A WSUD PLANNING FRAMEWORK FOR MEETING LONG-TERM CATCHMENT-SCALE PLUVIAL FLOOD MITIGATION TARGETS

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(Source: stablediffusionweb)

Pluvial Flooding:
A Growing Challenge

- Countless possible combinations across catchment
- Detail design + flood modelling

WSUD:
A Resilient Solution

(Source: Thames21)

- Target-oriented approach

Framework for Planning WSUD Strategies to Achieve Catchment-Scale Flood Mitigation Targets

- **Target Oriented**:

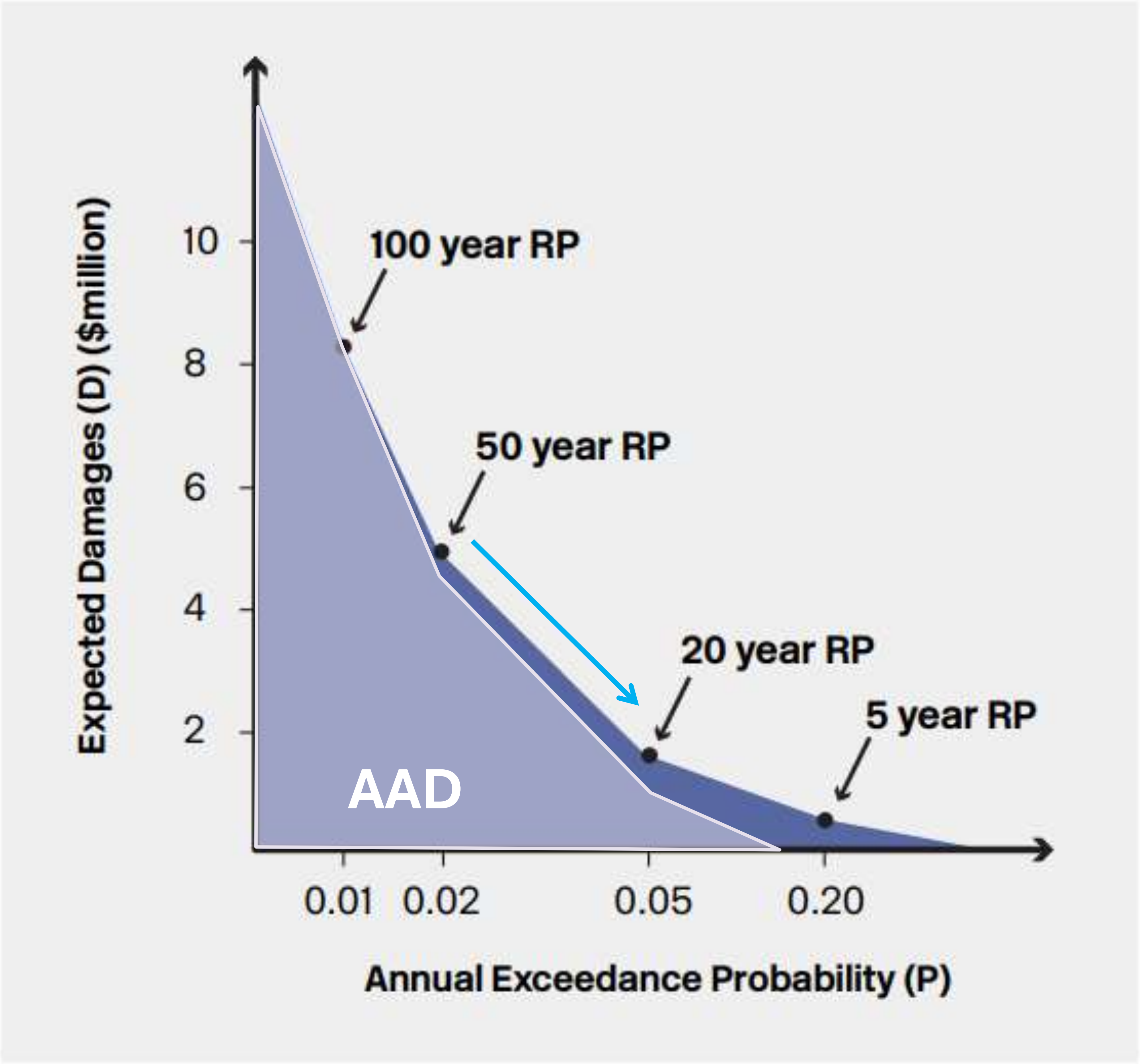
  - Reduce flood damage return period (RP)

  - Reduce average annual damage (AAD)

