CHAPTER V

MAJOR FINDINGS AND SUGGESTIONS

The research has performed to understand the characteristics of the research records and the citations on the subject of environmental science research in India published during 1999-2013 and reflected in SCOPUS online database. The thesis has divided into five chapters; the first chapter has explained the background and the introduction, statement of the problem, the system developed at the national level to solve the problem, the need of the study, the objectives, etc. as per the standard method used in the doctoral theses.

The second chapter has devoted for the literature review, about seventy research articles on the evaluation of environmental science research and the related area from various sources have critically reviewed. The reviewed articles have categorized into five groups as given below:

i. The articles on theory
ii. The articles on the assessment in environmental science research in India and abroad
iii. The articles on the assessment of relevant to environmental science research
iv. The articles on other than environmental science but relevant to the research
v. The articles on the assessment of academic institutions, individuals, countries, etc.

The third chapter has assigned for research methodology and design, as per the standard method used in all the thesis. The detail statement of the method, scope, sample selection, data collection, and the method of analysis has given in this chapter.

The bullet point method has used to present the major findings of Chapter IV, which has devoted for the Analysis and Interpretation of data. Chapter IV has sub-divided into four parts. They are as follow:

Chapter IV (i): Comparison of Indian Research records with the World
Chapter IV (ii): Authorship Analysis
Chapter IV (iii): Citation Analysis
Chapter IV (iv): Domain-wise Records and the Citation analysis

In bullet point presentation the same sequence has followed as, Chapter IV (i) to IV (iv) to maintain the uninterrupted flow of the presentation.
CHAPTER IV

4.1: Comparison of Indian research records with the world

Chapter IV has focused on the comparison of Indian research records in environmental science research with the world. The comparison has assessed in term of growth, an annual number of records, percentage, share, Activity Index, language wise contribution and the type of documents. Some of the variables like top authors, top source titles, have analyzed in Chapter IV (i) at world level and for contry (Indian) level analysis, Chapter IV (ii) and Chapter IV (iii) has used respectively.

- There were 12,36,114 research records have published in environmental science in the world including 51382 (4.1 per cent) records of India during 1999-2013.
- The highest annual growth of records in the world has observed in the year 2005 (14.46 per cent) and in India the highest has observed in the year 2009 (25.17 perc ent).
- The highest numbers of records in the world have 1,25,583 (about ten per cent) in the year 2013 and for India, the highest 6,482 (5.16 per cent) records have found in the year 2013.
- The average growth in the world during the study period has 6.39 per cent, and it has 11.65 per cent in India.
- The highest share of India in the world has found 5.15 per cent in the year 2013.
- Activity Index (AI) of Indian research output has observed minimum 65.05 in the year 1999 and maximum 129.85 in the year 2011.
- It has observed that More populous countries have fewer records per capita than less populated countries.
- The highest number of records 455 have contributed by Li, W. from the United States affiliated with George Washington University. He has received 92,255 citations, and his h-index has observed 118. His other indicators, such as, citations and the h-index have also found the highest among all the authors.
- The research work performed with more co-authors received more citations than fewer co-authors.
- The publications and the expense on R & D against the GDP of top countries have observed positive.
- The US has always remained at top position during the study period.
- India has always maintained the position in top ten countries, and its ranking position has upgraded compared to the past.
- China has achieved a remarkable stage of the second position in top ten countries, its journey is a long way, China was already there in the list of top ten holding ninth positions during 1999, and it has moved to the second ranking position during 2013.
In the early period of the study 1999-2003 Japan has ranking at fifth but during 2012-2013 it could not maintain the position in the list of top ten countries.

Instead, India holds the fifth position during 2010-2013.

