# Memo: Analysis of *Clark and Harley (2019)* Citations (v1)

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As requested by Alicia Harley on March 11, this paper provides a broad-scope analysis of the citations in *Sustainability Science: Toward a Synthesis (Harvard Sustainability Science Program Working Paper 2019-01)*. Please consider this memo a draft; I would be happy to expand upon or refine any of its contents, if it would be helpful.

## Method

I used an REF extractor script to extract the Zotero citations from the paper's .docx file. Then, I extracted the DOIs from this file using the 'wp_zotero_citation_analysis.Rmd' script and imported them into Web of Science. From there, I created a marked list, which I exported to a .bib file. Finally, I read the .bib file into 'wp_citation_analysis.Rmd' and analyzed it using the bibliometrix() package.

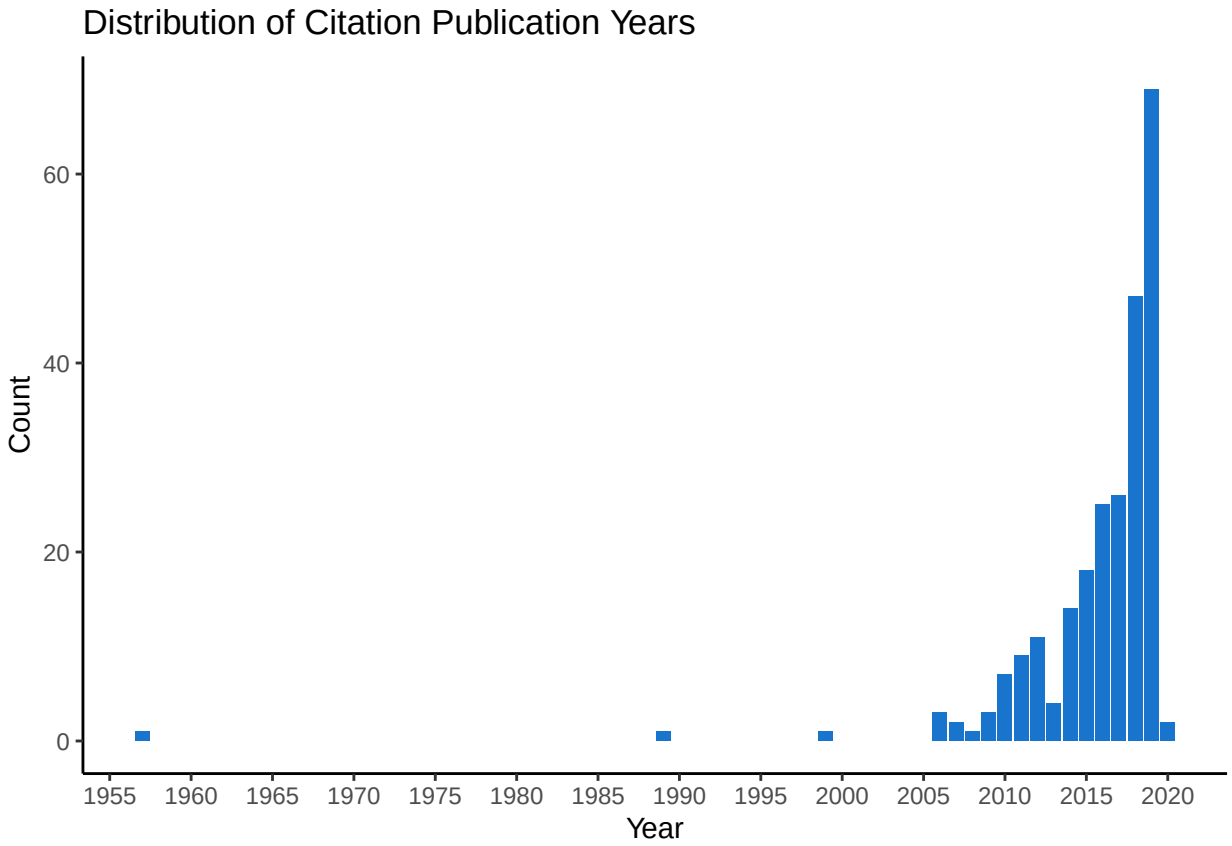
The original paper cites 420 articles, 246 of which had DOIs assigned within our shared sust_sci Zotero. This memo only analyzes the 246 articles which had DOIs assigned. I would be happy to manually assign DOIs to the appropriate Zotero articles and re-run the analysis script, if that would be helpful.

