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Society's Dependence on Resilient Critical Infrastructures – National and Regional Scales

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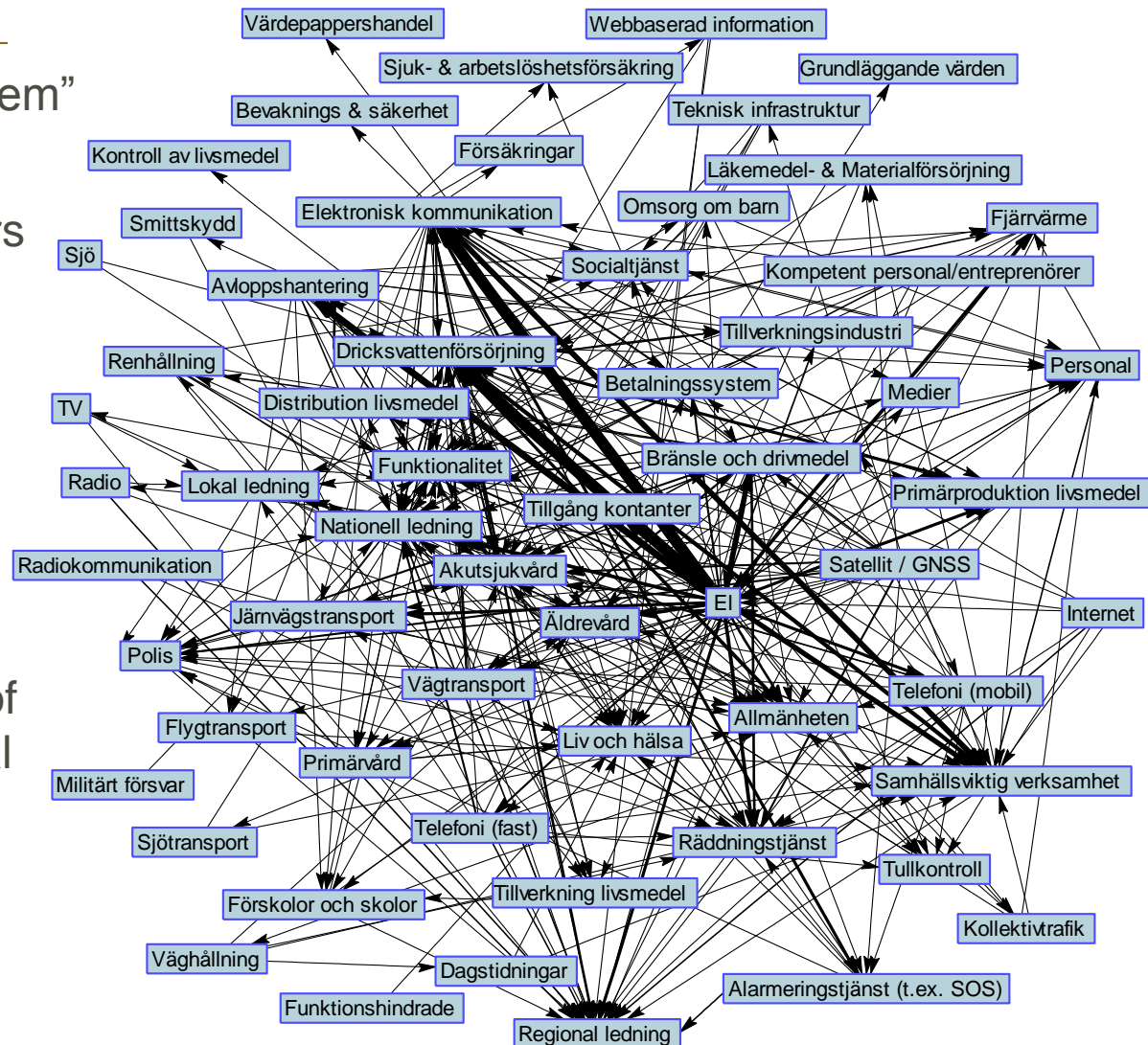
Content

- Introduction: Complexity of society
- Three perspectives on society's dependence on CIs:
 - 1) Cascading Effects (Global and local scales of infrastructures)
 - 2) Infrastructures and societal consequences (National/regional)
 - 3) Community and infrastructures (Local)
- Aiming at giving an overview of the different scales of critical infrastructures, their interdependencies and how the society depend on the services these deliver.



Complexity of society

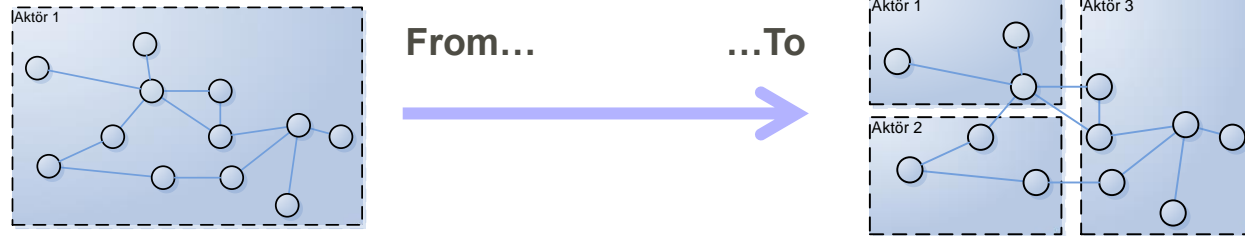
- The overall “societal system” is tightly interconnected
- Societal trends are drivers for efficiency but also introduces new risks and vulnerabilities, constantly changing the picture.
- The fundamental understanding of the interconnectedness of societal functions / critical infrastructures and the mechanisms of how consequences can spread are very limited.



Contextual drivers concerning CIs

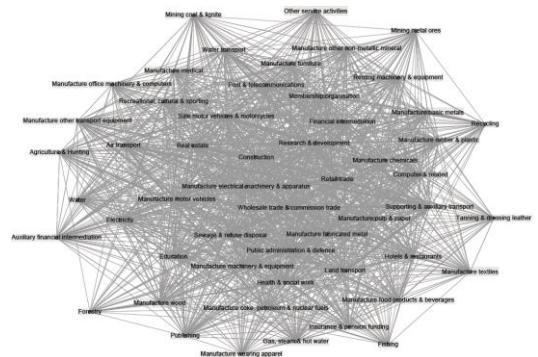
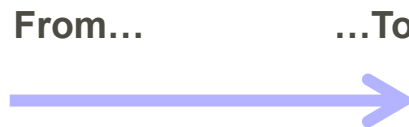
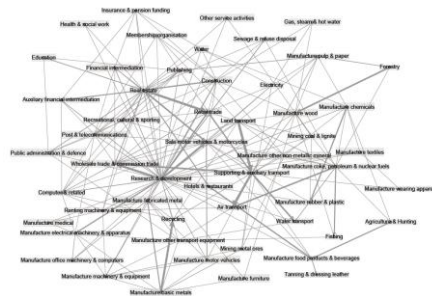
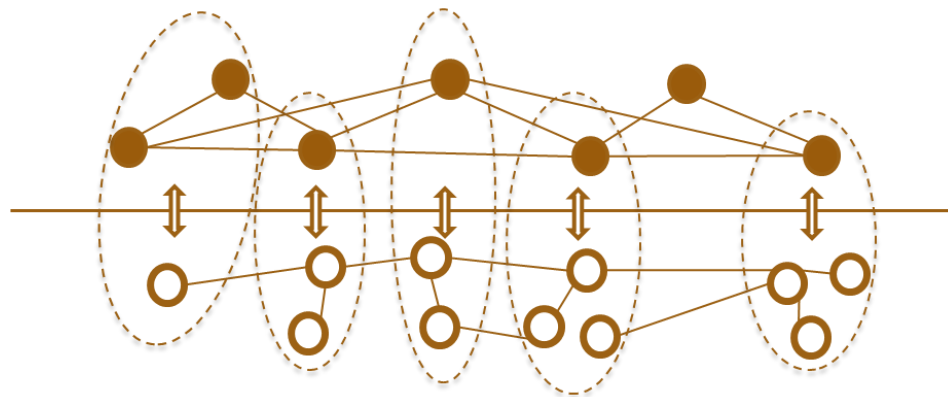
- The society is continuously changing and is getting both increasingly interconnected and fragmented due to several trends, such as:
 - Changing dependencies between sectors
(e.g. “internet-of-things”, electric cars)
 - Larger geographical systems and geographic interconnectedness
(e.g. internet, train, power systems)
 - Specialization, privatization and outsourcing
(e.g. deregulation of railway)
 - Globalization
(e.g. cross-national CI governance)
 - Urbanization
(e.g. concentration of infrastructures and demand)

