Stars of mitigation? Participation-based structure in a city-to-business network

Milja Heikkinen[1,2], Onerva Korhonen[3], Sirkku Juhola[1,4], & Tuomas Ylä-Anttila[2,5]

[1] Ecosystems and Environment Research Programme, University of Helsinki, Finland

[2] Helsinki Institute of Sustainability Science (HELSUS), Finland

[3] Université de Lille, CNRS, UMR 9193 - SCALab - Sciences Cognitives et Sciences Affectives, Lille, France, onerva.korhonen@gmail.com

[4] Centre for Climate Science and Policy Research, Linköping University, Sweden

[5] Faculty of Social Sciences, University of Helsinki, Finland

Background

- Climate change is one of the most important problems the humankind is facing.
- Cities are key players in climate change mitigation [1].
- Private actors produce most of the greenhouse gas emissions [2] → collaboration between cities and private sector is required.

Climate Partners (CP):

- A city-to-business network founded by the city of Helsinki, Finland, in 2011
- Members: 83 companies from different fields operating in the Helsinki metropolitan area
- Activities: 1) Climate Commitments with individual mitigation goals singed by the companies while joining the network, 2) Seminars and workshops for the member companies
- Aims: introducing new operating methods and business opportunities, reducing emissions through cooperation, sharing best practices

Research question

Does CP manage to meet its aims?

Or, in particular:

1. **Does CP bring together companies from different fields** of business to promote experience sharing?
2. **Do the companies engage** to the CP activities?

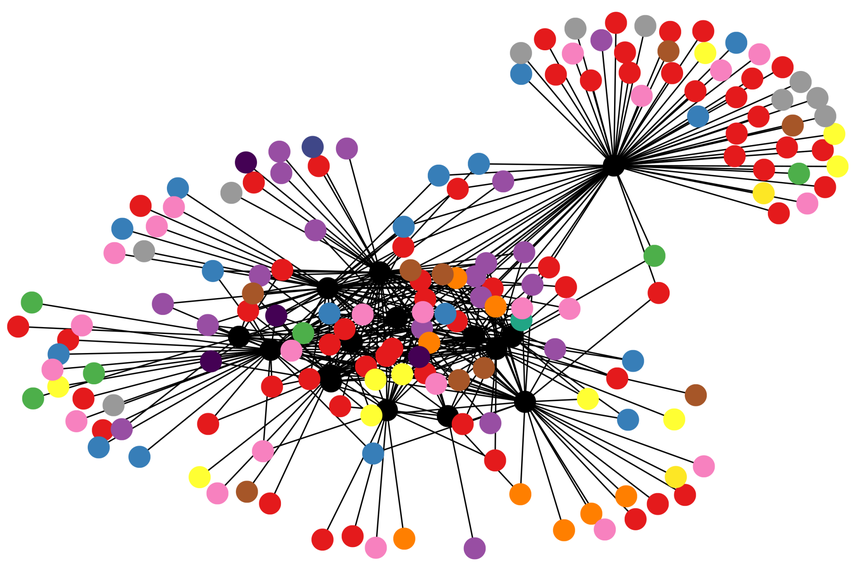
Data

- participant information of the 15 CP events organized in 2011–2018, 28.8 ± 16.5 participants/event (mean $\pm$ STD)
- participating companies classified to 20 fields of business

Methods

Bipartite network construction

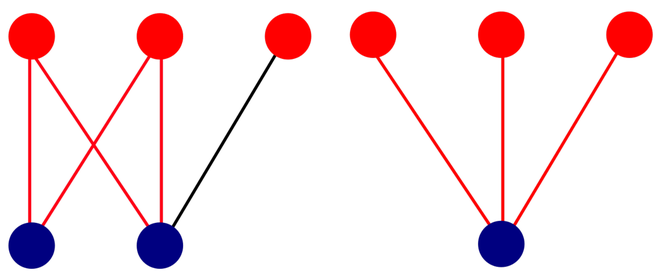
- Bottom nodes = CP events, top nodes = CP member companies
- Links connect companies and the events they participated.



Detecting bi-cliques

The bi-clique detection algorithm [3]:

1. Add links between all bottom-bottom and top-top node pairs → a monopartite network
2. Detect cliques of the monopartite network
3. Remove cliques corresponding to all bottom nodes and all top nodes
   - A **bi-start** = a bi-clique with only one bottom node



Left: A bi-clique of four nodes (red links) and one non-clique node (black link). Right: A bi-star of four nodes.

