The difference between transition and transformation: a bibliometric analysis of two scientific networks.

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Abstract

The terms 'transition' and 'transition management' encompass the change towards a more sustainable society and embody questions of how this goal should be achieved. Researchers under the banner of 'transition' are concentrated in the Netherlands. To find out to what extent 'transition' is a Dutch preoccupation, we perform a literature search to identify key references, key authors, and the coherence between references and authors. We contrast this with an alternative denominator 'transformation'.

By analysing co-author and citation networks, we find large differences in these groups of documents. The transition literature is characterised by a large network of directly and indirectly cooperating authors with clear clusters; transformation literature only contains small and isolated author networks. The transition literature is tightly knit with high degrees of internal references and a clearly distinguishable core. Transformation literature has no clear core and fewer connections between authors and articles.

Key transition authors are predominantly Dutch. They repeatedly write together and cite each other's work. The transformation literature makes more use of highly cited research outside the field. Whether this is an indicator of quality remains to be seen. This analysis can be used as a first step for opening up that debate: it should be enriched by systematic in-depth exploration of the field, including research into societal pay-back.

Keywords:
Transition, Transformation, Bibliometrics, Citations, Author network

1. Introduction

In the light of dwindling (energy) resources and increased pollution due to a myriad of emissions, governments since "Limits to growth" (Meadows and Club of Rome, 1972) and the oil shocks in the 70s have been trying to work towards a more sustainable society. The envisioned changes are said to require a different way of thinking and a different structure for our society (Raskin et al., 2002). In the international arena agreements were made e.g. for banning CFKs and curbing CO_2 emissions (UNFCCC, 1998), which were translated into national, regional and local policies.

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In the Netherlands, the Ministry of Environmental Affairs in the early 2000s introduced a new concept called 'transitions' in their environmental policies (Ministry of VROM, 2001) that built on a range of academic concepts from technology history, systems and complexity science, and management (Rip and Kemp, 1998; Rotmans et al., 2001a). It met fertile ground and 'transition thinking' became a key concept in the Dutch sustainability debate, with the Prime Minister heading a 'Transition Platform': a broad coalition of actors working towards a more sustainable future. Later, the Task Force Energy Transition was formed (Task Force Energietransitie, 2006), which became a coordinating council for energy initiatives (Interdepartementale Programmadirectie Energietransitie, 2010). While academic thinking spawned political debate, the reverse was also true: the transition movement became a reality that required further description and elaboration.

Being part of the Dutch academic world and having a keen interest in sustainable energy use, one cannot avoid the strong influence of transition thinking over the last decade. However, as a critical researcher, one should also attempt to understand the basis upon which the transition thinkers build. A suitable method for doing this is literature analysis (Creswell, 2009) and some recent examples of qualitative analyses by Chappin (2011, chapter 2) and Holtz (2011). Modern information technology in combination with graph theory (Newman et al., 2006; Strogatz, 2001) allows for more quantitative analysis of the scientific network upon which this field builds.

In that context, various questions can be formulated:

- Who are the key authors in the transition literature? Who should I definitively meet?
- What are the key papers in the transition literature? What should I definitively read?
- What are the characteristics of the scientific network in the transition literature?
- What are the most relevant streams of theory and ideas in the transition literature?

In this paper, we will give first answers to these questions for the literature on *transitions* and aim to start the debate on a refined and broadened research agenda. To structure this analysis, we use bibliometrical tools (Smith, 1981). Using co-author analysis (de Solla Price and Beaver, 1966; Stokes and Hartley, 1989) and citation analysis (Garfield, 1972) we compare the literature on transitions to the literature on *transformations*, a near-synonym that has also been proposed as one of the mechanisms in a typology of change (Geels and Kemp, 2007), but more general, that concept has been used for describing societal change.

In section 2, we elaborate on the approach that we took to obtain the structure and characteristics of the literature on transition and transformation. The results are presented and analysed in section 3. Afterwards we draw conclusions in section 4.

2. Approach

Science is a complex adaptive system (Simon, 1973): an uncontrolled, bottom-up knowledge creation process that is partially steered by peer review, science ethics, and funding criteria. One of the outcomes of this process is the collection of scientific papers that focus on particular subjects. These papers are embedded in their field through citations (Garfield, 1972). Papers refer to other papers to provide an intellectual or methodological basis, to support or oppose the approach taken and to judge the findings of the research performed. The metaphorical 'shoulders of giants' (which as a graph could be depicted as a tree), are papers referring to each other forming a network of papers and citations.

