Informetric Portrait of Elinor Ostrom, the Nobel Laureate in the Field of Economic Sciences

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ABSTRACT
The publication productivity of Elinor Ostrom, the renowned American Political economist and the first woman laureate to win the most aspired highest prize that is the Nobel Prize in Economics in 2009 for her analysis of economic governance is analysed. The present study has analysed her 197 publications as indexed in Scopus using bibliometric methods covering the period 1965-2018. It is observed that during her 54 years of publication she published average 3-4 works each year. The years 2006, 2008-2013 accounts for 103 publications i.e. 52.28% and they are the most productive years in her life. She published 85 single-authored papers and 112 multi-authored papers. James Michael Walker who co-authored 19 publications is the most prominent collaborator. Natural resources management is the prominent area of her research. Ostrom used 116 channels prominently being the journal articles covering 119 (60%) of her publications. Ostrom’s works had high reception which can also be seen from the citations received; 50552 citations as per Scopus. Her Recency Index is nearly 0.47 which indicates that nearly 47% of her works are cited in the last five years. Ostrom’s works are an inspiration for the future Nobel aspirants and researchers in economics because she designed a new principle and argued with proof that common resources are best utilised and best managed when they are managed by the localities of the areas where those resources are found. This provided an opportunity for the common people to earn a living as well as helped in the best utilisation of the resources which is a unique idea. Her works therefore opened up avenues to find out the new resources of various areas and continues to be important in the future. The bibliometric analysis attempts to draw some insights of her interesting and important work.

Keywords: Informetric Portrait, Nobel laureate, Elinor Ostrom, Common resources, Economic Sciences.

INTRODUCTION
The Nobel Prize is the highest prize for research accomplishment. The reputation of a nation and its scientific community depends upon these highest awards and the intellectuals eagerly wait to earn such appreciation for their hard work. In 1901, the Nobel Prizes were started in physics, chemistry, medicine or physiology, literature and peace. In 1968, the Central Bank of Sweden (Sveriges Riksbank), concurrence with its tercentenary celebration introduced a new award, “The Central Bank of Sweden Prize in Economic Science in Memory of Alfred Nobel” on the basis of an economic assurance by the bank in infinity. The award followed the same principles and rules as the original Nobel prizes.¹

So, till date this prize is called as “The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel”. From 1969 to 2019 the total number of Nobel Laureates in economic sciences is 83. In the initial years and till 2008 no woman was awarded the Nobel Prize in Economic sciences but Elinor Ostrom, Professor at the University of Indiana, USA became the first woman to be honoured with the award in 2009 jointly with Oliver E. Williamson from University of California, Berkeley, CA, USA. Her win ensured that 2009 was a record-breaking Nobel year for women in Economic Sciences.

Ostrom’s work was to go underneath the usual economic statements of the problem and examine the microeconomic nature of how institutions evolved to alleviate common property issues. In the process she became one of the leading political economists of her time.² Ostrom’s ideas are so pertinent because they are not simply theoretical proposals or the result of some laboratory experiment. Rather, they are based on far-reaching compilation of real life cases in many different countries and cultures and for different types of commons. This type of research provides insights
based on the empirically observed behavior of individuals under conditions they live in. Kevin Gallagher, one of the reporters in the Guardian after Ostrom's win reports on Oct 13, 2009 “Ostrom won the Nobel prize for showing that privatisation of natural resources is not the route to halting environmental degradation.” Actually she contradicted with many environmental experts and proved that the government may not be the best allocator of public resources either. Often governments are seen as illicit, or their rules cannot be imposed. Indeed, Ostrom’s Governing the Commons: The Evolution of Institutions for Collective Action looking at forests, lakes, groundwater basins and fisheries shows that the commons can be an opportunity for communities themselves to manage a resource. When communities are given the right to self-organise they can democratically govern themselves to preserve the environment. In the Obituary column of the Economist on June 30, 2012, it has been very rightly mentioned that "while others wrote gloomily of the tragedy of the commons, seeing only overfishing and over farming in a free-for-all of greed, Mrs Ostrom, with her loud laugh and louder tops, cut a cheery and contrarian figure."

