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A Bibliometric and Visualized Analysis of the Global Literature on Black Soil Conservation from 1983–2022 Based on CiteSpace and VOSviewer

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Abstract: Many scholars have conducted in-depth studies on the research area of black soil conservation (BSC) and produced fruitful research results, but there is still a lack of scientific quantitative analysis and objective comprehensive evaluation of the research results. In order to grasp and clarify the current status of BSC research, we explored the trending topics and frontier issues in this research field, as well as the overall evolution trend from 1983 to 2022. Based on the publication information of BSC topics in the core database of Web of Science (WOS), this study utilized the superior tools in two major bibliometric software; they are the VOSviewer and CiteSpace to draw visual maps, such as collaboration networks and keyword co-occurrence maps, to further analyze the research progress and frontiers. The results are as follows: First, research on BSC began in 1983 and can be divided into three phases: the period of nascent research, steady development, and rapid growth. The subject increasingly became an area of research focus in academia, but gradually produced signs of intersection with other disciplines, such as agronomy, biology, and economics. Second, the distribution of research institutions and countries has become more concentrated, forming geographically small research clusters in typical black soil area countries, such as Russia and China, where the centrality of research institutions is higher than 0.20. Research networks have also been initially established between developed and developing countries, such as the United States and China, with a high centrality close to 0.50. Third, the research content is increasingly cross-cutting and systematic, and the research focus can be divided into five major areas, such as black soil distribution and physical and chemical characteristics. Fourth, the research areas cover agronomy, chemistry, geography and other levels, and a more systematic research system has been formed. In the future, it is still necessary to strengthen the establishment of data monitoring systems in black soil areas, the improvement of black soil information database, the assertion of conservation tillage technology and the strengthening of extreme climate early warning network to maintain the soil nutrient content and to guarantee the sustainable development of agriculture.

Keywords: BSC research; visual analysis; bibliometrics; trending topics; sustainable development

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1. Introduction

Black soil conservation, dynamic changes in the distribution area of black soil and its impact on food security and sustainable agricultural development have become one of the frontiers and trending topics of research by scholars around the world [1–4]. With the global population explosion and the development of modern science and technology, human interference with soil has exceeded the regenerative capacity of soil itself, especially the rare black soil resources [5]. In April 1991, the FAO convened an international conference on "Sustainable Agriculture and Rural Development" in The Netherlands and issued the famous "Den Bosch Declaration", which defined sustainable agriculture as "the management and conservation of basic natural resources and the reorientation of technological and institutional change... Such sustainable development has a clear effect on the conservation

of land, water, plant and animal genetic resources and does not cause environmental and ecological degradation" [6,7]. For many years, the balance and sustainability of agriculture and ecology has been a trending topic closely related to the macroeconomic situation of each country or region. In particular, the physical and chemical properties, erosion, and degradation of soils have become a hot issue of interest for governments, research institutions and scholars from various disciplines [8–10]. Taking China as an example, China's black soil is mainly in the central part of the Northeast Plain, especially in the low mountains, hills, and plains below 600 m above sea level. According to the data of the second national land survey and the results for the county arable land quality survey and evaluation, the arable land in the northeast black soil area is approximately 18.53 million hectares, which is an important base for China's commercial grain production and comprehensive development of agriculture, forestry and animal husbandry, as well as a key point for ensuring national food security [11]. However, due to natural conditions and anthropogenic factors, a series of problems, such as quality decline, environmental degradation and organic matter loss has gradually emerged in the black soil region of Northeast China, which seriously restricts sustainable development of the ecological environment in the region [12,13]. In March 2020, China's Ministry of Agriculture and Rural Affairs and Ministry of Finance jointly issued the document "Northeast Black Soil Conservation Tillage Action Plan (2020–2025)", which highlights the need to strengthen the role of policy guidance and promote conservation tillage as an overall national action [14–16]. As one of the most cherished and high-nutrient soil types, BSC research has received increasing attention from scholars in various countries, and related research results are constantly being developed and updated.

According to Thomson Reuters' WOS, a citation database, there are several review papers on BSC. The article by Han et al. examines the research and measures taken in China over the past 70 years to reduce the chemical content of black soil and conservation tillage practices, and suggests future directions for technological development [17]. Xu et al., analyzed the degradation characteristics of soils in black soil areas, the compositional decay of soils, the chief influencing factors and specific preventive measures, with 146 citations [18]. A brief summary of the main elements of BSC agricultural farming technology in China in recent years was presented by Qingjie et al. [19]. With the rapid progress made in the field of natural sciences concerning black soils, it is also important to determine and analyze the overall status of BSC research. Due to technical limitations, traditional bibliometric analysis methods mostly rely on the tireless efforts of scholars to retrieve, screen, review and count article data. Xu and Wang et al., integrated multi-database information for specific analysis through manual data collation and screening [20,21]. Qu et al. performed the analysis by using more particular principal component extraction and clustering methods [22]. GM et al. applied geographic information mapping theory and methods to construct cropping pattern maps based on 2017–2019 crop classification data in the Northeast Black Soil Region, which still has limitations [23]. These suggest that the subject is an important area of knowledge in constant development, yet unfortunately existing research still lacks a systematic review of scholarly findings over time.

This study was designed to explore bibliometric-based BSC research, to find popular frontier topics, and to track trends within the BSC field and the evolution of research disciplines. The overall research process was structured around the following research questions: What are the extensive trends in publications within the field of BSC research, who are the major contributing authors, institutions, and countries in the field of BSC research? What are the keywords and trending topics in the BSC research field? What is the trajectory of the evolution of research topics? To answer the above questions and to provide a comprehensive review of BSC research, this study takes the academic literature published on the field of BSC research worldwide in the past four decades as the object of study, and uses citation analysis and co-occurrence analysis in bibliometrics as the theoretical basis to synthesize the different advantages of two major visualization software, VOSviewer and CiteSpace, respectively, for quantitative analysis. This study may make the following marginal contributions: First, this study provides an in-depth bibliometric

analysis of the evolution of subject vocabulary in the field of BSC research and visualizes the mapping from the knowledge structure of the BSC field. This visual and statistically significant assessment of the BSC field can help scholars new to the field to more quickly become familiar with and grasp the topics and scientific trends in BSC, provide theoretical references, thought insights, and methodological lessons for further academic research design, and also contribute to policy formulation in BSC. Second, the analysis tools are flexible and diverse, overcoming the technical limitations of previous review-type studies. In this paper, according to the research needs and the analysis advantages of different software, we use VOSviewer1.6.18 software (Created by Nees Jan van Eck and Ludo Waltman, and the location of the software source is the Science and Technology Research Center at Leiden University, Leiden, Netherlands) for visual analysis of authors, institutions, countries and keywords and CiteSpace6.1.R3 software (Created by Chaomei Chen, and the location of the software source is the Drexel University, Pennsylvania, USA) for analysis of evolutionary lineage and highlighted words. The presentation of the graphs is more diversified and flexible, which improves the scientific nature of the analysis. Third, this study provides a comprehensive overview of the existing research results of BSC from the aspects of publication trend analysis and collaborative networks, time zone evolution and research frontiers, with a more across-the-board perspective.

2. Data Source and Research Methods

2.1. Data Source

The literature search process of this study was designed based on the WOS Technology and Innovation Citation Platform of Thomson Technology (now Corevantage), USA, and eight databases covered by the WOS core dataset, including Science Citation Index (SCI-E) and Social Science Citation Index (SSCI), were selected as data sources. Since the first article information about BSC was recorded in 1983, the search time was set to 1983–2022 in this study in order to minimize the loss of literature volume. After several discussions and attempts, we used a search formula such as "("Black Earth" OR "Black soil" OR "Black Land" OR "Black Earth Zone" OR "Black soil area" OR chernozem OR Phaeozem OR "Black calcium soil") and (Protect* OR erosion OR drain OR wastage OR governance OR manage OR administer OR Degradation OR Restor* OR renovate OR Ecolog* OR cultivate)" to start the literature search, with the wildcard "*" appearing in the formula indicating that any word starting with its preceding letter should be taken into account. A total of 1614 publications were found using "subject" (covering article title, abstract, author, keywords, and keyword plus) as the search term. Further, the data can be exported to plain text format containing "Full Record and Cited Reference" by clicking "Save as another file format" on the search result screen of the database. The exported documents are saved and downloaded as "download_xxx". In the derived bibliographic data, each bibliographic entry will contain information, such as type, author, title, country/region, abstract, keywords, journal, year of publication, and references. The number of literature downloads per batch is $\leq$500. To avoid duplicate publications being used during the study, we used CiteSpace's deduplication function to check, and seven duplicate publications were excluded. Then, 1607 journal articles were selected (data retrieved: 19 August 2022, 9:16 AM).

2.2. Research Methods

With the growing interest in the visual analysis of literature data and knowledge mapping as a tool for academics and people from all walks of life, bibliometric methods based upon the intersection of informatics, metrology, statistics and mathematics, which present the research history, core knowledge structure, research frontiers and overall research context of a field in a colorful visual form, have received increasing attention [24,25]. Chen at Drexel University subsequently used this concept to develop CiteSpace, a sight Java1.8.0 software (Created by Oracle, Texas, America) that identifies and displays research trends and research hotspots. Its main inspiration was Kuhn's evolution of the methodical

structure, which argues that scientific developments can be extracted from the published literature. The software combines contemporary co-citation analysis theory, pathfinding network algorithms, information visualization methods from interactive visualization tools, and data mining algorithms [26,27]. Since then, it has become one of the most representative bibliometric visualization tools. CiteSpace (https://sourceforge.net/projects/citespace//, accessed on 17 August 2022) stands for Citation Space, and Knowledge Graph is an area where citation analysis is the main emerging field of research with content technology. As a regulated literature data mining and visualization software, it combines various methods such as cluster analysis and social network analysis to visualize the development history, structural features and evolution patterns of scientific knowledge in a complex scientific knowledge domain through data mining, information processing, knowledge measurement and graphical mapping, and presents this information on the form of a colorful map, which is a new development in scientometrics. VOSviewer (https://www.vosviewer.com, accessed 28 August 2022) is a JAVA-based software developed in 2009 by van Eck and Waltman at the Center for Scientific and Technological Studies (CWTS) of Leiden University, Leiden, The Netherlands, which focuses on the analysis of visual networks for literature data. The clustering in VOSviewer is calculated based on the strength of association, and its visualization mapping image is clear and beautiful with high credibility. Therefore, the author mainly uses VOSviewer 1.6.18.

Knowledge visualization mapping is a method of presenting information in terms of co-occurrence weights and total link strength of items, which can be used to analyze the impact and strength of relationships between different article attributes. Various specific technical tools are included under this methodological system, mainly covering citation analysis, co-occurrence analysis and coupling analysis. The results for the literature measurement can be further enhanced by network analysis and visualization effects. In network analysis, the strength of association between item nodes is determined by the weight attributes, i.e., the "link" attribute and the "total link strength" attribute. In the visual interface of the bibliometric software, the size of an item's label and circle is determined by the weight of the item (the software's default node shape is a circle). The higher the weight the item takes up, the larger the label and circle of the item. The stronger the link between two items, the thicker the line showing the link in the visualization atlas. The default color scheme combinations of VOSviewer software and CiteSpace software were retained in this study.

3. Results

3.1. Analysis of Publication Development Trends

The annual distribution with the number of published articles provides a clear picture of the breadth and depth of the overall level of research within the BSC research field [28]. In this study, the number of annual article publications in the BSC field was clearly plotted using a dotted line graph with the statistical function in WOS, as shown in Figure 1. From the steepness of the lines and the important turning points, we can evidently see that the number of published articles in BSC research has generally shown a continuous growth trend from 1983 to 2022 and has gone through three phases, i.e., the period of budding research, the period of steady development, and the period of rapid growth. A special emphasis here is that in 2022, there is a relatively large decline, which is due to the fact that the year 2022 only counts the literature up to July, and the number of literatures at the end of the year is yet to continue to rise.

