Migration Letters

Volume: 21, No: S4 (2024), pp. 332-348

ISSN: 1741-8984 (Print) ISSN: 1741-8992 (Online)

www.migrationletters.com

A Bibliometric Review On Migration Of Pro-Environmental Behavior: Trends And Developments

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Abstract:

This paper aims to study the research trend and future research direction of the change of pro-environment behavior over time. A systematic analysis of all literature on pro-environmental behavior in the Scopus database is conducted using cite space. According to analysis, the quantity of publications on pro-environmental behavior has increased by years, and fluctuated greatly since 2008. Keyword co-occurrence analysis showed that the main keywords of pro-environment behavior are tourist behavior, western Europe, consumption behavior, conservation of natural resources, energy conservation, and environmental protection. Keyword clusters reveal the prevailing research direction of pro-environmental behavior mainly focuses on different environmental protection behaviors and factors affecting pro-environmental behavior. Keyword burst analysis shows that in the future, it has great research value in improving public participation, corporate social responsibility, and promoting environmentally sustainable development. This study provides evidence for further exploring the research gaps and hotspots of pro-environment behavior.

Keywords: *Cite space; Pro-environmental behavior; Research status; Keyword co-occurrence; Keyword clusters; Keyword burst; Visualization analysis.*

1. Introduction

The United Nations Environment Programme (UNEP) just came out with a report called "Emissions Gap Report." in 2022. This paper provides a summary of the prevailing circumstances surrounding the inadequate global advancements in addressing climate change after the 26th Conference of the Parties (COP26). Expenditure is on the rise because of the intensifying consequences of global climate change, including the depletion of environmental resources and biodiversity, the repercussions of the worldwide COVID-19 pandemic, and the persistent release of greenhouse gases. The global community has not yet achieved the objectives outlined in the Paris Agreement, indicating a significant gap

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between current efforts and the desired outcomes. Consequently, there is an immediate need for the world to enhance its capacity to adapt to the consequences of climate change.

Sociologists and psychologists focus on examining the underlying motivations that drive individuals to engage in environmentally conscious behaviors. That is, pro-environmental behavior, which is also referred to as "green" behavior, is a form of prosocial behavior that encompasses individuals' inherent tendency to engage in actions that promote environmental well-being. The concept of environmental sustainability is predominantly observed in our day-to-day activities, encompassing recurring behaviors that promote the well-being and protection of the natural environment (Cleveland et al., 2005).

At present, there is a lot of research on pro-environment behavior, but there is a lack of integration and analysis of research results. In this paper, Citespace analysis software is used to examine and evaluate the literature on pro-environmental behavior in the Scopus database. Through the form of a "scientific knowledge map", this paper sort out the research trends of crimes of pro-environmental behavior and explore research gaps and research hotspots, filling the gaps in the current literature integration on pro-environmental behavior.

2. Literature sources and research methods

The information in this publication is derived from the Scopus database. In the Scopus literature search box, "pro-environmental and behavior" is used to search, and a total of 4962 literatures are obtained. To make the analysis results more reliable, conference papers, newspapers, books, chapters, reviews, and yearbooks are removed from the search results. After that, a total of 4217 pieces of literature are obtained, which are used as the literature sources for this study. All documents are exported in the Rif. format and rename download_. format, which is used by citespace for format conversion.

2.2 Research method

Save the download_. file to the input folder in the newly created input folder, output folder, data folder, and project folder. Open citespace, select "data", "Import/Export", "Scopus", and "Scopus(RIS)>WoS" to complete the data format conversion, and save it in the "project" folder as the source file for subsequent program analysis. Open the operation interface, and set Time slicing as 1994-2023 and Time slice as 3 years. In this way, the research period of 30 years is sliced into units of 3, which is exactly 10 pieces for easy analysis. Node Types first select keywords for keyword co-occurrence analysis, keyword cluster analysis, and keyword breakout analysis, and then select cited author, cited journal, etc., for author co-citation analysis and journal co-citation analysis. Pruning adopts sliced networks(Chen, n.d.). This study was based on the visual analysis of Cite space6 6.2.R2 (64-bit), and the data is analyzed using Microsoft Excel.

3. Results and analysis

To understand the trend of the quantity of papers published on pro-environmental behaviors over time, this paper conducted an annual statistical analysis on the number of published papers since 1976, The data is depicted in Figure 1. The figure illustrates that the research

on pro-environmental behaviors can be roughly divided into two stages: 1976-2008 and 2008 till now. Before 2008, countries around the world did not have enough awareness of environmental protection behavior, and sociologists and psychologists did not make much effort to environmental protection. In 2005, the first Kyoto Protocol after the international climate Convention was signed and entered into force, which legally clarified the global and national emission reduction targets for the first stage and the tasks that countries should undertake in environmental protection. Since then, worldwide environmental protection began to rise gradually, and the literature on the amount of environmental protection behavior has sprung up like mushrooms. Since 2008, with the gradual intensification of global greenhouse gas emissions, the effect of environmental protection is not enough to break the deteriorating environmental status quo. Researchers have further focused their research on the implementation of individual environmental behaviors and measures to promote environmental protection behaviors, calling on citizens around the world to start from themselves and improve their environmental behavior habits. At this stage, the field of research pertaining to pro-environmental behavior is currently highly active and widely discussed, and the number of papers published every year increases dramatically, which still has great development potential and extensive research prospects.

