cascades

Cascading climate risks:
Towards adaptive and
resilient European Societies

Archetypes of cascading climate change impacts

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Aim

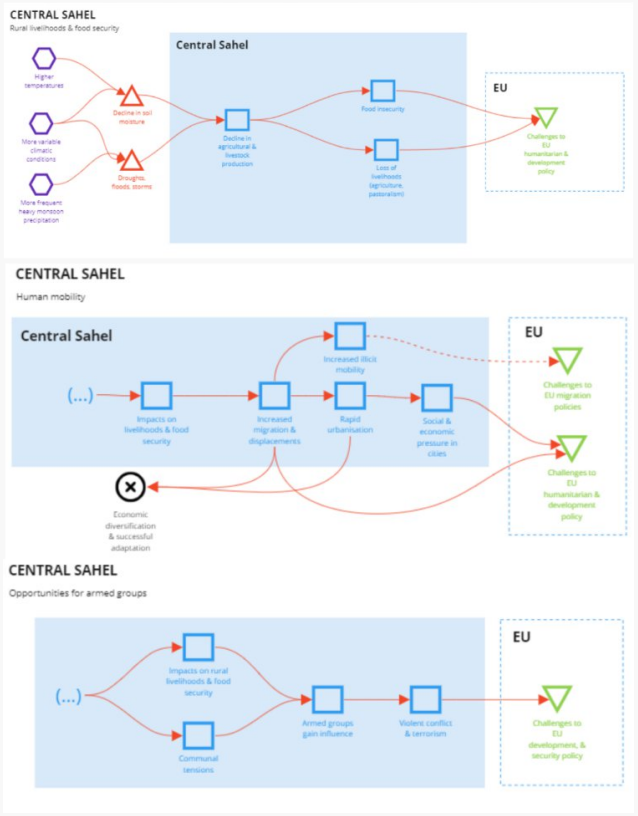
- Network model synthesizing results of CASCADES project
- Integrate indirect effects, i.e. cascades of interacting systems
- Identify leverage points for policy

Leverage point = most influential nodes to trigger cascading impacts

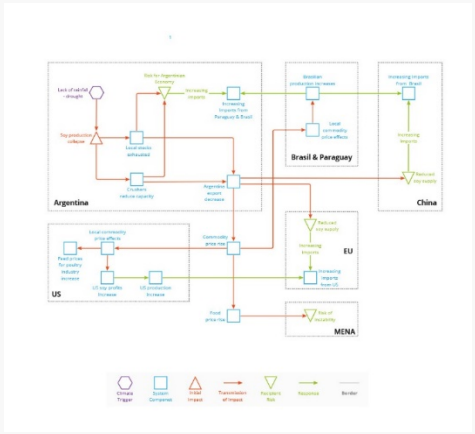
Approach

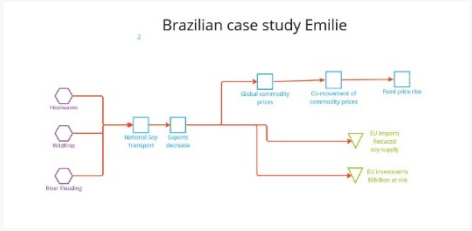
- Extract archetype of cascades provided from CASCADES partners Ⓟ Use frequent subgraph analysis
- Analyze archetype with inverse PageRank algorithm to identify leverage points
- Conduct PageRank on national data and identify most important systems in countries
- Cluster regions of similar dynamics with K-Means

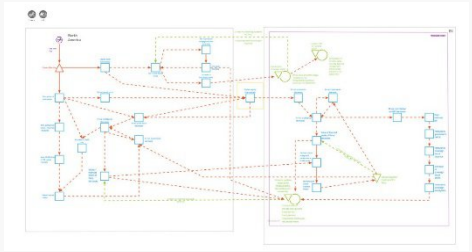
Archetype extraction – Input diagrams



Conceptual framework of diagrams by Carter et al.





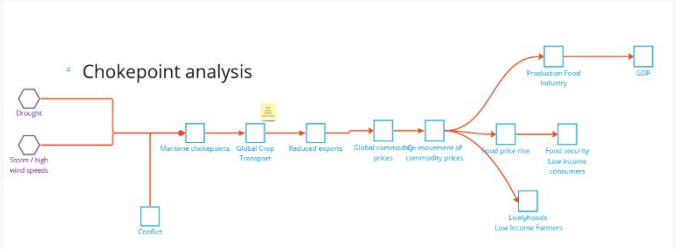


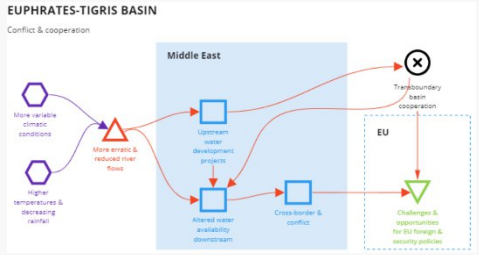
Potential impact cascades from areas

- à Foreign policy, human security, & development
- à International value & supply chains
- à Finance