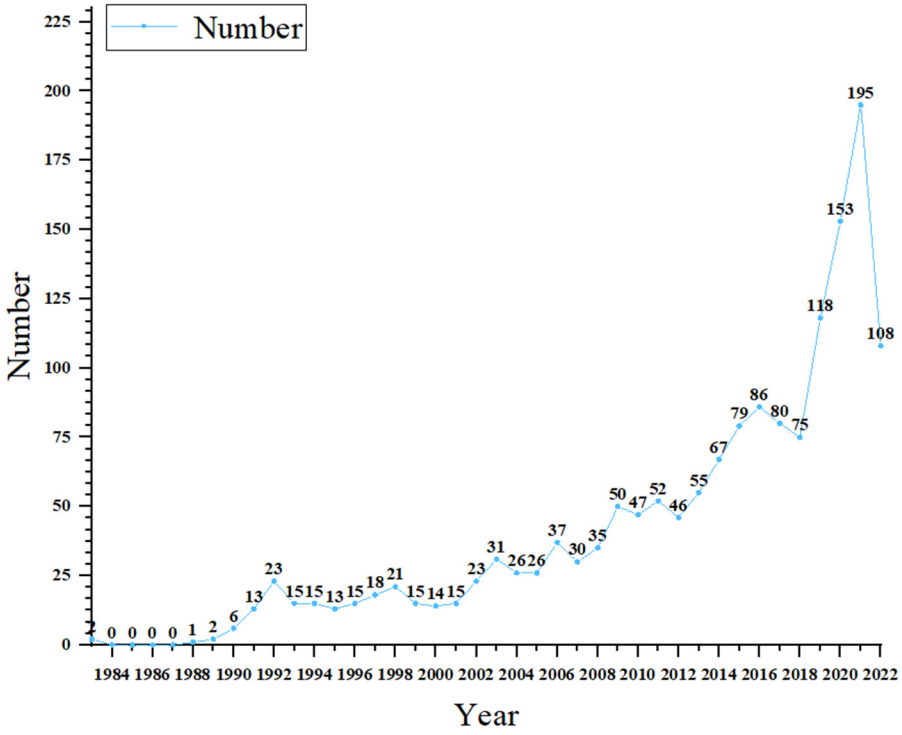

Figure 1. Number of publications contributed on BSC topics per year from 1983–2022.

The budding stage of research (1983–2002). During this period, research in the field of BSC was still in its infancy, and the number of publications in the academic community was low across years and the overall fluctuations were small, indicating that the field had not yet gained enough attention and was just making progress. Meanwhile, the research topics were relatively more focused on the understanding of black soil as a special soil type, and there were few research scholars involved in this field, mainly on the conservation behavior of black soil. Before the emergence of the nascent field of BSC research, the subject of land conservation or soil degradation had been studied more intensively in academia, before enough attention had been developed for black soils. For example, in 1976, Schwartz et al. conducted a study on soil conservation [29]. After 1983, a group of scholars, including Glaser, focused on the physicochemical characteristics and nutrient content of black soil, with the aim of gaining a more accurate understanding about the soil type [30].

The stable development phase of research (2002–2018). The degree of change of the dotted line in Figure 1 shows that the number of articles related to the BSC field published during this research period has generally continued to increase across the years, albeit accompanied by small fluctuating situations. This can indicate that the academic community has fully demonstrated a greater interest in the topic to the field of BSC during this period, and that the research content and research perspectives have been further extended, highlighting some leading studies, such as Zhang and Wei et al. [31,32]. During this period, events such as the SARS epidemic, the Iraq war, and the worldwide financial crisis have seriously affected the world's economic performance, and the IMF predicted that global economic growth rate was 3.3% in 2014, much lower than previously expected. These economic events have led to widespread interest in academic research related to sustainable agricultural development, land-use change, and soil safety. As the research on global black soil use pattern change and BSC has intensified, scholars have studied climate change, biodiversity, agriculture, and organic carbon, and the research methods and regions have been further enriched [33].

Rapid growth phase of research (2018-present). During this period, there has been a "steep" growth trend due to the number of publications and a gradual deepening of research themes and perspectives. In the research agenda of BSC, the research perspective focuses

on both regional macro issues and micro issues, including farming systems, organic matter, land fertility, sustainable development, ecological quality, etc., and the overall research continues to be in-depth. On 5 December 2018, the fifth World Soil Day, Monique Barbut, Under-Secretary-General of the United Nations and Executive Secretary of the United Nations Convention to Combat Desertification (UNCCD), mentioned in her message the importance of soils to natural systems and human well-being. She noted that, "Healthy soils, which are essential for sustainable agricultural Healthy soils are the basis for sustainable agricultural development, the safeguarding of fundamental ecosystem functions and the maintenance of food security, and are therefore the key to sustaining life on earth". Once again, this drew attention to the issue of soils and BSC, stimulating an increase in the number of studies.

3.2. Network Analysis of Cooperation

3.2.1. Analysis of Author Cooperation Network

By performing a visualization of author collaboration networks, we can get a clearer picture of the strength of representative scholars and highly collaborative and cohesive research teams in the BSC research field [34]. In this study, VOSviewer 1.6.18 software was used for network visualization analysis, and in order to present the collaboration intensity more clearly. We adjusted the threshold value to control the number of publications used for screening to five and above, and then overlaid and visualized the collaboration network of authors with a higher association intensity. The gradients generated by the software for different colors provide a visualization of the collaboration among scholars in academia over the past four decades (Figure 2), and the specific information of the top 20 authors in terms of the number of publications is presented in a tabular manner (Table 1). Through the visualization mapping, we can clearly find that the highest authors in terms of a number of published articles show obvious clustering network characteristics, mainly including five collaboration networks of LIU, Zhang Ying, Zhang Shao, Liu Xiaobing, and Zhou. This indicates that these are the core authors studying BSC, and they have formed a research team with a high volume of publications in the field, forming a certain scale. The top three scholars in terms of the number of individual publications are Xiaobing Liu (24 articles), Xingyi Zhang (18 articles), and Gang Liu (17 articles). This indicates that after more than 40 years of development, a core group of authors in the field of BSC research has been initially formed, and Chinese's scholars have formed a certain research group, which still needs further development and depth.

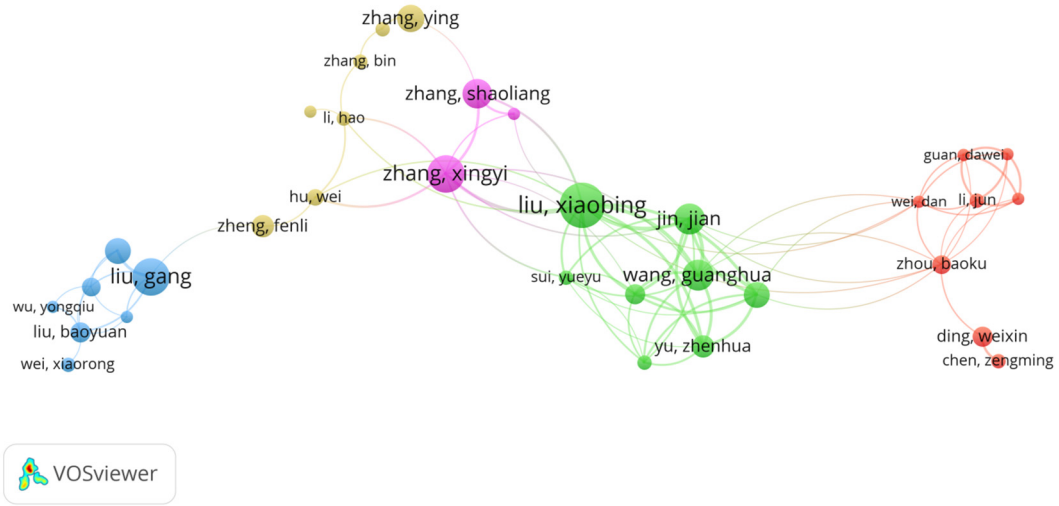

Figure 2. Clustering mapping of author collaboration networks for BSC domain publications.

Table 1. Information on the top 20 authors in terms of number of publications.

Ranker	Num.	Centrality	Year	Authors	Ranker	Num.	Centrality	Year	Authors
1	24	0.02	2011	Xiaobing Liu	11	10	0.00	2018	SAGLARA
2	18	0.00	2011	Xingyi Zhang	12	9	0.00	2011	Zhanghua Yu
3	17	0.00	2013	Gang Liu	13	9	0.00	2015	Yun Xie
4	12	0.00	2018	Tatiana	14	9	0.00	2019	Yu
5	11	0.00	1995	Shaoliang Zhang	15	9	0.00	2014	RADKA
6	11	0.00	2011	CA Campbell	16	8	0.00	2013	S. K. Ray
7	11	0.00	2011	Junjie Liu	17	8	0.00	2013	T. Bhatta
8	11	0.00	2011	Jian Jin	18	8	0.00	2013	K. M. Nair
9	11	0.00	2011	Guanghua Wang	19	8	0.00	2018	Svetlana
10	10	0.00	2009	Baoyuan Liu	20	8	0.00	2013	DKPAL

Note: The centrality indicator measures the number of articles published by the author in cooperation with other authors. The higher the value of centrality, the higher the number of articles published by the author in collaboration with other authors. Conversely, a low value of the centrality indicator indicates that the authors have published few articles in the form of collaborations in the research field. The year represents the year of publication of the publication. If not specified, "centrality" and "year" in the table below are interpreted in the same way as they are.

3.2.2. Analysis of Institutional Cooperation Network

In this study, by setting research institutions as node types and performing visual mapping analysis, a collaborative network graph of research institutions in the BSC domain is obtained at the VOSviewer interface (Figure 3). In Figure 3, the distribution status of nodes is in a localized state of close aggregation, which indicates that there is a certain degree of cooperation among research institutions. Generally, the number of research institutions related to BSC is high, but a large multinational institutional cooperation cluster has not yet been formed. Based on the summary information of the top 20 research institutions in terms of the number of published articles (Table 2), we can see that six organizations have published more than 50 articles in this field. The Chinese Academy of Sciences published the highest number of articles (230), followed by the Russian Academy of Sciences (117), the University of Chinese Academy of Sciences (63), and Agriculture and Food Canada (53), which also have the greatest number of publications, and a research network has been formed with these Chinese and Russian research institutions as the core. For example, researchers at Northeastern Agricultural University, China Agricultural University and Shenyang Agricultural University in China have published numerous papers on BSC. This indicates the strong scientific importance and influence of these institutions in the field. In particular, it is significant to mention that the reason for the highest number of publications by the Chinese Academy of Sciences is to a large extent closely related to the national context of China. The main reason is that China is a populous country and the ecological condition of the land is closely linked to the sustainable development of agriculture, and the black soil region of Northeast China is an important base for commercial food, and maintaining the "health" of the black soil is an important step to ensure food security. Therefore, the Chinese government is highly concerned about BSC and has issued a series of policies to guide and support it. For example, in 2021, the Ministry of Agriculture and Rural Development and seven other departments jointly issued the "National BSC Project Implementation Plan", which explicitly proposes to complete the task of protecting 100 million mu of black soil during the 14th Five-Year Plan period, pay close attention to the decline of black soil quality, and form a long-term governance mechanism linking government and society for BSC.

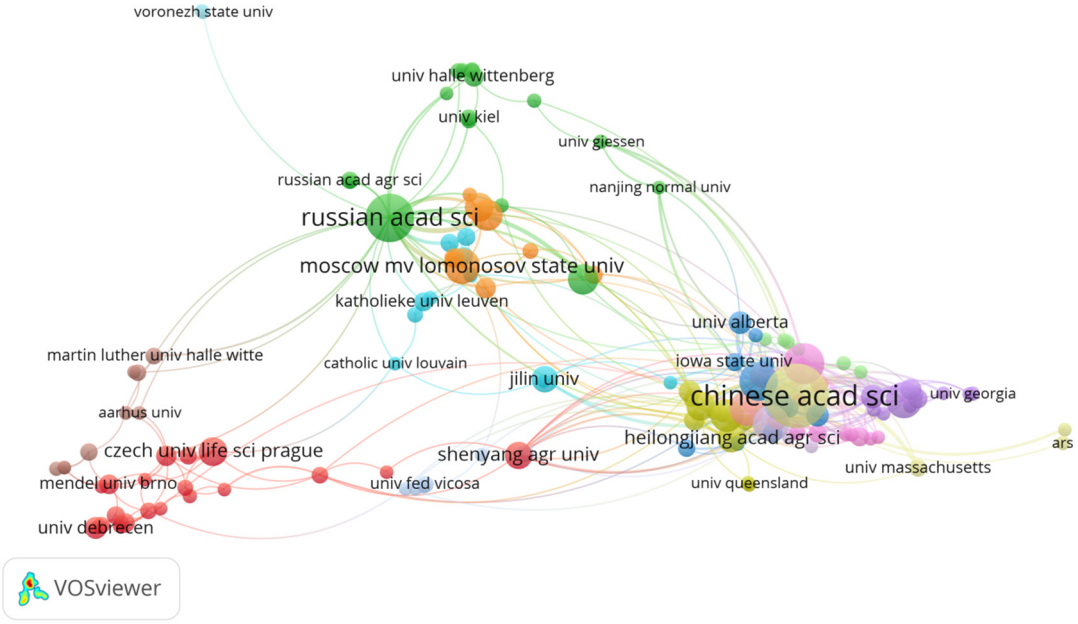

Figure 3. Clustering mapping of institution collaboration networks for BSC domain publications.

