A bibliometric analysis of research on haze during 2000–2016

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Introduction

Haze, which is produced by smoke, fog, dust and other tiny particles in the air, often occurs in metropolis [1, 5]. Haze is mainly composed of PM10 and PM2.5. Haze weather can not only reduce visibility, increase the frequency of traffic accidents, but also cause decline in air quality and induce respiratory and cardiovascular diseases[2,3,4]; The haze phenomenon can also have an impact on the earth's climate effect by affecting the earth's radiation budget situation[6,7,8]. Therefore, haze problem has attracted more and more attention.

Some scholars have analyzed the solutions of controlling haze weather [9, 10, 11]. Fu and Chen (2017) proposed the suggestions on future directions of haze pollutions in China by reviewing factors contributing to haze formation.; Many researchers have examined the components of PM2.5 from the chemical and physical properties[12,13,14,15,16,17,18,]; There have also been many published papers which have revealed the features of haze problem from the human health perspective[19,20,21,22].

As a statistical approach on published papers, bibliometrics provides a way to analyze academic documents quantitatively [23, 24]. There have been a lot of studies which evaluate research relationships of authors, institutes, countries etc. in specific research fields [25, 26, 27, 28, 29, 30]. In recent years, a great number of publications have been published on haze and related fields. There have been 5606 documents on haze in the Science Citation Index Expanded (SCI-Expanded) and Social Science Citation Index (SSCI) of the ISI-Thomson Reuters Scientific database from 2000-2016. Much attention has been paid to haze problem, however, few papers attempted to analyze and examine global academic publications data visually. Therefore, the present study is to disclose research patterns in features of author distribution, international collaboration and academic relationship on haze research.

Materials and methods

Bibliometric methods provide an approach to identify the development trends or future research orientations by analyzing the publication output, keywords, authors, institutes, countries [31, 34]. The statistical results related to distribution of authors, institutes, countries/ territories and keywords can be visually showed by using bibliometric analysis tools including VOSviewer, Citespace, HistCite etc.

CiteSpace is a scientific visualization software which is used for visualizing and mapping statistical publication data from the ISI-Thomson Reuters Scientific database. It concentrates on distinguishing pivots in the evolution of a research field. Providing diverse functions to promote the comprehension and recognition of network patterns, CiteSpace can identify the citation hotspots in the assemblage of publications, decompose a network into clusters, label clusters with terms from citing articles (Chen, 2014). Not only upholds temporal and structural interpretations of a variety of networks retrieved from scientific documents, including collaboration networks, author co-citation networks, and document co-citation networks, CiteSpace also upholds networks of combinative node types such as authors, institutes, countries, and combinative link types [32]. CiteSpace will handle the data from the Web of Science which is the dominant source of input data [33].

The data for the present study were collected in March 2016 from Web of Science (http://webofknowledge.com). In particular, the Science Citation Index Expanded (2000-2016), Social Science Citation Index (SSCI, 2000-2016), have been collected through the online documents published by Thomson Reuters. The data retrieval strategies were set as follows:

Topic= “Haze”; it means that the word in title, abstracts or keywords of articles will be retrieved.

Timespan=2000-2016.

5473 papers from four document types including article, review, meeting abstract and proceedings paper were derived in this study.

Time Slicing was set from 2000 to 2016. Years Per Slice was set 1. Term Source was set “Title”, “Abstract”, “Author Keyords(DE)”, “Keywords Plus(ID)”.Term Type was set “Burst Terms”. Node Types were set “Author”, “Institution”, “Country”, and “Keyword” respectively. The size of circles

indicates the publication number, and the length between two circles is inversely ratio to the collaboration between two authors, countries/territories and institutes. Concretely, the shorter length between two circles is, the more collaboration between two authors is.

Results and discussion

Publication year: From the period of 2000 to 2016, 5606 documents were published in the ISI-Thomson Reuters Scientific database. In 2000, 153 documents were published; the number of documents increased as 779 was in 2016. Results revealed that the research on haze was nearly consistently the focus of scholars during the past 17 years.