The source title, SAE Technical Papers has ranked first with 37510 records in environmental science in the world

Environmental Health Perspectives having highest SCImago Journal Ranking value 2.775

The highest Impact Per Paper value has observed 6.395 to the Environmental Health Perspectives

The highest SNIP value has observed to Journal of Hazardous Material 2.179

The highest h-index has 252 for Environmental Science and Technology

Environmental Health Perspective has highest SJR and also highest IPP

The top twenty-two affiliations have published 1,17,899 records out of which 59,239 records (> 50 per cent) have published by the US.

The eleven affiliations among top twenty belong to the US

The US has dominated in publications in environmental science in the world

The environmental science scientific papers have 92.18 per cent in the English language in the world.

The Chinese language has ranked at second position with 3.11 per cent records.

About ninety-six percent of records have in English and Chinese and rest of the four percent records have distributed in thirty-one languages in the world.

The article was the major type of documents used by the authors 75.23 per cent in the world and 85.89 per cent in India.

The source type Journal has published the highest number of records in environmental science, at world level, it was 86.9 per cent, and at Indian level, it was ninety percent.

4.2 Authorship Pattern in environmental science in India

There is consistent decreasing trend in single authorship work; Maximum was 22.42 percent in the year 2001, and the minimum was 5.6 percent in the year 2011

The authorship trend shows single-author records are decreasing, and multi-authored records are increasing

The average percentage of single author records for the study period was 10.63 per cent

The single-author category records shows a decreasing trend; the maximum was observed 35.2 per cent in the year 1999, and the minimum was 27.21 per cent in the year 2013.

Two-author category records were the highest 15346 records 28.91 per cent among all.

Two-author category records trends have observed decreasing trend it was maximum 35.2 percent in 1999 and minimum 27.21 percent in 2013.
• Three-author category has the second highest records 13363 (25.52 percent) in the series
• Four-author records, the highest contribution, was 18.26 per cent in the year 2013, and the lowest was 11.6 per cent in 2002 this category data shows slow but consistent increasing trend.
• The attitude of authors performing research in a group for the subject of environmental science is increasing as it has observed for other subjects
• The single author records were consistently decreasing during the block of 5 years.
• Single author records were 11.6 per cent contributed by 3.61 per cent authors during 15 years
• The two author records have seen the decreasing trend during a block by block but as compared to single author records the decreasing rate has slow.
• Two author records were 29.87 per cent contributed by 18.6 per cent author's during 15 years
• The three author publications during the first block were 24.84 per cent contributed by 27.31 per cent authors
• During the second block, there were 26.45 per cent records contributed by 25.69 per cent authors
• During the third block, there were 26.14 per cent records contributed by 22.87 per cent author's
• The highest number of records 26.45 per cent were during the second block, but the number of authors was consistently decreasing during the entire study period in this category.
• Three author records were 26 per cent contributed by 24.3 per cent authors during 15 years
• Four authored contribution shows the consistent increasing trend block by block
• Four author records were 15.93 per cent contributed by 19.87 per cent author's during 15 years
• Each category of > 4 authors records shows the consistent increasing trend.
• Mega-Author records have observed 0.9 per cent during 1999-2013, whereas average citations received to the mega-author records have about three percent.
• Mega-author records have a potentiality to pull the citations more than the average citations.
• Year by year multi-authored papers was predominant over single author papers
• Collaborative research in environmental science in India is increasing
• The author performed the research with a maximum number of co-authors received the maximum number of citations than otherwise.
• The attitude of authors performing research in a group for the subject of environmental science is increasing as observed in other subjects.
• Single author contribution in environmental science in 1999 was 19.6 percent; reduced to 7.34 per cent in 2013.
• Two author contribution in environmental science in 1999 was 35.2 per cent; reduced to 27.21 per cent in 2013
• A group of three authored papers and after that, the trend of research papers in environmental science in India shows the increasing trend.
• The uniqueness of the three author group has observed than other groups that, single author records and number of authors have a decreasing trend, two author records, and the authors have also observed as a decreasing trend. The group of three author records has observed increasing trend during the second block and decreasing trend during the third block. The rest of the groups have shown increasing trend in records as well as authors. But only the group of three authors records have a trend of increasing and decreasing during the study period.

