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Urban Rhythms: Simulating Urban Flows and Ecological Resilience in Melbourne's CBD

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Keywords

Urban simulation, Ecological resilience, Microclimates, Pedestrian dynamics, Virtual reality

Abstract

Our study leverages the GAMA platform to simulate Melbourne's urban environment, focusing on critical factors such as wind dynamics, water drainage, biodiversity, pedestrian movement, and traffic patterns [3]. Using open data collected by students and agent based modelling method, the project models the city's microclimates and urban flows, offering insights into how environmental factors interact with infrastructure to influence liveability and ecological resilience.

This study focuses on Melbourne's Central Business District (CBD), where the dynamic interactions between natural elements and urban structures shape the experience of the city's residents and its ecological systems. Our simulations reveal significant findings: skyscrapers along Collins and Bourke Streets amplify wind speeds, creating wind tunnels that affect pedestrian comfort, while flood risks remain high in historically vulnerable areas such as Elizabeth Street. Heat islands are prominent in concrete-heavy zones like Swanston Street, contrasting with cooler microclimates found in green spaces such as Birrarung Marr. Biodiversity corridors are essential for wildlife in spaces like Flagstaff Gardens, though urban fragmentation limits movement. In terms of urban flow, the CBD is primarily dominated by retail zones, yet pedestrian movement is concentrated along specific streets, with some retail areas underutilized. Traffic congestion on major streets like Flinders and Elizabeth exacerbates pollution, especially in areas where the "urban canyon effect" worsens air quality.

To deepen public engagement and further explore urban planning scenarios, we employed virtual reality (VR) simulations by coupling GAMA and Unity using this framework [2]. These VR models of key locations in Melbourne's CBD enabled users to experience the environmental and urban flow dynamics from a pedestrian perspective. The simulation was also displayed on a tangible interface at the Melbourne School of Design as part of the Toria project, providing an interactive way to engage with the data inspired by the CityScope framework [1, 4]. Participants could assess the impact of proposed design solutions on ecological systems and human well-being, providing valuable feedback for future city planning initiatives. The VR and tangible interface approach demonstrated how alterations in green space distribution, building layout, and pedestrian flow affect both environmental sustainability and urban livability.

By simulating the interplay between environmental processes and urban infrastructure, this project provides actionable insights into enhancing the sustainability and ecological resilience of Melbourne's CBD. The integration of immersive VR and tangible interface simulations facilitated public engagement and supported the exploration of innovative urban planning strategies. Project Toria continues to speculate on the future of urban living, workspaces, and ecological balance within the State of Victoria, envisioning a future that pushes the boundaries of traditional city planning toward a more resilient, liveable, and sustainable urban environment.

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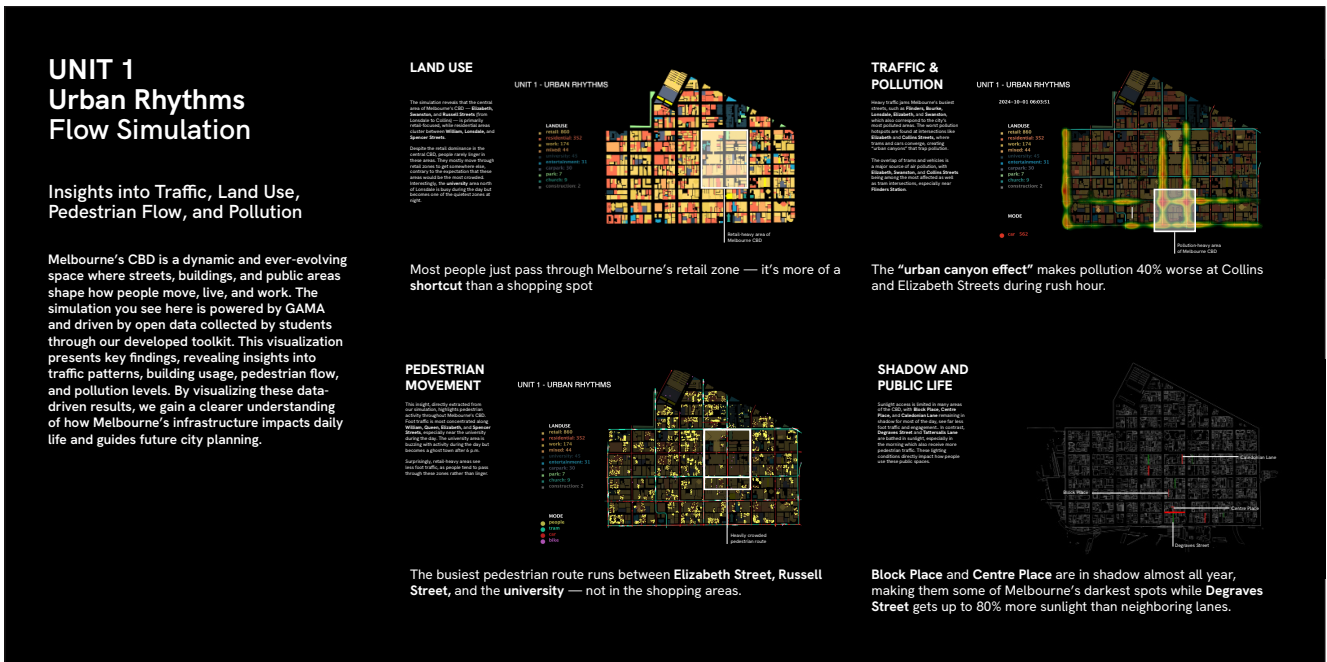


