Scientific Productivity of Karnataka State during 1999-2011

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Abstract

The paper discusses the contribution of scientists and researchers from Karnataka state (India) as per Web of Science (WoS) during 1999-2011. The objective of the study is to assess the research output such as growth of publications and citations, institutions productivity in Karnataka, ranking of authors according to publications output, international collaborations, journals preferred by the scientists, subject wise and domain wise activity indices. The results of the study show that the Activity Index of Engineering, Materials Science, Biochemistry & Molecular Biology, Crystallography, Food Science & Technology and Computer Science are found to be higher than that of India's average. The present study also enables the policy makers / decision makers of Govt. of Karnataka to take appropriate measures and to identify low productive disciplines, thereby developing feasible plan of action to increase their productivity.

Keywords

Activity Index, Bibliometric Measures, Growth of Literature, Karnataka, Scientific Publications, Scientometrics.

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INTRODUCTION

Bibliometric measures have been used to measure the performance of the scientific community. Although a bibliometric study can be applied to define general productivity in a given area, it may also be used to evaluate the productivity of individual researchers, journals, countries, states or any other levels of performance (Andres, 2009). The basic assumption underlying such applications is that these measures can be regarded as a measure of scientific quality or impact (Aksnes, 2006). Hence, bibliometric indicators have been increasingly applied in the context of science policy and research evaluation (Davarpanah and Amel, 2009).

The scientific publications are the embodiments of intellectual discoveries expressed explicitly aiming to transmit new ideas or information for further advancement in knowledge (Sharma, 2009). Over the years, India in general and Karnataka state in particular have invested heavily in developing infrastructure for R & D activities in almost all subjects (Gupta and Dhawan, 2006). As reflected in the publications indexed in international multidisciplinary subject databases such as Web of Science and Scopus, Karnataka's publications growth rate has been relatively much faster in recent years.

REVIEW OF LITERATURE

Science and Technology, today, has acquired an International recognition. It is very difficult for many countries in the world, particularly the developing countries, to conduct scientific research at individual levels (Gupta et al., 2002). Gupta and Dhawan (2006) provide a quantitative and qualitative analysis of the progress of Indian S & T as reflected in its publications output reported in national and international journals. Further, the authors examine the status of S & T in the country. Sangam (2000) investigates the nature and type of collaborative research in India as reflected in Psyclit CD-ROM database during 1974-1998.

Recently, there have been numerous Scientometric studies dealing with various disciplines of S & T in India reported in the literature: Karki et al. (2000) on Activity and growth of Organic Chemistry research in India during 1971-1989; Kademani et al. (2006a) on Scientometric dimensions of nuclear science and technology research in India: A study based on INIS (1970-2002); Kademani et al. (2006b) on Scientometric dimensions of Thorium research in

India; Kademani (2008) on Scientometric mapping of Vacuum research in nuclear science and technology; Mahbuba et al. (2010) on a Scientometric analysis of health and population research in South Asia: focus on two research organizations; Gupta (2010) on a comparative study of India, China and South Korea S & T publications output during 1998-2008; Sanni et al. (2013) on evaluating the growth pattern and relative performance in Nipah virus research from 1999 to 2010; Chuang et al. (2013) on high-impact papers published in journals listed in the field of chemical engineering and Yang and Lee (2013) on Bibliometric approach to research assessment: publication count, citation count & author rank.

It is observed from the literature that most of the studies have been done on countries output on specific discipline or group of disciplines, studies on specific subject or group of subjects, individual scientist, particular organization or comparative study between two organizations etc. Very few studies were observed on productivity of states / provinces of any country. It is important to study the productivity of states / provinces considering the total output of any country. Further, such studies enable the policy makers / decision makers of respective states to take appropriate measures and to identify low productive disciplines, thereby developing feasible plan of action to increase their productivity. Hence, the authors have undertaken the present study.

OBJECTIVES

The main objective of the study is to present the growth of literature published by the scientists (irrespective of subjects) of Karnataka during 1999-2011 as per the Web of Science (WoS) database. In particular, the study focuses on the following objectives:

- To study the growth of publications and citations,
- To study the institutional productivity in Karnataka,
- To study the ranking of authors according to publications output,
- To study the international collaborations,
- To study the journals preferred by the scientists,
- To study the subject and domain activity indices.

METHODOLOGY

At present, there are two citation databases, viz., Web of Science (WoS) and Scopus, wherein a scientist or a researcher can rely on these databases for citations. For the present study the data was collected by using Web of Science (WoS), particularly Science Citation Index Expanded (SCI-Expanded), Social Science Citation Index (SSCI) and Arts & Humanities Citation Index (A&HCI) for the duration 1999-2011. The Web of Science provides researchers, scientists, administrators, academic community a quick and powerful access to the world's leading citation databases. By using suitable search syntax, records pertaining to Karnataka state in the address field were downloaded for the period 1999-2011.

For Province / State
PS=Karnataka was used for the data (for other states same search syntax was used except its name)
CU=India was used for the different subjects (To calculate Activity Index of various subjects)

For Activity Index SU=Chemistry AND CU=India was used for collecting data (Same syntax was used for other subjects). The search was carried out in the first week of July, 2012. A total of 44,446 publications and 356,323 citations were received for the duration 1999-2011.

