




## Multifunctional rural landscape: a systematic review and bibliometric perspective

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**ABSTRACT:** This study offers a glimpse into the research direction of “Multifunctional” and “Rural Landscape” by using a bibliometric research approach as well as the VosViewer quantitative analysis software, presenting the knowledge structure of the field with a scientific knowledge map, mainly in the form of information visualization. Based on the quantitative analysis of the bibliographic data, the study reveals three thematic clusters for this research direction in the Web of Science database: first, “ecosystem services” and “management”; second, “multifunctional agriculture,” “land-use”; third, “sustainability,” “diversity.” These three thematic clusters clarify the current state of research on Multifunctional Rural Landscape and provide a reference for subsequent research. The study suggests that future research will be situated in the post-epidemic era and the contemporary context of the fourth industrial revolution, based on its combination of rural landscape with a study on rural landscape perception experience, to form new research themes.

**Keywords:** multifunctional; rural landscape; bibliometrics; analysis; research review.

### Paisagem rural multifuncional: uma revisão sistemática e perspectiva bibliométrica

**RESUMO:** Este estudo oferece um vislumbre da direção de investigação "Multifuncional" e "Paisagem Rural", utilizando uma abordagem de investigação bibliométrica, bem como o software de análise quantitativa VosViewer, apresentando a estrutura de conhecimento do campo com um mapa de conhecimento científico, principalmente sob a forma de visualização de informação. Com base na análise quantitativa dos dados bibliográficos, o estudo revela três grupos temáticos para esta direção de investigação na base de dados Web of Science: primeiro, "serviços ecossistêmicos" e "gestão"; segundo, "agricultura multifuncional", "uso da terra"; terceiro, "sustentabilidade", "diversidade". Estes três grupos temáticos clarificam o estado atual da investigação sobre a Paisagem Rural Multifuncional e fornecem uma referência para a investigação subsequente. O estudo sugere que a futura direção da investigação se situará na era pós-epidémica e no contexto contemporâneo da quarta revolução industrial, com base na combinação da paisagem rural com a experiência de percepção da paisagem rural, para formar novos temas de investigação.

**Palavras-chave:** multifuncional; paisagem rural; bibliometria; análise; revisão da investigação.

### 1. INTRODUCTION

The research on rural landscape functions is a comprehensive exploration in the face of the current social environment, rural functions, and people's needs. The purpose is to make a reasonable discussion on the functional transformation of rural landscape, sum up the exploration and discussion of rural landscape functions such as economic, social, ecological, and aesthetic functions, and reasonably evaluate rural landscape functions in the future. To reveal the existing problems in rural landscapes, determine future development direction, and provide a theoretical basis for rural landscape planning and multifunctionality.

A systematic literature review based on a Multifunctional Rural Landscape can provide insight into the research progress in this area. From the existing research reviews in the international academia, for the field of the rural landscape, some scholars have done a systematic literature review on agricultural and land use research (GONG et al., 2022; LIAO et al., 2022; SUN et al., 2022; THANH et al., 2018). Some

articles have done a systematic literature review the post-agricultural abandonment trajectories (LIU, 2018; XIE et al., 2022; YANG; XU, 2022; ZHANG et al., 2023; FAYET et al., 2022); others have done systematic literature reviews of research on the role of forests and agroforestry systems in the fao globally important agricultural heritage systems (SANTORO et al., 2020).

Meanwhile, some scholars in the Web of Science database have used a systematic and quantitative approach to review research progress on the Multifunctional Approach and Rural Landscape (CHEN; WEI, 2022). Some scholars used VosViewer software to practice bibliometric methods to analyze Landscape characters (BOLLIGER et al., 2011; CHEN et al., 2022; IBÁÑEZ-JIMÉNEZ et al., 2022; RENTING et al., 2009). Although the above reviews are all about multifunctional approaches to agriculture and rural areas, neither Web of Science nor Scopus databases have systematically reviewed the intersection of rural landscape and multifunctional research directions. Only some scholars

use bibliometrics to quantitatively analyze the intersection of rural landscape and multifunctionality.

Therefore, to fill the research gap in the literature review of this area, the authors chose a bibliometric perspective and adopted a quantitative analysis method based on the VosViewer software, exporting data from the Web of Science database to make a scientific knowledge map of the knowledge structure of this research area. This study focuses on the intersection of multifunctional and rural landscapes and forms a systematic literature review through information visualization. The research results include the following five parts: first, the co-occurrence analysis of the countries and institutions in this research direction; second, the co-occurrence analysis of the keywords in this research direction; third, the co-occurrence analysis of the most cited literature in this research direction; fourth, the co-occurrence analysis of the most productive authors and the most cited authors in this research direction; fifth, the co-occurrence analysis of the subject terms in this research direction, which finally resulted in three thematic clusters for further interpretation.

**2. RESEARCH METHODOLOGY**

As a mainstream quantitative research methodology, bibliometrics analyzes literature data to develop a scientific knowledge map. Its basic approach allows the exploration of

research themes and trends and obtains the number of papers of the authors and co-author networks in specific research areas (ZHANG et al., 2019).

At the same time, the main purpose of bibliometric analysis is to review existing literature and organize relevant information based on specific topics. It is also a research method to show the progress of scientific research and to understand the development of the research field, the quality of literature, literature resources, and authors' impact (Van ECK; WALTMAN, 2014). As can be seen, bibliometrics provides a visual path to quantify qualitative data for literature reviews in different research fields and can find the basic status, trends, and gaps in the preliminary stage.

