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MAPPING OF GLOBAL NATURAL HAZARDS RESEARCH PRODUCTIVITY DURING 2006-2015

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Abstract

This paper examines with scientometric tools a total of 7659 publications on natural hazards indexed in web of science database during the period 2006-2015. The average number of publications published per year was 765.9. The highest number of publications (1264) was recorded in the year 2015. The relative growth rates (RGR) has decreased from 2007 (0.72) to 2015 (0.18) in the span of 10 years. The doubling time (DT) has gradually increased from 0.96 in 2007 to 3.85 in 2015. The exponential growth of publications was observed during the study period. Majority of publications were found in English language. Authors from USA have contributed maximum number of publications compared to the other countries and India stood 8th rank in terms of productivity in this period. A total of 7274 different institutions were involved in the productivity, among them Harvard University, USA contributed highest number of 110 articles. The subject Geology contributed the largest share (22.93%) among subjects followed by Environmental science ecology (19.66%), water resources (15.45%) and Meteorology atmospheric sciences (12.43%) etc since the natural hazards are delt by many disciplines.

Keywords: *Productivity on Natural hazards, Trend in the productivity, relative growth rate and doubling time.*

1. Introduction

Natural hazards are frequently occurring now a days because the imbalance created by the human in the physical and social environments of the globe. A natural hazard is a natural phenomenon that might have a negative effect on humans or the environment. Natural hazards are naturally occurring physical phenomena caused either by rapid or slow onset events which can be grouped into two broad categories. Geophysical hazards encompass geological and meteorological phenomena such as avalanche, earthquakes, volcanic eruption, wildfire, cyclonic storms, floods, drought, blizzard, hailstorm, heat wave, tornado, ice storm, climate change, coastal erosion, fires are socio-natural hazards since their causes are both natural and manmade. Biological hazards can refer to a diverse array of disease and infestation. So the natural hazards effects are increasing day by day and creating danger for human life in the coming years. This is clear from the scientometric evidence from 2006 to 2015, that the number of publications in the Web of Science database was increased from 372 to 1133. Therefore the present study has been undertaken to know the growth and development of publications in the field of natural hazards.

Scientometrics is one of the most important measures for the disciplines of science based on published literature and communication. Scientometric analysis is the quantitative study of a subject growth by using bibliometric indicators and statistical tools and techniques. It throws light on the pattern of growth of individual to the respective subject literature, inter-relationship among different branches of knowledge, productivity, authorship pattern, degree of collaboration, pattern of collection building, and their use. Scientometric evaluation is a very key component of any research and development activity. One well known productivity indicator is the number of publications produced by the scientists, institutions and countries. Studies like this will provide some insight into the complex dynamics of research activity and enable researchers, scientists, policy makers and science administrators to provide adequate facilities and proper guidance in which direction the researches to be conducted. Hence, such an indispensable technique is used to evaluate the quality and quantity of literature published across disciplines within a particular geographical area.

2. Objectives for the Study

The present study has been undertaken with the objectives of analysing the following aspects:

- Year wise growth of publications
- Most prolific authors

- ❖ Highly productive countries
- ❖ Highly productive institutes
- ❖ Language-wise distribution of publications
- ❖ Most preferred source titles for publication in the field and
- ❖ High productive subject areas

3. Materials and Methods

The Web of Science database was used for retrieving data on natural hazards in topic field. A total of 7659 publications were downloaded and analysed by using the Microsoft excels per the objectives of the study. The Web of Science database allows us to refine the results in terms of publication years, countries, institutes, authors, language, subjects and source titles.

