
A BIBLIOMETRIC ANALYSIS OF GEOTEXTILE AS UNDERGROUND FILTRATION IN SUBSURFACE DRAINAGE TOWARDS SLOPE STABILITY USING VOSVIEWER

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ABSTRACT

Geotextiles are geosynthetic tools in civil engineering used to address geotechnical problems. As an alternative used in handling soil foundations, geotextiles have functions such as separation, filtration, drainage, reinforcement, stabilization, protection, and combinations of these functions. This research aims to systematically map the scientific research results on slope stabilization and geotextiles using a quantitative review method known as bibliometric analysis. Bibliometric analysis is a widely used and powerful method for investigating and analyzing large sets of scientific data. This approach allows us to uncover the complexities of evolution in a particular field and illuminate emerging areas. With the assistance of Publish or Perish, data sourced from the Crossref database will be analyzed using VOSviewer software. The research results show that the highest number of document publications occurred in 2023 with 74 journals published in that year. These findings reveal a significant focus on slope reinforcement among researchers, evidenced by 810 articles published from 2000 to 2023. Of these, 54% consist of papers published in journal articles. In short, this research provides a quantitative examination of trends and future directions in this field of study, serving as a valuable resource for researchers. Additionally, this paper will be a valuable reference for gaining insights into the available techniques and procedures for conducting studies using bibliometric analysis.

Keywords: Geotextile, Slope Stability, Landslide, Erosivity, Water Filtration, Subsurface Drainage, Rainfall Intensity.

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INTRODUCTION

Geotextile is one of the technological developments in the textile sector currently developing rapidly. The term "Geotextiles" is derived from the combination of "Geo," referring to the ground or land, and "Textiles," a broad term encompassing materials made from fibers, filaments, or yarns characterized by flexibility, fineness, and a high length-to-thickness ratio. Geotextiles are permeable fabrics used with soil to provide protection, separation, filtration, reinforcement, and drainage. These fabrics are crafted from both natural and synthetic fibers, with the possibility of blending the two. Geotextiles, classified as technical textiles, are poised to play a significant role in the future textile market. They have a profound impact on safeguarding against natural disasters. In the current scenario, countries face heightened vulnerability to the effects of climate change, resulting in a rising number of disasters. Geotextiles emerge as a crucial solution for protecting infrastructure such as bridges, roads, and soil from these disasters. This is achieved by constructing embankments and retaining walls, showcasing the versatile applications of Geotextiles in disaster mitigation (Hasan, 2020).

Geotextiles in Indonesia began in the 1970s when the country started adopting geosynthetic technology in construction and civil engineering projects. During that time, geotextiles were used in road construction, dams, and other water-related projects. However, it is essential to remember that geotextiles may be more common in large projects and projects requiring specialized solutions involving soil, water, or environmental protection. The use of geotextiles in Indonesia varies depending on each project's geographical and engineering requirements. These materials are valued for their versatility and ability to improve various civil engineering and construction projects' performance, durability, and environmental sustainability.

Geotextiles have gained extensive use as an alternative to granular filters in underground structure drainage systems, offering convenient construction and ready availability. A geotextile serving as a filter must satisfy the criteria for retaining soil, facilitating permeability, and meeting the anti-clogging requirement. This is crucial because fine particles may accumulate within the pores of the geotextile during its operational lifespan, potentially leading to the clogging of the filtration system (Du et al., 2022).

The soil is a fundamental resource for ensuring human survival, and soil erosion poses a significant threat to food security and ecosystems (Wüpper, 2020). The study suggests that the conditions of most soils globally are generally subpar or extremely unfavorable (Alewell et al., 2019). The main factors contributing to soil loss are the splashing effect of raindrops hitting the ground and the scouring effect caused by surface runoff. Landslides are one of the common natural disasters that can occur in mountainous and hilly areas, especially during the rainy season. This disaster can result in property damage and loss of life, as well as environmental damage and damage to other infrastructure, such as housing, industry, and agricultural land, which can impact the local economy. Landslides occur due to disturbance in the balances of slopes, leading to the movement of soil and rocks to lower areas. This movement can happen on soil or rocks with less resistance than the soil or rock's weight (Nurhidayati & Alhadi, 2021).

This study aims to elucidate the application of geotextiles in Indonesia, particularly in the context of landslide disasters. Additionally, it seeks to offer insights into the factors contributing to landslides and how geotextiles can be employed for mitigation. In addition, the study aims to investigate patterns in research and publishing using a bibliometric analysis of the literature on scientific literacy research. Such analysis can unveil prevalent topics and research opportunities in scientific literacy education, particularly within physics (Effendi et al., 2021).

