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STRENGTHENING URBAN RESILIENCE FROM UNDERSTANDING CITIES AS COMPLEX ADAPTIVE SYSTEMS

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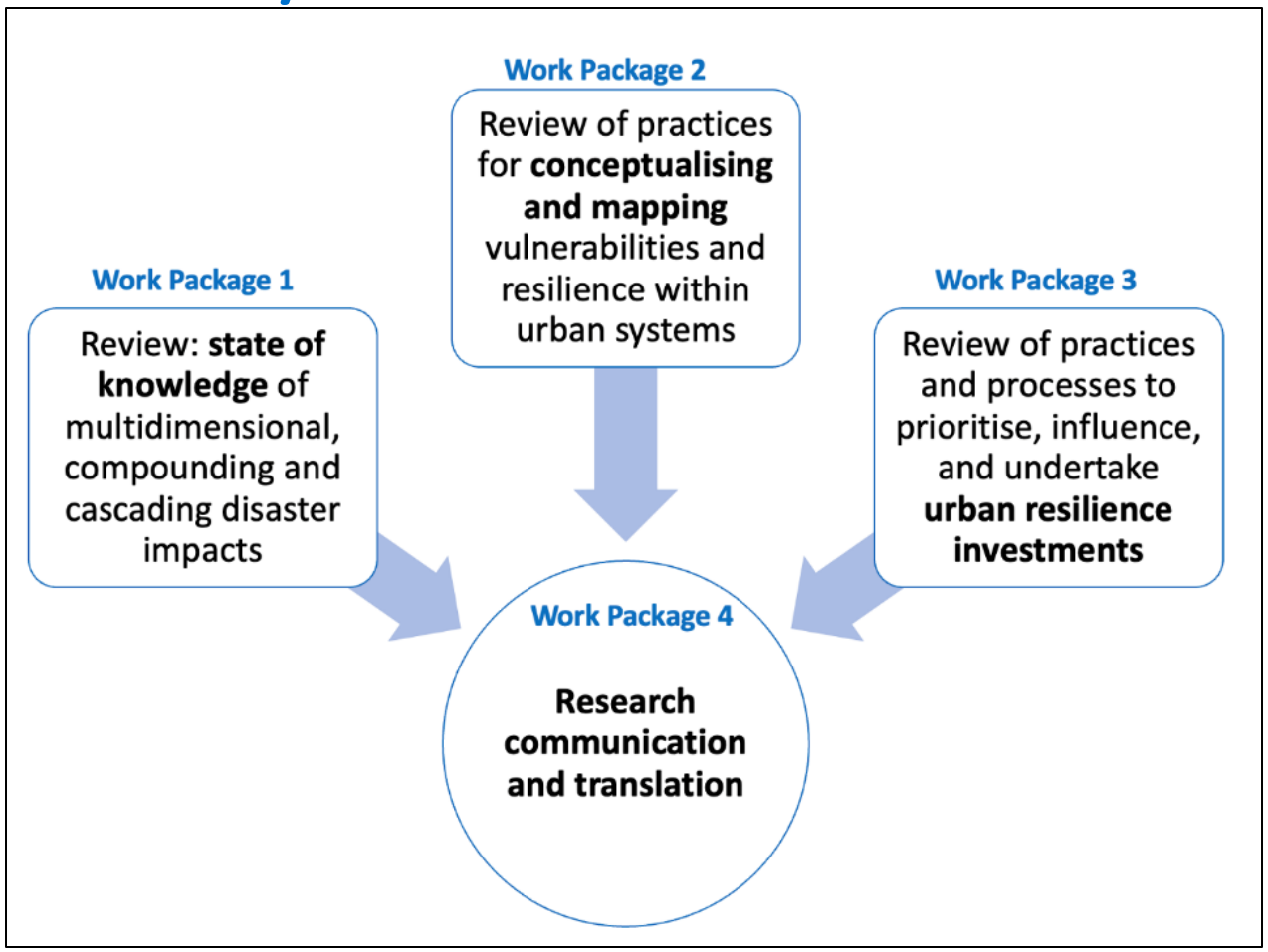
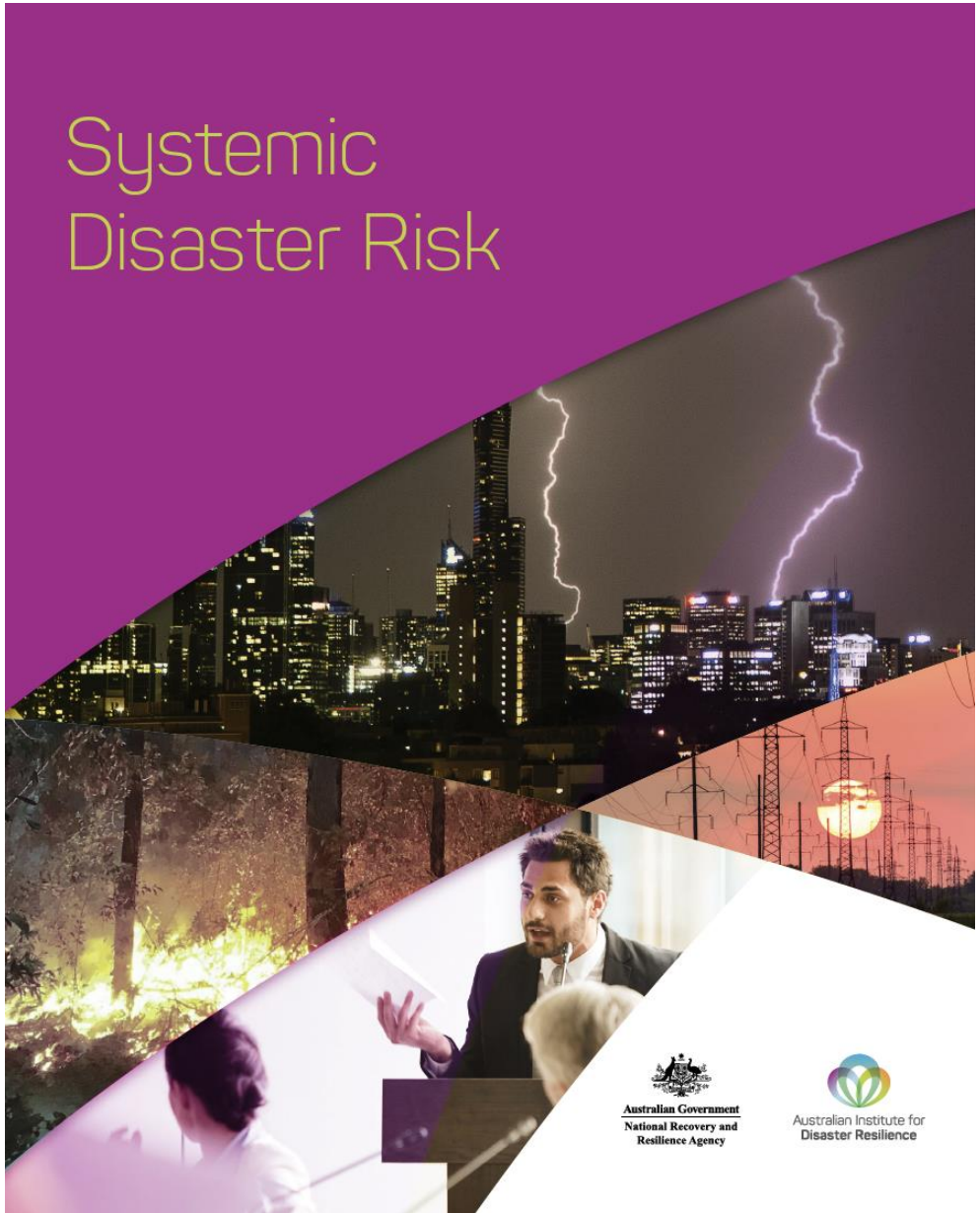
T2-A9 Natural Hazards and resilience in complex urban systems

