EARTH SCIENCES
RESEARCH JOURNAL
Earth Sci. Res. J. Vol. 29, No. 3 (September, 2025): 249 - 259

UNIVERSIDAD NACIONAL DE COLOMBIA

GEOLOGICAL ENGINEERING

Landslide Research in CIS countries: Remote Sensing, Hazards, and Research Trends

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ABSTRACT

Landslides are among the major environmental hazards, with large-scale socio-economic and environmental impacts, that jeopardize socio-economic well-being in the countries of the Commonwealth of Independent States (CIS). Landslides are caused by the interaction of several complex factors, including local or regional geology, geomorphology, topography, and seismic motions. The factors that can trigger landslides are classified into three categories: external, internal, and anthropogenic (human-induced). It has been identified that geophysical, geotechnical, and statistical approaches are commonly used in landslide research in the CIS states. The goal of this study is to review published articles on landslides in CIS countries from 1966 to 2022. In line with this goal, we have collected (using Scopus database), reviewed, and analyzed 944 papers published during 1966–2022. Bibliometric analysis revealed that all articles were published in two languages: English and Russian. The highest publication numbers came from the Russian Federation, followed by Kyrgyzstan, Kazakhstan, Germany, the United States, Japan, Uzbekistan, Belgium, China, and Italy. Furthermore, our research shows that the largest number of papers were research articles, comprising 559 (59%) of 944, followed by 282 documents of conference proceedings, 75 book chapters, and 15 review papers. In contrast, there were only 1% of other document types (e.g., Book 6, Editorial 3, Note 2, Erratum 1, Short Survey, and Retracted, each with 1). The scientometric analysis revealed that international research on landslides is necessary to enhance scientific exchange on this topic.

Keywords: Landslide; Remote Sensing; CIS countries; Research trend; Citations; Review.

Investigación sobre deslizamientos de tierra en la Comunidad de Estados Independientes: teledetección, riesgos y tendencias de investigación

RESUMEN

Los deslizamientos de tierra son uno de los principales riesgos ambientales, con impactos socioeconómicos a gran escala, que ponen en peligro el bienestar socioeconómico de los países de la Comunidad de Estados Independientes (CEI). Los deslizamientos son causados por la interacción de varios factores complejos, que incluyen la geología local y regional, la geomorfología, la topografía y los movimientos sísmicos. Los factores que pueden desencadenar los deslizamientos se clasifican en tres categorías: externos, internos y antropogénicos (inducidos por los seres humanos). Se ha identificado que los abordajes desde la geofísica, la geotecnia y la estadística se usan comunmente en la investigación de los deslizamientos de tierra en los estados de la CEI. La meta de este estudio es revisar artículos publicados sobre deslizamientos en los paises de la CEI entre 1966 y 2022. En línea con este objetivo, hemos recopilado (utilizando la base de datos Scopus), revisado y analizado 944 artículos publicados durante el período de estudio. El análisis bibliométrico reveló que todos los artículos se publicaron en dos idiomas: inglés y ruso. Los números más altos de publicaciones vinieron de la Federación Rusa, seguida de Kirguistán, Kazajistán, Alemania, Estados Unidos, Japón, Uzbekistán, Bélgica, China e Italia. Además, nuestra investigación muestra que la mayor cantidad de artículos fueron artículos de investigación, que comprenden 559 (59%) de 944, seguidos de 282 documentos de actas de conferencias, 75 capítulos de libros y 15 artículos de revisión. En contraste, hubo solo un 1% de otros tipos de documentos (por ejemplo, Libro 6, Editorial 3, Nota 2, Fe de erratas 1, Encuesta corta 1 y Retractado 1). El análisis cienciométrico reveló que la investigación internacional sobre deslizamientos de tierra es necesaria para mejorar el intercambio científico sobre este tema.

Palabras Clave: Deslizamientos de tierra; detección remota; países de la Comunidad de Estados Independientes; temas tendencia de investigación; citaciones; revisión

Record
Manuscript received: 14/02/2025
Accepted for publication: 17/09/2025

How to cite this item:
Kannazarova, Z., Khadjiyeva, Z., Abdikairov, B., Juliev, M., Sharipov, Z., & Berdimuratov, P. (2025). Landslide Research in CIS countries: Remote Sensing, Hazards, and Research Trends. *Earth Sciences Research Journal, 29*(3), 249-259. https://doi.org/10.15446/esrj.v29n3.118866

ISSN 1794-6190 e-ISSN 2339-3459
https://doi.org/10.15446/esrj.v29n3.118866

1. Introduction

Landslides cause substantial economic losses and casualties and among the most common geohazards worldwide, especially in rural and mountainous areas in Commonwealth of Independent States (CIS) countries (Okalp & Akgün, 2022; Froude & Petley, 2018). Landslides have a considerable impact on mountainous regions, although their economic consequences are often underestimated (Sekarlangit et al., 2022; Gracheva & Urushadze, 2011). Landslides can be induced by various factors, such as intense or prolonged rainfall, earthquakes, water level fluctuations, rapid snowmelt, volcanic eruptions, and human activities, leading to tragic loss of life, substantial economic damage, and environmental degradation (Niu et al., 2014; Wu et al., 2014; McAdoo et al., 2018; Mertens et al., 2016).

Landslide-triggering factors can be classified into external, internal, and anthropogenic (human-induced) causes. Key external factors include the following rock strata weathering, increased pore water pressure, resulting from rainwater infiltration or a rise in groundwater levels (Regmi et al., 2013; Hossain et al., 2025; Stein et al., 2024). Additional loading that can induce a landslide includes rainfall (Zhang et al., 2019), snow accumulation (Wang et al., 2019), or dense vegetation (Schmidt et al., 2001), as well as the loss of supporting forces at the slope's toe due to processes such as weathering and erosion (Zhao et al., 2022). On the other hand, previous landslides or faults, failure of underlying strata, increased lateral pressure caused by rock fractures, freezing of water, or expansion of clay, seismic events such as earthquakes and vibrations, heavy rainfall may all contribute to the occurrence of landslides (Kharismalatri et al., 2018; Yang et al., 2020). According to Osipov et al. (2019), other factors, such as ground subsidence linked to the formation of limestone caves as well as certain human activities may also act as an external trigger of landslides. For instance, modifying the slope by removing material at its toe can increase its steepness (Chakraborty & Dey, 2019). The construction of buildings on a slope adds to the load (Stanley Gathekia, 2024), while the disposal of artificial waste (Zhan et at., 2021) can further intensify the driving forces acting on slope materials. As mentioned by Simonyan & Volkov (2021) poor site selection, such as building roads along or across slopes or leveling terrain for construction, might also destabilize slopes, leading to landslides. Internal factors contributing to landslide occurrence are related to the physical characteristics of soil and rock (Cheskidov et al., 2018). These include the presence of weak or soft rock materials, rock layers with multiple joints or shear fractures, and geological structures (Li et al., 2021). Topography and vegetation also play a role in slope stability by influencing the adhesive and frictional forces between rock particles, which, when reduced, make slopes more susceptible to failure (Fata et al., 2021). According to Reichenbach et al. (2018) to assess landslide susceptibility, various methods and models have been developed. The primary objective of landslide susceptibility analysis is to understand the relationship between landslide occurrences and contributing factors (Fell et al., 2008).

The Commonwealth of Independent States (CIS), established on December 8, 1991 in Belarus, is a community of independent countries that has declared itself the successor to the Union of Soviet Socialist Republics (USSR) in several areas of international law and politics (Palgrave Macmillan, 2016). CIS consists of Armenia, Azerbaijan, Belorussia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan and Uzbekistan and Turkmenistan which relinquished its ongoing participant status and became an associate member on August, 26, 2005 (Turner, 2014). The growth of the CIS commenced with the dissolution of the Soviet Union in the 1990s (Tanaguzova et al., 2023). It was established to handle the Soviet Union's demise and promote post-Soviet cooperation in politics, economics, and security (Kubicek, 2009). The CIS conducts its shared affairs on a multilateral, interstate basis rather than via centralised organisations (Hunter, 1995).

In the CIS region, geophysical, geotechnical, and statistical methods are predominantly applied in landslide studies (Rosi et al., 2023; Shuvalova et al., 2021; Saponaro et al., 2015). Among geophysical techniques, seismic refraction and electrical resistivity tomography are the most widely used, especially for analyzing seismically and tectonically active areas (Bogoslovsky & Ogilvy, 1977; Dalatkazin et al., 2022). Geotechnical methods are mainly related to the soil characteristics and properties and their impact to the slope failure processes (Kiernan et al., 2022). Statistical methods mainly related with spatial analysis using Geographic Information System (GIS) and Remote Sensing (RS) techniques (Juliev et al., 2018) which commonly used to identify areas most prone to landslides (Smirnova & Kirsanov, 2021).

