ENGINEERING AND SCIENCE
SHOWCASE

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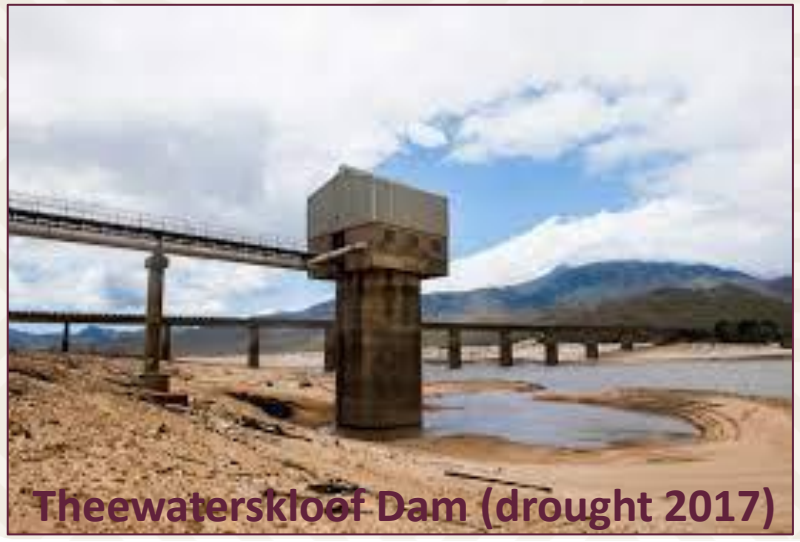
Resilient Water Infrastructure: Solutions from Stellenbosch

21 May 2025

Dr Adèle Bosman

WHY WATER INFRASTRUCTURE MATTERS

- Droughts and floods threaten livelihoods and infrastructure.


Theewaterskloof Dam (drought 2017)

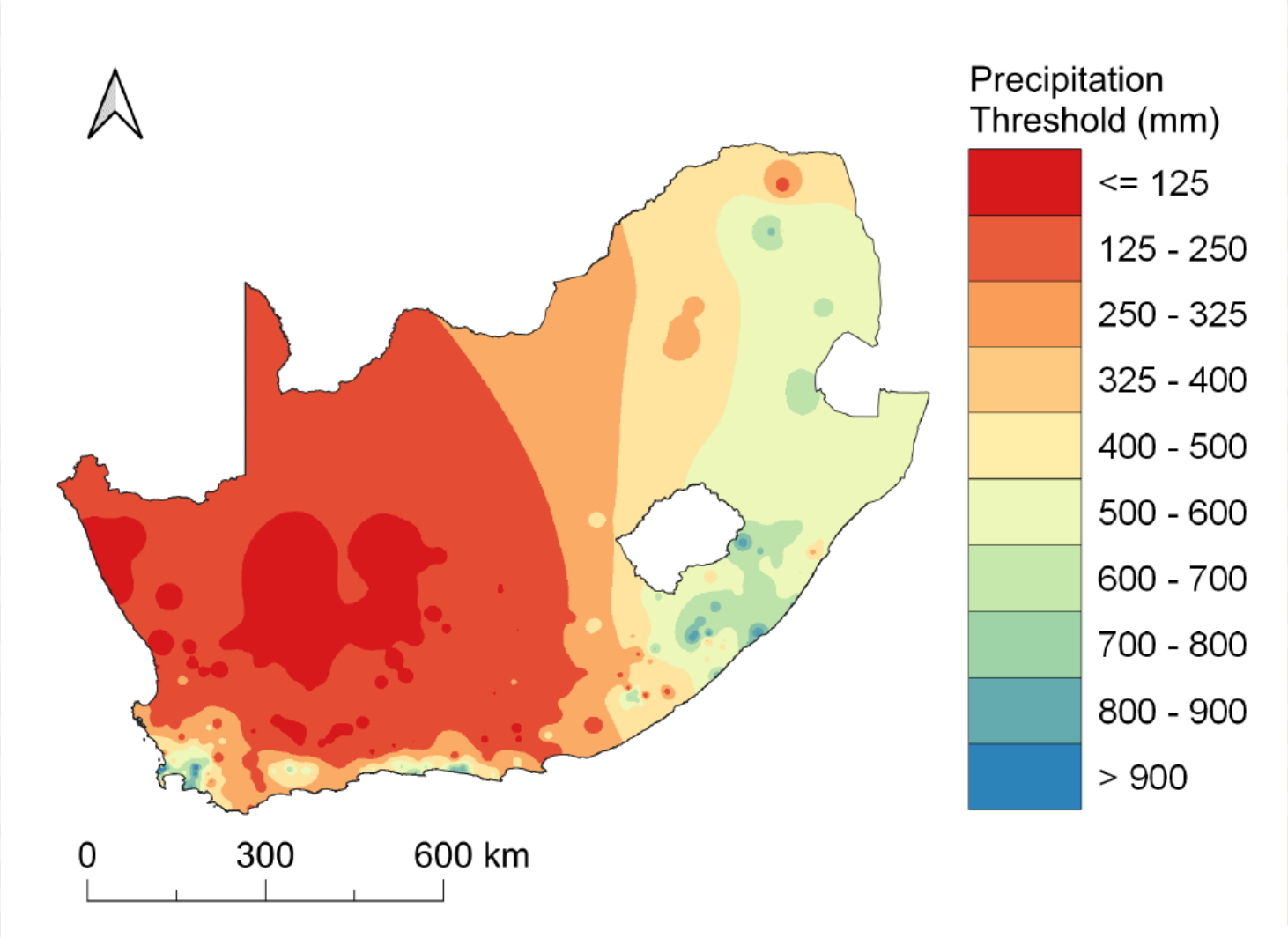

Theewaterskloof Dam (28 April 2017)

WHY WATER INFRASTRUCTURE MATTERS

Flooding

THE CHALLENGE: WATER STRESS

- South Africa faces growing water scarcity and uneven rainfall.
- Infrastructure must adapt to these changing conditions.



WHY WATER INFRASTRUCTURE MATTERS

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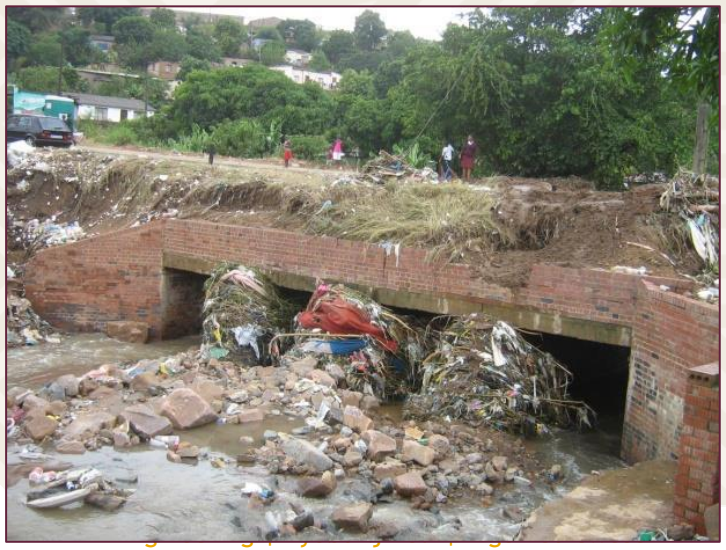

What does “Resilient” look like?

- Water systems services are important to enhance a city’s liveability, resilience, sustainability, and productivity.
- Urban design must consider water as part of the landscape.
- Strategic investment is needed to adapt to a changing climate.

