CHEMICAL ENGINEERING TRANSACTIONS
VOL. 56, 2017

A publication of AIDIC
The Italian Association of Chemical Engineering
Online at www.aidic.it/cet

Guest Editors: Jiří Jaromír Klemeš, Peng Yen Liew, Wai Shin Ho, Jeng Shiun Lim

ISBN 978-88-95608-47-1; **ISSN** 2283-9216

DOI: 10.3303/CET1756114

Preliminary Analysis of Remote Sensing Technology in Urban Planning in Malaysia

Siti Shazwani Mohamad Akhir[a], Kasturi Devi Kanniah*[,a, b,c]

[a]Faculty of Geoinformation and Real Estate, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor
[b]UTM-MIT Malaysia Sustainable City Programme, Institute Sultan Iskandar, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor
[c]Centre for Environmental Sustainability and Water Security (IPASA), Research Institute for Sustainable Environment (RISE), Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor
kasturi@utm.my

Phenomenon of rapid urbanization and industrialization is an index of transformation to the huge impact of deposited CO_2 into atmosphere, greenhouse gasses and unbalanced climate change. This serves as a wakeup call to all nations for a properly examination when designing cities and it should move towards more comprehensive green and sustainable approach. In recent decades, many studies have emphasized on various guidelines for green space planning that have been published in the urban planning research. There has been relatively little research on the holistic approach of using an advanced technique such as remote sensing as the future problem solving method for highly complex process of decision-making in planning. This paper presents a review based on the existing literature and its current issues prior to 2015, emphasizing on the approaches of remote sensing that have been extensively used for various purposes of green urbanism. The analysed data derived from the remote sensing images are indicated as simple and comprehensible for city planning. The quality and quantity of urban green space is one of the prime concerns for planners and city administrators. This paper shows how remote sensing can provide an in-depth analysis of mapping and monitoring of green space at large scale areas that is significant for urban planning studies.

1. Introduction

Rapid urbanization and industrialization is an index of transformation on the huge impact of deposited CO_2 into atmosphere, greenhouse gasses and unbalanced climate change (Kamyab et al., 2015). The growing concern about global climate change serves as a wakeup call to all nations for properly design cities and moving towards more comprehensive green and sustainable urbanism. Urban dwellers, developers and policy-makers need to consider the importance of green space in making cities more sustainable (Heng and Tsai, 1999).

Green space, in the view of most planners, can be defined as ‘any land covered with vegetation or green zone referring to recreational parks, open space, golf courses, sports fields and open space with or without built up area’ (Yusryzal, 2013). A point supported by Swanwick et al. (2002) and emphasized by The Multilingual Dictionary of Environmental Planning, Design and Conservation (2001) extends the definition of green space as ‘an area primarily free of buildings which is sometimes protected from development by government action’.

Berry (1990) stated that a lot of green space has been developed in the European and Asian countries including Malaysia since the 1970s. However, most of these spaces have not been properly organized or supervised by the enforcement parties despite their significant contribution in carbon sequestration (Kanniah et al., 2014), temperature reduction (Sheikhi et al., 2015), increasing humidity (Chang and Li, 2016) and storm water management (FAO, 2016). Cities continually undergo rapid development and green areas are continuously being neglected. Fast developing countries like Malaysia are lacking of strategy and supervision. Many cities are experiencing severe loss of green areas in most major cities, including Kuala Lumpur, Penang and Johor Baharu. The evidence reported by the United Nations Framework Convention on Climate Change (UNFCCC, 2012) shows that Malaysia has lost about 4,727,800 ha of green areas in a ten-year period by the

Please cite this article as: Mohamad Akhir S.S., Kanniah K.D., 2017, Preliminary analysis of remote sensing technology in urban planning in malaysia, Chemical Engineering Transactions, 56, 679-684 DOI:10.3303/CET1756114

end of 2012. Continuous loss of vegetation will produce a negative impact on the environmental stability, urban flooding and will threaten the whole planet (Mayers, 1986).