This network, in which papers form nodes and citations are the links, is a resultant of networks of co-authoring scientists. The networks of papers and scientists co-evolve under the influence of aforementioned peer pressure, rules of conduct, and funding schemes. Thus, good science is perpetuated and good scientists are credited. On the other hand, due to the immense volume of scientific literature some potentially important findings may be forgotten. Moreover, self-organisation could lead to self-preservation, in which non-optimal outcomes are sustained instead of falsified. By analysing the networks in science – by means of citations *and* co-authorships – one may better understand the cohesion, quality, level, and coverage of a specific part of the literature.

We have used a structured keyword-based search to gather papers, citations, and authors in the fields of 'transition' and 'transformation'. The approach is summarized as follows (for a detailed description for repetition and verification purposes, see the appendix):

1. Collection of scientific sources based on key terms. This can be done with a range of on-line tools such as Scopus[1], Web of Knowledge[2] and Google Scholar[3]. We performed our search using the following key terms with Scopus. Scopus purportedly has a more European focus, encompasses more modern sources, and also lists some conference proceedings. The keywords 'transition' and 'transformation' were not searched in solo, but accompanied with additional keywords to gain enough focus in the search. For transition, we used the keywords 'sociotechnical transition', 'socio-technical transition', 'societal transition', 'technological transition' and 'transition management'. For transformation we used the same accompanying terms.
2. For all sources we extracted the authors and the citations. Unfortunately, in Scopus or Web of Knowledge only scientific articles can be extracted. Therefore, books as primary sources are not taken into account. References to books, however, are recorded.
3. We drew a network graph of 1) links between authors, based on co-authorships, and 2) the links between papers, based on citations and co-citations.
4. We compared the structure of the network graphs and identified key researchers and papers. In addition, we compared the result of the two searches (transition and transformation) and looked up the citations of the key papers in other fields.

3. Results and analysis

3.1. Overview of the results

An overview of the results can be found in table 1. The literature search resulted in ~400 documents for both the transition and transformation keywords. However, when the co-cited references were included[4] the transformation network increased to 518 documents, whereas the transition network increased to 922 documents. Thus, the network of scientific documents in the transition literature is larger than that of transformation.

[1] `http://www.scopus.com`

[2] `http://apps.webofknowledge.com`

[3] `http://scolar.google.com`

[4] The initial sets of papers from the search are expanded with the documents they cite, but only if these are cited by more than one paper. We label the total set of papers as the *expanded* set of documents.

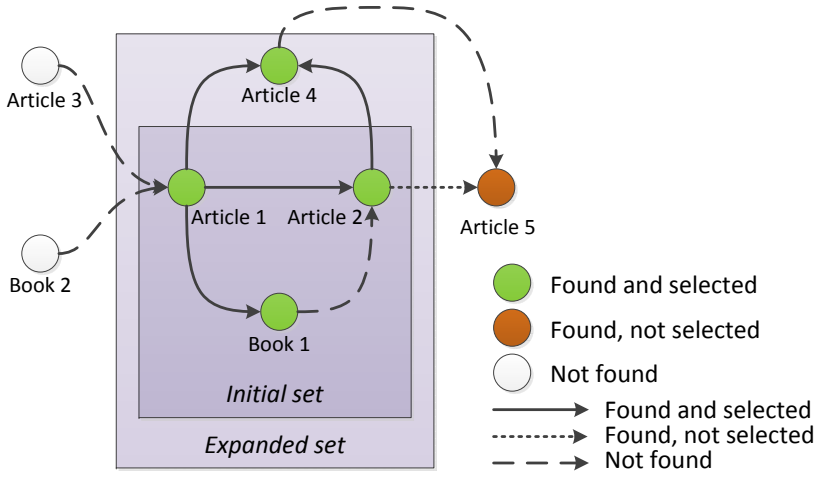

Figure 1: This graph shows the method for our analysis: of all literature found by the keywords-based search (in the inner box), we collected the references and only selected those that are co-referenced by two or more of the articles we read. Article 4 is included in the analysis, whereas article 5 is not.

The total number of citations within this group of co-cited references (the groups of 518 and 922 documents) is 648 respectively 2,799. That means that within the set of papers found in our search – including the co-cited references – there are more links between the papers on transition than on transformation. Indeed, the number of citations found between the documents is more than 4 times larger for transition than for transformation. Per original document the number of citations found is 6.3 within the field of transition, with 1.6 for transformation. We can see that the papers on transition are strongly linked together. This is less the case for transformation. This suggests the transition researchers form a more tight community.

We also counted the number of authors of the extended set and the links (i.e. co-authored papers) between those authors. We find more distinct authors in the transition literature in absolute terms (546 versus 325), but per document the ratios are similar. On average, documents on transition are written by 0.59 unique authors, while this average for transformation is 0.63.

Furthermore, the number of links between authors jointly writing a paper are not far apart. On average for transition author, there are 2.1 authors per paper, while for transformation the average is slightly lower (2.0). These numbers imply that there is not a large difference in the number of co-authors per paper, nor in the number of different author in the field.

