The True Colours of Urban Green Spaces: Identifying and Assessing the Qualities of Green Spaces in Kuala Lumpur, Malaysia

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Abstract

This thesis starts from the proposition that the ingrained perception of urban green space as being synonymous only with fairly well maintained amenity parkland is too narrow and generally overlooks the many environmental and social benefits that other types of green space and their natural habitats bestow on urban residents and wildlife. A critical review of the literature on the benefits which different kinds of green space confer on urban residents in environmental, social, health and well being and economic terms confirms the need for a more holistic approach to the study of green spaces in cities and also highlights the need to develop and realise a more comprehensive 'ontology' of urban green space in tropical countries, a fundamental task which is a main concern of the present thesis. From reviewing the classification schemes or typologies used in different countries to formally recognise and to distinguish different types of green space, the author develops a new, expanded typology for urban green space adapted to Malaysian conditions, aiming to use this as far as possible as a framework to categorise the green spaces of Kuala Lumpur (KL). KL provides a particularly interesting case study as a rapidly growing city in a developing country with a tropical climate, a context where there has been relatively little research on urban green space, despite shade being particularly appreciated in very hot climates. Also KL has experienced much loss of green space in recent decades: on its periphery from urban expansion; and around the city centre from the drive, fuelled by economic growth, to use central land more intensively.

The main empirical analysis in the thesis uses data obtained from remotely sensed satellite images of high resolution (from the IKONOS satellite) to try to identify all vegetated forms of land cover in KL and to discern their nature, primarily whether trees, shrubs or grass, regardless of their location, using object oriented software to process the IKONOS data. The degree to which the different types and functions of green space can be identified from IKONOS imagery using both semi-automated and manual methods of visual interpretation is then compared. The results show that, using high resolution IKONOS imagery, it is not possible to identify unambiguously all the types of green land use or green land cover that are found in the proposed, new typology of green space, either by using semi-automatic classification or by visual interpretation, although the latter enables more types of green space to be distinguished with confidence.

A key result of the preceding analysis, nevertheless, is to produce maps of green space showing the foregoing 3 classes of vegetation (plus water, bare ground and built up areas) for the entire city in very fine detail using first a semi-automated classification followed by selective manual revision. This produces a more complete picture of the geography of these 3 basic types of green space across the whole city than the typical picture purely or mainly of public parks generated from the typologies used by city governments in developing countries, including KL, simply reflecting their traditional concerns being largely restricted to the latter kinds of green space. These finely detailed maps showing the complex mosaic of green space are, in some respects, the most important result of the thesis. These maps of green space produced from satellite data are linked in a geographic information system (GIS) with data on land use for small land parcels and, using dasymetric methods, with data on population from the census to produce a range of alternative, illuminating perspectives on the nature and extent of green space across the whole city, often at a very fine geographical scale, and including an analysis of the relative provision (or lack thereof) of green space over the whole city; this also yields insight into the role of particular green spaces in the wider urban system. Subsequently, the use of GIS operations enables officially recognised green spaces and the even more extensive and diverse areas of green space not officially recognised to be mapped and examined separately, possibly for the first time in KL.

A social survey designed mainly for urban planners and landscape architects in KL was carried out mainly to learn and study their views on the nature, roles and benefits of urban green space, on the new expanded typology, on the problems of protecting urban green space in KL and on what attributes of green spaces they considered should be seen as most important when considering how much priority a particular green space should be given for preservation. From some 38 environmental and social criteria the 41 respondents considered very important, 31 criteria (13 environmental and 18 social) were chosen as attributes to use in evaluating 17 different green spaces of various types in different parts of the city through assessment on site by a small team of trained assessors. A smaller subset of 4 environmental and 3 'social' (actually all accessibility) criteria, selected from the foregoing 31 criteria, was identified which could be estimated 'remotely' by 'desk based' methods i.e. by using the satellite data and the population data held in our GIS, as well as by direct field survey.

It was then possible to compare the 3 sets of evaluations for the 17 green areas in the form of overall rankings in turn on the environmental and then accessibility criteria: firstly the ranks of the sites on all 13 environmental criteria, then on the subset of 4 environmental criteria (both of

the latter from field assessment) and finally on the same subset of 4 criteria estimated ‘remotely’. The equivalent overall rankings for the 18 social amenity criteria, then the subset of 3 accessibility indicators from field observation and lastly the same subset of 3 but estimated remotely were then compared. The results showed clear similarities and strong correlations between the three sets of evaluations for the 4 environmental criteria measuring aspects of vegetative cover and ‘green connectivity’ but less consistent similarity for the social and accessibility measures, with only weak correlations between rankings on the field and remote estimates for the 3 accessibility indices. The main conclusion is therefore that ‘remote’ evaluation could potentially have a useful role, complementary to ground surveys, in monitoring and assessing green spaces as regards some key environmental criteria and, more debatably, may also be able to provide useful measures of accessibility, which are difficult to estimate from field visits. However, observation on site is necessary for assessment of nearly all the social criteria relevant to evaluating urban green spaces.

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I wish to dedicate my thesis to my wife, Norhani Hasan, and to my children, Aiman and Aliya, for their patience in having to adapt to my rigorous schedule. Finally, thank you to my Dad, Haji Mohd Yusof, and to my late Mum, Arwah Hajah Maimunah, who had the wisdom to allow me to follow my own dreams.

Declaration

I hereby declare that the thesis has been composed by me, that the work is my own, and that it has not been submitted for any other degree or professional qualification.

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List of Acronyms and Abbreviations

ANGSt	Accessible Natural Greenspace Standards
API	Aerial Photo Interpretation
CABE Space	the Commission of Architecture and the Built Environment (design and management of parks and public space)
DBKL	Kuala Lumpur City Hall
GIS	Geographical Information System
ILA Malaysia	Institute of Landscape Architect Malaysia
ILAM	Institute of Leisure and Amenity Management
JLN	National Landscape Department, Malaysia
JPBD	National Department of Town Planning, Malaysia
JUPEM	Department of Survey and Mapping, Malaysia
KLCC	Kuala Lumpur City Center
KLCP 2020	Kuala Lumpur City Plan 2020
KLSP 2020	Kuala Lumpur Structure Plan 2020
LIS	Land Information System
MACRES	Malaysian Remote Sensing Agency
MPD	Master Plan Department, DBKL
NGO	Non-governmental Organisation
NPFA	National Playing Field Association, United Kingdom
OS	Ordnance Survey
PAN 65	Planning Advice Notes Number 65
PBCD	Planning and Building Control Department, DBKL
PPG 17	Planning Policy Guidance 17: Planning for Open Space, Sport and Recreation
RSPB	the Royal Society of Protection of Birds
TTA	Training or Test Areas
URGE	Urban Green Environment (European Commission)

Chapter 1

INTRODUCTION

1.0 The Subject of the Research

Urban green space can be broadly defined as any land predominantly covered with vegetation or water that is situated within an urban area. This space can include parks, gardens, playing fields, children's play areas and also derelict and vacant land. Green space is often considered to be an essential type of urban land use that can benefit urban dwellers through making their everyday life more pleasant, liveable and healthy but in some countries and cities one which is diminishing too frequently in extent. Many areas of green space within or adjacent to cities are experiencing pressures and threats resulting from the processes of urban growth and redevelopment that are occurring in cities in all parts of the world. There is thus a widespread concern that the rapid expansion and internal restructuring of urban areas in many countries can isolate urban dwellers from direct contact with nature (Wilson, 1984; Miller, 2005; Fuller et al., 2007). These concerns appear to be particularly strong in developing countries, where there is evidence that urban green spaces are often being lost or degraded at alarming rates (Kuchelmeister and Braatz, 1993; Yaakup et al., 2004).

The United Nations estimate for the world's population in 2010 was approximately 6.9 billion and was forecast to increase to 9 billion by the year 2050 (United Nations, 2009). Already more than 50% of the world's population is living in urban areas. Even in less developed regions, the overall number of urban dwellers is expected to rise to equal the number of rural dwellers by 2017. This rapid growth of urban populations is likely to demand and require large quantities of land to be used for providing housing, education, employment, transport and other infrastructure and amenities. Although such urban growth seems inevitable and planners and related professionals will need to make provision for it, it seems reasonable to argue that there will also be a need to plan urban growth more explicitly and proactively to help preserve adequate areas of greenery or, where appropriate, create new ones, because poorly planned urban development can damage existing green natural environments which are critical to the good functioning of urban areas. Also, within existing urban areas it is clear that powerful pressures to intensify the use of land, especially near city centres, can lead to loss of existing green and open space, so it can also be argued there is often a need for strong policies and/or regulations to preserve as much green space as is possible or as is compatible with other needs.

As urban areas have expanded, in the views of some authors they have sometimes even posed threats to the environment of the whole planet (Mayer, 1986; Munson, 1993; and Jones, 1994). Jafari and Wall (1994) have therefore suggested that urban development should aim to be more self-sufficient in its use of resources rather than depleting resources drawn from areas outside the city. There is thus a growing interest in reducing the ecological footprint of cities (Rees and Wackernagel, 1996) and in thereby making cities more sustainable and self-sustaining. From various perspectives, there is an emerging understanding that sustainability needs to be given greater priority in considering the growth of cities both in terms of their impact on the physical environment and with respect to how the latter interacts with society. This implies that the urban landscape should be developed in a manner that takes into account the physical character of the original natural environment on which the city is built. Within this context, it can be argued that green spaces should not be seen as merely the ‘left-over’ spaces that have not yet been developed within an urban area, but as spaces which function as part of the life-support system of the city and which benefit the urban dwellers through providing them with better surroundings in which to live and work and hence to enjoy a better quality of life. In Europe and North America, an effective and comprehensive system for planning the protection and development of urban green spaces is now widely seen as essential to ensure the preceding environmental and social benefits can be maintained as urban growth continues. By making cities more attractive and healthy places to live, work and visit, such provision should also have social and economic benefits.

As a developing country, Malaysia is no exception to the phenomenon of rapid urban growth. According to the Population and Housing Census of 2010, the proportion of Malaysians living in urban areas grew rapidly from 62% to 71% over the previous ten years. Thus, Malaysian cities are still in a period of rapid physical growth. Almost inevitably, this increase in Malaysia's urban population has placed great pressure upon the country's urban environments, especially on its urban green spaces. According to Sham (1993) and Sreetheran (2007), there is now considerable evidence of the deterioration of the remaining green environments within Malaysian cities, as the country strives to become a developed nation.

As regards our study area, the conurbation of Kuala Lumpur has changed considerably since the country's independence in 1957. It continues to experience a high rate of what has been seen by some authors as rather poorly controlled urban growth (Yusof, 2003), through taking over undeveloped land on what were the outskirts of the city and also by redeveloping areas of green or vacant land within the city boundary for urban functions. In the year 2000, the population of the Federal Territory of Kuala Lumpur (hereafter referred to as simply 'Kuala Lumpur' or 'KL') was approximately 1.4 million; this number is expected to increase to 2.2 million by the year 2020 (DBKL, 2003). Because of the high land values within the city area, some of the existing urban green spaces can come under considerable pressure for development, leading to a reduction in their number and extent (Webb, 1998).

The Malaysian government has made a number of efforts to remedy some aspects of the recognised deterioration of the physical environment resulting from what has been seen in some areas as rather poorly planned or even, in a few places, uncontrolled urban growth. In 1997, the government announced its vision of becoming a 'Garden Nation' by the year 2005 and launched a new national tree planting campaign. By the year 2006, it was claimed that this goal had been achieved. The government then announced its further vision of becoming the 'Most Beautiful Garden Nation' by the year 2020. Numerous strategies were formulated in order to fulfil this vision, mainly focused on the design, creation and development of public green spaces within urban areas.

When considering claims about the status of green space within KL, it is essential to distinguish between spaces that have been given a strong degree of official statutory protection from development - called '*gazetted*' green and open space - and other spaces which, although they may presently function as green space and may even be officially recognised as green spaces, are not gazetted and therefore have much less formal protection and are therefore more susceptible to development. The city of KL's inventory of the green and open spaces it recognised officially as such in 2007 was kindly made available to the author by Mrs Noraini Kassim, Head of the Green Space Division of KL's City Government, often referred to as KL's 'City Hall' or by the acronym DBKL. These records show that in 2007 DBKL officially recognised 645 existing green and open spaces, with a total area of 1,556.2 hectares representing some 6.4% of the 244 square kilometres (or 24,400 hectares) within KL's boundary (DBKL, 2007). In 2007 it also had definite plans to create a further 246 green or open spaces by 2020, representing an additional area of 752.4 hectares (DBKL, 2007), which seems ambitious as well as laudable and yields a total of 891 existing and planned green spaces, covering 2308.6 hectares or some 9.5% of the city's surface. If all these planned green areas were realised by 2020, at face value having some 9.5% of the city's surface as officially recognised green and open space seems relatively abundant provision. Furthermore, of the city's 891 existing and planned green spaces with a total area of 2308.6 hectares, at least 420 (47.1%) accounting for at least 1347.4 hectares (58.4% of this total green area) are officially categorised in status as *gazetted* green spaces i.e. green spaces which have strong formal protection from development. Since DBKL's inventory states that it has 'no information' on the status (i.e. gazetted or not) of 216 of its 891 existing or planned green spaces and another 255 are described as 'not yet applied', the figures of 420 gazetted and 1347.4 hectares gazetted have to be taken as minima for how much of this 'official' green space enjoys effective formal protection. The status of DBKL's recognised green spaces will be discussed in more detail in Section 3.4 of Chapter 3 and Section 5.3.1 of Chapter 5. However, taking the figures just cited together, they suggest that in 2007 DBKL was been making serious efforts to protect much of its green space. Teh (1994) noted nearly 20 years ago that many of those green spaces he had mapped, many of which were then under private ownership were likely to be lost soon to development. Apparently, this vulnerability of privately owned green space mentioned by Teh, a small amount of which may even be officially recognised as green space, accords with the general experience in KL in recent decades that it seemed to be much easier to get planning permission to develop green space if it was privately owned. As a result, by 2007 much privately owned green space, whether officially recognised as such or not (probably mostly the latter), had probably been lost. However, 13 privately owned green spaces were still among the officially recognised green spaces in 2007, all recreational in character, including five private golf courses, three of which are under the aegis of the Royal Selangor Golf Club (RSGC) on essentially one extensive gazetted piece of land, a club which seems to be perceived as having something of an 'elite' character and whose courses are therefore possibly fairly immune to the threat of development for that and other reasons.

With so many entries in DBKL's inventory blank or indefinite, we cannot tell how many of the city's recognised green spaces are not gazetted. If a number of these 'official' green spaces are not gazetted, one result may be that the loss of these and of private green spaces to other uses may have been monitored less thoroughly or even not routinely monitored at all by planning agencies, in the case of private spaces perhaps because requests to develop any private green land (rarely gazetted as will be shown in Section 5.3.1) seemed to gain the necessary planning approval fairly easily, at least till recently. Possibly as a result, recent planning documents produced by DBKL, such as the National Urbanisation Plan, do not suggest any crisis concerning loss of green space, possibly because relatively few of the gazetted spaces are the subject of requests for re-zoning and development. Concern is expressed mainly about achieving a target of 11 square meters of green space per person by the year 2020, given the anticipated extra 600,000 people who will be living in the city (DBKL, 2008).

Observations made by remote sensing and aerial photography, however, can present a different picture. Using a time series of LANDSAT images, Yaakup et al. (2004) estimated that in just ten years between 1988 and 1998, 33.2% of green land cover within the Greater Klang Valley area, encompassing Kuala Lumpur and surrounding urban centres, was lost to other uses, mainly for housing to cater for the population increase and for industrial development. When Yaakup and co-authors broke this overall loss into figures for each of the main areas of the conurbation, KL's loss from 1988 to 1998 was estimated at 48.5% with the other settlements ranging from 55.5% loss (Petaling Jaya) to 16.7% (Hulu Langat). This apparently rapid loss within the whole conurbation paints a striking picture of the pressure for development over the whole Klang Valley region, but it must be kept in mind that Yaakup et al.'s results were based on satellite data with a rather coarse level of spatial resolution of around 30 metres, which means that small public green spaces and even moderately large private gardens could be missed, thereby underestimating the extent of green areas. Nevertheless, Teh in 1989 noted that the maps and statistics of green space he had compiled from aerial photos with high spatial resolution indicated that green spaces were 'rapidly being replaced by development projects', although he observed that Kuala Lumpur was then still well endowed with green spaces (Teh, 1989).

The availability of green space within the city also needs to be considered in relation to the rising population of the city. With official estimates for the population of KL by 2020 set at around 2.2 million (DBKL, 2003), even if the entire 2,308.6 hectares recognised at present by the City Hall as green and open space or planned as such within the city boundaries were to be gazetted (perhaps a rather unlikely scenario in the face of development pressures), this would amount to a level of provision of only around 1 hectare of officially recognised green space per 1000 people. Although this would be an improvement on the present level of provision (estimated by the Malaysian Nature Society in 2008 to be as low as 0.4 hectares per 1000 people), it would still be much less than the ratios of green space enjoyed by the residents of many cities in North America and Europe (e.g. 2 hectares per 1000 population in Toronto; 4 hectares per 1000 in London).

So, as Malaysia approaches the year 2020, city planners may well have to make difficult decisions about how this vision of becoming the 'Most Beautiful Garden Nation' will be achieved through local planning actions (Sreetheran, 2007). Of particular importance for this thesis are questions being debated in planning bodies about how 'urban greening', including protection of existing green spaces, within KL should be pursued. In the face of development pressures, can it be more than a token urban beautification? Can the strategy of developing more urban green spaces suggested in the 2020 Structure Plan for KL (DBKL, 2003) be achieved? If the relative availability of green space to population is actually in decline, might a more pragmatic or realistic goal for the authorities be to prioritise protection or conservation of those green spaces remaining in the central parts of Malaysia's most heavily populated urban area, where green space is most scarce?

This thesis will examine what urban planners and related professionals in Malaysia actually recognise as urban green space, what they feel are the main beneficial effects of green spaces, how far they accept that part of the broad goal of planning for sustainable urban development should include providing green spaces which yield broad environmental and social benefits, how they weigh that goal against plans that aim to maximise economic gains and how concerned they are about the protection of green spaces in KL. The thesis will also consider whether there are any obstacles, challenges or information requirements that planners think need to be addressed before they can formulate and implement the pro-active, strategic plans needed for creating new green spaces or for protecting the existing areas of green space.

As will be discussed in Chapter 2, recent literature on green spaces in the urban areas of the developed countries has emphasised the need to take a wider and more comprehensive view of what constitutes green space in cities, paying more attention to spaces such as overgrown areas of derelict land, gardens, cemeteries, green roofs, pots of plants on balconies or the green verges of transport corridors, all of which were somewhat neglected in previous work compared to more ‘conventional’ green spaces such as public parks, recreation areas and green belts. This recent work shows a greater awareness of the diversity of green spaces in urban areas and of the variety of roles these play. Such approaches have been accompanied by attempts to produce more holistic typologies of categories for classifying green spaces, which will be considered in Chapter 2, one of which has been used here in modified form.