Geotextile for Subsurface Drainage

Regarding geotextiles, some engineers still fear using them, even if they sometimes might be considered as rather ordinary projects. Some fear geotextiles are fragile and compressible layers, very different from the characteristics of traditional granular filters, which have decades of experience. Under this perspective, these characteristics might yield the conclusion that geotextiles would be more likely to fail in retaining soil particles. Others need more long-term experience with such synthetic materials to ensure that geotextiles will last long enough or behave long enough with time to fulfill their role in major engineering projects. From this standpoint, there is a hesitation that these features might make geotextiles more susceptible to failure in retaining soil particles. Additionally, there is anxiety about the lack of extensive long-term experience with synthetic materials like geotextiles, raising doubts about their durability and ability to fulfill their role over extended periods in significant engineering projects. Over the past few decades, research findings

and case studies have demonstrated that most of these concerns can be effectively addressed, ensuring a secure and enduring performance.

Geotextiles have served as filters in geotechnical and geoenvironmental projects for fifty years. Numerous researchers have studied the factors influencing the behavior of geotextile filters over time, and their findings have been consolidated in crucial literature. Indeed, various factors can impact the effectiveness of filters in general, and these structures are expected to perform reliably over an extended period in various engineering projects (Palmeira et al., 2019). The widespread adoption of geotextiles can be attributed to their ease of transportation and installation in the field. Additionally, as manufactured products, geotextiles offer uniform and replicable properties. Moreover, using geotextile filters contributes to a decrease in environmental impacts compared to conventional methods employing granular materials (Frischknecht et al., 2012). The geotextile filter needs to exhibit sufficient permeability to facilitate efficient water drainage while simultaneously retaining soil particles to prevent their erosion (Chen et al., 2008).

An infiltration discontinuity emerges between the geotextile structure and the underlying soil. Due to seepage flows, it is crucial to permit certain soil particles to move through the geotextile. Following installation, a state of equilibrium must be established to prevent continuous piping of soil particles through the nonwoven geotextile. Consequently, three zones can be identified: the bridging network, soil filter, and undisturbed soil. Geotextiles commonly employed for filtration also often serve as a separation function (Markiewicz et al., 2022).

Achieving the appropriate deprive the opening of a geotextile filter involves striking a balance between retaining soil particles upstream and preventing excessive clogging of the geotextile. While this equilibrium is generally achievable for most soil types and hydraulic conditions, challenges arise when dealing with turbid flowing liquids (containing many suspended particles) and under high or dynamic hydraulic gradients (Sansone & Koerner, 1992). As crucial as the design itself, the installation process must be executed to ensure the effective functioning of the filter throughout its intended service life. Hence, all potential impacts during installation must be considered (Heibaum, 2016).

Slope Stability

Ensuring the stability of slopes is a critical and intricate issue in civil engineering, especially in significant projects like dams, highways, and tunnels. Slope stability is arguably the most complex and challenging of all the subdisciplines of geotechnical engineering. It is often the least understood (Duncan et al., 2014). Slopes are the appearance of natural surfaces that have different heights. Slope stability involves landslides, which move land masses from high to lower places (Pangemanan et al., 2014).

Slope conditions, especially with heavy loads and steep slopes, can lead to landslides. So, slope reinforcement is required, one of which is with geotextile (Chasanah, 2012). To prevent the occurrence of erosion hazards and obtain a safe solution, conditions such as soil slope stability and increased soil density must be considered (Indrawahyuni & Damayanti, 2009).

In prior landslide research, the natural slope was often perceived as parallel. However, it has been observed that landslides frequently occur on concave and convex slopes in addition to parallel slopes (Al-Adhadh et al., 2021). The paper concisely overviews current methods for identifying critical slip surfaces. Various techniques and strategies are suggested to enhance the effectiveness

and resilience of some existing approaches. Additionally, a new solution scheme is introduced for the swift calculation of the slope's safety factor (Li & White, 1987).

In various contexts, the fundamental goal of evaluating slope stability is to enhance the safe and economical design of diverse structures, including excavations, embankments, earth dams, landfills, and spoil heaps. Assessing slope stability entails identifying crucial geological, material, environmental, and economic factors that may influence the project. It also entails understanding potential slope-related issues' nature, magnitude, and frequency. Prior geological and geotechnical experience in the specific area is beneficial when dealing with slopes in general and conducting slope stability analyses in particular. The slope analysis encompasses topography, geology, and material properties, considering whether the slope is naturally formed or engineered (Cha & Kim, 2011).