4. DATA ANALYSIS AND INTERPRETATIONS

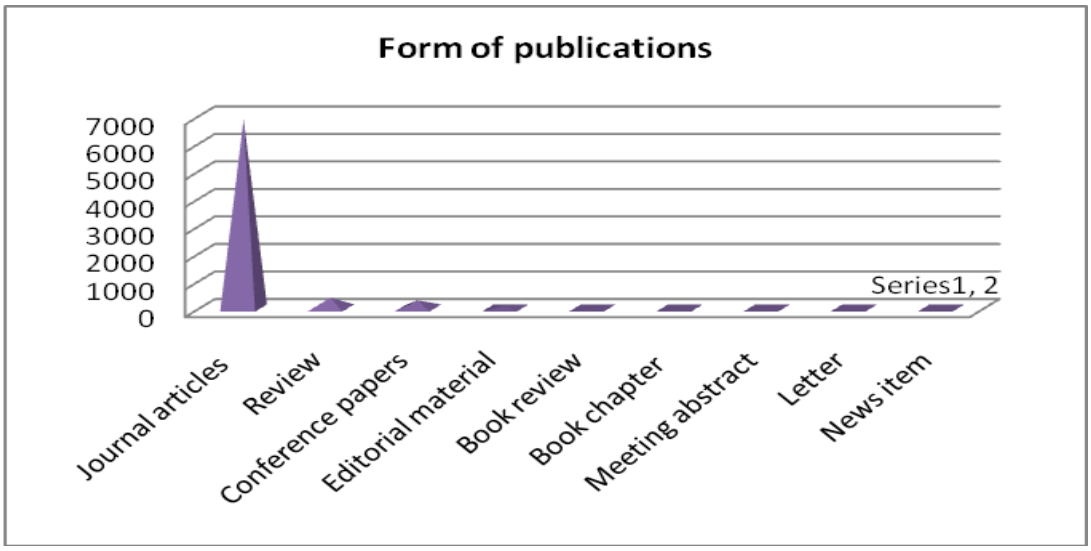
4.1 FORMS OF PUBLICATIONS

Table 1 Forms of publications

S. No.	Forms of publications	No. of publications	Percentage
1	Journal articles	6868	89.67
2	Review	378	4.93
3	Conference papers	277	3.62
4	Editorial material	98	1.28
5	Book review	17	0.22
6	Book chapter	11	0.14
7	Meeting abstract	5	0.07
8	Letter	3	0.04
9	News item	2	0.03
Total		**7659**	**100.00**

The table 1 reveals that the major source of publications covered by web of science databases on natural hazards research is Journal articles with 6,868 publications (89.67%) followed by Review articles with 378 publications (4.93%). Conference papers ranks the third position with 277 publications (3.62%) and Editorial material with 98 publications (1.28%) and remaining forms are less than one percentage as seen in the table. The results indicate that the research outputs on natural hazards of the period covered by the study are mostly published in the form of journal articles.

Figure 1 Form of publications



4.2 TREND ANALYSIS - METHOD OF LEAST SQUARES

The least square method is used for the trend analysis so as to focus or predict the trend for the future of further ten years from 2016 to 2025. It is a new approach to the field of Scientometric made by this paper. However, this projection for the future may be depends upon the obselence characters of the subject. If the obselence is quick, this may not be suitable. This method works on the following formula:

The straight line trend has an equation of the type: $Y = a + bX$,

Where,

Y represents the estimated values of the trend, X represents the deviations in time period; ‘a’ and ‘b’ are constants.

The values of two constants ‘a’ and ‘b’ are estimated by solving the following two normal equations.

$$\sum Y = Na + b\sum X$$

$$\sum XY = a \sum X + b\sum X^2$$

Where N represents number of years for which data is given.

The variable X can be measured from any point of time as origin. To make calculation simpler, it is better to take the mid-point of time as the origin because the negative values of first half of the time series will equalize the positive values in the second half of the series which symbolically gives $\sum X = 0$.

When $\sum X = 0$, the two normal equations for finding the constants 'a' and 'b' will be

$$\Sigma Y = Na \Rightarrow a = \frac{\Sigma Y}{N} = Y$$

$$\Sigma XY = b\Sigma X^2 \Rightarrow b = \frac{\Sigma XY}{\Sigma X^2}$$

This provides that the constant 'a' is simply equal to the mean of Y values and the constant 'b' gives the rate of change. The constant 'a' refers to the Y intercept, i.e. the difference between the point of origin and the point where the trend line touches the Y axis. The constant 'b' refers to the slope of the line which indicates the change in Y for each unit change in X.

Table 2 Computation of Straight Line Trend by the Least Squares Method

Year	No. of Publications Actual (Y)	Deviation	Multiply (X)	XY	X^2	No. of Publications Trend
2006	428	-4.5	-9	-3852	81	354
2007	448	-3.5	-7	-3136	49	445
2008	553	-2.5	-5	-2765	25	537
2009	587	-1.5	-3	-1761	9	629
2010	663	-0.5	-1	-663	1	720
2011	746	1	1	746	1	812
2012	908	1.5	3	2724	9	903
2013	995	2.5	5	4975	25	995
2014	1067	3.5	7	7469	49	1087
2015	1264	4.5	9	11376	81	1178
2016			11			1270
2017			13			1361
2018			15			1453
2019			17			1545
2020			19			1636
2021			21			1728
2022			23			1819
2023			25			1911
2024			27			2003
2025			29			2094
	7659			15113	330	24480