A recent report (March 2010) by the Commission for Architecture and the Built Environment (CABE) on the data available on urban green spaces in England has emphasised the need for a more comprehensive set of the basic data required to adequately describe the extent, condition, quality, facilities and uses of all types of urban green spaces, including those types neglected in previous studies (‘*Urban green nation: Building the evidence base’*). It also argued that a more complete understanding of the role of green spaces, even in the cities of the developed world, still requires much basic information on their extent, condition, role and use to be collected and collated and for this data to be more fully and regularly monitored for urban areas (CABE, 2010). Thus, to gain a more complete understanding of green spaces in the cities of the developed countries, it seems there is still a need for more research on quite fundamental attributes of green spaces, employing broader and more inclusive perspectives as to their nature. There is also a need to explore and assess possible methods for collecting such data more routinely and consistently.

Since it seems fairly clear there has in fact been comparatively little research on green spaces in the cities of many developing countries, it can be argued that the need to identify the range, diversity and basic attributes of their green spaces is even greater. Consequently, there is also a need to explore and assess critically possible methods for collecting such fundamental data for these cities, many of which are growing rapidly. It is also worth noting here that, since most large urban areas in the developing countries are in tropical or sub-tropical climates and the role of green spaces there can sometimes be rather different to temperate climates (e.g. the greater importance of shade and water bodies), much of the existing research literature on green spaces, which has mostly been concerned only with cities of the developed countries, may not be immediately applicable to cities in countries with quite different climatic regimes, as well as different economic, social and cultural conditions. For these reasons, the typologies of urban green spaces that have been developed for use in UK and European countries have had to be modified carefully for the present study. These differences and the limited amount of research on urban green space in the developing countries make it all the more desirable to develop and test different methods that can be used to identify some of the basic properties of green spaces for a whole conurbation in a developing, tropical country like Malaysia.

High resolution data obtained by remote sensing from satellites potentially offers at least four important advantages in addressing this latter need: firstly, information from different sensor wave bands can allow different types of vegetation forming the ground cover to be identified, possibly helping to identify various types of green space; secondly, if the level of resolution is high, say a few metres, all but the tiniest green spaces should be visible; thirdly, if there is no cloud cover, such data may give a remarkably comprehensive and simultaneous picture of all green spaces over an entire city or region and; fourthly, if this method is successful in obtaining some of the key data needed, it would also have the advantage of reducing the need for time consuming and expensive surveys on the ground and could be fairly regularly updated to monitor changes. A major concern of the present thesis is therefore to assess how well data of high resolution obtained by remote sensing can yield the information required by city planners and other professionals about urban green space. The particular set of remotely sensed data used here consists of a mosaic of images from the IKONOS satellite taken in 2002 with a resolution of 1 meter. However, even data from such high resolution satellite sensors may not be sufficient to provide the information needed on its own. It is therefore necessary to explore also how it may be combined with other types of data such as data on land parcels and to assess the value of this high resolution data used separately and in combination with other data.

In this study, we will therefore examine whether the mosaic of IKONOS high resolution imagery that was obtained via the planners in City Hall is useful or not on its own for capturing significant characteristics of Kuala Lumpur’s green spaces. We evaluate this by producing two classifications of urban green spaces within Kuala Lumpur, the first derived from the satellite imagery using automated methods and the second stage involving additional visual inspection to correct obvious misclassifications. We will then test the accuracy of these classifications against reference data obtained by ground observations of urban green spaces distributed throughout the city. This also allows the relative effectiveness of the more automated methods of image classification to be compared against a more interpretative method that urban planners may be more familiar with. Thus, the use of remote sensing was explored and assessed as one possible means by which comprehensive and timely information about urban green space might be obtained. Although the accuracy of this mapping of green space is evaluated quantitatively, the value of this mapping was also explored in terms of whether the imagery could yield the information about the nature of green land cover or land use which interested professionals need.

While remotely sensed data may be able to give a comprehensive, accurate and 'objective' picture of where there is some kind of green vegetation covering the surface, essentially this tells us little about how different types of green land cover are viewed by residents of the city, including planners and landscape architects. To gain a more comprehensive picture of the role of green space in the city, of its benefits, of pressures for it to be developed, of the difficulties of preserving it and of the success or otherwise of DBKL's policies, we therefore needed firstly to question those with formal responsibilities for planning and administering its provision and protection, mainly urban planners and landscape architects working for DBKL. It seemed natural to also elicit the views of others outside DBKL with similar professional interests in urban green areas or with some relevant expert technical knowledge (say of the design and function of certain types of green areas), again trying to gain insights into the latter topics and trying to ascertain simply how such professionals view the basic subjects under consideration. Among other things, we therefore needed to ask the professionals involved fundamental questions related to what constitutes 'urban green space' for them, what benefits or disadvantages they think such spaces confer on urban residents and what characteristics of green spaces may make them particularly deserving of protection. In these questionnaires, it was also possible to elicit their views on how useful is the main typology used in the study. It also made sense to ask these respondents what data they feel are needed to characterise the condition of green spaces and to evaluate them as regards their priority for preservation. By asking such questions we can also begin to assess whether the new types of remotely sensed data that are becoming available now could make a significant contribution to meeting the needs of these concerned with the provision of green space in the city.

Because of their specialist interest, knowledge and experience, it also seemed relevant and appropriate to ask this group about the nature of the threats to the preservation of Kuala Lumpur's green spaces, what they thought the difficulties of preserving these are and what they thought Kuala Lumpur's priorities should be as regards its future policies and plans for its green spaces. Such questions were intended to give insight into the wider situation of Kuala Lumpur's green spaces and the problems involved in protecting them as well as contributing to the discussion about which criteria could be used to make a case for conserving a particular green space. In addition, the answers to such questions may help us to recognise that the task of planning the conservation of urban green spaces can only be solved in part through improving methods of data collection and analysis and that any solution being developed needs to show awareness of the wider set of social, economic and political factors that may influence decisions about urban green space that are made by planners, related professionals and politicians in the face of economic and sometimes political pressure to prioritise economic development over public provision of green space. A variety of published documents, including official reports, were also reviewed at an early stage to understand better what was and is now generally 'officially' considered to constitute urban green space and to ascertain whether the creation or conservation of green space forms any part of the vision for KL to become a 'Tropical Garden City'.

In summary, a variety of approaches for gathering data was utilised. A social survey of professionals, mostly in Kuala Lumpur, concerned in various ways with the subject was undertaken to discover their views about various aspects of green spaces in KL and what further information about green spaces would most assist them to make strategic decisions about urban green space. We then explored how high resolution remotely sensed data might be used for identification and monitoring of green spaces within the city, using available IKONOS data. Recognising that remote sensing is rarely a solution on its own, we then examined how such remotely sensed data might be combined with other data more typically used by planners to provide relevant information in forms that urban planners could find useful for monitoring and perhaps controlling the loss of green space across the city. The final type of data used in this thesis is from ground surveys. Data were obtained from 17 sites, representing different types of green spaces distributed throughout Kuala Lumpur. These data were used to assess the accuracy of the classification of the remotely sensed data, but also enabled comparisons to be drawn between the description of the green spaces that could be extracted from the remotely sensed and GIS data sets and the picture obtained from the site surveys.

1.1 Author's Reasons for Choosing to Study Green Spaces in Kuala Lumpur

As a landscape architect and a resident of Kuala Lumpur, the author was aware of several aspects of this general situation. Seeing some important green spaces being converted to housing and commercial development provoked the author's interest to investigate the extent of these losses. This curiosity also prompted a number of preliminary questions for the author: *how much green space is left in Kuala Lumpur city?; what functions do these spaces provide?; what is being done by the government to protect and conserve these urban green spaces?; what are the challenges and difficulties in protecting the remaining green spaces?; and what kind of information can be used to assist strategic planning to better protect these green spaces?*

Once in the United Kingdom (UK) the author became aware of new ideas about the roles and functions that green spaces provide. The author also became aware of new data, including satellite data, and new technologies such as GIS that were starting to be used in Europe, North America and some other countries to provide information to assist planning professionals in assessing the provision of green space within cities and for making strategic decisions about the protection of green spaces. A preliminary literature review also made the author aware of how data about the distribution and extent of green spaces in different parts of a city might be collected and processed using these new technologies. For example, a recent systematic review of knowledge gaps concerning urban green space conducted by Bell et al. (2007) in the UK concluded that, as well as further studies into the economic, environmental, health and amenity benefits provided by different types of green space to urban residents, more repeatable and consistent means for identifying and monitoring the actual distribution of the remaining green spaces within cities, particularly in relation to city populations, were urgently needed. Even in UK cities, the creation of detailed inventories that capture the variety of green spaces had only been achieved by the time this thesis was submitted (CABE SPACE, 2010; Scottish green space inventory – Scottish Executive, 2011).

In Malaysia, planners are still considering the more basic question of which types of space to recognise and monitor.

To help to define the focus of the research, some preliminary surveys were carried out to explore and refine some of the research questions in the summer of 2007. Firstly, a series of visits to sites of both public and private green space were conducted to observe some of the different types of green spaces in Kuala Lumpur. Interviews were carried out in several of these with a small sample of users of public green spaces, asking them mainly about how they used public parks and other green spaces, what they liked and disliked about them, how they could be improved and how accessible they thought public green spaces were in KL. Interviews were also carried out with selected professionals, mainly planning officers in DBKL, which explored a range of topics, including how the respondents defined green spaces, what categories of green space they recognised, DBKL's policies and aspirations for green spaces, how well green spaces had been protected and what environmental and other attributes should be used in assessing the quality and role of green spaces. The latter set of interviews served as a kind of pilot for the main interviews of professionals carried out in the spring and summer of 2009. During this preliminary study in 2007, digital data for land parcels and their land use and IKONOS satellite imagery that were then available to the planners in the City Hall's Administration were also collected as it was thought that it would be useful to work with these, the best datasets available at that time, as the basis for further detailed analysis.

1.2 Broad Aims of the Research

The broad aims set out for the research were to develop as comprehensive an understanding of the nature, diversity and value of green spaces in Kuala Lumpur as the limits of time and resources permitted and to assess how far remote sensing and GIS plus a ground survey and a social survey of relevant professionals could help to achieve these aims. A second broad aim was to develop and assess methods that could provide a basis for informing strategic planning about the case for conservation of the remaining areas of green space within the city and examining the relative merits of particular spaces.

In order to achieve these broad aims, the following specific objectives were formulated:

(i) to review the existing research literature and use that to construct an appropriate, more comprehensive typology for identifying and describing the green spaces that might be found within the boundaries of Kuala Lumpur;

(ii) to investigate the extent to which the different types of green spaces set out in the typology are actually recognised by urban planners and landscape architects in Kuala Lumpur as ‘urban green space’ and whether the latter identify any not in the typology and to discover how these different types are evaluated by this group of professionals;

(iii) to identify which of the different types of green spaces included in (i), whether accepted as such by professionals in (ii) or not, can be identified from the high resolution optical satellite imagery used in this study; and

(iv) to determine if any of the characteristics of green spaces reported as important by the respondents could be identified by classifying or interpreting the satellite imagery and to assess how this desk-based approach compared with more conventional methods for assessing green spaces, such as by making site visits.

1.3 Relevance and Scope of the Research

This research focused specifically on Kuala Lumpur as a case study, mainly because urban greening has become one of the key goals within Malaysia’s development agenda. Malaysia has a vision of becoming the ‘Most Beautiful Garden Nation’ by the year 2020. A possible obstacle to achieving this is that the Kuala Lumpur conurbation is among the fastest developing cities in South-East Asia. It was hoped that the research might have some relevance to policy in that the results might help to stimulate discussions among city planners in Kuala Lumpur as to which green spaces should have the strongest priority for conservation, as to where development might be considered less damaging and with regard to whether satellite imagery was a useful further source of information in making such decisions. Only the urban green spaces within the Federal Territory of Kuala Lumpur were considered, because some of the most extensive and intensive development and greatest population growth have occurred within this part of the conurbation, which also seems to have suffered a serious loss of green space. Land parcel, satellite imagery and population data were also available for Kuala Lumpur and access to city planners was also possible there.

Urban green spaces cover a broad range of landscape elements and support many possible activities. Since green spaces in urban areas provide a wide range of functions and have value to a wide range of potential users, it was necessary to limit the scope of the main part of the research to considering primarily some of their environmental and social benefits. This was partly because these two groups of benefits are more tangible and also partly because there is more evidence from previously published research on how these two factors might be observed, both directly and remotely.

Given the emphasis in this study on developing a means of inventory for green spaces, it was decided that the research would concentrate firstly on the environmental and secondly on the social benefits provided by green spaces since, as just noted, there was an expectation that at least some of these would be measurable and observable city-wide using remote sensing and GIS, as well as by direct field observation. Narrowing the focus also made it possible to address questions that could be answered with respect to the datasets available at the time of the study.

1.4 Main Research Questions

It is now possible to restate the research focus as a series of related questions:

(i) What is the nature of green space within Kuala Lumpur?; how many different types of green spaces exist in the city? (These questions cannot be answered definitely and exhaustively; rather the author will try to show how different kinds of answers are offered by the different types of data examined.)

(ii) How well does the typology of green spaces used in this study capture or characterise the diverse range of green spaces actually encountered in the city?

(iii) What types of urban green spaces are currently recognised in the strategic planning documents of KL City Hall? Does the current typology used in these documents recognise adequately the many environmental and social benefits of urban green spaces? If not, what further types of green spaces should KL City Hall consider recognising when trying to protect the most valuable existing or potential green spaces from development?

(iv) Which types of green spaces are recognised as such by the professionals who completed the main survey questionnaire and how do their responses accord with the main typology employed? What functions of green spaces do they most value and can their evaluations be used to assess how strong is the case for conserving particular green spaces?

(v) How well does the remotely sensed data help in characterising the variety of green spaces found in Kuala Lumpur, for example their extent, distribution, and main attributes?

(vi) Which of the attributes of green space found to be important from the social survey can be observed through site visits and can any be measured using remotely sensed imagery and GIS?

In comparing these questions with the broad aims and more specific objectives set out earlier in Section 1.2, it is worth emphasising that, in many respects, the focus of the thesis is primarily 'ontological' in that it is concerned with trying to establish what kinds of green spaces actually do exist in Kuala Lumpur i.e. the most fundamental questions underlying the research are those set out above in (i). It seems clear that addressing such basic ontological questions is a necessary and important task for research in this field, particularly in the cities of the developing world, though it seems there is still much to be done on the topic also in cities of the developed world. Remotely sensed images of high resolution appear to offer some potentially comprehensive answers to the basic questions in both contexts, answers which could give a basis for critically assessing the ontologies of green space perceived by urban planners and landscape architects and also those ontologies encapsulated in the 'official' typologies employed in the documents of various institutions, sometimes expressing their ideals, visions or policies for urban green space. A second broad concern is to see whether the data from the remotely sensed images, when combined with other data, can provide methods of assessing how strong is the case for preserving particular areas of green space within the city. How well remotely sensed images can actually realise their ontological potential, however, first needs to be resolved and this is the main underlying concern of Chapter 5 and to a lesser extent 6.

1.5 The Thesis Structure

A possible publication strategy was considered when writing this thesis. The results chapters (Chapter 4, 5 and 6) are written in a form that allows extraction of thesis material to create academic papers. In summary, the thesis is presented in eight chapters, as illustrated in Figure 1.1. It is organised as follows:

The present chapter outlines the context for the research. It sets out the research subject, briefly explains the author's early interest in the topic and formulates the research aims, the main questions posed and how these were approached. The study is thus given focus by addressing a series of specific objectives and a set of questions to be tackled. It also explains how the scope of the study was made manageable by restricting the research to a defined geographical area for which data sets could be acquired and by considering only a subset of benefits that can be provided by green spaces.

Chapter Two mainly reviews previous research on urban green spaces. It firstly discusses the concept of 'urban greening', the definition of urban green space and the historical development of urban green space in the UK, particularly parks. It then explores how Ebenezer Howard's visionary idea of a 'Garden City' and various concepts associated with it and subsequently derived from it or stimulated by it have provided influential and enduring models for integrating green spaces in the urban landscape in Malaysia as well as UK. The way these concepts have influenced the design and layout of several urban centres in the Kuala Lumpur conurbation over many decades, not least in the way they have been 'greened' is also explored briefly. This chapter then reviews previous work that has explored the environmental, social, economic, and health and well-being benefits provided by urban green space. It introduces some of the typologies that have been developed to describe green space in developed countries, especially those established in the UK. Recent research which has used medium and higher resolution remote sensing as a method for mapping and monitoring green space within cities in different parts of the world is then reviewed and some of the advantages and limitations of using satellite remote sensing as a supplement to more traditional sources of data about urban green spaces are considered. The chapter concludes by highlighting key gaps in knowledge that the present study will attempt to address.

Chapter Three begins by introducing planning and development practice regarding urban green space in Malaysia. It presents some general background information about Malaysia, its urban development process, Kuala Lumpur's vision of becoming a 'Tropical Garden City' and discusses the importance of urban green spaces to the country. Subsequently, it examines Kuala Lumpur City Hall's perception, management and strategic planning of its green spaces. It also examines the current typology of green spaces defined by DBKL and suggests a more comprehensive typology that could be used for recognising and managing these green spaces.

Chapter Four presents the results and analysis of the survey questionnaire undertaken with selected professionals in Kuala Lumpur who are involved either directly or indirectly with urban planning, the urban environment or the urban landscape. It analyses their responses and their comments about Kuala Lumpur's green spaces. These include the respondents' opinions about the meaning of the phrase 'Tropical Garden City', the value of the wider 'green space' terminology being proposed by the author, their opinions about the main roles and functions of green spaces and the benefits that green space provides to Kuala Lumpur. This chapter then offers a critical analysis of the respondents' views on Kuala Lumpur's aspirations for its green spaces. Next, it explores the respondents' opinions about the vulnerability of green spaces in Kuala Lumpur. Finally, the chapter analyses the respondents' evaluation of various potential environmental and social criteria that could be used when determining which green spaces should be given priority for preservation.

Chapter Five compares the results of two methods for green space identification in Kuala Lumpur. Firstly, this chapter develops a GIS-based approach for approximating the existing green and open spaces in Kuala Lumpur by using the city's digital data on land parcels. This is contrasted with a second method for the identification of the city's green spaces using data from high resolution IKONOS imagery. The IKONOS imagery is first classified using a semi-automated approach; the accuracy of this mapping is then increased by inspection of visual images and a manual reclassification technique. The chapter concludes by comparing the relative advantages of the mapping of green spaces produced from the two data sets.

Chapter Six develops two sets of indicators which seek to capture some of the environmental and social benefits of the various green spaces within the city and which could be used to help assess particular green spaces as regards their priority for preservation. The two sets of indicators draw on findings from Chapters 4 and 5. Firstly, a series of 31 indicators of environmental and social value are identified that could be observed through site assessment visits. For these observations, made at 17 different sites of green space, an assessment sheet is used as a means of evaluating these green spaces on the 31 indices. Secondly, the data mapped from the IKONOS classification of green space is analysed using GIS to derive estimates for a subset of 7 of the preceding 31 indicators. These 7 were chosen simply because they could be estimated from the satellite data but their choice broadly accords with the survey respondents' priorities in evaluating some of the criteria that could be taken into account when assessing the merits of particular green spaces. This second set of indicators include various measures of the accessibility of green spaces to the city population, a measure of how much shade and shelter green spaces provide, a measure of the variety of different types of vegetation in green spaces, a measure of the connectivity between the existing green spaces and a measure of the relative abundance of green space. Values for most of the latter are computed for zones across the whole city, but for a few it was only appropriate to calculate estimates for the 17 sites visited (e.g. access to public transport). One of the advances made in Chapter Six is to use the map of green space from the satellite imagery and the technique of Dasymetric mapping to produce a more realistic distribution of the city population than the aggregated population data available from government sources; this allows the availability of green space to be evaluated more locally than has hitherto been possible.

