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A comprehensive review of soil erosion research in Central Asian countries (1993–2022) based on the Scopus database

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Abstract: Soil is a valuable resource for food production, and it demands a long time to recover itself. Soil erosion is one of the most important issues for countries based on agriculture. This review article analysed articles published on the topic of general soil erosion in Central Asian countries in 1993–2022. More than 50% of the articles reflect the results of the conducted practical work. The main content of these scientific works is aimed at the prevention of erosion processes, their evaluation and the development of countermeasures. During the considered period, the number of publications on soil erosion has increased in the last years compared to the first years, which indicates that the attention to the topic has increased in recent years. The purpose of this article is to get accurate information about the state of soil erosion in the countries of Central Asia and to get acquainted with the practical works carried out against erosion in these countries. For this aim, the contents of the articles were reviewed and the results of the scientific works conducted on the topic of erosion in each country were presented. According to the content of the articles, the use of modern techniques and technologies in the evaluation and prevention of soil erosion gives effective results.

Keywords: Central Asia; co-occurrence; Scopus; soil erosion

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BIBLIOMETRIC REVIEW

Through bibliometric analysis, the researcher can better understand the essence of the chosen scientific work and choose easier methods for conducting the scientific work (Kraus et al. 2022). In addition, through bibliometric analysis, the researcher can be aware of the shortcomings in the field of research (Xaliqulov et al. 2023). This type of articles has become popular in recent years in every field (Kraus et al. 2022). An example from the field of medicine is the bibliometric review written by Huang et al. (2020), examining trends and issues related to the use of traditional medicine in stroke research. Another example is the bibliometric article written by Brika et al. (2021), on the analysis of literature on the quality of higher education. Also, in the field of agriculture, bibliometric articles such as landslides (Khasanov et al. 2021), Marginal lands (Jumaniyazov et al. 2023), and sustainable agriculture (Sarkar et al. 2022) can be found. There are many bibliometric articles on the topic of soil erosion (Nasir Ahmad et al. 2020; Borrelli et al. 2021; Wen et al. 2023). A review article published by Borrelli et al. (2021) analysed the models used to predict and prevent soil erosion. About 70 authors collaborated on this article and analyzed 1 697 articles. The revised Universal Soil Loss Equation (RUSLE) model is used in the world for the obtained results. Chinese scientists Wen et al. (2023) analysed 779 articles to study soil erosion control techniques and technologies used around the world. Unlike the above-mentioned review articles, this article analyzes the articles published on the topic of general soil erosion in Central Asian countries during 1993–2022.

Providing information on soil and soil erosion prior to analyzing the articles will allow for a better understanding of the articles and the importance of the topic during the analysis process.

Definition of soil and soil erosion

Soil is a porous and biologically active medium located in the upper part of the earth's crust (Sposito 2024). It is the main natural resource for mankind and a number of living organisms because it provides water and nutrients to living organisms (Fulajtár et al. 2017; Sposito 2024). It takes 100 years, sometimes 1 000 years, to produce fertile soil for agriculture (FAO 2011). Although soil formation is a long-term process, it is a very fragile resource (Huang et al. 2011; Duulatov et al. 2019). Unfortunately, 1/3 of the world's soils are damaged for various reasons (FAO 2022). Land degradation is caused by various factors: salinization, reduction of pastures, deforestation, erosion processes, contamination of soil with agrochemicals and industrial waste (Gafforov et al. 2019; Gerts et al. 2020; Gafurova & Juliev 2021). Soil erosion is one of the main causes of soil degradation (Gafforov et al. 2020). The term soil erosion appeared at the beginning of the 20th century and it means loss of soil by water and wind (Zachar 1982). Later, this term was expanded by scientists and given a more precise definition. Soil erosion means that the upper fertile layer of the field is washed or blown away by wind and water (Schmidt 2000; Morgan 2005). This phenomenon can be a natural and human-made process (Chen et al. 2023). If the upper fertile layer of the soil is washed away or blown away as a result of water, wind, melting glaciers, this is called a natural erosion phenomenon (Zachar 1982). Water erosion mainly occurs under the influence of heavy rainfall (Morgan 2005). The intensity, frequency, and duration of rainfall events can significantly affect erosion rates. Heavy rainfall can lead to increased runoff and soil erosion, which can become a major factor in erosion (Webster 2005). Wind erosion is also an important type of natural erosion processes like water erosion. This type of erosion is common in arid regions with little rainfall, and the top layer of soil is blown away by the wind (Zachar 1982). However, these processes can be accelerated and intensified under the influence of human activity, causing harmful consequences for the environment and agriculture. Human activities such as agriculture, construction, mining, and urban expansion can disrupt natural landscapes and promote soil erosion. Unsustainable land use practices, such as poor tillage or a lack of erosion control measures, can worsen erosion (Schmidt 2000; Morgan 2005; Borrelli et al. 2017; Kabała et al. 2021). As a result of the rapid growth of the world's population, the demand for new land is increasing, which in turn increases the pressure on the soil, leading to the destruction of the soil structure and soil degradation (Pennock 2019).