Authorship: According to the data from SCI-Expanded and SSCI database, the top three most productive authors, of which were Li J. with 46 articles, Li L. with 29, Zhang Y. with 29, as well as other scholars in this domain, have made great contributions to haze research (**Fig. 1**).

Countries/territories: The publications on haze research were primarily originated from the USA, China, Germany and France (**Fig. 2**).

Institutions: The major academic contributions, which were concluded in terms of total publication frequency, primarily originated from the Chinese Acad Sci, NASA, CALTECH and Univ Arizona (**Fig. 3**).

Keywords: The primary hot topics of haze research could be concluded as “aerosol”, “atmosphere”, “particle”, “PM2.5 ”and“ air quality” from 2000 to 2016 (**Fig. 4**).

And these will still be the pivotal issues in haze research hereafter. All of these research findings could provide foundation to understand the research developing process and trends in haze analysis for researchers in the field of haze.

Acknowledgements

This study has been supported by the National Natural Science Foundation of China (41371226), National Key Technology Support Program (2015BAD06B01) and Beijing Municipal Science and Technology Project (Z161100001116016).

References

1. Kim Oanh, N.T., Leelasakultum K .(2011) Analysis of meteorology and emission in haze episode prevalence over mountain-bounded region for early warning. *Sci Total Environ.* **409(11)** 2261-2271
2. Fu H.B., Chen J.M.(2017) Formation, features and controlling strategies of severe haze-fog pollutions in China. *Sci Total Environ.***578** 121–138
3. Zhang, Z., Gong, D.,Kim, S.J., et al.(2015)Cause and predictability for the severe haze pollutions in downtown Beijing during November–December. *Sci. Total Environ.* (in press). http://dx.doi.org/10.1016/j.scitotenv.2016.12.070
4. Hand, J.L., Schichtel, B.A., Malm, W.C.(2014) Widespread reductions in haze across the United States from the early 1990s through 2011. *Atmos. Environ.* **94** 671-679
5. Yang, L., Han, L., Chen, Z.,et al.(2015). Growing trend of China's contribution to haze research *Scientometrics* **105(1)** 1-11
6. Davies, S.J., Unam, L.,1999. Smoke-haze from the 1997 Indonesian forest fires: effects on pollution levels, local climate, atmospheric CO2 concentrations, and tree photosynthesis. *Forest Ecology & Management* **124(2–3)** 137-144
7. Bytnerowicz, A., Padgett,P.E., Arbaugh, M.J., et al.,2003.Methodological needs and perspectives for monitoring ambient air pollution and regional haze: tools for understanding forest responses. *Developments in Environmental Science* **2** 263-283
8. Tonnesen, G., Wang, Z., Omary, M.,et al., 2003.Formulation and application of regional air quality modeling for integrated assessments of urban and wildland pollution. *Developments in Environmental Science* **2(02)** 299-324
9. Gao, G., 2008. The climatic features and change of haze days over China during 1961–2005. *Acta Geogr Sin*. **63(7)** 761–768
10. Voiland, A., 2009. New map offers a global view of health-sapping air pollution. NASA. http://www.nasa.gov/topics/earth/features/health-sapping.html
11. Wang, W., Zheng, G., 2013. Green paper on climate change: a report on fighting climate change 2013. Social Sciences Academic Press, pp. 184–186
12. Bates, D.V., Sizto, R., 1987.Air pollution and hospital admissions in Southern Ontario: the acid summer haze effect. *Environ Res*. **43** 317–331
13. Thurston, G.D., Iot, K., Hayes, C.G.,et al.,1994. Respiratory hospital admissions and summertime haze air pollution in Toronto, Ontario: consideration of the role of acid aerosols. *Environ Res.* **65** 271–290
14. Ma, J.Z., Xu, X.B., Zhao, C.S., et al., 2012. A review of atmospheric chemistry research in China:

photochemical smog, haze pollution, and gas-aerosol interactions. *Adv Atmos Sci.* **29** 1006–1026
15. Jansen, R.C., Shi, Y., Chen, J.M,et al., 2014.Using hourly measurements to explore the role of secondary inorganic aerosol in PM2.5 during haze and fog in Hangzhou, China. *Adv Atmos Sci.* **31** 1427–1434
16. Sun, Y., Wang, Z., Du, W., Zhang, Q., 2015.Long-term real-time measurements of aerosol particle composition in Beijing, China: seasonal variations, meteorological effects, and source analysis. *Atmos. Chem. Phys.* **15** 10149–10165
17. Zhang, X., Wang, L., Wang, W., Cao, D., et al., 2015.Long-term trend and spatiotemporal variations of haze over China by satellite observations from 1979 to 2013. *Atmos. Environ.* **119** 362–373
18. Wu, X.H.,Chen, Y.F., Guo, J.,et al.,2017. Spatial concentration, impact factors and prevention control measures of PM2.5 pollution in China. *Nat Hazards*.**86** 393-410
19. Davis, D.L., Bell, M.L., Fletcher,T .,2002.A look back at the London smog of 1952 and the half century since. *Environ Health Perspect.* **110(12)** A734–A735
20. Tie, X., Wu, D., Brasseur, G., 2009.Lung cancer mortality and exposure to atmospheric aerosol particles in Guangzhou, China. *Atmos. Environ.* **43** 2375–2377
21. Liu, Y., Li, Y., Chen, C., 2015.Pollution: build on success in China. *Nature* **517** 145
22. Ren, J., Li, B., Yu, D., Liu, J., Ma, Z., 2016.Approaches to prevent the patients with chronic airway diseases from exacerbation in the haze weather. *J Thorac Dis.* **8** E1–E7
23. Mayr, P., Scharnhorst, A., 2014. Scientometrics and information retrieval: weak-links revitalized. *Scientometrics* 1–7
24. Chen, D., Liu, Z., Luo, Z.H.,et al.,2016. Bibliometric and visualized analysis of emergy research. *Ecological Engineering* **90** 285–293
25. Abramo, G., D'Angelo, C.A., Viel,F., 2011. The field-standardized average impact of national research systems compared to world average: the case of Italy. *Scientometrics* **88 (2)** 599–615
26. Wang, M.H., Yu, T.C., Ho, Y.S., 2010. A bibliometric analysis of the performance of Water Research. *Scientometrics* **84 (3)** 813–820
27. Matthews,A. P.,2013. Physics publication productivity in South African universities.*Scientometrics* **95** 69–86
28. Gupta, B. M., Bala, A., 2012. S&T publications output of Nepal: A quantitative analysis, 2001–10.*Scientometrics* **93** 1029–1046
29. Bajwa,R.S.,Yaldram,K.,2013. Bibliometric analysis of biotechnology research in Pakistan.*Scientometrics* **95** 529–540
30. Li, W., Zhao, Y., 2015. Bibliometric analysis of global environmental assessment research in a 20-year period. *Environ. Impact Assess. Rev.* **50** 158–166
31. Li, J., Jovanovic, A., Klimek, P., et al., 2015. Bibliometric analysis of fracking scientific literature. *Scientometrics* **105** 1273. doi:10.1007/s11192-015-17397
32. Chen,C.,2004. Searching for intellectual turning points: progressive knowledge domain visualization. *Proc. Natl. Acad. Sci. U.S.A.* **101 (Suppl. 1)** 5303–5310
33. Chen, C., 2006. CiteSpace II: detecting and visualizing emerging trends and transient patterns in scientific literature. *J. Am. Soc. Inform. Sci. Technol.* **57 (3)** 359–377
34. Chen, D.,Liu, Z.,Luo, Z.,et al.,2016. Bibliometric and visualized analysis of emergy research. *Ecological Engineering* **90** 285-293