Research questions revisited from bipartite perspective

1. ***How diverse** are the bi-cliques of the participation network?*
   - **Effective diversity** [4, 5] of bi-clique A defined as

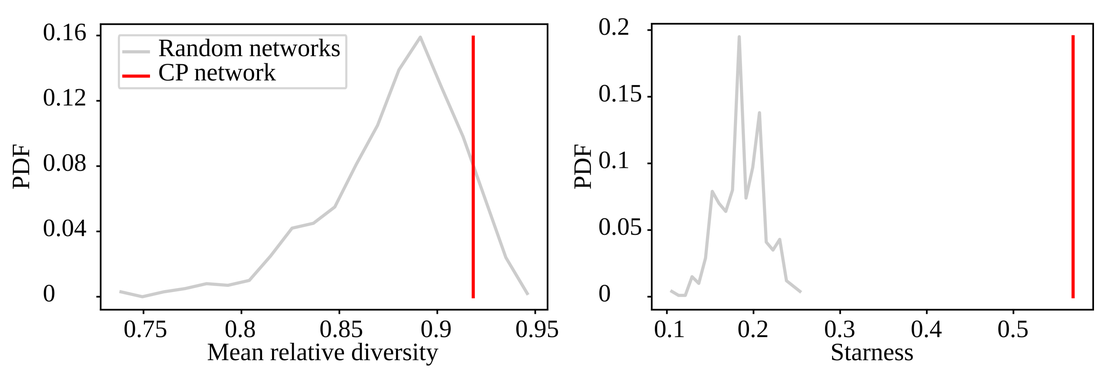
$$D_{eff} = \frac{1}{1 - GS(A)} = \frac{1}{\sum_{i=1}^{N_f} p_i^2}, \quad (1)$$

   where $GS(A)$ is the Gini-Simpson index of A, N_f is the total number of fields, and p_i is the fraction of companies from field i out of all companies in A
   - Normalized by clique size to get **relative diversity**
   - Compared against a **field-shuffled null model** with original link structure (1 000 iterations)
2. ***How many bi-stars** does the network contain?*
   - **Starness** of the network G defined as

$$S(G) = \frac{\sum_{i=1}^{N_{stars}} N_i}{N_C}, \quad (2)$$

   where N_{stars} is the number of bi-stars in G, star i contains N_i companies, and N_C is the total number of companies
   - Compared against a **link-shuffled null model** (1 000 iterations)

Results



- The CP network is **as diverse as the null model**: similar number of fields of business per clique (6.04 vs 5.67), effective diversity (5.39 vs 4.79), and relative diversity (0.92 vs 0.88)
- The CP network has **higher starness than the null model** (0.57 vs 0.19)

Conclusions

- **CP brings together companies from diverse fields**, opening possibilities for information transfer and innovative collaborations.
- **Bi-stars of mitigation**: companies stop participating in CP activities after their first events.
- **Low engagement may make meeting the CP aims challenging.**
- Although not participating in CP activities, **companies may take other actions to mitigate the climate change**.

- Does CP membership alone lead to more ambitious mitigation goals? **Next step: analyzing the evolution of companies' Climate Commitments** reported in CP's annual reports

References

[1] A. Revi, D. Satterthwaite, F. Aragón-Durand, J. Corfee-Morlot, R. Kiunsi, M. Pelling, D. Roberts, and W. Solecki, "Urban areas," in *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (C. Field, V. Barros, D. Dokken, K. Mach, M. Mastrandrea, T. Bilir, M. Chatterjee, K. Ebi, Y. Estrada, R. Genova, B. Girma, E. Kissel, A. Levy, S. MacCracken, P. Mastrandrea, and L. White, eds.), p. 535–612, Cambridge, UK and New York, NY, USA: Cambridge University Press, 2014.

[2] K. Abbott, "Orchestration. strategic ordering in polycentric governance," in *Governing Climate Change. Polycentricity in Action* (A. Jordan, ed.), pp. 188–209, Cambridge, UK: Cambridge University Press, 2018.

[3] K. Makino and T. Uno, "New algorithms for enumerating all maximal cliques," in *Algorithm Theory - SWAT 2004. SWAT 2004. Lecture Notes in Computer Science, vol 3111.* (T. Hagerup and J. Katajainen, eds.), pp. 260–272, Heidelberg and Berlin, Germany: Springer, 2004.

[4] L. Jost, "Entropy and diversity," *OIKOS*, vol. 113, no. 2, pp. 363–375, 2006.

[5] R. H. MacArthur, "Patterns of species diversity," *Biological Reviews*, vol. 40, no. 4, pp. 510–533, 1965.

KONE FOUNDATION

MH has been supported by the Kone Foundation. OK has been supported by the Osk. Huttunen Foundation. Poster template by Gerlinde Kettl and Matthias Weiser (www.LaTeXTemplates.com), published under CC BY-NC-SA 3.0.