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# Risk governance of critical energy infrastructure: benefits of a multi-risk approach

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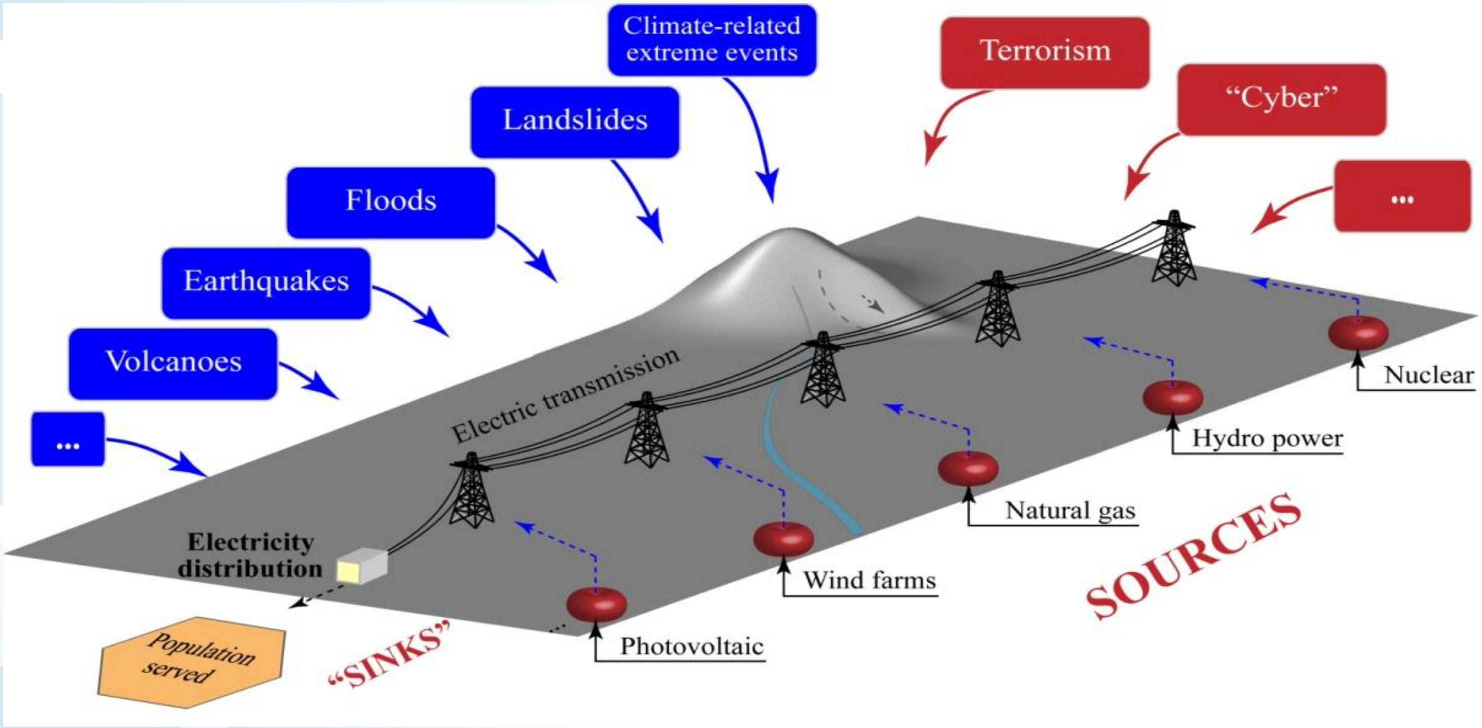
# Critical energy infrastructure is a subject to multiple risks




Source: Garcia, 2016

Grids are already subject to impacts of natural hazards such as extreme weather and space events, earthquakes, cyclones, storms and heat waves

Impacts affect physical integrity of electricity transmission grids and decrease transmission capacity

