



Water Security & Sustainability Lab
Department of Environmental Sciences & Technology

The Urban and Built Environment Ecology Lab
Department of Environmental Science & Technology

Green Infrastructure and Ecosystem Services Assessment in Urban Environment

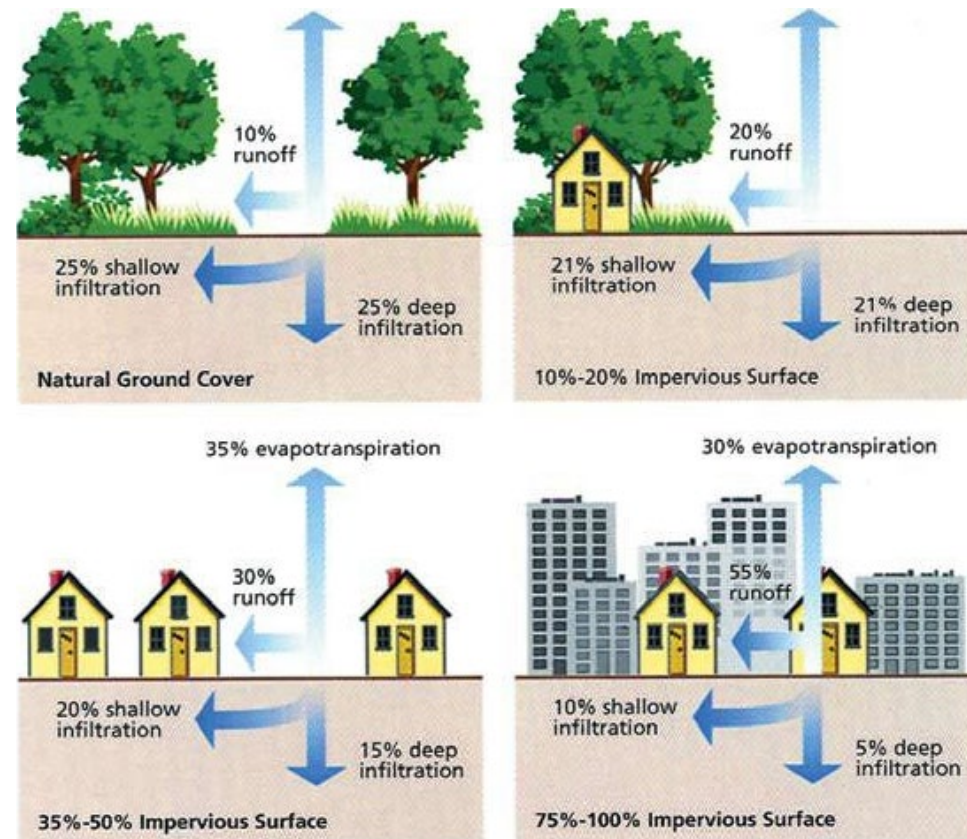


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Managing Water in Urban Areas