Based on this, the main steps of this study are divided into five main parts. The first step is to identify the research area and the search terms. The second step is to determine the search database. The third step is to determine the criteria for the search. The fourth step is to determine the supporting software. The fifth step is to analyze the data and map the scientific knowledge. These five main steps make it possible to visualize the area's basic status and gain a visual perception of research trends. This research methodology is mainly used to analyze qualitative literature based on bibliometric methods and is one of the common methods used by the international academic community (MOUSTAKAS, 2022). The detailed research procedure can be seen in Figure 1.

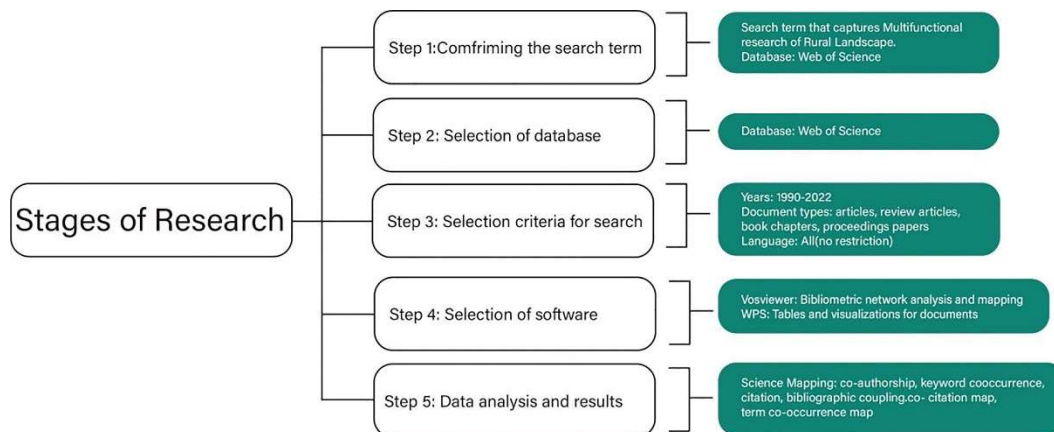


Figure 1. Research procedure.  
Figura 1. Procedimiento de pesquisa.

**2.1. Identification of search terms**

The core search terms were set as “multifunctional” and “rural landscape” to search for the most accurate research results in the field of study. As there are various translations of these two keywords in the international academic community, such as “Countryside landscape” or “multifunctional rural landscape” and “village landscape” or “versatility”. The search terms were identified to (i) allow for a comprehensive quantitative analysis with the maximum number of documents to be collected. (ii) allow for identifying thematic clusters from the widest range of literature data through keyword searches. To make the search results more comprehensive and precise and to avoid the occurrence of keywords with similar pronunciations but different concepts, the authors decided to use the most widely used keyword in the academic community, namely the generic combination of “multifunctional,” “rural landscape” was chosen as the search terms.

**2.2. Selection of database**

The Web of Science database was chosen as the primary data source for this study. Although the mainstream databases used for bibliometric analysis are not limited to the Web of Science database, the selection of the database was based on the correspondence between the research topic, the search result and the analysis software.

The Scopus and Web of Science databases are popular because they are widely available, easy to search by keywords, and have high accessibility and popularity among international academic communities and across multiple disciplines (COLARES et al., 2020). Although both Scopus and Web of Science can be used for relevant research, the initial keyword search results show that the Web of Science database is more thematically focused, and the exported literature data is more compatible with the VosViewer software. Therefore, to provide proper literature data for later analysis, the Web of Science database was chosen for its compatibility with VosViewer software.

### 2.3. Criteria for Search Selection

As for the literature search criteria, guided by the most extensive search results, the authors identified the basic criteria for the literature search. A topic search based on the keywords “multifunctional” and “rural landscape” was conducted in the Web of Science database [topic; TS= (“multifunctional” “rural landscape”)]. In terms of the year of the literature, the literature search results were set as from the earliest to the latest occurrence, i.e., 1996 to 2022. As for the type of literature, it was limited to research papers, reviews, book chapters, conference papers, etc. In terms of language, all languages were chosen with no specific restrictions. Based on the above search criteria, the record content was set to full records and cited references, the file format was set to plain text, and the record sources data sets with 287 records.

### 2.4. Selection of Software

Two software packages were chosen for the literature review, VosViewer and WPS Office, which are commonly used for quantitative research reviews. VosViewer is multifunctional ed as software for the visual analysis of literature data and is used to integrate and quantify literature data, which can result in key information such as publication trends, citation trends, top authors, top cited papers, top countries, top institutions, etc.; thus forming a scientific knowledge map to find hot spots and gaps in package multifunctional research. The published literature map can be presented in various ways, such as mapping scaling systems, scrolling and searching, which enables a detailed description of the research status quo. The VosViewer mainly presents specific information about the bibliometric graphical map (Baier-Fuentes et al., 2019).

WPS Office is a non-paying software compatible with Microsoft Office documentation format; in other words, it is easier to work with texts and tables than the former. WPS Office is mainly a complement to VosViewer, forming tables based on the quantitative data exported by VosViewer to present the quantitative analysis process of the qualitative data. A combination of the two software was used to visually present the information in this study.