# Some examples

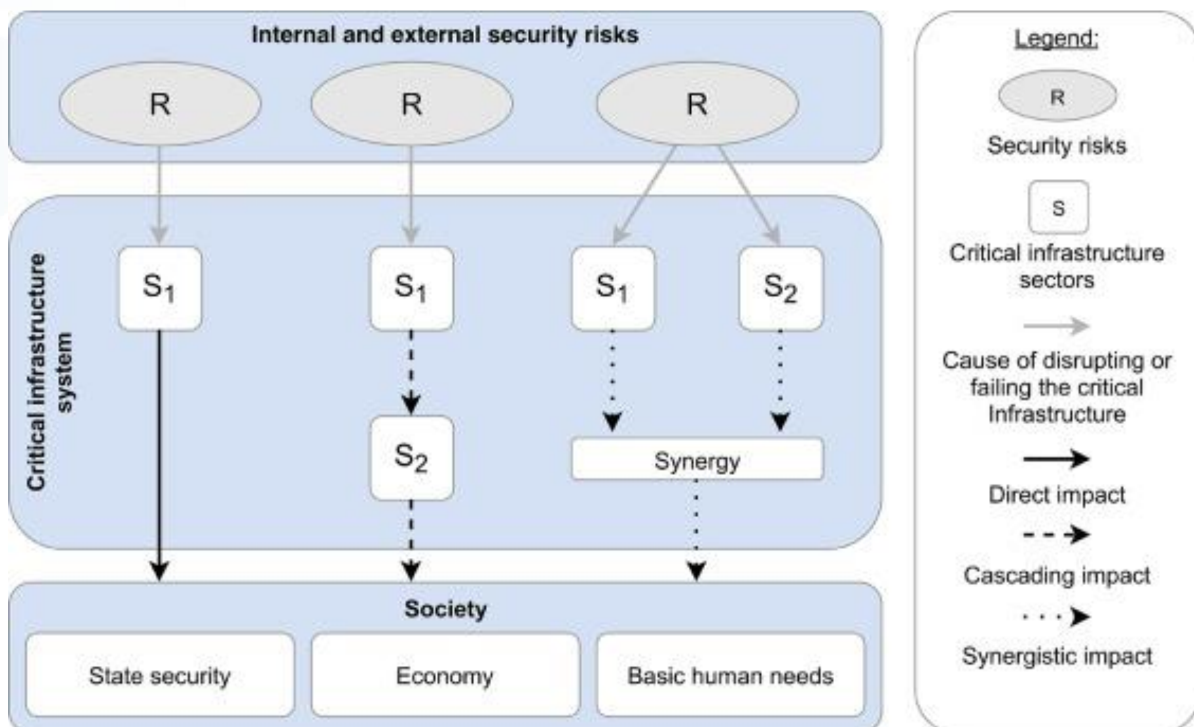
| | Earthquake | Space weather | Flood |
|---|---|---|---|
| **Damage types** | Structural damage due to inertial loading<br>Foundation/ground failure | Damage to transmission and generation equipment from GICs<br>Potential for system-wide impact | Damage to transmission tower foundations due to erosion and/or landslides<br>Moisture and dirt |
| **Contributing factors** | Soil liquefaction<br>No warning time | Early warning possible | Early warning possible |
| **Most vulnerable equipment** | Heavy equipment (e.g. generators, LPTs)<br>Ceramic parts (e.g. bushings, bus bars) or equipment (e.g. transformers) | Equipment vulnerable to direct current (e.g. transformers)<br>Equipment protected from DC excitation (tripping) | Transmission towers<br>Substation equipment |
| **Recovery time is driven by** | Number of items in need of repair or replacement<br>Access to conduct repairs | System-wide impact<br>Delayed effects | Floodwaters recession (access)<br>Number of items in need of repair or replacement |
| **Recovery time range** | A few hours to months; most commonly, 1 to 4 days | Power to areas serviced by equipment which has only tripped offline restored within less than 24 hours after the end of the storm<br>Repairs of damaged equipment may take several months | Less than 24 hours to 3 weeks<br>Longer recovery times (up to 5 weeks) with hurricane and/or storm damage |



Source: JRC, 2017

# Cascading impacts on other infrastructure

| | Earthquake | Space weather | Flood |
|---|---|---|---|
| **Transportation** | Structural damage to ports, airports, bridges, roads and railroad tracks.<br>Debris may block road and rail transportation.<br>Tsunamis may damage port infrastructure. | GNSS unavailability and/or positioning errors (navigation).<br>Radiation risk to avionics.<br>Minor disruption to road and railway transportation. | Flooding of roads and railway tracks.<br>Obstruction of roads due to debris left by floods.<br>Traffic congestion associated with evacuation may delay preventive shut down. |
| **Communications** | Structural damage to cell towers and two-way radio repeaters.<br>Cell phone network congestion. | HF radio communications blackout.<br>Satellite communications affected.<br>Cellular network base stations and two-way radio repeaters could experience increased static at dawn and dusk. | Inundation of telecommunications systems facilities and assets. |