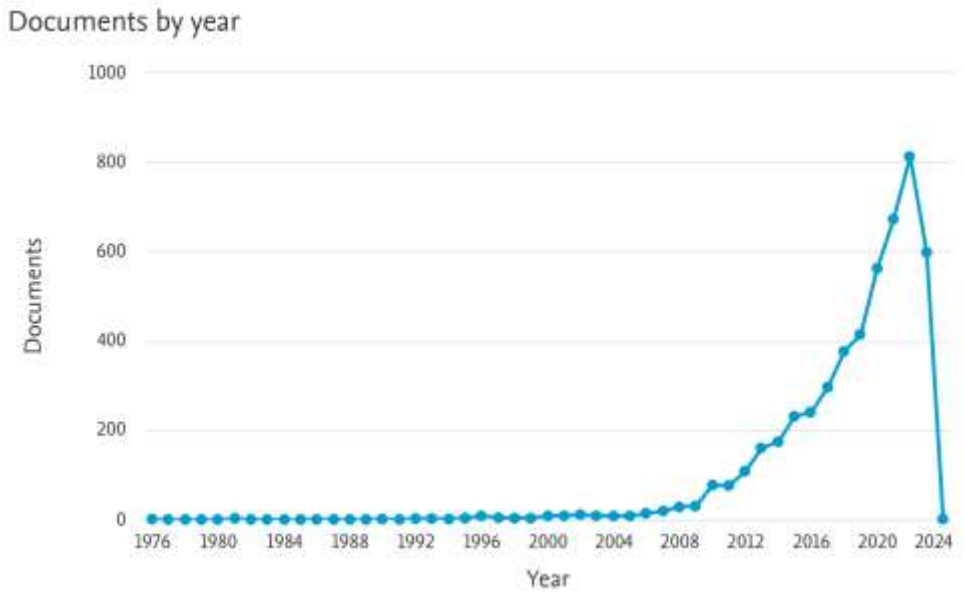

Figure 1 Annual number of publications in the Scopus database

3.2 Study country distribution

At present, the countries with popular research on pro-environmental behavior are shown in Figure 2. The top 10 countries with the quantity of scholarly articles that have been officially released are the United States, the United Kingdom, China, Australia, Germany, Canada, Spain, the Netherlands, Italy, and Malaysia, which have made great contributions to the research field of pro-environmental behavior. This is closely related to the country's status of the economy, scientific and technological development level, and degree of concern for the environment. In general, a country's environmental consciousness improves alongside its economic development and the education level of its population (Junsheng et

al., 2019).

