International Conference "Water, Environment, Energy and Society" (WEES–2009)
New Delhi, 12–16 January 2009

A Bibliometric and Citation Analysis of Drinking Water-Related Research in India

R. Malarvizhi[1] and N. Sulochana[2]
Department of Chemistry
National Institute of Technology, Trichy - 620 015, INDIA
E-mail: [1]malar_abc@yahoo.com; [2]sulochan@nitt.edu

Ming-Huang Wang and Yuh-Shan Ho[3]
Department of Environmental Sciences
College of Environmental Science and Engineering
Peking University, Beijing, 100871, People's Republic of CHINA
E-mail: [3]dr_ysho@hotmail.com

ABSTRACT: The main aim of the study is to investigate the trend and performance in drinking water related research in India for the past 16 years. For this paper we used Science Citation Index (SCI), Institute for Scientific Information (ISI) database to investigate the research work related to drinking water in India. There is a steady increase in publications related to drinking water research till 2004 and a sudden increase in 2005 to 2007. More collaborative work has been carried out with USA. Maximum number of articles in drinking water was published by the journal *Fluoride*. Arsenic has been used as the most popular keyword used frequently in the last 6 years and adsorption is another keyword in the same period.

INTRODUCTION

Water is one of the prime elements responsible for life on earth. In many countries, to avoid health problems from water borne bacteria, tube wells have been sunk to aquifers containing water free from micro-biological contaminants. In some instances, these aquifers have been found to contain water with high arsenic levels. This arsenic contamination invariably arises from natural geological and environmental conditions. Our drinking water today, contains more than 200 commercial chemicals. Fluoride is another major, naturally occurring contaminant in drinking water in many regions of the world. At low levels, say 1 mg/L, it is found to be beneficial in preventing dental cavity. However, exposure to high levels can cause structural tooth damage and at a high level can cause skeletal damage. Certain areas of India and China have very high levels of Fluoride giving rise to major health problems. The geological crust in India is very rich in fluoride bearing minerals (Ramesam, 1987); because of that nearly 20 million people from 17 states suffer from high fluoride concentration in drinking water. The presence of carbonate and bicarbonate ions plays an important role in the conversion of fluorite into fluoride (Jacks *et al.*, 2005; Saxena and Ahmed 2001). In six districts of West Bengal arsenic has been found in ground water above the maximum permissible limit recommended by the WHO of 0.05 mg/L.

So far the largest population exposed to inorganic arsenic is West Bengal in India and Bangladesh (Rahman, 1998). A large population in West Bengal in India has been exposed to naturally occurring inorganic arsenic through their drinking water (Chatterjee, 1995; Das, 1995). A cross-sectional survey involving 7683 participants of all ages was conducted in an arsenic-affected region between April 1995 and March 1996 (Mazumder *et al.*, 1998). According to the study by the National Academy of Sciences, arsenic in drinking water causes liver, lung, kidney, and bladder cancer (Smith, 1992; Chen, 1992; Smith, 1998; Hopenhayn-Rich, 1996; Hopenhayn-Rich, 1998). The study also found that arsenic harms the central and peripheral nervous systems (Rodriguez, 2003), as well as heart and blood vessels, and causes serious skin problem (Das, 1995). It may cause birth defects and reproductive problems. (Kwok, 2006). Drinking water would be the major source of exposure for people living near a source of arsenic. Drinking water-related research has been conducted for many decades (van't, 1902; Forbes and Pratt, 1903; Sammis, 1912;

[1]Conference speaker

Rook, 1976; Martyn, 1989; Smith, 1992; Smith, 2000; Nickson, 2005). For further development in drinking water research in India, we attempted to do bibliometric analysis for the drinking water related literature published by Indian researchers from 1992 to 2007. This will provide a comprehensive evaluation of current drinking water related research in India. Such information may have significant implications for research policy and resource allocation.