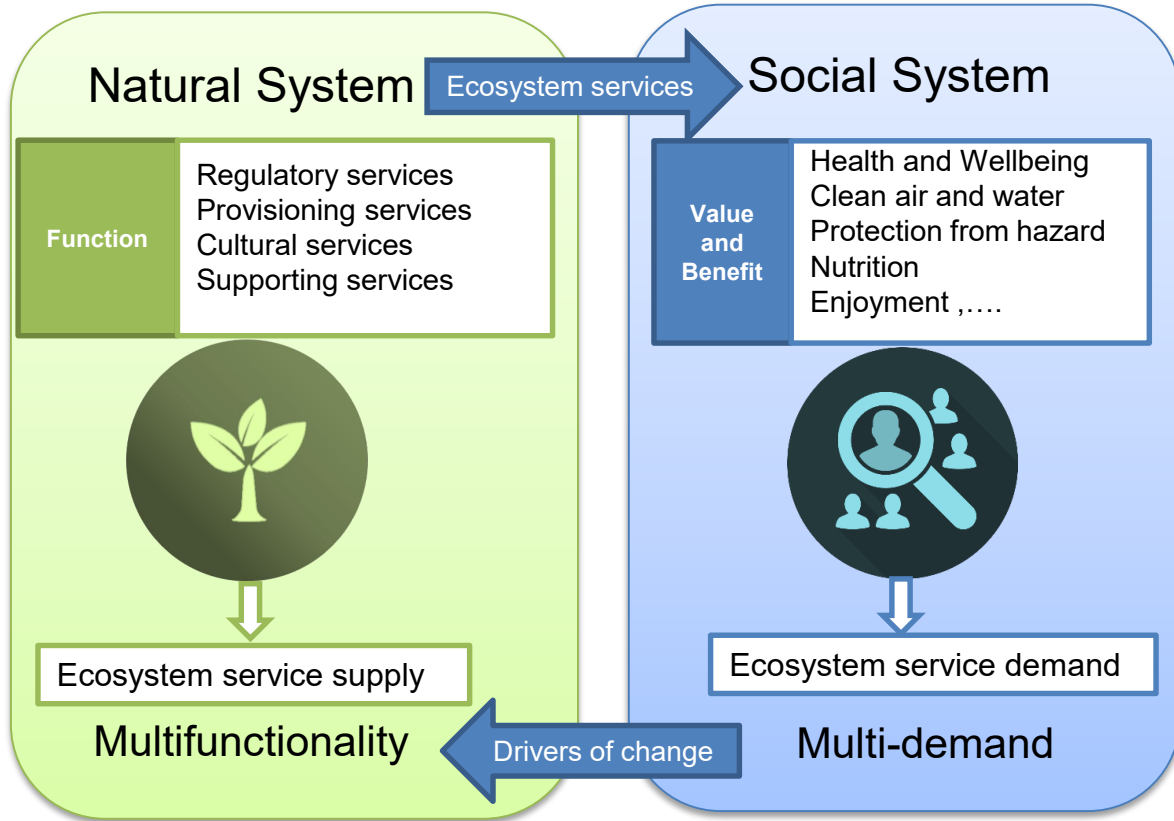
- Climate change
 - Increase risk of flooding
 - Water scarcity
- Urbanization
 - Urban population (U.S.): 82% (Central Intelligence Agency, 2017)
 - Urban development
 - Increase impervious surfaces
 - Increases the runoff volume and rate
 - Reduces groundwater recharge and evapotranspiration



<https://www.arcsa.org/>

Green Infrastructure (GI) as a solution

- Green Infrastructure
 - Economical, resilient tool to managing humid weather
(EPA, 2018)
- Ecosystem Services
 - do not exist without demand by humans
(Fisher et al., 2009)



Adapted from Vallecillo et al. (2018)

Green Infrastructure Ecosystem Services

- *Primary*

- Flood control
- Pollution reduction
- Climate adaptation
- Water harvesting
- Groundwater recharge

- *Secondary*

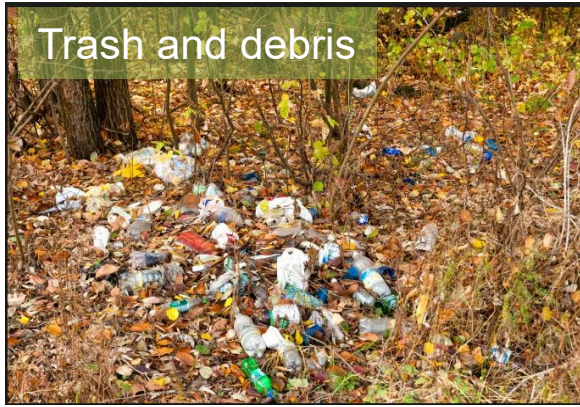
- Cultural services
- Supporting services
- ...