### 2.5. Data Analysis

The quantitative analysis of the literature data was divided into five main parts. The first part is the co-occurrence

analysis of the countries and institutions with the most published literature. The second part is the co-occurrence analysis of keywords. The third part is the co-occurrence analysis of the most cited literature. The fourth part is the co-occurrence analysis of the literature's most published and cited authors. The fifth part is the co-occurrence analysis of the subject terms. In addition, a density co-occurrence words map is important for bibliometric analysis because it shows the density of keywords, allowing an overview of the general structure of bibliometric plots to be obtained (ZHANG et al., 2019).

Therefore, based on the support of the density co-occurrence words map, in the fifth part of the data analysis, the authors analyzed the three main clusters formed by the subject terms from the perspective of the thematic classification. These efforts aim to present visualized information in different colors to analyze the knowledge structure of this research direction on Rural Landscape in a package. Based on the VosViewer quantitative analysis software, a five-part bibliometric analysis constitutes the scientific knowledge map of this research direction.

## 3. RESULTS

As can be seen, 287 records were retrieved, including 234 journal papers, 46 conference papers, 18 reviews and other literature records from 1996 to 2022. Regarding the trend of literature publication, the number of research literature in the direction of Multifunctional and Rural Landscape reached its peak in 2019 with 30 articles and its low points in 1996 and 1999 with 1 article, respectively. In terms of the number variation of publications, the number of publications began to show a gradual upward trend in 2000 (with four papers), reaching the first peak in 2010 (with 14 papers), the second peak in 2014 (with 24 papers), the third peak in 2019 (with 30 papers), until 2020 (with 30 papers), when the number of publications reached its high point.

The following years have witnessed a slow fall, which can be seen in Figure 2 in detail. Based on the literature data exported from the Web of Science database, the next step in the bibliometric analysis process was to analyze the co-occurrence of countries and institutions, the co-occurrence of keywords, the co-occurrence of cited literature, the co-occurrence of authors and the co-occurrence of subject terms.

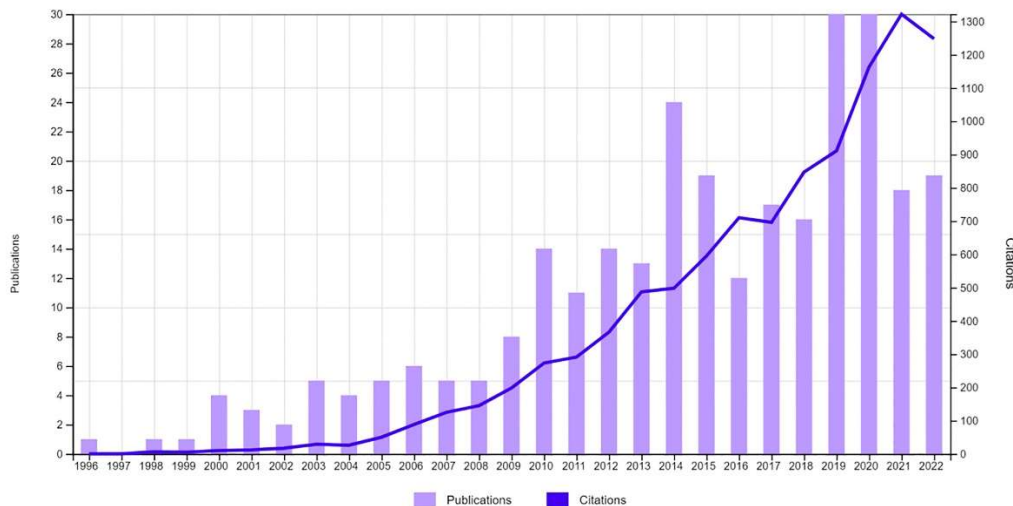


Figure 2. Publication trends.

Figura 2 Tendências de publicação.

3.1. Analysis of country and institutional collaboration

The top 20 countries and institutions producing literature in Multifunctional Rural Landscape are shown in Table 1 and Table 2. Regarding the whole picture, 22 countries (regions) and 253 institutions are involved in this area of research.

Among the top 20 countries, developed countries, Australia accounts for the majority, while developing countries in Asia account for a minority. The top five countries comprise four developed countries, i.e., Australia, Italy, USA, Netherlands and Germany, occupying 44% of the total. In addition, only two developing countries, China and Brazil, are on the list. Developed countries comprise 90% of

the top 20, with 85% of countries whose mother tongue is not English and 15% of countries whose mother tongue is English. The top five institutions are the University Copenhagen, Wageningen University, University Evora, Vrije University Amsterdam, and Swedish University Agricultural Sci. This shows that for the top 20 countries in this direction, the research progress in Europe and the US is faster than that in Asia, and the countries with many published papers are mainly developed countries in Europe and the US. China makes the top five in terms of both country and institution rankings.

Table 1. Co-occurrence of collaboration in the top 20 countries.  
Tabela 1. Co-ocorrência de colaboração nos 20 principais países.

Serial No.	Country	Documents	Citations	Total link strength
1	Australia	36	1333	2014.36
2	Italy	33	530	2015.63
3	USA	29	932	2014.17
4	Netherlands	28	2007	2012.89
5	Germany	25	1148	2016.04
6	England	24	2409	2012.63
7	China	24	489	2019.52
8	Spain	23	578	2017.26
9	France	16	1020	2012.53
10	Portugal	13	1162	2013.77
11	Canada	13	207	2016.08
12	Sweden	13	188	2016.92
13	Denmark	12	684	2014.25
14	Belgium	11	1320	2010.82
15	Switzerland	8	318	2017.38
16	Finland	8	264	2016.13
17	Poland	8	113	2018.00
18	Romania	7	322	2017.00
19	Brazil	7	122	2016.67
20	Slovakia	6	212	2014.83

Table 2. Co-occurrence of collaboration in the top 20 institutions.  
Tabela 2. Co-ocorrência de colaboração nas 20 principais instituições.

