IM3

INTEGRATED MULTISECTOR MULTISCALE MODELING

Strategic Systematic Review and Exploration of the Research Area of MultiSector Dynamics using Natural Language Processing, Graph Machine Learning, and Large Language Models

Chris R. Vernon and Patrick M. Reed

on behalf of the MSD CoP facilitation team

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Baylor University | Boston University | Cornell University

NC State University | The University of North Carolina at Chapel Hill | UC Davis University of California | PennState

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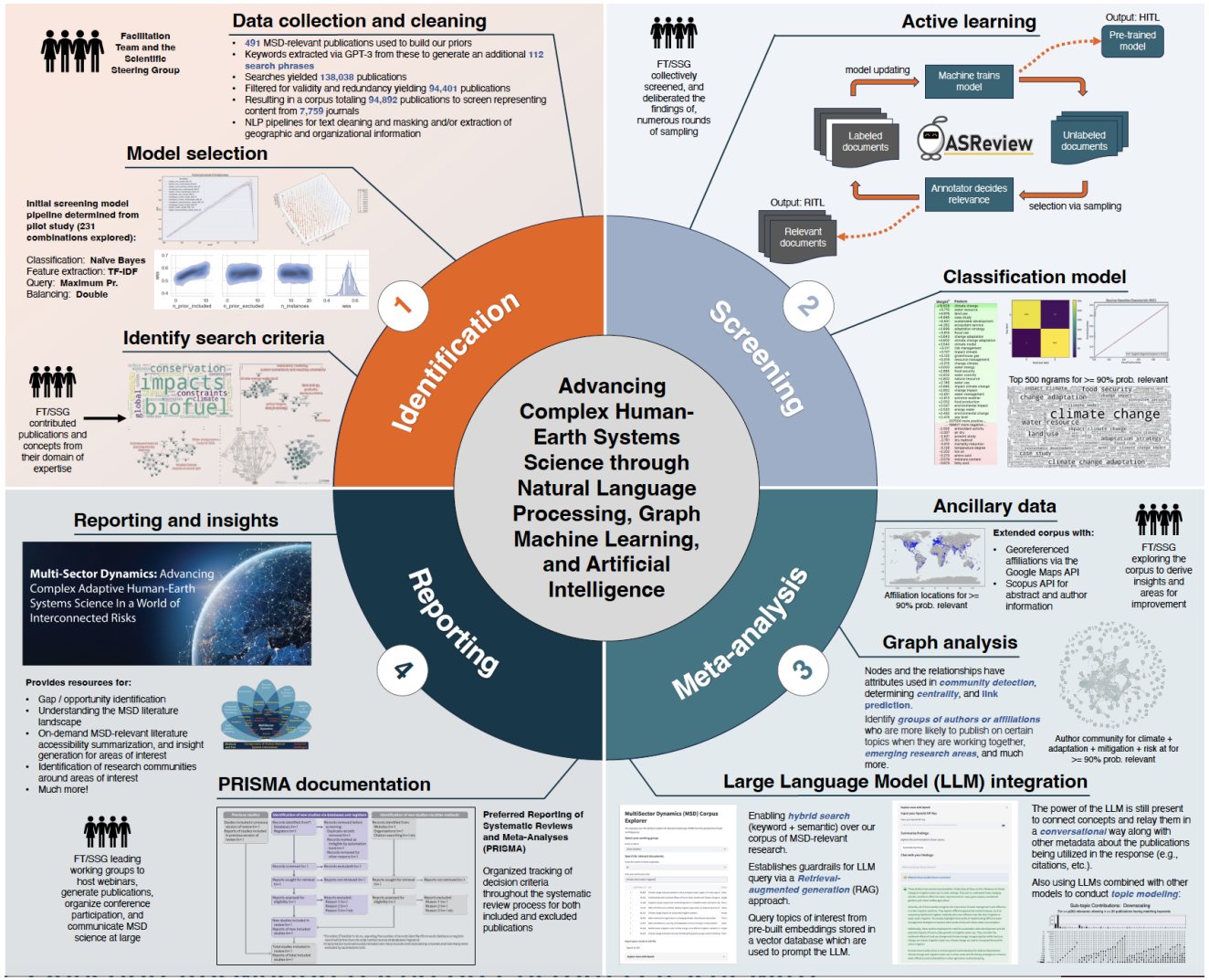
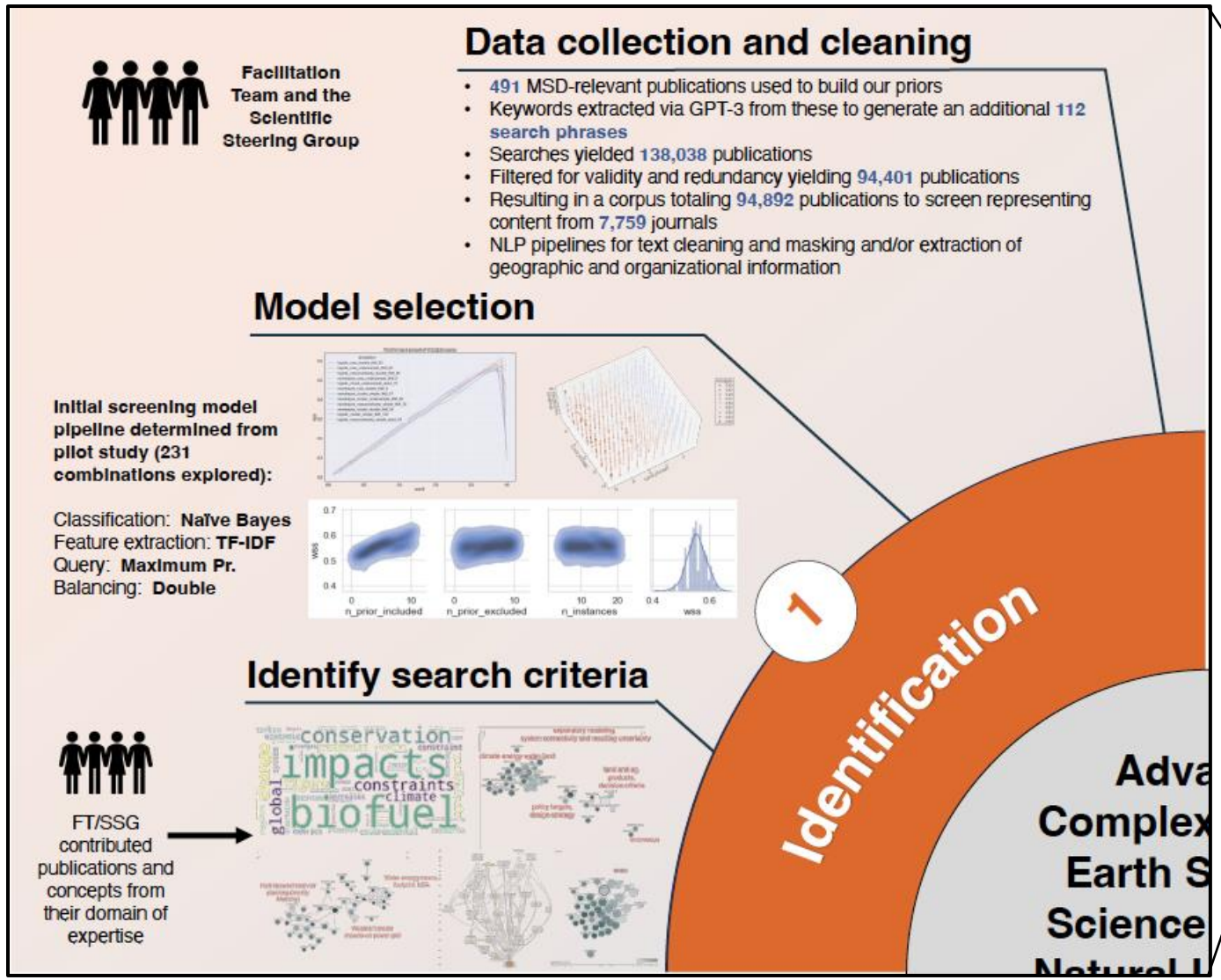
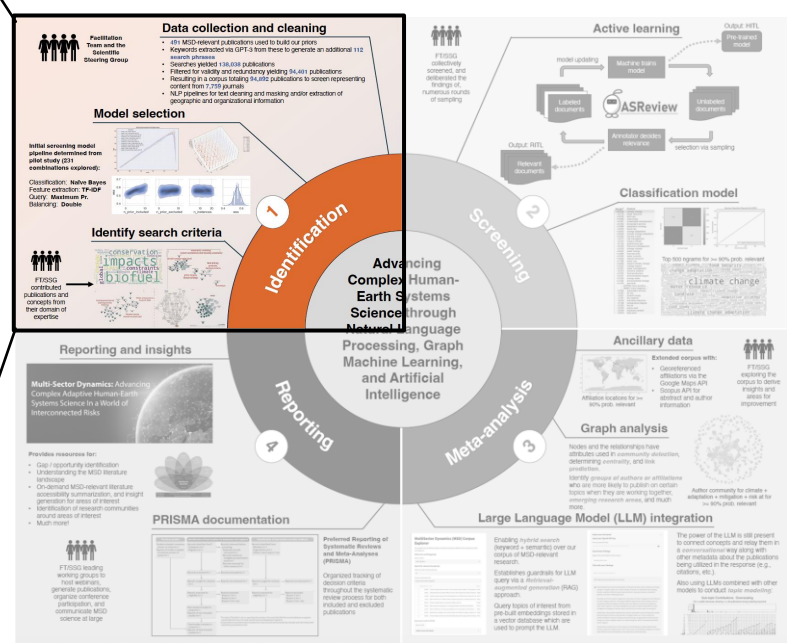
MSD-FUTURES: AI-ENABLED SYSTEMATIC REVIEW OF MSD

- Collaborative effort with our SSG and FT members
- **Fully transferable framework** using Large Language Model and Graph, and other ML innovations to understand the MSD literature landscape at large for **105,336** publications
- Identify gaps and opportunities for collaboration
- **MSD-FUTURES**: Foresights for Understanding Thematic Unity in Reviews of Emergent Science



