The aerodynamics of skyscrapers: tall building clusters and the urban environment

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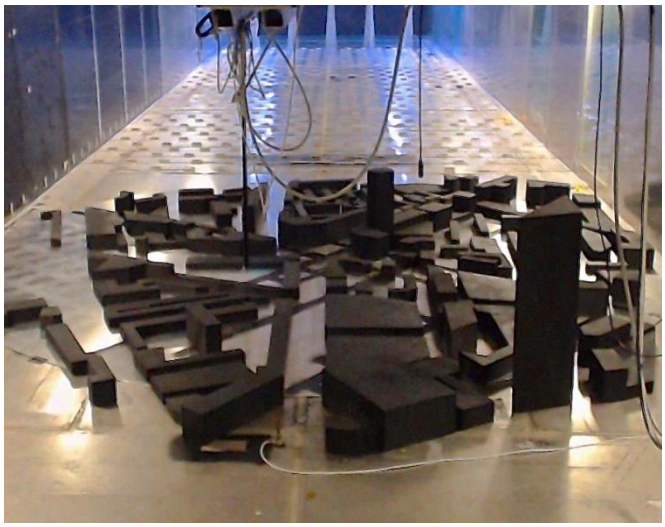
By 2050 our cities will host 68% of the world's population, compared to the current 54%, and 33% in the 1960s. This increase is often accomplished by the proliferation of tall buildings (TBs) that maximise the provision of housing and commerce using a limited street-level footprint. Tall structures affect local microclimate, pedestrian comfort and urban air quality. However, a framework that incorporates the effects of these buildings (particularly when clustered together) on wind, pollutant dispersion and temperature does not currently exist. As a result TB effects are not modelled in current weather forecast and air quality models. This is of particular concern for cities in Asia with very tall buildings and poor air quality such as Shanghai, but even in London TB clusters are more and more common. Understanding, modelling and predicting their effects are of paramount importance.

While there is growing use of air quality sensors within urban environments, the complexity of cities means that it is difficult to diagnose mass transfer processes, influences of atmospheric stability on pollutant dispersion and the location and nature of sources of pollution. Therefore, wind tunnel investigations are required to provide high quality data suitable for developing models and parameterisations. The project will be primarily experimental, using the EnFlo NERC/NCAS National Facility stratified-flow wind tunnel at the University of Surrey. Data analysis and interpretation, including the development of mathematical parametrisations, will be carried out in collaboration with the Department of Meteorology at the University of Reading.

Hong Kong, a prototype for "tall cities" (*Credits: Jim Trodel*)



1:200 scale model of a London neighbourhood with tall buildings inside the wind tunnel.

Training opportunities:

The work will be highly relevant to companies, government departments and research organisations requiring knowledge and understanding of the physics of air flow and pollutant dispersal, especially in an urban context. Besides the extensive training opportunities available within the SCENARIO DTP, the students will benefit from collaboration with large research projects such as MAGIC (www.magic-air.uk), in partnership with Imperial College London and the University of Cambridge and FUTURE (Universities of Reading and Southampton). Specific training courses offered by NCAS (National Centre for Atmospheric Science) and the Von Karman Institute for Fluid Mechanics (Belgium) will also be available.

Student profile:

This project will best suit a student with a degree in a relevant engineering field (aeronautics, environmental, civil, mechanical) or physical/environmental science (physics, meteorology). We are seeking candidates preferably with a first-class degree or a good 2:1, and proficient with the English language. Good team working and communications skills are also essential. Previous experience, or a keen interest in experimental work would be beneficial. Some level of computer-coding skills might be advantageous, but it is not necessary if keen to learn.

https://research.reading.ac.uk/scenario/