METHODOLOGY

The 2007 edition of the Journal Citation Reports (JCR), published by the Institute for Scientific Information (ISI), lists 6,166 journals in the Science Citation Index (SCI). Data used in this research were obtained from the online version of the ISI Web of Science: SCI (Science Citation Index). All documents from 1992 to 2007 with "India" in the address field and which had the following keywords were downloaded: drinking water, drinking waters, drinkable waters, and drinking waterborne. In total, 918 publications met the selection criteria. Upon further examination, only 850 publications were categorized as "articles". The others were reviews (43), notes (9), meeting abstracts (7), editorial materials (6), and letters (3) were obtained from the results of the search for document types. Downloaded information included names of authors, contact address, title, year of publication, keywords, subject categories of the journal, names of journals publishing the articles, and times cited for each year. The records were downloaded into Excel spreadsheet software, and additional coding was manually performed for the number of authors, country of origin of the collaborators, and impact factors of the publishing journals. Impact factors were taken from the Journal Citation Report (JCR) published in 2007.

To assess the visibility of an article, we used the number of times it was cited as an indicator. However, the numbers of times cited for an article is highly correlated with the length of time since its publication. To adjust for that, a new variable was created. Figure 1 shows the relationship between the average number of times cited per paper and the number of years since its publication for the 850 articles and the 918 papers of all documents. It shows that the frequency of being cited was highest in the 2nd full year since its publication, and began to decrease thereafter. Thus, to adjust for bias due to differences in the length of time since publication, a new variable, TC2 (times cited before year 2), instead of just times cited since publication, was used to assess the visibility of articles. A TC2 for year 2005 would be the number of times being cited before the end of 2007 for all the articles published in 2005. Another variable PCPP (Peak-Year Citation per Publication) for articles published in a particular year was calculated as TC2 divided by the number of articles published in that year. Contributions of different countries were estimated by the corporate addresses given in the byline of the publication. Articles originating from England, Scotland, Northern Ireland, and Wales were grouped under the UK heading. This is done mainly to compare the Indian researchers' paper with worldwide.

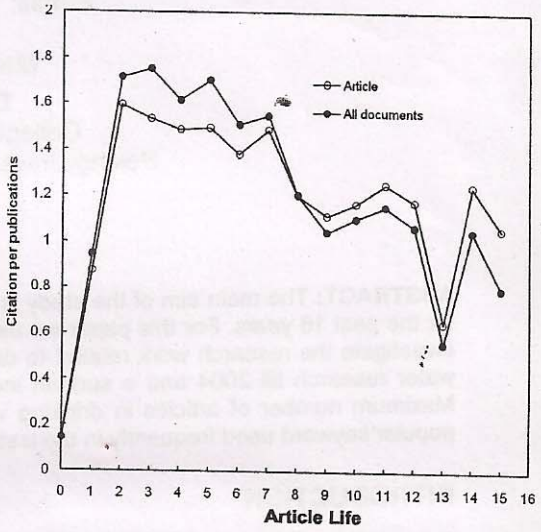

Fig. 1: Citation per publication by article life

RESULTS AND DISCUSSION

Article Characteristics

The total amounts of SCI articles including searching keywords in title during the last 100 years were counted and displayed in Figure 2. Along with the development of SCI, drinking water research continually grew in this long period, started to go up significantly in the year of 1992 and rocketed in the 21st century. The number of drinking water-related articles published by Indian researchers has significantly increased since 1992, as displayed in Table 1. There were 850 drinking water-related articles published from 1992 to 2007. There were 18 articles in 1992. There is a slow increase in articles till 2004. After that, there has been a steady increase. In 2006, it reached 106, and in 2007, articles numbers increased to 153. The growth trends of drinking water-related publications by Indian researchers relative to worldwide drinking water-related publications are displayed in Figure 3. The rate of the annual increase in the number of articles has accelerated in the last two years. The number of scientific papers written by Indian

Table 1: Drinking Water Related Articles Published by Indian Researchers from 1992 to 2007

Year	A	TC2	PCPP	AU	AU/A	PG	PG/A	NR	NR/A
1992	18	24	1.3	68	3.8	135	7.5	380	21
1993	15	13	0.87	48	3.2	96	6.4	237	16
1994	24	11	0.46	78	3.3	156	6.5	400	17
1995	22	60	2.7	84	3.8	174	7.9	515	23
1996	33	26	0.79	106	3.2	238	7.2	825	25
1997	31	54	1.7	110	3.5	212	6.8	759	24
1998	22	39	1.8	81	3.7	168	7.6	525	24
1999	41	65	1.6	156	3.8	313	7.6	1,079	26
2000	45	95	2.1	179	4.0	400	8.9	1,295	29
2001	41	80	2.0	150	3.7	324	7.9	1,209	29
2002	54	122	2.3	218	4.0	419	7.8	1,489	28
2003	67	200	3.0	273	4.1	663	9.9	2,140	32
2004	69	258	3.7	295	4.3	595	9	2,182	32
2005	109	444	4.1	457	4.2	953	8.7	3,722	34
2006	106			454	4.3	904	8.5	3,573	34
2007	153			642	4.2	1,257	8.2	5,191	34
Total	850	1,491	2.6	3,399	4.0	7,007	8.2	25,521	30

