

## EDITORIAL

# Sustainable urban development and geophysics

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The new millennium has seen a fresh wave of world economic development especially in the Asian-Pacific region. This has contributed to further rapid urban expansion, creating shortages of energy and resources, degradation of the environment, and changes to climatic patterns. Large-scale, new urbanization is mostly seen in developing countries but urban sprawl is also a major social problem for developed nations. Urbanization has been accelerating at a tremendous rate. According to data collected by the United Nations [1], 50 years ago less than 30% of the world population lived in cities. Now, more than 50% are living in urban settings which occupy only about 1% of the Earth's surface. During the period from 1950 to 1995, the number of cities with a population higher than one million increased from 83 to 325. By 2025 it is estimated that more than 60% of 8.3 billion people (the projected world population [1]) will be city dwellers.

Urbanization and urban sprawl can affect our living quality both positively and negatively. In recent years geophysics has found significant and new applications in highly urbanized settings. Such applications are conducive to the understanding of the changes and impacts on the physical environment and play a role in developing sustainable urban infrastructure systems. We would like to refer to this field of study as 'urban geophysics'.

Urban geophysics is not simply the application of geophysical exploration in the cities. Urbanization has brought about major changes to the geophysical fields of cities, including those associated with electricity, magnetism, electromagnetism and heat. An example is the increased use of electromagnetic waves in wireless communication, transportation, office automation, and computer equipment. How such an increased intensity of electromagnetic radiation affects the behaviour of charged particles in the atmosphere, the equilibrium of ecological systems, or human health, are new research frontiers to be investigated [2]. The first objective of urban geophysics is to study systematically the geophysical fields in cities, searching for principles and processes governing the intensity and patterns of variation of the geophysical properties, as well as the potential consequences on the biosphere.

Secondly, geophysics has already been found to be a useful tool for subsurface detection and investigation, hazard mitigation, and assessment of environmental contamination. Geophysicists have documented numerous cases of successful applications of geophysical techniques to solve problems related to hazard mitigation, safeguarding of lifeline infrastructure and urban gateways (air- and sea-ports, railway and highway terminals), archaeological and heritage surveys, homeland security, urban noise control, water supplies, sanitation and solid waste management etc. In contrast to conventional geophysical exploration, the undertaking of geophysical surveys in an urban setting faces many new challenges and difficulties. First of all, the ambient cultural noise in cities caused by traffic, electromagnetic radiation and electrical currents often produce undesirably strong interference with geophysical measurements. Secondly, subsurface surveys in an urban area are often targeted at the uppermost several metres of the ground, which are the most heterogeneous layers with many man-made objects.

Thirdly, unlike conventional geophysical exploration which requires resolution in the order of metres, many urban geophysical surveys demand a resolution and precision in the order of centimetres or even millimetres. Finally restricted site access and limited time for conducting geophysical surveys, regulatory constraints, requirements for traffic management and special logistical arrangements impose additional difficulties. All of these factors point to the need for developing innovative research methods and geophysical instruments suitable for use in urban settings.

This special issue on ‘Sustainable urban development and geophysics’ in *Journal of Geophysics and Engineering* is a response to the call for the development of novel geophysical techniques especially applicable to city settings. It consists of 11 papers which are selected and expanded from a collection of papers presented to the special sessions on ‘Sustainable Urban Development and Geophysics’ (U14A, U15A, and U41B) in the Union section of the Western Pacific Geophysics Meeting held in Beijing, China, on 22–27 July 2006 [3]. This indicates that new and innovative geophysical applications in urban settings have emerged, and these innovations may be potentially useful for the planning, implementation, and maintenance of urban infrastructure systems. These 11 research papers can be divided into three groups: (1) geophysics and urban infrastructure; (2) geophysics and urban environment; and (3) geophysical investigations associated with geological hazards.

The first group of papers focuses on urban infrastructure. Fred Stumm *et al* reported a geohydrologic assessment of fractured crystalline bedrock with borehole radar in Manhattan, New York in preparation for the construction of a new water tunnel. Using GPR, Xie *et al* conducted a quality control study of the walls of the river-crossing highway tunnel in Shanghai. For the same purpose, S Liu *et al* investigated the effect of concrete cracks on GPR signatures using a numerical simulation technique. Sun *et al*, using seismic surface waves, investigated road beds and the degree of weathering of the marble fence in the Forbidden City, Beijing.

In the second group of papers, using a numerical simulation technique, L Liu *et al* studied the effect of a building coordinate error on sound wave propagation with the aim of locating sound sources in urban settings. Chan *et al* studied the abundance of radio elements in weathered igneous bedrock in Hong Kong for the purpose of the promotion of public health in the urban environment.

The third group includes five papers on geo-hazards. The three papers by B Zhao *et al* and Z Zhao *et al* address the problem of earthquake strong ground motion in urban regions using case studies from Osaka, Japan and the city of Yinchuan, China. The other two papers study the geological hazard of surface subsidence using geophysical tools: G Leucci reported a comprehensive study in Nardò, Italy, while Kim *et al* reported a similar case study for a small city in South Korea.

One striking feature of all the papers in this special issue is that multiple authors with at least 3 co-authors wrote the majority of the papers, which indicates strong team work and interdisciplinary collaboration. This is essential for the successful application of geophysical science and technology in tackling a variety of engineering and environmental problems for the urban setting. The only sole author, Dr Leucci, expressed deep gratitude in his acknowledgements to his team members who carried out substantial parts of the data acquisition.

We are pleased to present this special issue to the engineering and environmental geophysics community and hope that it can serve as a snapshot of the current state-of-the-art studies in urban geophysics.

## References

- [1] United Nations 1990 *World Demographic Estimates and Projections (1950–2025)* (New York: Press of United Nations)
- [2] Chen Y, L-S Chan and S Yu 2003 *J. Geodesy & Geodynamics* **23** 1–4 (in Chinese)
- [3] American Geophysics Union 2006 *Eos Trans. AGU* **87** (36)