- Lack of functionality
Prevents appropriate ecosystem services provision



Risks to GIs

Trash and debris



Sedimentation



Invasive species



Source of pollution



Improper design



blockage



Extreme events



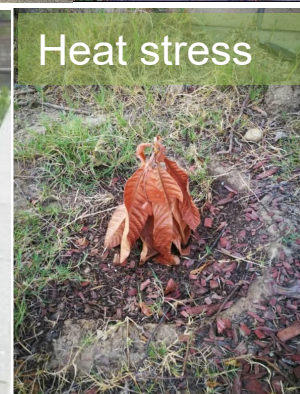
Social attitude



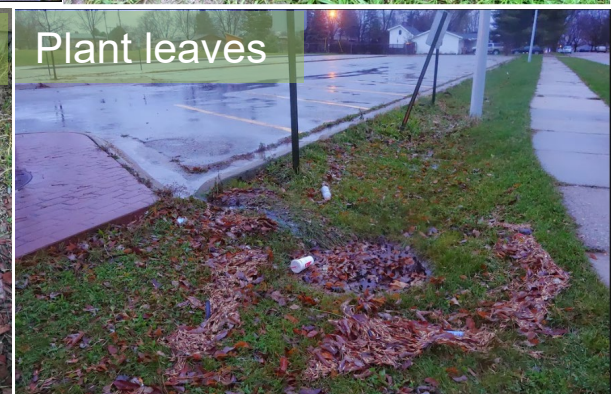
Stagnant water



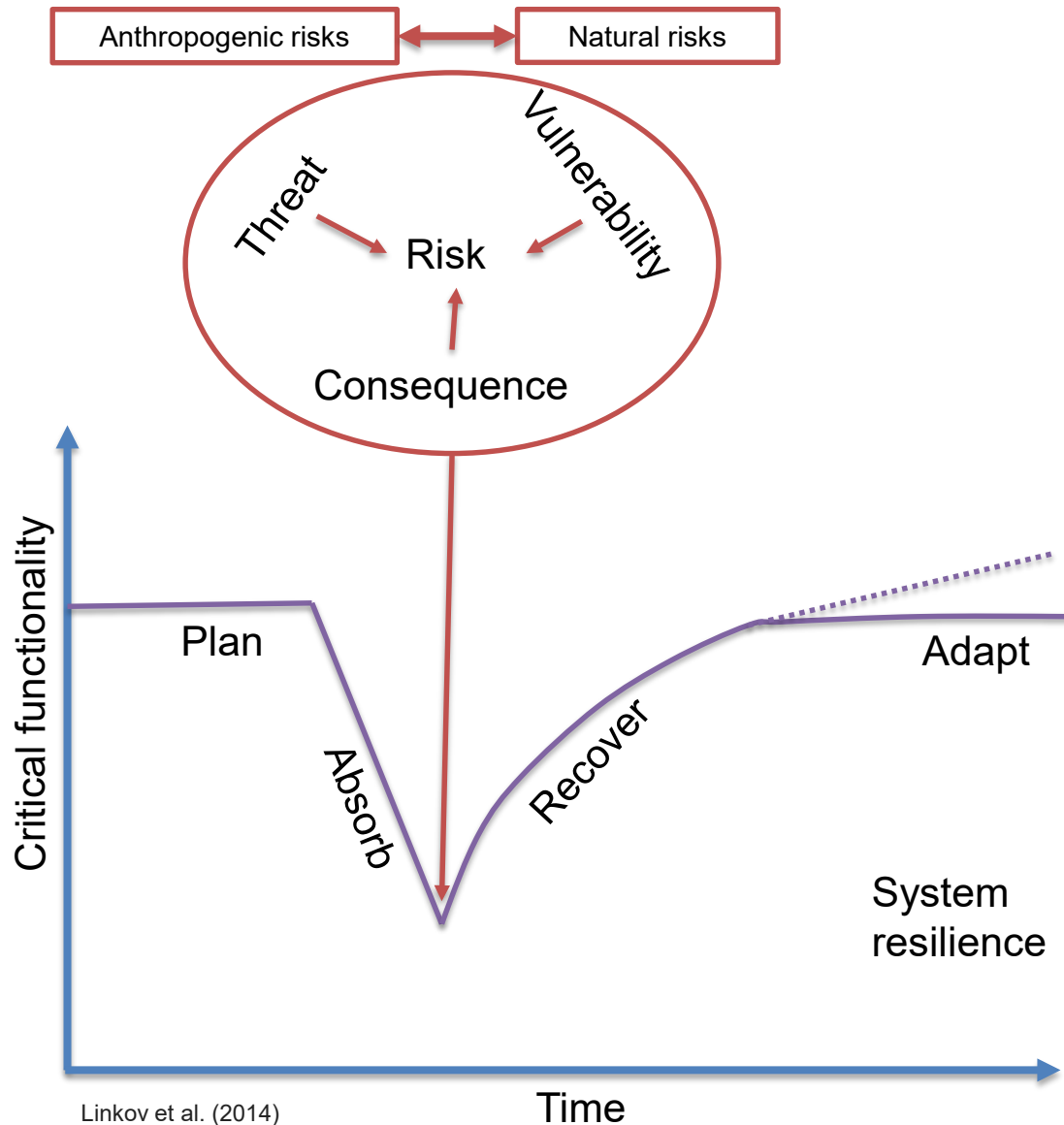
