Exploring the nature scientific research related to Sustainable Development Goals: The case of Colombia

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The nature of sustainable Development goals

- Interactions across multiple sectors, governance forms and social an environmental goals.

- Multiple synergies and trade-offs

- Coordination processes across regions (international, regional and local level)

- Systems problems such hunger, inequality and climate change.
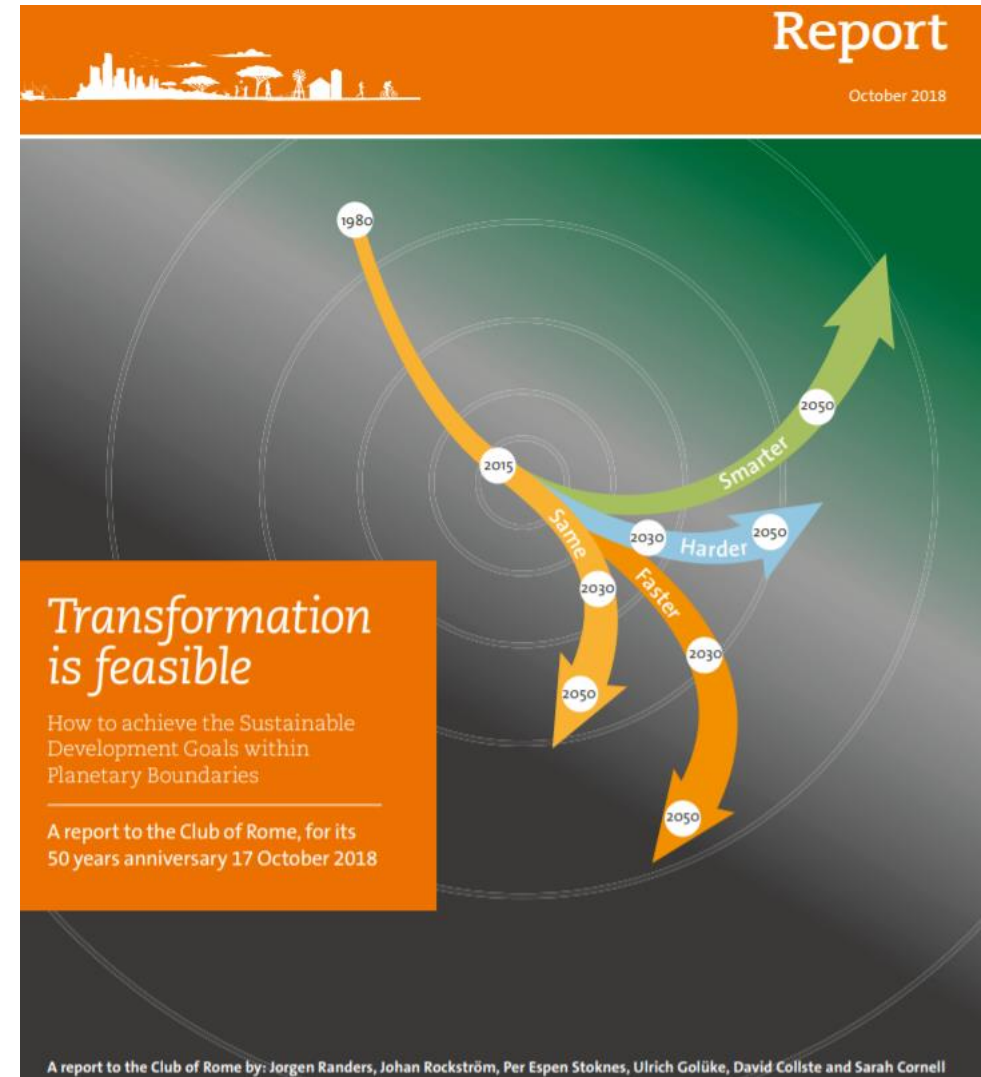
Dynamic of knowledge related to SDGs

Sustainability research has its own characteristics (e.g. interdisciplinary and transdisciplinarity) which differentiate this type of knowledge to other type of research

- Cross-learning.
- Intermediation processes.
- Coordination and circulation.
- Second order learning

Cornell, S. et al. (2013) 'Opening up knowledge systems for better responses to global environmental change', Environmental Science and Policy. Elsevier, 28, pp. 60–70. doi:10.1016/j.envsci.2012.11.008.
**Kanda, W., Kuisma, M., Kivimaa, P., & Hjelm, O. (2020).** Conceptualising the systemic activities of intermediaries in sustainability transitions. Environmental Innovation and Societal Transitions.

Research question

- **Main Question:** which is the nature of scientific research related to Sustainable Development Goals and the mechanisms behind of knowledge integration across the SDGs?
  - **SQ 1**: which are the similarities and differences between knowledge related to SDGs and other type of research? and in which areas are they connected and the possible interdependencies between them? What are the dynamics of cross learning between knowledge related to SDGs and those knowledges that are not directly related to this Agenda?
  - **SQ 2:** which are the characteristic of those topics that may permit interactions between multiple SDGs and research communities?