MSD-FUTURES: AI-ENABLED SYSTEMATIC REVIEW OF MSD





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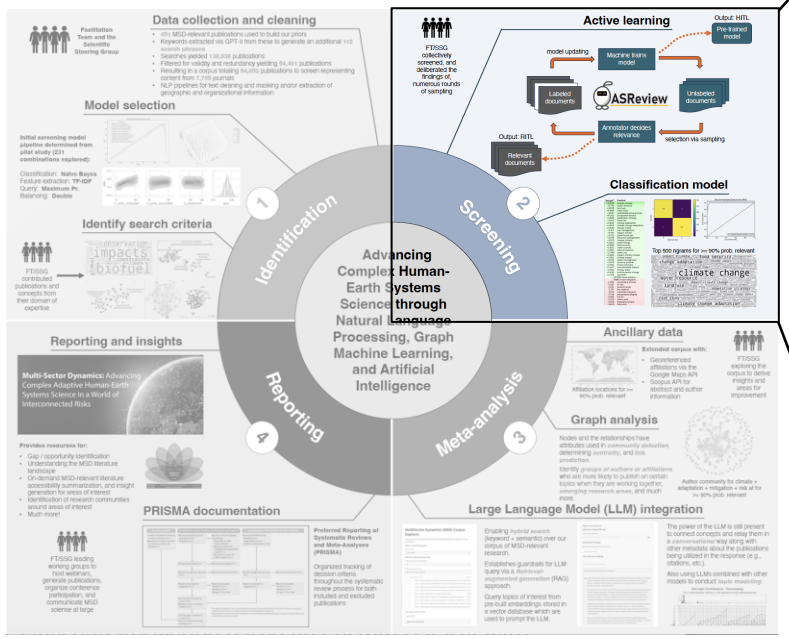
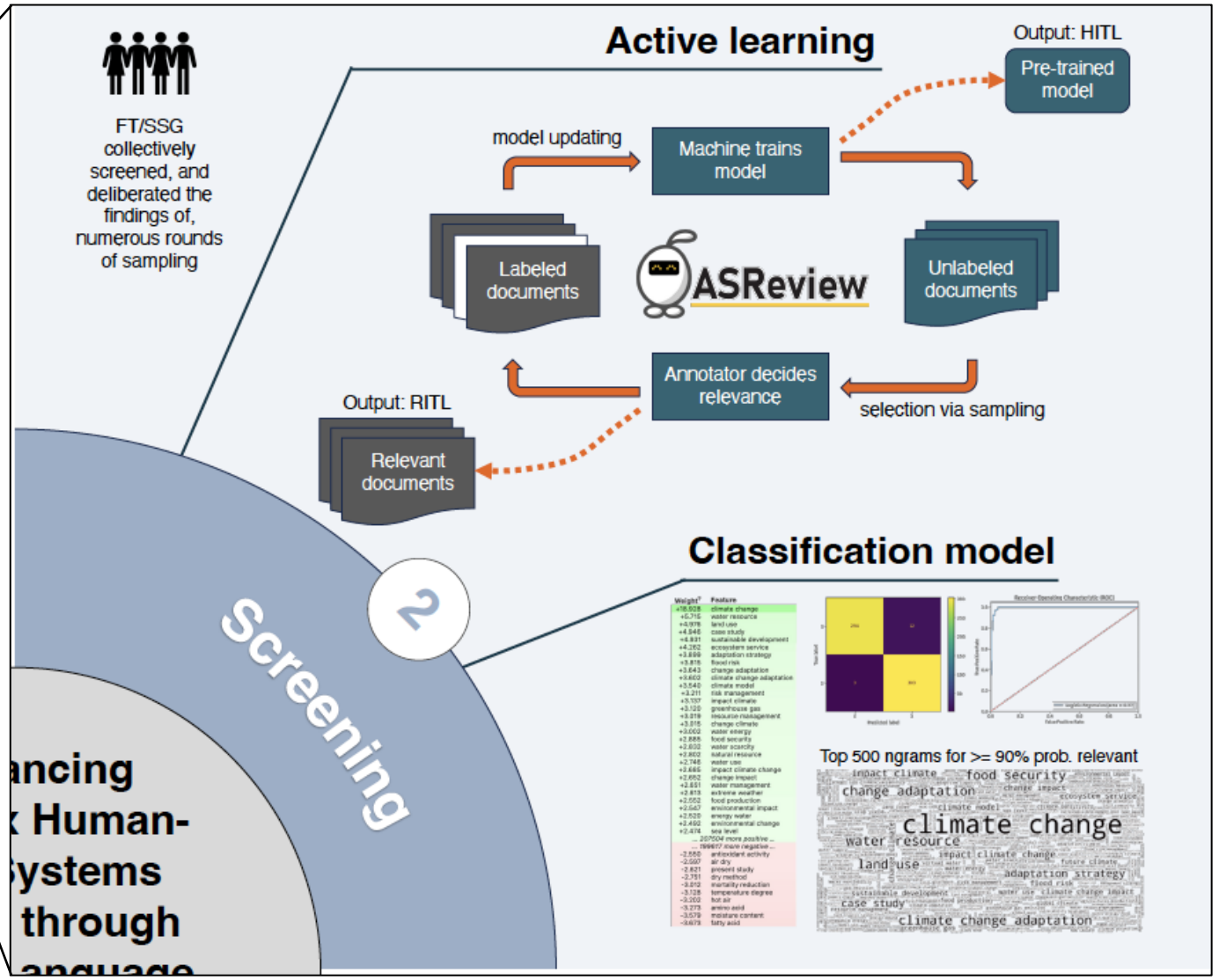
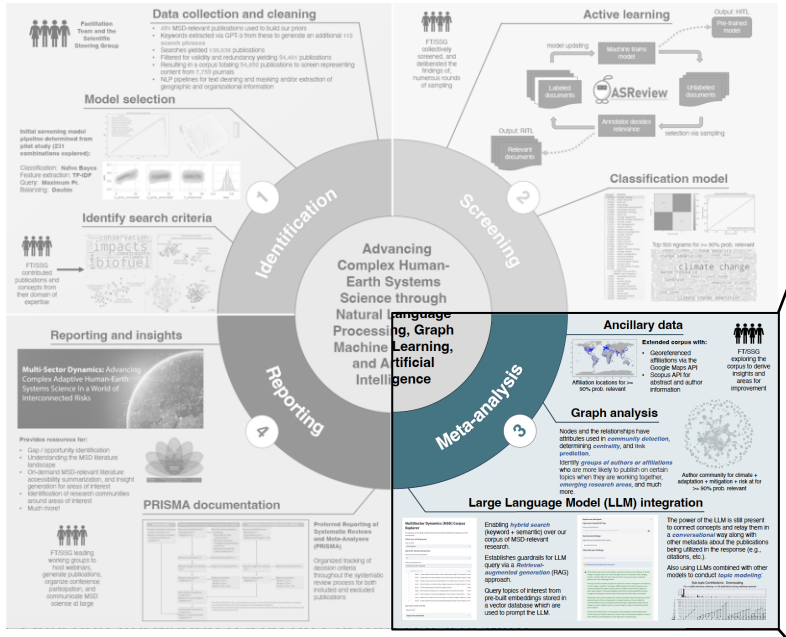
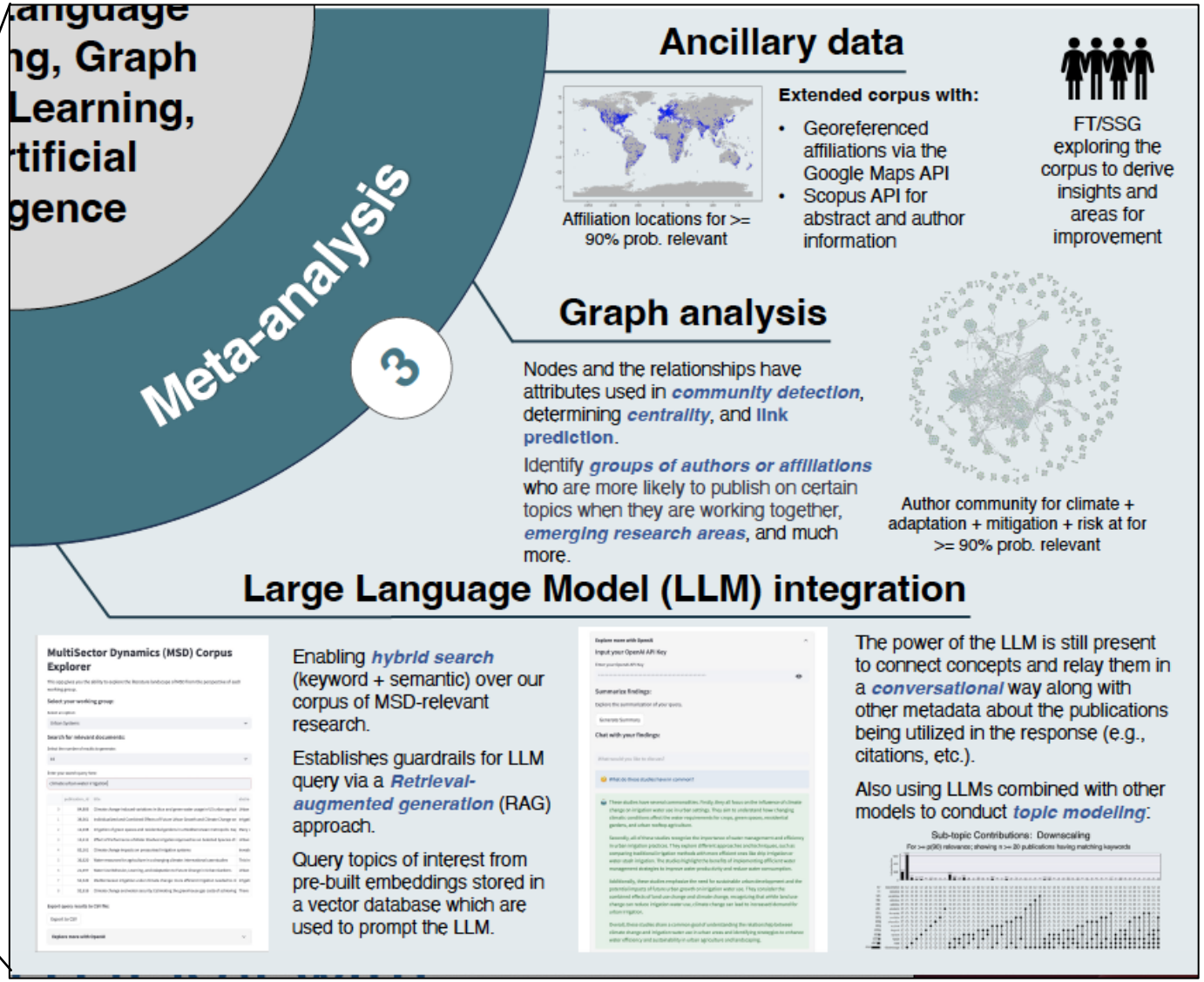




MSD-FUTURES: AI-ENABLED SYSTEMATIC REVIEW OF MSD





MSD-FUTURES: AI-ENABLED SYSTEMATIC REVIEW OF MSD

Reporting and insights

Multi-Sector Dynamics: Advancing Complex Adaptive Human-Earth Systems Science In a World of Interconnected Risks

Provides resources for:

- Gap / opportunity identification
- Understanding the MSD literature landscape
- On-demand MSD-relevant literature accessibility summarization, and insight generation for areas of interest
- Identification of research communities around areas of interest
- Much more!

