People, place and purpose – Harnessing **complexity** to provide ecosystem services in urban environments via blue-green stormwater infrastructure

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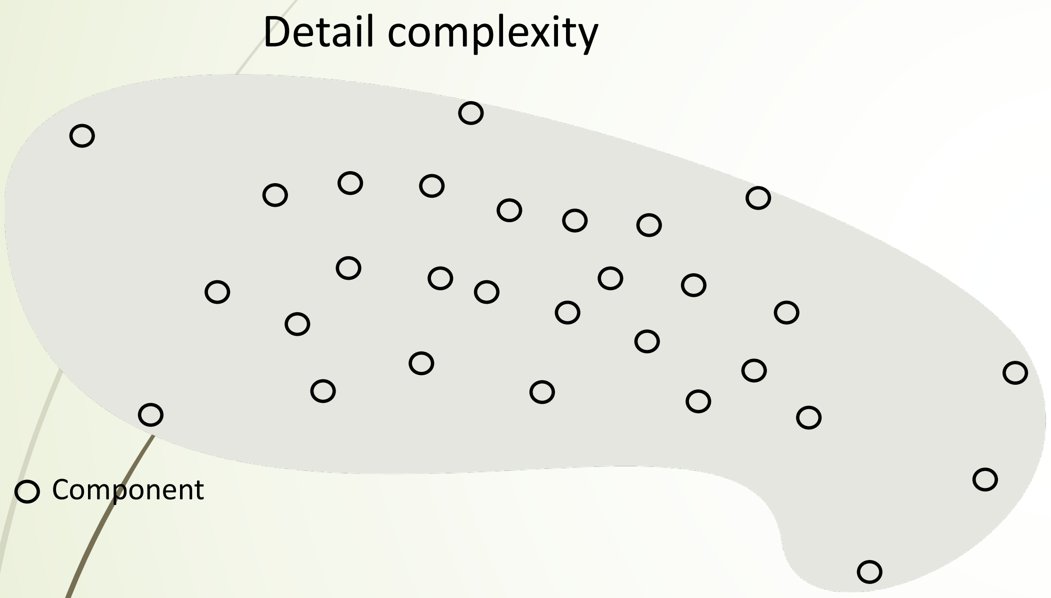
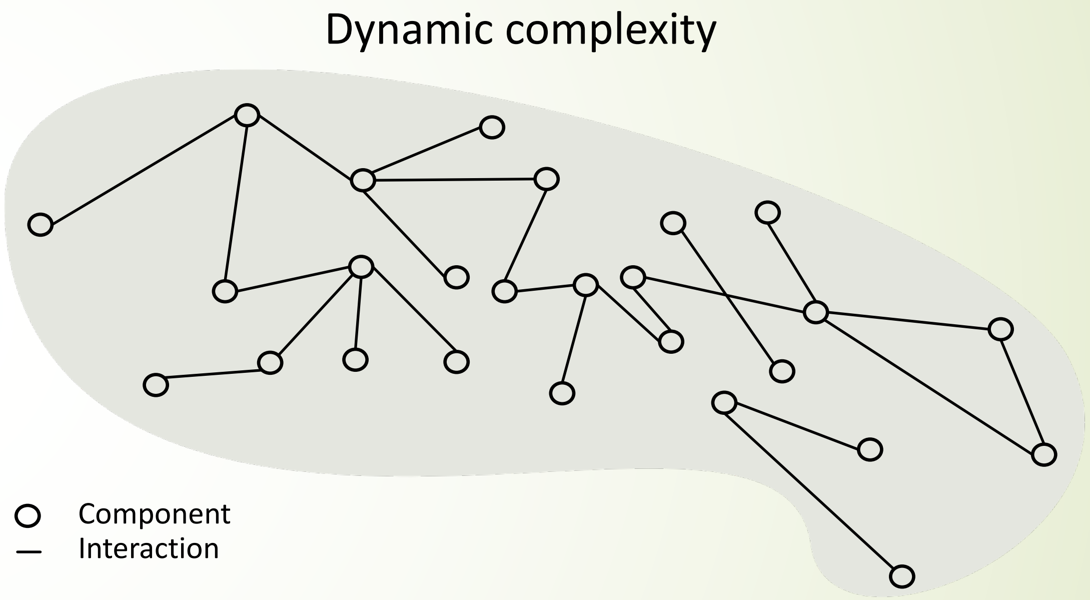
Urban stream complexity