- **Rapid and Exploratory:**

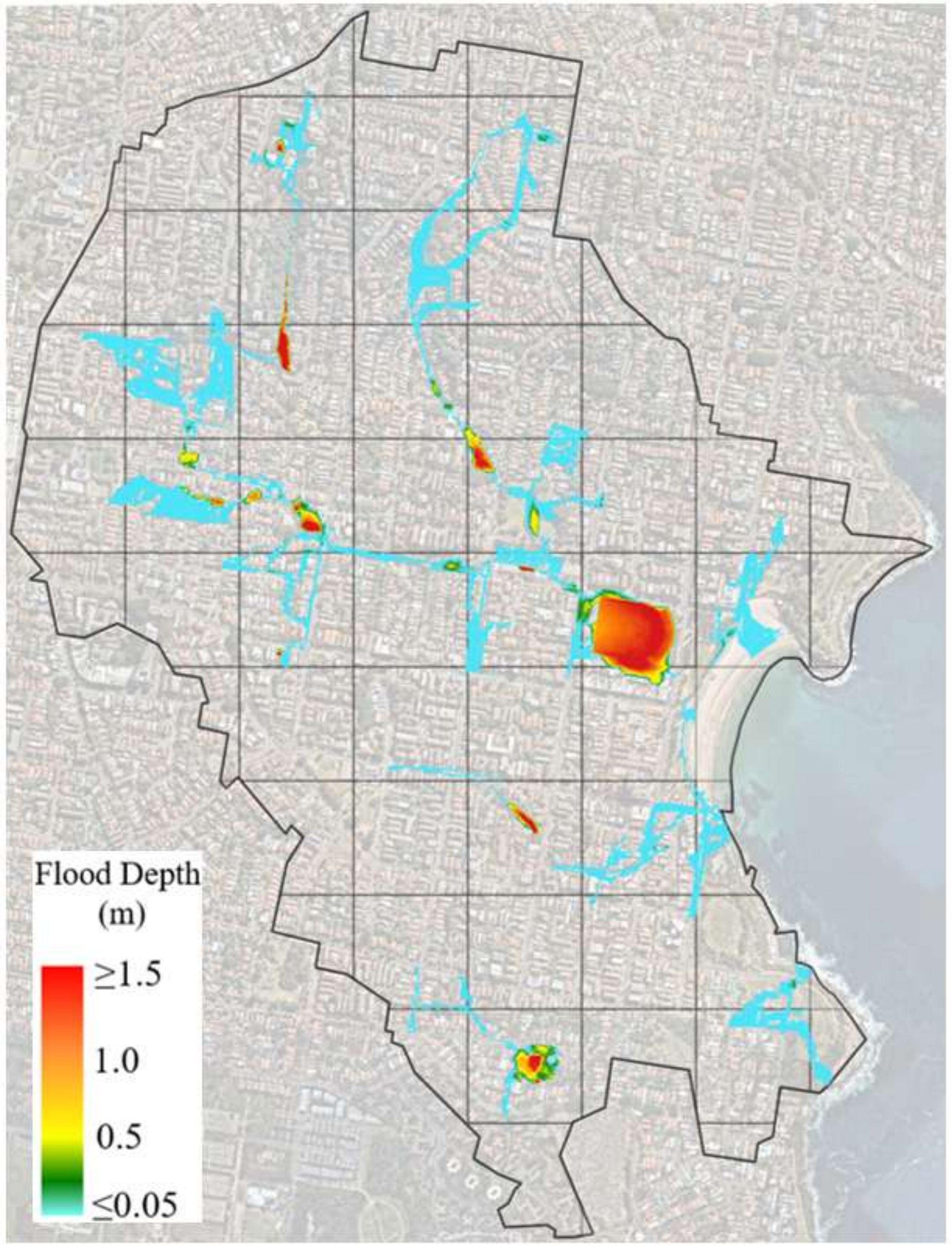
  - Screen through scenarios without detailed WSUD design

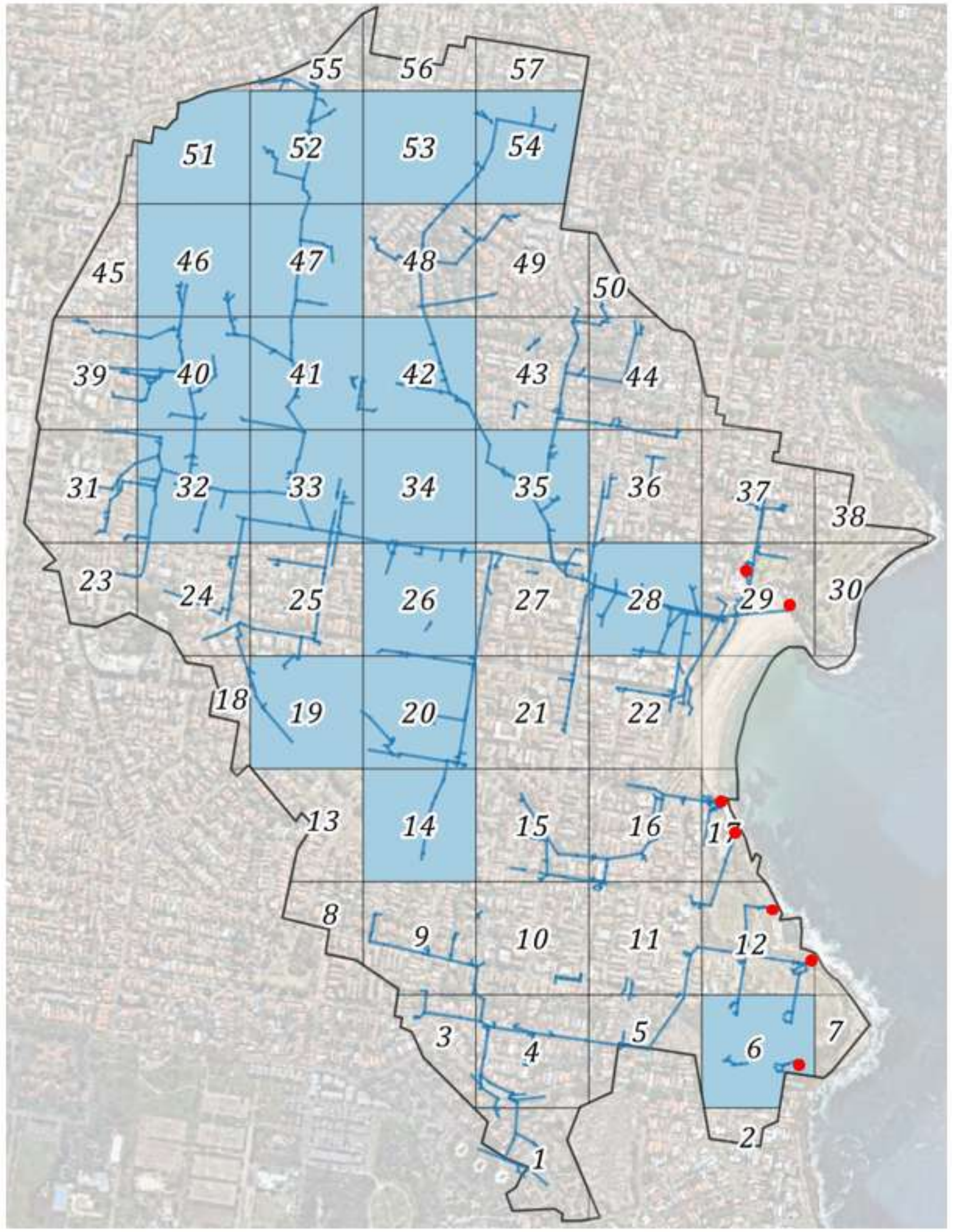
- **Catchment and WSUD antecedent condition**



(Adopted from Olesen et al., (2017))