The equation of the straight line trend is Y= a + bX

Since ∑ X=0, therefore

$$a = \frac{\sum Y}{N} = \frac{7659}{10} = 765.9$$

$$b = \frac{\sum XY}{\sum X^2} = \frac{15113}{330} = 45.80$$

Thus substituting the value of 'a' and 'b' in the straight line of the trend, we get

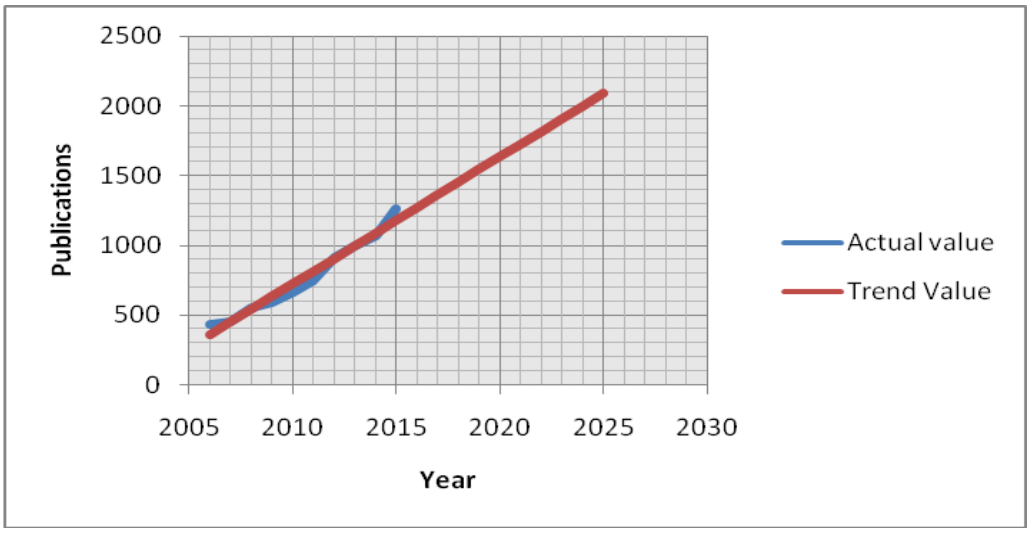
$$Y = a = bX \Rightarrow Y = 765.9 + 45.80 \times X$$

Estimate of 2025 will be calculated on the basis of X= 29

$$Y_{2025} = 765.9 + 45.80 \times 29 = 2094.1$$

Table 2 shows that the Trend value of the total publications, calculated year wise. Increasing trend is seen in next 10 years of the period. The Trend value has been increased from 354 in 2006 to 2094 in 2025.

Figure 2 Trend of the Natural hazards literature



4.3 GROWTH OF PUBLICATIONS

Relative Growth Rate (RGR) and Doubling Time

The Relative Growth Rate (RGR) is the increase in number of articles or pages per unit of time. This definition derived from the definition of relative growth rates in the study of growth analysis in the field of natural hazards

. The mean relative growth rate (R) over the specific period of interval can be calculated from the following equation.

Relative Growth Rate (RGR)

1 - $2R=\text{Log } W_2 - \text{Log } W_1 / T_2 - T_1$

Whereas

1-2 R- mean relative growth rate over the specific period of interval

$\text{Log}_e W_1$ - log of initial number of articles

$\text{Log}_e W_2$ - log of final number of articles after a specific period of interval

$T_2 - T_1$- the unit difference between the initial time and the final time

The year can be taken here as the unit of time.

