9th International Conference on Urban Drainage Modelling
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DAnCE4Water's BPM

A planning algorithm for decentralised water management options

Peter M. Bach

David T. McCarthy, Christian Urich, Robert Sitzenfrei,
Manfred Kleidorfer, Wolfgang Rauch, Ana Deletic

Urban BEaTS

MONASH water for liveability

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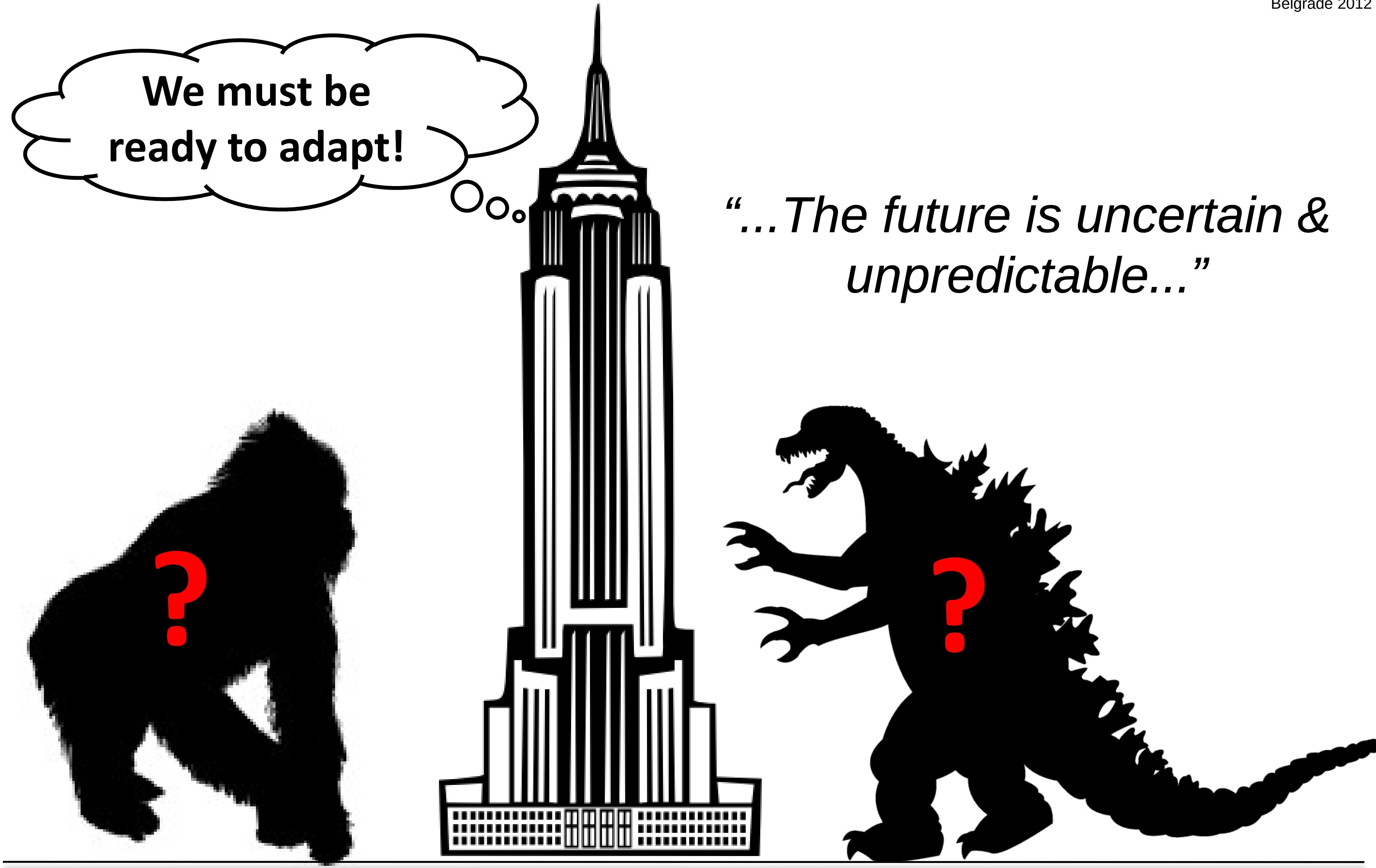
Melbourne Water

CRC for Water Sensitive Cities

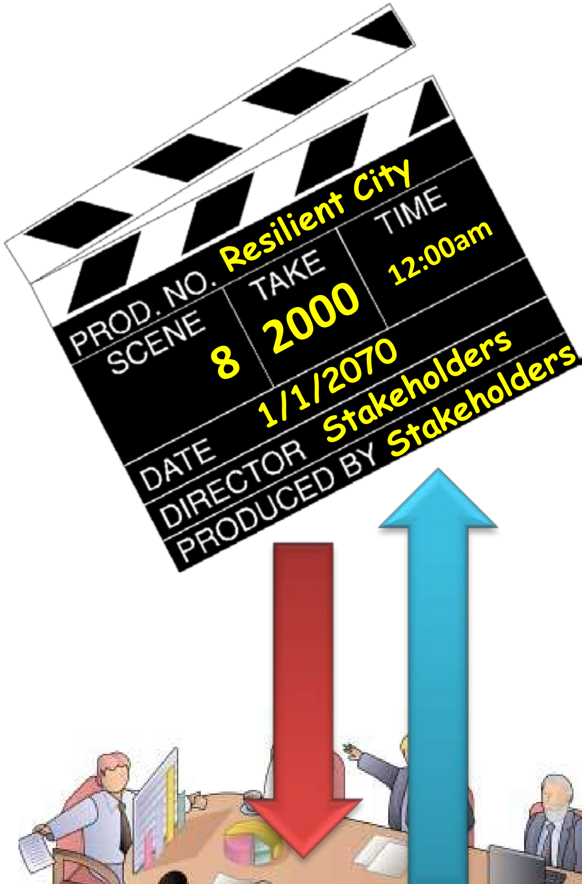
Today's Presentation involves…

Our focus is on Planning...

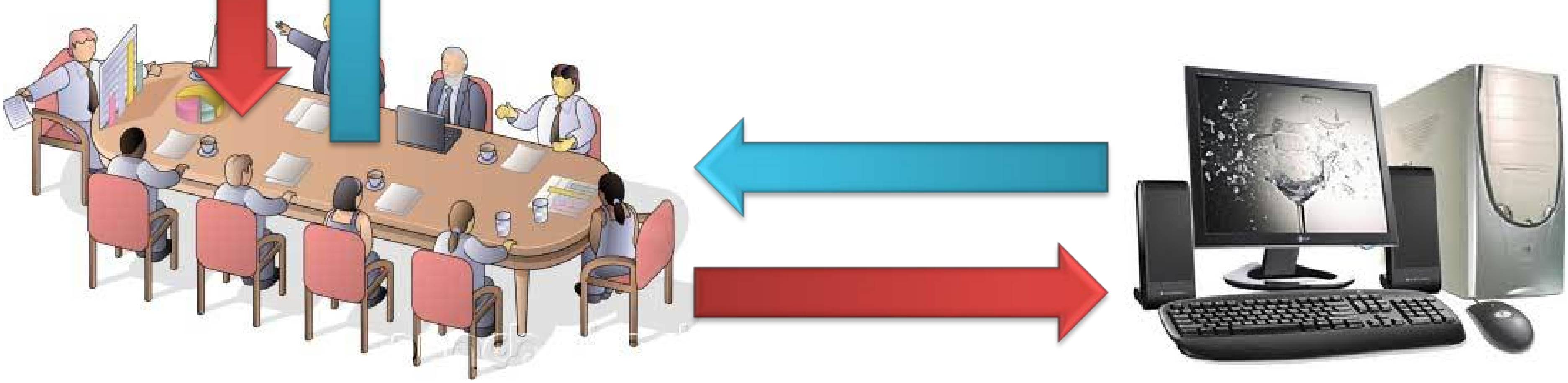


"...The future is uncertain & unpredictable..."

Today’s Presentation



- A different kind of “model”
- DAnCE’s Biophysical Module
- Overview of Methods
- Initial Applications
- Dynamic Planning Example



A different kind of "Modelling"

- Planning for **<insert latest buzzword here>** implies a need for integration

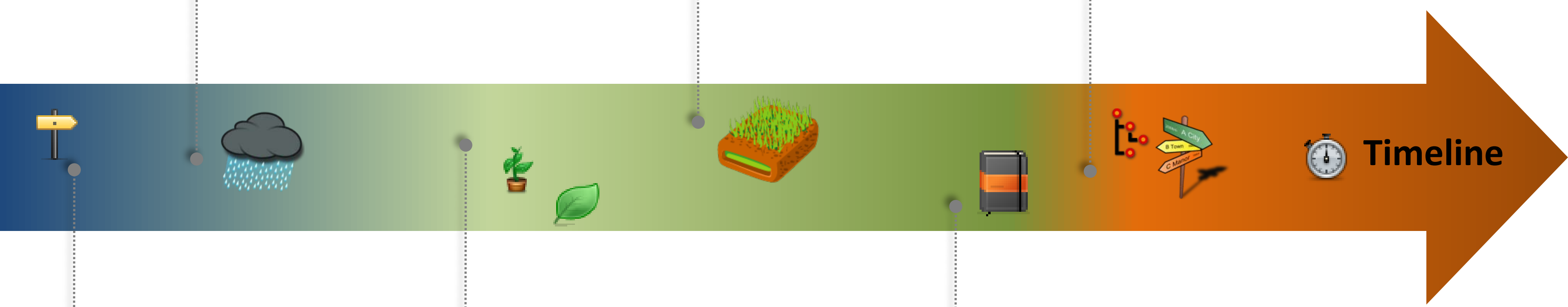
"Sustainability"
"Resilience"
"Adaptation" or
"Adaptive Capacity"
"Preparedness"

- Participatory and interdisciplinary approach to planning – how to facilitate?

- Scientific rigour in the thought process, how can modelling help?

- Scenarios should be <u>dynamic</u> and <u>evolving</u>

An Example Scenario



1960

In the Beginning
Not much awareness, deal with sediment and flow where appropriate.