Rainfall Induced Landslides

The most common cause of landslides is Rainfall (Polemio & Petrucci, 2000). Rainfall-induced slope instability is a common geotechnical problem in tropical and subtropical regions (Tsaparas et al., 2002). In recent years, landslides have frequently occurred in Indonesia, especially in South Sulawesi province, due to heavy rain (Hasnawir, 2012). While the impact of Rainfall on landslide occurrence is evident, explaining it precisely poses challenges (Caine, 1980). This complexity arises from the fact that precipitation influences slope stability indirectly through its impact on the water-pore conditions within the material forming the slope (Satya et al., 2014).

Typically, landslide studies assume the presence of an impermeable boundary at a specific depth, where failure is presumed to occur. However, this assumption only sometimes holds, as failures can manifest at varying depths. Studies emphasize that various factors influence the stability of a slope experiencing rainfall infiltration. These include the duration, intensity, and pattern of the Rainfall, the soil's saturated hydraulic conductivity, the slope's geometry, the beginning conditions, and the boundary conditions (Ali et al., 2014).

The incidence of landslides is intricately connected to the nature of Rainfall on a particular day and the preceding days' Rainfall (Wang et al., 2013). Previous research has utilized the connection between Rainfall and landslides as a foundation for the real-time prediction of landslide occurrences (Keefer et al., 1987). Numerous efforts have been made to establish correlations between Rainfall and landslides, typically assuming a direct relationship between landslide occurrences and the amount of Rainfall. This can refer to the intensity of Rainfall, the duration of rainstorm events, or short-term precipitation (Dai & Lee, 2001).

Rainfall infiltration is recognized as a significant catalyst for slope instability, with numerous slope occurrences documented during or immediately after Rainfall. Failures induced by Rainfall are influenced by an intricate interplay of slopes' topographical, hydrological, and geological conditions. Consequently, the slope inclination plays a crucial role in determining stability during Rainfall. Despite research efforts to examine the mechanisms of rainfall-induced landslides, there is a need for comprehensive experimental studies on the factors influencing the initiation of slope failure (Gallage et al., 2021).

This study aims to elucidate the application of geotextiles in Indonesia, particularly in the context of landslide disasters. Additionally, it seeks to offer insights into the factors contributing to landslides and how geotextiles can be employed for mitigation. The importance of this research lies in its potential to provide effective solutions for disaster mitigation in a country prone to natural disasters, thereby safeguarding infrastructure and human lives. Furthermore, the study aims to

investigate patterns in research and publishing using a bibliometric analysis of the literature on scientific literacy research. This bibliometric approach will systematically map the scientific research outcomes on slope stabilization and geotextiles, offering a quantitative examination of trends and future directions in this research field .

METHOD

This study employs bibliometric methods to introduce an objective measure into scientific literature assessment. These methods have the potential to enhance rigor and alleviate researcher bias in scientific literature reviews by aggregating the perspectives of multiple scholars in the field. Bibliometric methods will serve as a valuable complement to meta-analysis and qualitative structured literature reviews for examining and evaluating scientific literature. To illustrate the application of bibliometric methods, the research conducts a citation and co-citation analysis, mapping the intellectual structure of the *Organizational Research Methods* journal (Zupic & Čater, 2015). The bibliometric methods use several software including Harzing's Publish or Perish and Vos Viewer.

Bibliometric analysis and VOSviewer are tools and techniques used in bibliometrics to analyze and visualize scientific literature, particularly publications, and understand the relationship between publications, authors, and research topics (Komarudin et al., 2023). So, bibliometric analysis is a quantitative approach for evaluating scholarly publications. At the same time, VOSviewer is a software tool that helps researchers visualize and analyze bibliometric data to gain insights into the structure and trends in scientific literature and collaboration networks. They provide valuable information for informed decision-making and research assessment in academia and beyond (Moral-Muñoz et al., 2020). This software was used to gain information about geotextile usage as underground infiltration in subsurface drainage towards slope stability.

Bibliometric analysis is an objective research method for evaluating articles, where the article is filtered according to the criteria and discards the unrelated ones (Desiana & Soebagyo, 2022). The results of bibliometrics have two forms: performance analysis and article mapping, where each successively shows the Number of citations and visualizations (Supinah & Soebagyo, 2022). Bibliometric analysis can also provide researchers with the knowledge to know the trend of a theme from each selected article (Ajinegara & Soebagyo, 2022). The main principle of bibliometric analysis consists of three steps: specifying keywords, performing searches with search applications such as Publish or Perish, and saving articles in specific extensions (Sarman & Soebagyo, 2022). Generally, bibliometric analysis methods are used through data collection, processing, and analysis of selected article data (Eryanti & Soebagyo, 2021).