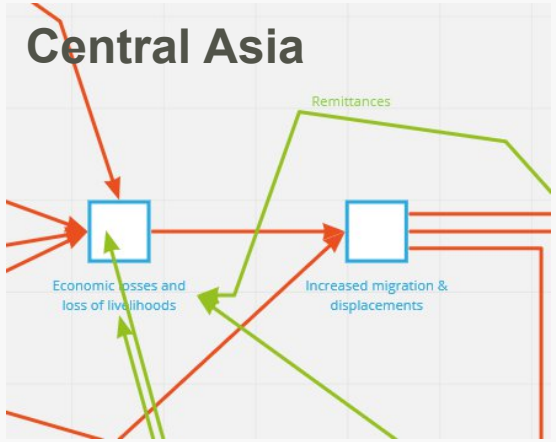
Based on:

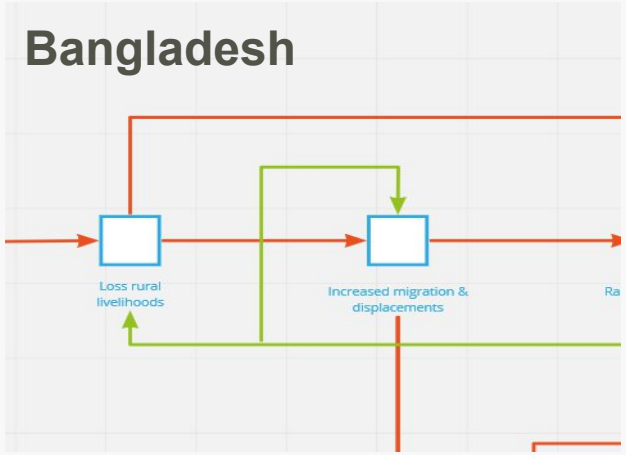
- 4-year long stakeholder interaction
- Model results from Cascades partners
- Desk-based research