1970

Let's Manage Water
Some increase in awareness and adoption

1980

Nutrients a pest!
TN and TP management now required to protect the environment

1990

Emergence of Bioretention
New technology emerges, targets become more stringent

2000

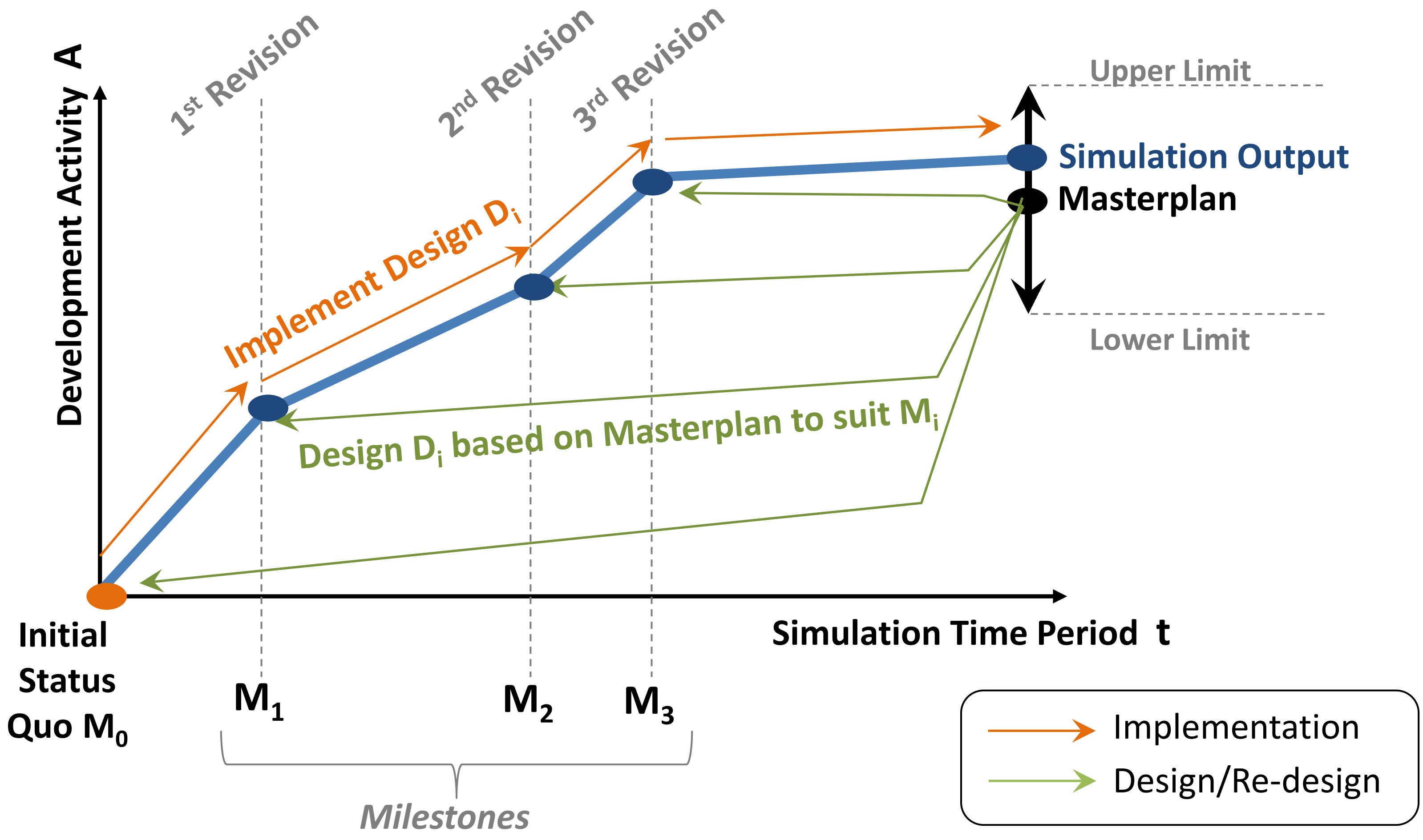
A New Mandate
Required to treat 70% of the total catchment area

2010

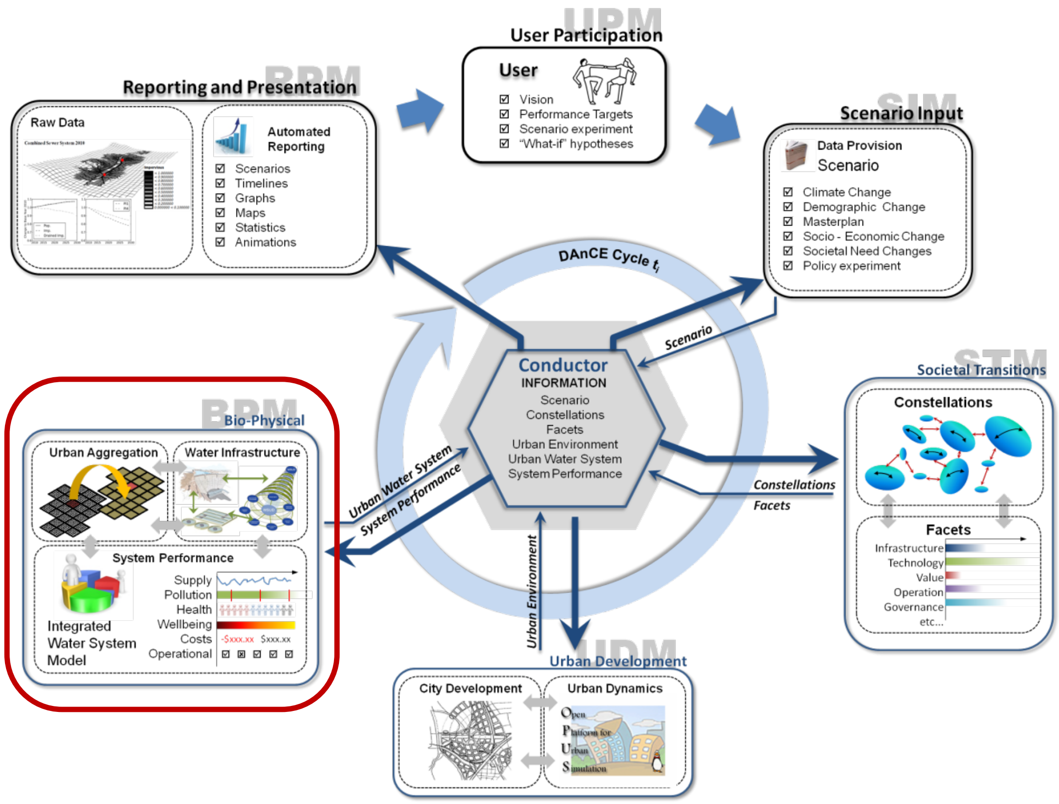
Greater Challenge
Revised targets

We want a model that can...

- Planning according to Dynamic and Evolving scenarios



Dynamic Adaptation for enabling City Evolution for Water



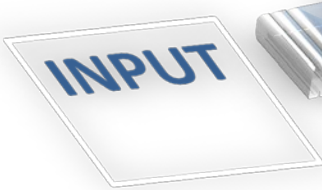
Strategic Planning Tool

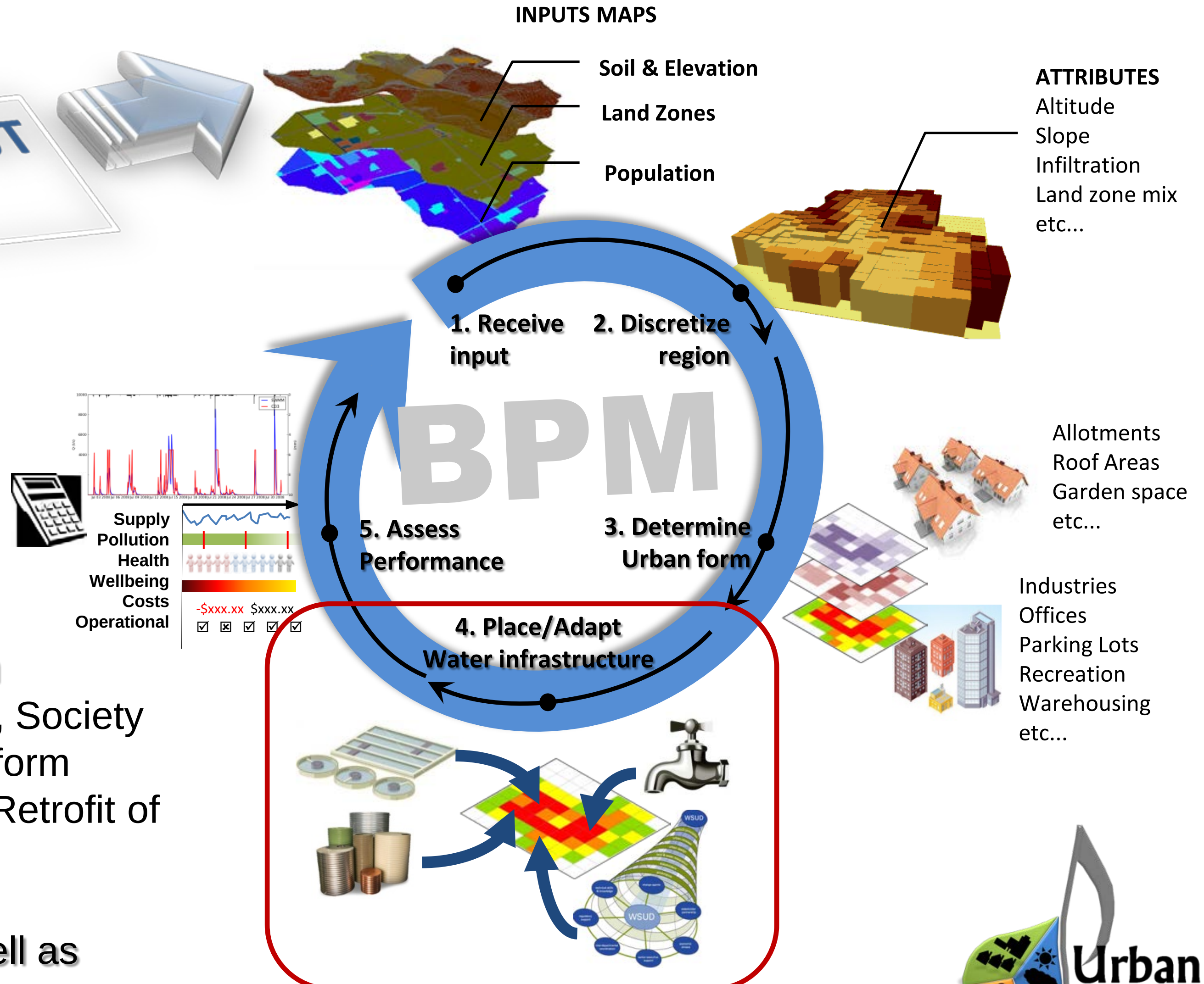
- Scenario assessment on the longer term and city scale
- Software and participatory scenario making
- Integrating biophysical, urban development and societal models