Table 2. Information on the top 20 institutions in terms of number of publications.

Ranker	Num.	Centrality	Year	Research Institutions	Ranker	Num.	Centrality	Year	Research Institutions
1	230	0.28	2003	Chinese Academy of Sciences	11	35	0.02	2017	Lomonosov Moscow State University
2	117	0.20	1999	Russian Academy of Sciences	12	26	0.10	2008	China Agricultural University
3	63	0.07	2014	Chinese Academy of Sciences	13	23	0.02	2012	Heilongjiang Academy of Agricultural Sciences
4	53	0.03	1998	Agriculture and Agri-Food Canada	14	22	0.01	2011	Czech University of Life Sciences Prague
5	51	0.02	2007	Beijing Normal University	15	22	0.00	2016	Jilin Agricultural University
6	46	0.01	2014	Northeast Agricultural University	16	21	0.01	2016	Jilin University
7	42	0.08	2014	Northwest A&F University	17	21	0.00	2016	Dokuchayev Institute of Soil Science
8	41	0.01	2001	Moscow State Mikhail Vasilievich Lomonosov University	18	19	0.01	2015	Shenyang Agricultural University
9	36	0.05	2013	Chinese Academy of Agricultural Sciences	19	14	0.00	2004	USDA Agricultural Research Institute
10	36	0.00	2014	Southern Federal University	20	13	0.01	2001	University of Debrecen

3.2.3. Analysis of Country Cooperation Network

In this study, the node type was set to country to generate a visual graph (Figure 4), with specific information on the top 20 countries in terms of the number of published articles (Table 3). According to Figure 4 and Table 3, China, Russia, the United States, and Canada published more than 100 articles, which is significantly higher than other countries. These four countries published 36.09%, 26.26%, 7.47% and 6.29% of the total number of articles in this field, respectively. It is clear from the number and density of connecting lines in Figure 4 that the nodes show aggregation among them, which indicates the existence of many closer collaborative relationships between different countries. Among the nodes, Russia (0.43), China (0.30), Germany (0.25), and the Czech Republic (0.11) have high centrality values, all above 0.1, indicating that these countries are in a relatively central position in the field of BSC research and that relevant research has a significant impact on the field.

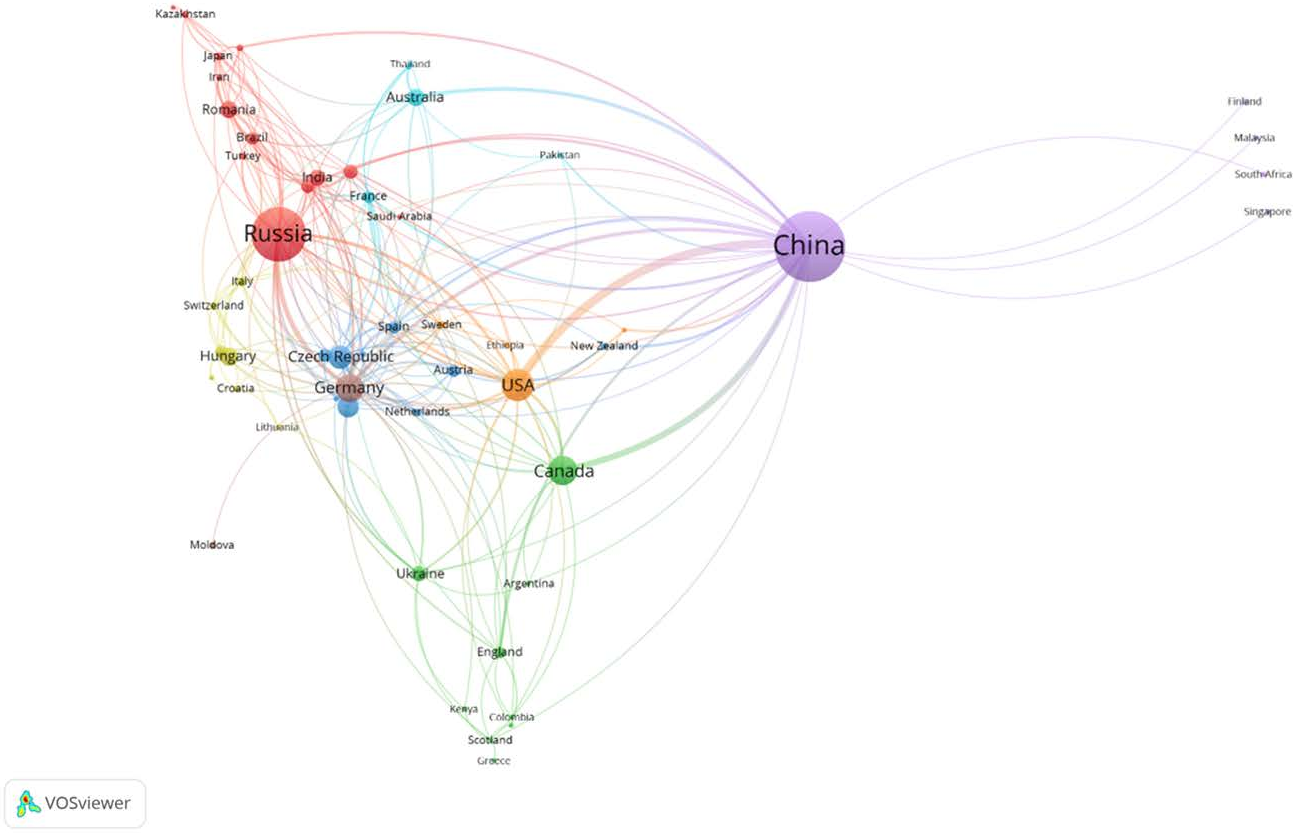

Figure 4. Clustering mapping of country collaboration networks for BSC domain publications.

Table 3. Information on the top 20 countries in terms of number of publications.

Ranker	Num.	Centrality	Year	Countries	Ranker	Num.	Centrality	Year	Countries
1	580	0.30	2003	China	11	27	0.00	1989	Australia
2	422	0.43	1998	Russia	12	27	0.01	2007	India
3	120	0.07	1997	USA	13	18	0.00	2007	Mexico
4	101	0.01	1995	Canada	14	17	0.06	2006	Belgium
5	90	0.25	1993	Germany	15	15	0.03	2013	Serbia
6	72	0.01	2012	Ukraine	16	13	0.02	2002	Brazil
7	65	0.11	1998	Czech Republic	17	12	0.00	1998	Slovakia
8	54	0.01	2005	Poland	18	12	0.00	2009	Moldova
9	42	0.04	2002	Romania	19	11	0.01	2010	France
10	37	0.01	2001	Hungary	20	11	0.00	2003	Austria

3.3. Analysis of Hot Research Topics and Frontiers Trending

3.3.1. Analysis of Hot Research Topics

Research hotspot refers to a group of research problems or topics that have been focused on by researchers in a certain period of time, and the number of related literature publications has increased significantly, forming a network of links. In an article, keywords can highly refine, extract, and summarize the main idea of the article, and more graphically reflect the direction and value of the research results, which is the core part of the article [35]. This study used VOSviewer software to visually analyze the keywords of the published literature on the BSC research area to form a knowledge graph, where the round nodes represent each keyword. The longer diameter and larger area of the circular nodes represent the higher frequency of the keyword in the BSC research domain, and the association curves appearing between the circular nodes represented the co-occurrence between the keywords. In addition, in the knowledge graph drawn by VOSviewer, different colors represent distinct clusters of nodes, and nodes with the same color constitute the duplicate cluster. Through the keyword co-occurrence map (Figure 5), we can easily find that the keyword knowledge map of the whole BSC domain is centered on the three major words "black soil", "land use" and "carbon", which are located in the central area of the picture, and surrounded by other circular nodes of different sizes, creating an outward radiation from the center to the surroundings. In order to clearly show the keywords with high frequency, we set the threshold value to 5 and obtained 550 high-frequency keywords, and the details of the top 20 keywords with the highest frequency are shown in Table 4. The BSC field is represented by the terms "black soil" (198), "soil" (169), "erosion" (149) and "Chernozem" (146). The clustering of keywords in different colors in the chart shows that these highly frequent words act as a kind of linking hub to bring conjointly various low-frequency words, which together constitute a popular frontier research topic in the field of BSC for the past four decades.

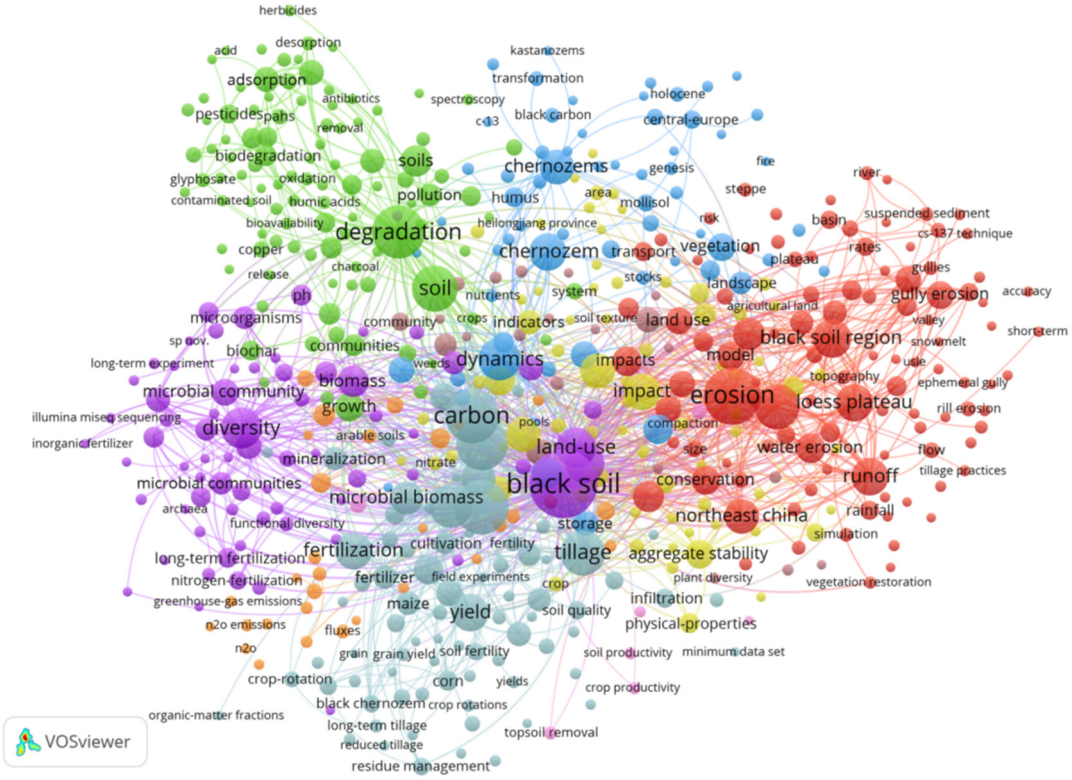

Figure 5. Clustering mapping of keyword co-occurrence networks for BSC domain publications.

Table 4. Information on the top 20 keywords in terms of number of publications.