So studying her life and works and analyzing them through scientometric indicators in this paper turns out to be very interesting from cross-disciplinary point of view. Such studies are either called as bio-bibliometrics or informetric portraits. ‘Bio-bibliometrics’ the term was first coined by Sen and Gani to describe the quantitative and analytical method for finding and generating functional relationships between bio-data and biblio-data elements. Recently the term ‘Bio-bibliometrics’ is being used for a method of retrieving and visualizing biological information that uses co-occurrence of gene naming terms in Medical Sciences to generate semantic links between genes. Kalyane and Kalyane for the first time used the phrase ‘Scientometric Portrait’ to carry out bio-bibliometric studies on scientists while Sinha and Bhamagar and Sinha and Ullah used the term ‘Information profile’ for such studies.

Therefore from the different studies, it is suggested that ‘Scientometric Portrait’ is the appropriate phrase for the studies on scientists and ‘Informetric Portrait’ can be used for the studies on personalities in other disciplines such as arts, humanities and social sciences. The importance of the study can be comprehended from the fact that by analysing individual bibliographical and biographical data those who have touched the top position in academic and research life may inspire the younger generations. The study of famous women who reached the top position in academic life makes the women society more stimulating.
of 18. His productivity co-efficient was 0.69, publication density was 2.18 and publication concentration was 23.68. El Aichouchi and Gorry[20] explores Hagenmuller’s (a figure of French solid-state chemistry) works using scientometric analysis. They reveal the impact of his research, main research topic and his collaboration with other collaborators.

The above studies which focused on the works of different scholars as well as Noble laureates from various fields provided grounding for the present study on Elinor Ostrom.

The study aims to find out why Ostrom inspite of being a Political scientist with all her degrees in Political science became so famous among the Economists that she was awarded one of the highest prizes. For this concentration has been paid on Ostrom’s publication productivity over the years, the most prominent researchers with whom she collaborated for her researches, the major subject domains on which Ostrom worked, the works which received highest citations and the most used keywords used in the titles of Ostrom’s works. The main research questions drawn from these objectives are therefore:

a) How the publication productivity of Ostrom changed over the years?

b) How collaboration in researches has been observed from Ostrom’s works?

c) Which subject domain received most attention from Ostrom?

d) How the top cited works affected the winning of noble prize by Ostrom?

e) Which field of Ostrom’s work received wide acclamation?

**METHODOLOGY**

The data presented in this paper have been accessed from Scopus (an Elsevier’s abstract and citation database launched in 2004). The basic data, relating to the bibliometric characteristics of Elinor Ostrom were collected using ‘Author Search’ option in Scopus. Due to non-availability of exact name search facilities in the database, the search result was refined by author affiliation. Affiliation of the author was determined by authors’ address. All the searched results were first saved in CSV file and then imported into MS-Excel. Only for the citation analysis two other databases as Google scholar and Web of Science in addition to Scopus are consulted to collect data. However book citations of Elinor Ostrom are not found in Web of Science database probably because they are not indexed in that database and hence are omitted in the tabular data. After sorting the data in MS-Excel the data is analysed to satisfy the objectives.

The following formulae have been used to calculate the Collaborative Index and Collaboration co-efficient in the Table 1.

Collaborative Index (C.I.) = \[ \frac{\sum f_i}{N} \]

Collaboration Co-efficient (C. C.) = \[ 1 - \frac{\sum f_i}{N} \]

where, \( f_i \) = The number of papers j authors in collection K

\( N \) = The total no. of papers in collection K

\( A \) = The total no. of authors in collection K

Degree of collaboration is defined as the ratio of the number of collaborative research papers to the total number of research papers published in the disciplines during a certain period of time. Degree of collaboration (DC) = \[ \frac{N_m}{N} \] where \( N_m \) = number of Multiple-authored research papers in the discipline published during a year and \( N \) = number of single-authored research papers in the discipline published during the same year.[21] It is also shown in Table 1.