If you are viewing the HTML version, please use the tabs below to navigate through different metrics. Please excuse the rather clunky formatting in some places (I am still trying to understand the nuances of presenting data in R).

## First-Order Citation Trends

### Temporal Trends

As the graph below shows, most citations were published within the last five years. The median publication year is 2017. The median publication year is 2015.86. Each bar represents 1 year (binwidth = 1).




**Authors**

The table below includes all authors that were cited more than twice by Clark and Harley (2019). Note that all authors listed on all citations were included in this analysis (not just first or second authors).

Most Frequently Cited Authors

All authors cited more than 2 times are listed.

| Author Name | Times Cited |
|---|---|
| FOLKE C | 13 |
| ADGER WN | 8 |
| ANDERIES JM | 8 |
| BIGGS R | 8 |

| | |
|---|---|
| SCHEFFER M | 8 |
| CARPENTER SR | 7 |
| OSTROM E | 6 |
| POLASKY S | 6 |
| AVELINO F | 5 |
| BROWN K | 5 |
| CLARK WC | 5 |
| LAMBIN EF | 5 |
| VAN NES EH | 5 |
| BARBIER EB | 4 |
| CHOWDHURY RR | 4 |
| DIAZ S | 4 |
| GEELS FW | 4 |
| PITTMAN J | 4 |
| ROCHA JC | 4 |
| WALKER B | 4 |
| YOUNG OR | 4 |
| ALEXANDER SM | 3 |
| BRONDIZIO ES | 3 |
| CORNELL SE | 3 |
| CREPIN AS | 3 |
| DAKOS V | 3 |
| EAKIN H | 3 |
| FRANTZESKAKI N | 3 |
| GALAZ V | 3 |
| JANSSEN MA | 3 |
| LEVIN SA | 3 |
| LIU J | 3 |
| LOORBACH D | 3 |
| MAZZUCATO M | 3 |
| MORRISON TH | 3 |
| PETERSON GD | 3 |
| RAVEN R | 3 |
| REYERS B | 3 |
| ROCKSTROM J | 3 |
| SCHLUTER M | 3 |
| SCHOT J | 3 |
| SITAS N | 3 |
| STEFFEN W | 3 |

| | |
|---|---|
| TURNER BL | 3 |
| VAN DE LEEMPUT IA | 3 |
| VAN KERKHOFF L | 3 |
| WITTMAYER JM | 3 |

**Geographies**

Following standard bibliometric procedure, I used the corresponding author's "affiliated country" in Web of Science to assign a country ID to each citation. The table below lists all countries cited by Clark and Harley (2019).

Most Frequently Cited Countries
All countries are listed (no min. threshold.

| Country | Times Cited |
|---|---|
| USA | 105 |
| UNITED KINGDOM | 30 |
| SWEDEN | 23 |
| NETHERLANDS | 18 |
| AUSTRALIA | 14 |
| GERMANY | 9 |
| NORWAY | 6 |
| SWITZERLAND | 6 |
| CANADA | 5 |
| AUSTRIA | 4 |
| BELGIUM | 4 |
| FRANCE | 4 |
| SOUTH AFRICA | 4 |
| ARGENTINA | 2 |
| SPAIN | 2 |
| BRAZIL | 1 |
| CHINA | 1 |
| FINLAND | 1 |
| INDIA | 1 |
| ITALY | 1 |
| JAPAN | 1 |
| NEPAL | 1 |
| NEW ZEALAND | 1 |

**Institutions**

Again following standard bibliometric procedures, I use the corresponding author's "affiliated institution" in Web of Science to assign an institutional ID to each citation. The table below lists all institutions cited more than twice by Clark and Harley (2019).

