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Cross-border climate impacts and systemic risks in Europe and beyond
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A Framework for Multi - and Systemic -Risk Analysis: Focusing on Indirect Risks Based on Dependencies

Stefan Hochrainer -Stigler, Robert Šakić Trogrlić, Karina Reiter

*hochrain@iiasa.ac.at

International Institute for Applied Systems Analysis (IIASA)

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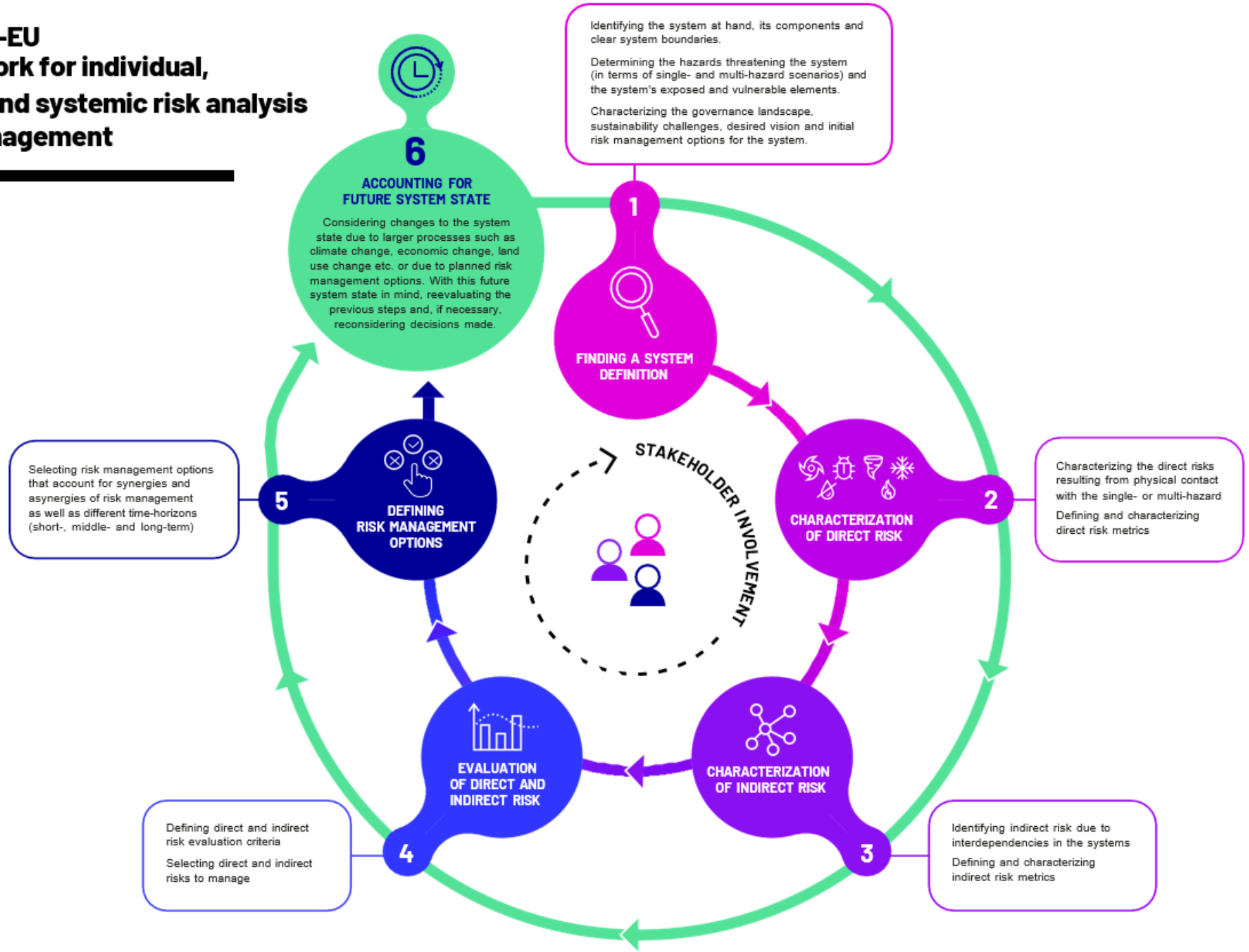
Background

- Importance of considering **multiple hazards and their interactions** (independent, triggering, amplifying, compound, consecutive):
  - *Impacts greater than the sum of its parts*
  - *Distorted management priorities and options*
- We live in an **interconnected world** with natural hazards having **ripple effects across boundaries** (e.g., 2011 Thailand floods, 2010 heatwave in Russia and floods in Pakistan) resulting in **systemic risk**
  - *System as a set of (partly) interconnected elements with clear boundaries, and systemic risk as a risk emerging due to interdependencies between elements of the system*
- **Lack of clear framework** for multi and systemic-risk assessment and management (Ward et al., 2022; UNDRR, 2021, Sillman et al. 2022)
- MYRIAD-EU proposes **a framework for multi -hazard, multi -sectoral, systemic risk analysis and management** to be implemented and co-developed in five pilots (Danube, North Sea, Scandinavia, Veneto, and Canary islands)