Case Study: Coogee Catchment, Sydney, Australia

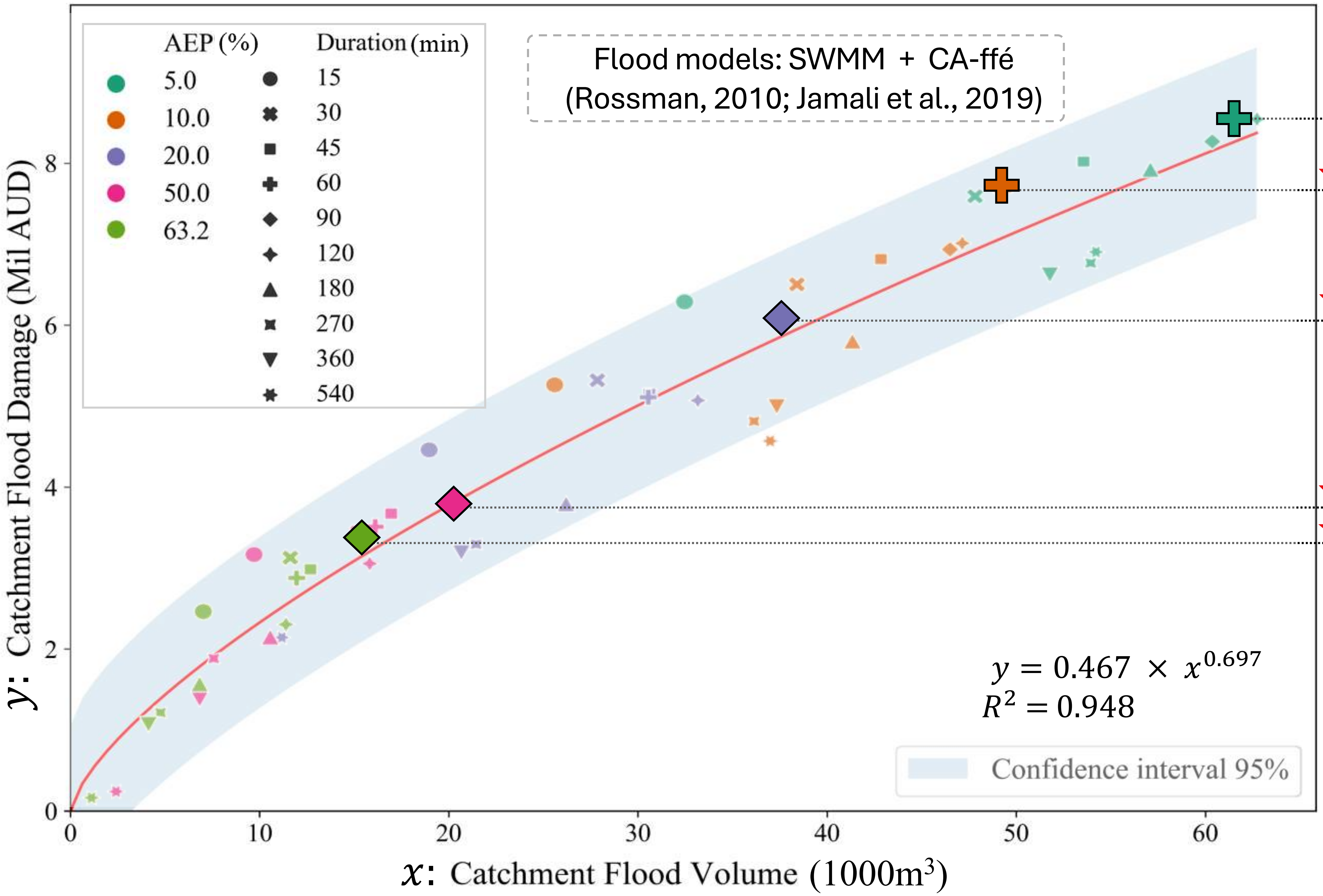




- Highly urbanised catchment 2.9km^2 in size with steep slope.
- Priority subcatchments in blue.

(Data Source: Coogee Bay Flood Study Final Report - Randwick City Council, 2013)

