

A VISUALIZATION REVIEW OF DISASTER LOGISTICS RESEARCH FROM 2001 TO 2015

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ABSTRACT. *Disaster logistics has received wide attention in the early 21st century. In order to identify the intellectual bases, research fronts and development trends on disaster logistics, in this work we use one mainstream citation analysis tool, that is, CiteSpace, to conduct a visualization review of disaster logistics researches published from 2001 to 2015. Based on 500 records collected from Web of Science, we visualize the extant researches on disaster logistics from five aspects: cited references, cited journals, countries, authors and keywords. By the visualization of cited references and journals, we detect out the most influential studies, journals and publishers on disaster logistics research. By the country and author visualization, we find the development path and identify the current hot areas, as well as the most influential authors. The keyword visualization reveals the intellectual bases and focuses of disaster logistics in the literature.*

Keywords: Disaster logistics, Citation analysis, Visualization review, CiteSpace

1. **Introduction.** Due to the surging demands in response to disasters, relief supplies play a key role in reducing loss of life and property [1,2]. Disaster logistics, also called humanitarian logistics, specializes in organizing the production, collection, transportation and distribution of relief supplies during disasters to affected areas. However, the operation of disaster logistics often faces various challenges caused by the emergency, complexity and uncertainty in response to disasters [3-6]. In order to deal with these challenges, more and more works on disaster logistics have been presented.

To summarize the extant studies and find potential research directions, some review works on disaster logistics have been consecutively reported. In 2006, Altay and Green III argued that the OR/MS community did not pay enough attention to disaster management in comparison with the social sciences and humanities community, and identified that disaster logistics should be further studied due to the dimness of key characteristics of relief supplies transportation [7]. Then, Kovács and Spens gave a more specific review on humanitarian logistics [8]. In the review, the actors, characteristics and a framework

of disaster relief logistics were recognized. As we identified in this work, the above two early review works really provided a starting point for subsequent interested researchers in disaster operation. Later on, plenty of studies on disaster logistics have sprung up. Recently, Özdamar and Ertem also presented a summary on the studies of the models, solutions and technologies in humanitarian logistics [9]. Readers could refer to the review work for details on recent disaster logistics researches.

Although the above reviews summarized the related works on disaster logistics, all of them failed to analyze the extant studies based on the citations. The times cited of one paper represent the influence of the paper, so co-citation analysis is an effective way to measure the impact of studies, journals, countries and authors in the development of one specific research area [10]. Meanwhile, it will provide scholars a strong support to identify the intellectual bases and leading edges of disaster logistics. Motivated by this observation, we conduct a visualization review of disaster logistics research using one mainstream co-citation analysis tool – CiteSpace. The main contributions of the work include: i) The most influential studies and journals on disaster logistics from 2001 to 2015 are identified, providing guidance for interested researchers to make further studies; ii) From the country and author visualization, we find the development path of disaster logistics research and identify the current hot areas, as well as the most influential authors; iii) 22 keywords are identified to reveal the intellectual bases and focuses of disaster logistics in the literature.

The organization of the rest is as follows. Section 2 gives the data collection and review visualization tool. In Section 3, we present visualization results from five aspects: cited references, cited journals, countries, authors and keywords. Section 4 concludes the review.

2. Methodology.

2.1. Data collection. In this work we collected related studies on disaster logistics in Web of Science (WoS). Specific steps of the collection of studies on disaster logistics in the work are as follows: (1) Open the WoS search website: <https://apps.webofknowledge.com/>; (2) Select the Web of Science Core Collection and conduct the advanced search with the setting: TS = ((Disaster or Humanitarian) and Logistics) where TS denotes the topic of the studies; (3) The language, document type and timespan are respectively set as English, Article and 2001-2015. By the above setting, we retrieved 774 records of related studies, sorted these records by times cited from the highest to the lowest, and downloaded the full record and cited references of the first 500 studies since the citation time of remaining studies is not more than 1. The full record and cited references were saved in the text format for the requirement of CiteSpace.