MYRIAD-EU framework for individual, multi-, and systemic risk analysis and management



Hochrainer-Stigler et al.
iScience 2023a

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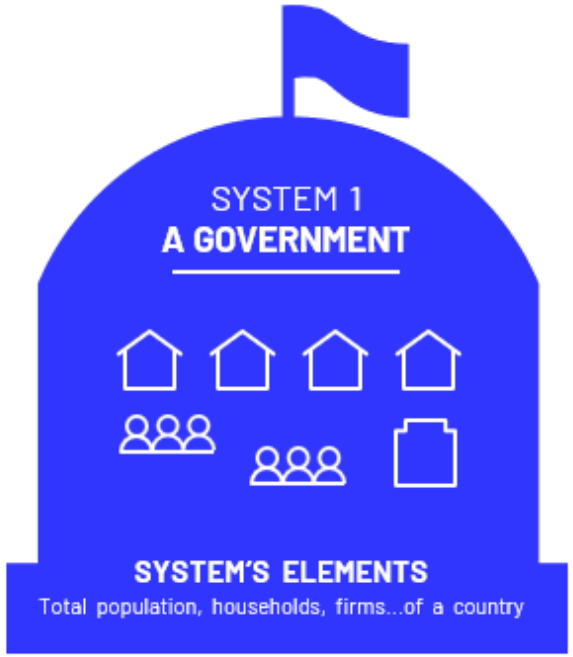
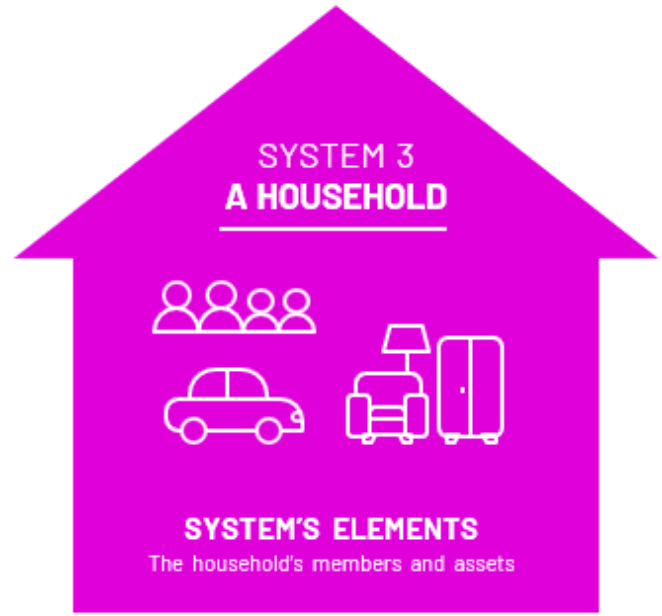
KEY CONCEPT

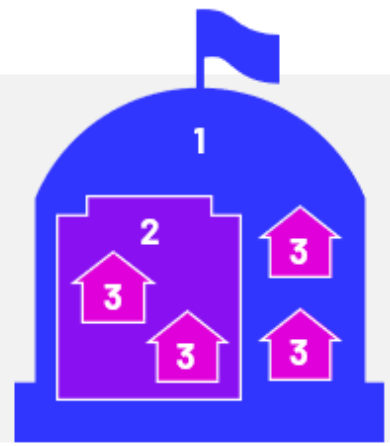
What is a system and what are system elements?





What are systems of systems?

The **Government is a system (1)** which includes **all households (system 3)** as well as the **insurance company (system 2)** which, in turn, includes a part of **all households (system 3)**



