“A definition of Bioeconomy through the bibliometric networks of the global scientific literature.”

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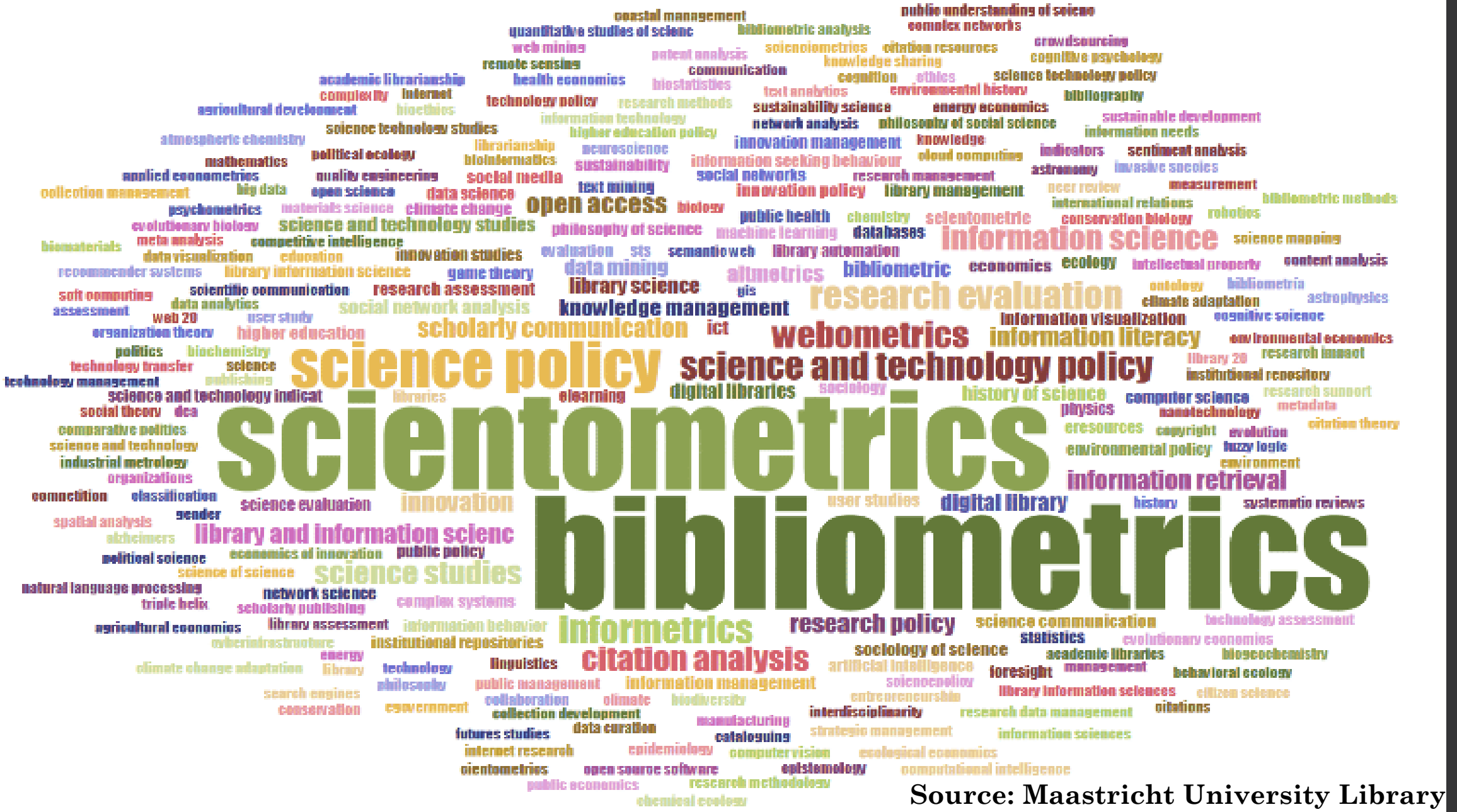
What is the Bibliometric Analysis?



Source: Maastricht University Library

Bibliometric Network

A bibliometric network is defined as the visual representation, with nodes and links, of complex meanings with multi-level influences that allows us to transform the quantitative, bibliometric information into qualitative conclusions.

There are **five main types of analysis** that are used to determine the relatedness of the network's terms (van Eck et al. (2009):

1. **Co-authorship analysis:** The relatedness of items is determined based on their number of co-authored documents.
2. **Co-occurrence analysis:** The relatedness of items is determined based on the number of documents in which they occur together.
3. **Citation analysis:** The relatedness of items is determined based on the times they cite each other.
4. **Bibliographic coupling analysis:** The relatedness of items is determined based on the number of references they share.
5. **Co-citation analysis:** The relatedness of items is determined based on the number of times they are cited together.

Centrality Indices

1. **Degree Centrality (D.C):** The D.C measure quantifies how many ties a node has to other nodes in the network.
2. **Eigenvector Centrality (E.C):** Is defined as the ith element of the leading eigenvector of the adjacency matrix. The leading eigenvector is the eigenvector corresponding to the largest positive eigenvalue. The Eigenvector Centrality, proposed by Bonacich (1989), is an extension of the simpler Degree Centrality because it gives each actor a score proportional to the scores of its neighbors.
3. **Betweenness Centrality (B.C):** For each node u, BC is the ratio of all geodesics between pairs of nodes which run through u. It reflects how often that node lies on the geodesics between the other nodes of the network. The BC score of each actor can be interpreted as a measure of potential control as it quantifies just how much that actor acts as an intermediary to others. An actor which lies between many others is assumed to have a higher likelihood of being able to control information flow in the network.
4. **Closeness Centrality (C.C):** This CC index focuses on how close each node is to all other nodes in the network. Nodes with high Closeness Centrality are those who can reach many other nodes in few steps. The idea is that a node is more central if it can quickly interact with more of the others.