In the last few decades, many studies have emphasized on various guidelines for the development of green space in the urban planning. Relatively little research has been conducted on the holistic approach of using an advanced technique such as remote sensing as an automatic programme-assistance in the green space planning decision-making. This paper presents a review based on the existing literature and its current issues prior to 2015, emphasising on the current issues in green planning and the integration of remote sensing as a valuable tool to efficiently plan for green space in the urban areas.

2. Research Method and Materials

The materials for this paper are sourced from the Web of Science (WoS) database that is more extensive to the Scopus database (Salisbury, 2009). The papers published in WoS were professionally vetted based on the accepted publication standard and the quality of citation (Garfield, 1990). Based on the little research publication on how remote sensing had been used extensively in urban planning, this paper attempts to fill the gaps by reviewing the research findings derived from the past and current research. The scope of this study is restricted to the discussion of green space planning issues and the potential of using remote sensing as effective empirical method assistance in the green space planning decision-making. Three keywords used in the WoS search were “green space”, “planning”, “and remote sensing”. The articles were sorted from the oldest to the newest publication, 86 articles and the relevant articles have been selected to enhance the review quality. The papers cover the potential of remote sensing in urban planning studies. This review presents the issues relevant to the green space planning mainly in Malaysia and the preliminary analysis of remote sensing technology in the urban planning studies.

3. Issues in Green Space planning

Many researchers have concluded that the loss of green space is closely linked to the rate of urbanization, which in turn is highly influenced by the city economic growth (CABE Space, 2004). The provision of green space mainly lies under the purview of government agencies. The tremendous losses of green space are largely due to the land conversion to other uses and green space has always been neglected when development takes place (Yusof, 2013). Ashiha (1998) argues that urban green spaces in Malaysia are designed only for beautification. She asserts that these green spaces should be viewed in a broader perspective as having an influential role to mitigate climate change and reduce pollution. Another issue is the lack of expertise and coordination in the planning, managing, monitoring and conducting studies on urban spaces in Asia (DBKL, 2008). CABE Space (2010) and Scottish Green Space Inventory (Scottish Executive, 2006) indicated that urban planner should study more consistent means for identifying and monitoring the actual distribution of green space. This can be done by creating inventories and capturing the varieties of green space for better planning and decision-making.

4. Potential of Remote Sensing for urban planning

Remote sensing, through satellite observation, is able to collect comprehensive and accurate data such as the quantity and quality of green vegetation covering the surface and different types of green space. Remote sensing is defined as the art of science to obtain information about an object without the physical contact between the object and the sensor. It involves the process of collecting information through satellite about the earth’s surface and phenomena using sensors not in physical contact with the surface and phenomena of interest (Jensen, 2007). Remote sensing has the unique capability to support decision-making with spatial, quantitative data and information products on various topics, ranging from the extraction of urban morphology to the detection of urban and environmental growth and surface temperatures, to the monitoring of traffic or the assessment of population (Ravindra et al, 2008).

4.1 Mapping for in-depth case study analysis

The automatic processing system of remotely sensed images can be effective data collection and analytical tools for urban planning as they can provide very fine and detailed information at the secondary planning stage. These include to quickly, accurately and economically investigating the present situation in land management, urban terrain and its geometric information, high-density geographical patterns of population, resources environment and social economics. This system is beneficial for in-depth mapping analysis, obtaining and updating the information in an easy and fast way. This is a great improvement compared to the conventional methods that consumed much labour force, material, and money for a result that was neither timely nor accurate. The accessed information of green space and maps in Figure 1 is obtained from the simple processing of remote sensed system. The maps provide specific land use in the form of visual (map) and statistical attributes. The statistical result refers to the percentage and area *(ha)* for each land use class that will be helpful in planning. The maps provide real-time assessments of green space and urban features distribution per capita in the areas. They could provide land use information over a large coverage area at national scale with good cost effectiveness. Since this uses an automated method of data processing and image analysis, it can provide multiple options to support planners in decision making with accurate and up-to-date geo-information.