A simplified view of these drivers...



”Governance System”

”Functional System”

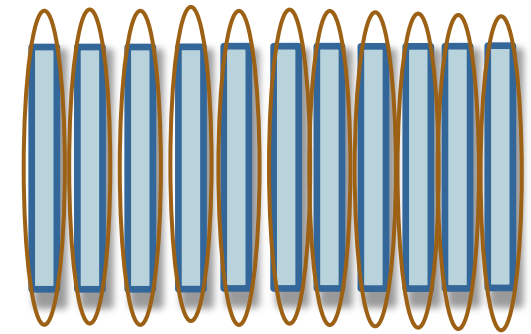


Perspective 1

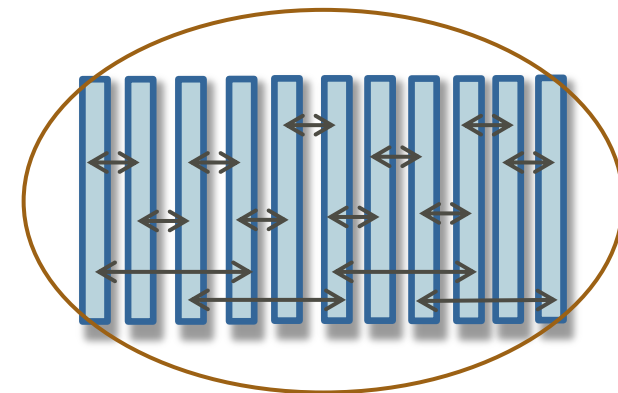
Interdependencies and Cascading effects CIs

- Critical infrastructures can collapse due to:
 1. Exogenous hazards (e.g. flooding or terrorism)
 2. Internal hazards (e.g. equipment malfunction or operator mistakes)
 3. Dependencies to other infrastructures (e.g. telecommunication on electric power)
- (1) and (2) typically covered by sector regulations and individual infrastructure owner's internal e.g. risk/resilience management, accident investigation processes, business continuity, etc.
(as e.g. Krempel pointed out for the aviation industry yesterday)
- (3) requires a more holistic perspective on:
 - Critical infrastructure interdependencies
 - Society's dependence on critical infrastructures
 - Risk governance to facilitate cross-actor risk language, understanding and management