1. Flood Volume vs. Damage



Reduction in Flood Damage Return Period

★ **Target 1**: 5%AEP → 10%AEP

★ **Target 2**: 10%AEP → 20%AEP

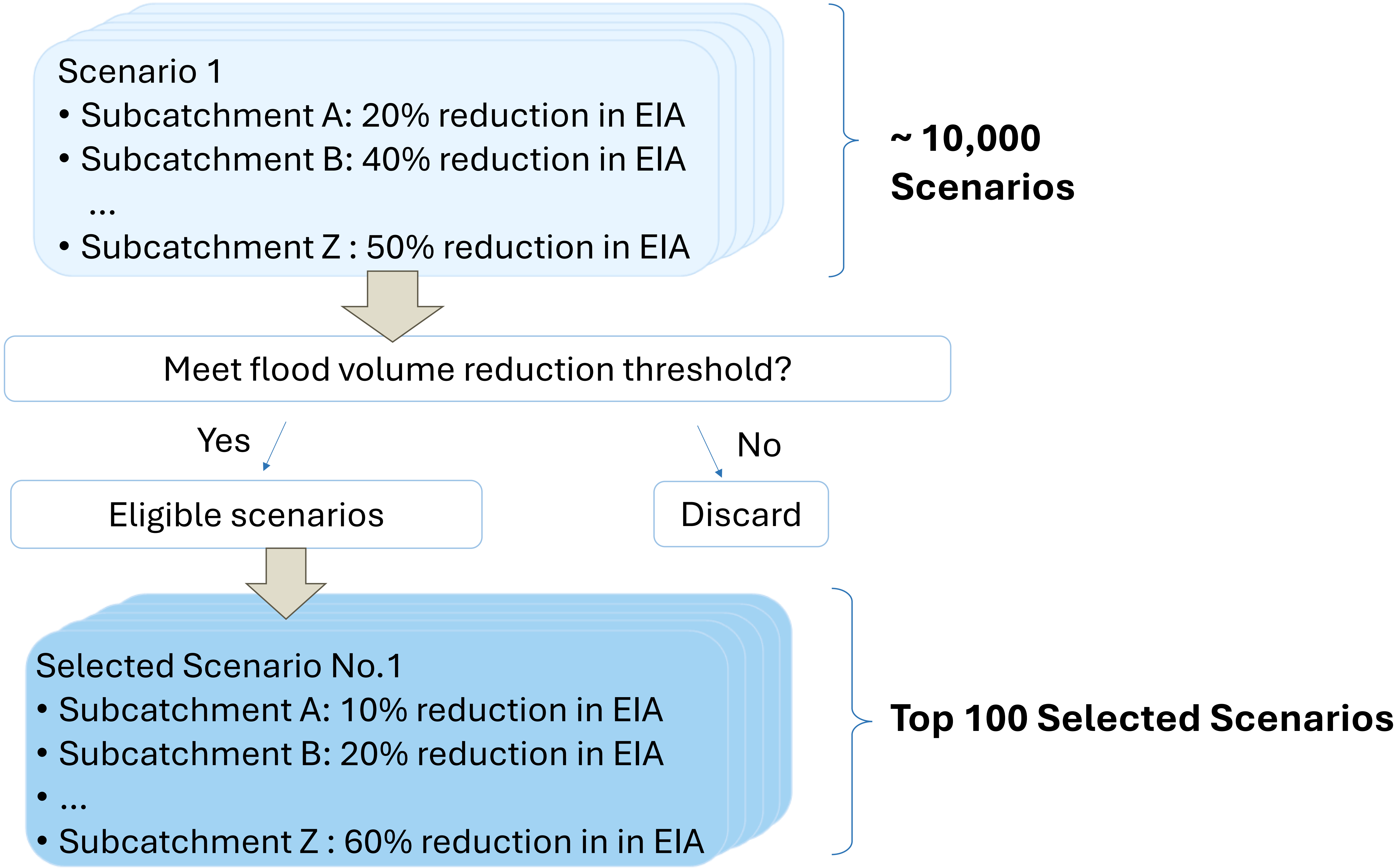
★ **Target 3**: 20%AEP → 50%AEP

★ **Target 4**: 50%AEP → 63.2%AEP

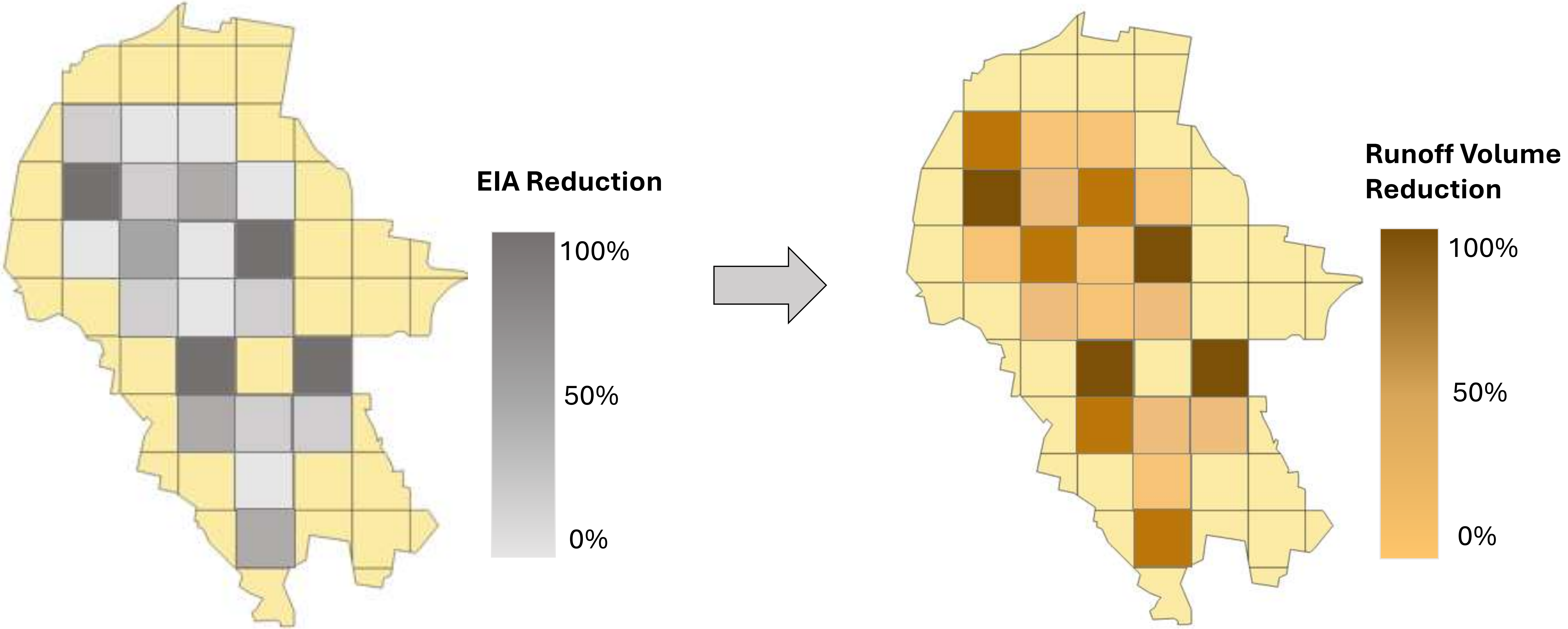
	Desired Reduction in Damage (*y*) (Mil. AUD)	Required Reduction in Volume (*x*) (m^3)
Target 1	0.877	9,322

3. Generate Flood Volume Reduction Scenarios

- Sobol sampling sequence: quasi-Monte Carlo, low-discrepancy sequences, uniform coverage
- Sample 0-100% reduction in Effective Impervious Area (EIA) in each priority subcatchment