In the present study, the Activity Index (AI) for Karnataka has been calculated for different years to see how Karnataka's performance changed. The Activity Index was first suggested by Frame (1977) and used among others by Schubert and Braun (1986); Nagpaul (1995); Karki and Garg (1997); Garg and Padhi (1999); Kumari (2006); Chetri et al. (2009); Sagar and Kademani (2011).

The Activity Index (AI) characterizes the relative research effort of a country for a given subjects. It is defined as

$$AI = \frac{\text{given field's share in the country's publication output}}{\text{given field's share in the world's publication output}}$$

Mathematically $AI = \frac{nij/nio}{noj/noo} \times 100$

Where

nij - Indian output of papers in a particular field
nio - Total Indian output on all subjects
noj - World output of papers in a particular field
noo - Total world output in all fields

The same indicator is adopted for Karnataka State.

ANALYSIS AND RESULTS

State wise distribution of Publications

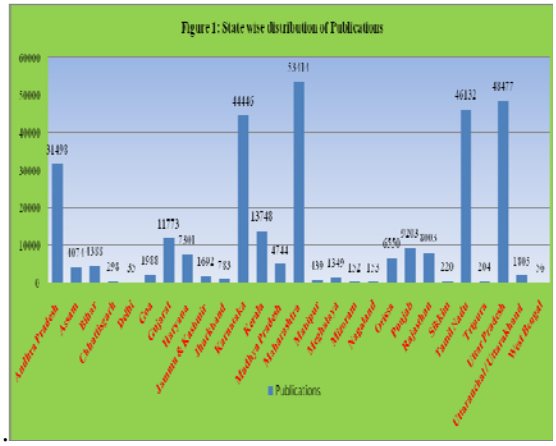
Table 1 shows state distribution of publications. Among the different states in India, the Maharashtra state tops the list with 53,414 publications in all disciplines. Uttar Pradesh's publications count is 48,477, followed by Tamil Nadu with 46,132 publications, Karnataka with 44,446 and Andhra Pradesh with 31,498 publications rank third, fourth and fifth respectively. It is observed from the data that there are no publications attributable to Arunachal Pradesh, and Himachal Pradesh, which are covered in the Web of Science. A peculiar situation is that though there is a state university in Arunachal Pradesh state still papers from this state have not appeared in the Web of Science database.

During the period, nine states (Chattisgarh, Delhi, Jharkhand, Manipur, Mizoram, Nagaland, Sikkim, Tripura and West Bengal) have less than a thousand publications. Among these nine states, five states belong to seven sister states (North-Eastern). Though there are quite a good number of central (receive funds directly from the central govt.) and state universities in this region, the productivity is very less compared to other states. The time is ripe for the scientists / researchers of this region to become more proactive in conducting research as well as to increase collaboration with other scientists / researchers in order to increase their productivity.On 9 November 2000, the 27th state in India named Uttaranchal was carved out of the Himalayan and adjoining northwestern districts of Uttar Pradesh. In the year 2006 Uttaranchal was renamed Uttarakhand. It was observed that 564 publications were received for Uttaranchal and 1241 publications were received for Uttarakhand. Hence, the publications of both the states were added and the total count for Uttarakhand (erstwhile Uttaranchal) came to 1805

.

Name of the State	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Andhra Pradesh	1449	1483	1493	1625	1852	1945	2301	2577	2865	3178	3167	3610	3953	31498
Arunachal Pradesh	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Assam	137	129	115	134	181	178	204	248	310	530	497	629	782	4074
Bihar	224	240	230	230	242	293	307	342	411	458	401	481	529	4388
Chhattisgarh	---	---	03	15	10	09	10	14	24	35	36	69	73	298
Delhi	---	---	---	03	---	02	---	01	03	03	05	07	11	35
Goa	97	85	89	99	88	97	144	198	152	219	211	215	294	1988
Gujarat	502	483	525	551	627	675	735	907	1031	1267	1345	1498	1632	11773
Haryana	340	337	320	378	378	425	497	497	647	814	801	879	988	7301
Himachal Pradesh	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Jammu &Kashmir	43	54	34	36	55	63	93	87	147	218	253	295	314	1692
Jharkhand	---	01	11	15	21	26	28	43	58	129	124	157	170	783
Karnataka	1930	2073	2178	2414	2570	2683	3013	3283	4018	4527	4967	5214	5576	44446
Kerala	595	595	632	756	803	762	899	1118	1267	1531	1509	1538	1743	13748
Madhya Pradesh	251	224	217	176	201	243	230	323	397	571	607	657	647	4744
Maharashtra	2001	2103	2248	2539	3278	3626	3891	4347	4837	5690	5917	6262	6675	53414
Manipur	12	21	16	08	13	21	30	23	34	63	55	65	78	439
Meghalaya	89	67	73	71	79	88	113	96	106	124	137	151	155	1349
Mizoram	---	02	04	03	08	08	06	09	06	17	30	26	33	152
Nagaland	02	02	09	06	09	11	16	12	09	19	19	21	18	153
Orissa	373	341	352	393	398	432	367	428	484	593	738	825	826	6550
Punjab	288	355	308	388	457	514	565	699	884	1039	1076	1238	1392	9203
Rajasthan	331	353	394	392	516	511	476	581	744	860	858	958	1029	8003
Sikkim	05	04	04	06	07	10	07	12	13	30	32	43	47	220
Tamil Nadu	1423	1345	1342	1666	2524	2832	3266	3799	4510	5336	5531	5895	6663	46132
Tripura	07	05	07	07	07	03	10	12	14	18	32	36	46	204
Uttar Pradesh	2193	2274	2201	2354	2610	2930	3328	3976	4573	5853	5296	5565	5824	48477