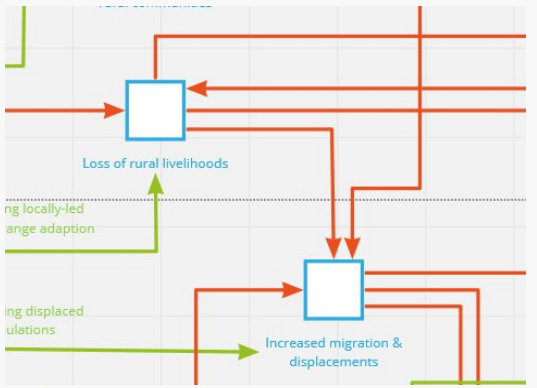


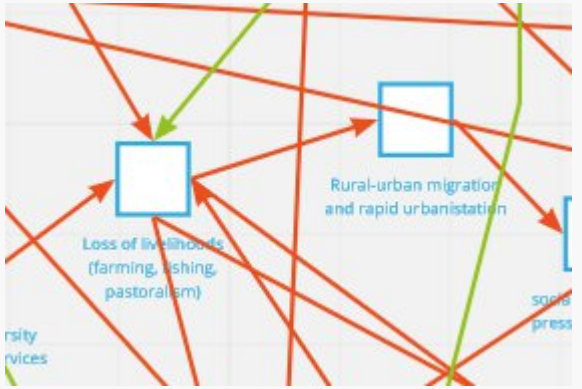


Archetype extraction – Input by workpackages









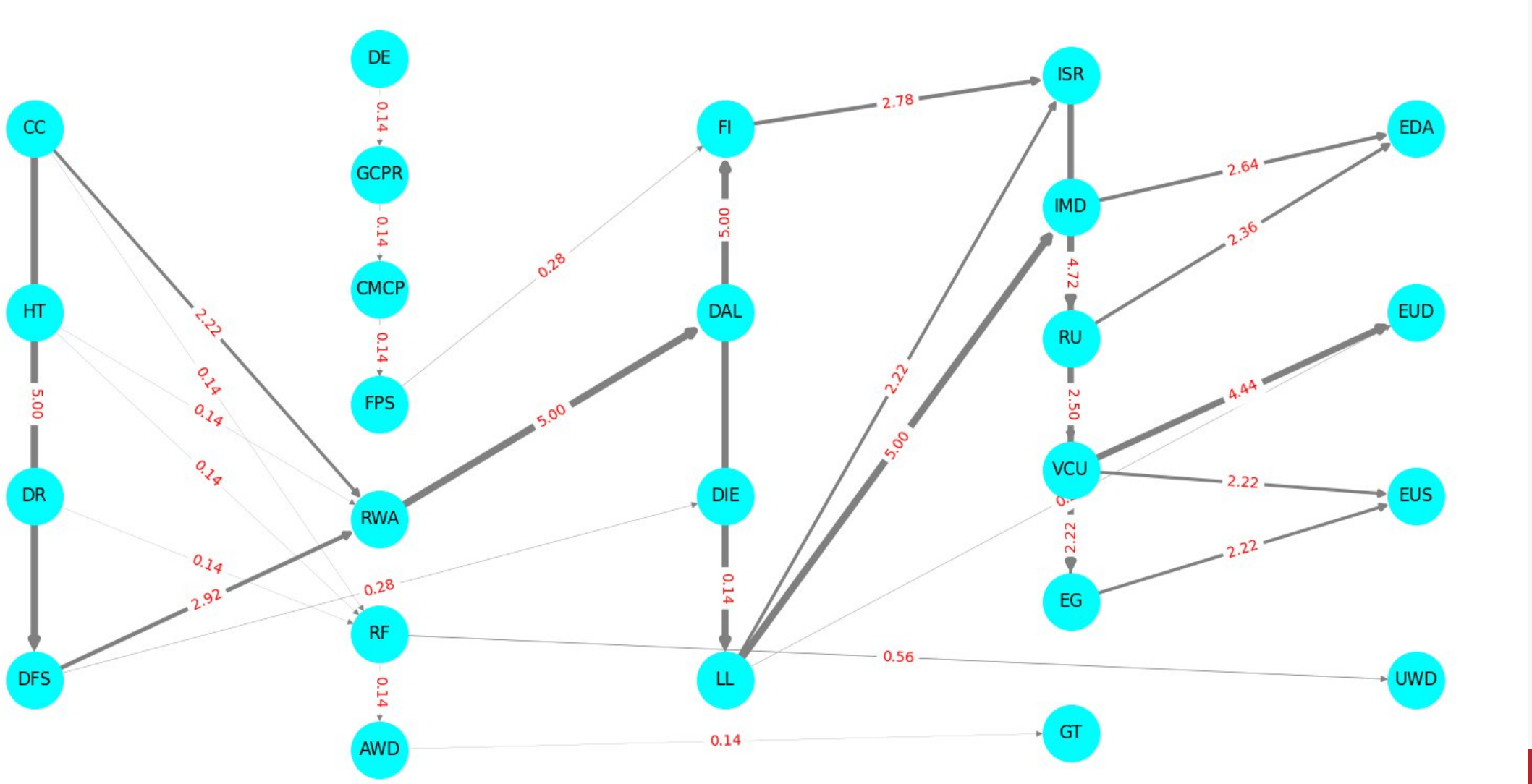
à Repetitive patterns