Ranker	Num.	Centrality	Year	Keywords	Ranker	Num.	Centrality	Year	Keywords
1	198	0.00	2006	Black soil	11	100	0.00	2010	Impact
2	169	0.00	1998	Soil	12	94	0.00	1995	Tillage
3	149	0.00	1997	Erosion	13	83	0.00	1997	Dynamics
4	146	0.00	1996	Chernozem	14	80	0.00	1995	Yield
5	129	0.00	1997	Carbon	15	78	0.00	1995	Management
6	127	0.00	1995	Nitrogen	16	75	0.00	2008	Organic carbon
7	125	0.00	2003	Degradation	17	70	0.00	2003	Diversity
8	120	0.00	1998	Organic matter	18	60	0.00	1995	Fertilization
9	110	0.00	2000	Soil erosion	19	59	0.00	2013	Loess plateau
10	104	0.00	2006	Land use	20	58	0.00	2010	Black soil region

In order to locate and distill popular research topics in the BSC field more obviously, intuitively, and quickly from the tightly connected nodes and links, we use the unique clustering density view function of VOSviewer software to further visualize the keyword clustering results (Figure 6). In the clustering density view, the highlighted focus part can be clearly seen, and the density of each node changes with the high and low frequency of surrounding keywords. The density of each node is closely related to the number and weights of the nodes distributed around it. The higher the density of nodes in the center, the closer the color of the nodes is to red (i.e., the darker the color) and the higher the research intensity of the topic and the key area of research. On the contrary, the lower the density of nodes on the edge, the closer the color is to blue, which means that the research topic is not very popular. Therefore, the process from the red area in the center to the blue area at the edge reflects the change of the research topic's popularity [36]. Based on the density clustering results in Figure 6, we can extract five frontiers trending topics in the current BSC research field (Table 5) and further analyze and discuss the research content and important results of each topic.

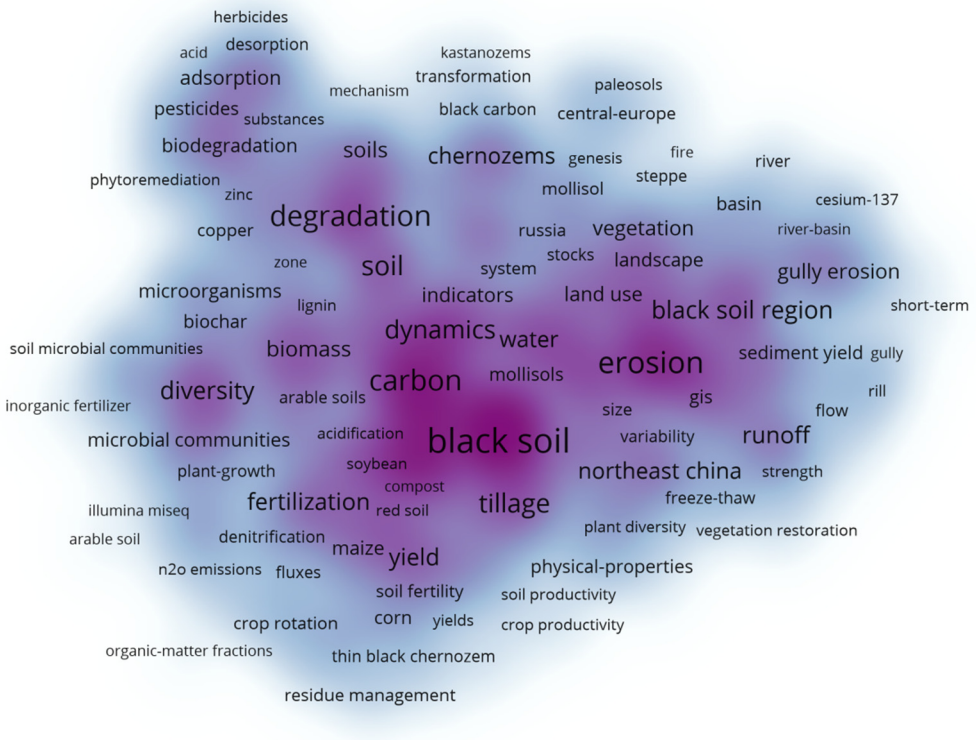

Figure 6. Keyword co-occurrence clustering density view within the BSC research area.

Spatial Distribution of Black Soil

In the early days, the discovery of black soils set in a wave of academic exploration of the location of these rare soils, and the term "black soils" was imported westward from Russia to Europe in the early 19th century, when British geoscientific researchers compared the value of black calcareous soils in Russia with that of coal mines in England, recognizing the high value of these soil resources [37]. Subsequently, scholars from various countries tried extremely hard to determine the distribution of black soil in different parts of the world. Later, after the black soil area was determined, the change in a black soil area brought about the reduction of a distribution area, and likewise caused concern in academic circles. Although land is a renewable resource, however, with the increase of the world population and the development of science and technology, human interference with the land exceeds the regenerative capacity of the land. In China, for example, the black soil area is mainly located in the central tablelands of the Northeastern plain, which belongs to the more socio-economically developed areas. The expansion of non-agricultural land during the process of industrialization and urbanization has led to a continuous decrease in the amount of black soil resources, which threatens food security in China [38]. Zentner and Zhang et al. found that the development of land-use practices, such as traditional agriculture, will inevitably have more or less of an impact on the soil, making it susceptible to problems, such as soil erosion, leading to the degradation and reduction of the area of black soil, thus affecting the production of major food crops [39–41].

Table 5. Information about the top five keyword groups within the BSC research area.

Cluster-ID	Research Topics	Main Keywords Included
1	Spatial distribution of black soil	Abandonment; accuracy; agricultural catchment; areas; basin; black soil area; black soil region; black soil region of northeast China; catchment; cesium-137 technique
2	Physical and chemical properties of black soil	Accumulation; acid; adsorption; aminomethyl phosphonic; antibiotics; atrazine; availability; barley; behavior; benzopyrene
3	Organic matter and carbon storage	Aggregation; black chernozem; brown chernozem; Canada; canola; carbon sequestration; carbon storage; compost; conservation agriculture; conventional tillage
4	Sustainable agriculture	Aggregate stability; agricultural land; agriculture; agroecosystems; bulk density; calibration; chemistry; city; classification; clay
5	Biological diversity	Acidification; amendment; bacteria; bacteria community; bacteria diversity; biodiversity; biogeography; biomass; cattle manure; community structure

Physical and Chemical Properties of Black Soil

Due to the inappropriate selection of agricultural reclamation methods and the large proportion of cultivated land, black soil has been subjected to relatively serious erosion, and the soil has shown a trend of declining fertility. Degradation of black soil is mainly manifested in the significant decrease of humus content deposited in the cultivated layer, the gradual deterioration of soil physical and chemical properties, the structural change of soil, the gradual increase of soil bulk, and the sharp decrease of soil pore space, making the soil state increasingly unsuitable for agricultural practices, and reducing its ability to withstand extreme weather conditions, such as drought and flood. Moreover, with the rise of chemical agriculture, inorganic fertilizers and pesticides are used in large quantities by farmers, which not only causes a gradual decline in crop quality but also destroys soil quality, which in turn makes farmers mistakenly put in more chemicals, further deteriorating the agro-ecological environment and leading to a vicious circle [42]. The causes of changes in the physical and chemical properties of black soils come from microscopic mechanisms, such as a drastic decrease in organic matter and structural deterioration. In particular, the exchange of materials and energy between soil and organisms can cause greater harm due to the frequent occurrence of problems, such as unregulated land use and infiltration of

chemical substances in recent years. Rainfall, evaporation and plant transpiration, and irrigation and drainage from agricultural production can lead to changes in soil moisture and alter soil properties, thus indirectly affecting the effectiveness of selenium in soil and its environmental risks [43]. Therefore, focusing on the balance between changes in soil moisture and conservation of soil physicochemicals in soil ecosystems is a key issue. Studies have shown that soil moisture affects the biological effectiveness of metals mainly by influencing soil Eh, pH, dissolved organic carbon (DOC), and microbial activity [44–46]. Scientific assessment of soil moisture and the phenomenon of freeze-thaw alternation and precipitation distribution at high latitudes can inform the rationality of BSC tools. Systematic BSC planning can achieve a balance between food security, soil and water conservation, and ecosystem sustainability.

Organic Matter and Carbon Storage

Agricultural soils are most strongly perturbed by human actions, e.g., nitrogenous compounds in soil organic matter can be strongly changed by fertilization [47], and irrational management and land-use practices can cause changes in the soil environment and alter soil physicochemical properties. From 1995 to 2015, many scholars gradually shifted their attention to the relationship between organic matter, long-term fertilization practices, and the causal relationship between soil degradation to find a solution to the puzzle of soil quality decline. For example, they found that fertilizer application alone had little effect on soil organic matter content at all grain levels in the Heilongjiang region of China, while some studies showed that straw return and manure addition improved the physical characteristics of the soil to some extent and created a good environment for root growth [48]. In addition, fertilizer application can change the chemical composition of the soil in addition to the organic matter content [49]. Moreover, changes in mycorrhizal species will lead to a transformation of the current agricultural system [50,51]. Under different fertilization conditions, the structural characteristics and composition of soil microbial communities in black soils change over time. In other words, soil bacterial community structure is closely related to soil physicochemical properties, and soil pH is the main factor affecting bacterial communities in black soil areas [52,53]. Productive agricultural areas, mainly used for cultivation, are receiving increasing attention. In pursuit of the unity of economic production, ecological conservation, and sustainable development, BSC is being focused on by more disciplines [54].

Sustainable Agriculture

In order to prevent the degradation of black soil fertility caused by over-cultivation and irrational farming practices and to reduce the disruption of soil ecological balance caused by excessive and illogical application of chemical fertilizers and pesticides, tillage, fertilization, and soil enrichment measures of different degrees of protection have been adopted in various countries around the world. Large-scale sprinkler irrigation systems have been built in Canada and the United States to reduce the limiting factors caused by soil moisture, and the system has been used to spray liquid agrochemicals to improve water and fertilizer utilization [55]. Henderson believes that the most effective and economical way to control agricultural nonpoint source pollution is to adopt appropriate farm management practices, such as less tillage, no tillage, crop intercropping, and organic and inorganic fertilizer application in combination [56]. For soils of different fertility, there should be distinct tillage cultivation measures. In the 1980s and 1990s, China initially developed a concern for arable land conservation. The Acts of Agricultural Law and Land Management Law were formulated and implemented, and in 2008, the Medium and Long-Term Planning Outline of National Food Security was introduced. The issues of black soil resource measurement and evaluation as well as soil and water conservation in the Northeast—an important national grain production base—gradually grew in importance. In addition, agricultural waste, if not properly utilized, poses both a waste of resources and a serious threat to the environment [57–59]. Returning agricultural waste to land not only reduces resource waste,

reduces fertilizer application, improves soil structure, increases soil fertility, and reduces environmental pollution but also modifies greenhouse gas emissions by affecting soil carbon sequestration potential, thereby mitigating its contribution to global climate [60]. In recent years, scholars have preferred to study the socioeconomic impacts of this evolution of black soil degradation in terms of agricultural productivity. We can find different descriptions of the scope of research in the nomenclature of the cluster set analysis, such as agriculture, agricultural soils, growth, wheat, maize, olive, etc., showing a trend of research across crop species, disciplines, and regions.

Biological Diversity

As the impact of human actions on the ecological equilibrium of black soil has gradually intensified, the native plants attached onto the surface have been damaged and replaced by a large uptake of nutrients by agricultural crops. The infiltration and accumulation of various pollutants have seriously affected the living conditions of soil organisms, causing damage to both the structure and function of the ecosystem. The structure of the soil biological community is closely related to the ecosystem of soil and is a key link to the normal operation of the system, so the diversity of soil organisms is gradually becoming a trending research topic in the field of ecology and soil science. The crop cultivation method, selection of agricultural reagents, fertilization method, and land use type for the farming system influence the community structure, diversity, and spatial distribution of soil organisms, and the soil organisms are indicative of the superiority or inferiority of the environmental impact of black soil. In recent years, the assessment of ecosystem services in rural production activities in black soil areas has also been a strong research trend [61–63]. Its applications are focused on quantification of the value of ecosystem black soil services that guide agricultural production [64], management of soil quality levels [65], ecological transformation of agricultural waste [66], and conservation of organic matter within the soil [67,68]. The assessment of the value of agricultural production services of black soil is oriented toward scientific management and sustainable development, providing a more scientific basis to support and guide land use and conservation decisions.