Uttaranchal / Uttarakhand	---	01	21	32	78	66	68	91	109	214	295	402	428	1805
West Bengal	01	---	---	02	01	01	01	06	09	16	10	11	03	56



Growth of Publications and Citations of Karnataka

Table 2 depicts the yearly distribution of publications and citations. There was a total of 44,446 publications by the scientists and researchers of Karnataka across different disciplines during 1999-2011 as per the Web of Science. These publications received 356,323 citations with 9.69 average citations per publication. The highest number of publications 5576 (12.54 %) were published in 2011, while the average number of publications per year was 3418; the average number of citations per publication was 9.69 and the average number of citations per year was 27,409. It was observed from the study that the older publications tend to receive more citations than the latest publications. The highest number of citations i.e. 36,059 (6.04 %) occurred in 2004 and the lowest (5168 citations) for the year 2011.

Table 2: Growth of Publications and Citations

Year	Total Publications (TP)	%	Total Citations (TC)	Average Citations per Publication (ACP)
1999	1930	4.34	27684	14.34
2000	2073	4.66	31639	15.26
2001	2178	4.90	32923	15.12
2002	2414	5.43	31077	12.87
2003	2570	5.78	33089	12.88
2004	2683	6.04	36059	13.44
2005	3013	6.78	31476	10.45
2006	3283	7.30	30833	9.39
2007	4018	9.04	31572	7.86
2008	4527	10.18	27568	6.09
2009	4967	11.18	23666	4.76
2010	5214	11.74	13569	2.60
2011	5576	12.54	5168	0.93
Total	44,446	100.00	3.56,323	9.69

Relative Growth Rate (RGR) and Doubling Time (Dt.)

Relative Growth Rate (RGR) is the increase in number of publications per unit of time. There exists a direct relation between relative growth rate and the doubling time. The relative growth rate and doubling time of publications have been calculated using the formula given by Krishnamurthy et al. (2009). It is seen from table 3 that RGR has been decreasing from 2000 (0.73) to 2011 (0.14). On the other hand, the Doubling Time (Dt.) has shown an increasing trend. The Doubling Time has increased from 0.94 in the year 2000 to 4.95 in the year 2011.

Table 3: Relative Growth Rate (RGR) and Doubling Time (Dt.)

Year	No. of publications	Cumulative No. of publications	$\text{Log}_e 1^P$	$\text{Log}_e 2$ P	RGR	Mean (RGR)	Dt.	Mean Dt.
1999	1930	1930		7.56				
2000	2073	4003	7.56	8.29	0.73		0.94	
2001	2178	6181	8.29	8.73	0.44		1.57	
2002	2414	8595	8.73	9.05	0.32		2.16	
2003	2570	11165	9.05	9.32	0.27		2.56	

2004	2683	13848	9.32	9.53	0.21	0.26	3.30	3.33
2005	3013	16861	9.53	9.73	0.20		3.46	
2006	3283	20144	9.73	9.91	0.18		3.85	
2007	4018	24162	9.91	10.09	0.18		3.85	
2008	4527	28689	10.09	10.26	0.17		4.07	
2009	4967	33656	10.26	10.42	0.16		4.33	
2010	5214	38870	10.42	10.56	0.14		4.95	
2011	5576	44446	10.56	10.70	0.14		4.95	

Institutional Productivity

Table 4 gives a ranked list of the top 20 highly productive Research Institutions in Karnataka based on the number of publications, total number of citations and average number of citations in all disciplines. The Indian Institute of Science, Bangalore topped the list with a total of 14,868 publications to its credit, followed by the University of Mysore with 2467, Jawahar Lal Nehru Centre for Advanced Science & Research, Bangalore with 2219, Centre for Food and Technological Research Institute, Mysore with 1747 and Karnatak University, Dharwad with 1520 publications ranked second, third, fourth and fifth respectively. In terms of citations received, the Indian Institute of Science (IISc), Bangalore ranked first with 187,741 citations and 12.63 Average Citations per Paper (ACP), followed by JNCASR, Bangaore with 41,696 citations and 18.79 ACP (highest among top 20 institutions), whereas, CFTRI, Mysore with 18,913 citations and 10.83 ACP which ranked second and third respectively. Karnatak University, Dharwad ranked fourth in terms of citations (12,864) and seventh in terms of ACP (8.46). The Council of Scientific and Industrial Research (CSIR) publications were excluded in this study, since CSIR laboratories are spread across different states in India, which affects the total count of publications for all states.