RESULTS AND DISCUSSION

This analysis is used to examine bibliographic content and analyze citations of articles in international journals related to using geotextiles as underground filtration in subsurface drainage toward slope stability. Retrieved from Google Scholar from 2000-2023 acquired through the use of Publish or Perish software and visualization of data using VOSviewer by using these keywords: Geotextile, slope stability, landslide, erosivity, water filtration, subsurface drainage, rainfall intensity. Supplying keywords is a crucial step in bibliometric analysis. In this study, the keywords yielded 810

published articles in the 2000-2023 period. In addition, this research also used Mendeley software to help generate references, citations, and bibliographies in a whole range of journal styles.

Research Developments by Year

Figure 1 displays a graph illustrating the evolution or progress of research from 2000 to 2023, utilizing the mentioned topic and keywords, encompassing 810 articles. According to Figure 1, the evolution of research over the past 23 years, namely from 2000-2023, the publications increased in 2001 and decreased again starting from 2002. Then, it slowly increased annually from 2002 to 2009, and after that, every year, it went up and down, as shown in Figure 1, with the highest publications in 2023 with 75 publications. Then, it slowly increased annually, from 2002 to 2009. After that, it went up and down every year, as shown in Fig 1, with the highest publications in 2023, with 75 publications.

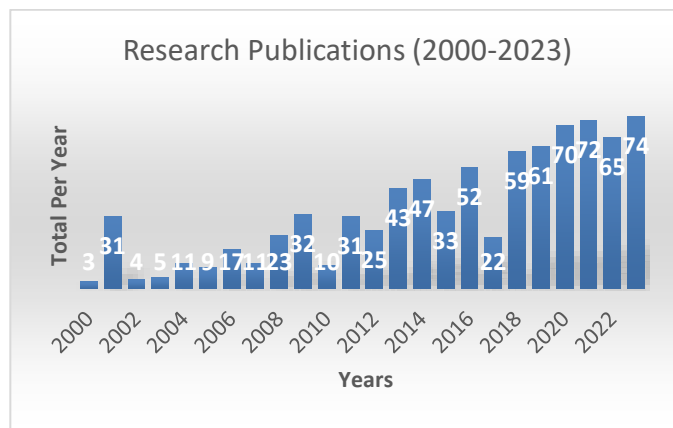


Figure 1. Publications by Year

After examining the increase in the Number of articles regarding "Geotextile as Underground Filtration in Subsurface Drainage Towards Slope Stability" across different years, the analysis will be enhanced to reveal insights that contribute to a clearer understanding of the significance of prior research. This study utilized bibliometric analysis, and data collection was performed using the Crossref database through searches for the expressions of geotextile, slope stability, landslide, erosivity, water filtration, subsurface drainage, and rainfall intensity. The search outcomes identify a cumulative total of 810 documents within the Crossref database from 2000 to 2023.

Table 1. Publications categorized by Document Type

Type of Document	Quantity of Publications	Percentage of Total Publications (%)
Journal-Article	375	46
Book	229	28
Posted-Content	119	15
Other	87	11
Total	810	100

This research investigates various document types, encompassing studies related to slopes. Table 1 illustrates publications associated with the keywords geotextile, slope stability, landslide, erosivity, water filtration, subsurface drainage, and rainfall intensity by document type. The presented statistics reveal that 46% of documents are concentrated within a single category, primarily published as journal articles. Books consist of 28% of documents, posted content consists of 15% of documents, and other documents consist of 11% of documents.

Network Visualization Based on Keywords

The visualization network will display the network between the visualized terms. Figure 2 illustrates the connections between terms, visually representing relationships in a network or lines connecting one term to another. The examination involved identifying and analyzing the most frequently used keywords to categorize the 810 articles in the sample. This analysis highlights the recurring themes in the examined field.

As depicted in Figure 2, this study employed network analysis to identify crucial interconnected terms related to slope stability and geotextile. The network analysis, accompanied by keywords and the VOSviewer software, aimed to highlight various aspects and insights into the investigation of slope stability and geotextile, particularly its impact on industries. The co-occurrence analysis of the author and index terms resulted in this study. The significance of this analytical approach lies in its ability to assist the researcher in uncovering the development and structure of the research field.