Two perspectives on sectors

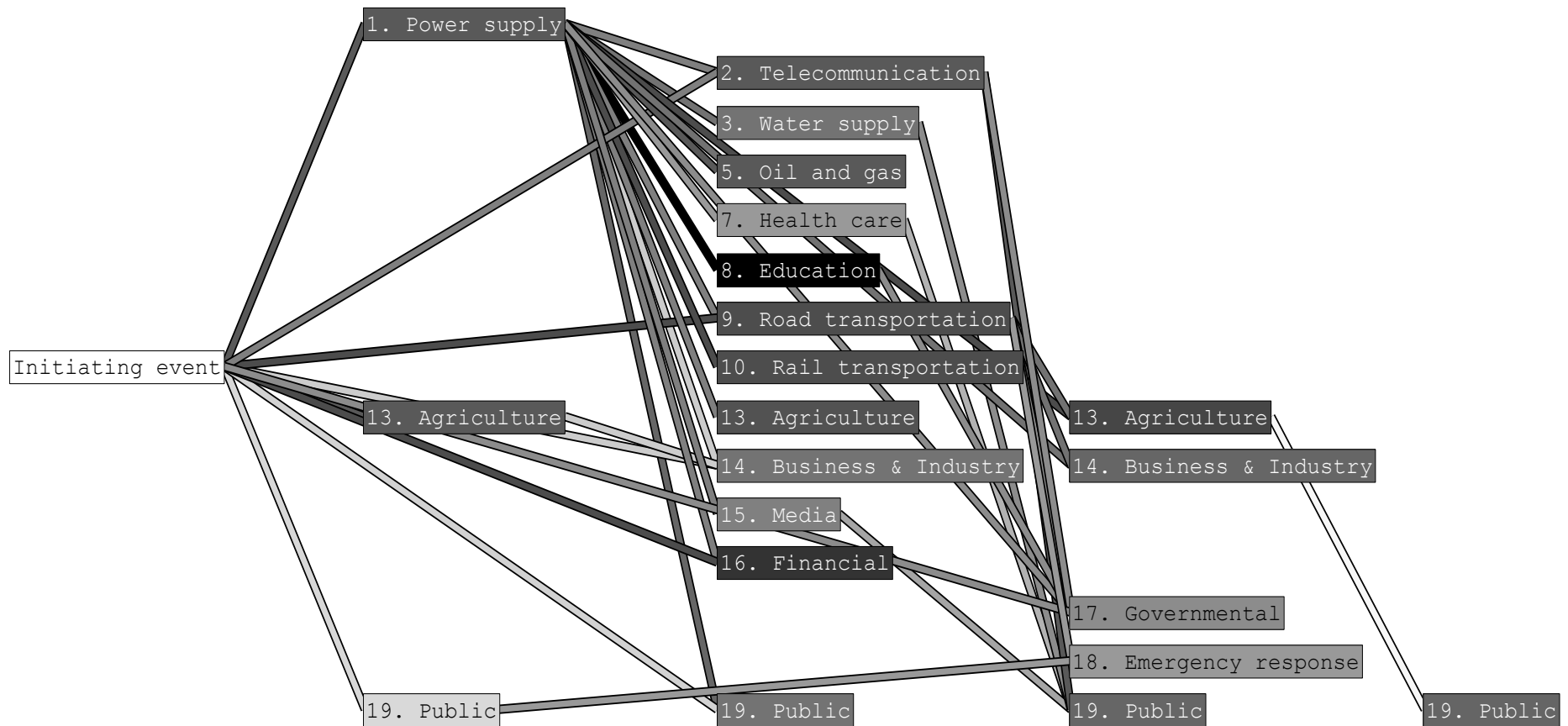


or



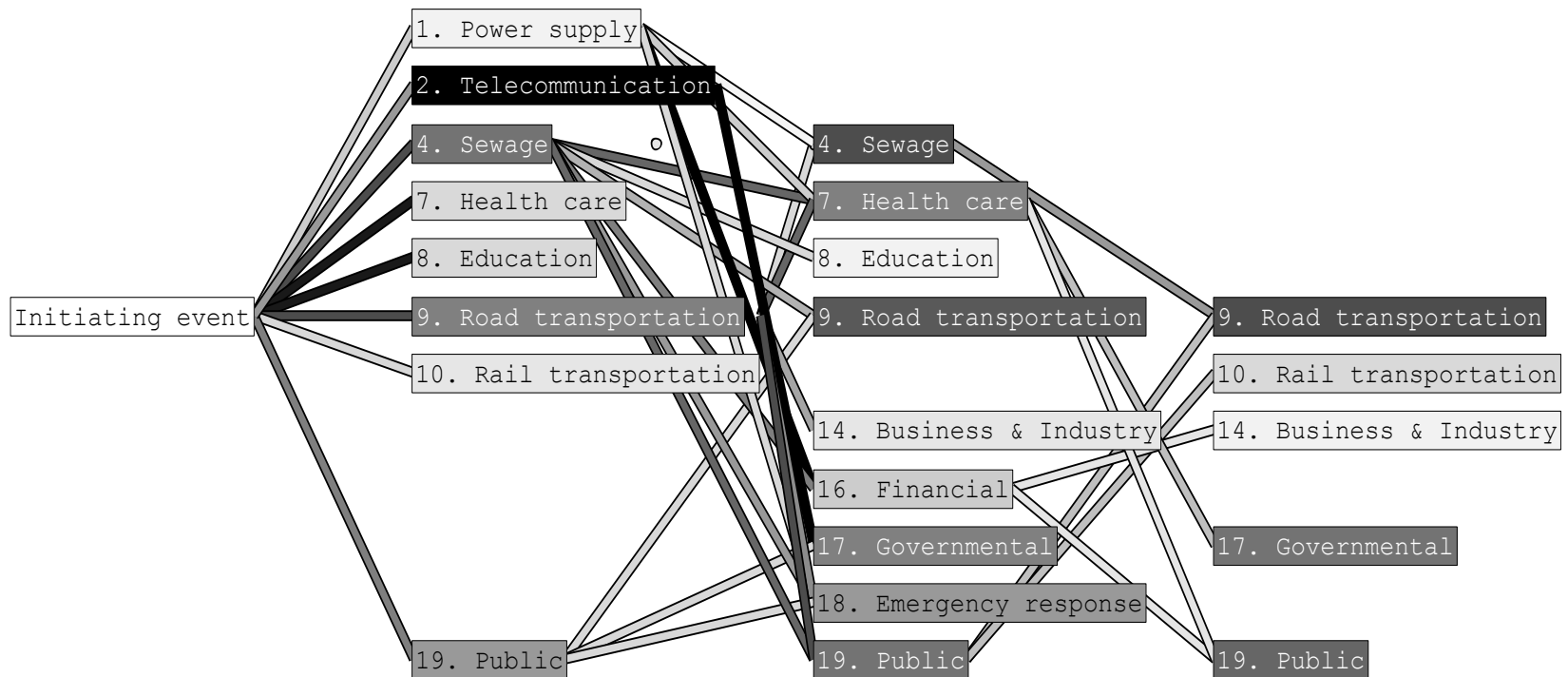
Perspective 1

Cascading effects – (inter)national or local event?



Perspective 1

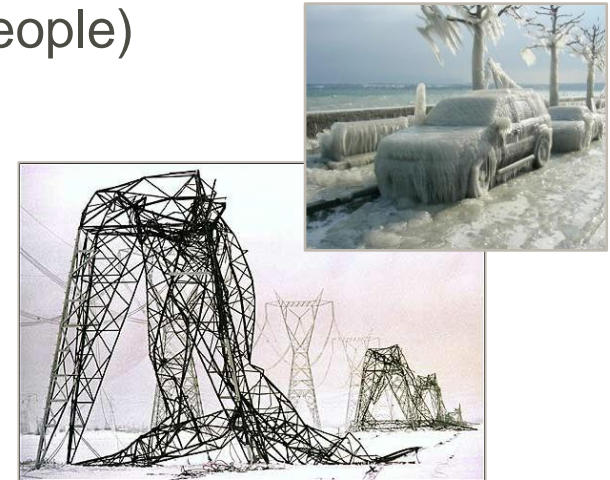
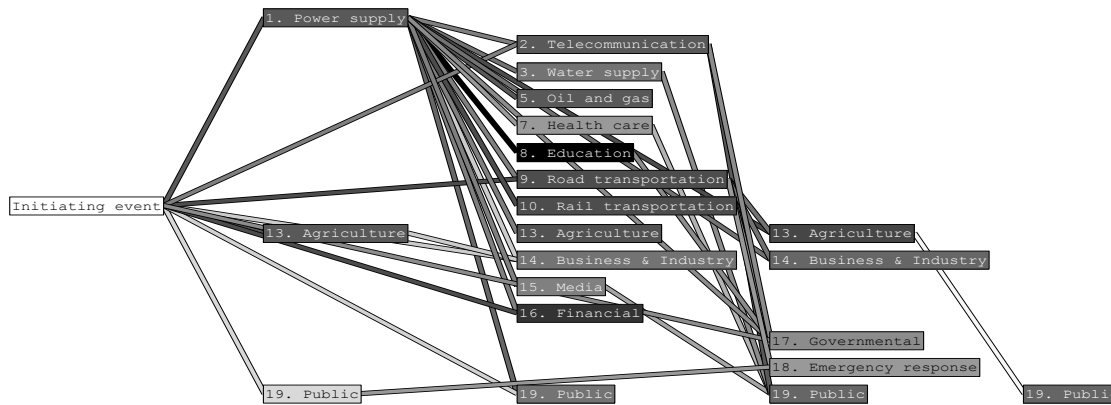
Cascading effects – (inter)national or local event?



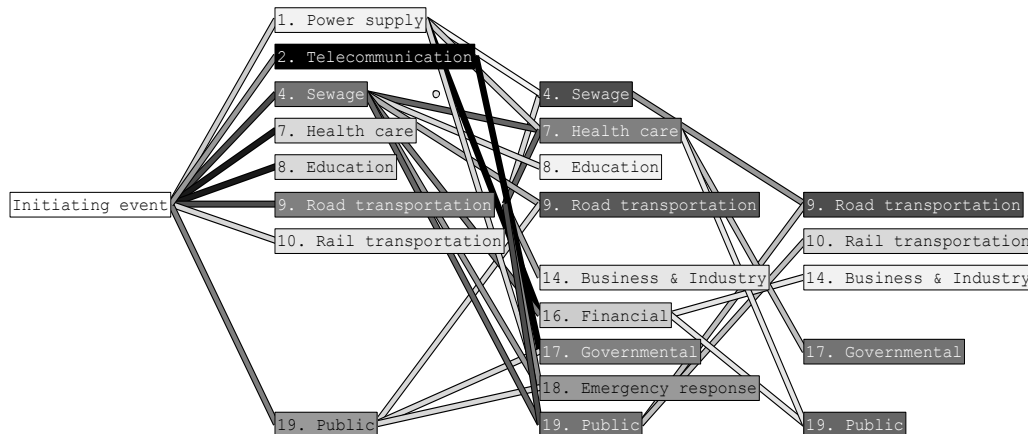
Perspective 1

Cascading effects – (inter)national or local event?