Table 4: Institutions Productivity

Rank by TP	Rank by ACP	Rank by TC	Research / Academic Institution	TP	TC	ACP	H-Index
1	03	01	Indian Institute of Science, Bangalore	14868	187741	12.63	119
2	14	06	University of Mysore, Mysore	2467	10726	4.35	34
3	01	02	Jawaharlal Nehru Centre for Advanced Science & Research (JNCASR), Bangalore	2219	41696	18.79	82
4	05	03	Centre for Food and Technological Research Institute, Mysore	1747	18913	10.83	49
5	07	04	Karnatak University, Dharwad	1520	12864	8.46	40
6	13	10	Bangalore University, Bangalore	1387	7246	5.22	32
7	09	07	National Institute of Mental Health and Neuro Sciences, Bangalore	1365	9350	6.85	35
8	04	05	Raman Research Institute, Bangalore	1106	12824	11.59	47
9	06	08	Indian Institute of Astrophysics, Bangalore	1023	8780	8.58	37
10	17	12	Mangalore University, Mangalore	918	3435	3.74	23
11	18	14	Kasturba Medical College and Hospital, Managalore	790	2832	3.58	21
12	20	20	Manipal University, Manipal	590	1068	1.81	14
13	08	11	University of Agricultural Science, Bangalore	570	4079	7.16	30
14	02	09	Tata Institute of Fundamental Research, Bangalore	555	8041	14.49	39
15	11	13	National Aerospace Laboratories, Bangalore	502	3068	6.11	25
16	12	16	Gulbarga University, Gulbarga	451	2435	5.40	22
17	10	15	Kuvempu University, Shimoga	437	2701	6.18	23
18	19	19	University of Agricultural Sciences, Dharwad	423	1078	2.55	15
19	15	17	Indian Statistical Institute, Bangalore	383	1611	4.21	18

20	16	18	National Institute of Technology, Surathkal	372	1556	4.18	18

TP-Total Publications TC-Total Citations ACP-Average Citations per Publication

Highly Productive Scientists

Table 5 reveals 20 highly productive scientists based on the number of publications irrespective of their disciplines during 1999-2011 appeared in Web of Science. C.N.R. Rao, ranked first with a total of 569 publications to his credit. He also ranked first in terms of citations received (21,452), ACP (37.86) and H-index (72). Yathirajan, H.S. with 460 (1220 citations) publications ranked second, followed by Kumar, S. who ranked third with 425 (3908 citations) publications. Though the author Natarajan, S. has published 199 papers (ranked 15th) and he is ranked second in terms of citations received (6249, second highest among twenty authors), ACP (31.40) and H-index (41). Similarly, the author Aminabhavi, T.M. who has published 252 papers, (ranked 7th in terms of total publications) ranked 3rd in terms of the number of citations received (5602), ACP (22.23) and H-index (35).

It is observed that the scientists from Chemistry, Physics and Engineering branches are more productive than the other branches. Among the top twenty scientists, more than ten scientists belong to Indian Institute of Science, Bangalore. And only five scientists belong to academic institutions (universities). Considering the total productive scientists in Karnataka, the contribution of the scientists from IISc, Bangalore is more compared to that of academic and other research institutions. Most of the scientists' areas of research is Chemistry, Physics, Engineering, Materials Science, Crystallography etc.

Table 5: Highly Productive Scientists in Karnataka

Rank by TP	Rank by TC	Rank by ACP	Author	Affiliation	Area of Research	TP	TC	ACP	h-index
1	01	01	Rao, C.N.R.	Jawaharlal Nehru Center for Advanced Scientific Research, Bangalore	Chemistry	569	21452	37.86	72
2	15	20	Yathirajan, H.S.	University of Mysore, Mysore	Crystallography	460	1220	2.65	13
3	06	10	Kumar, S.	Indian Institute of Science IISc Bangalore	Chemistry	425	3908	9.20	28
4	19	19	Narayana, B.	Mangalore University, Mangalore	Crystallography	357	1037	2.90	12
5	11	11	Kumar, A.	Indian Institute of Science IISc Bangalore	Physics	319	2760	8.65	25
6	05	07	Madras, G.	Indian Institute of Science IISc Bangalore	Engineering	262	3911	14.93	30
7	03	03	Aminabhavi, T.M.	Karnatak University, Dharwad	Polymer Science	252	5602	22.23	35
8	12	12	Row, T.N.G.	Indian Institute of Science IISc Bangalore	Crystallography	244	1942	7.96	21
9	10	09	Bhattacharya, S.	Indian Institute of Science IISc Bangalore	Chemistry	225	2920	12.98	28
10	09	08	Nethaji, M.	Indian Institute of Science IISc Bangalore	Chemistry	224	2982	13.31	30
11	17	17	Kumar, P.	Indian Institute of Science IISc Bangalore	Physics	221	1136	5.14	16
12	16	16	Nandibewoor, S.T.	Karnatak University, Dharwad	Chemistry	218	1196	5.49	16
13	13	14	Krupanidhi, S.B.	Indian Institute of Science IISc Bangalore	Physics	213	1543	7.24	20
14	04	04	Bagchi, B.	Indian Institute of Science IISc Bangalore	Physics	202	4377	21.67	32
15	02	02	Natarajan, S.	Jawaharlal Nehru Center for Advanced Scientific Research, Bangalore	Chemistry	199	6249	31.40	41
16	20	18	Rangappa, S.	University of Mysore, Mysore	Chemistry	195	926	4.75	15
17	08	06	Surolia, A.	Indian Institute of Science IISC Bangalore	Biochemistry Molecular Bio	188	2999	15.95	30
18	07	05	Sood, A.K.	Indian Institute of Science IISc Bangalore	Physics	182	3528	19.38	25
19	14	13	Sinha, S.	National Institute of Mental Health	Neurosciences	179	1404	7.84	19

				Neurosciences, Bangalore	Neurology				
20	18	15	Shankar, S.K.	National Institute of Mental Health Neurosciences, Bangalore	Neurosciences Neurology	167	1059	6.34	16

International Collaboration

Table 6 gives the list of countries, which collaborated with the academic and research institutions located in Karnataka. Among the different collaborative countries, the USA ranked first with 4396 publications and 72,207 citations (16.43 ACP and 98 H-index), followed by Germany, which ranked second with 1129 publications & 16,713 citations (14.80 ACP and 57 H-index). England ranked third with 1098 publications and 17,159 citations. France with 817 and Japan with 740 publications ranked fourth and fifth respectively.