Serial No.	Organization	Documents	Citations	Total link strength
1	Univ Copenhagen	11	658	59.82
2	Wageningen Univ	9	658	73.11
3	Univ Evora	9	221	24.56
4	Vrije Univ Amsterdam	7	387	55.29
5	Swedish Univ Agr Sci	7	102	14.57
6	Univ Wageningen & Res Ctr	6	397	66.17
7	Univ Gottingen	6	274	45.67
8	Univ Autonoma Madrid	4	276	69.00
9	Chinese Acad Sci	4	199	49.75
10	Beijing Normal Univ	4	136	34.00
11	Babes Bolyai Univ	4	130	32.50
12	Univ Kassel	4	99	24.75
13	Stockholm Univ	4	85	21.25
14	Katholieke Univ Leuven	4	84	21.00
15	Univ Santiago De Compostela	4	61	15.25
16	Univ Extremadura	3	263	87.67
17	Sapientia Hungarian Univ Transylvania	3	237	79.00
18	Penn State Univ	3	163	54.33
19	Univ Twente	3	158	52.67
20	Univ Ghent	3	125	41.67

Thanks to the country co-occurrence function of VosViewer, the links of the individual clusters are presented in an informative visualization. The parameters are set so that each country constitutes a different cluster with a minimum of 5 and a maximum of 25 publications, in which case 22

countries (regions) constitute 4 clusters. Australia has the most extensive connections, ranking first at 2014.36, followed by Italy in second place with 2015.63, and the USA in third place with 2014.17. The green cluster is represented by Spain and links countries such as Portugal, Denmark,

Romania, and Greece; the yellow cluster is represented by the Netherlands and links countries such as Belgium; the blue cluster is represented by Germany and links countries such as Switzerland, Poland and Slovakia; Italy represents the red cluster and links countries such as France, Spain and the

Netherlands; Australia represents the red cluster and links countries such as Italy, France and China. These Four clusters show the global publications on the multifunctional landscape, and the different colored lines represent the links between different countries (Figure 3).

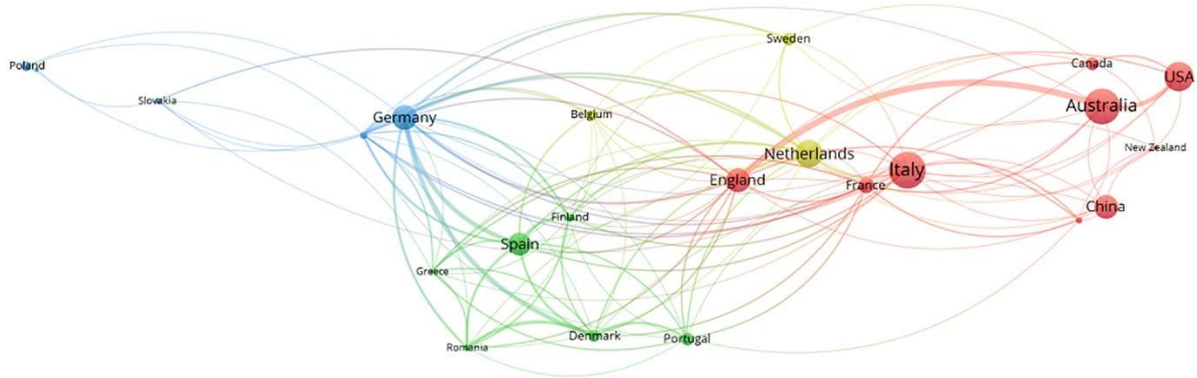


Figure 3. Co-occurrence of country cooperation.  
 Figura 3. Co-ocorrência de cooperação entre países.

Among the top 20 countries, developed countries in Europe and the United States account for the majority, while developing countries in Asia account for a minority. The top eight countries consist of seven developed countries, namely Australia, Italy, USA, Netherlands, Germany, England, China, and Spain, which occupy 80% of the total. In addition, only one developing country, China, is on the list.

**3.2. Co-occurrence analysis of keywords**

From the keyword analysis results obtained in Vosviewer, 100 keywords were derived. The top 20 keywords are shown in Table 1, with the top five keywords being “ecosystem services,” “management,” “Agriculture,” “biodiversity” and “conservation”, with co-occurrences of 57, 54, 43, 41 and 39 respectively, and connection strengths of 287, 263, 212, 198 and 193 respectively. The strongest link is “ecosystem services” and the weakest is “coast”. In addition, in terms of the number of co-occurrences of the remaining keywords, “transition”, “land-use change” and “countryside” with co-occurrence of 15, 15, 16. These three keywords are together in the low parts of the top 20.

Subsequently, the authors used the keyword co-occurrence analysis function in VosViewer to present a scientific knowledge map. In creating the scientific knowledge map, the clusters formed by the keywords are connected and distinguished by the network (Van ECK; WALTMAN 2014). As shown in Figure 3, the keywords in the map form six clusters, with the red cluster consisting of 22 keywords, represented by keywords such as “ecosystem services” and “management” at the primary level of clustering and the keywords “conservation”, “biodiversity” and “multifunctional landscape” at the secondary level of clustering.