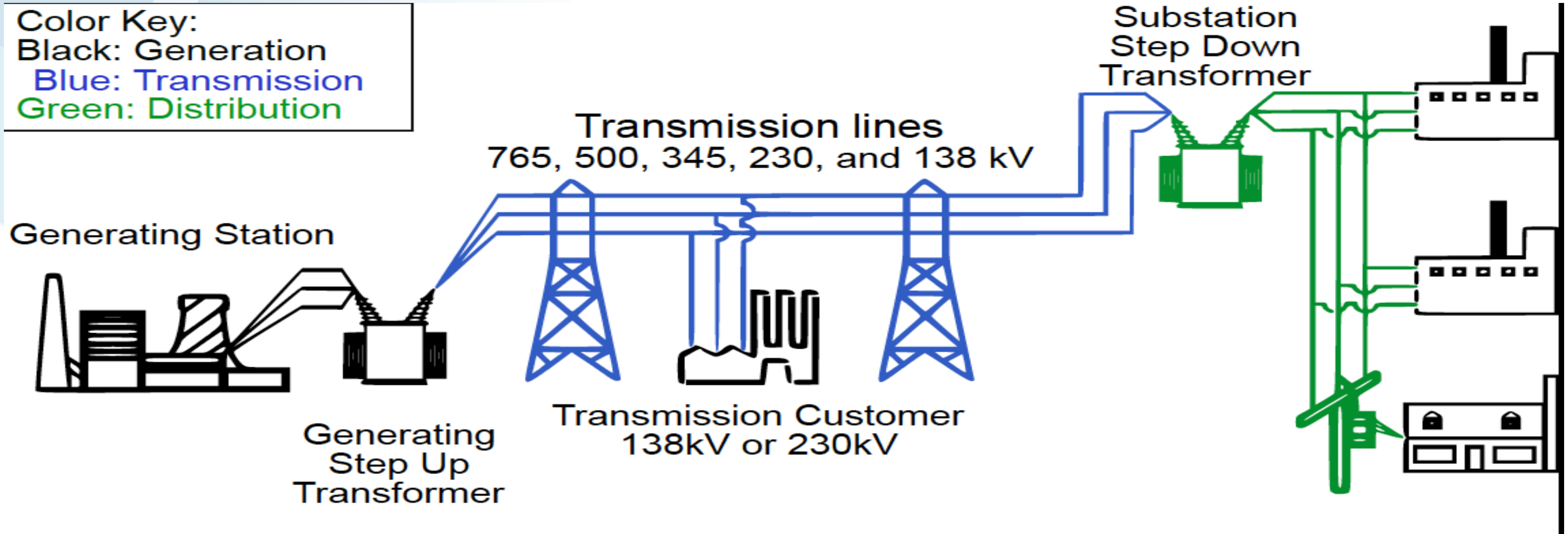

Source: Rehak et al., 2018

# Risk governance for critical energy infrastructure means

Various ways in which stakeholders:

- Policy-makers
- Practitioners
- Infrastructure operators
- Insurance companies
- Researchers
- General public

manage their common risk issues



# Risk governance

- Risk assessment should use a consistent set of scenarios
- Risk management efforts should be integrated to maximize efficiency
- Building resilience into power grid to enable to function under disaster conditions and recover quickly
- Spare items should be stockpiled to expedite the repair or replacement of key assets and equipment
- TSOs/DSOs should develop, implement and exercise outage management plans
- Interoperability among neighboring TSOs/DSOs, and between TSOs/DSOs and emergency management organizations should be ensured

Source: JRC, 2017

# Risk governance not only for risk mitigation but also for risk management

| Component | Repair strategy | Repair time |
|---|---|---|
| Transmission Tower | Replacement | 10 days |
| | Erect temporary tower | 1-2 days |
| Large Power Transformer | Inspect, reset and re-energize | 14-20 hours |
| | Refill oil, onsite | 2 days |
| | Minor repair, onsite | 1-2 weeks |
| | Change windings, onsite | 3 months |
| | Replace (no existing spare) | 1 year or more |
| | Replace with spare | 5 days |