**Biographical sketch of Elinor Ostrom**

Elinor Ostrom or Lin, as she is often called was born on 7th August 1933 in Los Angeles, California and grew up in a family of simple means. She lived with her divorced mother. She graduated with honours in political science from the University of California. She got her Ph.D. awarded in 1665. She married political economist Vincent Ostrom. She started her academic career at Indiana University, was also a founding director of the Centre for the Study of Institutional Diversity at Arizona State University. She published several books during her career like Governing the Commons (1990) and Understanding Institutional diversity (2009). She was the first woman to receive the prestigious Nobel in economic sciences in 2009 which raised some eyebrows. On December 8, 2009 she delivered her Nobel Prize lecture in Stockholm, Sweden entitled “Beyond Markets and States: Polycentric Governance of Complex Economic Systems” which was published in American Economic Review by American Economic Association in June 2010.[22] Her award-winning scholarly work demonstrates how communities can successfully share common resources, such as waterways, livestock grazing land and forests, through collective property rights that best define her legacy. She died on 12th June 2012 in Bloomington, USA.

**DATA ANALYSIS AND DISCUSSIONS**

**Growth of Publications**

Table 1 depicts that Ostrom published 197 scholarly publications with an average of 3–4 publications per year, during her long publication productivity age of 54 years from
Table 1: Year and age-wise distribution of publications by Elinor Ostrom.