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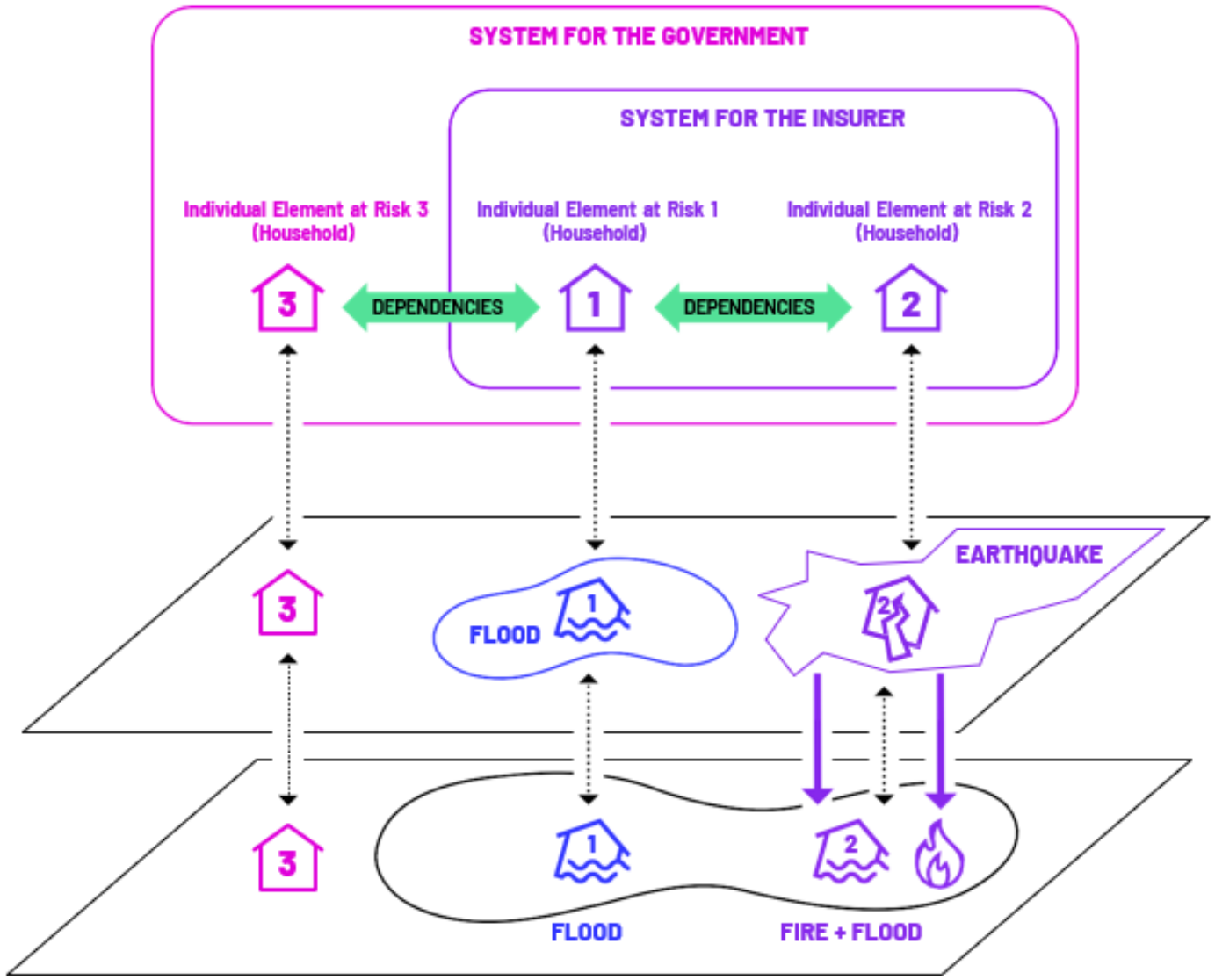
KEY CONCEPT

What do we mean by dependencies ?



- In the example, Household 3 not directly affected by natural hazards
- However, due to dependencies (e.g., economic dependencies) to Household 1, indirect impact occurs
- Indirect risk arises due to dependencies between system elements

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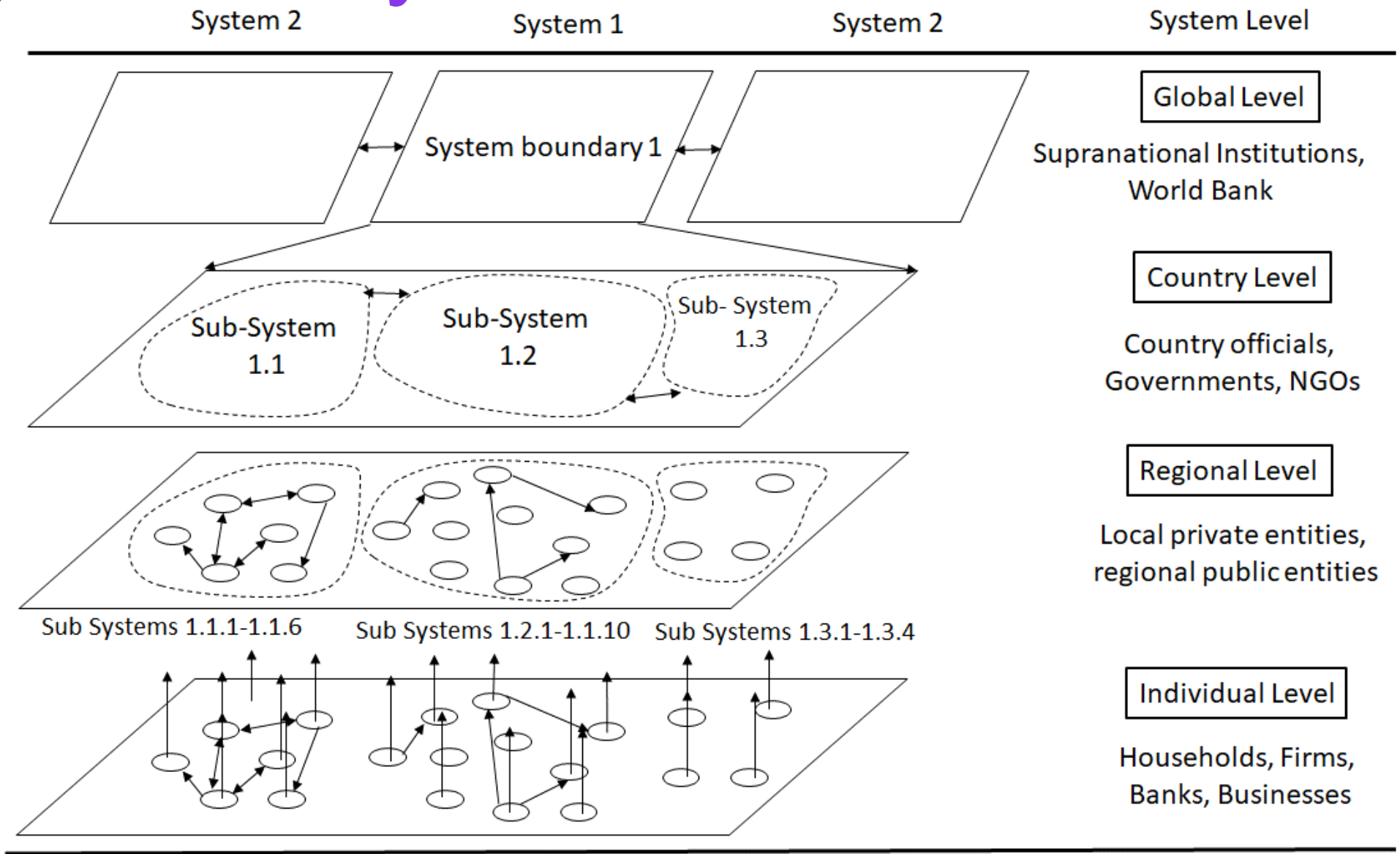
System of Systems