The similarity between estimates of the second set of 7 green space indicators as derived from GIS techniques and as estimated from site investigations is then examined to see whether the former 'desk based' approach produces a similar ranking of the sites as regards their value for protection to that obtained from site visits. The benefits and limitations of both approaches are then discussed, leading to suggestions about a way in which both approaches could be combined harmoniously to assist urban planners in making decisions about whether specific spaces should be retained or could perhaps be sacrificed, if there is a need or strong case for development.

Chapter Seven brings the results from chapters 4, 5 and 6 together, drawing out the main findings and relating these to the main questions posed and to the wider literature. The value of extending the typology used for recording green spaces in Malaysia is first considered and related to the opinions of the respondents in the questionnaire survey. The case for recognising a broader set of green spaces (public and private) is made and the case for gazetting more of these green spaces in order for KL to meet its targets of green space provision for its population is examined. The chapter then considers the degree to which imagery such as the IKONOS data and newer higher resolution imagery could be used to provide a consistent and comprehensive inventory of green space within a city such as KL, concluding that such imagery should not be considered as a substitute for conventional ground surveys of green spaces, but as a means to make such surveys more focused and as a source of other information, particularly contextual, about green spaces which is difficult to obtain from field surveys alone. By comparing the information that can be obtained from the satellite imagery and from the site visits, differences and similarities are further assessed. A variety of ways in which the satellite data could be used to enhance the existing maps and data sets used to support decisions about green space conservation is then outlined, leading to a series of recommendations of topics for further research.

Chapter Eight summarises the main conclusions that can be drawn from the preceding analysis and discussion.

Section	Chapters
Focus of Research	**CHAPTER 1** Introduction
Background: Literature review and Kuala Lumpur's attempts to control the development of its green spaces	**CHAPTER 2** Literature review: Urban greening, Garden Cities and the history, role and classification of urban green spaces
	CHAPTER 3 Background on Kuala Lumpur and an overview of attempts to control development on green spaces in the city
Results, Analysis and Discussion	**CHAPTER 4** Results of the questionnaire survey on the nature, functions and management of green spaces in Kuala Lumpur
	CHAPTER 5 A comparison of digital land parcel data and remote sensing data for creating an inventory of green spaces in Kuala Lumpur
	CHAPTER 6 Assessing Kuala Lumpur's green spaces
Discussion of Findings, Recommendations and Final Conclusions	**CHAPTER 7** Discussion of results
	CHAPTER 8 Final conclusions

Figure 1.1: Summary of the structure of the thesis

Chapter 2

LITERATURE REVIEW:
URBAN GREENING, GARDEN CITIES AND THE HISTORY, ROLE AND CLASSIFICATION OF URBAN GREEN SPACES

2.0 Introduction

This chapter opens by reviewing literature related to the broad topics of 'urban green space'and 'urban greening'. The former term has a longer history which will be discussed shortly. Though the latter term has gained some popularity over the last decade or so, authors often seem to use it without defining it explicitly, as happens with Westphal (1999) and with Cox and Grayson (2004). However, its implicit meaning is usually fairly clear: 'urban greening' can be conveniently defined here as being concerned with the provision, protection, extension or enhancement of areas of the city which are or could become vegetated, whether naturally vegetated or by planting, and may also include areas of water. An attraction of urban greening as aconcept is that it seems to provide a comprehensive and inclusive framework embracing a wide range of vegetated land use when treated as an inventory term or, when used as a verb, referring to projects or activities concerned with providing, conserving, improving or extending vegetated areas in cities. Thus, urban greening projects can involve urban forestry, tree planting on streets or the creation of other kinds of urban green spaces. The basic concern of the present thesis, however, is with identifying the nature and range of different kinds of urban green space in Kuala Lumpur, so this chapter is primarily concerned with presenting a review and summary of literature on that topic.

Firstly, the various ways urban green space and open space can be defined are discussed. Since the author has not found any generally agreed definition of urban green space, the chapter goes on to develop and try to justify the definition that will be mainly used in this study. Next, the history of the development of urban green spaces, particularly parks, is examined mainly in the UK because of the basic importance of UK's experience in this field to the history of urban greening on the globe but also because UK's experience in this area has had a significant influence on the planning, design and provision of urban green spaces in Malaysia both during British colonial rule and after Malaysia's independence from 1957 onwards.

There is then a discussion of Howard's concept of the 'Garden City', since various ideas related to the latter model have had a strong influence on how particular kinds of urban green space have been incorporated into plans and designs for urban areas in UK, Malaysia and many other countries since 1920 or even before. Indeed, from 1945 onwards Howard's concept of the Garden City and the concepts involved after World War Two in the design of New Towns in the UK, which built on and extended Howard's original ideas, had a major influence on the design and layout of at least four of the main urban centres forming the Kuala Lumpur conurbation i.e. Petaling Jaya, Shah Alam, Bangi and Putrajaya (Ju, Zaki and Choi, 2009), not least in the way a strong element of greening was integrated into their design from the outset. Moreover, it can be argued that the broad vision behind Howard's Garden City and a number of concepts associated with it or derived from it have had a significant influence upon the vision and inspirations informing Malaysian planning practice generally, including the way green spaces were incorporated in several cities in Malaysia, even including Kuala Lumpur to a limited extent, from the 1920s onwards, as Shamsudin (2005) has noted. As will be discussed briefly in Chapter 3, the broad idea of a Garden City may also have had some influence on the Government of Malaysia's vision in 1997 of Malaysia becoming a 'Garden Nation' by 2005 and its subsequent vision of Malaysia becoming the 'Most Beautiful Garden Nation' by 2020. It may also have influenced the aspiration that Kuala Lumpur should become a 'Tropical Garden City', initially put forward by the city council during the 1990s.

Next, some views regarding the essential characteristics and potential roles of urban green space are explored critically and various ways of identifying the particular properties that green space needs to have to qualify as being of 'high quality' are considered. This leads on to a discussion of the mainfunctions of urban green spaces: thus their roles and benefits for a range of purposes such as improving environmental, social, economic and health and well-being conditions are then considered in this context. The wide range of green spaces that actually occur in various cities is then explored which helps to illustrate the diversity of green spaces that is now recognised in many countries. This is followed by a discussion of a number of typologies for classifying urban green spaces and of how well they capture this diversity. Although examples and research from many countries are considered in this review, a particular emphasis is again given to research carried out and planning policies followed in the UK, as UK has had a significant influence upon Malaysia in this field from the colonial period onwards, as already noted.

The final part of this critical review of the literature explores new methods for mapping and monitoring green space within urban areas. Although this has been traditionally undertaken by a mixture of site surveys and, when available, by interpretation of aerial photography, we also review the growing use of satellite imagery in conjunction with socio-economic data held in geographic information systems (GIS) as more contemporary ways of mapping green space which may offer a more suitable method for green space mapping in rapidly developing cities. Studies using both medium and higher resolution satellite imagery for cities in different parts of the world are reviewed, discussing the types of sensor data and methods of processing often used and the types of urban land cover that have been mapped.

The concluding section summarises the main findings of the review of the research literature and tries to identify some significant gaps in knowledge and understanding of urban green spaces which the present study can attempt to address.

2.1 What is an Urban Green Space?

As just noted, the term green space has no universally agreed definition. According to the Multilingual Dictionary of Environmental Planning, Design and Conservation (2001), green space is "*a generic term covering primarily planted public and private open space in urban areas*". Greenspace Scotland, an organisation which promotes the creation and maintenance of quality green spaces in Scottish cities and towns, defined green space in 2004 as "*any vegetated land or water within or adjoining an urban area*". Similarly, URGE (a green space project to improve the quality of life in European cities and urban regions) defines green space "*as a public and private open space in urban areas, primarily covered by vegetation, which are directly (e.g.: active or passive recreation) or indirectly (e.g.: positive influence on the urban environment) available for the users*".

According to Swanwick et al. (2002), the two terms 'green space' and 'open space' are often used loosely and interchangeably, a point supported by Chang (2000) who argued that in a planning context, green space is more or less equivalent to open space, despite the clear difference. He added that open space has been widely used to describe an outdoor space that consists of landscape features. The Dictionary of Urbanism (2005) emphasises the social function of these spaces, describing open space as "*an outdoor space that enables groups of people to discuss ideas and share experiences".* The Multilingual Dictionary of Environmental Planning, Design and Conservation (2001) extends the definition by emphasising the protected status of these planned areas and defines open space as "*an area or plot of ground predominantly free of buildings in an urban region, which is sometimes protected from development by government action to provide for outdoor recreation"*. This aspect of a space protected from development can be traced back at least as far as Abrams (1971) who defined open space as "*a portion of the landscape which has not been built over and which is sought to be reserved in its natural state or for agricultural or outdoor recreational use"*.

To summarise, neither green space nor open space has a widely accepted definition. Rather, definitions appear to draw on a myriad of complex ideas that reflect the different needs, priorities and situations of the organisations and communities concerned, some tending to emphasise a particular role such as the recreational or social or even a particular mode of creation (e.g. planting). However, a clear definition is now needed to help describe and delimit the area of research to be pursued here. Since we are potentially concerned with virtually all kinds of urban green spaces and wish to consider, at least initially in conceptual terms, all the possible benefits (and/or disadvantages) they may confer on cities, to capture as many of the latter effects as possible, it makes sense at the outset to define urban green spaces very broadly. This study will therefore use the term'green space' to simply describe any area or land covered with vegetation or water that is within an urban area, a definition very similar to that of Greenspace Scotland. This working definition is intended to be as comprehensive and inclusive as possible: it allows the inclusion of parks, gardens, green corridors, playing fields, natural forest, cemeteries and derelict or vacant land which is vegetated. With this definition, it is quite explicit that green space involves more than simply parks, gardens and playing fields. Including a much wider set of land cover types than formal open space therefore allows not only the social and amenity benefits of these spaces to be considered and evaluated but also a range of their environmental benefits and this may be of particular significance in the rapidly growing cities of the developing world with tropical climates.

Thus we try to take into account the full extent of all urban green space, not only green public spaces and places specifically designed for recreation. Later, it will be argued that adopting a more inclusive definition of urban green spaces is actually an essential first step in enabling the role of green spaces to be more fully recognised and better understood, although the latter definition is wider than some currently used by a number of urban planning organisations.

2.2 History of the Development of Urban Green Space in the UK

It is helpful at this early stage to outline briefly the historical development of urban green spaces, exploring particularly the development of urban parks in developed countries, mainly the UK. According to Whitaker and Browne (1971), the word 'parc' or 'park' originally referred to an enclosure that contained animals for hunting. Turner (1996) also comments that the first park was created when humans initially erected fences to enclose and protect a parcel of land. Subsequently, more extensive barriers were erected, especially by monarchs, who began to think about keeping private parks for the use of their own families by creating royal private parks. Initially created as gardens for private enjoyment and use within the royal or other noble families and their entourages, these parks came to be developed not just for leisure and pleasure but also for hunting, and celebrations involving the ruler and his or her family members.

The history of parks and green spaces is inseparable from the development of cities and urban areas. Greenhalgh and Worpole (1995) claim that the development of parks and open spaces is part and parcel of the overall development of a city, and that park are therefore almost an integral part of the urban process and way of life. In developed countries, including the UK, many public parks were established in response to the rapid growth of cities, particularly during the period of rapid industrialisation which took place in the second half of the 19th century. At that particular time, green spaces and urban parks seem to have been regarded as good quality environments that provided places for recreation and leisure (Greenhalgh and Worpole, 1995).

In the 19th century, the development of parks in the UK began to change. According to Conway (1991), during the latter period the urban population increased considerably and urban centres expanded greatly, hence new buildings were often constructed over existing green spaces within cities. This resulted in governments officially recognising green spaces e.g. in 1833 the Select Committee of Public Works presented a report to the UK Parliament which persuaded the government to recognise the need for public parks (Conway, 1991). Subsequently, between 1833 and 1845, the park movement in the UK became recognised and the development of parks received greater attention from local governments. By the 1870s, local authorities throughout the UK had acquired full powers to enable them to develop and maintain parks (Conway, 1991).

At the end of the 19th century, the innovative idea of the 'Garden City' was put forward by Ebenezer Howard. Howard suggested developing completely new towns in the middle of the countryside for many reasons, not least to reverse the flow of migration from rural areas to towns and to allow urban residents to enjoy the benefits of a better quality of urban environment through houses with gardens and public green spaces of various types and sizes in their surroundings (see Section 2.2.1 for a fuller discussion of Howard's 'Garden City' concept). At this period, according to Briffett et al. (1999), efforts were also made to establish and incorporate green spaces in cities. These efforts provided more opportunities for people to enjoy a healthier lifestyle by spending some leisure time in parks. It seems that the late 19th and early 20th century was an era when the benefits and importance of parks and other urban green spaces were recognised and appreciated e.g. as 'green lungs' for the city and as providing contact with nature and greenery (Conway, 2000; Woudstra and Feildhouse, 2000). However, by the middle of the 20th century, Whitaker and Browne (1971) claim that parks in the UK were in decline. This was partly due to the financial constraints faced by local authorities in the early 1970s, which resulted in cuts in budgets for maintaining parks (Kendle and Forbes, 1997). Some consequences of reduced budgets, as Kendle and Forbes point out, were that the reductions in numbers of park staff contributed to a deterioration in park maintenance and to an increase in vandalism (and/or the visual evidence of vandalism) and in other anti-social activities. Not surprisingly, during this period many parks became less popular and less attractive due to all these problems and to the lower standard of up-keep of their facilities.

The second half of the 20th century saw more affluent people shift away from cities to the suburbs or countryside, where the quality of life was thought to be much better, and a number of country parks being developed on the urban periphery (Woudstra and Fieldhouse, 2000). The latter authors also argue that visitors to urban parks further declined partly due to this suburbanisation and exurbanisation of population, but also due to lack of modern attractions, vandalism, poor security and indifferent standards of maintenance. This general scenario resulted in urban parks being neglected not only by local citizens but also by local governments in terms of budget allocations.

In the late 20th century and beginning of 21st century, it appears that people were becoming more concerned about their quality of life and environment with some renewed interest in urban green spaces as providing places for community activities. At the same time, in the year 2002 through the publication of 'Green Spaces, Better Places', the UK government and local authorities also started to introduce improved methods of planning and redesigning public green spaces and parks. Besides that, non-governmental organisations such as CABE Space, Green Space, Greenspace Scotland, Natural England and RSPB (the Royal Society for the Protection of Birds) also started making greater efforts to study and research the quality of urban green spaces and parks. Recently, awards such as the Green Flag Award, GreenSTAT and Spaceshaper have been introduced as means of assessing and determining the various qualities of these parks and green spaces, taking into consideration their environmental characteristics and condition, their social amenities, their economic benefits and other features. This seems to indicate increased interest and concern in urban planning and related fields in the quality of urban green spaces and parks and this is expected to continue in the future. Figure 2.1 attempts to summarise the main features of the historical development of parks experienced by developed countries such as the UK.

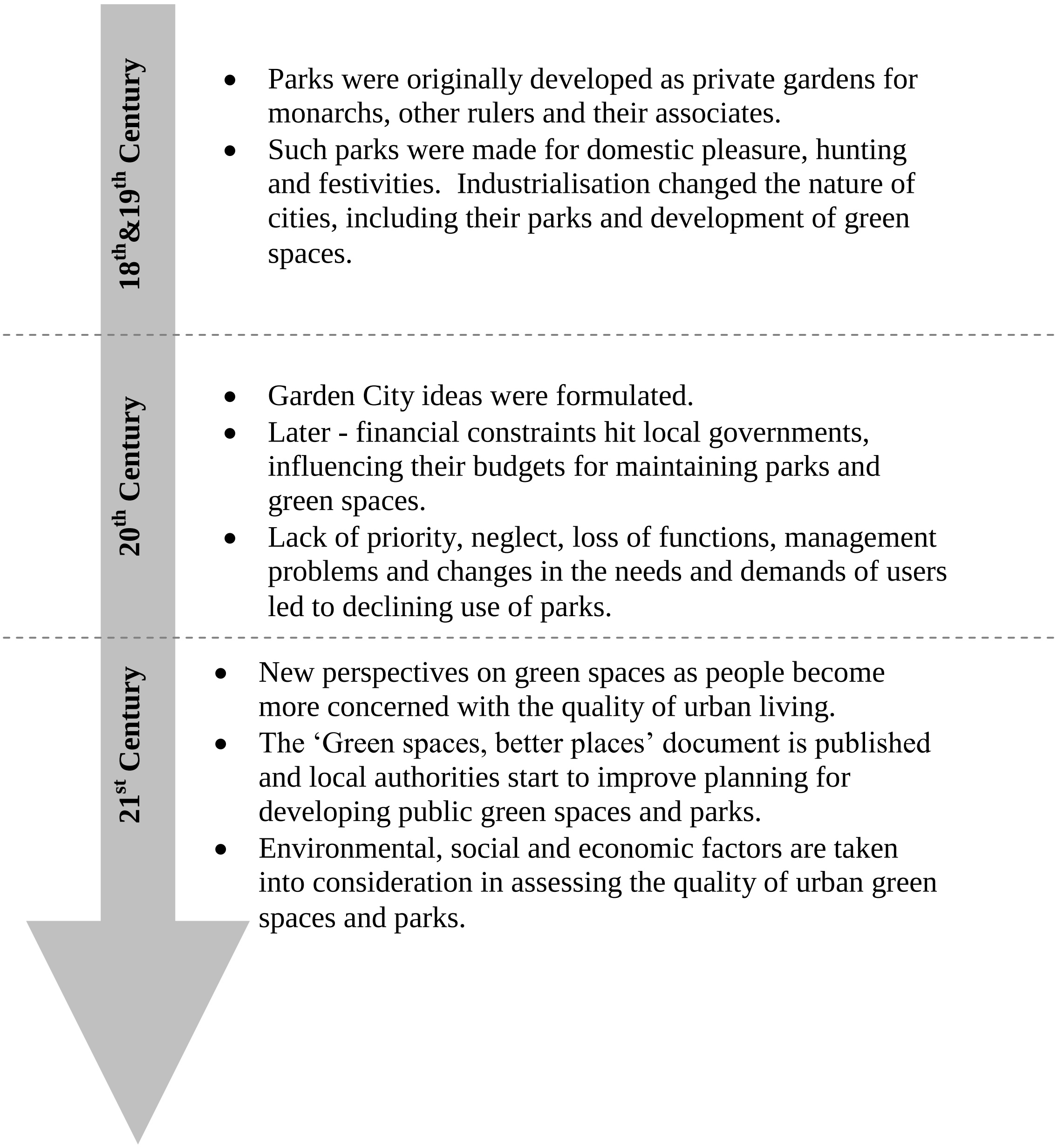

Figure 2.1: The historical development of parks and other urban green spaces in the UK

2.3 Ebenezer Howard's 'Garden City'

One of the key influences on the roles, spatial arrangement and design of parks and other urban green spaces in cities and towns in the UK since the start of the 20th century came froma range of ideas associated with the concept of 'Garden Cities', first put forward by Ebenezer Howard in 1898 under the title 'To-morrow: A peaceful path to real reform' and then published again, more successfully, in1902 under the title 'Garden Cities of To-morrow'. Thus Buder (1990) argues that the 'Garden City' concept was very influential on ideas about the greening of cities from the end of 19th century. In thesevolumes Garden Cities were proposed by Howard partly as an alternative to the overgrown and over-congested industrial cities and the depressed, depopulated countryside he saw around them in the late 19th century.