Natural Hazards Research Australia

RMIT UNIVERSITY





2021

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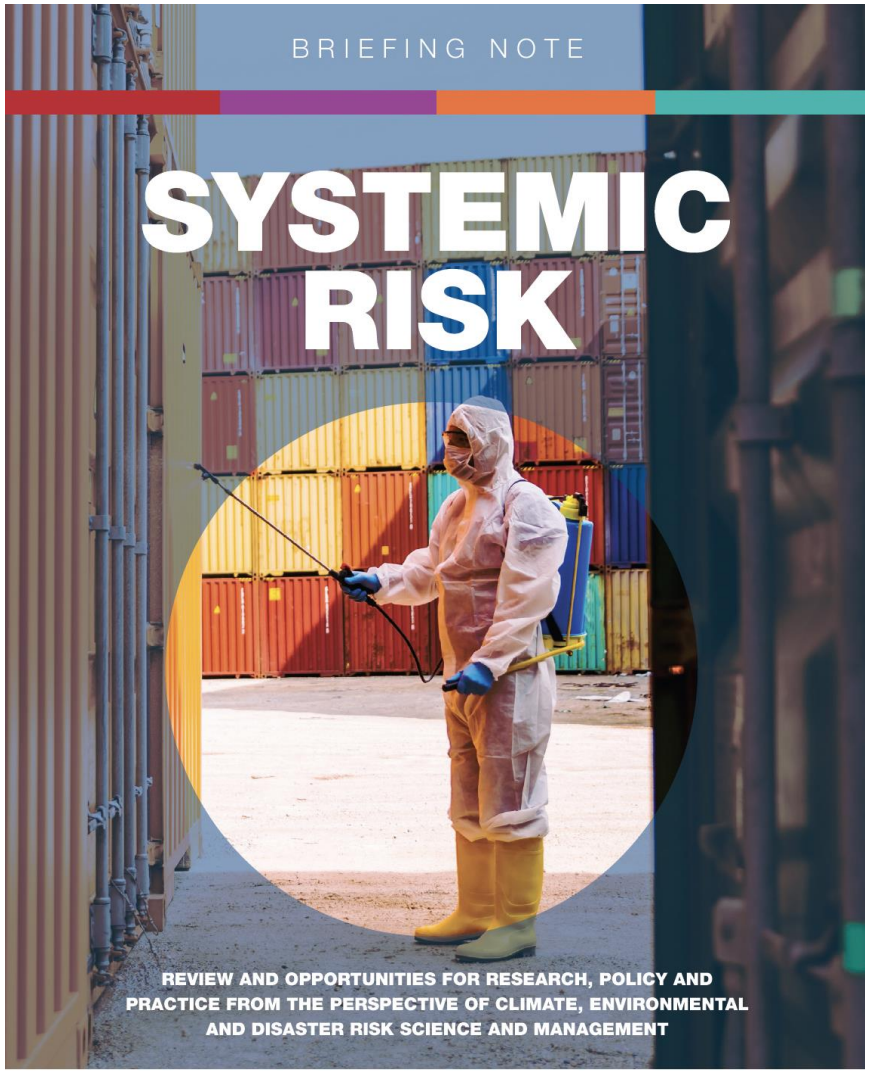