- North American Ice Storm 1998 (~6 million people)



- Malmö Floods in 2014 (~0,3 million people)



Perspective 1

Cascading effects in past events (16 out of 40 exemplified)

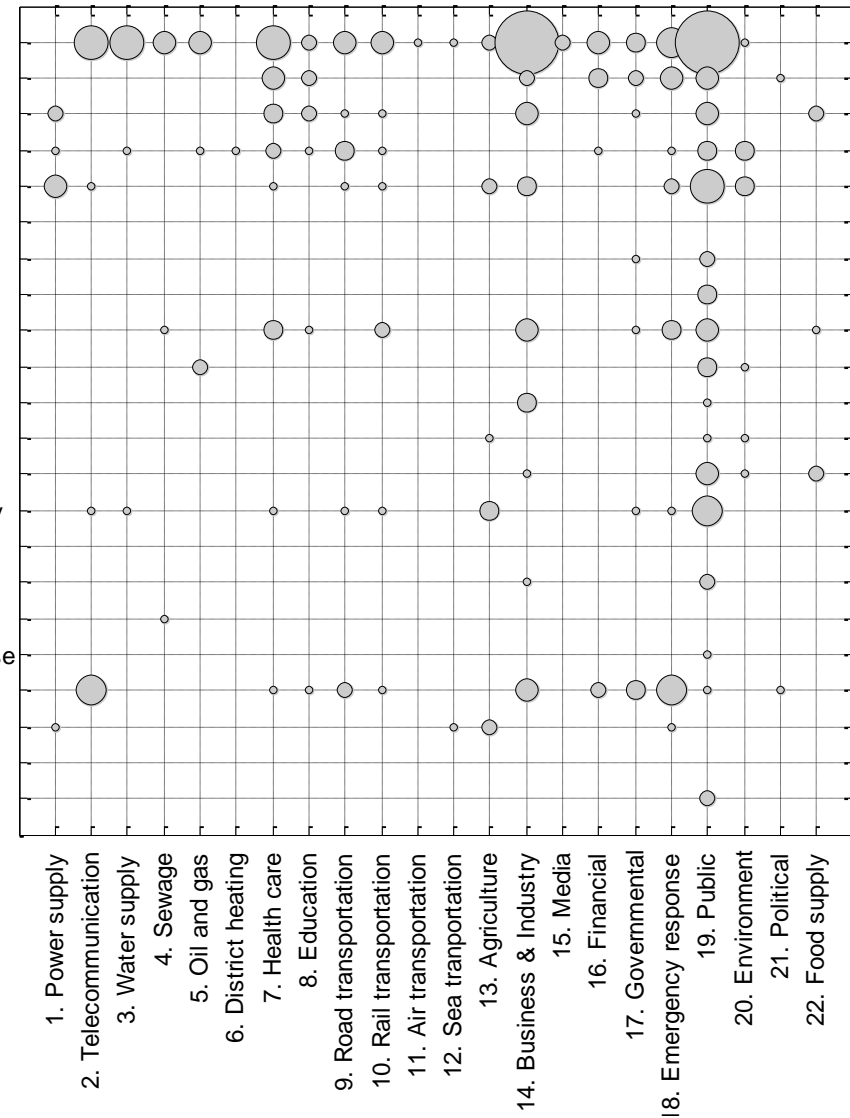
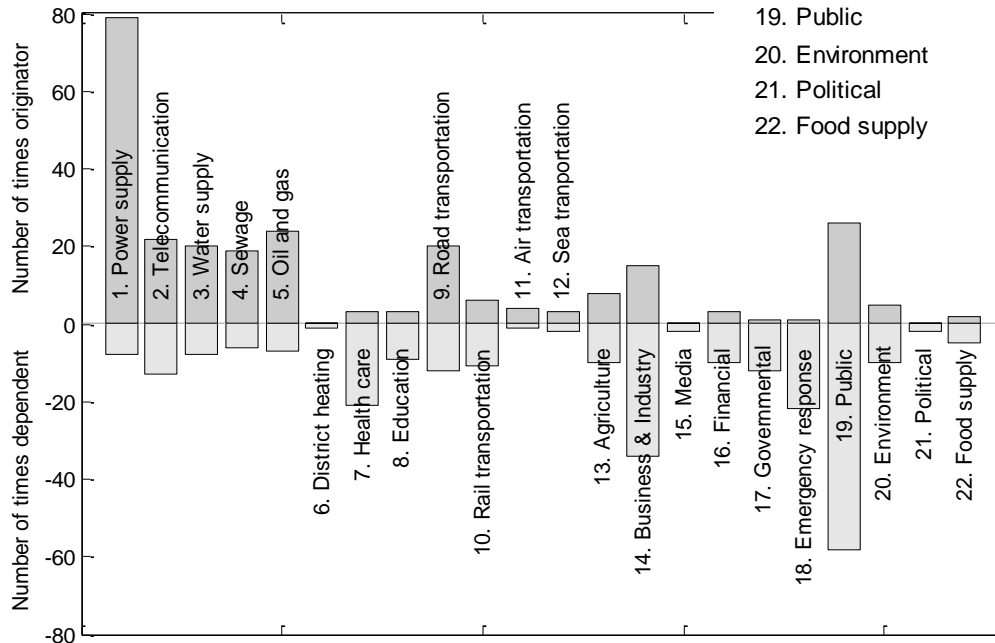
Event	Location	Year	IE type	Systems	Casc. order	Event duration	
1	Auckland	New Zealand	1998	Power outage	11	5	2m5d
2	Tieto	Sweden	2011	IT-event	7	4	2m
3	UK floods	UK	2007	Flooding	13	3	6m3d
4	Enschede	Netherlands	2000	Explosion	6	3	3y7m
5	London bombing	UK	2005	Terrorism	8	3	1y11m
6	Mont Blanc	Switz. France	1999	Fire	4	2	3y3m
7	Sandy	N. America	2012	Hurricane	18	5	2m1w
8	Eyjafjallagökull	Iceland	2010	Volcano eruption	5	2	1m1w
9	Malmö floods	Sweden	2014	Flooding	12	3	1d12h
10	Myyrmanni	Finland	2002	Terrorism	4	3	2w4d
11	Kista blackout	Sweden	2001	Power outage	9	3	1d16h
12	Östersund	Sweden	2010	Contam. water	7	3	5m4w
13	Baltimore	USA	2001	Tunnel Fire	10	4	2w2d
14	L'Aquila	Italy	2009	Earthquake	11	2	5y
15	European blackout	Europe	2006	Power outage	4	2	2h
16	Ice storm	N. America	1998	Ice storm	15	4	1m1d
...							