In Howard's scheme each garden city would be carefully planned, placed in a rural setting and limited in both its areal extent and population size. In Ward's view (1992), the basic 'Garden City' concept is not a combination of the town and country, as often claimed,but is first of all a town in the country, where people may enjoy the best qualities of town and country life with opportunities to work and ample space to live. From Ward's perspective, Howard believed that an improved quality of life would be available in these new settlements, including better housing, work and leisure conditions, but he also saw the co-operative, self-governing and self-organising community which he envisaged to design, build and run each Garden City as providing a means of transforming social relations and religious sensibilities. Thus, for Ward, the fundamental purpose behind Howard's 'Garden City' concept was not to provide an improved environmental frame for the existing socio-economic system, but to provide a motor for fundamental social transformation; thus it was not intended as a treatment for the existing cities of his time but as a proposal for a new kind of city and society.

Howard also believed that the flow of migration from the countryside to the town could be redirected by the magnetic attraction of his garden cities. He envisaged the town and country in their existing form as two magnets, each striving to draw people to themselves. The garden city would be the third or 'town-country' magnet, a new attractive force over-riding the traditional magnets (Figure 2.2).

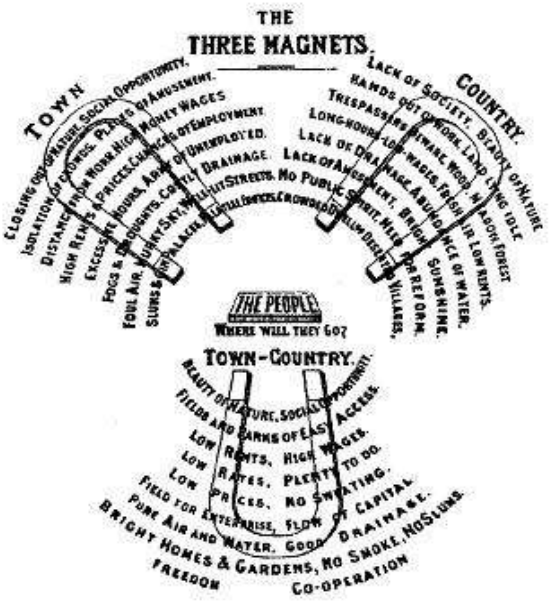

Figure 2.2: The three magnets of Ebenezer
Howard's 'Garden City' concept
(Sources: Howard, 1946)

The garden city as envisaged by Howard could also provide everyone with a healthy environment and beautiful surroundings in which to work, raise families, socialise and fulfil the responsibilities of citizenship. His basic idea contemplated new towns of some 32,000 people living on 1,000 acres of land and surrounded by a much larger area of 5,000 acres of permanent green belt (Figure 2.3). The city would incorporate much urban green space within it: in Howard's own diagram illustrating his ideas this would mainly be in rings around the centre which would be traversed by highways radiating from the town centre to connectthe city with neighbouring garden cities. This design would thus include concentric belts with major roads, parks and housing with gardensall rippling out from the town centre with a circular railway and canal circumventing the town periphery and also leading off to provide transport to the neighbouring sister settlements. Howard, however, did note that his concentric ring design was only intended as a diagram illustrating just one way his basic vision could be implemented; the actual design would depend on the site and the designer.

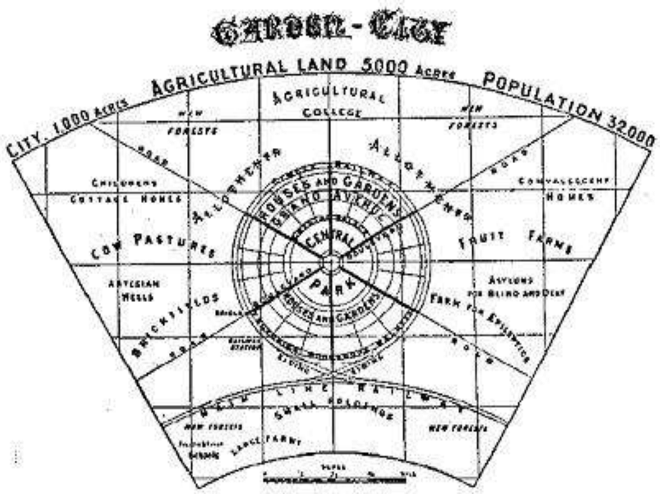

Figure 2.3: ‘Garden City’ by Ebenezer Howard
(Sources: Howard, 1946)

In two places in England towns more or less implementing the essence of Howard’s ideas on physical design were built, namely Letchworth (1908) and Welwyn Garden City (1924), though these probably went less far in putting into practice his innovative social ideas. However, in considering the influence of ideas related to the ‘Garden City’ on urban design, particularly as it affects urban green spaces, it is impossible to separate Howard’s contribution from that of Raymond Unwin, who designed Letchworth (Hall, 2002). Among various influences, Unwin was attracted to the irregular, organic street patterns of medieval towns, particularly in Germany, and he also seems to have found the village greens at the centre of many villages in the North of England very appealing in aesthetic and social terms. Thus his design for Letchworth avoided straight streets and used many terraces and other winding street paths following the topography. He also provided fairly ubiquitous areas of grass which ranged in size and shape from local patches, akin to small village greens, to sizable parks and playing fields to serve wider districts of Letchworth or the town as a whole.

The latter idea of providing green areas of different sizes in a kind of hierarchy was taken a step further in many of the British New Towns built after World War Two, whose physical designs incorporated many of Howard’s and Unwin’s ideas but also drew on the ideas of two Americans, Clarence Perry and Clarence Stein (Hall, 2002). Following the ’neighbourhood’ concept formulated by Perry, these New Towns were often composed of a number of discrete neighbourhood units of 5-10,000 people, focused on a centre with a secondary school(with ample playing fields around it), a community centre and churches etc. The layout of roads and footpaths within the neighbourhood could then be designed to ensure that children of primary school age could walk to school along footpaths, often through green landscaped areas, without crossing roads with motor traffic; the latter principle was the essence of Stein's concept of what became known as the 'Radburn Layout'. The use of the latter two concepts in New Towns built in UK and other countries (including Malaysia) after 1945 meant there was often a discernible hierarchy of green spaces from small local areas of grass to parks, playing fields and/or school sports fields serving the neighbourhood with possibly a larger park and area of playing fields to serve the town or region as a whole (sometimes with 'green routes' connecting many streets to primary schools, neighbourhood centres or parks).

Howard's holistic vision of a 'Garden City', Unwin's ideas and his practical designs, which are still often praised, plus the various ideas in urban design implemented in the British New Towns have attracted worldwide attention, clearly exerting a diverse range of influences on the thinking, practices and education of urban planners, urban designers, landscape architects and others (including politicians) in many parts of the globe during much of the 20^{th} century, not least in Malaysia (Ju, Zaki and Choi, 2009). In the latter case this influence may reflect not only the obvious role of British colonial administrators and planners before the country's independence in 1957 (Shamsudin, 2005) but also the fact that many Malaysians workingin the above professions in Malaysia today had all or part of their education in UK or were partly taught by British academics working in Malaysian universities before or after independence. It may also reflect the fact that some Malaysians have found these ideas sufficiently interesting, stimulating and even congenial within the local cultural context to engage with them and adapt or transform them to suit Malaysia's conditions, including its tropical climate.

From the range of ideas associated with the whole 'Garden City' vision or derived from it, those ideas which have had some relevance to the role of green spaces in cities or have had some influence on how they should be (or actually are) provided can be grouped broadly into the following:

(a) the idea of building a new, planned city of a limited size in a rural setting, possibly within a green belt (including perhaps some protected forest areas) to constrain its growth, and designing it internally with good provision of gardens, parks and other green spaces as part of the overall aim of achieving a good quality of life;

(b) the idea of designing any urban neighbourhood or district with moderately low density (mostly low rise or medium rise housing), allowing many residents to have gardens and allowing reasonably generous provision of public green spaces of various kinds and sizes, often (but not necessarily) in an informal layout or street plan;

(c) the ideas related to urban layout and design involving the neighbourhood and Radburn concepts such as a hierarchy, even an informal one, of green spaces for functional, aesthetic and social reasons and of using some of these green spaces to allow some local journeys to services to be made on foot or by cycle on paths partly traversing green areas i.e. designing some green corridors or links between land uses of various kinds;

(d) more broadly, the idea or general principle of trying to improve the quality of urban life by finding ways to protect, enhance or extend the city's green areas(i.e. seeing Howard's vision and the associated ideas as an early, but impressively holistic, approach to 'greening' the city);

(e) even more generally, the idea of using the preceding concepts as a stimulus or inspiration to devise fresh or innovative ways of integrating green areas with the urban built environment, as Howard and Unwin did in their own eras, but possibly in quite different ways from theirs.

Hampstead Garden Suburb, originally designed by Unwin on the outskirts of London in the 1920s and a section of Żoliborz, a suburb of Warsaw from the same period, can be seen as examples of (b). Indeed, the example in Żoliborz helps to illustrate how widely and quickly Howard's and Unwin's ideas spread. Together, these examples indicate that areas now well within large cities may have been influenced in their overall design and provision of green spaces by some of the ideas associated with garden cities.

The influence of some of the preceding ideas from British planning on Malaysia can be seen quite conspicuously in a number of towns within the conurbation centred on Kuala Lumpur. The construction of the New Town of Petaling Jaya (PJ), some 11 km south west of the centre of K.L. and still somewhat separated from it by a discontinuous belt of green spaces, started in 1953. It was planned as a satellite town for KL for some 70,000 people and was originally intended partly to encourage industrial development which would employ population resettled from squatter settlements in K.L. Much of its design was based on the neighbourhood unit (called 'seksyen') with each of these centred on a school and demarcated by major roads, sometimes fringed with trees (Ju, Zaki and Choi, 2009). Today with many of its earlier sections still composed of one and two storey family houses with garden space around them and with its green spaces and water bodies of varying sizes, PJ still has some of the feel of a Garden City or New Town. It has, however, grown to an estimated population of around 700,000 permanent residents in 2010 and many high rise commercial buildings and a number of tall blocks of flats have replacedthe original low rise structures in some sections in recent decades, particularly around the centre, somewhat to the detriment of the original green character of these areas.Thus, being initially designed comprehensively as a kind of Garden City is no guarantee of permanent protection to its green spaces for a city which was well greened from its inception, once pressures to intensify its land use become very powerful. However, so far much of PJ seems to have kept its 'green character' quite well.

Shah Alam, some 25 km south west of the centre of K.L., was also planned, perhaps even more systematically, along Garden City lines, starting in 1963, as a new capital for the state of Selangor (Ju, Zaki and Choi, 2009). Having maintained its reputation for good planning and design with relatively little high rise or high density development and still considered to have been relatively successful in protecting its green areas, Shah Alam can be seen as a fairly successful mixture of (a) and (b) with elements of (c) above (personal communication from Mohamed Nazari Jaafar, Managing Director of Spatialworks, based in Petaling Jaya, and a resident of Shah Alam).

More recently, a new Federal capital to house the government and its ministries has been constructed from 1995 onwards at Putrajaya, 25 km south of the centre of Kuala Lumpur, to be an 'intelligent garden city', centred around a newly created lake (Yamamoto, 2009). A recent study of it states that with its design and layout Putrajaya "unabashedly boasts of its Garden City influences" (Calvin, 2010). Indeed, the government and other public buildings in the centre and the ornamental elements of the landscape nearbyhave been constructed on such an impressively elegant and grand scale that advocates of traditional Garden Cities might be taken a back or even rather disconcerted! It is, nevertheless, clear that ideas associated with the Garden City concept have had a pervasive influence on Malaysian urban planning in the second half of the 20th century and still exert a significant attraction in the thinking of some Malaysian planners.

In fact, such influence has quite a long history. Charles C. Reade, one of Howard's associates, an advocate of the Garden City idea and a pioneer of the early town planning movement associated with it, worked in Malaya from 1921 to 1929, acting as an advisor on town planning to the colonial administration and being involved in establishing the first town planning department in Kuala Lumpur in 1921 (Shamsudin, 2005). In planning the first new town of the British administration in Malaya (albeit on a fairly small scale) at Kuala Kubu Baru, some 40 kilometers north of Kuala Lumpur and completed about 1928, Shamsudin notes that he used Garden City principles, but adapted them to a Malaysian setting. He was also involved in planning a residential area for factory workers about 3 kilometers south east of the centre of Kuala Lumpur near Chan Sow Lin where he again used some of the ideas of Garden Cities on design and layout.

The preceding examples can therefore be taken as evidence of the interest shown by Malaysian planners in general and particularly those working in the Kuala Lumpur conurbation in Howard's ideas over 6 or even 8 decades. The Malaysian government now has great concerns about counter-balancing the rapid urban development of the country with programmes for the development of parks, campaigns for tree planting and efforts to protect forest reserves and other natural environments within the city. The various initiatives and policies behind these activities over the last two decades or so have been given such labels as 'KL as a Garden City', 'Malaysia as a Garden Nation', 'KL as a Tropical Garden City' and 'Malaysia as a Most Beautiful Garden Nation'. It is at least possible that these concerns and the resulting initiatives have been partly stimulated by the awareness evident among Malaysian planners of the Garden Cities and New Towns as possible models or ideals for cities, not least for the greening of cities, and by the quality of urban landscape provided by some of Kuala Lumpur's satellite towns which embody these design principles. If so, these greening initiatives and activities can perhaps be seen as potential examples of Howard's and Unwin's ideas providing a broad direction or possibly an indirect influence or stimulus i.e. as examples of the kinds of influence noted earlier in (d) and (e). It can be argued, nevertheless, that the basic ideas associated with the concept of a Garden City have little practical relevance to the problems involved in trying to green already built up areas, especially areas so densely built up as the central parts of KL. Yet even in such areas, the latter ideas and their derivative concepts may still provide a stimulus and motivation for greening projects as a way for KL to try to match its greener neighbours with its own vision of KL as a kind of ‘Garden City’ or at least one engaged in greening (or ‘regreening’) itself. Further discussion of how Malaysia’s ‘Garden Nation’ concept has been implemented and of how the concept of a ‘Tropical Garden City’ has been applied to Kuala Lumpur (especially drawing on the work and views of Justice, 1984, Webb, 1998, and, latterly, Sreetheran, 2010) will be presented in the next chapter, which focuses mainly on Kuala Lumpur itself (Sections 3.1.3 and 3.2.2 of Chapter 3). The degree to which planning professionals see the latter two local initiatives as related to the concepts associated with the Garden City will also be explored later (in Chapter 4) throughthe relevant section of the results from the questionnaire survey of some of KL’s professionals involved in planning and landscape architecture (Section 4.2).

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2.4 Views and Visions Regarding the Ideal or Potential Roles and Desirable Characteristics of Urban Green Spaces

The existence of urban green space provides many opportunities and benefits to people or, indeed, to many living creatures. An obvious example is how these green spaces can provide opportunities for activities such as jogging and walking, which can yield benefits such as improved mental and physical health. Thus, having discussed the general definition and historical development of urban green spaces and having discussed the Garden City model as one way of integrating green spaces into the whole landscape and layout of a city, it is now essential to consider more closely what the basic characteristics and benefits of urban green space really are and what their roles are or should ideally be.

A review of the literature uncovers many different characteristics, almost all desirable, and a range of roles of urban green space, virtually all positive, which have been recognised and discussed extensively. This leads naturally to the question “what makes a ‘high quality’ green space?”, a question which has been answered in different ways and which will be the focus of the present section. The literature also includes a considerable amount of research which actually gives empirical evidence of the beneficial effects that particular green spaces can have and how strong these effects can be; this will be the main concern of several subsequent sections of the present chapter. In addition, some publications discuss how the properties and beneficial effects of a specific green space may be translated into a measure of its overall ‘character’ or ‘general quality’, which will be explored in Chapter 6. How the specific features or facilities of a green space may benefit particular user groups and/or be of general benefit to the urban environment as a whole and to its eco-systems will also has receive some consideration here.

To answer the question of what makes a good quality green space, Greenspace Scotland (2004) defines it as a place that is fit for its purpose and lists the following four criteria as highly desirable if a particular green space is to fulfil that purpose:

- *“it is in the right place and easily accessible;*
- *it is safe, inclusive and welcoming;*
- *it is well maintained and actively managed;*
- *above all, it meets the current local needs and is flexible enough to continue to meet these needs in future”.*

While these criteria seem very valuable as broad principles, it may be fair to point out that, of themselves, they provide little concrete guidance as to what actually makes green space welcoming and inclusive or as to how planners can assess what makes for a good location. Greenspace Scotland (2008) goes on to suggest that a spatial mosaic of high quality green spaces is required throughout a city, in order to meet the needs for green spaces at different spatial levels. This includes the “*local (e.g. providing play amenity space for local communities); regional (e.g. offering a connected network of spaces, that provide corridors of movement); and in a few cases, national (e.g. contributing to biodiversity and mitigating the impacts of climate change)”*. This accord well with the ideas of Unwin and Stein discussed in the previous section and may even have been influenced by them directly or indirectly. Although the four preceding criteria for a high quality green space proposed by Greenspace Scotland are of some utility at a very general level, it can be argued that the qualities particularly required at the local level focus more on the social and amenity benefits that urban green spaces can offer to the surrounding community whichis likely to usethem. At the regional or national scales, the benefits of green spaces for the maintenance of biodiversity and for limiting harmful environmental changemay assume more significance.

Taking an even wider perspective, several studies by individuals or by other organisations broadly outlining the desirable qualities of urban green spaces have included not only their social and environmental aspects but also their economic advantages. Thus, according to Beer et al. (2001), high quality green spaces are places that have multi-functional characteristics. Despite this, Beer and co-authors claim that most green spaces for cities are still being planned mainly on aesthetic and cost considerations alone. Beer et al. (2001) therefore go on topropose that high quality green spaces should be seen as multi-functional places that should be designed to achieve a wide range of goals including:

- *"support the recreational, experiential and health requirements of the local people, as well as visitors;*
- *contribute to the way they encourage people to spend leisure time locally by reducing vehicles usage;*
- *allow urban dwellers the opportunity of being in places experienced as relatively quiet and 'different' from the city streets;*
- *foster a feeling of community pride in a local area;*
- *support the development and maintenance of biodiversity in urban areas;*
- *support the local management of water flows and quantity;*
- *allow local composting of biodegradable waste;*
- *contribute to cleaning particulates out of the air, through their trees and shrub cover;*
- *help reduce the urban 'heat island' effect;*
- *increase the economic attractiveness of a city".*

This list offers more of a balance between the environmental benefits that urban green spaces may or should provide to the city in general and those seen as likely to be enjoyed mainly by nearby residents. On a critical note, however, Beer and co-authors do not provide enough detailed or convincing evidence that green spaces are actually able to carry out all these proposed roles effectively. While evidence for the actual benefits provided by green spaces will be discussed in the sections which follow, it is relevant to note here that there is evidence for most of the benefits implied by the above list. However, little evidence has been found in the literature for the second function i.e. reducing vehicle usage, though it may happen. In setting out potential roles, it would be helpful if authors and institutions noted which were grounded in evidence and which were more speculative.