A, number of articles; AU, number of authors; PG, page count; NR, cited reference count; AU/A, the average number of author per article; PG/A, the average page count per article; NR/A: the average cited reference count per article

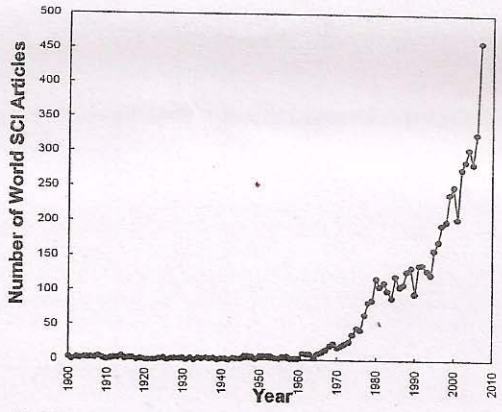

Fig. 2: Number of SCI articles referring to searching Keywords related to the title during the last 100 years

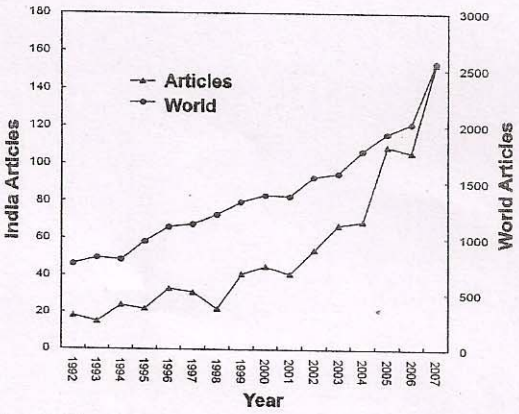

Fig. 3: Number of articles published by India and worldwide, 1992 to 2007

researchers in SCI journals increased from 106 articles in 2006 to 153 articles in 2007. Table 1 also shows TC2 and PCPP. Since PCPP were calculated based on the frequency of being cited before the 2nd full year of article life, articles published after 2005 would not have the above two parameters. Only 591 articles had a PCPP value and this value also fluctuated over the years.

Citation Analysis

The Citation analysis means, it is a citation count for a particular paper published in a journal which is cited in other papers published in the same journal or papers published in other journals. It is a measure of its visibility. The CPP value is suddenly increased in 1995 which is shown in Figure 4 and Table 1. This is because the health effect due to arsenic is noted in 1995 in West Bengal. So the papers published in that year were referred by many researchers. The international collaboration articles have more CPP value. The CPP value for Bangladesh papers have 10, the reason behind is this country is the worst affected (next to West Bengal) country by arsenic contamination in drinking water. Even though the number of articles published by Environmental Health Perspectives journal is less (1.0%) when compare to other journals, its CPP value is more and the impact factor is also high (9.2). Tables 2, 3, 4 and 5 gives the information about

the subject category, names of journals keywords and keywords plus along with the number of research papers published by these journals, PCPP, IF and PCPP/IF. More number of articles published under the subject environmental sciences (143), toxicology (124), Public, environmental and occupational health (70), and water resources (52). The Fluoride journal published large number of articles (27), followed by the Asian Journal of Chemistry (17), Current Science (15), Environmental Monitoring and Assessment (15), and Toxicology Letters (14). For journal citation studies, the most reliable source is impact factor which has not been replaced by any other worldwide accepted method so far (Garfield, 1955; Luukkonen, 1990). The journal Fluoride which published more number of articles had a PCPP of 1.9 and had an IF of 1.611.