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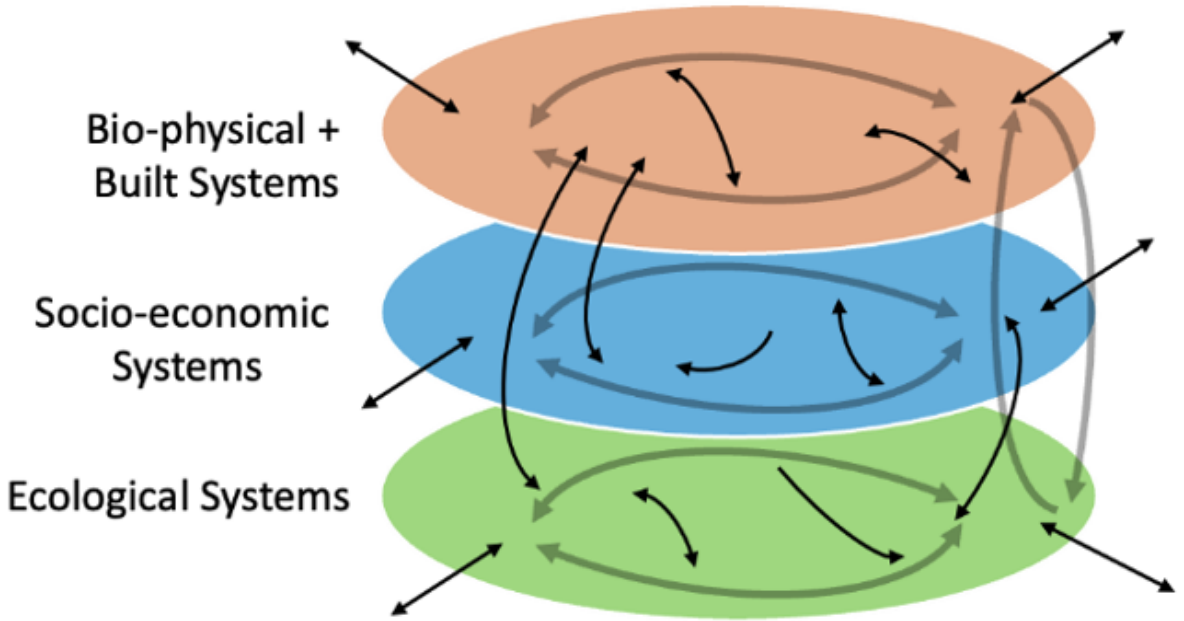
Cities are complex systems of open systems