In environmental and geological research, remote sensing has emerged as a crucial instrument, providing unmatched capabilities for observing, charting, and examining Earth's surface processes (Yamashkin et al., 2020). Through the use of satellite images, aerial photography, and other sensor-based technologies, remote sensing delivers high-resolution data across multiple time periods, which is essential for investigating dynamic events like landslides. Its capacity to survey extensive and often unreachable areas makes it particularly useful for evaluating landslide-susceptible regions, recognizing triggers, and tracking changes across time. Methods such as Synthetic Aperture Radar (SAR), Light Detection and Ranging (LiDAR), and optical imaging have transformed landslide studies, allowing for accurate measurements of land deformation, slope stability, and interactions with water systems (Teshebaeva et al., 2015). Consequently, remote sensing has become fundamental to modern landslide hazard evaluation, offering insights that aid in developing effective strategies for risk reduction and managing disasters (Thien et al., 2022).

Previous researches on landslide and its importance in the following CIS countries indicate that in Russia new radiocarbon dating of previously discovered evidences of powerful ancient earthquakes inside the highest and most seismically active southeastern region of Russian Altai (SE Altai) within the last four thousand years was reported (Nepop & Agatova, 2017), in Kazakhstan the Ile Alatau range's low-mountain zone on the northern side had the highest density of seismogenic landslides, resulting from a magnitude 9 earthquake in 1887 where landslides had a volume of almost 400 million m^3 and density of 1/5 km^2 (Medeu et al., 2018), in Kyrgyzstan Romanenko et al. (2020) identified the importance to manage the risk of activation of landslide processes in the territory of the Kyrgyz Republic, which cause significant economic, environmental and social damage and lead to large human casualties. In case of Uzbekistan Mamadjanova & Leckebusch (2022) analyzed precipitation-induced flooding which were a severe and long-standing challenge causing landslides. Mardanov et al. (2017) devoted their research to analyze the potential for forecasting alterations in the landscape structure of highlands within the Greater Caucasus natural region, utilising diverse data sets. This statistical analysis elucidated the primary distinctions among the factors influencing relief conditions, including exodynamic relief and landscape formation processes, as well as the nature and intensity of land use, which variably impact landslides and are simultaneously influenced by their destructive effects.

Bibliometric analysis identifies cognitive structures and intellectual relationships by analyzing the performance of documents, authors, countries, journals, and institutions (Maassen, 2016). The purpose of this study to provide systematic methods for the acquisition of transparent bibliographic information related to a specific field of study (Sawassi & Khadra, 2021). It also discovers topics where the scientific community considers relevant to social, economic, and environmental sustainability (Durán-Sánchez et al., 2020). Furthermore, bibliometrics has contributed to various academic fields such as groundwater (Kannazarova et al. 2024), irrigation and drainage (Kannazarova et al. 2024), agricultural mechanization (Xaliqulov et al., 2023), soil erosion (Juliev et al., 2024), digital education (Juliev et al., 2024), sustainability (Pizzi et al., 2020), environment (de Sousa, 2021), ecosystem services (Djanpulatova et al., 2025), urban planning (Elshater & Abusaada, 2022), engineering (Cancino et al., 2017), industry (Mei et al., 2021), linguistic issue (Mardieva et al., 2024), smart logistics (Mukanov et al., 2024) and soil salinity modelling (Abdikairov et al., 2024).

The purpose of this study is to analyze current topics and key regions in the CIS countries in landslide research as well as to use historical scientometric data to gain new insights into trends and emphasis of international landslide research. The selected timeframe of 1966 to 2022 provides a comprehensive overview of the development and evolution of landslide research over several decades. This period captures the significant scientific advancements and methodological innovations in environmental science, earth and planetary sciences, and related fields. Furthermore, it enables the identification of long-term trends, shifts in research focus, and emerging themes over time. These countries encompass diverse landscapes, including mountainous terrain, prone to landslides and other geohazards, making them highly relevant for studying landslide phenomena. Additionally, the region has undergone significant social, political, and economic transitions, influencing research output and collaboration patterns. Analysing landslide studies from these countries offers insights into regional scientific contributions and challenges, while also highlighting the importance of bilingual research in both English and Russian. This dual-language focus ensures a more inclusive analysis, capturing publications that may otherwise be overlooked, thus promoting a deeper understanding of landslide research across different cultural and academic contexts.

2. Methodology and analysis methods

2.1 Article review and study eligibility criteria

The research was carried out on the most widely used bibliographic online databases Scopus for period of 1966-2022 using landslide and CIS countries, including Russian Federation, Belarus, Azerbaijan, Moldova, Armenia, Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan as the keywords. The analysis was carried out in March 2023. A total of 944 final published papers belonging to CIS countries sorted out for the further analysis on landslide issue. The analysis was performed using CSV file, Microsoft Excel 2021, RIS, VOS viewer and Map chart.

For the searching process, relevant information, such as keyword "landslide" in the title of papers and all articles in English and in Russian, were added to a spreadsheet. Article = ("landslide"), document type = "article", timespan = "1966-2022", Subject area = Environmental Science, Earth and Planetary Sciences, Agricultural and Biological Sciences, countries = Russian Federation, Belarus, Azerbaijan, Moldova, Armenia, Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan, language= "English", "Russian" and deadline = March 2023. Figure 1 shows the flow of the selected methodology for the research.

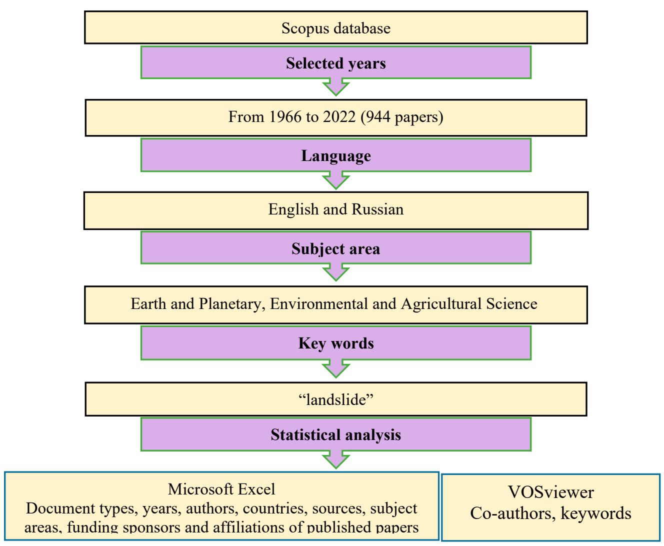


Figure 1. Methodology flowchart for the research

During the screening process, the following exclusion criteria were used:
1. Lack of definition of search terms (stability, sensitivity, resistance).
2. Many articles do not have a DOI and the ability to find articles is limited. In general, it was not possible to exclude these articles using the filter options in Scopus.

2.2. Bibliometric Analysis

The data, provided in CSV format, was uploaded to Excel for further bibliometric analysis. Prior to conducting the analysis, the dataset was meticulously reviewed to identify and correct any errors. The analyzed articles were evaluated to identify the most relevant works and the most productive authors, highlighting key contributors. The collected articles were categorized based on various criteria, including the number of publications per year, document type, top-ranking articles, leading journals, primary funding sponsors, and distribution by subject categories, journals, countries, and institutions. Additionally, a co-authorship and keyword co-occurrence analysis were provided which can be generated using VOS viewer based on bibliographic data. Supported file formats include .txt, ris, and .csv from Scopus databases where the raw file was imported into VOS viewer and a map of co-authorship and keyword co-occurrence were performed using the software. This analysis identified clusters of frequently used keywords and authors collaboration providing insight into the core themes and research trends in the domain. Additionally, Mapchart online platform was utilized to demonstrate countries research activity level.

3. Results

3.1 Trend of publications on landslide studies only in CIS countries

A total of 944 papers were published between 1966 and 2022 on landslide research in CIS countries (Fig. 2). In this review, the scientific articles consist of three periods of development: introduction (1966–2004), slight growth (2005–2012), and stable growth (2013–2022). The numbers above the curve mean the quantity of published papers for each year. Every period has its maximum level indicating 2003, 2006, and 2020 with 12, 32 and, 108 published research, respectively. It is noticeable to point out that since 1991, every year has demonstrated research publications which was not possible for previous years. Overall, research interest and technological advances in monitoring promote sustainable development of the research area. Below, every research period was described in detail with a particular explanation.

