

# Bibliometric Analysis of Urban Runoff Study with help of Google Scholar

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## Abstract

The paper discusses the dynamics of research frontiers on urban runoff problems. The outbursts of digitized and indexed Google Scholar publications on the subject under study happened in the 1960s-1970s and in 1994-1998. Besides, the first full-text publications, whose titles include studied terms, appeared during the first time lapse. It shows that a share of full-text publications on the problem in question changes from 16 to 22%, of which a share of journal articles makes up 43-44%. A frequency distributions of journals and authors collectives, who published articles on urban runoff problem in 2012-2013, showed that those articles were published in 47 journals, of which the most frequent ones were Urban Water Journal, Journal of Hydrology and Huan Jing Ke Xue.

**Keywords:** Google Scholar, Urban runoff, Bibliometric analysis, Structural dynamics, Frequency distribution, Publication activity

## 1 Introduction

Nowadays a problem of studying, simulating and driving the urban runoff is of current interest because it has started to influence on water bodies much more than industrial and household wastewater. A phenomenon of urban runoff was noticed by specialists in late 19th - early 20th due to the flooding of urban areas and a necessity of rapid removal of urban storm water into water bodies through special sewers (Kuichling, 1889; Lloyd-Davies, 1906).

All the achievements in developing engineering methods to calculate urban runoff as of the end of the 1940s had been generalized in Hydrology Handbook (ASCE Hydrology Committee, 1949), as of the early 1960s – in Handbook of Applied Hydrology (Chow, 1964).

As cities and traffic intensity went up, the load on urban surfaces grew significantly. In this regard, specialists have become to take heed of the fact that urban runoff exerts a negative impact on water bodies receiving it. The first systematic field studies in this sphere were conducted by Cincinnati Water Research Laboratory, U.S. Department of the Interior, whose experts published their works in Journal of Water Pollution Control Federation (Weibel, et al., 1964; Evans, et al., 1968).

After obtaining an extensive amount of field data on water quality of urban runoff, researchers started developing system (imitation) models on forming water quality of urban runoff, which contained blocks of pollutants accumulated in urban areas during dry lapses and when cleaning street during those periods, as well as the block of calculation of runoff hydrograph during rainfall events and the block of calculation of removing pollutants during those events (calculation of pollute graph). The first of such models designed were Storm Water Management Model (SWMM) (Metcalf and Eddy, In, 1971) and STORM (Hydrology Engineering Center, 1976).

More than a century of studying of urban runoff allows to analyse trends in the development of such studies. The most appropriate methods for that are scientometric or bibliometric analyses. These methods have been widely applied to the analysis of scientometric outputs and research trends.

To identify publications on the subject under study using advance search of Google Scholar, in line “with exact phrase” one can test terms “urban runoff”, “urban run-off” and ‘urban stormwater’, and in the line below, we type ‘scientometric’ or ‘bibliometric’. After that one can carry out a test in a reverse order, i.d. in line ‘with exact phrase’ we type ‘scientometric’ or ‘bibliometric’, and in the line below we type our special terms. In this way we managed to identify a number of papers that are the most relevant to our topic. Thus in (Blank, et al., 2013), with the help of Web of Science Database, we tested the terms of ‘green roof’, ‘ecological roof’, ‘living roof’, et al. and found out that publications on ‘green roof’ appeared only sporadically in late 1960s and during 1970s. Until 1992 only 4 publications were listed by ISI. The number of papers steadily increased from the early 90s, reaching 74 papers in 2012. It is important to note that ‘green roof’ topic is closely related to the “urban runoff” topic.

In (Hassan, et al., 2014), on the ground of Scopus Database (2000-2010), the authors studied publication activity, citation, citation per article by countries and top-15 institutions by different sub-areas of sustainable development topic. In this bibliometric study a large number of key words were tested, among which were the most suitable to our investigation such as ‘urban water’ in ‘water’ topic.

In (Ali Khan & Ho, 2012), the basis of Web of Science Database was used to retrieve the top-cited articles in environmental sciences having 500 or more total citations from these publications to 2010.

Scientometric analysis on the basis of SCI-Expanded was led for constructed wetlands topic (Zhi & Ji, 2012).

In all the above articles (Blank, et al., 2013; Hassan, et al., 2014; Ali Khan & Ho, 2012; Zhi & Ji, 2012), identified with help of Google Scholar, the terms under study occurred episodically.

According to Wang & Ho (Wang & Ho, 2011), in recent years many bibliometric investigations have been carried out in environment-related topic.

