Towards More Resilient Water Infrastructures

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Resilent Cities (ICLEI)

Why cities need more resilience?

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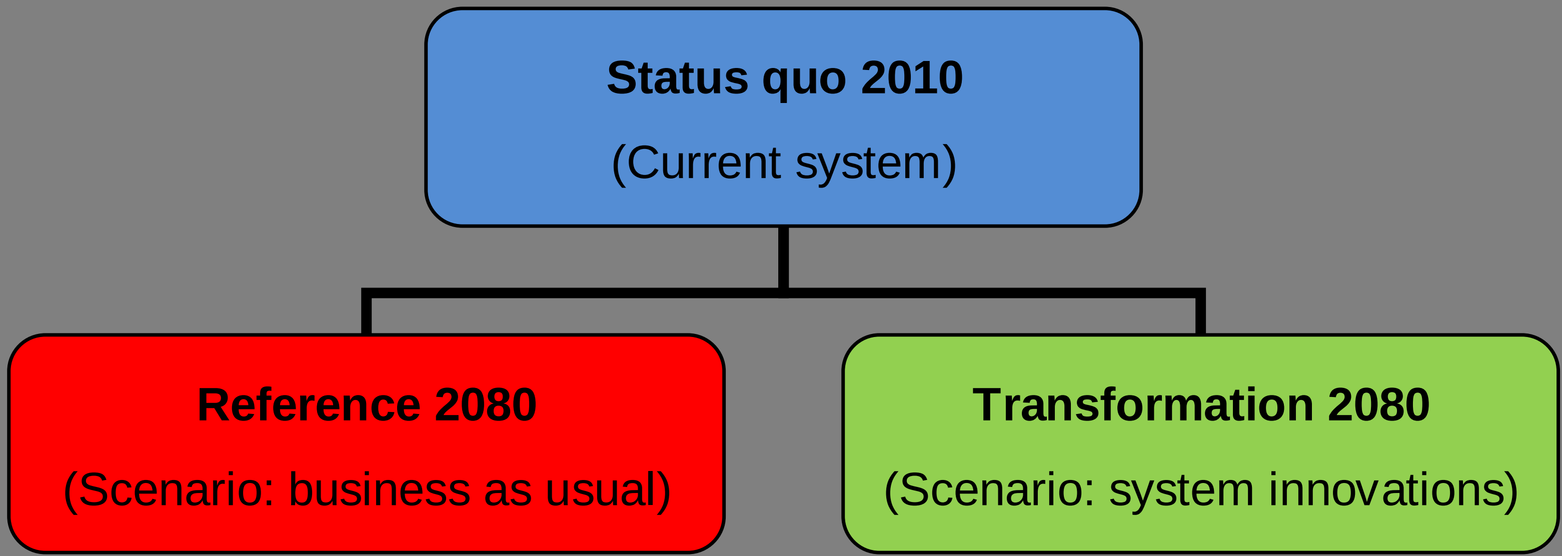
- Water plays a pivotal role in the constitution of any specific city
  - Water is the most important urban material flux
- Cities are highly vulnerable due to uncertain future developments
- Changing framework conditions (without secure predicitions)
  - Climate change: Affecting water availability and use patterns
  - Demographic change, urbanisation and land subsidence with the risk of a non-sufficient water supply and waste water system
  - Changing energy systems (reduced coal and oil ressources) lead to high energy prices
  - New environmental requirements (e.g. EU Water Framework Directive, micro-pollutants)
- Aoviding second order problems: Maladaptation can result in negative effects that are as serious as the effects that are being avoided
- Error-tolerant solutions / adaptation to the changed framework conditions

The challenge

- Conventional water infrastructure systems and key management principles (centrality; uniformity) established and successfully operated, but:
  - Long lifetimes due to high capital investment and long depreciation
  - High fixed costs, independent of operating performance
  - High need of rehabilitation
  - Overcapacities/underutilization attended by technically and economically problems
  - Vulnerability is high
  - Flexibility is low
  - Possibility of adaptation to changing conditions is limited
  - Persistence due to established decision routines and a well-rehearsed daily operation
- As a consequence incremental innovation options are preferred
- Transition to (more) resilent infrastructures is neglected
- Sustainable system innovations are out of perspective