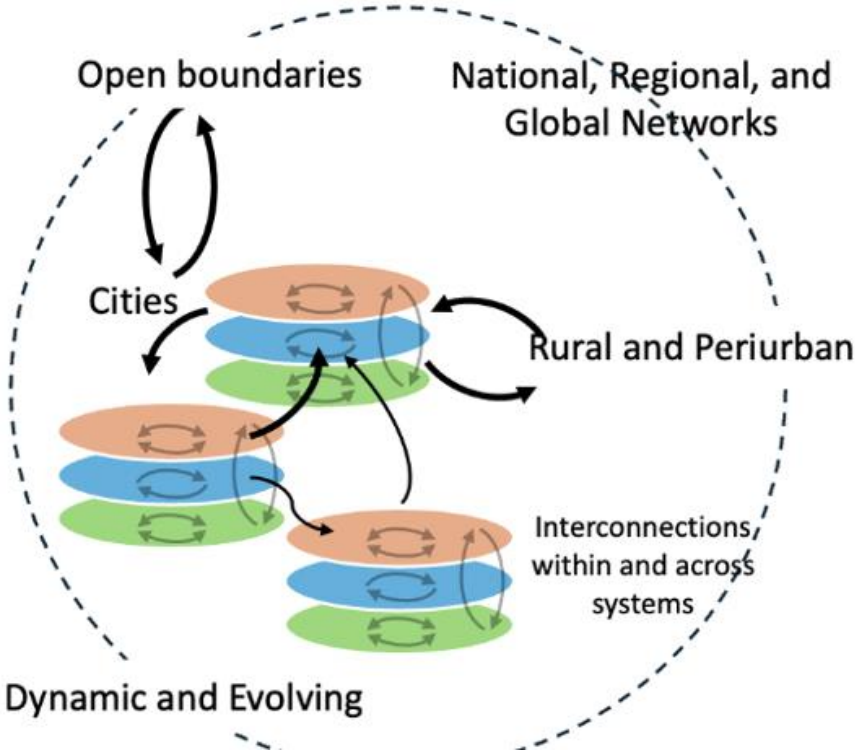
CITIES AS COMPLEX SYSTEMS

Interconnected elements, subsystems and systems



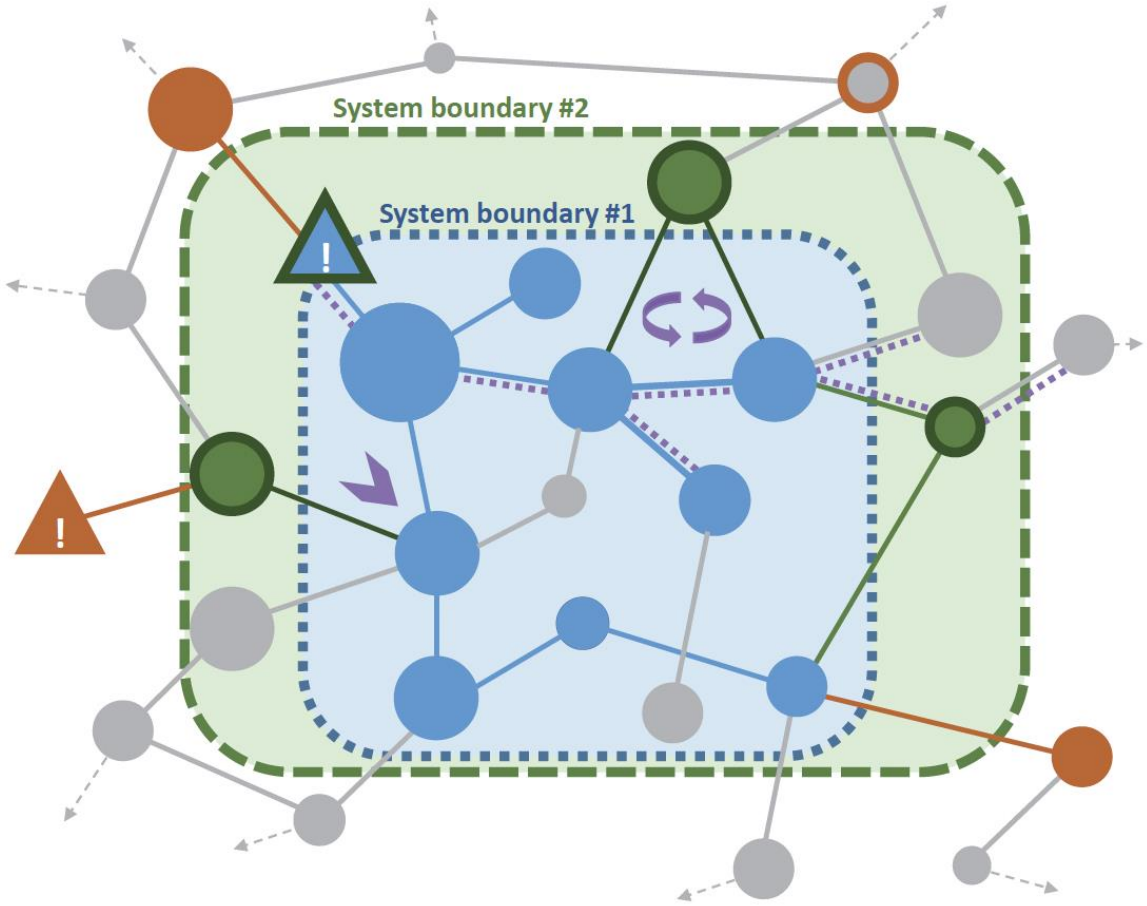
CITIES AS OPEN SYSTEMS

Cities are open systems, both influencing and influenced by the external world via complex linkages and feedback loops



(Bai, et al., 2016)

Complex, open systems → Systemic risk



Legend

Colours represent inclusion in model (or perspective)

- Endogenous system component (directly modelled)
- Exogenous system component (passed to model)
- Unmodelled or unknown component

