantly enhanced the ability to derive the individual factors used in the Revised Universal Soil Loss Equation (RUSLE).
Alewell et al., 2019	The aim of this paper is to analyze and evaluate the most commonly used USLE-type models for soil erosion modeling, applied in 109 countries over the past 80 years. It focuses on understanding their effectiveness and identifying key areas for improvement.	The study highlights four key areas for future research: (i) addressing the difference between modeled and measured erosion rates, (ii) using high-resolution remote sensing data for large-scale models, (iii) improving measurement and monitoring programs, and (iv) conducting thorough uncertainty assessments in soil erosion modeling.

Table 1 continued

Research	Objective of the research	Results and findings
Present research	Unlike the previous articles, this manuscript studies 620 English-language papers published globally in Scopus database from 1987 to 2024, specifically focusing on the RUSLE topic. This analysis does not include other models with USLE-type algorithms, such as WaTEM/SEDEM.	Based on the results of the bibliometric analysis, there was a significant rise in the number of articles on the topic of RUSLE compared to previous years. China and India emerged as the leaders in terms of publication output. Among the journals, <i>Environmental Earth Sciences</i> published the highest number of articles on this subject, ranking first in the field. As for the authors, Renard K.G. and Li Y. were identified as the most active contributors. Regarding keywords, “Soil Erosion” was the most frequently occurring term.

A total of 620 articles were retrieved from the database based on the entered search criteria. These articles were then analyzed using Biblioshiny, MapChart.net, and VOSviewer according to several categories, including years, journals, authors, keywords, countries, affiliations, most cited articles, trend topics, and mixed analysis. Table 2 presents details about the research methodology.

Table 2. Research design and workflow

Filters	Results
Database	Scopus
Searching query	TITLE (rusle OR “Revised universal soil loss equation”)
Acquisition date	September 27, 2024
Time period	1987–2024
Categories	Environmental Science, Earth and Planetary Sciences, Agricultural and Biological Sciences
Sources	All type of article types
Language	English
Number of publications	620

RESULTS AND DISCUSSION

Figure 1 illustrates the trend of published articles related to the RUSLE model over the years under consideration. As shown in the chart, the years can be divided into three distinct periods: the years with the fewest articles, the average years, and the most productive years.

In the first period, from 1987 to 1996, the number of articles was the lowest, ranging from 1 to 3 per year. This low figure can be attributed to the lack of technological advancements during these early years. Articles published during this period made up only 2% of the total articles. The articles published during these years primarily fo-

cused on the outcomes of scientific efforts aimed at enhancing the RUSLE model through various methods. For instance, in a 1994 study by Benkobi, an improved surface cover subfactor (RSC) of the revised universal soil loss equation (RUSLE) was assessed to better predict soil erosion from pastures. The findings revealed that the RUSLE model, with the RSC, delivered more accurate land loss estimates compared to the original RUSLE model, although it still underestimated the actual land loss (Benkobi et al., 1994). A similar follow-up article from this period discusses the new RUSLE model, which is designed to model land changes and water quality, as well as the data that will be input into this model (Renard, Ferreira, 1993).

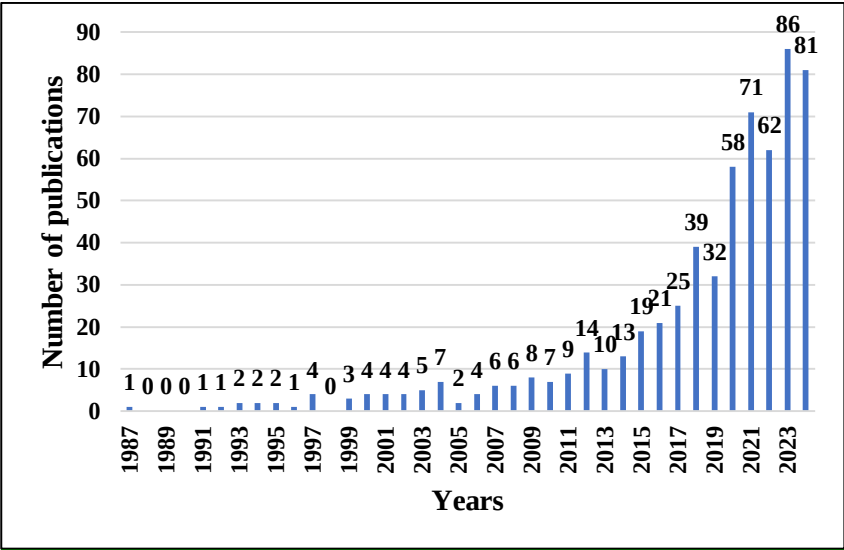


Fig. 1. Trend of published papers with RUSLE model.