Among these works, (this article mentions 18 of such works), there were investigations related to water resources (Wang, et al., 2011; Chuang, et al., 2011; Wang, et al., 2010). And despite the fact (mentioned by Wang & Ho (Wang & Ho, 2011) that water-related topics received the most attention from researches in comparison with other environmental topics, there are still no bibliometric studies on problem of 'urban runoff'.

## 2 Methods

As an instrument for bibliometric analysis, we will use Google Scholar. To analyse long-term

dynamics of publication clusters or research fronts generated by terms 'urban runoff', 'urban run-off' and 'urban stormwater', we will test these terms in advance search with exact phrase at five-year time intervals after receipt of the first responses. The search will be conducted through the options 'anywhere in the article' and 'in the title article'. For the latter case, we will additionally define publication sets with full text.

The last publication sets will be allocated at five-year time intervals according to edition types: Journals, Books, Thesis, Reports, Conference Papers, Chapter of Books.

As the final step, there will be performed a frequency distribution of journals and authors' collectives, who published articles in these journals on the urban runoff problems over a two-year (throughout 2012-2013), based on this distribution, we will obtain the distribution of journal articles by authors' countries.

## 3 Results and Discussion

Testing terms 'urban runoff', 'urban run-off' and 'urban stormwater' through advanced search, with help of Google Scholar, in the line 'with exact phrase' at five-year time intervals resulted in the outputs displayed in Table 1.

**Table 1. Dynamics of publications obtained through testing terms 'Urban runoff', 'Urban run-off' and 'Urban stormwater' with help of Google Scholar, 27.01.2014-05.02.2014.**

Years	Urban Runoff <sup>1)</sup>			Urban Run-off <sup>2)</sup>			Urban Stormwater <sup>3)</sup>		
	Any-where in the article	In the title article	Full text, in the title article	Any-where in the article	In the title article	Full text, in the title article	Any-where in the article	In the title article	Full text, in the title article
1934-1938	1	0	0	0	0	0	0	0	0
1939-1943	2	0	0	0	0	0	0	0	0
1944-1948	3	3	0	0	0	0	0	0	0
1949-1953	2	2	0	0	0	0	0	4	0
1954-1958	0	0	0	1	0	0	2	0	0
1959-1963	14	7	0	1	0	0	2	0	0
1964-1968	49	12	0	4	0	0	16	3	0
1969-1973	311	82	8	28	0	0	43	10	1
1974-1978	1070	290	21	62	3	1	380	111	5
1979-1983	1140	255	22	130	7	0	576	144	19
1984-1988	1330	216	16	119	4	0	487	98	6
1989-1993	1590	167	12	182	5	0	737	144	9
1994-1998	2410	207	25	292	10	2	1290	246	21
1999-2003	4610	253	53	532	10	4	2340	290	46
2004-2008	7560	332	97	759	10	4	4330	383	106
2009-2013	9410	401	106	989	7	2	6800	469	160
Sum	29502	2227	360	3099	56	13	17007	1898	373
Unlimited time	36600	2330		3220	58		17850	2020	

<sup>1)</sup> 27.01.2014; <sup>2)</sup> 04.02.2014; <sup>3)</sup> 05.02.2014

In the table we can see that the first indexed Google Scholar publications took place in the 1930s.

Thus the outputs of classical studies, which resulted in developing methods of calculating urban runoff:

runoff-rational (Kuichling, 1889; Lloyd-Davies, 1906), time-area (Linsley, et al., 1958) and unit-hydrograph method (Sherman, 1932), have been neither digitized nor put up on the Internet yet. An outburst of digitized and indexed Google Scholar publications on the subject under study happened in the 1960s-1970s, which meant an increased awareness of the importance of that problem as well as with a wide range of studies initiated in the USA after the establishment of the Environmental Protection Agency. Another significant outburst of publications on the topic was in 1994-1998.

A share of full-text publications, whose titles included the term 'urban runoff', of the total number of publications amounted to:  $(360 / 29502) * 100\% = 16.2\%$ . For the term 'urban stormwater', this share equals to:  $(373 / 17007) * 100\% = 21.9\%$ . As seen from Table 1, the first full-text publications, whose headlines embody studied terms, refer to 1960s-1970s.

The structural dynamics of full-text publications, whose titles include terms 'urban runoff' and 'urban stormwater', is shown in Table 2.