The green cluster consists of 18 keywords, represented by the keywords “multifunctional agriculture”, “land-use” and “landscape” at the first level, and “policy”, “farmers” and “urbanization” at the second level. The blue cluster consists of 18 keywords, represented by the keywords “Australia” and “countryside” and “transition” at the first level and “post-productivism”, “tourism” and “governance” at the second

level. The yellow cluster consists of 18 keywords, represented by the keyword’s “sustainability”, “diversity”, and “climate-change” at the first level, and “resilience”, “land” and “adaptation” at the second level. The purple cluster consists of 14 keywords, represented by the keyword “agriculture”, “rural landscape” and “biodiversity conservation” at the first level and “health”, “perceptions” and “services” at the secondary level. The light blue cluster consists of 8 keywords, represented by the keyword “multifunctionality” at the first level and “landscape functions” at the secondary level. From the presentation of these six keyword clusters, the research on Multifunctional Rural Landscape mainly takes “ecosystem services” as the starting point. It presents the status quo of crossover and interdisciplinarity in different directions.

Table 3. Co-occurrence of top 20 keywords.  
 Tabela 3. Coocorrência das 20 principais palavras-chave.

Keyword	Occurrences	Total link
ecosystem services	57	287
management	54	263
Agriculture	43	212
biodiversity	41	198
conservation	39	193
land-use	36	188
multifunctional	40	161
landscape	36	259
sustainability	31	154
policy	27	149
multifunctionality	33	146
multifunctional	26	117
Australia	22	114
indicators	17	110
farmers	19	106
rural development	18	95
systems	18	86
transition	15	81
land-use change	15	76
countryside	16	74

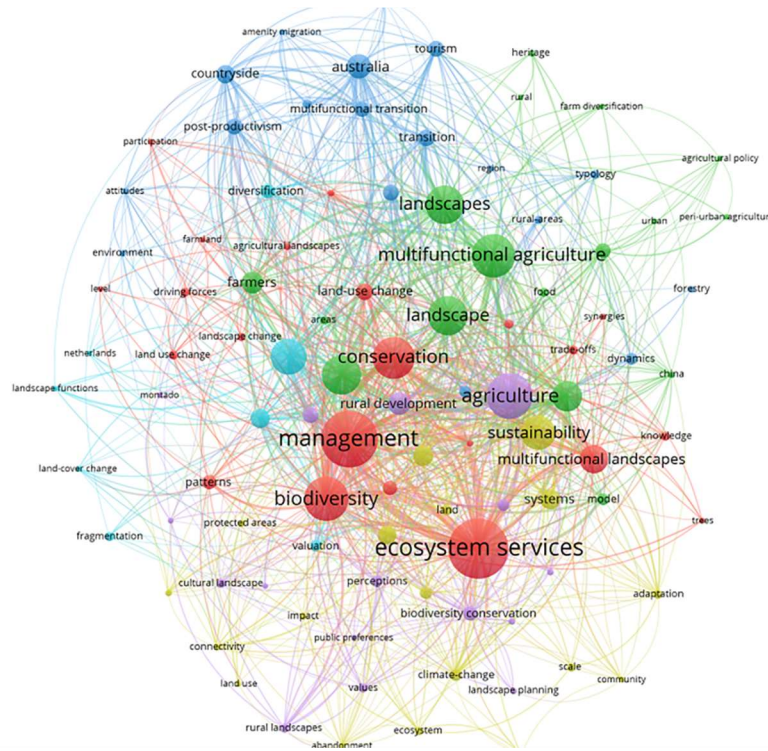


Figure 4. Co-occurrence of All Keywords.  
 Figura 4. Coocorrência de todas as palavras-chave.

**3.3. Analysis of the Most Cited Literature**

The literature data exported from the Web of Science database shows that the crossover between rural and multifunctional landscapes has a cluster of highly cited papers. As shown in Table 2, in the case of the top 10 most cited papers, the most cited paper is cited 964 times, with institutions from Ghent University. Antron, Marc published

78 publications from 1993 to 2022, totaling 5, 202 citations. In the top 3 most cited literature, the authors and institutions of the literature have a similar profile, i.e., there is a common collaboration of multiple authors and institutions, which indicates the formation of a multi-party collaboration base in the field in terms of institutional collaboration of highly cited literature.

Table 4. Top 10 cited literature.  
 Tabela 4. 10 principais literaturas citadas.