Methodological approach

- Social Network Analysis and systems thinking
  - Analysis of cohesive communities (the notion of structure and multiple agencies)
  - Strong and weak ties
  - Roles and position analysis. Centrality measures connected to the attributes of nodes (actors)
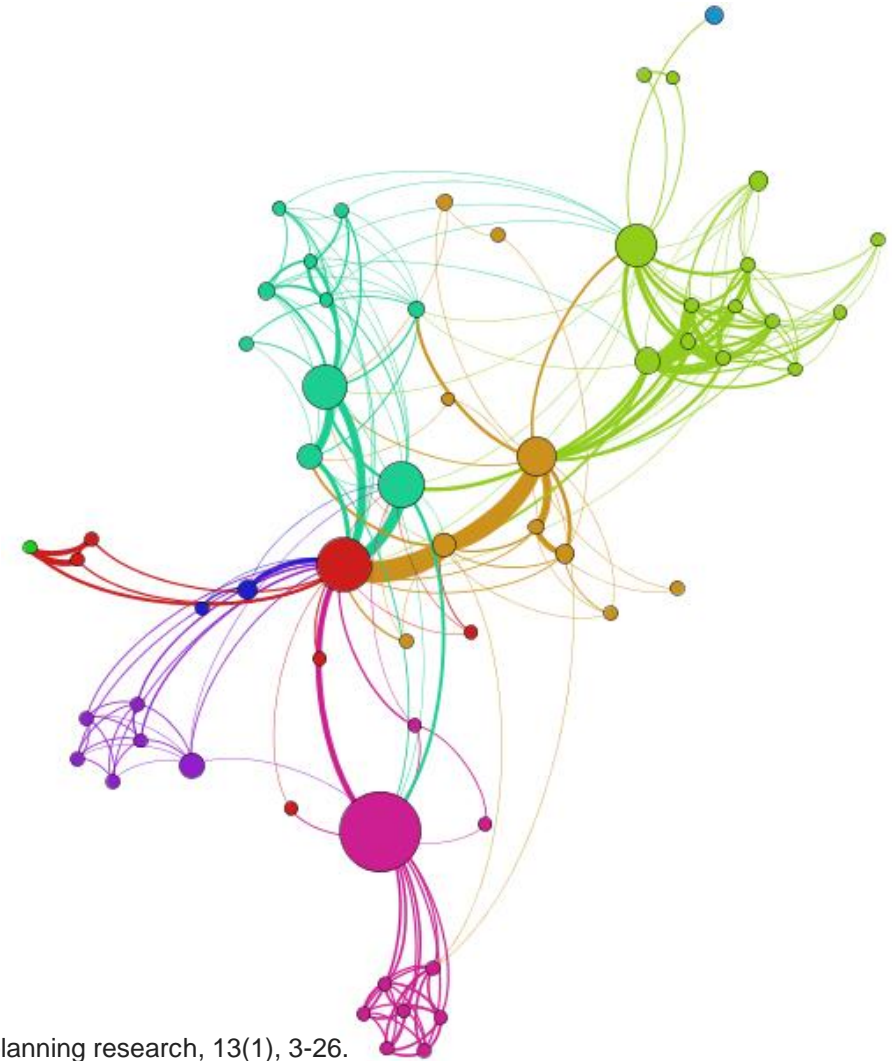
Borgatti, S. P., & Everett, M. G. (1992). Notions of position in social network analysis. *Sociological methodology*, 1-35
Henning, C., & Lieberg, M. (1996). Strong ties or weak ties? Neighbourhood networks in a new perspective. Scandinavian Housing and planning research, 13(1), 3-26.
Levin, D. Z., & Cross, R. (2004). The strength of weak ties you can trust: The mediating role of trust in effective knowledge transfer. *Management science*, *50*(11), 1477-1490.
Leydesdorff, L. (2007) 'Betweenness centrality as an indicator of the interdisciplinarity of scientific journals', Journal of the American Society for Information Science and Technology. Wiley-Blackwell, 58(9), pp. 1303–1319. doi: 10.1002/asi.20614
Newman, M. E. J. and Girvan, M. (2004) 'Finding and evaluating community structure in networks', Physical Review E - Statistical, Nonlinear, and Soft Matter Physics. doi:

Detecting knowledge communities working in SDGs: Bibliography Coupling-Research Communities

Tie formation: Less → **Intermediate** →**Higher**

a) $\delta = 0$ — No Communities
b) $\delta = 1$ — Some Communities
c) $\delta = 5$ — Community Formation
d) $\delta = 7$ — Communities
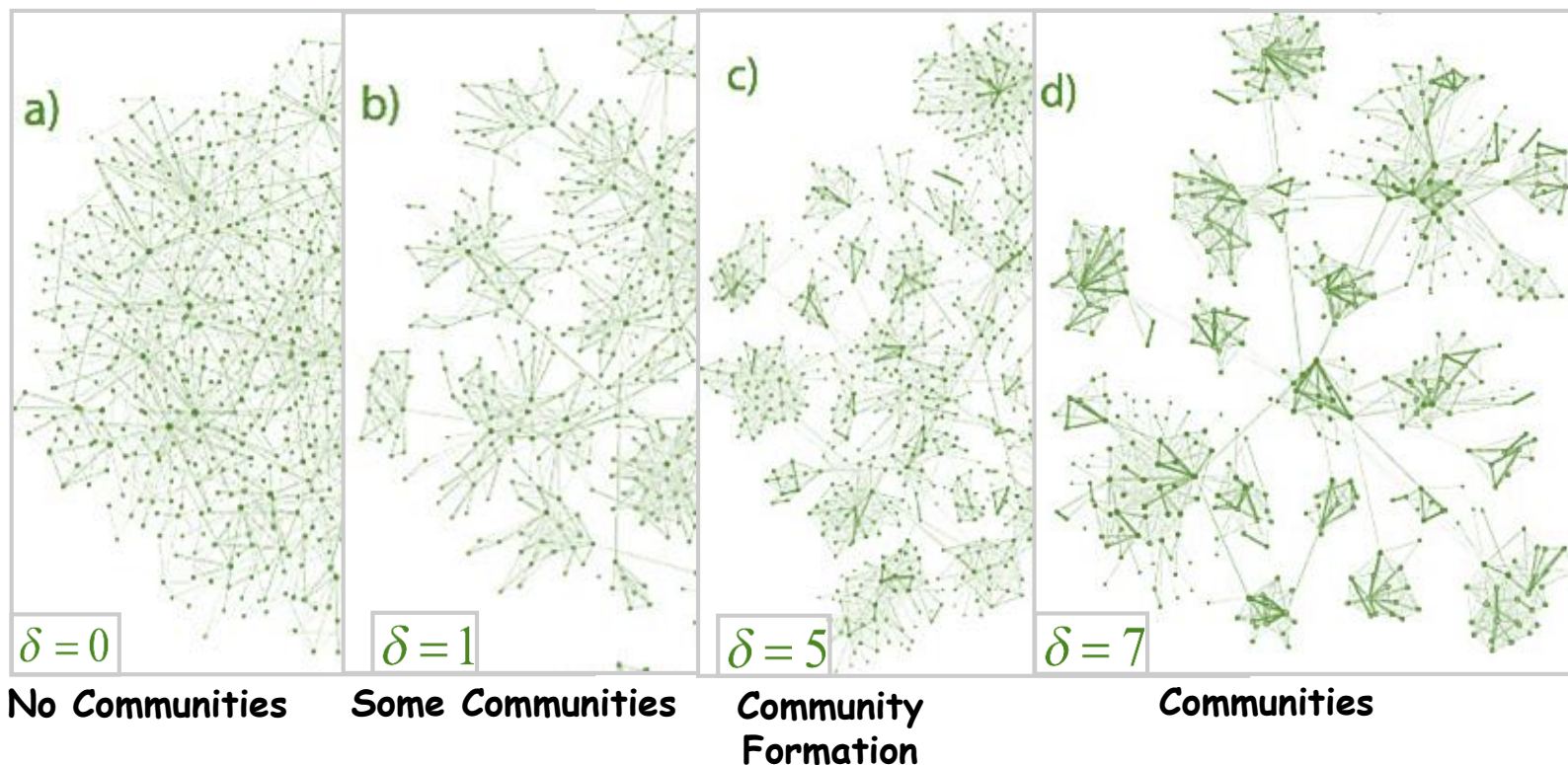
Based on modularity maximation. It permits detection of research communities which share a high percentage of bibliography. Therefore, they have a "short" cognitive distance

Bordons, M., Morillo, F. and Gómez, I. (2006) 'Analysis of Cross-Disciplinary Research Through Bibliometric Tools', in Handbook of Quantitative Science and Technology Research. doi: 10.1007/1- 4020-2755-9_20

De Meo, P. et al. (2011) 'Generalized Louvain method for community detection in large networks', in 2011 11th International Conference on Intelligent Systems Design and Applications. IEEE, pp. 88–93. doi: 10.1109/ISDA.2011.6121636.