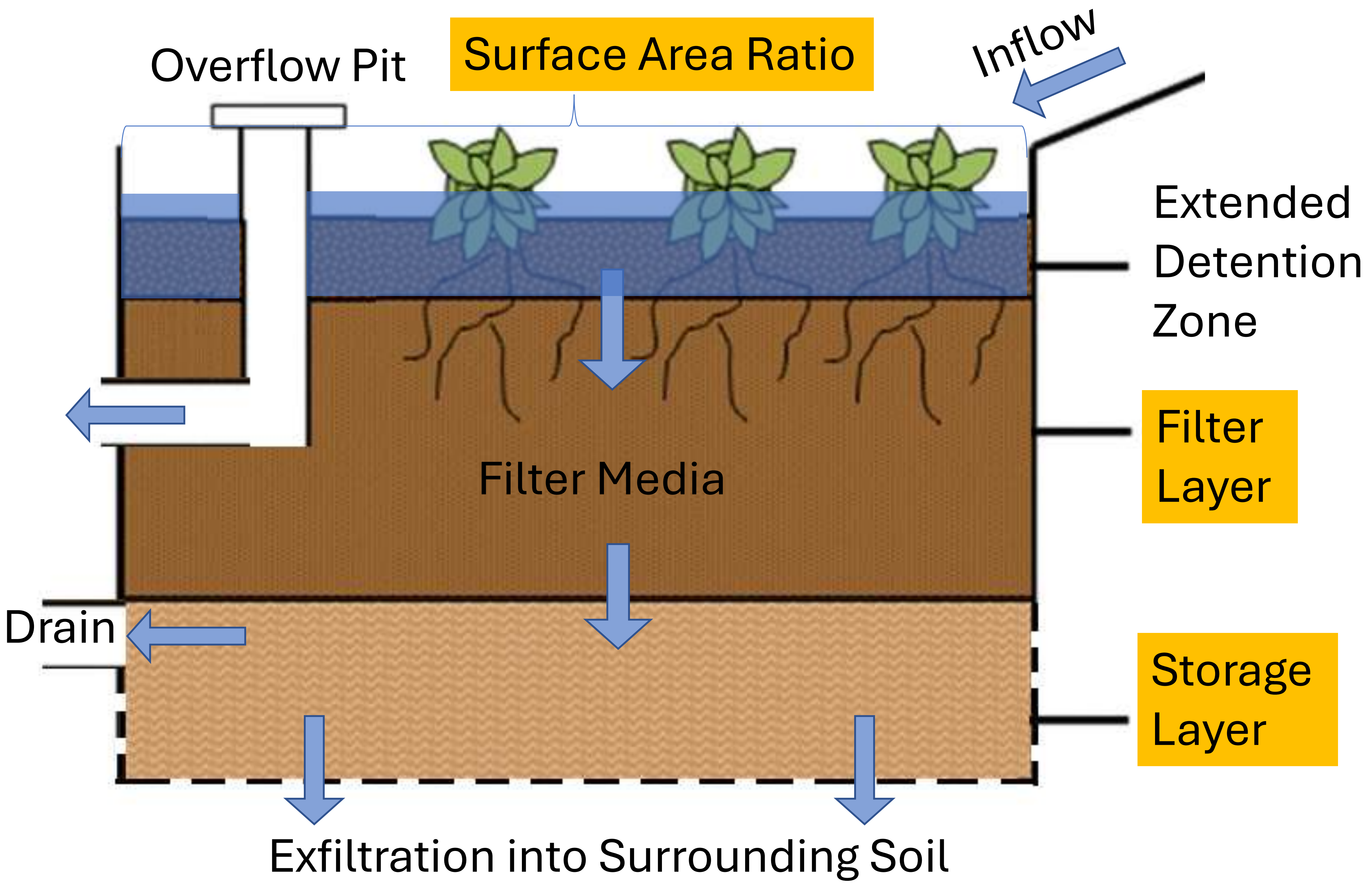


4. Set Subcatchment Runoff Volume Reduction Targets



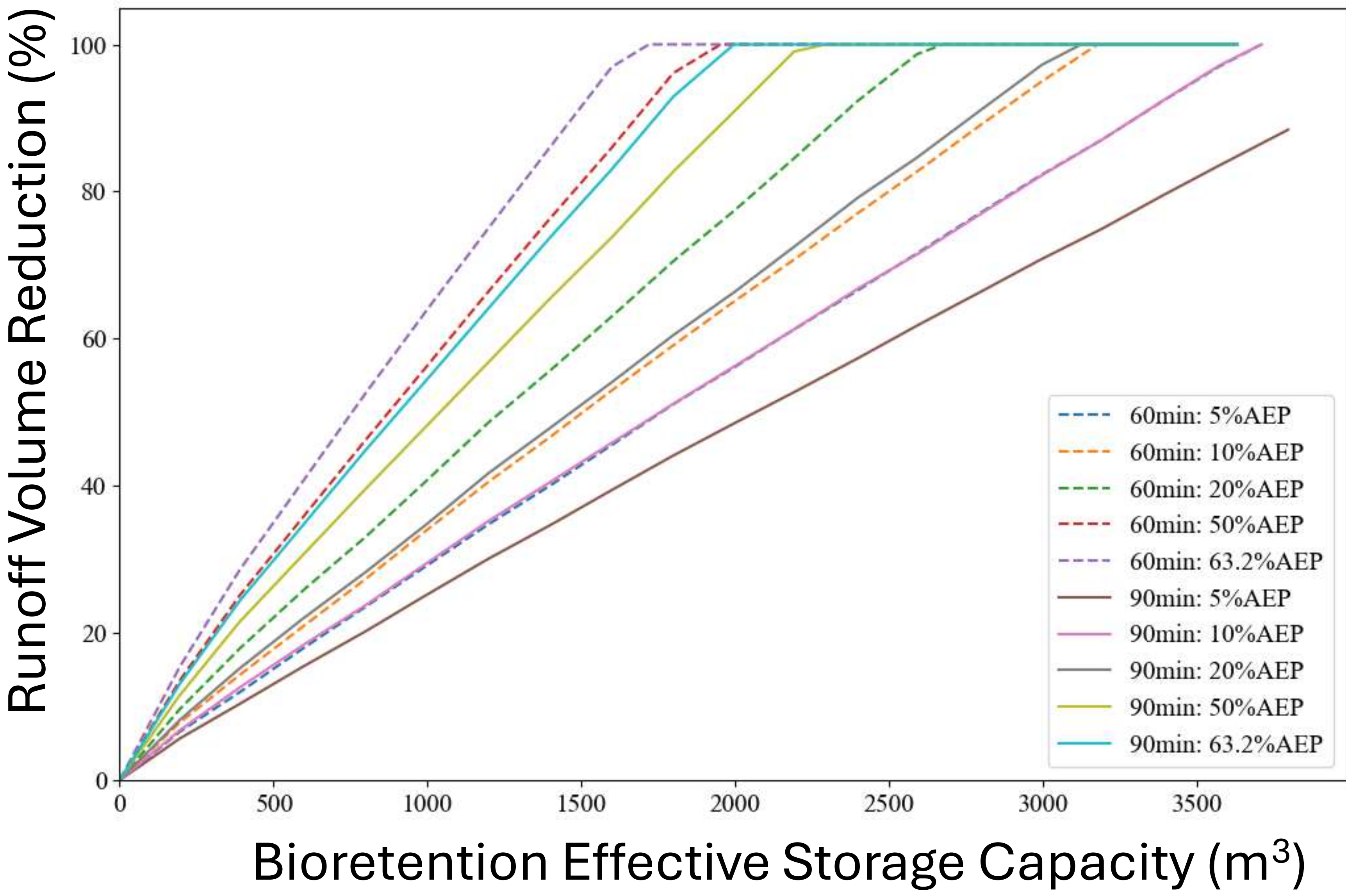
5. Size WSUD Using Design Curves for Subcatchment Runoff Volume Reduction