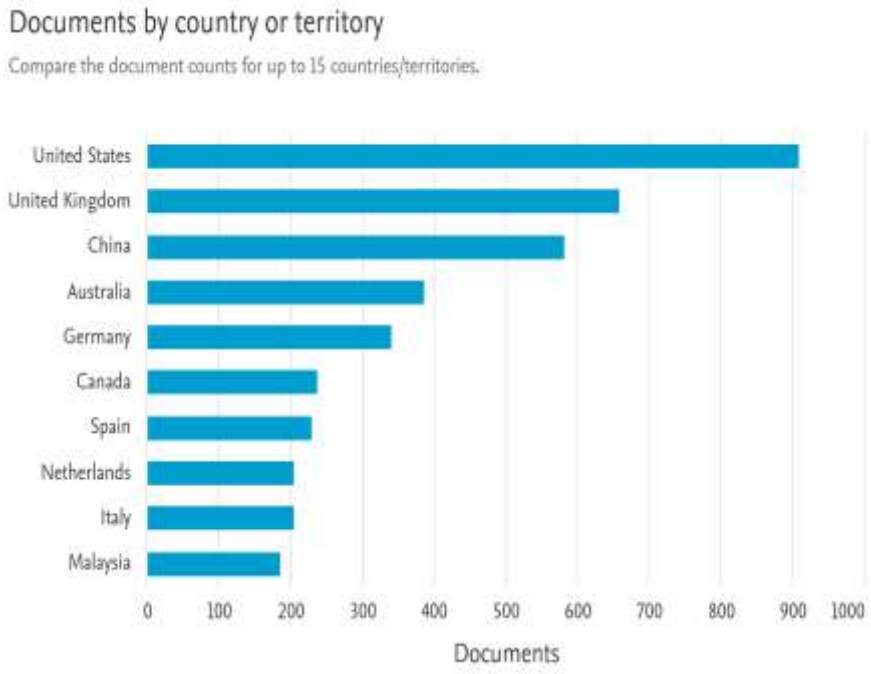

Figure 2 Country distribution in the Scopus database

3.3 Analysis of published journals

As shown in Figure 3, there are 163 nodes and 354 connections in the co-occurrence visualization diagram of published journals. The 163 nodes indicate that a total of 163 journals have included articles on pro-environmental behavior research by 2023. The size of the node is expressed in frequency, which stands for the whole amount of articles included in the journal. The larger the node, the more research articles in the related field are included in the journal. For example, the occurrence frequency of JAMA-J AM MED ASSOC. is 213 times, the occurrence frequency of NEW ENGL J MED is 133 times, and the occurrence frequency of SCIENCE is 110 times. These three journals have made the greatest contribution to the investigation into the topic of eco-friendly actions, and are the frontier and hot journals in this field. The color rings of the node circles represent the year of publication, and the thicker the rings, the more publications in that year. The lines represent the cooperation between journals, and the more lines, the higher the similarity of research directions, indicating that the research forces are more concentrated, and the research hotspots can be better highlighted. The centrality of nodes is a key indicator to analyze the value of individual network nodes. It is between 0 and 1, 0.1 is the demarcation point. A higher centrality indicates that the node plays a crucial role in the network. CONFLICT Q, INT STUD QUART, MED SCI LAW and so on all have great centrality. Those nodes having a centrality greater than 0.1 and their frequency are shown in Table 1.

Table 1 Journal nodes with centrality greater than 0.1

Freq	Centrality	Label	Freq	Centrality	Label
2	0.4	CONFLICT Q	79	0.15	AM J PSYCHIAT

Table 1 Journal nodes with centrality greater than 0.1

Freq	Centrality	Label	Freq	Centrality	Label
10	0.4	INT STUD QUART	4	0.15	DIAGN STAT MAN MENT
2	0.35	MED SCI LAW	4	0.14	INT J MENT HEALTH
20	0.33	PSYCHOL BULL	19	0.14	SURVIVAL
4	0.31	P7	9	0.14	POLITICAL TERRORISM
8	0.26	INJURY	91	0.14	LANCET
20	0.24	J PERS SOC PSYCHOL	9	0.14	J INFECT DIS
12	0.21	AM SOCIOL REV	2	0.12	INT J HLTH SERVICES
110	0.2	SCIENCE	74	0.12	MIL MED
6	0.19	J BIOL CHEM	44	0.11	AM POLIT SCI REV
2	0.17	FOREIGN POLICY	6	0.11	WORLD POLIT
2	0.17	TERRORISM IRELAND	133	0.11	NEW ENGL J MED
21	0.16	ANN SURG	8	0.1	J CLIN MICROBIOL
2	0.16	RES DEMOCRACY SOC	2	0.1	THEORETICAL PERSPECT
213	0.16	JAMA-J AM MED ASSOC	2	0.1	PSYCHOL REV

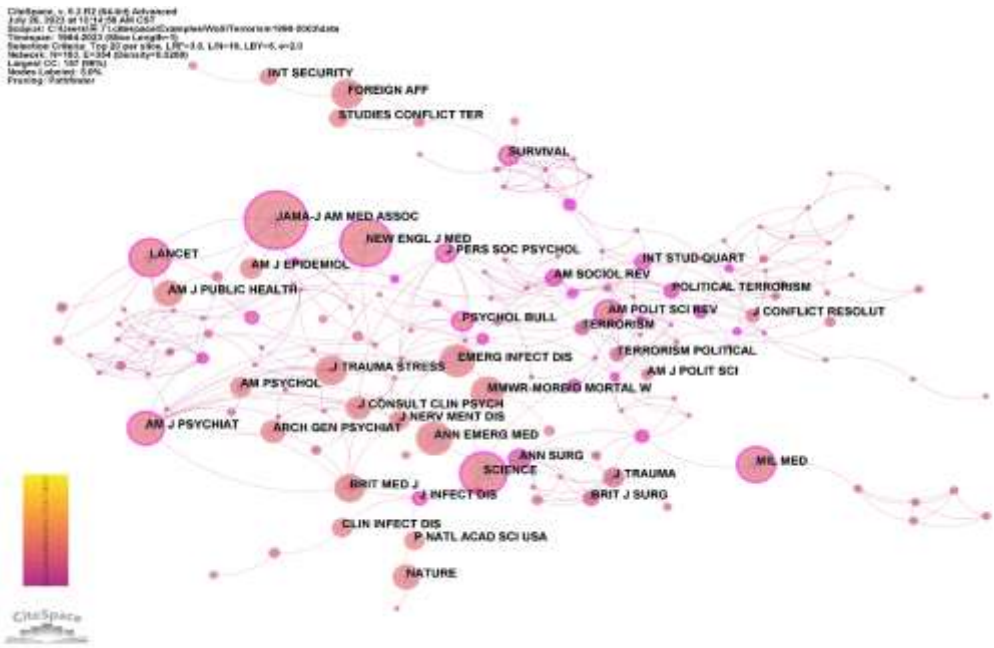

Figure 3 Journal distribution in the Scopus database

3.4 Research field analysis

Figure 4 is a summary of the research fields of pro-environmental behavior in the past 30 years. As shown in the figure, 4,217 papers covering 11 disciplines have been published. Considered a leading area of study in environmental protection, the amount of literature devoted to eco-friendly practices accounts for 21.9% within the context of environmental science, 20.4% in the field of social science, and 11.7% in the field of Business & management. They are the three main directions of current papers published in the study of eco-friendly practices. Otherwise, pro-environmental behavior research appears as a marginal discipline in medicine, agriculture, and other fields, with a small number of papers.