- Introduction period. The first 1966-2004 period consists of 63 publications, representing 6.67% of the total. The results show that the interest in the landslide theme with the agriculture lands started from the environmental problem–solution relationship, geophysical methods for the investigation of landslide (Bogoslovsky & Ogilvy, 1977), simplified model of tsunami generation by submarine landslides (Pelinovsky & Poplavsky, 1996) and active faulting and natural hazards in Armenia, eastern Turkey and northwestern Iran (Karakhanian et al., 2004).
- Slightly growth period including 2005-2012 shows 150 documents representing 15.89% of the total, with a growth that marks both scientific interest in this field of research and technological advances in observation. The data show that the number of articles by region increased during this period due to the following facts - volcanic activity in Kamchatka (Russia) which led to landslide appearance (Ponomareva et al., 2006), earthquake contributing to landslide origin in Tajikistan in 1949 which associated loss of life (Evans et al., 2009), environmental changes as climate and land are likely to be reflected in alterations to the size–frequency distribution of landslides in case of Kyrgyzstan (Schlögel et al., 2011).
- Stable growth covering 2013-2022 period. The last period represents the key to exponential growth, grouping 731 documents (77.43% of the total). In 2020, the highest number of publications was reached during the period of analysis with 108, followed by the year 2021 (with 94), making it a constant growth field (Figure 2). The use of remote sensing and geospatial technologies has increased to improve landslide monitoring and prediction in CIS countries with a significant increase in publications in the last decade. One of the research projects belonged to Sharapov & Varlamov, (2015) identified remote sensing monitoring of landslides, landslips and karst collapses applying neural networks, calculation of the landslide volume from remote sensing data with combination of field data were investigated by Razakova et al. (2020), as well as investigations on application of multimodal experimental geomechanical and geodynamic data to promote innovative analytical framework for contemporary integrated satellite monitoring to investigate the origins of source zones of natural and anthropogenic disasters including landslide had been demonstrated (Potapov et al., 2022).

Moreover, our study shows that the largest number 559 (59%) of 944 papers were research articles, followed by 282 articles conference proceedings, 75 book chapter and 15 in review papers whereas there were only 3% of other document types (e.g. Book 6, Editorial 3, Note 2, Erratum 1, Short Survey and Retracted each 1) (Fig. 3).

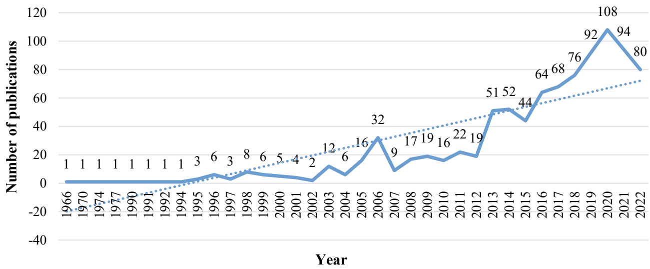


Figure 2. Annual growth rate of publications in landslide

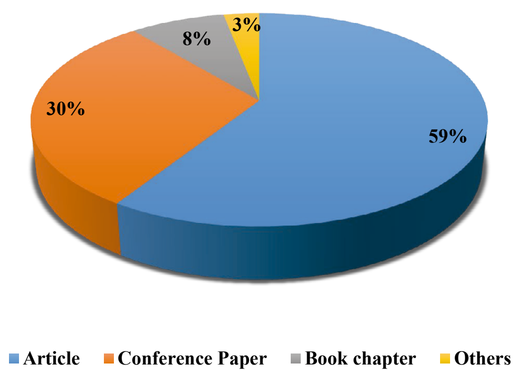


Figure 3. Publication type on landslide in CIS countries

3.2 Journals on landslide in CIS countries

The review provides an overview of journals and knowledge topics related to this academic field (Montalván-Burbano et al., 2020). There was a distribution of the total output across 122 journals published in 77 countries based on the communication patterns of the scholars. Of these 20 journals published 335 (35,4%) papers and remaining 64,6% papers were published in other journals. Table 1 lists name of the 64 journals which published minimum 3 and higher number of papers during the abovementioned period. Among them Iop Conference Series Earth and Environmental Science had the highest number of publications with 36, following by E3s Web of Conferences 29 papers and International Multidisciplinary Scientific Geoconference Surveying Geology and Mining Ecology Management Sgem with 27 papers in this field.

Table 1. List of the journals on landslide by the year of publication issues in CIS countries

Scopus Source title	Number	Scopus Source title	Number
IOP Conference Series Earth and Environmental Science	36	Mining Science and Technology Russian Federation	6
E3s Web of Conferences	29	Springer Proceedings in Earth and Environmental Sciences	6
International Multidisciplinary Scientific Geoconference Surveying Geology and Mining Ecology Management Sgem	27	Volcanology and Seismology	6
Sustainable Development of Mountain Territories	27	Geotectonics	5
Iop Conference Series Materials Science and Engineering	23	Journal of Volcanology and Geothermal Research	5
Landslides	21	Journal of Volcanology and Seismology	5
Bulletin of The Tomsk Polytechnic University Geo Assets Engineering	20	Lithology and Mineral Resources	5
Geomorfologiya	17	News of The National Academy of Sciences of The Republic of Kazakhstan Series of Geology and Technical Sciences	5
Pure and Applied Geophysics	16	Russian Journal of Pacific Geology	5
Russian Geology and Geophysics	14	Doklady Physics	4
Gornyi Zhurnal	13	Journal of Applied Mechanics and Technical Physics	4
Oceanology	13	Marine Geology	4
Doklady Earth Sciences	12	Planetary and Space Science	4
Sovremennye Problemy Distantsionnogo Zondirovaniya Zemli Iz Kosmosa	12	Proceedings of The International Offshore and Polar Engineering Conference	4
Earth S Cryosphere	11	Science of Tsunami Hazards	4
Geomorphology	10	Soil Mechanics and Foundation Engineering	4
Journal of Mining Science	9	Springer Geology	4
Remote Sensing	9	Bulletin of Volcanology	3
Moscow University Geology Bulletin	8	Catena	3
Natural Hazards	8	Earth Science Reviews	3
Natural Hazards and Earth System Science	8	Earth Surface Processes and Landforms	3
Environmental Science and Engineering	7	Environmental Earth Sciences	3

Scopus Source title	Number	Scopus Source title	Number
Geodynamics and Tectonophysics	7	Eurasian Mining	3
Geologiya I Geofizika Yuga Rossii	7	Geodezia I Kartografia	3
Izvestiya Atmospheric and Ocean Physics	7	Issledovanie Zemli Iz Kosmosa	3
Lecture Notes in Civil Engineering	7	Izvestiya Rossiiskoi Akademii Nauk Seriya Geograficheskaya	3
Procedia Engineering	7	Journal of Marine Science and Engineering	3
Russian Journal of Earth Sciences	7	Mining Informational and Analytical Bulletin	3
Geography and Natural Resources	6	Natural Hazards and Earth System Sciences	3
Geosciences Switzerland	6	Proceedings of SPIE The International Society for Optical Engineering	3
Izvestiya Physics of The Solid Earth	6	Quaternary International	3
Matec Web of Conferences	6	Reliability Theory and Applications	3

3.3 Authors, co-authorships and keyword co-occurrence

A total of 2466 researchers participated in the retrieved documents regarding the application of landslide, which corresponds to a mean of 2.46 authors per document. Single-authored documents comprised a total of 25 (2.64% of the total) publications. Table 2 lists the top 14 active authors in the field of landslide issue. Among them, Strom, A. reigned with 42 publications, followed by Havenith, H.B. with 24, Torgoev, I. with 20, Pelinovsky, E. with 14.

Table 2. Top 15 active authors in the field of Landslide

Standard Competition Ranking (SCR)	Author	Articles (%)
1st	Strom, A.	56 (5,92)
2nd	Havenith, H.B.	24 (2,54)
3rd	Torgoev, I.	20 (2,11)
4th	Pelinovsky, E.	14 (1,5)
5th	Fomenko, I.K.	13 (1,4)
6th	Rabinovich, A.B.	12 (1,3)
6th	Zakharov, A.I.	12 (1,3)
7th	Abdrakhmatov, K.	11 (1,16)
7th	Kazeev, A.	11 (1,16)
7th	Leibman, M.	11 (1,16)
7th	Zakharova, L.N.	11 (1,16)
8th	Lebedeva, E.V.	10 (1,05)
8th	Postoev, G.	10 (1,05)
9th	Torgoev, A.	9 (0,95)

Co-authorship and keyword co-occurrences analysis can be generated using VOS viewer based on bibliographic data. File formats supported include .txt, ris, and .csv from databases such as Scopus (Samir Kumar Jalal, 2019). The raw file was imported into VOS viewer and a map of co-authorship (shown in Figure 4) were created using the software. The co-authorship analysis resulted in a network of 2466 authors. Only authors having a minimum of five publications on the topic of landslide were included. The more circles the more published researches and collaborations where Stom, A. had a greatest number of publications and cooperation activity. Also, the following researchers shown in the figure demonstrated higher research activity and partnership level– Torgoev, I., Zakharov, A.I., Fomenko, I.K.