Finally, we used the Herfindahl-Hirschman Index[5] to determine the concentration of authors in the field. Whereas both fields have a low concentration, the index for transition is considerably larger than the index for transformations.

3.2. Co-author networks

A strong evidence for links between researchers is in joint publications (Mählck and Persson, 2000). When drawing networks based on authors as nodes and publications as links we found

[5]The HHI is normally used to calculate market concentration. It is found by $HHI = \sum_{i=1}^{n} M_i^2$, where n is the number of authors, M_i is the number of papers for author i, divided over the total number of papers.

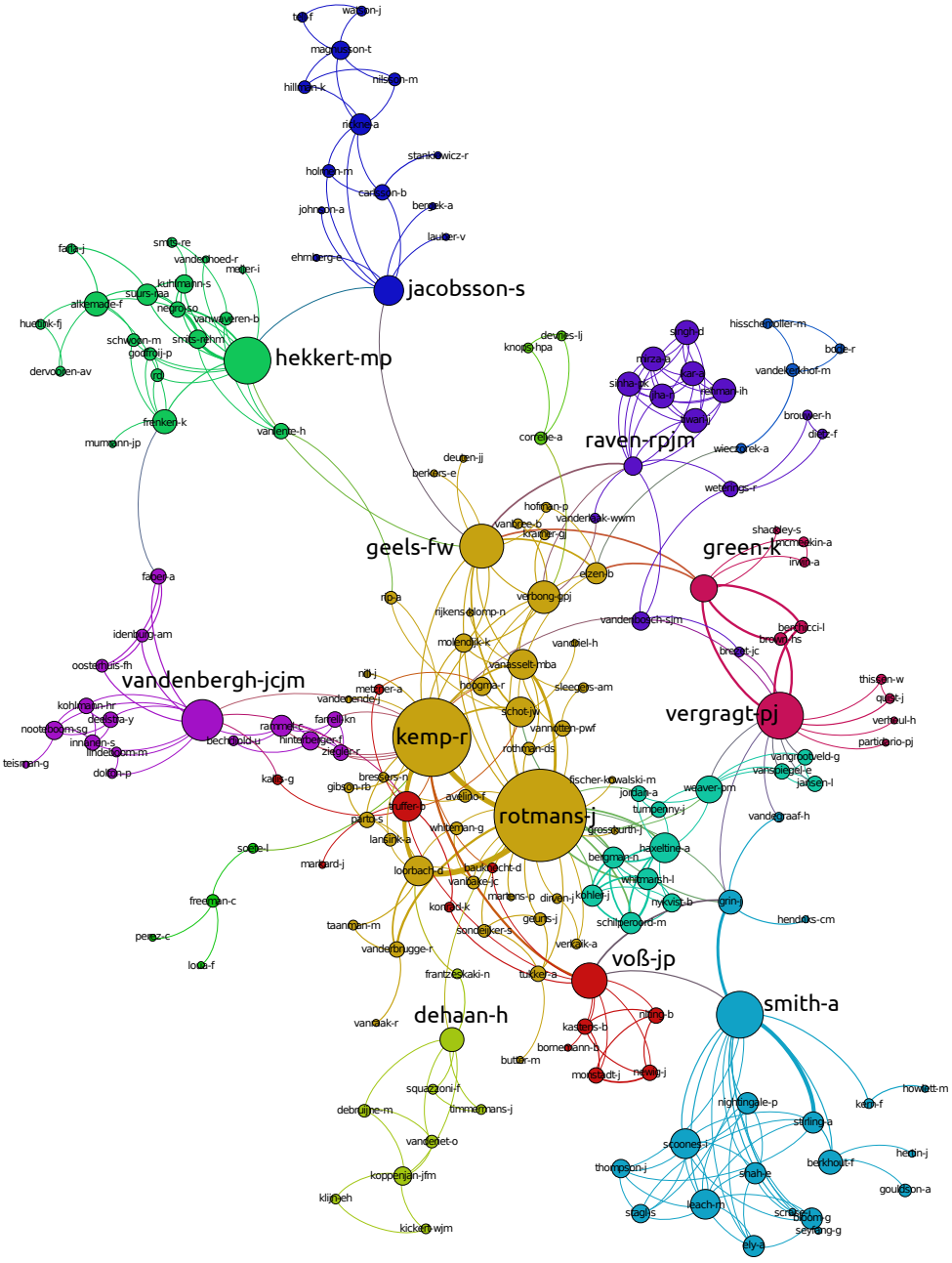

Figure 2: Main network of 181 transition authors. The nodes represent authors. The size of the node represent the number of papers written. The width of the edges indicates the number of co-authored publications between two authors. The colour of the nodes represent different clusters of authors.