- Bioretention as an example
- Global sensitivity analysis on site characteristics + design parameters under different rainfall

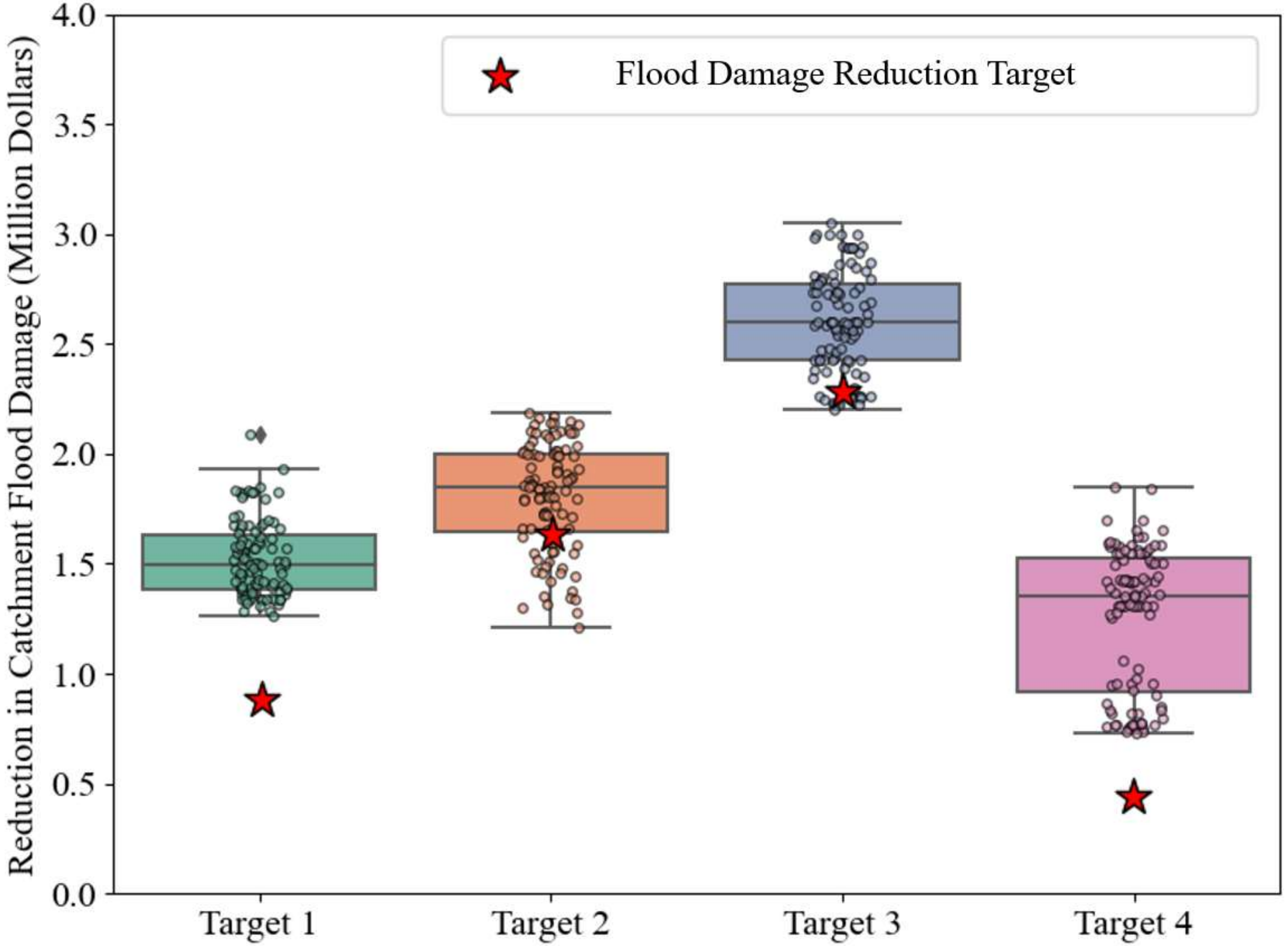


Bioretention Structure
(Adopted from Goh et al., 2019)