Table 6: International Collaboration in all Academic and Research Institutions of Karnataka

Rank by collaborative papers	Country	Total Publications (TP)	Total Citations (TC)	Average Citations per Publication (ACP)	H-Index
1	USA	4396	72207	16.43	98
2	Germany	1129	16713	14.80	57
3	England	1098	17159	15.63	59
4	France	817	14503	17.75	58
5	Japan	740	13257	17.91	52
6	Canada	518	9509	18.36	46
7	Italy	413	10712	25.94	50
8	South Korea	401	5651	14.09	25
9	Australia	371	7726	20.82	36
10	Malaysia	305	2930	9.61	19
11	People's Republic China	295	8185	27.75	40
12	Netherlands	294	8205	27.91	33
13	Switzerland	266	7280	27.37	38
14	Singapore	239	4923	20.60	28
15	Sweden	213	3888	18.25	28
16	Spain	210	5718	27.23	35
17	Taiwan	176	2305	13.10	21
18	Israel	159	4411	27.74	31
19	Scotland	154	2626	17.05	21
20	Belgium	153	4493	29.37	28

Journals Preferred by the Scientists

Table 7 gives the list of the top twenty productive journals preferred by the scientists of Karnataka. *Current Science* (India) ranked first in terms of publications (1511) and fourteenth in terms of ACP (2.99), followed by *Acta Crystallographia* (from USA), which ranked second in terms of publications and fifteenth in terms of ACP. *Physical Review B* (USA) ranked third with 388 publications and third in terms of ACP, followed by *the Journal of Food Science and Technology*, which ranked fourth with 315 publications and sixteenth in terms of ACP. *The Journal of Physical Review Letters* ranked thirteenth in terms of publications, and ranked first in terms of ACP. Similarly, *the Journal of Physical Chemistry B* ranked seventh with 255 publications, and second in terms of ACP.

Table 7: Major Journals Preferred by the Scientists of KAR for Publications

Rank by TP	Rank by ACP	Source / Journal	Country	TP	TC	ACP
1	14	Current Science	India	1511	4516	2.99
2	15	Acta Crystallographica	USA	954	1849	1.94
3	03	Physical Review B	USA	388	6768	17.44
4	16	Journal of Food Science & Technology	India	315	518	1.64
5	11	Journal of Applied Polymer Science	USA	311	2679	8.61
6	09	Physical Review E	USA	265	2524	9.52
7	02	Journal of Physical Chemistry B	USA	255	4826	18.93
8	05	Journal of Chemical Physics	USA	254	3405	13.41
9	08	Tetrahedron Letters	UK	251	2839	11.31
10	17	Journal of the Geological Society of India	India	242	344	1.42
11	20	Indian Veterinary Journal	India	240	111	0.46
12	07	Monthly notices of the Royal Astronomical Society	UK	233	2691	11.55
13	01	Physical Review Letters	USA	231	6249	27.05
14	13	Indian Journal of Chemistry Section B: Organic Chemistry including medicinal chemistry (confirm)	India	225	779	3.46
15	10	Journal of Applied Physics	USA	222	2097	9.45
16	04	Astrophysical Journal	England	216	3029	14.02
17	18	Lecture notes in Computer Science	Germany	211	290	1.37
18	19	Indian Journal of Animal Sciences	India	210	145	0.69
19	06	Astronomy Astrophysics	EDP Sciences	205	2596	12.66
20	12	Bulletin of Materials Science	India	196	1063	5.42

KAR - Karnataka

Subject wise distribution in Karnataka

The Web of Science was employed again to investigate the subject distribution in Karnataka state. For this purpose, top ten subjects (Chemistry, Physics, Engineering, Materials Science, Biochemistry & Molecular Biology, Pharmacology & Pharmacy, Crystallography, Food Science & Technology, Computer Science and Agriculture) were considered on the basis of the total number of publications. During the period 1999-2011, chemistry topped the list (ranked first) with 7489 (9.62%) publications. Physics is ranked second with 5586 (10.42%) publications. Other subject's productivity is given in table 7. Karnataka's contribution in the field of Food Science and Technology ranked eighth is 23.47 % to the India's literature on the subject. Similarly, Karnataka's contribution in the field of Crystallography is 21.69 % to the overall India's literature. Subject distribution data in Karnataka and India is given in tables 8 and 9

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Table 8: Subject wise Productivity in Karnataka

Year	Chemistry	Physics	Engineering	Materials Science	Biochemistry & Molecular Biology	Pharmacology & Pharmacy	Crystall-ography	Food Science & Technology	Computer Science	Agriculture	**Total**
1999	343	263	213	183	132	29	53	83	68	69	**1436**
2000	348	304	211	194	132	28	39	89	72	77	**1494**
2001	414	334	229	223	140	49	67	94	61	79	**1690**
2002	466	371	272	237	167	57	67	98	72	106	**1913**
2003	474	335	259	238	188	44	80	102	85	90	**1895**
2004	494	315	282	211	209	63	95	112	121	78	**1980**