Natural systems are complex

Engineered systems are simple(r)

Natural systems - streams



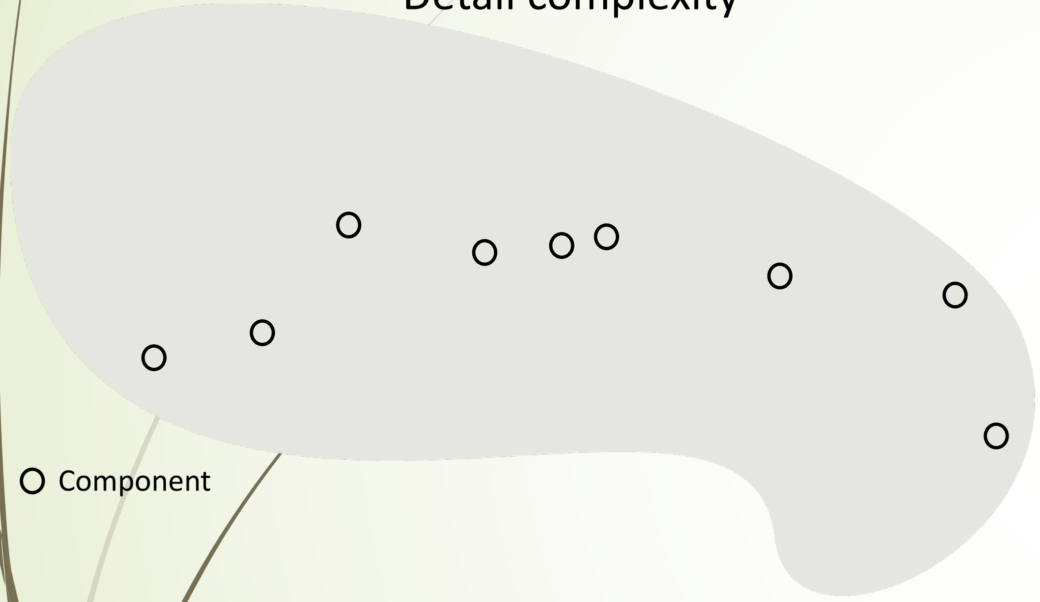


Ecosystem - A dynamic complex of living and non-living components interacting as a functional unit.

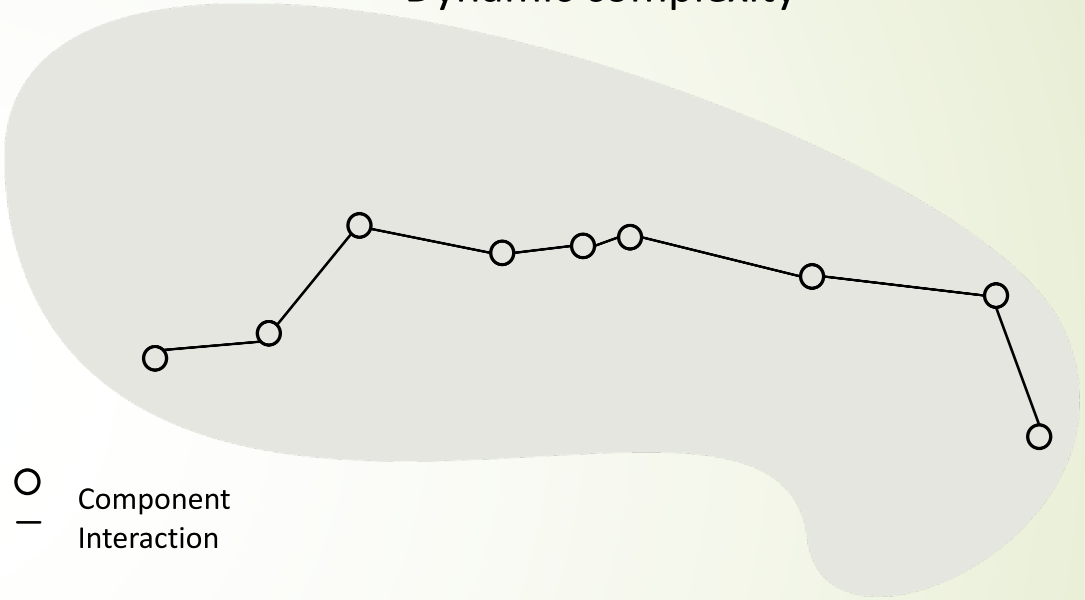
Maynard, S., James, D., & Davidson, A. (2010). The development of an Ecosystem Services Framework for South East Queensland. *Environ Manage, 45*(5), 881-895.

