Chapter 23
Indicator Modelling and Interactive Visualisation for Urban Sustainability Assessment

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ABSTRACT

This chapter presents a novel framework for the integration of the principles of sustainable development within the urban design processes. The framework recognises that decision making for sustainable urban planning is a challenging process: requiring an understanding of the complex interactions amongst environmental, economic, and social issues. Methodologies are required that would support non-experts to become more involved in the urban design process. Towards this, the authors develop an indicator modelling and visualisation tool which comprises 1) indicator selection, 2) modelling techniques that allow spatio-temporal prediction of indicators, 3) interactive 3D virtual world where visualisation techniques are used to present indicator information overlaying the virtual world to facilitate effective communication with a wide range of stakeholders. The sustainability modelling and 3D visualisations are shown to have the potential to enhance community engagement within the planning process, thus enhancing public acceptance and participation within the urban or rural development project.

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INTRODUCTION

Sustainable development applied to urban design is an action plan set out to achieve urban sustainability and due to its multi-faceted nature it requires the effective engagement of a wide range of stakeholders e.g., planners, landscape architects, engineers, policy makers and wider communities, which is often a difficult task. These stakeholders will contribute at different stages of the urban planning process but it has been argued that urban planning and design must be fostered at the local level, involving local authorities, communities and local businesses.

A large number of tools, techniques, and guidance documents have been produced to support decision makers in achieving sustainable urban environments. Many approaches apply a sustainability assessment, characterized by an indicator set, which provides tangible information on whether things are getting better or worse. Examples of sustainability indicator sets include: the United Nations (UN) working list of Indicators of Sustainable Development (ISD's) based on Agenda 21 (Rio de Janeiro 1992), water industry (Water UK, 2000), bioenergy systems (Buchholz, Luzadis, & Volk, 2009)and construction indicators (CIRIA, 2001). It is widely accepted that no standard set of indicators exists and indicators should be selected on a case-by-case basis (Ashley et al., 2008; Starkl & Brunner, 2004; CIRIA, 2004). Although indicator sets exists there are still weaknesses in the approaches and methodologies that make use of these indicator sets (Walton et al., 2005). Walton et al. (2005) summarized the deficiencies of existing tools and methodologies for sustainable development as:

1. Lack of integrated and multidimensional frameworks that bring existing approaches together.
2. Lack of transparency and communication in the promotion of sustainability assessment amongst a wide-ranging group of stakeholders.
3. Lack of recognition of the context-specific nature of sustainability analysis.
4. Better inclusion of stakeholders in the assessment process.

The technical and cross discipline nature of sustainable development has been a barrier to widening stakeholder engagement. This is in confounded by the traditional methods of data communication which is typically Geographical Information Systems (GIS). GIS tools allow geospatial analysis and multiple map overlays, and are used extensively used by local authorities for communicating plans and decision making in urban planning (Drummond & French, 2008; Harris & Elmes, 1993; Stevens, Dragicevic, & Rothley, 2007; States, 2000; Lodha & Verma, 2000). It has been shown that (Lowe, 2004; Lowe, 2003) nn-expert stakeholders have difficulty in understanding data produced by GIS systems. This is in part due to complexity of the GIS software and that the user needs "to think like a geographic information scientist" (Clarke, 2001). GIS is still considered to be a complex, expert oriented tool (Traynor & Williams, 1995) due to its enormous functionality and analysis capabilities. Its use in decision making has made it difficult for non-expert stakeholders, especially the general public, to participate fully in planning decisions (Salter, Campbell, Journeay, & Sheppard, 2009; Al-Kodmany, 2002).

Contrastingly the role of 3D visualization in urban planning has exploded forming an increasingly important role in decision making (Isaacs, Falconer, Gilmour, & Blackwood, 2011) and it is expected that visualizations can communicate proposals to both experts and laypersons (Downes & Lange, 2014). This has taken the form of interactive visualizations and augmented reality applications (Bishop, 2014; Cirulis & Brigmanis, 2013). Visualizations can be exploited to aid decision making and widen engagement as has been done in a number of fields where technical detail can be conveyed in an engaging manner: oil