| Qui. | BA  | PY   | Number of Papers under various authorship | Main author | Co-author | APC  | CAPC | %CAPC | PPA  | DC  | CI  | CC  |
|------|-----|------|------------------------------------------|-------------|-----------|------|------|-------|------|-----|-----|-----|
|      |     |      | Single | MAP |           |   |     |      |     |     |     |     |
| Q1   |     |      |       |     |           |   |     |      |     |     |     |     |
| 32   | 1965| 1    | 1     | 1   | 1         | 1  | 0.51| 1     | 1   | 2   | 0.75|
| 33   | 1966| 1    |       |     |           | 1  | 0.51|       |     |     |     |
| 34   | 1967| 1    |       |     |           | 3  | 0.51|       |     |     |     |
| 35   | 1968| 1    | 1     | 1   | 2         | 1  | 1.02|       | 0   | 1   | 0   |
| 36   | 1969| 2    |       |     |           | 5  | 1.02|       |     |     |     |
| 37   | 1970| 2    |       |     |           | 6  | 1.02|       |     |     |     |
| 38   | 1971| 1    | 1     | 1   | 3         | 1  | 1.52|       | 0   | 1   | 0   |
| Q2   |     |      |       |     |           | 1  | 1.52|       | 0   | 1   | 0   |
| 39   | 1972| 3    |       |     |           | 8  |     |       |     |     |     |
| 40   | 1973| 1    | 1     | 1   | 4         | 1  | 2.03|       | 0   | 1   | 0   |
| 41   | 1974| 1    | 1     | 5   | 5         | 1  | 2.03|       | 0   | 1   | 0.89|
| 42   | 1975| 1    |       |     |           | 6  | 3.05|       | 1   | 1   | 0   |
| 43   | 1976| 1    | 1     | 7   | 3.55      | 12 |     |       | 0   | 1   | 0   |
| Q3   |     |      |       |     |           | 7  | 3.55|       | 13  |     |     |
| 44   | 1977| 7    |       |     |           | 13 | 1.52|       | 0   | 1   | 0   |
| 45   | 1978| 1    | 1     | 2   | 2         | 9  | 4.57|       | 0.50| 2.50| 0.75|
| 46   | 1979| 9    |       |     |           | 15 | 4.57|       | 15  |     |     |
| 47   | 1980| 9    |       |     |           | 16 | 4.57|       | 16  |     |     |
| Q4   |     |      |       |     |           | 9  |     |       | 0   | 1   | 0   |
| 48   | 1981| 1    | 1     | 1   | 10        | 10 | 5.08|       | 1    | 9.00| 0.99|
| 49   | 1982| 1    | 1     | 11   | 11        | 18 | 5.58|       | 2.00| 1    | 0.75|
| 50   | 1983| 2    |       | 2    | 2         | 13 | 6.6 |       | 19  | 0   | 1   |
| 51   | 1984| 13   |       |     |           | 20 | 6.6 |       |     |     |     |
| 52   | 1985| 1    | 1     | 1    | 2         | 15 | 7.61|       | 0.50| 1.50| 0.50|
| 53   | 1986| 1    | 1     | 16   | 16        | 21 | 8.12|       | 22  | 0   | 1   |
| 54   | 1987| 16   |       |     |           | 23 | 8.12|       |     |     |     |
| Q5   |     |      |       |     |           | 17 | 8.12|       | 23  |     |     |
| 55   | 1988| 1    | 1     | 1    | 17        | 24 | 8.63|       | 0   | 1   | 0   |
| 56   | 1989| 1    | 1     | 1    | 19        | 25 | 9.64|       | 0.50| 2.00| 0.67|
| 57   | 1990| 2    | 2     | 4    | 23        | 26 | 11.67|      |     | 0.50| 2.00|
| 58   | 1991| 1    | 3     | 4    | 27        | 27 | 13.71|      |     | 0.75| 1.75|
| 59   | 1992| 2    | 3     | 1    | 31        | 28 | 15.74|      |     | 0.50| 1.75|
| 60   | 1993| 1    | 1     | 2    | 33        | 29 | 16.75|      |     | 0.50| 2.00|
| 61   | 1994| 1    | 2     | 1    | 36        | 30 | 18.27|      |     | 0.67| 2    |
| 62   | 1995| 2    | 3     | 3    | 41        | 31 | 20.81|      |     | 0.60| 1.60|
| Q6   |     |      |       |     |           | 16 | 8.12|       | 23  |     |     |
| 63   | 1996| 1    | 1     | 1    | 42        | 32 | 21.32|      |     | 1    | 0   |
| 64   | 1997| 42   |       |     |           | 33 | 21.32|      |     |     |     |
| 65   | 1998| 1    | 1     | 1    | 43        | 34 | 21.83|      |     | 0   | 1   |
| 66   | 1999| 1    | 4     | 3    | 48        | 35 | 24.37|      |     | 0.80| 3.80|
| 67   | 2000| 5    | 5     | 8    | 56        | 36 | 28.45|      |     | 0.38| 2   |
| 68   | 2001| 4    | 4     | 6    | 60        | 37 | 30.46|      |     | 1.50| 3.50|
| 69   | 2002| 3    | 1     | 4    | 64        | 38 | 32.49|      |     | 0.25| 1.75|
| 70   | 2003| 7    | 4     | 9    | 73        | 39 | 37.01|      |     | 0.78| 2.44|
| 71   | 2004| 5    | 1     | 5    | 78        | 40 | 39.6 |      |     | 0.60| 2.20|

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1965–2018 which are indexed by Scopus database. Year-wise and the cumulative number of publications are shown in Figure 1. As shown in the Table 1 and Figure 1, maximum number of articles are published in the years 2006, 2008–2013 which accounts for 103 publications i.e. 52.28% and they are the most productive years in her life, Ostrom published on an average 12-13 articles during those years. The highest number of contributions is found when Ostrom’s age was 77 years in 2010 with 21 publications (9 single authored and 12 multi-authored papers) followed by 2009 when she was 76 years, with 17 publications the year after and the year of winning the Nobel Prize. No publications are seen during 1966–1967, 1969–1970, 1972, 1977, 1979–1980, 1984, 1987, 1997, 2016–2017. It also appeared that many years after her death in 2012, her contributions are being published. She published 85 single-authored papers and 112 multi-authored papers. She was the main author in 104 (52.79%) of her publications and in 93 publications acted as co-author. Her productivity coefficient was found to be 0.80 which indicates her publication productivity was steady throughout the period.

\[
\text{Productivity Coefficient} = \frac{\text{Fifty percentil age}}{\text{Total productivity age}} = \frac{43}{54} = 0.80
\]