Shiffrin, R. M. and Börner, K. (2004) 'Mapping knowledge domains.', Proceedings of the National Academy of Sciences of the United States of America. National Academy of Sciences, 101 Suppl(suppl 1), pp. 5183–5. doi: 10.1073/pnas.0307852100.
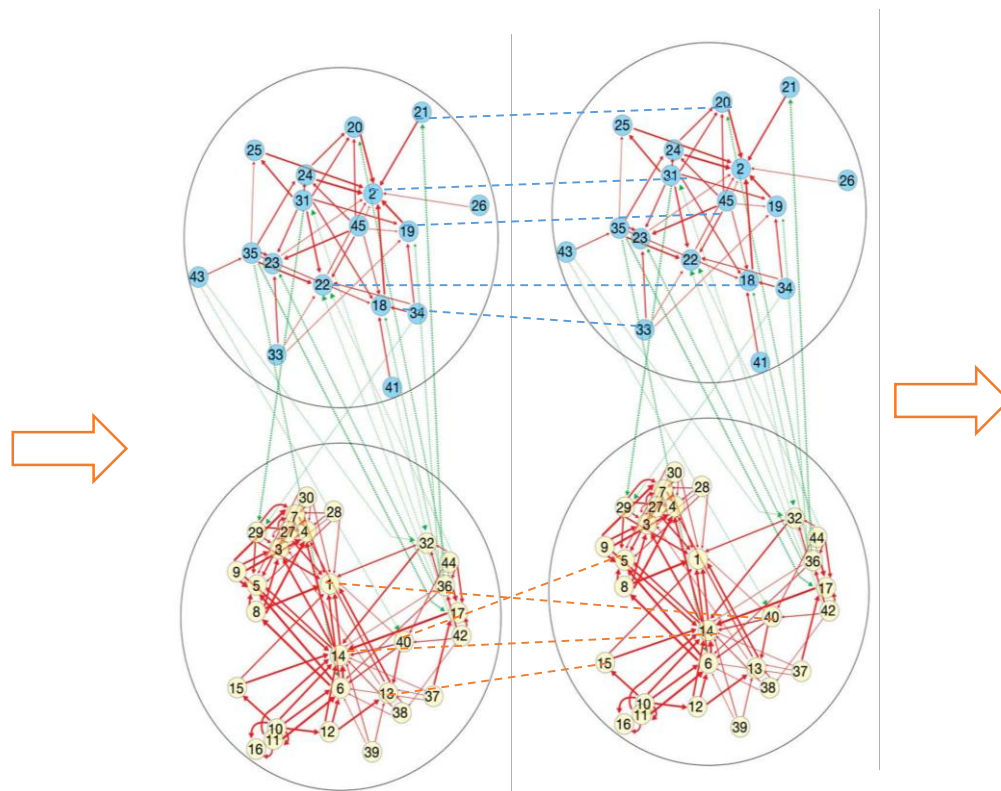
Grauwin, S. and Jensen, P. (2011) 'Mapping scientific institutions', Scientometrics, 89(3), pp. 943– 954. doi: 10.1007/s11192-011-0482-y.
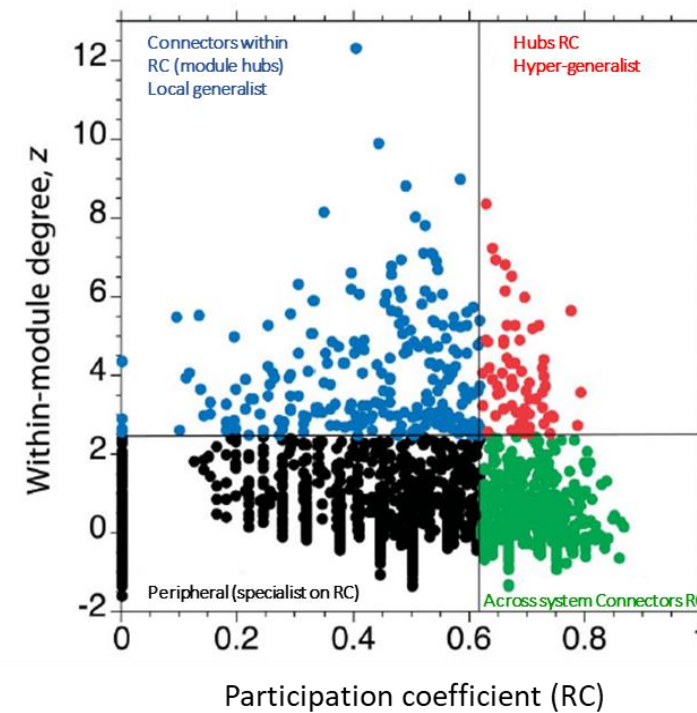
Intermediation
Within one Research Community

Between research communities across SDGs
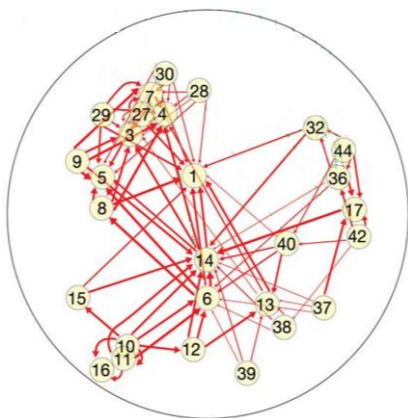
Intermediation within one module. This actors
permits the cohesion of cohesive communities .

Cross systems intermediation

Guimera, R., & Amaral, L. A. N. (2005). Functional cartography of complex metabolic networks. nature, 433(7028),
895-900.
Guimera, R., & Amaral, L. A. N. (2005). Cartography of complex networks: modules and universal roles. Journal of
Statistical Mechanics: Theory and Experiment, 2005(02), P02001
Dupont, Y. L., & Olesen, J. M. (2009). Ecological modules and roles of species in heathland plant-insect flower visitor
networks. *Journal of Animal Ecology*, 346 353.

Method

- Bibliometric data
  - Academic publications related to Colombia (national level). Web of Science and SciELO Citation index between 2002 and 2019.
- Thesaurus data set.
- **2103 search sources.**
- Co-bibliography network and modularity maximization
- Analysis of roles and positions

Methodological approach developed

1. **Developing a thesaurus.**

SDG2. End hunger, achieve **food security** and improved nutrition and promote **sustainable agriculture**
e.g.
2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help **maintain ecosystems,** that strengthen capacity for adaptation to **climate change**, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality

2. **Search sources (1) (875)**

1. ACCESSIB#LAND#AGRICULTUR
2. AGRICULTUR#BIODIVERSITY
3. AGRICULTUR#CONSERVATION
4. CLIMATE CHANGE#AGRICULTUR
5. FOOD SECURITY
6. FOOD SOVEREIGNTY
7. SUSTAINABLE AGRICULTURE

8. PEASANT AGRICULTUR
9. ORGANIC AGRICULTUR
10. DIETARY INTAKE

Search

3. WoS and SciELO from 2002 to 2019. Tittle, abstract and key words of every bibliometric source

4. Data sub-set.

Analysis of frequency of key words (3) and we enriched our data set by selecting some of the key words suggested By Elsevier and SIRIS Project

6. 2103 search sources.