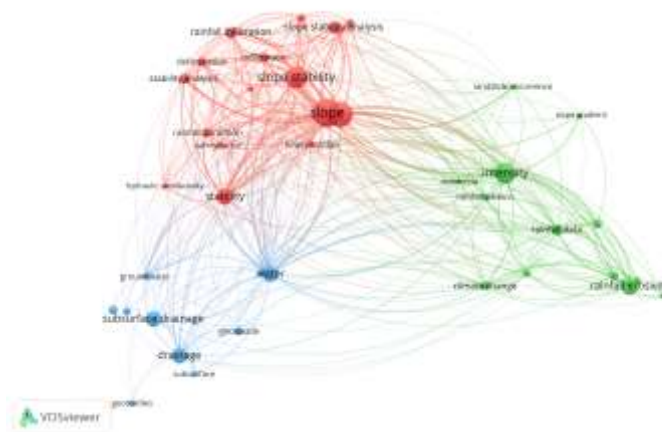


Figure 2. Keyword Trends (2000-2023)

The map depicted in Figure 2 categorizes keywords into three clusters. Slope (in the red cluster), Intensity (in the green cluster), and Water (in the blue cluster) are the main keywords for each cluster. These terms indicate the research direction and possible areas for further study possibilities.

Density Visualization Based on Keywords

Density visualization explains the density of the keywords geotextile, slope stability, landslide, erosivity, water filtration, subsurface drainage, and rainfall intensity. A visual representation of the extensive research depth within the field associated with slopes can be seen in Figure 3. Figure 3 depicts the density visualization method. We can see how frequently the term will be used in density visualization research. The shade of a phrase can be used to assess how frequently it is used. The deeper the term's shade, the more frequently it is used. The density visualization results show that slope is the most concentrated color, meaning that slope is the primary key widely discussed in this research.

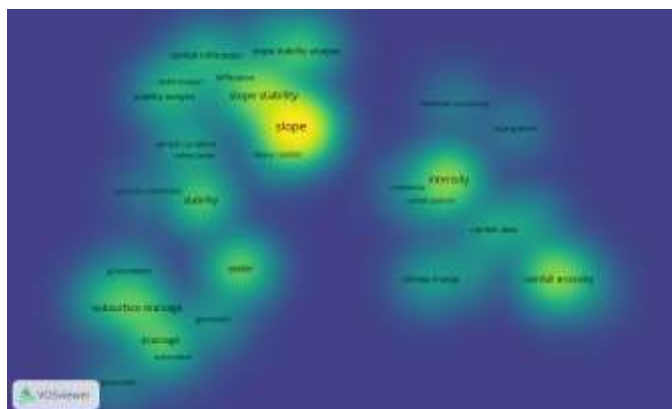


Figure 3. Density Visualization Based on Keywords (2000-2023)

The visualization result of Figure 3 shows the relationship between various themes with geotextiles, such as underground filtration in subsurface drainage towards slope stability, consisting of 41 themes or terms related to the keywords. The yellow color symbolizes the density of the research theme, which means the high frequency of research on the topic or the relationship between the themes. Variables that are dimly colored possess the potential for future investigations. These results indicate that the themes of landslide occurrences and slope gradients are recommended for investigation in the following study.

Influential Authors

We performed a co-authorship study using the VOSviewer program, a tool for finding notable institutions and scientists and examining their relationships. This analysis helped rank the leading authors based on the Number of documents and citations. As illustrated in Figure 4, the Number of documents published delineates the top 15 most significant authors. Figure 4 portrays the bibliographic coupling of authors, enabling us to observe and quantify the strength of connections among them. Meanwhile, Table 1 presents the prominent authors categorized by their respective document counts.

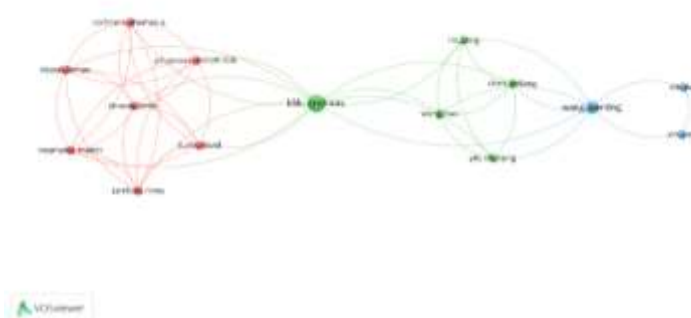


Figure 4. displays influential authors identified by VOSviewer.