The second period, spanning from 1997 to 2014, was much more productive, with the number of articles rising from 4 to 14 per year. This marked a significant increase in research output. During this period, articles on the topic of RUSLE began to highlight work done using modern technologies like GIS and RS. For instance, in 2004, a study by

Shi in China aimed to develop an updated RUSLE model using GIS to mitigate soil erosion. As a result, the RUSLE-GIS model proved to be an effective tool for resource management and soil conservation (Shi et al., 2004). In addition, research papers have been published that calculate annual soil loss using the RUSLE model in watersheds (Kouli et al., 2009).

The final period, covering the years from 2015 onward, stands out as the most productive phase. A sharp increase in the number of publications was observed, especially in 2023, when the number of articles reached an all-time high of 86. This period accounted for over 80% of the total articles published. In recent years, the RUSLE (Revised Universal Soil Loss Equation) model has been widely used in different regions (Al Shoumik et al., 2023; Wang et al., 2023), including river basins situated in mountainous areas (Thomas et al., 2018; Das et al., 2020). Additionally, it has been applied alongside various climate models to assess soil erosion under different environmental conditions and changing climate scenarios (Getachew et al., 2021). This combination helps to improve the accuracy of predictions regarding soil erosion and better understand how factors like rainfall, vegetation, and land slope contribute to soil loss in these areas (Teng et al., 2018; Pal, Chakraborty, 2019). In addition to the modern technologies and models mentioned above, Google Earth Engine (Jodhani et al., 2023; Aldiansyah, Wardani, 2024) is also being used to estimate annual soil loss during this period.

Several factors contribute to this surge in publications in recent years. The rapid integration of modern technologies across various sectors, including agriculture, and the growing global focus on addressing soil erosion, driven by international organizations, have played key roles in the increasing interest and research on the RUSLE model.

Analysis of Journals

The third table presents the names of the 10 journals that published the most articles on the RUSLE topic during the review period, along with their respective H-indexes. As shown in the Table 3, *Environmental Earth Sciences* and *Modeling Earth Systems and Environment* lead the list, with H-indexes of 15 and 14, respectively, publishing 30 and 28 articles. The journal *Catena* ranks third with 19 articles,

while the *Journal of Soil and Water Conservation* completes the top ten with 10 articles. The journal that ranked first in terms of the number of articles published, published more articles on the topic of RUSLE primarily towards the end of the years (Islam et al., 2024; Nizar et al., 2024; Oudchaira et al., 2024) covered. This journal is a hybrid type of journal, publishing 24 issues per year.

Figure 2 below illustrates the increasing trend in the number of articles published in the five journals that contributed the most on the selected topic during the review period. As shown in the diagram, *Catena* was the first journal to publish articles on this subject, with the first RUSLE article appearing in 1998. The number of articles in this journal has steadily increased over the years. Almost a decade later, in 2007, *Environmental and Assessment* joined the list by publishing its first article on RUSLE, initially showing slow growth, followed by a more significant increase. *Environmental Earth Sciences*, added third in 2009, began publishing articles at a rapid pace, ultimately achieving the best results in this trend. The most recent addition, *Modeling Earth Systems and Environment* (2014), ranked second in terms of growth.

Analysis of Authors

The authors of an article are considered key contributors to their field because they are the ones who share the results of scientific and practical work with the broader public. A total of 159 authors contributed to the publication of articles on the RUSLE model. Figure 3 highlights the scientists who have published the most articles on this topic. Among them, Renard K.G. and Li Y. stand out as the top contributors, each publishing seven articles on the RUSLE topic. Renard K.G. has been the first author of nearly all of his articles and has been publishing research on the RUSLE topic since 1991 (Renard et al., 1991, 1994, 2011; Renard, Ferreira, 1993). Li Y. has been a co-author in nearly 80% of these seven articles and started participating in papers related to the RUSLE topic from 2015 onwards (Tang et al., 2015; Zeng et al., 2017; Paul et al., 2021). The other authors in the top ten have all made significant contributions, each publishing five articles.