Network Tools

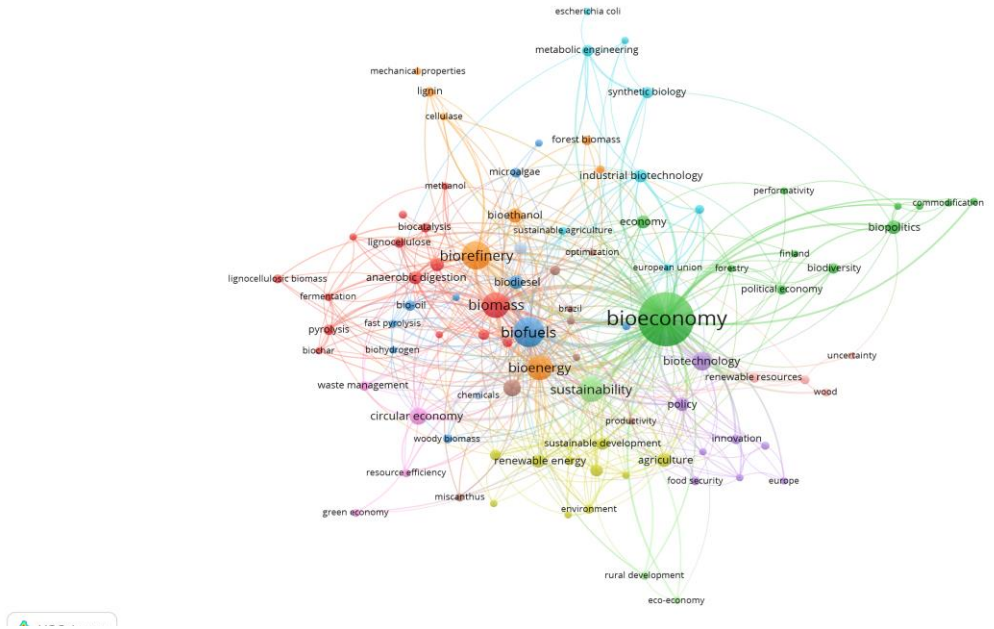
To construct the network and calculate its centrality indices we used two (2) programs namely, **VOSviewer** (Van Eck and Waltman, 2009) and **SOCnetV** (Kalamaras D., 2014) whose selection was based on **the four criteria** below:

1. **Tested:** have been used in similar, methodological, studies.
2. **Reliable:** to be commonly accepted in their operation.
3. **User friendly:** no seminar or specialized knowledge is needed.
4. **Open Software:** Anyone can access them for gratis.

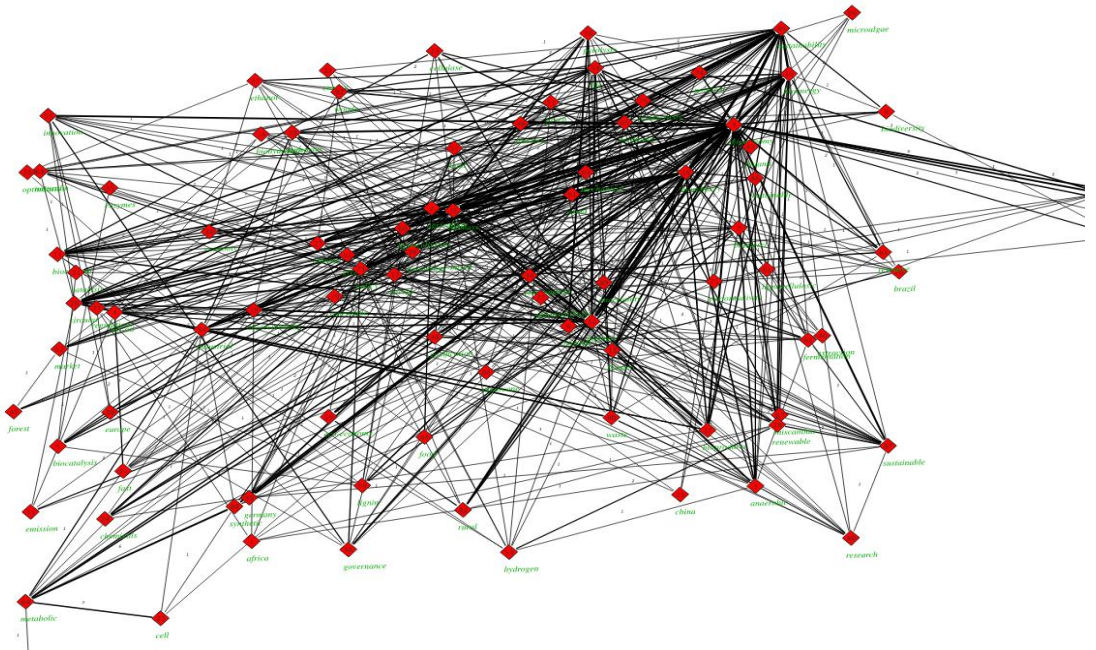
- Software programs that fulfill the above conditions contribute to the following:

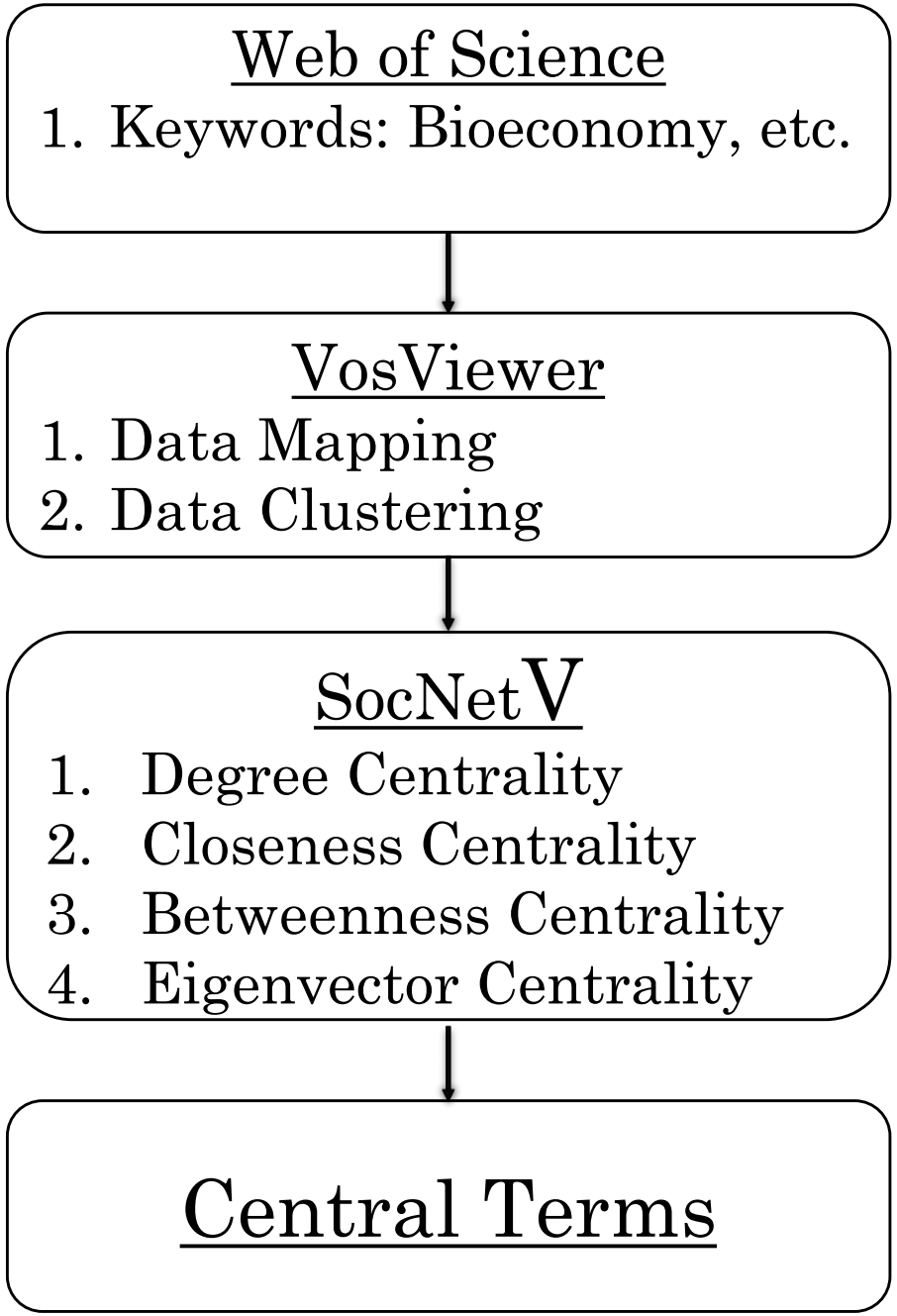
1. **Accessibility:** Anyone can access both work data and its tools.
2. **Repeatability:** The results can be reproduced.
3. **Valuation:** Factors 1 and 2 related, contribute to the validity of the conclusions.

- **VOSviewer:**



- **SoCNetV:**




Web of Science
1. Keywords: Bioeconomy, etc.
VosViewer
1. Data Mapping
2. Data Clustering
SocNetV
1. Degree Centrality
2. Closeness Centrality
3. Betweenness Centrality
4. Eigenvector Centrality
Central Terms