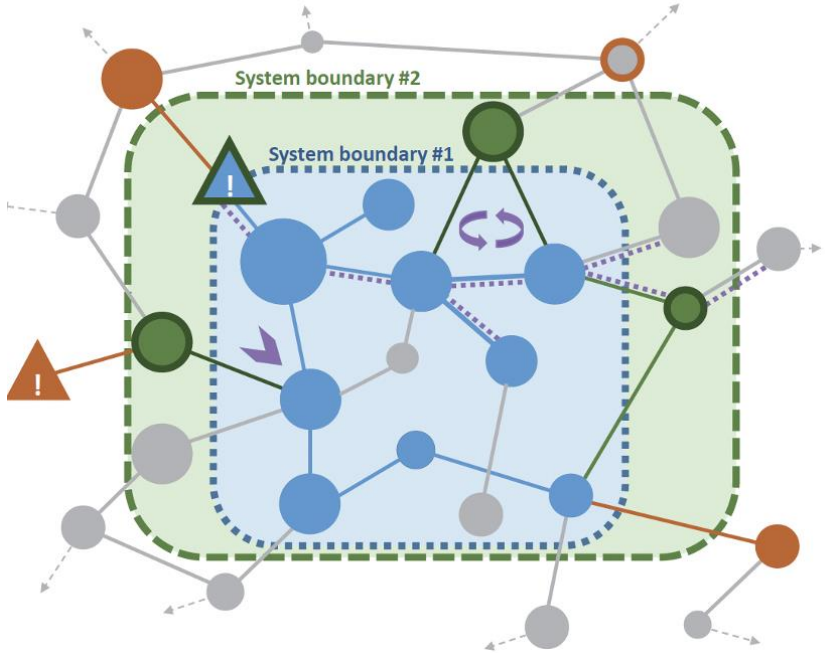
Shapes represent system elements and interactions

- **System element**
  Representation within system boundaries (colours)
  Size of circle indicates element prominence
- **Event/shock affecting system elements**
  Representation within system boundaries
- **Element interaction/dependency**
- **Interaction outside of displayed system**

Special symbols and letters represent important systemic effects exemplified by key system points

- **Cascading risk**
- **Feedback loop**
- **Compound risk**

Systemic risk in complex, open systems →



- Non-linear interactions between elements, subsystems and systems
- Unpredictability of cause-and-effect outcomes
- Causes the system to respond by adjusting and adapting into new patterns (self-organizing)
- As new patterns emerge, the system becomes “more than a sum of its parts”

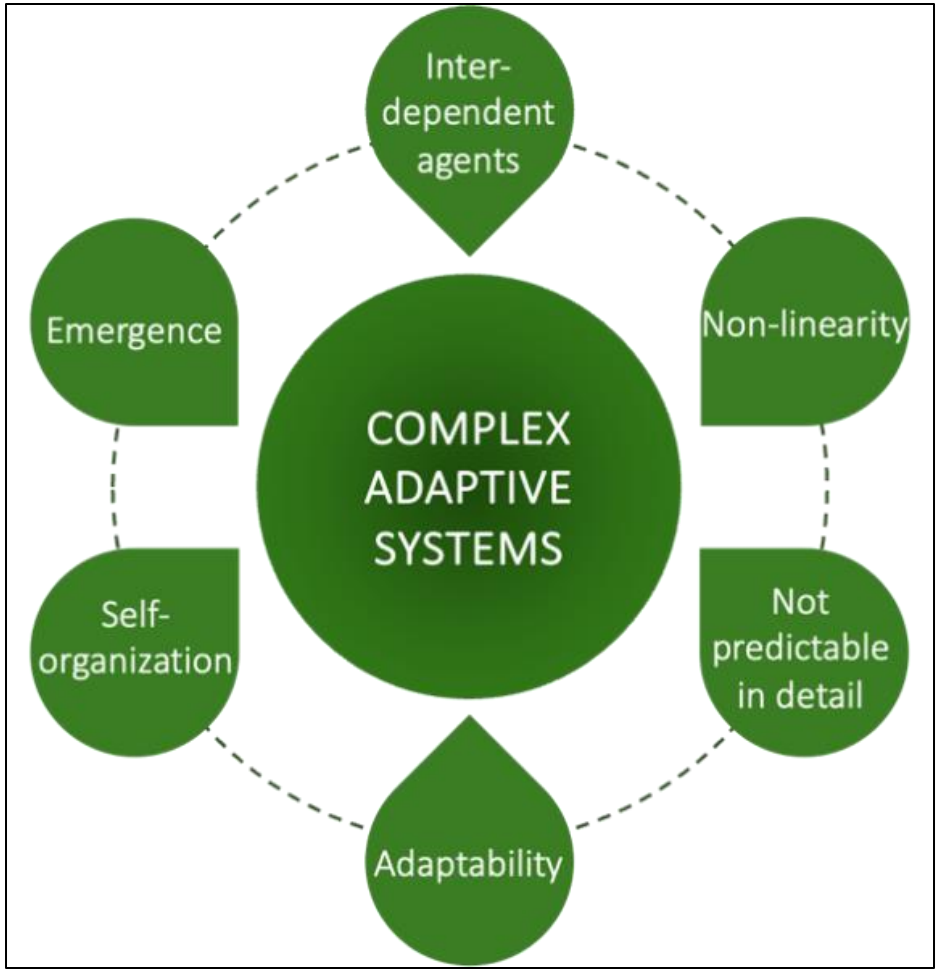
Cities are a particular type of system

Cities are Complex Adaptive Systems (CASs)

When disruptions occur, they have the capacity not just to **self-organise**, but to continuously **re-organise** their elements, sub-systems, and the patterns and impacts of their interactions.