OUR RESEARCH FOCUS AT STELLENBOSCH UNIVERSITY

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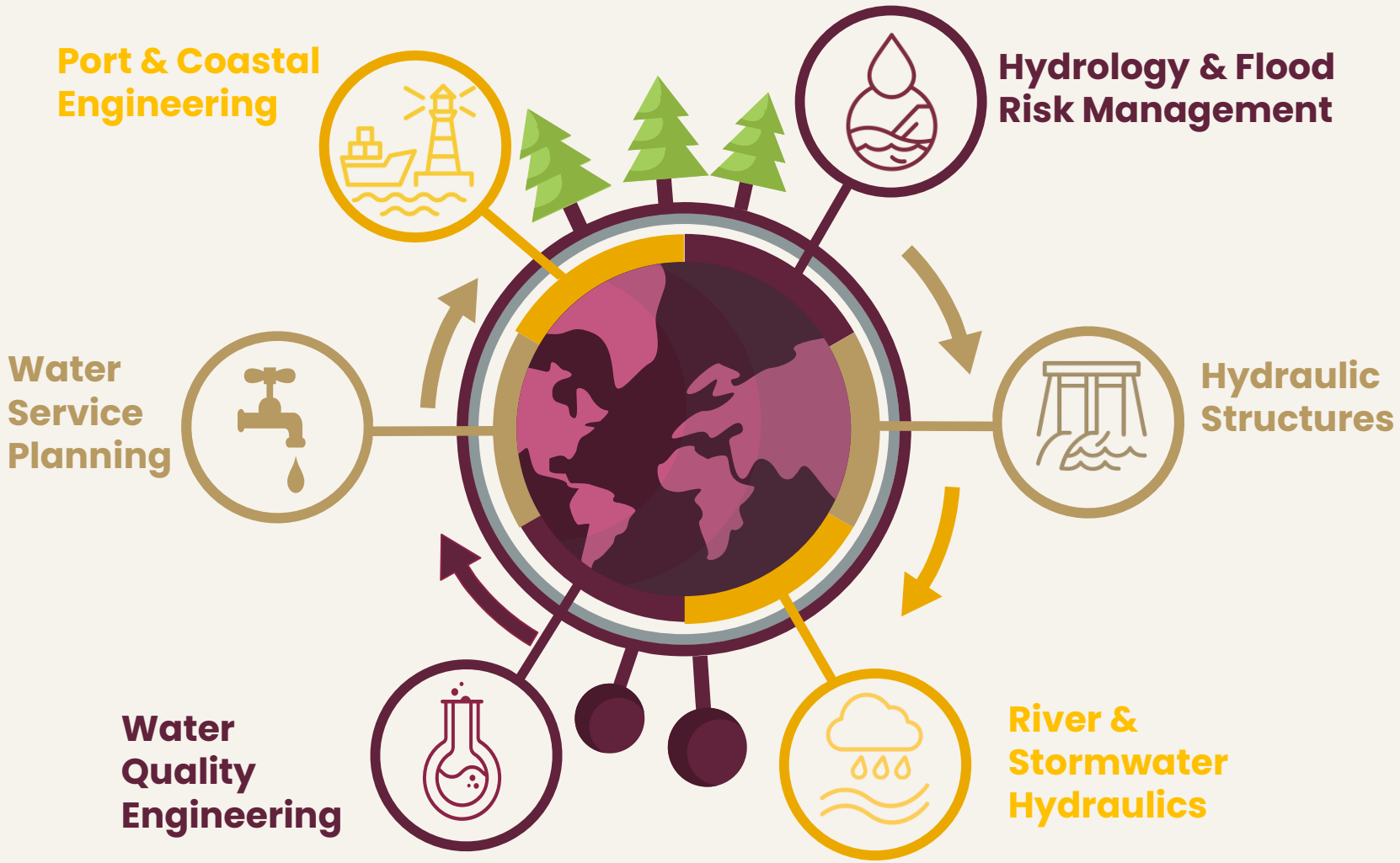
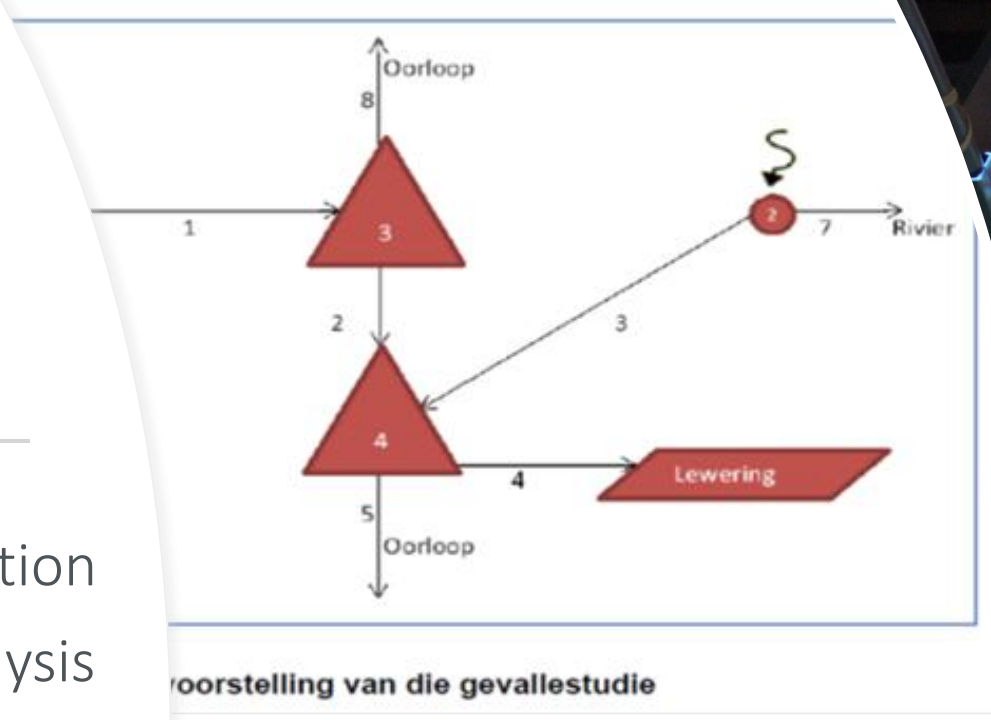
Water Division

