

Bibliometric analysis of “rainfall” and “Alps” research papers from 1991 to 2010

Guido Nigrelli*

* Consiglio Nazionale delle Ricerche,
Istituto di Ricerca per la Protezione
Idrogeologica.

1. Introduction

Geographically and climatically, the Alps are one of Europe's most complex regions. Covering an area of 390,000 km² and comprising several metropolitan areas, the region provides an attractive working and living space for 70 million inhabitants. Historically, it is also a major contact zone between Germanic, Latin and Slavic populations (Alpine Space Programme, 2011).

The birthplace of mountain meteorology, the European Alps have been the subject of numerous climatological studies (Barry, 2008). The region's climate is highly complex due to interactions between the mountains and the general atmospheric circulation, resulting in gravity wave breaking, blocking highs, and föhn winds. Compounding this complexity is the competing influence of four very different climatological regimes: Mediterranean, Continental, Atlantic, and Polar (Beninson, 2005). Unsurprisingly, one of the most complex and extensively studied climatic parameters in the region is rainfall. But how many recent studies on the rainfall in the Alps are there? And which European countries have mostly contributed to scientific research on the rainfall in the Alps? These are the two questions we will try to answer.

2. Bibliometric data

Using the Web of Science® (henceforth WoS), we conducted a bibliometric analysis of global research ac-

tivities associated with rainfall and the Alps. The WoS provides access to the world's leading citation databases. Authoritative, multidisciplinary coverage includes current and retrospective journal and proceedings data in the sciences, social sciences, arts, and humanities. WoS is available via the ISI Web of Knowledge, a comprehensive research platform of choice for over 20 million users in 90 countries worldwide.

The present analysis was based on scientific publications in peer-reviewed journals listed in five WoS databases: Science Citation Index Expanded (SCI-EXPANDED); Social Sciences Citation Index (SSCI); Arts & Humanities Citation Index (A&HCI); Conference Proceedings Citation Index-Science (CPCI-S); and Conference Proceedings Citation Index-Social Science & Humanities (CPCI-SSH).

For the analysis we used the “Topic” search field which includes title, abstract, author keywords and Keywords Plus®. Instances in the main text are not included. We chose four keywords in various combinations: “rainfall”; “rain* event*”; “Alps”; and “alpine”. Wildcards can be entered in all search fields that allow words and phrases. We used the asterisk (*) in “rain* event*” keyword to represent any group of characters, including no character (e.g., rains, rainfall, events). Importantly, in these cases it is the author who defines what he or she intends as rainfall and rainfall event, or Alps and alpine, as in the instance of “mountain” (Körner, 2009). In a more detailed search, the first two keywords were combined with the other two with the Boolean search operator “AND”. Data for analysis were collected on April 13, 2011.

Rainfall in the European Alps is a highly complex and extensively studied climatic parameter. But how many studies on rainfall in the Alps have been published recently? And which European countries have principally contributed to scientific research on this topic? In this bibliometric analysis of global research concerning both rainfall and the Alps, a total of 98,774 documents were retrieved using the Web of Science® and Italy ranked first as the authors' country with the highest number of papers on this subject.

Keywords: Bibliometric analysis; Precipitation; Rainfall; Alps; Italy.

Analisi bibliometrica con parole chiave “rainfall” e “Alps”, per il periodo 1991-2010. In ambiente alpino le piogge sono un parametro climatico di notevole importanza ma piuttosto complesso da studiare. A proposito di questo, quanti sono gli studi sulle piogge in ambiente alpino che sono stati recentemente pubblicati? Quali sono i paesi che hanno maggiormente contribuito allo sviluppo delle conoscenze in tale materia? Per rispondere a queste due semplici domande è stata eseguita un'analisi bibliometrica utilizzando il ben noto Web of Science®. L'elaborazione dei dati ha evidenziato una produzione scientifica di 98774 documenti, per un periodo indagato che va dal 1991-2010 e la nazione che ha maggiormente contribuito a questi studi è stata l'Italia.

Parole chiave: Analisi bibliometrica; Precipitazioni; Piogge; Alpi; Italia.