Data Collection

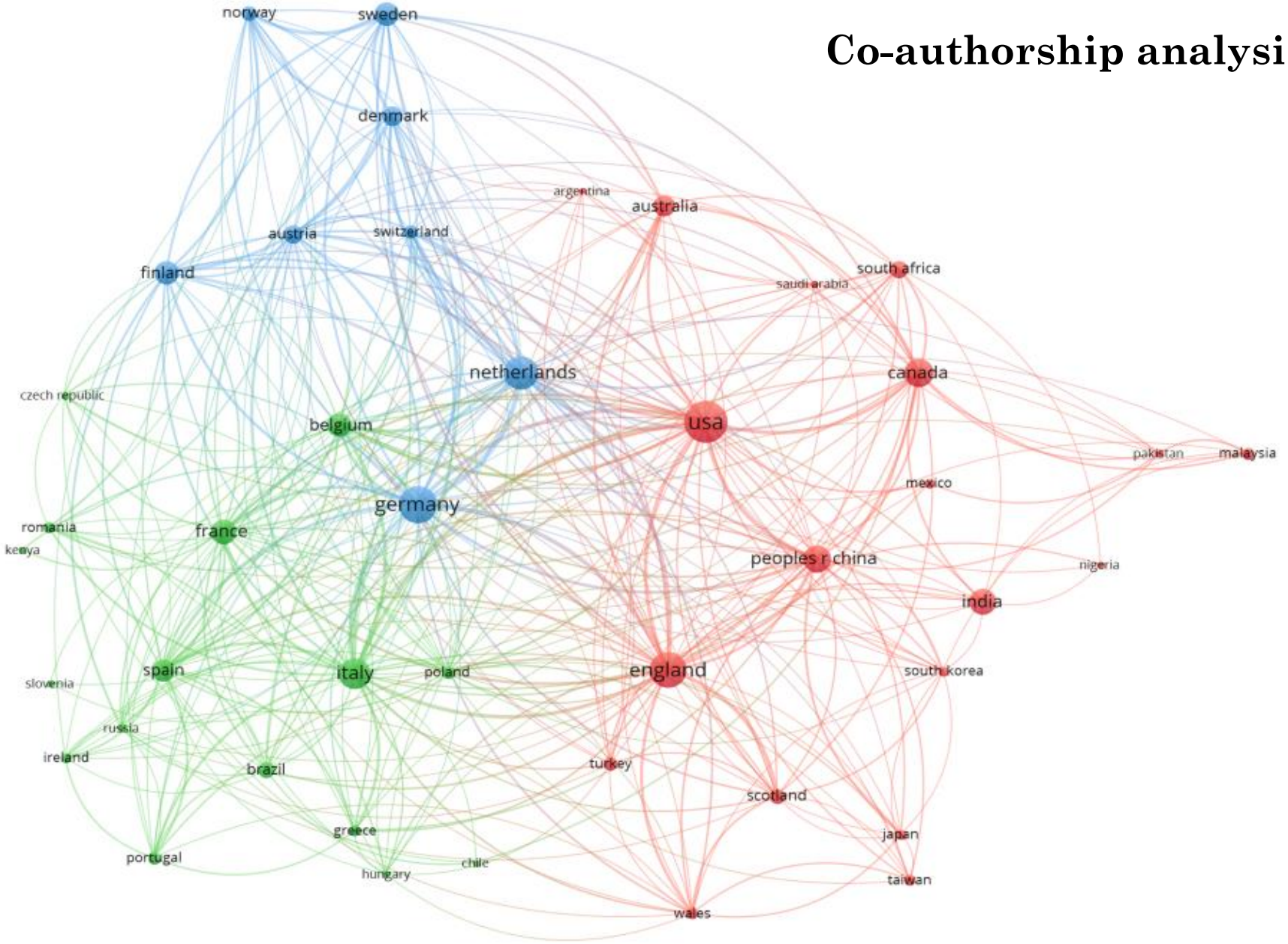
We attempted to achieve the maximum (possible) gathering of related scientific literature regarding the bioeconomy, for this reason we opted to focus our research on the Core Collection of the Web of Science (WoS) website since it fulfills three main criteria:

1. extensive coverage of the database;
2. extensive availability of features for searching, sorting, and exporting bibliographic data as well as for computing performance indicators on them;
3. open access of the database (not subscription-based).

Table of Results:

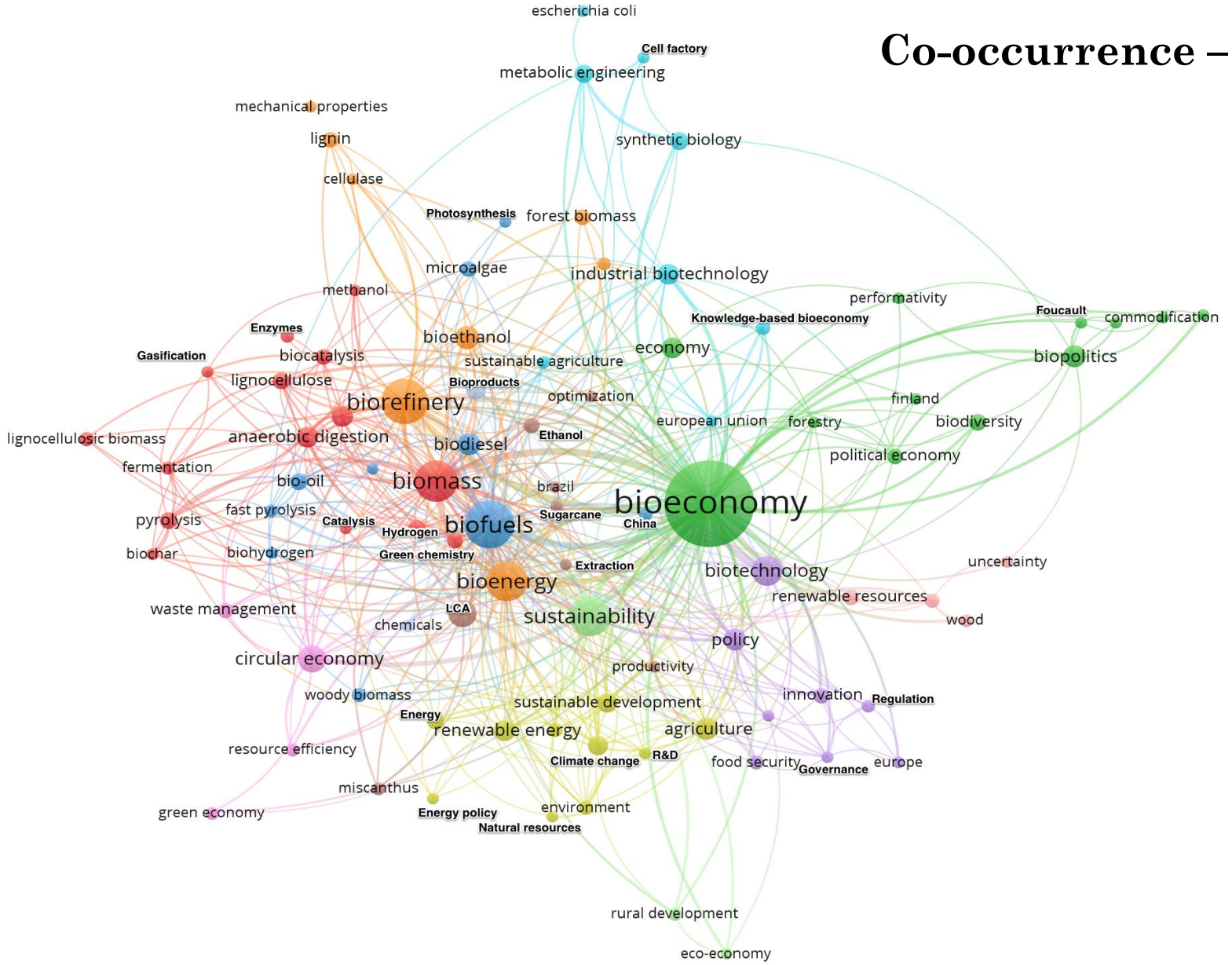
	Number of Results	Number of Results after the deletion of doubles
Bioeconomy	600	
Bio-economy	171	
Bio economy	889	
Bio-based economy	260	
Bio based economy	506	
TOTAL	**2426**	**1369**