à Look for frequent subgraphs

Archtetype extraction – Frequent subgraph analysis

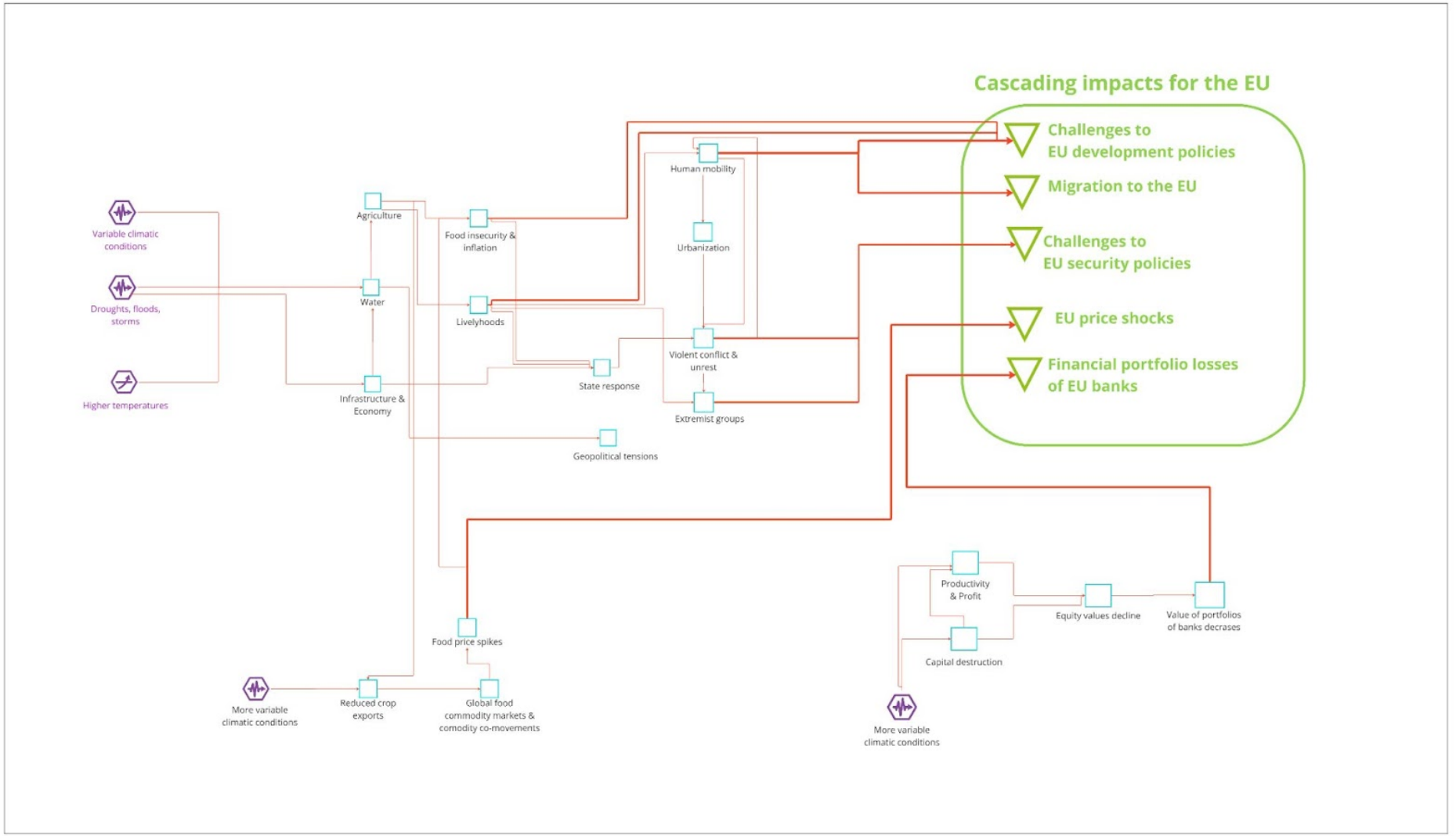
Identification of recurring patterns in graphs or networks