As shown in Table 2, Thomas A. Cochrane, Tomas Dostal, and Lisbeth Lolk Johannsen with the most documents published (6 research), followed by Martin Neumann, Peter Strauss, Nives Zambon, and David Zumr (5 research); Deling et al. (4 research); Hao et al. (3 research). The research they conducted is still related, as shown in Figure 4. This means they all focused on accommodating keyword research and striving to produce quality articles.

Table 2. Authors with notable contributions based on documents.

Rank	Author	Documents
1	Thomas A. Cochrane	6
2	Tomas Dostal	6
3	Lisbeth Lolk Johannsen	6
4	Martin Neumann	5
5	Peter Strauss	5
6	Nives Zambon	5
7	David Zumr	5
8	Deling Chen	4
9	Zeng He	4
10	Andreas Klik	4
11	Hao Wang	3
12	Shuiqing Yin	3
13	Wenting Wang	3
14	Yun Xie	3
15	Yan Xin	3

Analyzing citations is regarded as a crucial aspect of bibliometric research. Based on the discussion on this study, the discussion that can calculate and determine the quality of usefulness of a study made by a person is citation analysis. Citation analysis measures the intensity or how much work others cite. The more people who cite, the more valuable the work is and the higher the need of society for scientific research.

Table 3. Prominent Authors by Citations

Rank	Authors	Citations
1	Murielle Ghestem, Roy C. Slide, Alexia Stokes	324
2	S. Assouline, M. Ben-Hur	244
3	Jon A. Zahner, Fred L. Ogden, Charles W. Downer, Nawa Raj Pradhan	168
4	Alexander Marco da Silva	162
5	Edson Wendland, Mark A. Nearing, Paulo Tarso Sanches Oliveira	132
6	Mengistu B. Defersha, Assefa M. Melesse	124
7	Gen Furuya, Yoichi Okura, Takuro Matsui, Toshiaki Sammori, Hirotaka Ochiai, Tomomi, Yasuhiko Okada	120
8	Jian-qi Zhuang, Jian-bing Peng	111
9	Cristiano Ballabio, Panos Panagos, Katrin Meusbürger, Pasquale Borrelli	108
10	Francesco Granata, Rudy Gardano, Giovanni de Marinis	104

In this study, a compilation was made of 10 authors whose citations exceeded 100 published papers, aiming to categorize the most pertinent and highly regarded authors. As depicted in Table 2, the most frequently cited authors were Murielle Ghestem, Roy C. Slide, and Alexia Stokes, with 324 citations, followed by S. Assouline, M. Ben-Hur (244 citations), and so on. Examining the most cited articles in terms of historical and annual averages can assist researchers in identifying seminal materials that can serve as references to support their studies. This provides a clear starting point in advance.

Country Distribution

The crossref database includes various journals and articles. Statistics on the author's country of affiliation can be used to understand which countries researchers have made the most significant contribution to slope research. Examining the authors' countries reveals that the research topic is global, as the 810 articles in the sample are spread across 90 countries. This indicates that at least one article has been published in each country. The highest-rated papers are represented by the top 10 nations shown in Table 2. The citation ranking of countries indicates that they are in the leading position based on documentation and citations.

Table 4. Prominent Authors by Publications and Citations

Rank	Country by Documents	Documents	Rank	Country by Citations	Citations
1	America	132	1	America	1010
2	China	35	2	China	375
3	Japan	28	3	Italy	348
4	India	22	4	Brazil	300
5	Korea	17	5	India	248
6	Italy	16	6	Australia	127
7	Australia	13	7	Korea	107
8	Indonesia	10	8	Indonesia	71
9	Canada	7	9	Japan	38
10	Brazil	5	10	Africa	25

The United States was at the forefront of researching and delving deeper into the practices related to slope and conducting analyses on slope failures, surpassing other ranked countries. China secured the second position in both citation and documentation and so on. It is evident that high-income countries consistently held prominent positions, being more inclined to generate and publish more documents due to adequate funding access to suitable tools, equipment, and infrastructure. Conversely, countries with emerging economies needed to be more frequent and regular in the literature, mainly due to insufficient resources.

CONCLUSION

This research aims to perform a bibliometric analysis of geotextiles for underground filtration in subsurface drainage toward slope stability. The reference manager application facilitated the data collection for this research: Publish or Perish. The data resulted from filtering articles with keywords such as "Geotextile, slope stability, landslide, erosivity, water filtration, subsurface drainage, rainfall intensity." The bibliographic data utilized in this study encompassed subject areas, titles, keywords, and abstracts. The outcome revealed 810 related articles published between 2000 and 2023. The analysis indicates a growing number of articles addressing slope stability, particularly since 2018.