FT/SSG leading working groups to host webinars, generate publications, organize conference participation, and communicate MSD science at large

Reporting

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Natural L
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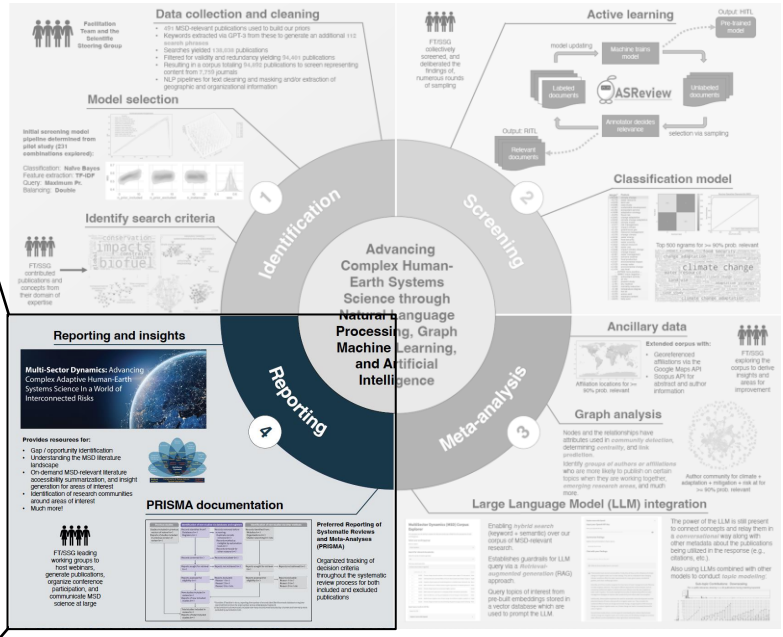
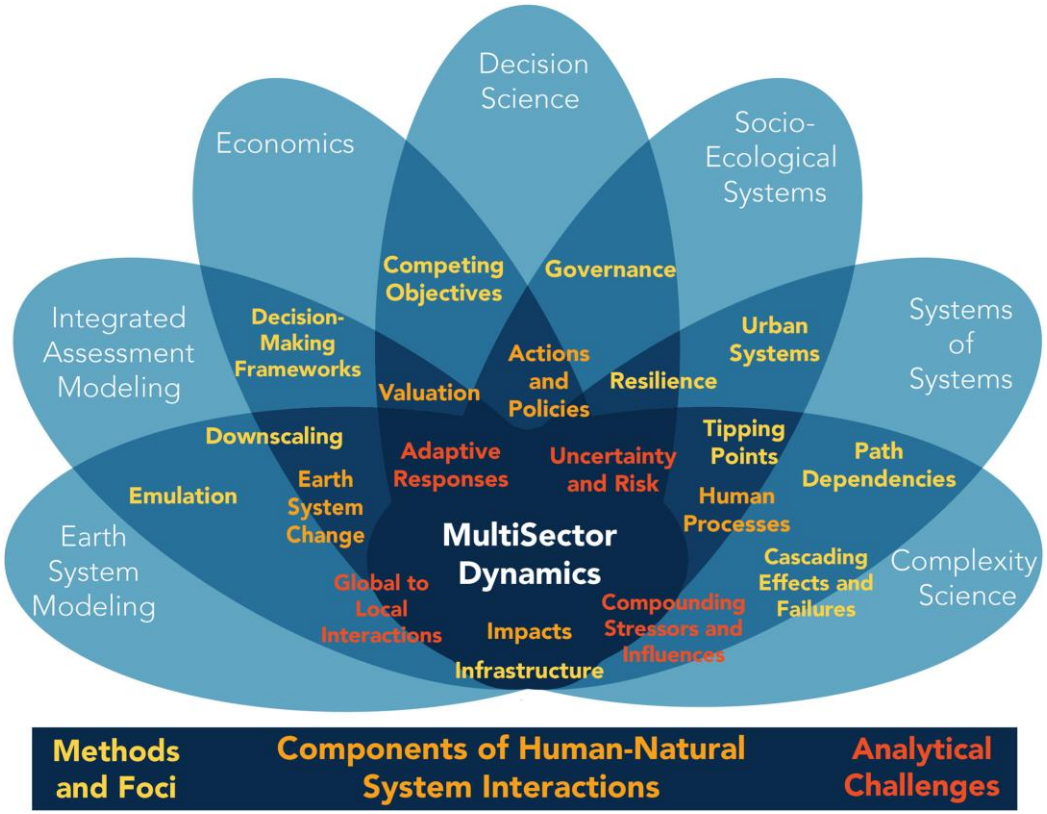
PRISMA documentation

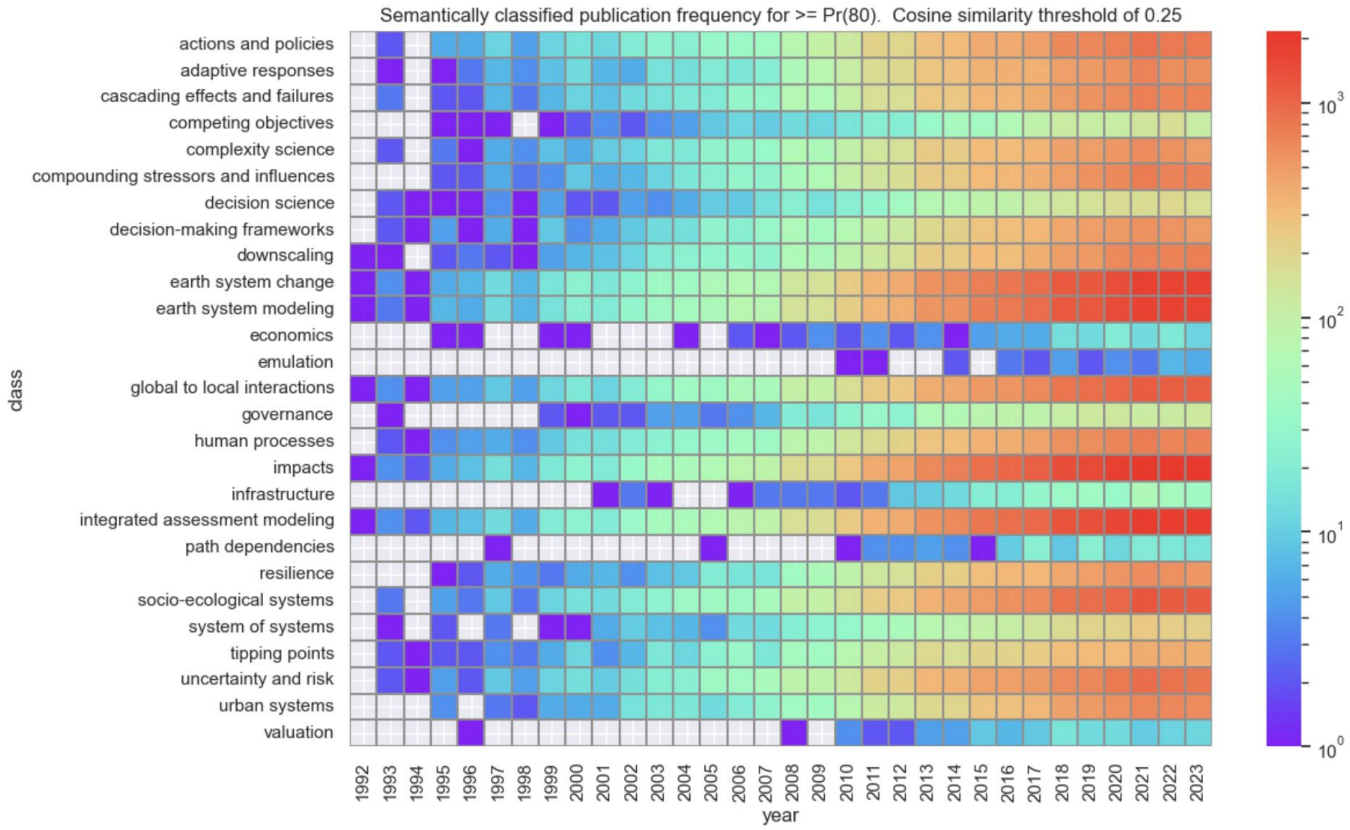
Preferred Reporting of Systematic Reviews and Meta-Analyses (PRISMA)

Organized tracking of decision criteria throughout the systematic review process for both included and excluded publications



FROM QUALITATIVE TO QUANTITATIVE

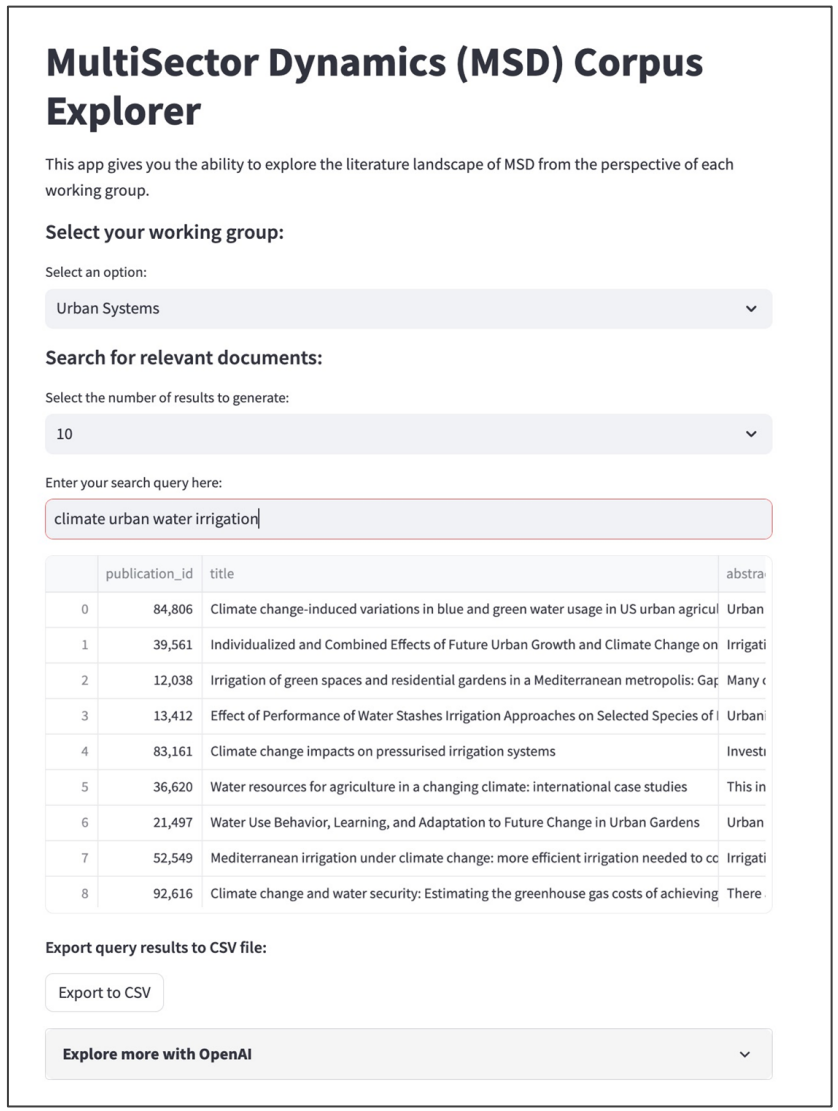




Reed et al., 2022, Earth's Future
https://doi.org/10.1029/2021EF002621

Shows raw count of publications per year per feather for P (X >= 80) under a higher similarity threshold; number of documents = 19031

LARGE LANGUAGE MODEL (LLM) INTEGRATION



MultiSector Dynamics (MSD) Corpus Explorer

This app gives you the ability to explore the literature landscape of MSD from the perspective of each working group.