- è Discovery of significant patterns and relationships
- è Put all cascade graphs in adjacency matrices
- è Harmonize terms (focus on systems) and levels
- è Isomorphic subgraph matching with support = 3

Archetype extraction – Frequent subgraph analysis



Archetype extraction – Frequent subgraph analysis



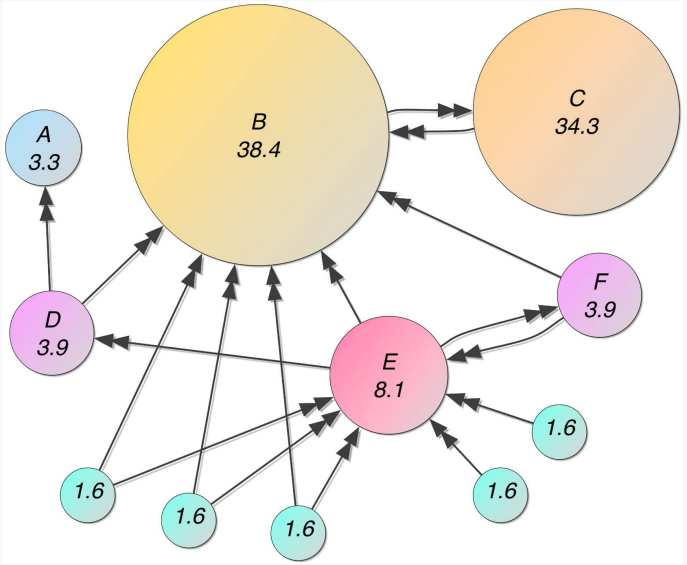
Identification of leverage points by PageRank

Use inverted version of PageRank:

Take archetype and invert edges

- find leverage points

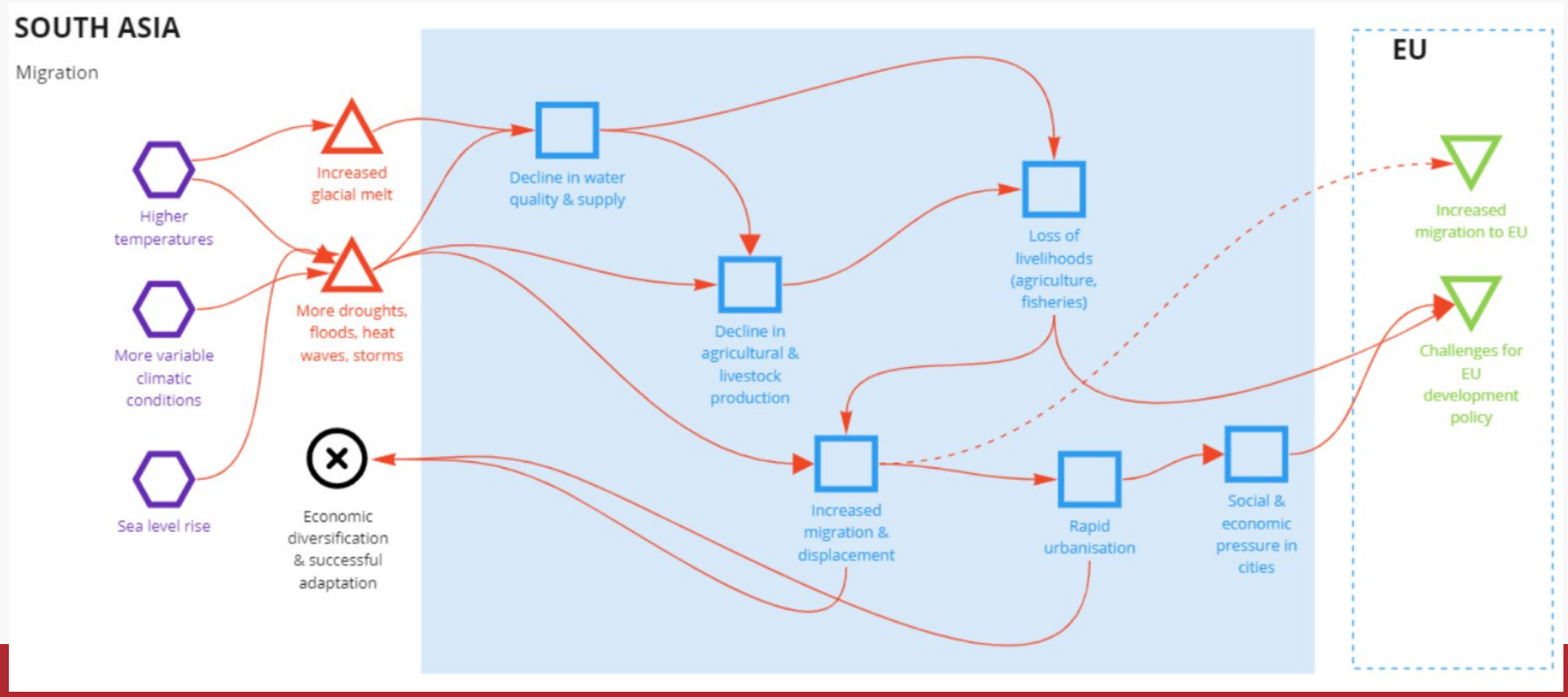
$$PR(p) = 1 - d\frac{1-d}{N} + d \cdot \sum_{q \epsilon B\_q} \frac{PR(q)}{|B_p|}$$