KEY CONCEPT

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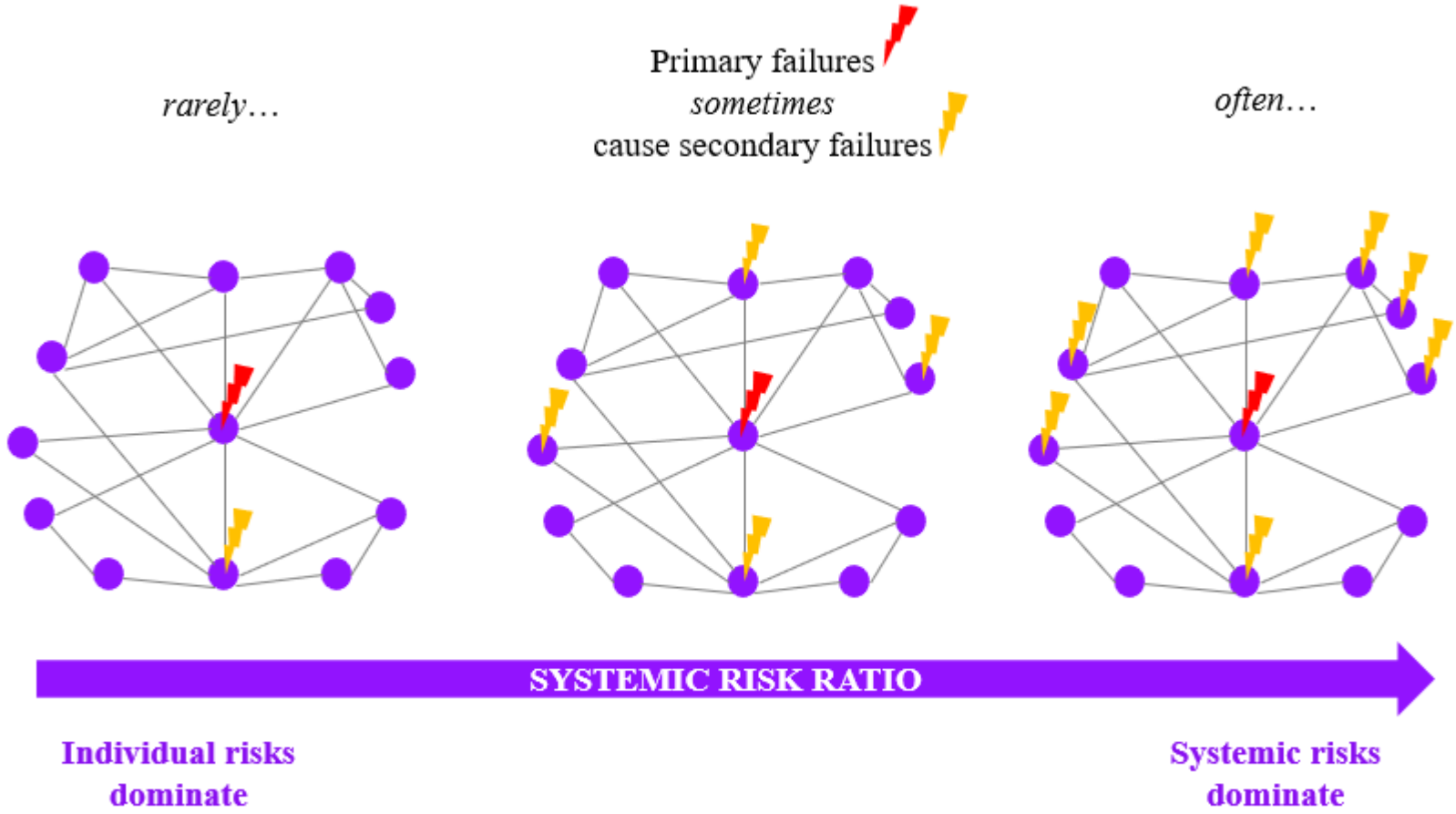
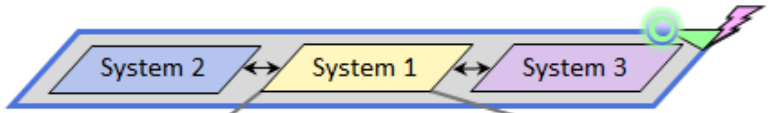
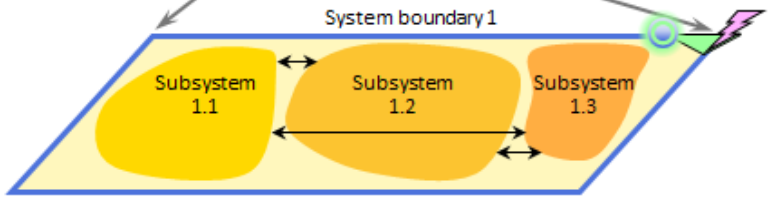