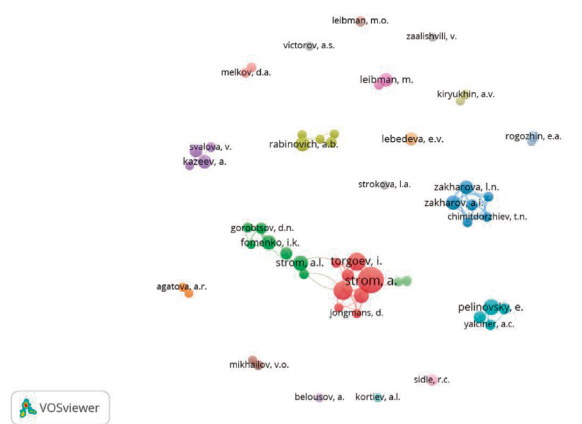


Figure 4. Network map of top co-authorships based on the total link strength

To ascertain the authors' study focus, we must initially depict the network established by the co-occurrence of author keywords. Figure 5 illustrates the network map of the top 31 authors' keyword co-occurrence. The size of the node reflects the keyword's degree of importance. This data visualisation allows you to comprehend the connections and patterns between keywords in landslide research by displaying the most relevant and often co-occurring terms.

There are 31 items distributed over 5 clusters with different colours: cluster 1 (deformation, earthquakes, geology, geophysics, landslides, rocks, seismology, slope protection, slope stability, soils), cluster 2 (gis, hazards assessment, hazards, monitoring, remote sensing), cluster 3 (climate change, geomorphology, landslide, permafrost), cluster 4 (erosion, landforms, reservoirs (water), rivers), cluster 5 (earthquake, numerical model, submarine, landslide, tsunami). Dating aspect was not mentioned due to unavailability among keywords from this research.

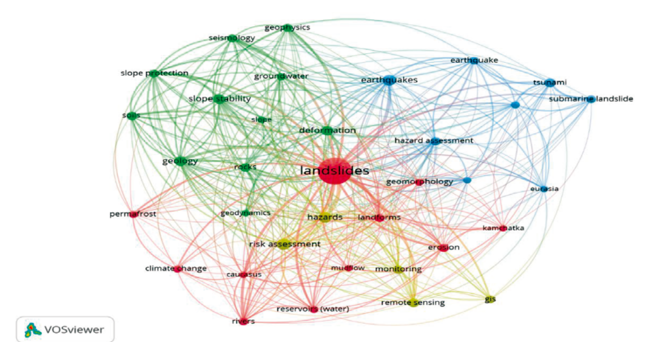


Figure 5. Network map of top keywords

3.4 Top institutions

Institutions are classified according to the quality and number of the articles they publish (Khasanov et al., 2021a). For the period of 56 years, one hundred sixty different institutions cooperated to publish 944 papers related to landslide studies in CIS countries. Our analysis of the top 10 institutes' publications on landslide researches allowed us to determine the influential and productive institutions in this field. As indicated in Figure 6, of the 10 institutions, all of them were from Russian Federation where "Russian Academy of Sciences" occupied the leadership with 25.9% share and followed by Lomonosov Moscow State University with contribution of 9.8% and Siberian Branch of Russian Academy of Sciences with 7.8% of supported papers. Contribution of other states varied between 2.8%-4.7%.

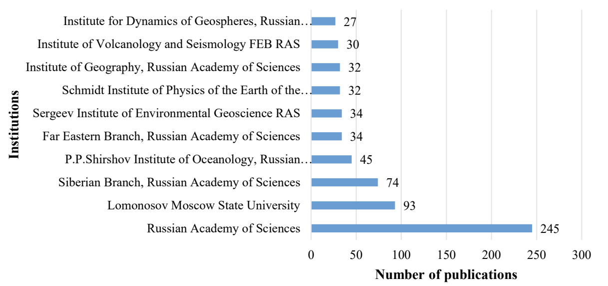


Figure 6. List of top institutions on landslide study

3.5 Top countries on landslide studies of CIS countries in the world

Mapchart online platform was applied to indicate countries activity on landslide studies in the world. A total of 77 countries actively participated in production of 944 research papers on selected topic. The number of publications of the most ten productive countries in the field of landslide research between 1966 and 2022 are illustrated in Figure 7. Russian Federation, as an absolute leader among states, dominated with 804 published papers and followed by Kyrgyzstan 65. The shortlist of countries includes both advanced and developing regions as Kazakhstan, Germany, United States, Japan, Uzbekistan, Belgium, China, and Italy where landslide research is a part of modern scientific issue due to their mountainous terrain. Total number of published papers on landslide studies by selected 10 countries outperformed 944 as some publication might belong to more countries at the same time.

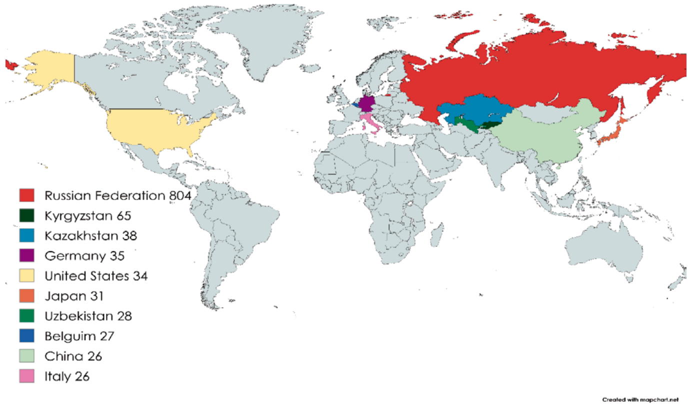


Figure 7. List of top countries on landslide

3.6 Top cited publications on landslide studies for CIS countries

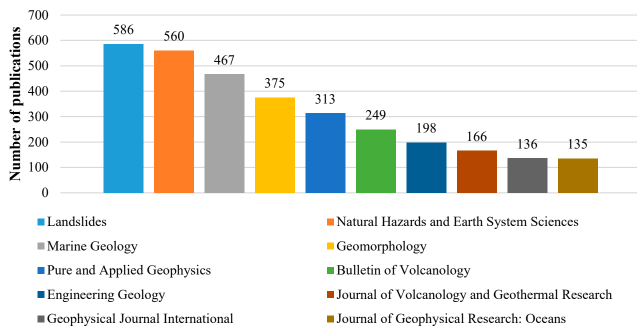
Table 3 demonstrates top 10 mostly cited articles on landslide research including publisher name, corresponding author, date of publication as well as number of citations and document type. A total of 1894 citations were given to selected 10 papers for the research period. The most cited paper was published in Natural Hazards and Earth System Science in 2006 which covered 17.8% of citations received by all selected articles. Surprisingly, conference paper titled "The Grand Banks landslide-generated tsunami of November 18, 1929: Preliminary analysis and numerical modeling" occupied the second position with 279 citations. There were 9 research articles and 1 conference paper in the shortlist.