Brocke further extends this discussion of multi-functionality, linking the potential roles of green spaces directly to the sustainable city concept. According to Borcke (2009), quality green spaces are places that should be sustainable in every sense of the word i.e. ecologically, socially and economically:

- *"ecologically – affecting positively micro-climate, creating wildlife habitats;*
- *socially – making places more likeable, hence increasing the sense of ownership, counteracting urban stress and improving quality of life for urban populations;*
- *economically – enhancing property values because of a better quality of life in the local area".*

CABE Space (an organisation that works with national, regional and local bodies to deliver well-designed and managed public spaces across England) in several of their research projects and publications (2005a, 2005b, 2006) have also expressed a belief in high quality green spaces which ought to have multi-functional characteristics. They explain the benefits that green spaces may provide to a city through a series of potential relationships:

- *"increased house prices;*
- *an improved image of an area and attracting investment;*
- *their contribution to biodiversity;*
- *their contribution to promoting exercise and the benefits to health;*
- *the role of public space design and management in tackling social issues such as risk and anti-social behaviour".*

In a similar vein the final report of the Urban Green Spaces Taskforce produced by the Department of Transport, Local Government and the Regions (DTLR, 2002) emphasised that green spaces of good quality have been shown to:

- *"support the local economy by making neighbourhoods more desirable;*
- *enhance physical and mental health;*
- *benefit children and young people;*
- *reduce crime and fear of crime;*

- *support social cohesion;*
- *aid movement between other spaces;*
- *protect biodiversity and enhance the environment".*

It is worth noting here that the latter report shows a commendable interest in empirical evidence of the actual benefits of urban green spaces, which sometimes seems to receive insufficient attention in some of the foregoing documents.

The wide range of potential advantages just described can provide the basis for a multi-functional evaluation of these spaces. An appreciation of these different possible benefits of green spaces is particularly important in situations where the value of an urban green space is being assessed, especially in the face of pressures for its development. Hence local Authorities in the UK and elsewhere are being encouraged to maintain and monitor the quality of green spaces in cities more rigorously than before. In England and Wales, a non-governmental organisation initiated an award named the Green Flag Award to assess and recognise existing urban green spaces which could be seen as of high quality. This award is designed to recognise the quality of individual sites (not the quality of service delivery as a whole) and to emphasise the importance of several criteria that are felt should be met by any individual site in order to receive the award. Similarly, a practical tool called Spaceshaper by CABE Space was introduced to enable planners and Local Authorities in England to assess the quality of green space. This practical tool (which uses a questionnaire and involves organising a workshop) can be employed to assess a particular green space on several criteria before planning for modifications or a redesign to improve the space concerned.

Although the introduction of these tools and awards signifies an increased recognition by both the public and local authorities of the need to evaluate and monitor urban green spaces, the tools involved presently only take account of certain attributes of green spaces and do not cover the whole range of social, environmental, economic and health and well-being criteria that could or should be used. Hence, there still remains a challenge to professionals and researchers to devise and develop a framework or method for fully assessing the potentially numerous and diverse benefits of any particular green space. According to a survey of existing research on urban green spaces by Bell et al. (2008), this constitutes a significant gap in the research literature and more work is needed to create and test appropriate methods to help planners and landscape architects to assess the varied advantages (and disadvantages) of urban green spaces as comprehensively as possible.

2.5 Actual Roles and Benefits of Urban Green Spaces

It is worth emphasising at this point that the publications just discussed from various institutions and authors tend to be more concerned with what roles their authors think green spaces, often public parks, ought to perform i.e. they tend to emphasise somewhat their potential or ideal roles. In setting out what can be seen as essentially their visions for urban green space, some of the authors seem to pay inadequate attention to empirical evidence of the actual benefits to users or to the general urban environment of urban green spaces and a few even seem to show insufficient interest in such evidence, which can be seen as a weakness underlying the assertions made in some instances about the roles desired for green spaces. Thus, reliable data or other convincing evidence about what benefits urban green spaces do actually generate in various contexts is clearly essential, if the possible or potential roles of urban green spaces are to be discussed and debated in a meaningful and realistic manner. Otherwise goals may be assumed or set for green spaces which are inappropriate or difficult to adequately attain or over ambitious for a particular context.

The principle concern of the following sections will therefore be with literature trying to actually measure what the real benefits of urban green spaces are and how strong they appear to be. Nevertheless, in doing so it is worth noting at the outset that a number of significant benefits may be rather intangible and therefore difficult to assess empirically. Also, since resources available for research are always limited, as Bell et al. (2007) note in a very extensive and impressively comprehensive survey of research published in English on green and public urban space (also including some unpublished work), some potentially significant benefits have been relatively neglected, particularly many aspects of health and well-being, simply because the priorities of bodies funding research probably lay elsewhere.

2.6 Environmental Benefits

Green space can provide many environmental benefits to urban areas, a claim generally well supported by much evidence from the researchliterature. In fact, in reviewing priorities for research on green and public urban space Bell et al. (2007) note in a very thorough survey of research published in English that the impact of green and open spaces on environmental quality and biodiversity has been a very fruitful topic for research and constitute one of the better understood benefits. Nevertheless, even in this area there are some significant gaps in knowledge e.g. on the possible effects of climate change. The present section will explore the most salient of these benefits arranged into several sub-themes.

2.6.1 Air Quality and Mitigation of Pollution

Several studies have provided evidence that urban vegetation can purify both the air and water as well as reducing noise (Conway, 2000; Woudstra and Fieldhouse, 2000; Ong, 2003; and Chiesura, 2004). According to Haq (2011), a study done by Bolund and Sven (1999) in Stockholm, Sweden, pointed out that vegetation helps to reduce air pollution, though the amount of this reduction depends on the location of the area. In the same study, Bolund and Sven (1999) claimed that vegetation is much better in filtering the air compared to water or open space and can also contribute to the mitigation of the urban heat island effect, which Haq (2011) notes can increase air temperatures in the city by as much as 5°C. Haq also notes that on average 85% of air pollution in a park can be filtered by its vegetation.

Furthermore, studies by Von Stulpnagel et al. (1990), Flores et al. (1998), NurAshiha (1998), Jo (2002) and Conine et al. (2004) have also confirmed that the pollutants in urban air can be significantly reduced through the provision of natural features, particularly trees, which not only absorb pollutants, but also moderate the extremes of urban climate and encourage airflow. Moreover, a study involving a modelling experiment was conducted in the United States (US) by Nowak et al. (2006) which claimed to show that urban trees throughout 55 cities in US managed to reduce annual pollutants by 711,000 tonnes, valued at US$3.8 billion. The latter study went on to suggest that urban trees are very effective in reducing air pollutants and improving the general quality of air and hence argued that more trees should be planted in cities of the USA to reduce the level of pollutants. Recognition of this positive effect of trees in reducing airborne pollutants and improving air quality is also particularly relevant to cities in developing countries because their rapid growth and development and increasing use of motor vehicles can cause serious deterioration in air quality. Hence maintaining existing green spaces can have positive benefits to the atmosphere.

2.6.2 Microclimate Modification

Some research also suggests that urban green spaces make a substantial contribution to stabilising the microclimate and moderating the extremes of urban climate. A number of studies have suggested that the vegetation in green spaces plays an important role through its cooling effect as it provides shade and thus reduces heat from solar radiation (Johnston and Newton, 1993; Flores et al., 1998; Papadakis et al., 2001; Gomez-Munoz et al., 2010; and Georgi and Zafiriadis, 2000). According to Akbari (2001) shade from trees provides a significant benefit by lowering air temperature. He estimated that, over the life of a tree, the savings associated with these benefits, which vary by climate region, can be up to US$200 per tree (Akbari, 2001). Akbari also claimed that urban greening can reduce the national demand for cooling (i.e. mainly by air conditioning) by up to 20 percentin some instances in US cities.

Takebayashi and Moriyama (2007), who ran in situ measurements of heating on green surfaces in Kobe, Japan, have claimed that the surface temperatures were lower on green surfaces in comparison to concrete slabs. Similarly, a recent experimental study in nine cities in different climatic zones (Athens, Hong Kong, London, Montreal, Moscow, Riyadh, Mumbai, Beijing and Brasilia) by Alexandri and Jones (2008) claimed that both the air and surface temperatures are significantly lower in all the climates involved when walls and roofs are covered with vegetation. They added that outdoor thermal comfort can be improved by covering the roofs and walls with vegetation and, if applied to the whole city, this can mitigate the intrinsically higher urban temperatures and might be able to save between 32 per cent and 100 per cent of the energy used for cooling the buildings, depending on the climatic region concerned (Alexandri and Jones, 2008). A similar study in Athens, Georgia, on green roofs using cost-benefit analysis strongly supports the preceding findings (Carter and Keeler, 2008).

Another interesting study in this context is from the Czech Republic which looked at the dissipation of solar energy and its modification by management of water and vegetation (Pokorny, 2001). This study claimed that a single tree can be considered to be a ‘perfect air conditioner’ and that having green spaces with lush vegetation might significantly decrease urban temperatures. These findings further confirm the significant contribution urban green spaces can make in moderating the micro-climate of a particular city, which is particularly relevant to cities in tropical countries where extremely high temperatures cause discomfort to residents and increase demand for air conditioning, which may further increase the temperature outside the buildings employing it.

2.6.3 Biodiversity

According to Balmford et al. (2001) a possible 50 percent or more of all species could be at risk due to urbanisation because urbanisation significantly reduces the extent of natural habitat. Balmfordet al. would seem to be making a rather large claim, even if it were to be applied to a very urbanised country like UK because only around 6% of the surface of UK is actually covered by urban areas, according to a recent study by the Centre for Ecology and Hydrology (Daily Mail, July 7th 2011). Balmford's claim may be more tenable, nevertheless, in the context of Sub-Saharan Africa which he is concerned with, if the ecological impact of urban areas and their growing populations extends well beyond the built up areas. As biodiversity is thought to play a critical role in long term sustainability, preventing a potentially drastic decrease in biodiversity needs to be given some priority. Promoting urban biodiversity through protecting and conserving urban green spaces therefore seems a desirable option.

Neimela (1999), Attwell (2000), Beer (2001) Jorgensen et al. (2002), Gaston et al. (2005), Smith et al. (2005) and Barbosa et al. (2007) have all claimed that urban green space performs an important role in conserving wildlife habitats, ecological value and biodiversity in cities. According to the Institute of Leisure and Amenity Management (ILAM,1995), public green spaces help to conserve natural eco-systems and their associated species within the urban environment and provide contrasting habitats to those designed to conserve wildlife within fairly natural, 'wild' surroundings in or near urban settlements (and probably to the habitats created by the built environment itself and the species found within it or dependent on it). Alvey (2006) states that trees are one of the main types of habitat for many faunal species. Thus, there is a need for the number and variety of trees to be maintained for the sake of the survival of many species in the urban environment. Not surprisingly, however, according to Sandstrom et al. (2006), there tends to be a decrease in the number of habitats when moving from the surrounding region to locations within an urban area due to the decreasing amount and variety of vegetation, so it may be difficult for cities to provide the diversity of niches found in surrounding more rural areas.

Alvey's views are broadly supported in a study by Mortberg and Wallentinus (2000) which surveyed land cover and bird biodiversity at 28 sites within Greater Stockholm, Sweden and claimed that conserving large areas of natural vegetation together with a network of green spacesis very important in sustaining the variety of habitats needed to preserve biodiversity. Not only that, a study of urban parks by Cornelis and Hermy (2004) in Flanders, North Belgium even reported that urban parks may be considered as important 'hotspots' for biodiversity in cities. Preserving these parks can therefore be seen as essential to conserve natural biodiversity in cities.

It is also interesting in this context to consider a study by Hodgkison et al. (2007) who surveyed birds, reptiles, mammals, amphibian biodiversity and habitat characteristics on 20 suburban golf courses in South East Queensland, Australia. Their results led the authors to claim that golf courses could also perform a positive role in conserving wildlife in an urban landscape which had been degraded (it could be added here that converting the bare or derelict land left by tin mining in Kuala Lumpur to golf courses or other green recreational spaces could be an example of this). Similarly, Tanner and Gange (2005) suggested that golf courses do provide a refuge for animals in the urban environment, even though the 'urban savannah' landscape of golf courses (Teh, 1989) may not provide the ideal diversity of habitats needed to fully foster urban biodiversity. They claimed, nevertheless, that preserving golf courses in an urban environment will not only benefit the human population but also the populations of flora and fauna.

2.6.4 Hydrological Benefits

Urban green spaces, especially with turf and grass, are generally believed to moderate the flow of surface run-off by water which can cause erosion. Thus various studies have also claimed that such green spaces can be used to help control storm water run-off in cities and thereby possibly reduce the risk of flooding (Beard and Green, 1994; Roy et al., 2000). Moreover, a study done by Shepherd (2006) in Ohio, US, claimed that trees can also modify the way water moves through urban catchments; 22 percent increases in canopy cover of vegetation were found to reduce run-off by seven percent (Shepherd, 2006). Therefore, the value of urban green spaces in preventing erosion and mitigating flooding cannot be overlooked. Obviously, this may be especially important in cities of tropical countries which can experience heavy rain fall and in developing countries generally where flash floods in cities can be a serious hazard.

2.7 Social Role

Not surprisingly, many studies of green spaces are concerned with their social functions; obviously, spaces such as parks and gardens have long played an important role in the social aspect of peoples' lives (Nicol and Blake, 2000; Wooley, 2003). However, it is helpful to identify the actual range of positive social effects involved and examine them in some detail under several sub-themes.

2.7.1 Social Interaction and Integration

In research carried out for CABE Space (2004), one of the benefits of high quality parks was found to be its potential as a venue for social interaction and integration. According to Hutchinson (1987), More (1988) and Loukaitou-Sideries (1995), green space provides a neutral meeting ground for all members of society and can become a focus of community spirit through the many and varied opportunities provided for social interaction. It can also, according to Germann-Chiari et al. (2004) and Martin et al. (2004), offer broader social benefits as a meeting place that gives a shared focus to diverse communities and neighbourhoods. At the same time, according to Swanwick et al. (2002), green space contributes significantly to social inclusion due to the fact that it is free and accessible to all.

Green spaces that are open to all, regardless of ethnic origin, age or gender; they can bring communities together; and they may provide meeting places and foster social ties of a kind that have been disappearing in many urban areas (Wooley and Rose, 2004). Such spaces can help to reduce inequalities and social exclusion, especially in deprived areas, and may reduce any inherent tension between diverse social and ethnic groups (ILAM, 1995; Conway, 2000). Green spaces also provide places for strangers to meet, as well as public places where one can transcend the crowd and be anonymous or alone, if one wishes to (Thompson, 2002). At the same time, according to Kaplan (1983), green space also enhances contemplativeness and provides a sense of peacefulness and tranquillity. It can also, according to Kuo et al. (1998), help people to relax and restore themselves as well as help to reduce feelings of aggression.

An interesting finding of a recent Australian study suggested that green space in a city not only improves the general quality of urban environment but also increases the level of social connectedness and trust through interaction with others in a particular local community (Townsend et al. 2006). Similarly, according to Sullivan et al. (2004), the presence of trees and grass created more opportunities for informal social interaction. The latter study, based on observations in 59 common outdoor spaces, also discovered that residents closer to green spaces enjoyed more social activities, knew more of their neighbours and had a stronger sense of belonging compared to residents living next to what were seen as 'barren' spaces.

Several studies of the social benefits of green spaces have also suggested that community involvement in green spaces is linked to an increase in 'social capital'. This is because communities that work together, for instance through involvement in community parks or through creating a community garden, may well know one another better and hence may help and 'look out for' each other. According to Sherer (2004), social capital leads to concrete improvements in the community such as "*fewer incidents of violent crime, fewer property crimes including graffiti, reduced juvenile delinquency, higher educational achievement, lower rates of asthma and teenage pregnancy and better response to the community's needs by central governments because they stand on a united front*". Similarly, a project on Human Development in Chicago neighbourhoods found that in neighbourhoods where social capital is strong, rates of violence are low, regardless of socio-demographic status and amount of disorder (Townsend et al. 2006). The preceding studies clearly suggest that the presence of green spaces in urban neighbourhoods can improve their quality of life, particularly social life, and can provide opportunities for more social networking, better social cohesion and a stronger sense of community identity.

2.7.2 Physical and Recreational Activities

As well as being venues for social interaction and community activities, studies have also shown that green spaces serve as providers of passive and active recreation and so help to meet the leisure needs of a community (Mahesan, 1993; Reeves, 2000; Thompson, 2002; and Grose, 2009) through furnishing places for play, sport, recreation, special events and other leisure activities. From research carried out by CABE Space (2004), green spaces alsoprovide spaces for activities for all age groups as well as offering opportunities for children to have fun, exercise and learn.

According to Williams (1995), most city dwellers prefer to have their recreational facilities and needs within their home locality. In fact, for green spaces to be seen as accessible to residents in a neighbourhood, studies by Harrison et al. (1995) have suggested that the minimum distance is 280 metres. In 1996 English Nature (a statutory body that champions the conservation and enhancement of the wildlife and natural features of England) published what they termed their model for Accessible Natural Greenspace Standards (ANGSt) in which they asserted that"*no person should live more than 300 meters (approximately five minutes walking distance) from their nearest area of natural green spaces of at least two hectares in size"* (Harrison et. al, 1996). Hence, maintaining access to urban green spaces seems to be critically important as a meansof increasing physical activity. In the view of Isenberg et al. (2002), access to the environment has the potential to encourage a more physically active lifestyle and can result in gains in fitness and greater participation in vigorous activities.

2.7.3 Perception of Safety in Green Spaces

In a study by Sampson et al. (2001) involving 98 apartment buildings in Chicago, USA, for over two years, it was discovered that apartment buildings surrounded by trees and greenery were significantly safer. Their study claimed that a higher level of greenery tends to reduce total crime by 52 percent and suggested that might be because greenery helps to reduce feelings of aggression. Thus people feel more relaxed in a greener environment and, in addition, their involvement in outdoor activities will increase surveillance and thereby indicate that the apartment building is cared for by its residents, who watch over it and each other (Sampson et al. 2001).

A related study by Kuo et al. (1998) also suggested that the greener the space in a neighbourhood the better. However, this latter study also claimed that the tree composition or vegetation arrangement was important in order not to block views users had of areas they might consider unsafe. Similarly, according to Jorgensen et al. (2002), tall trees and open, grassy areas with low shrubs and flowers that preserve visibility are recommended as potential crime deterrents. Conversely, criminals can use dense vegetation such as shrubs to conceal their activities and to block visibility, which can evoke fear (Jorgensen et al., 2002). As a kind of corollary, Herzog and Chernick (2000) argue that maintenance of a particular green space can also be important in providing residents and/or users with a sense of safety in such places.