Document Title	Authors	Publication Title	Total Citations	Year
Landscape change and the urbanization process in Europe	Antrop, M.	Landscape And Urban Planning	964	2014
Ecological impacts of arable intensification in Europe	Stoate, C.; Boatman, N. D.; Borralho, R. J.; Carvalho, C. R.; de Snoo, G. R.; Eden, P.	Journal Of Environmental Management	837	2017
From productivism to post-productivism ... and back again? Exploring the (un)changed natural and mental landscapes of European agriculture	Wilson, G.A.	Transactions Of The Institute Of British Geographers	470	2014
Multifunctional peri-urban agriculture - A review of societal demands and the provision of goods and services by farming	Zasada, I.	Land Use Policy	388	2000
Impulses towards a multifunctional transition in rural Australia: Gaps in the research agenda	Holmes, J.	Journal Of Rural Studies	359	1996
Exploring multifunctional agriculture. A review of conceptual approaches and prospects for an integrative transitional framework	Renting, H.; Rossing, W. A. H.; Groot, J. C. J.; Van der Ploeg, J. D.; Laurent, C.; Perraud, D.; Stobbelaar, D. J.; Van Ittersum, M. K.	Journal Of Environmental Management	294	2010
Wood-pastures of Europe: Geographic coverage, social-ecological values, conservation management, and policy implications	Plieninger, T.; Hartel, T.; Martin-Lopez, B.; Beaufoy, G.; Bergmeier, E.; Kirby, K.; Jesus Montero, M.; Moreno, G.; Oteros-Rozas, E.; Van Uytvanck, J.	Biological Conservation	170	2011
Hedgerows and their role in agricultural landscapes	Burel, F.	Critical Reviews In Plant Sciences	160	2000
Space for people, plants, and livestock? Quantifying interactions among multiple landscape functions in a Dutch rural region	Willemen, L.; Hein, L.; van Mensvoort, M. E. F.; Verburg, P. H.	Ecological Indicators	136	2008
The spatiality of multifunctional agriculture: A human geography perspective	Wilson, G. A.	Geoforum	136	2002

In terms of the topic of literature retrieval, the top 10 most-cited texts are directly related to the study of multifunction rural landscapes, especially related to the ecological services of rural landscapes (BUREL, 1996; STOATE et al., 2001; WILLEMEN et al., 2010). The topic of multifunctional rural landscapes is directly related, emphasizing ecological service changes in rural landscapes. There are few references in rural landscape planning about people's preference for multifunctional rural landscapes, while there are more references in the preference of other disciplines.

**3.4. Analysis of the status of highly cited authors and co-cited authors**

Table 5 shows the top 3 most cited authors, with the exact number derived from VosViewer software. The top 3 authors are Verburg, Peter H., Plieninger, Tobias, Hartel, and Tibor, who have published 7, 6, 5 papers and have been cited more than 300 times, up to 393 times, but with a low overall connection strength. Moreover, the authors who have been the most cited do not publish many articles, which makes it difficult to form a strongly connected scientific knowledge map.

Table 5. Highly cited authors.  
Tabela 5. Autores mais citados.

Serial No.	Author	Documents	Citations	Total link strength
1	Verburg, P. H.	7	393	4
2	Plieninger, T.	6	338	8
3	Hartel, T.	5	300	8

A similar situation is seen in the case of co-cited authors, which is illustrated in Table 6. The top 3 Co-edited authors are Wilson, G.A., Holmes, J. and Marsden, T., all of whom have been cited more than 80 times, with a maximum of 122 and a moderate overall link strength. This shows that, in the research direction of the multifunctional rural landscape, there are more papers with high citation counts, a stable cluster of highly cited literature has been formed for the time being given the overall research status, and the co-cited authors constitute a strong connection in the overall graph.

In this case, researchers need to conduct in-depth research in this field, and cross-collaboration between multiple institutions can increase the power of the association of co-cited authors.

Table 6. Co-cited authors.  
Tabela 6. Autores co-citados.

Serial No.	Author	Citations	Total link strength
1	Wilson, G.A.	122	432
2	Holmes, J.	93	339
3	Marsden, T.	88	373

**3.5. Analysis of Subject Term Co-occurrence**

Based on the subject term co-occurrence analysis function of VosViewer, a total of 117 subject terms co-occurred. The top 3 terms include “challenge”, “biodiversity”, and “diversity”, which are directly related to the research topic of the multifunctional rural landscape, with several 50, 47 and 40, respectively, and connectivity of 0.69, 0.41 and 0.35, respectively. The research topics in this field cross over each other, such as the ecosystem service field terms,

“ecosystem services”, “land-use change” and “rural development”, but they are generally related to the search terms “multifunctional” and “rural landscape”, which shows the crossover research status quo.

Through the term co-occurrence analysis function of VosViewer, dividing the terms in this study into red, green and blue clusters is convenient. The red cluster has 19 subject terms, the green cluster has 18 subject terms, and the blue cluster has nine subject terms. By analyzing the literature in these three clusters, the dynamics of the research themes in the field can be generally clarified, as well as the status of the research. Based on this, the scientific knowledge map formed by the subject terms is shown in Figure 6.

Table 7. Co-occurrence of top 20 subject terms.  
Tabela 7. Coocorrência dos 20 principais termos de assunto.

Serial No.	term	Occurrences	Relevance
1	challenge	50	0.69
2	biodiversity	47	0.41
3	diversity	40	0.35
4	benefit	39	0.65
5	ecosystem service	37	0.43
6	assessment	36	0.39
7	forest	35	0.75
8	importance	35	0.61
9	nature	35	0.43
10	transition	35	1.44
11	person	31	0.52
12	future	30	0.48
13	society	30	0.78
14	stakeholder	30	0.39
15	trend	30	0.44
16	order	29	0.48
17	protection	29	0.69
18	survey	29	0.65
19	tourism	28	0.94
20	place	27	0.39