Most Frequently Cited Institutions

All institutions cited more than 2 times are listed.

| Institution | Times Cited |
|---|---|
| STOCKHOLM UNIV | 13 |
| ARIZONA STATE UNIV | 8 |
| HARVARD UNIV | 7 |
| YALE UNIV | 7 |
| INDIANA UNIV | 6 |
| STANFORD UNIV | 6 |
| WAGENINGEN UNIV | 6 |
| ERASMUS UNIV | 5 |
| STELLENBOSCH UNIV | 5 |
| UNIV SUSSEX | 5 |
| COLORADO STATE UNIV | 4 |
| UNIV CALIF BERKELEY | 4 |
| UNIV MANCHESTER | 4 |
| UNIV OSLO | 4 |
| JAMES COOK UNIV | 3 |
| LUND UNIV | 3 |
| UNIV ARIZONA | 3 |
| UNIV CALIF SANTA BARBARA | 3 |
| UNIV E ANGLIA | 3 |
| UNIV MINNESOTA | 3 |

**Journals**

The table below lists all journals cited more than once by Clark and Harley (2019). Note that Web of Science disaggregates *Annual Reviews* into its separate volumes, which I can correct in future analyses.

Most Frequently Cited Journals

Note that Web of Science disaggregates Annual Reviews into its separate volumes.

| Journal | Times Cited |
|---|---|
| PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA | 24 |
| ECOLOGY AND SOCIETY | 13 |

| | |
|---|---|
| GLOBAL ENVIRONMENTAL CHANGE-HUMAN AND POLICY DIMENSIONS | 13 |
| SCIENCE | 11 |
| ENVIRONMENTAL RESEARCH LETTERS | 9 |
| NATURE SUSTAINABILITY | 9 |
| CURRENT OPINION IN ENVIRONMENTAL SUSTAINABILITY | 8 |
| ENVIRONMENTAL SCIENCE \& POLICY | 8 |
| RESEARCH POLICY | 8 |
| SUSTAINABILITY | 8 |
| CLIMATIC CHANGE | 7 |
| ANNUAL REVIEW OF ENVIRONMENT AND RESOURCES VOL 43 | 5 |
| WORLD DEVELOPMENT | 5 |
| ANNUAL REVIEW OF ENVIRONMENT AND RESOURCES VOL 42 | 4 |
| ENERGY RESEARCH \& SOCIAL SCIENCE | 4 |
| ENVIRONMENTAL INNOVATION AND SOCIETAL TRANSITIONS | 4 |
| POLICY AND SOCIETY | 4 |
| AMBIO | 3 |
| ANNUAL REVIEW OF ENVIRONMENT AND RESOURCES | 3 |
| ANNUAL REVIEW OF ENVIRONMENT AND RESOURCES VOL 36 | 3 |
| ANNUAL REVIEW OF ENVIRONMENT AND RESOURCES VOL 41 | 3 |
| INTERNATIONAL JOURNAL OF THE COMMONS | 3 |
| ANNUAL REVIEW OF ENVIRONMENT AND RESOURCES VOL 35 | 2 |
| ANNUAL REVIEW OF ENVIRONMENT AND RESOURCES VOL 37 | 2 |
| ANNUAL REVIEW OF ENVIRONMENT AND RESOURCES VOL 40 | 2 |
| ANNUAL REVIEW OF ENVIRONMENT AND RESOURCES VOL 44 | 2 |
| ANNUAL REVIEW OF POLITICAL SCIENCE VOL 20 | 2 |
| ANNUAL REVIEW OF POLITICAL SCIENCE VOL 21 | 2 |
| ANNUAL REVIEW OF RESOURCE ECONOMICS VOL 6 | 2 |
| ANNUAL REVIEW OF RESOURCE ECONOMICS VOL 8 | 2 |
| ECOLOGICAL ECONOMICS | 2 |
| ECONOMIC JOURNAL | 2 |
| ENVIRONMENTAL \& RESOURCE ECONOMICS | 2 |
| INDUSTRIAL AND CORPORATE CHANGE | 2 |
| POLICY SCIENCES | 2 |
| SUSTAINABILITY SCIENCE | 2 |
| TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE | 2 |
| TRENDS IN ECOLOGY \& EVOLUTION | 2 |

**Keywords**

The table below lists the author keywords assigned to five or more articles cited by Clark and Harley (2019).