Engineered systems – pipes and drains

Detail complexity



Dynamic complexity



Comparatively simple systems are easier to understand, monitor and manage

Where does blue-green infrastructure sit?
What does it aim to achieve?

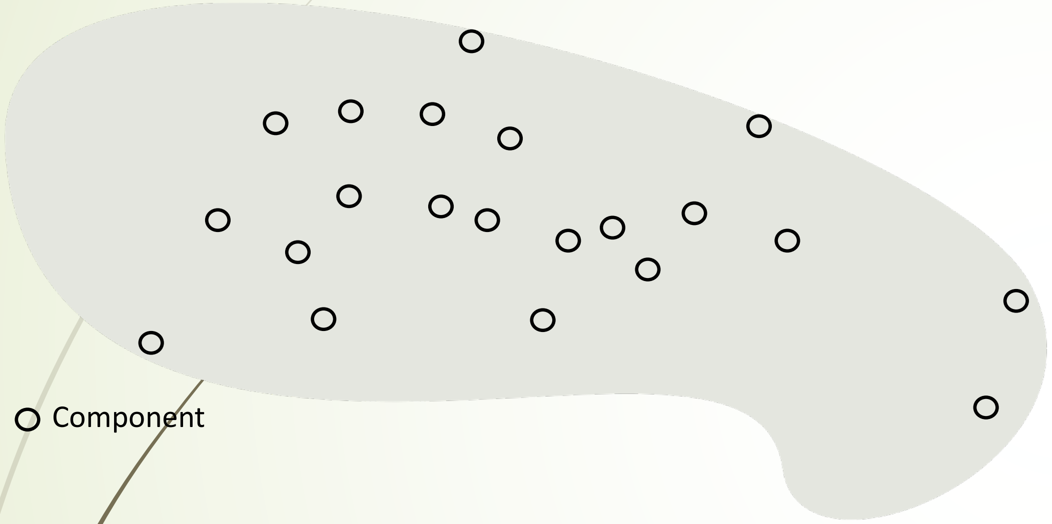
Blue-green stormwater infrastructure

Bioretention basins

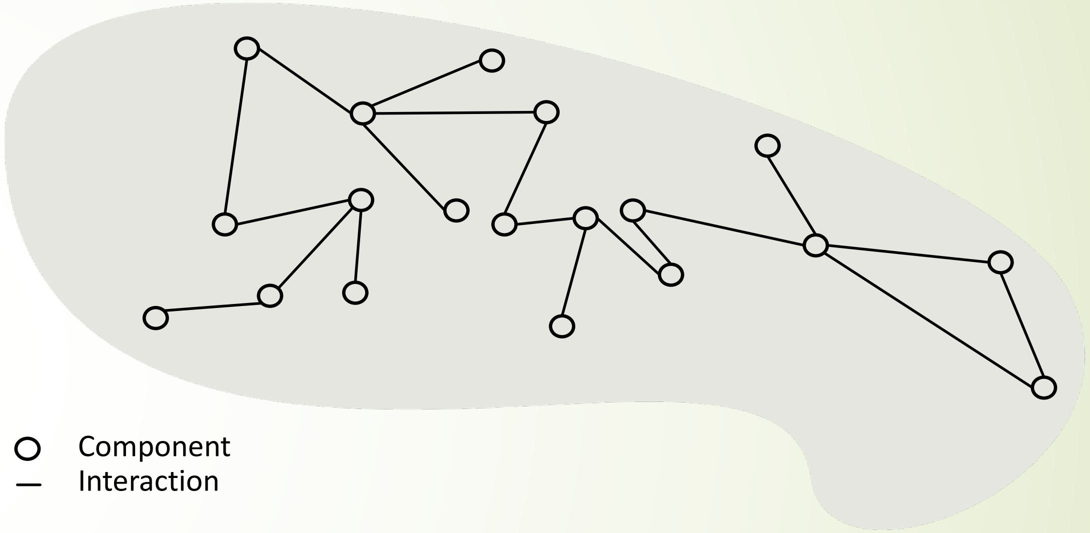
Artificial wetlands

Blue-green infrastructure systems

Detail complexity



Dynamic complexity



The complexity of blue-green infrastructure makes these systems harder to understand and manage