In this study we listed only 18 journals and 10 subject categories from 1992 to 2005 due to the highly selective nature of the database, though totally 253 journals were published in drinking water research articles under 92 subject categories during the past 16 years. Nearly 2,251 keywords were used for this analysis. Table 4 and 5 shows keywords and keyword plus, which are appeared more than 10 papers. The most frequently used keyword was arsenic for the past 7 years. Most of the research work is related to groundwater pollution due to arsenic and fluoride. Adsorption kind of work is carried out to treat the ground water. In the keyword plus search, the most frequently used keyword was drinking water. The keywords like West Bengal, toxicity, lipidperoxidation, exposure, Bangladesh, India, and groundwater appeared more than forty papers.

Table 2: Subject Category (Top ten)

Subject Category	*TP*	*TC2*	*PCPP*	*%TP*
Environmental Sciences	143	352	2.5	24
Toxicology	124	378	3.0	21
Public, Environmental and Occupational Health	70	214	3.1	12
Water Resources	52	90	1.7	8.8
Environmental Engineering	45	126	2.8	7.6
Biochemistry and Molecular Biology	42	100	2.4	7.1
Pharmacology and Pharmacy	36	166	4.6	6.1
Analytical Chemistry	26	108	4.2	4.4
Oncology	24	49	2.0	4.1
Multidisciplinary Chemistry	24	29	1.2	4.1

Table 3: Core Journals

Journal	*TP (%)*	*TC2*	*PCPP*	*IF*	*PCPP/IF*
Fluoride	27 (4.6)	50	1.9	1.611	1.1
Asian Journal of Chemistry	17 (2.9)	4	0.2	0.173	1.4
Current Science	15 (2.5)	46	3.1	0.737	4.2
Environmental Monitoring and Assessment	15 (2.5)	20	1.3	0.793	1.7
Toxicology Letters	14 (2.4)	47	3.4	2.784	1.2
Environmental Geology	12 (2)	12	1.0	0.61	1.6
Indian Journal of Animal Sciences	10 (1.7)	2	0.2	0.064	3.1
Journal of Environmental Biology	10 (1.7)	9	0.9	0.197	4.6
Journal of Environmental Science and Health Part A-Toxic/Hazardous Substances and Environmental Engineering	9 (1.5)	35	3.9	0.669	5.8
Biological Trace Element Research	9 (1.5)	10	1.1	1.007	1.1
Water Research	9 (1.5)	44	4.9	2.459	2.0
Indian Journal of Medical Research	8 (1.4)	8	1.0	1.224	0.8
Human and Experimental Toxicology	8 (1.4)	15	1.9	1.122	1.7
Journal of the Geological Society of India	7 (1.2)	1	0.1	0.296	0.5
Cancer Letters	7 (1.2)	12	1.7	3.277	0.5
Journal of Environmental Engineering-Asce	6 (1)	12	2.0	0.725	2.8
Desalination	6 (1)	5	0.8	0.917	0.9
Science of the Total Environment	6 (1)	29	4.8	2.359	2.0

Table 4: Top 20 Keywords

Author Keywords	*TP*	*92–07 Rank (%)*	*92–95 Rank (%)*	*96–99 Rank (%)*	*00–03 Rank (%)*	*04–07 Rank (%)*
Arsenic	76	1 (8.9)	N/A	3 (5.6)	1 (9.1)	1 (15)
Drinking Water	52	2 (6.1)	3 (6.1)	1 (12)	2 (7.3)	3 (6.9)
Fluoride	41	3 (4.8)	1 (14)	2 (6.7)	13 (2.4)	5 (6.3)
Oxidative Stress	37	4 (4.4)	N/A	16 (2.2)	3 (6.7)	5 (6.3)
India	37	4 (4.4)	7 (4.1)	16 (2.2)	4 (4.8)	4 (6.6)
Adsorption	33	6 (3.9)	N/A	49 (1.1)	16 (1.8)	2 (7.7)
Groundwater	27	7 (3.2)	N/A	16 (2.2)	4 (4.8)	8 (4.5)
Zinc	24	8 (2.8)	N/A	49 (1.1)	16 (1.8)	7 (5.3)
Water	18	9 (2.1)	N/A	16 (2.2)	4 (4.8)	11 (2.1)
Lipid Peroxidation	18	9 (2.1)	20 (2)	49 (1.1)	4 (4.8)	11 (2.1)
Water Quality	17	11 (2)	N/A	16 (2.2)	4 (4.8)	15 (1.8)
Vanadium	16	12 (1.9)	7 (4.1)	16 (2.2)	11 (3)	15 (1.8)
Sodium Fluoride	16	12 (1.9)	N/A	49 (1.1)	9 (4.2)	11 (2.1)
Ground Water	16	12 (1.9)	3 (6.1)	N/A	16 (1.8)	9 (2.6)
Toxicity	15	15 (1.8)	N/A	3 (5.6)	16 (1.8)	15 (1.8)
Antioxidants	15	15 (1.8)	20 (2)	49 (1.1)	9 (4.2)	23 (1.6)
Fluorosis	14	17 (1.6)	7 (4.1)	3 (5.6)	16 (1.8)	40 (1.1)
Rats	13	18 (1.5)	7 (4.1)	3 (5.6)	16 (1.8)	58 (0.79)
Hepatocarcinogenesis	12	19 (1.4)	20 (2)	3 (5.6)	95 (0.61)	29 (1.3)
Liver	12	19 (1.4)	20 (2)	11 (3.4)	16 (1.8)	29 (1.3)
Defluoridation	11	21 (1.3)	N/A	N/A	95 (0.61)	9 (2.6)
Rat	11	21 (1.3)	20 (2)	8 (4.5)	16 (1.8)	58 (0.79)
Dental Fluorosis	10	23 (1.2)	3 (6.1)	16 (2.2)	16 (1.8)	107 (0.53)