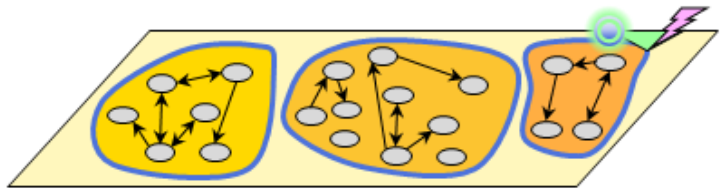
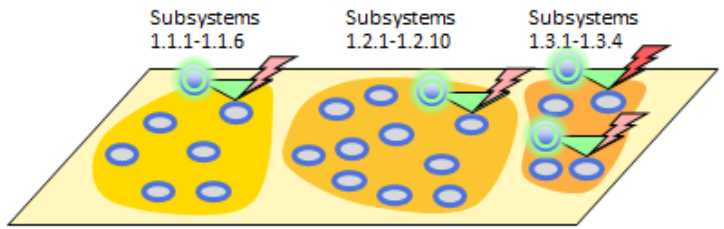
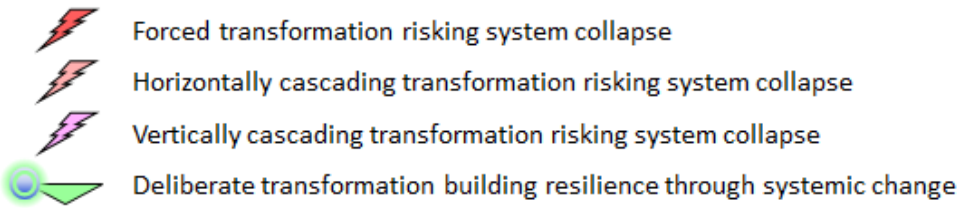
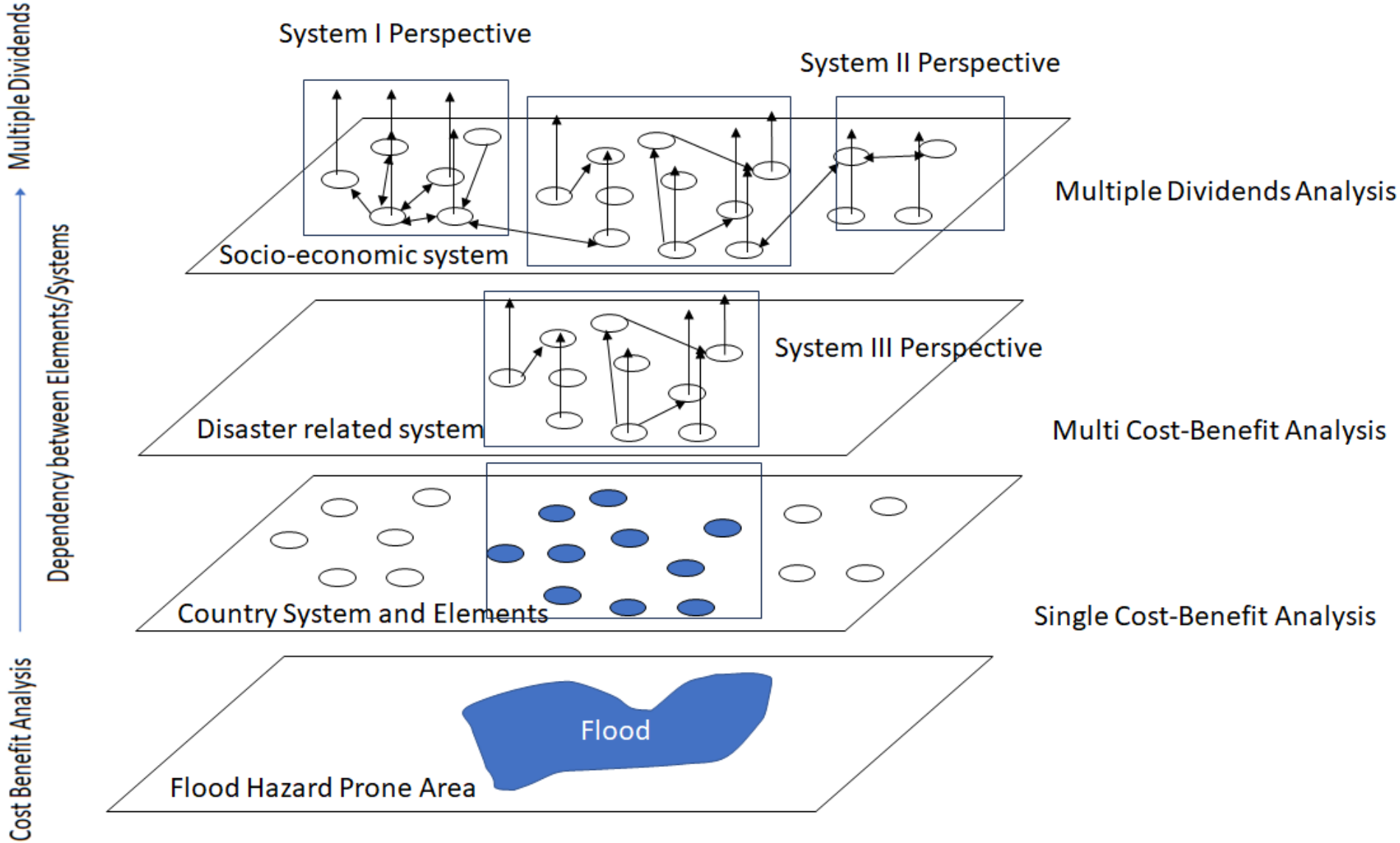