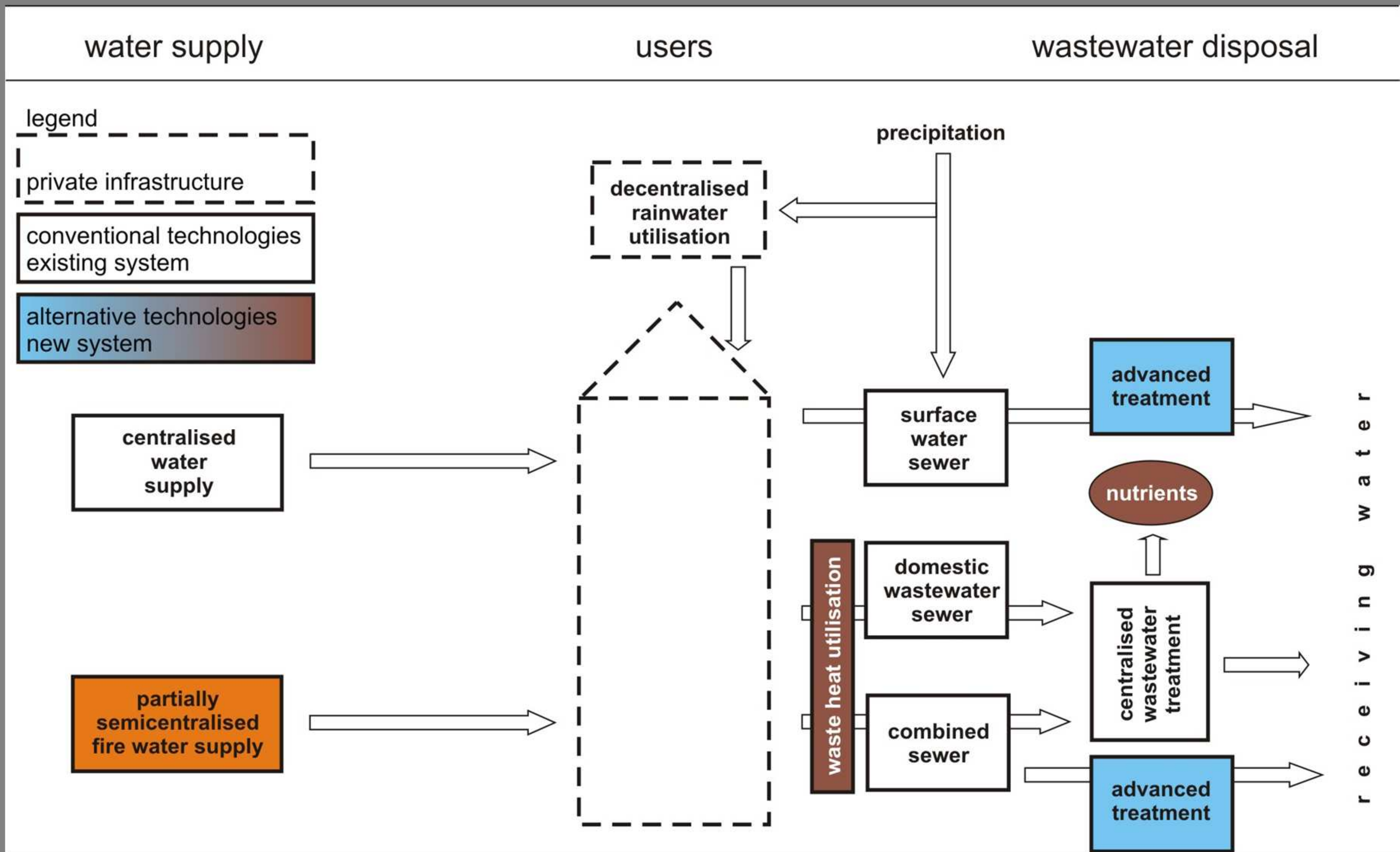
Scenarios: Conventional and more resilient system