**Table 2. Structural dynamics of full-text publications obtained through testing terms 'Urban runoff' and 'Urban stormwater' with help of Google Scholar, 27.01.2014-05.02.2014.**

Years	Edition types													
	Journals		Books		Theses		Reports		Conference papers		Chapter of books		Sum	
	UR*	US**	UR	US	UR	US	UR	US	UR	US	UR	US	UR	US
1969-1973	0	0	2	0	3	0	3	1	0	0	0	0	8	1
1974-1978	2	0	6	0	2	2	9	3	2	0	0	0	21	5
1979-1983	1	2	13	3	1	0	6	4	1	8	0	2	22	19
1984-1988	7	3	6	0	2	1	0	2	1	0	0	0	16	6
1989-1993	6	3	2	0	1	0	3	2	0	4	0	0	12	9
1994-1998	5	7	3	1	2	3	6	7	9	3	0	0	25	21
1999-2003	17	16	4	0	5	5	13	12	12	12	2	1	53	46
2004-2008	54	50	2	2	8	13	11	11	19	29	3	1	97	106
2009-2013	66	81	0	3	16	28	12	16	11	30	1	2	106	160
Sum	158	162	38	9	40	52	63	58	55	86	6	6	360	373

\* - Urban Runoff (27.01.2014)

\*\* - Urban Stormwater (05.02.2014)

From this we can see the shares of journal articles for the terms in question are approximately the same and make up about 43-44%. A share of Conference papers for these terms ranged from 15.3 to 23.1%, Reports share– from 15.6 to 17.5%, Thesis share – from 11.1 to 13.9%. The smallest shares of full-text publications were for Chapters of Books (1.6-1.7%) and Books (2.4-10.6%).

When studying the structure of publications, we noticed that Theses are most frequently located in electronic repositories of Australian universities: [eprints.usq.edu.au](http://eprints.usq.edu.au) and [eprint.lib.uts.edu.au](http://eprint.lib.uts.edu.au). Many

Reports were introduced by the US Geological Survey (Water-Resources Investigations Reports, [pubs.usgs.gov](http://pubs.usgs.gov)) and Water Resources Research Institute of the University of North Carolina. Also a sufficiently large number of publications were introduced in voluminous Water Resources Monograph 'Urban Stormwater Hydrology'.

A frequency of distribution of journals and authors' collectives, who published articles in these journals on the runoff urban topics for two-year period, is displayed in Table 3.

**Table 3. Frequency distributions of journals and authors collectives, who published articles in these journals on the ‘Urban runoff’ problems, obtained with help of Google Scholar. Term ‘Urban runoff’ in the article title 2012-2013, 04.02.2014.**

N/N	Journal Name	Number of papers	National and International Co-authorship	Number of papers
1	Urban Water Journal (vol. 9)	6	Canada, Austria	1
			Israel, USA	1
			Sweden	1
			Portugal	1
			India	1
			Poland	1
2	Journal of Hydrology (vol. 496)	5	France, UK, Portugal	1
			Japan, Sweden	1
			China, UK	1
			France	1
			USA	1
3	Huan Jing KeXue (vol. 33)	5	China	5
4	Water Research (vol. 46)		USA, Australia	1
			Denmark	1
			USA	1
			Saudi Arabia	1
5	Frontiers of Environmental Science and Engineering (vol. 6)	4	China	4
6	Journal of the American Water Resources Association (vol. 48)	4	USA	4
7	Water Science and Technology (vol. 68)	4	Australia	1
			China	1
			Denmark	1
			South Korea	1
8	Journal of Environmental Management (vol. 128)	3	China	1
			China	1
			Germany, USA	1
9	Environmental Science and Pollution Research (vol. 20)	3	China, USA	1
			China	1
			China	1
10	Environmental Pollution (vol. 183)	2	China, USA	1
			USA	1
11	Environmental Science and Technology (vol. 46)	2	USA	2
12	Hydrological Processes (vol. 27)		Sweden, Canada	1
			USA	1
13	Journal of Irrigation and Drainage Engineering (vol. 139)	2	Spain, Chile	1
			China	1
14	Science of the Total Environment (vol. 431)	2	UK	1
			Canada	1
15	Journal of Environmental Engineering (vol. 138)	2	USA	2
16	Advanced Materials Research (vol. 588-589)	2	China	2
17	Hydrology and Earth System Science	2	Iran	2