Heat stress



Plant leaves



GI for increasing resilience for urban areas vs. GI resilience



Structure of the framework

Stage 1

- Determination of gaps for existing GI frameworks



Stage 2

- Listed categories
- Provided a general procedure



Stage 3

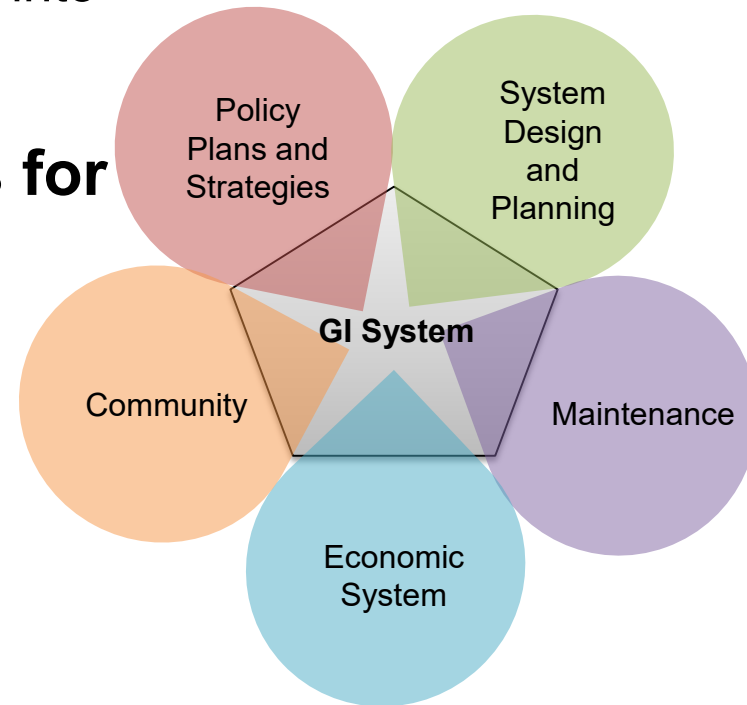
- Listed detailed indicators