Most Frequently Used Author Keywords in Citations

All keywords used 5 or more times are listed.

| Keyword | Times Cited |
|---|---|
| CLIMATE CHANGE | 41 |
| GOVERNANCE | 34 |
| MANAGEMENT | 33 |
| POLICY | 27 |
| FRAMEWORK | 25 |
| SCIENCE | 24 |
| SYSTEMS | 23 |
| POLITICS | 21 |
| RESILIENCE | 20 |
| SUSTAINABILITY | 20 |
| DYNAMICS | 17 |
| ADAPTATION | 16 |
| ECOSYSTEM SERVICES | 16 |
| KNOWLEDGE | 16 |
| BIODIVERSITY | 14 |
| MULTILEVEL PERSPECTIVE | 14 |
| SOCIAL ECOLOGICAL SYSTEMS | 14 |
| ENERGY | 13 |
| CONSERVATION | 12 |
| LESSONS | 11 |
| ECONOMICS | 10 |
| GROWTH | 10 |
| INSTITUTIONS | 10 |
| UNCERTAINTY | 10 |
| DECISION MAKING | 9 |
| PERSPECTIVE | 9 |
| POWER | 9 |
| VULNERABILITY | 9 |
| COMMONS | 8 |
| COMMUNITY | 8 |
| REGIME SHIFTS | 8 |
| SUSTAINABILITY TRANSITIONS | 8 |

| | |
|---|---|
| SUSTAINABLE DEVELOPMENT | 8 |
| ADAPTIVE CAPACITY | 7 |
| PARTICIPATION | 7 |
| STRATEGIES | 7 |
| ADAPTIVE GOVERNANCE | 6 |
| CARBON | 6 |
| CLIMATE | 6 |
| COLLECTIVE ACTION | 6 |
| COPRODUCTION | 6 |
| DEFORESTATION | 6 |
| FISHERIES | 6 |
| GRASS ROOTS INNOVATIONS | 6 |
| HEALTH | 6 |
| INEQUALITY | 6 |
| LAND | 6 |
| LAND USE | 6 |
| MODELS | 6 |
| PATHWAYS | 6 |
| TECHNOLOGICAL INNOVATION SYSTEMS | 6 |
| TECHNOLOGY | 6 |
| CAPACITY | 5 |
| CHALLENGES | 5 |
| CONSUMPTION | 5 |
| EARLY WARNING SIGNALS | 5 |
| ECOSYSTEMS | 5 |
| GLOBAL ENVIRONMENTAL CHANGE | 5 |
| GOVERNMENT | 5 |
| IMPACT | 5 |
| IMPACTS | 5 |
| INCOME INEQUALITY | 5 |
| INFORMATION | 5 |
| NETWORKS | 5 |
| ORGANIZATIONS | 5 |
| POPULATION | 5 |
| RESPONSES | 5 |
| RISK | 5 |
| SCENARIOS | 5 |
| STATE | 5 |
| SYSTEM | 5 |

**Citation Counts**

The table below lists the citation counts (as reported by the Web of Science) for articles cited by Clark and Harley (2019). To be included in the table, an article must have more than 50 citations.

Citation Counts

All articles with more than 50 citations are listed.

| Article | Citation Count |
|---|---|
| ADGER WN, 2006, | 2246 |
| DAHL RA, 1957, | 1514 |
| KABEER N, 1999, | 1029 |
| NELSON DR, 2007, | 879 |
| MARKARD J, 2012, | 834 |
| SCHEFFER M, 2012, | 736 |
| OSTROM E, 2010, | 711 |
| O'REILLY CA, 2008, | 656 |
| MANI A, 2013, | 594 |
| DIAZ S, 2015, | 583 |
| SCOONES I, 2009, | 533 |
| OSTROM E, 2011, | 442 |
| CHAPIN FS, 2010, | 415 |
| OSTROM E, 2007, | 399 |
| TILMAN D, 2014, | 394 |
| BIGGS R, 2012, | 346 |
| O'BRIEN K, 2012, | 344 |
| WISE RM, 2014, | 338 |
| MCGINNIS MD, 2014, | 306 |
| COLLINS PH, 2015, | 286 |
| PASCUAL U, 2017, | 261 |
| MEYFROIDT P, 2011, | 261 |
| POLASKY S, 2011, | 260 |
| TENGO M, 2014, | 257 |
| BRONDIZIO ES, 2009, | 257 |
| LAWLER JJ, 2014, | 250 |
| STEFFEN W, 2018, | 245 |
| PEATTIE K, 2010, | 221 |
| BROWN K, 2011, | 209 |