Perspective 1

Exploring dependencies

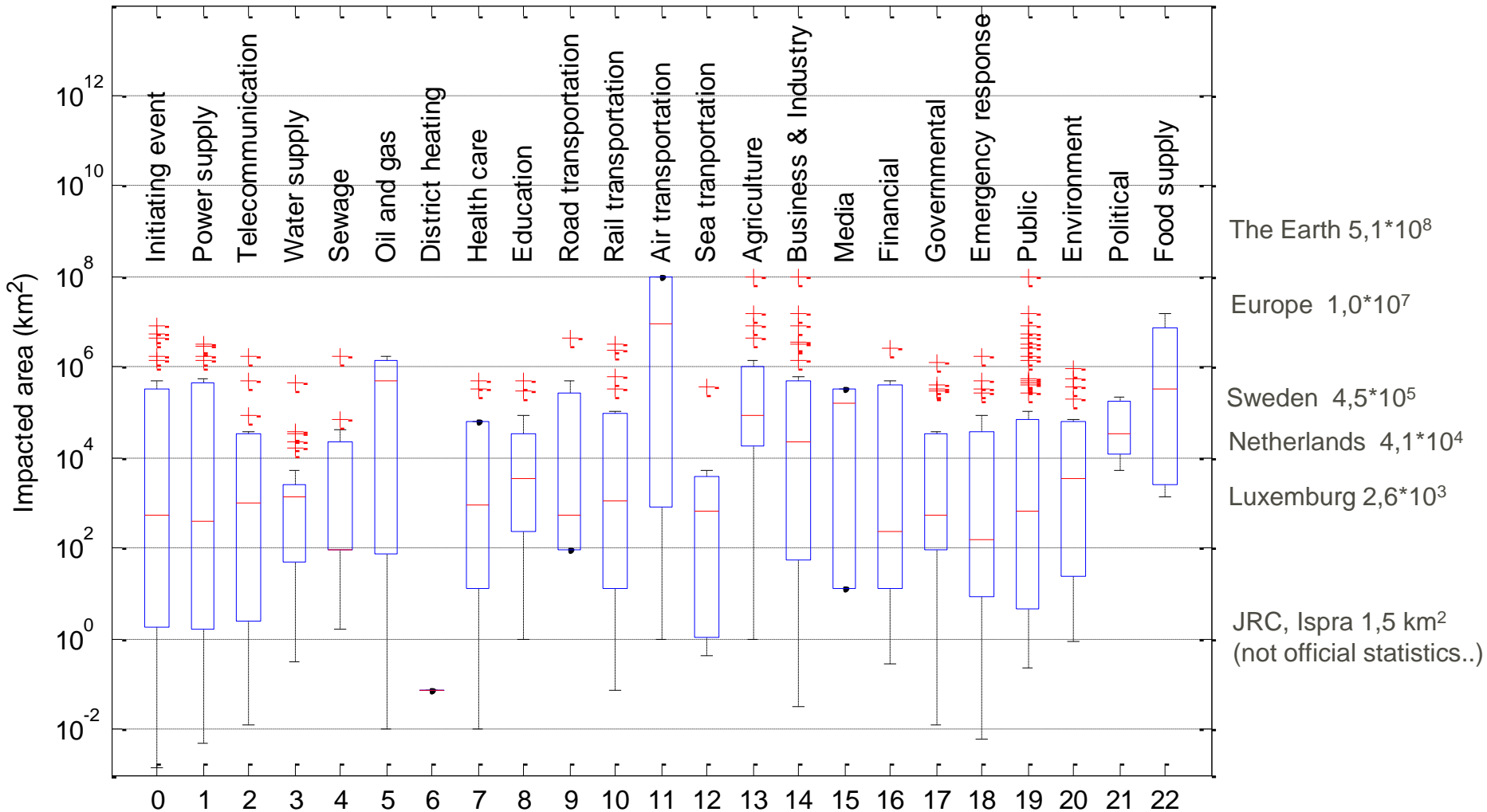
- **Originating systems:**
Power, Telecom, Sewage, etc.
- **Dependent systems:**
Business & Industry, Public, Health Care, Education

1. Power supply
2. Telecommunication
3. Water supply
4. Sewage
5. Oil and gas
6. District heating
7. Health care
8. Education
9. Road transportation
10. Rail transportation
11. Air transportation
12. Sea transportation
13. Agriculture
14. Business & Industry
15. Media
16. Financial
17. Governmental
18. Emergency response
19. Public
20. Environment
21. Political
22. Food supply