Using the specified keywords, a clustering approach yielded three clusters (red, green, and blue) with varying numbers in each cluster. Among the researchers, Martin Neumann, Peter Strauss, and Nives Zambon demonstrated the highest productivity, each contributing to six scientific publications. Regarding citations, Murielle Ghestem, Roy C. Slide, and Alexia Stokes emerged as the most cited authors, with 324 cited documents. Regarding country distribution, the United States

ranked first with 132 published articles and 1010 cited documents. The study recommends that future research employ a more extensive data sample for a more comprehensive research mapping.

REFERENCES

- Ajinegara, M. W., & Soebagyo, J. (2022). Analisis Bibliometrik Tren Penelitian Media Pembelajaran Google Classroom Menggunakan Aplikasi VOSViewer. *JNPM (Jurnal Nasional Pendidikan Matematika)*, 6(1), 193–210.
- Al-Adhadh, A. R., Abbas, B. J., & Hamza, A. J. (2021). Analysis and Evaluation of Landslide Failure and Using Different Techniques for the Mitigation. *IOP Conference Series: Materials Science and Engineering*, 1090(1), 12008.
- Alewell, C., Borrelli, P., Meusburger, K., & Panagos, P. (2019). Using the USLE: Chances, challenges, and limitations of soil erosion modeling. *International Soil and Water Conservation Research*, 7(3), 203–225.
- Ali, A., Huang, J., Lyamin, A. V., Sloan, S. W., & Cassidy, M. J. (2014). Boundary effects of rainfall-induced landslides. *Computers and Geotechnics*, pp. 61, 341–354.
- Caine, N. (1980). The rainfall intensity-duration control of shallow landslides and debris flows. *Geografiska Annaler: Series A, Physical Geography*, 62(1–2), 23–27.
- Cha, K. S., & Kim, T. H. (2011). Evaluation of slope stability with topography and slope stability analysis method. *KSCE Journal of Civil Engineering*, 15(2), 251–256. <https://doi.org/10.1007/s12205-011-0930-5>
- Chasanah, U. (2012). *Analisis Stabilitas Lereng Dengan Perkuatan Geotekstil Menggunakan Program Geoslope*.
- Chen, R.-H., Ho, C.-C., & Hsu, C.-Y. (2008). The effect of acceptable soil content on the filtration characteristics of geotextile under cyclic flows. *Geosynthetics International*, 15(2), 95–106.
- Dai, F. C., & Lee, C. F. (2001). Frequency–volume relation and prediction of rainfall-induced landslides. *Engineering Geology*, 59(3–4), pp. 253–266.
- Desiana, D., & Soebagyo, J. (2022). Bibliometric Analysis of the Spontaneous Group Discussion Method of Learning Mathematics Using Vosviewer Software. *Jurnal Paedagogy*, 9(3), 345–353.
- Du, C., Xu, C., Yang, Y., & Wang, J. (2022). Filtration Performance of Nonwoven Geotextile Filtering Fine-Grained Soil under Normal Compressive Stresses. *Applied Sciences*, 12(24), 12638.
- Duncan, J. M., Wright, S. G., & Brandon, T. L. (2014). *Soil strength and slope stability*. John Wiley & Sons.
- Effendi, D. N., Anggraini, W., Jatmiko, A., Rahmayanti, H., Ichsan, I. Z., & Rahman, M. M. (2021). Bibliometric analysis of scientific literacy using VOS viewer: Analysis of science education. *Journal of Physics: Conference Series*, 1796(1), 12096.
- Eryanti, I., & Soebagyo, J. (2021). Bibliometric Analysis of Blended Learning Mathematics in Scientific Publications Indexed by Scopus. *Numerical: Jurnal Matematika Dan Pendidikan Matematika*, 91–102.
- Frischknecht, R., Stucki, M., Büsser, S., Itten, R., & Wallbaum, H. (2012). Comparative life cycle assessment of geosynthetics versus conventional construction materials. *Ground Engineering*, 45(10), 24–28.
- Gallage, C., Abeykoon, T., & Uchimura, T. (2021). Instrumented model slopes to investigate the effects of slope inclination on rainfall-induced landslides. *Soils and Foundations*, 61(1), 160–174.
- Hasan, R. (2020). An overview of geotextiles: industrial application in technical textiles. *J Text Sci Fash Technol*, 4(4).
- Hasnawir, H. (2012). Intensitas Curah Hujan Memicu Tanah Longsor Dangkal Di Sulawesi Selatan. *Jurnal Penelitian Kehutanan Wallacea*, 1(1), 62–73.
-