Co-authorship analysis - Countries

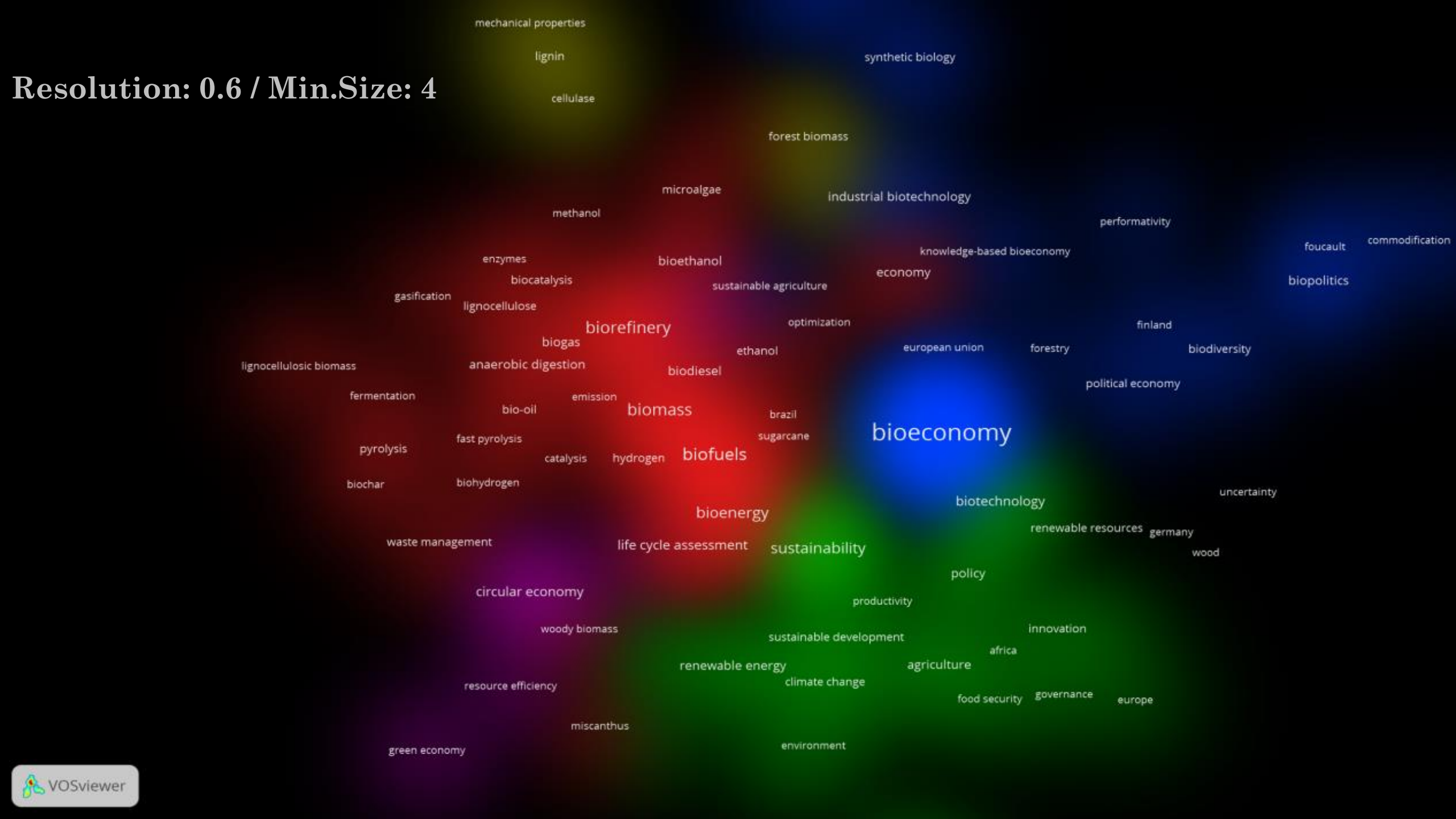


VOSviewer

Co-occurrence – Author Keywords



VOSviewer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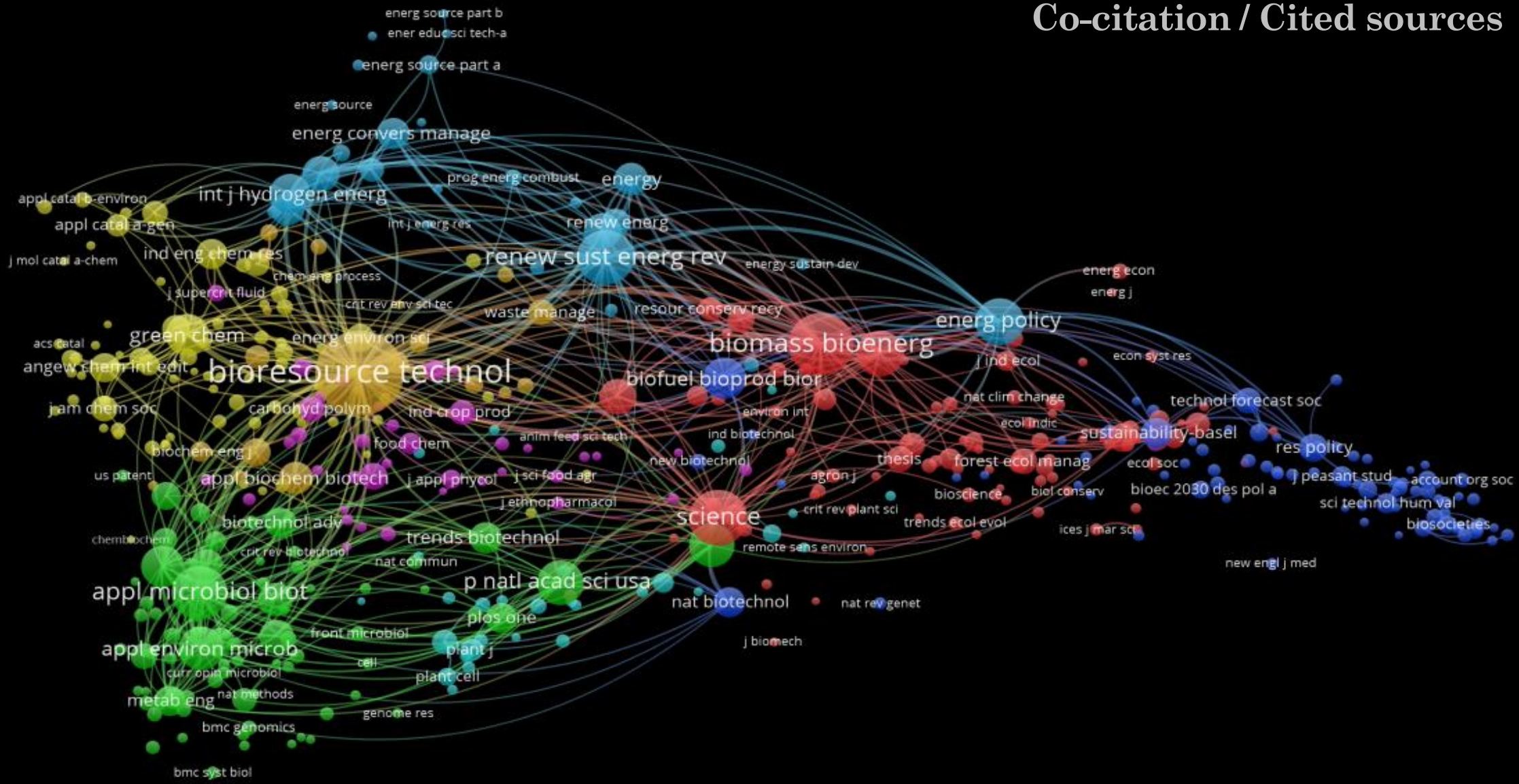
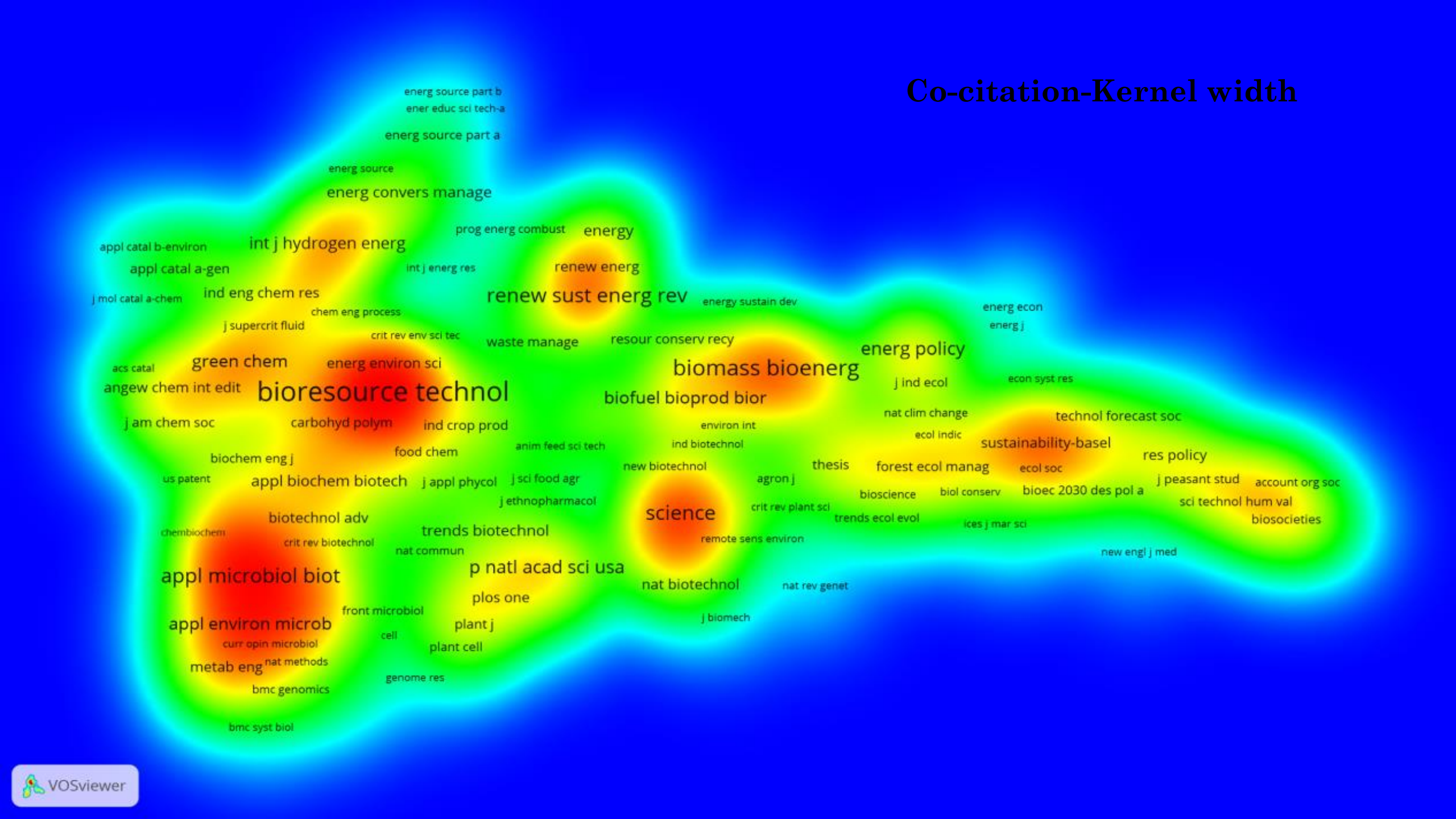
mechanical properties
lignin
synthetic biology
cellulase
forest biomass
microalgae
industrial biotechnology
methanol
performativity
knowledge-based bioeconomy
foucault
commodification
enzymes
bioethanol
economy
biocatalysis
sustainable agriculture
biopolitics
gasification
lignocellulose
optimization
finland
biorefinery
biogas
ethanol
european union
forestry
biodiversity
lignocellulosic biomass
anaerobic digestion
biodiesel
political economy
fermentation
emission
bio-oil
biomass
brazil
bioeconomy
fast pyrolysis
sugarcane
pyrolysis
catalysis
hydrogen
biofuels
biochar
biohydrogen
uncertainty
biotechnology
bioenergy
renewable resources
germany
waste management
life cycle assessment
sustainability
wood
policy
circular economy
productivity
woody biomass
innovation
sustainable development
africa
renewable energy
agriculture
climate change
resource efficiency
food security
governance
europe
miscanthus
green economy
environment
VOSviewer