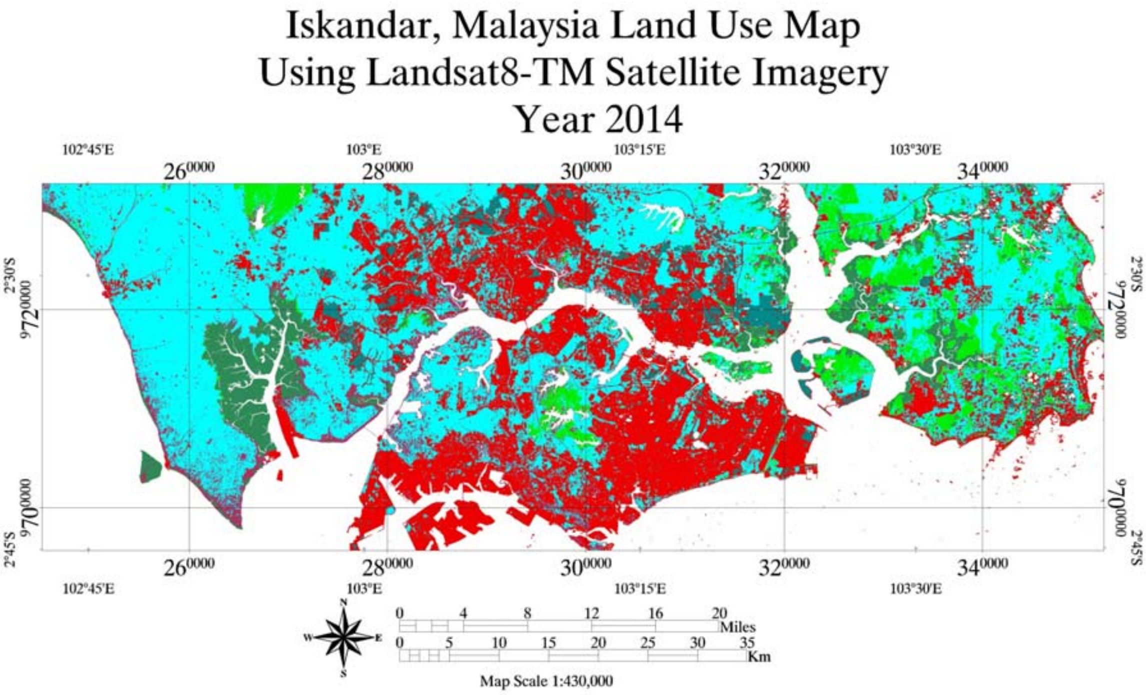

Figure 1: Example of Land use in Iskandar Malaysia region in 2014 derived from remotely sensed images

4.2 Monitoring analysis for large scale planning

Knowing how landscape is changing is vital for understanding the impact of those changes (their interactions) and helps in understanding the pressure being brought to bear on the environment, climate, and ecosystem pattern changes. Urban population and urban sprawl-induced land use changes coupled with the industrial development have caused unplanned and misuse of land. These can lead to conversion of agriculture to non-agriculture (i.e residential, commercial and industrial), loss of greenery and water bodies (Kanniah et al., 2015), development along main transport routes and drainage lines, which could degrade the quality of urban environment (Kumar,2008). Detection of large-scale conversion of agriculture or green space into non-agriculture land has been useful for determining the extent of built-up areas before the government decides to acquire land. However, creating reliable evidence (such as surveys, periodic detailed samples with the associated broad-scale land use maps) of those changes specifically at a national scale is very time consuming and costly. Finding the cost-effective approaches are becoming increasingly important. The complexity of urban development is so dynamic that it calls for the immediate prospective planning for cities. Remote sensing can improve the efficiency in planning or improve the evidence by providing faster ways of monitoring these changes and identifying the present scale of urban expansion in cities.
Figure 2 serves as an example of the land use expansion at different time between 1991 and 2014, a period of approximately 23 y of monitoring and assessing the landscape changes of urban expansion and green space distribution in Iskandar Malaysia. Remote sensing can monitor, estimate and classify the various attributes of green space in a very accurate and detailed way. The quantity and quality distribution of the spatial map for the green space can be generated (Kanniah et al., 2015). It is a more advanced and convenient technique than other traditional techniques, such as the land parcel data collection (Yusof, 2013), which are often unable to accurately provide the overall estimation of the total amount of green space. The ground surveys are very time consuming and costly.