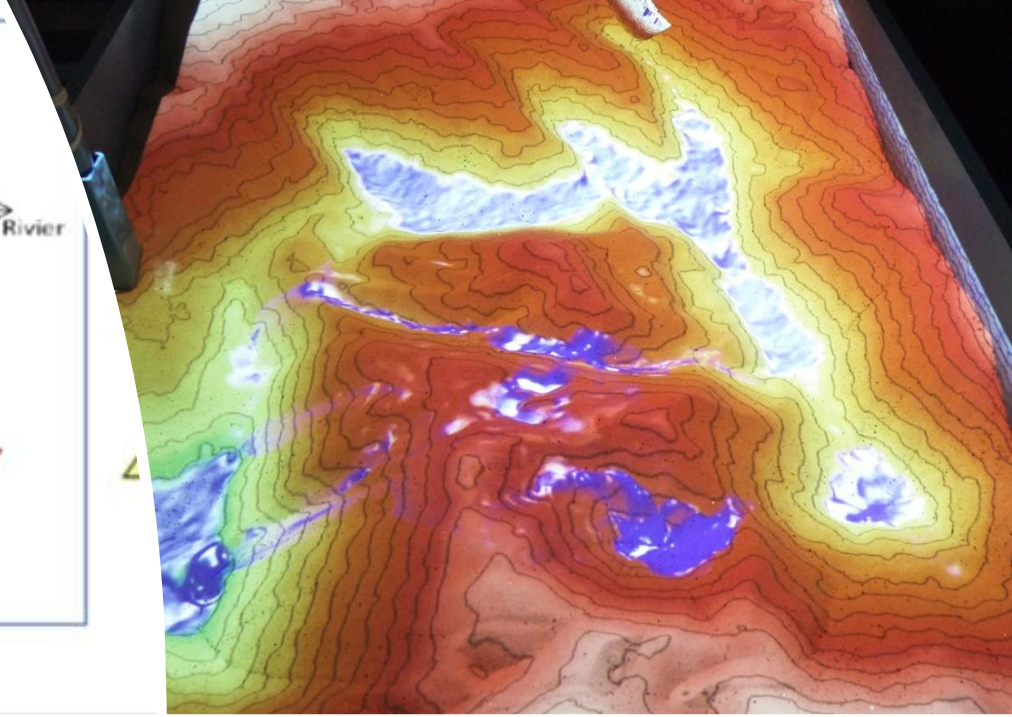


HYDROLOGY & FLOOD RISK MANAGEMENT

- Hydrological event & climate change adaption
- Drought & flood analysis
- Water resource management
- Urban water management
- Irrigation demand analysis
- Dam balancing simulations



voorstelling van die gevallestudie



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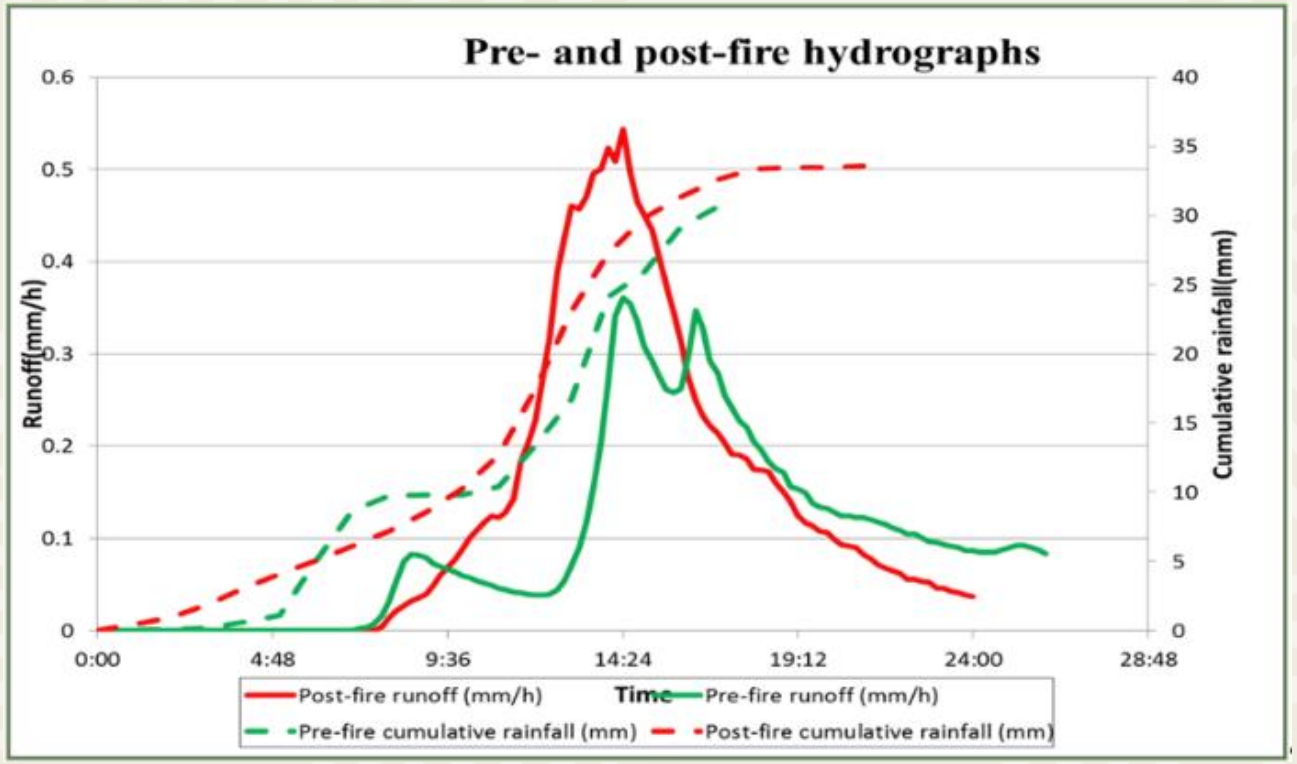
HYDROLOGY & FLOOD RISK MANAGEMENT

The impact of fires on runoff peaks and volumes



HYDROLOGY & FLOOD RISK MANAGEMENT

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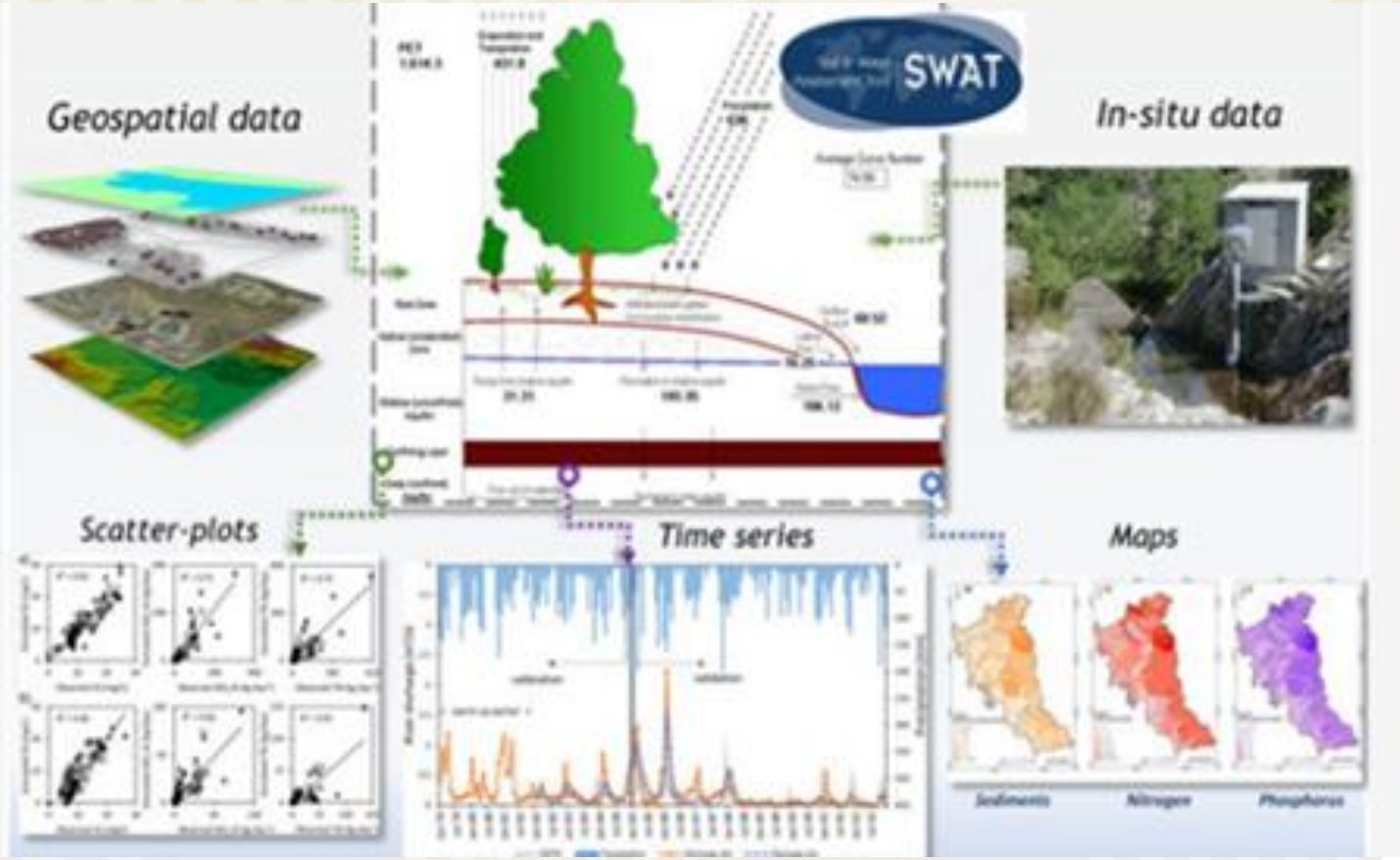
Support drought resilience through catchment modelling