- Without any dependencies between hazards or system elements, a multi-hazard and multi-risk perspective can be handled by single hazards and single risk assessment frameworks .
- In case of dependencies , a multi-risk framework is needed, and options can be considered based on the systemic perspective .

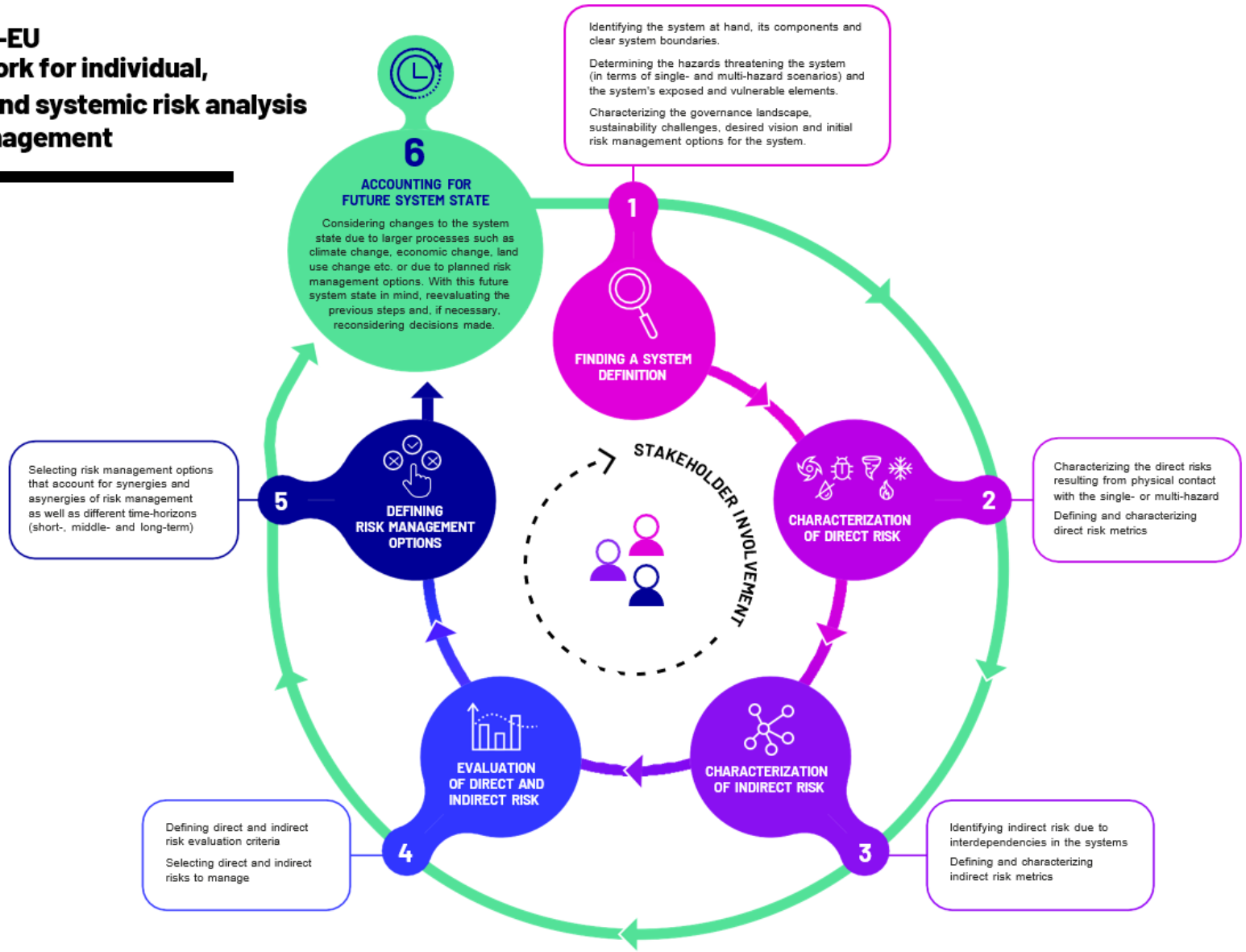
System scales	System actors (examples)	System boundaries and system interactions	Systemic risks (examples)	Options for systemic risk governance (examples)
Global level	Supranational institutions		Global system crash	Global pool for transformation
National level	Governments, NGOs, country officials		Country default	National socio-economic transformation
Regional level	Regional private entities, regional public entities		Regional ruin, community desolation	Regional socio-economic transformation
Individual level	Households, firms, banks		Household, firm, or bank collapse	Managed retreat and livelihood transformation