Ambitions for blue-green infrastructure… are set (and limited) by legislation

Climatic Region	Design Objectives			
	Minimum reductions in mean annual load from unmitigated development (%)			
	Total Suspended Solids (TSS)	Total Phosphorus (TP)	Total Nitrogen (TN)	Gross Pollutants >5mm
South East Queensland	80	60	45	90

Queensland Government State Planning Policy

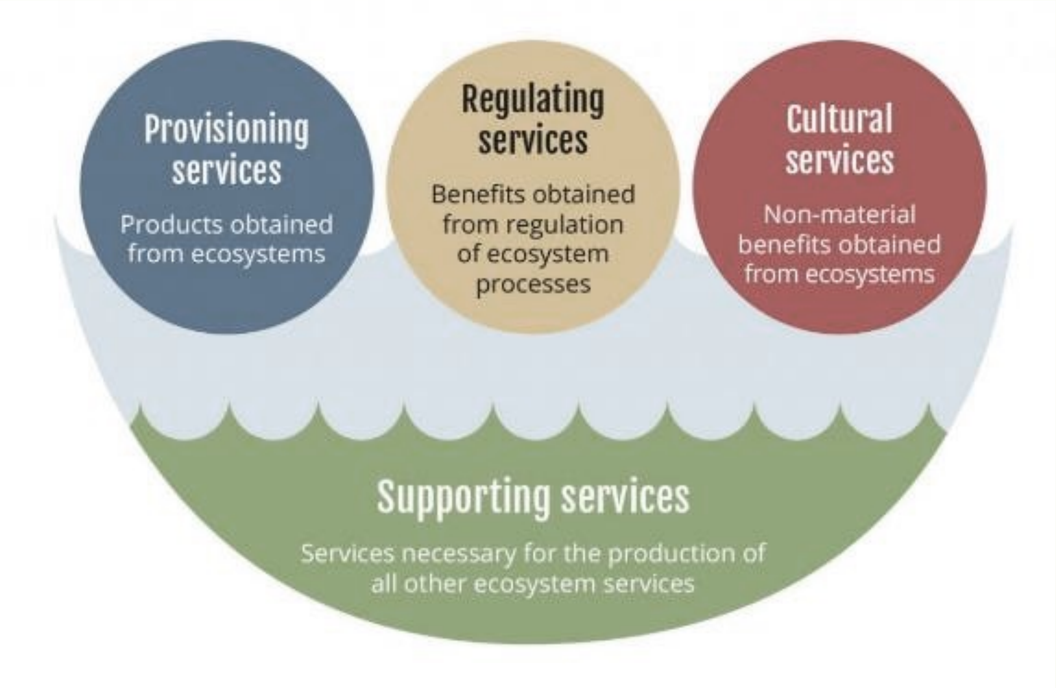
These are strong (and ambitious) receiving water quality targets… but can/should we do more/better?

Broadening our ambitions - An ecosystem services approach to stormwater management

Air quality, climate, water runoff, natural hazards, pollination

Food, fibre, biomass (fuel), freshwater, natural medicines

First Nations values, ethical values, existence values, tourism / recreation



Nutrient cycling, water cycling, soil formation, photosynthesis

What ecosystem services do our stormwater systems seek to achieve?