Table 3. Top ten journals with publications about RUSLE model in the period of 1987 to 2024

Sources	Category	Number of publications	H-index
Environmental Earth Sciences	Agricultural and Biological science	30	15
Modeling Earth Systems and Environment	Agricultural and Biological science	28	14
Catena	Earth and Planetary sciences	19	14
Arabian Journal Of Geosciences	Environmental science	16	12
Environmental Monitoring And Assessment	Environmental science	14	8
International Soil and Water Conservation Research	Agricultural and Biological science	12	10
Iop Conference Series Earth and Environmental Science	Earth and Planetary sciences	12	3
Sustainability Switzerland	Environmental science	12	7
Water Switzerland	Environmental science	11	7
Journal Of Soil and Water Conservation	Agricultural and Biological science	10	8

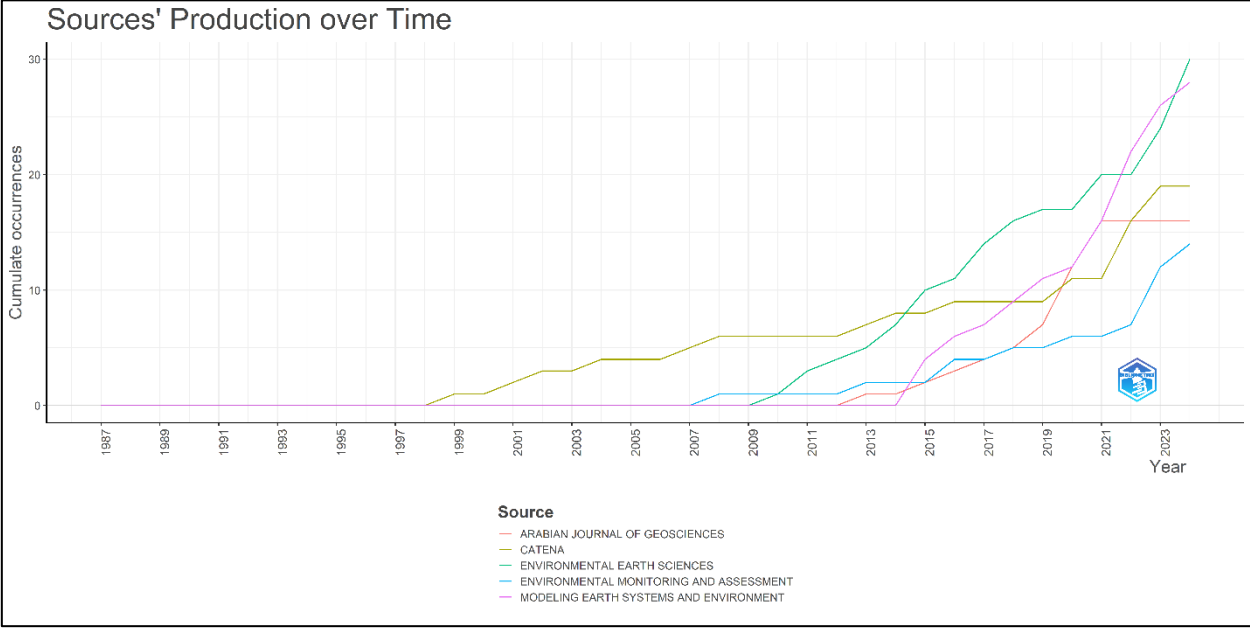


Fig. 2. Growth trend of journal sources publishing articles on the topic of the RUSLE model from 1987 to 2024.