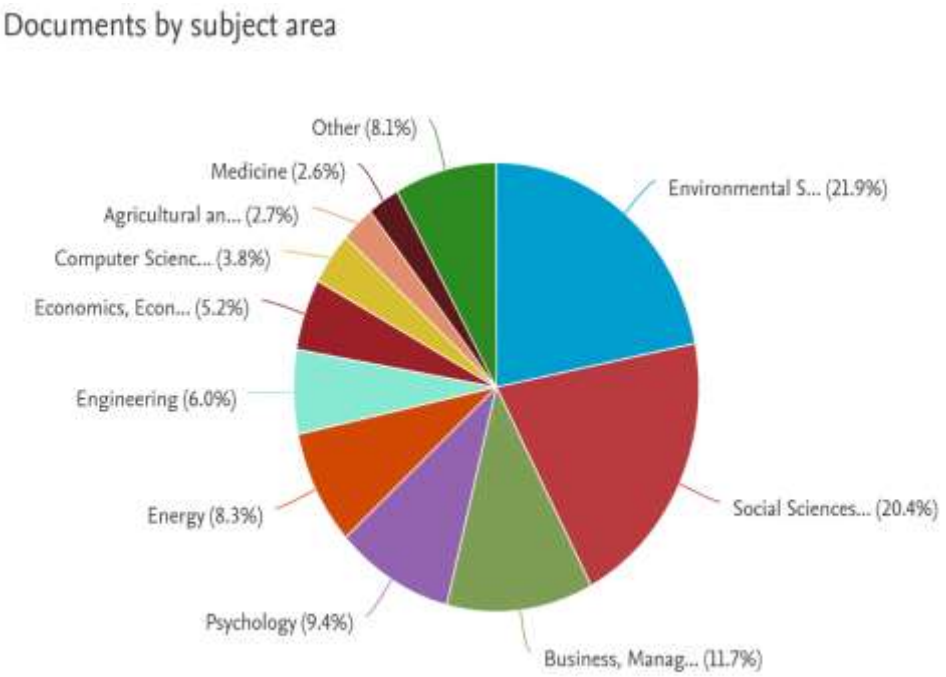

Figure 4 Research field on pro-environmental behavior in the Scopus database

3.5 Keyword co-occurrence analysis

As one of the key parts of the research topic of the representative article, the occurrence frequency of keywords represents the hot field of pro-environmental behavior research in the past 30 years. As shown in Figure 5, with TOP N=100 per slice as the criteria, a total of 211 nodes and 269 lines were obtained by keyword visualization map analysis, indicating that 211 keywords appeared more than 100 times in all studies on pro-environmental behavior in the past 30 years, and the lines represent the relationship between keywords. The more obvious the connection, the more significant the relationship between keywords, that is, keywords that may appear in the same article. The size of the node indicates how often a particular keyword appears. As can be seen from the figure, pro-environmental behavior, sustainability, climate change, perception, female, male, environmental values, public attitude, environmental education, psychology, human experiment, recycling, theory of planned behavior, and so on are high-frequency keywords, according to which we can analyze the current research hotspots. First, study of eco-friendly practices is mainly concentrated in the field of social science, with sustainable development and climate change as the themes. According to the findings of the influence of demography on pro-environment behavior, the effects of environmental education, perception, attitude, value, and other psychological variables on recycling behavior and consumption behavior were discussed. At present, the main theoretical basis is the theory of planned behavior. The centrality of nodes also reflects the importance of nodes in the network. Table 2 shows the nodes with centrality higher than 0.1 and their frequency of occurrence. It's important to remember that the node with the highest centrality is tourist behavior, with a centrality of 0.41. In recent years, increases in the number of scholars have paid attention to

environmental protection in tourism. For example, Han et al. (2021) studied the use of social media to encourage environmentally friendly habits among Chinese tourists. Q. Li & Wu (2020) studied the pro-environment behaviors of tourists in tourist destinations. The second node of centrality is Western Europe, which has a long history of attaching importance to environmental protection behaviors. Duarte et al. (2017) investigated the impact of families, schools, and groups on European students' environmental attitudes. Vicente-Molina et al. (2018) studied how gender plays a role in shaping the pro-environmental behavior of students in the Basque country. In recent years, the purchasing behavior of environmental protection products, sustainable consumption, environmental energy use, and other aspects have been extensively studied in the field of environmental protection(Paço & Lavrador, 2017; Prete et al., 2017; Wang & Hao, 2018).