| | |
|---|---|
| ARROW KJ, 2012, | 203 |
| ERIKSEN SH, 2015, | 173 |
| CLARK WC, 2016, -a | 169 |
| HANSEN T, 2015, | 167 |
| FOXON TJ, 2011, | 163 |
| LE BLANC D, 2015, | 161 |
| BETTENCOURT LMA, 2011, | 158 |
| LEISEROWITZ AA, 2006, | 153 |
| CLARK WC, 2016, | 150 |
| MARSHALL NA, 2012, | 132 |
| ANDERIES JM, 2013, | 129 |
| YOUNG OR, 2011, | 118 |
| SCHAFFARTZIK A, 2014, | 115 |
| NORDHAUS WD, 2017, | 108 |
| HOLDEN E, 2014, | 108 |
| GEELS FW, 2017, | 107 |
| CARPENTER SR, 2012, | 105 |
| CLEMENT F, 2010, | 105 |
| SCHEFFER M, 2015, | 104 |
| GEELS FW, 2015, | 95 |
| SEN A, 2013, | 94 |
| HICKS CC, 2016, | 92 |
| MILANOVIC B, 2011, | 91 |
| SETO KC, 2016, | 86 |
| CHOWDHURY RR, 2006, | 85 |
| EPSTEIN G, 2015, | 84 |
| ANDONOVA LB, 2010, | 80 |
| AGYEMAN J, 2016, | 78 |
| LOORBACH D, 2017, | 74 |
| WELLS P, 2012, | 72 |
| VAN KERKHOFF LE, 2015, | 71 |
| WALKER B, 2010, | 71 |
| DALTON PS, 2016, | 63 |
| MARQUIS C, 2016, | 61 |
| BINZ C, 2017, | 57 |
| CARPENTER SR, 2015, | 56 |
| SCHOT J, 2018, | 54 |
| FISCHER LB, 2016, | 53 |
| MANSBRIDGE J, 2014, | 52 |

| | |
|---|---|
| WILSON S, 2013, | 51 |
| ASHEIM GB, 2010, | 50 |

### Cited References

Another question that might be useful to ask: What are the cited references made by the "pool" of articles cited by Clark and Harley (2019)? In the bibliometric working paper draft Alicia and I are working on, we ask the same question about the "pools" of papers produced by the Kates reader and ARER over the past 10 years. This could potentially be an useful area of analysis.

Since the pool from Clark and Harley (2019) currently has missing DOIs and might change, I have not yet carried out this analysis. Please let me know if you would like me to; it should only take approximately 1 hour.

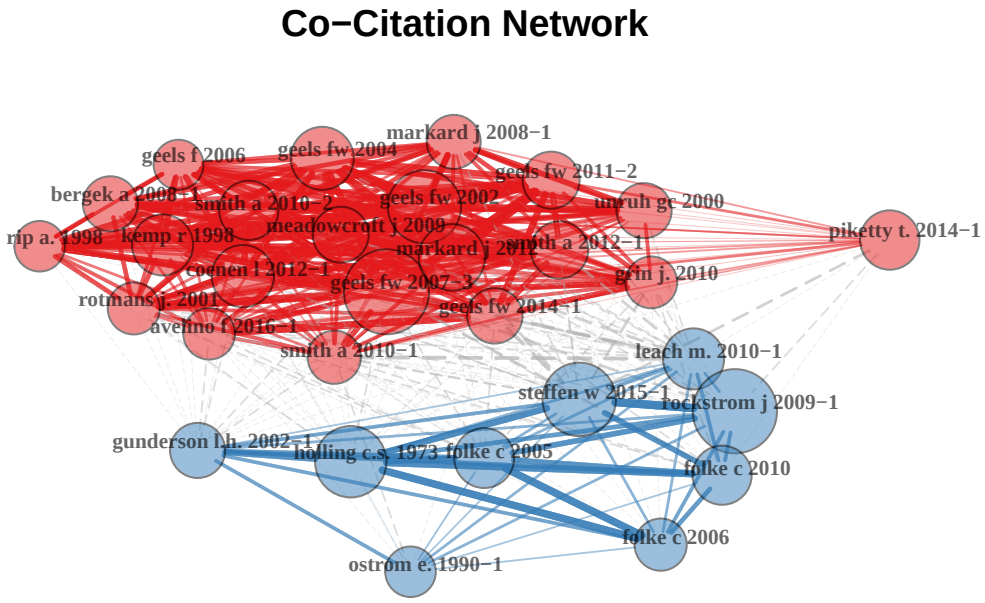
## Network Analysis

Using elementary machine learning, this section analyzes the connections between citations.