EU FP7 Project

- PREPARED: Enabling Change
- Austria-Australian Collaboration between Innsbruck University and Monash University

The Biophysical Module



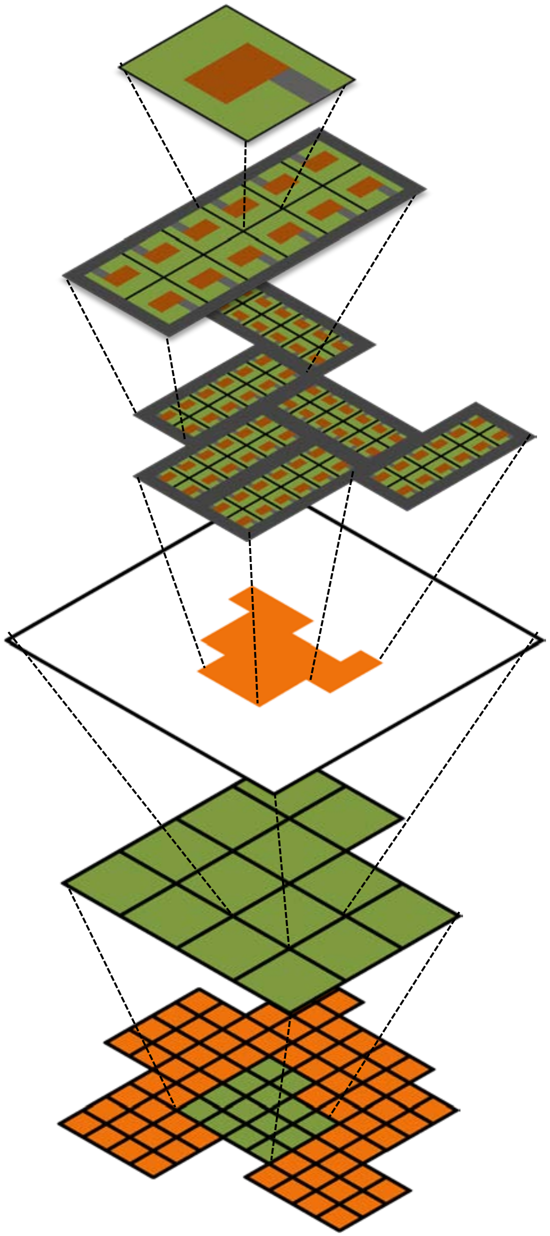


Urban Design & Water Infrastructure Adaptation

- Compliance to Legislation, Society
- Integration into the urban form
- Implementation/Removal/Retrofit of Technologies

Within DAnCE4Water as well as Standalone

Spatial Representation

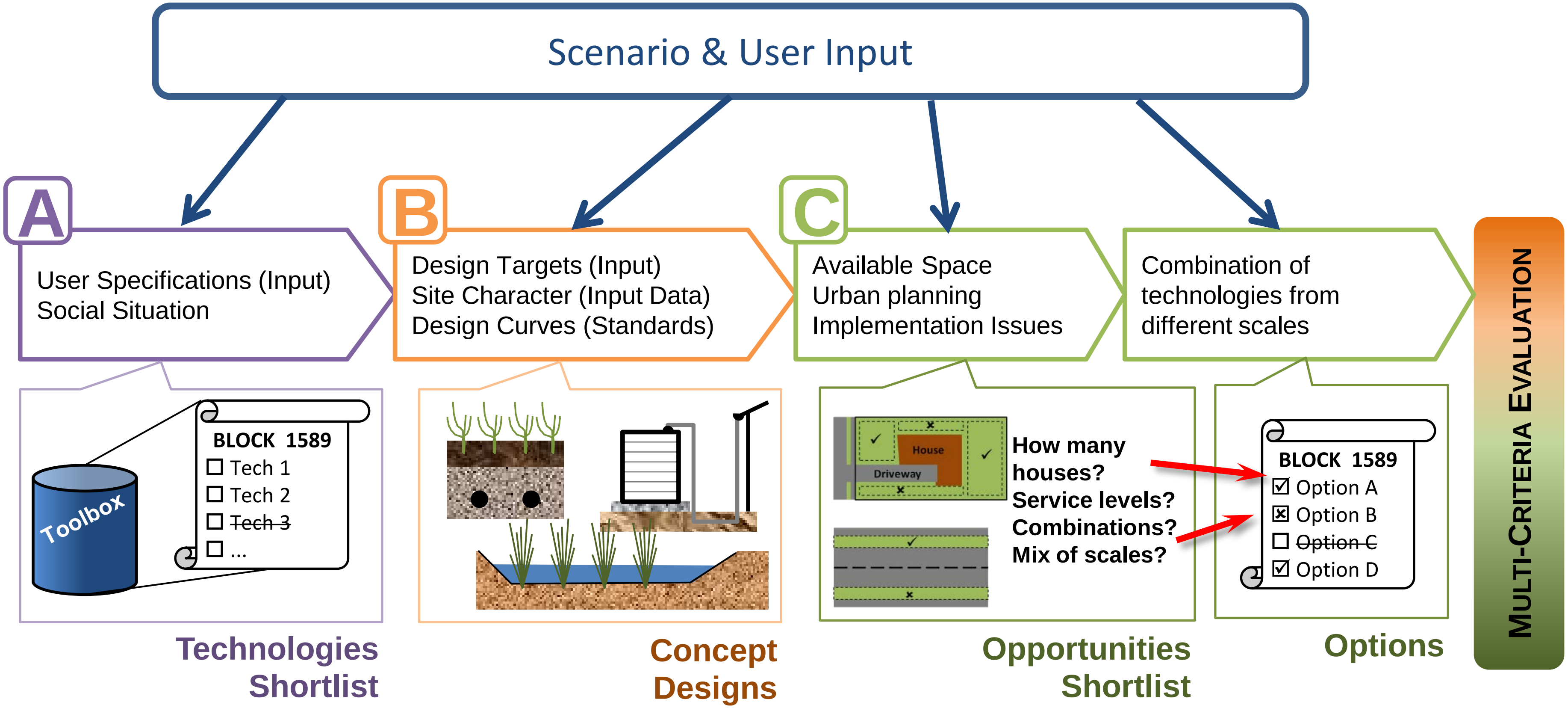


- **Lot/Parcel:** Planning Rules to 'reconstruct' the urban form
- **Patch/Block:** Data and User Input – dependent on size of case study
- **District/Basin:** Data of Geopolitical & Natural Terrain

For more details, see:

BACH, P. M., URICH, C., MCCARTHY, D. T., SITZENFREI, R., KLEIDORFER, M., RAUCH, W. & DELETIC, A. 2011. Characterising a city for integrated performance assessment of water infrastructure in the DAnCE4Water framework. *12th International Conference on Urban Drainage (12ICUD). Porto Alegre, Brazil.*

The Technology Planning Algorithm



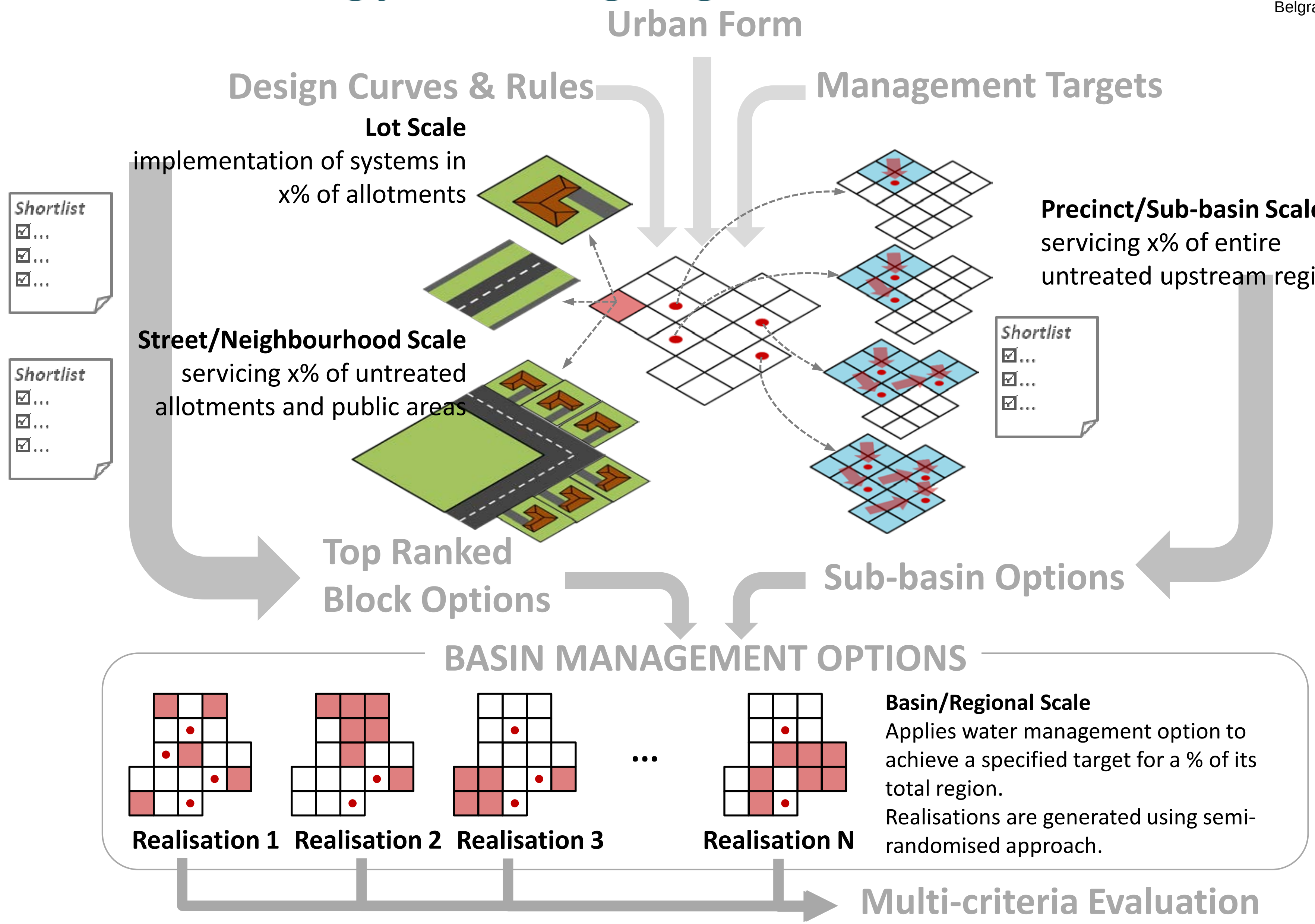
Some Terminology

- **Target:** Deem-to-comply values, these are set by legislation and must be met for a given area (e.g. % reduction in pollutant loads)