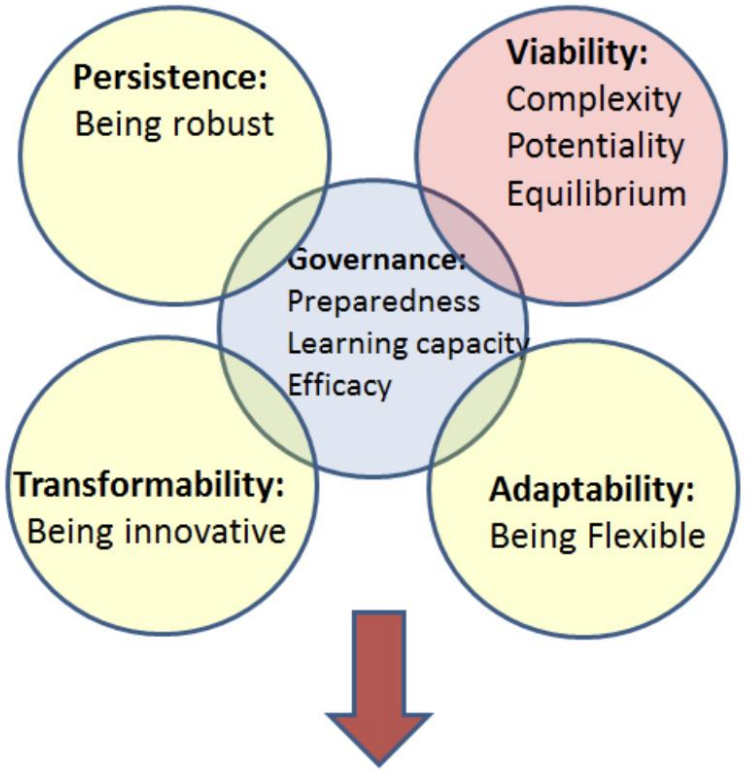
Their **emergent** properties are more than the sum of the individual parts — but feed back to the parts, thus contributing to new ongoing interactions.

(Adapted from Folke, 2006, pp. 5-6)



(Adapted from Akinboade, 2021, p. 5)

What do the changes in CASs lead to?



Equilibrium **OR** Resilience?

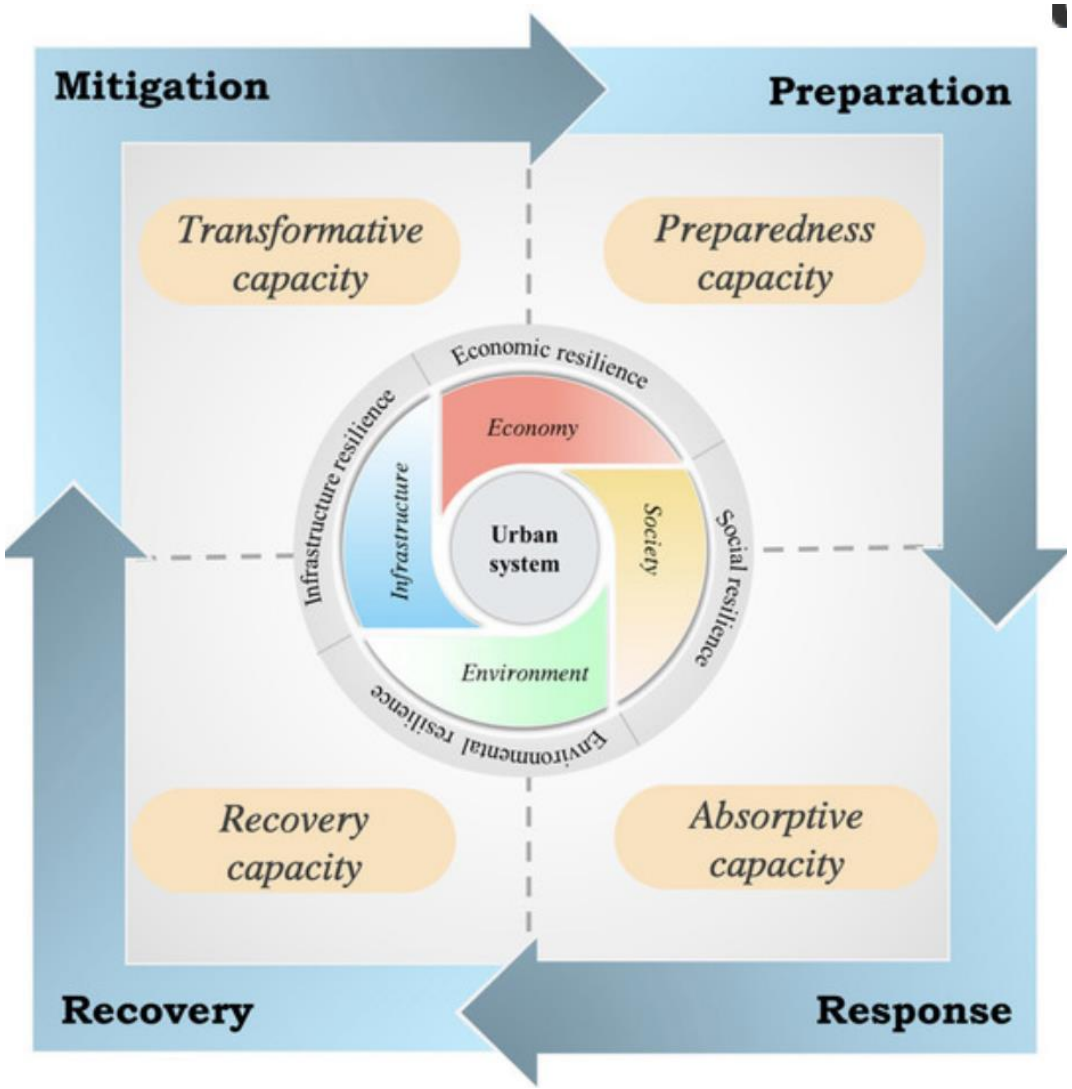
EQUILIBRIUM describes a a state of balance that a system seeks to return to in response to disturbances of any kind