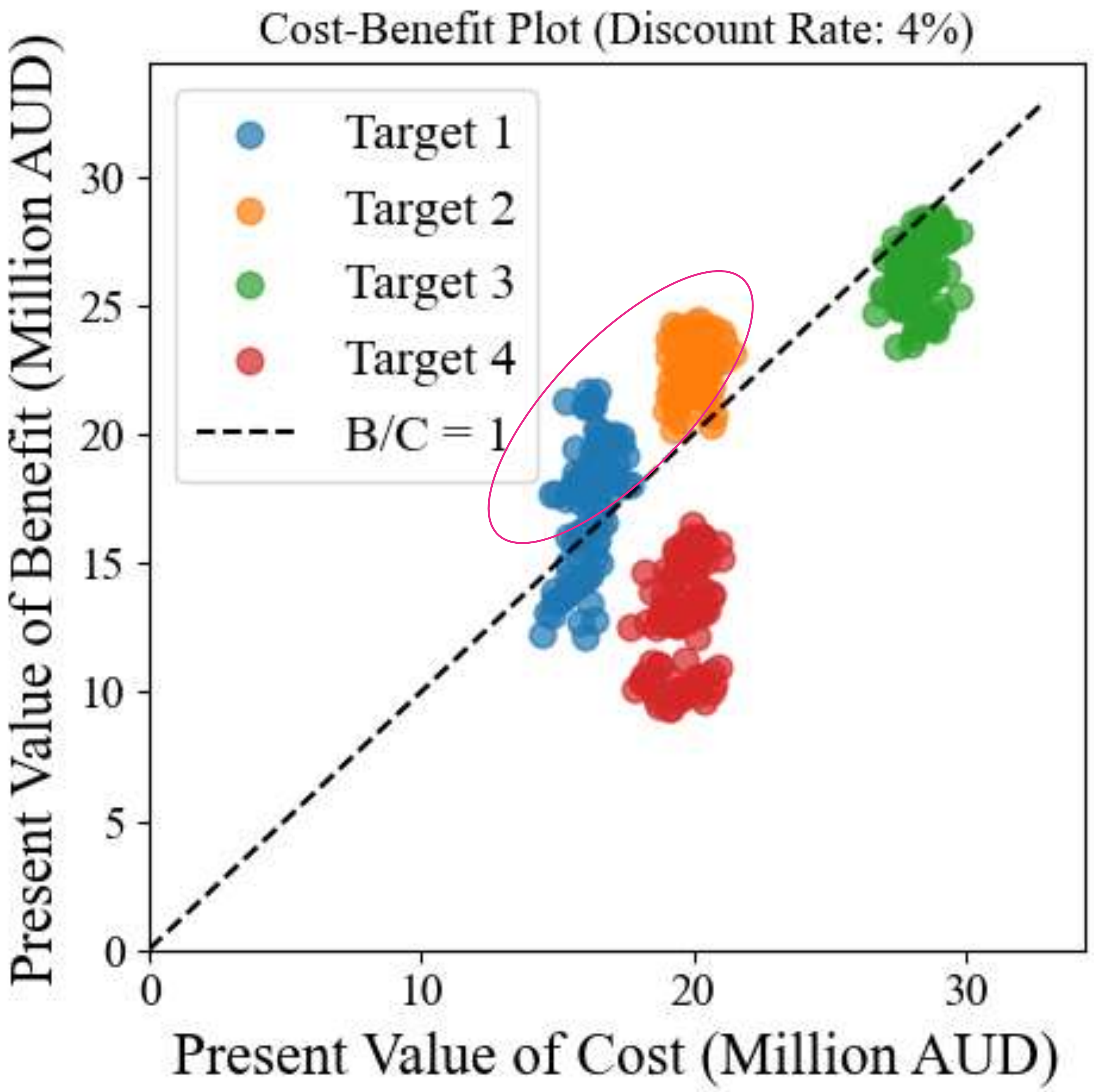
Representative Design Curves



6. Generate WSUD Strategies → 7. Valid Against Targe s

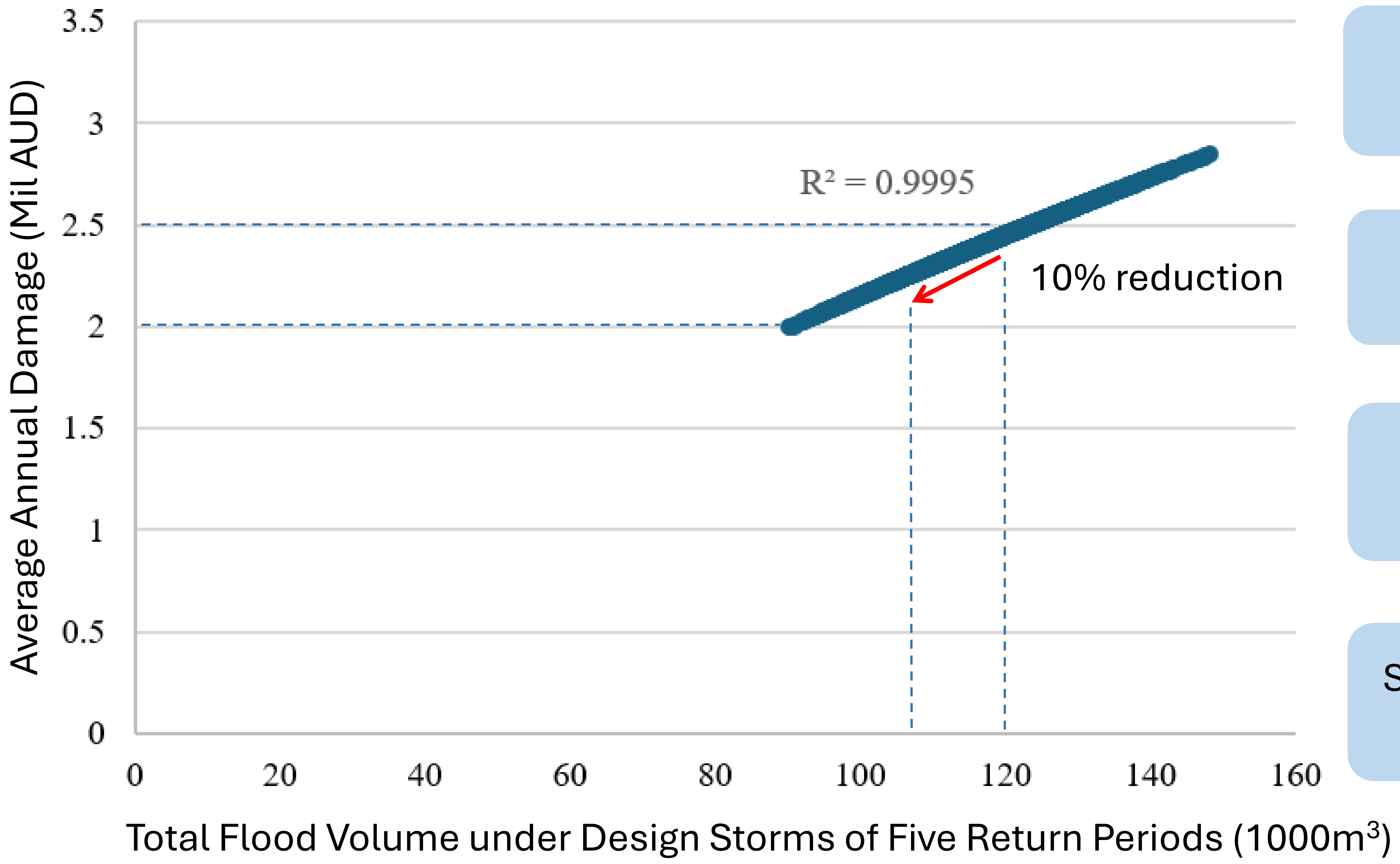


5%AEP → 10% AEP   10%→ 20%   20%→ 50%   50%→ 63.2%



- Most cost-effective when planning WSUD to align with drainage system capacity (mostly 20%AEP, some 10%AEP).