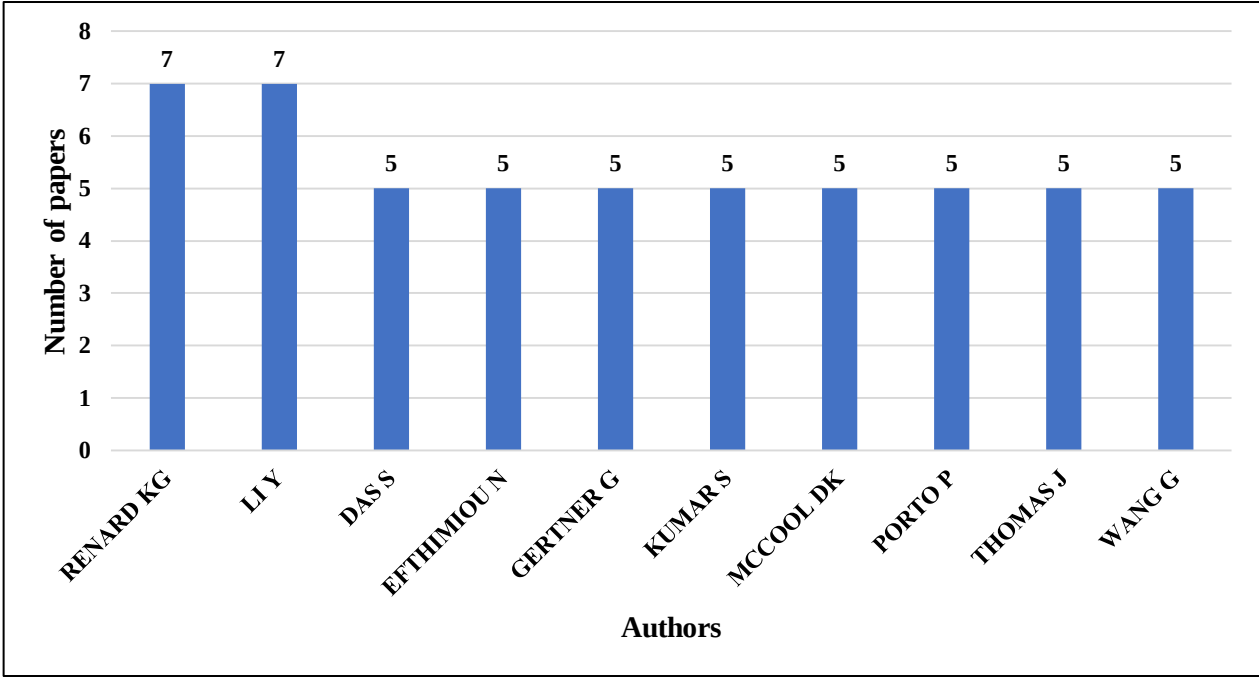


Fig. 3. Top ten authors who have published the most articles on the RUSLE model.

Keyword Analysis

Figure 4 shows the fifty most frequently used keywords in articles published on the topic of RUSLE worldwide between 1987 and 2024. The keyword size in this graph tells you how often that keyword is used. As you can see from the picture, the most important keyword in the topic being studied is “soil erosion”.

To help the reader understand the keywords more clearly and make it easier to retrieve information, Figure 5 shows the tree plot of top-30 author-keywords in specific numbers. The RUSLE documents utilized the author-keyword is “soil erosion”. This word appeared as an author-keywords 484 times and have 14% contribution in the top 30 author-keywords. The next most common author-keywords were “revised universal soil loss equation” and “erosion” with 270 and 218 occurrences, respectively. The author-keywords reveal that RUSLE is predominantly utilized for soil erosion modeling. The keyword “soils” was also used as an author-keyword 189 times in articles published within the scope of the topic under study, ranking fourth.

Analysis of the top Countries and Affiliations

A map of the countries that published the most articles on the topic (Fig. 6) was created using map chart.com. In the list of the top ten countries, China ranks first with 235 articles. There are several reasons for this. In China, economic and population growth are impacting the environment and land use, leading to serious issues such as soil erosion (Lai et al., 2024). Additionally, some regions (Chinese Loess Plateau) of this country are facing some of the most severe soil erosion in the world (Tang et al., 2015). India also has a significantly higher number of articles on RUSLE than the other eight countries, and is second in the top ten after China with 219 articles. There are enough reasons to pay serious attention to the issue of soil erosion in India, such as climate (Masroor et al., 2022; Nizar et al., 2024), flash floods caused by cloudbursts (Singh, Kansal, 2023) and the main reason is that India, about 53% of its total land area, is prone to erosion and loses about 5 334 metric tons of soil every year (Pandey et al., 2023). The USA is third with 129 articles and Ethiopia is fourth with 88 articles. Turkey rounded out the top ten countries in terms of publishing articles on the topic under consideration with 38 articles.