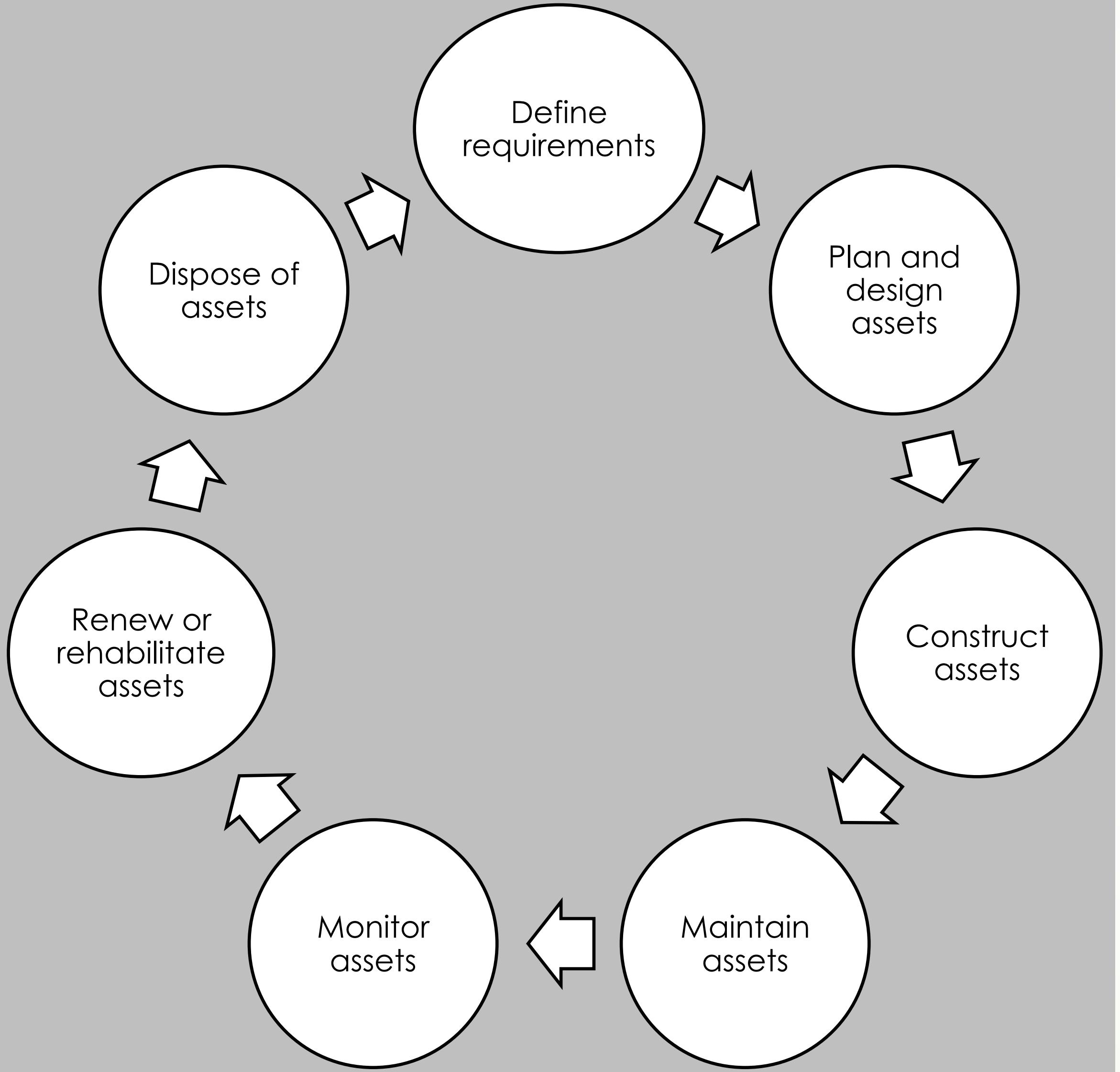
Grey design objectives focus on flood mitigation, reducing risk to lives and livelihoods

Blue-green design objectives focus on flood mitigation and removing coarse pollutants, sediment and nutrients to improve receiving water quality