Table 3. List of top cited articles on landslide for CIS countries

№	Title	Journal	Corresponding author	Year	citations	Document type
1	Meteotsunamis: Atmospherically induced destructive ocean waves in the tsunami frequency band	Natural Hazards and Earth System Science	Monserrat S	2006	332	Article
2	The Grand Banks landslide-generated tsunami of November 18, 1929: Preliminary analysis and numerical modeling	Marine Geology	Fine I.V	2005	279	Conference Paper
3	Giant landslides, topography, and erosion	Earth and Planetary Science Letters	Korup O.	2007	255	Article
4	Geophysical methods for the investigation of landslides	Geophysics	Bogoslovsky V.A.	1977	185	Article
5	Fatal landslides in Europe	Landslides	Haque U	2016	168	Article
6	Multiple edifice failures, debris avalanches and associated eruptions in the Holocene history of Shiveluch volcano, Kamchatka, Russia	Bulletin of Volcanology	Belousov A.	1999	145	Article
7	The Armenian earthquake of 1988 December 7: faulting and folding, neotectonics and palaeoseismicity	Geophysical Journal International	Philip H.	1992	132	Article
8	Fluvial response to large rock-slope failures: Examples from the Himalayas, the Tien Shan, and the Southern Alps in New Zealand	Geomorphology	Korup O	2006	129	Article
9	Tsunamigenic-seismogenic structures, neotectonics, sedimentary processes and slope instability on the southwest Portuguese Margin	Marine Geology	Terrinha P	2003	126	Article
10	Slider block friction model for landslides: Application to Vaiont and La Clapière landslides	Journal of Geophysical Research: Solid Earth	Helmstetter A	2004	113	Article

3.7 Top cited journals on landslide on for CIS countries

An effectiveness of journals is usually measured by the number of published papers and received citations. For this research we collected top 10 cited journals which published the highest number of papers. A total of 3185 citations were received by these journals for 1966-2022 research period. First of all, we sorted source names alphabetically of excel extension file of 944 documents. After step-by-step total papers citations were summarized by each journal. Interestingly, at the result we accepted updating list with potential journal names. Initial 10 journals were selected and shown in Figure 8. As a result, Landslide journal took the greatest number of citations and contributed 18.3% share and followed by Natural Hazards and Earth System Sciences journal with 17.5% share. Other journals contribution varied between 4.2-14.6% share.



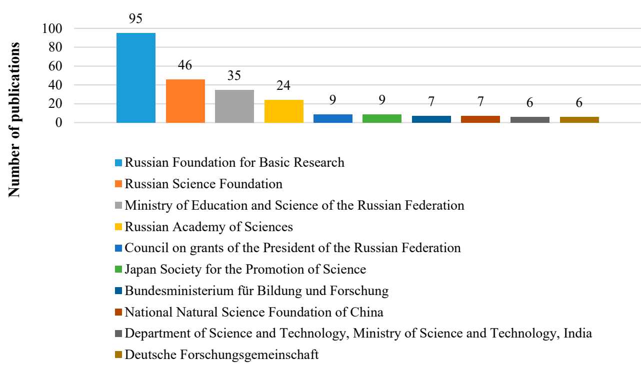


Figure 9. List of top funding sponsors on landslide studies for CIS countries

There are different topic cluster names available for the subject areas given in Scopus database. Most of the papers published on landslide issue in CIS countries belong to three different topic cluster names which demonstrated in Figure 10. Earth and Planetary Sciences topic cluster name as an absolute leader covered 59% of publications and followed by Environmental Science 24%. Engineering covered 17% of total publications for research period on landslide studies. These major cluster names are mainly concentrated on researches about environmental changes including landslides, earthquakes, seismology.

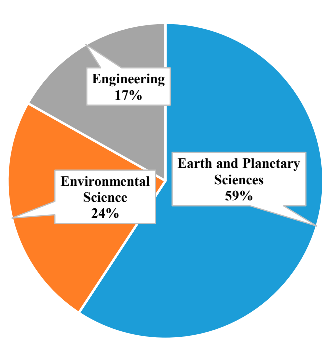


Figure 10. Top topic cluster name on landslide in CIS countries

4. Discussion

This bibliometric review provides a comprehensive overview of landslide research in the CIS countries from 1966 to 2022, showing the number of publications, thematic focus, methodological approaches, and institutional contributions. The results not only reveal historical and contemporary trends, but also highlight current challenges and emerging opportunities in the field.

A central observation is the significant increase in the number of publications over the past decade, reflecting the growing recognition of landslides as a scientific and societal problem. Commentators have stressed the need to interpret this increase more clearly in the context of broader global trends, and indeed our results are consistent with international bibliometric studies that show an exponential growth in hazard-related research as a result of advances in remote sensing and geospatial technologies (Wu et al., 2014; Gariano et al., 2018). However, in the CIS, this increase has additional significance: it coincides with political and economic changes that have changed the landscape of scientific collaboration and funding. Thus, the sharp increase since 2013 reflects not only the adoption of technologies but also the stabilization of academic systems after decades of restructuring.

Remote sensing technologies, in particular SAR, LiDAR, and optical surveys, have redefined landslide hazard mapping and monitoring. They provide essential data for analyzing slope stability in mountainous areas that are otherwise inaccessible. For example, Kyrgyzstan and Tajikistan, where the rugged terrain makes ground-based studies difficult, have benefited greatly from this technique. Furthermore, integrating remote sensing with GIS platforms has enabled multi-temporal analyses, which have produced more reliable susceptibility maps and hazard models. However, despite these advances, the availability of high-resolution imagery remains uneven across the region, with local researchers often facing financial and infrastructural barriers. This disparity reflects one of the main concerns of commentators: the persistent information inequality between the wealthy CIS countries (especially Russia) and the smaller republics.

Another notable trend is the regional focus of research**.** The Russian Federation dominates in terms of publication volume, institutional contribution, and funding. The Russian Academy of Sciences and Moscow State University produced a disproportionate share of publications, and Russian funding agencies supported almost 86 percent of all funded projects. While this leadership reflects institutional strength, it also reveals structural imbalances. As commentators have noted, the voices and contexts of smaller CIS countries can be overshadowed. For example, despite Kyrgyzstan's high vulnerability to landslides, its scientific output is quantitatively smaller than Russia's. This imbalance calls for greater investment in capacity-building initiatives and multinational collaborations that strengthen underserved regions. Encouragingly, bibliometric data show that such collaborations are beginning to take shape, with the number of cross-border co-authors increasing.

The thematic development of landslide research in the CIS countries is also noteworthy. In previous decades (1966–2004), studies often considered landslides in the context of geophysical research or environmental problem-solving, with limited integration of socio-economic perspectives. However, since 2005, publications have expanded to include predictive modeling, climate change impacts, and hydrological factors such as precipitation-induced flooding. An example from Uzbekistan is Mamadjanova and Lekkebusch (2022) linking hydrology to disaster management, highlighting excessive precipitation as a major driver of slope failure. This broader perspective is consistent with the reviewers' suggestions that the manuscript should better integrate anthropogenic and climatic factors. Indeed, global climate change is increasing the risk of landslides by increasing precipitation extremes and accelerating the melting of permafrost in high-altitude areas. CIS studies have begun to capture these connections, but further integration of climate science with geomorphic models is essential.

Geotechnical and statistical approaches emphasize the need to use established frameworks for slope stability assessment. However, in recent years, more sophisticated applications of machine learning and artificial intelligence, such as neural network-based monitoring of exogenous processes, have emerged (Sharapov and Varlamov, 2015). Commentators have recommended taking this change into account, and in our discussion, we highlight how these tools offer real-time risk detection capabilities. However, their successful implementation requires robust datasets and computational resources, which are unevenly distributed across slope stability organizations. Future progress therefore depends not only on technical innovations but also on the equitable distribution of resources.

Another important finding is the trend towards bilingual publications, where English and Russian are dominant. This linguistic duality allows for greater international reach while maintaining access to local stakeholders. However, this leads to citation asymmetry: English-language articles are cited more frequently globally, which may limit valuable Russian-language research. Commentators have called for a more critical approach to this issue, and we argue that bilingual distribution strategies, such as promoting English abstracts for Russian-language articles, could address this gap.

Research centres in seismically and geomorphologically active regions: the Caucasus, Central Asia and the Altai Mountains. These regions combine steep slopes, seismicity and extreme weather events, which leads to a high risk potential. However, the distribution of research sites is uneven, with limited research in less dangerous but still vulnerable regions such as Moldova and Belarus. This geographical orientation reflects the distribution of landslide events and the priorities for research funding. A balanced regional approach will allow for a more complete assessment of landslide risk in the CIS.

Looking ahead, the field faces a number of challenges and opportunities. First, there is a clear need to integrate interdisciplinary approaches that link geology and social sciences to better understand vulnerability and resilience. Landslides are not only physical phenomena, but also socio-economic phenomena that disrupt livelihoods, infrastructure and ecosystems. Incorporating community-level observations and socio-economic datasets into risk assessments will enrich existing models. Second, there is a pressing need to strengthen the capacity of early warning systems. Despite advances in hazard mapping, early warning mechanisms are lacking in many CIS countries, leaving communities vulnerable. As Alcantara - Ayala and Garnica-Peña (2023) point out, low- and middle-income countries face systemic barriers to implementing effective warning systems, and many of these constraints are common to CIS countries. These issues should be included in future landslide research programs. By combining climate projections with disaster models, researchers can make practical recommendations for long-term land use planning and disaster risk reduction.