Group 1: 781
Group :1322
The number of search items in every SDG was limited to **between 100 and 140**
It was reduced the correlation from 0.7236 to 0.098

RQ1: Which are the similarities and differences between knowledge related to SDGs and other type of research? and in which areas are they connected and the possible interdependencies between them? What are the dynamics of cross learning between knowledge related to SDGs and those knowledges that are not directly related to this Agenda?

1. Identifying research communities in the Colombian research system (all academic communities)

2. Labelling publications related to the SDGs.

3. Analysing the number of research communities with papers related to SDGs (participation)

4. Studying the dominance of this papers in this research communities

- % SDGs research system
- % SDGs Research communities
- Abundance of SDGs per community.
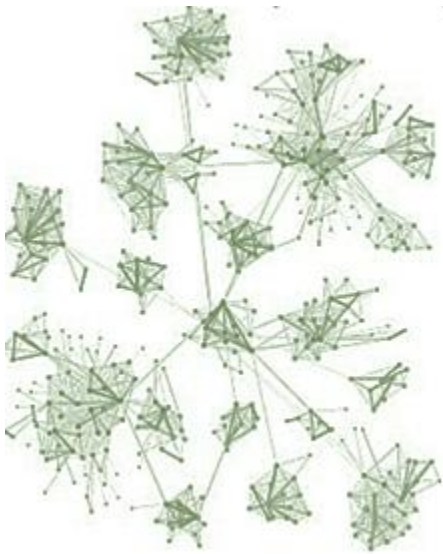
Detecting Colombian research communities   Identifying research communities related to the SDGs

SQ 2: which are the characteristic of those topics that may permit interactions between multiple SDGs and research communities?

1. Labelling publications related to the SDGs.

2. Identifying research communities in the Colombian research system (all academic communities)

3. Analysing roles and positions

4. Co-words similarity.

Labelling SDGs academic publications
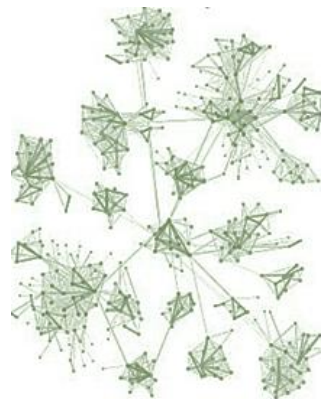
SDGs communities

-Analysis roles and positions of SDGs publications
-Analysis of co-words networks by every type of role an position
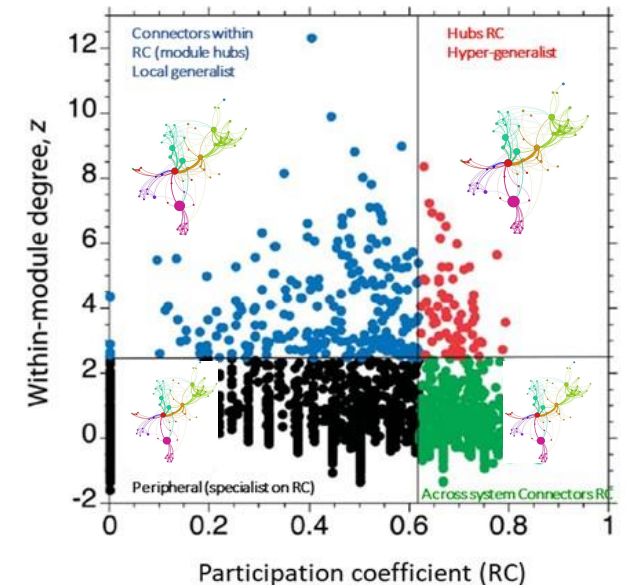
Colombia Publications