Table 5: Top 20 Keywords Plus

Keywords Plus	*TP*	*92–07 Rank (%)*	*92–95 Rank (%)*	*96–99 Rank (%)*	*00–03 Rank (%)*	*04–07 Rank (%)*
Drinking-Water	225	1 (31)	1 (12)	1 (18)	1 (27)	1 (39)
West-Bengal	58	2 (8)	N/A	5 (7.1)	3 (9.2)	2 (8.8)
Toxicity	52	3 (7.2)	N/A	11 (5.1)	4 (8.7)	4 (8.1)
Lipid-Peroxidation	50	4 (6.9)	N/A	22 (3)	8 (6.9)	2 (8.8)
Exposure	50	4 (6.9)	36 (1.9)	11 (5.1)	2 (10)	7 (6.8)
Bangladesh	48	6 (6.7)	N/A	22 (3)	6 (8.1)	5 (7.8)
India	48	6 (6.7)	36 (1.9)	11 (5.1)	4 (8.7)	7 (6.8)
Groundwater	42	8 (5.8)	36 (1.9)	22 (3)	17 (4.6)	6 (7.6)
Cancer	39	9 (5.4)	1 (12)	2 (9.1)	12 (5.2)	19 (3.8)
Calamity	35	10 (4.9)	N/A	11 (5.1)	9 (6.4)	14 (4.8)
Adsorption	33	11 (4.6)	N/A	86 (1)	23 (3.5)	10 (6.5)
6 Districts	32	12 (4.4)	N/A	3 (8.1)	7 (7.5)	31 (2.8)
Metabolism	32	12 (4.4)	3 (7.7)	7 (6.1)	10 (5.8)	26 (3)
Removal	31	14 (4.3)	N/A	86 (1)	31 (2.9)	11 (6.3)
Affected People	31	14 (4.3)	N/A	7 (6.1)	12 (5.2)	17 (4)
Superoxide-Dismutase	30	16 (4.2)	13 (3.8)	86 (1)	18 (4)	13 (5)
Glutathione	30	16 (4.2)	3 (7.7)	37 (2)	53 (1.7)	12 (5.3)
Cells	29	18 (4)	36 (1.9)	5 (7.1)	23 (3.5)	19 (3.8)
Liver	29	18 (4)	3 (7.7)	11 (5.1)	35 (2.3)	17 (4)
Contamination	29	18 (4)	36 (1.9)	19 (4)	23 (3.5)	15 (4.5)
Induction	29	18 (4)	13 (3.8)	7 (6.1)	12 (5.2)	26 (3)