4.3 Citation Analysis

• There were 51382 records have published on the subject of environmental science
• Out of it, 31867 (62.02 percent) records were received 389064 citations
• The Average Citations Per Paper (ACPP) was 7.57 during the study period
• The highest ACPP was 11.89 in the year 2006
• The lowest ACPP was 1.62 in the year 2013
• In the years, 2010-2013 the ACPP was below average
• Out of 51382 records, 19515 (37.98 percent) were not received citations
• The highest Citation Rate (CR) of 0.69 was in the year 2000 and the year 2003
• The lowest CR was 0.41 in the year 2013
• The Average CR during 1999-2013 was 0.62
• Due to smaller citation window, the years 2011-2013 the CR was below average
• The minimum percentage of Not Cited Records (PNC) 30.08 in the year 2003
• The highest PNC 59.71 was in the year 2013
• The highest number of citations 926 for the article published in 2007
• Prolific Indian authors published more than fifty records were observed about thirty-two authors
• Highest citation receiver authors received more than 300 citations were twenty-one records
• There is no any relation between prolific authors and the highest citation receiver author
• Among the thirty-two prolific authors and twenty-one highest citations receivers, only one author was observed as common in both the lists
• Gupta, V.K. was observed twice in the list of highest citation receiver author and also found on the list of prolific authors.
• V.K. Gupta has published the sixty-five records holding the twelfth rank, received 28191 citations with firstrank and his h-index was 116 ranked at the top position, he has performed the research with 150 co-authors
• About thirty percent records have received the citations between the range of one to four
• About thirty percent records have received the citations between the range of five to fifty
• About two percent records have received the citations between the range of 51-926
• Top contributors (prolific authors) may not be top citation receivers
• It has observed that about forty-eight percent of the cited records have received the citations in the ranges of one to four. About forty-nine percent of cited records have received the citations in the ranges of five to fifty and rest is about one percent records have received 51>900 citations.
• Bradford’s Law of Scattering
• The fifteen (1.5 percent) Journals have contained 15139 (34 percent) records
• The sixty-six (6.5 percent) Journals have contained 14666 (33 percent) records
• 947 (92.1 per cent) Journals have contained 14340 (33 per cent) records
• Out of the fifteen core journals ten (66.6 percent) have published from India
• The top most SJR among core journals has 2.472 for ‘Bio-resource Technology’ of UK
• The top most h-index among core journals has observed 152 to ‘Bio-resource Technology’ of UK
• The top most SNIP among core journals has 2.463 for ‘Bio-resource Technology’ of UK
• The top most IPP among core journals has 5.627 for ‘Bio-resource Technology’ of UK
• Out of fifteen core journals, two each from Netherlands and US and one from the UK
• Maximum Annual Growth Rate of records in India has observed 25.17 percent during 2009
• The minimum Annual Growth Rate of records in India has observed – 5.48 during 2002
• Maximum Annual Growth Rate of authors in India has 30.73 during 2005
• Minimum Annual Growth Rate of authors in India has – 4.12 during 2002
• Maximum Annual Growth Rate of pages in India has 59.8 during 2005
• Minimum Annual Growth Rate of pages in India has -16.87 during 2006
• Maximum Annual Growth Rate of References in India has 39.14 during 2003
• Minimum Annual Growth Rate of References in India has -4.28 during 2002
• Maximum Annual Growth Rate of citations in India has 27.87 during 2000
• Minimum Annual Growth Rate of citations in India has -46.65 during 2013
• Average Growth Rate for block of 2009-2013 for the record, author, page and reference have increased, but citations have decreased as compared to the previous five-year blocks
• Younger records received fewer citations than the older.
• Younger records contain more references than the older.
• During 1999, the Author counts above average, Records, Pages and References have observed below average, the citation has found below average.
• During 2000 and 2001 the records, authors, references have above average the Pages below average; the citations indicate above average
• During 2002 the records, authors, pages, references and also the citations have observed below average
- During 2003 the records, authors, pages, references and also the citations have observed above average
- During 2004 the records, authors, pages, references and also the citations have observed below average
- During 2005 the records, authors, pages, references and also the citations have observed above average
- During 2006 Records, Pages, Authors, References have below average but the citations have observed above average
- During 2007 the records, authors, pages, references and also the citations have observed above average
- During 2009 the Records, Author, References have found above average, the pages have observed below average but the citations have found above average
- During 1999-2013, the average number of records measured 11.5 and the last phase of the period 2011-2013, indicates the below average records
- During 1999-2013, the number of pages per author has to show decreasing trend in 2011-2013
- The actual numbers of references have increasing, but the trend of average references has indicated decreasing during 2011-2013.