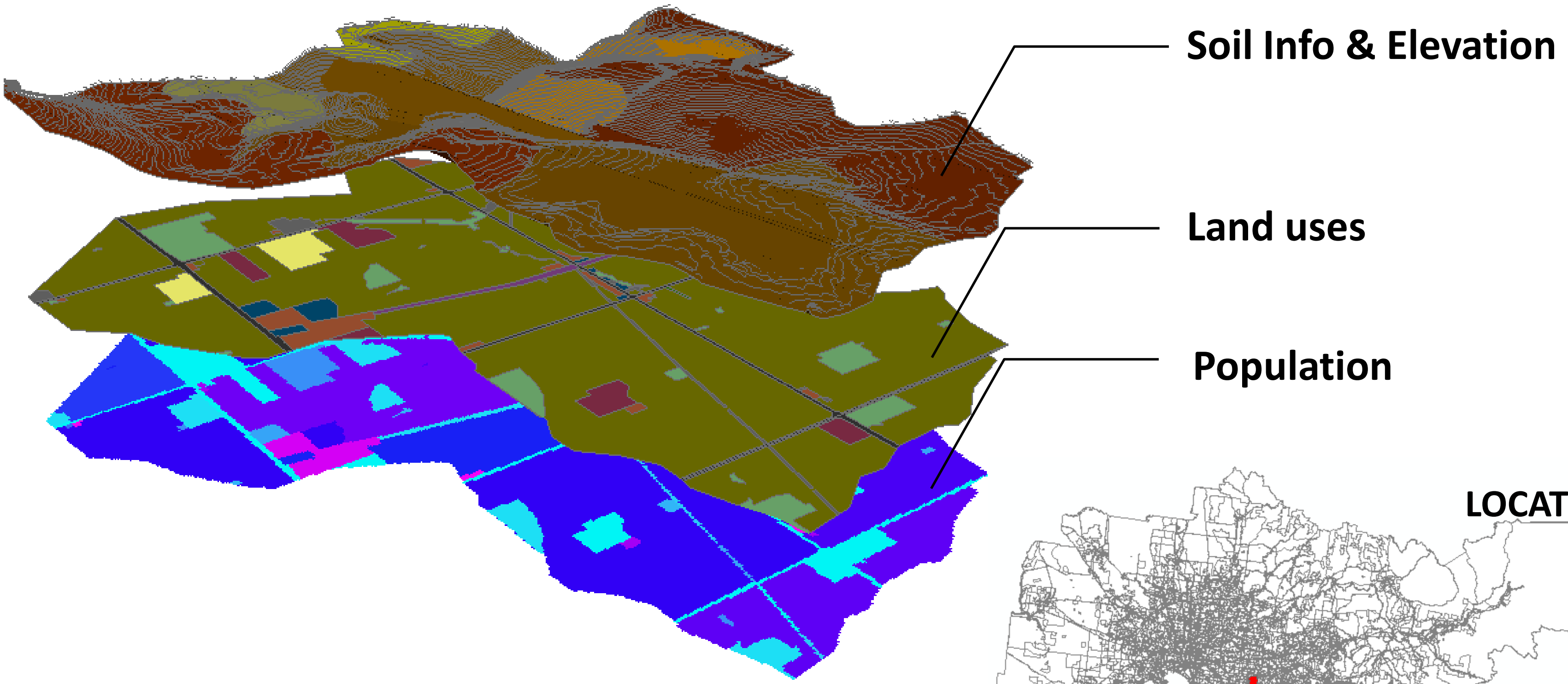
- **Service:** The % of a catchment's impervious area treated (or population provided for) by a technology or group of technologies

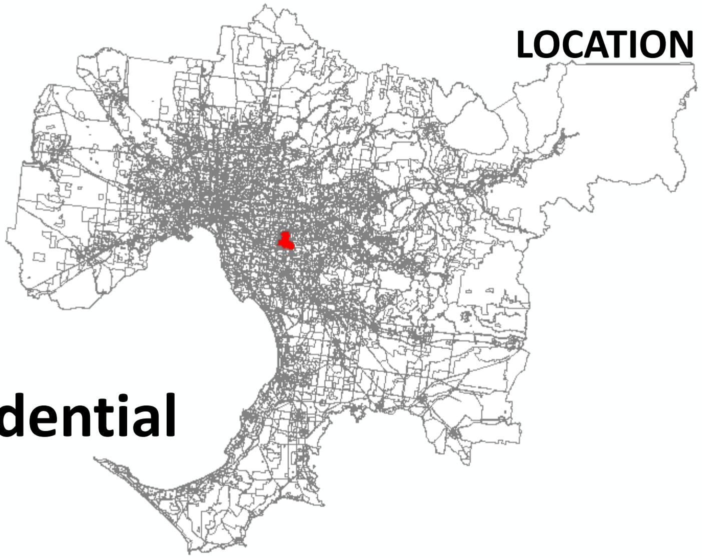
- **Option:** A particular combination of technologies at different scales to provide "Service" to the catchment to prescribed "Target"

The Technology Planning Algorithm



Case Study – Scotchman's Creek



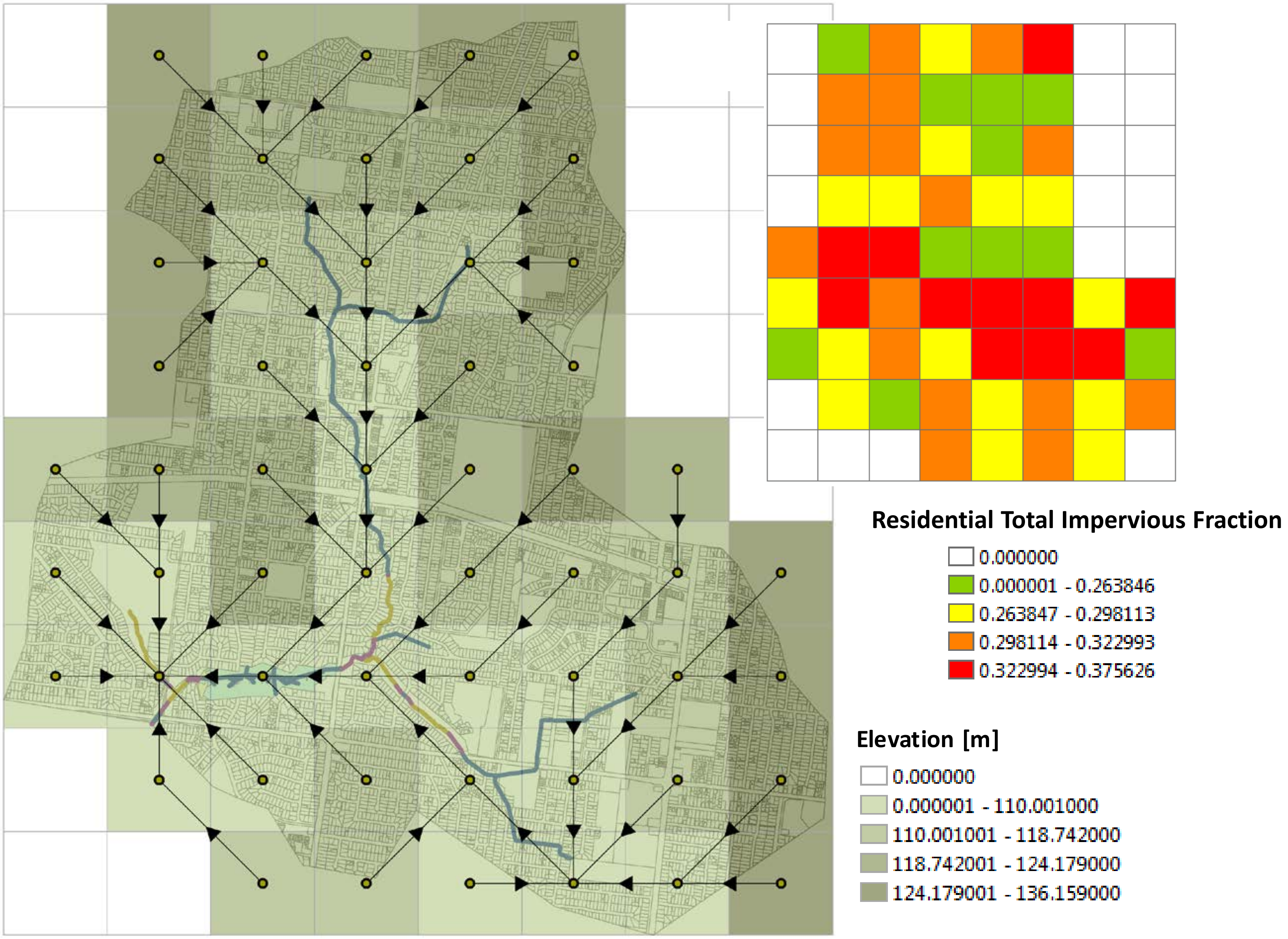


Catchment Area: 10km^2
Type: Urban – low/medium density residential
Location: Melbourne