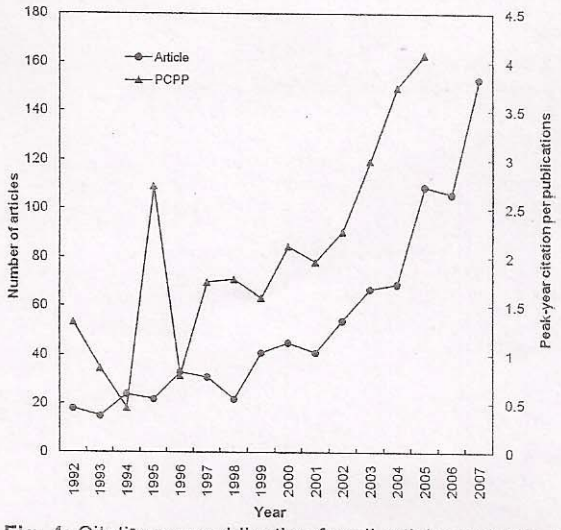

Fig. 4: Citation per publication for all articles published for the past 15 years

International Collaborations

Among the 591 articles, 103 articles, nearly 17% had International Co-Authorship (ICA). The articles with ICA were listed in Table 6 and 7. India had collaborative work with the 7 major industrial countries called G7. Mostly the articles with ICA had higher visibility than others which is reflected in the PCPP value. India had more collaborative work with US (40) followed by UK (13), Bangladesh (9), Germany (9), Japan (7) and Netherlands (7). ICA articles with the highest PCPP values were co-authored with researchers from Bangladesh, Sweden, Australia, Chile, Netherlands, and UK. The articles from these countries had average PCPP of 8.8, 8.4, 7.5, 7.0, 6.4 and 6.2 respectively. Bangladesh is our neighbor country and the problems in drinking water faced by the people in West Bengal in India and Bangladesh are very similar in arsenic content in drinking water.

Table 6: Collaboration Type of all Article Published in 1992 to 2005

Collaboration type articles published from	*TP*	*%TP*	*TC2*	*%TC2*	*PCPP*
India	488	83	1,018	68	2.1
International collaboration	103	17	473	32	4.6
Total	591	100	1,491	100	2.5

First Author and Corresponding Authors

Tables 8, 9, 10 and 11 give the information's about the first author and the corresponding authors of the articles. Out of 591 articles nearly 92% articles (546) were published by Indian researchers as first authors. It was assumed that the first author of an article performed most of the research and the corresponding author (reprint author) generally provided the professional support and funding for the published studies (Ho, 2007). The remaining 8% of the articles (45) were published by 11 foreign countries. From the Table 6 and 7, it is very clear that India had more collaborative work with USA and UK in the form of funding the projects or researchers moves to these two countries for their higher studies. A bias in analysis of authorship might occur when different authors had the same name or one author used different names (e.g. maiden names) in their articles. Confusion arises when an author moves from one affiliation to another (Macroberts and Macroberts, 1989). So it was strongly recommended that an "International Publication Identity Number (IPIN)" for all authors should be created when they published their first paper in an ISI-listed journal, to establish an unambiguous association of each author with his/her articles (Ho, 2007).

Table 7: 103 International Collaborative Articles

Country	*TP*	*TC2*	*PCPP*	*%TP*
USA	40	184	4.6	39
UK	13	81	6.2	13
Bangladesh	9	79	8.8	8.7
Germany	9	39	4.3	8.7
Japan	7	33	4.7	6.8
Netherlands	7	45	6.4	6.8
Sweden	5	42	8.4	4.9
Canada	4	15	3.8	3.9
South Africa	4	1	0.3	3.9
Chile	3	21	7.0	2.9
France	3	4	1.3	2.9
Australia	2	15	7.5	1.9
Italy	2	10	5.0	1.9
New Zealand	2	11	5.5	1.9
Portugal	2	2	1.0	1.9
Taiwan	2	2	1.0	1.9
Argentina	1	2	2.0	1.0
Austria	1	3	3.0	1.0
Belgium	1	5	5.0	1.0
Botswana	1	0	0.0	1.0
Colombia	1	2	2.0	1.0
Costa Rica	1	2	2.0	1.0
Israel	1	0	0.0	1.0
Mexico	1	2	2.0	1.0
Nigeria	1	0	0.0	1.0
South Korea	1	1	1.0	1.0
Ukraine	1	2	2.0	1.0

Table 8: First Author Article

First author article	TP	%TP	TC2	PCPP
India	546	92	1,275	2.3
Others	45	7.6	216	4.8
Total	591	100	1,491	2.5

Table 9: First Author Article (first author from other countries)