Soil erosion risk and prevention measures

Soil erosion is considered to be a risk factor for the environment and human health (Dou et al. 2022). Healthy soil is important for human health, human life and other living organisms (Panova et al. 2019), because humans get 95% of their food directly and indirectly from soil and plants also get

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15 of the 18 nutrients they need from soil (FAO 2022). Unfortunately, a total of 30% of the world's land area and 3 billion people suffer from degradation (Boroughani et al. 2023). In Asia, 21% of the total area suffers from water erosion and 9% from wind erosion, and these percentages correspond to 66% of the total degradation in the Asian region (FAO 2015). In Europe, 16% of the total land area (excluding Russia) suffers from water erosion, and the estimated wind erosion rate for all European land areas is estimated to be between 10 and 42 million hectares (European Commission, Joint Research Centre, Institute for Environment and Sustainability, European Environment Agency 2012). While soil erosion remains a serious problem for several countries, it is important to prevent this problem and develop necessary countermeasures (Zachar 1982). In order to prevent soil erosion, it is necessary to develop countermeasures based on natural conditions and a deep understanding of erosion processes (Morgan 2005). In addition, it is very important to choose the right erosion control measures to control erosion processes or reduce their damage (Schmidt 2000). First of all, it is necessary to reduce changes in land use as much as possible, for example, reduction of practices such as cutting down large forests and turning pastures into cropland (Pennock 2019). The next stages are aimed at reducing the level of erosion, which includes practices such as less tillage, reducing the water velocity on the slopes, and building terraces on the slopes (Zachar 1982).

There are three different ways to estimate erosion. (1) Evaluation by observation of visible signs of erosion. (2) By mapping factors determining erosion risk. (3) By applying soil loss models (Salumbo 2020). There is no division or boundary between these methods, they always complement each other. The first method is mainly carried out with the help of field studies and aerial photographs. In this, indicators such as erosion points, land use, land slope indicators and rainfall amount of the studied area are mapped. (Parsons 2019; Salumbo 2020). In the next step, a map of factors that help to determine the risk of erosion will be created. These are indicators such as slope, height, soil type, and vegetation cover (Arabameri et al. 2018; Boroughani et al. 2023). In the last method, the total soil loss is predicted by entering the data obtained in the first and second methods into soil loss prediction models (Ganasri & Ramesh 2016; Arabameri et al. 2021; Abdelsamie et al. 2022).

The purpose of this bibliometric article is to analyse the articles published in the Scopus database on the topic of soil erosion in Central Asian countries between 1993–2022 years by factors such as top authors, countries, institutions, years, journals, document types and keywords.

METHODOLOGY

This review article used the Scopus database articles published in English on the topic of soil erosion. According to the territorial classification of FAO, the countries of Central Asia are Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan (FAO 2012). Based on the purpose of our research, 126 English-based publications were selected for the years 1993–2022 for the Central Asian countries. These articles contain the word soil erosion in the title, abstract and keywords. It refers to general soil erosion rather than a specific type of soil erosion. All publications were analysed and reviewed using soil erosion as a keyword. Then, a database was categorized, including the year of publication, name of journals, authors' names, countries, institutions, the type of publications, top co-authorships and keywords. MS Excel, Mapchart.com, VOSviewer softwares were used for statistical analysis. VOSviewer focuses on the graphical representation of bibliometric maps and is therefore considered a useful program for the visualization of large bibliometric maps (Van Eck & Waltman 2010). Figure 1 shows a flowchart of the research methodology chosen for this study.

RESULTS

Published papers on soil erosion. Published papers on soil erosion show the importance of a given topic for the Central Asian countries. Unfortunately, between 1993 and 2012, almost no articles on the topic were published. This means that the subject was neglected in those years. The number of papers had a fluctuation trend of almost 5 between 2012 and 2017. There was a significant increase in the number of papers between 2018 and 2022, with 29 papers peaking in 2020. Several reasons can be given for the increase in the number of papers in recent years. Most importantly, the world's governments and environmental agencies are working together on the problem of soil erosion. An example of this is the Sustainable Development Goals (SDG), which are 17 goals signed by the United Nations in 2015. Neutrality of land