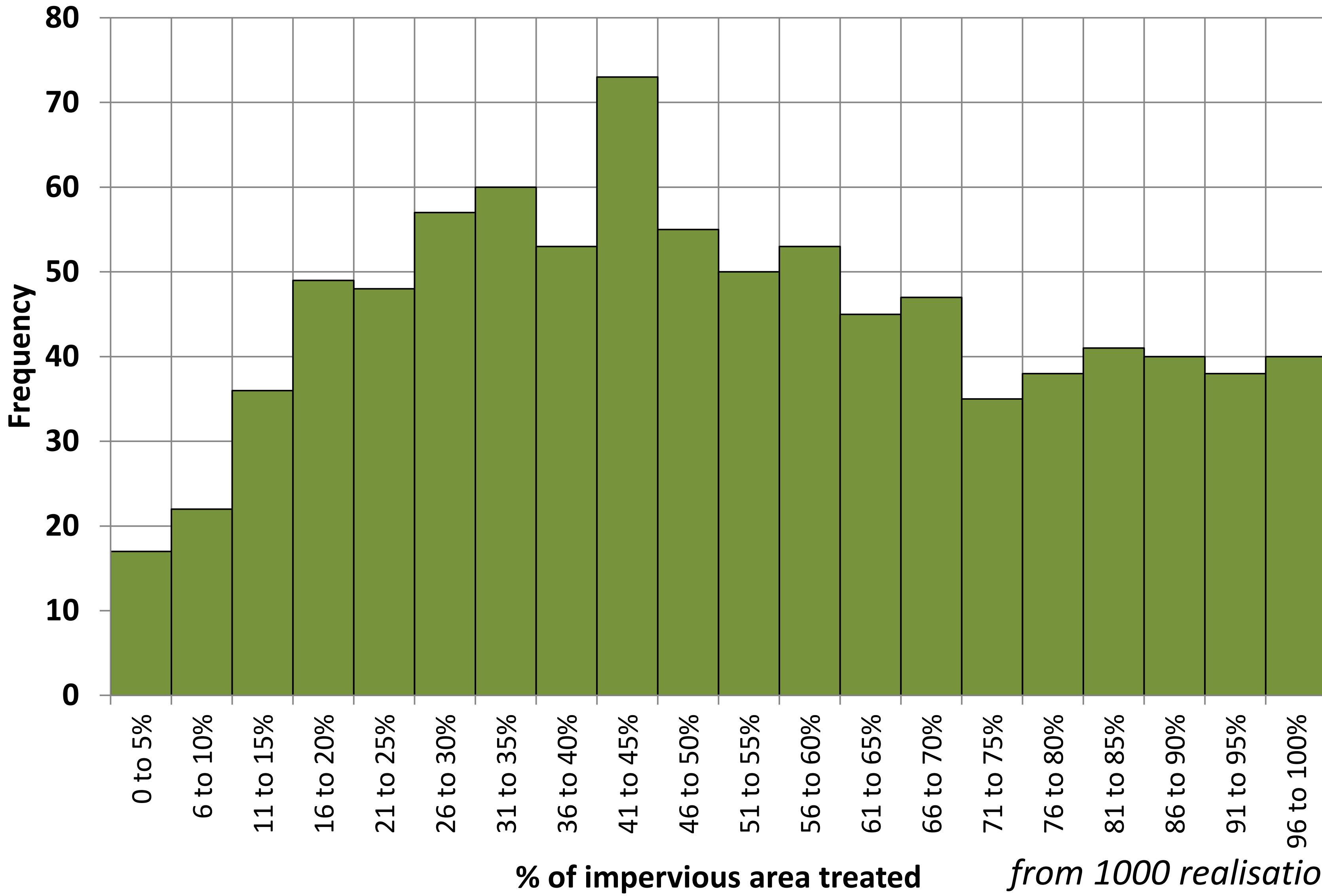
Case Study Setup

- 500m x 500m Block Size
- Urban Planning Regulations: Melbourne
- 5 system types: Bioretention, Infiltration, Wetlands, Ponds & Swales (design curves derived from Melbourne guidelines)
- Multi-Criteria Scoring: Adapted version of the DayWater Multi-Criteria Matrix (equal weightings)

Some Basic Outputs



Different Technology Options

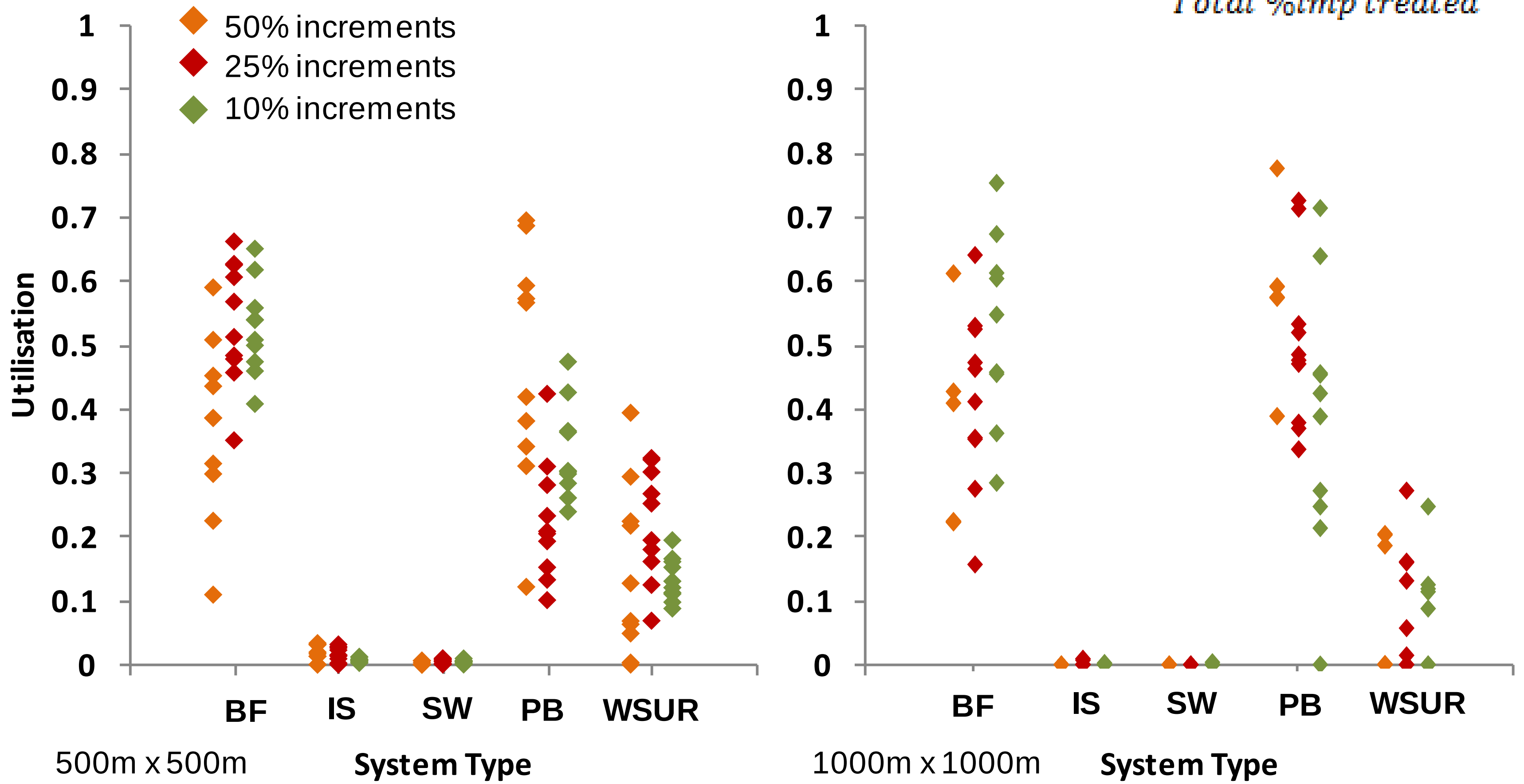


from 1000 realisations
(avg. = 53%, med. = 56%)

Technology Utilisation

- **Utilisation of different technologies reflect the unique characteristics of the catchment**

$$U = \frac{\%imp\ treated\ by\ technology\ i}{Total\ \%imp\ treated}$$

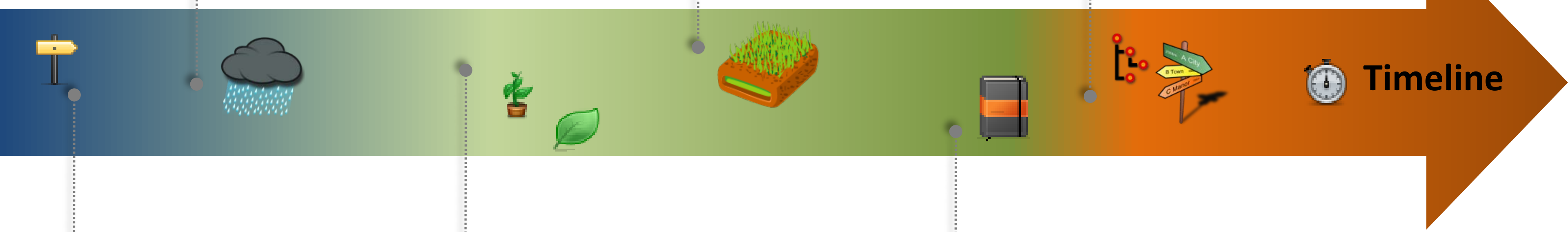


CRC for Water Sensitive Cities

Some Key Findings

- Combined used of Bioretention and Ponds/Wetlands Favourable
- Urban Form of catchment constrains the opportunities for stormwater management
- Choice of block size and level of rigour in assessment dependent on case study and modelling aims

Back to our Scenario



1960

In the Beginning
Targets: V 50%, TSS 50%

Service: 10%
Systems available:
- Infiltration Systems
- Ponds

1970

Let's Manage Water
Targets: V 50%, TSS 50%

Service: 30%
Systems available:
- Ponds & Basins
- Infiltration Systems

1980

Nutrients a pest!
Targets: V 50%, TSS 70%,
TN 20%, TP 20%
Service: 50%
Systems available:
- Ponds & Basins
- Infiltration Systems
- Wetlands