- **68,393 Scientific Publications between 2002 and 2019**
- **152 communities**
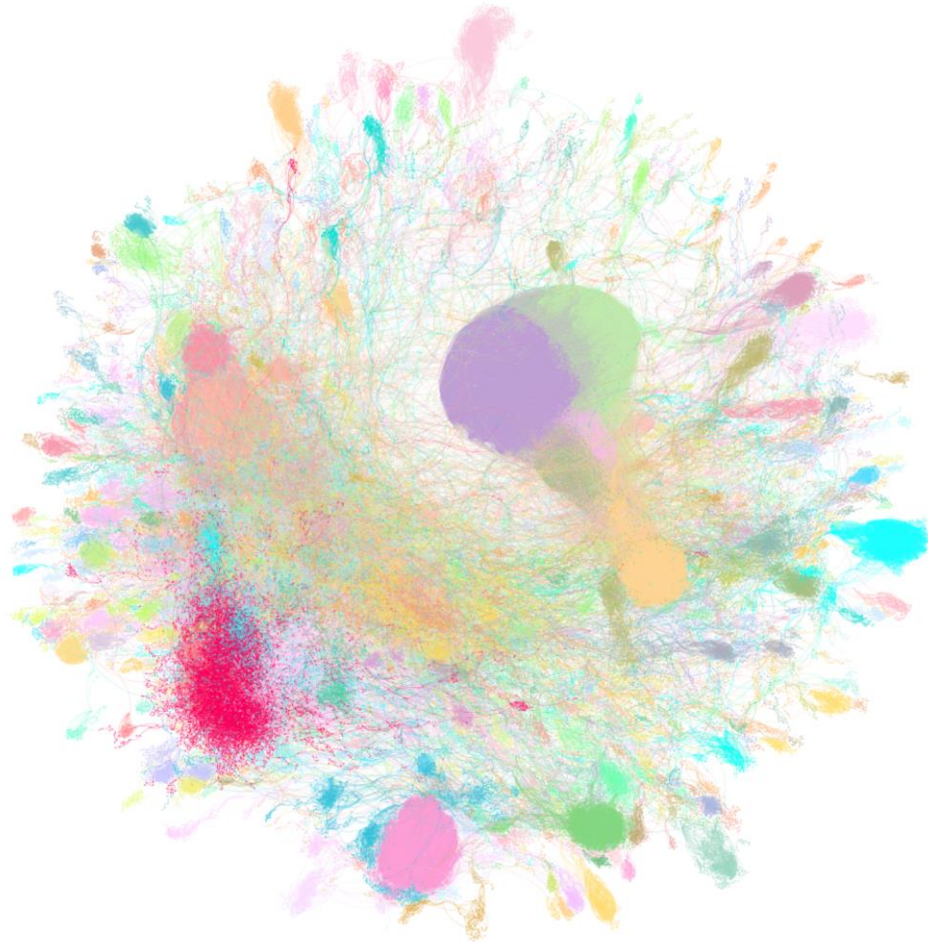
SDGs publications within the research system
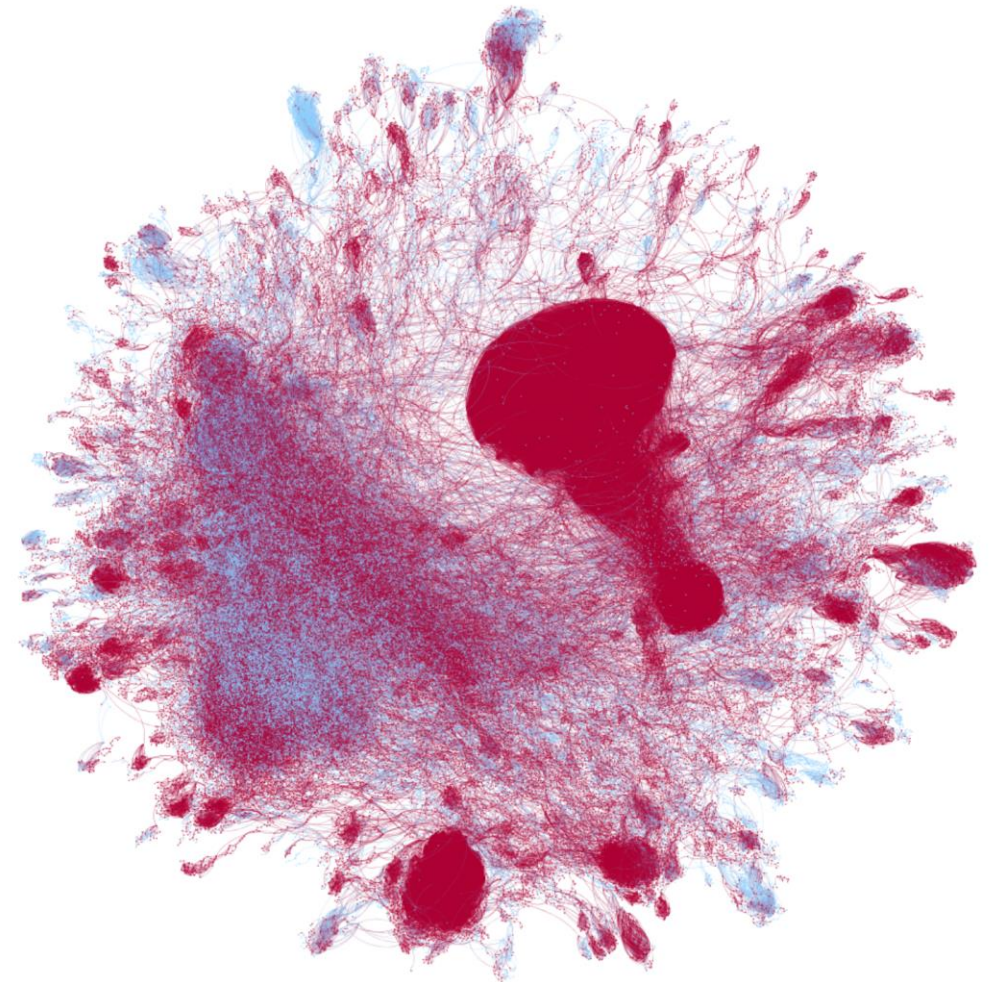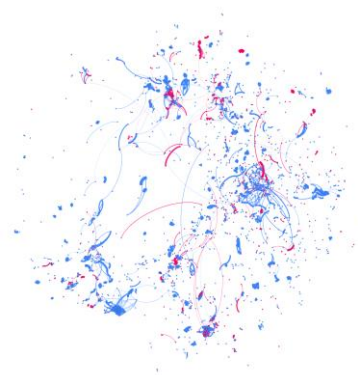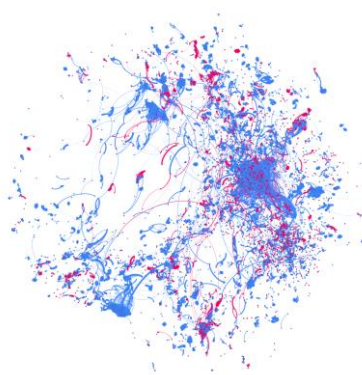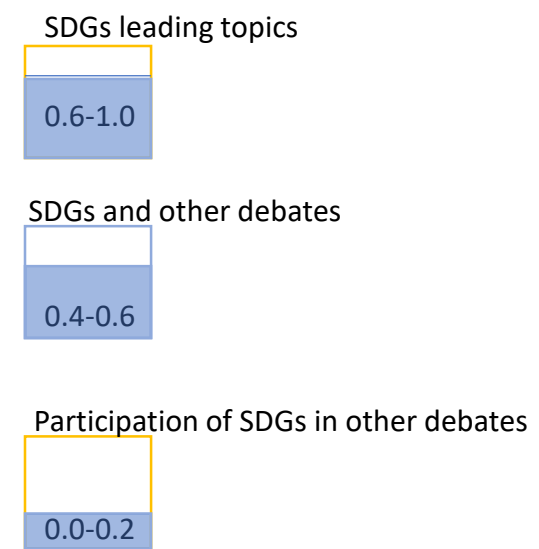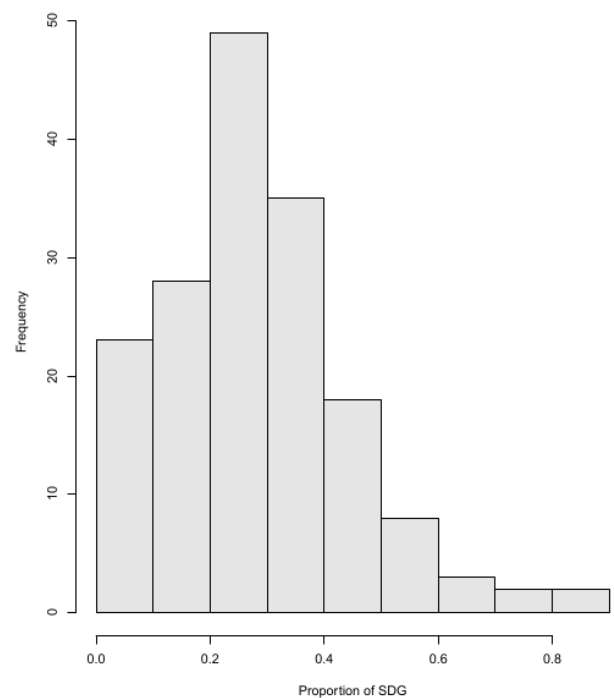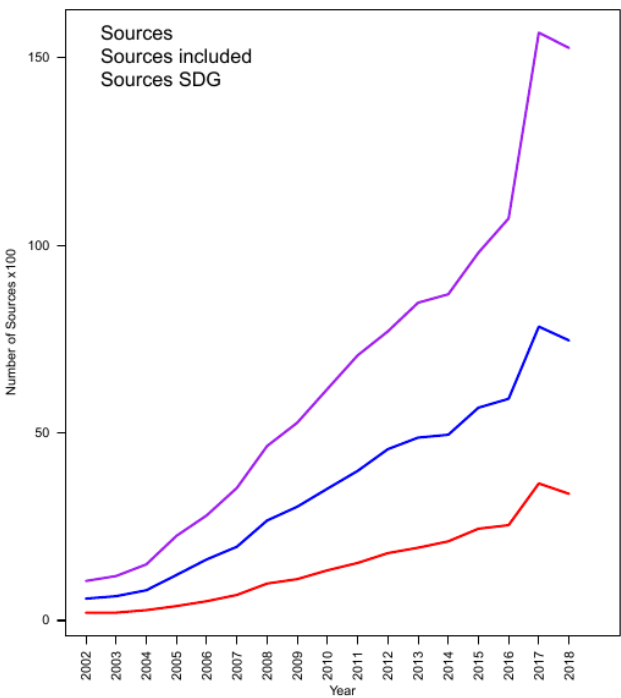
2002-2004   2005-2007   2008-2010   2011-2010