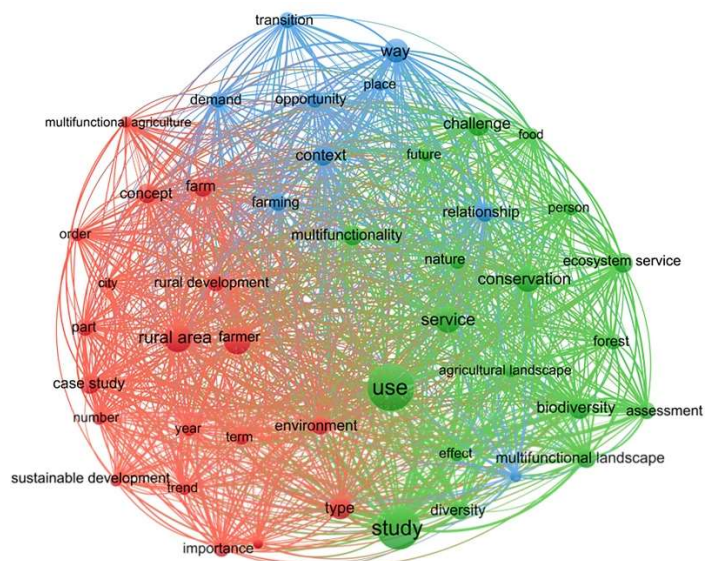


Figure 5. Co-occurrence of subject terms.  
Figura 5. Co-ocorrência de termos sujeitos.

### 3.5.1 Red cluster: rural area, rural development, and environment

The red cluster is the core cluster in the rural area field, with 19 commonly presented thematic terms. The distribution of the subject terms shows that the cluster is directly related to the topic of research in a rural landscape, with the primary clusters consisting of the subject terms “farmer” and “rural development”, the secondary clusters consisting of the terms “concept”, “type” and “importance”, and the third level of “city”, “trend” and “environment”. For example, Yueying Chen and Wenbin Wei, took utilized a landscape multifunctional approach and a comprehensive methodology comprising space syntax and field investigations to validate the relationship among ecology, social properties, and cultural connotation in space, offering a new perspective on the alteration of historic rural landscapes (CHEN; WEI, 2022). Marc Antrop, points out that it is useful when decisions have to be taken for the future management of landscapes, their restoration and even for creating new ones. Landscapes of the past cannot be brought back. Still, how valuable elements and areas can be preserved and embedded functionally in the modern urbanized and globalized society must be studied (ANTROP, 2005).

Willemen, Louise, Hein, Lars, van Mensvoort, and Martinus E. F. discuss the multifunctionality of rural landscape and use case analysis to identify and quantify the direct interaction of landscape functions in vibrant rural areas. Plant habitat, arable land production, and recreational cycling were quantified and mapped using landscape indicators. Landscape functions were aggregated to identify and quantify multifunction, and the impact of multifunction on landscape functions was discussed (WILLEMEN et al., 2010).

Zoncova, Michaela, Vojtekova, and Jana the Slovak pointed out that with the change of rural functions, the rural landscape presented diversity. They evaluated the diversity of rural landscapes with the multi-indicator analysis method. As can be seen from the results of the red cluster, most of the literature in this section is directly related to the multifunctional rural landscape research field, which analyzes the influence of the diversity of multifunctional rural landscape and the interrelationship of each function in multifunctional rural landscape.

### 3.5.2 Green cluster: use, study, and conservation

The green cluster has a total of 18 commonly presented keywords. The primary cluster consists of keywords such as “use”, the secondary cluster consists of keywords such as “service”, “conservation” and “biodiversity”, and the tertiary cluster consists of the keywords “ecosystem service”, “diversity”, and “nurture”. Zasada, I, analyzed academic discourse and empirical insights about agricultural structures and practices outside traditional agriculture.

Diversification, leisure and environmental agriculture, landscape management and professionalization, and direct marketing are all considered and discussed in the context of landscape functioning in contrast to the social needs of urban agriculture in the provision of rural goods and services. Plieninger, T., Hartel, T., Martin-Lopez, B., and Beaufoy, G. conducted a pan-European assessment of forest pastures in Europe in the context of agricultural intensification and abandonment of agricultural land, discussing the artificial characteristics of forest pastures, the need for multifunctional land management. It concludes that research should be guided by a holistic view of forest pasture, which incorporates information on ecology, social values and institutional arrangements (PLIENINGER et al., 2015).

Holmes J. pointed out that in the rich Western society, the direction, complexity and speed of rural change can be conceptualized as a multi-functional transformation, which is driven by three main driving forces: first, agricultural overcapacity; The emergence of market-driven comfort values; And a growing social awareness of sustainable development and conservation issues (HOLMES, 2006). Most of the research in the green cluster is related to agriculture and land use, agricultural protection, diversification and multi-functional landscape, and ecological services, mainly around the functional research level of multi-functional rural landscapes.

### 3.5.3 Blue cluster: way, context, and opportunity

The blue cluster has only nine commonly presented keywords. The primary cluster consists of keywords such as “way”, the secondary cluster consists of keywords such as “farming” and “transition” and the tertiary cluster consist of keywords such as “place” and “relationship”. For example, Wilson, GA, discusses the importance of studying the spatiality of versatility and Asks the question of whether global-level strong multifunctionality is possible or whether strong multifunctionality in one territory is predicated on weak multifunctionality in others (HOLMES, 2006). Land abandonment is a common process in many regions of the world due to changes in socio-economic conditions and land use. Quintas-Soriano, C.; Buerkert, A.; Plieninger, T. pointed out that the research on land abandonment focuses more on the results of nature's contributions to human beings (such as biodiversity and species habitat). At the same time, few studies consider the effects of good quality of life on social aspects (FAYET et al., 2022). The blue cluster focuses on opportunities and challenges after land abandonment and discusses the transformation of multifunctional agriculture after land abandonment in the future.