Source: JRC, 2017

## Today

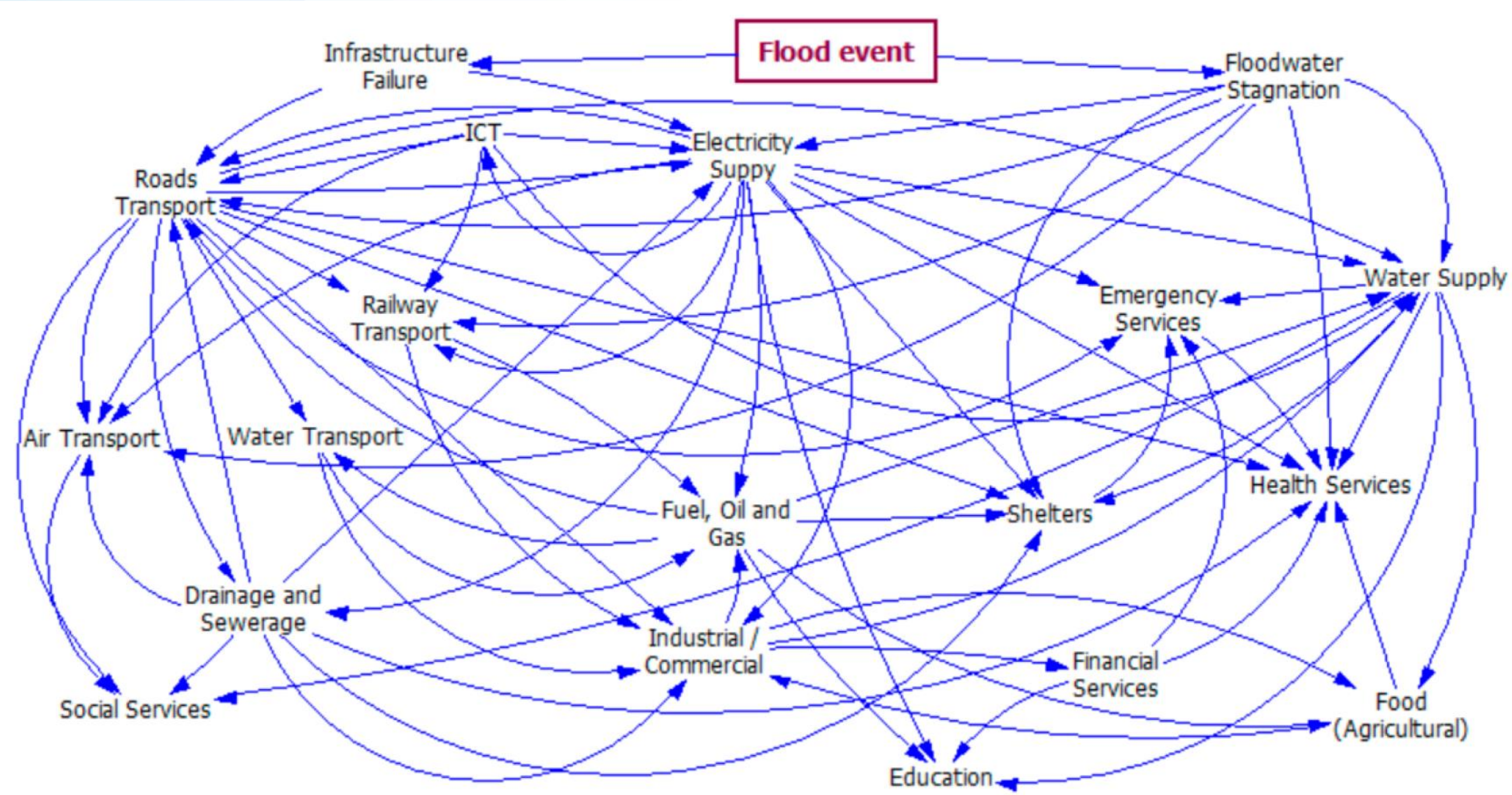
- Frequent prioritization of risks which can be significantly reduced and not necessarily risks with highest impacts
- Absence of systematic consideration of cascades and associated impacts

## Benefits of multi-risk approach

- Multi-risk approach – comparing and ranking of different risks, holistic view of interactions and conflicts of risks
- Improvement of spatial planning, emergency management and multi-risk governance
- Cost reduction, improvements in efficiency of risk mitigation and management measures and better identification of actions priorities