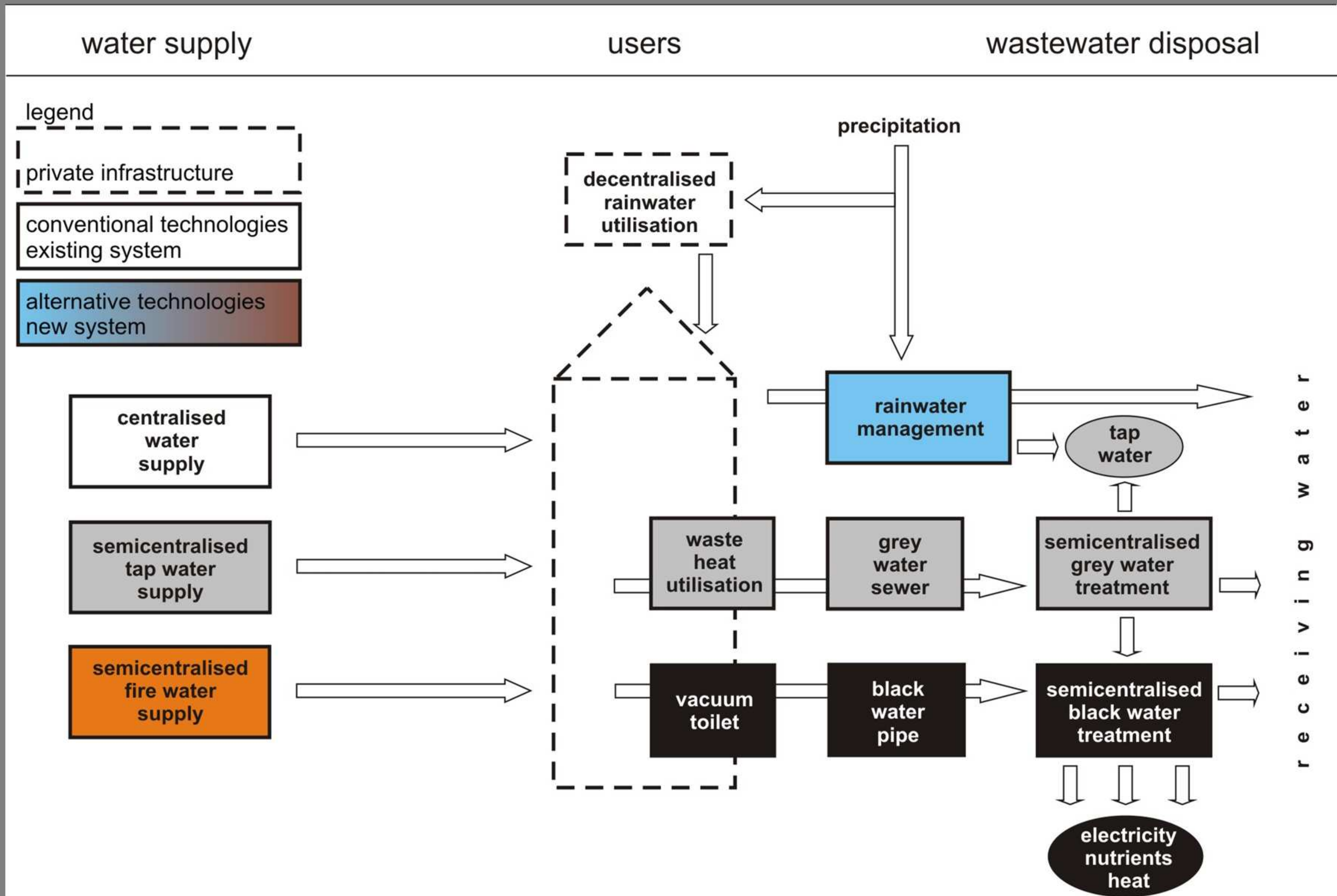
Main assumptions:

- Time horizon of 70 years
- Equal urbanistic development
- **Population decrease of 25 %**
- Sewage sludge disposal and co-fermentation of organic waste are considered qualitatively but not numerically

Scenario „reference“ (business as usual)



Scenario „transformation“ (system innovations)



Underlying requirements for transition

- Vulnerability check
  - Where has to be taken action on what? What allows higher resilience?
- Investments of existing infrastructures have to be (re)considered
  - Reclamation of components, depending on state of repair and wastewater stream quality
- Water/wastewater utilities should be consolidated and managed in one hand
  - Preventing “cherry picking” by third parties and managing increased coordination effort
- Transformation in subareas will occur spatial and temporal differently
  - Some subareas are amenable to a larger degree and earlier to system innovations than others
- Technological developments for domestic water infrastructure might favour transition
  - Synchronisation of municipal and domestic water infrastructure is upcoming necessity

Impact assessment and evaluation (eco-efficiency analysis)