- Provided a checklist
- Related each indicator to dimension of resilience

Stage 1: Identifying the Gaps of previous frameworks

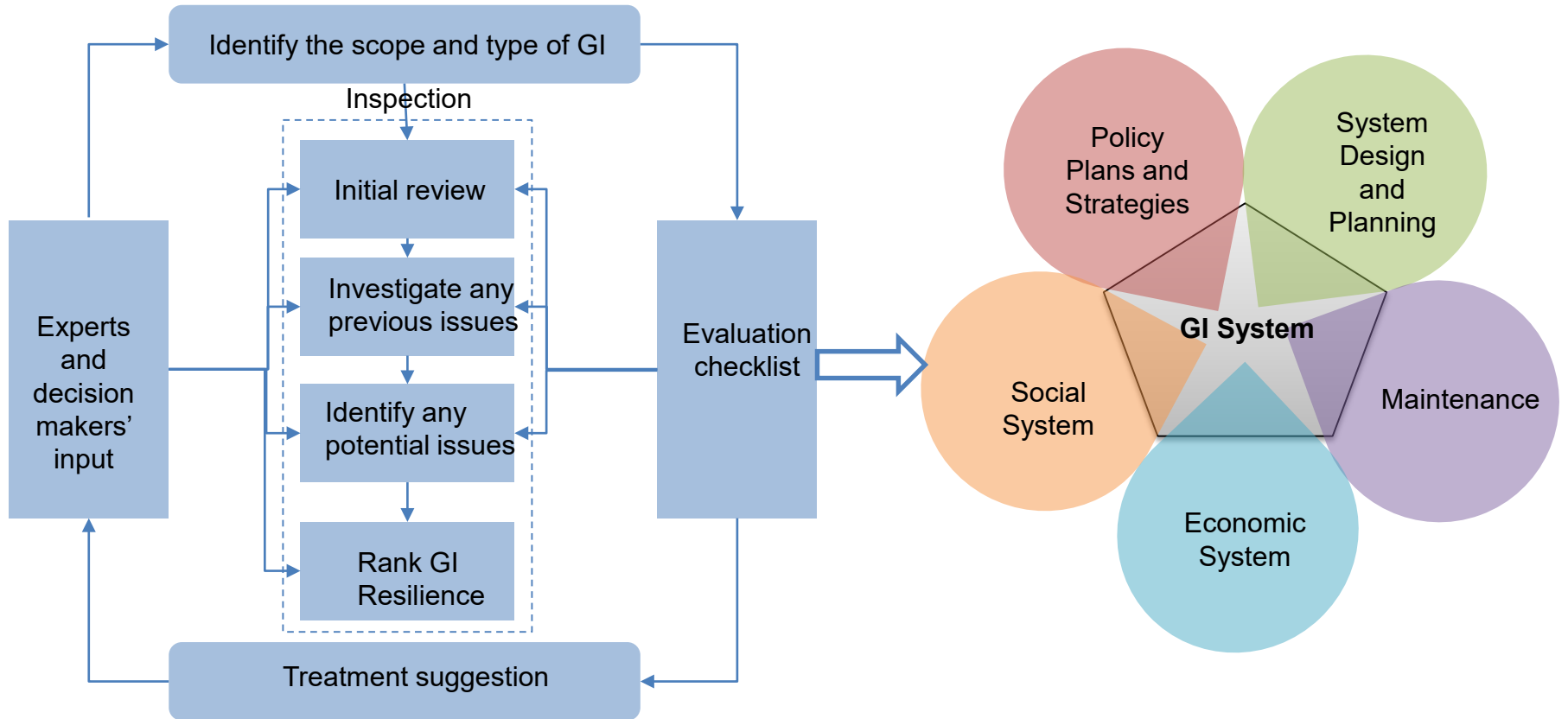
- Lack of attention to important categories such as maintenance in GI assessment
- Lack of detailed information for practical assessment
- Lack of integrating resilience concept into the assessment