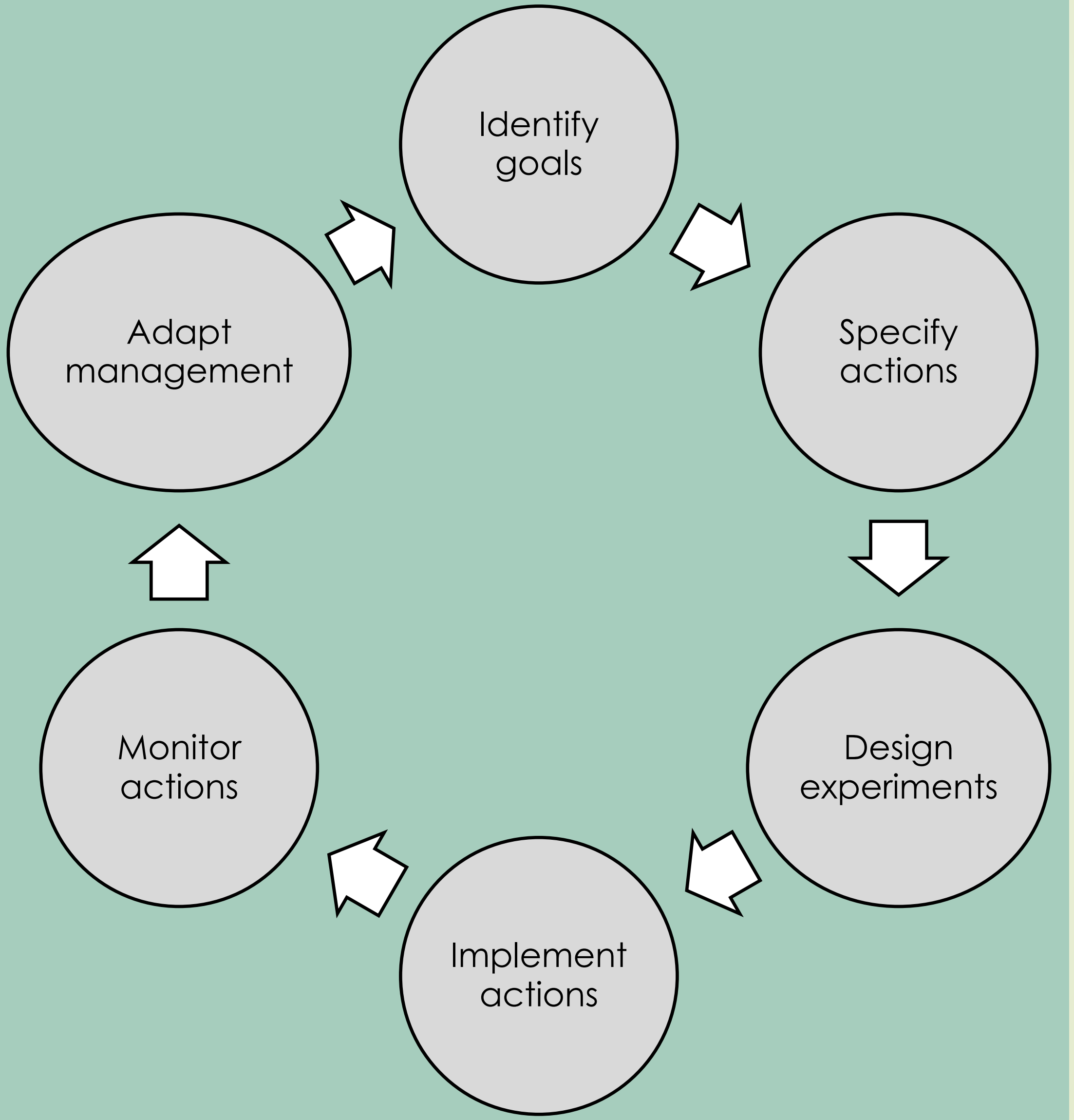
Mapping current designed features of stormwater assets to ecosystem services

Urban stormwater systems	Ecosystem Services			
	Provisioning	**Regulating**	**Supporting**	**Cultural**
Underground pipes and drains	X	Water runoff, natural hazards	X	X
Hardened stream channel	X	Water runoff, natural hazards	Photosynthesis*	X
Bioretention basin	Improved freshwater quality*	Air quality, climate, water runoff, natural hazards, pollination	Nutrient cycling, water cycling, photosynthesis	X
Artificial wetland	Improved freshwater quality*	Air quality, climate, water runoff, natural hazards, pollination	Nutrient cycling, water cycling, photosynthesis, soil formation	Existence values*