2005	522	438	345	301	197	70	145	126	147	97	**2388**
2006	591	472	377	293	189	93	153	141	144	80	**2533**
2007	698	491	480	399	227	162	237	164	106	126	**3090**
2008	671	529	504	417	260	277	129	141	117	139	**3184**
2009	800	568	531	500	246	312	192	146	115	149	**3559**
2010	806	584	507	468	283	304	238	161	111	133	**3595**
2011	862	582	564	540	274	318	275	187	158	132	**3892**
Total	**7489**	**5586**	**4774**	**4204**	**2644**	**1806**	**1770**	**1644**	**1377**	**1355**	**32649**

***** the data from table 7 has been used for the calculation of Activity Index for various subjects.

Table 9:

Subject wise Productivity in India

Year	Chemistry	Physics	Engineering	Materials Science	Biochemistry & Molecular Biology	Pharmac-ology & Pharmacy	Crystall-ography	Food Science & Technology	Computer Science	Agriculture	Total
1999	3444	2546	1849	1372	830	451	321	308	348	1219	**12688**
2000	3304	2593	1914	1440	749	487	227	339	391	1295	**12729**
2001	3835	2716	1858	1719	849	585	363	353	372	1210	**13860**
2002	4334	3033	1994	1778	949	684	439	377	463	1098	**15149**
2003	4772	3153	2231	1969	1122	795	420	396	526	1268	**16652**
2004	5390	3582	2490	2129	1320	1014	407	440	813	1161	**18746**
2005	5678	3979	2755	2437	1439	1031	558	484	827	1133	**20321**
2006	6525	4353	3259	2694	1511	1318	758	582	769	1192	**22961**
2007	7139	4713	3724	3341	1647	1583	976	705	685	1718	**26231**
2008	7311	5328	4231	3747	1747	2817	771	680	750	2170	**29552**
2009	8038	3525	4593	4253	1920	2608	902	707	818	1976	**31340**
2010	8516	5912	4670	4421	2049	2820	924	816	899	2073	**33100**
2011	9550	6155	4995	4744	2275	2975	1091	816	1160	1907	**35668**
Total	**77836**	**53578**	**40563**	**36044**	**18407**	**19168**	**8157**	**7003**	**8821**	**19420**	**288997**

* The percentage has been calculated using subject wise productivity in India in respective subjects from table 8.

Subject Activity Index

The Activity Index was highest for the following subject categories: Chemistry (89.57) in 2000, Physics (101.02) in 2001, Engineering (110.48) in 2008, Materials Science (117.59) in 1999, Biochemistry and Molecular Biology (151.72) in 2000, Pharmacology & Pharmacy (104.81) in 2009, Crystallography (2444.44) in 2010, Food Science & Technology (243.47) in 2004, Computer Science (174.07) in 1999 and Agriculture (76.38) in 2002. It is observed from the data that Engineering, Material Science, Biochemistry, and Molecular Biology, Crystallography, Food Science & Technology and Computer Science's average AI is higher than that of India. For Engineering (except the year 2000), Biochemistry & Molecular Biology, Crystallography, Food Science & Technology and Computer Science subjects AI has always (during 1999-2011) been high, which indicates that Karnataka's research efforts in these five subjects correspond precisely to the India's average.

The Activity Index for Food Science & Technology, Crystallography, Computer Science, Biochemistry & Molecular Biology, Engineering (except in the year 2000) for all years (from 1999-2011) is high compared to other subjects and India's average. The average Activity Index for Food Science & Technology is 215.37, which clearly indicates that there is a huge contribution of scientists from Karnataka in this subject compared to the India's total output in the Food Science & Technology. The Activity Index was lowest for the Physics, Chemistry, Pharmacology & Pharmacy and Agriculture. The contribution of Karnataka in the Chemistry and Physics subjects are more but the Activity Index is lowest among the different subject categories. This means that Karnataka's research efforts in these subjects are low to that of India's average.

Table 10: Activity Index of Various Subjects

Year	Chemistry	Physics	Engineering	Materials Science	Biochemistry & Molecular Biology	Pharmacology & Pharmacy	Crystallography	Food Science & Technology	Computer Science	Agriculture
1999	87.82	91.5	102.06	117.59	140.00	57.14	144.00	237.50	174.07	50.00
2000	89.57	100.49	94.00	114.15	151.72	47.36	152.94	226.92	160.00	50.49
2001	88.40	101.02	100.74	105.64	134.42	66.66	184.61	220.00	138.46	52.87
2002	85.17	96.50	108.39	105.12	140.32	64.44	125.00	212.50	123.33	76.38
2003	87.41	93.12	102.25	105.93	147.76	56.09	168.00	230.43	141.93	61.84
2004	86.75	83.24	107.57	93.80	150.00	57.40	223.80	243.47	141.86	63.93
2005	78.13	93.84	106.66	105.88	117.14	58.00	222.22	226.08	152.50	72.72
2006	82.04	98.41	104.96	98.29	113.84	63.15	181.81	220.00	169.69	60.78
2007	82.72	88.26	109.92	101.57	117.74	86.66	205.40	203.84	130.76	61.53
2008	85.02	92.22	110.48	103.17	137.28	90.52	153.84	191.30	144.00	68.25
2009	87.50	90.34	102.05	103.70	113.11	104.81	189.28	186.36	123.07	65.07
2010	87.15	91.01	100.00	97.74	127.86	98.82	244.44	183.33	111.11	58.06
2011	82.77	86.62	102.85	103.75	111.11	97.59	233.33	218.18	125.00	62.26
Average AI	**85.41**	**92.81**	**103.99**	**104.33**	**130.94**	**72.97**	**186.82**	**215.37**	**141.21**	**61.86**