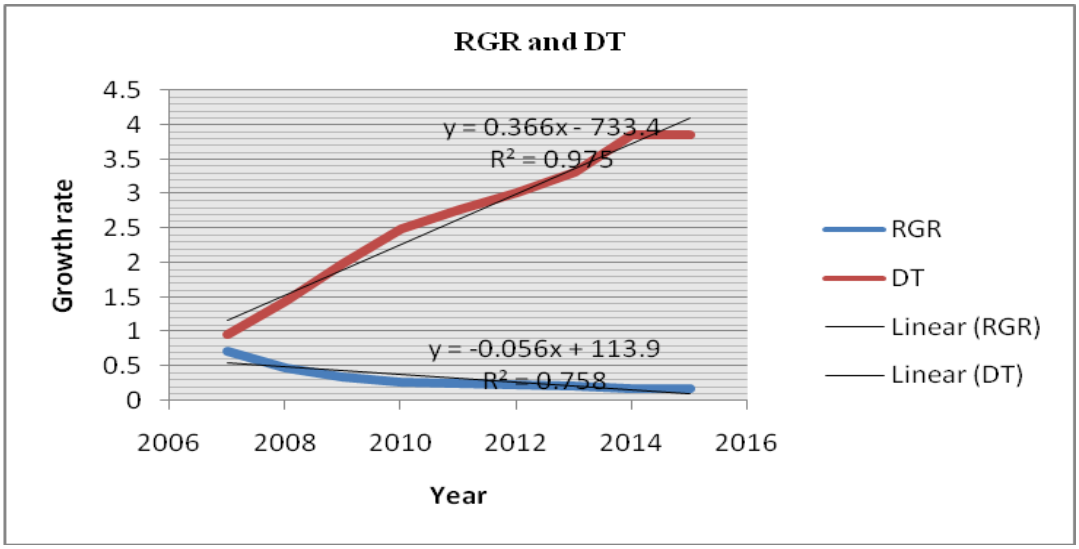
Doubling Time (DT) = 0.693/R

Table 3 Relative growth rate (RGR) and Doubling time (DT) of publications

Year	No. of Publications (%)	Cumulative Total	W1	W2	RGR	DT
2006	428 (5.59%)	428	-	6.06	-	-
2007	448 (5.85%)	876	6.06	6.78	0.72	0.96
2008	553 (7.22%)	1429	6.78	7.26	0.48	1.44
2009	587 (7.66%)	2016	7.26	7.61	0.35	1.98
2010	663 (8.66%)	2679	7.61	7.89	0.28	2.48
2011	746 (9.74%)	3425	7.89	8.14	0.25	2.77
2012	908 (11.85%)	4333	8.14	8.37	0.23	3.01
2013	995 (12.99%)	5328	8.37	8.58	0.21	3.30
2014	1067 (13.93%)	6395	8.58	8.76	0.18	3.85
2015	1264 (16.50%)	7659	8.76	8.94	0.18	3.85

The year wise RGR is found to be in the range of 0.72 to 0.18. It has been observed from Table 2 and figure 2 that RGR is downward trend from 2007 (0.72) to 2015 (0.18). The doubling time (DT) was upward trend from 2007 (0.96) to 2015 (3.85).