2.2. Visualization tool. Author co-citation analysis (ACA), originally introduced by White and Griffith [11], is an effective method to identify and visualize the intellectual structure of one specific research field [12]. CiteSpace, one of ACA tools, was initially developed by Chen in 2004 [13,14], and is lastly updated by Chen's research team. The current version is CiteSpace 4.0.R5 SE, available at <http://cluster.ischool.drexel.edu/~cchen/citespace/download/>. The principle of CiteSpace is based on co-citation analysis theory and pathfinder network scaling algorithms, so CiteSpace can detect the development paths and trends of one specific subject. In this work, we use the latest version of CiteSpace, that is, 4.0.R5 SE. Before installing the CiteSpace, we equipped our computer with Java Runtime (JRE) 8.0. With the 500 full records on disaster logistics, we present the visualization results in the following section.

3. Visualization Results. In this work, we make co-citation visualization, cooperation visualization and co-occurrence visualization by analyzing cited reference, cited journal, country, author and keyword.

3.1. Cited reference visualization. The time slicing is from 2001 to 2015, and the year per slice is set as 1. The node type is selected as cited reference, and the strength among links is measured by the Cosine metric [13,14]:

$$\text{Cosine}(x, y) = \frac{C_x C_y}{\|C_x\| \|C_y\|}$$

where $C_x C_y$ represents the co-citation count between paper x and paper y , and $\|C_x\|$ and $\|C_y\|$ represent the times cited of paper x and paper y , respectively.

Filtering strategy is one another key setting for the co-citation analysis. In this work we use the most common strategy, that is, Top N strategy. This filtering strategy selects out top N records which have the highest citation frequency in the slice. Considering the number of our records, we take N as 50, that is, 50 records are selected in each slice. After 3969 iterations, the cited reference visualization is obtained, as Figure 1 shows. In Figure 1, eight most influential studies on disaster logistics from 2001 to 2015 are identified (Here the threshold of times cited is set as 35).

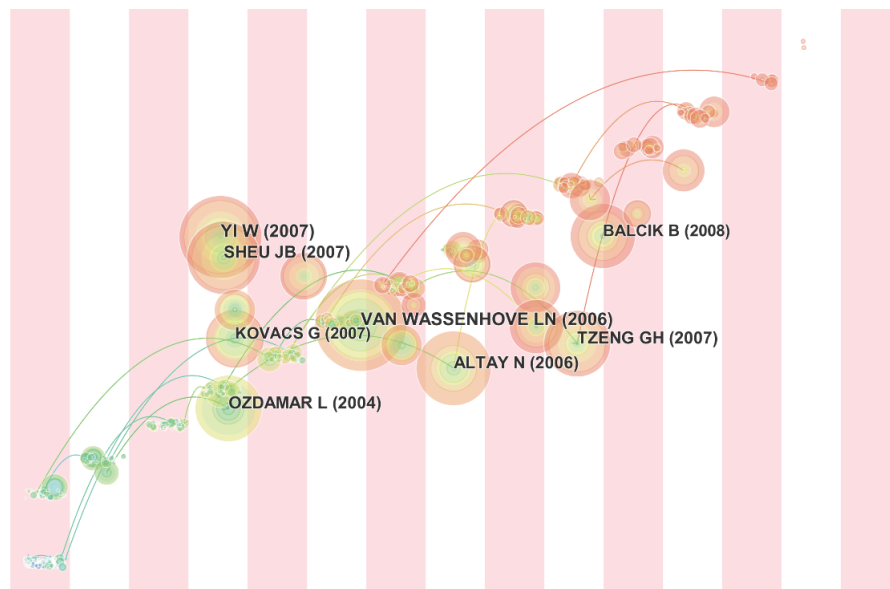


FIGURE 1. Cited reference visualization

The study titled “Humanitarian aid logistics: Supply chain management in high gear” by Wassenhove in 2006 [15] has the most citations. This study argued that the participation of private logistics in humanitarian logistics could greatly improve the efficiency of disaster relief, and used a case to show the collaboration among humanitarians, businesses and academics in response to disasters. As we can see, this work is a qualitative analysis work with no models and algorithms, but presented enlightening insights for further studies. The most influential studies also include another qualitative work “OR/MS research in disaster operations management” by Altay and Green III in 2006 [7]. As stated, the review work really provided a starting point for interested researchers in disaster operation. Similarly, Kovács and Spens presented another review work on disaster logistics [8].