3.3.2. Analysis of Frontier Trending Topics

The time zone view in CiteSpace software mainly presents the interplay of research content within a certain time interval, concentrates the time when keywords first appear, and presents the evolutionary trend of research hotspots in terms of time series. The clustering density map in VOSviewer software only provides insight into the trend of topic concentration and identifies important areas. However, this view cannot show the span of time. In this study, using the time zone diagram function of CiteSpace software, the keywords in the BSC domain are arranged in a time series, which can more clearly show the distribution of trending topics in each period stage and the evolutionary history. Therefore, we combined the CiteSpace software time zone view with this module of burst word detection to show the evolution of popular research topics over four decades. We constructed a keyword time zone map from 1982 to 2022 with slice length = 1 (Figure 7). In addition, the top 20 burst words are shown (Figure 8).

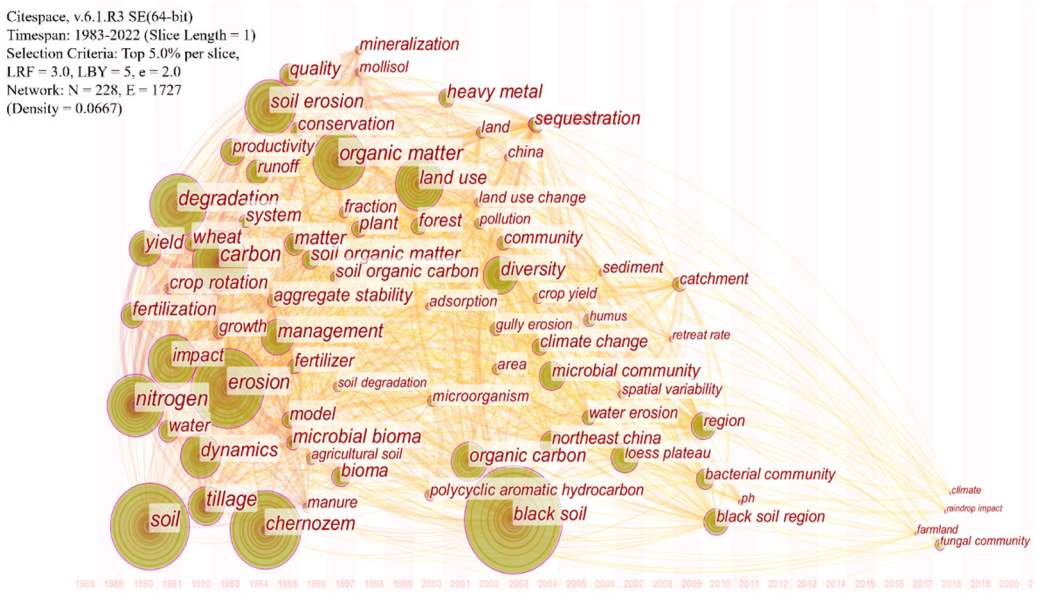

Figure 7. Time zone map of the evolutionary path of the BSC study. The label next to a node indicates the keyword represented by that node. The size of the node is proportional to the frequency of the keyword. The purple halo at the periphery of the node indicates that the node has high mediated centrality (mediated centrality > 0.1). The red part in the node means that the node has a high emergent value. The left-to-right ordering of the nodes indicates the year of publication of the literature from far to near. The connecting lines between nodes represent the strength of association between keywords.

Top 20 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	1983 - 2022
southwestern saskatchewan	1983	5.3527	**1995**	2001	
black chernozem	1983	4.9453	**1995**	2007	
tillage	1983	14.5109	**1995**	2008	
fertilization	1983	8.0521	**1995**	2006	
rotation	1983	4.0042	**1995**	2013	
yield	1983	7.1983	**1995**	2011	
nitrogen	1983	18.1526	**1995**	2008	
soil organic matter	1983	4.8586	**1995**	2006	
matter	1983	5.402	**1997**	2010	
crop rotation	1983	8.1673	**1997**	2007	
carbon	1983	10.7015	**1997**	2010	
microbial bioma	1983	7.5271	**1997**	2007	
soil	1983	8.7738	**1998**	2009	
wheat	1983	9.5851	**2004**	2012	
sequestration	1983	5.3925	**2005**	2014	
organic matter	1983	6.6481	**2005**	2012	
maize	1983	3.8097	**2006**	2015	
grassland	1983	5.9654	**2006**	2014	
residue management	1983	3.8441	**2007**	2009	
bioma	1983	3.8549	**2008**	2010	

Figure 8. The top 20 high-frequency keywords in the BSC research area and their occurrence times. Among them, "year" represents the starting time set in this study; "intensity" represents the intensity of the keyword outbreak; "start" and "end" represent the starting and ending years of the keyword emergence respectively; the red part of the line represents the emergence time.

The trend of development in the field of BSC research can be seen visually in the picture in Figure 7. The beginning of the data is in the 1980s, when the first node in the

figure begins to appear, which is the beginning of BSC research, and the main studies that appear are from Russia, with keywords such as soil, nutrients, fertility, water, tillage, and degradation. It can be seen that this stage is the initial understanding of black soil, with academics beginning to explore the composition, distribution, and advantages of this soil, and beginning to pay attention to the phenomenon of degradation. By the end of the 20th century, the keywords changed to organic carbon, uptake, land use, heavy metals, diversity, climate change, etc., with a movement toward words regarding management of the soil and protection of the ecology. Over time, research on BSC has gradually shifted to micro-flora status, and has become more interdisciplinary, linking to social issues such as agricultural economy.

Further, we can see from the prominence of keywords in Figure 8 that topics related to soil science, ecology, and topics in agricultural production have been popular in research on BSC during the period 1983–2022. This represents the persistent frequency of the approved topic on BSC over the past 39 years and the important key topic emergence nodes. In particular, research on the chemical composition of black soils, quality assessment, and agricultural productivity levels has been a trending topic for many years. For better focus, we intercepted only the top 20 keywords with the highest frequency, which all appear continuously and closely, thus showing the popularity of research on BSC.

In terms of the distribution of time periods and the evolution of the content, the focus of research has been in a transitional form of "natural science exploration—large-scale conservation—economic benefits—ecological benefits", and the content is mainly focused on chemical composition, microbial properties, and conservation agriculture. Before the year 2000, the issue of organic matter composition changes under the influence of agricultural production behavior and land degradation was a trend research topic for 4 years, and after 2000, issues related to agricultural land use and management mechanisms became the main area of research, especially the study of rural crop yields and the adverse effects of soil erosion. On the one hand, it shows the inseparable relationship between soil and agriculture, and on the other hand, it is enough to reflect the increasing concern for ecological issues worldwide year by year.

Synthetically, restorative research on soil distribution has lasted the longest, 18 years to be exact. The monitoring of dynamic changes in the distribution of black soils allows for effectively tracking a range of problems, such as soil erosion, reduction of organic matter content, soil pollution, soil hardening, soil salinization, reduction of biodiversity, soil closure, landslides, and desertification. Due to the application of new tools and instruments, research on BSC is increasingly focused on such data and techniques.

4. Discussion

Research in the field of BSC is based on soil science, ecological methods, and economic development strategies, with the goal of analyzing the degradation and restoration of black soils, and the pull or inhibition of agricultural behavior by changes in their physicochemical properties. The issues of ecological and economic balance behind BSC research and the science of agricultural production and management behavior have been of great concern. The involvement of government control, the role of farmers' ecological behavior, the need to perceive the status and characteristics of BSC from a physical geography perspective, and to provide a more integrated perspective for rational planning of the sustainability of black soil are becoming increasingly important. Research tools, methods, and techniques used to interpret the physicochemical characteristics, distribution patterns, microbial structure, and regional evolutionary mechanisms of black soil are constantly updated and integrated in order to provide scientific and all-encompassing analyses of BSC from different perspectives and disciplines. BSC has comprehensive, diverse, and close links with the natural environment, economic policies, and ecological conservation awareness within the region. All in all, BSC should be discussed among the various factors that drive such changes in black soil and lead to diverse forms of research, characterized by a wide coverage and a

complex system of topics. Therefore, multi-disciplinary and multi-perspective co-operation analysis should continue for the future.

4.1. Research Process

There are four main analysis paths, all of which are performed using VOSviewer and CiteSpace.

Visual network mapping analysis: using this method of literature analysis allows us to scientifically determine the general status of BSC research, we designed this part of the study to include the number of publications, the countries where relevant research work is carried out, and the situation of the network of cooperation between organizations and scholars. The time span for making the analysis was designed to be from 1983 to 2022.

Cluster analysis of BSC researched hotspots: Through the analysis of research hotspots, we can find the topics and content that most scholars believe exists in the field of BSC research, which helps to understand the research focus of the field, find existing problems, and get reference information for future research. From a bibliometric point of view, research hotspots are generally reflected by the frequency and citation frequency of keywords in the research field, and the higher the frequency of keywords in a certain time period, the more popular are the keywords. With the help of centrality and centrality methods, we study and analyze the research hotspots in the BSC research field, extract the keywords in the literature for clustering and then sort and systematize the knowledge links among many literatures to get the evolution pattern of the topics.

Time zone diagram analysis: The clustering view is to locate and identify keyword groups where a high degree of centrality exists, but the change of topics within a research field is temporal in nature, and the time zone diagram can just make up for the lack of a timeline in the clustering view. By analyzing keywords in the form of nodes over a period of time with time as the axis, the internal connections between them can be clearly observed, which in turn provides a better interpretation of the evolution of research hotspots and topics in BSC, which is conducive to grasping the focus of attention during the development of the field. This study uses the time zone mapping function of CiteSpace to better present the temporal distribution and interrelationships of BSC research.

Keyword term mutation detection: In CiteSpace software, using the built-in mutation detection algorithm, we can get a ranking graph of the emergent value under the research frontier terms on the BSC research field, whose main theory is the arithmetic analysis of the keywords in this research field. A mutation term is a keyword whose frequency of occurrence appears to increase or decrease suddenly in a relatively short period of time, and its emergence timeline changes significantly. By analyzing the burstiness of mutation words, it is possible to find the change trend of subject words in the field, and it can also effectively reveal the frontier of academic research in the field [69]. It emphasizes sudden changes, bursts, or sharp increases in keywords within a period of time, rather than focusing more on whether the frequency of citations in the articles themselves is high.

4.2. Research Hotspots

In summary, BSC studies have focused on the conservation of soil organic matter, elemental carbon, and nitrogen [70–72], as well as erosion and erosion phenomena [73–76]. Research on BSC emerged early and has a high volume of publications. The purpose of BSC is to scientifically plan and assess land use and human economic activities in rural areas to maintain soil nutrients in black soil at appropriate spatial scales and time periods and to seek to stabilize and balance ecosystems and economic and social development to maintain ecological and socioeconomic sustainability [77]. BSC is an effective way to apply the results of many farmland conservation techniques [78–83]. Land use is the policy vehicle for the concrete implementation of BSC, which directly acts on the quality level of soil and is an important influencing factor [84–90]. BSC-related species diversity, among others, has also been the focus of scholarly attention [91,92]. Black soil as an extremely valuable and

fertile soil with diverse species structure in the form of agricultural production is the key to stimulate and conserve biodiversity [93–96].

Moreover, these keywords do not always stand alone, but often present a related state of research, e.g., the impact of land resource degradation on traditional agricultural production and different forms of management behaviors for black soil as well as biodiversity conservation [97–104]. A negative correlation was found between increased intensity of land use or agricultural production exploitation and black soil sustainability, biodiversity, organic matter quantity, and soil and water conservation [105,106]. Dynamic changes in crop output levels lead to changes in the quality of black soil [107,108]. In BSC-related studies, productivity indicators are usually combined with the evaluation analysis of soil quality and are widely used [109–116].

4.3. Research Deficiencies and Future Improvements

There are still some limitations for this study due to the complexity of the related disciplines. First, this study conducted text data collection based on the WOS core collection database, ignoring the time gap required for inclusion, which has a certain lag. Future studies can try to adopt particular cutting-edge technologies to collect and analyze data in real time for the subject area of interest, making the research results more immediate. Second, in applying CiteSpace for bibliometric analysis, other excellent database resources, such as CNKI database and CSSCI database, were not used due to the limitation in the functional support of this software. High-quality Chinese citation databases can be covered in the bibliometric analysis in future studies, and the publication characteristics of Chinese and foreign databases can be compared and analyzed. Third, the textual data types included in the BSC research field are characterized by diversity, including books, patents, regulations, and other forms in terms of literature types. This study lacks diverse attempts to fuse and analyze these data, and in future research, we can try to combine books, patents, and other forms of literature to enrich the research results in the field of BSC. Fourth, although the paths of BSC research frontiers are based on citation clustering results, they are still somewhat subjective and need additionally sorting and analysis. Considering issues, such as depth and comprehensiveness, more scientific and mature bibliometric analysis methods and paths can be further introduced in the future based on the big data literature system and based around larger disciplinary content.