- Heibaum, M. (2016). Geotextiles used in filtration. In *Geotextiles* (pp. 257–275). Elsevier.
- Indrawahyuni, H., & Damayanti, I. (2009). Pengaruh variasi kepadatan pada permodelan fisik menggunakan tanah pasir berlempung terhadap stabilitas lereng. *Rekayasa Sipil*, 3(3), 192–208.
- Keefer, D. K., Wilson, R. C., Mark, R. K., Brabb, E. E., Brown III, W. M., Ellen, S. D., Harp, E. L., Wieczorek, G. F., Alger, C. S., & Zarkin, R. S. (1987). Real-time landslide warning during heavy Rainfall. *Science*, 238(4829), 921–925.
- Komarudin, P., Sodiki, M., Toyyibah, I. A., Syahrani, S., & Zakiyah, Z. (2023). Bibliometric Mapping of Research Developments Using Qardh Financing Topics On Google Scholar Using Vosviewer. *Islamic Banking: Jurnal Pemikiran Dan Pengembangan Perbankan Syariah*, 8(2), 275–302.
- Li, K. S., & White, W. (1987). Rapid evaluation of the critical slip surface in slope stability problems. *International Journal for Numerical and Analytical Methods in Geomechanics*, 11(5), 449–473.
- Markiewicz, A., Koda, E., & Kawalec, J. (2022). Geosynthetics for filtration and stabilization: a review. *Polymers*, 14(24), 5492.
- Moral-Muñoz, J. A., Herrera-Viedma, E., Santisteban-Espejo, A., & Cobo, M. J. (2020). Software tools for conducting bibliometric analysis in science: An up-to-date review. *Profesional de La Información/Information Professional*, 29(1).
- Nurhidayati, S., & Alhadi, Z. (2021). Kendala Dalam Menanggulangi Bencana Longsor Berdasarkan Badan Penanggulangan Bencana Daerah Di Kabupaten Agam. *Jurnal Teori Dan Riset Administrasi Publik*, 5(1), 92–99.
- Palmeira, E. M., Melo, D. L. A., & Moraes-Filho, I. P. (2019). Geotextile filtration opening size under tension and confinement. *Geotextiles and Geomembranes*, 47(4), 566–576.
- Pangemanan, V. G. M., Turangan, A. E., & Sompie, O. B. A. (2014). Analisis kestabilan lereng dengan metode Fellenius (Studi kasus: Kawasan Citraland). *Jurnal Sipil Statik*, 2(1).
- Polemio, M., & Petrucci, O. (2000). Rainfall as a landslide triggering factor: an overview of recent international research. *Landslides in Research, Theory and Practice*.
- Sansone, L. J., & Koerner, R. M. (1992). OK, a fraction filtration test is needed to assess geotextile filter performance. *Geotextiles and Geomembranes*, 11(4–6), 371–393.
- Sarman, S. N., & Soebagyo, J. (2022). Analisis Bibliometrik terhadap Kemampuan Berpikir Kritis Matematika Berdasarkan Pemecahan Masalah Berbasis VOS Viewer. *Vygotsky: Jurnal Pendidikan Matematika Dan Matematika*, 4(2), 117–128.
- Satya, G., Andriawan, A. H., Ridho'i, A., & Seputro, H. (2014). Intensitas curah hujan memicu tanah longsor dangkal di Desa Wonodadi Kulon. *JPM17: Jurnal Pengabdian Masyarakat*, 1(01).
- Supinah, R., & Soebagyo, J. (2022). Analisis bibliometrik terhadap tren penggunaan ICT pada pembelajaran matematika. *JNPM (Jurnal Nasional Pendidikan Matematika)*, 6(2), 276–290.
- Tsapas, I., Rahardjo, H., Toll, D. G., & Leong, E. C. (2002). Controlling parameters for rainfall-induced landslides. *Computers and Geotechnics*, 29(1), 1–27.
- Wang, H., Zhang, Y. C., & Hu, H. Y. (2013). A study on the relationship of landslide occurrence and Rainfall. *Applied Mechanics and Materials*, p. 438, 1200–1204.
- Wüpper, D. J. (2020). *Dataset: countries and the global rate of soil erosion (Wuepper et al. 2020, Nature Sustainability)*.
- Zupic, I., & Čater, T. (2015). Bibliometric Methods in Management and Organization. *Organizational Research Methods*, 18(3), 429–472. <https://doi.org/10.1177/1094428114562629>



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