SDGs leading topics

0.6-1.0

SDGs and other debates

0.4-0.6

Participation of SDGs in other debates
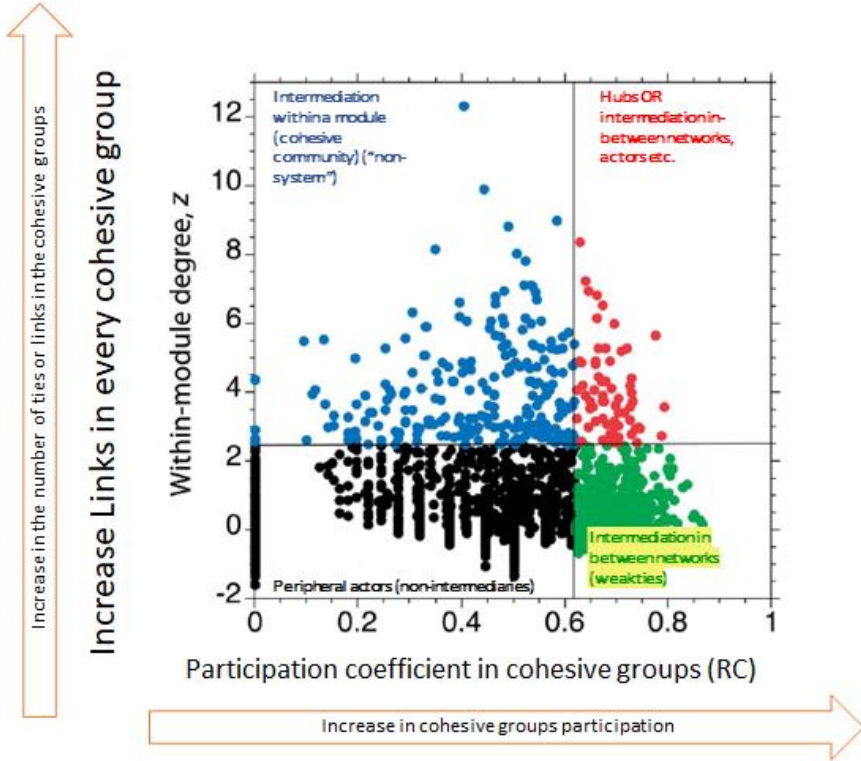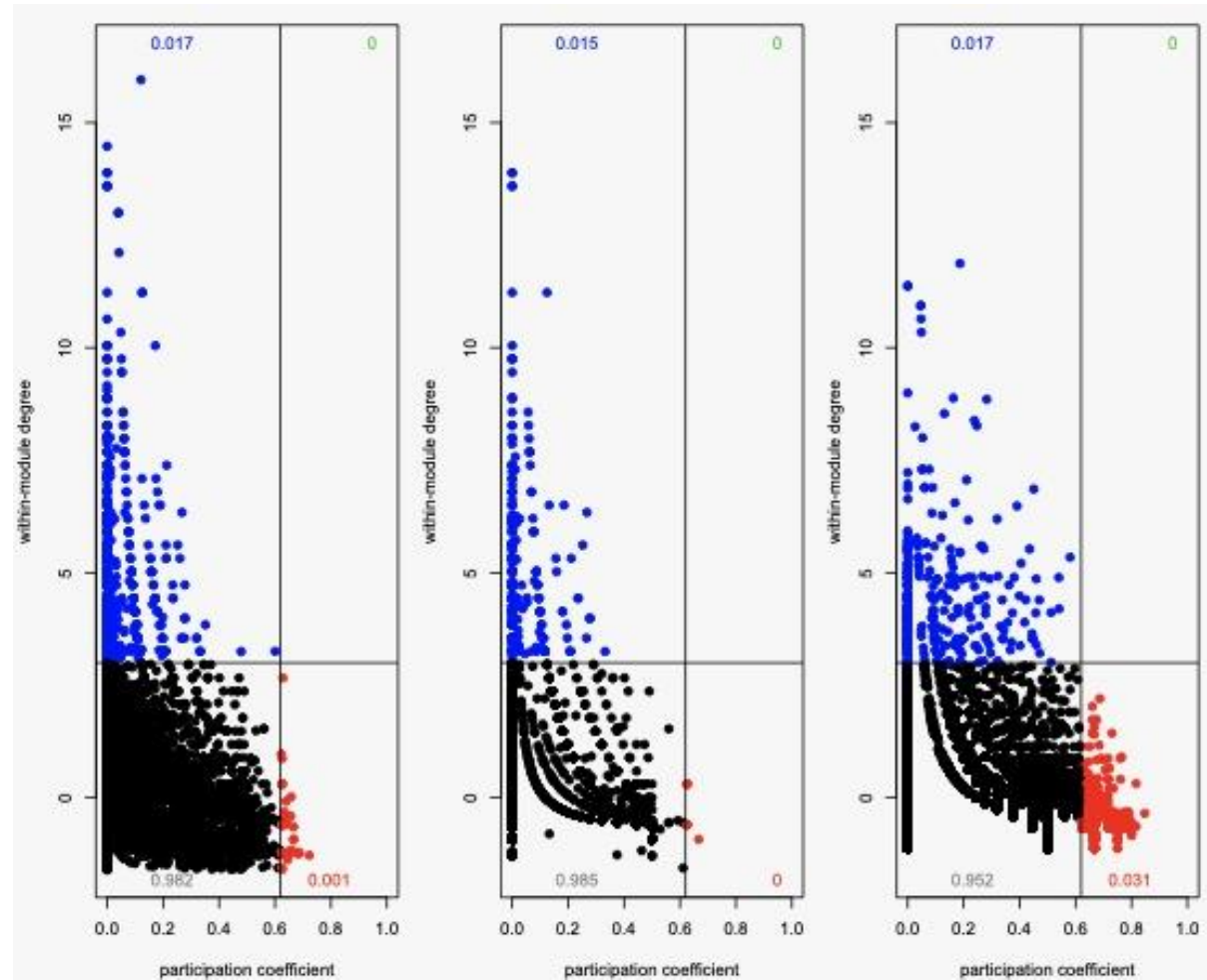
0.0-0.2
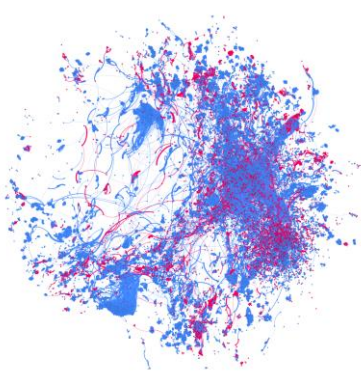