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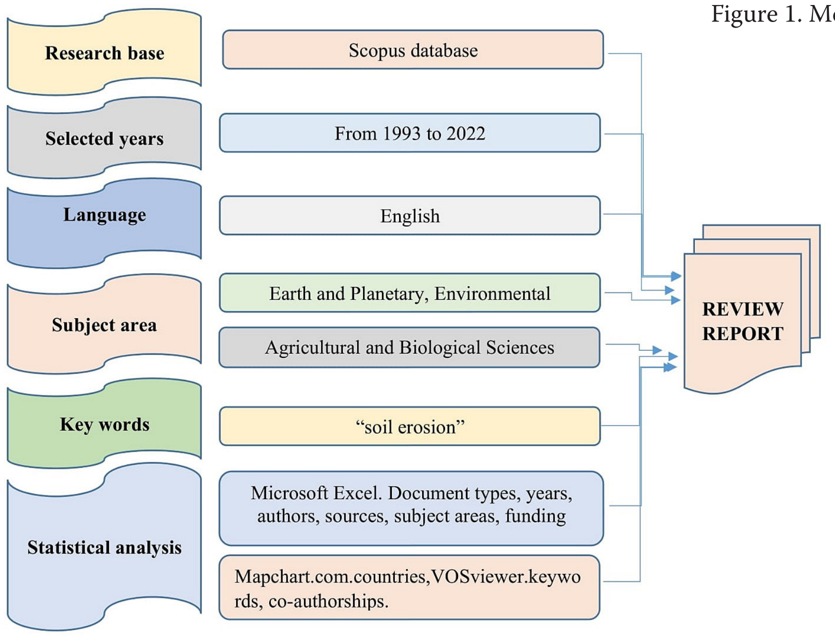

Figure 1. Methodology flowchart for the research

degradation is a particular focus of SDG15.3 (Nasir Ahmad et al. 2020; Wen et al. 2023). Figure 2 shows the number of papers on soil erosion.

Journals on soil erosion. Choosing the right journal is very important in the publishing process. Scopus is based on 126 articles on the problem of soil erosion published in 74 different journals. In the period under consideration in Central Asian countries, three journals are in the leading position in publishing articles on the topic. They are: E3 s Web of Conferences, IOP Conference Series and Environmental Science, and IOP Conference Series Materials Science and Engineering. The first and second journals are at the top with 13 and 12 articles, respectively, in these years. As can be seen from Table 1 below, the other journals were content with publishing 2 and 1 article during the years under review.

Top authors on the topic of soil erosion. Over the past thirty years, a total number of 160 different authors have worked to publish 126 articles on the problem of soil erosion in Central Asia. Among the authors, Mamatov F., Mirzayev B., Issanova G. published more articles than the rest of the authors during the period under review, and as can be seen from the Figure 3, Mamatov is the first among them with 7 articles. Mirzayev B. and Issanova G. published 6 and 4 articles respectively on the topic of soil erosion. The most important thing is that the authors who published the most articles belong to the state

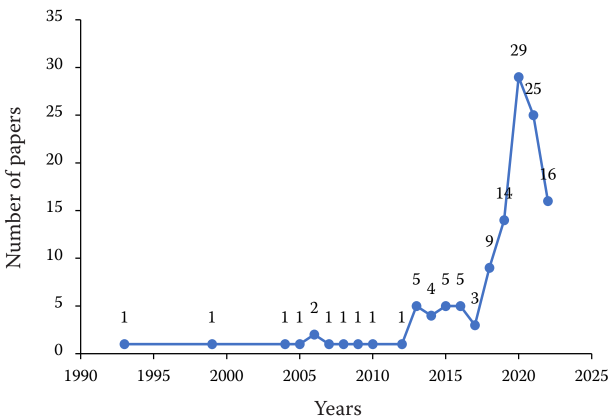

Figure 2. Number of articles on soil erosion published in Central Asia by year

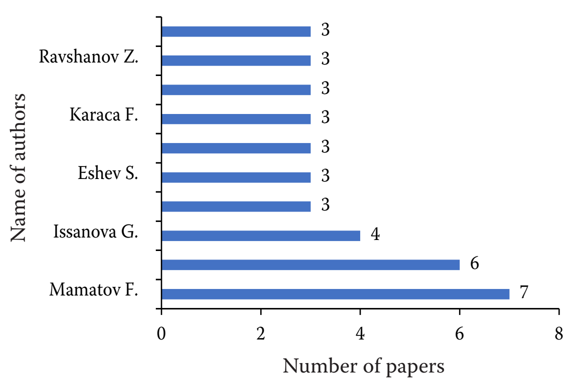

Figure 3. List of top authors published on soil erosion issue in Central Asia countries

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Table 1. List of the journals on soil erosion in Central Asia countries

Scopus source title	No.	Scopus source title	No.
E3 s Web of Conferences	13	Procedia Environmental Science Engineering and Management	2
IOP Conference Series Earth and Environmental Science	12	Eurasian Chemico Technological Journal	2
IOP Conference Series Materials Science and Engineering	8	Eurasian Soil Science	2
Journal of Critical Reviews	4	Geoderma	2
Sustainability Switzerland	4	International Multidisciplinary Scientific Geoconference Surveying Geology and Mining Ecology Management Sgem	2
Biosciences Biotechnology Research Asia	2	Journal of Ecological Engineering	2
Catena	2	Land Degradation and Development	2
Environmental Earth Sciences	2	News of the National Academy of Sciences of the Republic of Kazakhstan Series of Geology and Technical Sciences	2
Environmental Science and Engineering	2		

of Uzbekistan. Figure 3 shows the names of top authors on the soil erosion issue.