Two of the most influential studies are from Özdamar’s team, that is, “Emergency logistics planning in natural disasters” [16] and “A dynamic logistics coordination model for evacuation and support in disaster response activities” [17]. Then, a special issue on challenges of emergency logistics management was organized by Sheu in 2007 [18], so the journal of Transportation Research Part E: Logistics and Transportation Review yields two of the most influential studies on disaster logistics, that is, [19] and [20]. Later on, Balcik and Beamon [21] reported a facility location solution in 2008 which was also

identified as one of the most influential studies on disaster logistics. These five works presented specific models and solutions for dealing with the disaster logistics.

3.2. Cited journal visualization. Cited journal is one another aspect of co-citation visualization. Using the same setting with that in 3.1, we could get the cited journal visualization by selecting the node type as cited journal. After 427 iterations, the cited journal visualization was obtained, as Figure 2 and Table 1 show (Here the threshold of times cited is set as 50).

As Table 1 shows, the TOP five journals are European Journal of Operational Research, Journal of the Operational Research Society, Transportation Research Part E: Logistics and Transportation Review, Disasters, and Annals of Operations Research. Interestingly, four of the above five journals reported the most influential studies identified in 3.1. This reveals the important role of key studies in improving the position of academic journals.

In the aspect of publishers, Elsevier makes the highest citations, with a total of 590 times recorded in Table 1. Wiley ranks as the second most influential publisher, then, INFORMS and Springer. Thus, publishers could recognize the contribution of their journals to the field of disaster logistics, and make proper publishing policies to enhance their positions in the development of disaster logistics research. For interested researchers, the results in Figure 2 and Table 1 are helpful for them to catch mainstream academic journals on disaster logistics. To sum up, the visualization of cited journals provides supports for both publishers and researchers to make their research decisions, which is finally favorable to the academic development and practical application of disaster logistics research.