Country	*TP*	*TC2*	*PCPP*	*%TP*
USA	22	118	5.4	3.7
UK	9	56	6.2	1.5
Germany	3	19	6.3	0.5
Netherlands	3	7	2.3	0.5
Portugal	2	2	1.0	0.3
Belgium	1	5	5.0	0.2
New Zealand	1	2	2.0	0.2
Colombia	1	2	2.0	0.2
Austria	1	3	3.0	0.2
Australia	1	2	2.0	0.2
Israel	1	0	0	0.2

Table 10: Corresponding Author Article

Corresponding Author Article	TP	%TP	TC2	PCPP
India	464	90	1,135	2.4
Others	50	10	227	4.5
Total	514	100	1,362	2.6

Table 11: Corresponding Author Article (corresponding author from other countries)

Country	*TP*	*TC2*	*PCPP*	*%TP*
USA	29	136	4.7	5.6
UK	6	53	8.8	1.2
Germany	3	19	6.3	0.58
Portugal	2	2	1.0	0.39
Netherlands	2	1	0.5	0.39
Japan	1	3	3.0	0.19
Colombia	1	2	2.0	0.19
Taiwan	1	2	2.0	0.19
New Zealand	1	2	2.0	0.19
Israel	1	0	0.0	0.19
Nigeria	1	0	0.0	0.19
Australia	1	2	2.0	0.19
Belgium	1	5	5.0	0.19

SUMMARY

The rapid increase in population and industrialization led United Nations organization to declare 2005–2015 as "water for life decade" (UN millennium goals). This is reflected by the number of articles published in 2005. Since the surface water is getting depleted day by day, the next source for the drinking water is ground water. But in India the groundwater is highly contaminated with the toxic chemicals like arsenic and fluoride (WHO 96). The western country like Alaska also a group of people consumed arsenic contaminated water, but the health effects are very less due to their highly nourished food. The number of articles increased suddenly from 106 to 153 from 2006 to 2007, revealed that the Indian researchers are concentrating more on drinking water related work. "Arsenic", "Drinking Water", "Oxidative Stress" and "India" were the most frequently used keywords for the last 10 years. In addition adsorption was the next popular word in the last four years. This shows that there is a strong relationship between the adsorption kinetics study and the drinking water problem. A large number of articles were published in excellent journals such as fluoride and environmental science related journals. The number of ICA increased for the past few years and had remarkably higher PCPP values than the other articles. To find out a permanent solution for the drinking water related problems in India, more research work should be carried out in future. For this, large number of water research centers should be started in central government and state government institutions immediately. In order to get fruitful results in this research area, the government should support (funding the projects) the institutions that are publishing very good articles related to drinking water and water treatment, either independently or through international collaborations.

REFERENCES

Chatterjee, A., Das, D., Mandal, B.K., Chowdhury, T.R., Samanta, G. and Chakraborti, D. (1995), "Arsenic in ground-water in six districts of west-bengal, India—the biggest arsenic calamity in the world. Part I. Arsenic species in drinking-water and urine of the affected people". *Analyst*, 120(3), 643–650.

Chen, C.J., Chen, C.W., Wu, M.M. and Kuo, T.L. (1992). "Cancer potential in liver, lung, ladder and kidney due to ingested inorganic arsenic in drinking-water". *British Journal of Cancer*, 66(5), 888–892.

Das, D., Chatterjee, A., Mandal, B.K., Samanta, G., Chakraborti, D. and Chanda, B. (1995), "Arsenic in ground-water in 6 districts of west-bengal, India—the biggest arsenic calamity in the world, 2. Arsenic concentration in drinking-water, hair, nails, urine, skin-scale and liver-tissue (biopsy) of the affected people". *Analyst*, 120(3), 917–924.

Fluoride in Drinking-water, Background document for development of WHO Guidelines for Drinking-water Quality, (1996).

Forbes, F.B. and Pratt, G.H. (1903), "The determination of carbonic acid in drinking-water". *Journal of the American Chemical Society*, 25(7), 742–756.

Garfield, E. (1955), Citation indexes to science: "A new dimension in documentation through the association of ideas". *Science*, 122(3159), 108–111.

Ho, Y.S. (2007), "Bibliometric analysis of adsorption technology in environmental science". *Journal of Environmental Protection Science*, 1(1), 1–11.

Hopenhayn-Rich, C., Biggs, M.L. and Smith, A.H. (1998), "Lung and kidney cancer mortality associated with arsenic in drinking water in Cordoba, Argentina". *International Journal of Epidemiology*, 27(4), 561–569.