Identification of leverage points by PageRank

Why inverting the Network:

Where do my cascades come from? What are frequent triggers?



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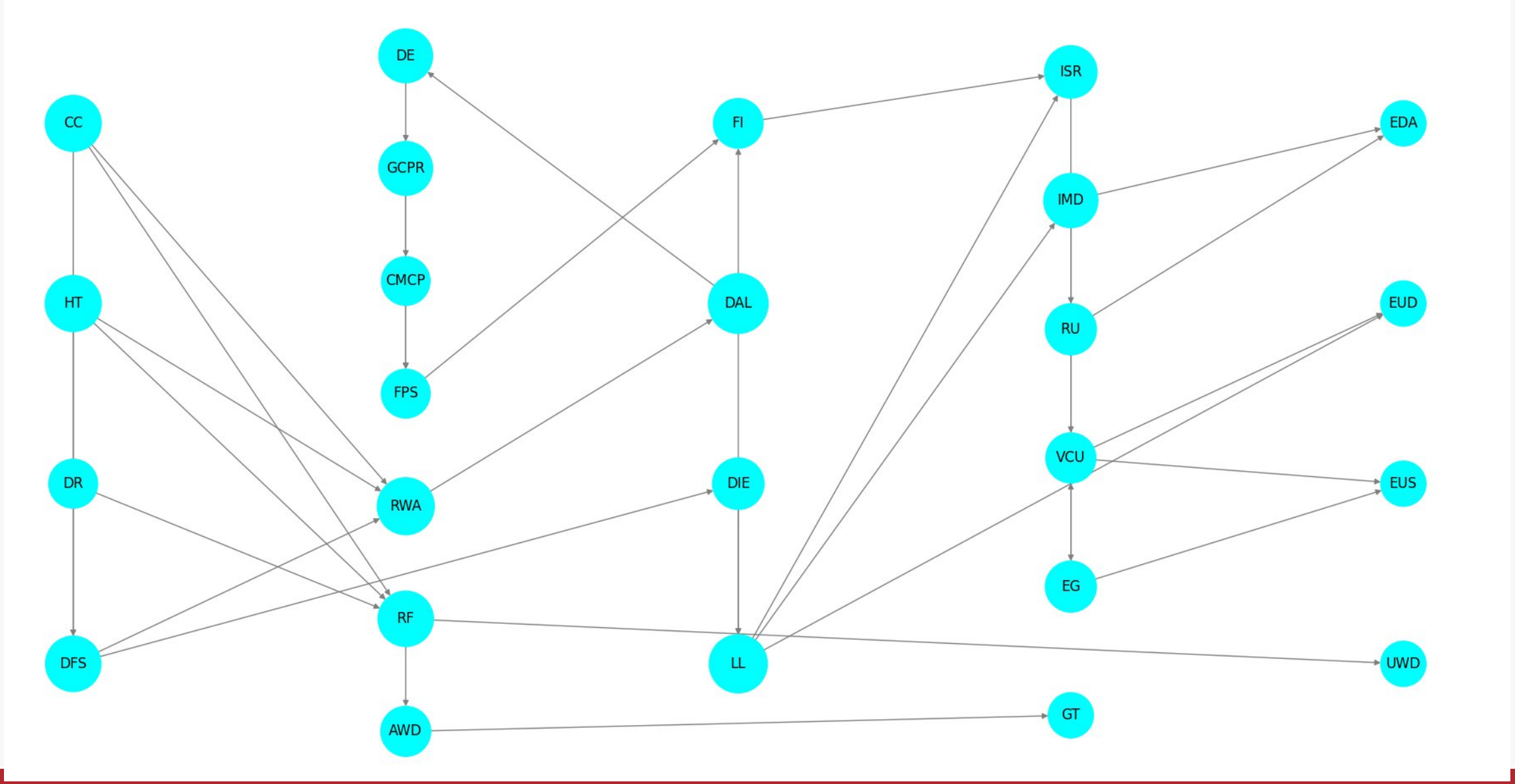
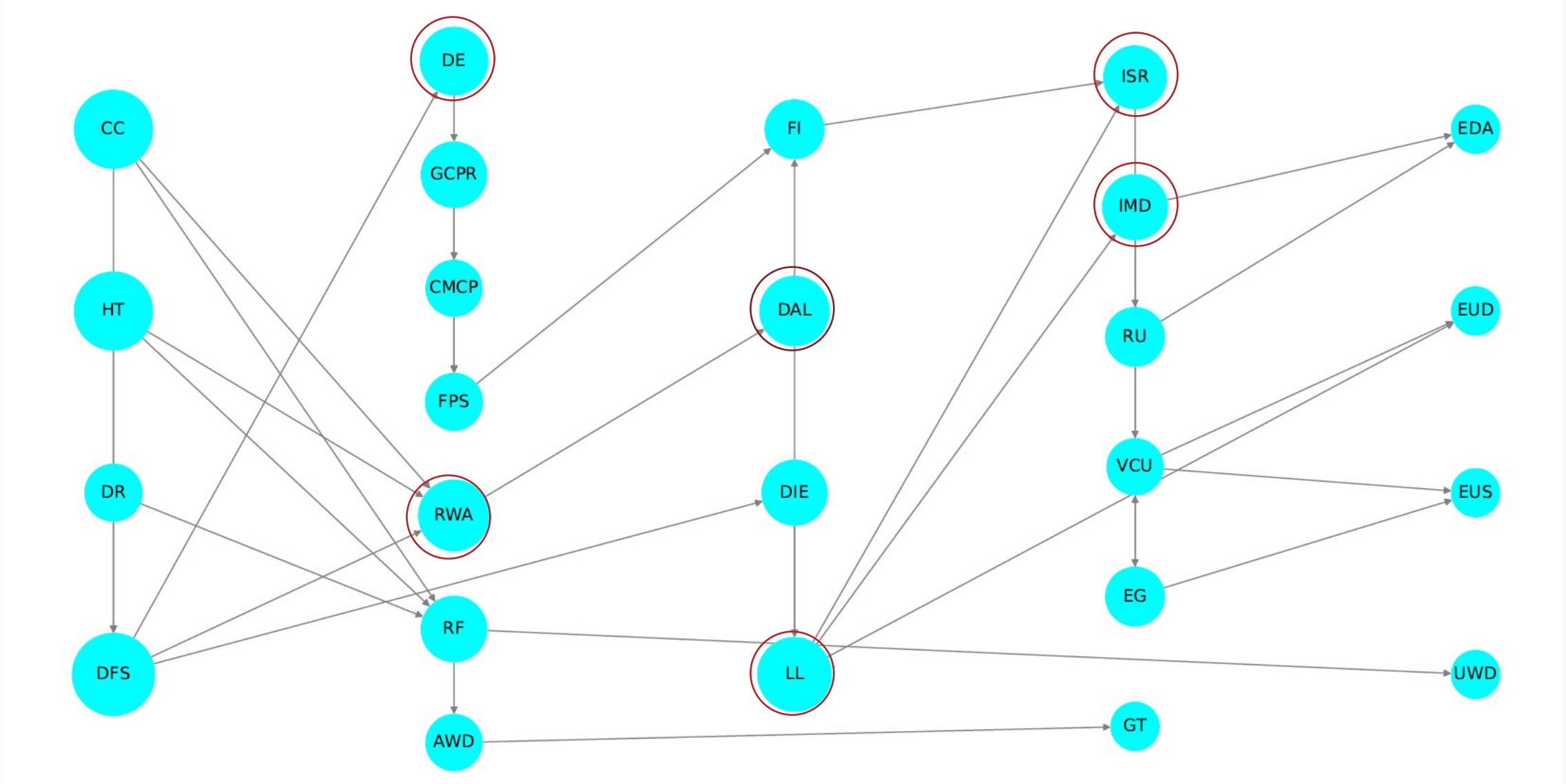
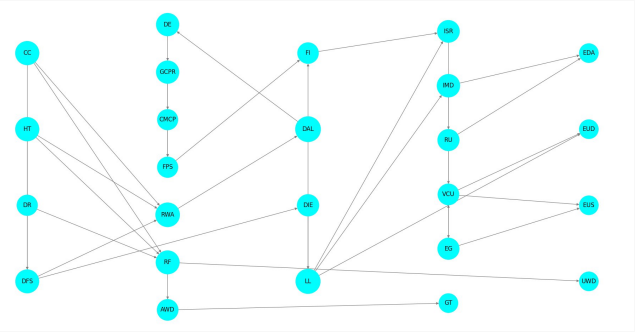


Identification of leverage points by PageRank



Clustering regions of similar dynamics



Run PageRank for each country

- Populate archetype with national data
- Edge assignment with INFORM Risk, ND-Gain and project results

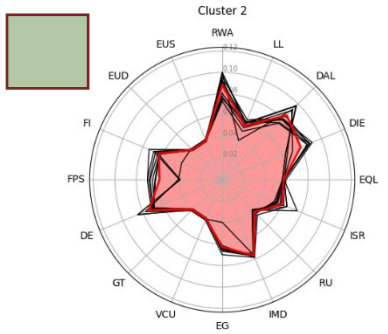
PageRank: vector of importance for n system components