Figure 3 Relative growth rates for research output



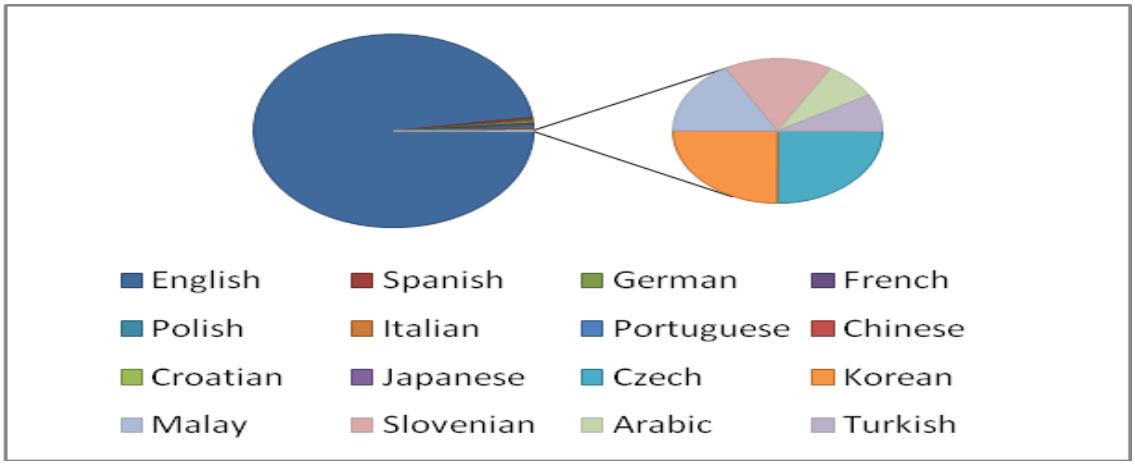
4.4 LANGUAGE WISE DISTRIBUTIONS

Table 4 Language wise distribution of publications

Rank	Language	No. of Publications	Rank	Language	No. of Publications
1	English	7488 (97.77%)	9	Croatian	4 (0.05%)
2	Spanish	37 (0.48%)	10	Japanese	4 (0.05%)
3	German	34 (0.44%)	11	Czech	3 (0.04%)
4	French	30 (0.39%)	12	Korean	3 (0.04%)
5	Polish	27 (0.35%)	13	Malay	2 (0.03%)
6	Italian	10 (0.13%)	14	Slovenian	2 (03%)
7	Portuguese	7 (0.09%)	15	Arabic	1 (0.01%)
8	Chinese	10 (0.12%)	16	Turkish	1 (0.01%)

Publications on natural hazards are spread over 16 languages. The study reveals that the maximum number of publications have been published in English language with 7488 (97.77%) publications, followed by Spanish language with 37 (0.48%) publications, German language ranks third position with 34 (0.44%) publications, French language with 30 (0.39%) publications, Polish language with 27 (0.35%) publications, Italian language with 10 (0.13%) publications and Portuguese language with 7 (0.09%) publications. The most predominant language used for communication was English in every year in total productivity on the subject during the study period.

Figure 4 Language wise distributions of publications



4.5 HIGHLY PRODUCTIVE COUNTRIES

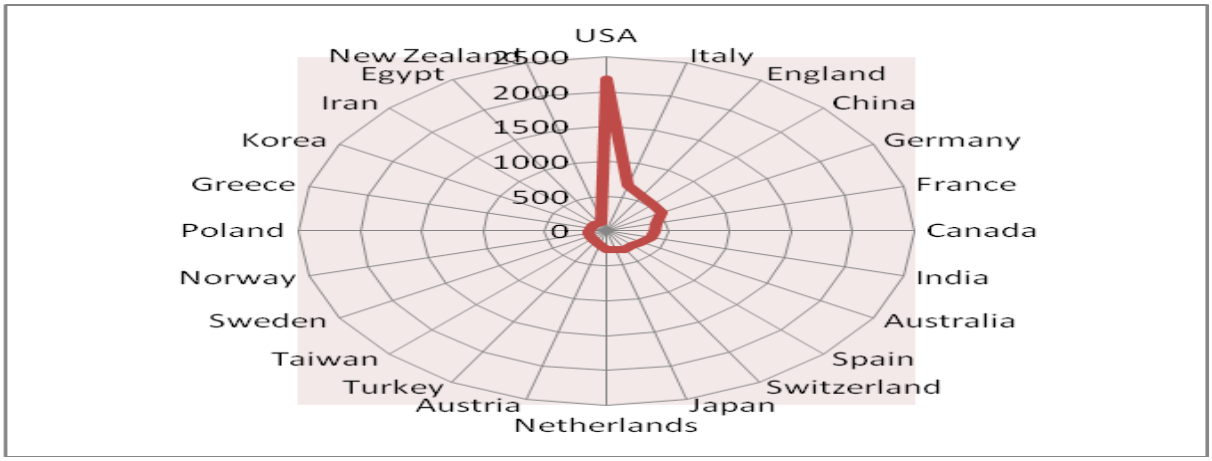
Table 5 Highly productive countries

Rank	Country	Total Publications (%)	Rank	Country	Total Publications (%)
1	USA	2183 (28.50%)	13	Netherlands	266 (3.47%)
2	Italy	682 (8.91%)	14	Austria	194 (2.53%)
3	England	579 (7.56%)	15	Turkey	171 (2.33%)
4	China	549 (7.17%)	16	Taiwan	159 (2.08%)
5	Germany	524 (6.84%)	17	Sweden	147 (1.92%)
6	France	428 (5.59%)	18	Norway	139 (1.82%)
7	Canada	401 (5.24%)	19	Poland	139 (1.82%)
8	India	383 (5.00%)	20	Greece	134 (1.75%)
9	Australia	323 (4.22%)	21	Korea	134 (1.75%)
10	Spain	302 (3.94%)	22	Iran	131 (1.71%)
11	Switzerland	302 (3.94%)	23	Egypt	125 (1.63%)
12	Japan	271 (3.54%)	24	New Zealand	125 (1.63%)

In all, there were 126 countries involved in the research in natural hazards field and which published at least one publication. The publications share of highly productive countries (≥125 publications) in natural hazards varies from 1.63% to 28.50% as seen in the table 4 and figure 4. USA topped the list with highest share 2183 (28.50%) of publications. Italy ranked second with 682 (8.91%) share of publications followed by England 579 (7.56%) share of publications, China with 549 (7.17%) share of publications, Germany with 524 (6.84%) share of publications, France with 428 (5.59%) share of publications, Canada with

401 (4.24%) share of publications and India with 383 (5.00%) share of publications and the remaining countries are publishing less than 5% of the research output in this study period.