Table 1: Search statistics

Search term	Documents in search	Expanded set	Total citations	Total authors	Co-author-ships	HHI index
Transition	439	922	2,799	546	596	0.0041
Transformation	396	518	648	325	333	0.0025

Table 2: Author networks with 10 or more authors. The listed key authors are the most central in the network.

Size	Key authors
Transition	
181	Van den Bergh, Geels, Hekkert, Jacobsson, Kemp, Loorbach, Rotmans, Smith, Vergragt, Voß
22	Scholtz
18	Carpenter, Folke
Transformation	
19	Kemp, Schot, Truffer
14	Ferreira, Henriques, Rodrigues
14	Bahler, Beets, Billari, Desequelles, Fokkema, Solaz, Speder, Vikat

several separate author networks, both for transition and transformation. Table 2 provides an overview of the three largest author networks in the transition and transformation literature. The networks not shown in this table only contain few authors that have cooperated on one or two papers – we ignore these, since we are interested in the cohesion of the fields.

In transition literature there is one huge author network containing 181 authors (see figure 2). Other authors are not connected to this network by co-authoring references. The smaller networks are one of 22 authors with Scholtz as key author (the one with most papers), and another of 18 authors with Folke and Carpenter as key authors.

For the transformation literature, the largest network is a lot smaller: 19 authors, lead by Kemp (see figure 3). There are only two other relevant network that both contain 14 authors, the one lead by Ferreira and the other by Billari.

The topology of the networks provides additional insight in the structure of the different research themes within the field. Such thematic clusters can be shown by grouping highly interconnected authors. The visualisation of such clusters can be achieved by using a network visualisation tool with an appropriate network layout algorithm[6].

Looking at the largest networks in more detail, we find nine separate clusters of transition authors outside the center. We define the center as the cluster surrounding Rotmans, Kemp, and Geels. An overview of these clusters can be found in table 3. In figure 2, the colours indicate those clusters.

Such clustering is not possible with the transformation literature as the literature consists of many small, unconnected sets of authors. The largest set of 19 connected authors is shown in figure 3. Interestingly, all authors of this set also occur in the transition author network. Some

[6]The graphs shown in this paper are produced using Gephi with a Force Atlas and Yifan Hu layouts. The coloured clusters have been identified using Gephi's Modularity function.

Table 3: Clusters in the main transition author network represented in figure 2.

Location	Link to center	Core topic
Center	Rotmans, Kemp, and Geels	Transition Management, Transformation, Socio-technical Change
Upper-left	Hekkert – Geels	Functions of Innovation Systems
Upper-mid	Jacobbson – Geels	Diffusion of Renewable Energy Technologies
Upper-right	Raven – Geels	Strategic Niche Management
Mid-left	Van den Bergh – Kemp	Evolutionary and Environmental Economics
Mid-far-right	Vergragt and Green – Geels	Social Innovation and Participation
Mid-right	Haxeltine – Rotmans	Modelling
Lower-left	De Haan – Rotmans	Computational and Mathematical Models
Lower-mid	Voß – Kemp	Reflexive Governance and Long-term Policy
Lower-right	Smith and Grin – *via Voß*	Learning, Governance, Regimes

of the topics of these smaller clusters relate to e.g. the change from a Eastern European guided economy to a market economy and the shift from an industrial towards an information society.

3.3. Core transition and transformation references

An overview of the most cited documents (in the expanded set) are listed in table 4. One of the striking differences between the two sets is that the number of citations within our set – the in-degree – is far higher for transition. The average for the top documents on transition is 37; for transformation this is eight times lower, (4.5). In great contrast, the number of citations as listed by Google Scholar is more than four times higher for transformation: the average for the top on transitions is 1,409, whereas for transformation this is 5,506. Even if you argue that the average is not a good indicator, 'key papers' with very high citations are also more prominent in the transformation literature. There is one reference for transition and no less than nine references for transformation that have a very high number of citations (i.e. 1k-23k). Apparently the core documents part of and underlying the transformation literature contains a significant number of references that are important in a broader scientific sense.

It must be noted that the transformation literature bases itself on older references (thus increasing the chance of amassing citations). The average age of the sets lies far apart: the top transition references stem from 2002 on average, compared to 1982 for transformation.

The multiple occurrence of authors in the top is higher for transition (10 authors) than for transformation (6 authors). For transition, the top list (ordered by occurrence): Geels (6), Kemp (5), Rotmans (4), Schot (3), van Asselt (2), Berkhout (2), Hoogma (2), Loorbach (2), Smith (2), and Stirling (2). For transformation, the duplicate authors in the top list is shorter: Kemp (4), Hoogma (2), Nee (2), Nelson (2), Schot (2), Winter (2).