CONCLUSION

The primary objective of the study is to present the growth of literature published by the scientists of Karnataka for 1999-2011 as per the Web of Science (WoS) database. A total of 44,446 publications and 3,56,323 citations were received during 1999-2011. Among the different states in India, the Maharashtra State topped the list with 53,414 publications in all disciplines; the highest number (5516) publications were published in 2011. There was exponential growth of publications during the period. Among the research / academic institutions, Indian Institute of Science, Bangalore (one of the premier research institutions in the country) top the list with 14,868 publications. The scientist, C.N.R. Rao ranked first among the highly productive scientists in Karnataka with 569 publications, 21,452 citations, 37.86 ACP and H-index is 72. Among the different collaborative countries, the USA ranked first with 4396 publications and 72,207 citations. *Current Science* (India) ranked first (1511) in terms of publications. The Activity Index of Engineering, Material Science, Biochemistry & Molecular Biology, Crystallography, Food Science & Technology and Computer Science is consistently higher than that of India's average. The Activity Index of Food Science & Technology (AI > 200) reflects higher activity than India's average. The average AI for Chemistry and Physics is 85.41 and 92.81, which indicates that Karnataka's research effort in Chemistry and Physics is on par with India's average. It is observed from the study that the Indian Institute of Science (IISc), Bangalore topped the list (with 14868 publications) among the productive institutions. The University of Mysore has 2467 publications to its credit and ranked second. Considering the fact, there is a huge gap of publications between IISc and the University of Mysore. The contribution from academic institutions is less compared to that of research institutions. It is observed from the literature especially in Scientometric and Bibliometric studies that most of the journals from India (Karnataka state is not an exception to this) are not included in the International databases. It is almost true in case of journals from other disciplines. Some of the universities / research institutions of national importance to initiate more number of journals in all subjects with a strict peer-review process attracting authors from other countries. This will definitely increase the number of citations for both the authors and journal and impact factor of the journals as well. The journal publishers should not compromise with the quality of the papers. To encourage research activity in Karnataka state, the Karnataka State Council for Science and Technology (KSCST) has been pro-actively engaging itself to identify specific needs / problems in the broad areas of Science & Technology. In Co-operation with the Indian Institute of Science (IISc, Bangalore) and several other premier R & D institutes in the state, KSCST executes many projects and programmes

leading to find S & T based solutions (KSCST, 2013).

The study also reveals that the contribution from authors of science discipline is more compared to authors of social science and other discipline authors. This really affects the overall publications productivity of any state or a country. In the subject wise productivity of Karnataka, the subject fields from other disciplines like Public Environmental Occupational Health, Business Economics, Psychology, Anthropology and other subjects have less number of publications. There is a lack of awareness among the other discipline authors regarding peer-review process, importance of Scientometric and Bibliometric studies, impact factor of the journal, h-index, g-index, citation databases etc. It is recommended to the authors from social science and other disciplines to identify the journals covered under citation databases (Web of Science and Scopus) in their respective subjects and publish the papers accordingly. A training programme in this regard for all the scientists / authors should be conducted at regular intervals on all these aspects. To encourage social scientists and authors from other disciplines, the Government of Karnataka should establish respective Councils to encourage authors from different disciplines and to be proactive in providing necessary facilities and scope for the overall development and to identify specific needs /problems of the authors. In the Karnataka state, now, almost every district has one state university. Earlier to the establishments of universities, medical and engineering colleges and other colleges offering courses were affiliated to respective state universities viz. University of Mysore (Established in 1916), Karnatak University, Dharwad (Established in the year 1950), Bangalore University, Bangalore (Estd. in 1964), Mangalore University, Mangalore (Estd. in 1980), Gulbarga University, Gulbarga (Estd. in 1980) and Kuvempu University, Shimoga (Estd. in 1987). During 1996 Rajiv Gandhi University for Health Sciences (RGUHS), Bangalore for Medical and in 1998 Visvesvaraya Technological University (VTU), Belagavi for Engineering and allied subjects were established. After establishment of these two universities, medical and engineering colleges were separated from the respective state universities and affiliated to RGUHS and VTU respectively. Earlier to the establishment of RGUHS and VTU, state universities were having good infrastructure at all levels and adequate facilities both for teaching and research activities. Now, the state has a separate law university, Hubli-Dharwad (Estd. in 2009); Karnataka State Women University, Bijapur; two Agricultural Universities (Bangalore and Dharwad); Veterinary University, Bidar; Horticulture University, Bagalkot; Folklore University, Shiggaon; Karnataka Sanskrit University, Bangalore; Karnataka State Music University, Mysore; Kannada University, Hampi; and other state universities in different districts Tumkur, Davanagere, Bellary, Belagavi were established recently (after 2000). In the realm of this development, almost all universities are struggling for the financial support from the Government of Karnataka. It would be better if the Govt. of Karnataka should stop opening a new university at least for a decade from now so as to strengthen the already established universities in all respects.