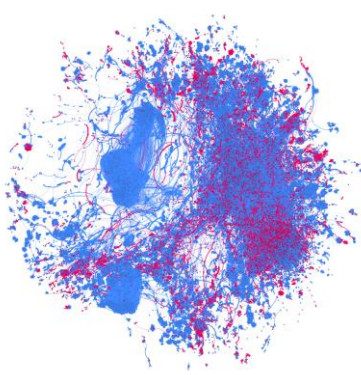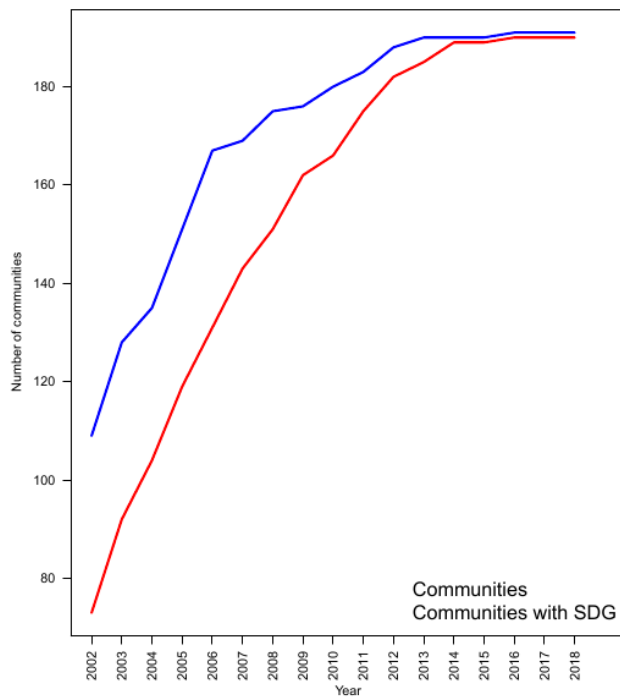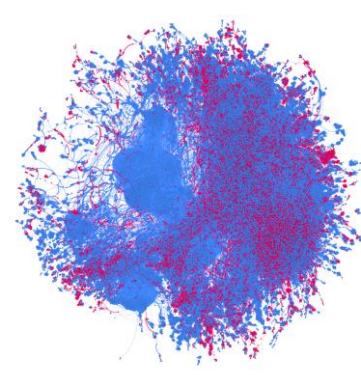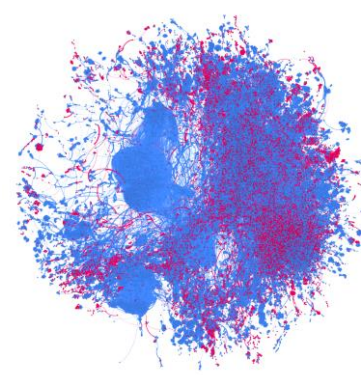
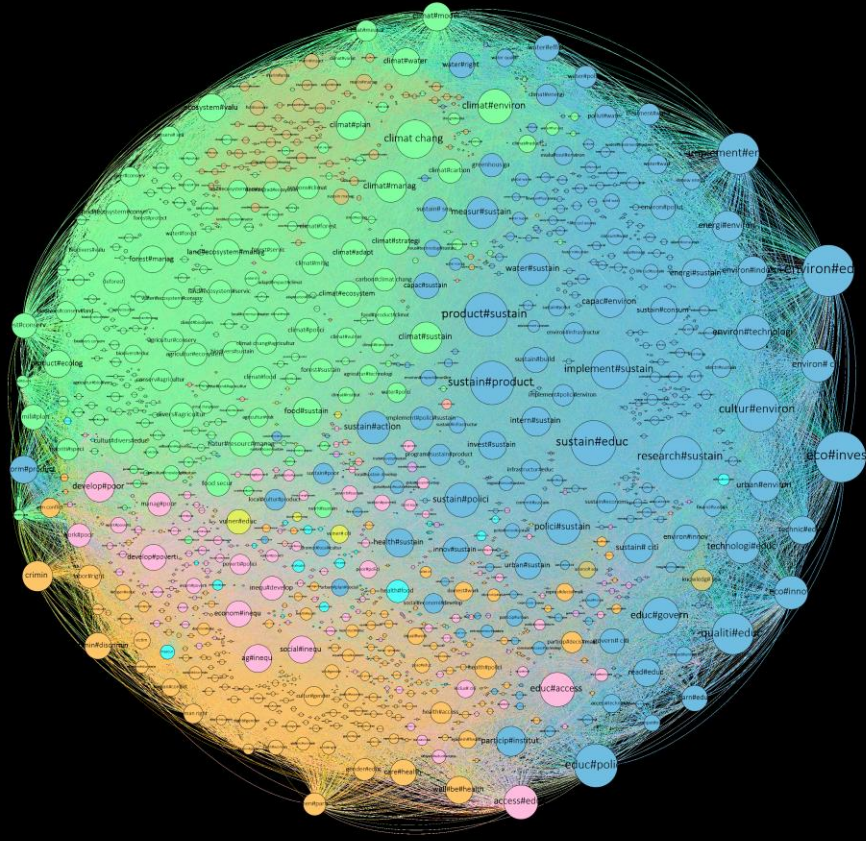# Roles and positions Analysis (knowledge circulation)