Table 2 Keyword nodes with centrality greater than 0.1

Freq	Centrality	Label	Freq	Centrality	Label
84	0.41	tourist behavior	179	0.15	recycling
3	0.36	Western Europe	146	0.15	decision making
153	0.32	consumption behavior	24	0.15	consumer behavior
511	0.29	human	108	0.14	ecotourism
270	0.29	male	30	0.14	environmental planning
92	0.28	conservation of natural resources	124	0.13	motivation
444	0.25	article	55	0.13	united kingdom
117	0.25	energy conservation	209	0.12	China
322	0.22	humans	206	0.12	public attitude
7	0.22	Eurasia	78	0.12	sustainable consumption
282	0.21	environmental protection	61	0.12	cognition
177	0.2	environmental attitudes	3	0.12	social capital
336	0.19	perception	129	0.11	social behavior
277	0.19	female	433	0.1	climate change
130	0.19	behavioral research	25	0.1	social responsibility
55	0.16	attitudinal survey			

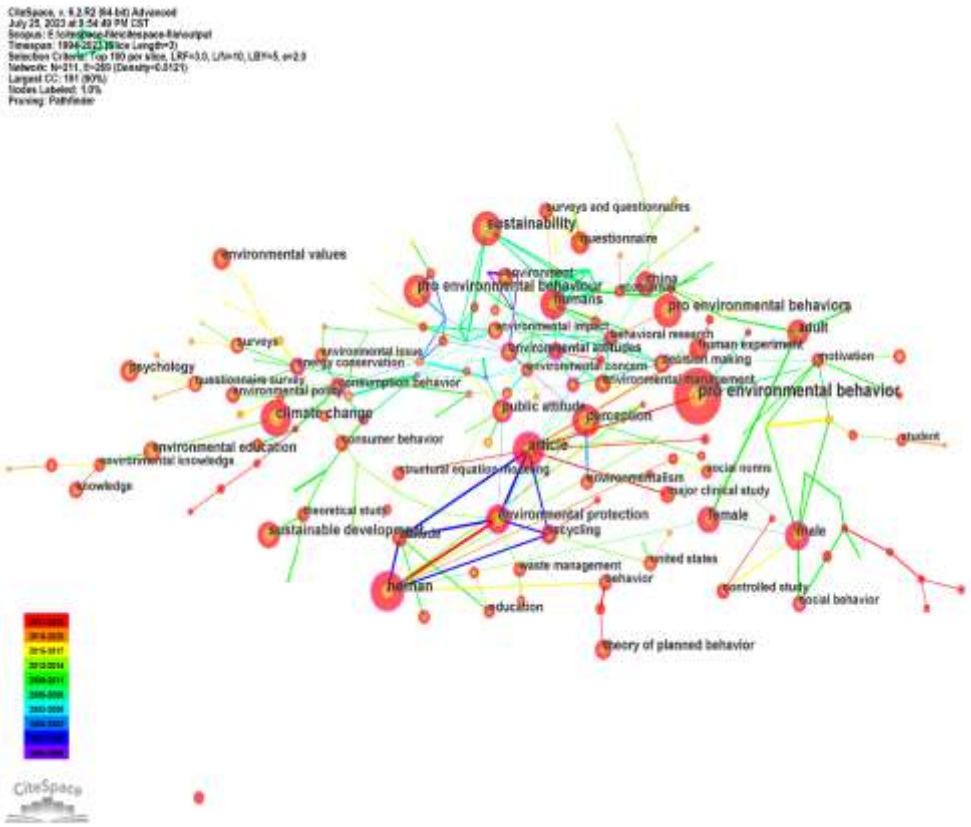

Figure 5 Keywords co-occurrence map

3.6 Keywords cluster analysis

Cluster analysis is a method of statistical analysis to summarize data, which can find hidden internal connections and rules in data according to data characteristics (Backhaus et al., 2023). The indexes of significance and credibility in the Citespace cluster analysis map are module value (Q value) and Silhouette (S value). It is generally believed that clustering has high significance and credibility when Q > 0.3 and S > 0.5. The results of the cluster analysis for the keywords of pro-environment behavior are based on the LLR algorithm, and the outcomes are depicted in Figure 6 below. From the graph, we can see that Q=0.76 and S=0.9355 of the cluster analysis indicates that this cluster is credible. The clusters with large keywords in the figure are pro-environmental behavior, top management commitment, consumer behavior, corporate social responsibility, subjective well-being, self-determined motivation, marine protected area, nature connectedness, alternative fuel vehicle, environmental education, raising students awareness, and healthy behavior. Pro-environmental behavior, consumer behavior, healthy behavior, alternative fuel vehicle, and marine protected areas are different aspects of pro-environmental behavior. Top management commitment, corporate social responsibility, subjective well-being, self-determined motivation, nature connectedness, environmental education, raising students' awareness, and other keywords often appear in the influence factors of actions favoring the environment. According to the classification results, the studies related to pro-environmental behavior from 1994 to 2023 can be divided into two aspects: the research

on various forms of environmental conduct and the study of environmental activism's motivating causes.