5. Conclusions

This study focused on landslide, research hotspots, and possible research directions regions in the CIS countries from 1966 to 2022 using bibliometric approaches based on the online Scopus database. In this bibliometric analysis, we have collected, reviewed, and analyzed 944 publications. The scientometric analysis reveals that over the past 56 years, the highest research output on landslides has occurred in the last decade. The analysis of annual article production on landslides in CIS countries from 1966 to 2022 indicates three distinct phases of development: (1) Introduction (1966–2004), (2) slightly growth (2005–2012), and (3) Stable growth (2013–2022). During the introduction period, research interest focused on landslides within the context of environmental problems and solutions. The slightly growth period marks an increase in scientific attention, with a rise in the number of regional publications. The stable growth period is characterized by the widespread use of remote sensing and geospatial technologies to enhance landslide monitoring and prediction efforts across CIS countries. Within the CIS region, Russian Federation leads in terms of institutional contributions, country-level research output, and funding support. The Russian Foundation for Basic Research ranks first among funding sponsors, with 95 articles published. This leadership can be attributed to Russia's status as a well-developed country within the CIS, home to numerous prestigious research institutions and universities that drive scientific advancements in landslide research.

Acknowledgments

The authors express their appreciation to the project USAID Central Asia's Regional Water and Vulnerable Environment Activity for technical support in the framework of the Young Scientists Competition. In addition, the authors are grateful to the anonymous reviewers of earlier drafts for constructive comments that helped to improve the manuscript.

References

Abdikairov, B., Juliev, M., & Kholmurodova, M. (2024). Analyses and assessment of soil salinity modeling: review of papers from Scopus database. *Journal of Geology, Geography and Geoecology*, *33*(4), 647–661. https://doi.org/10.15421/112459

Alcántara-Ayala, I., & Garnica-Peña, R. J. (2023). Landslide Warning Systems in Low-And Lower-Middle-Income Countries: Future Challenges and Societal Impact. In K. Sassa, K. Konagai, B. Tiwari, Ž. Arbanas, & S. Sassa (Eds.), *Progress in Landslide Research and Technology, Volume 1 Issue 1, 2022* (pp. 137–147). Springer International Publishing. https://doi.org/10.1007/978-3-031-16898-7_9

Basharat, M., Riaz, M. T., Jan, M. Q., Xu, C., & Riaz, S. (2021). A review of landslides related to the 2005 Kashmir Earthquake: Implication and future challenges. *Natural Hazards*, *108*(1), 1–30. https://doi.org/10.1007/s11069-021-04688-8

Cancino, C., Merigó, J. M., Coronado, F., Dessouky, Y., & Dessouky, M. (2017). Forty years of Computers & Industrial Engineering: A bibliometric analysis. *Computers & Industrial Engineering*, *113*, 614–629. https://doi.org/10.1016/j.cie.2017.08.033

Chakraborty, R., & Dey, A. (2019). Effect of Toe Cutting on Hillslope Stability. In A. I.V. & V. B. Maji (Eds.), *Geotechnical Applications* (Vol. 13, pp. 191–198). Singapore: Springer Singapore. https://doi.org/10.1007/978-981-13-0368-5_21

Cheskidov, V. V., Lipina, A. V., & Melnichenko, I. A. (2018). Integrated monitoring of engineering structures in mining. *Eurasian Mining*, *2018*(2), 18–21. https://doi.org/10.17580/em.2018.02.05

De Sousa, F. D. B. (2021). Management of plastic waste: A bibliometric mapping and analysis. *Waste Management & Research: The Journal for a Sustainable Circular Economy*, *39*(5), 664–678. https://doi.org/10.1177/0734242X21992422

Djanpulatova, Z. A., Juliev, M. K., Abdikairov, B. E., Kholmurodova, M. D., Turdalieva, S. R., & Khadjieva, Z. B. (2025). Ecosystem services in achieving SDGs: A bibliometric overview 2015-2024. *Applied Ecology and Environmental Research*, *23*(4), 6223–6246. https://doi.org/10.15666/aeer/2304_62236246

Durán-Sánchez, A., Álvarez-García, J., González-Vázquez, E., & Del Río-Rama, M. de la C. (2020). Wastewater Management: Bibliometric Analysis of Scientific Literature. *Water*, *12*(11), 2963. https://doi.org/10.3390/w12112963

Evans, S. G., Roberts, N. J., Ischuk, A., Delaney, K. B., Morozova, G. S., & Tutubalina, O. (2009). Landslides triggered by the 1949 Khait earthquake, Tajikistan, and associated loss of life. *Engineering Geology*, *109*(3–4), 195–212. https://doi.org/10.1016/j.enggeo.2009.08.007

Fang, K., Tang, H., Li, C., Su, X., An, P., & Sun, S. (2023). Centrifuge modelling of landslides and landslide hazard mitigation: A review. *Geoscience Frontiers*, *14*(1), 101493. https://doi.org/10.1016/j.gsf.2022.101493

Fata, Y. A., Hendrayanto, Murtilaksono, K., & Erizal. (2021). The role of hydro-mechanical vegetation in slope stability: A review. *IOP Conference Series: Earth and Environmental Science*, *794*(1), 012041. https://doi.org/10.1088/1755-1315/794/1/012041

Fell, R., Corominas, J., Bonnard, C., Cascini, L., Leroi, E., & Savage, W. Z. (2008). Guidelines for landslide susceptibility, hazard and risk zoning for land use planning. *Engineering Geology*, *102*(3–4), 85–98. https://doi.org/10.1016/j.enggeo.2008.03.022

Froude, M. J., & Petley, D. N. (2018). Global fatal landslide occurrence from 2004 to 2016. *Natural Hazards and Earth System Sciences*, *18*(8), 2161–2181. https://doi.org/10.5194/nhess-18-2161-2018

Gariano, S. L., Petrucci, O., Rianna, G., Santini, M., & Guzzetti, F. (2018). Impacts of past and future land changes on landslides in southern Italy. *Regional Environmental Change*, *18*(2), 437–449. https://doi.org/10.1007/s10113-017-1210-9

Gracheva, R., & Urushadze, T. (2011). Landslides in a rural mountainous region: damaging and resource-forming impacts (South Caucasus, Georgia). *Geography, Environment, Sustainability* (pp. 59–68). https://doi.org/10.24057/2071-9388-2011-4-1-59-68

Hossain, S., Al Noor Tushar, M., Islam, S., Razzak, Md. Z. A., Alve, A., & Junayed, T. R. (2025). Investigating the role of rock weathering and clay mineralogy in landslide occurrences within the exposed Tertiary Formations in Rangamati area. *Geoenvironmental Disasters*, *12*(1), 20. https://doi.org/10.1186/s40677-025-00324-w

Hunter, B. (1995). *The Statesman's Year-Book 1995-96* (1st ed. 1995). London: Palgrave Macmillan UK. https://doi.org/10.1057/9780230271241

Juliev, M., Abdikairov, B., Kholmurodova, M., Djanpulatova, Z., Mingboyeva, M., & Makhmudova, M. (2024). Mapping the Landscape: A Bibliometric Analysis of Digital Education Research. *E3S Web of Conferences*, *590*, 03009. https://doi.org/10.1051/e3sconf/202459003009

Juliev, M., Kholmurodova, M., Abdikairov, B., & Abuduwaili, J. (2024). A comprehensive review of soil erosion research in Central Asian countries (1993-2022) based on the Scopus database. *Soil and Water Research*, *19*(4), 244–256. https://doi.org/10.17221/82/2024-SWR

Kannazarova, Z., Juliev, M., Abuduwaili, J., Muratov, A., & Bekchanov, F. (2024). Drainage in irrigated agriculture: Bibliometric analysis for the period of 2017–2021. *Agricultural Water Management*, *305*, 109118. https://doi.org/10.1016/j.agwat.2024.109118

Kannazarova, Z., Juliev, M., Muratov, A., & Abuduwaili, J. (2024). Groundwater in the commonwealth of independent states: A bibliometric analysis of scopus-based papers from 1972 to 2023, emphasizing the significance of drainage. *Groundwater for Sustainable Development*, *25*, 101083. https://doi.org/10.1016/j.gsd.2024.101083

Karakhanian, A. S., Trifonov, V. G., Philip, H., Avagyan, A., Hessami, K., Jamali, F., Salih Bayraktutan, M., Bagdassarian, H., Arakelian, S., Davtian, V., & Adilkhanyan, A. (2004). Active faulting and natural hazards in Armenia, eastern Turkey and northwestern Iran. *Tectonophysics*, *380*(3–4), 189–219. https://doi.org/10.1016/j.tecto.2003.09.020

Kharismalatri, H. S., Ishikawa, Y., Gomi, T., Sidle, R. C., & Shiraki, K. (2018). Evaluating factors for controlling sediment connectivity of landslide materials: A flume experiment. *Water (Switzerland)*, *11*(1). https://doi.org/10.3390/w11010017