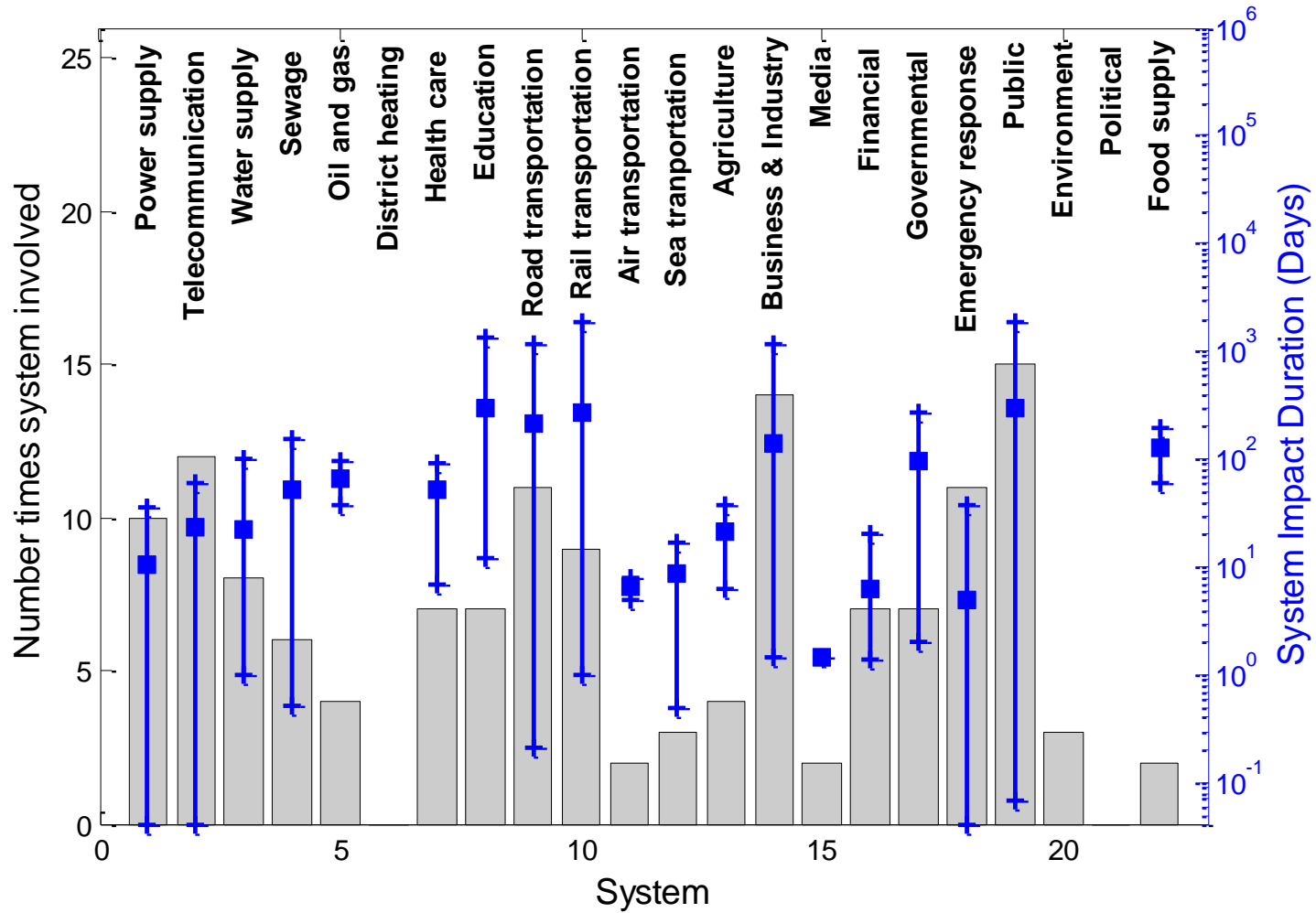
Perspective 1

(Inter-)National and local scales of critical infrastructures



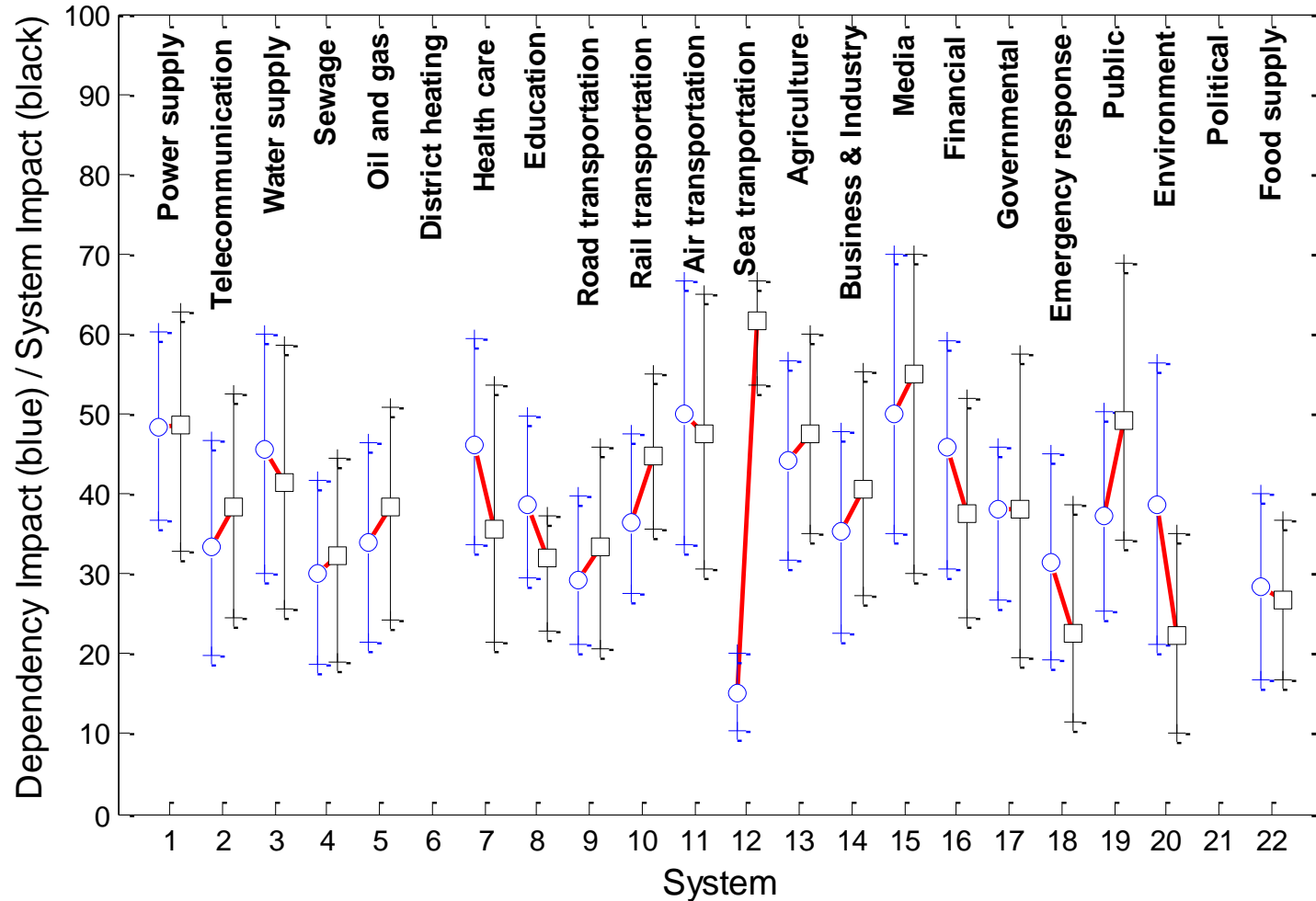
Perspective 1

Time-scales of critical infrastructures



Perspective 1

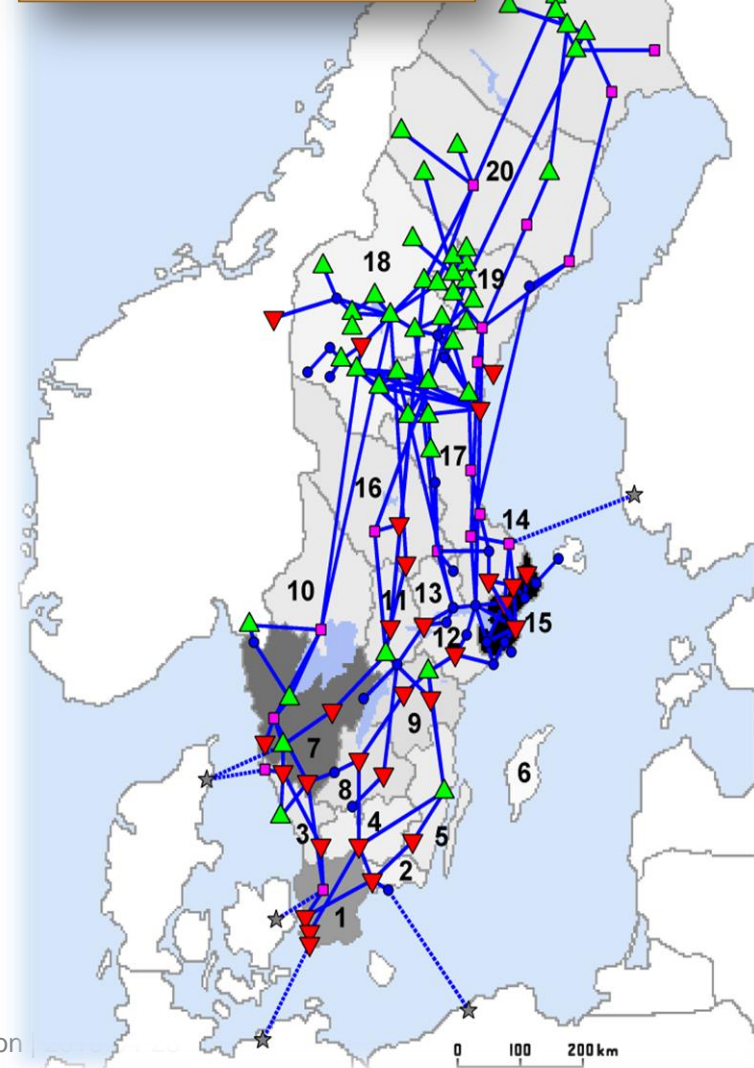
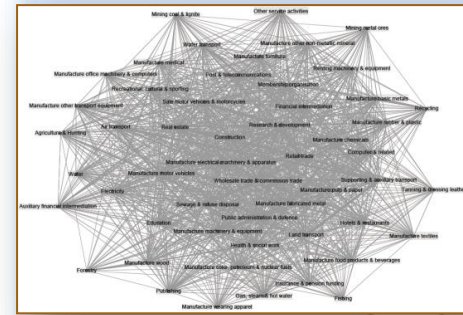
“Resilience” of critical infrastructures