The fact that more others occur multiple times in transition cannot be explained by the lower amount of authors in the transition literature: the total number of different authors is not far apart. There seems to be a tendency of the top authors on transition to write together.

In addition, the origin of the authors occurring multiple times, is noteworthy: except for Smith and Stirling, all of the transition authors are Dutch. On transformation, only three of duplicates are Dutch (and they also appeared in the top on transitions).

Looking at the mode of publication, Research Policy is the most important journal for both fields. The publication of books, however, is also very common, particularly for transformation.

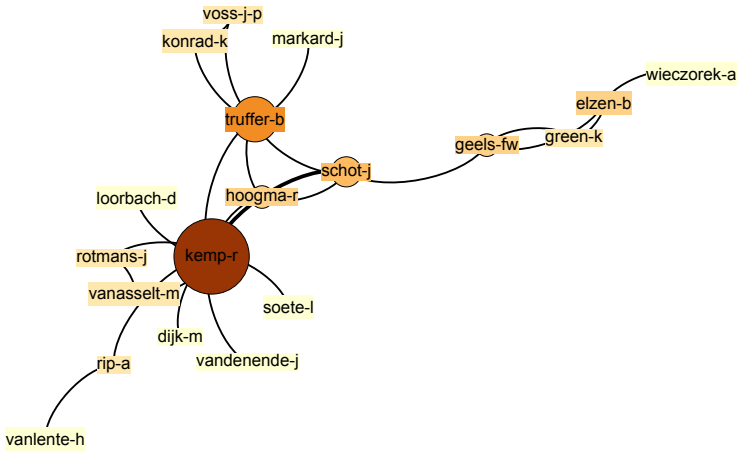

Figure 3: Main network of 19 transformation authors (who to a large extent coincide with transition authors). The nodes represent authors. The size and colour of the node represent the number of papers written. The width of the edges indicates the number of co-authored publications between two authors.

There are surprising documents in the top references regarding transition. First, there is the inaugural lecture of Rotmans. Second, it is surprising that a letter to the editor by Shove and Walker (2007) in Environmental Planning A is in the top list on transition. This letter to the editor is titled *CAUTION! Transitions ahead: politics, practice, and sustainable transition management* and criticizes the transition management literature. There has been a response by Rotmans and Kemp (2008) titled *Detour ahead: A response to Shove and Walker about the perilous road of transition management*. And, in response, an article by Shove and Walker (2008), titled *Transition Management and the politics of shape shifting*. However, both responses are not in the top list.

3.4. Citation networks

Finally, one can look at the depiction of the full network of *documents*, linked by citations. For transition this leads to figure 4. The nodes (documents) with the highest in-degree are the ones that are cited most. We consider this key references and in the graph they are given a larger size. The result is a tightly-knit graph, indicating a large number of cross-references between authors, which is what we expected after our analysis of author networks. What we further notice is that all top articles – the largest nodes – are in the center, suggesting that they belong together in the sense that they are cited together in other publications.

When we compare this graph to the transformation-related search, figure 5 emerges. Although the initial number of documents is roughly the same ($\sim$ 400), the resulting graph looks decidedly different. The graph is split up in several different sub-clusters that correspond to different groups of researchers interested in societal transformation. The analysis of author networks showed that the transformation authors are not part of the same network. This citation analysis demonstrates that although authors do not write together, they are aware of each others' work. Thus they can still be considered a somewhat coherent field.

Table 4: Articles with most citations within this research's set of publications (*a*) and in Google Scholar (*b*). Complete references can be found in the reference section of this paper.

