

# Chapter 17

## The Big Brother: Monitoring Urban Growth and Change for Sustainable Infrastructure Provision

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### ABSTRACT

*Monitoring urban growth and land-use change is an important issue for sustainable infrastructure planning. Rapid urban development, sprawl and increasing population pressure, particularly in developing nations, are resulting in deterioration of infrastructure facilities; loss of productive agricultural lands and open spaces; pollution; health hazards; and micro-climatic changes. In addressing these issues effectively, it is crucial to collect up-to-date and accurate data and monitor the changing environment at regular intervals. This chapter discusses the role of geospatial technologies for mapping and monitoring the changing environment and urban structure, where such technologies are highly useful for sustainable infrastructure planning and provision.*

### INTRODUCTION

The global trend is towards increased urbanization wherein more than half the world's population nowadays lives in cities and towns. Rapid urban development, and increasing land use changes due to increasing population and economic growth in selected landscapes, is being witnessed of late in developing countries. All this rapid development, with or without planned growth of urban sprawl and increasing population pressure, is resulting

in deterioration of infrastructure facilities, loss of productive agricultural lands and green open spaces, as well as causing air pollution, health hazards and micro-climatic changes. It is estimated that by 2030, urban dwellers will make up roughly 60 percent of the world's population as a result of rapid urban growth in Asia and Africa (UN, 2006/7). Considering this projected urban global growth in these regions of the world, it becomes imperative to use advanced technologies to map and monitor this growth so as to minimize its ill effects, and to better manage changes for sustainable infrastructure planning and provision.

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The concentration of people in very densely populated urban areas (mainly in the developing countries) points to a critical need for the introduction of sophisticated systems to monitor urban growth in these regions. These countries often have limited infrastructure, and lack the capabilities which are necessary for modern city planning. To effectively address the issues arising from unplanned and rapid urban growth, one requires – at regular intervals – up-to-date and accurate data on the changing urban sprawl, urban land use, urban resources and urban environment. It is in this context that geospatial technologies – such as satellite Remote Sensing, Geographical Information System (GIS), Global Positioning System (GPS) and so on – with their abilities to provide reliable and accurate data, offer excellent possibilities for mapping, monitoring and measuring the various facets of urban development.

Urban planning and development could significantly gain from the information thus generated, in terms of generating appropriate plans and strategies. The requirement for remotely sensed data of high spatial and spectral resolution for the purpose of detailed urban survey is increasing. This is the result of the high density dwelling and low floor space area which, in turn, is due to compact land parcel sizes and lack of physical spacing and homogeneity in the surface, built-up features of these urban areas. In this context, the availability of space-borne data becomes more relevant and important for urban planning and development. Satellite remote sensing, with repetitive and synoptic viewing capabilities, as well as multi-spectral capabilities, offers unique opportunities for mapping and monitoring some of the elements of urban core, its dynamics, and the resultant urban structure. Image archives store a large number of satellite remote sensing imagery data which began in the early seventies and increases on a daily basis.

Geographical information system (GIS), another form of geospatial technology, is a

computer based system. It is capable of input, storage, manipulation, as well as analysis of data that is useful for planning, decision making and implementation. It is a potent tool in the hands of urban planners to view different scenarios and their outcomes so that an optimal strategy may be chosen for planning and development. Data is one of the indispensable components for GIS and one that requires time and cost. Global Positioning system (GPS) is one of the most precise geospatial data collection technologies which were originally designed for navigational and military uses. It is now being increasingly used to generate civilian GIS data in the field, to update GIS data, and to verify the location of points on a GIS map. This chapter describes the role of these geospatial technologies for mapping and monitoring urban growth for sustainable urban planning.

### **The Role of Remote Sensing**

Before satellite based remote sensing gained ground, aerial photography was being commonly used for defense and civilian purpose during the 20th century. Using elements of aerial photo-interpretation, traditional photo-interpretation skills are able to capture and measure the outline and height of urban features, as well as any changes over time. This may be attributed to the fact that aerial photos possess the ability to identify features clearly but at a highly localized scale (Wolf, 2000). It remains relevant even today, primarily for routine digital photogrammetric large-scale map production.

Alternatively, digital multi-spectral sensors on board remote sensing satellites at higher altitudes are able to record the reflectance properties of an entire city at various spectral levels. A much broader spectral range and much higher spatial resolution of remotely sensed data is required for urban applications, due to the immense variety in the type and composition of objects and surfaces compared to most other applications (Mesev, 2003). Where large areas are concerned, the maps

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