1990

Emergence of Bioretention
Targets: V 60%, TSS 80%,
TN 30%, TP 30%
Service: 50%
Systems available:
- Ponds & Basins
- Infiltration Systems
- Wetlands
- Bioretention

2000

A New Mandate
Targets: V 70%, TSS 80%,
TN 30%, TP, 30%
Service: 70%
Systems available:
- Ponds & Basins
- Infiltration Systems
- Wetlands
- Bioretention

2010

Greater Challenge
Targets: V 80%, TSS 90%,
TN 45%, TP 45%
Service: 70%
Systems available:
- Ponds & Basins
- Infiltration Systems
- Bioretention
- Wetlands

A More Dynamic Case Study

Implementation Rules

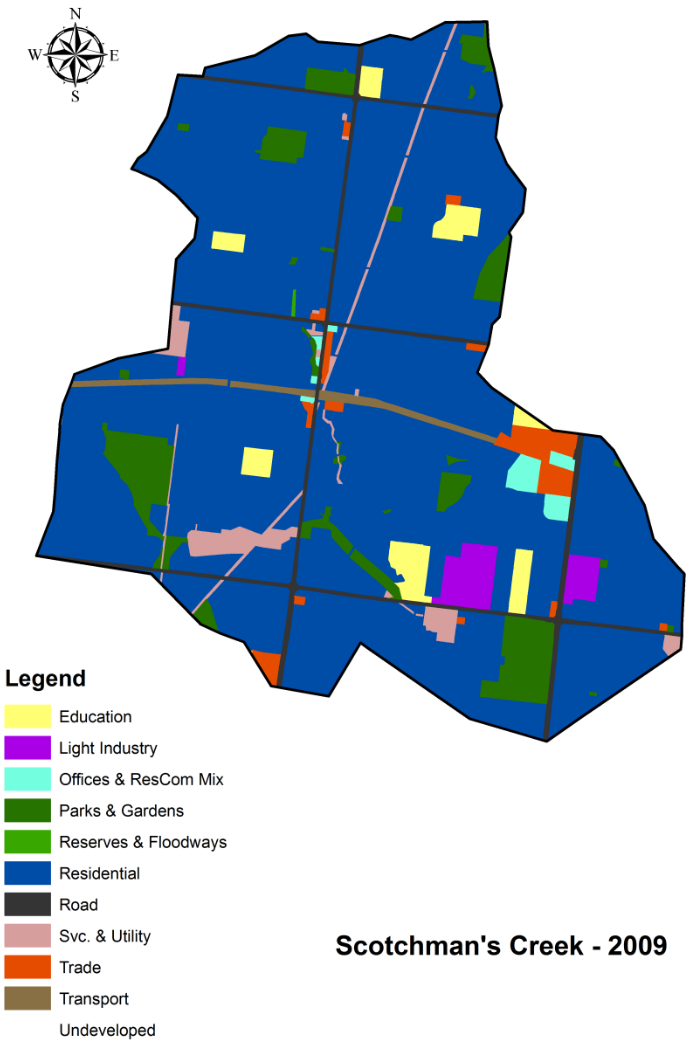
- Based on rate of Urban Development

Retrofitting of Existing Areas

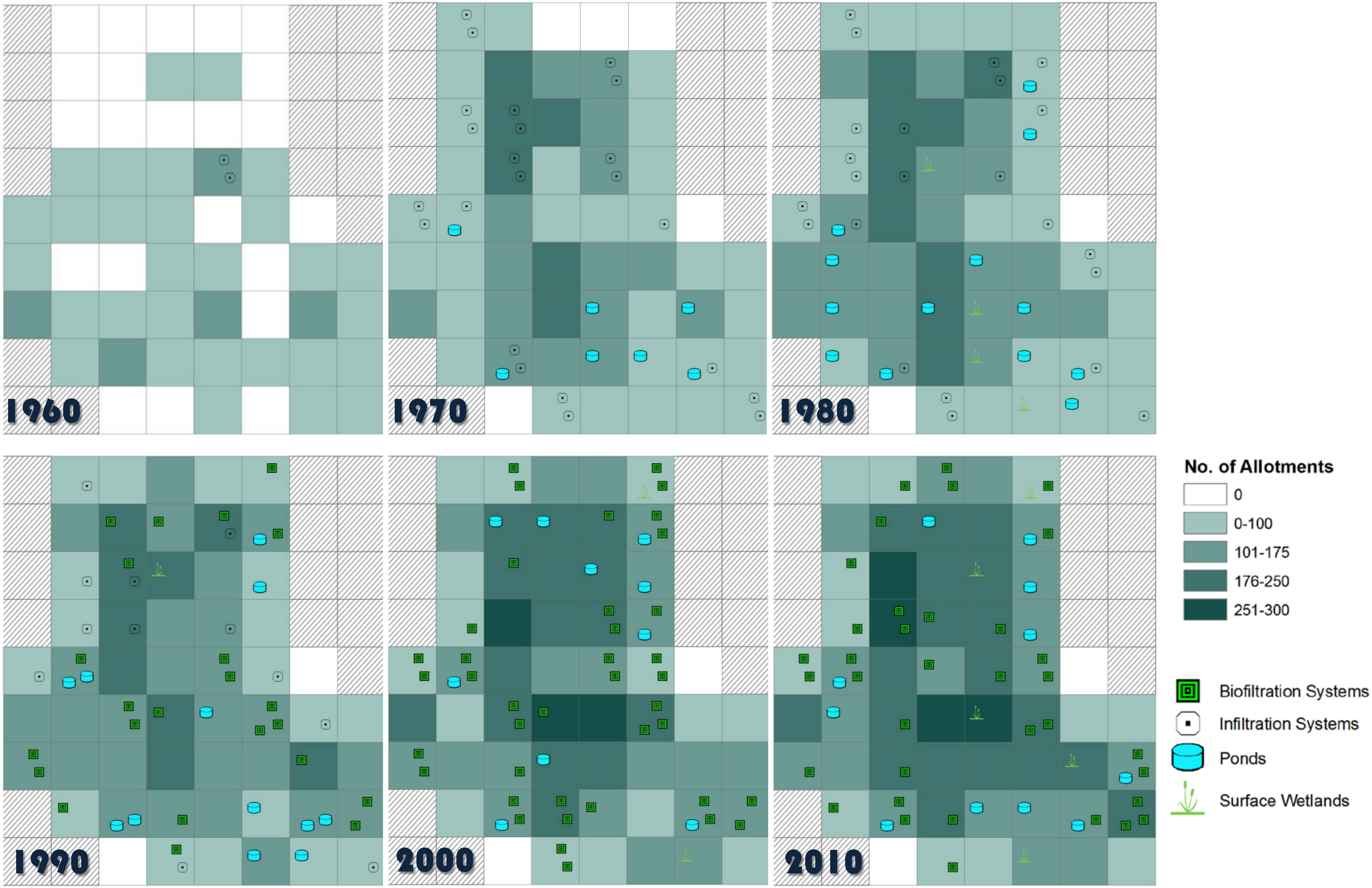
- Performance and System Age Dependent
- Three possible dynamics: keep, upgrade, decommission

Simulation Period: 50 years

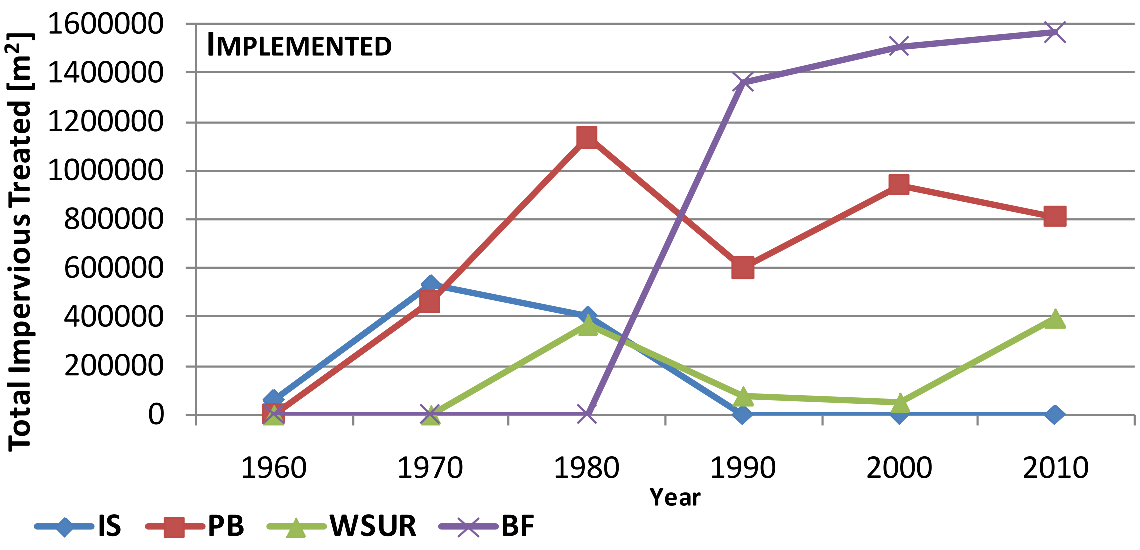
Dynamics of Urban Development based on Urich et al., 2012 (9UDM)



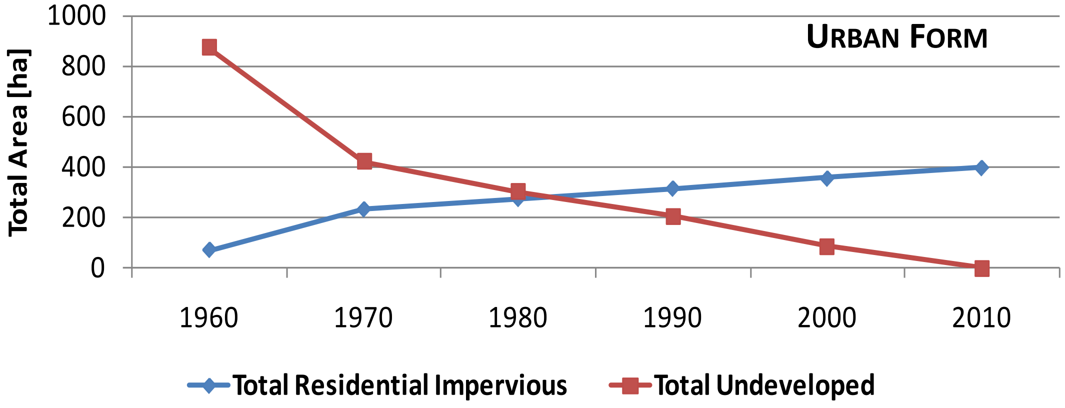
Infrastructure Over Time



Some Quantitative Observations



IS = Infiltration System
PB = Ponds & Basins
WSUR = Surface Wetland
BF = Biofiltration System