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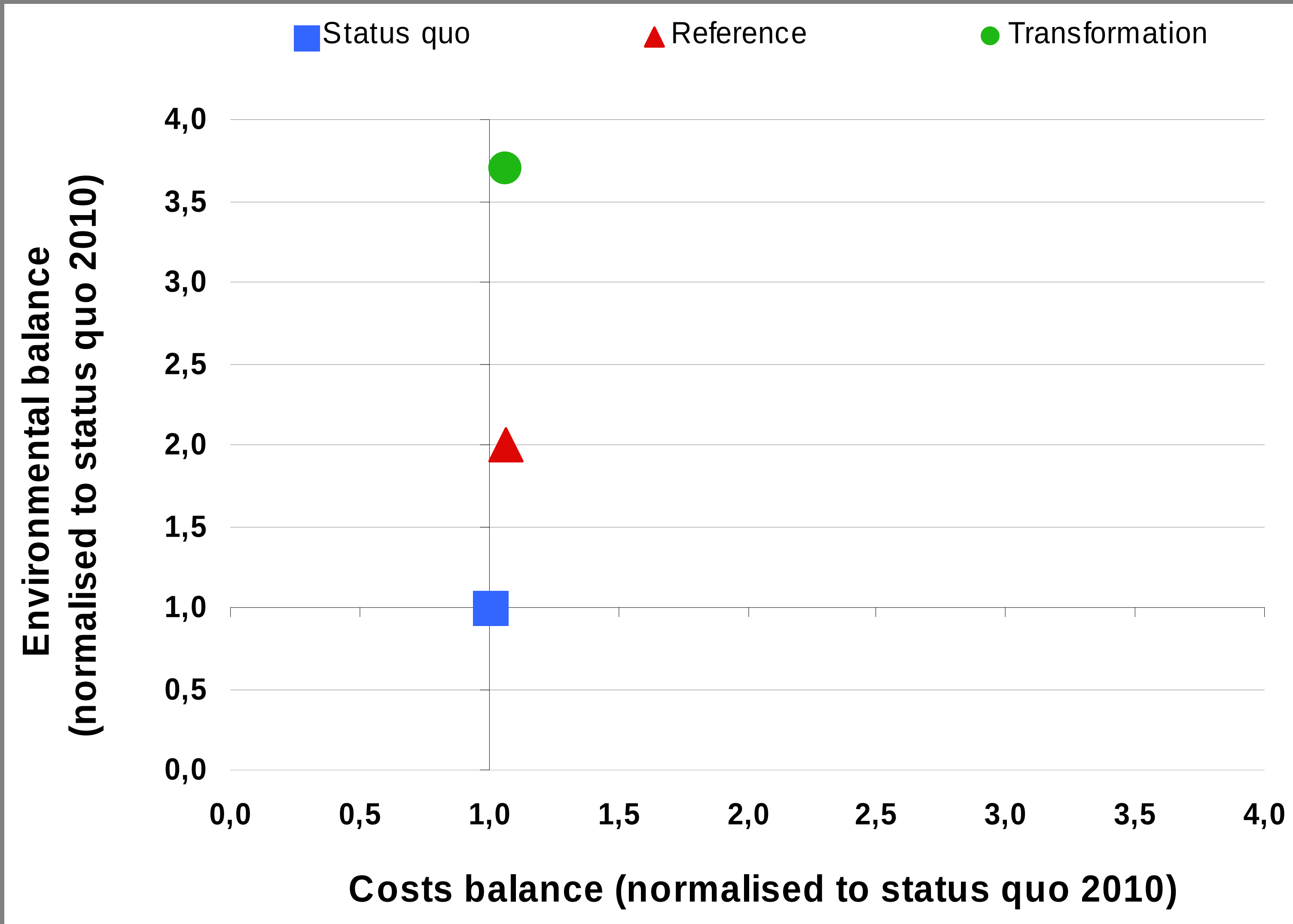

Way to resilient water infrastructures

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- Transition be technically possible and economically feasible
- Looking for a bundle of flexible measures (system innovation)
  - ➢ Coupled management of water and wastewater as a challenge
- Identifying “windows of opportunity”: Winning time
- Smooth transformation allows regarding existing obstacles
  - ➢ Transformation management on municipal level required)
- Lighthouse projects: from large pilot projects to transformed city quarters / subareas as „best practices“
  - ➢ Further research regarding specific requirements (law, acceptance, governance

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Thanks for Your Attention!

and to

- German Federal Ministry
  of Education and Research
- Colleagues of netWORKS
- German partner cities and stakeholders

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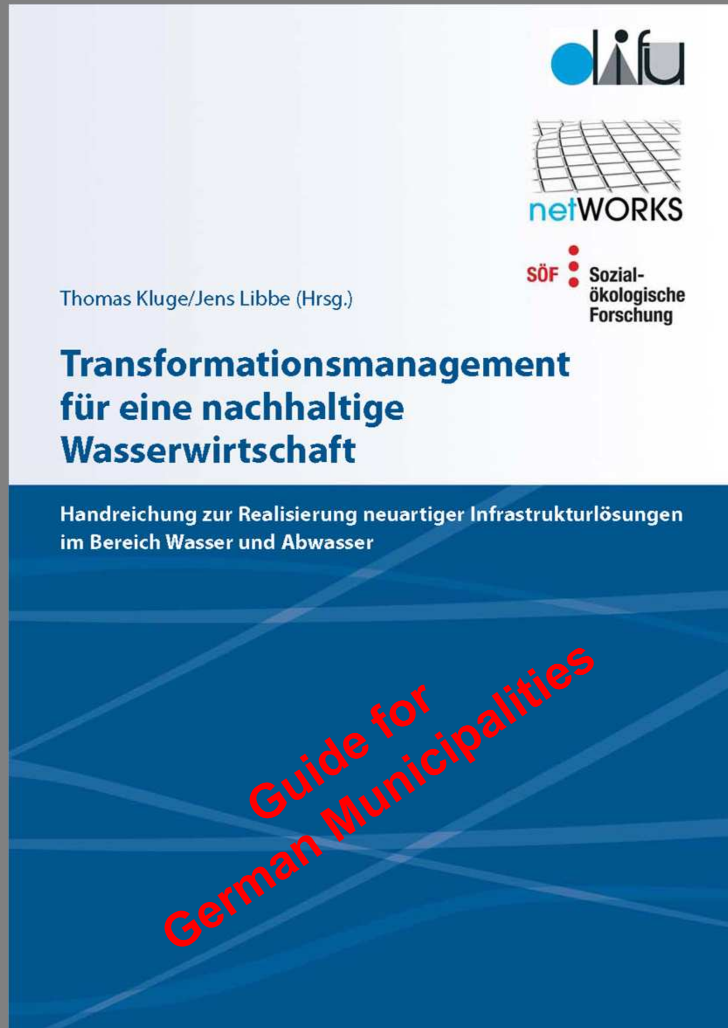