Again Table 1 depicts the quinquennial publication data of Elinor Ostrom which shows that the highest publication output of 62 papers (31% of her total contributions) is found during the 10th quinquennial during 2010–2014 (age range 77–81) and second highest is found during the 9th quinquennial during 2005–2009 (age range 72–76) i.e. 55 papers (28% of her total contributions). It is worth mentioning that Prof. Ostrom received the Nobel prize during these two quinquennium. The contribution of Ostrom was least during the age range 32–36 years i.e. since 1965–1969. It is seen that Ostrom’s contribution increased with her age.

**Co-Authorship pattern**

It appears from the Table 1 that Prof. Ostrom contributed 85 publications under single authorship and 112 publications are result of collaboration out of total 197 publications. Two-authored collaboration resulted in the largest number of publications, i.e. 51, 27 publications are found to be three-authored collaboration, 16 publications by four-authored collaboration, 6 publications by four-authored and remaining publications are more than five authored. Ostrom collaborated with 421 different authors in various publications. The highest number of collaborators in Ostrom’s papers is found to be 256 in a paper published in 2010 and the second highest number of collaborators is found to be 22 in a paper in 2011. Collaboration in scientific research is a growing phenomenon and the proportion of co-publications in the total number of scientific publications is growing steadily. The proportion of co-authorship of Prof. Ostrom increases significantly since 1999, at least 421 different collaborators are associated with her in various publications. Table 2 shows the prominent collaborators associated with her. The most prominent co-author is James Michael Walker who co-authored 19 publications over 21 years and both are affiliated to the same university, followed by Marco A. Janssen, Professor, Arizona State University where she was founding director of the Centre for the Study of Institutional Diversity, co-authored 12 publications over 7 years.
| Sl. No. | Co-Author’s name       | No. of papers contributed with Elinor Ostrom | First Publication year | Last Publication year | Total Years | Co-Author’s Affiliation                          |
|--------|------------------------|---------------------------------------------|------------------------|-----------------------|-------------|------------------------------------------------|
| 1      | Walker, James Michael  | 18                                          | 1990                   | 2010                  | 21          | Indiana University, United States               |
| 2      | Janssen, Marco A.      | 12                                          | 2005                   | 2011                  | 7           | Arizona State University, United States        |
| 3      | Ahn, T. K.             | 9                                           | 2000                   | 2011                  | 12          | Seoul National University, South Korea         |
| 4      | Basurto, Xavier        | 6                                           | 2009                   | 2018                  | 10          | Duke University, United States                 |
| 5      | Gardner, Roy J.        | 6                                           | 1990                   | 2010                  | 21          | Indiana University, United States               |
| 6      | Nagendra, Harini       | 5                                           | 2006                   | 2014                  | 9           | Azim Premji University, India                   |
| 7      | Poteete, Amy R.        | 5                                           | 2004                   | 2010                  | 7           | University Concordia, Canada                   |

**Degree of collaboration**

Value of Degree of Collaboration (DC) gives a fairly clear idea of degree of collaboration with Prof. Ostrom. From Table 1 it has been observed that in her 54 years of productive life, DC=1 only for 7 years which implies that no single author publications of the author appear in these years. Value of DC lies between 0.5 and 1 for 12 years means multi-authored papers of Ostrom are published more than her single authored papers in these years, value of DC equal to 0.5 for 6 years means multi-authored publications and single-authored publications are equal in number, value of DC is less than 0.5 for 5 years means multi-authored papers of Ostrom are published less than her single authored papers in these years and value of DC equal to zero for 11 years i.e. only single-authored publication appears in these 11 years.