Hopenhayn-Rich, C., Biggs, M.L., Fuchs, A., Bergoglio, R., Tello, E.E., Nicolli, H. and Smith, A.H. (1996). "Bladder cancer mortality associated with arsenic in drinking water in Argentina" *Epidemiology*, 7(2), 117–124.

Hsieh, W.H., Chiu, W.T., Lee, Y.S. and Ho, Y.S. (2004). "Bibliometric analysis of patent ductus arteriosus treatments". *Scientometrics*, 60(2), 205–215.

Jacks, G., Bhattacharya, P., Chaudhary, V. and Singh, K.P. (2005). "Controls on the genesis of some high-fluoride groundwaters in India". *Applied Geochemistry*, 20 (2), 221–228.

Kwok, R.K., Kaufmann, R.B. and Jakariya, M. (2006). "Arsenic in drinking-water and reproductive health outcomes: A study of participants in the Bangladesh integrated nutrition programme". *Journal of Health Population and Nutrition*, 24(2), 190–205.

Luukkonen, T. (1990). "Bibliometrics and evaluation of research performance". *Annals of Medicine*, 22(3), 145–150.

MacRoberts, M.H. and MacRoberts, B.R. (1989). "Problems of citation analysis: A critical review". *Journal of the American Society for Information Science*, 40(5), 342–349.

Martyn, C.N., Osmond, C., Edwardson, J.A., Barker, D.J.P., Harris, E.C. and Lacey, R. (1989). "Geographical relation between Alzheimers-disease and aluminum in drinking-water". *Lancet*, 1(8629), 59–62.

Mazumder, D.N.G., Haque, R., Ghosh, N., De, B.K., Santra, A., Chakraborty, D. and Smith, A.H. (1998). "Arsenic levels in drinking water and the prevalence of skin lesions in West Bengal", *International Journal of Epidemiology*, 27(5), 871–877.

Nickson, R.T., McArthur, J.M., Shrestha, B., Kyaw-Myint, T.O. and Lowry, D. (2005). "Arsenic and other drinking water quality issues, Muzaffargarh District, Pakistan". *Applied Geochemistry*, 20(1), 55–68.

Rahman, M., Tondel, M, Ahmad, S.A. and Axelson, O. (1998). "Diabetes mellitus associated with arsenic exposure in Bangladesh". Am J of Epidemiol, 148, 198–203

Ramesam, V. (1987). "Hydrogeochemistry of fluoride in the drought-prone hard-rock regions of peninsular India". *Fluoride*, 20(1), 4–10.

Rodriguez, V.M., Jimenez-Capdeville, M.E. and Giordano, M. (2003). "The effects of arsenic exposure on the nervous system". *Toxicology Letters*, 145 (1), 1–18.

Rook, J.J. (1976). "Haloforms in drinking-water". *Journal of American Water Works Association*, 68(3), 168–172.

Sammis, J.L. (1912), "A simple method for purifying drinking water". *Journal of Industrial and Engineering Chemistry*, 4, 681–682.

Saxena, V.K. and Ahmed, S. (2001). "Dissolution of fluoride in groundwater: A water-rock interaction study". *Environmental Geology*, 40(9), 1084–1087.

Smith, A.H., Goycolea, M., Haque, R. and Biggs, M.L. (1998). "Marked increase in bladder and lung cancer mortality in a region of Northern Chile due to arsenic in drinking water". *American Journal of Epidemiology*, 147(7), 660–669.

Smith, A.H., Hopenhaynrich, C., Bates, M.N., Goeden, H.M., Hertzpicciotto, I., Duggan, H.M., Wood, R., Kosnett, M.J. and Smith, M.T. (1992). "Cancer risks from arsenic in drinking-water". *Environmental Health Perspectives*, 97, 259–267.

Smith, A.H., Lingas, E.O. and Rahman, M. (2000). "Contamination of drinking-water by arsenic in Bangladesh: a public health emergency". *Bulletin of the World Health Organization*, 78(9), 1093–1103.

UN millennium development goals, United Nations Organization, www.un.org/millenniumgoals.

Van't Hoff, H.J. (1902). "Purification of drinking water using ozone". *Zeitschrift fur Elektrochemie*, 8, 504–507.