What is to be done?

- Communicating with policymakers about water resilience-building tactics
  - Bundling chlimate change discourse with other challenges
- Identifying/building new constituencies for water/sanitation resilience policies
- Piloting urban-based resilience strategies through city networks such as ICLEI
- Promoting policies and funding to better resilience in water infrastructuresa
- Building capacity and networks and developing new funding streams for resilience strategies

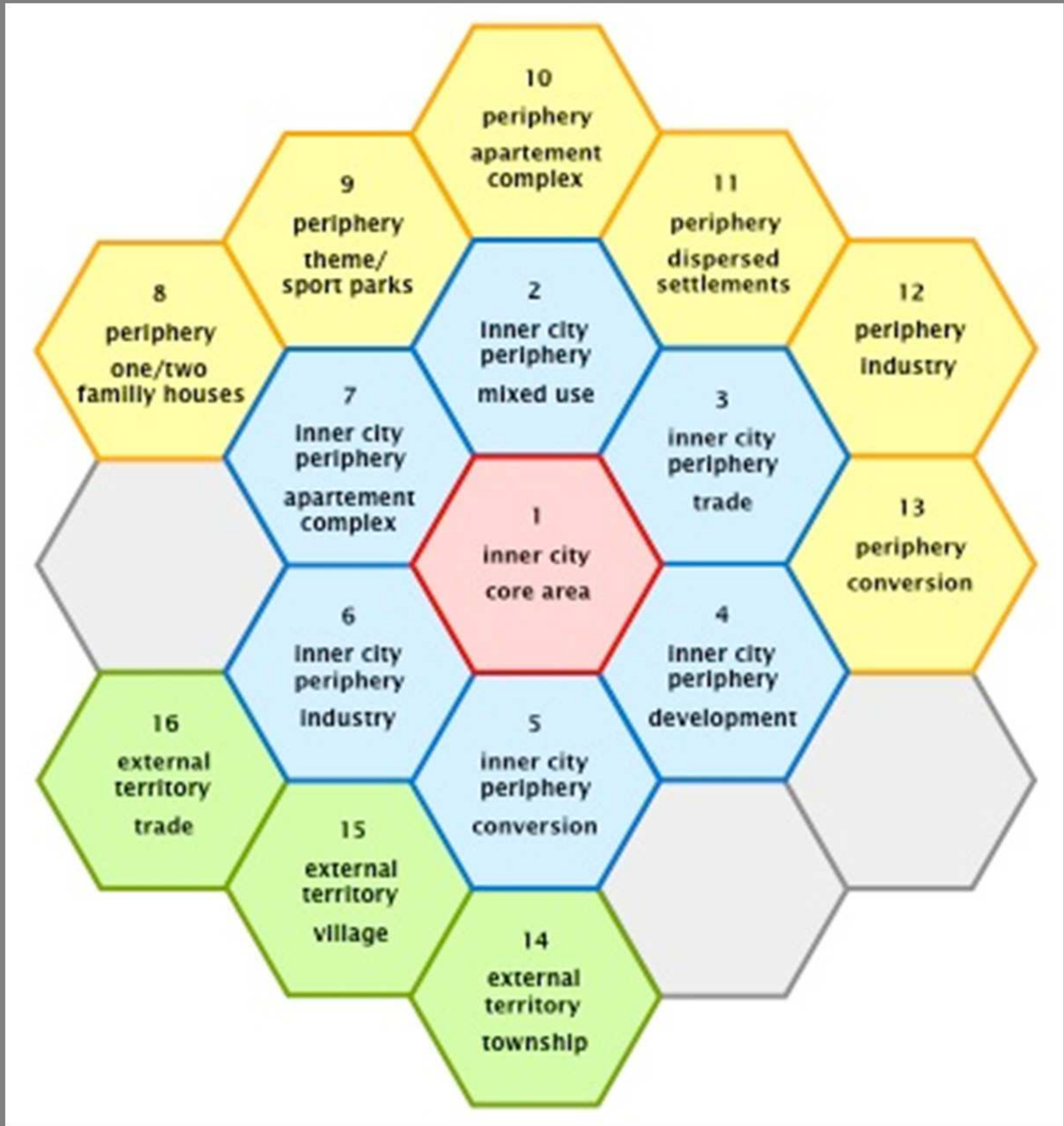
Resilience affords more adaptivity and flexibility

