Emerging trends in modelling integrated urban water systems
Integrated Urban Water Management

by managing the urban water cycle as a whole; a more efficient use of resources can be achieved providing not only economic benefits but also improved social and environmental outcomes

Wikipedia
Water Management in Cities of the Future
- A vision for water sensitive cities

Water sensitive cities are resilient, liveable, productive and sustainable.

They: efficiently use the diversity of water resources available within towns and cities; enhance and protect the health of urban waterways and wetlands; and mitigate against flood risk and damage.

They also create public spaces that harvest, clean and recycle water, increase biodiversity and reduce urban heat island effects.
The transformation of urban water systems from a focus on water supply and wastewater disposal (the ‘taps and toilets’ water utilities) to more complex, flexible systems that:

- integrate various sources of water;
- operate through a combination of centralised and decentralised systems;
- deliver a wider range of services to communities (e.g. ecosystem services, urban heat mitigation); and
- integrate into urban design.
 Emerging trends in Integrated Urban Water Management

by managing the urban water cycle as a whole; a more efficient use of resources can be achieved providing not only economic benefits but also improved social and environmental outcomes

Emerging trends in our ability to incorporate the socio-technical interplay of urban water systems will determine the significance of our traditional modelling capabilities in influencing the transformation of cities into resilient, liveable and sustainable places

Wikipedia
Multiple drivers, Multiple criteria & Multiple scenarios

- The emergence of new performance indices
- Simulating the influence of socio-technical dynamics
- Capturing uncertainties
- Revisiting the concept of optimisation
Multiple drivers, Multiple criteria & Multiple scenarios

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Safe conveyance or detention of floodwater for events up to the 100 year ARI; buildings sited above 100 year ARI flood level with appropriate freeboard

< 10 sewer overflow occurrences in 10 years

Stormwater conveyance in pipes or swales for events up to 5 year ARI

Maintaining peak 1.5 year ARI to pre-development level

Best Practice Pollutant Reduction applied to >80% of stormwater runoff volume

Waterway geomorphic protection

Stormwater quality improvement

Major events drainage infrastructure

Minor events drainage infrastructure

Reduction in sewer overflows to urban waterways

Australian Practice

2008

- Safe conveyance or detention of floodwater for events up to the 100 year ARI; buildings sited above 100 year ARI flood level with appropriate freeboard
- < 10 sewer overflow occurrences in 10 years
- Stormwater conveyance in pipes or swales for events up to 5 year ARI
- Maintain natural hydrology for events up to 1 year ARI
- Stormwater harvesting
- Best Practice Pollutant Reduction applied to >80% of stormwater runoff volume
- Stormwater quality improvement
- Waterway geomorphic protection
- Reduction in sewer overflows to urban waterways
- Managing stormwater as a resource
- Reducing hydrological disturbances in urban waterway

Flood Return Period

0.1 1 10 100 1000
Multiple Hydrologic and Hydraulic Design Objectives for Drainage Infrastructure

- Stormwater quality improvement
- Waterway geomorphic protection
- Minor events drainage infrastructure
- Major events drainage infrastructure
- Reducing hydrological disturbances in urban waterway
- Managing stormwater as a resource
- Stormwater quality improvement
- Best Practice Pollutant Reduction applied to >80% of stormwater runoff volume
- Maintaining natural hydrology for events up to 1 year ARI
- Stormwater conveyance in pipes or swales for events up to 5 year ARI
- Stream Erosion Index < 2
- Safe conveyance or detention of floodwater for events up to the 100 year ARI; buildings sited above 100 year ARI flood level with appropriate freeboard
- < 10 sewer overflow occurrences in 10 years
- Reduction in sewer overflows to urban waterways

Flood Return Period

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Multiple drivers, Multiple criteria & Multiple scenarios

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- Resilient
- Liveable
- Sustainable

- Comfort Capacity
- Carrying Capacity
- Coping Capacity
Multiple drivers, Multiple criteria & Multiple scenarios

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Resilient Liveable Sustainable

Comfort Capacity
Carrying Capacity
Coping Capacity
Linking Urban Water Management and Urban Liveability

Linking Urban Water Management and Urban Liveability

Effective Drainage & Flood Mitigation

- Future cities would incorporate into its urban planning and design of appropriate land uses in accordance to the three-tiered approach of retreat, adapt and defend against future flood vulnerability.

- A water sensitive city would establish a network of blue and green open spaces and corridors to serve as an integral element of the city’s drainage infrastructure and floodway for flood conveyance during rare (low probability) storm occurrences.

Linking Water Sensitive Urbanism to Urban Liveability

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Urban design strategy

- Parklands, green waterways, structures and buildings are ‘green infrastructure’ that emphasise the important role that vegetation (and therefore water and irrigation) plays in urban environments.

- Access to alternative fit-for-purpose water sources provides an additional and abundant source of water to allow the greening of cities.
The quality of public spaces

- Urban water systems designed in urban environments to incorporate means of enhancing social engagement and cultural expression.

- Public spaces to include the celebration of water in urban environments with art features that respond to water availability and seasonality, and the establishment of biodiversity terrestrial and aquatic corridors.
Mitigating urban heat

- **Climate responsive designs** will have a positive effect on human health. Urban heat mitigating design responses should place particular emphasis on the strategic implementation of WSUD technologies and green infrastructure.

- Green infrastructure supported by such **design principles of keeping water in the landscapes and promoting lush and well-irrigated vegetation** can provide microclimate benefits by reducing excess urban heating (through shading, and cooling by evapotranspiration) and limit human exposure to extreme heat.
Multiple drivers, Multiple criteria & Multiple scenarios

- The emergence of new performance indices
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Stormwater runoff is generated across distributed areas and therefore presents the best opportunity for green infrastructure to be distributed throughout the urban area for effective realisation of multiple benefit outcomes
Multiple drivers, Multiple criteria & Multiple scenarios

- The emergence of new performance indices
- Simulating the influence of socio-technical dynamics

**ReVISIONS**

Regional Visions of Integrated Sustainable Infrastructure Optimised for Neighbourhoods

**DAnCE4Water**

Dynamic Adaptation for enabling City Evolution for Water

**CORFU**

FP7 Collaborative research on flood resilience in urban areas

**CRC for Water Sensitive Cities**
Multiple drivers, Multiple criteria & Multiple scenarios

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**PROPOSED METHODOLOGY**

Sources of uncertainties: input data, model structure, model parameters, etc

Capturing the cascade of uncertainties
Multiple drivers, Multiple criteria & Multiple scenarios

- The emergence of new performance indices
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conclusions

Integrated urban water management

- the emergence of hybrid centralised/decentralised infrastructure and green infrastructure

- water management for multiple benefits that include enhancing urban liveability

- solutions are distributed throughout the urban area for effective realisation of multiple benefit outcomes

- strategies need to be adaptive to the socio-technical dynamics of urban growth, expanding integration and changing priorities of management objectives
conclusions

our ability to incorporate the socio-technical interplay of urban water systems will determine the significance of our traditional modelling capabilities in influencing the transformation of cities into resilient, liveable and sustainable places