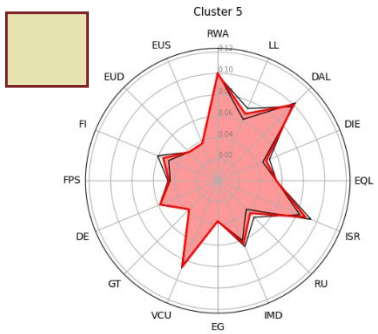
$$PR(c_i) = (w_{s0i}, \ldots w_{sni}))$$

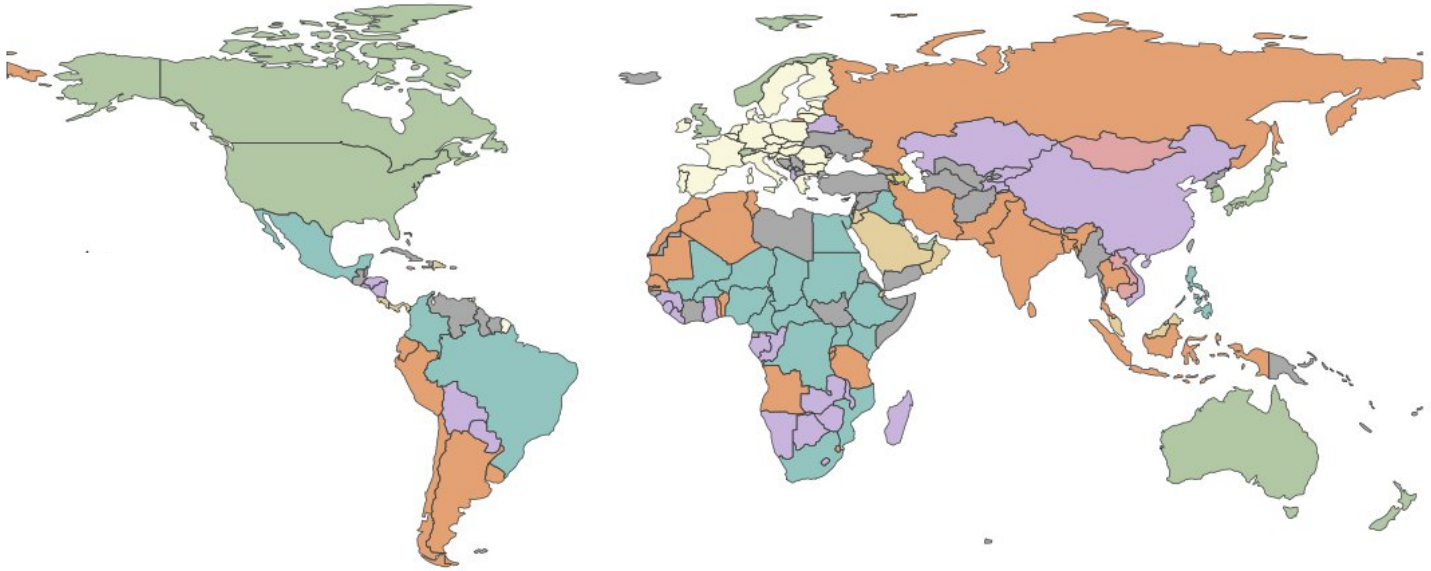
Clustering via K-Means:

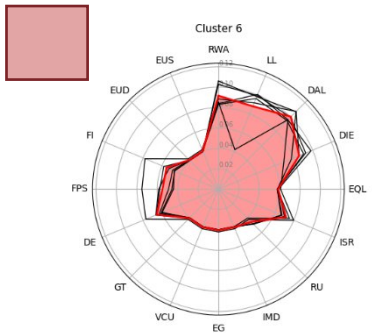
- Cluster regions with similar leverage points

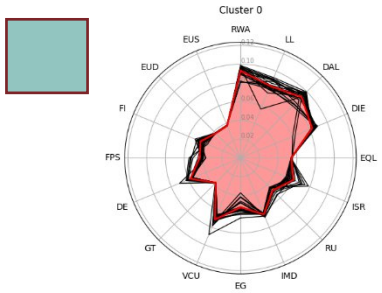
Clustering regions of similar dynamics - results

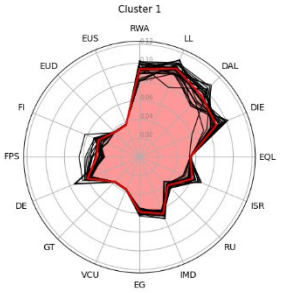


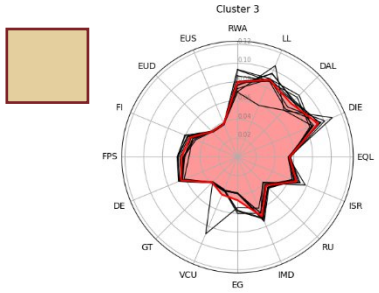


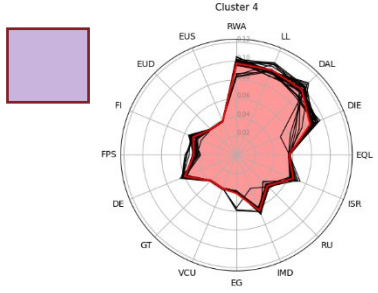












Summary

- Network based on stakeholder input, model results, desk research
  - bringing together a system of cascades
- Network analysis for leverage points
- Extraction of regions for similar leverage points