Document	Source	Citations	
Transition		*a*	*b*
Rotmans, Kemp, and Van Asselt (2001a)	Foresight	75	512
Geels (2002)	Research policy	68	675
Rip and Kemp (1998)	In Rayner and Malone (1998)	53	664
Smith, Stirling, and Berkhout (2005)	Research policy	50	352
Kemp, Schot, and Hoogma (1998)	Techn. an. & strat. man.	48	678
Geels and Schot (2007)	Research policy	42	365
Elzen, Geels, and Green (2004)	Book	40	225
Loorbach (2007)	Book	38	225
Geels (2005)	Book	30	307
Nelson and Winter (1982)	Book	27	19,735
Berkhout, Smith, and Stirling (2004)	In Elzen et al. (2004)	26	225
Rotmans et al. (2001b)	Report by MERIT	24	7
Geels (2004)	Research policy	24	0
Hoogma, Kemp, Schot, and Truffer (2002)	Book	24	23
Rotmans (2005)	Inaugural Lecture	22	8
Shove and Walker (2007)	Environment and Planning A	22	130
Loorbach and Rotmans (2006)	In Olshoorn (2006)	20	117
Transformation		*a*	*b*
UNDP (1994)	Human development report	7	295
Rip and Kemp (1998)	In Rayner and Malone (1998)	7	664
Geels (2002)	Research policy	5	675
Kemp, Schot, and Hoogma (1998)	Techn. an. & strat. man.	5	678
Smith, Stirling, and Berkhout (2005)	Research policy	5	352
Nelson and Winter (1977)	Research policy	5	1,769
Appadurai (1996)	Book	4	10,923
Dosi (1982)	Research policy	4	4,646
Freire (1990)	Pedagogy of the oppressed	4	599
Granovetter (1985)	American journal of sociology	4	17,713
Hoogma, Kemp, Schot, and Truffer (2002)	Book	4	23
Hughes (1987)	In Bijker et al. (1987)	4	1,339
Kemp and Loorbach (2006)	In Voß et al. (2006)	4	89
Marx (1867)	Book	4	19,852
Nee (1989)	American sociological review	4	788
Nee (1992)	Admin. science quarterly	4	692
Polanyi (1944)	Book	4	12,353
Rona-Tas (1994)	American journal of sociology	4	400
Schultz (1964)	Book	4	43
Nelson and Winter (1982)	Book	4	19,735
Giddens (1984)	Book	4	22,296

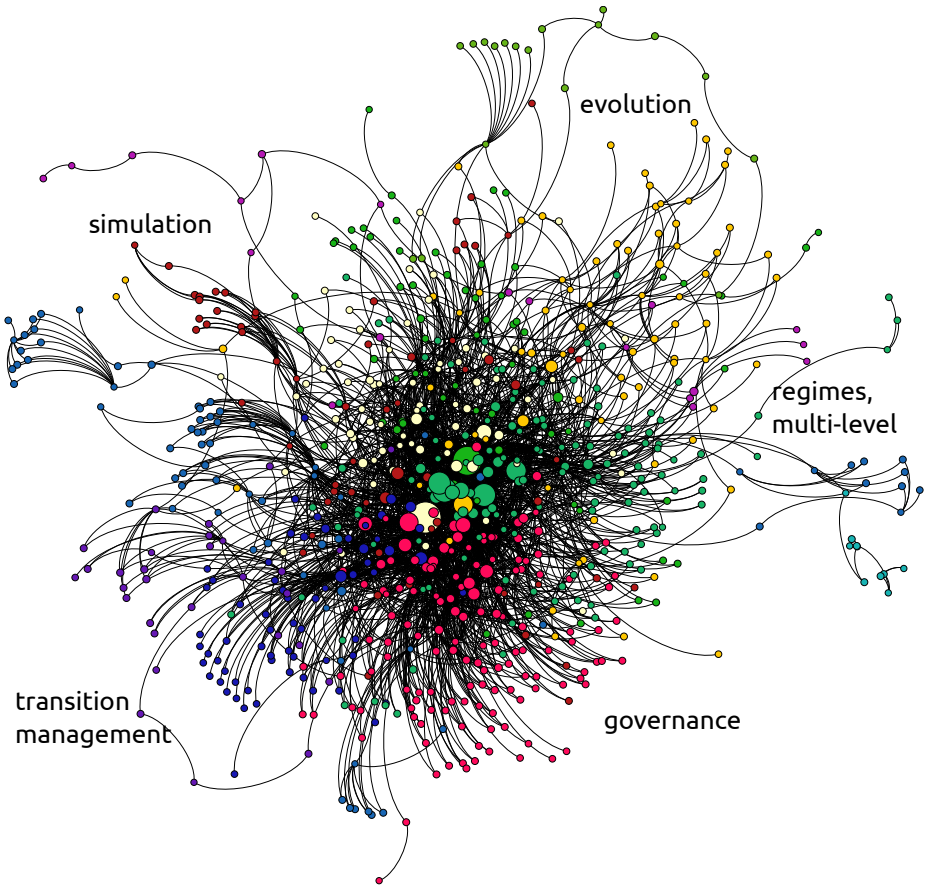

Figure 4: The 'transition' citation network with a rough indication of central topics (in colour). Large nodes are cited more frequently.

4. Conclusion

In order to visualize and access the intellectual core of transition and transformation literature, we have presented an analysis of networks in the respective fields. By comparing the structures of the literature, we have made an overview of the key papers that researchers in these fields should certainly read, we found clues as to the strengths and weaknesses of the fields, and identified opportunities for future developments.

The notion of *transition* – substantial change in the systems that make our society function – has been strongly linked to a Dutch context (as illustrated by the key articles and authors). In addition, *transition* has been linked to the desire to make societies sustainable. Although the described changes in this literature are large (Rotmans et al., 2001a), the truly revolutionary change (e.g. from a communist to a capitalist society) is described in the *transformation* literature. Also, the latter field seems to be less engaged in normative, prescriptive approaches and more in inquisitive, historical practices.