Select your working group:

Select an option:

Urban Systems

Search for relevant documents:

Select the number of results to generate:

10

Enter your search query here:

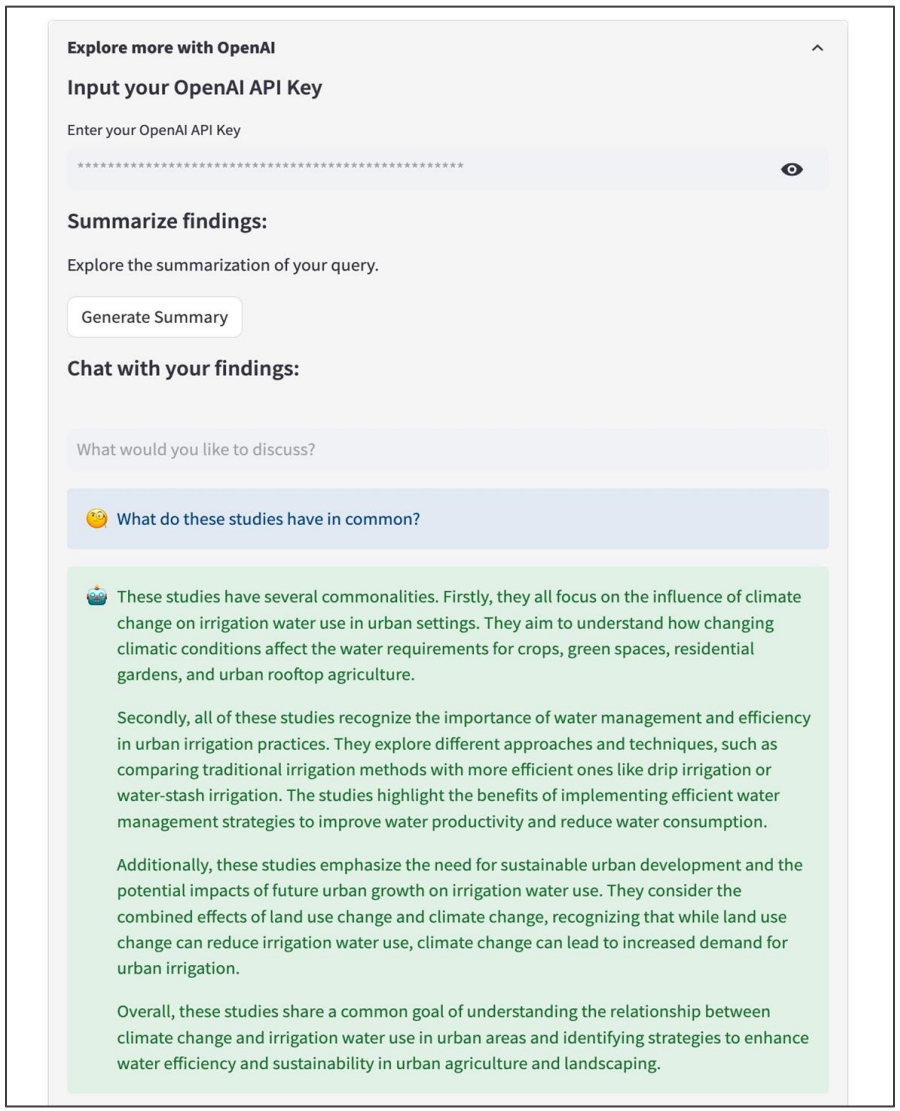
climate urban water irrigation

	publication_id	title	abstra
0	84,806	Climate change-induced variations in blue and green water usage in US urban agricul	Urban
1	39,561	Individualized and Combined Effects of Future Urban Growth and Climate Change on	Irrigati
2	12,038	Irrigation of green spaces and residential gardens in a Mediterranean metropolis: Gap	Many
3	13,412	Effect of Performance of Water Stashes Irrigation Approaches on Selected Species of	Urban
4	83,161	Climate change impacts on pressurised irrigation systems	Investi
5	36,620	Water resources for agriculture in a changing climate: international case studies	This in
6	21,497	Water Use Behavior, Learning, and Adaptation to Future Change in Urban Gardens	Urban
7	52,549	Mediterranean irrigation under climate change: more efficient irrigation needed to cc	Irrigati
8	92,616	Climate change and water security: Estimating the greenhouse gas costs of achieving	There

Export query results to CSV file:

Export to CSV

Explore more with OpenAI



Explore more with OpenAI

Input your OpenAI API Key

Enter your OpenAI API Key

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Summarize findings:

Explore the summarization of your query.

Generate Summary

Chat with your findings:

What would you like to discuss?

What do these studies have in common?

These studies have several commonalities. Firstly, they all focus on the influence of climate change on irrigation water use in urban settings. They aim to understand how changing climatic conditions affect the water requirements for crops, green spaces, residential gardens, and urban rooftop agriculture.

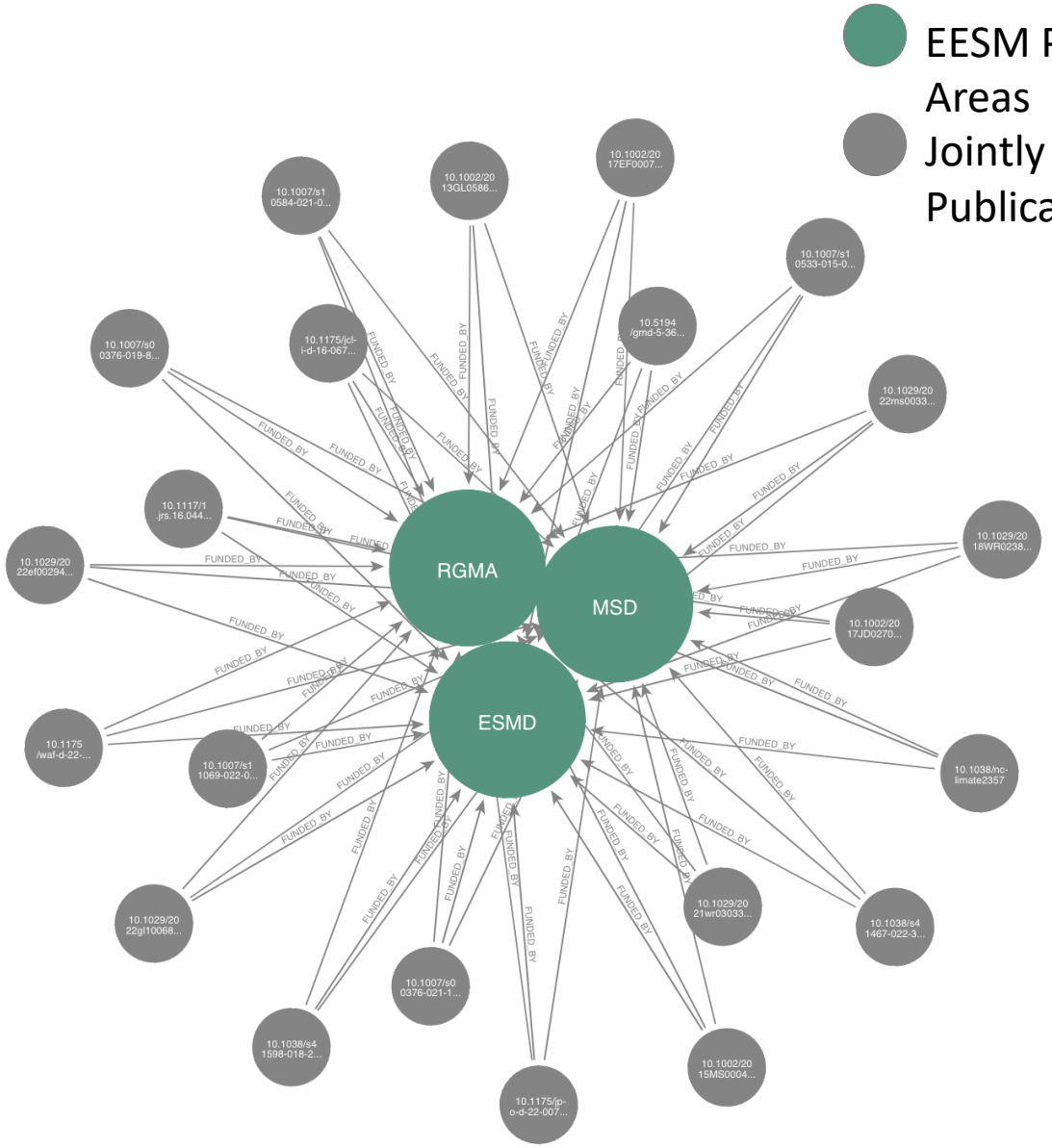
Secondly, all of these studies recognize the importance of water management and efficiency in urban irrigation practices. They explore different approaches and techniques, such as comparing traditional irrigation methods with more efficient ones like drip irrigation or water-stash irrigation. The studies highlight the benefits of implementing efficient water management strategies to improve water productivity and reduce water consumption.

Additionally, these studies emphasize the need for sustainable urban development and the potential impacts of future urban growth on irrigation water use. They consider the combined effects of land use change and climate change, recognizing that while land use change can reduce irrigation water use, climate change can lead to increased demand for urban irrigation.

Overall, these studies share a common goal of understanding the relationship between climate change and irrigation water use in urban areas and identifying strategies to enhance water efficiency and sustainability in urban agriculture and landscaping.

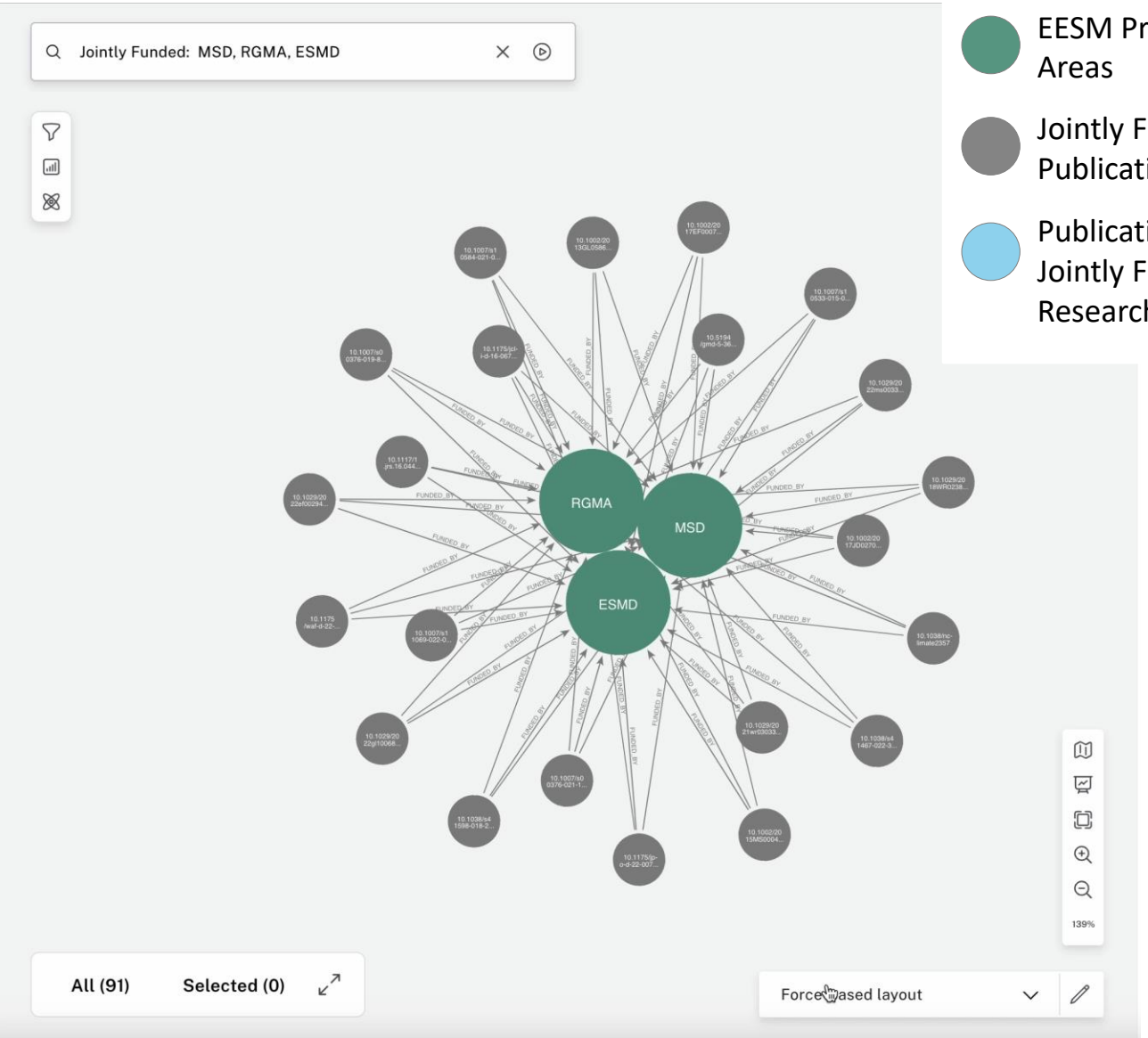
ILLUSTRATIVE EXAMPLE: EXTENDING METHODS TO EESM AT LARGE

- Scraped the EESM publications website for all journal articles listed as funded under MSD, RGMA, or ESMD
- Produced 2,243 journal articles
- Of which, 22 were co-funded by all three program areas
- Let's talk about these for a few minutes…