- Assist municipalities in planning for water security under drought conditions.
- Custom hydrological models simulate supply scenarios and system performance.
- Supports proactive infrastructure investment and emergency planning.
- Applicable to IDP and Water Services Development Plan (WSDP) formulation.

HYDROLOGY & FLOOD RISK MANAGEMENT

Extending Coverage with Satellite-Calibrated Rainfall Data

- Satellite rainfall datasets calibrated with ground observations.
- Enable hydrological modelling in data-scarce or ungauged catchments.
- Improves spatial coverage and model reliability.
- Supports catchment planning beyond gauged records.



HYDROLOGY & FLOOD RISK MANAGEMENT

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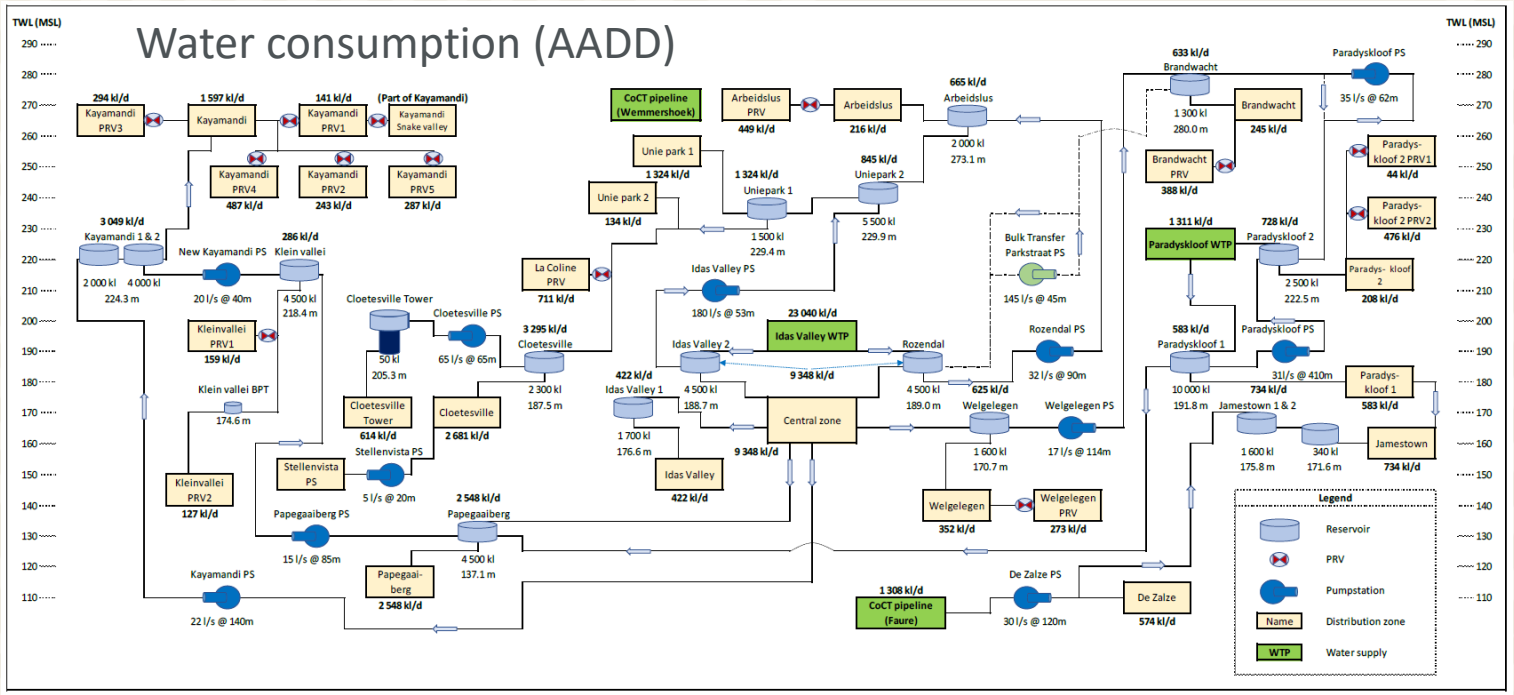
Conjunctive Use Planning: Dams and Groundwater

- Model joint utilisation of surface water and groundwater.
- Supports system-wide optimisation under drought or variable demand.
- Improves infrastructure planning for sustainable conjunctive use.
- Applied in municipal bulk supply strategy development.



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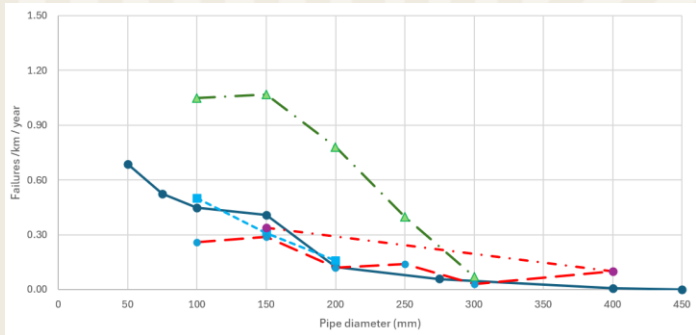
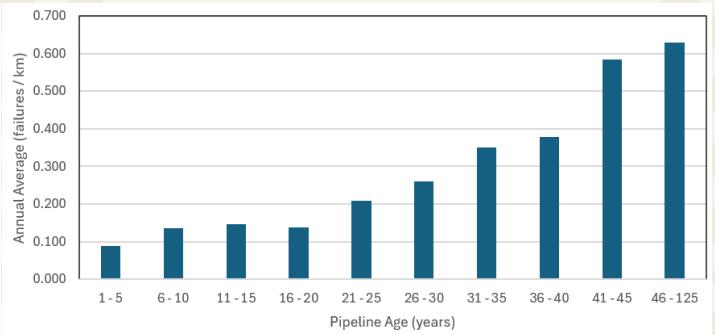
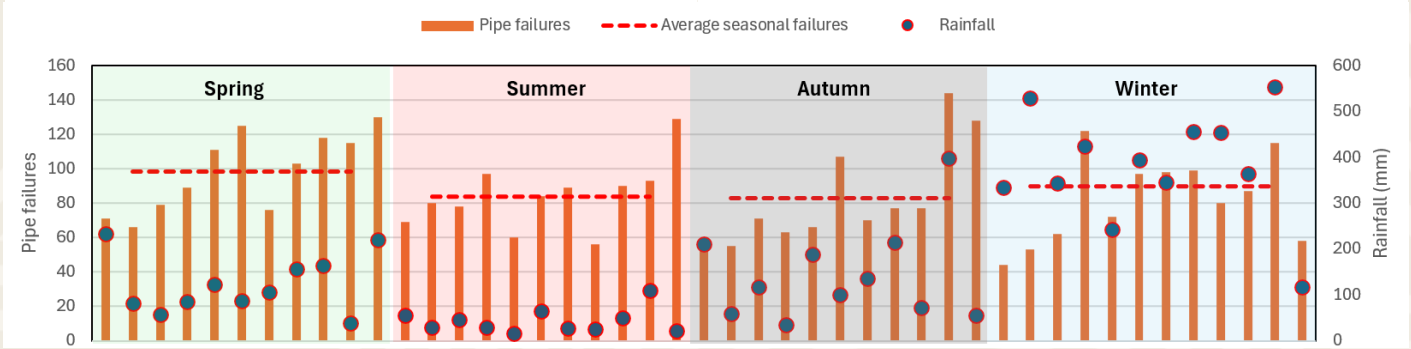
Pipe Replacement Prioritisation and Response Support