## 4. DISCUSSION

The quantitative analysis of the VosViewer software has formed a scientific knowledge map of research findings on multifunctional rural landscapes in the Web of Science database. Based on data collected from 287 literature from 1996 to 2022, the resulting scientific knowledge map consists of two parts. The first half consists of a co-occurrence analysis of countries and institutions, a co-occurrence analysis of keywords, a co-occurrence analysis of cited literature, and a co-occurrence analysis of authors, while the second half consists of a co-occurrence analysis of subject terms, with this study focusing on explaining the three main thematic clusters of this research direction.

Firstly, from the annual publication trend of this research direction, the number of publications on multifunctional rural landscapes is increasing yearly until the number of articles reaches 30 in 2020, and the number of articles is generally low. The paper citation rate will peak in 2021. From 2021 to 2022, there was an obvious downward trend. This indicates that the results of this research direction are not hot spots in the academic circle, and the number of publications needs to be increased by combining facts with hot spots. Secondly, judging from the current situation of cooperation between countries and institutions in this research direction, all countries in the world are involved in the research of the Multifunctional Rural Landscape, and the participation rate of developed countries in this research direction is more than 90%.

In contrast, the participation of developing countries is relatively small. Although China and Brazil, as the



representatives of developing countries, come in 7 and 19 rankings, occupying 10% of the institutional participation, in terms of the number of cited literature, the number of publications and citations in developed countries, represented by England and Australia, far exceeds that of developing Asian countries. This shows that developed countries in Europe and the US still dominate this research direction and developing countries in Asia still need to make efforts in this direction. Thirdly, most of the research results related to Multifunctional Rural Landscape in the Web of Science database are combined with multifunctional agriculture and a few with ecosystem services, which shows the current crossover and interdisciplinary research situation. This shows that the field still needs to keep up with the times and make a breakthrough in traditional methodologies in new contexts.

Fourthly, the current situation of highly cited literature shows that among the top 20 most cited literature in this field, fewer results are directly related to the multifunctional rural landscape and more often related to ecosystem service, biodiversity, and the rural area, and multifunctional is not at the forefront of these studies. Therefore, research results directly related to multifunctional rural landscapes are urgently needed at this stage, which is of great importance to increase the influence of the rural landscape discipline in the international academic community. Fifthly, the status of highly cited authors in the field shows that it still needs to be improved to form strong author collaborations. This situation is because the research direction of Multifunctional Rural Landscape has yet to be the hot spot of the discipline, and the number of core authors and publications is low.

To form clusters of highly cited literature, deepening the cooperation between authors and increasing the number of co-cited literature among peers can significantly improve the strength of author co-citation connections. Sixthly, for the state of subject term co-citation in the field, the study of multifunctional Rural Landscape has shifted from the traditional physical to the service direction. Regarding topic selection, most scholars chose to associate their research topics with use directions such as sustainable development and assessment. This indicates that research on Multifunctional Rural Landscape has shifted with the changing times, and a stable cluster of research themes has been formed. Based on these six points, it is possible to identify the structural focus of the scientific knowledge map in this research area and the points that need to be complemented. Still, two limitations need to be pointed out for the presentation of the results of this scientific knowledge map.

One of this study's limitations is that the literature data collection was limited to the Web of Science database. Specifically, the authors found literature directly related to this research direction through a preliminary data search in databases such as Scopus and Jstor. Still, only a single data source was chosen to focus the results on the scientific knowledge map of the Web of Science database. In the future, attempts will be made to select a wider range of databases to collect more diverse literature data that can provide a more comprehensive scientific knowledge map to review research in this area. The second limitation of this study is that the quantitative analysis software used was limited to VosViewer, and no other software options were adopted to assist in the analysis.

As the quantitative analysis method of VosViewer was found to be more compatible with the data collection method of the Web of Science database in preliminary tests, only one mainstream quantitative analysis software was chosen for

mapping purposes better to demonstrate the core analytical functions of the software. In the future, other quantitative analysis software such as Cite Space and Bibliometric can assist in interpreting VosViewer results and creating a more diverse scientific knowledge map.

## 5. CONCLUSIONS

Based on a bibliometric methodology, the authors have used the Vos viewer quantitative analysis software to map scientific knowledge on the research direction of Multifunctional Rural Landscape. This research review fills a gap in the review of the field by presenting a scientific knowledge map as a means of information visualization.

The themes of the research results in the Web of Science database, based on 287 literature data from 1996 to 2022, fall into three main categories: research themes in ecosystem service, use and conservation, research themes in rural areas, development and importance, and research themes in opportunity, transition and multifunctional agriculture.

These three intersecting themes constitute an interplay of research on the multifunctional Rural Landscape in different disciplinary directions and are not limited to the field of Rural Landscape.

In terms of future trends, the number of research results related to multifunctional rural landscapes will rise further, the intertextuality with rural landscape perception experience will be a future research trend, and multifunctional rural landscape research will be more integrated with interactive perception, from static research to dynamic change.

The current status of research on Multifunctional Rural Landscape shows the general characteristics of crossover and disciplinary integration. However, the small number of literature in this field and the low number of co-citations indicate that this research direction still lacks a core cluster of in-depth research literature, and further cooperation among authors, countries and institutions is needed in the future to form a more closely connected core cluster.

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**Data availability:** Study data can be obtained by e-mail from the corresponding author or the second author upon request. It is not available on the website as the research project is still under development.

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