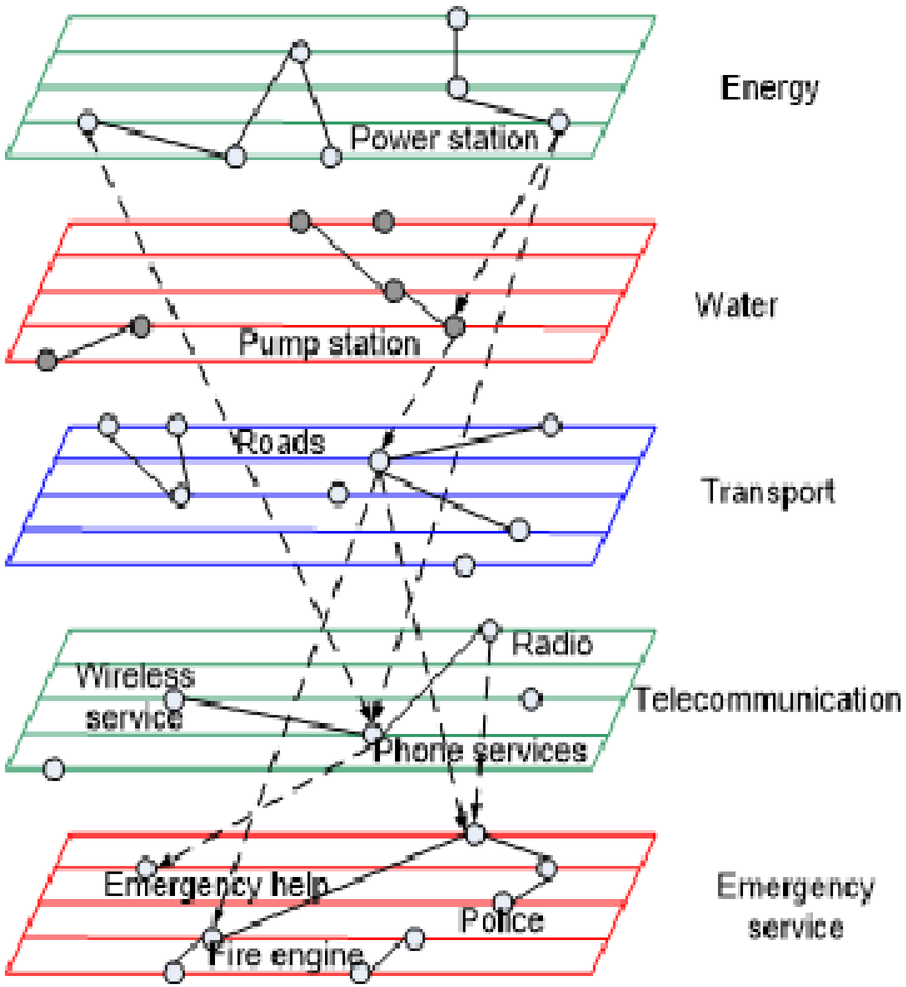
## Single risk centred regulation and institutional frameworks

- lack of integrated practices for risk management (that could support the implementation of a multi-risk approach)
- domino effects usually not included in risk zoning and urban planning



# Different goals and priorities of the agencies in charge of hazard management

- priority identification is single-risk centred and decisions are based on the risks that could be most reduced and not necessarily the highest assessed risks
- resources and capacities focused on hazards considered as major and primary (e.g., earthquakes) with induced effects (e.g. tsunami) being secondary




Source: Kirov et al., 2015

## Unsatisfactory public private partnership

- lack of communication between public and private actors (especially between industrial and natural risk sector)
- contradictory results of risk assessment

But

- Multi-risk governance demands a higher degree of cooperation between the public and private sector in order to understand and better manage unexpected events and their consequences