- Analyse pipe age and pressure to predict breakage likelihood.
- Support proactive pipe replacement programs.
- Improve response times to reduce service interruptions.
- Applicable to utilities aiming to enhance asset management.







HYDROLOGY & FLOOD RISK MANAGEMENT

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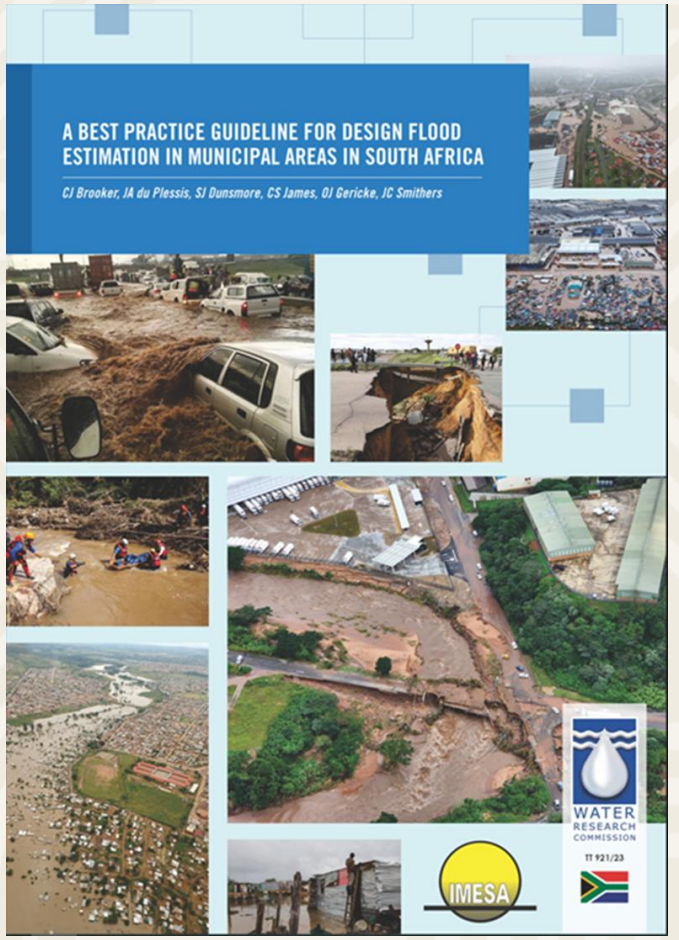
Partnering for Catchment-Scale Water Resource Interventions

- Tailored solutions for municipalities, developers, and water boards.
- Hydrological and supply models for planning and resilience.
- Supports IDPs, WSDPs, licensing, and infrastructure programmes.
- Available via collaboration, consulting, or research partnership.



HYDRAULIC STRUCTURES

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- Investigation of potential water sources
- Dam site selection
- Dam design: type, structural aspects, spillways, energy dissipation, outlet works
- Hydropower schemes
- River abstraction works
- Scour and erosion analysis
- Hydrodynamic investigation


Van Phong Dam, Vietnam


Physical hydraulic model

HYDRAULIC STRUCTURES

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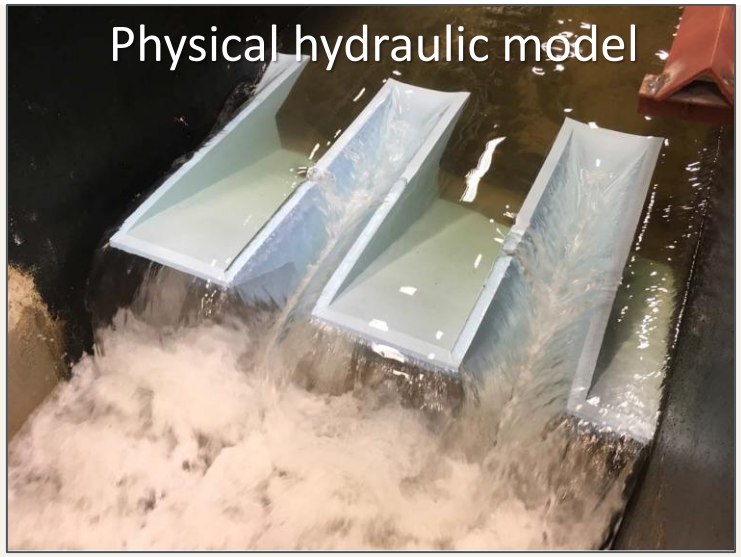
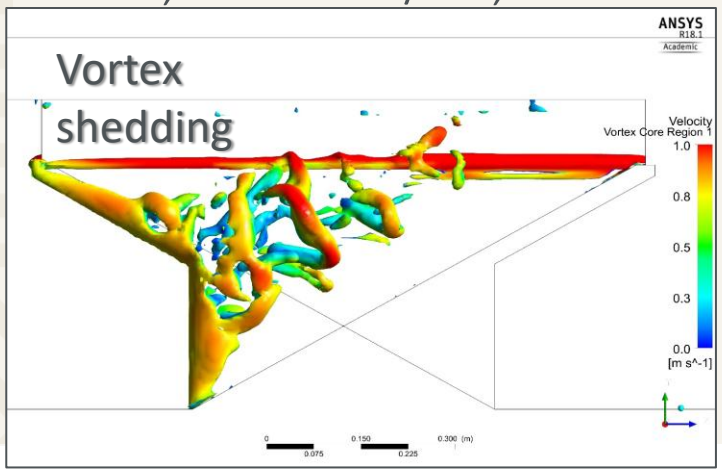
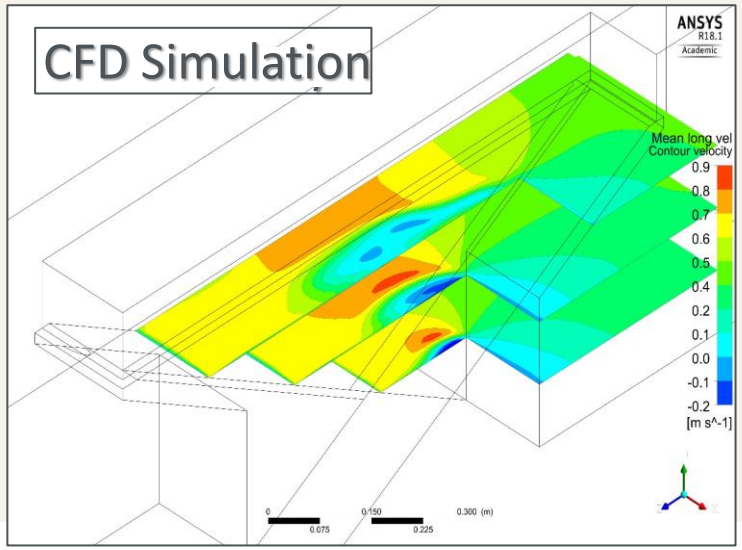
Integrated Design Approach

- Design and optimise hydraulic structures using combined physical and numerical models.
- Flow visualisation, scour prediction, and energy dissipation performance are investigated in both lab-scale models and CFD simulations.
- Software used: FLOW-3D, Fluent, MIKE 11/21, Delft2D/3D, HecRAS.