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Future Work

1) Implementation of Water Recycling Technologies (e.g. Rainwater tanks, advanced stormwater harvesting plants)

2) Addition of decentralised wastewater and water supply technologies

3) Detailed coupling with other modules to better incorporate social and urban development feedbacks

4) More rigorous testing on Scotchman's Creek and other examples

Final Remarks

1) Planning for an uncertain future requires the use of dynamic and evolving scenarios

2) DAnCE4Water's Biophysical Module offers a means for exploring many possible configurations of decentralised urban water technologies and their evolution over time

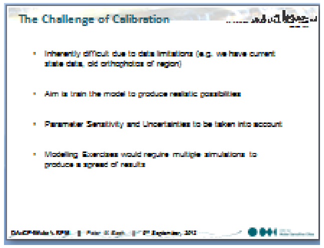
3) The use of such models in the planning process can build a better understanding of the complexity of our urban environment and water infrastructure

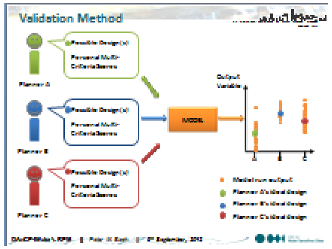
Thank You for your Attention!
Any Questions?

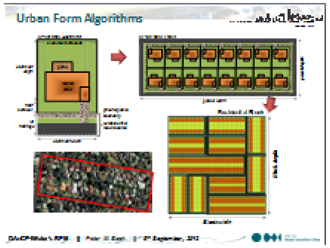
Peter M. Bach
MONASH water for livability
Building 60, Monash University, Clayton VIC 3800
Australia

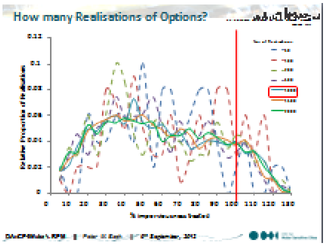
email: *Peter.Bach@monash.edu*
visit: ***www.urbanbeatsmodel.com***

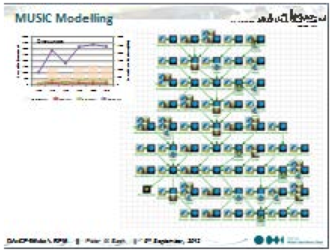
Additional Slides









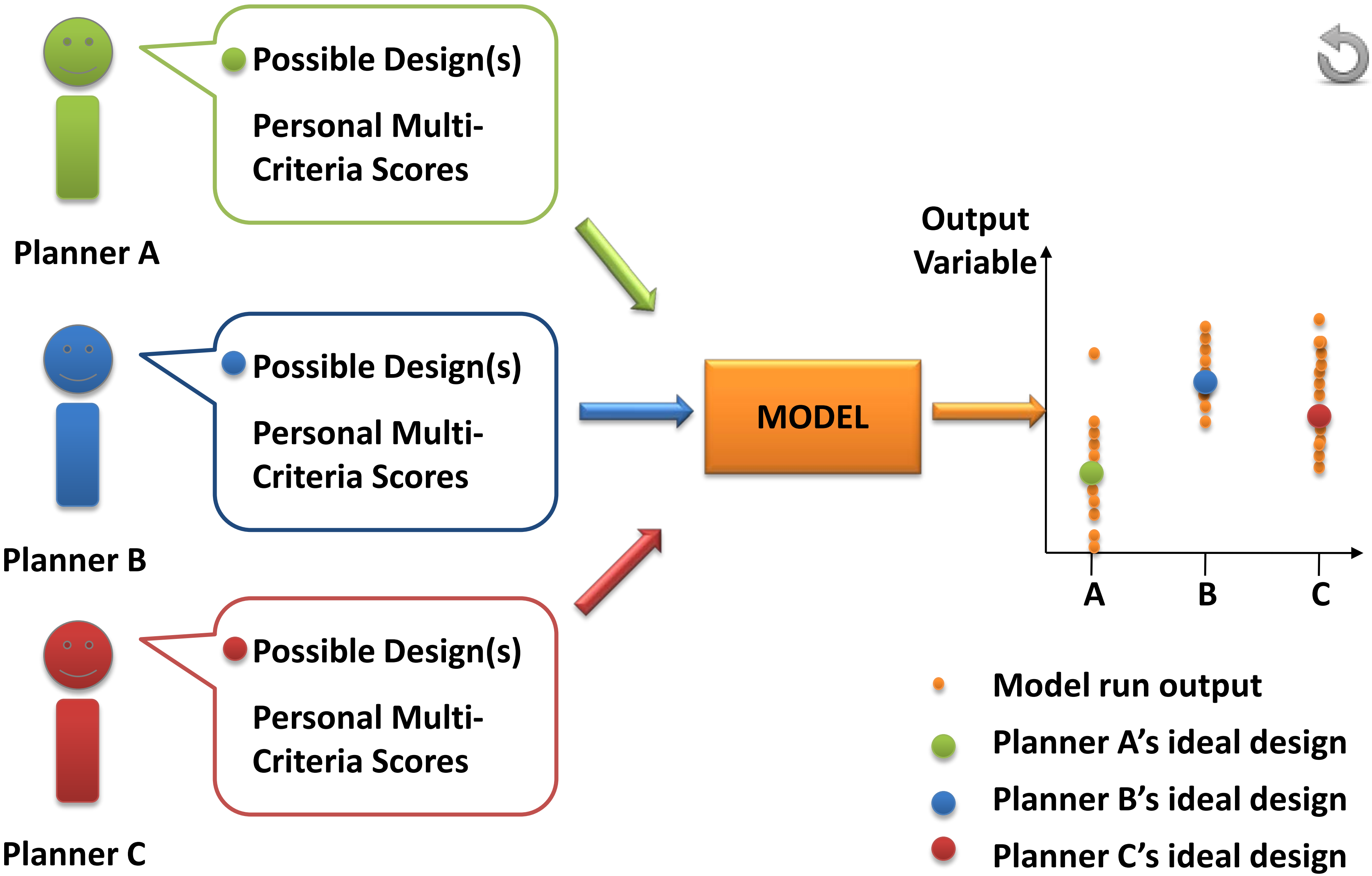


CRC for Water Sensitive Cities

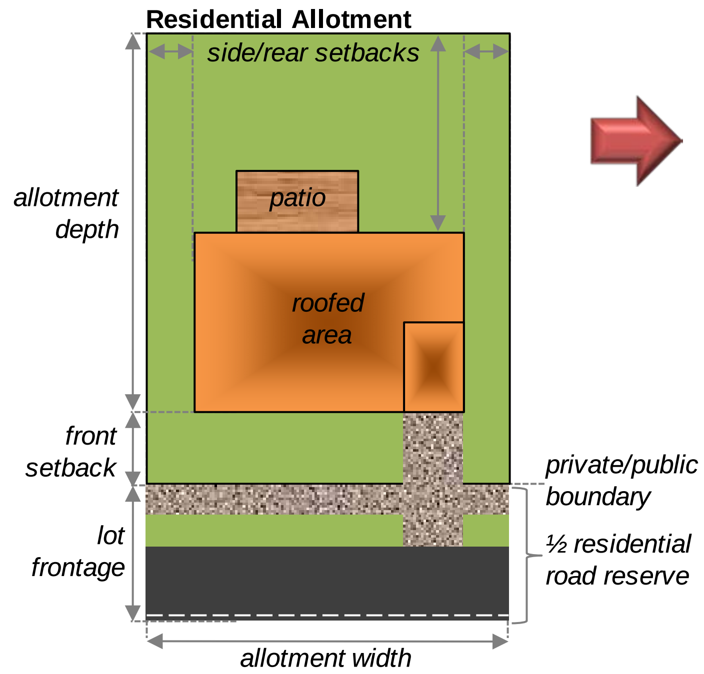
The Challenge of Calibration

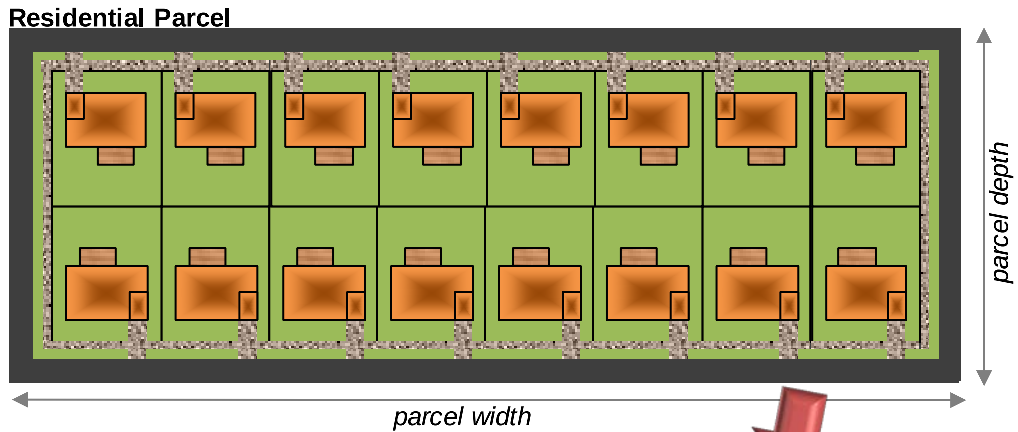
- Inherently difficult due to data limitations (e.g. we have current state data, old orthophotos of region)
- Aim is train the model to produce realistic possibilities
- Parameter Sensitivity and Uncertainties to be taken into account
- Modelling Exercises would require multiple simulations to produce a spread of results