Studies on different types of environmental behaviors mainly focus on recycling behaviors, tourism behaviors, green product purchasing behaviors, and energy-saving behaviors (Hooi Ting & Chin Cheng, 2017; Meng & Trudel, 2017; Paço & Lavrador, 2017; Ramkissoon et al., 2012). In terms of influencing factors of pro-environment behavior, recent studies mainly focus on various psychological variables, environmental education, government policy cognition, and other aspects, which are currently the hot topics of research (Chaisamrej & Zimmerman, 2014; Chakraborty et al., 2017; Ho et al., 2015; MacIntyre et al., 2019; Rajapaksa et al., 2018). Table 3 shows the total quantity of keywords in 12 keyword clusters respectively, Silhouette, and the average year of the keyword appearance.

Table 3 Keyword cluster analysis in Scopus database

ClusterID	Size	Silhouette	mean(Year)	Label (LLR)
0	31	1	2010	pro-environmental behavior
1	24	0.819	2006	top management commitment
2	23	0.856	2010	consumer behavior
3	22	0.978	2013	corporate social responsibility
4	19	0.949	2010	subjective well-being
5	18	0.962	2011	self-determined motivation
6	15	0.969	2005	marine protected area
7	14	0.932	2006	nature connectedness
8	9	0.921	2012	alternative fuel vehicle
9	7	1	2010	environmental education
10	5	0.939	2005	raising students awareness
11	4	0.979	2012	healthy behavior

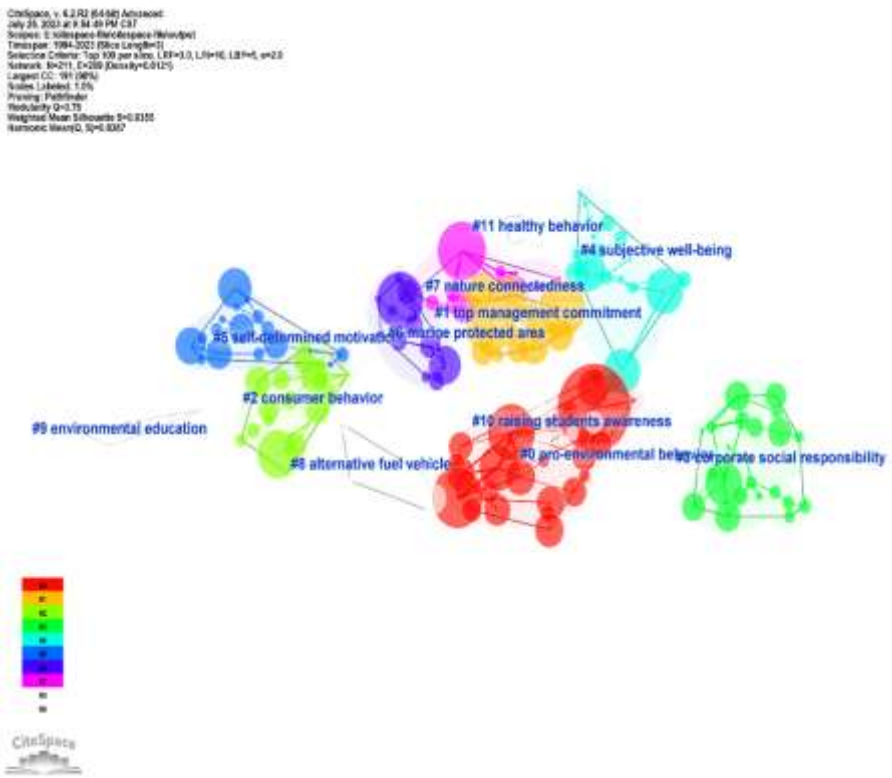

Figure 6 Keywords Cluster analysis map

Figure 7 is the time diagram of keyword clustering, which reflects the time arrangement of keywords according to the year in which they appear. Thus, it can show the development of the time in which keywords appear in each cluster. From the cluster of pro-environment behavior numbered 0, We can see that "pro-environmental behavior" as a keyword first appeared around 2004, and planned behavior theory as a keyword first appeared around 2010.