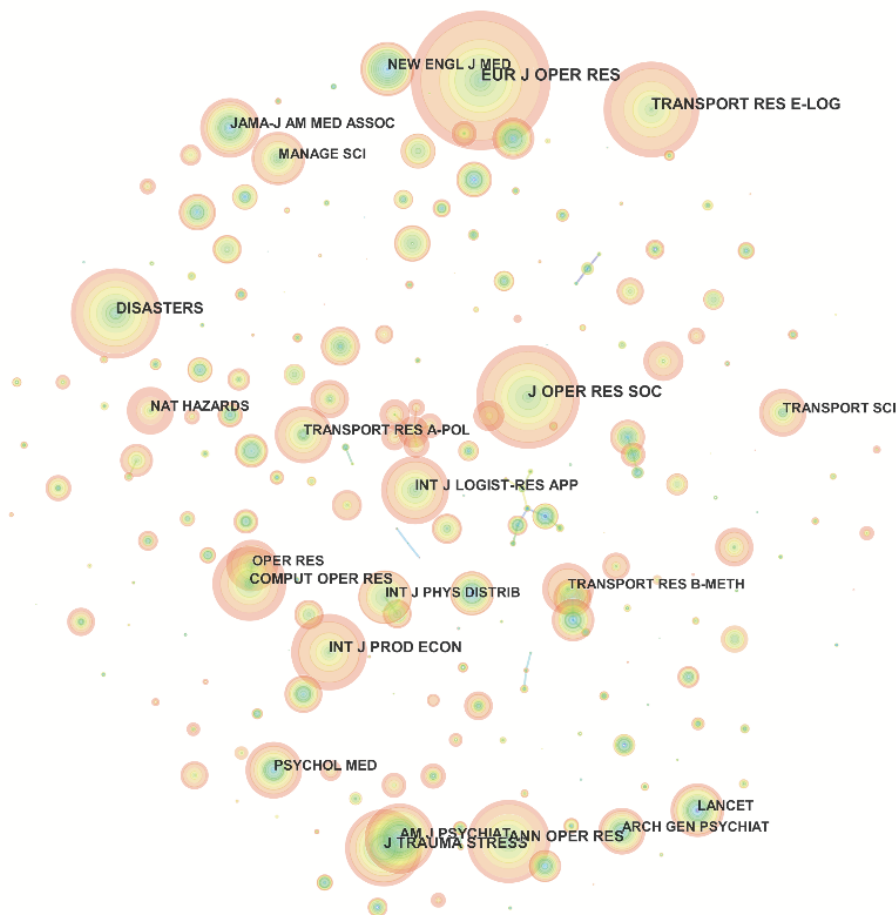


FIGURE 2. Cited journal visualization

TABLE 1. The frequency of cited journals

Full journal names	Abbreviated journal names	Times cited	Publishers
European Journal of Operational Research	EUR J OPER RES	148	Elsevier
Journal of the Operational Research Society	J OPER RES SOC	111	Palgrave Macmillan
Transportation Research Part E: Logistics and Transportation Review	TRANSPORT RES E-LOG	102	Elsevier
Disasters	DISASTERS	96	Wiley
Annals of Operations Research	ANN OPER RES	89	Springer
Journal of Traumatic Stress	J TRAUMA STRESS	86	Wiley
International Journal of Production Economics	INT J PROD ECON	82	Elsevier
Computers & Operations Research	COMPUT OPER RES	80	Elsevier
American Journal of Psychiatry	AM J PSYCHIAT	77	American Psychiatric Association
International Journal of Logistics Research and Applications	INT J LOGIST-RES APP	74	Taylor & Francis
Journal of the American Medical Association	JAMA-J AM MED ASSOC	66	American Medical Association
Psychological Medicine	PSYCHOL MED	64	Cambridge University
Transportation Research Part A: Policy and Practice	TRANSPORT RES A- POL	62	Elsevier
New England Journal of Medicine	NEW ENGL J MED	60	Massachusetts Medical Society
Lancet	LANCET	60	Elsevier
Management Sciences	MANAGE SCI	57	INFORMS
International Journal of Physical Distribution & Logistics Management	INT J PHYS DISTRIB	57	Emerald
Transportation Research Part B: Methodological	TRANSPORT RES B- METH	56	Elsevier
Operations Research	OPER RES	56	INFORMS
Archives of General Psychiatry	ARCH GEN PSYCHIAT	53	American Medical Association
Transportation Science	TRANSPORT SCI	52	INFORMS
Natural Hazards	NAT HAZARDS	52	Springer

3.3. Country visualization. Country is one key aspect of cooperation visualization. By choosing the node type as country, we got the country visualization of the 500 studies on disaster logistics, as Figure 3 shows. In Figure 3, the threshold of times cited is 6, that

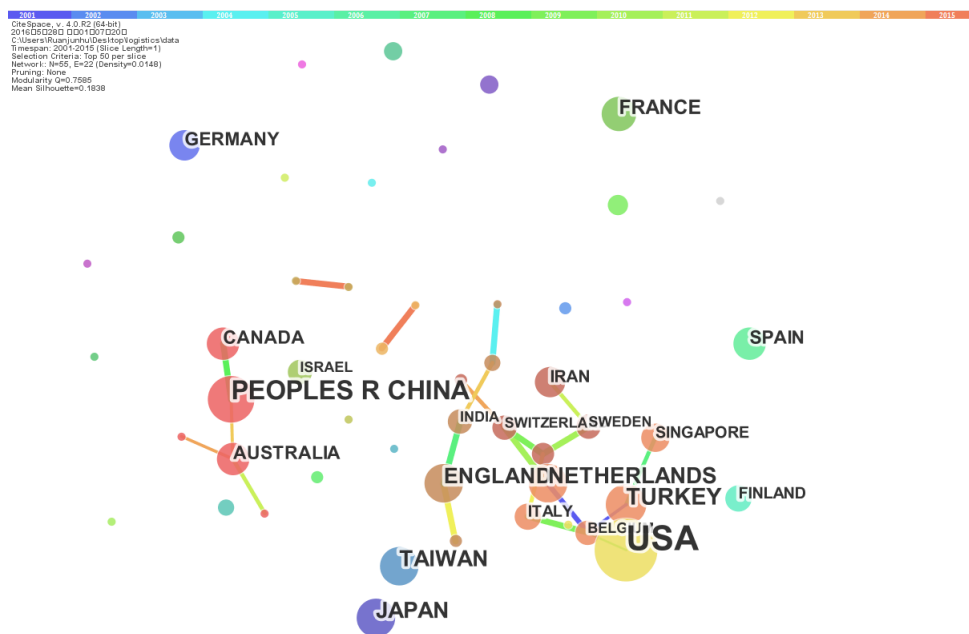


FIGURE 3. Country visualization

is, all the countries with more than 6 citations are labeled out. We also labeled out the hot period in these countries using different colors, as the top bar shows in Figure 3.