4.3 Integration of remote sensing for planning

Planning is widely accepted as a way to address the complex problems of resource allocation and decision-making in urban development. It involves the use of collective intelligence and foresight to determine direction and to make progress in the public activity related to human, environmental and general welfare. In order to provide more effective and meaningful direction for better planning and development, support of the advance information system and empirical techniques has become essential. The need for competent information management systems is increasingly vital in all planning and development activities (Ravindra et al. 2008). This section comprises a brief discussion on the role and innovation of remote sensing in the various stages of planning, implementation and monitoring of the urban area by providing the advanced tools of information analyzing systems.

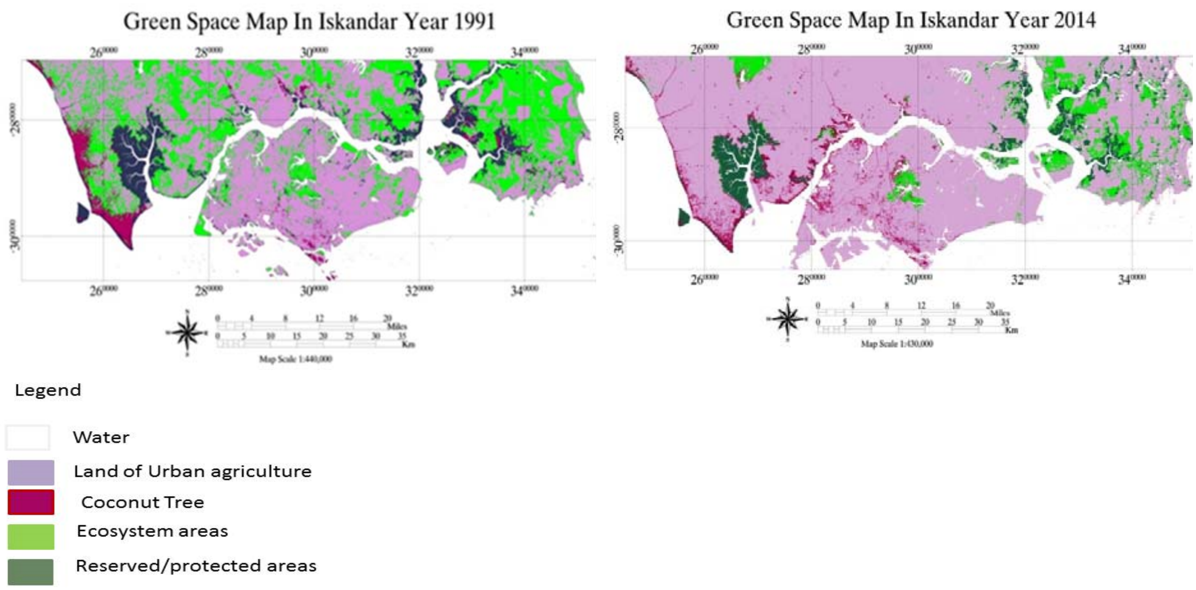

Figure 2: The changing pattern of green space landscape in Iskandar Malaysia over a 23 y period