RESILIENCE is the capacity of a system to absorb disturbance/s and then reorganize and adapt to the new conditions through self-organisation and emergence and, thus be better prepared for future disturbances.

Inherent resilience

All cities have a degree of pre-existing resilience

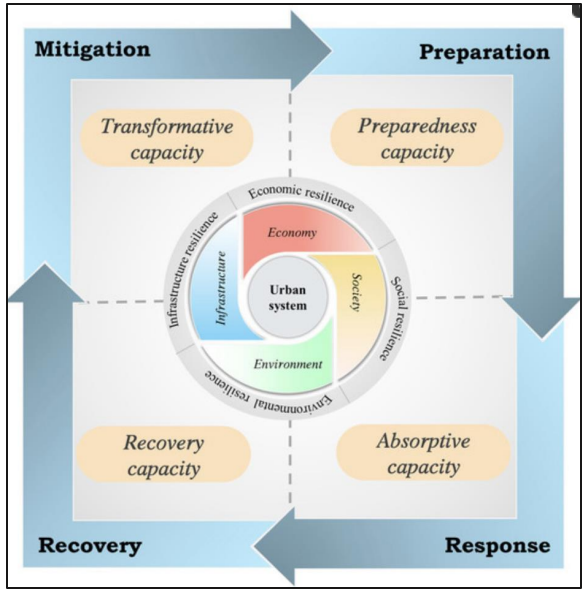
- Based upon a variety of capacities.
- But these are unevenly distributed in society – and urban centres
- Capacities for resilience can be strengthened
- **Planned resilience**