Data Source: https://climatemodeling.science.energy.gov/publications

A SNAPSHOT OF IMPACT WHEN EESM JOINTLY FUNDED



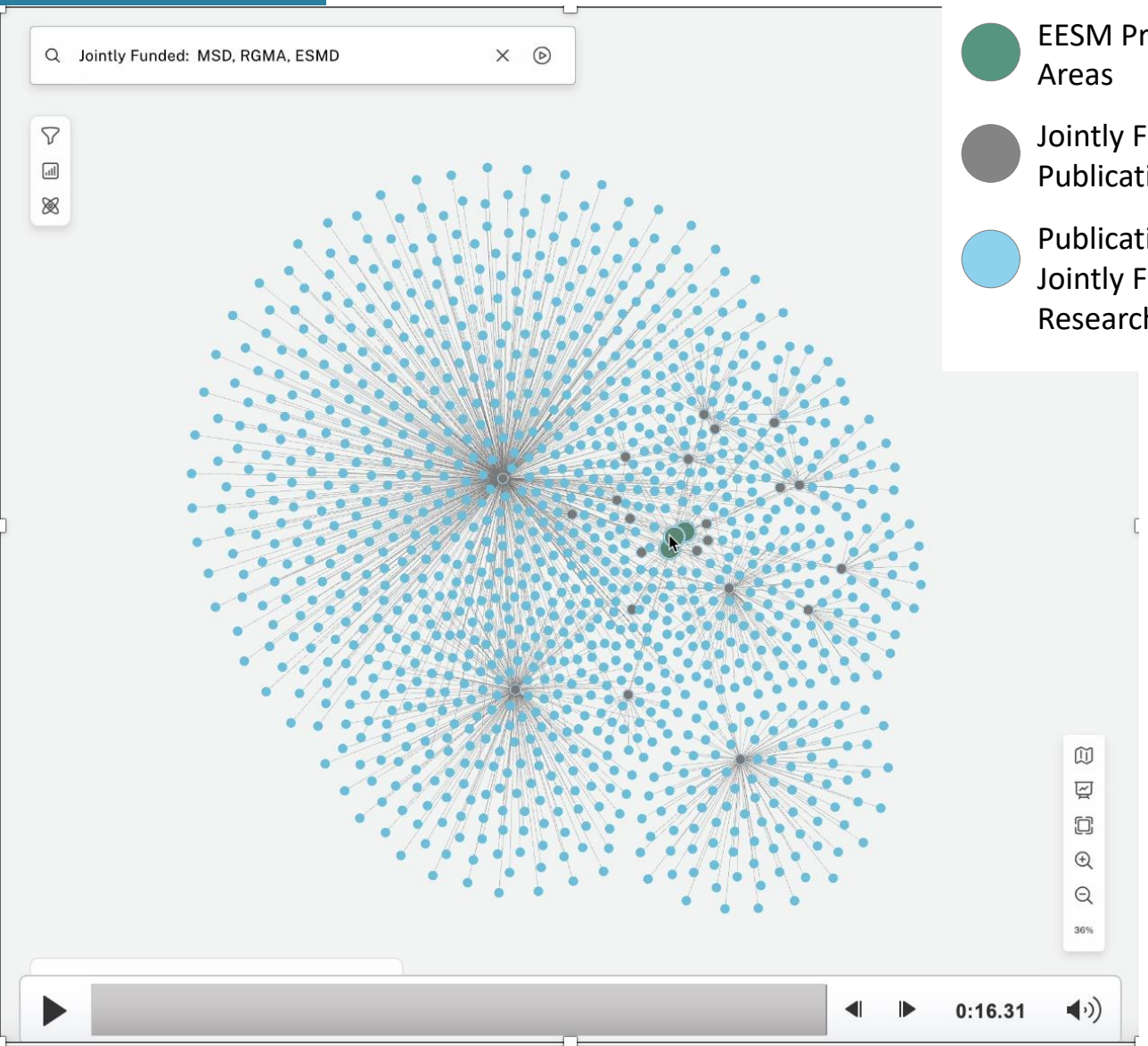
EESM Program Areas

Jointly Funded Publications

Publication Citing Jointly Funded Research

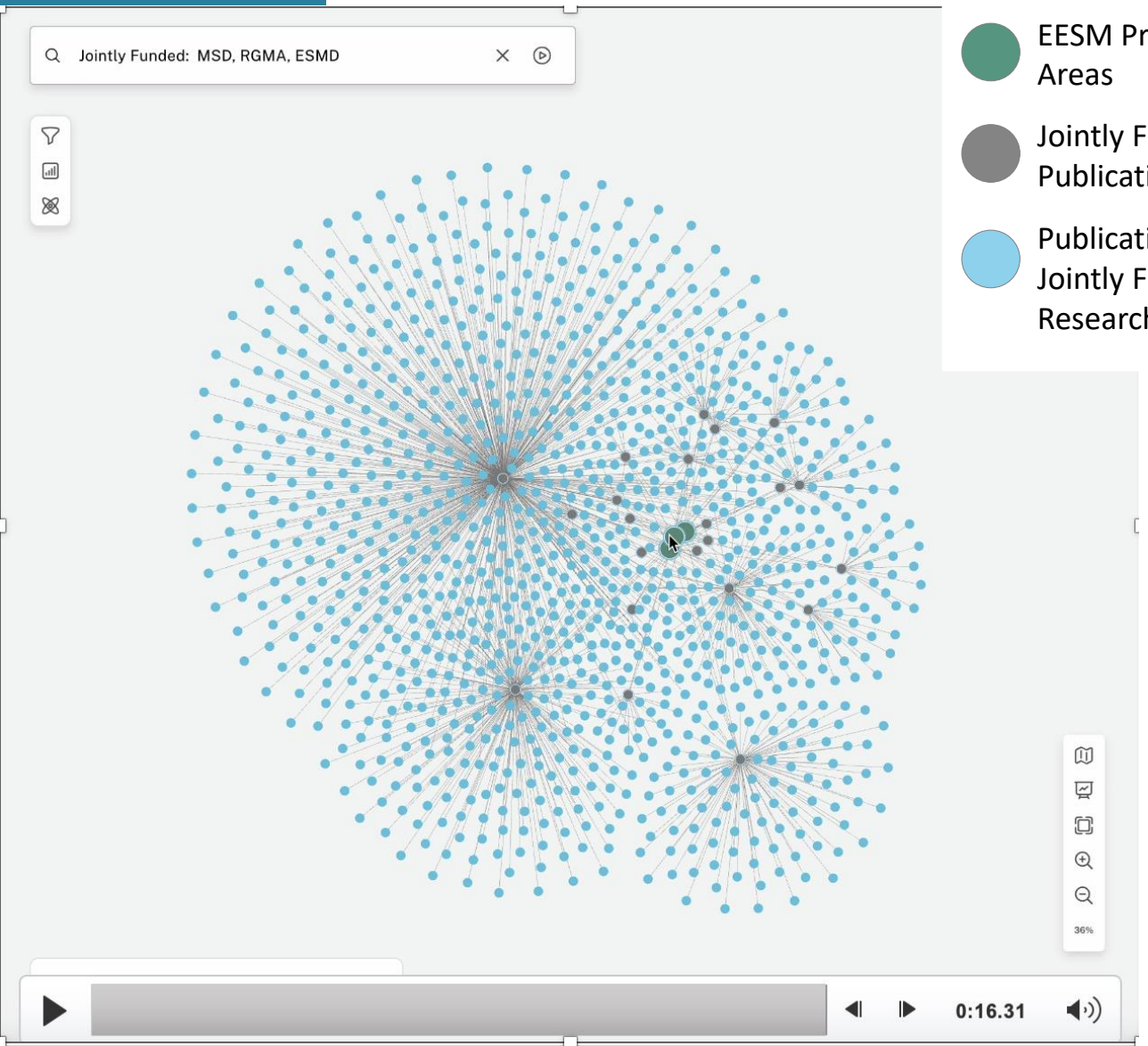
- The 22 jointly funded publications by all three program areas were cited 1,120 times

A SNAPSHOT OF IMPACT WHEN EESM JOINTLY FUNDED

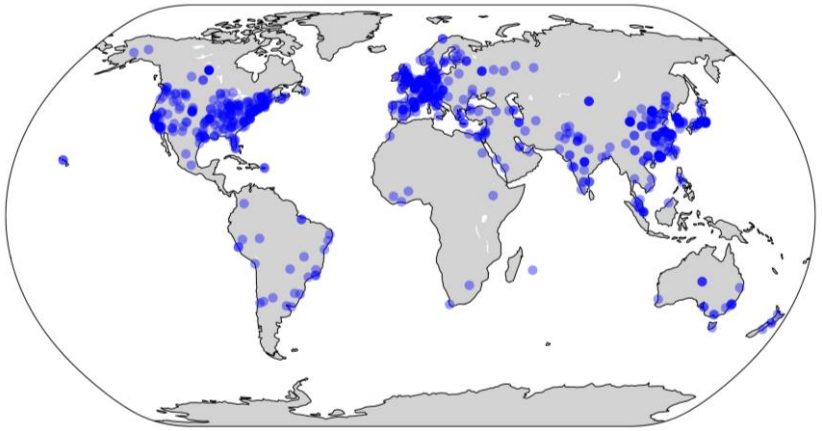


- The 22 jointly funded publications by all three program areas were cited 1,120 times
- Only 62 citations were from other EESM funded research – leaving an external impact of 1,058 citations

