IWA World Water Congress & Exhibition
11-15 AUGUST 2024 | TORONTO, CANADA | www.worldwatercongress.org

Designing an effective stormwater treatment system: a case study in South East Queensland using PCSWMM and MUSIC tools

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Abstract: In response to global recognition of climate change, demographic shifts, and resource constraints impacting urban stormwater infrastructure, scholars advocate a transition from centralized systems to integrated water management. This paper presents a case study on urban stormwater treatment in South East Queensland (SEQ) to address extreme rainfall events. Using PCSWMM and MUSIC tools, it bridges the gap between stormwater quantity and quality control, modeling the urban water management system under various weather scenarios. The study focuses on identifying, validating, and improving urban stormwater treatment designs. PCSWMM assesses design efficiency during the 2011 flood period in SEQ, measuring velocity, volume, and flooding for stormwater quantity. MUSIC evaluates pollutant removal, including TSS, TP, TN, and GP, for stormwater quality. The analysis assesses design resilience to extreme rainfall in 2011, impacting both quality and quantity control. The study employs the innovative AIP (Area-Infrastructure-Policy) method to identify optimal locations for implementing WSUD components.

Keywords: Integrated water management; Stormwater treatment; Water-sensitive urban design

Cities around the world are grappling with the increasing challenges of managing stormwater due to climate change and population shifts. Traditional stormwater systems struggle with more frequent and severe storms, causing floods, pollution, and damage. SEQ, Australia, is no different, facing these issues. This paper discusses a case study that aims to improve stormwater management in SEQ by combining technology and nature-based solutions to address both water quantity and quality concerns (Meng & Kenway, 2018; Meng, 2022).

The significance of this case study goes beyond the specific context of SEQ. It serves as a model for addressing the challenges posed by climate change and urbanization in urban areas worldwide. By integrating both stormwater quantity and quality considerations, applying advanced technology, and utilizing a systematic approach to decision-making, this study provides a blueprint for developing resilient and ecologically conscious stormwater management systems. These systems are essential for protecting water resources, mitigating flooding risks, and fostering healthier and more resilient urban ecosystems.

In this study, research used data from 2019 LiDAR and surveys to see how well the proposed stormwater treatment system worked. The results showed something amazing: the system made the water flow much better. In the older system, water moved at a rate of 0.37 cubic meters per second through a traditional 142-meter-long DN375 drainage design. But with the new system, this rate increased to 0.51 cubic meters per second, which is 37.84% better. This means the system can handle heavy rainfall and flooding, like the big floods in 2011.

This paper also looked at how clean the water was in the area around Mt. Gravatt Cemetery. The paper did this by studying different things like the leftover pollution, total suspended solids (TSS), total phosphorus (TP), total nitrogen (TN), and gross pollutants (GP). After the project put in new grass swale and rock-lined open drain, the water got a lot cleaner. The leftover pollution went down from 12.08 million liters per year to 11.22 million liters per

year, which is a 7% improvement. But the best part is that TSS, TP, and TN – which are bad for water – got much lower. They went down by 50.89%, 35.30%, and 13.57%, respectively. GP, which are big, visible pollutants, went down by 100%, so there were none left.

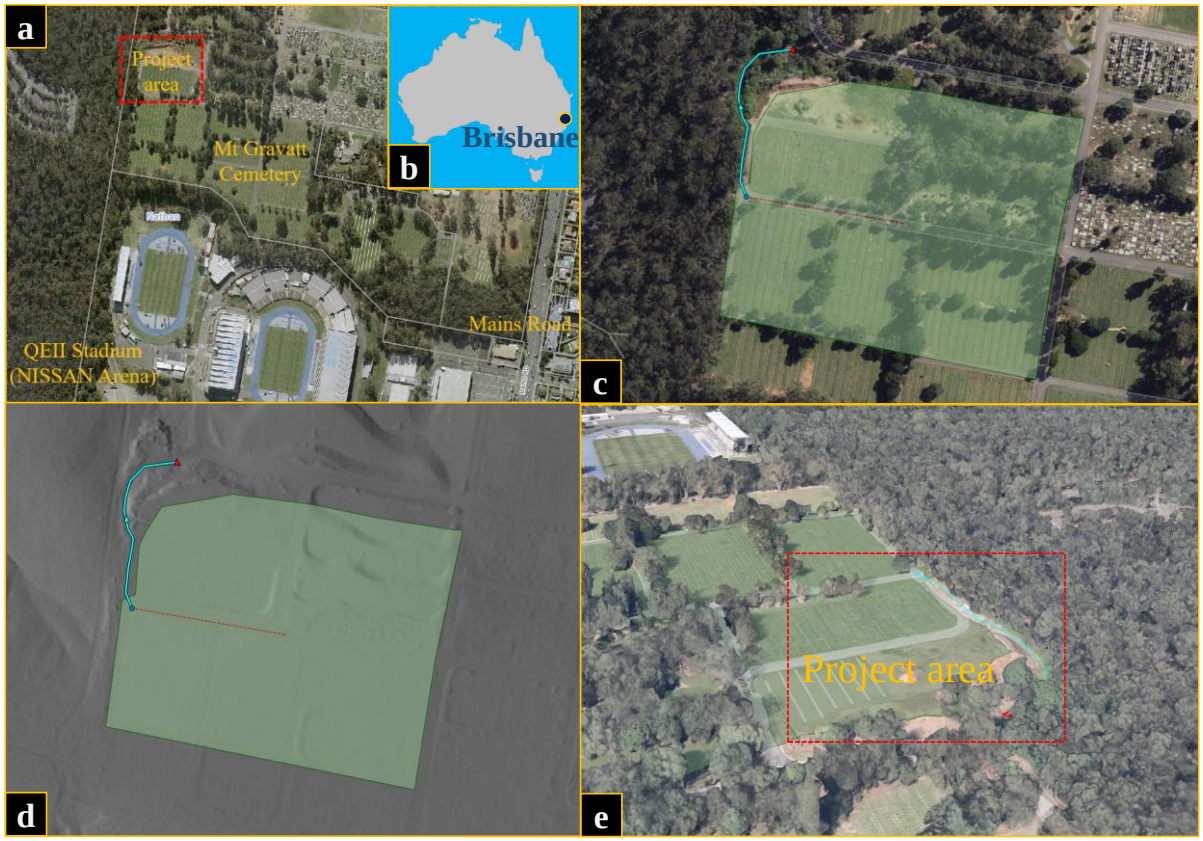

Figure 1 provides an overview of the study, featuring: (a) The delineation of the research area in Southeast Queensland (SEQ). (b) in Australia. (c) Presentation of project utilizing traditional pipe design in PCSWMM. (d) Presentation of project employing innovative WSUD design in PCSWMM. (e) Presentation of project in 3D amp.

Table 1 comparative analysis of pollutant reduction outcomes: traditional drainage vs. innovative WSUD design

	Sources	Residual Load	% Reduction
Flow (ML/yr)	7.29	6.90	5.28
Total Suspended Solids (kg/yr)	1282.36	629.75	50.89
Total Phosphorus (kg/yr)	2.71	1.75	35.30
Total Nitrogen (kg/yr)	20.09	17.36	13.57
Gross Pollutants (kg/yr)	172.48	0	100

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