Figure 5 Highly productive countries



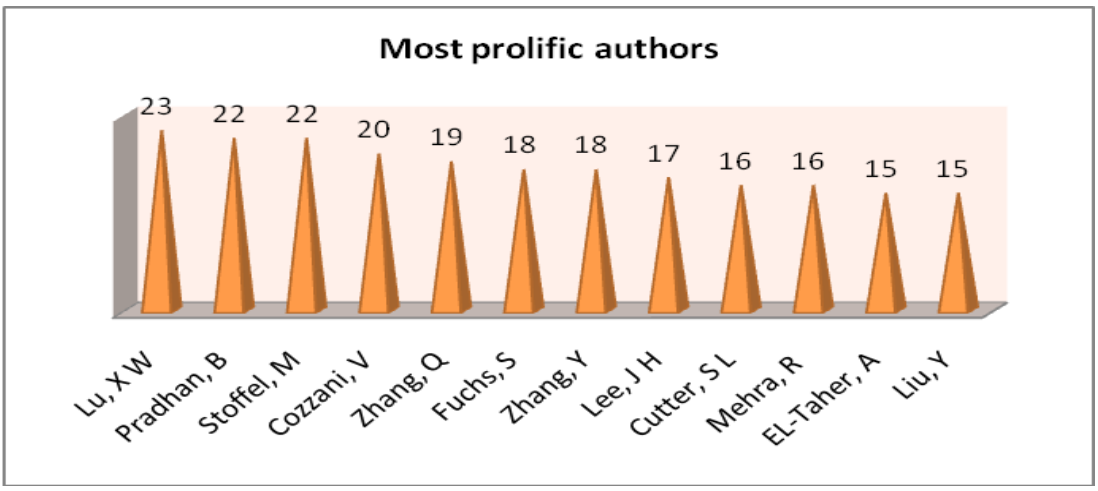
4.6 IDENTIFICATION OF MOST PROLIFIC AUTHORS

Table 6 Identification of most prolific authors

Rank	Author	No. of publications	Percentage
1	Lu, X W	23	0.30
2	Pradhan, B	22	0.29
3	Stoffel, M	22	0.29
4	Cozzani, V	20	0.26
5	Zhang, Q	19	0.25
6	Fuchs, S	18	0.24
7	Zhang, Y	18	0.24
8	Lee, J H	17	0.22
9	Cutter, S L	16	0.21
10	Mehra, R	16	0.21
11	EL-Taher, A	15	0.20
12	Liu, Y	15	0.20

The authors having 15 or more publications during 2006-2015 are given in Table 6. Lu, X W is the most productive author with 23 (0.30%) publications followed by Pradhan, B with 22 (0.29%) publications, Stoffel, M with 22 (0.29%) publications, Cozzani, V with 20 (0.26%) publications, Zhang, Q with 19 (0.25) publications, Fuchs, S with 18 (0.24%) publications, Zhang, Y with 18 (0.24%) publications and Lee, J H with 17 (0.22%) publications respectively. And a total of 28,503 authors are contributed entire research output of the period under study.

Figure 6 Most prolific authors



4.7 HIGHLY PRODUCTIVE INSTITUTES

Table 7 Highly productive institutes

Rank	Institutions	Country	No. of Publications	Percentage
1	Harvard University	USA	110	1.44%
2	Chinese Academic of Sciences	China	103	1.35%
2	College of Natural Resources, Berkeley	USA	80	1.05%
3	University of North Carolina	USA	77	1.01%
4	Mayo Clinic	USA	71	0.93%
5	Columbia University	USA	63	0.82%
6	University of Washington	USA	62	0.81%
7	University California San Francisco	USA	60	0.78%
8	IST Nazl Geofis & Vulcanol	Italy	58	0.78%
9	Indian Institute of Technology	India	56	0.73%
10	Texas A & M University	USA	55	0.72%
11	United States of Geological Survey	USA	53	0.69%
12	ETH Zurich	Switzerland	52	0.68%
13	University of Bern	Switzerland	50	0.65%