Top published countries on soil erosion. Central Asian countries cooperated with many countries of the world on the topic of soil erosion during the considered period. In total, 53 countries worked together on the topic from 1993 to 2022 and according to articles published on the subject, Uzbekistan and Kazakhstan have been leading among these countries. Uzbekistan is in the first place with 57 articles, and Kazakhstan is in the second place with 55 articles. One of the reasons for the leadership of the countries of Uzbekistan and Kazakhstan is that the scientists working in the field in this country have worked intensively and they are sufficiently encouraged by the relevant organizations. Countries such as Russia, Germany, and China have contributed to scientific research on soil erosion with 19, 17, and 13 articles, respectively. As shown in Figure 4, Tajikistan and Kyrgyzstan participated in publishing

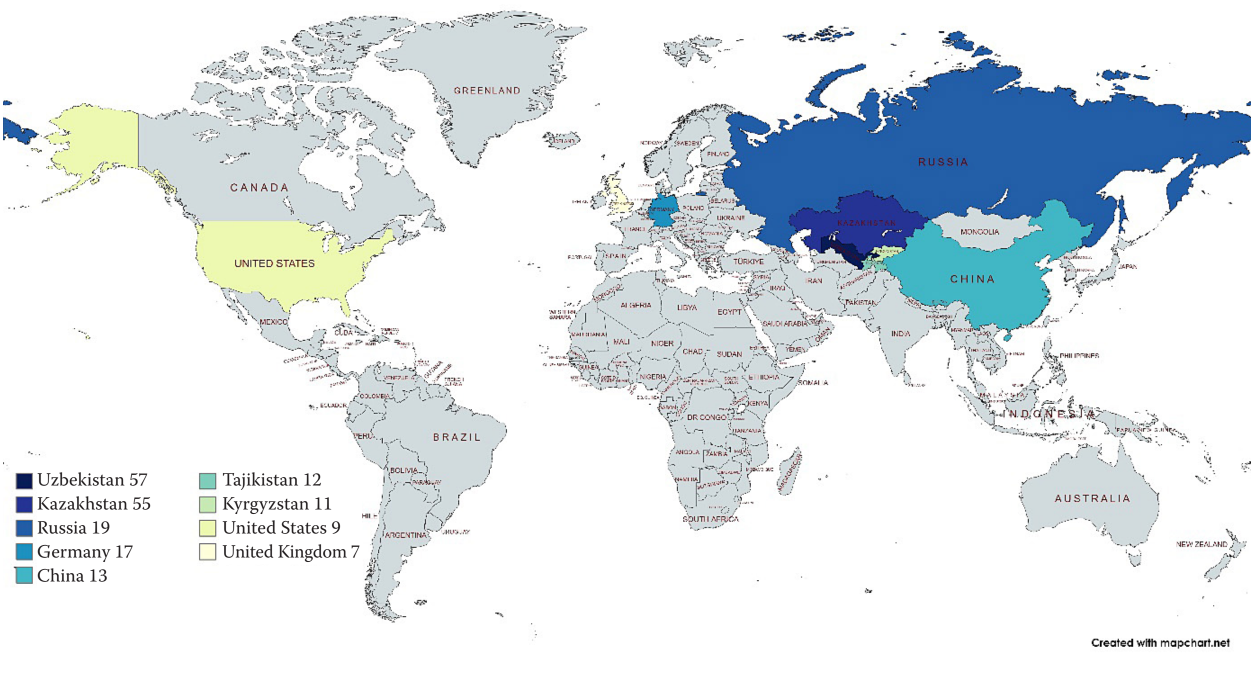

Figure 4. List of top countries on soil erosion issue in Central Asia countries

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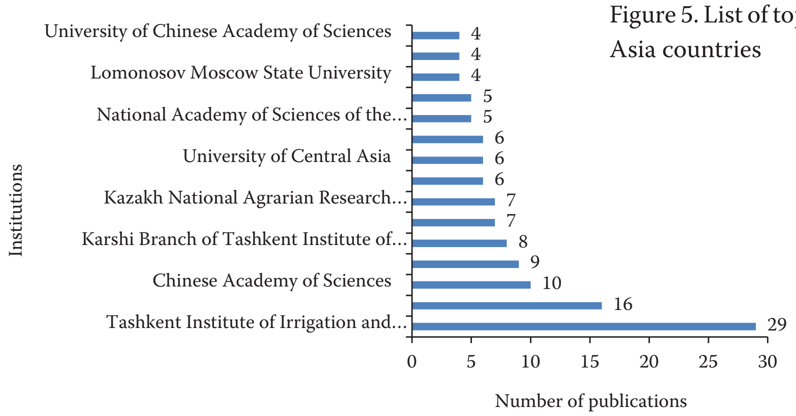

Figure 5. List of top institutions on soil erosion issue in Central Asia countries

more than 10 articles, which shows that they are not indifferent to the topic and that soil erosion is also being paid attention to in these countries. The map of the top countries (Figure 4) was created using the Mapchart.com software.