**Domain-wise contribution**

Prof. Ostrom’s research area can broadly be categorized into 17 subfields of social science. Her publications are not limited to a specific area of research. Natural resources management is the prominent area of her research, she has contributed total 84 (42.64%) publications followed by the Environmental economics with 21 (10.66%) publications and Public finance with 21 (10.66%) publications. Ostrom’s work has wide dispersion covering 116 journals. ‘Science’ (published by American Association for the Advancement of Science, USA), published the maximum number of her works i.e. 9 in number and 4.57% works of her total contributions followed by Journal of Theoretical Politics (7) and Ecological Economics (6). There are four channels carrying 5 publications, four channels carrying 4 publications, three channels carrying 3 publications, 20 channels 2 publication and 82 channels carrying 1 publication each. Top 14 channels published 34% of her total works.

**Item type distribution**

Figure 2 depicts the item type distribution of Ostrom’s works. Journal articles top the list with 119 (60%) publications followed by book chapter (31), review (18), book (10), editorial (7) and note (6). Only two contributions each are made in the item categories namely conference paper, letter and short survey.

**Citation analysis**

After publication, research results are used by other researchers for their own studies and cited as references in their subsequent articles. The citation of one article by another is characteristic of scientific publications and it is generally accepted that the number of citations of a particular article is a reflection of its impact in the scientific community.[23] Citations provide data that can be used statistically and mathematically to quantify the relative importance of a particular article or a particular journal. There is positive correlation between citation and $H$-index of a researcher.

As per SCOPUS record, a total of 197 scholarly publications have received 50718 citations, while Google scholar reports the citation number to be 204963 and Web of Science indicates the number of citations to be 20277. So we can say that Google scholar outshines the reporting for the number of citations when compared to other databases.

Table 3 depicts the list of works of Ostrom which are cited more than 100 times in Scopus database. It is noticed that the first two highly cited works are books and then the next three highly cited works are the publications in the Journal Science. Seven of her works published in the journal Science received 100 or more than 100 citations. Among the 63 works which received 100 or more citations 24 works are published post Nobel Prize and rest are published prior to the receiving of Nobel Prize.

**Scientometric Indicators of Elinor Ostrom**

Table 4 depicts the different indexes calculated for Elinor Ostrom. The $h$-index is 77 according to Scopus. The Recency Index of Ostrom is nearly 0.47 which indicates that nearly 47% of her works are cited in the last five years i.e. in between
Figure 1: Publications productivity.

Figure 2: Item type distribution.

Table 3: Citation profile of significant works by Elinor Ostrom ≥ 100 citation (as on April 19, 2020).