- Resilience generally means the ability to recover from (or to resist being affected by) some shock, insult, or disturbance

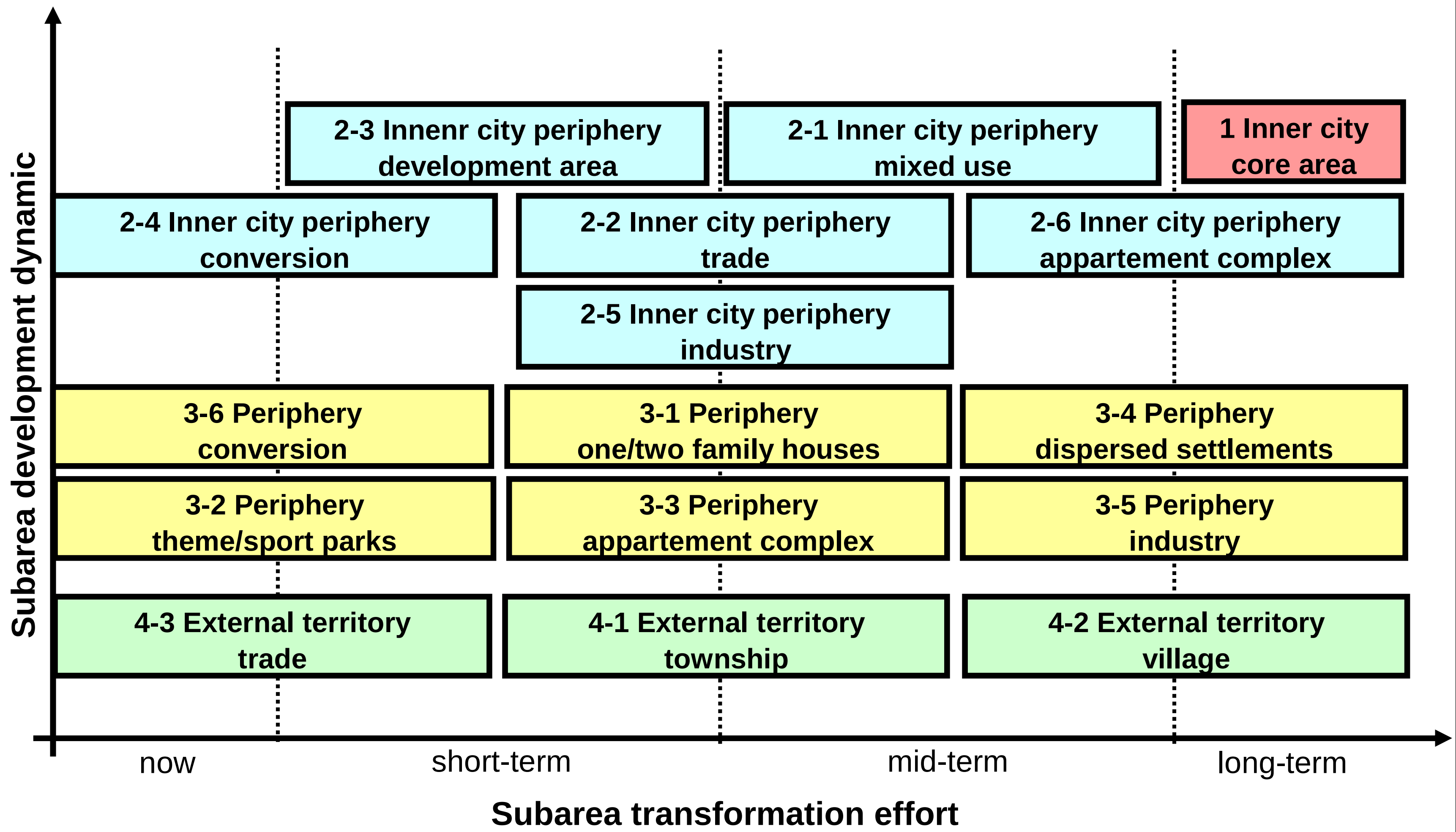
- Resilience is the ability of the (water) infrastructure to provide and maintain an acceptable level of service in the face of various faults and challenge