### Co-Citation Network

Following the approach of Batagelj & Cerinsek (2013) and Aria & Cuccurullo (2017), I conducted co-citation analysis. The network plot below shows the 30 articles from the Clark and Harley (2019) "pool" that were most frequently cited by other articles from the pool. Thicker lines between articles indicate that they are frequently cited by the same papers (i.e. individual papers frequently cite both). Grey dashed lines indicate co-citation occurs relatively less frequently. Once a group of articles becomes sufficiently interconnected and experiences relatively little co-citation from other articles in "pool", it is split off into a cluster and denoted with a different color.

Note that there are two distinct clusters of articles, indicating that there are two groups of authors speaking to one another, with relatively few citations occuring between the two groups. Apologies that this is slightly difficult to read, I am still working on formatting.

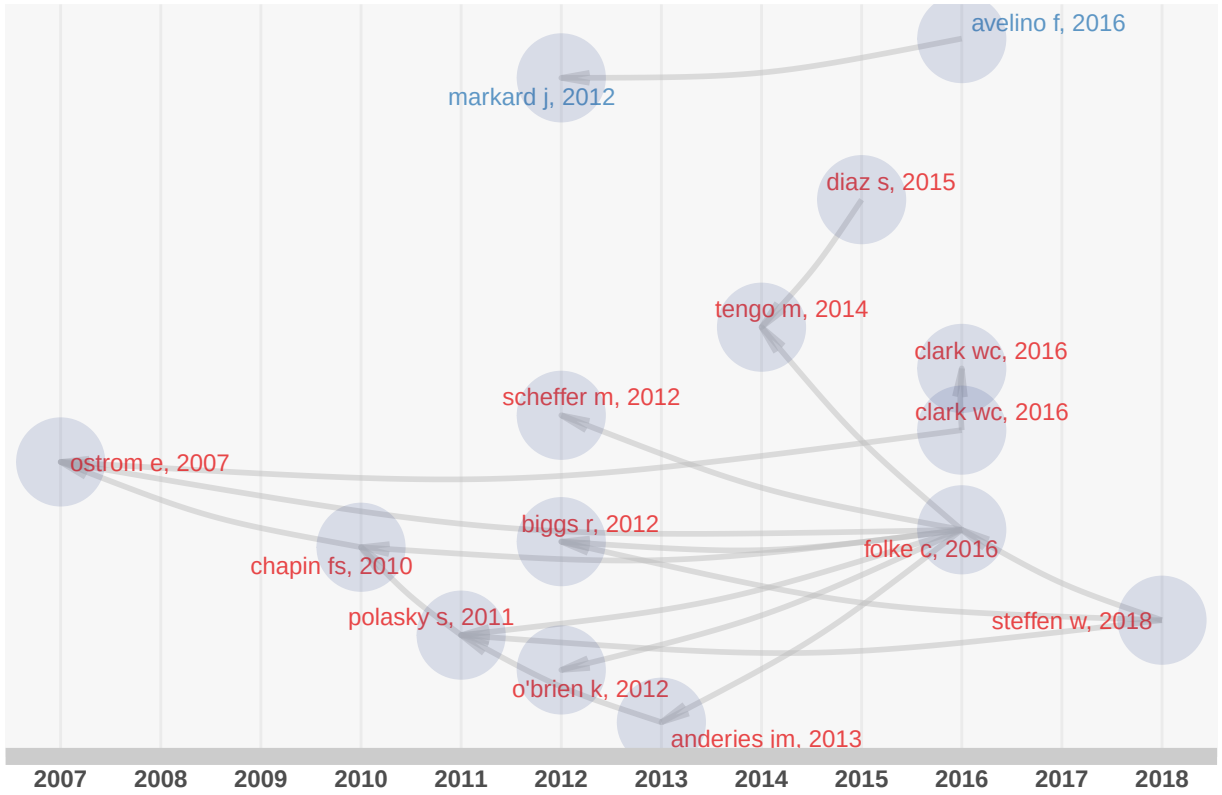



### Historical Citation Network

The historiographic map is a graph proposed by Garfield (2004) to represent a chronological network map of most relevant direct citations resulting from a bibliographic collection. The map below shows how the 15 most co-cited papers within the Clark and Harley (2019) "pool" are connected to one another chronologically.

```
## Articles analysed   100
## Articles analysed   143
```