Top institutions on soil erosion. The rank of institutes is mainly determined by the number of articles published by the institute's staff in internationally recognized journals. Between 1993 and 2022, a total number of 160 different institutions collaborated on 126 articles. Figure 5 shows the list of top institutions. Among them, the Tashkent Institute of Irrigation and Agricultural Mechanization is at the top with 29 articles. Al Farabi Kazakh National University is in second place with 16 articles, Chinese Academy of Sciences is in next place with 10 articles.

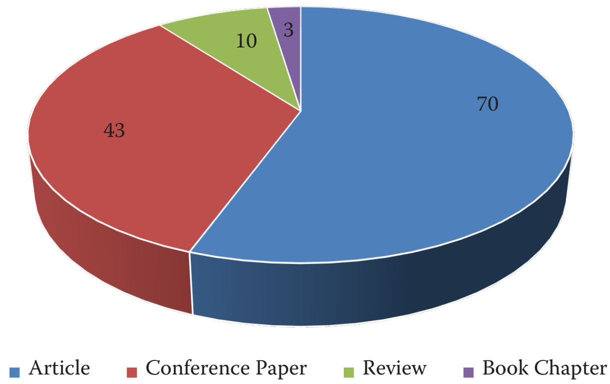

Figure 6. Publication type on soil erosion issue in Central Asia countries

Publication type on soil erosion. There are many types of publications available for researchers to publish the results of their research. Our studies have shown that during the considered period, four types of publications were chosen by the authors. During the considered period, 56% of the total number of articles were published in the article type and took the first place, and 34% of the articles were published in the conference paper type and took the next place. While the review article type occupies 10% of the total articles, the book chapter ranks last with 3%. Figure 6 shows the publication type on soil erosion.

Top funding sponsors on soil erosion. Between 1993 and 2022, a total number of 48 sponsoring or-

Figure 7. Funding sponsors on soil erosion in Central Asia countries

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Number of papers

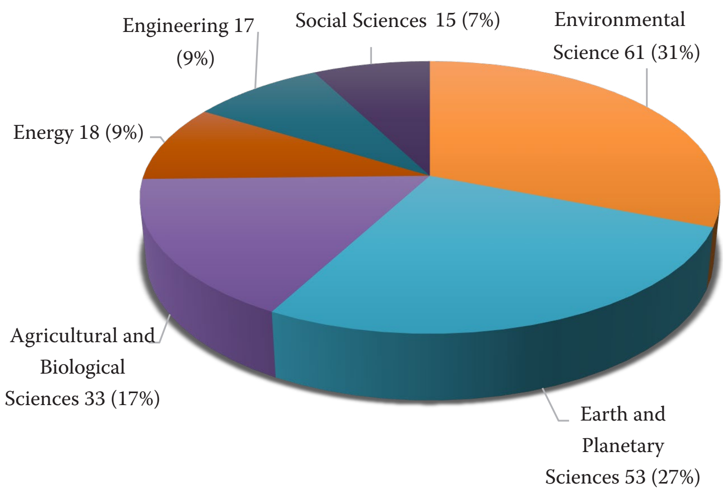

Figure 8. Top subject areas on soil erosion in Central Asia countries

ganizations funded 72 articles. Figure 7 lists the top 14 funders, and Kazakhstan and China contributed the most funding. If the scientific works of authors who can contribute to the development of the field are financially supported in all countries, it will be useful to fight against the processes of erosion in agriculture. As a result of the lack of financial support, important and useful scientific work carried out by researchers is usually not carried out.

Publications by the subject areas on soil erosion. There are several types of subject areas that can be published in the Scopus database, where each subject area contains articles based on its topic and title. Figure 8 shows the names of the subject areas where articles on the topic of soil erosion have been published. During the reviewed years, almost 60% of the articles were published in two subject areas: Environmental Science and Earth and Planetary Sciences. According to this indicator, Agricultural and Biological Sciences is in third place with a 17% indicator. The names of the energy and engineering subject areas are the same by subject 9% contributed by publishing articles.

Top co-authorships and keywords on soil erosion. Co-authorship, keyword co-occurrences, citations, bibliographic coupling, and co-citation maps can be created using VOSviewer based on bibliographic data. By importing the raw file into VOSviewer, Figures 9 and 10 were created. The co-authorship analysis resulted in a network of 593 authors. Figure 9 shows how the authors are related to each other. Only authors having a minimum of two publications on the topic of soil erosion were included. There are 8 items distributed over three clusters: cluster 1 (3 items), cluster 2 (3 items), cluster 3 (2 items).