Multiple Dividends



Links to Storylines: Future System State



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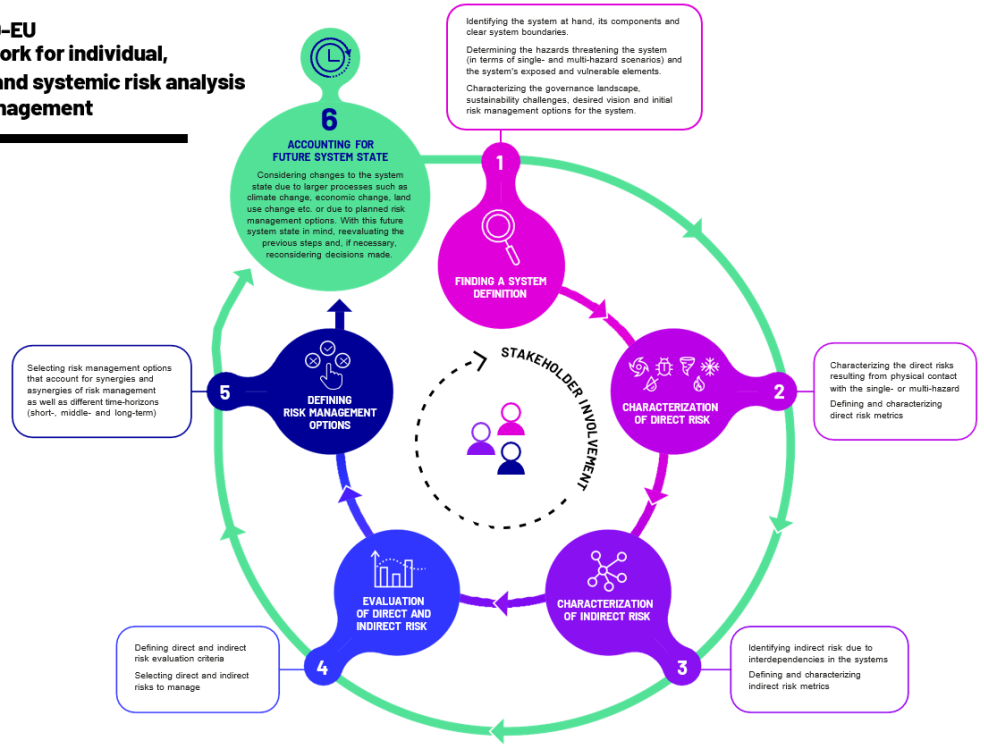
Framework benefits and limitations

Benefits

- Flexibility to address single - to multi - and systemic risks
- Accounts for risk dynamics
- Explicit focus on indirect risk
- Multiple lines of evidence approach
- System of systems perspective allowing for risk analysis and management across scales
- Strong emphasis on stakeholder engagement and co-production
- Forward -looking and embedded in larger sustainability issues