| Sl. No. | Title                                                                 | Year | Source                                      | Citation received (SCOPUS) |
|---------|------------------------------------------------------------------------|------|---------------------------------------------|----------------------------|
| 1       | Governing the commons: the evolution of institutions for collective action | 1990 | Cambridge University Press                  | 13889                      |
| 2       | Understanding institutional diversity                                   | 2009 | Princeton University Press                 | 2931                       |
| 3       | A general framework for analyzing sustainability of social-ecological systems | 2009 | Science                                    | 2756                       |
| 4       | The Struggle to Govern the Commons                                      | 2003 | Science                                    | 2063                       |
| 5       | Complexity of coupled human and natural systems                         | 2007 | Science                                    | 1679                       |
| 6       | Collective action and the evolution of social norms                    | 2000 | Journal of Economic Perspectives           | 1471                       |
| 7       | A behavioral approach to the rational choice theory of collective action presidential address, American political science association, 1997 | 1998 | American Political Science Review         | 1468                       |
| 8       | Revisiting the commons: Local lessons, global challenges               | 1999 | Science                                    | 1393                       |
| 9       | A diagnostic approach for going beyond panaceas                        | 2007 | Proceedings of the National Academy of Sciences of the United States of America | 1245                      |
| 10      | Property-rights regimes and natural resources: a conceptual analysis    | 1992 | Land Economics                             | 1059                       |
| 11      | Beyond markets and states: Polycentric governance of complex economic systems | 2010 | American Economic Review                   | 1022                       |
| 12      | Covenants with and without a Sword: Self-Governance Is Possible        | 1992 | American Political Science Review          | 999                        |
| 13      | Crossing the great divide: Coproduction, synergy and development       | 1996 | World Development                          | 806                        |
| 14      | Polycentric systems for coping with collective action and global environmental change | 2010 | Global Environmental Change                | 782                        |
| 15      | Working together: Collective action, the commons and multiple methods in practice | 2010 | Princeton University Press                | 682                        |
| 16      | Coping with tragedies of the commons                                   | 1999 | Annual Review of Political Science         | 599                        |
| 17      | The concept of scale and the human dimensions of global change: A survey | 2000 | Ecological Economics                      | 575                        |
| 18      | A grammar of institutions                                              | 1995 | American Political Science Review          | 541                        |
| 19      | Governing the commons: The evolution of institutions for collective action | 2015 | Cambridge University Press                 | 487                        |
| 20      | Background on the Institutional Analysis and Development Framework     | 2011 | Policy Studies Journal                     | 484                        |
| 21      | Coupled human and natural systems                                       | 2007 | Ambio                                      | 469                        |
| 22      | The globalization of socio-ecological systems: An agenda for scientific research | 2006 | Global Environmental Change                | 459                        |
| 23 | Going beyond panaceas | 2007 | Proceedings of the National Academy of Sciences of the United States of America |
| 24 | An agenda for the study of institutions | 1986 | Public Choice |
| 25 | Collective action, property rights and decentralization in resource use in India and Nepal | 2001 | Politics and Society |
| 26 | Social-ecological system framework: Initial changes and continuing challenges | 2014 | Ecology and Society |
| 27 | Analyzing decentralized resource regimes from a polycentric perspective | 2008 | Policy Sciences |
| 28 | Insights on linking forests, trees and people from the air, on the ground and in the laboratory | 2006 | Proceedings of the National Academy of Sciences of the United States of America |
| 29 | Local enforcement and better forests | 2005 | World Development |
| 30 | Heterogeneity, group size and collective action: The role of institutions in forest management | 2004 | Development and Change |
| 31 | Connectivity and the governance of multilevel social-ecological systems: The role of social capital | 2009 | Annual Review of Environment and Resources |
| 32 | Earth system science for global sustainability: Grand challenges | 2010 | Science |
| 33 | Trust and Reciprocity: Interdisciplinary lessons from experimental research | 2003 | Trust and Reciprocity: Interdisciplinary Lessons from Experimental Research |
| 34 | Consumers as coproducers of public services: some economic and institutional considerations | 1981 | Policy Studies Journal |
| 35 | The Samaritan's Dilemma: The Political Economy of Development Aid | 2005 | The Samaritan's Dilemma: The Political Economy of Development Aid |
| 36 | Reconnecting to the biosphere | 2011 | Ambio |
| 37 | Moving beyond panaceas: A multi-tiered diagnostic approach for social-ecological analysis | 2010 | Environmental Conservation |
| 38 | The contested role of heterogeneity in collective action: Some evidence from community forestry in Nepal | 2001 | World Development |
| 39 | How types of goods and property rights jointly affect collective action | 2003 | Journal of Theoretical Politics |
| 40 | Robustness of social-ecological systems to spatial and temporal variability | 2007 | Society and Natural Resources |
| 41 | Human ecology and resource sustainability: The importance of institutional diversity | 1995 | Annual Review of Ecology and Systematics |
| 42 | Resilience, vulnerability and adaptation: A cross-cutting theme of the International Human Dimensions Programme on Global Environmental Change | 2006 | Global Environmental Change |
| 43 | Toward a behavioral theory linking trust, reciprocity and reputation | 2003 | Trust and Reciprocity: Interdisciplinary Lessons from Experimental Research |
| 44 | Lab experiments for the study of social-ecological systems | 2010 | Science |
| 45 | Nested externalities and polycentric institutions: Must we wait for global solutions to climate change before taking actions at other scales? | 2012 | Economic Theory |
| 46 | Rational choice theory and institutional analysis: Toward complementarity | 1991 | American Political Science Review |
| 47 | Aligning key concepts for global change policy: Robustness, resilience and sustainability | 2013 | Ecology and Society |
| 48 | Constituting Social Capital and Collective Action | 1994 | Journal of Theoretical Politics |
| 49 | Analyzing collective action | 2010 | Agricultural Economics |
| 50 | The challenge of common-pool resources | 2008 | Environment |
| 51 | The Nature of Common-Pool Resource Problems | 1990 | Rationality and Society |
| 52 | The meaning of social capital and its link to collective action | 2009 | Handbook of Social Capital: The Troika of Sociology, Political Science and Economics |
Table 4: Values of different indexes calculated for Prof. Elinor Ostrom.