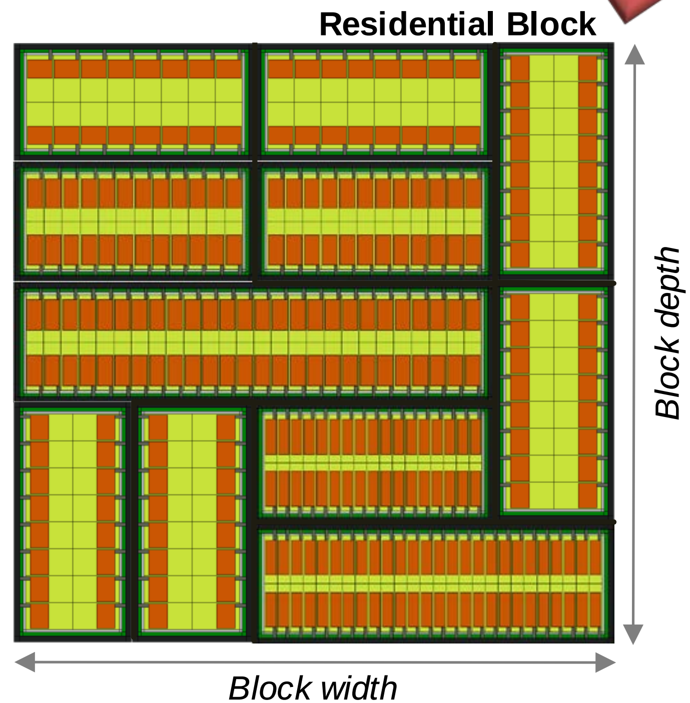
Validation Method



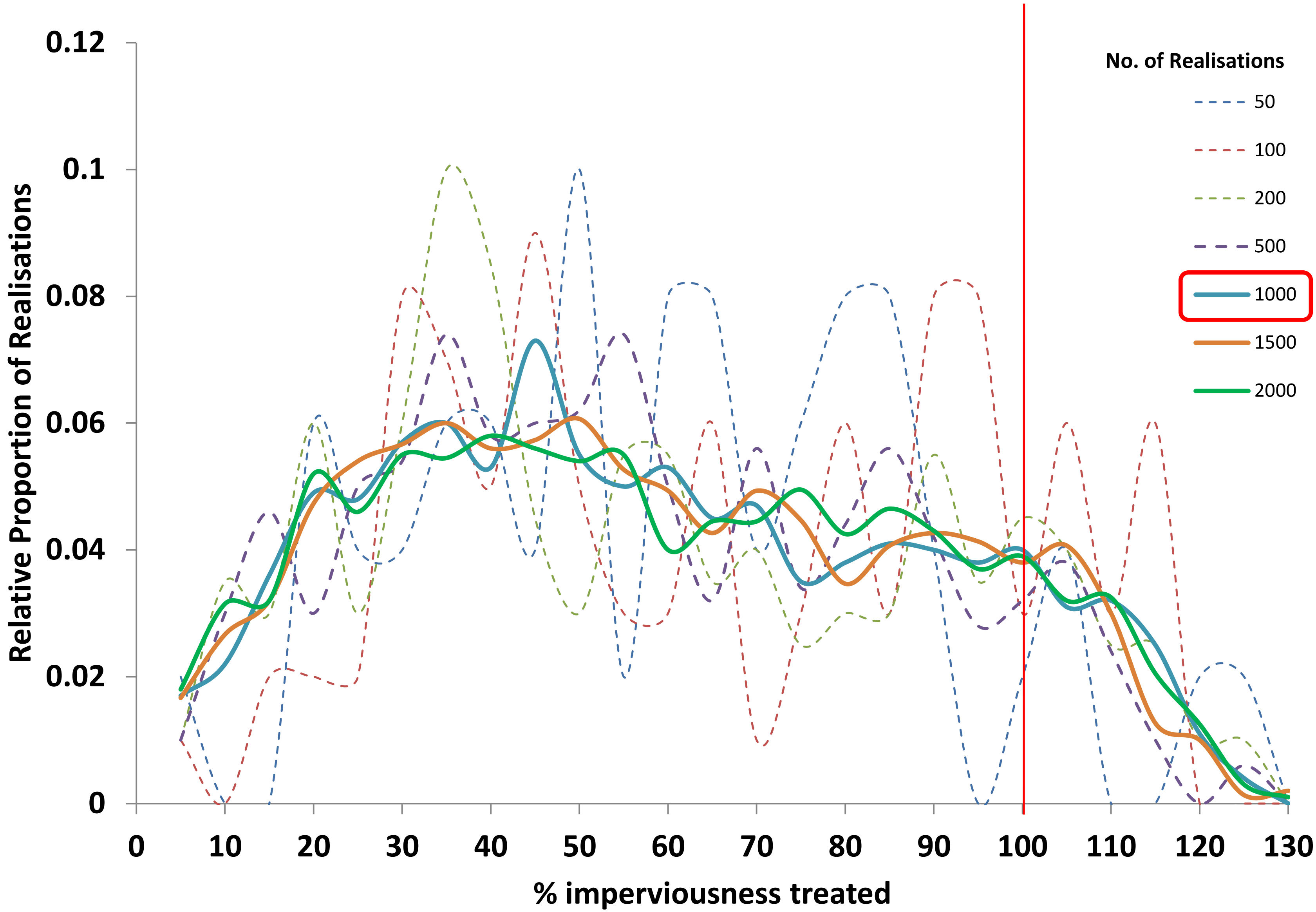
Urban Form Algorithms



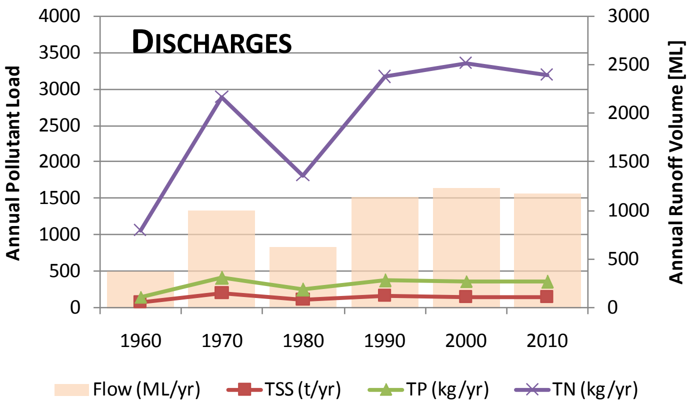


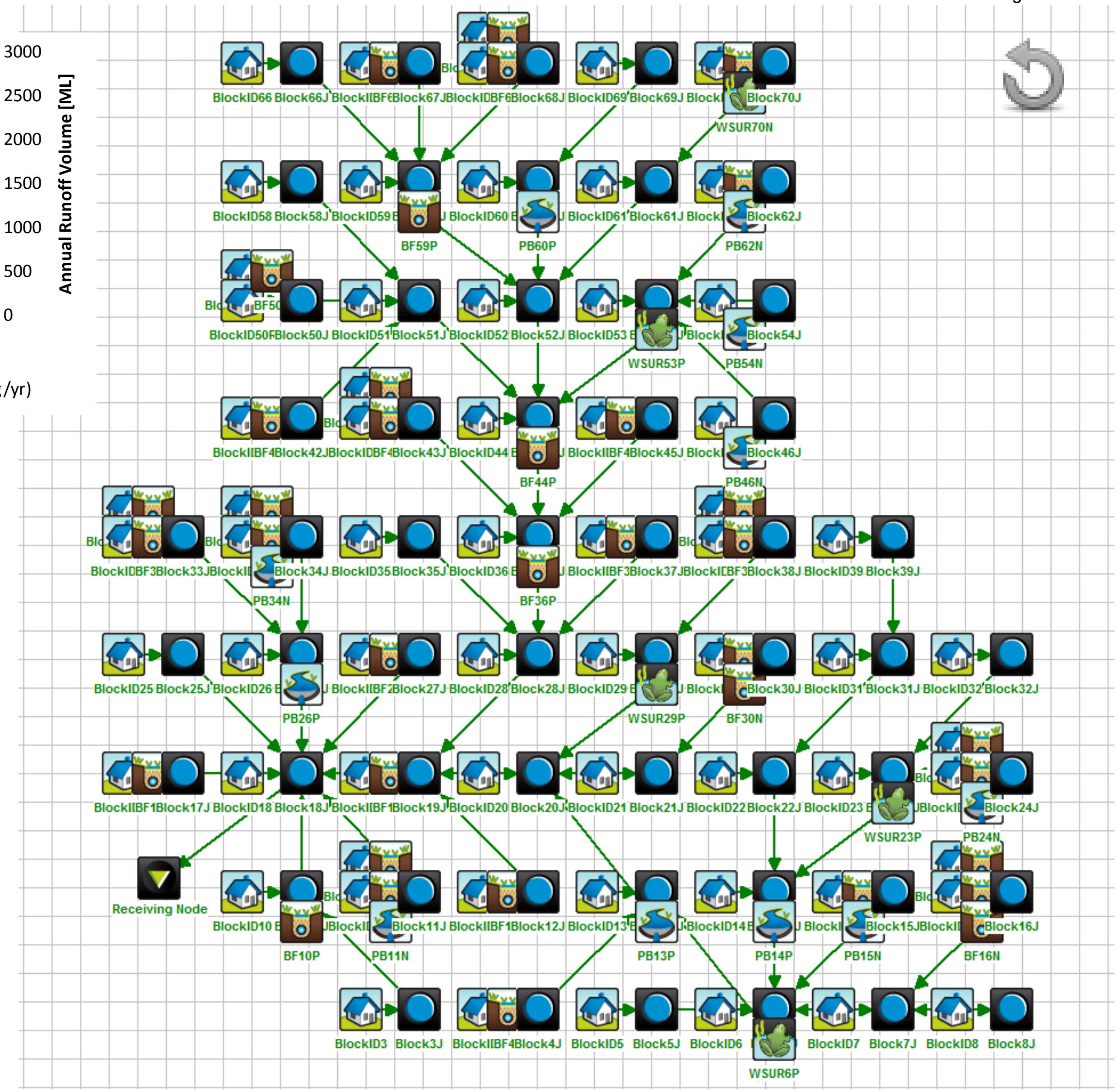


How many Realisations of Options?



MUSIC Modelling





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