Based on the citations, USA, China, Turkey, Netherlands, Taiwan, Japan and then other countries or regions make decreasing contributions to the intellectual bases of disaster logistics. Meanwhile, these countries have different hot periods. Japan, Germany and Taiwan focused on the disaster logistics at an earlier stage, mainly before 2004; Finland, Spain, France and Israel were the next followers, mainly during 2004 and 2010; Recently, the research attention was extended to more countries including USA, Turkey, Netherlands, England, China, Canada and Australia.

From the country visualization, we could find the development path of disaster logistics research and identify the current hot areas. Meanwhile, the research connections among countries could also be detected. For example, China, Australia and Canada have close academic cooperation on the disaster logistics research, so for England and India, Turkey and Singapore. The formulation of these academic connections is mainly due to the exchange and cooperation among related researchers.

3.4. Author visualization. Author is one another aspect of cooperation visualization. By selecting the node type as author, we got the author visualization of the 500 studies, as Figure 4 shows. Based on the author visualization, we could find the most influential researchers on disaster logistics.

Linet Özdamar, from Yeditepe university, ranks the top in the list. Actually, several Ozdamar's cooperators are also identified as the most influential scholars on disaster logistics, such as Wei Yi from Nanyang Technological University and Gülay Barbarosoglu from Bogaziçi University. Burcu Balcik ranks the second. She is from Ozyegin University, who is another outstanding Turkey scholar focusing on disaster logistics. Her cooperator, Benita M. Beamon from University of Washington, is also identified as one of the most influential scholars on disaster logistics. As we can see, the above Turkey scholars and their cooperators made an outstanding contribution to the development of disaster logistics research.

Another group of the identified scholars are from well-known management organizations. Luk N. Van Wassenhove, a leading management thinker and educator from the Business School for the World (INSEAD), is the Director of the Humanitarian Research

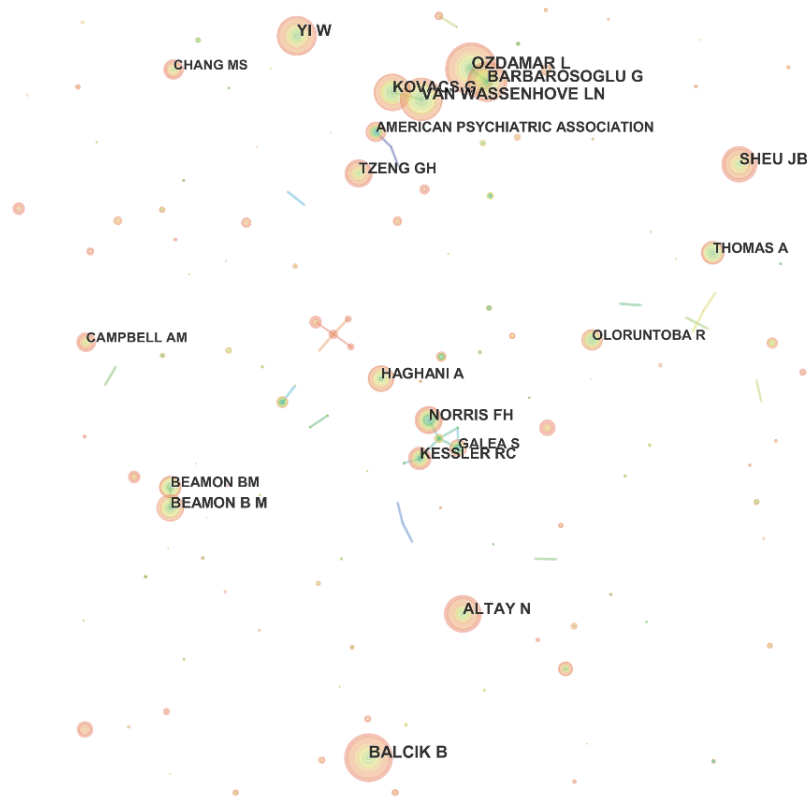


FIGURE 4. Author visualization

Group of INSEAD. His recent research has focused on managing humanitarian logistics. Gyöngyi Kovács is from Humanitarian Logistics and Supply Chain Research Institute (HUMLOG Institute). She has made plenty of works on disaster logistics, including the co-authored works with Prof. Van Wassenhove. Anisya Thomas is a co-founder of Fritz Institute which is a non-profit organization to innovate solutions and facilitate the adoption of best practices for disaster response and recovery.