Co-citation / Cited sources

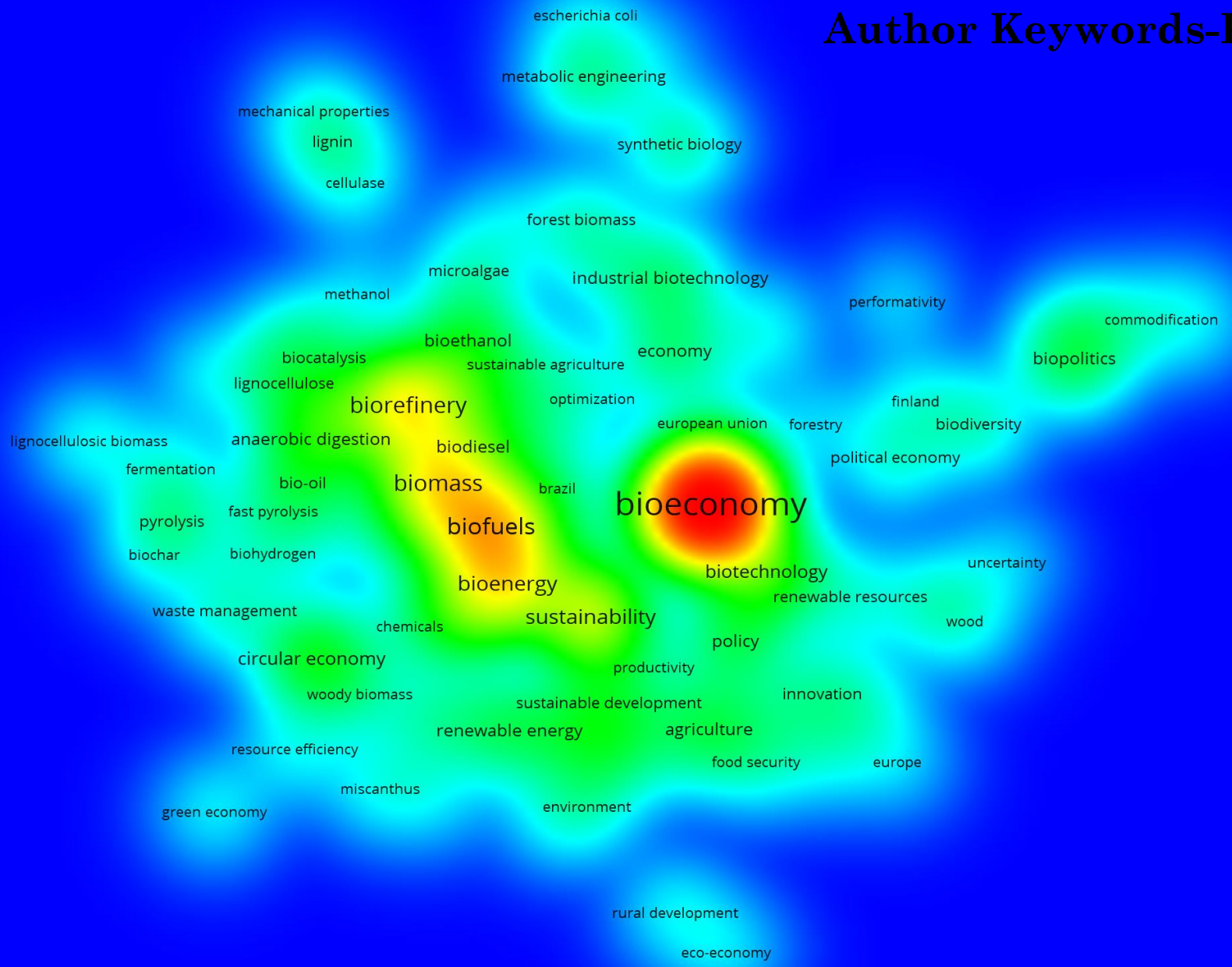


Co-citation-Kernel width



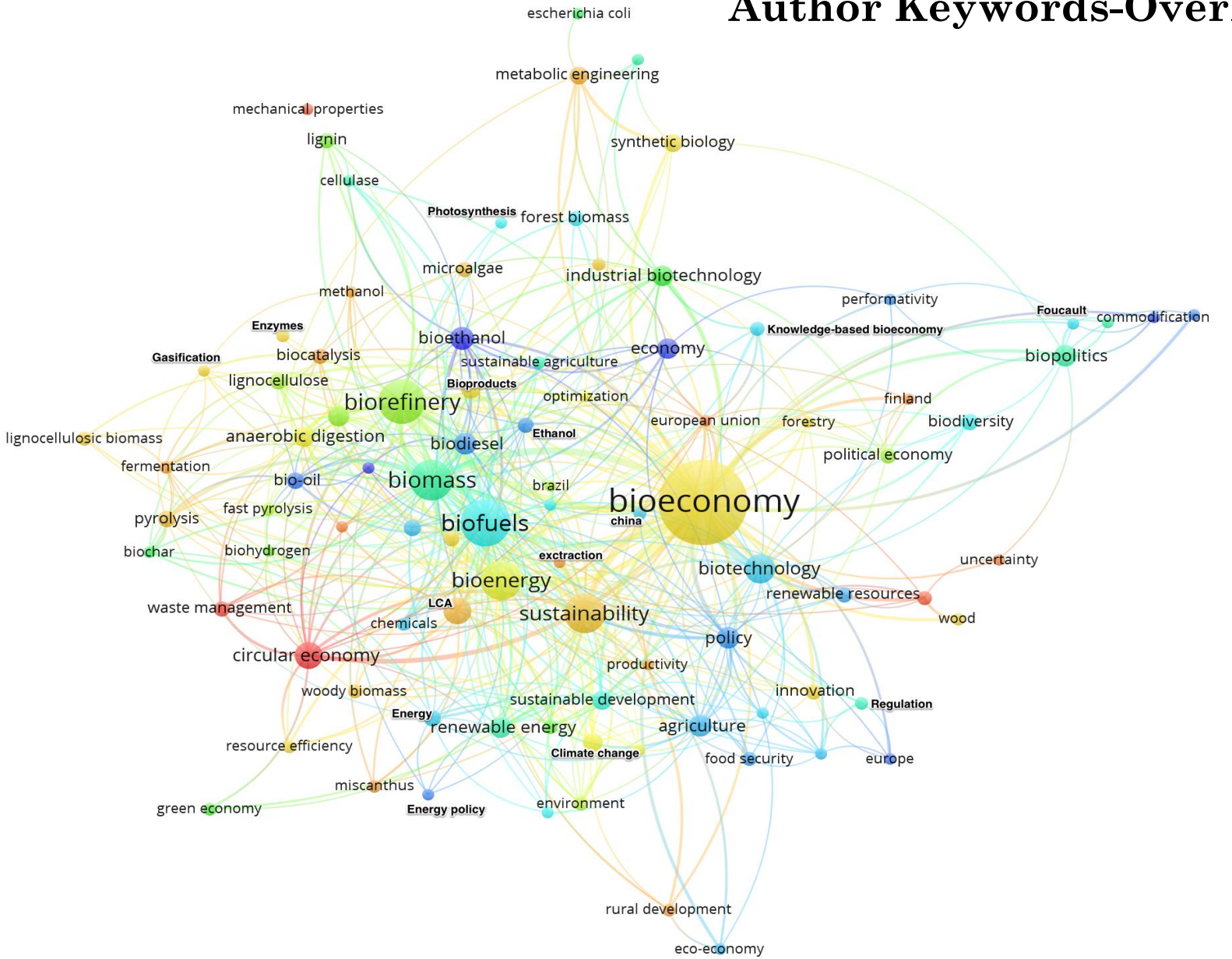
VOSviewer

Author Keywords-Kernel width



VOSviewer

Author Keywords-Overlay Visualization



VOSviewer

2012 2013 2014 2015 2016 2017

Conclusions:

Past:

Bioeconomy scheme formulated by the same roots of the existing model as a necessity to environmental (and economic) instabilities and the more and more intense awareness of the natural limits of the geosphere. It is characteristic that it is not bioeconomy who invented the bio-oriented energy terms but rather the opposite way as shown both in Kernel width and the Overlay visualization. The transition towards bioeconomy followed the biological law according to which, the accumulation of small, quantitative differentiations leads to qualitative differentiations. Respectively, small technical differentiations from the linear carbon-centered model, driven by objective environmental uncertainties, tend to reorient the whole structure of the model towards a new one. In the new model, some elements from the previous model will be sustained but radical distinctive qualitative parts which makes the model a new one would also be contained.

Present:

Today's form of bioeconomy acts in four main levels that we set as: Energy demand, Land Demand, Governance, Interaction with other schemes and present bellow with the most central terms that they include.

Energy Demand	Land Demand	Governance	Interaction
• Biorefinery • Biomass • Biofuels • Bioenergy	• Sustainability • Biotechnology • Agriculture • Policy	• Bioeconomy • Industrial Biotechnology • Biopolitics	• Circular Economy • Green Economy

Future:

The overlay network showed that the most recent scientific references relate bioeconomy with circular economy. We analyzed the meaning of circular economy and we suggested that the ideal scenario would be a synergetic relation of bioeconomy and circular economy, that would relate the bio-resource bioeconomic principle with the circular-processes mentality of circular economy, which would abolish both the “linear” and the “carbon terms” from the production.

Thank you very much for your attention!