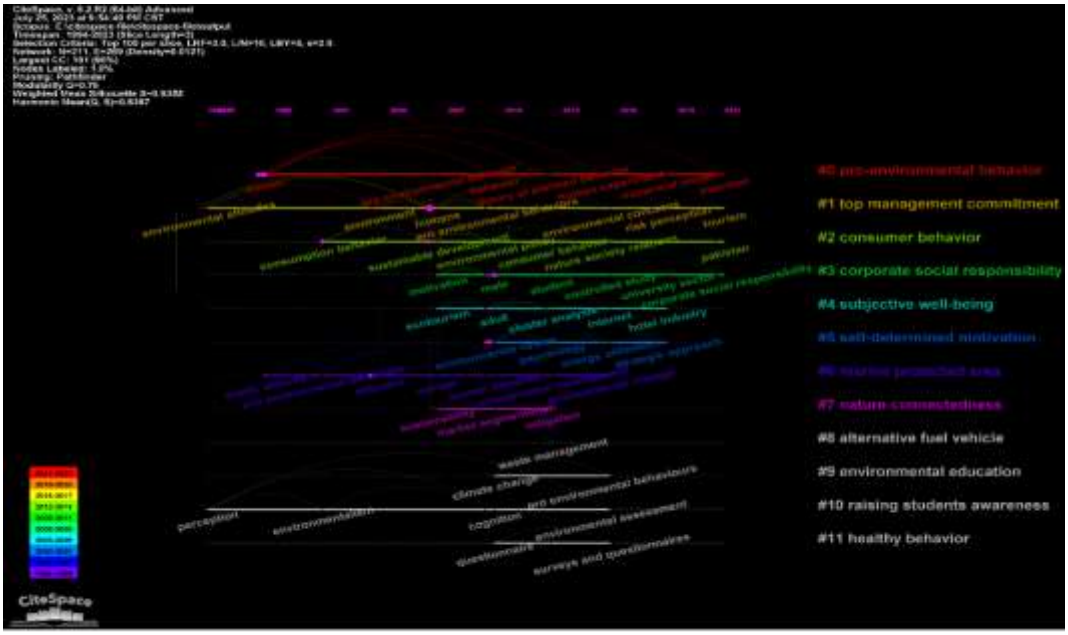

Figure 7 Keywords Cluster timeline map

3.7 Keyword burst analysis

Keyword burst analysis can understand the duration of keywords and recent research hotspots according to the map, which is of great significance for predicting the future research direction in the field of pro-environmental conduct. The burst results of keywords related to pro-environment behavior are shown in Figure 8, and the red line in the figure shows the continuous research time of keywords. From the figure, we can see the hot spots and trends of research on pro-environment behavior in different periods. Based on this analysis, thematic research on pro-environment behavior can be divided into three-time stages: before 2017, 2017-2020, and 2021-present. Studies in the first period mainly focused on European countries' environmental attitudes, global warming, and other behaviors of adolescents, which is consistent with the analysis of the country and year of publication mentioned above (Arvola et al., 2008). The research hotspots emerging in the second period are very much in line with the initiatives of world environmental protection organizations, mainly using less energy and producing fewer emissions, and the natural social view of harmonious coexistence between man and nature (Casaló et al., 2019; Paço & Lavrador, 2017). In the third period, the current research on pro-environmental behavior, influenced by the global COVID-19 epidemic, researchers focus on how to promote citizens' environmental awareness through public participation and improving enterprises' social responsibility, and promoting environmentally sustainable development through the gradual recovery of tourism after the epidemic. Therefore, at this time, publicity and communication from the government, the Internet, and other media may have a positive impact on improving the public's environmental awareness and pro-environmental behavior(Q. Li & Wu, 2020; Zhao et al., 2021).