## Historical Direct Citation Network



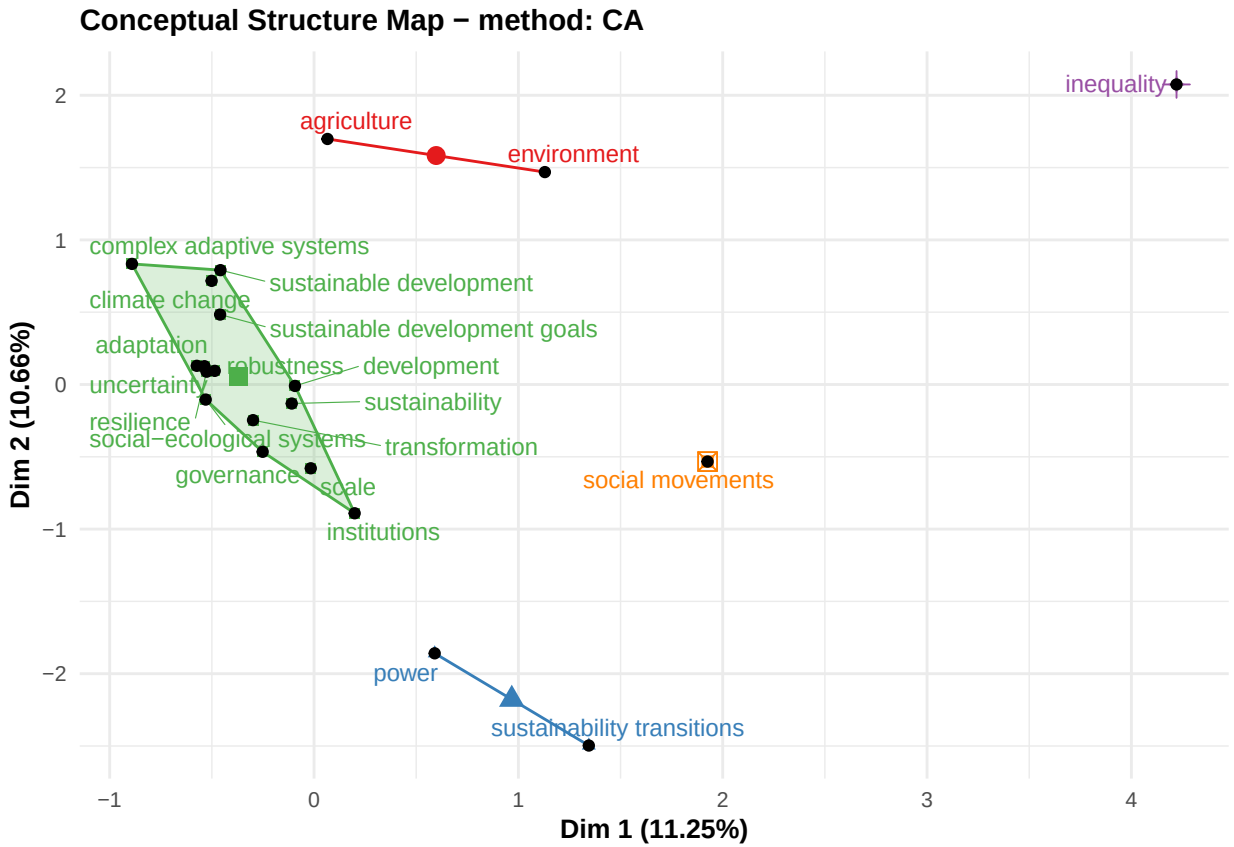

```
##
##  Legend
##
##                          Paper                                DOI Year LCS GCS
## 2007 - 7      OSTROM E, 2007,              10.1073/PNAS.0701886104 2007  18 399
## 2010 - 13     OSTROM E, 2010,       10.1016/J.GLOENVCHA.2010.07.004 2010  10 711
## 2010 - 15    CHAPIN FS, 2010,            10.1016/J.TREE.2009.10.008 2010   8 415
## 2011 - 23    POLASKY S, 2011,            10.1016/J.TREE.2011.04.007 2011  10 260
## 2012 - 32   SCHEFFER M, 2012,               10.1126/SCIENCE.1225244 2012   8 736
## 2012 - 33    O'BRIEN K, 2012,             10.1177/0309132511425767 2012  11 344
## 2012 - 36    MARKARD J, 2012,          10.1016/J.RESPOL.2012.02.013 2012  17 834
## 2012 - 37     ARROW KJ, 2012,             10.1017/S1355770X12000137 2012  11 203
```

```
## 2012 - 39      BIGGS R, 2012,  10.1146/ANNUREV-ENVIRON-051211-123836 2012  10 346
## 2013 - 42  ANDERIES JM, 2013,                10.5751/ES-05178-180208 2013   9 129
## 2014 - 45      TENGO M, 2014,              10.1007/S13280-014-0501-3 2014   9 257
## 2015 - 65       DIAZ S, 2015,           10.1016/J.COSUST.2014.11.002 2015  10 583
## 2016 - 77    AVELINO F, 2016,          10.1080/1523908X.2015.1112259 2016  11  27
## 2016 - 81     CLARK WC, 2016,                10.1073/PNAS.1601266113 2016  10 150
## 2016 - 82   CLARK WC, 2016, -a               10.1073/PNAS.0900231108 2016  10 169
## 2016 - 91      FOLKE C, 2016,                10.5751/ES-09088-210444 2016  11  32
## 2018 - 125   STEFFEN W, 2018,                10.1073/PNAS.1810141115 2018   8 245
```