5. Conclusions

This study combines the strengths of VOSviewer 1.6.18 and CiteSpace 5.7.R1 and uses a comprehensive bibliometric approach to visualize and analyze the publications published in the WOS database between 1983 and 2022 with BSC as the research topic; conducts a series of mapping of knowledge networks, etc.; and discusses the research progress, trending topics, and evolution in the field of BSC. The research progress, trending topics, and evolution of the BSC field are discussed. First, from the total amount of retrieved literature and the annual distribution, the research field continues to produce new research results, and the number of articles shows an overall slow upward trend in all years, with rapid development in the later years. The extensive development process can be specifically divided into three stages: the period of budding research, the period of steady development, and the period of rapid growth. Second, in terms of cooperation, the cooperation among authors is better, and an incipient group of authors has been formed, but it is still fragmented and weakly clustered on the whole. In contrast, the cooperation among research institutions is closer and the cooperation map is more concentrated, forming several small clusters, which indicates that the cooperation among research institutions is numerous but scattered and has not yet formed a large cooperative group. The density of cooperation networks between countries is low, with Russia and China, which have large black soil areas, as the main nodes, and transnational cooperation is still lacking. Third, the topic nodes with keywords, such as black soil, soil, and degradation, show outward radiation, forming the top five most popular frontier issues in the BSC field. In addition, due to the complexity

of BSC research topics, research in this field involves multiple disciplines, and research methods are not quite the same, showing the development characteristics of convergence, frontier and dynamism. In addition, with the emergence of emerging issues, such as food security maintenance, sustainable agricultural development, conservation tillage practices, and soil ecological performance, BSC-related research is also facing new opportunities and challenges. The present study is designed to provide relevant researchers in the field of BSC with an overview of research within the field over a 40-year period. Admittedly, this is only a portion of the existing BSC-related research and is not comprehensive. The research perspective of this study focuses on conservation and management. As one of many soil types, black soil is an important part of the ecosystem, and a series of activities, such as material exchange in space are inextricably linked to it, and it is a vehicle for human activities. This paper aims to protect the precious black soil in order to better maintain the balance between economy and nature. In achieving this goal, it is worthwhile for researchers to re-examine the relationship between humans and ecology and between economy and ecology in order to better contribute to the conservation of black soil.

The field of BSC research is characterized by rapid changes in hotspots and strong interdisciplinarity, which should be maintained with long-term attention, and the following aspects can be enhanced in future research. First, more timely black soil data tracking and updating actions should be taken. Early explorations of the distribution and area of black soil areas spanned a long period of time, and the original data were scattered, lacking uniform indicators for delineating regional boundaries. In China, for example, the long-time interval of the current national soil census data makes it difficult to dynamically track the soil changes in black soil areas, which is not conducive to conservation and development work. At the same time, advanced technologies, such as hyperspectral remote sensing should be used to construct a scientific, systematic, and continuous ecological information base of black soil, contributing basic information and reference values for the implementation of related work. Second, we should pay attention to and increase the research on the effects of chemical inputs in agricultural production on the physicochemical properties of black soil. Inorganic chemicals provide short-term incremental gains for farmers, but the long-term inputs are pollution of the soil and damage to the ecological environment. With the rise of smart agriculture, an increasing number of high-end intelligent agricultural machinery can realize the key technology of conservation tillage and help to form a more systematic BSC mechanism. Third, further research could focus on the impact of climate issues on black soil ecosystems, which is an ongoing global topic for the future. The elevated frequency of extreme weather and climate events in recent years can greatly increase the frequency of disasters, such as droughts and low-temperature cold damage. Such frequent freeze-thaw processes will affect the moisture and nutrients of black soils, as well as the diversity of soil organisms. Therefore, improving the scientific system of agro-meteorological disaster monitoring and assessment is an important step to prevent and control problems, such as droughts and floods and soil erosion.

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References

1. Liang, A.; Li, L.; Zhu, H. Protection and Utilization of Black Land and Making Concerted and Unremitting Efforts for Safeguarding Food Security Promoted by Sci-tech Innovation—Countermeasures in Conservation and Rational Utilization of Black Land. *Bull. Chin. Acad. Sci. (Chin. Version)* **2021**, *36*, 557–564. [CrossRef]
2. Gilbert, N.A.; Ferguson, P.F. Landscape patterns associated with occupancy of disturbance-dependent birds in the Blackland Prairie Ecoregion of Alabama and Mississippi. *Southeast. Nat.* **2019**, *18*, 381–404. [CrossRef]
3. Wang, H.; Zhang, C.; Yao, X.; Yun, W.; Ma, J.; Gao, L.; Li, P. Scenario simulation of the tradeoff between ecological land and farmland in black soil region of Northeast China. *Land Use Policy* **2022**, *114*, 105991. [CrossRef]
4. Dai, T.; Wang, L.; Li, T.; Qiu, P.; Wang, J. Study on the Characteristics of Soil Erosion in the Black Soil Area of Northeast China under Natural Rainfall Conditions: The Case of Sunjiagou Small Watershed. *Sustainability* **2022**, *14*, 8284. [CrossRef]
5. Huang, D.; Su, L.; Zhou, L.; Fan, H. Gully is the dominant sediment source of snowmelt erosion in the black soil region—A case study. *Soil Tillage Res.* **2022**, *215*, 105232. [CrossRef]
6. Pereira, B.; Rosário, P.; Núñez, J.C.; Rosendo, D.; Roces, C.; Magalhães, P. Food Availability, Motivational-Related Factors, and Food Consumption: A Path Model Study with Children. *Int. J. Environ. Res. Public Health* **2021**, *18*, 12897. [CrossRef] [PubMed]
7. Johnson, B.N.; Quashie, M.L.A.; Adjonou, K.; Segla, K.N.; Kokutse, A.D.; Kokou, K. Morphological Variability of Pterocarpus erinaceus Poir. in Togo. *Int. J. For. Res.* **2020**, *2020*, 1–16. [CrossRef]
8. Titova, J.; Baltrėnaitė, E. Physical and chemical properties of biochar produced from sewage sludge compost and plants biomass, fertilized with that compost, important for soil improvement. *Waste Biomass Valoriz.* **2021**, *12*, 3781–3800. [CrossRef]
9. Zhu, T.; Shao, T.; Liu, J.; Li, N.; Long, X.; Gao, X.; Rengel, Z. Improvement of physico-chemical properties and microbiome in different salinity soils by incorporating Jerusalem artichoke residues. *Appl. Soil Ecol.* **2021**, *158*, 103791. [CrossRef]
10. Voltr, V.; Menšík, L.; Hlisnikovský, L.; Hruška, M.; Pokorný, E.; Pospíšilová, L. The soil organic matter in connection with soil properties and soil inputs. *Agronomy* **2021**, *11*, 779. [CrossRef]
11. Liu, D.; Wang, Z.; Zhang, B.; Song, K.; Li, X.; Li, J.; Fang, L.; Duan, H. Spatial distribution of soil organic carbon and analysis of related factors in croplands of the black soil region, Northeast China. *Agric. Ecosyst. Environ.* **2006**, *113*, 73–81. [CrossRef]
12. Gu, Z.; Xie, Y.; Gao, Y.; Ren, X.; Cheng, C.; Wang, S. Quantitative assessment of soil productivity and predicted impacts of water erosion in the black soil region of northeastern China. *Sci. Total Environ.* **2018**, *637*, 706–716. [CrossRef]
13. Fang, H. Impacts of rainfall and soil conservation measures on soil, SOC, and TN losses on slopes in the black soil region, northeastern China. *Ecol. Indic.* **2021**, *129*, 108016. [CrossRef]
14. Tang, Z.; Song, W.; Zou, J. The Early Effect of Black Land Protection Plan in Northeast China on Industrial Pollution Using Synthetic Control Method. *Land* **2022**, *11*, 585. [CrossRef]
15. Huang, Y.; Tao, B.; Xiao, Z.; Yang, Y.; Liang, L.; Wang, L.; Pierre, J.; Han, T.; Ren, W. Conservation tillage increases corn and soybean water productivity across the Ohio River Basin. *Agric. Water Manag.* **2021**, *254*, 106962. [CrossRef]
16. Gao, Q.; Ma, L.; Fang, Y.; Zhang, A.; Li, G.; Wang, J.; Wu, D.; Wu, W.; Du, Z. Conservation tillage for 17 years alters the molecular composition of organic matter in soil profile. *Sci. Total Environ.* **2021**, *762*, 143116. [CrossRef]
17. Han, X.Z.; Zhou, W.X. Research perspectives and footprint of utilization and protection of black soil in northeast China. *Acta Pedofil. Sin* **2021**, *58*, 1341–1358. [CrossRef]
18. Xu, X.Z.; Xu, Y.; Chen, S.C.; Xu, S.G.; Zhang, H.W. Soil loss and conservation in the black soil region of Northeast China: A retrospective study. *Environ. Sci. Policy* **2010**, *13*, 793–800. [CrossRef]
19. Wang, Q.; Cao, X.; Wang, C.; Li, H.; He, J.; Lu, C. Research Progress of No/Minimum Tillage Corn Seeding Technology and Machine in Northeast Black Land of China. *Nongye Jixie Xuebao/Trans. Chin. Soc. Agric. Mach.* **2021**, *52*, 1–15.
20. Xu, S. Temporal and spatial characteristics of the change of cultivated land resources in the black soil region of Heilongjiang Province (China). *Sustainability* **2018**, *11*, 38. [CrossRef]
21. WANG, J.; Xu, X.; PEI, J.; Li, S.Y. Current situations of black soil quality and facing opportunities and challenges in northeast China. *Chin. J. Soil Sci.* **2021**, *52*, 695–701. [CrossRef]
22. Qu, J.; Liu, Y.; Xu, X.; Liu, Z.; Meng, X. Evaluation of the effects of different fertilization modes on black soil fertility in China based on principal component and cluster analysis. *Agrochimica* **2020**, *64*, 149–166. [CrossRef]
23. GM, D.U.; Zhang, R.; Yu, F.R. Analysis of cropping pattern in black soil region of Northeast China based on geo-information Tupu. *J. Appl. Ecol.* **2022**, *33*, 694–702. [CrossRef]
24. Shiffrin, R.M.; Börner, K. Mapping knowledge domains. *Proc. Natl. Acad. Sci. USA* **2004**, *101*, 5183–5185. [CrossRef]
25. Ali, M.; Prakash, K.; Hossain, M.A.; Pota, H.R. Intelligent energy management: Evolving developments, current challenges, and research directions for sustainable future. *J. Clean. Prod.* **2021**, *314*, 127904. [CrossRef]
26. Chen, C. Science mapping: A systematic review of the literature. *J. Data Inf. Sci.* **2017**, *2*, 1–40. [CrossRef]