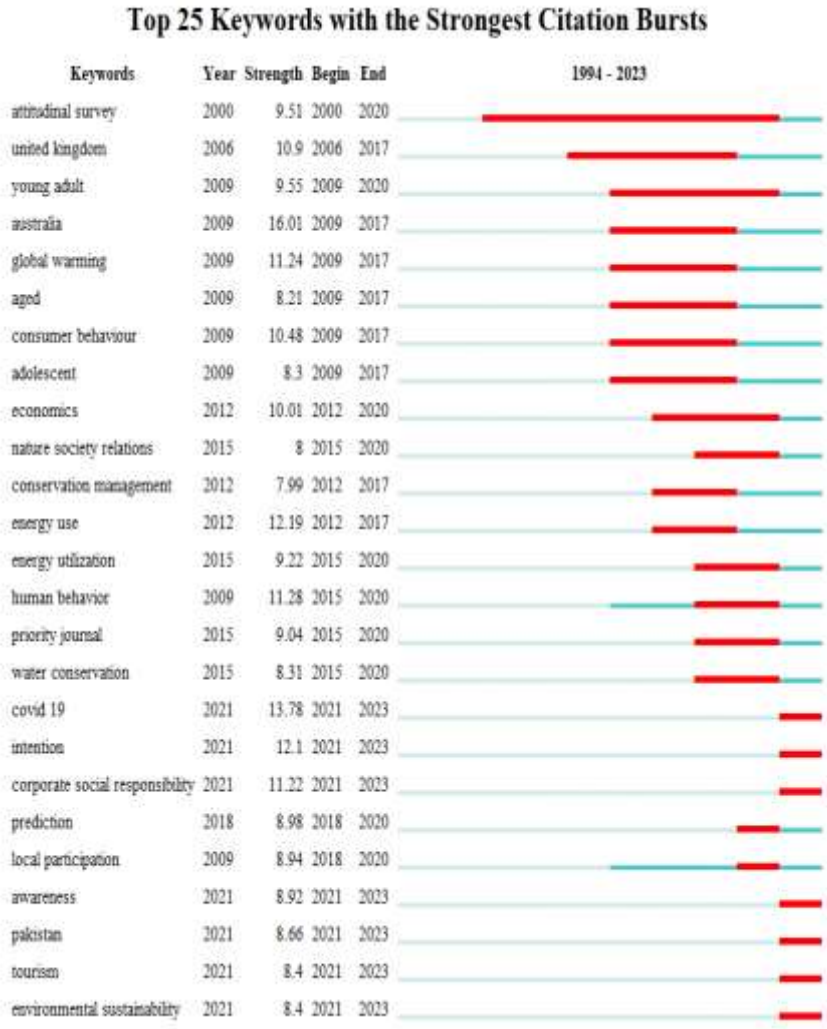

Figure 8 Top 25 Keywords with the Strongest Citation Bursts

4. Discussion

The present study reviewed the overall situation of 4217 articles on the topic of pro-environmental behavior in the Scopus database, including the annual statistics of publication volume, publication country, research field, keywords involved in research and keywords burst. Through keyword cluster analysis and keyword emergence analysis, the current research on pro-environment behavior can be divided into two areas. The first is pro-environment behavior paradigm (e.g., environmental protection donation behavior paradigm, recycling behavior paradigm, energy saving behavior paradigm, green product choice behavioral Paradigm) (Lange, 2022). Lange (2022) sorted out the research literature on pro-environment behavior paradigms in the Web of Sciences database, and summarized 5 effective pro-environment behavior paradigms and 99 specific behavior types from 103 effective literature, advocating the use of environmental behavior paradigms in the measurement of pro-environment behavior, rather than relying solely on self-reported patterns of environmental behavior measurement (Lange et al., 2018). The second area is the study of the factors that influence pro-environment behavior. Through keyword cluster

analysis, the current influencing factors on pro-environment behavior can be divided into two categories: external factors such as social and cultural atmosphere, climate change impact, and overall social environment (e.g., COVID-19); internal factors such as gender, education level, environmental cognition, and environmental risk perception, etc. (Blankenberg & Alhusen, 2019; Grilli & Curtis, 2021; D. Li et al., 2019). The research on the influencing factors is to explore the methods and measures to improve pro-environment behavior, such as alternative fuel vehicles, environmental education, raising students' awareness, etc., which appear in the keyword clustering in this study. Both as an influencing factor and as a measure to improve pro-environmental behavior. Grilli & Curtis (2021) used the case study method to summarize the methods of encouraging pro-environmental behaviors and showed that five types of behavioral experiments, including education and awareness, and social influence, have positive effects on the improvement of pro-environmental behaviors. Huoponen (2023) proposed favorable factors and promotion methods to overcome adolescents' pro-environmental behavior disorders through the study of adolescents in schools and proposed an environmental education model to promote adolescents' pro-environmental behavior to improve adolescents' environmental awareness and behavior. Bentler et al. (2023) proposed that cognitive dissonance interventions at home and work can promote pro-environmental behaviors. All these are consistent with the keywords summarized in this paper.

5. Conclusion

As an important part of the field of social science research, pro-environmental behavior research has attracted more and more attention from social scientists and psychologists in recent years because of the global ecological environment. The research hotspots in the field of actions favoring the environment are closely related to the global ecological environment, and economic and social development, mainly focusing on using less energy and producing fewer emissions, promoting the progression of tertiary industries such as tourism, and promoting environmental awareness, environmental attitude and recycling behavior of citizens and the young generation, as well as the purchase of eco-friendly goods. The theory of planned behavior has always been the research hotspot and theoretical basis in this field. At present, how to improve the participation of enterprises and citizens in actions that benefit the environment, how to promote the environmental awareness of the young generation, expand the awareness of environmental sustainability and the intention of environmental behavior is still the hot spot and trend of future research.

6. Application and limitation

Visual quantitative analysis of literature is an important way to systematically sort out and summarize the research field, which can objectively analyze a certain research field and save time compared with a literature review. It can be used to discover research topics, hot spots, and future research trends in a particular area. Based on the quantitative analysis of the literature in the realm of eco-friendly actions, this paper analyzes the hot spots and trends of the research on the temporal evolution of pro-environmental behavior by combing the research context of the historical number of published papers, published countries, published journals and keyword emergence in this field. This paper fills the research gap

in previous studies that did not carry out time analysis (Farrukh et al., 2023), and puts forward current research hotspots and future research trends.

This study has the following limitations. First of all, in terms of literature sources, only the Scopus database was selected in this study. There are many literatures on this topic in other databases such as the Web of Science. However, due to the large number of literature in this study, no other databases are analyzed, and literature from different databases can be compared and analyzed in future studies. Second, in terms of keyword selection, only "Pro-environmental and behavior" was selected in this study, and literature related to other keywords in this field was not analyzed. Search keywords can be added in future studies, such as "Green environmental behavior" and "Environmental protection". Finally, the analysis of research hotspots and future trends in this field is based on the personal summary of keyword co-occurrence and keyword burst results, which may have some limitations, and future studies can be based on the current authoritative literature for systematic and in-depth literature review.

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