Perspective 2

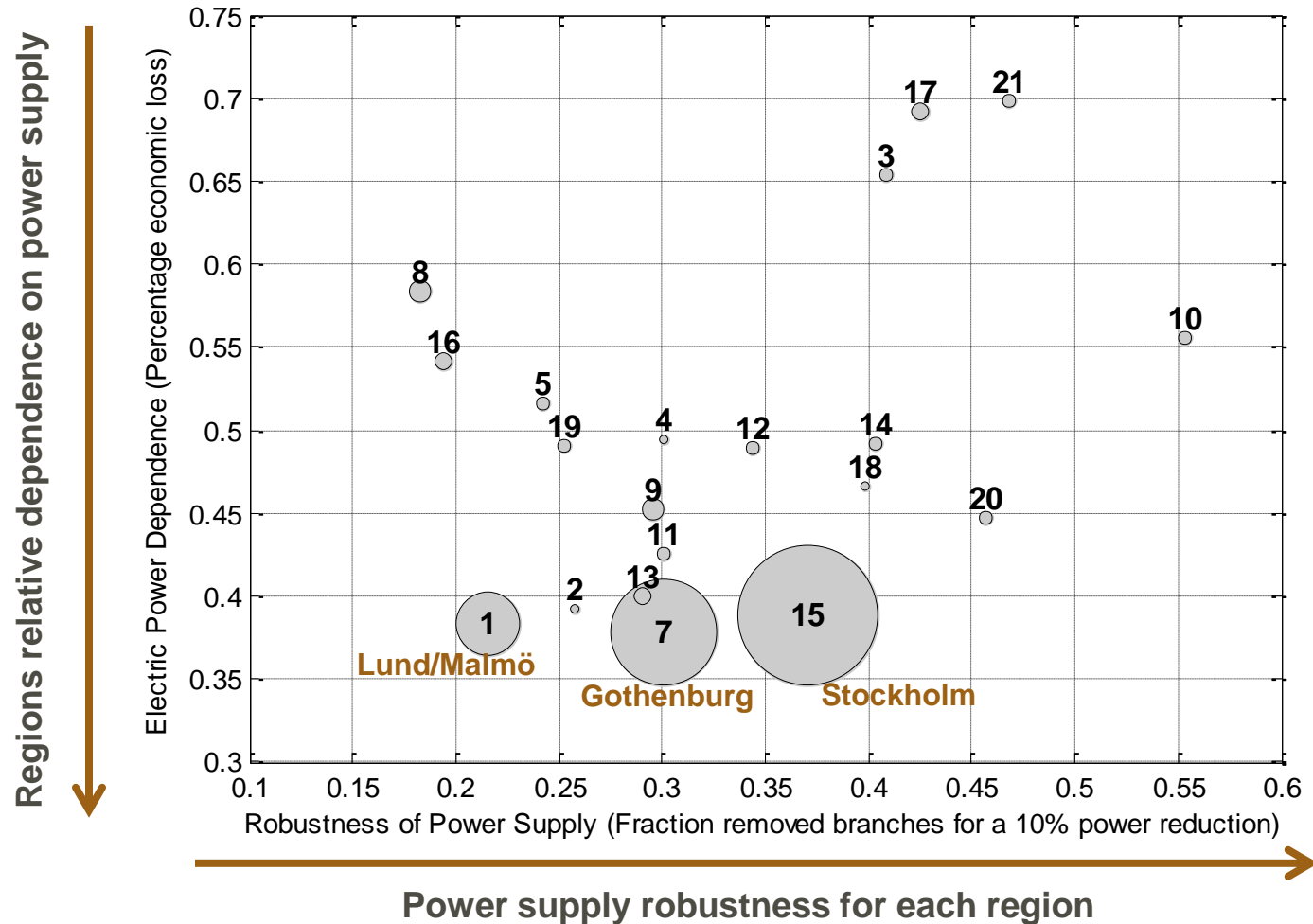
Infrastructure and societal consequences

- Question?
 - How does the vulnerability of the Swedish transmission system correlate to regional societal consequence of power outages?
- Power system
 - Representative DC-model of the Swedish Transmission system
 - Configuration in accordance with 23rd of September blackout in 2003
- Societal consequences
 - Economical Inoperability Input-Output model (IIM) – a linear model with its deficiencies
 - National economical data of 55 sectors make/use dependencies
 - Broken down to 21 regions (län)
 - Skåne, V.Götaland, Stockholm: 57% of GRP



Perspective 2

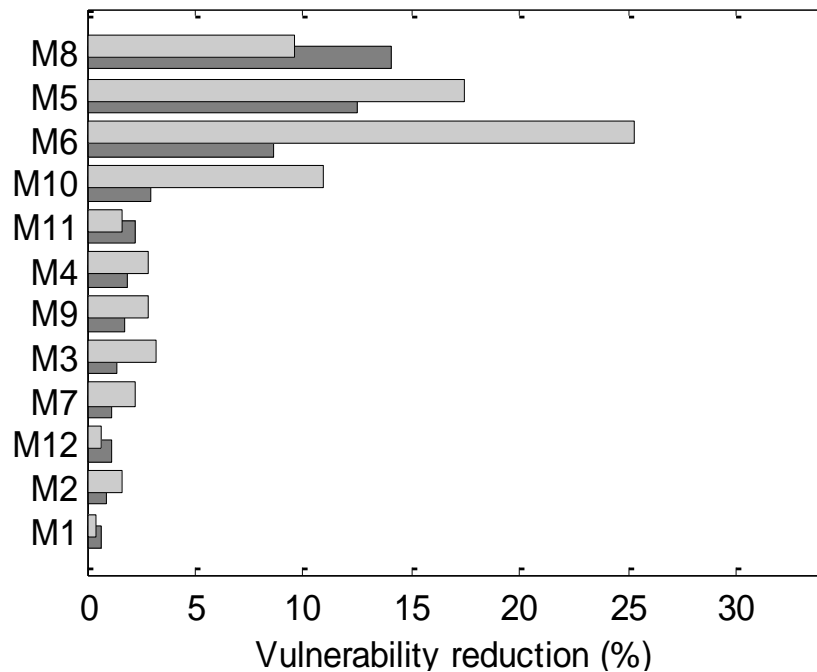
Infrastructure and societal consequences



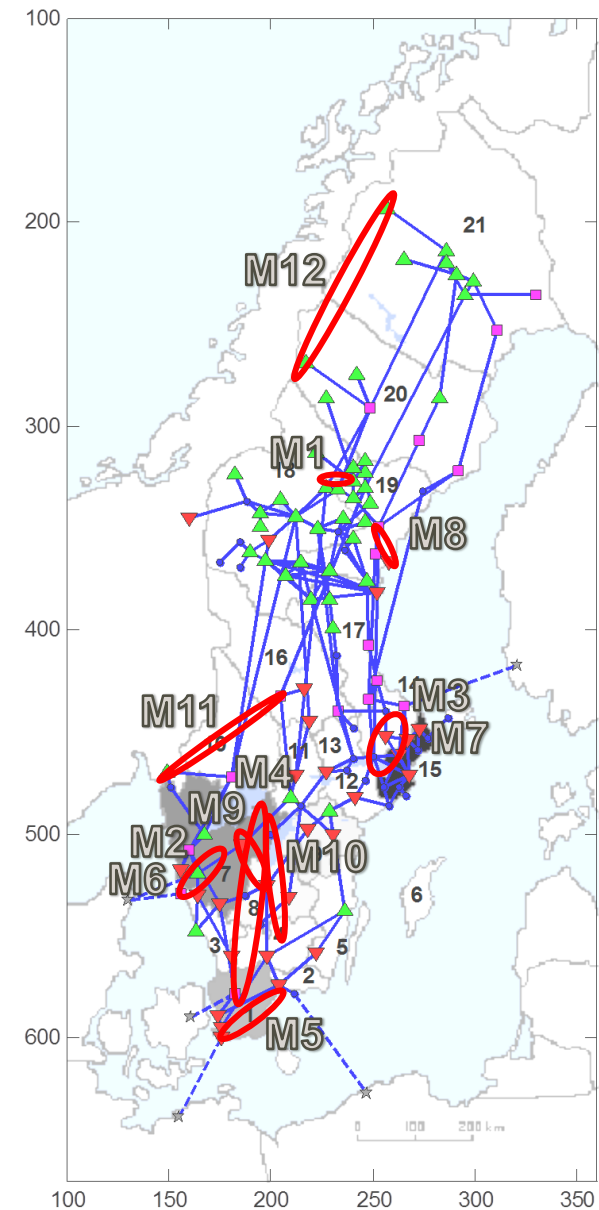
Perspective 2

Infrastructure and societal consequences

- Does infrastructure improvement measures equally reduce the vulnerability of the infrastructure and the society?