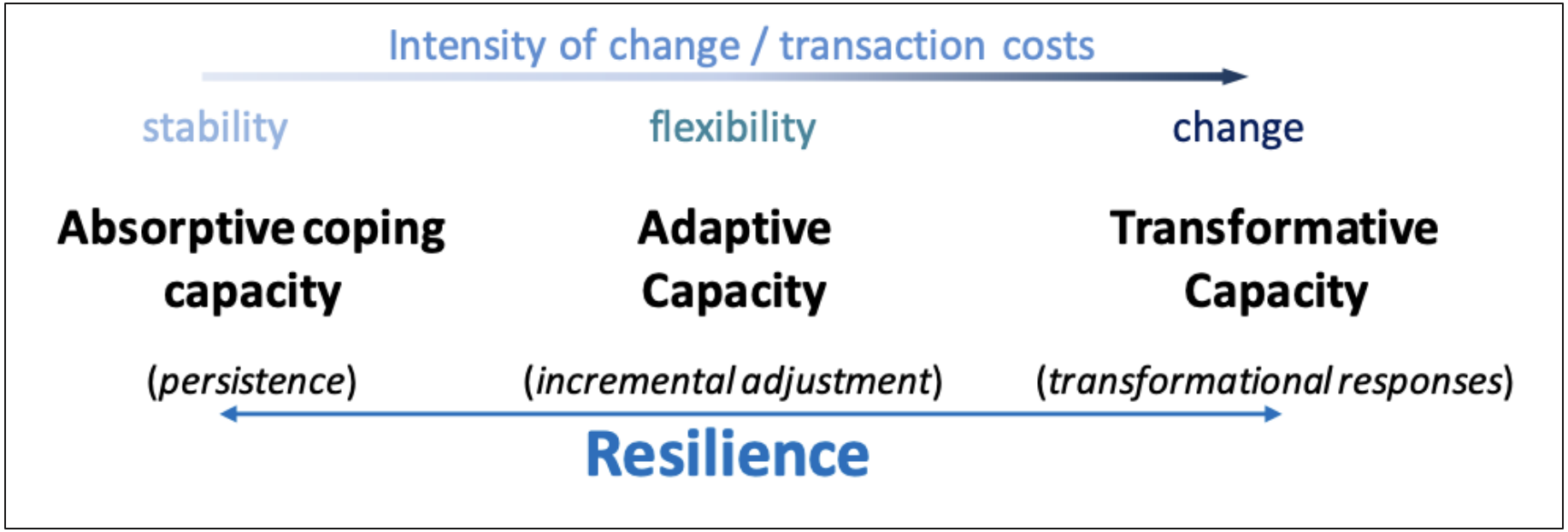


(Scheffran, 2016, Figure 1)

And here we have decisions to make!

- How do we define resilience?
- Do we want to address drivers of shocks or the stressors that intensify vulnerabilities
- What capacities need strengthening?
- How much change can society tolerate? What transaction costs will we bare?





Implications

- The causes and impacts of hazard events and vulnerability are systemic.
- Systemic risks lead to compound hazards and disasters that have system-wide cascading impacts.
- Multi-hazard and multi-risk approaches are necessary to reduce vulnerabilities and strengthen resilience
- Treating cities as complex adaptive systems facilitates action at key leverage points of the stressors that cause systemic vulnerability.
- Action on leverage points is best embedded upstream in the dynamics of urban systems, rather than after a disaster.
- Risk awareness, risk resistance and absorption, adaptation and transformation are needed to reduce systemic vulnerabilities and help future-proof the resilience of urban subsystems and systems.

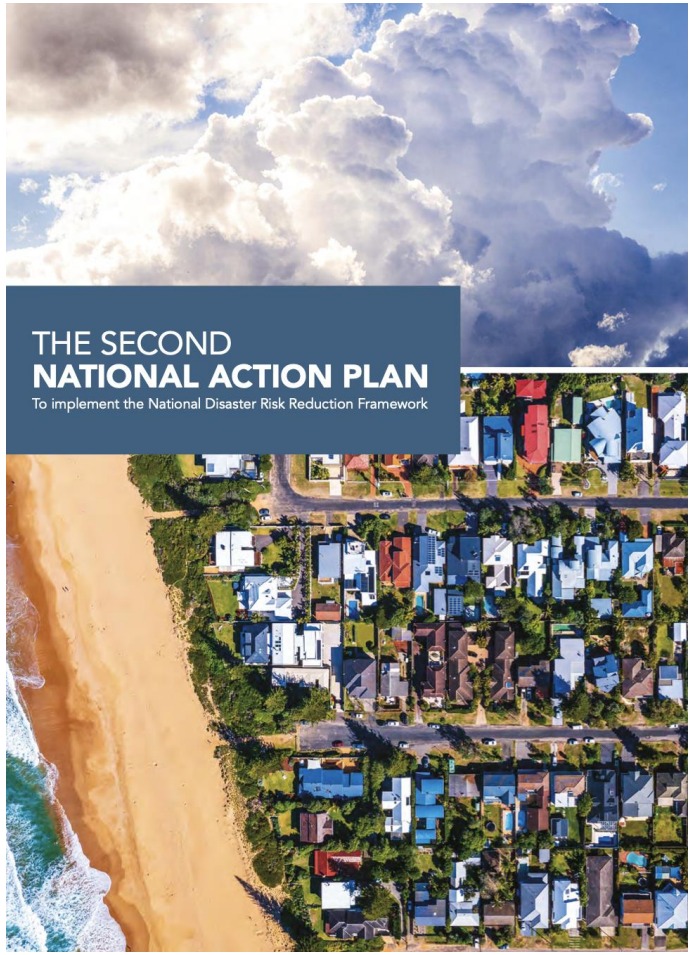
Summary

- **Strengthening urban resilience requires approaches to risk and disaster preparation, mitigation and recovery that:**

  - Multiple rather than single hazards and risks
  - Anticipate and plan for cascading impacts
  - Adopt an area-based approach (local context matters!)
  - Address underlying systemic or structural causes of vulnerability
  - Strengthen the adaptive capacities needed for systems resilience
  - Recognize the agency of humans in complex adaptive systems
  - Insist upon the primary agency of those most involved and impacted.

Second National Action Plan

to implement the National DRR Framework



For disaster resilience, we must:

- Take a big-picture, integrated approach to disaster risk reduction to mobilise all sectors to build resilience for the long-term.
- Accelerate efforts to reduce the drivers of vulnerability and disaster (e.g. emission reduction, poverty, inequality, social determinants of health).
- Shift mindsets and ways of thinking about disaster risk reduction to resonate with whole-of-society agency and action.

(NEMA, 2023, p. 73)

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