A SNAPSHOT OF IMPACT WHEN EESM JOINTLY FUNDED

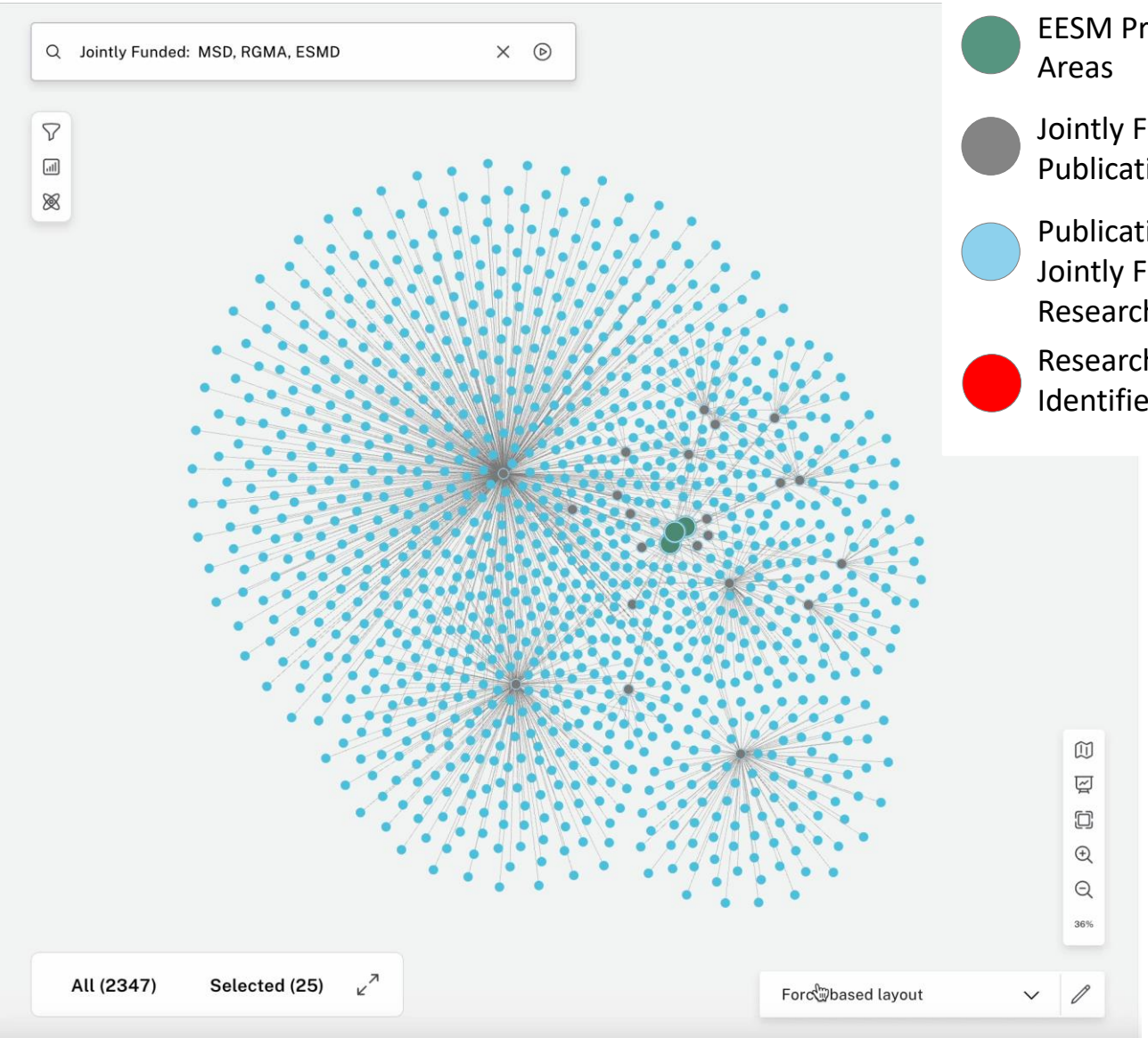


- The 22 jointly funded publications by all three program areas were cited 1,120 times
- Only 62 citations were from other EESM funded research – leaving an external impact of 1,058 citations
- Citations included 801 unique author affiliations that were globally distributed



Blue markers: geocoded affiliation locations

RESEARCH THEMES FOR THOSE CITING EESM JOINTLY FUNDED PUBLICATIONS



EESM Program Areas

Jointly Funded Publications

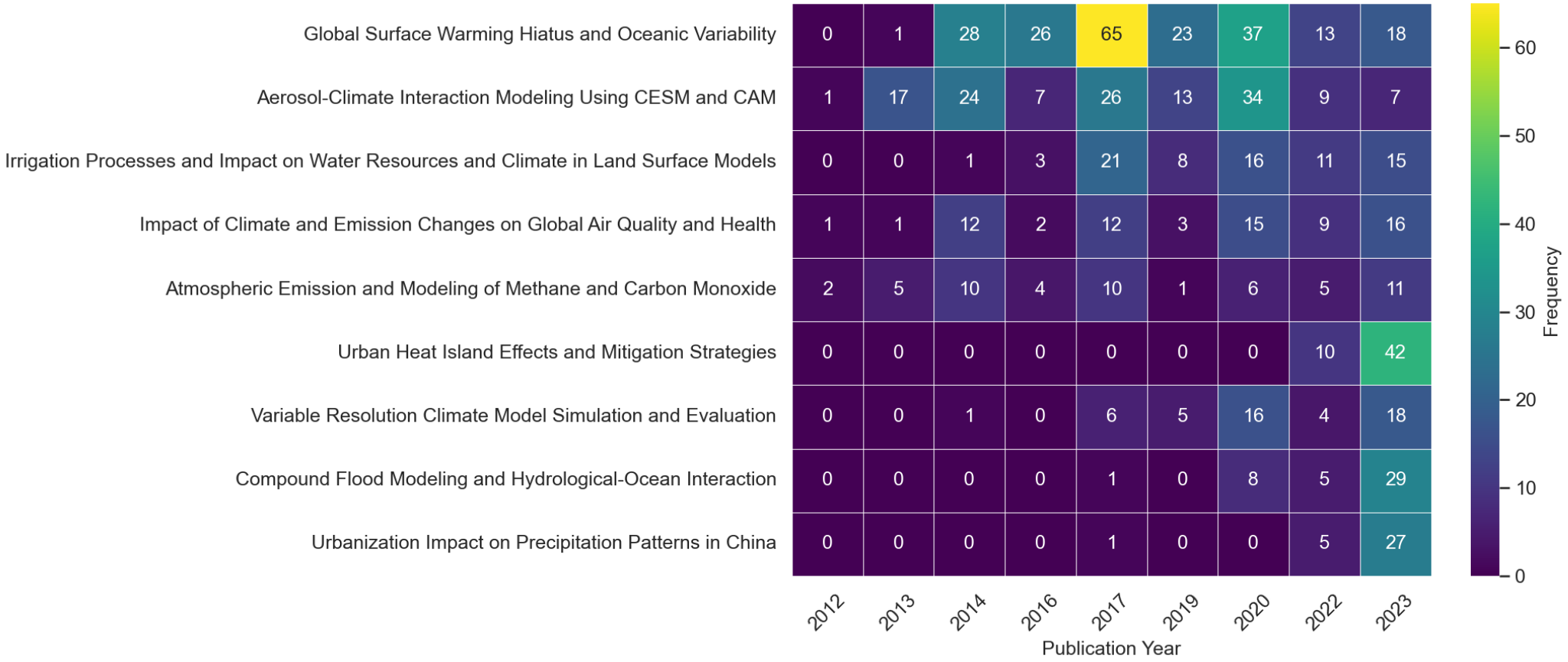
Publication Citing Jointly Funded Research

Research Theme Identified

- When we are jointly funded, which research communities are we impacting?
- Topic modeling (unsupervised) using the same semantically rich embedding model that ChatGPT uses to extract knowledge
- Seeks out common themes in research
- Generated 18 research themes, each having at least 10 publications to identify as a theme
- Let's look at the top 9 themes…

RESEARCH THEMES FOR THOSE CITING EESM JOINTLY FUNDED PUBLICATIONS

We can look at the number of publications cited in each research theme over time to look at emergent and diminished themes

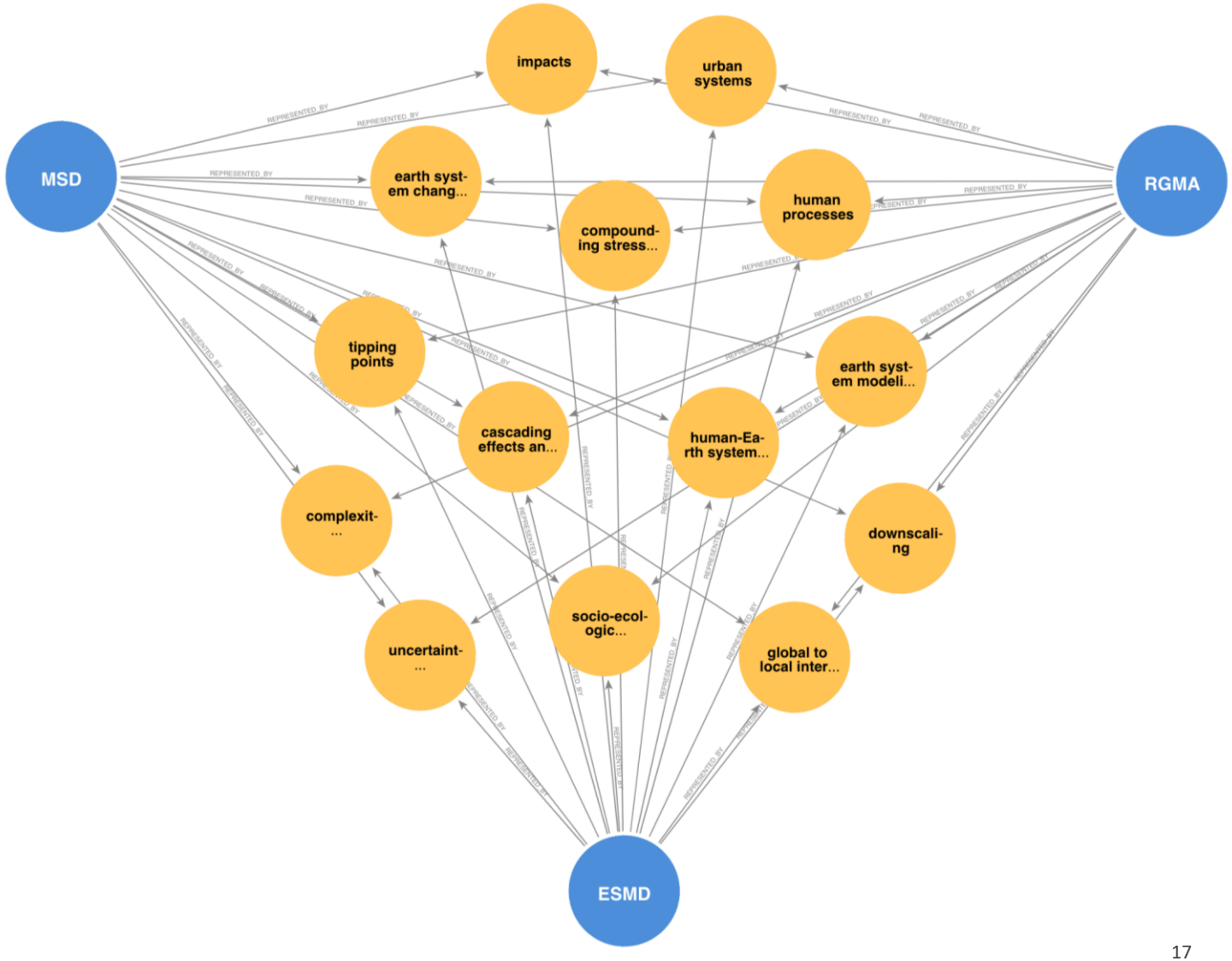


COMMUNITY DETECTION TO IDENTIFY OPPORTUNITIES

- Explore the communities of researchers, institutions, program areas, etc. that are highly related to each other and various research areas

- Helps **identify groups of researchers who could potentially conduct research together** very easily – these groups may be completely unaware of each other