Figure 1: Urban Rhythms Flow Simulation: Insights into Traffic, Land Use, Pedestrian Flow, and Pollution

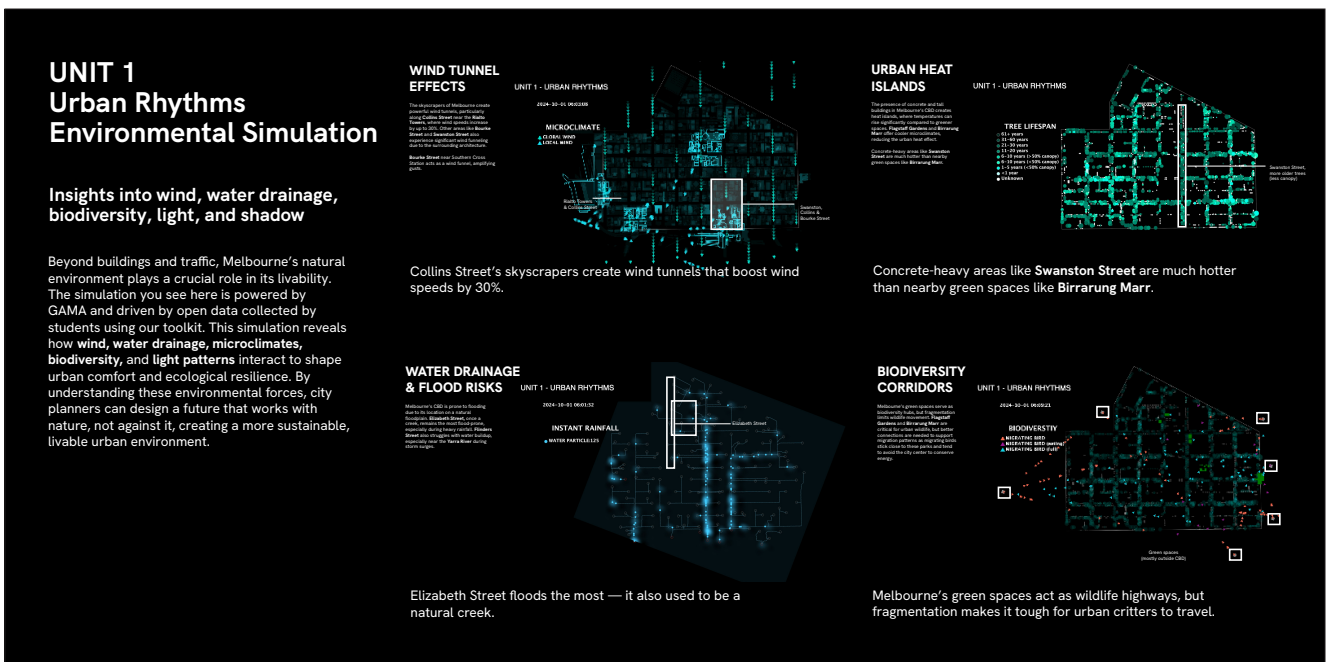


Figure 2: Urban Rhythms Environmental Simulation: Insights into wind, water drainage, biodiversity, light, and shadow