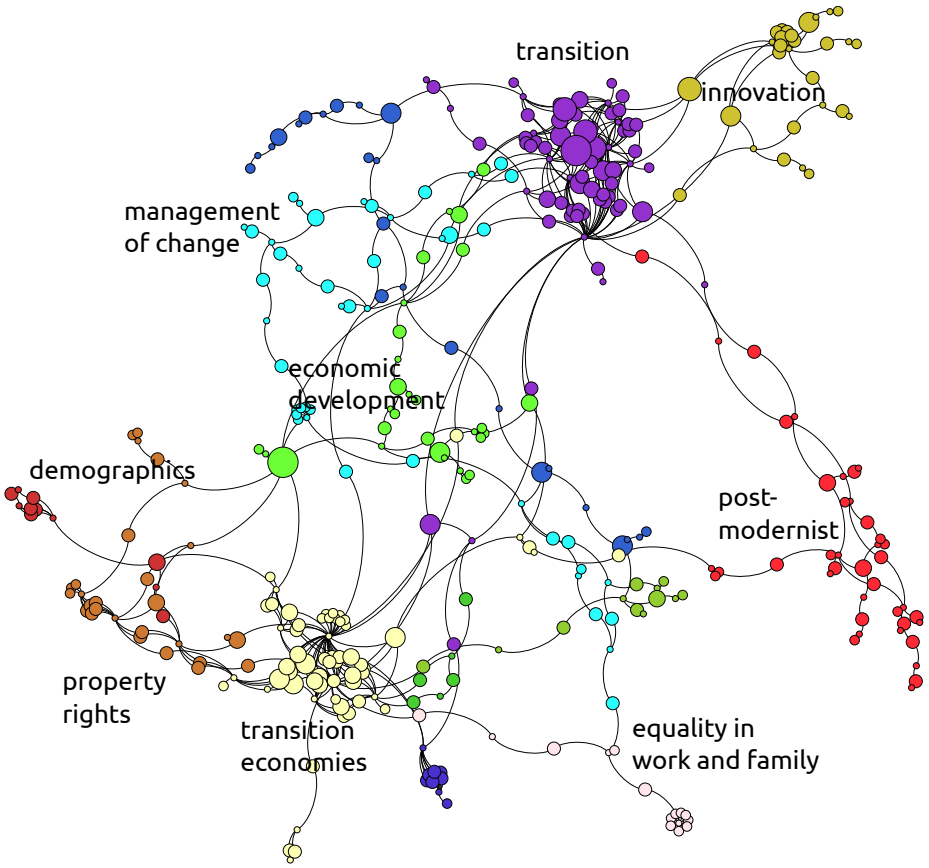

Figure 5: The 'transformation' citation network with a rough indication of central topics (in colour). Large nodes are cited more frequently.

Identifying key authors and key literature. The approach we have described here is a valuable help in identifying key authors and literature in the field of interest. Table 2 provides us with the summary of the key authors and table 4 of the top documents within these fields. For researchers new to the field, these provide a guideline to the heart of the discussion. For already active researchers, it shows whom to contact or to seek collaboration with.

The analysis shows the strong Dutch influence in transition. Furthermore, the publications seem to be concentrated in the journal *Research Policy* as well as several books.

Relevant streams of theory and ideas. The use of the author and reference maps allows for the visual identification of clusters within one field. In transition, these clusters largely overlap, although there are differences between the more analytical clusters (e.g. evolutionary and multi-level analysis) and the more design-focused (e.g. transition management and governance). In transformation, there are also transition and innovation clusters, but these lie at a further distance from others. Moreover, the general themes all relate to large, macro-level changes in societies (e.g. demographics, economic development).

In this paper, the identification of these clusters was based on the knowledge and assess-

ment of the researchers, rather than a method of key term extraction and corpus analysis (the co-occurrence of words in a set of texts (van Eck, 2011)) which may be an interesting add-on for follow-up research. We believe that figures 4 and 5 already show some clearly identifiable streams.

Structure of the scientific network. We also find interesting characteristics as to the nature of the scientific network. Figures 4 and 5 provide some intuitive clues. Together with the information from tables 2 and 4, we conclude that the transition network is closer knit, uses more co-authorship, and refers more to the same key references. One could see this as a more coherent field. As indicated above, we believe the scope of the field (although still large) is smaller than that of transformation, which also leads to more coherence. This, however, also has a negative side: there is a risk of limited learning through in-crowd behaviour and group-think. Repeatedly writing together (co-authorship) and citing each other's work (cross-referencing) could be an indicator of myopia to larger (scientific) developments. The difference between the in-field citations and global citations (columns *a* and *b* in table 2) suggests this might be the case. Researchers should be aware of this danger. On the other hand, the societal contribution is hardly captured by these indicators. For transition, this appears to be an important goal of the researchers (which is shown in the Dutch policy context). More research into societal pay-back would enlighten this debate, but conclusive evidence may only be available in several decades' time.