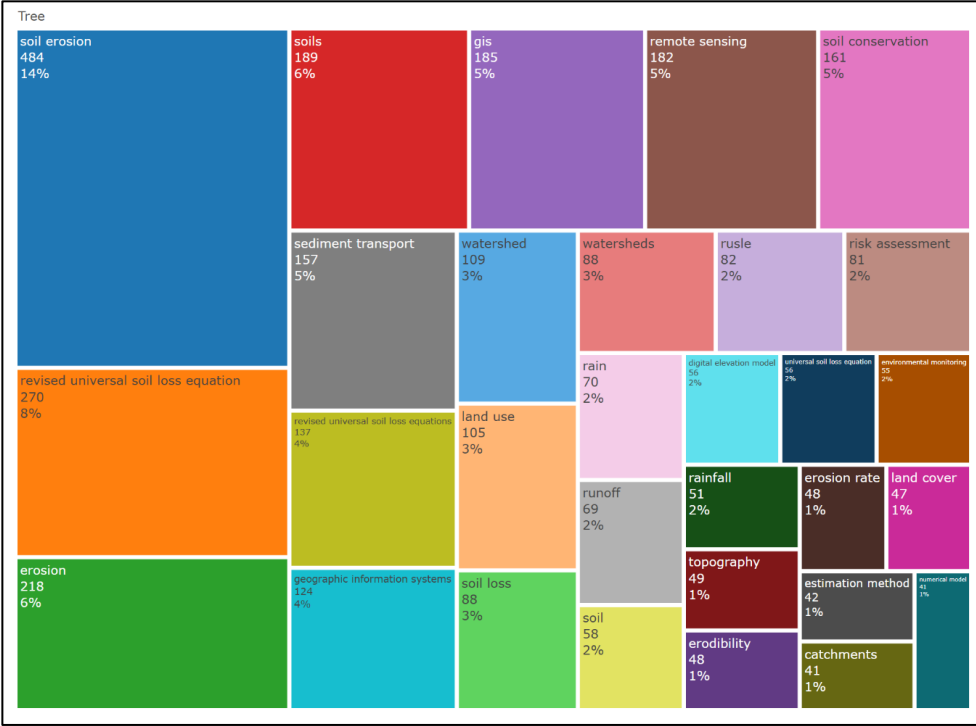


Fig. 5. Tree plot of top-30 author-keywords in the RUSLE topic in numbers and percentages.

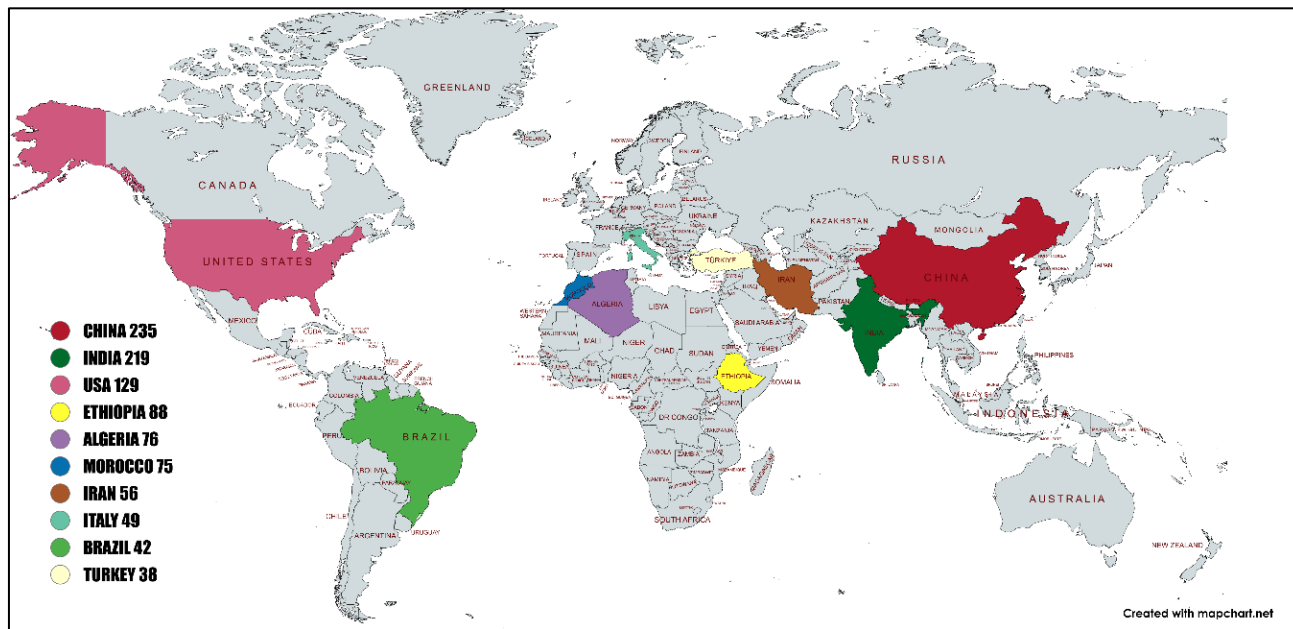


Fig. 6. List of top countries on RUSLE articles.

The following graph (Fig. 7) shows the institutions that participated in publishing the most articles on the 7 RUSLE topics. Along with the top countries, this graphic shows that two Chinese institutes have the most publications. They are: Chinese Academy of Sciences and University of Chinese Academy of Sciences. Both of these institutions have published 12 articles each. The Chinese Academy of Sciences is a place that brings together engineers and scientists from China and around the world to solve theoretical and practical problems. The developments created at this academy should serve the interests of China and countries around the world. In the next third and fourth places are Bahir Dar and Debre Tabor universities in Ethiopia with 9 articles each.

Analysis of the most cited documents, countries and year

More specifically, a citation is a brief alphanumeric phrase that is included into the body of an intellectual work and indicates an entry in the work's bibliographic (Colavizza et al., 2020). Table 4 shows the names of the most cited articles on the topic of RUSLE. Renard K.G.'s article "RUSLE: Revised Universal Soil Loss Equation" published in the Journal of Soil & Water Conservation in 1991 had the greatest citation rate during the review period, with 1,239 citations.