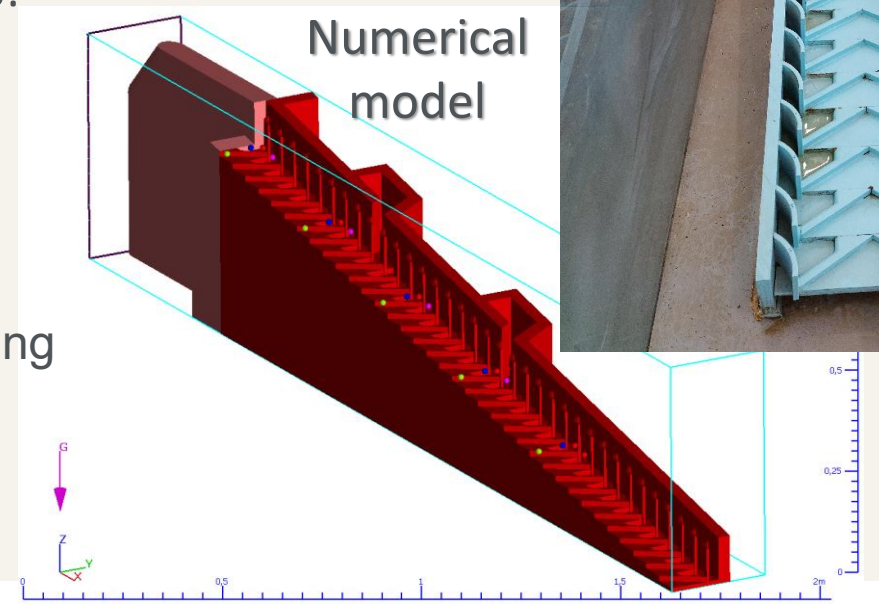


HYDRAULIC STRUCTURES

Fishway-Canoe Chute (BRVAS)

- Hydraulic performance and optimisation of a dual-purpose fishway-canoe chute for the Berg River Voëlvlei Augmentation Scheme (BRVAS).
- 1:15 physical model constructed and tested at SU Hydraulics Lab.
- FLOW-3D model calibrated against physical results.

Straightening of angled canoe at entry



HYDRAULIC STRUCTURES

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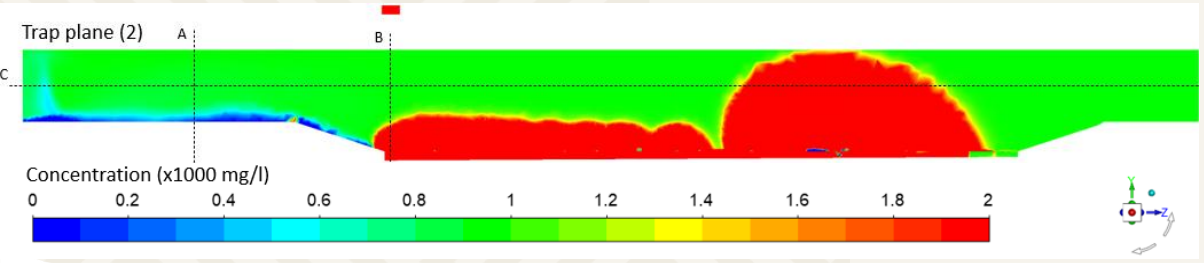
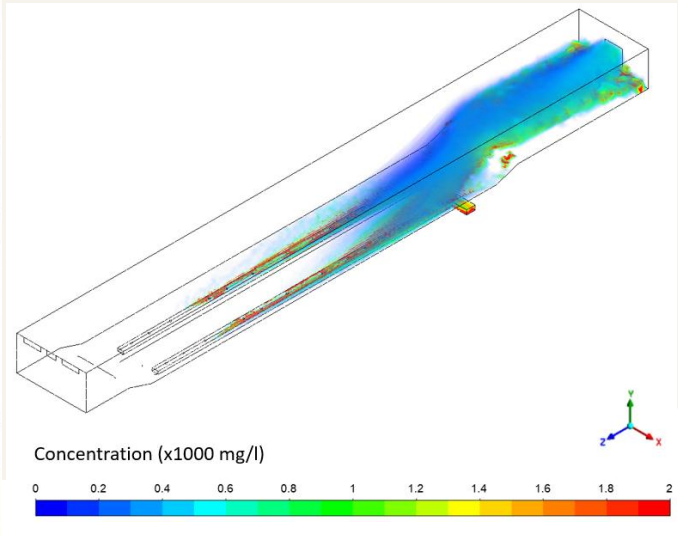
Sand Trap in eSwatini

- Sediment excluder underperformed due to turbulence and poor design.
- Field measurements combined with ANSYS Fluent CFD modelling.
- Trapping efficiency improved from 27% to 85% after design modifications.
- Supports continuous irrigation operations and reduces manual cleaning.