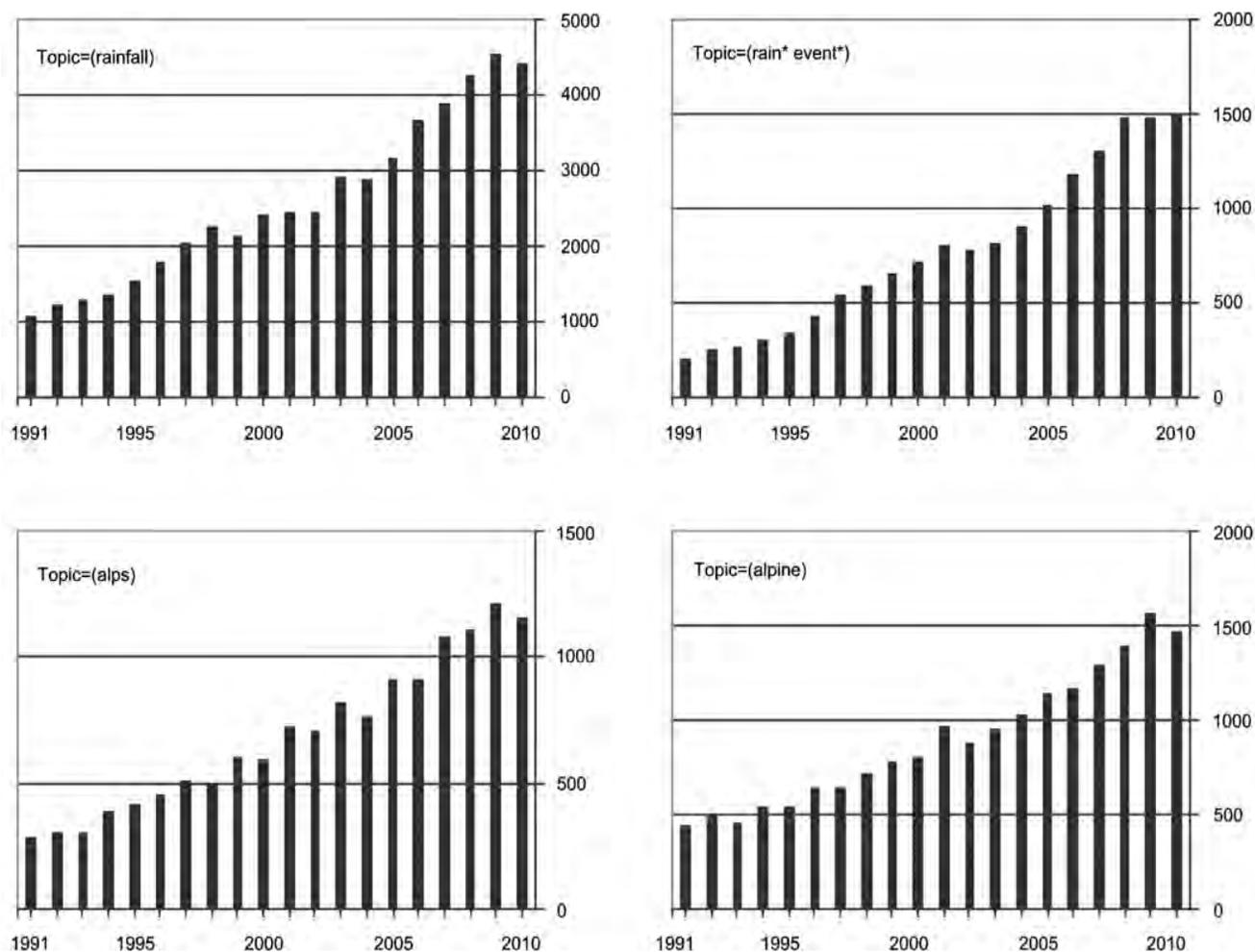


Fig. 1. Chronological distribution of ISI publications in the 20-year period from 1991 to 2010.

Andamento della quantità di pubblicazioni ISI annuali (periodo 1991-2010), riferite alle quattro tipologie di parole chiave utilizzate ("pioggia", "evento pluviometrico", "Alpi", "alpine").

3. Results of bibliometric analysis

A total of 98,774 documents were retrieved (all languages and not only in english), of which the major output of scientific research was presented in journal articles (77,564; 79%), followed by proceedings papers (16,564; 17%), and reviews (2,648; 3%). Specifically, the keyword "rainfall" retrieved 51,710 documents; "rain* event*" 15,457; "Alps" 13,719; and "alpine" 17,888 (Tab. 1). When ranked by subject area, "Water resources" was most often associated with the search term "rainfall" (10,993; 21%), "Meteorologic & atmospheric sciences" with "rain* event*" (3,621; 23%), and "Alps" and "alpine" with "Geosciences, multidisciplinary" (3,275; 24% and 3,122; 17%, respectively). In the matches between subject area and search terms, there was an evident difference in the types of major subject areas between rain ("rainfall" plus "rain* event*") and Alps ("Alps" plus "alpine") research.

Fig. 1 shows the four trends for the keywords "rainfall", "rain* event*", "Alps" and "alpine". The annual number of ISI publications related to the four keywords

increased meaningfully during the 20-year period from 1991 to 2010.