4.4: Domain-wise Analysis and top Institutions in India

- The subject of environmental science has categorized into twelve domains
- The domain ‘Pollution’ has (9310) the highest number of records, measuring 18.11 percent
- The minimum 330 records (0.64 percent) have found in the domain of ‘Ecological Modeling’ it received 4223 (1.09 percent) citations, it has observed as minimum among all the domains.
- The maximum citations 64198 (16.5 percent) have received for the domain of ‘Health, Toxicology, and Mutagenesis.’
- The highest Average Citations Per Paper (ACPP) has observed 13.46 for the domain of ‘Waste Management and Disposal.’
- The domain of ‘Ecological Modeling’ has received the lowest number of citations, but ranking at second highest in term of ACPP measuring 12.81
- The minimum ACPP has found 3.35 for the domain of ‘Environmental Science (Miscellaneous)’
- About forty-eight percent citations have received by three domains and fifty-two percent of the citations have received for the rest of the nine domains
- The domain of ‘Health, Toxicology and Mutagenesis’ has observed 6463 (12.5 percent) records during the study period
- The domain of ‘Health, Toxicology and Mutagenesis’ has received 64198 (16.49 percent) citations and the ACPP has found 9.93 during the study period
The publication trends show the decreasing number of records for the domain of ‘Health, Toxicology and Mutagenesis’ i.e. during 1999 it has found fourteen percent and during 2013, it has observed eleven percent.

The domain of ‘Health Toxicology and Mutagenesis’ has received highest number of citations in percentage 24.71 percent during 2000 and the lowest has found 2.46 percent during 2013.

The highest number of records, in percentage for the domain of ‘Health, Toxicology and Mutagenesis’ was in the years 2005 & 2006 (14.2 per cent) each and after that, the decreasing trend has observed.

The highest share of the records for the domain of ‘Health, Toxicology and Mutagenesis’ 11.8 percent has found in the 2004 and 2006.

Anna University was holding the first position with 987 records, 10666 citations and also with highest not cited 392 records.

Indian Institute of Chemical Technology has observed at the first rank with 18.4 ACPP.

Indian Institute of Chemical Technology has found 88.90 percent (maximum) records have cited.

The domain of ‘Health Toxicology and Mutagenesis’ has fifteen affiliations from publications point of view and seventeen affiliations from citations point of view.

Maximum affiliations nineteen have observed for the domain of ‘Environmental Science (Miscellaneous)’ as contributors and nine have observed as citation based affiliations.

The three domains, ‘Ecological Modeling,’ ‘Global and Planetary Change’ and ‘Management, Monitoring Policy and Law’ no single domain has found from publication point of view or citation point of view among top fifty.