There are five stages in planning and design management, as shown in Figure 3**.** Each stage plays a significant role in achieving strategic and sustainable planning of the urban compound system (Llewelyn-Davies, 2000). The first stage involves setting the outline and project background, such as the execution of the plan proposal, and establishes the objective of the planning and deliverables. Stage two, associated with investigation and site analysis, involves collecting information and undertaking an in-depth appraisal of the environment and landscape (a SWOT analysis for the overall character of the sites). At this stage, information collection and site observation is a crucial part of planning as it helps in setting out the characteristics of the area, such as human history, the forms of settlements, buildings and spaces, ecology and archaeology, location and the routes that pass through it before decision and design structure can take place. This is where remote sensing technology could be integrated into urban planning by providing physical observation information of cities and towns, at both micro and macro analysis levels. Achieving reliable data analysis of landscape or surrounding built environment, geology, drainage, and development position which directly relate to urban structures is a crucial part in planning position development.

Combining remote sensing with Geographic information system (GIS) literally offers interpretation of physical (spatial data) characteristics with other socio-economic data, and thereby providing an important basis in planning or designing urban structure and making it more effective and meaningful. In the past, this task consumed a considerable amount of money and it was laborious. Remote sensing technology can be used to swiftly investigating the urban terrain, physiognomy, lakes, plants, green space, sight, traffic, land utilization and building distribution. To conclude, remote sensing can be used to obtain and updated urban geometric and some spatial attribute information quickly, accurately and economically (Ravindra et al., 2008).

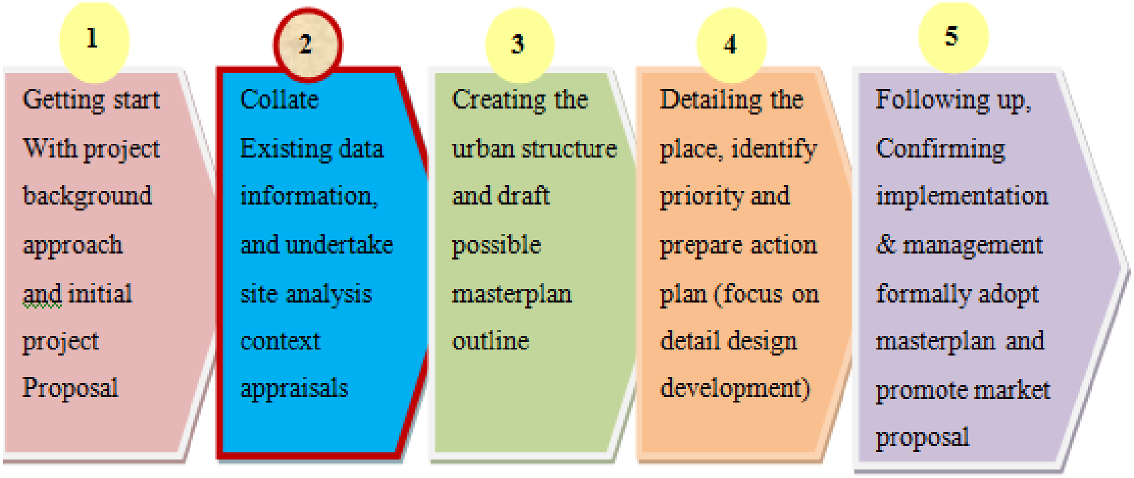

Figure 3 : Design management flowchart and planning stages (modified from Llewelyn-Davies, 2000)

5. Conclusion

In Malaysia, the complexity of urban development is so dramatic that it demands immediate attention and the prospective physical planning of cities (Yusof, 2013). Malaysian cities will have to compete with others to attract investment, and therefore issues such as quality of infrastructure, energy efficient service provision and environmental condition, as well as economic stability, will play a significant part. Furthermore, given the new era of globalization and economic liberalization, it is becoming very pressing for policy makers to find more adequate and effective methods to address these issues and respond rapidly in the planning and management of cities. In order words, the urban planning authorities and agencies should adopt the new technologies like remote sensing and GIS to achieve a more sustainable green planning. These have capability to provide necessary physical input and intelligence for preparing of base maps, for decision-making and proposal, and large-scale monitoring tool during implementation of planning phases.