27. Zhang, J.; Liu, J.; Chen, Y.; Feng, X.; Sun, Z. Knowledge Mapping of Machine Learning Approaches Applied in Agricultural Management—A Scientometric Review with CiteSpace. *Sustainability* **2021**, *13*, 7662. [CrossRef]
28. Brody, T.; Harnad, S.; Carr, L. Earlier web usage statistics as predictors of later citation impact. *J. Am. Soc. Inf. Sci. Technol.* **2006**, *57*, 1060–1072. [CrossRef]
29. Schwartz, S.I.; Hansen, D.E.; Foin, T.C. Landowner Benefits from Use-Value Assessment under the California Land Conservation Act. *Am. J. Agric. Econ.* **1976**, *58*, 170–178. [CrossRef]
30. Glaser, B.; Lehmann, J.; Zech, W. Ameliorating physical and chemical properties of highly weathered soils in the tropics with charcoal—A review. *Biol. Fertil. Soils* **2002**, *35*, 219–230. [CrossRef]
31. Zhang, X.Y.; Yue-Yu, S.U.I.; Zhang, X.D.; Kai, M.E.N.G.; Herbert, S.J. Spatial variability of nutrient properties in black soil of northeast China. *Pedosphere* **2007**, *17*, 19–29. [CrossRef]
32. Wei, J.B.; Xiao, D.N.; Zeng, H.; Fu, Y.K. Spatial variability of soil properties in relation to land use and topography in a typical small watershed of the black soil region, northeastern China. *Environ. Geol.* **2008**, *53*, 1663–1672. [CrossRef]
33. Ren, G.; Shang, Z.; Long, R.; Hou, Y.; Deng, B. The relationship of vegetation and soil differentiation during the formation of black-soil-type degraded meadows in the headwater of the Qinghai-Tibetan Plateau, China. *Environ. Earth Sci.* **2013**, *69*, 235–245. [CrossRef]
34. Cheng, P.; Tang, H.; Dong, Y.; Liu, K.; Jiang, P.; Liu, Y. Knowledge Mapping of Research on Land Use Change and Food Security: A Visual Analysis Using CiteSpace and VOSviewer. *Int. J. Environ. Res. Public Health* **2021**, *18*, 13065. [CrossRef]
35. Tian, D.; Shi, Z. A two-stage hybrid probabilistic topic model for refining image annotation. *Int. J. Mach. Learn. Cybern.* **2020**, *11*, 417–431. [CrossRef]
36. Chen, X.; Chen, J.; Wu, D.; Xie, Y.; Li, J. Mapping the research trends by co-word analysis based on keywords from funded project. *Procedia Comput. Sci.* **2016**, *91*, 547–555. [CrossRef]
37. Boulaine, J. Histoire de la fertilisation phosphatée. *Étude Gest. Sols* **2006**, *13*, 129–137.
38. Sun, C.; Liu, J.; Wang, Y.; Sun, L.; Yu, H. Multivariate and geostatistical analyses of the spatial distribution and sources of heavy metals in agricultural soil in Dehui, Northeast China. *Chemosphere* **2013**, *92*, 517–523. [CrossRef]
39. Zentner, R.P.; Stephenson, J.; Campbell, C.; Bowren, K.; Moulin, A.; Townley-Smith, L. Effects of rotation and fertilization on economics of crop production in the Black soil zone of north-central Saskatchewan. *Can. J. Plant Sci.* **1990**, *70*, 837–851. [CrossRef]
40. Zentner, R.P.; Stephenson, J.E.; Johnson, P.J.; Campbell, C.A.; Lafond, G.P. The economics of wheat rotations on a heavy clay chernozemic soil in the black soil zone of East-Central Saskatchewan. *Can. J. Plant Sci.* **1988**, *68*, 389–404. [CrossRef]
41. Zhang, Z.; Brown, R.; Bauer, J.; Bedard-Haughn, A. Nutrient dynamics within drainage ditches under recent, medium, and long-term drainage in the Black soil zone of southeastern Saskatchewan. *Geoderma* **2017**, *289*, 66–71. [CrossRef]
42. Xiang, C.; Wang, Y.; Liu, H. A scientometrics review on nonpoint source pollution research. *Ecol. Eng.* **2017**, *99*, 400–408. [CrossRef]
43. Van Den Berg, G.A.; Loch, J.P.G. Decalcification of soils subject to periodic waterlogging. *Eur. J. Soil Sci.* **2000**, *51*, 27–33. [CrossRef]
44. Honma, T.; Ohba, H.; Kaneko-Kadokura, A.; Makino, T.; Nakamura, K.; Katou, H. Optimal Soil Eh, pH, and Water Management for Simultaneously Minimizing Arsenic and Cadmium Concentrations in Rice Grains. *Environ. Sci. Technol.* **2016**, *50*, 4178–4185. [CrossRef]
45. Das, S.; Chou, M.-L.; Jean, J.-S.; Liu, C.-C.; Yang, H.-J. Water management impacts on arsenic behavior and rhizosphere bacterial communities and activities in a rice agro-ecosystem. *Sci. Total Environ.* **2016**, *542*, 642–652. [CrossRef]
46. Lv, H.; Chen, W.; Zhu, Y.; Yang, J.; Mazhar, S.H.; Zhao, P.; Wang, L.; Li, Y.; Azam, S.M.; Fekih, I.B.; et al. Efficiency and risks of selenite combined with different water conditions in reducing uptake of arsenic and cadmium in paddy rice. *Environ. Pollut.* **2020**, *262*, 114283. [CrossRef]
47. Bol, R.; Poirier, N.; Balesdent, J.; Gleixner, G. Molecular turnover time of soil organic matter in particle-size fractions of an arable soil. *Rapid Commun. Mass Spectrom.* **2009**, *23*, 2551–2558. [CrossRef]
48. Wu, T.; Schoenau, J.J.; Li, F.; Qian, P.; Malhi, S.S.; Shi, Y. Influence of fertilization and organic amendments on organic-carbon fractions in Heilu soil on the loess plateau of China. *J. Plant Nutr. Soil Sci.* **2005**, *168*, 100–107. [CrossRef]
49. Ng, E.-L.; Patti, A.F.; Rose, M.T.; Schefe, C.R.; Wilkinson, K.; Smernik, R.J.; Cavagnaro, T.R. Does the chemical nature of soil carbon drive the structure and functioning of soil microbial communities? *Soil Biol. Biochem.* **2014**, *70*, 54–61. [CrossRef]
50. Zhao, B.; O'Connor, D.; Zhang, J.; Peng, T.; Shen, Z.; Tsang, D.C.W.; Hou, D. Effect of pyrolysis temperature, heating rate, and residence time on rapeseed stem derived biochar. *J. Clean. Prod.* **2018**, *174*, 977–987. [CrossRef]
51. Kundu, D.; Oberholzer, P.; Glaros, C.; Bouzid, A.; Tervoort, E.; Pasquarello, A.; Niederberger, M. Organic Cathode for Aqueous Zn-Ion Batteries: Taming a Unique Phase Evolution toward Stable Electrochemical Cycling. *Chem. Mater.* **2018**, *30*, 3874–3881. [CrossRef]
52. Xue, L.; Ren, H.; Li, S.; Leng, X.; Yao, X. Soil Bacterial Community Structure and Co-occurrence Pattern during Vegetation Restoration in Karst Rocky Desertification Area. *Front. Microbiol.* **2017**, *8*, 2377. [CrossRef]
53. Ezeokoli, O.T.; Mashigo, S.K.; Paterson, D.G.; Bezuidenhout, C.C.; Adeleke, R.A. Microbial community structure and relationship with physicochemical properties of soil stockpiles in selected South African opencast coal mines. *Soil Sci. Plant Nutr.* **2019**, *65*, 332–341. [CrossRef]
54. LI, W.; LIU, Q.; CHEN, P. Effect of long-term continuous cropping of strawberry on soil bacterial community structure and diversity. *J. Integr. Agric.* **2018**, *17*, 2570–2582. [CrossRef]

55. Klocke, N.L.; Stone, L.R.; Clark, G.A.; Dumler, T.J.; Briggeman, S. Water allocation model for limited irrigation. *Appl. Eng. Agric.* **2006**, *22*, 381–389. [CrossRef]
56. Henderson, F.M.; Hart, T.F.; Orlando, L.; Heaton, B.; Portolese, J.; Chasan, R. Application of C-CAP protocol land-cover data to nonpoint source water pollution potential spatial models in a coastal environment. *Photogramm. Eng. Remote Sens.* **1998**, *64*, 1015–1020.
57. Lin, A.Y.C.; Huang, S.T.Y.; Wahlqvist, M.L. Waste management to improve food safety and security for health advancement. *Asia Pac. J. Clin. Nutr.* **2009**, *18*, 538–545. [CrossRef]
58. Singh, R.P.; Singh, P.; Araujo, A.S.; Ibrahim, M.H.; Sulaiman, O. Management of urban solid waste: Vermicomposting a sustainable option. *Resour. Conserv. Recycl.* **2011**, *55*, 719–729. [CrossRef]
59. Gomiero, T. Large-scale biofuels production: A possible threat to soil conservation and environmental services. *Appl. Soil Ecol.* **2018**, *123*, 729–736. [CrossRef]
60. Venglovsky, J.; Sasakova, N.; Placha, I. Pathogens and antibiotic residues in animal manures and hygienic and ecological risks related to subsequent land application. *Bioresour. Technol.* **2009**, *100*, 5386–5391. [CrossRef]
61. Soldat, I.E.; Solntsev, P.I.; Shapovalov, H.K. Technology of cultivation of sugar beet in the adaptive landscape system of agriculture of the south-western part of the Central Black-Earth Region. *Sakharnaya Svekla* **2018**, *2018*, 21–23.
62. Shutko, A.P.; Zaschepkin, E.E.; Perederieva, V.M. Cellulolytic activity of leached black earth for no-till in connection with the question of winter wheat diseases. *Agrar. Nauchnyy Zhurnal* **2018**, *2018*, 37–41. [CrossRef]
63. Kurkina, Y.N.; Ngo, T.D.K. Morpho-biological features of collection varieties of broad bean in the conditions of the South of the Central Black Earth Region. *Vestn. OrelGAU* **2017**, *2017*, 35–44. [CrossRef]
64. Dominati, E.; Mackay, A.; Green, S.; Patterson, M. A soil change-based methodology for the quantification and valuation of ecosystem services from agro-ecosystems: A case study of pastoral agriculture in New Zealand. *Ecol. Econ.* **2014**, *100*, 119–129. [CrossRef]
65. Hua-Jun, F.A.N.G.; Xue-Ming, Y.A.N.G.; Zhang, X.P.; Liang, A.Z. Using 137 Cs tracer technique to evaluate erosion and deposition of black soil in Northeast China. *Pedosphere* **2006**, *16*, 201–209. [CrossRef]
66. Chekmarev, P.A.; Kupreev, E.M.; Ermakov, A.A. To the problem of soil acidity of the non-black soil zone of the russian federation. *Achiev. Sci. Technol. Agro-Ind. Complex* **2017**, *2017*, 14–19.
67. Lettens, S.; Van Orshoven, J.; Van Wesemael, B.; De Vos, B.; Muys, B. Stocks and fluxes of soil organic carbon for landscape units in Belgium derived from heterogeneous data sets for 1990 and 2000. *Geoderma* **2005**, *127*, 11–23. [CrossRef]
68. Cheng, S.; Fang, H.; Zhu, T.; Zheng, J.; Yang, X.; Zhang, X.; Yu, G. Effects of soil erosion and deposition on soil organic carbon dynamics at a sloping field in Black Soil region, Northeast China. *Soil Sci. Plant Nutr.* **2010**, *56*, 521–529. [CrossRef]
69. Wang, L.; Su, W.; An, J. Focus, Evolution Path and Frontier for Digital Currency Research in China:Based on CiteSpace Analysis. *J. Beijing Univ. Posts Telecommun. Soc. Sci. Ed.* **2021**, *23*, 52–63. [CrossRef]
70. Frąc, M.; Hannula, S.E.; Bełka, M.; Jędryczka, M. Fungal Biodiversity and Their Role in Soil Health. *Front. Microbiol.* **2018**, *9*, 707. [CrossRef]
71. Bei, S.; Zhang, Y.; Li, T.; Christie, P.; Li, X.; Zhang, J. Response of the soil microbial community to different fertilizer inputs in a wheat-maize rotation on a calcareous soil. *Agric. Ecosyst. Environ.* **2018**, *260*, 58–69. [CrossRef]
72. Wen, L.; Jinlan, W.; Xiaojiao, Z.; Shangli, S.; Wenxia, C. Effect of degradation and rebuilding of artificial grasslands on soil respiration and carbon and nitrogen pools on an alpine meadow of the Qinghai-Tibetan Plateau. *Ecol. Eng.* **2018**, *111*, 134–142. [CrossRef]
73. Liu, X.; Lee Burras, C.; Kravchenko, Y.S.; Duran, A.; Huffman, T.; Morras, H.; Studdert, G.; Zhang, X.; Cruse, R.M.; Yuan, X. Overview of Mollisols in the world: Distribution, land use and management. *Can. J. Soil Sci.* **2012**, *92*, 383–402. [CrossRef]
74. Badía-Villas, D.; González-Pérez, J.A.; Aznar, J.M.; Arjona-Gracia, B.; Martí-Dalmau, C. Changes in water repellency, aggregation and organic matter of a mollic horizon burned in laboratory: Soil depth affected by fire. *Geoderma* **2014**, *213*, 400–407. [CrossRef]
75. Deng, Q.; Qin, F.; Zhang, B.; Wang, H.; Luo, M.; Shu, C.; Liu, H.; Liu, G. Characterizing the morphology of gully cross-sections based on PCA: A case of Yuanmou Dry-Hot Valley. *Geomorphology* **2015**, *228*, 703–713. [CrossRef]
76. Liu, L.-Y.; Li, X.-Y.; Shi, P.-J.; Gao, S.-Y.; Wang, J.-H.; Ta, W.-Q.; Song, Y.; Liu, M.-X.; Wang, Z.; Xiao, B.-L. Wind erodibility of major soils in the farming-pastoral ecotone of China. *J. Arid Environ.* **2007**, *68*, 611–623. [CrossRef]
77. Li, X.-L.; Perry, G.L.W.; Brierley, G.; Sun, H.-Q.; Li, C.-H.; Lu, G.-X. Quantitative assessment of degradation classifications for degraded alpine meadows (Heitutan), Sanjiangyuan, Western China. *Land Degrad. Dev.* **2012**, *25*, 417–427. [CrossRef]
78. Grant, B.; Smith, W.N.; Desjardins, R.; Lemke, R.; Li, C. Estimated N_2O and CO_2 Emissions as Influenced by Agricultural Practices in Canada. *Clim. Change* **2004**, *65*, 315–332. [CrossRef]
79. Shang, Z.H.; Ma, Y.S.; Long, R.J.; Ding, L.M. Effect of fencing, artificial seeding and abandonment on vegetation composition and dynamics of "black soil land" in the headwaters of the Yangtze and the Yellow Rivers of the Qinghai-Tibetan Plateau. *Land Degrad. Dev.* **2008**, *19*, 554–563. [CrossRef]
80. Deubel, A.; Hofmann, B.; Orzessek, D. Long-term effects of tillage on stratification and plant availability of phosphate and potassium in a loess chernozem. *Soil Tillage Res.* **2011**, *117*, 85–92. [CrossRef]
81. Zentner, R.; Lafond, G.; Derksen, D.; Campbell, C. Tillage method and crop diversification: Effect on economic returns and riskiness of cropping systems in a Thin Black Chernozem of the Canadian Prairies. *Soil Tillage Res.* **2002**, *67*, 9–21. [CrossRef]