SUGGESTIONS:

I. Strategic level suggestions:

(i) When the consequences of the population growth have examined, ecological problem assumed importance. In this regard, it has already pointed out by K. Mahadevan (1992) that relatively small number of population experts cannot convey the need and urgency for population control, protection of ecosystem and improvement in the quality of life. Therefore the subject of population studies, earlier which was called human ecology should be expeditiously integrated at different levels of education with as many relevant subjects as possible. Moreover, it has been stated that instead of continuing to concentrate only on the academic exercise of population studies the demographers should concentrate on application part of the population studies. The curriculum should be broad based...
as suggested by Mahadevan (1992) to ensure the stabilization of population for a better quality of life and to control the further damage of the ecological balance. The researcher has repeated the suggestion for the subject of environmental science in India. It will geared up the research activities, the ranking will improve at the world level.

Environmental Science has its roots in the subject of Demography; the discipline of environmental science has divided into twelve domains, but no single domain has found for demographic studies, further the subject of demography has no place for environmental science. Since there is close relationship of the environmental science and the demography, so the environmental science should have the domain of demography, as well as the subject of demography should have broaden the scope to accommodate the environmental science for the overall development of the subject.

Alternatively, the concept of Population Studies have broader than the Demography, but the Population Science has not recognised as a discipline by any International or national agency. This is the suggestion that the Population Studies should have the discipline and the selected domains of the environmental science including demography should have incorporated in Population Science.

(ii) The research has discovered the top countries in term of research output. Fortunately India (as a country) has always remained in top ten during the period of 1999-2013. The researcher has tried to establish the relationship of research output with the expenditure on R & D against the GDP of the top countries. It has observed that India has lowest expenditure on R & D against their GDP among the top ten countries. The maximum expenses on R & D against GDP in the world has observed 4.149 per cent by South Korea (ranking at first) and 2.43 per cent of the GDP spent on R & D by Belgium ranking at tenth position. India has observed 26th ranking position by the expenditure against GDP on R & D with 0.82 per cent but by the number of publications it has ranked at fifth position and it has always remianed among top ten during 1999-2013.
Pearson Correlation Coefficient has measured and presented to find out the relationship of publications and the expenditure on R & D against GDP of top 32 countries. The r value has observed 0.13 (positive). Which shows that there is positive relationship of number of publications and the expenditure on R & D against the GDP.

If the Government of India has make note of it and provide fund for research in environmental science to upgrade the ranking position of India in the world.

II. Institutional level suggestions:
   (i) At global level the list of top 22 institutions have presented and it has observed that no single institution from India has found in the list. Assessment of research output of an institution reflects the scientific developments and progress. It also highlights the contribution of an individual authors involved in research. It has suggested that other qualitative indicators based on citations and impact factors of the Institution may be taken up so that the Institute’s indicator get enhance to stand at global level.
   (ii) The Institutions in India, those who are conducting research in Environmental Science should make a note that no single Institution has conducting the research in the following three domains of the environmental science:
   (a) Ecological Modeling
   (b) Global and Planetary Change
   (c) Management, Monitoring Policy and Law

III. Individual level suggestions:
   (i) From the above study it has observed that the multi-author and the mega-author records have potentiality to receive the citations. The author should make a note that the group word acceptability has wider than the solo work. For example, 1.05 per cent records have found in the study as mega-author records and it received 2.83 per cent citations. It shows the potentiality to receive the citation to the group work.
   More over it should also be noted by the authors that solo author records, two author records and three author records have found decreasing trend in the study.
(ii) Authors have suggested to see the journal indicators before submission of manuscript for publication. The list of top authors in the world has presented in the research and found only one Indian author G.P. Nair has found in the list. The authors should concentrate on publishing their research publication in qualitative source title.

(iii) Research publication in English language has wider acceptance, so authors are suggested to prefer to publish in English language

(iv) The researchers in environmental science should concentrate on thirst areas, identified in the thesis

LIMITATIONS OF THE STUDY:

1. The main data source is a SCOPUS online database, the records have limited to SCOPUS
2. The duration of data for analysis has 1999-2013
3. World level data analyzed, limited to the records for comparison with India
4. Author-related analysis has done by the first author
5. The evaluation of the environmental science research has discovered existing situation, to find out the causes and it has kept open for research