| Index                                                                 | Values |
|----------------------------------------------------------------------|--------|
| No. of Publications                                                  | 197    |
| Citations Received till date (19th Apr. 2020)                        | 50552  |
| Citations received last five years (i.e., 2015-2019)                  | 23866  |
| Recency = Citations Received last five years/Citations received till date | 0.47   |
| h-index                                                              | 77     |
| i$_{10}$-index                                                       | 159    |
| Total citations received by all papers in the h-core (C$_{hcore}$)   | 47706  |
| Excess Citations (EC) = C$_{hcore}$– $h^2$                           | 41777  |
| e-index=                                                             | 204.4  |
| Ratio of e-index and h-index = e/h                                    | 2.65   |
| a-index = $C_{hcore}$/h                                              | 619.6  |
| R-index = $\sqrt{C_{total}}$                                         | 218.4  |

2015-2019. It means that her works got more recognition and importance over time and there is rare chance of obsolescence of her works in the coming future. As scientists like Ostrom receives large recognition for her works so it is not only sufficient to evaluate the academic performance based on h-index and therefore to get accurate results e-index is calculated in addition to h-index depicted in the citation database to make up the loss of citation information. The quality of Ostrom’s papers is evaluated by the a-index and R-index.

**Keyword Tomography**

The titles of the publications express the reflective content of the papers. Keyword in the titles is one of the best indicators of understanding the thought content of the scholarly writings. Therefore, if certain key-words are used repeatedly in the titles of an author’s research writings, then it reflects an idea of the theme of her research.

The most frequent keyword (after removing the commonly used English word like Article, preposition, pronoun etc.) appeared in the titles of writing of Prof. Ostrom are commons(24), collective(23), action(22), institutional(21), systems(19), institutions(19), change(14), social(13), social-ecological(12), common-pool(10), polycentric(10), approach(10) and resource(10).

**CONCLUSION**

This study on Elinor Ostrom, the first woman Nobel laureate in Economic sciences is indeed interesting as one can get an overview of some of the most vital publications and the trend of her research publications. Her publications are found for 54
long years in Scopus database and the scientometric indicators indicate a very high recognition of her works. She has a high h-value and e-value which jointly reflects that her works are highly cited. Also the papers are highly qualitative and that brought her the real laurel with the award of the highest prize. Her works are so worthy that they are continued to be published even after her death. She is such a scholar with simple living but high thinking and great modesty that even in her Nobel lecture which was published in the American Economic Review in 2010 she included 195 references which is worth praising. Even if we leave her 45 self-citations, the number of others references are still 150. She shows her reverence for other researchers which included Noble laureates like Amartya Sen, Oliver E. Williamson among many others. Her argument that individuals and communities could manage their own collective resources challenged Hardin’s approach to the “Tragedy of the Commons”. She set some design principles while working in Maine, Indonesia, Nepal and Kenya and showed that the common resources are well managed when they are managed by the localities who live in close proximity of those resources. She showed the real path for the sustainable development of the communities and reflected clearly that government interventions will not be effective unless and until they are well supported by individuals and communities (Elinor Ostrom– The “non-tragedy of the commons.”[26])

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ABBREVIATIONS

BA: Biological age, PY: Year of Publication, APC: Annual Publication Count, MAP: Multi Authored Publication, PPA: Publication Productivity Age, DC: Degree of collaboration CI: Collaborative Index, CC: Collaboration Co-efficient, Qui.: Quinquennium, CAPC: Cumulative no. of Annual Publication Count.

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