Future work:

- Validation
- Embrace again more complexity multiplex graphs
  -> emphasize underlying capital
  -> complex dynamics (migration, etc)

Thank You

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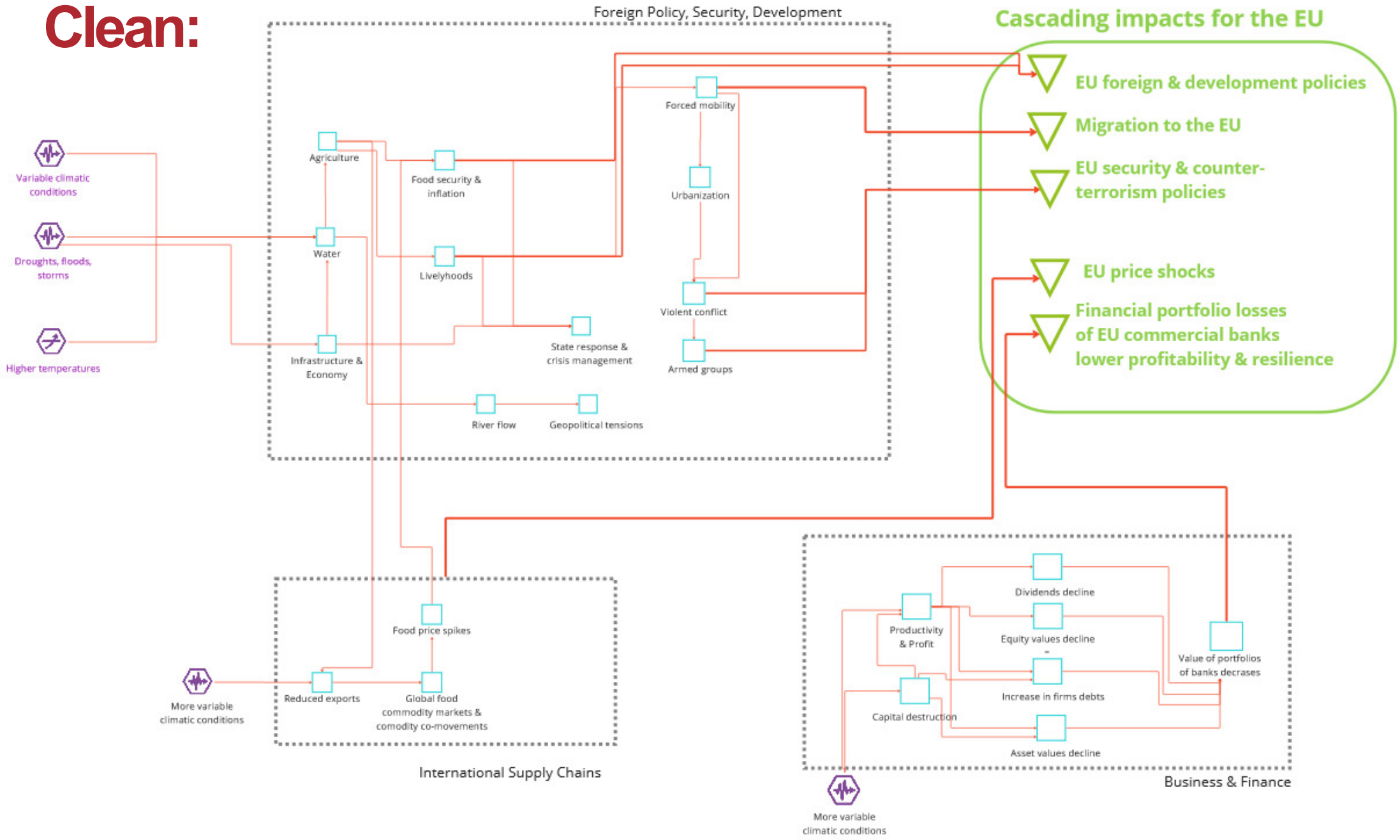
Foreign Policy, Security, Development
Cascading impacts for the EU
EU foreign & development policies
Migration to the EU
EU security & counter-terrorism policies
EU price shocks
Financial portfolio losses of EU commercial banks lower profitability & resilience
Variable climatic conditions
Droughts, floods, storms
Higher temperatures
Agriculture
Water
Infrastructure & Economy
Food security & inflation
Livelyhoods
River flow
Geopolitical tensions
State response & crisis management
Forced mobility
Urbanization
Violent conflict
Armed groups
More variable climatic conditions
Reduced exports
Food price spikes
Global food commodity markets & comodity co-movements
International Supply Chains
Productivity & Profit
Capital destruction
Dividends decline
Equity values decline
Increase in firms debts
Asset values decline
Value of portfolios of banks decrases
More variable climatic conditions
Business & Finance