Khasanov, S., Juliev, M., Uzbekov, U., Aslanov, I., Agzamova, I., Normatova, N., Islamov, S., Goziev, G., Khodjaeva, S., & Holov, N. (2021a). Landslides in Central Asia: A review of papers published in 2000–2020 with a particular focus on the importance of GIS and remote sensing techniques. *GeoScape*, *15*(2), 134–145. https://doi.org/10.2478/geosc-2021-0011

Khasanov, S., Juliev, M., Uzbekov, U., Aslanov, I., Agzamova, I., Normatova, N., Islamov, S., Goziev, G., Khodjaeva, S., & Holov, N. (2021b). Landslides in Central Asia: A review of papers published in 2000–2020 with a particular focus on the importance of GIS and remote sensing techniques. *GeoScape*, *15*(2), 134–145. https://doi.org/10.2478/geosc-2021-0011

Kubicek, P. (2009). The Commonwealth of Independent States: an example of failed regionalism? *Review of International Studies*, *35*(S1), 237–256. https://doi.org/10.1017/S026021050900850X

Li, J., Zhang, B., & Sui, B. (2021). Stability Analysis of Rock Slope with Multilayer Weak Interlayer. *Advances in Civil Engineering*, *2021*(1), 1409240. https://doi.org/10.1155/2021/1409240

Maassen, S. (2016). Bibliometric Analysis of Research on Wastewater Irrigation During 1991-2014: Bibliometric Analysis of Research on Wastewater Irrigation (1991-2014). *Irrigation and Drainage*, *65*(5), 644–653. https://doi.org/10.1002/ird.1981

Mamadjanova, G., & Leckebusch, G. C. (2022). Assessment of mudflow risk in Uzbekistan using CMIP5 models. *Weather and Climate Extremes*, *35*, 100403. https://doi.org/10.1016/j.wace.2021.100403

Mardanov, I., Yusifova, S., & Sumqayit State University. (2017). The geo system analysis of exogenesis of high-mountainous landscapes of Azerbaijanian part of great caucasus. *Sustainable Development of Mountain Territories*, *9*(1), 32–39. https://doi.org/10.21177/1998-4502-2017-7-9-32-39

Mardieva, D., Bakiyeva, G., Kannazarova, Z., & Saidova, Z. (2024). A Bibliometric Review: Interventions for Enhancing Speaking Skills in non-English-Speaking Contexts. *XLinguae*, *17*(4), 195–224. https://doi.org/10.18355/XL.2024.17.04.12

Marín-Rodríguez, N. J., Vega, J., Zanabria, O. B., González-Ruiz, J. D., & Botero, S. (2024). Towards an understanding of landslide risk assessment and its economic losses: A scientometric analysis. *Landslides*. https://doi.org/10.1007/s10346-024-02272-2

McAdoo, B. G., Quak, M., Gnyawali, K. R., Adhikari, B. R., Devkota, S., Rajbhandari, P. L., & Sudmeier-Rieux, K. (2018). Roads and landslides in Nepal: how development affects environmental risk. *Natural Hazards and Earth System Sciences*, *18*(12), 3203–3210. https://doi.org/10.5194/nhess-18-3203-2018

Medeu, A. R., Blagoveshchenskii, V. P., & Zhdanov, V. V. (2018). Gravitational Seismodislocations in Mountainous regions of Southeastern Kazakhstan. *Geography and Natural Resources*, *39*(1), 79–87. https://doi.org/10.1134/S1875372818010110

Mei, Y., Ma, T., & Su, R. (2021). How marketized is China's natural gas industry? A bibliometric analysis. *Journal of Cleaner Production*, *306*, 127289. https://doi.org/10.1016/j.jclepro.2021.127289

Mertens, K., Jacobs, L., Maes, J., Kabaseke, C., Maertens, M., Poesen, J., et al. (2016). The direct impact of landslides on household income in tropical regions: A case study from the Rwenzori Mountains in Uganda. *Science of The Total Environment*, *550*, 1032–1043. https://doi.org/10.1016/j.scitotenv.2016.01.171

Montalván-Burbano, N., Pérez-Valls, M., & Plaza-Úbeda, J. (2020). Analysis of scientific production on organizational innovation. *Cogent Business & Management*, *7*(1), 1745043. https://doi.org/10.1080/23311975.2020.1745043

Mukanov, T., Umetaliev, A., Mambetkulova, A., Kaiyrbekov, A., Goncharova, I., Veres, P., Tamás, P., & Kannazarova, Z. (2024). New trends in sustainable supply chains: Insights from recent studies. *Advanced Logistic Systems - Theory and Practice*, *18*(2), 52–60. https://doi.org/10.32971/als.2024.017

Nepop, R. K., & Agatova, A. R. (2017). Earthquake Induced Landslides in Russian Altai: Absolute Dating Applying Tree-Ring and Radiocarbon Analysis. In M. Mikoš, N. Casagli, Y. Yin, & K. Sassa (Eds.), *Advancing Culture of Living with Landslides* (pp. 141–148). Springer International Publishing. https://doi.org/10.1007/978-3-319-53485-5_15

Niu, R., Wu, X., Yao, D., Peng, L., Ai, L., & Peng, J. (2014). Susceptibility Assessment of Landslides Triggered by the Lushan Earthquake, April 20, 2013, China. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, *7*(9), 3979–3992. https://doi.org/10.1109/JSTARS.2014.2308553

Okalp, K., & Akgün, H. (2022). Landslide susceptibility assessment in medium-scale: Case studies from the major drainage basins of Turkey. *Environmental Earth Sciences*, *81*(8), 244. https://doi.org/10.1007/s12665-022-10355-3

Osipov, V. I., Rumyantseva, N. A., & Eremina, O. N. (2019). Living with risk of natural disasters. *Russian Journal of Earth Sciences*, *19*(6). https://doi.org/10.2205/2019ES000673

Pacheco Quevedo, R., Velastegui-Montoya, A., Montalván-Burbano, N., Morante-Carballo, F., Korup, O., & Daleles Rennó, C. (2023). Land use and land cover as a conditioning factor in landslide susceptibility: A literature review. *Landslides*. https://doi.org/10.1007/s10346-022-02020-4

Palgrave Macmillan. (2016). Commonwealth of Independent States (CIS). In Palgrave Macmillan (Ed.), *The Statesman's Yearbook* (pp. 47–47). London: Palgrave Macmillan UK. https://doi.org/10.1007/978-1-349-68398-7_30

Pelinovsky, E., & Poplavsky, A. (1996). Simplified model of tsunami generation by submarine landslides. *Physics and Chemistry of the Earth*, *21*(1–2), 13–17. https://doi.org/10.1016/S0079-1946(97)00003-7

Pizzi, S., Caputo, A., Corvino, A., & Venturelli, A. (2020). Management research and the UN sustainable development goals (SDGs): A bibliometric investigation and systematic review. *Journal of Cleaner Production*, *276*, 124033. https://doi.org/10.1016/j.jclepro.2020.124033

Ponomareva, V. V., Melekestsev, I. V., & Dirksen, O. V. (2006). Sector collapses and large landslides on Late Pleistocene–Holocene volcanoes in Kamchatka, Russia. *Journal of Volcanology and Geothermal Research*, *158*(1–2), 117–138. https://doi.org/10.1016/j.jvolgeores.2006.04.016

Potapov, V. P., Oparin, V. N., Mikov, L. S., & Popov, S. E. (2022). Information Technologies in Problems of Nonlinear Geomechanics. Part I: Earth Remote Sensing Data and Lineament Analysis of Deformation Wave Processes. *Journal of Mining Science*, *58*(3), 486–502. https://doi.org/10.1134/S1062739122030164

Razakova, M., Kuzmin, A., Fedorov, I., Yergaliev, R., & Ainakulov, Z. (2020). Methods of calculating landslide volume using remote sensing data. *E3S Web of Conferences*, *149*, 02009. https://doi.org/10.1051/e3sconf/202014902009

Regmi, A. D., Yoshida, K., Dhital, M. R., & Devkota, K. (2013). Effect of rock weathering, clay mineralogy, and geological structures in the formation of large landslide, a case study from Dumre Besei landslide, Lesser Himalaya Nepal. *Landslides*, *10*(1), 1–13. https://doi.org/10.1007/s10346-011-0311-7

Romanenko, S., Larionova, E., Maldibaev, U., Aydaraliev, B., & Ordobaev, B. (2020). Risk management technique of landslides activation with account of seismic activity factor in Kyrgyzstan. *Izvestiya Tomskogo Politekhnicheskogo Universiteta Inziniring Georesursov*, *331*(10), 155–163. https://doi.org/10.18799/24131830/2020/10/2865

Rosi, A., Frodella, W., Nocentini, N., Caleca, F., Havenith, H. B., Strom, A., et al. (2023). Comprehensive landslide susceptibility map of Central Asia. *Natural Hazards and Earth System Sciences*, *23*(6), 2229–2250. https://doi.org/10.5194/nhess-23-2229-2023

Samir Kumar Jalal. (2019). Co-authorship and co-occurrences analysis using BibliometrixR package: A case study of India and Bangladesh. *Annals of Library and Information Studies*, *2*(66), 57–64.