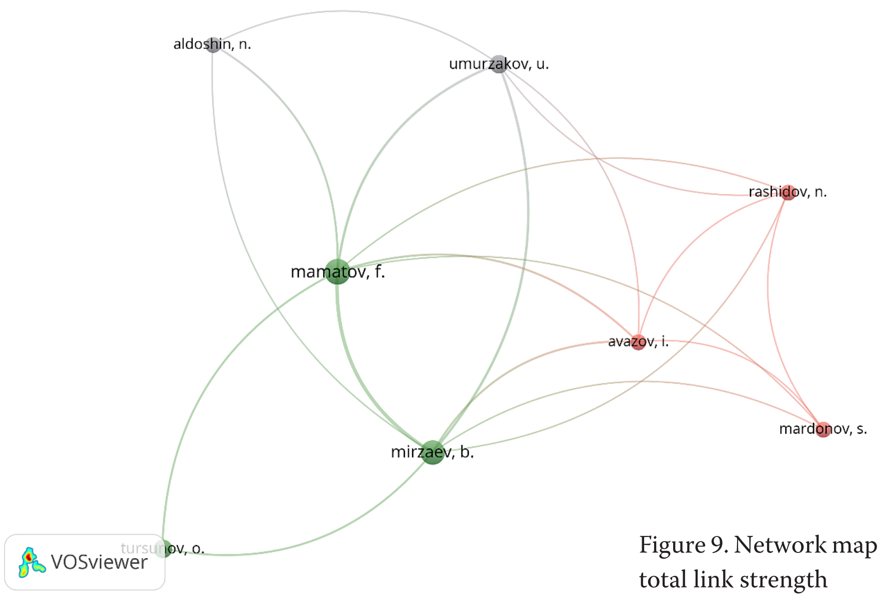

Figure 9. Network map of top co-authorships based on the total link strength

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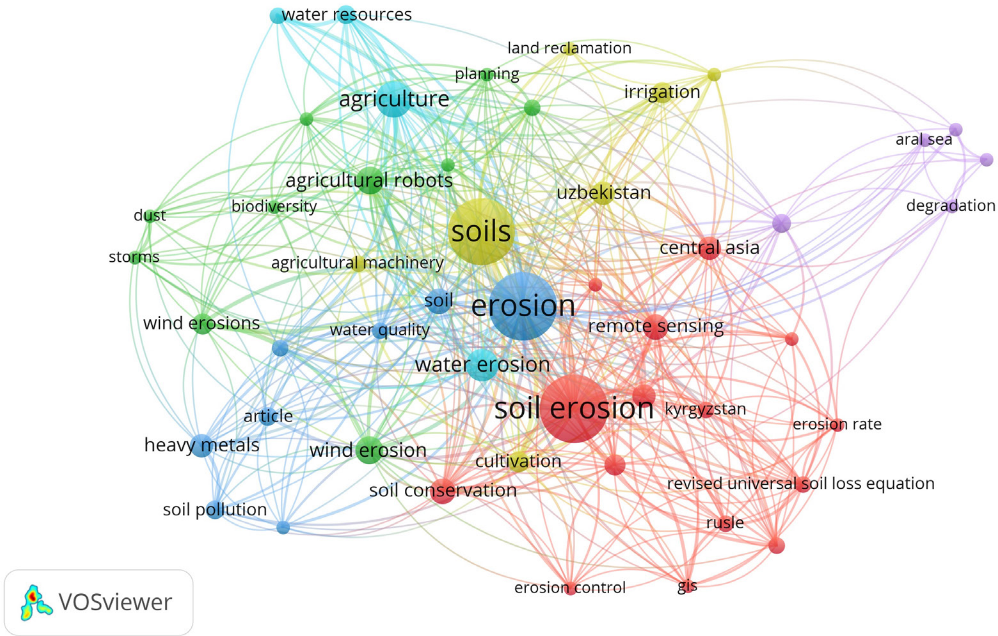

Figure 10. Network map of top keywords based on the total link strength

When keywords were analysed a total number of 1 220 keywords came out. After excluding the general keywords with a low relevance score and those with low occurrence (by default, a minimum of four occurrences of a keyword is selected, to strengthen the co-occurrence results), 49 items were finally identified. Based on the total link strength, each resulting keyword is sketched in a node, creating a network map (Figure 10) of all keywords. Among the keywords, the most common words were soils, erosion, soil erosion.

Top cited publications on soil erosion. Recently, highly cited publications have been employed as a criterion for appraising research (Aksnes 2003). The ten most cited articles on soil erosion are selected and presented in Table 2. A total of 1 120 citations were given to 96 articles out of 126 articles. The article titled ''A Justification of Broach-Plow's Parameters of Ridge-Stepped Plowing" is at the top of the table with 56 citations. This article was written by Mirzayev B. and published in E3S Web of Conferences. As can be seen from the table, the 4 most cited articles were published by this author in 2019. The content of these articles is mainly about the prevention of erosion processes by improving soil tillage techniques. Umurzokov's

Table 2. List of top cited publications on soil erosion in Central Asia countries

Title	Citation	Year	Published journals	Author
A justification of broach-plow's parameters of the ridge-stepped ploughing	56	2019	E3S Web of Conferences	Mirzaev B.
Technologies and technical means for anti-erosion differentiated soil treatment system	52	2019	E3S Web of Conferences	Mirzaev B.
Anti-erosion two-stage tillage by ripper	51	2019	TAE 2019 – Proceeding of 7th International Conference on Trends in Agricultural Engineering 2019	Mirzayev B.
Restoring degraded rangelands in Uzbekistan	50	2019	Procedia Environmental Science, Engineering and Management	Mirzaev B.
Exploration of tillage technologies in the Republic of Uzbekistan	45	2020	IOP Conference Series: Earth and Environmental Science	Umurzakov U.
The formation of loess deposits in the Tashkent region and parts of Central Asia; and problems with irrigation, hydrocollapse and soil erosion	43	2006	Quaternary International	Smalley I.