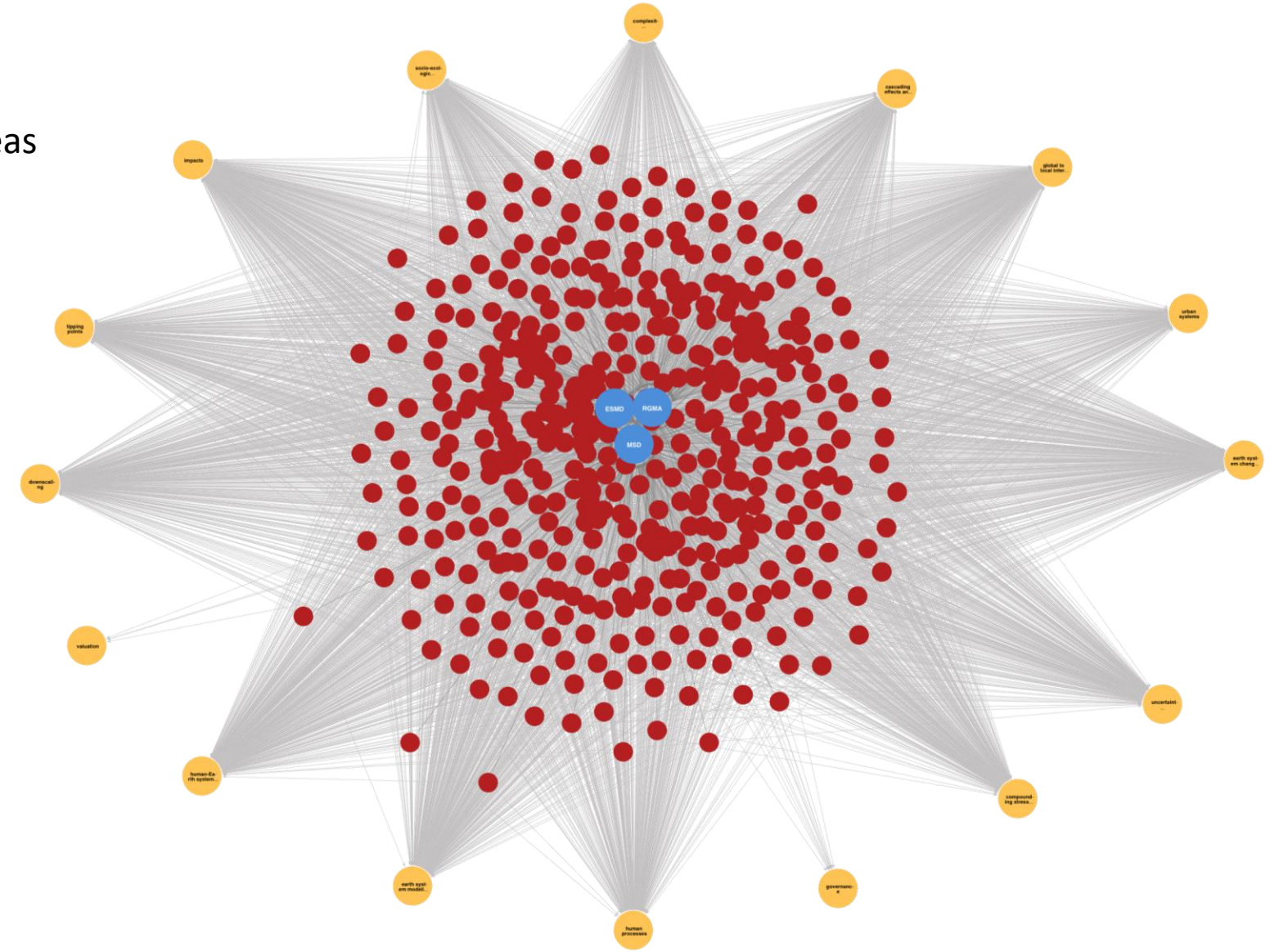
- Used to predict emerging research topics and potential growth patterns within MSD at large



Snapshot of MSD, RGMA, and ESMD funded intersecting research areas from the MSD corpus

COMMUNITY ANALYSIS

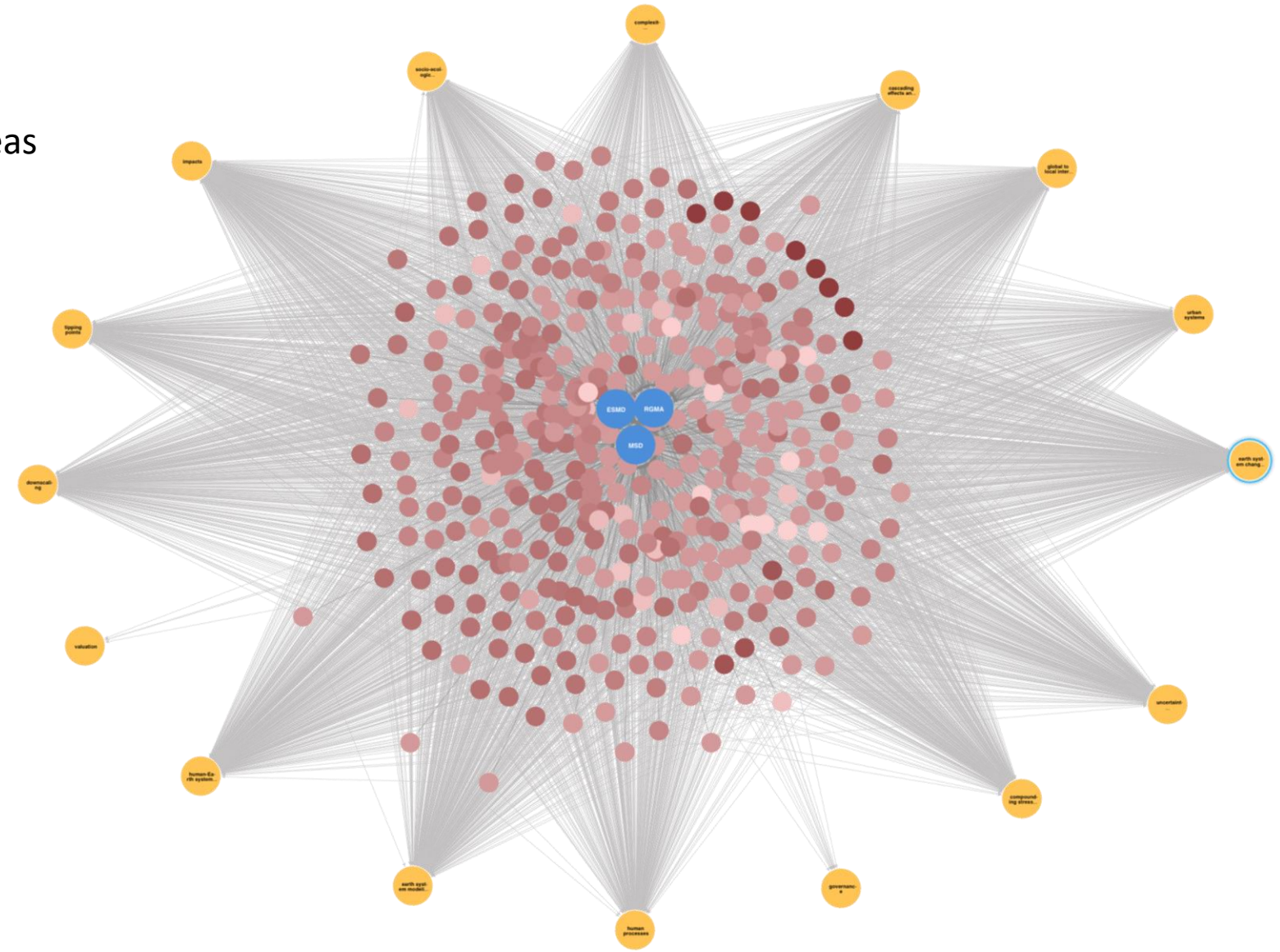
- EESM Program Areas
- Research Areas
- Authors



Preliminary Results – Snapshot of EESM funded research – P(X >= 80) to MSD

COMMUNITY ANALYSIS

- EESM Program Areas
- Research Areas
- Authors

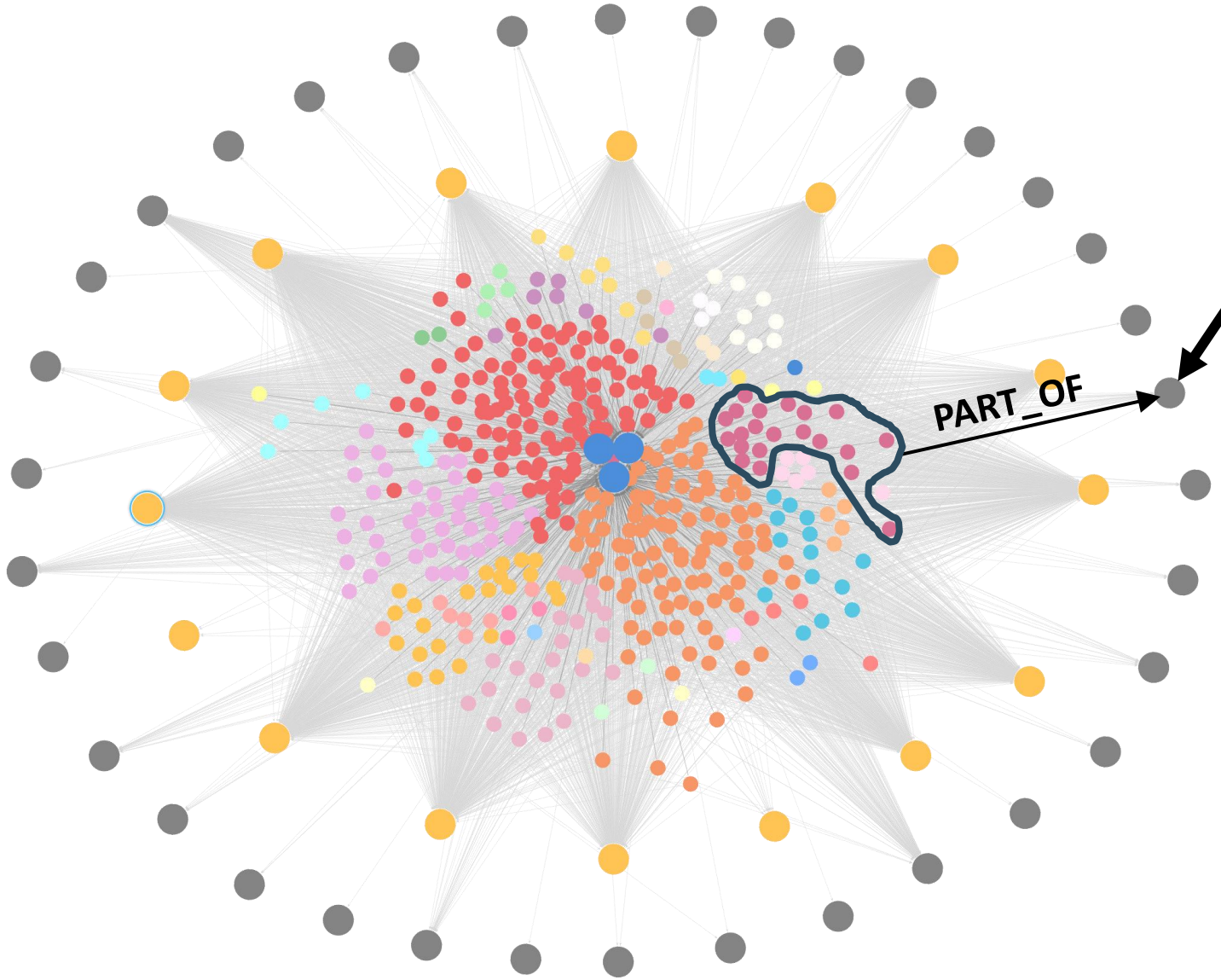


Moving from single authors to communities of authors by existing collaboration and like research