2.7.4 Cultural Values

In an extensive review of the roles of open space in democratic, pluralistic, multi-cultural and diverse society, Ward Thompson (2002) emphasises that, among other functions green spaces in cities have potential as places to celebrate cultural diversity, to engage with natural processes and to conserve memories. Partly in consequence of this, she also sees these spaces as providing places where historic, cultural and traditional events can be organised and celebrated. In a somewhat similar vein, Jordan (2002) sees green spaces as vital community assets which can offer a series of hidden narratives of the cultural and historical aspects of a place.

Exploring related aspects of their cultural and psychological roles, a number of studies have suggested that green spaces can improve both the city's identity and image. Thus McInroy (2000) views urban green spaces as a crucial facet of a city's identity and as thereby fulfilling an important functional role in city life. Hence, as Woodstra and Fieldhouse (2000) have noted, urban green spaces can also contribute to a citizen's sense of place and hence encourage civic pride. In essence, Morgan (1996) also gives support to the validity of this perspective, by drawing attention to the way urban green spaces can provide the central image of a city: "*The architectural and aesthetic form of towns is shaped by well-planned green spaces, and this environmental function is supportive of economic objectives and activities"*(Morgan, 1996). Examples of green spaces which seem to play a strong role in shaping the city's image could include Central Park in New York and perhaps also Princes Street Gardens and the Meadows in Edinburgh.

2.8 Health and Well-Being Benefits

In the UK, there is a growing concern about people's health, particularly ofchildren. Research carried out for CABE Space (2004) has shown that 20 percent of four-years-old are obese, with 8.5 percent of those six years-old and 15 percent of those 15 years-old also obese. In Australia, according to the Australian Department of Health and Aging (2002), the incidence of overweight and obesity have almost doubled amongst Australian adults over the last two decades and it is claimed that Australia is now ranked as one of the fattest developed nations. This problem is normally linked to sedentary lifestyles and less involvement in outdoor activities. It therefore seems obvious that urban green space can help to improve their physical health by encouraging people to walk, play or simply enjoy the natural and green environment. Work by Woudstra and Fieldhouse (2000) affirms the positive role urban green space can play in fostering a healthier life style among urban dwellers.

Hull and Harvey (1989) noticed that people visit parks in order to experience an emotional quality that is unavailable in other environments. Numerous studies have also shown that natural environments have a positive influence on psychological and mental health, and some verification has been found for assumptions about their benefits in stress-reduction, induced feelings of control and reduced frustration and irritation (Ulrich, 1979; Ulrich, 1981; Kaplan, 1982; Burgess et al., 1988; Hull and Harvey, 1989; Neal, 1994; Kuo et al., 1998; Conway, 2000; Richardson et al., 2010).

In classic studies by Ulrich, connections were shown between health and vegetation (refer to Ulrich, 1979; Ulrich, 1981; and Ulrich, 1984). A further study by Ulrich also found that natural scenes promoted recovery from illness far quicker than scenes containing artificial features (Ulrich and Simons, 1996). This finding is further supported by Sherman et al. (2005) who suggested that feelings of emotional distress and pain are lower when one is in a garden compared with inside a hospital. Furthermore, Kaplan (1995) claimed thata natural landscape nearby, even when only viewed from a window, had a substantial beneficial effect in the work setting, affecting job satisfaction and well-being. Grahn et al. (1997) broadly concur, suggesting that day care centres with diverse vegetation may improve children's health and emotional well-being.

An interesting and extensive study in the Netherlands by De Vries et al. (2003) analysed the health information of 10,000 residents to determine whether there were any links between green spaces and health. The data from the study apparently allowed the authors to claim that in greener environments people report fewer health complaints and have better mental health. Another striking discovery of the preceding research is that when it comes to health, all kinds of greenery are equally effective; the benefits are the same whether one is living near an agricultural area, a forest or urban parks (De Vries et al.,2003).

2.9 Economic Benefits

Cheisura (2004) believes that urban green space provides economic benefits not only for municipalities as a whole but also for the individual urban residents. Research by CABE Space (2004) provides some ground for thinking that a high quality public environment can have significant impacts on the economic life of urban centres. Furthermore, the Institute of Leisure and Amenity Management (ILAM, 1995) and Reeves (2000) have both claimed that urban green space could help the economic revival of certain cities by increasing their attractiveness, improving their image as places for investment and creating positive publicity for business.

Numerous studies from the North America, Europe and Asia have shown that urban green space can add value to properties and increase their market value (Tagtow, 1990; Geoghegan et al., 1997; Tyrvainen, 1997; Luttik, 2000; Crompton, 2001; Morancho, 2003; Jim and Wendy, 2007; Kong et al,. 2007). Various kinds of methods such as hedonic price modelling and the contingent valuation method have been used in assessing the property values involved. A study by Cho et al. (2007) using hedonic valuation modelling to measure property values in Tennessee, USA, found that proximity to green spaces influencesa property'smarket value. Similarly, More et al. (1988) noted that house prices declined for each meter that a house was located away from a green space.

A fascinating study by Luther and Gruehn (2001) claimed to show that in the year 2000 in Berlin, proximity to playgrounds in residential areas increased land values by up to 16 percent. Green spacescan also, according to Bolitzer and Netusill (2000), have a statistically significant effect on the sale price of houses in close proximity. In China, Kong et al. (2007) have stated that properties in Jinan City with a higher percentage area of green space within a 300 metre radius have higher house values, with each percentage point of green space adding about 2.1 percent to the price per square metre.

As noted earlier, since urban green space may also improve the image of a city, these spaces may help to attract investment and businesses (More, 1988). At the same time, the presence of good quality green space can have a significant impact upon attracting employees and in turn may affect their productivity.

2.10 General Contribution of Green Spaces to Cities

Summarising the overall effect of many of the key benefits just examined, Morris (2003) simply stated that urban green spaces make a substantial contribution to the general quality of life in cities. Indeed, in England research carried out for CABE Space remarked that 85 percent of people surveyed felt that urban green space had a direct impact on their lives and the way they feel (CABE Space, 2004). In short, it can be readily seen that there is a positive contribution made by urban green space across a wide spectrum of social, environmental, and economic criteria (Adnan, 1998; Shafer, 1999; Attwell, 2000; Ismawi, 2000; Tyrvainen, 2001; Lutz and Bastian, 2002; Swanwick et al., 2002; Wooley, 2003; Laing et al., 2005; Li et al., 2005; Bell, 2007; Borcke, 2009; and James 2009).

An even broader summary prepared by The Council of Europe encapsulates quite vividly the integral role played by green spaces in urban life, emphasising that they are "*an essential part of the urban heritage, a strong element in the architectural and aesthetic form of a city".* This goes on to state that green space*"plays an important educational role, is ecologically significant, is important for social interaction and in fostering community development and is supportive of economic objectives and activities".* This summary then continues to the effect that *"in particular it helps reduce the inherent tension and conflict in deprived parts of urban areas of Europe; it has an important role in providing for the recreational and leisure needs of a community and has an economic value in that of environmental enhancement"* (Council of Europe, 1986). Similarly and rather more concisely, Collin (1994) reports that the Ontario Federation of Parks and Recreation identifies four categories of benefits for urban green spaces namely personal, social, economic and environmental.

Perhaps the most striking finding of the preceding survey is of the remarkably wide range of benefits identified which urban green spaces can confer on cities. It is also vital to know that the existence of some of these has been confirmed by fairly reliable empirical evidence and in some cases the strength of their positive effects has been estimated or even converted to monetary values in a few cases. None of this research was available in 1898 to Ebenezer Howard when he put forward a vision for cities which integrated green spaces and their many benefits into the urban landscape or to Raymond Unwin when he produced a practical design 5 years later for effectively greening Letchworth with accessible green areas of varying sizes throughout the town in the spirit of Howard's ideas. With some wisdom of hindsight we can now realise more lucidly how prescient these pioneers and their associates, including Charles Reade in Malaya, actually were.

2.11 Typologies of Green Space

Sections 2.5 to 2.9 have tried to identify the wide range of benefits which urban green spaces can confer and have tried to give a fairly comprehensive inventory and assessment of their positive effects. However, in order to contemplate all the possible benefits produced by green spaces in general or just by one particular green space, it is essential to first have some common understanding of which particular spaces in an urban area are actually to be included as green spaces. Indeed, because of the very wide range of possible benefits which diverse green spaces can generate, it is now of fundamental importance to become more aware of all the possible types of green spaces that may exist in cities and to be able to characterise or categorise them.

Various sources have been used for reference as bench marks in trying to establish a full inventory of possible types. However, there are some initial problems in gaining a clear picture of how many types of green space do actually exist in urban areas because of the inconsistency in categories used by different governments, local authorities and other organisations. Comprehensive and continually updated information on the quantity and condition of all green spaces is obviously very helpful in this context but is not generally readily available, even in developed countries (CABE Space, 2010), as noted in Chapter 1 and this constitutes a further difficulty. As an aside, it may be worth noting here that different types of urban green spaces are subject to different pressures as well as to different aspirations on the parts of particular managements or authorities. Hence different types of green space may be lost to encroaching development at different rates, which makes a holistic awareness of all possible types and up to date information on these all the more desirable, though near impossible to achieve.

From research on the management of urban green space in eleven different cities and countries (Melbourne, Australia; Curitiba, Brazil; Aarhus, Denmark; Paris, France; Hanover, Germany; Tokyo, Japan; Groningen, Netherlands; Wellington, New Zealand; Malmo, Sweden; Zurich, Switzerland and Minneapolis, US), CABE Space (2004) has reported that nearly all these cities use some kind of typology of green space in managing and planning and that these typologies are mostly based on the size and/or function of green spaces. In reality most of these typologies actually represent non-statutory, locally-derived categories inspired by the local context (CABE Space, 2004). For example, in Malmo and Tokyo the classificationof green space has a planning function through facilitating an even distribution of various types of green space across these cities. Similarly, in Curitiba, the green space classification was revised to better control development and to protect the existing green spaces more effectively. However, according to the report by CABE Space, some cities like Paris and Minneapolis do not have an officially designated hierarchy of green space for management purposes. Almost all urban green spaces in the latter cities are simply classified as parks and gardens (CABE Space, 2004).

In England, Bell et al. have recently (2007) set out a detailed typology devised originally by the Urban Green Spaces Task Force (Table 2.1). This typology was developed from discussions with all national and voluntary agencies involved in planning and managing urban parks and green spaces. In the Task Force's report, *Green Spaces, Better Places*, the UK government went on to suggest that this typology should be adopted and used byall local authorities in England (DTLR, 2002).

Type	Sub-sets of 'open space'	Suitability of this type or class for planning purposes and use in open space strategies	More detailed classification for open space audits and academic research purposes
Urban open spaces	Green spaces	Parks and gardens	Urban parks Country parks Formal gardens (including designed landscapes)
		Provision for children and teenagers	Play areas (including LAPs, LEAPs and NEAPs) Skateboard parks Outdoor basketball goals Hanging out areas (including teenage shelters)
		Amenity greenspace (most commonly, but not necessarily, in housing areas)	Informal recreation spaces Housing green spaces Domestic gardens Village greens Other incidental space
		Outdoor sports facilities (with natural or artificial surfaces)	Tennis courts Bowling greens Sport pitches (including artificial surfaces) Golf courses Athletics tracks School playing fields Other institutional playing fields Other outdoor sports areas
		Allotments, community gardens and urban farms	Allotments Community gardens City (urban) farms
		Cemeteries and churchyards	Churchyards Cemeteries
		Natural and semi-natural urban greenspaces, including woodland or urban forestry	Woodland (coniferous, deciduous, mixed) and scrub Grassland (e.g.downland, meadow) Heath or moor Wetlands (e.g. marsh, fen) Open and running water Wastelands (including disturbed ground) Bare rock habitats (e.g.cliffs, quarries, pits)
		Green corridors	River and canal banks Road and rail corridors Cycling routes within towns and cities Pedestrian paths within towns and cities Rights of way and permissive paths
	Civic space	Civic spaces	Sea fronts (including promenade) Civic squares (including plazas) Market squares Pedestrian streets Other hard surfaced pedestrian areas

Table 2.1: Typology of Urban Open and Green Space in England
(Source: DTLR, 2002)

Similarly, in Scotland the Development Department of the then Scottish Executive (redesignated as the Scottish Government in 2007) has developed its own typology of urban green space. According to Planning Advice Notes Number 65 (PAN 65), there are nine main types of urban green space in Scotland. The detailed structure of this typology is presented in Table 2.2.

Types	Description
Public parks and gardens	Areas of land normally enclosed, designed, constructed, managed and maintained as a public park or garden
Private gardens or grounds	Areas of land normally enclosed and associated with a house or institution and reserved for private use
Amenity greenspace	Landscaped areas providing visual amenity or separating different buildings or land uses for environmental, visual or safety reasons i.e. road verges or greenspace in business parks, and used for avariety of informal or social activities such as sunbathing, picnics or kickabouts
Playspace for children and teenagers	Areas providing safe and accessible opportunities for children's play usually linked to housing areas
Sports areas	Large and generally flat areas of grassland or specially designed surfaces, used primarily for designated sports i.e. playing fields, golf courses, tennis courts, bowling greens - areas which are generally bookable
Green corridors	Routes, including canals, river corridors and old railway lines, linking different areas within a town or city as part of a designated and managed network and used for walking, cycling or horse riding or linking towns and cities to their surrounding countryside or country parks. These may link green spaces together.
Natural/semi-natural greenspaces	Areas of undeveloped or previously developed land with residual natural habitats or which have been planted or colonised by vegetation and wildlife, including woodland and wetland areas.
Other functional greenspaces	Allotments, churchyards and cemeteries
Civic space	Squares, streets and waterfront promenades, predominantly of hard landscaping that provide a focus for pedestrian activity and make connections for people and for wildlife, where trees and plants are included.

Table 2.2: Types of green space in Scotland
(Source: Scottish Executive, 2003)

It can be observed that the two preceding tables (Tables 2.1 and 2.2) have several similarities in their hierarchies of green spaces for England and Scotland. However, there are also some interesting differences. Perhaps the most notable is that in Table 2.2 the main elements of the fifth and sixth categories of Table 2.1 (i.e. respectively 'Allotments' etc and 'Cemeteries and Churchyards' are grouped together in the Scottish classification scheme under the one broad heading of 'Other functional green spaces'. Conversely, the public and private green spaces grouped under 'Amenity green space' in Table 2.1 are separated into two different categories in Scotland's scheme. It is not clear why two similar hierarchies with only rather small differences are used in these neighbouring countries of the United Kingdom, but it is possible that the strong rivalry between the two nations may be a factor. Nevertheless, both hierarchies appear to be quite comprehensive and seem to cover most types of urban green space likely to exist in any particular city.

In contrast, much simpler typologies are used for their green spaces by some cities in developing countries, including Yogyakarta in Indonesia, Kuala Lumpur in Malaysia and Singapore. According to Indra (2008), public spaces in Yogyakarta, including a few broad types of green space, are characterised firstly by their shapes, as Table 2.3 indicates.

Types	Shape	Sub-types	Description
Public Space	Linear	Open	Commercial/Retail Street Vendor Commercial Social Space
	Square / Non-Linear	Open	Alun-Alun/Sport Field Recreation Park Town Park Parking Area Social Space
		Close	Modern Shopping Mall Traditional Market Hall Education Building Government's Building Entertainment Building Transportation Nodes Tourist Area

Table 2.3: Types of Green Space in Yogyakarta, Indonesia

(Source: Indra H, 2008)

Another rather simple typology is used generally in Malaysia, including for the city of Kuala Lumpur, in which these spaces are classified mainly by size. It is evident from Table 2.4 that the typology of green spaces in Kuala Lumpur only covers spaces that are meant for recreational purposes. Other types such as civic space (e. g. a town square, boulevard or waterfront), forest, cemeteries and agricultural land are apparently not yet considered to be green spaces. Nevertheless, it is interesting to note that in this typology accessibility measures are considered in categorising these green spaces.

Types and Hierarchy	Size	Location
Playing Lot	0.2 – 0.6 hectare	At small neighbourhood centre within walking distance of 0.5 km
Playground	0.6 – 2.0 hectares	At small neighbourhood centre and within walking distance of 1.0 km
Neighbourhood Park	2.0 – 8.0 hectares	Within or near neighbourhood centre and within bicycling and walking distance of 1.5 km
Local Park	8.0 – 40.0 hectares	Within or near the service centre. Easy to reach by walking, bicycling and public or private transport (within 3.0 km)
Urban Park	40 – 100 hectares	In the urban centre and within walking distance of 0.5 km (or ½ hour journey)
Regional / State Park	100 hectares and above	At the periphery of urban areas and within one hour's journey by motor vehicle
National Park	No limit	Located in suitable and unique area with existence of wildlife flora and fauna for environmental research

Table 2.4: Hierarchy of Open and Green Space in Malaysia

(Source: JPBD, 2000)

A much more holistic attempt to characterise Kuala Lumpur's green spaces by Lim (1995) for his Urban Green Project launched in 1988 is shown in Table 2.5. Despite the much more comprehensive framework embodied in Lim's typology, his scheme has not been used or implemented by the city. However, discussion of typologies for Kuala Lumpur's green spaces will be continued in more detail in Section 3.5 of the next chapter where a more comprehensive structure for encapsulating the diversity of Kuala Lumpur's green spaces will be proposed and applied to help identify and classify the city's green spaces.

Types	**Description**
Urban green space	Modified Forest
	Amenity Grassland
	Secondary Forest
	Emergent Aquatic Vegetation
	Urban Savannah
	Submerged and Floating Vegetation
	Scrub
	Abandoned Plantations
	Coarse Grassland
	Pioneer Vegetation
	Managed Horticulture
	Agriculture
	Bare Ground

Table 2.5: Suggested Classification of Green Spaces for Kuala Lumpur City in the 1990s (Source: Lim, 1995)

In Singapore, green spaces have been mainly classified by the national government according to their functions. Table 2.6 shows the resulting official typology for those green spaces in the city which are publicly accessible. Two notable features of this system of terminology are the categories for ‘Park Connectors’ (green corridors that connect parks in the city to from a green network) and for ‘Blue Space’ (essentially marine resources such as islands, mangrove swamps, coral reefs and beaches).

Types	Description
Green space	Nature Areas and Reserves
	Parks and Open Space
	Park Connectors
	Golf Courses
	‘Blue Space’

Table 2.6: Typology of Green Spacesin Singapore

(Source: Ministry of National Development, Singapore, 2000)

Generally, the preceding typologies demonstrate the widely differing ways urban green spaces can be classified with two contrasting approaches clearly emerging from the examples considered, namely the comprehensive frameworks of the first two and the rather simpler, narrower typologies used by the latter three cities which in fact fail to cover all the obvious main types of urban green space. It might seem premature at this point to decide that the two more comprehensive typologies are better than the simpler ones, but it is vital for a city to show awareness of the full range of its green spaces which can be seen together as forming a kind of green fabric for urban life, whether publicly or privately owned and managed and whether their sites are accessible for public use and recreation or not (Swanwick et al., 2002).