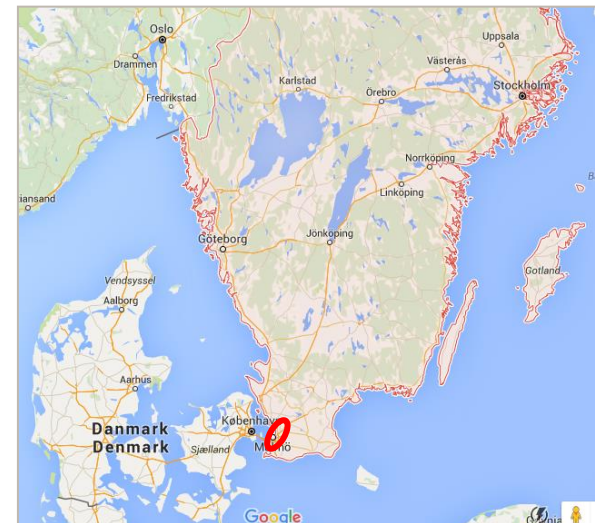
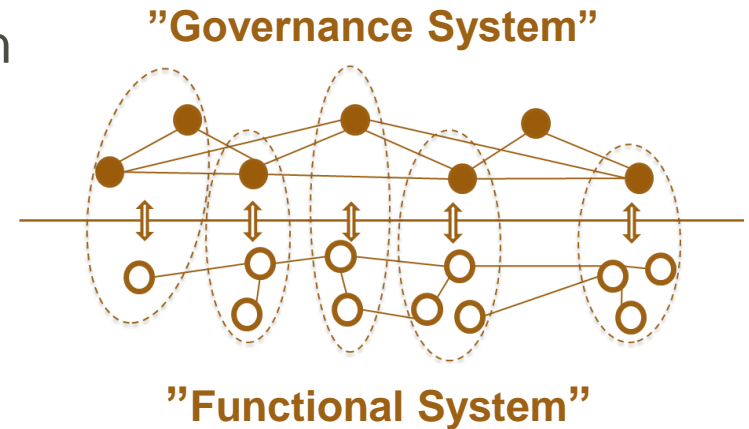
Dark grey = Power system improvement
Light grey = Societal economic improvement



Perspective 3

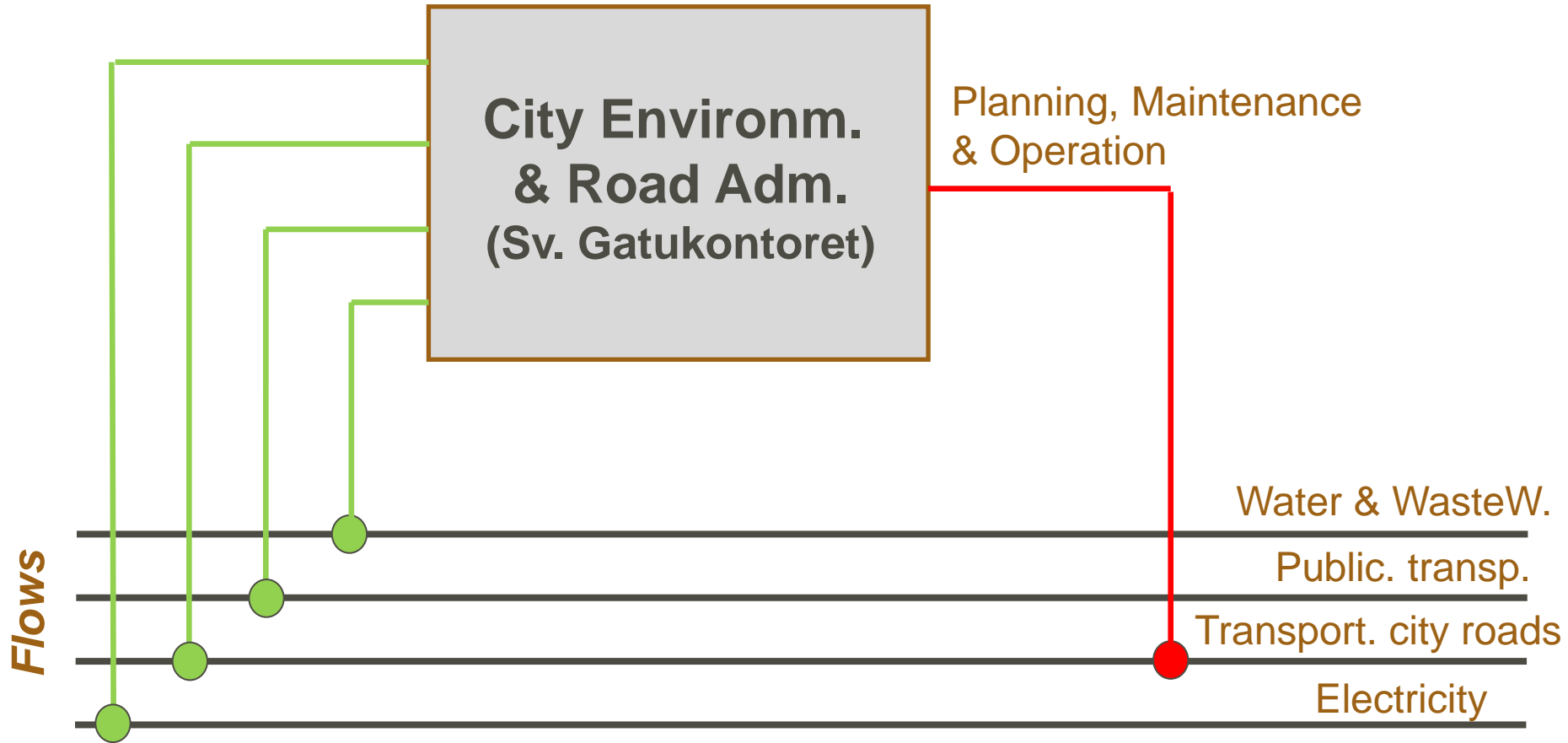
Local community and infrastructures

- **Actors** dependence and influence on flows at a municipal level
- **Flow** is a movement of goods, services, humans, capital or information that
- Using a flow as an “abstract” actor intermediary:
 - “actor-flow-actor” interdependencies
- Preliminary study of Malmö/Lund region in Southern Sweden



Perspective 3

Local community and infrastructures



What are some of the challenges ahead?

- Improved empirical data on interdependencies
- Improved understanding of society's dependence upon critical infrastructures
- Improved modelling and simulation approaches and capabilities
- Enhanced cross-sectorial regulation and incentives
- Improved private-public-academia collaborations
- Need to communicate the limits of critical infrastructures!
 - Important input to understanding and assessing community resilience



Please feel free to contact me

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