Colombian research
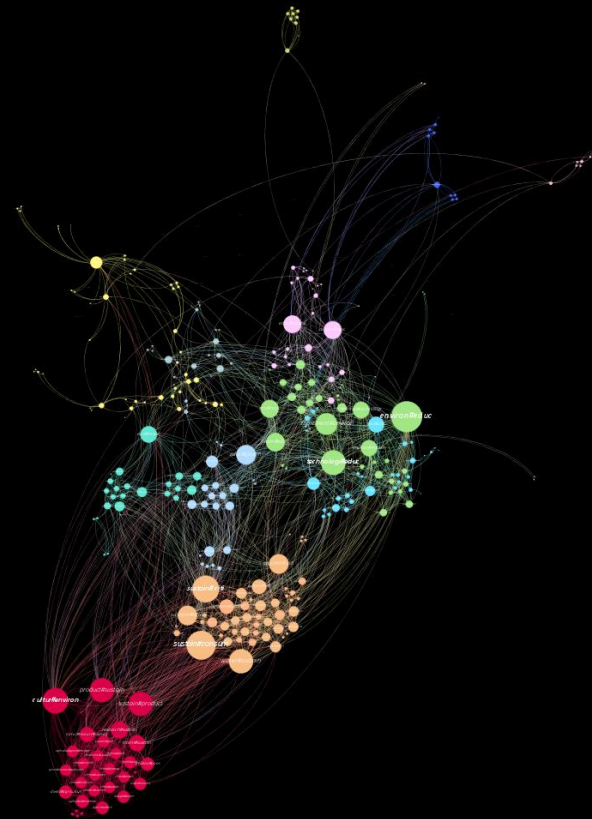
SDGs research withing the Colombian system
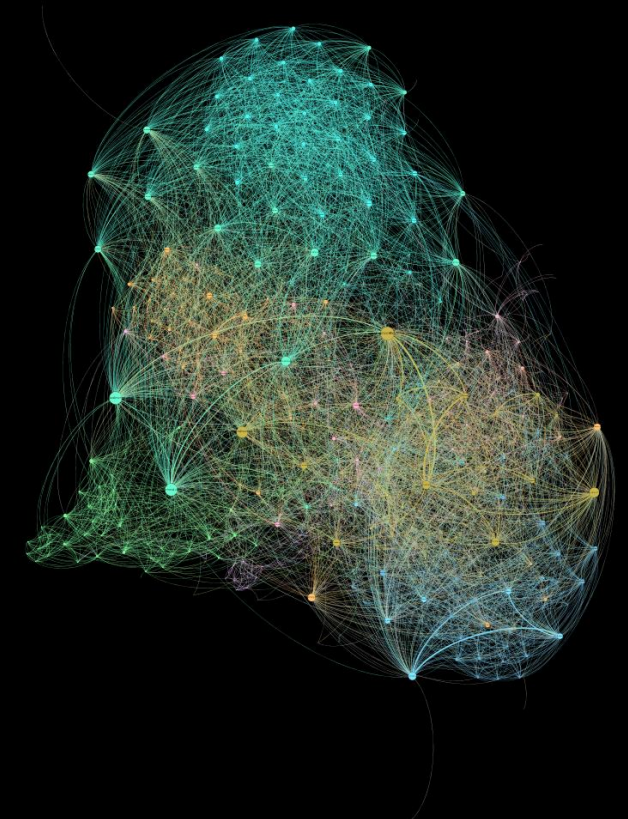
Only SDGs research

Peripheral articles

Module-connectors

Cross system connectors

Co-word similarity. Two words are connected because they appear in the same article (title, abstract and keywords)

SQ 2: which are the characteristic of those topics that may permit interactions between multiple SDGs and research communities?

Jaccard indicator of similarity

	Periferico	modular-hub	Hub-connector
Nodos Periferico	1	0.23715415	0.389986825
modular-hub	0.23715415	1	0.608108108
Cross system connector	0.389986825	0.608108108	1

Network metrics

	perispheral	cross system conectors	modular-hub
Nodes	1518	592	360
Links	81492	6037	2146
Modularity	0.458	0.68	0.734
Number of moduls	20	15	16
Clut. Coeficient	0.671	0.763	0.778
Number of triangles	2685208	42629	8896
Average Path length	2.132305982	2.689640029	3.120023154
Diameter	5	7	8
Average Degree	108.656	21.648	12.871
density	0.072	0.039	0.039
DegreeCentralization	0.488880957	0.239601912	0.170133086
BtwsCentralization	0.043605352	0.089455271	0.092431883
Moduls	23	36	34
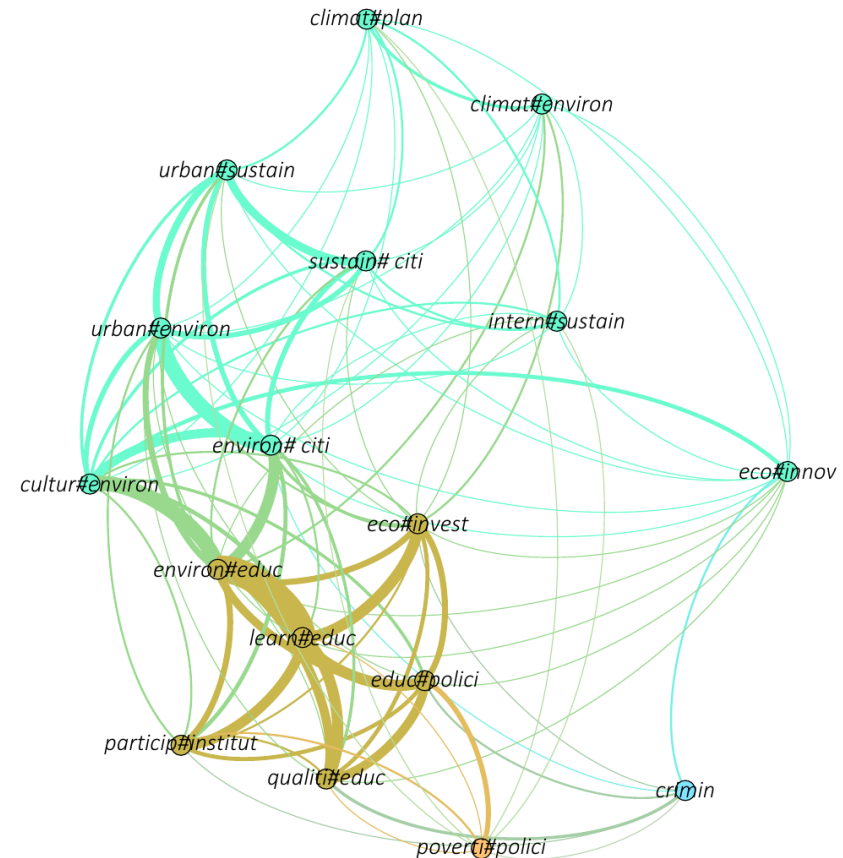
Conclusions

- Strong interaction between the *knowledge system* and the Sustainable Development Goals. The knowledge systems in LA born with agendas related to sustainability and social goals. Therefore, the quality of the knowledge system impacts directly the research related to the sustainable development goals.

- Possible bias of using an specific thesaurus, this results must be contrasted with other thesaurus.

- The research related to SDGs is broadly spread in the research communities although most of them do not have a "dominant" role on those communities.

- Modular hubs and cross learning roles shows a more structured topics structure than peripheral articles.