Scientometric and other metric studies enable the science policy makers and administrators to understand and grasp the growth, development and impact of research in a specific field of study or group of fields. These studies help to know the countries, states, institutions and the individual scientists who are active in a particular field of research activity. Further, these studies also provide some insights into the dynamics of research activity and enable one to gauge the direction of research activity and take appropriate measures (Kademani, 2011). The present study enables the policy makers and administrators of Govt. of Karnataka to take necessary steps (looking into the productivity of academic institutions and research institutions coming under the purview of Govt. of Karnataka) and appropriate measures for the overall development of the institutions in general and productivity of Karnataka state (in terms of publications) in particular.

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Appendix 1: Ten Highly Cited Papers from Karnataka

Sl. No.	Details of the Paper	Citation received
1	Title: Data Clustering: A review Author(s): Jain, AK; Murty, MN; Flynn, PJ Source: ACM COMPUTING SURVEYS Volume: 31 Issue: 3 Pages: 264-323 Published: SEP 1999Indian Institute of Science, Bangalore	2166
2	Title: Epitaxial BiFeO3 multiferroic thin film heterostructures Author(s): Wang, J; Neaton, JB; Zheng, H; Nagarajan, V; Ogale, SB; Liu, B; Viehland, D; Vaithyanathan, V; Schlom, DG; Waghmare, UV; Spaldin, NA; Rabe, KM; Wuttig, M; Ramesh, R; Source: SCIENCE Volume: 299 Issue: 5613 Pages: 1719-1722 Published: MAR 14 2003Jawaharlal Nehru Centre for Advanced Science & Research (Bangalore	1800
3	Title: Metal carboxylates with open architectures Author(s): Rao, CNR; Natarajan, S; Vaidhyanathan, R; Source: ANGEWANDTE CHEMIE-INTERNATIONAL EDITION Volume: 43 Issue: 12 Pages: 1466-496 Published:2004Jawaharlal Nehru Centre for Advanced Science & Research (JNCASR), Bangalore	1299
4	Title: Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies Author(s): Barba, C; Cavalli-Sforza, T; Cutter, J; Darnton-Hill, I; Deurenberg, P; Deurenberg-Yap, M; Gill, T; James, P; Ko, G; Miu, AH; Kosulwat, V; Kumanyika, S; Kurpad, A; Mascie-Taylor, N; Moon, HK; Nishida, C; Noor, MI; Reddy, KS; Rush, E; Schultz, JT; Seidell, J; Stevens, J; Swinburn, B; Tan, K; Weisell, R; Wu, ZS; Yajnik, CS; Yoshiike, N; Zimmet, P Source: LANCET Volume: 363 Issue: 9403 Pages: 157-163 Published: JAN 10 2004Institute of Population Health and Clinical Research, Bangalore	1142
5	Title: A dipole mode in the tropical Indian Ocean Author(s): Saji, NH; Goswami, BN; Vinayachandran, PN; Yamagata, T; Source: NATURE Volume: 401 Issue: 6751 Pages: 360-363 Published: SEP 23 1999 Indian Institute of Science, Bangalore	988
6	Title: Dabigatran versus Warfarin in Patients with Atrial Fibrillation Author(s): Connolly, SJ;Ezekowitz, MD; Yusuf, S; Eikelboom, J; Oldgren, J; Parekh, A; Pogue, J; Reilly, PA; Themeles, E; Varrone, J; Wang, S; Alings, M; Xavier, D; Zhu, J; Diaz, R;Lewis, BS; Darius, H; Diener, HC; Joyner, CD; Wallentin, L Source: NEW ENGLAND JOURNAL OF MEDICINE Volume: 361 Issue: 12 Pages: 1139-1151 Published: SEP 17 2009 St. Johns National Academy of Health Sciences, Bangalore	870
7	Title: Biodegradable polymeric nanoparticles as drug delivery devices Author(s): Soppimath, KS; Aminabhavi, TM; Kulkarni, AR; Rudzinski, WE; Source: JOURNAL OF CONTROLLED RELEASE Volume: 70 Issue: 1-2 Pages: 1-20 Published: JAN 29 2001Karnatak University, Dharwad	772
8	Title: Emergent properties of networks of biological signaling pathways Author(s): Bhalla, US; Iyengar, R; Source: SCIENCE Volume: 283 Issue: 5400 Pages: 381-387 Published: JAN 15 1999 National Centre for Biological Sciences, Bangalore	763
9	Title: Phase III study comparing cisplatin plus gemcitabine with cisplatin plus premetrexed in chemotherapy-native patients with advanced-stage non-small-cell lung cancer Author(s): Scagliotti, GV; Parikh, P; von Pawel, J; Biesma, B; Vansteenkiste, J; Manegold, C; Serwatowski, P; Gatzemeier, U; Digumarti, R; Zukin, M; Lee, JS; Mellemgaard, A; Park, K; Patil, S; Rolski, J; Goksel, T; de Marinis, F; Simms, L; Sugarman, KP; Gandara, D; Source: JOURNAL OF CLINICAL ONCOLOGY Volume: 26 Issue: 21 Pages: 3543-3551 Published: JUL 20 2008Bangalore Institute of Oncology, Bangalore	614
10	Title: Supramolecular Gels: Functions And Uses Author(S): Sangeetha, NM; Maitra, USource: CHEMICAL SOCIETY REVIEWS Volume: 34 Issue: 10 Pages: 821-836 Publishe: 2005Indian Institute Of Science, Bangalore	568