Stage 2: Identifying the categories for GI assessment

- Five categories
 - Policy plans and strategies
 - System design and planning
 - Maintenance
 - Economic system
 - Community

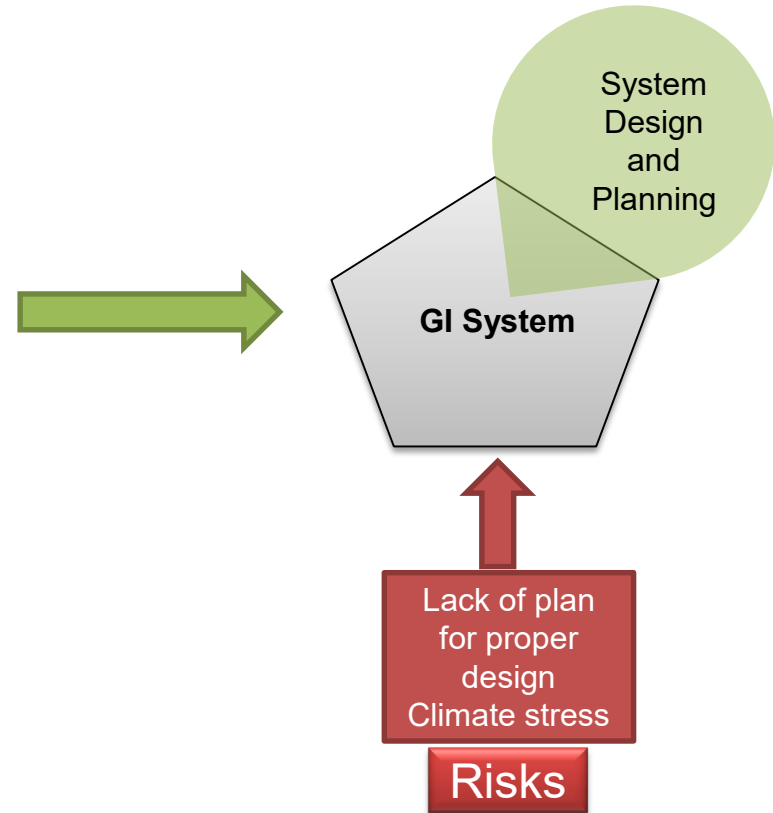


A general procedure for GI resilience evaluation



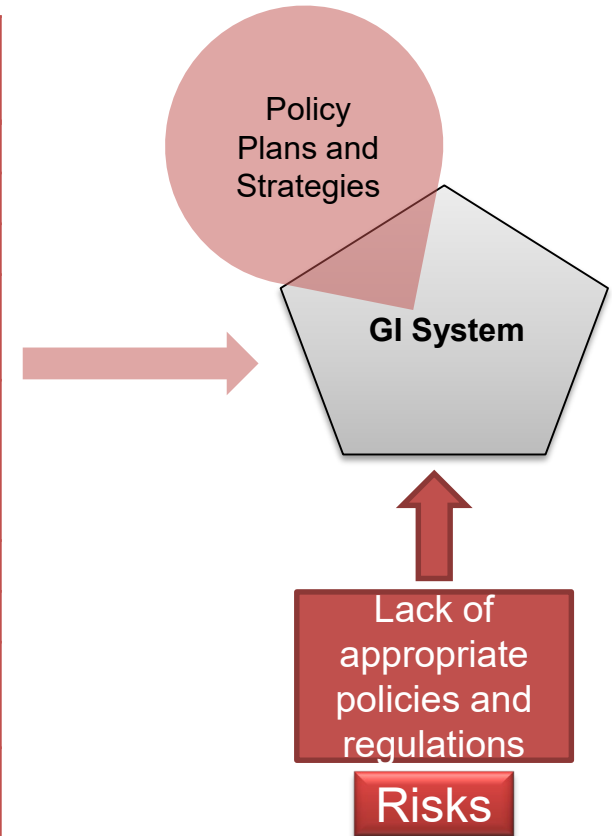
A proper design could mainly absorb the disturbance

	Indicator	Resilience dimension
Design and Planning	GI type selection	Absorb
	GI location	Absorb
	Climate of region	Absorb
	Capacity	Absorb
	Biophysical component	Absorb
	Biodiversity	Absorb
	Redundancy	Absorb
	Multi-functionality	Absorb, adapt
	Regenerative ability	Absorb, recover, adapt
	Failure identification	Recover, adapt
	Flexibility	Absorb



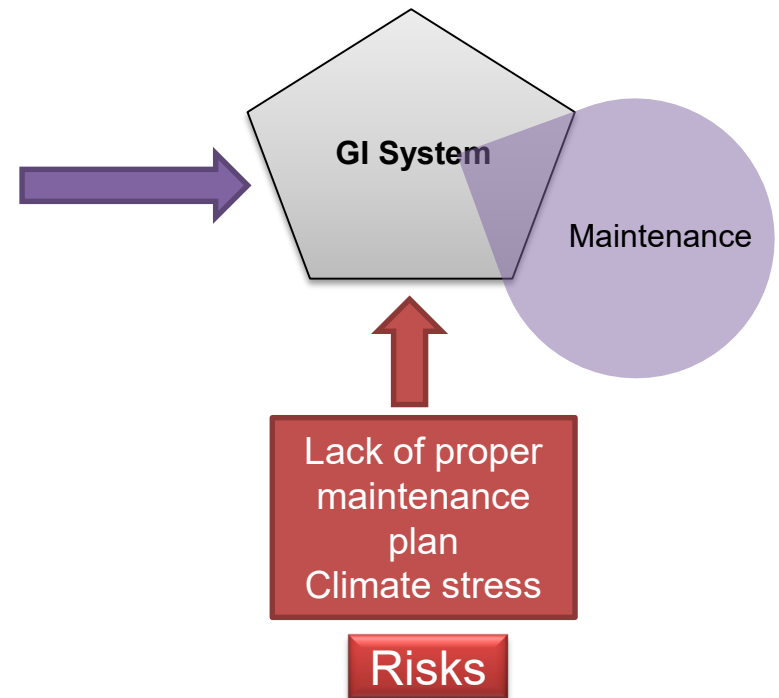
Appropriate policy could effectively help in absorb, recovery and adaptation

Policy Plans and Strategies	Indicator	Resilience dimension
	Defining policy	Absorb-recover-adapt
	Evaluation framework	Absorb
	Periodically audit	Absorb
	Maintenance	Absorb- recover-adapt
	Define responsibilities and obligation for any person working in the scope of GI	Absorb
	Review and edit policy actively	Absorb-adapt
	Availability to users	Absorb
	Holistic approach to see urban ecosystem as a whole system	Absorb
	Connection between long term and short term strategies	Adapt
	Connection between different sectors	Absorb-recover-adapt