Figure 8 lists the most cited countries. India leads all countries with 3,609 citations to its articles. China is second only to India in this indicator with 2,540 citations. The next 9th Figure shows which year the articles on the topic of RUSLE received the most citations. The articles on the topic under consideration received the most citations in the period from 1987 to 1992. In the remaining years, the number of citations given to articles has experienced a fluctuating trend of around 5.

Analysis of the trend topics in the RUSLE model articles.

Typically, the selection of a topic for a research paper focuses on the nature of the work being conducted and the methodology used in the topic. Figure 10 shows the trend of change in trend topics over the years selected for review in RUSLE-related articles. Terms such as "revised universal soil", "soil loss equation", and "universal soil loss" are among the most used topics in 2018.

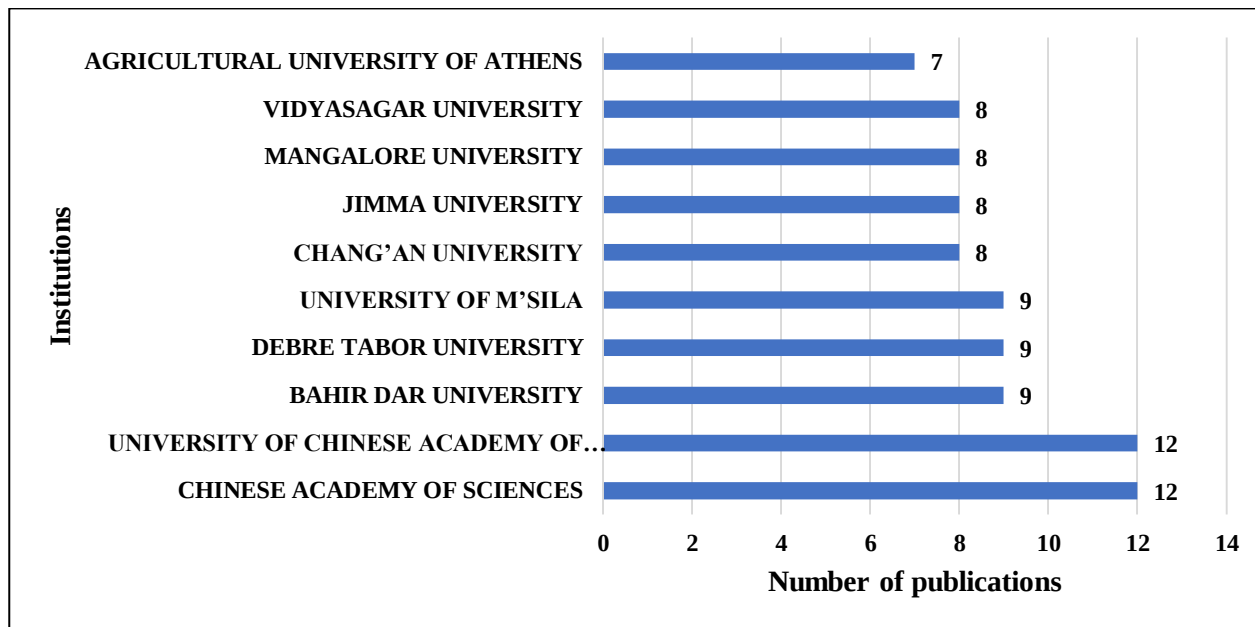


Fig. 7. Most relevant institutions on the topic of RUSLE model.

Table 4. Most global cited documents on the RUSLE topic

Paper	DOI	Total Citations	TC per Year
RENARD K.G., 1991, JOURNAL OF SOIL & WATER CONSERVATION		1239	36,44
GANASRI B.P., 2016, GEOSCI FRONT	10.1016/j.gsf.2015.10.007	604	67,11
MOORE I.D., 1992, JOURNAL OF SOIL & WATER CONSERVATION		541	16,39
PRASANNAKUMAR V., 2012, GEOSCI FRONT	10.1016/j.gsf.2011.11.003	418	32,15
MILLWARD A.A., 1999, CATENA	10.1016/S0341-8162(99)00067-3	367	14,11
ANGIMA S.D., 2003, AGRIC ECOSYST ENVIRON	10.1016/S0167-8809(03)00011-2	357	16,22
KOULI M., 2009, ENVIRON GEOL	10.1007/s00254-008-1318-9	351	21,9
FU B.J., 2005, LAND DEGRAD DEV	10.1002/ldr.646	335	16,75
BENAVIDEZ R., 2018, HYDROL EARTH SYST SCI	10.5194/hess-22-6059-2018	306	43,71
LU D., 2004, LAND DEGRAD DEV	10.1002/ldr.634	297	14,14