Table 7 presents the top 13 institutes that have contributed 50 or more publications on natural hazards during 2006-2015. A total of 7,274 institutions are contributed entire research output of the study. Harvard University, USA topped the list with 110 (1.44%) publications followed by Chinese Academy of Science, China with 103 (1.35%) publications, College of Natural Resources, Berkeley, USA with 80 (1.05%) publications, University of North Carolina, USA with 77 (1.01%) publications, Mayo Clinic, USA with 71 (0.93%) publications, Columbia University, USA with 63 (0.82%) publications, University of Washington, USA with 62 (0.81%) publications and University California San Francisco, USA with 60 (0.78%) publications.

4.8 MOST PREFERRED SOURCE TITLES

Table 8 Source Title of Publications

Rank	Source Title	No. of Publications	Percentage	Impact Factor
1	Natural hazards	428	5.59%	1.719
2	Natural hazards and earth system sciences	208	2.72%	1.735
3	Radiation protection dosimetry	104	1.36%	0.861
4	Environmental earth sciences	89	1.16%	1.059
5	Geomorphology	74	0.97%	2.577
6	PLOS One	69	0.90%	3.234
7	Journal of radioanalytical and nuclear chemistry	61	0.80%	0.983
8	International Journal of Disaster Risk Reduction	58	0.76%	1.242
9	Risk Analysis	57	0.74%	2.366
10	Journal of coastal research	50	0.65%	0.852

Table 8 provides the leading journals each with number of publications and impact factor. The scientific literature on natural hazards is spread over 2167 different web of science source journals. It reveals that Natural Hazards the list with the highest number of publications 428 (5.59%) and the impact factor is 1.719, followed by Natural hazards and earth system sciences with a share of 208 (2.72%) publications and the impact factor is 1.735. Radiation protection dosimetry occupies the third position with 104 (1.36%) publications and the impact factor is 0.861. The fourth highest source title is Environmental earth sciences with 89 (1.16%) publications and the impact factor is 1.059, Geomorphology with 74 (0.97%) publications and the impact factor is 2.577 and PLOS One with 69 (0.90%) publications and the impact factor is 3.234.

4.9 HIGH PRODUCTIVITY SUBJECT AREAS

Table 9 High productivity subject areas

Rank	**Subject**	**No. of Articles**	**Percentage**
1	Geology	1756	22.93
2	Environmental sciences ecology	1506	19.66
3	Water resources	1183	15.45
4	Meteorology atmospheric sciences	952	12.43
5	Engineering	839	10.95
6	Public environmental occupational health	471	6.15
7	Nuclear science technology	343	4.48
8	Physical geography	318	4.15

The scientific literature on natural hazards is spread over 117 different subjects. Table 9 shows high productivity subjects which are contributing more than 300 articles. It is found that Geology has highest number of articles with 1756 (22.93%) followed by Environmental sciences ecology contributing 1506 (19.66%) articles. Water resources occupy the third position with 1183 (15.45%) articles. The fourth highest articles belonged to the subject Meteorology atmospheric sciences with 952 (12.43%) articles, Engineering with 839 (10.95%) articles and Public environmental occupational health with 471 (6.15%) articles respectively.

5. Conclusions

The present study attempted to highlight the growth and development of research publication on natural hazards. A total of 7659 publications were published during 2006-2015 and the average number of publication per year was 765.9. The single most prevalent type of publications is the journal, in which 89.67 % of the total literature is published. It is found that natural hazards researcher's preferred medium of communication is journal articles. The exponential growth of publication was observed during the study period. Lu, X W is the most productive author with 23 (0.30%) publications followed by Pradhan, B with 22 (0.29%) publications and Stoffel, M with 22 (0.29%) publications. A total of 28,503 authors are contributed entire research output of the period under study. USA topped the list with highest share 2183 (28.50%) of publications. Italy ranked second with 682 (8.91%) share of publications followed by England with 579 (7.56%) share of publications, China with 549 (7.17%) share of publications and Germany with 524 (6.84%) share of publications. Harvard University, USA topped the list with 110 (1.44%) publications followed by Chinese Academy of Sciences, China with 103 (1.35%) publications, College of Natural Resources, Berkeley, USA with 80 (1.05%) publications, University of North Carolina, USA with 77 (1.01%) publications, The scientific literature on natural hazards is spread over 2167 different web of science source titles.

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