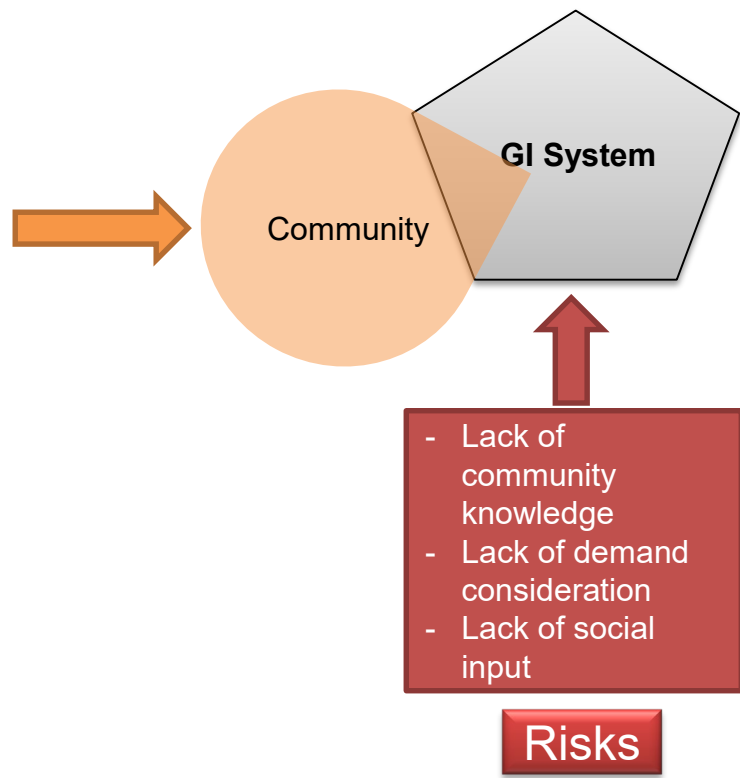
Maintenance mostly help to absorb the risks and disturbances

Maintenance	Indicator	Resilience dimension
	Existence of maintenance plan	Absorb, recover, adapt
	Line blockage	Absorb
	Sediment loading	Absorb
	Collecting trash	Absorb
	Consider plants as dynamic system	Absorb
	Pollution build up	Absorb
	Soil compaction	Absorb



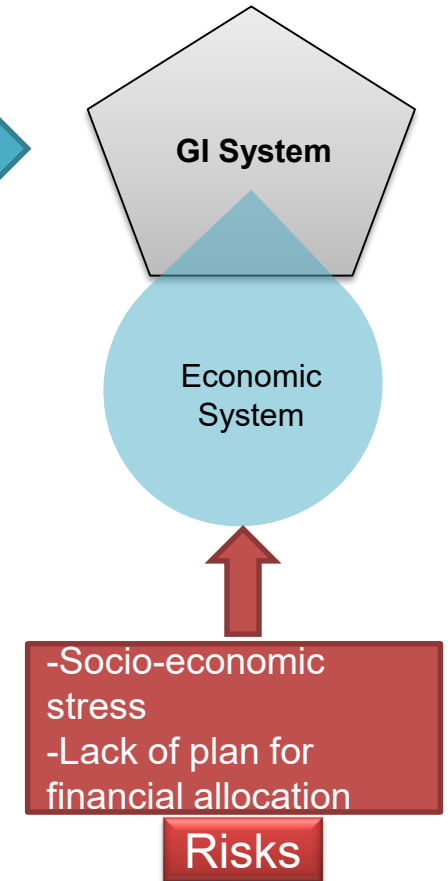
Community could be helpful for all dimension of GI resilience