  - ➢ adapt urban water infrastucture to cope with changing framework conditions

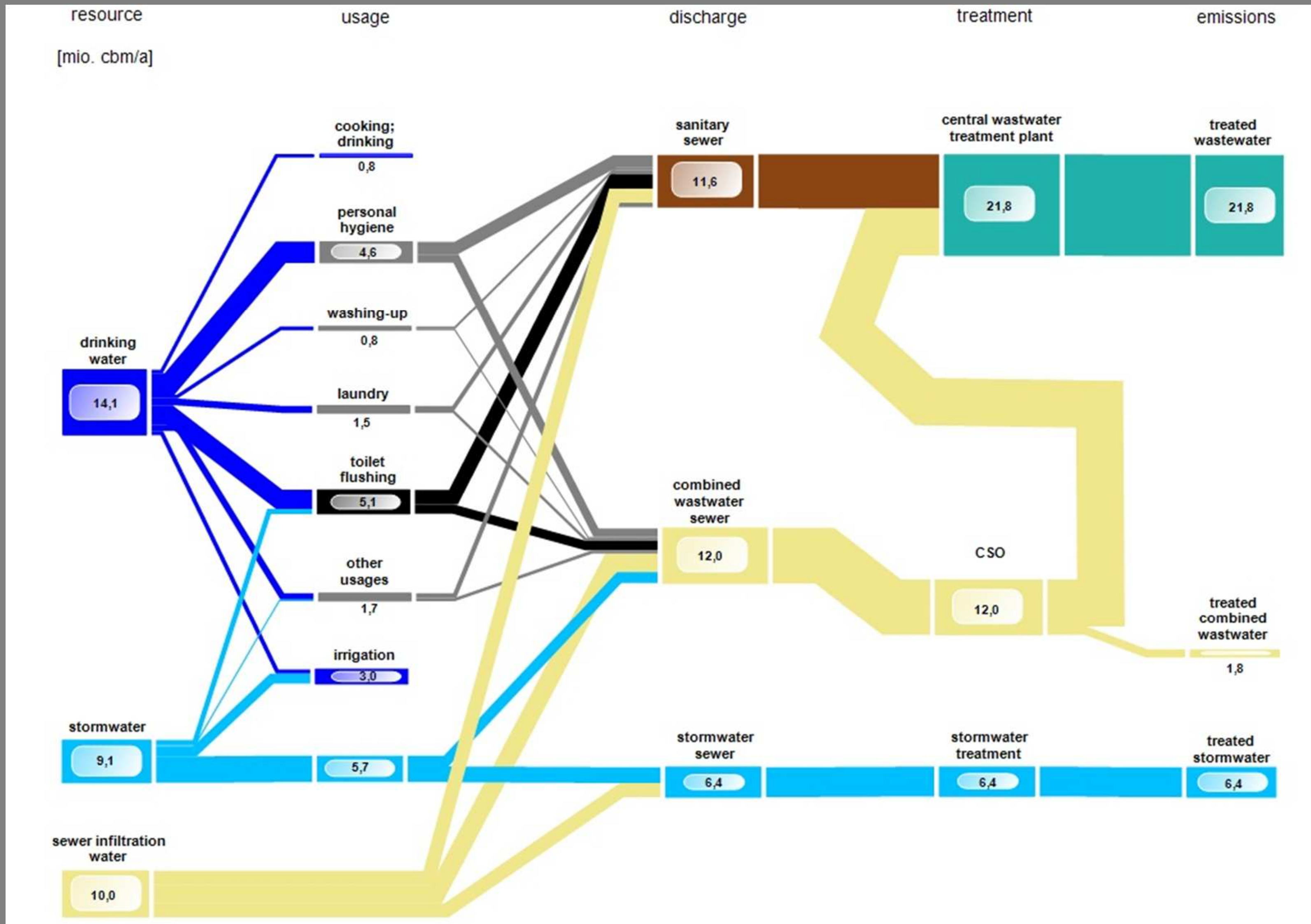
City model netWORKS



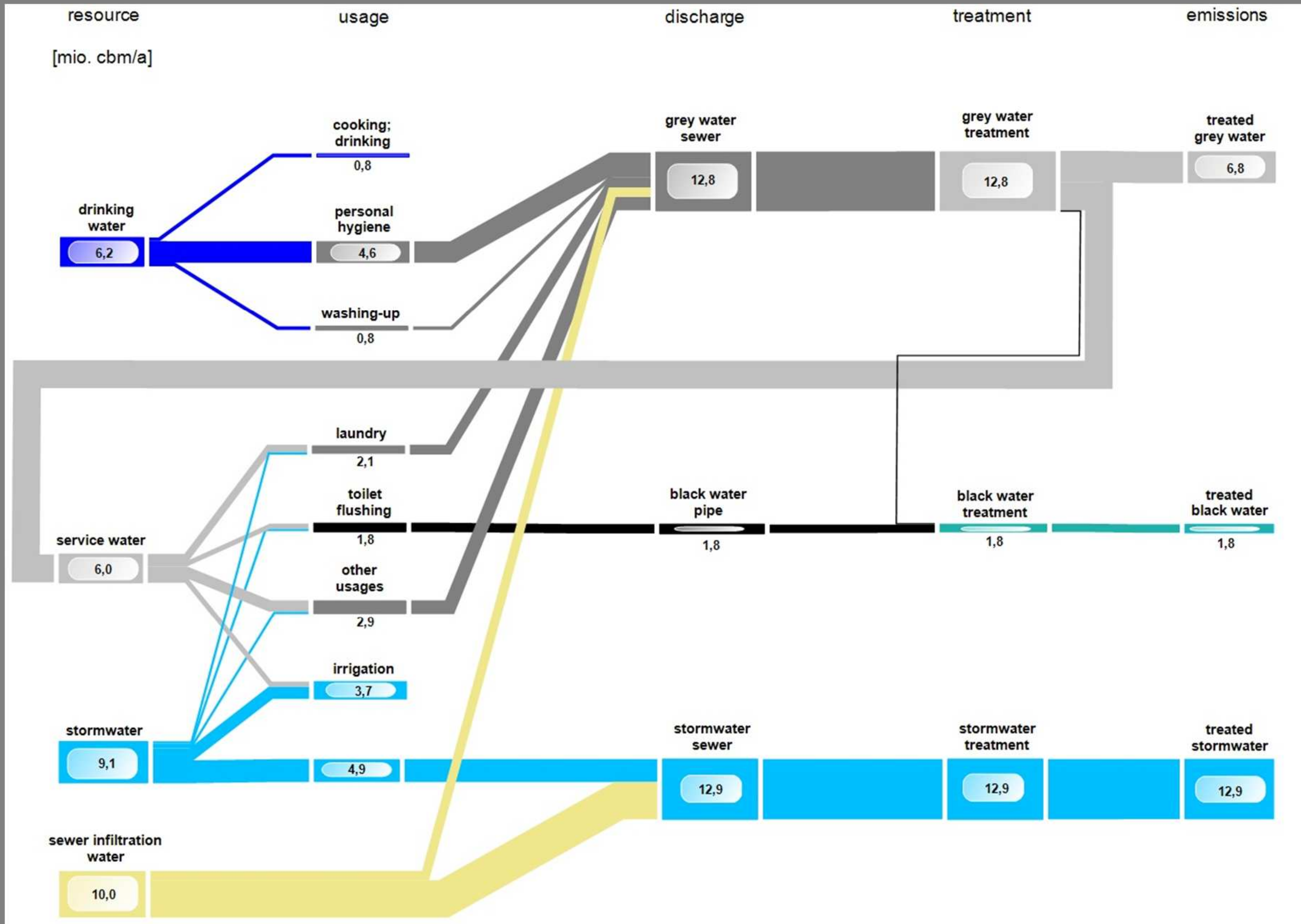
Transformation priority



Water flow analysis – reference 2080



Water flow analysis – transformation 2080



Balancing

Water balance [million m^3/y]	Status quo 2010	Reference 2080	Transformation 2080
Drinking water supply	25.1	14.1	6.2
Tap water utilization	0	0	10.8
Rainwater disposal	4.7	6.4	12.9
Grey water disposal	0	0	12.8
Storm water overflow	4.8	1.8	0
Wastewater disposal	30.7	21.8	0
Sludge liquor treatment	0	0.9	0
Black water disposal	0	0	1.8
Material balance [t/y]			
Phosphorous precipitation demand ($FeClSO_4$)	-5,019	0	0
Phosphorous precipitation demand (MgO)	0	-227	-310
Nitrogen precipitation demand (H_2SO_4)	0	-843	-5,842
Phosphorous reclamation	0	108	148
Nitrogen reclamation	0	222	1,537
Magnesium-ammonium-phosphate	0	475	650
Ammonium-sulphate-solution	0	2,661	18,449
Energy balance [MWh/y]			
Drinking water supply	-12,563	-7,050	-3,113
Tap water utilization (pressure increase)	0	0	-3,240
Advanced rainwater treatment	0	-3,206	-6,450
Grey water disposal	0	0	-7,680
Advanced combined wastewater treatment	-2,415	-1,802	0
Wastewater disposal	-20,000	-8,728	0
Phosphorous reclamation (electric)	0	-1,485	-2,917
Nitrogen reclamation (thermal)	0	-1,531	-3,008
Nitrogen reclamation (electric)	0	-8,352	-16,407
Carbon elimination (electric)	0	0	-2,735
Vacuum system	0	0	-4,500
Waste heat (wastewater, grey water)	0	43,642	183,600
Digestion black water (thermal)	0	0	-29,991
Digestion black water (electric)	0	0	4,041
Sum electric	-34,978	-23,803	-29,601
Sum thermal	0	35,290	137,201
Total	**-34,978**	**11,487**	**107,601**