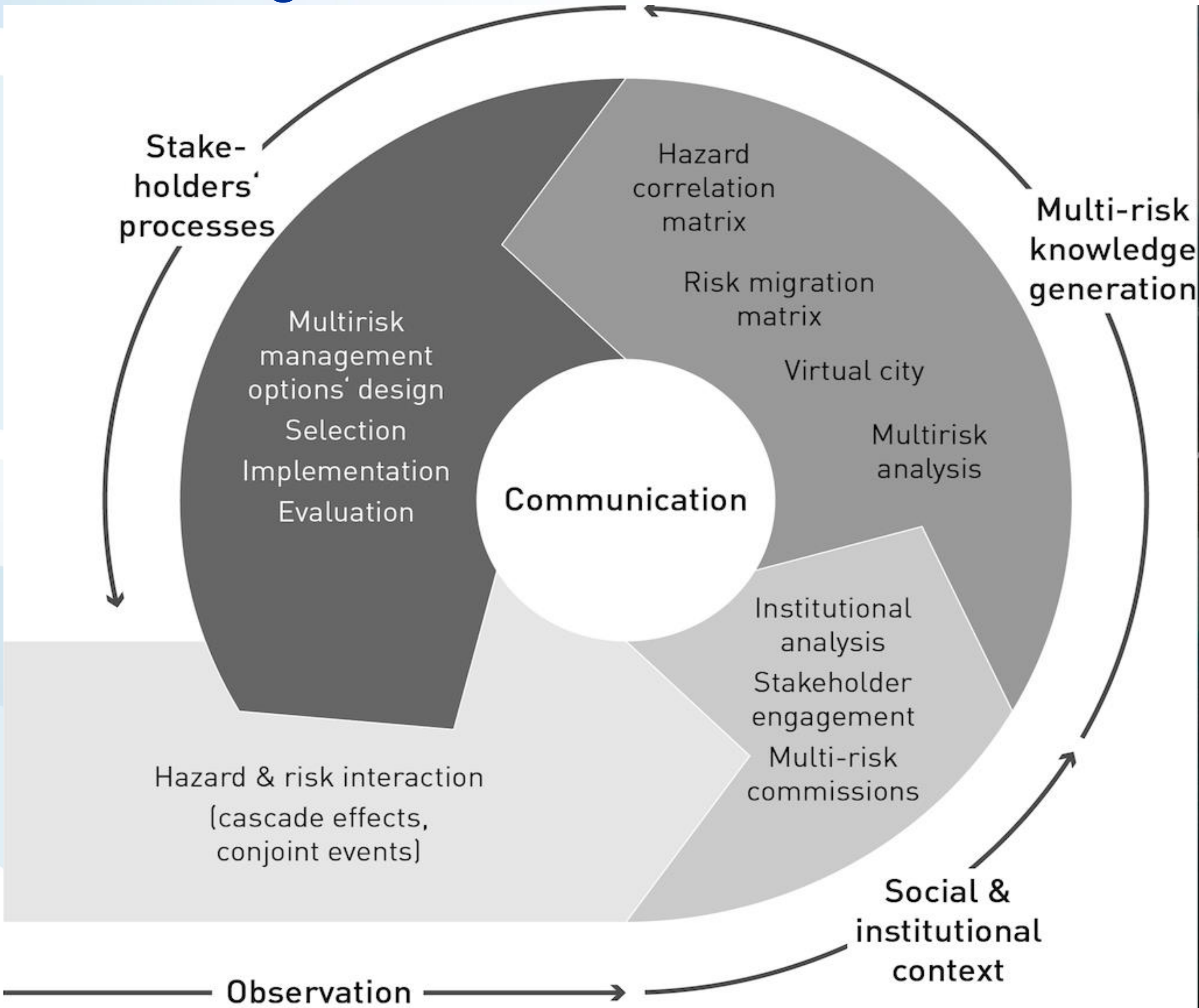
## Lack of interagency communication

- Cooperation and communication difficult for authorities acting at different levels
- Lack of harmonisation of the practices and decision making processes across hazards

Recommendation

- multi-risk commissions acting as boundary organisations would improve inter-agency cooperation, communication, or create opportunities for collaboration at the local level

# Multi-risk governance framework




Source: Scolobig, Komendantova and Mignan. Geosciences, 2017

# The framework foresees the following four phases:

- *Observation of hazard and risk interactions*, with a focus on the identification of cascades and associated effects;

- *Analysis of the social and institutional context*, including stakeholder engagement and the creation of forums/hubs to discuss, make decisions and set priorities for actions regarding multi-risk issues;

- *Generation of multi-risk knowledge*, including the use of different methods and tools such as multi-risk assessment, hazard correlation matrix and risk migration matrix, etc. in order to provide a preliminary scientific background for the following phase of multi-risk knowledge co-production and decision-making;

- *Stakeholder process,* aimed at designing and selecting multi-risk management/reduction options; implementing the chosen options, and evaluating them.

# Conclusion

- Multi-risk assessment have been developed in the past decade, the same is not true for multi-risk governance

- New multi-risk science can considerably improve planning and emergency management, it is still not yet clear how it can drive governance innovation in risk decision-making, legislation and policy

- Science-policy divide is apparent and needs to be addressed to mainstream multi-risk approaches in national and local risk policies

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