Limitations

- Framework complex
- Data requirements



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Framework implementation in practice

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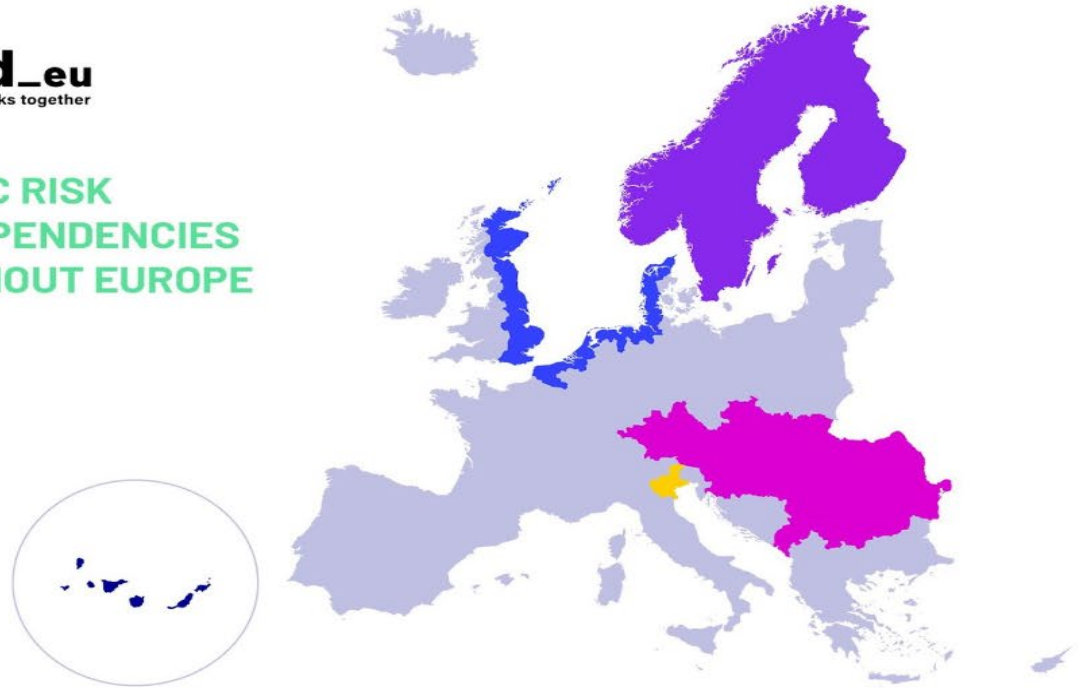
SYSTEMIC RISK
INTERDEPENDENCIES
THROUGHOUT EUROPE



NORTH SEA

CHALLENGE

How can spatial planning at the interface of the land and sea environments be optimised in the face of increasing and interrelated risk?

SECTOR
- ECOSYSTEMS & FORESTRY
- ENERGY
- INFRASTRUCTURE & TRANSPORT

HAZARDS
- Biological hazard
- Extreme wind
- Flood
- Heat
- Storm
- Thunder and hail

SCANDINAVIA

CHALLENGE

How can we maintain healthy ecosystems under climate-related risks while meeting increasing demands for energy, food, and other ecosystem services, and what is the role of nature-based solutions?

SECTOR
- ECOSYSTEMS & FORESTRY
- ENERGY
- FOOD & AGRICULTURE

HAZARDS
- Biological hazard
- Drought
- Fire
- Flood
- Heat
- Snow

CANARY ISLANDS

CHALLENGE

How can island regions with a strong dependence on tourism become more resilient to multi-hazard risk?

SECTOR
- ENERGY
- FOOD & AGRICULTURE
- TOURISM

HAZARDS
- Earthquake
- Flood
- Landslide
- Storm
- Tsunami
- Volcano

VENETO

CHALLENGE

How can diverse natural landscapes from the mountains to the sea achieve a forward-looking perspective conducive to multi-risk planning?

SECTOR
- ECOSYSTEMS & FORESTRY
- FINANCE
- TOURISM

HAZARDS
- Biological hazard
- Drought
- Fire
- Flood
- Landslide
- Snow

DANUBE

CHALLENGE

How can we increase resilience to multiple disasters that impact several interconnected countries with strong macro-economic relations?

SECTOR
- FINANCE
- FOOD & AGRICULTURE
- INFRASTRUCTURE & TRANSPORT

HAZARDS
- Drought
- Earthquake
- Flood
- Heat
- Landslide
- Thunder and hail

Concluding remarks on six steps

- We propose a framework for multi -hazard, multi -risk, systemic risk assessment and management
- The framework is iterative, and flexible to operate across single to multi -risk spectrum
- The framework is based on two core aspects: system boundaries and dependencies between elements of the system
- We will develop a set of guidance protocols for the implementation of the framework and a wide range of tools for the implementation of various steps of the framework

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End of Presentation Discussion

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