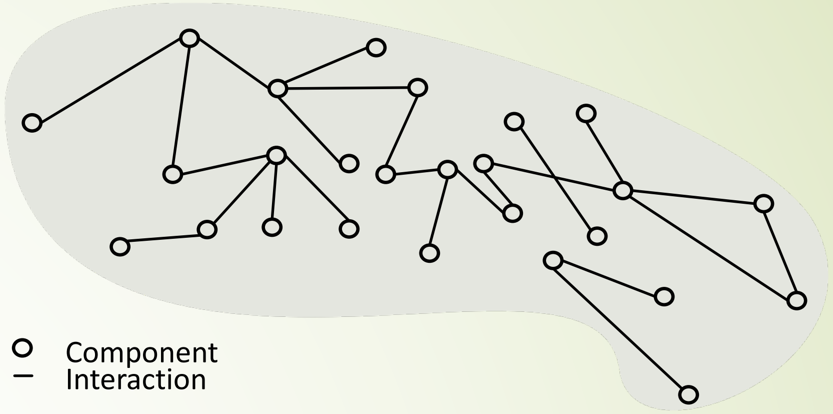
Asset management lifecycle activities



Adaptive management steps



Conclusions

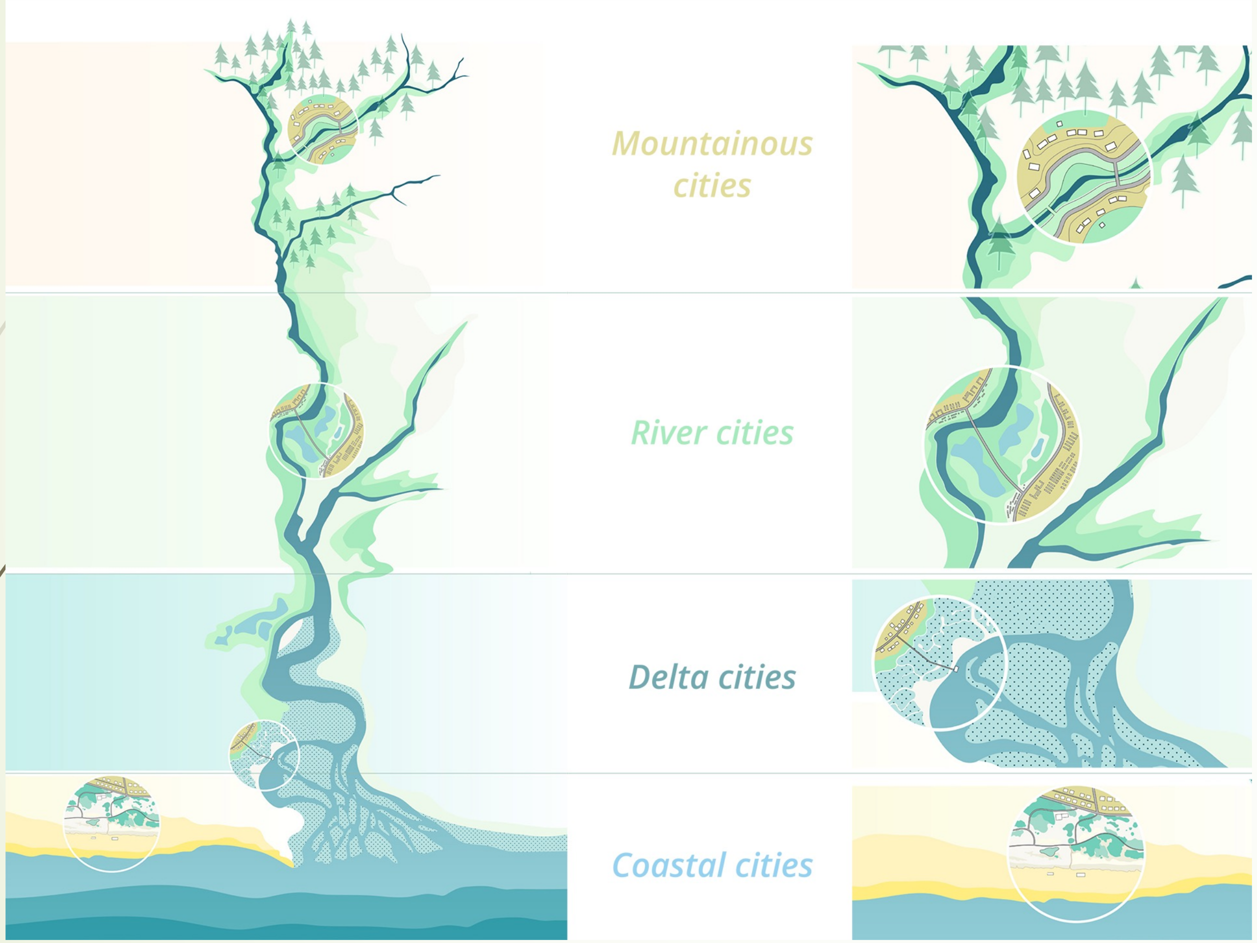


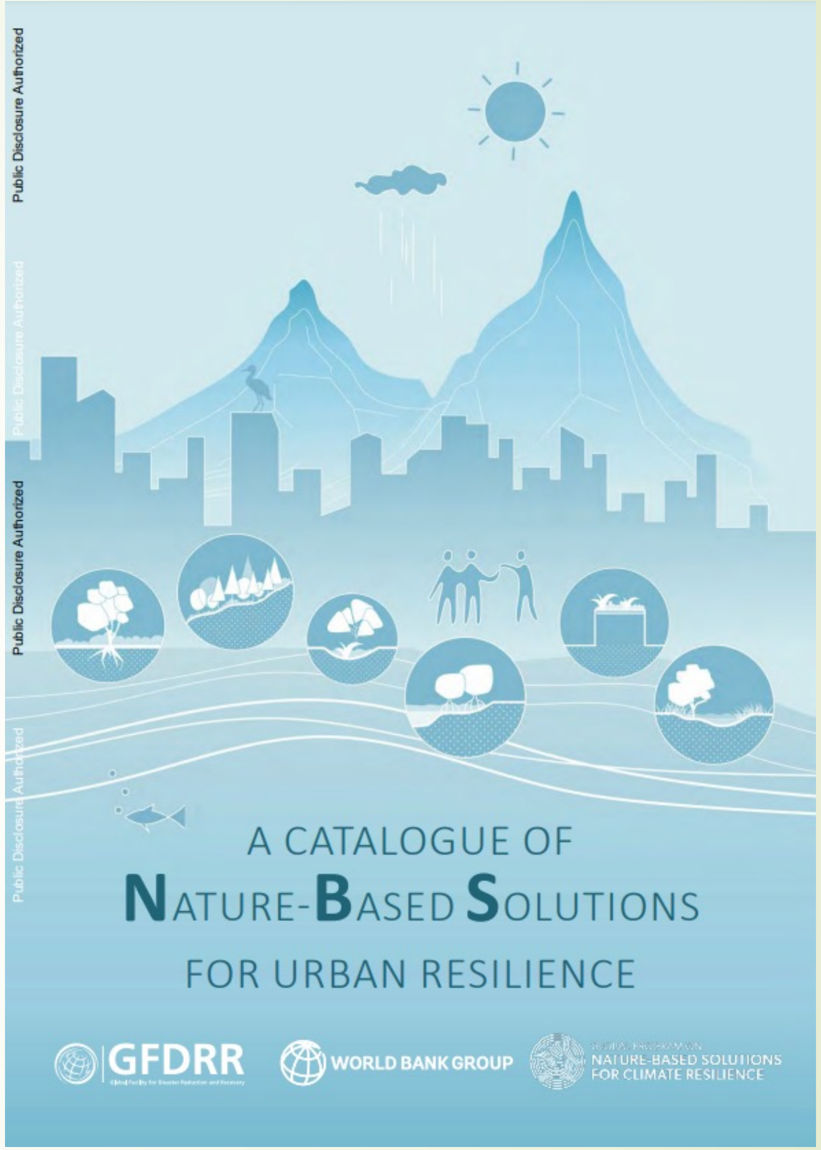
- Natural stream ecosystems are complex and dynamic
- Historical approaches have reduced complexity and reduced the flow of ecosystem services
- Blue-green stormwater assets strongly resemble ecosystems, with detail and dynamic complexity

- Folding ecosystem services as the purpose into asset design and management requires an understanding of complexity and change, ***but can achieve incredible multiple benefits for people, places and planet***

- To achieve this goal, adaptive management, which can cope with (and learn about) complexity, should be integrated into asset management – Adaptive Asset Management

Context and options





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