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two articles published in the journal "IOP Conference Series: Earth and Environmental Science" are also the most cited.

DISCUSSION

Types of erosion and factors contributing to erosion in Central Asian countries

Central Asian countries have a total of 392.7 million hectares of agricultural land, of which the largest amount of agricultural land belongs to Kazakhstan with 270 million hectares. Turkmenistan 47, Uzbekistan 42.5, Kyrgyzstan 19.2, Tajikistan has 14 million hectares of agricultural land (FAO 2012). Currently, the agricultural sector plays an important role in the economy and people's lives of Asian countries (Duulatov et al. 2019). In Central Asia, agriculture provides basic food for people and raw materials for producers (Qin et al. 2022). Almost 60% of Central Asia's population lives in rural areas, but 25% of the region's agricultural land is cultivable. Degradation of agricultural land is considered the main problem of the development of Central Asian countries because it threatens food security and agricultural life (Mirzabaev et al. 2016). About 84% of land degradation in Asia is due to soil erosion (Dou et al. 2022). From 2000 to 2015, Central and South Asia experienced 24% land degradation, second only to Oceania in the world (Alikhanov et al. 2020). In Central Asia, there are many soils formed in loess, and these types of soils are considered useful for agriculture from a physical and chemical point of view (Mueller et al. 2014). Loess soils are considered to have good conditions for plant root development, but they are also considered to be easily affected by water erosion (Smalley et al. 2006). Soil water erosion refers to the lateral movement of soil under the influence of precipitation (Francaviglia et al. 2023). Mountainous countries such as Tajikistan and Kyrgyzstan have more eroded agricultural land than non-eroded land, while lowland irrigated lands face the usual problems of waterlogging and salinization (Saparov et al. 2013). Central Asian countries are considered to be the centre of wind erosion by nature (Indoitu et al. 2012). As a result of agricultural mismanagement, that is, wind erosion of soils through plowing may become a global problem in the future (Nurbekov et al. 2016). More than half of Central Asia's agricultural land has strict restrictions, and this problem affects 80% of Kazakhstan's agricultural land (Bot et al. 2000). These issues include climate change and land management issues (Mueller et al. 2014). Precipitation variability due to climate change is causing significant soil loss due to precipitation in most countries around the world (Duulatov et al. 2019). Soil erosion will increase in the coming years due to various uncertain factors such as global warming, changes in vegetation cover, local warming and humidity (Qian et al. 2022).

Soil erosion status in Central Asian countries and causative factors

Uzbekistan. Soil erosion and soil erosion protection is a problem for many arid regions of the world, including Uzbekistan (Gafurova & Juliev 2021). Three million hectares of agricultural lands of the Republic of Uzbekistan have been eroded by wind and water, and according to the estimates of some researchers, more than 700 thousand hectares of soil have been eroded in the rainy farming regions of Uzbekistan (Juliev et al. 2022). In 2020, according to the results of experiments conducted by Gafforov et al. (2020), in the Chirchik-Akhangaran basin of the Republic of Uzbekistan in combination with RUSLE and GCMs climate models. In their work, the authors looked at how precipitation will change in 2030, 2050, and 2070 and its impact on erosion. The results showed that precipitation is likely to increase by 11.8%, 14.1%, and 16.3% in 2030, 2050, and 2070, respectively, and erosion processes are likely to increase by 17.1%, 20.5%, and 23.3% in the same scenario (Gafforov et al. 2020). The natural conditions of Uzbekistan cause the risk of erosion (Gafurova & Juliev 2021). The reasons for this are improper use of land, non-compliance with the necessary requirements for soil protection. Climate, relief and soil somehow cause the risk of erosion, but plant cover leaving will reduce or prevent the possibility of erosion (Djalilova et al. 2021).

Kyrgyzstan. In 2021 Duulatov et al. (2021), conducted a scientific study in Kyrgyzstan to determine the erosion potential for the entire territory of the country. Remote sensing and the RUSLE model were used to show the dangerous zones of soil erosion and soil loss; the results showed that the average annual soil loss in Kyrgyzstan is 5.95 t/ha/year per hectare. Very high and high soil erosion rates were observed in the western and southwestern parts of the country.

Kazakhstan. In some regions of the Republic of Kazakhstan, using the RUSLE model, GIS and Remote Sensing technologies, the amount of soil erosion has been determined and countermeasures have been developed. In 2019, it was determined by Mukanov et al. (2019), that the average annual soil loss of the

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basin is 0-32 t per hectare using the aforementioned models and technologies in the Esil River basin of Kazakhstan, and 48% of the basin area is free of erosion. Due to the low resistance of Kazakhstan's soil cover to anthropogenic loads, the most cases of degradation and desertification are observed compared to neighboring republics (Tokbergenova et al. 2018). More than 75% of the total area of the republic is subject to various degrees of degradation and desertification (Nyussupova et al. 2015).