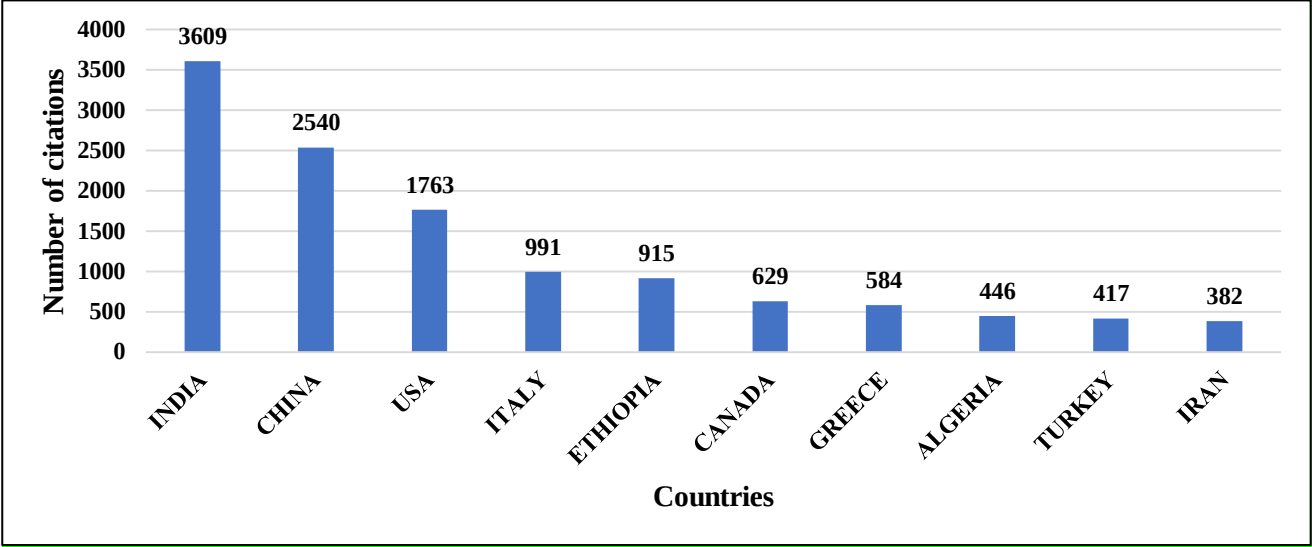


Fig. 8. Countries with the most cited articles on RUSLE.

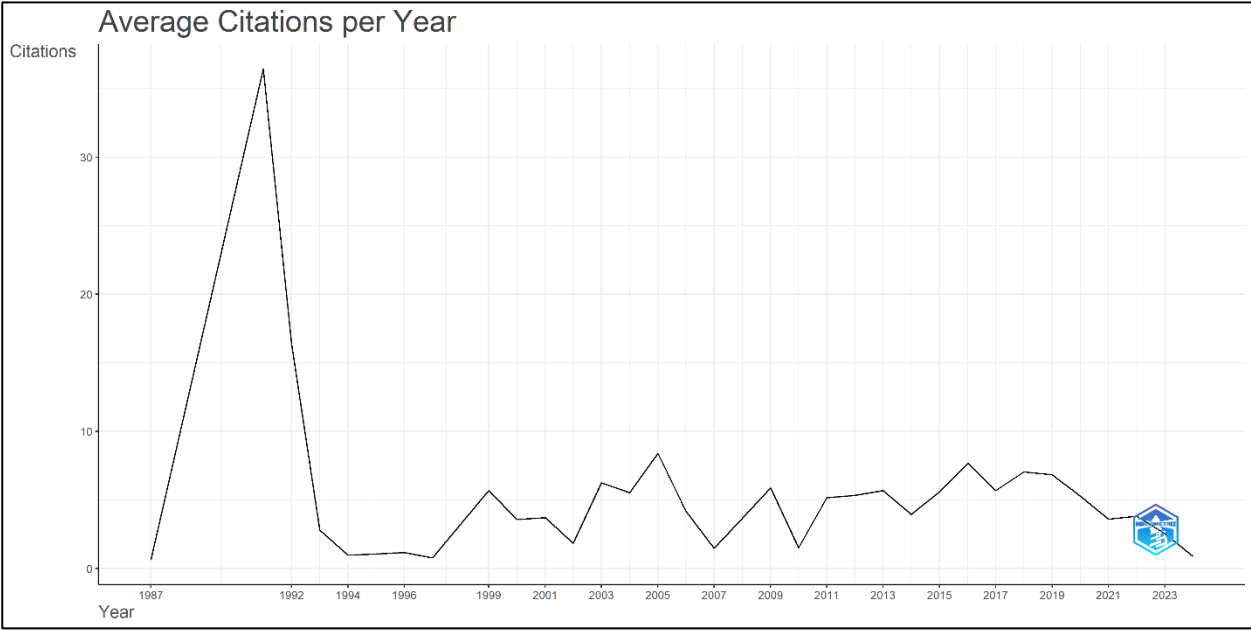


Fig. 9. The year in which articles on the topic of RUSLE received the most citations.