A second, more detailed step of the bibliometric analysis concerned the number of publications per country (authors' countries) retrieved by combining the four keywords. For this purpose, we entered the keyword combinations: "rainfall AND Alps"; "rainfall AND alpine"; "rain* event* AND Alps"; and "rain* event* AND alpine". Analysis by authors' country is illustrated in Table 2. The keyword combination "rainfall AND Alps" appeared in 380 documents, "rainfall AND alpine" in 418, "rain* event* AND Alps" in 253, and "rain* event* AND alpine" in 241. Italy ranked first for all four keyword combinations (25%, 20%, 26%, and 20%, respectively, of the total). Likely reasons for these rankings may be: 1) the amount of land area of Italian Alps (>80,000 km²); 2) prevalence of instability processes triggered by heavy rainfall (Luino, 2005); 3) effects of climate change on alpine tourist areas (Chiarle & al., 2007); 4), a long-standing scientific tradition and intense research activity. In general, the Swiss continue to lead mountain research, as observed previously (Körner, 2009).

Tab. 1. Number of ISI publications per subject areas for the 20-year period (1991-2010), using four and single keywords. Numero di pubblicazioni ISI restituite dal motore di ricerca (periodo 1991-2010), raggruppate per area tematica di appartenenza e suddivise per chiave di ricerca singola.

Subject areas	Number of ISI publications						
	rainfall	rain* event*	Sum	Alps	alpine	Sum	Total
Water resources	10,993	3,599	14,592				14,592
Meteorologic & atmospheric sc.	10,480	3,621	14,101				14,101
Environmental sciences	8,286	3,141	11,427		1,993		13,420
Geoscience, multidisciplinary	8,075	2,979	11,054	3,275	3,122	6,397	17,451
Ecology	4,607	1,309	5,916		2,466		8,382
Geochemistry & geophysics				2,095	1,525	3,620	3,620
Geology				2,014			2,014
Geography, physical				1,283			1,283
Mineralogy				1,047			1,047
Plant sciences					1,753		1,753
Sum	42,441	14,649		9,714	10,859		77,663
Others	9,269	808		4,007	7,027		21,111
Total	51,710	15,457		13,719	17,888		98,774

4. Conclusions

This bibliometric analysis of “rainfall” and “Alps” research shows a growing interest in these topics in the 20-year period from 1991 to 2010, derived perhaps in part from international and/or transnational research programmes on Alpine climate which have made a meaningful contribution to rainfall studies (HISTALP, 2011). The two scientific journals that have published the greatest number of articles containing the keywords “rainfall” and “Alps” were the *Journal of Hydrology* (2,335 articles) and *Tectonophysics* (694 articles), respectively.

Several ideas for further study may originate from this work. It would be interesting to extend the analysis to other disciplines correlated with “rainfall” and/or “Alps” research, such as different types of natural instability processes and climate change.

Analysis of bibliographic productivity has become a guiding practice as a reference for scientific output at the national or institutional level. New institutes for scientometrics are beginning to appear in many countries, with an eye to assessing national productivity in science, as shown in published research output (Sarmiento & Butler, 2011). For the 20-year period from 1991 to 2010, WoS database searches using “bibliometric” as a keyword yielded only 2,147 documents. On a final note, useful tools for citational bibliometric analysis of the statistical usage measurement of research for successful data monitoring should be in the hands of the research producers rather than in those of commercial entities with a vested interest in influencing investment strategies and national and international research policies (De Robbio, 2007).

Tab. 2. Number (and rank) of ISI publications per country for the 20-year period (1991-2010), using combined keywords. A: Austria, CH: Switzerland, D: Germany, F: France, I: Italy, SLO: Slovenia.

Numero di pubblicazioni ISI restituite dal motore di ricerca, raggruppate per Paese di provenienza degli autori (periodo 1991-2010) e suddivise per chiave di ricerca combinata. Fra parentesi è riportato il posizionamento del Paese rispetto al totale rilevato.

Countries	Number of ISI publications (rank)			
	rainfall	rainfall	rain* event*	rain* event*
	AND Alps	AND alpine	AND Alps	AND alpine
A	22 (8 th)	21 (11 th)	17 (7 th)	12 (8 th)
CH	66 (3 th)	62 (3 th)	57 (2 nd)	48 (2 nd)
D	37 (5 th)	50 (4 th)	30 (4 th)	31 (4 th)
F	72 (2 nd)	43 (5 th)	49 (3 th)	26 (5 th)
I	95 (1 st)	82 (1 st)	67 (1 st)	49 (1 st)
SLO	8 (13 th)	4 (18 th)	6 (12 th)	4 (16 th)
Sum	300	262	226	170
Others	80	156	27	71
Total	380	418	253	241

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