References

Ashiha Y.N., 1998, Landscape and True Goals, Towards Functional Landscape, National Landscape Department, Kuala Lumpur, Malaysia (in Malay).

Berry B.J.L., 1990, Urbanization, Ed. Turner II B.L., The Earth as transformed by human action, Cambridge University Press, Cambridge, UK, 103-119.

Chang N., Li D., 2016, A Study of the Temperature-humidity Effect and Luminous Environment design for Urban Green Space, Chemical Engineering Transactions 51, 103-108.

CABE (Commission for Architecture and the Built Environment) Space, 2004, The Value of Public Space: How High Quality Parks and Public Spaces Create Economic, Social and Environmental Value? CABE Space, London, UK.

CABE (Commission for Architecture and the Built Environment) Space, 2010, Urban green nation: building the evidence base, CABE, London, UK.

DBKL, 2008, Kuala Lumpur City Plan 2020, Kuala Lumpur City Hall, Kuala Lumpur, Malaysia.

Heng R.K.J., Tsai L.M., 1999, An estimate of forest in Ayer Hitam forest reserve, Pertanikan, Journal of Tropical Agriculture, 117-123

Jensen J.R., 2007, Introductory digital image processing: A remote sensing perspective. PTR, Prentice Hall, USA.

Kamyab, H., Goh R.K.Y., Wong J.H., Lim J.S., Khademi T., Ho W.S., Ahmad R., Hashim H., Ho C.S., Lee C.T., 2015, Cost-benefit and greenhouse-gases mitigation of food waste composting: A case study in Malaysia, Chemical Engineering Transactions 45, 577-582.

Kanniah K.D., 2016, Multi-sensor satellite data for carbon storage mapping of green space in a fast growing development corridor in Malaysia, Proceeding of 37th Asian Conference on Remote Sensing, 17-21 Oct 2016, Colombo, Sri Lanka.

Kanniah K.D., Sheikhi A., Kang C.S., 2014b, Exploring The Role Of Green And Blue Infrastructure In Reducing Temperature In Iskandar Malaysia, IOP Conf. Series: Earth and Environmental Science 18, 012151.

Llewelyn-Davies Y., 2000, Urban Design Compendium 1, English partnership 2000, <www.gov.uk/ government/publications/urban-design-compendium> accessed 16.11.2016

Mayers N., 1986, Tropical deforestation and a mega extinction spasm in Soule. Conservation Biology-The Science of Scarcity and Diversity, Sinauer Associates, Massachusetts, USA.

Ravindra K.V., Sangeeta K., Tiwary R.K., 2008, Application of Remote Sensing and GIS Technique for efficient Urban Planning in India, Geomatrix Conference Proceedings.

Scottish Executive, 2006, Scottish Planning Policy (SPP11): Physical Activity and Open Space Consultation Draft. Development Department, Scottish Executive, Scotland.

Sheikhi A., Kanniah K.D., Ho C.H., 2015, Effect of land cover and green space on land surface temperature of a fast growing economic region in Malaysia, Proc. of SPIE Vol. 9644, Earth Resources and Environmental Remote Sensing/GIS Applications VI, 16-20 October 2015, Toulouse, France, ID: 964413.

Swanwick C., Dunnett N., Wooley H., 2002, Nature, Role and Value of Green Space in Towns and Cities: An Overview, Built Environment. 29, 94-106.

UNFCCC (United Nations Framework Convention on Climate Change) 2012, UNFCCC Report, <unfccc.int/resource/docs/publications/handbook.pdf> accessed 16.11.2016

Yusof M.J.M., 2013, The true colour of Urban Green: Identifying and Accessing the qualities of green spaces in Kuala Lumpur, Malaysia, PhD Thesis, University of Edinburgh, Edinburgh, Scotland.

Yusryzal W.I.W., 2013, Green Space Audits on its accessibility in Pasir Gudang, Planning Malaysia 11, 39-56.