Saponaro, A., Pilz, M., Wieland, M., Bindi, D., Moldobekov, B., & Parolai, S. (2015). Landslide susceptibility analysis in data-scarce regions: the case of Kyrgyzstan. *Bulletin of Engineering Geology and the Environment*, *74*(4), 1117–1136. https://doi.org/10.1007/s10064-014-0709-2

Sawassi, A., & Khadra, R. (2021). Bibliometric Network Analysis of "Water Systems' Adaptation to Climate Change Uncertainties": Concepts, Approaches, Gaps, and Opportunities. *Sustainability*, *13*(12), 6738. https://doi.org/10.3390/su13126738

Schlögel, R., Torgoev, I., De Marneffe, C., & Havenith, H.-B. (2011). Evidence of a changing size-frequency distribution of landslides in the Kyrgyz Tien Shan, Central Asia: Landslide activity in the kyrgyz Tien shan. *Earth Surface Processes and Landforms*, *36*(12), 1658–1669. https://doi.org/10.1002/esp.2184

Schmidt, K. M., Roering, J. J., Stock, J. D., Dietrich, W. E., Montgomery, D. R., & Schaub, T. (2001). The variability of root cohesion as an influence on shallow landslide susceptibility in the Oregon Coast Range. *Canadian Geotechnical Journal*, *38*(5), 995–1024. https://doi.org/10.1139/t01-031

Sekarlangit, N., Fathani, T. F., & Wilopo, W. (2022). Landslide Susceptibility Mapping of Menoreh Mountain Using Logistic Regression. *Journal of Applied Geology*, *7*(1), 51. https://doi.org/10.22146/jag.72067

Sharapov, R., & Varlamov, A. (2015). *Using neural networks in remote sensing monitoring of exogenous processes* (Y. Wang, X. Jiang, & D. Zhang, Eds.; p. 94432P). https://doi.org/10.1117/12.2178879

Shuvalova, R. A., Burlutsky, S. B., Glazunov, V. V., & Zhdanov, S. V. (2021). Landslide Slope Stability Estimation by The Geotechnical and Geophysical Data. In *Engineering and Mining Geophysics 2021* (pp. 1–11). Online: European Association of Geoscientists & Engineers. https://doi.org/10.3997/2214-4609.202152022

Simonyan, V. V., & Volkov, V. I. (2021). Assessment of risk and safety of structures on slope areas according to geodetic monitoring data. *Geodezia i Kartografia*, *976*(10), 42–51. https://doi.org/10.22389/0016-7126-2021-976-10-42-51

Smirnova, I. O., & Kirsanov, A. A. (2021). The state of the art and prospects of remote sensing data application in the study of exogenous geological processes by the example of landslides. *Sovremennye Problemy Distantsionnogo Zondirovaniya Zemli iz Kosmosa*, *18*(3), 26–48. https://doi.org/10.21046/2070-7401-2021-18-3-26-48

Stein, S., Dugan, B., Gonzales Zenteno, E., Ticona, J., & Minaya, A. (2024). Slope stabilization through groundwater management with limited hydrogeological data: a case study from Majes, southern Peru. *Environmental Earth Sciences*, *83*(8), 231. https://doi.org/10.1007/s12665-024-11509-1

Sudani, P., Patil, K. A., & Kolekar, Y. A. (2023). Historical Development of Landslide Early Warning System (LEWS): A Review. In K. Muthukkumaran, B. Umashankar, & N. K. Pitchumani (Eds.), *Earth Retaining Structures and Stability Analysis* (Vol. 303, pp. 263–277). Springer Nature Singapore. https://doi.org/10.1007/978-981-19-7245-4_24

Tanaguzova, M., Nanovsky, S., & Orazgaliyev, S. (2023). Assessing the Effect of Joining the World Trade Organization on Trade Performance: A Study of CIS Countries. *Economies*, *11*(9), 236. https://doi.org/10.3390/economies11090236

Teshebaeva, K., Roessner, S., Echtler, H., Motagh, M., Wetzel, H.-U., & Molodbekov, B. (2015). ALOS/PALSAR InSAR time-series analysis for detecting very slow-moving landslides in Southern Kyrgyzstan. *Remote Sensing*, *7*(7), 8973–8994. https://doi.org/10.3390/rs70708973

Thien, B. B., Phuong, V. T., & Huong, D. T. V. (2022). Detection and assessment of the spatio-temporal land use/cover change in the Thai Binh province of Vietnam's Red River delta using remote sensing and GIS. *Modeling Earth Systems and Environment*. https://doi.org/10.1007/s40808-022-01636-8

Thirugnanam, H. (2023). Deep Learning in Landslide Studies: A Review. In I. Alcántara-Ayala, Ž. Arbanas, D. Huntley, K. Konagai, M. Mikoš, K. Sassa, S. Sassa, H. Tang, & B. Tiwari (Eds.), *Progress in Landslide Research and Technology, Volume 1 Issue 2, 2022* (pp. 247–255). Springer International Publishing. https://doi.org/10.1007/978-3-031-18471-0_20

Tkhak, K. S. (2013). *Past, Present and Future Passive Seismic Tasks for Sustainable Development*. Sustainable Earth Sciences 2013, Pau, France. https://doi.org/10.3997/2214-4609.20131639

Turner, B. (2014). Commonwealth of Independent States (CIS). In B. Turner (Ed.), *The Statesman's Yearbook* (pp. 46–47). London: Palgrave Macmillan UK. https://doi.org/10.1007/978-1-349-67278-3_29

Wang, T., Chen, J., Li, P., Yin, Y., & Shen, C. (2019). Natural tracing for concentrated leakage detection in a rockfill dam. *Engineering Geology*, *249*, 1–12. https://doi.org/10.1016/j.enggeo.2018.12.018

Wu, X., Chen, X., Zhan, F. B., & Hong, S. (2015). Global research trends in landslides during 1991–2014: A bibliometric analysis. *Landslides*, *12*(6), 1215–1226. https://doi.org/10.1007/s10346-015-0624-z

Wu, X., Ren, F., & Niu, R. (2014). Landslide susceptibility assessment using object mapping units, decision tree, and support vector machine models in the Three Gorges of China. *Environmental Earth Sciences*, *71*(11), 4725–4738. https://doi.org/10.1007/s12665-013-2863-4

Xaliqulov, M., Kannazarova, Z., Norchayev, D., Juliev, M., Turkmenov, X., Shermuxamedov, X., Ibragimova, G., & Abduraxmonova, S. (2023). Root harvester machine: A review of papers from the Scopus database published in English for the period of 1982-2022. *E3S Web of Conferences*, *402*, 10010. https://doi.org/10.1051/e3sconf/202340210010

Yamashkin, S. A., Yamashkin, A. A., Zanozin, V. V., Radovanovic, M. M., & Barmin, A. N. (2020a). Improving the efficiency of deep learning methods in remote sensing data analysis: Geosystem approach. *IEEE Access*, *8*, 179516–179529. https://doi.org/10.1109/ACCESS.2020.3028030

Yang, D., Qiu, H., Pei, Y., Hu, S., Ma, S., Liu, Z., et al. (2020). Spatial and Temporal Evolution of the Infiltration Characteristics of a Loess Landslide. *ISPRS International Journal of Geo-Information*, *9*(1), 26. https://doi.org/10.3390/ijgi9010026

Zhang, K., Wang, S., Bao, H., & Zhao, X. (2019). Characteristics and influencing factors of rainfall-induced landslide and debris flow hazards in Shaanxi Province, China. *Natural Hazards and Earth System Sciences*, *19*(1), 93–105. https://doi.org/10.5194/nhess-19-93-2019

Zhao, K., Coco, G., Gong, Z., Darby, S. E., Lanzoni, S., Xu, F., et al. (2022). A Review on Bank Retreat: Mechanisms, Observations, and Modeling. *Reviews of Geophysics*, *60*(2), e2021RG000761. https://doi.org/10.1029/2021RG000761