18	International Journal of Environmental Research and Public Health (vol. 10)	2	China	1
			Taiwan	1
19	Desalination and Water Treatment (vol. 51)	2	China	1
			South Korea	1
20	Separation and Purification Technology (vol. 84)	1	China, USA	1
21	International Journal of Applied Earth Observation and Geoinformation (vol. 16)	1	Poland, Belgium	1
22	Environmental Engineering Research (vol. 17)	1	South Korea	1
23	International Journal of Environmental Research (vol. 7)	1	Mexico	1
24	Journal of Hydroinformatics (vol. 15)	1	USA, Taiwan	1
25	International Journal of Environmental Health Science and Engineering (vol. 2)	1	Iran, Australia	1
26	International Journal of Environmental Science and Technology (vol. 9)	1	Malaysia	1
27	Journal of Environmental Quality (vol. 42)	1	Denmark	1
28	Marine Pollution Bulletin (vol. 64)	1	USA	1
29	PLoS One (vol. 7)	1	Australia	1
30	Water, Air and Soil Pollution (vol. 223)	1	USA	1
31	Critical Reviews in Environmental Science and Technology	1	India	1
32	Hydrology Research	1	China	1
33	Malaysian Journal of Society and Space (vol. 8)	1	Malaysia	1
34	Microbial Ecology (vol. 65)	1	USA	1
35	Transactions American Geophysical Union (vol. 94)	1	USA	1
36	Frontiers of Earth Science	1	China	1
37	Environmental Science: Processes and Impact (former Journal of Environmental Monitoring) (vol. 20)	1	Sweden	1
38	Riscuri Si Catstrophe (vol. 11)	1	Hungary	1
39	International Journal of River Basin Management (vol. 10)	1	Malaysia, Australia	1
40	Environmental Monitoring and Assessment (vol. 185)	1	China, USA	1
41	ISH Journal of Hydraulic	1	India	1
42	Bulletin of Environmental Contamination and Toxicology (vol. 90)	1	China	1
43	Urban Ecosystems (vol. 16)	1	USA	1
44	Journal of Hydrologic Engineering (vol. 18)	1	USA	1
45	International Journal of Geosciences (vol. 4)	1	USA	1
46	Journal of Hazardous, Toxic and Radioactive Waste (vol. 17)	1	USA	1
47	International Journal of Darshan Institute on Engineering Research and Emerging Technologies (vol. 1)	1	India	1

As seen from this table, relevant articles on the subject in question ('urban runoff' term was included in the article title) for two-year period were published in 47 journals, the most popular of which were Urban Water Journal, Journal of Hydrology and Huan Jing Ke Xue.

Along with established journals like Journal of Hydrology (vol. 496), Water, Air and Soil Pollution (vol. 223), Journal of Irrigation and Drainage

Engineering (vol. 139), Transactions American Geophysical Union (vol. 94) and others, we can see new Chinese (Frontiers of Environmental Science and Engineering (vol. 6), Frontiers of Earth Science (vol. 6)) and Iranian (Hydrology and Earth System Science (vol. 16), International Journal of Environmental Health Science and Engineering (vol. 2)) journals.

The distribution of journal articles by countries of the authors is shown in Table 4.

**Table 4. Distribution of journal articles by countries of the authors (articles with international co-authorship are distributed over different countries). Google Scholar, term 'Urban runoff' in the article title 2012-2013, 04.02.2014.**

Country	Article
USA	28
China	27
Australia	5
Sweden, India	by 4
UK, Canada, Denmark, South Korea, Iran, Malaysia	by 3
France, Portugal, Poland, Taiwan	by 2
Japan, Israel, Saudi Arabia, Germany, Spain, Chile, Belgium, Mexico, Austria, Hungary	by 1

As seen, the largest number of authors publishing articles on problems of urban runoff work in the USA and China. Additionally, scientists from 25 countries now elaborate on this subject.

#### 4 Conclusion

So, with help of Google Scholar, we have studied the dynamics of research frontiers on urban runoff problems. We have found out that outbursts of digitized and indexed Google Scholar publications on the subject under study happened in the 1960s-1970s and in 1994-1998. Besides, the first full-text publications, whose titles include studied terms, appeared during the first time lapse.

We have found out that a share of full-text publications on the problem in question changes from 16 to 22%, of which a share of journal articles makes up 43-44%. A frequency distributions of journals and authors collectives, who published articles on urban runoff problem in 2012-2013, showed that those articles were published in 47 journals, of which the most frequent ones were Urban Water Journal, Journal of Hydrology and Huan Jing Ke Xue. As this frequency analysis shows, the largest number of authors, pub-

lishing these articles, work in the USA, and China, and the total number of countries, in which the present problem is studied, is 25.

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