**Conceptual Structure Map**

Following the approach of Aria & Cuccurullo (2017), I conducted conceptual structure analysis (using the correspondence analysis method). By using natural language processing to analyze the titles, abstracts, and keywords of all papers cited by Clark and Harley (2019), this analysis attempts to divide author keywords into 5 groups, based on the degree to which their associated papers are most similar. Once a certain degree of dissimilarity is achieved, the program creates a new cluster of keywords. Each group is denoted by a different symbol and color.

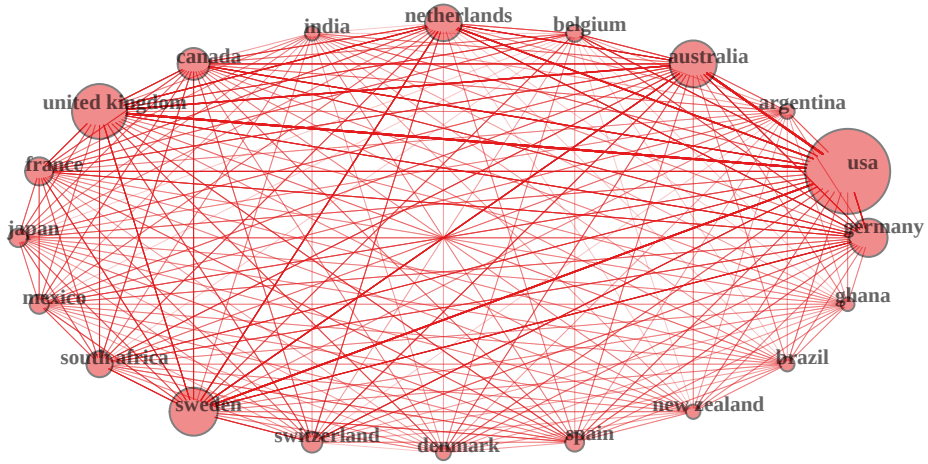
Keywords must be used at least 5 times to be included in the map below. The axes and relative positioning of the keyword groups are unimportant in this analysis; they are merely a side-effect of the way R produces graphs.




### Country Collaboration

Finally, I analyzed how authors were collaborating with one another across countries. Using the Web of Science "country affiliation" of all authors of each co-authored paper, I conducted network analysis to answer the following question: When a paper is co-authored, which countries are its co-authors affiliated with? Thicker lines between the countries below indicate that more scholars from those respective countries co-authored papers together in the Clark and Harley (2019) "pool." Larger circles around a country name indicate that country had more affiliated authors in the Clark and Harley (2019) pool. The 20 most-cited countries are included. If you are viewing the PDF version, it will be helpful to zoom in on this map to see the difference in line widths.

## Country Collaboration




## Conclusion

With the power of R and the bibliometrix() package, it is possible to answer almost any bibliometric question with just a few lines of code. This report can be exported in PDF, HTML, or DOCX format. Please let me know if I can be helpful in answering other questions.