It may be helpful at this point to introduce and define the concept of ‘green infrastructure’ for later reference. This concept emphasises the ‘life support’ functions provided by a network of natural ecosystems with an emphasis on how these ecosystems support long-term sustainability through their interconnectivity e.g. healthy soils and clean water. The concept seems to be mainly applied in rural areas or on urban peripheries but it could be adapted for use within cities. The concept of an ‘urban green infrastructure’ could then provide an attractive conceptual framework for viewing the mutual interdependence and interconnectivity of the ecosystems which exist within cities and which are mainly based in urban green spaces. However, urban green infrastructure functions in habitats that may partly consist of the built environment with which it may interact to some degree e.g. suburban gardens in Edinburgh sometimes support small populations of foxes which may thrive on food from garbage bins and also become predators on small animals or birds found in this environment, including small domestic animals occasionally. Thus the concept of urban green infrastructure is concerned with how the 'green fabric' just mentioned functions ecologically.

2.12 The Use of Remote Sensing and GIS for Monitoring Urban Green Spaces

Developing practical tools for monitoring and mapping urban green space remains a challenge for urban planners in many parts of the world. Writing in the context of planning for green corridors linking green spaces in Kuala Lumpur, Sreetheran and Adnan (2007) argues that mapping of the distribution of green spaces within urban areas needs to be detailed but also comprehensive (i.e. city-wide), since planning decisions about whether to conserve one green space rather than another need to take into account the relative amounts of green space in different parts of the city, the population around a green space and its proximity or connectedness to other green areas. Urban planners thus require to have to hand at any given time an overview of the current distribution of green spaces of different types within an area, so that they can objectively weigh up and make decisions between competing demands e.g. between developing an area or preserving it as green space. In some cities, data about the formally designated green and open spaces may already be stored and maintained using GIS as part of a city's cadastral data or in a land use/ land parcel database. In the UK, for example, many cities maintain detailed inventories of public open space in order to manage their obligations to maintain these spaces in good condition. In many cities in developing countries however, such detailed land parcel data is not available and alternative means to produce inventories of green space need to be developed.

GIS provide a practical means for maintaining inventories of urban green space. GIS is widely applied in many countries for monitoring urban land use and land ownership information. If data on the boundaries of urban green and open spaces have been recorded or can be mapped, these data can be incorporated as specific classes of features. Even in many developed countries however, it is only recently that such detailed geographic information about urban green spaces has been compiled nationally and GIS has been both the enabling technology for this task and the platform for accessing the results. For example, in 2010 Greenspace Scotland co-ordinated Scotland's first national green space mapping project. All green spaces within settlements of at least 3,000 people were interpreted from the OS Mastermap aerial photography and topography layers. 23 different types of green and open spaces were mapped (based on the typology set out in Planning Advice Note 65) including public parks, play areas, allotments, amenity greenspace and private gardens. The spatial data can be browsed online as an interactive map and downloaded by those GIS users with appropriate data licenses (Greenspace Scotland, 2010).

In England, having recognised only as recently as 2009 that there was no definitive estimate of the amount of urban green space, a first attempt at a national inventory of urban green space was compiled by CABE Space (2010). Over two years the project collected data from over 70 major data sources about more than 16,000 green and open spaces within urban areas. The resulting report estimates the amount of green space in 11 categories including parks, golf courses, nature reserves and allotments. Despite having an aspiration to produce a national green space map, this was not possible as not all of the green areas for which information was collected had well defined geographical boundaries. GIS was nevertheless central to the collation, fusion and reporting of data. The creation of digital boundary data for all the classes was recommended as a future activity so that the inventory could be made entirely available within GIS.

In United States, many local projects mapping urban green space have been carried out using GIS. For example, a study by Kendis (2012) in Olmsted County Minnesota developed a GIS based technique for mapping green space and using multi-criteria decision making to identify and prioritise their urban green space with the aim of protecting the most valuable areas within the city of Rochester. In another study, Dwyer and Miller (1999) explored how GIS could be used to map urban forests and other green areas in the city of Stevens Point, Wisconsin and how these data could help city planners make land use planning decisions for the city. Similarly, in Europe GIS has been used to identify remaining urban woodlands and other green areas for protection and conservation. Tyrvainen et al. (2007) used GIS to build an urban green space map of the city of Helsinki, Finland, and used this to survey city residents about their experiences of using these spaces. The above examples indicate how the use of GIS to map, to monitor and to plan for the conservation of green spaces within cities is now well established in developed countries.

In developing countries, urban green space mapping using GIS is less developed (Sreetheran and Adnan, 2007) but the use of GIS is becoming more common. Studies are emergingwhich use GIS to map urban green space in the cities of the developing world. For example, in Vietnam, Tran and Pham (2012) have developed GIS databases of urban trees and have mapped green space in the cities of Ha Tinh and Tra Vinh. The work aims to assist the city government to more comprehensively plan and manage their urban green spaces. The very well mapped city state of Singapore has had its green infrastructure mapped by its National Parks Agency in detail and this information has been related to topographic and land parcel databases maintained by the Singapore Land Authority. In the Malaysian cities of Kuala Lumpur, Johor Bahru and Georgetown, GIS is already widely used for a variety of urban planning functions. Geographical information exists about all of the green or open spaces that are formally protected (e.g. by being gazetted), but not about other green areas that function as green space and which might need to be recognised more fully in future.

Keeping GIS databases up to date, particularly in rapidly changing urban areas is a major challenge facing urban planners around the world. Although data sets from different functions can be cross checked and compared to identify possible changes e.g. in land use or ownership, ground checking is often still needed to confirm the accuracy and the currency of any particular GIS data set. The use of higher spatial resolution imagery now available from satellite sensors is creating alternative means for urban planners to obtain detailed and current information about some of the changes occurring in green areas in their city (Donnay et al., 2001; Masser, 2001; Cleve et al., 2008; Rozenstein and Karnieli, 2011). The ability of GIS to handle this raster imagery alongside more conventional vector mapping enables up to date information to be gathered from satellite sensors about changes in, for example, the extent, distribution and condition of green spaces in urban areas and this image based information may then be used to verify and to update the conventional mapping.

The strategy of combining data from remote sensing with existing topographic mapping by overlaying the two in GIS has been widely applied for updating maps of land use or land cover within cities (Donnay et al., 2001). GIS data can, reciprocally, assist with classifying remote sensing imagery. Several authors have found that the use of additional ancillary data, such as land parcel, population and other socio-economic data sets can further improve the classification of urban features compared to solely relying on the analysis of satellite imagery. For example, Herold et al. (2003) used aerial photography and IKONOS satellite imageryto create a detailed map of urban land cover in Santa Barbara, California. This was then stored in a GIS so that spatial analysis could be undertaken to understand the spatio temporal patterns of urbanisation.

In the past few years, several researchers have made use of satellite data for measuring urban growth. For example, Liu and Zhou (2004) used LANDSAT images from five dates between 1986 and 1997 to analyse the sprawl of Beijing. Although it was not the purpose of that study, the satellite data also showed the loss of green areas as the city expanded. With slightly higher resolution SPOT images from the period 1986 to 1996, Weber and Puissant (2003) were able to determine the extent and chronology of urban growth of the city of Tunis.

Although satellite sensors can now deliver imagery of better than one meter ground resolution, green space mapping using these higher resolution satellite data from sensors such as IKONOS (launched in 1999), Quickbird (2001) and Orbview (2003) still remains experimental. The majority of studies using satellite imagery, particularly higher resolution imagery for mapping urban land uses have so far been conducted for cities in North America and Europe. For example, using IKONOS images Lackner and Conway (2008) were able to recognise semi-automatically up to ten urban land use classes with an overall accuracy exceeding 80%, while Zhou and Troy (2008) used high-resolution digital aerial imagery and LIDAR data combined with property parcel boundaries and building footprints data to develop a parcel-based mapping of private residential lawns in Baltimore, Maryland.

The fact that these studies are mostly being conducted in Europe and North America and are often limited to 'proof of concept' studies in relatively small areas may be partly explained by the relatively high cost of acquiring high resolution data for large areas, as well as the expertise required to process such imagery, including the task of obtaining sets of images and fitting these together to form a mosaic covering large areas of a city.

In developing countries, techniques for green space mapping are somewhat less developed, despite, as Sreetheran and Adnan (2007) and others have pointed out, these being arguably where such mapping is most needed due to the rapid growth of these cities. However, there are now a number of studies using satellite data at increasingly high resolution and GIS for mapping urban land in the cities of the developing world. Chen (2007) for example used ASTER data to map land cover within Beijing, while Fung et al. (2008) also used ASTER data to map six broad types of green land cover in Nanjing and Chongqing. Blashcke (2010) reviews a number of studies conducted for areas of Beijing with higher resolution data. Stow et al. (2007) reported success using Quickbird data for mapping residential areas in Accra, Ghana.

Although it appears to provide much richer information about urban green spaces, higher resolution imagery contains some characteristics that can limit the effectiveness of the more automated image classification techniques. At a resolution of just a few metres, greater detail about the urban landscape is revealed, creating a greater number of surface types for classification. It can be difficult to distinguish some types of green surfaces from others based purely on their spectral properties in the image. For example, private gardens may reflect light in similar ways to road verges with trees or vacant lots with ephemeral vegetation. Areas that one would wish to classify together as a single green area such as a park may appear to be divided into many smaller patches of differing illumination or texture. Partly for these reasons, methods which classify each individual pixel in an image have been found less effective for classifying higher resolution imagery of urban areas. Instead, methods which aggregate pixels together to create 'objects' within the image have been found more effective, enabling features to be classified not only by their spectra but also by their shape, texture and their context or relationships to other objects (Blascke and Strobl, 2001).

Many of the studies reviewed above which used higher resolution imagery for mapping of urban areas in fact adopted object-based methods of image classification (e.g. Lackner and Conway, 1998; Stow et al., 2007; Chen, 2007; Durieux et al., 2008; and Zhou and Troy, 2008). The classifications were mostly conducted using quite specialist image processing software such as "eCognition" (Baatz and Schape, 2000) later renamed "Definiens" (Lang and Tiede, 2007). According to many authors, including Blaschke (2010), Herold et al. (2003), Laliberte et al. (2007) and Mathieu etal.(2007), the object-based approach has now clearly demonstrated its potential for improving the classification of urban areas compared to traditional pixel-based approaches, especially when higher resolution imagery is being used.

In Malaysia, there have been at least two previous efforts to map urban green space and both have had an input from remote sensing. The first, conducted by Teh (1989 and 1994) used mosaics of panchromatic aerial photos taken in 1987 plus field survey methods to record urban green spaces throughout the city. A more recent study by Yaakup (2004) used

LANDSAT satellite imagery from 1988 to 1998 to study urban growth in the Klang Valley, including Kuala Lumpur city. Workers such as Reyes-Firpo (2008) and Blacker (2009) subsequently explored the use of imagery of higher resolution than LANDSAT, in these cases SPOT and IKONOS respectively, to classify the green and open spaces within particular areas of Kuala Lumpur. Whilst Blacker (2009) found that SPOT data could be used to recognise larger vegetated areas such as parks and forest reserves within the city, the recognition of smaller vegetated areas such as private gardens and tree-lined streets required the use of the higher resolution IKONOS imagery (Reyes-Firpo, 2008). Despite some success in recognising these green spaces visually, both researchers found it difficult to classify areas in the imagery into the correct type of green space that would be recognised by ground survey. Nevertheless, the use of satellite imagery remains attractive, as it offers a means to obtain data for city areas at lower cost than by commissioning aerial photography.

In summary, GIS is a well-established means of assembling data about urban green space, while higher resolution satellite imagery offers the potential for producing comprehensive and updateable mapping of urban green spaces. Together, they offer urban planners a practical and relatively cost-effective means for monitoringall the green infrastructure across a city and supporting decisions about conserving these. However, despite some success reported in the literatureusing object-based techniques, mapping green spaces from higher resolution satellite imagery remains challenging due to the complexity of urban areas. So, whilst GIS and remote sensing are likely to become more widely accepted methods for maintaining information about green space in urban areas, ground checking of inventories produced by these methods will still be required and should be considered desirable.

2.13 Summary and Discussion

It is evident from the literature that there is a growing awareness of the importance of urban green spaces in enhancing the quality of urban dwellers' lives. This review has revealed an increasing amount of empirical research into the benefits of green spaces to the general well-being and health of their users. Many studies have shown that parks and gardens can help to improve people's health, both physically and emotionally. There is also clear evidence that a city which is well provided with a range of green spaces of varying types and of high quality, including parks with good facilities, is seen as more attractive to residents, businesses and investors. Data from research also confirm that green spaces can mitigate pollution in cities and improve air quality as well as help to sustain the city's biodiversity. Furthermore, there is a significant amount of research that provides evidence on the benefits of green spaces to the city's economy and social well-being. Figure 2.4 summarises some of these benefits.

Despite the considerable volume of research on so many facets of the contribution green spaces make to urban life, there remain many significant gaps in knowledge. In what is possibly the most comprehensive attempt to compare potentially significant research themes with research already done, Bell and co-workers (2007) conducted a seminar with over 40 stakeholders from the field to review the extensive inventory they had compiled of research already published (plus some unpublished research), discuss significant gaps and then vote on what were the priorities for future research. A number of significant gaps were identified with a fair degree of agreement emerging on what these were. For instance, they agreed more work was needed on health benefits in relation to key target groups in the population, especially children, older people and disabled people. Lack of knowledge of whether particular kinds of benefit exist for particular groups or not and, if they do, lack of data on how substantial such benefits actually are, means that the value of urban green spaces is far from being well understood, even in developed countries. Hence, when some of the positive (or negative) effects of urban green spaces are not really known, strong assertions about what the role of these spaces ought to be have to be viewed with some caution, as noted earlier.

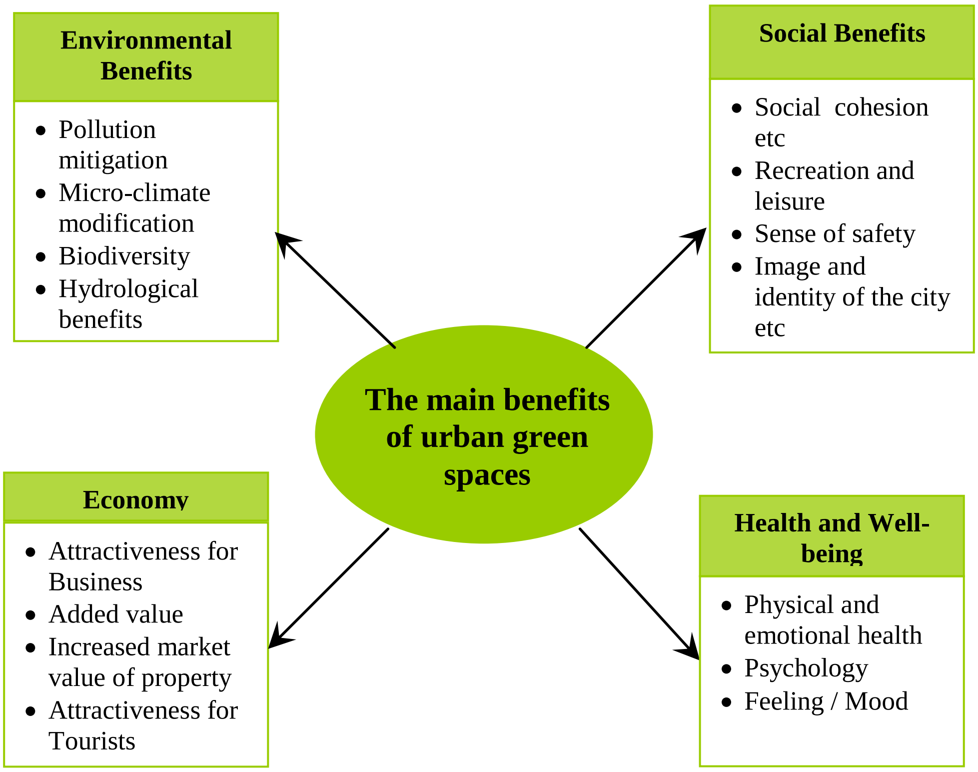


Figure 2.4: Summary of the main benefits of urban green spaces

However, the literature review has also shown that the lion's share of this research on the nature and beneficial (or otherwise) roles of urban green spaces has been carried out in the developed world i.e. Japan, North America, Australia, New Zealand and countries in Europe like the United Kingdom, Germany and France. As an obvious corollary, the amount of research carried out in nearly all of the developing countries on these aspects of green spaces has been relatively small; hence something of a 'research gap' seems to exist as regards the nature and roles of urban green spaces in the latter countries.

The review of literature has also established the necessity of identifying all the possible types of green space that may exist in a particular city through an appropriate typology, not least because this will assist in understanding their roles and in the planning and management of these spaces. Such typologies do not necessarily have to be consistent in every city but they need to be appropriate to their particular urban context and purpose and be composed of categories that are defined quite lucidly and are as easy as possible to identify on the ground or from images so they facilitate the processes of obtaining a clear and comprehensive picture of the real condition of all the city's green spaces.

The actual typologies just discussed here show there tend to be significant differences between the ways green spaces are classified in developed countries such as the United Kingdom and in cities of the developing countries, differences which are broadly summarised in Table 2.7. Edinburgh and London both have a comprehensive typology for their green spaces. The striking differences between the typologies of the latter two cities and the others in Table 2.7, if these can be regarded as typical, suggest that cities of developing countries may often need to review and expand the typologies of green space they use to bring them more in line with those now recognised in other parts of the world, but with due consideration of the local types of green space that are required and used by the people of Malaysia, Indonesia or Singapore, as the case may be.

Country/City Types of Green Spaces	Developed Countries/Cities		Developing Countries/Cities		
	England	Scotland	Yogjakarta, Indonesia	Singapore	Kuala Lumpur, Malaysia
Parks and gardens	X	x	X	X	X
Childrens' Play areas	X	x	X	X	X
Amenity green spaces	X	x	X	X	X
Outdoor sports facilities	X	x	X	X	X
Allotments, community gardens	X	x			
Cemeteries and churchyards	X	x			
Natural and semi-natural green spaces	X	x		X	
Green corridors	X	x		X	
Civic space	x	x	X		

Table 2.7: Differences in how different cities characterise urban green space

The review of the literature on the use of remote sensing for mapping green space indicates that higher resolution remote sensing may provide considerable information about the extent and distribution of green spaces across a city such as KL. However, research is needed to ascertain what information can be extracted from such imagery about different types of green spaces and how to use various ancillary data from GIS, such as land parcel and population data, to assist green space mapping for the city.

In conclusion, the critical review of literature has shown that a gap exists regarding existing knowledge and understanding of the nature and role of urban green spaces in developing countries. The present thesis will therefore try to address some aspects of this gap by firstly trying to identify all the types of green space which exist in a large tropical city in South East Asia, mainly by using remotely sensed images. Whether the city's scheme for classifying its green spaces needs to be expanded in the light of these results will also be considered. Before these questions are addressed, Chapter 3 will provide some local background and context by examining the situation regarding green spaces in Kuala Lumpur, focusing on their development and planning, briefly reviewing some of the issues that Kuala Lumpur has faced in recent years over its loss of urban green space and discussing some of the strategies the city planners have adopted in trying to conserve and enhance the city's green resources.