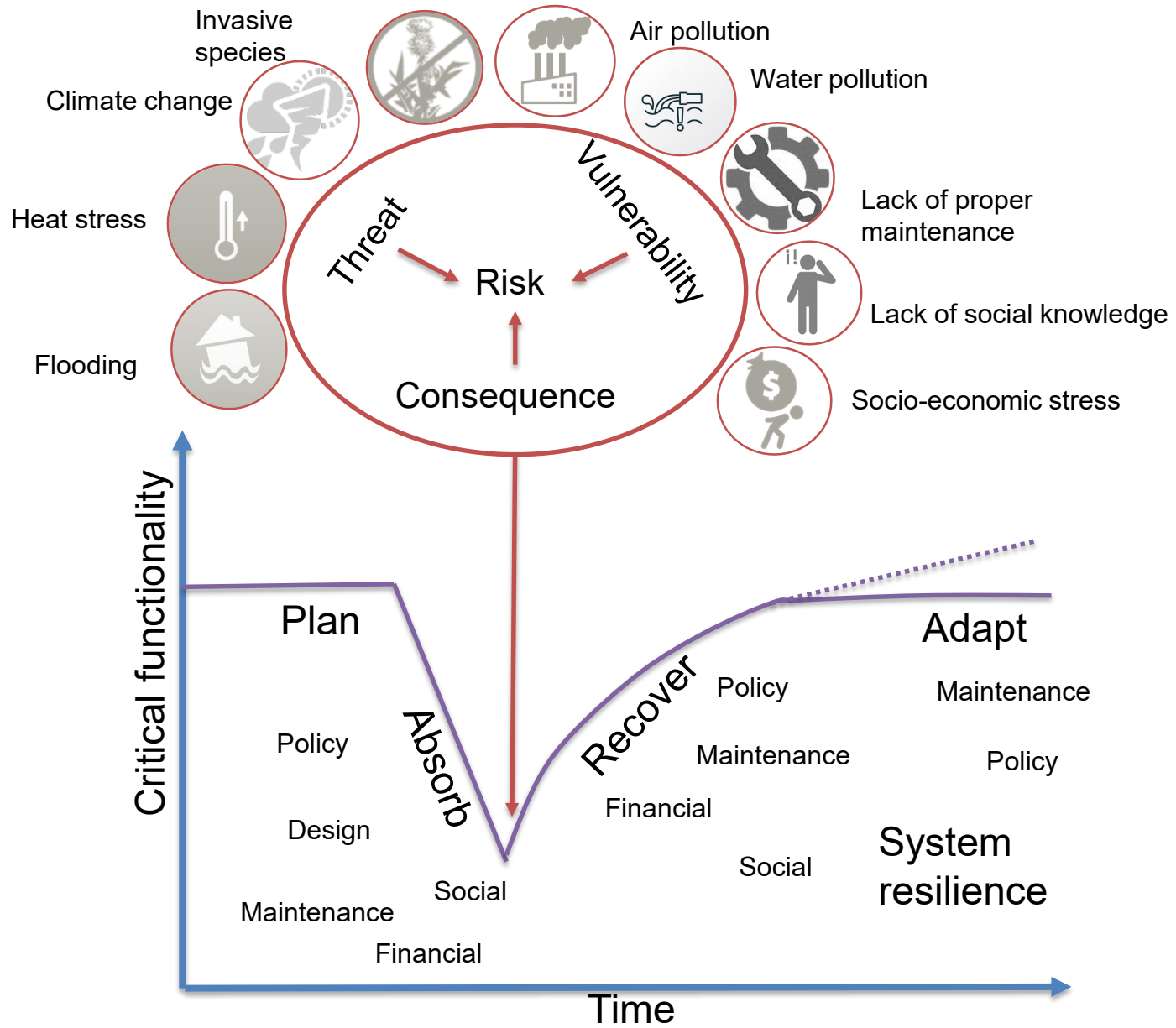
Community	Indicator	Resilience dimension
	Supply and demand of ecosystem services	Absorb, recover, adapt
	Society ecosystem services demand inquiry	Absorb
	Society awareness of SGI's benefits and conservation	absorb, recover, adapt



Economic system is essential for absorb, recovery and adaptation of GI system

	Indicator	Resilience dimension
Economic	City budget	Absorb, recover, adapt
	Society budget (willingness to spend)	Absorb, recover, adapt





Summary –Next Step

- ✓ This framework could be helpful to evaluate the level of resilience in GIs
- ✓ Can direct the attention to:
 - ✓ The level of resilience in GI,
 - ✓ Identify categories with low resiliency,
 - ✓ Help to improve the resilience
- ✓ Using stakeholders experience
- ✓ Applying this framework into case studies

Conclusion

- To maximize ES we need to identify how GI can respond to risks and disturbance (absorb, recover, adapt)
- To understand how to improve the aspects of the system that can absorb a disturbance
- In case of functionality loss- what aspects can help with recovery and adaptation



Thank You For Your Attention

Questions?

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