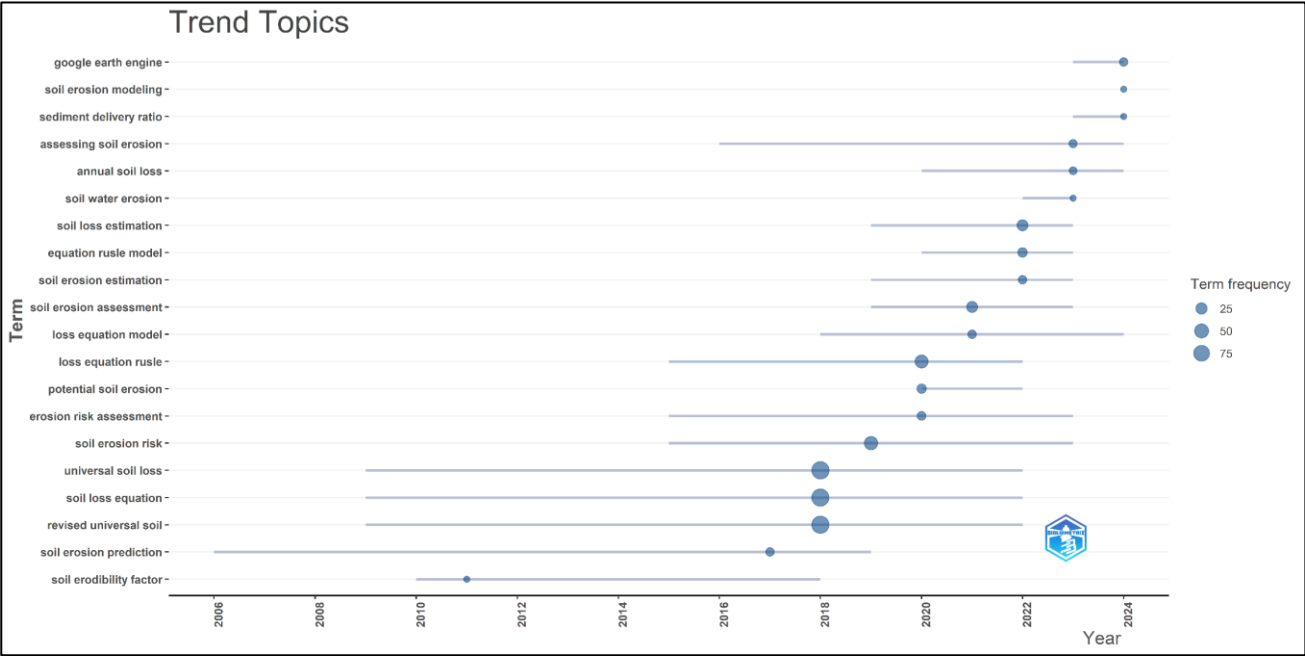


Fig. 10. Trend topics.

In recent years, between 2019 and 2020, the term “soil erosion risk” has become a trend. In recent years, terms related to modern technologies such as model, modeling, and Google Earth Engine have been added to the list of trending topics. This indicates the increased involvement of modern technologies in the subject under consideration.

CONCLUSIONS

This bibliometric analysis provides a comprehensive overview of global research on soil erosion modeling using the RUSLE model. It highlights 2023 as a key year with a significant increase in publications, driven by influential journals like *Environmental Earth Sciences* and *Modeling Earth Systems and Environment*. Leading authors, such as Renard K.G. and Li Y., have made substantial contributions to the field, and the frequent use of the term “soil erosion” reflects global concerns, particularly in countries like China and India where soil erosion is a critical issue.

The analysis identifies three key periods in the evolution of RUSLE research. The first period (1987–1996) had limited output due to technological constraints. The second period (1997–2014) saw a rise in publications with the integration of GIS and remote sensing. The third period (2015 – till now) marks the most productive phase, driven by advances in technology and heightened global awareness, particularly in 2023.

Modern technologies, such as GIS and remote sensing, have significantly enhanced soil erosion research by providing more accurate and scalable solutions for modeling and predicting erosion patterns. These tools support better environmental management and land conservation strategies. Overall, this analysis offers valuable insights for future research and provides a foundation for developing targeted strategies to combat land degradation and promote sustainable agricultural practices worldwide.

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