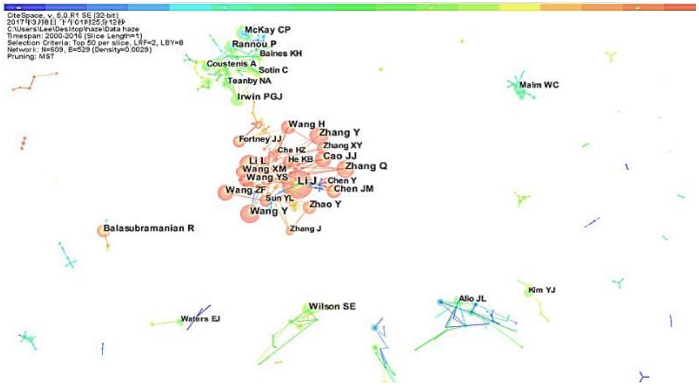

Fig. 1. Author co-citation map from 2000 to 2016

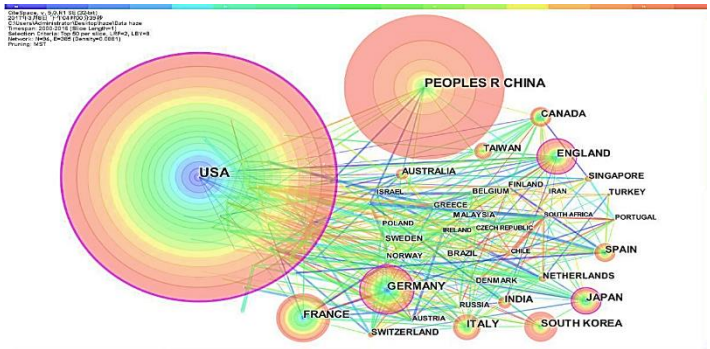

Fig. 2. Country/territory co-citation map from 2000 to 2016

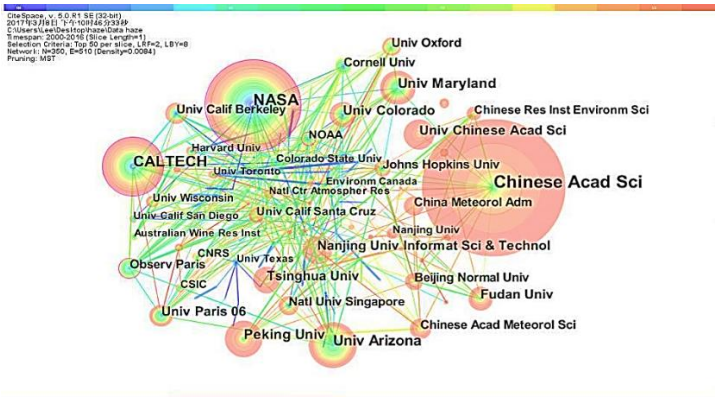

Fig. 3. Institute co-citation map from 2000 to 2016

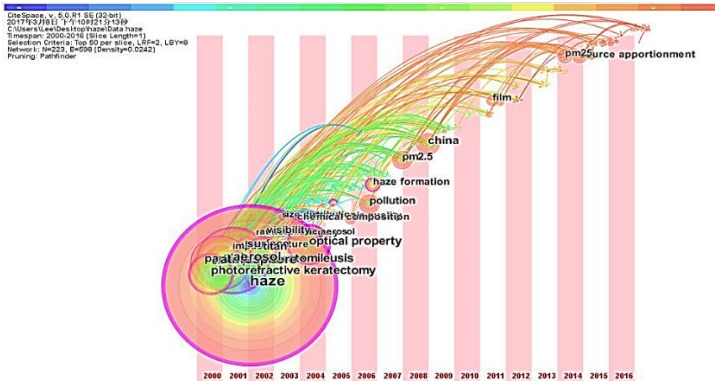

Fig. 4. Time zone view of the keywords co-citation map from 2000 to 2016