Three Taiwan scholars, Jiu-Biing Sheu, Gwo-Hshiong Tzeng and Mei-Shiang Chang, formulate another group of influential researchers on disaster logistics. Actually, Sheu and Chang have some cooperation works. All the remaining identified scholars except Richard Oloruntoba are working at USA universities, such as Nezih Altay, Ali Haghani, and Ann Melissa Campbell.

3.5. Keyword visualization. The keyword term could be used to cluster intellectual bases and find research directions. After 975 iterations, 22 keywords with more 20 citations were identified, as Figure 5 shows.

The 22 keywords could be divided into three categories: Disasters, Consequences and Responses. The Disasters category includes disaster(s), natural disaster and earthquake. These keywords reflect that the current literature mainly focuses on natural disasters, especially earthquakes. We could also find the cause of this research focus from the visualized authors in Figure 4. Turkey and Taiwan scholars made the outstanding contribution to disaster logistics, because both the two regions are earthquake-prone. The Consequences category includes PTSD (posttraumatic-stress-disorder), trauma, mental-health, depression, symptoms and prevalence. As we can see, the mental consequence gets the most attention, but it is really difficult due to the characteristics of complication and prevalence.

The Responses category includes two aspects. The first aspect shows the general methods, such as the model, operations, optimization, management and framework. This

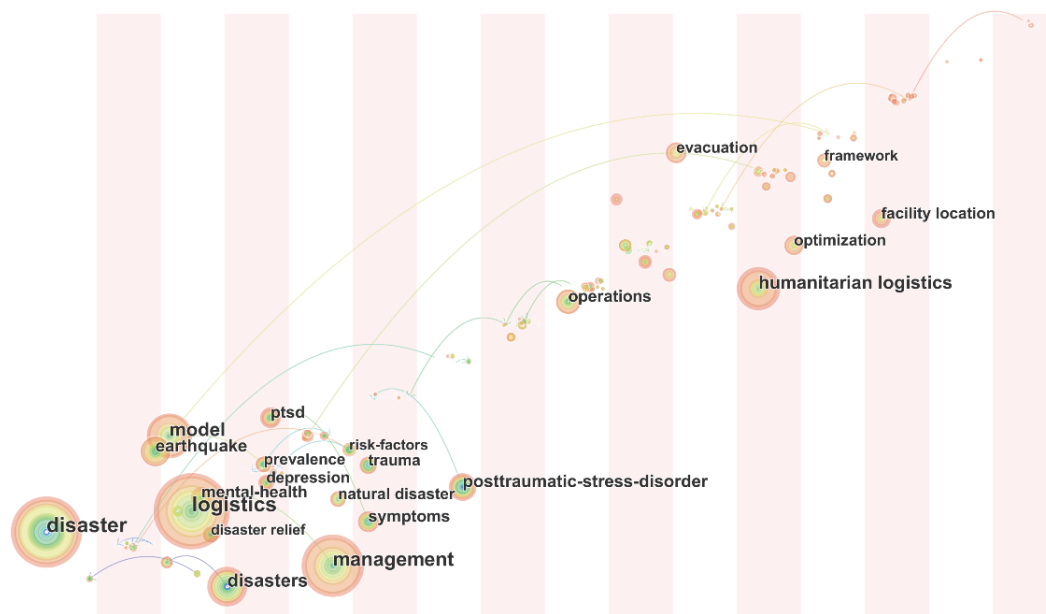


FIGURE 5. Keyword visualization

aspect shows operation optimization models, management methods and framework are the main types of applied methodologies in response to disasters. The other aspect shows the specific response problems, such as disaster relief, logistics, humanitarian logistics, facility location, evacuation and risk-factors. These identified response problems have attained popular attention in the literature.

4. Conclusions. In this work, we collected 500 records on disaster logistics from Web of Science, and conducted a visualization review on these studies using one mainstream co-citation analysis tool – CiteSpace. In comparison with several extant review works, our review was based on the citations of collected studies, which detected the intellectual bases, research fronts and development trends in the literature on disaster logistics. By the visualization of cited references, cited journals, countries, authors and keywords, the review provides specific guidance to help researchers and publishers conduct further studies on disaster logistics.

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