Tajikistan. In Tajikistan (Fayziabad) in 2010, Buhlmann et al. (2010) used the RUSLE model and GIS to develop several measures to reduce the risk of erosion processes for agricultural land. According to the results of the experiment, it is possible to reduce the erosion risk by 11% by contouring, by planting forage crops by 16%, and by 53% with drainage ditches, these are considered cheaper measures. Relatively more expensive measures: the risk of erosion can be reduced by 63% with agroforestry and by 93% with the combined use of agroforestry and terracing.

Considering that agriculture plays an important role in the life of Central Asian countries, it is necessary to pay serious attention to problems related to agriculture and develop prevention measures. From the reviewed articles, it became known that several factors cause erosion processes in the agricultural areas of the Central Asian countries. Incorrect organization of agriculture, non-use of modern techniques, lack of funds for the use of new technical technologies, improper irrigation of cultivated fields and other reasons lead to erosion. With the help of modern techniques and technologies, it is possible to identify the danger of erosion processes early and develop measures against them, thereby saving agricultural land.

Methods utilized for soil erosion assessment

Agricultural scientists have used several methods to assess and prevent soil erosion (Abdelsamie et al. 2022). Using existing continuous methods to evaluate erosion processes is an expensive and time-consuming process (Ganasri & Ramesh 2016). Currently, many scientists are effectively using technologies such as remote sensing (RS) and geographic information systems (GIS) to assess soil erosion (Ganasri & Ramesh 2016). Models and maps created using these technologies help to better understand and assess soil erosion (Othmani et al. 2023). A total of 435 soil erosion prediction and protection models and model variants are registered in Global Applications of Soil Erosion Modeling Monitor (GASEMT). Models such as (RUSLE), USLE, WEPP, SWAT, WaTEM/SDEM are the most widely used in the world (Borrelli et al. 2021). Such modern technologies are used in Central Asian countries to evaluate erosion processes. Unfortunately, such scientific works are very few and have been carried out in recent years. Duulatov (2019) assessed changes in erosion processes for Central Asian countries using global climate models (GCMs) and the RUSLE model. According to the results of scientific studies on the prediction of changes in precipitation erosion in the near and long term for the countries of Central Asia: the amount of annual precipitation erosion will increase from 5.6% in 2030 to 9.6% in 2070 (these indicators were obtained in connection with the amount of rainfall erosion in Central Asian countries during this scientific work). Kyrgyzstan and Tajikistan are expected to suffer the most from the projected increase in precipitation erosion. This model has been improved in various countries and is widely used in the assessment of water-induced soil erosion (Panagos et al. 2016). An important aspect of the work done by Panagos et al. (2016) using the RUSLE model for European countries is that each factor included in the model has been studied and published separately. This increases the reliability of the scientific work and provides a better understanding of each factor affecting erosion. A major problem currently hindering large-scale modelling and assessment of soil erosion is the lack of soil characterization data (Panagos et al. 2014). Therefore, measures and methods of combating erosion are being developed separately for each region. It mainly takes into account the available information, the conditions of the area, and the characteristics of the soil.

In world experience, soil erosion threatens not only agricultural areas, but also mountainous areas (Egli et al. 2010; Alewell et al. 2015). Special attention should be paid to the prevention of erosion processes in these areas, because these mountainous areas have services such as wood, fodder, and drinking water necessary for mankind (Alewell et al. 2015). Egli et al. (2010) noted that it would be more effective to study soil formation, age and fertile rocks in these areas, and then apply anti-erosion measures.

CONCLUSION

In the context of Central Asian nations, issues pertaining to agriculture are deemed fundamental and significant due to the agricultural sector's indispensable role within the regional economies.

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Concerns associated with soil, serving as the cornerstone of agricultural endeavours, are regarded as imperative challenges necessitating timely resolution. This is because soil represents a natural resource characterized by a protracted regenerative process. In our review article above, it is related to soil erosion in Central Asian countries between 1993–2022 years, and on this topic, we reviewed and analysed articles published in authoritative journals. During the analysis, we came to several different conclusions.

First, not all Central Asian countries are active in working within the framework of the topic, we observed such activity only in the countries of Uzbekistan and Kazakhstan.

Secondly, from the above studies, we have seen that several authors have pointed out that 60% of the agricultural land in Central Asian countries has strict limitations due to various problems (soil erosion is among these problems and the main one), and therefore they should pay enough attention to soil erosion, we think it is necessary. Considering the high risk of soil erosion for the region, we consider it important to encourage the development of anti-erosion measures.

Thirdly, as mentioned above, taking into account the conditions of each region, countermeasures have also changed, so it was considered appropriate to conduct more scientific research from scientists working in this field in the region.

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