Preliminary Results – Snapshot of EESM funded research – P(X >= 80) to MSD

COMMUNITY ANALYSIS

- EESM Program Areas
- Research Areas
- Community Nodes
- Authors in Communities

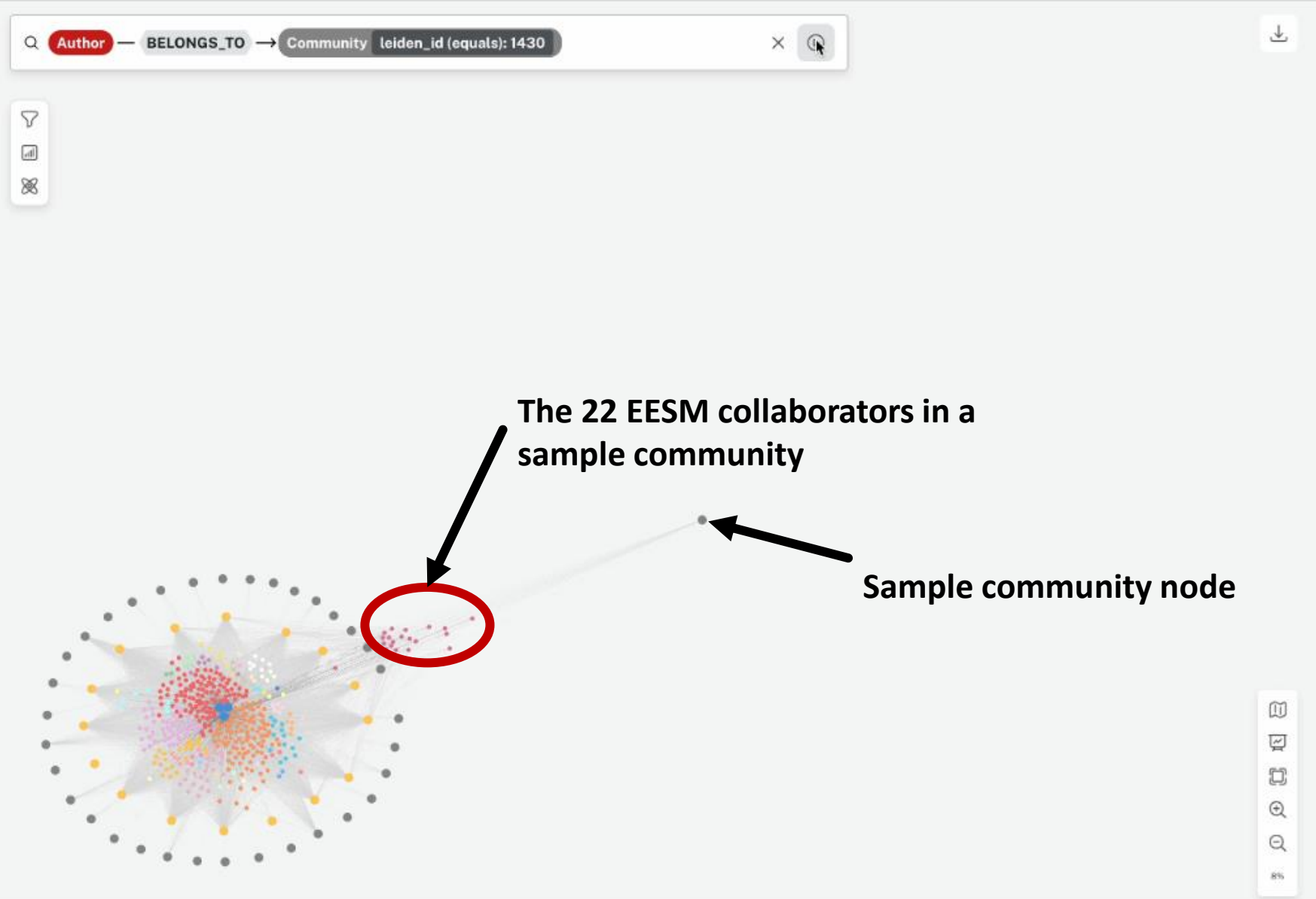


Sample community

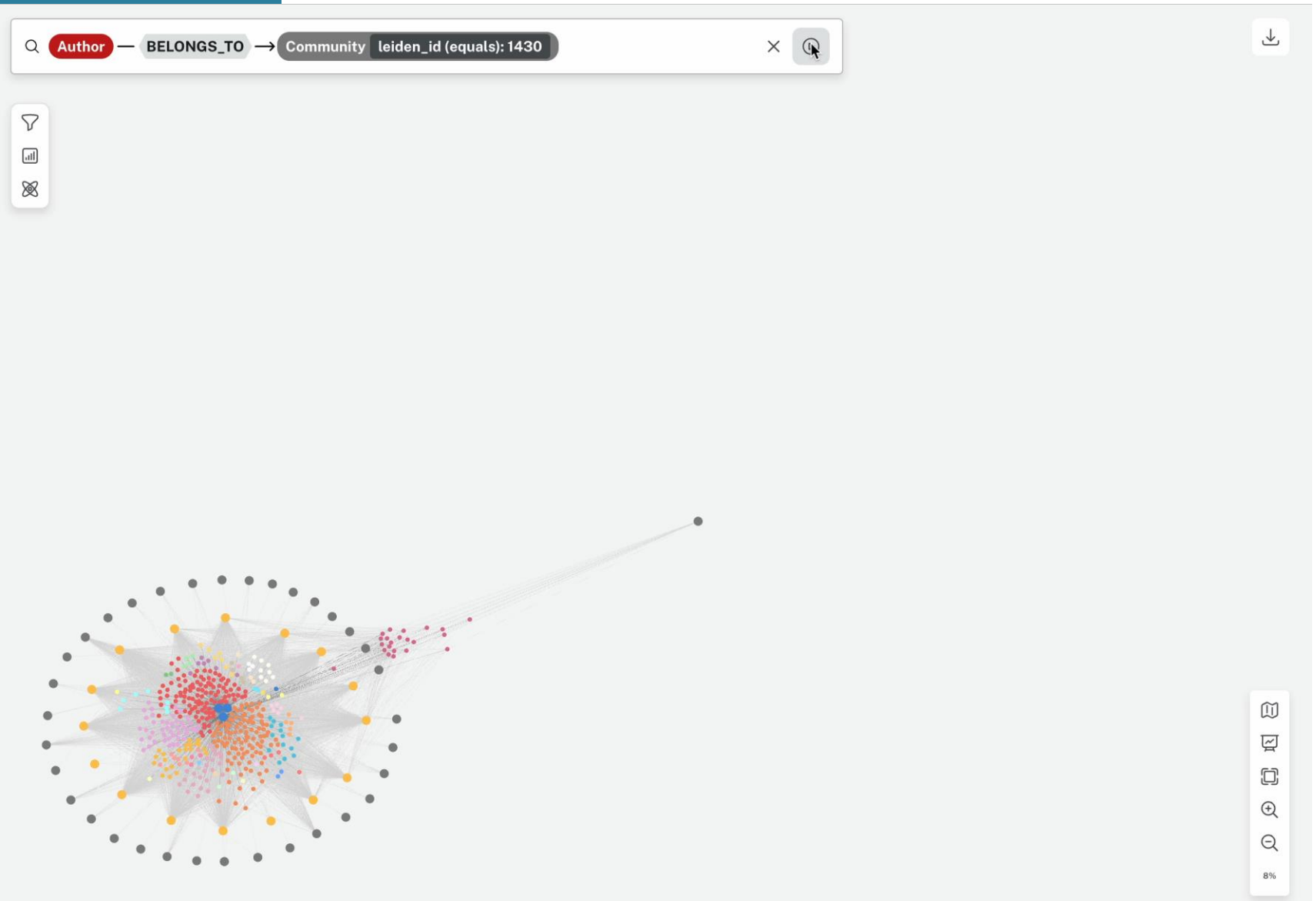
EESM funded author count: 22

Preliminary Results – Snapshot of EESM funded research – P(X >= 80) to MSD

COMMUNITY ANALYSIS



UNTAPPED POTENTIAL



- **Quickly identify untapped potential** in our existing author communities! Can also do this for institutions, geographic areas (varying scale), topics within communities, and much more through time!
- Explore aligned / parallel research activities within, and outside of, BER to avoid redundancy and promote **informed collaboration**
- To be published in new Earth's Future Special Issue as an MSD CoP collaborative contribution

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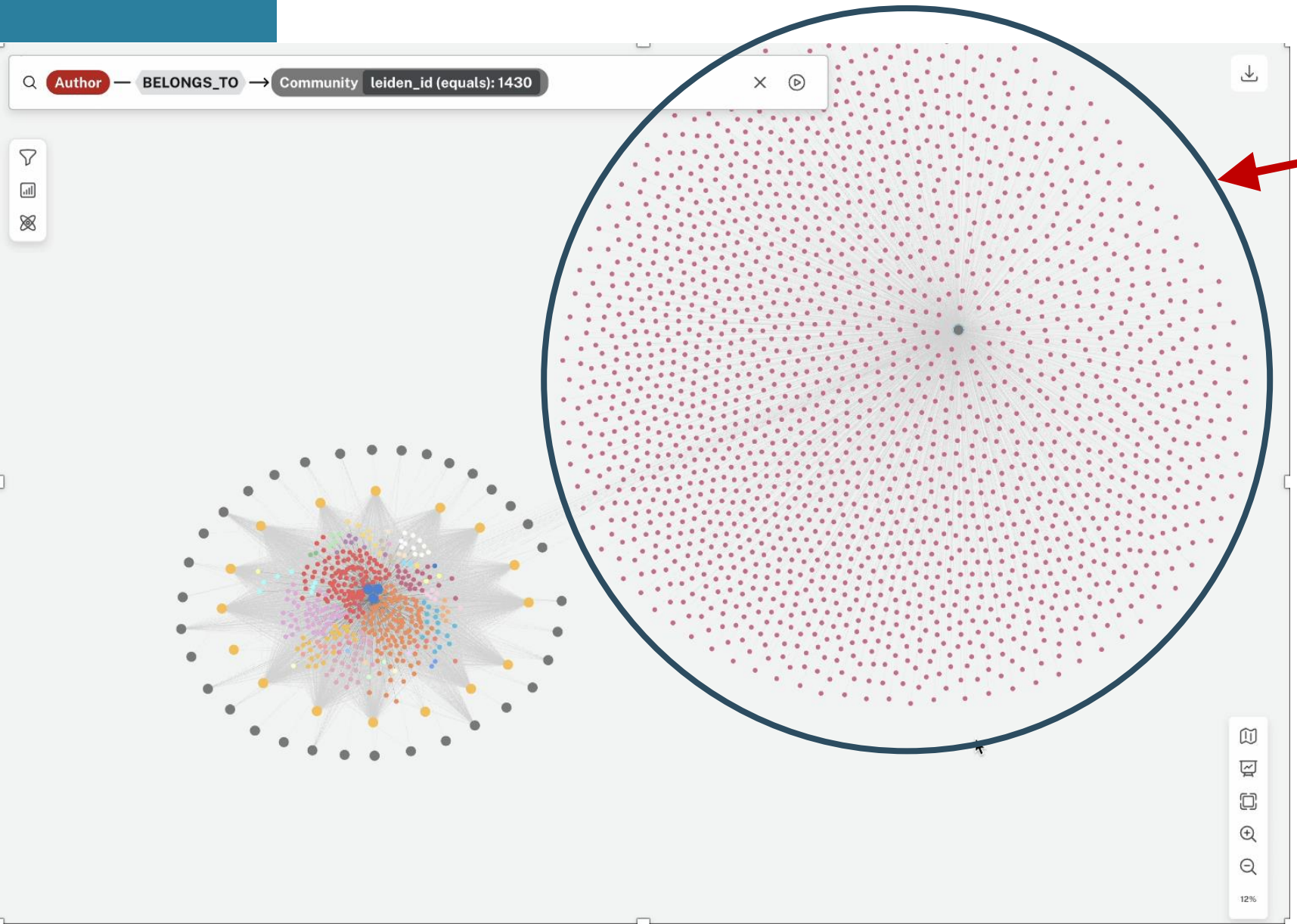

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THANKS!