HYDRAULIC STRUCTURES

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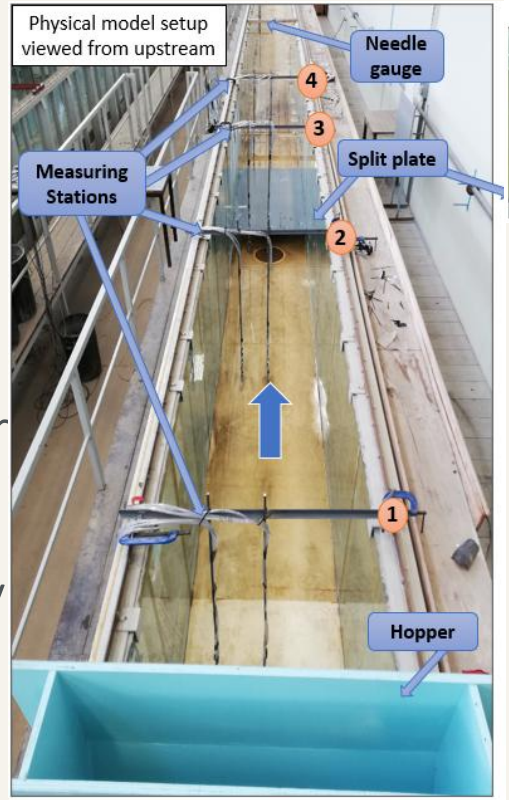
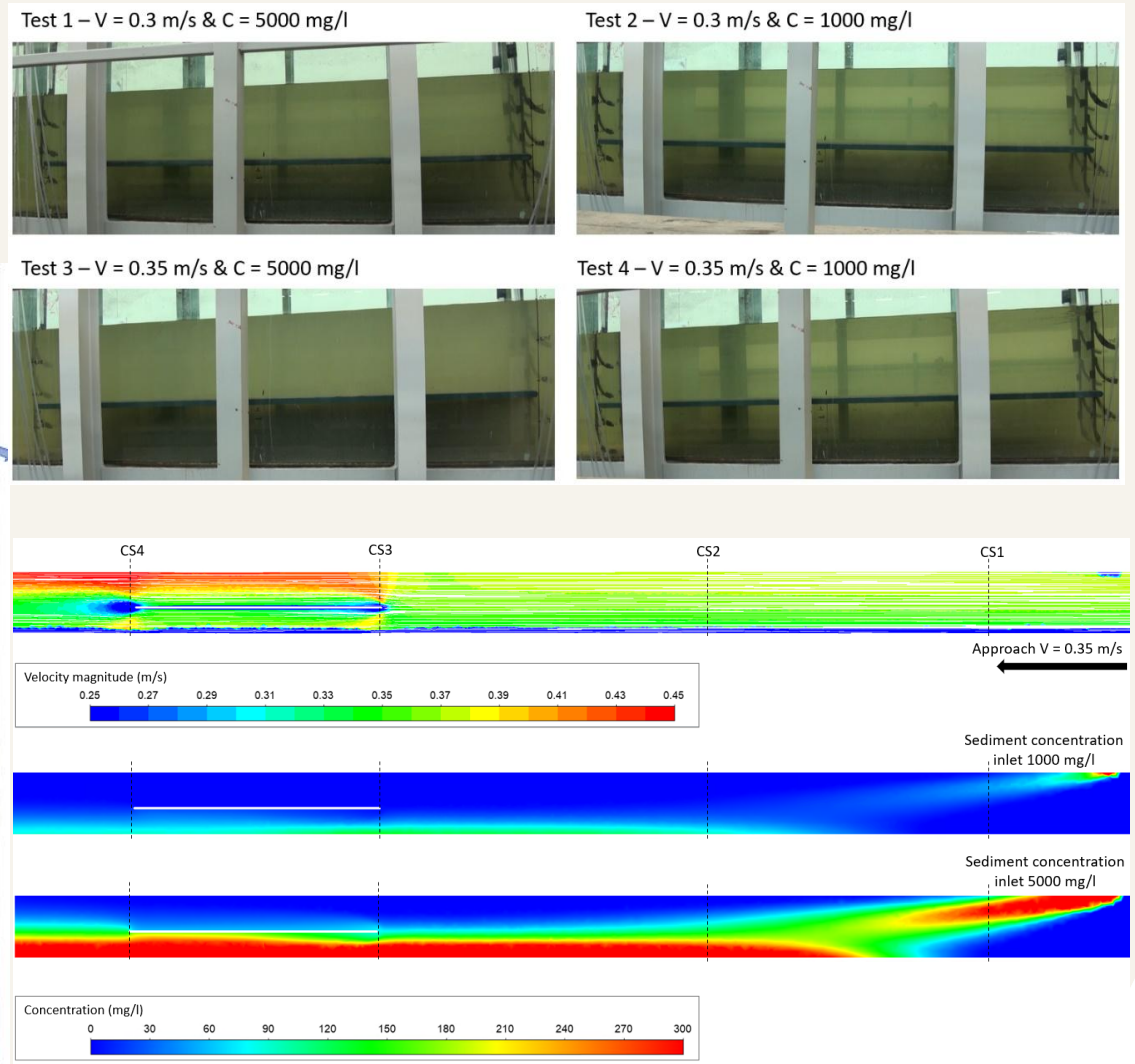
Split-and-Settle Sand Trap

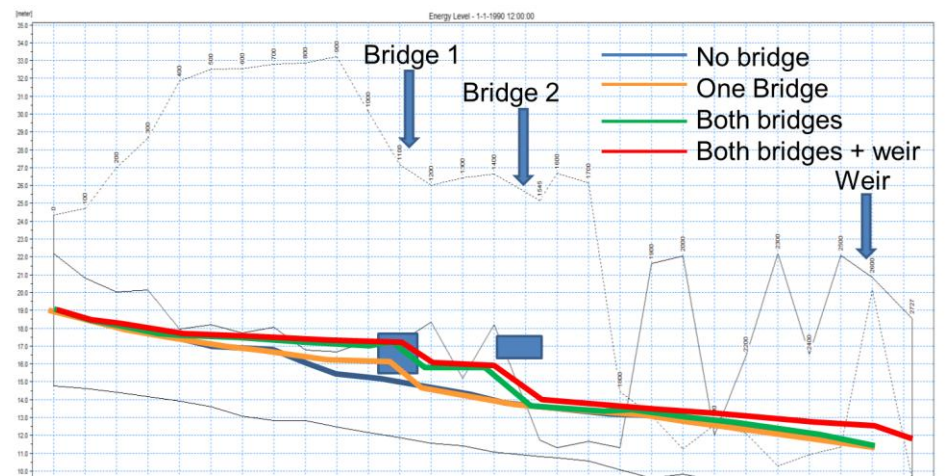
- Innovative method to separate sediment-laden and sediment-free flows.
- Full-scale physical model validated CFD simulations in ANSYS Fluent.
- Improved sediment removal without relying on large scour chambers.
- Applicable to sediment-heavy canals and hydropower intakes.





RIVER & STORMWATER HYDRAULICS

- River & Stormwater modelling
- Design of stormwater hydraulic structures
- Riverbank protection
- Design of retention & detention ponds
- Greenfield development
- Flood risk reduction industry






RIVER & STORMWATER HYDRAULICS

- Stormwater biofiltration and SuDS research
- Cleaner water for communities and urban areas.

WATER QUALITY ENGINEERING

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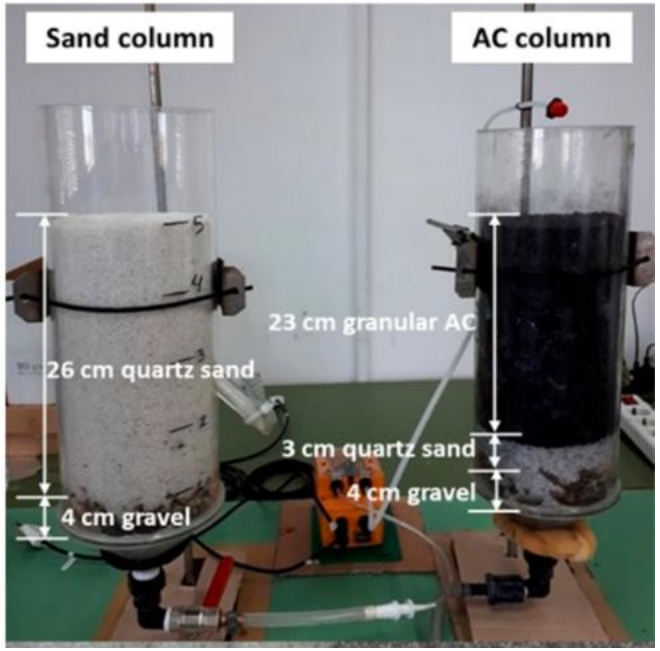
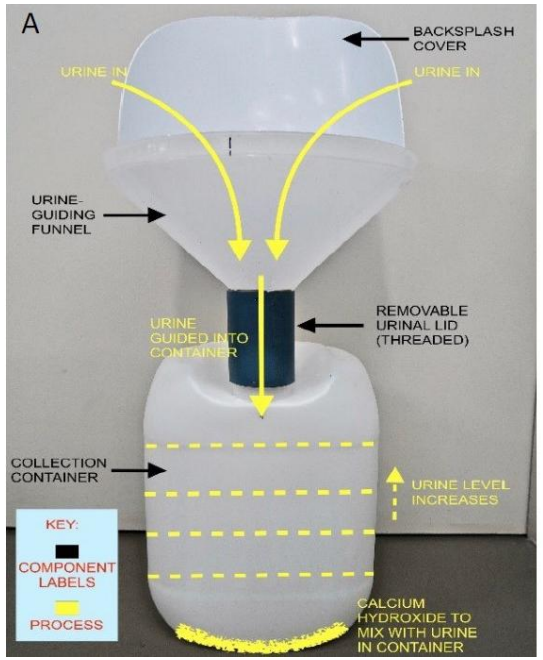
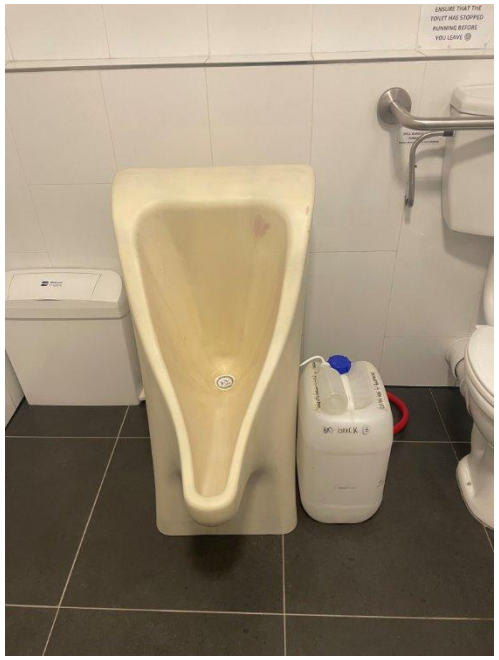
Water & Wastewater Treatment:

- Bench-top testing
- Filtration systems
- Urine-based fertilizers
- Reverse osmosis
- Ion exchange
- Contaminates of emerging concern
- Female urnials







WATER QUALITY ENGINEERING

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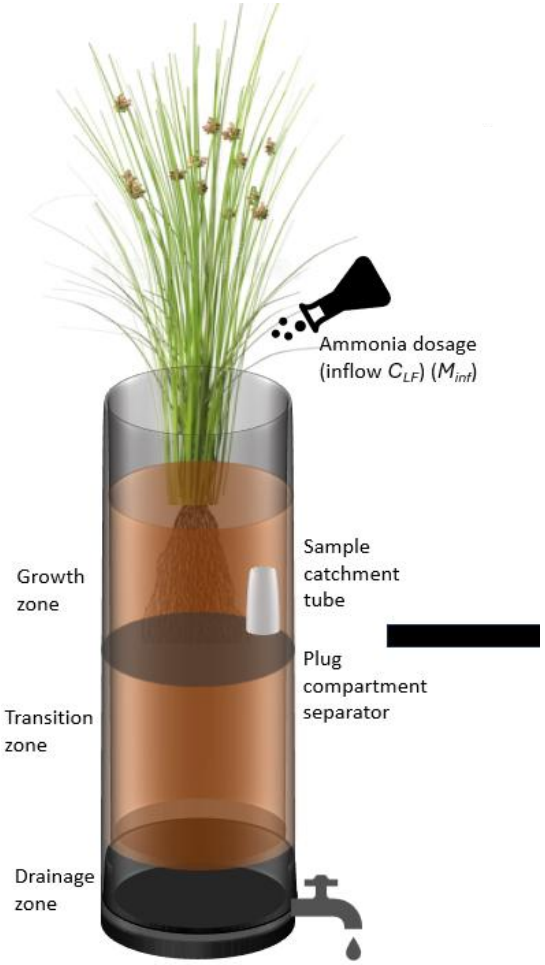
Nature-based treatment solutions:

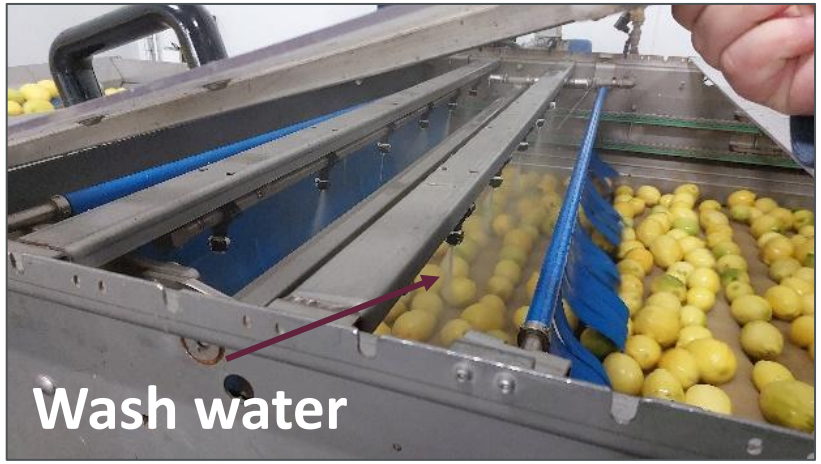
- Development of biofilters for ammonia removal using native plant *Juncus effusus*.
- Mathematical modelling of nitrification and validation through lab-scale experiments.
- Achieved 61% ammonia removal with inoculated biofilter



WATER QUALITY ENGINEERING

Fungicide removal from citrus wash water:

- Funded by Citrus Research International (CRI)
- Bench-scale testing of 6 technologies
  - Plant biofilters,
  - Sand filters,
  - Bacteria sand filters,
  - Oxidation,
  - Flocculation,
  - Granular Activated Carbon
- Biofilters outperformed other technologies for *Imazalil* removal



WATER QUALITY ENGINEERING

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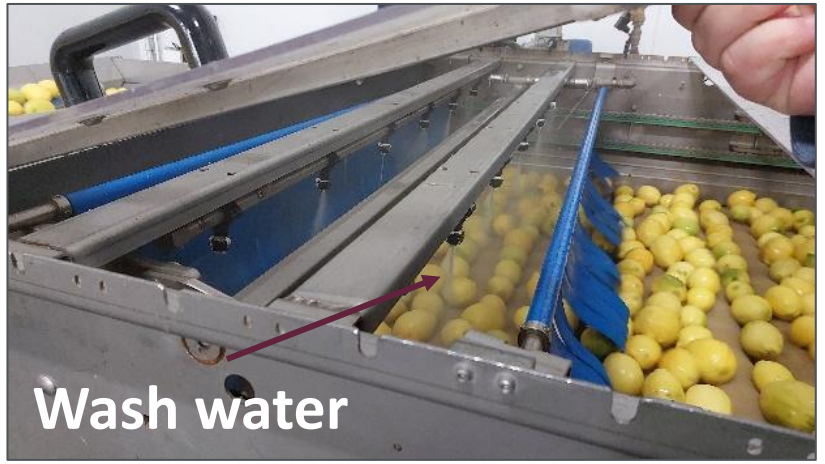
Partnering to expand national impact:

- Expansion beyond Western Cape to other fruit-growing regions
- Interest in testing wash water from stone fruit, pome fruit, and export vs. local markets
- Opportunity to inform national effluent guidelines for packhouses



WATER SERVICES PLANNING

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- Water networks
- Sewer networks
- Sewer sediment management
- Bulk pipelines
- Faults and blockage of sewers

WHO WE ARE

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- Multidisciplinary academic and student team.
- Engaged in postgraduate research and consulting.
- Future-ready engineers trained through real-world problems.
- Joint research and innovation opportunities.
- Testing, design, and student project partnerships.