Planning WSUD for Long-Term Targets: AAD Reduction



For X% AAD Reduction: Set Flood Volume Reduction Threshold

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Screen flood volume reduction scenarios

⇩

Estimate required reduction in subcatchment runoff (weighted average)

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Select WSUD effective storage size (weighted average design curves)

Part 1

- Identify most probable WSUD strategies for specified AAD reduction targets
- AAD calculated using design storms

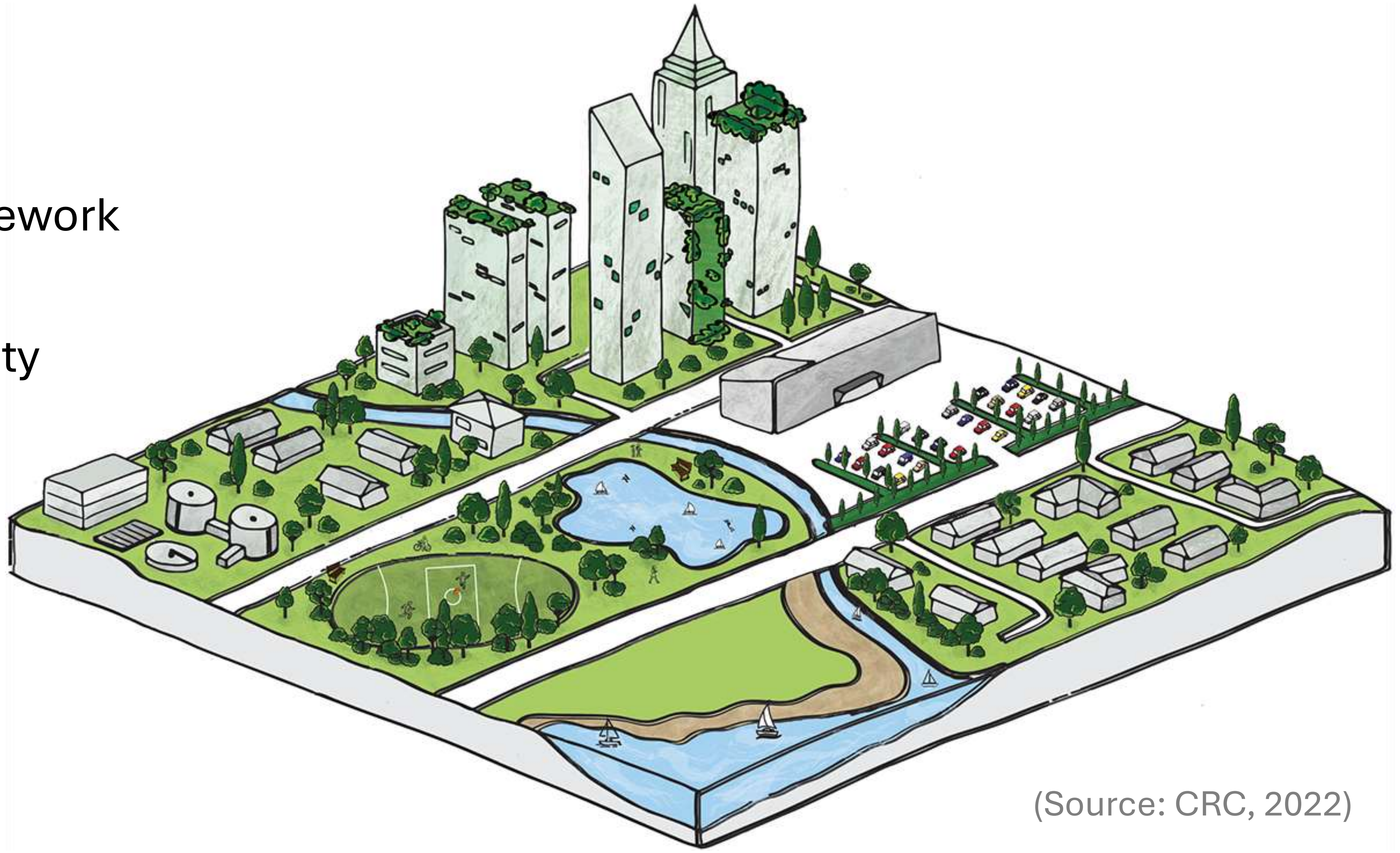
Part 2

- Assess WSUD antecedent condition in SWMM
- Flood inundation simulation for flood-inducing rainfall events only
- AAD calculated using all flood-inducing rainfall events in a year

Most probable WSUD strategies

Significance and Future Work

- Target-oriented high-level WSUD planning framework
- A pool of WSUD strategies, offering high flexibility
- Allows consideration of future conditions
- Inclusion of other storage-based WSUD types
- Possible integration with multi-objective WSUD planning



(Source: CRC, 2022)

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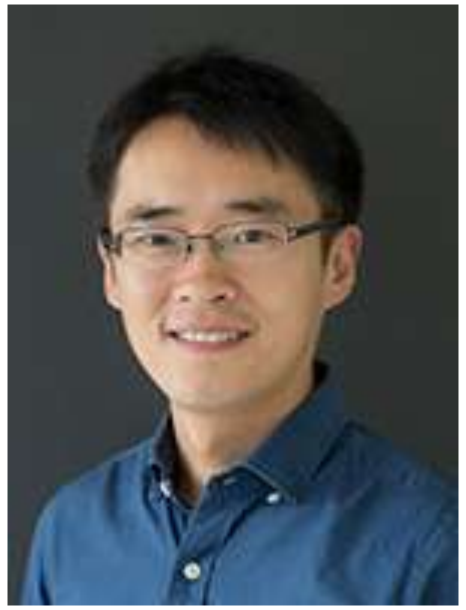

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- Wu, W., Jamali, B., Marshall, L., Deletic, A. and Zhang, K., (2025). A Water Sensitive Urban Design (WSUD) Planning Framework for Catchment-Scale Urban Pluvial Flood Mitigation Targets. Water Research, p.124095.
- Wu, W., Jamali, B., Zhang, K., Marshall, L. and Deletic, A., (2023). Water sensitive urban design (WSUD) spatial prioritisation through global sensitivity analysis for effective urban pluvial flood mitigation. *Water Research*, *235*, p.119888.