Outlook. The meaning of bibliometrics may be rather limited (Leydesdorff, 1998), as network structures often do not help in recognising *'quality'*. Therefore, McCain (1990) suggests calling in help for validating the findings of bibliometric research. Indeed, with this analysis we open up the discussion on new directions for the literature on transitions.

The tools demonstrated in this paper structure thinking about research fields. For those visually inclined the fancy figures already provide cognitive 'hooks' to help to see the coherence between documents and authors: like a street map that helps to understand a city and identify main buildings, thoroughfares, and neighbourhoods (or ghetto's). We emphasise that this is only one of the necessary approaches: this analysis should be enriched by systematic in-depth exploration of the field. Further in-depth research may also show that other researchers with similar interests may rally under different banners.

Further bibliometric analysis with regard to the transition and transformation field could lie in the co-citation analysis identifying which documents or authors are always mentioned together. This would indicate either interesting scientific disputes or be an additional indicator for *schools of thought*. Also, with the help of corpus analysis the coherence between specific key terms can be further investigated. A methodological advancement would be the dynamic representation of the growth and decline (!) of literature. One can imagine that certain key references are very popular but then, like fashions, fade away to become hip again after two decades. This way, the transition of scientific fields can be better understood.

Acknowledgements

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[7] `http://www.nextgenerationinfrastructures.eu`

market interactions[8], by the Knowledge for Climate program, project INCAH – Infrastructure Climate Adaptation in Hotspots[9], and by Climate Strategies, project Decarbonization of the Power Sector [10].

Appendix – Detailed steps for the literature network analysis

For researchers interested in repeating this analysis, we describe the steps in detail below. Next to the knowledge of the tools that were used, it is of importance to know the specifications of the input and output files that are generated in the different steps. A number of linux-based scripts and the results are available online[11].

Search in Scopus[12]

- Use the document search to query for a number of search terms in titles, abstracts and keywords, where the search terms are separated with AND.
- Select all documents found and use the export function. Select the complete format and export to a csv file.
- Combine the resulting csv files (if multiple queries were used).
- Use the scripts to reformat the resulting csv file to generate both a file with all citation combinations and a file with all author combinations.
  - *generateDocumentEdgeList.sh* – Run this script to generate an edge list for each citation that can be extracted from the Scopus file. The list will be saved to disk.
  - *generateAuthorEdgeListPartOne.sh* – The script to generate the edge list for co-authors is in two steps. The first step creates one file for the authors in the source documents and one for the cited documents (because they are formatted differently). After using this script, the resulting lists need to be corrected by hand by removing remaining titles (that have commas). The files need to be saved as *authors_primary_corrected* and *authors_secondary_corrected*, to be used by the second script.
  - *generateAuthorEdgeListPartTwo.sh* – The script generates the edge list for co-authors from the corrected lists.

Harmonise the result in Google Refine[13]

- Both lists need to be improved because the same author and documents have different identifiers (for example 'Nelson, R.' and 'Nelson, R.R.').

[8] http://www.edgar-program.com
[9] http://knowledgeforclimate.climateresearchnetherlands.nl
[10] http://www.climatestrategies.org
[11] https://svn.eeni.tbm.tudelft.nl/LiteratureAnalysis/TransitionAndTransformation
[12] http://www.scopus.com
[13] http://code.google.com/p/google-refine/

- Use the Cluster and edit function to find similar values and determine which should be duplicates. There are various clustering algorithms implemented. Also use this function to combine various editions of the same publication into one document identifier.
- Change everything to lower case. Remove malformatted references.
- Use the Facet by Blank function to deselect empty cells.
- Export the result as a tab-separated file.

Visualise and explore literature network with Gephi[14]

- Both harmonised lists are imported in Gephi to study the network.
- Check by hand for duplicate nodes and use the Merge nodes function. Remove erroneous nodes (such as commas only, or 'from china').
- Use the data explorer function to calculate general statistics of the networks and get an overview of the mostly cited papers.
- Format the color of the nodes based on the number of out-edges, which reflects the number of references to other documents. Format the size of the nodes to reflect the number of times the document has been cited within the network of documents. For the authors network, use the author name as labels. When appropriate, use the Modularity statistic to develop coloured clusters of documents and authors.
- Use Yuh Han and Force Atlas 2 algorithms to reposition the nodes in the graph. Select as filter the Giant Component to remove all unconnected groups of nodes.
- Export the graphs as a PDF file.

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