82. Ou, Y.; Rousseau, A.N.; Wang, L.; Yan, B. Spatio-temporal patterns of soil organic carbon and pH in relation to environmental factors—A case study of the Black Soil Region of Northeastern China. *Agric. Ecosyst. Environ.* **2017**, *245*, 22–31. [CrossRef]
83. Xin, Y.; Xie, Y.; Liu, Y.; Liu, H.; Ren, X. Residue cover effects on soil erosion and the infiltration in black soil under simulated rainfall experiments. *J. Hydrol.* **2016**, *543*, 651–658. [CrossRef]
84. Wani, S.P.; Chander, G.; Sahrawat, K.L.; Pal, D.K.; Pathak, P.; Pardhasaradhi, G.; Kamadi, P.J. Sustainable use of natural resources for crop intensification and better livelihoods in the rainfed semi-arid tropics of Central India. *NJAS—Wageningen J. Life Sci.* **2016**, *78*, 13–19. [CrossRef]
85. Guo, Y.; Luo, L.; Chen, G.; Kou, Y.; Xu, H. Mitigating nitrous oxide emissions from a maize-cropping black soil in northeast China by a combination of reducing chemical N fertilizer application and applying manure in autumn. *Soil Sci. Plant Nutr.* **2013**, *59*, 392–402. [CrossRef]
86. Sui, Y.; Jiao, X.; Chen, W.; Liu, X.; Zhang, X.; Ding, G. Labile organic matter content and distribution as affected by six-year soil amendments to eroded Chinese mollisols. *Chin. Geogr. Sci.* **2013**, *23*, 692–699. [CrossRef]
87. Komissarov, M.A.; Klik, A. The Impact of No-Till, Conservation, and Conventional Tillage Systems on Erosion and Soil Properties in Lower Austria. *Eurasian Soil Sci.* **2020**, *53*, 503–511. [CrossRef]
88. Pan, F.-J.; Xu, Y.-L.; McLaughlin, N.B.; Xue, A.G.; Yu, Q.; Han, X.-Z.; Liu, W.; Zhan, L.L.; Zhao, D.; Li, C.J. Response of soil nematode community structure and diversity to long-term land use in the black soil region in China. *Ecol. Res.* **2012**, *27*, 701–714. [CrossRef]
89. Shujie, M.; Yunfa, Q.; Lianren, Z. Aggregation stability and microbial activity of China's black soils under different long-term fertilisation regimes. *N. Z. J. Agric. Res.* **2009**, *52*, 57–67. [CrossRef]
90. Lafond, G.P.; Brandt, S.A.; Irvine, B.; May, W.E.; Holzapfel, C.B. Reducing the risks of in-crop nitrogen fertilizer applications in spring wheat and canola. *Can. J. Plant Sci.* **2008**, *88*, 907–919. [CrossRef]
91. Sushkova, S.N.; Minkina, T.; Deryabkina, I.; Mandzhieva, S.; Zamulina, I.; Bauer, T.; Galina, V.; Elena, A.; Rajput, V. Influence of PAH contamination on soil ecological status. *J. Soils Sediments* **2017**, *18*, 2368–2378. [CrossRef]
92. Ma, M.; Jiang, X.; Wang, Q.; Ongena, M.; Wei, D.; Ding, J.; Guan, D.; Cao, F.; Zhao, B.; Li, J. Responses of fungal community composition to long-term chemical and organic fertilization strategies in Chinese Mollisols. *MicrobiologyOpen* **2018**, *7*, e00597. [CrossRef] [PubMed]
93. Hong, Y.; Zhao, D.; Zhang, F.; Shen, G.; Yuan, Y.; Gao, Y.; Yan, L.; Wei, D.; Wang, W. Soil water-stable aggregates and microbial community under long-term tillage in black soil of Northern China. *Ecotoxicology* **2021**, *30*, 1754–1768. [CrossRef] [PubMed]
94. Wu, G.; Chen, Z.; Jiang, D.; Jiang, N.; Jiang, H.; Chen, L. Oxidases and hydrolases mediate soil organic matter accumulation in chernozem of northeastern China. *Geoderma* **2021**, *403*, 115206. [CrossRef]
95. Islam, M.N.; Germida, J.J.; Walley, F.L. Survival of a commercial AM fungal inoculant and its impact on indigenous AM fungal communities in field soils. *Appl. Soil Ecol.* **2021**, *166*, 103979. [CrossRef]
96. Ovsepyan, L.; Kurganova, I.; De, V.L.; Kuzyakov, Y. Conversion of cropland to natural vegetation boosts microbial and enzyme activities in soil. *Sci. Total Environ.* **2020**, *743*, 140829. [CrossRef]
97. Liu, Y.; Xu, Z.; Wu, X.; Gui, W.; Zhu, G. Adsorption and desorption behavior of herbicide diuron on various Chinese cultivated soils. *J. Hazard. Mater.* **2010**, *178*, 462–468. [CrossRef]
98. Zhang, Y.; Wang, P.; Wang, L.; Sun, G.; Zhao, J.; Zhang, H.; Du, N. The influence of facility agriculture production on phthalate esters distribution in black soils of northeast China. *Sci. Total Environ.* **2015**, *506–507*, 118–125. [CrossRef]
99. Ulrich, A.; Klimke, G.; Wirth, S. Diversity and Activity of Cellulose-Decomposing Bacteria, Isolated from a Sandy and a Loamy Soil after Long-Term Manure Application. *Microb. Ecol.* **2007**, *55*, 512–522. [CrossRef]
100. Sonnleitner, R.; Lorbeer, E.; Schinner, F. Effects of straw, vegetable oil and whey on physical and microbiological properties of a chernozem. *Appl. Soil Ecol.* **2003**, *22*, 195–204. [CrossRef]
101. Dridiger, V.K.; Ivanov, A.L.; Belobrov, V.P.; Kutovaya, O.V. Rehabilitation of Soil Properties by Using Direct Seeding Technology. *Eurasian Soil Sci.* **2020**, *53*, 1293–1301. [CrossRef]
102. Hitchner, S.; Schelhas, J.; Dwivedi, P. Safe havens: The intersection of family, religion, and community in black cultural landscapes of the southeastern United States. *Landsc. Urban Plan.* **2021**, *214*, 104136. [CrossRef]
103. LI, M.; ZHAO, L.; ZHANG, J. Effect of Temperature, pH and Salt on Fluorescent Quality of Water Extractable Organic Matter in Black Soil. *J. Integr. Agric.* **2013**, *12*, 1251–1257. [CrossRef]
104. Simić, M.; Dragičević, V.; Mladenović Drinić, S.; Vukadinović, J.; Kresović, B.; Tabaković, M.; Brankov, M. The Contribution of Soil Tillage and Nitrogen Rate to the Quality of Maize Grain. *Agronomy* **2020**, *10*, 976. [CrossRef]
105. Otto, A.; Simpson, M.J. Evaluation of CuO oxidation parameters for determining the source and stage of lignin degradation in soil. *Biogeochemistry* **2006**, *80*, 121–142. [CrossRef]
106. Otto, A.; Shunthirasingham, C.; Simpson, M.J. A comparison of plant and microbial biomarkers in grassland soils from the Prairie Ecozone of Canada. *Org. Geochem.* **2005**, *36*, 425–448. [CrossRef]
107. Campbell, C.A.; Zentner, R.P. Soil Organic Matter as Influenced by Crop Rotations and Fertilization. *Soil Sci. Soc. Am. J.* **1993**, *57*, 1034. [CrossRef]
108. Clapp, C.; Allmaras, R.; Layese, M.; Linden, D.; Dowdy, R. Soil organic carbon and 13C abundance as related to tillage, crop residue, and nitrogen fertilization under continuous corn management in Minnesota. *Soil Tillage Res.* **2000**, *55*, 127–142. [CrossRef]

109. Bíla, P.; Šarapatka, B.; Horňák, O.; Novotná, J.; Brtnický, M. Which quality indicators reflect the most sensitive changes in the soil properties of the surface horizons affected by the erosion processes? *Soil Water Res.* **2019**, *15*, 116–124. [CrossRef]
110. Di, B.; Yang, Z.; Liu, L.; Yang, Y.; Li, J. The regionalized ecological, economic and social benefit of China's sloping cropland erosion control during the 12th five-year plan (2011–2015). *J. Environ. Manag.* **2020**, *276*, 111314. [CrossRef]
111. Jin, H.; Shi, D.; Lou, Y.B.; Zhang, J.; Ye, Q.; Jiang, N. Evaluation of the quality of cultivated-layer soil based on different degrees of erosion in sloping farmland with purple soil in China. *CATENA* **2021**, *198*, 105048. [CrossRef]
112. Duan, X.; Xie, Y.; Liu, B.; Liu, G.; Feng, Y.; Gao, X. Soil loss tolerance in the black soil region of Northeast China. *J. Geogr. Sci.* **2012**, *22*, 737–751. [CrossRef]
113. Gong, H.; Meng, D.; Li, X.; Zhu, F. Soil degradation and food security coupled with global climate change in northeastern China. *Chin. Geogr. Sci.* **2013**, *23*, 562–573. [CrossRef]
114. Baltruschat, H.; Santos, V.M.; da Silva, D.K.A.; Schellenberg, I.; Deubel, A.; Sieverding, E.; Oehl, F. Unexpectedly high diversity of arbuscular mycorrhizal fungi in fertile Chernozem croplands in Central Europe. *CATENA* **2019**, *182*, 104135. [CrossRef]
115. Brito, W.B.M.; Campos, M.C.C.; de Brito Filho, E.G.; de Lima, A.F.L.; Cunha, J.M.; da Silva, L.I.; Luís, A.C.; Mantovanelli, B.C. Dynamics and spatial aspects of erodibility in Indian Black Earth in the Amazon, Brazil. *CATENA* **2019**, *185*, 104281. [CrossRef]
116. Menshov, O.; Kruglov, O.; Vyzhva, S.; Nazarok, P.; Pereira, P.; Pastushenko, T. Magnetic methods in tracing soil erosion, Kharkov Region, Ukraine. *Stud. Geophys. Geod.* **2018**, *62*, 681–696. [CrossRef]