Chapter 3

BACKGROUND ON KUALA LUMPUR AND AN OVERVIEW OF ATTEMPTS TO CONTROL DEVELOPMENT ON GREEN SPACES IN THE CITY

9.0 Introduction

Chapter Three provides an overview of development and planning policies as they relate to urban green space in Malaysia generally and more specifically to the city of Kuala Lumpur. It explores both the Malaysian Government's and Kuala Lumpur City Hall's (known as DBKL) efforts to balance the need for the country's economic development with the need to ensure adequate green spaces for their urban populations.

The chapter starts with some general background information about urban development in Malaysia. It then examines the importance of urban green spaces in Malaysia and how this relates to the country's vision of becoming the 'Most Beautiful Garden Nation' by 2020. The chapter continues with some information about Kuala Lumpur and its urban development. This is followed by an exploration of DBKL's vision for its provision and planning of urban green spaces and of the legislation and administrative mechanisms available to support this provision and also to control attempts to develop these spaces for other uses. It then analyses the current typology defined by DBKL for identifying and managing Kuala Lumpur's green spaces. This helps to give an understanding of the current situation and current planning practices, of the reasons for suggesting a more extensive typology in this thesis and of why adopting this wider view may assist with the protection and expansion of KL's (and perhaps also Malaysia's) urban green spaces.

In this chapter, the main sources of information which are examined and analysed are documentary material produced by relevant government agencies, which includes the Kuala Lumpur Structure Plan 2020 (DBKL, 2003), the draft of the Kuala Lumpur City Plan 2020 (DBKL, 2008), as well as reports, guidelines, newspaper articles, printed materials and other written information gathered from DBKL, its associated departments and websites.

9.1 Background on Malaysia

Malaysia is located at the centre of Southeast Asia. It stretches roughly from North to South between latitudes 1^o and 7^o North of the Equator, and lies from East to West between longitudes 100^o and 119^o East. Malaysia consists of two major regions, Peninsular Malaysia and East Malaysia. Peninsular Malaysia is bordered on the North by Thailand, on the South by Singapore, on the East by the South China Sea and on the West by the Strait of Malacca. East Malaysia is bordered on the North by the South China Sea and the Sulu Sea, on the East by the Celebes Sea, and on the South East, South and South West by Kalimantan (Indonesian Borneo). Its total area is approximately 329,758 square kilometres.

Malaysia experiences an equatorial climate which is both hot and humid all year round. It has uniformly high temperatures with average air temperatures about 26^oC and does not experience any significant changes of seasons. The annual rainfall averages around 2600 millimetres (just over 102 inches), which is normal for an equatorial region.

A census undertaken by the Department of Statistics, Malaysia, in the year 2010 recorded that Malaysia's total population numbered 28.3 million (compared to 23.3 million in 2000). This shows that the average annual population growth rate in Malaysia is about 2.0% over the 2000-2010 period (Department of Statistics, Malaysia, 2011). In terms of urbanisation, the Census of 2010 reported that the proportion of urban population was 71% in 2010, an increase from 62% in 2000 (Department of Statistics, Malaysia, 2011) with the highest urban population increase in the Federal Territory of Kuala Lumpur.

Generally, the population of Malaysia can be divided into three main ethnic groups: the Malays (also known as Bumiputra); the Chinese; and the Indians. Of the total Malaysian population, in the Census for 2010 the Malays/Bumiputra comprised

67.4%, the Chinese 24.6% and the Indians 7.3%. This may be compared with an ethnic composition of 65.1% Malay, 26.0% Chinese and 7.7% Indian in the year 2000. Non-Malaysian citizens totalled 8.2% in the census year of 2010, against 5.9% in the year 2000.

These population statistics show that Malaysia is experiencing positive annual population growth, with the increase concentrated in urban areas and particularly in the bigger cities, especially Kuala Lumpur. Hence in the long term, this increase is likely to fuel more urban development and thus put more pressure on urban green spaces.

9.1.1 Urban Development in Malaysia

In the early years Malaysia was an agriculturally based country. Since gaining independence from the United Kingdom in 1957, Malaysia has actively pursued policies intended to develop and modernise the country. In order to increase its economic growth, Malaysia made major efforts to become an industrial exporter with the 1970's witnessing the first really significant industrial and urban growth in the country. It has now grown to become the world's 19th largest trading nation in terms of its industrial exports (Sham, 1998) with the country's earlier economic focus on agricultural production being superceded. As a result, the country has experienced rural-urban migration and rapid urban population growth.

Hadi (1998) describes how Kuala Lumpur developed rapidly in the 20th century from a trading post to an international metropolis with its built up area now extending into the surrounding countryside to form a huge conurbation (Figure 3.1). Urban immigration of rural workers has contributed to the expansion of the existing city and the rise of satellite towns on previously forested land. This gradually changed the patterns of land use with agricultural land transformed into industrial, commercial, residential and recreational use. Keong (1998) claimed that between 1966 and the early 1980s, urban and associated land uses doubled in area from 74,000 hectares to 150,000 hectares.

These extensive land use changes in the 20th century had a significantly negative effect upon Malaysia's urban green spaces with urbanisation creating serious environmental and social implications for many urban areas. Razak (1999) forecast that Malaysia's land use changes and urban population growth would continue accelerating as the country geared its focus towards becoming a developed nation by the year 2020. It is Malaysia's aspiration, expressed in its 'Vision 2020' statement to become a developed country by that year, as will be discussed shortly in Section 3.1.2. It is also the government's policy to increase the population to 70 million by the year 2100 (Prime Minister Office, 2004). These policies will act as a catalyst to further urban development. Sham (1998) argued that with 600,000 further people expected to have moved into KL central city area by 2020, vacant sites and areas of urban green space in this area will come under great pressure from economic development.

9.1.2 Background on Kuala Lumpur

Kuala Lumpur was originally founded around 1857 as a centre for tin mining located at the confluence of the rivers Sungai Gombak and Sungai Klang, taking its name from the muddy convergence of these two rivers.

Figure 3.1: Kuala Lumpur – Past and Present (Source: DBKL, 2007)

Kuala Lumpur is the capital of Malaysia and is situated 3^{o} north of the equator with a total area of 244 square kilometres. It became the capital of the independent Federation of Malaya after the country gained independence from the United

Kingdom in 1957 and was again confirmed as the capital when Malaysia was founded in 1963; city status was conferred on it in 1972 (Figure 3.2). Two years later it was gazetted by the Federal Government of Malaysia as a Federal Territory, to be governed by the Federal Territories Ministry (Phang et al., 1996 and Bunnell et al., 2002). Kuala Lumpur forms the core of the nation's most populous urban region (Bunnell et al., 2002) with a population of 1.67 million in the year 2010, a number expected to increase to 2.2 million by the year 2020 (DBKL, 2003).

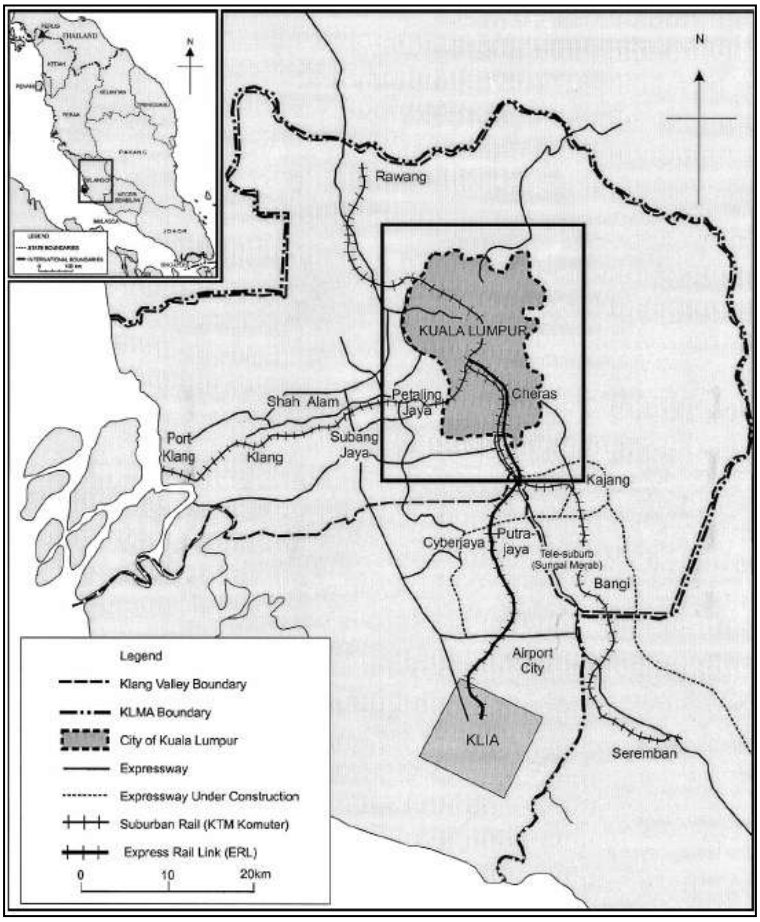


Figure 3.2: Map of Kuala Lumpur (Source: Bunnell et al., 2002)

With its tropical climate and an average annual rainfall of about 220 mm, the city is generally hot and humid throughout the year which produces its lush greenery of colourful tropical plants. Originally, Kuala Lumpur's natural landscape consisted of lowland Dipterocarp forest (Latiff, 2001). However, this has been transformed as the city has changed over time.

Kuala Lumpur started experiencing rapid urban development during the 19th century (Bunnell et al., 2002), quickly becoming the main centre for national development.

According to Hamzah (1965), by the early 1960s Kuala Lumpur and adjoining urban centres had started to develop as an industrial region and this area was recognised as a coherent urban planning region in the 1970's (Katiman, 1997). By the 1980s Kuala Lumpur was established as a commercial metropolitan city. Since then further vigorous urban development has taken place, including the building of the Kuala Lumpur Convention Centre (KLCC), a mega-project through which the Petronas Twin Towers became the world's tallest building for some time,

Kuala Lumpur has continued to undergo tremendously rapid urban development (Figure 3.3) which has put much pressure on forest and agricultural land for conversion into commercial and residential areas (Latiff, 2001) with the size of the city multiplying significantly. During a speech in 2002, the Mayor of Kuala Lumpur stated *"this is a long way for a village to have come, from the 0.6 sq km that made up all of Kuala Lumpur in 1895, to a city of 244 sq km"* (Mohamad Shaid, 2002).

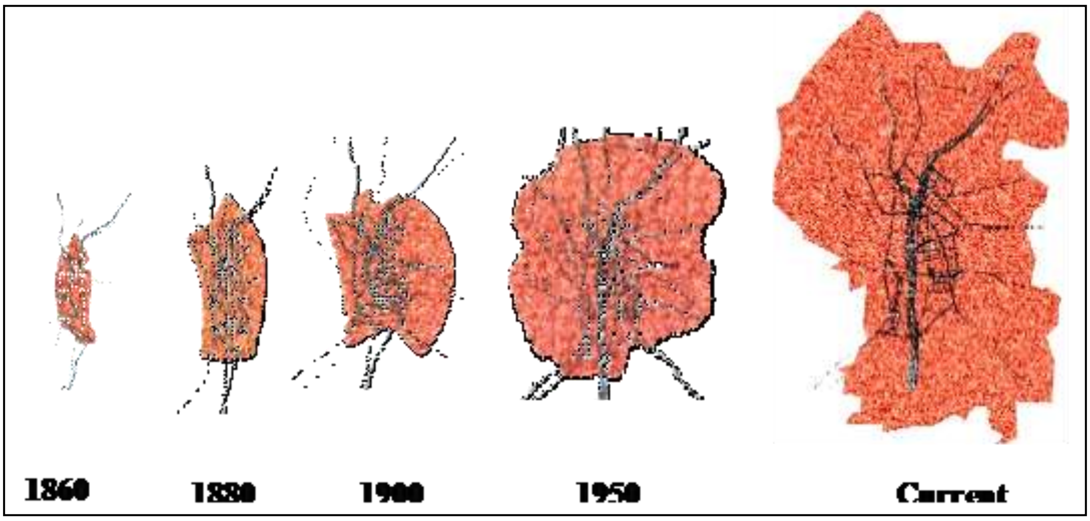


Figure 3.3: Expansion of the City of Kuala Lumpur (Source: LUCCD, 2003)

It was at around that same time that the government started to express its concern to develop the city as a 'clean and beautiful region' and to ensure that its residents have a better quality of life (Nordin et al., 2003), an aspiration similar to that of cities in other countries in recent decades.

Kuala Lumpur has been selected as a case study partly because, as the capital of Malaysia, it has experienced more intense and more complex phases of urban development in comparison to other urban centres in Malaysia, creating the serious land use problems associated with urban sprawl and the attendant loss of urban green spaces already noted. Moreover, the Kuala Lumpur region has continued to experience growth in population, a significant part of which is still quite highly concentrated within the Federal Territory of KL itself. Siti Zakiah and Noraini (1999) recount how in the past Kuala Lumpur has carried out intensive programmes in an effort to ensure that urban greenery and a high quality urban environment were given appropriate consideration when planning the development of other centres in the KL conurbation. However, the extent to which these efforts have been effective in improving the quality of life of dwellers in the conurbation, particularly in its central core has yet to be assessed properly. By selecting the main urban area in the conurbation, the area within the boundary of the Federal Territory of Kuala Lumpur for our case study, we can try to address this question.

9.1.3 Urban Green Spaces in Malaysia

As Malaysia's population continues to grow and concentrates in city regions, it can be argued that the important benefits of urban green spaces to the environment, to the economy and to the health and well-being of city residents become even more significant in counter-balancing some of the negative effects resulting from the country's urban development. A range of authors such as Mahesan (1993), Adnan (1998), NurAshiha (1998) and Ismawi (2000) have all suggested that urban green spaces are essential components of a city, improving both urban environmental quality and making the lives of those in the city more tolerable and congenial.

NurAshiha (1998) contends that Malaysia's urban green spaces play an important role in controlling and limiting the city's degradation of the physical environment. She argues that it would be fallacious to assume that Malaysia's urban green spaces are designed just for beautification. Rather, she asserts that these green spaces should be viewed in a broader perspective as having an influential role in mitigating the country's local climates and in reducing various types of pollution that affect both human health and the condition of the natural environment.

Similarly, according to Mahesan (1993), green spaces in a city are not just desirable but vital. Concrete structures in towns and cities without any greenery to provide relief, especially in a tropical climate, can create social as well as environmental problems. He contends that if urban green spaces in Malaysian cities were planned as an integral part of urban development, as they are in many developed countries, they could provide space for recreation as well as improving the quality of life. In addition, urban green spaces can assist in reducing the pressures of urban living by promoting human interaction with the surrounding natural environment. He also argued that the public parks that are being developed in Malaysia will ultimately help to create a more healthy society, both physically and psychologically. As urban areas have continued to develop in Malaysia, notwithstanding efforts to create green spaces in new towns such as Putrajaya and Cyberjaya, researchers such as Teh (1994) have focused attention on a growing shortage of green spaces in the Klang Valley and within the older central area of Kuala Lumpur.

The idea of transforming Malaysia into a Garden Nation came as a response from the government to an increased awareness among the public of the need to conserve and maintain a balance between urban development and the natural environment (Ismail, 1997). The idea was initiated during the 1989 summit meeting of Heads of Commonwealth held in Malaysia. During this summit, a statement known as the 'Langkawi Declaration' was agreed between member countries (JLN, 1996), according to which all policies and development programmes in the participating countries would put emphasis on the achievement of sustainable development. The declaration stated that control should be maintained by the respective countries over any activities and programmes that may endanger the environment.

In support of this declaration and also as a commitment to Local Agenda 21 on the Environment (from the Environment Earth Summit, Rio de Janeiro, 1992), the Malaysian government gave its commitment to retain 50% of its area as forest or green areas, compared to the world recommendation of 30%. According to Ismail (1997), the government's commitment to this issue was shown by the establishment of the National Landscape Department (JLN) on 3rd March 1997, which then started its programme of nationwide tree planting. The campaign was launched by the Prime Minister as the first step to achieving the status of a Garden Nation by the year 2005.

Following a National Tree Planting campaign, a National Landscape Conference on the Garden Nation was held in Shah Alam, Selangor, Malaysia, on 4th – 5th November 1997. The conference was organised by JLN, the Institute of Landscape Architects Malaysia (ILAM) and the University Putra of Malaysia (UPM). Participation in the conference was high with representatives from many government agencies, corporate agencies, the private sector, professionals, researchers and individuals involved in fields related to landscape and green spaces. The theme of the conference was 'Garden Nation: Vision and Challenges' which focused on the following three main issues:

i. Policy, Planning and Design;
ii. Implementation and Management;
iii. Research and Education.

During this conference, a policy paper on Malaysia's landscape development was presented by the Director General of JLN, Dato Hj Ismail Ngah (Ismail, 1997) discussing the government's ideas about a Garden Nation, the concept and strategies for its implementation. According to the Director General of JLN, the Malaysian concept of a 'Garden Nation' was influenced by and drew on Ebenezer Howard's 'Garden City' concept. However, the concept was now being applied at a much broader scale (i.e. at a national level rather than a city scale), the Malaysian Garden Nation concept included not only the idea of maintaining nature within the city, but considered the whole nation itself as a garden, suggesting that there is a need to balance green spaces and developed areas throughout the country, arguing that green space needs to be a significant part of the overall economic development of the country. This idea forms a central thrust of Malaysia's new Economic Transformation Programme, which promotes additional parks and tree planting by JLN within the Federal Territory as one means of making Kuala Lumpur an attractive area for employment and economic investment (Pemandu, 2012).

The Director General of JLN (Ismail, 1997) further suggested that in order to evaluate progress towards realising the 'Garden Nation' ideal, the amount of open and green space in Malaysian cities should be monitored and compared against national and international standards for urban green space in order to satisfy the public as the 'users' and particularly city dwellers. Ismail (1997) argued that the country had to set targets for the development of high quality, comprehensive green spaces and argued this could be achieved if all aspects of this development such as the green space planning, design, implementation, management and maintenance are done in a systematic way. This thinking has led to the inclusion of targets for urban green space in strategic economic plans such as Vision 2020.

9.1.4 Malaysia's Vision 2020

Vision 2020 sets out the Malaysian government's aspiration to build the nation into a fully developed country by the year 2020. This vision was introduced by the fourth Malaysian Prime Minister, Tun Dr Mahathir Mohamad, during his speech at the Malaysian Business Council on 28 February 1991 entitled "The Way Forward" (Prime Minister's Office, 2004). Vision 2020 envisages that Malaysia should be fully developed in all dimensions; economically, politically, socially, spiritually, psychologically and culturally: *"the country has to be fully developed in terms of its national unity and social cohesion, in terms of economy, in terms of social justice, political stability, system of government, quality of life, social and spiritual values, national pride and confidence"* (Prime Minister's Office, 2004).

This vision emphasises the need for balanced development of the country, not focusing only on one aspect (i.e. economic) and neglecting others. It also stresses that the quality of life should be given due consideration, that natural resources should not be wasted and that the environment should be maintained and improved while turning Malaysia into a developed country. These ambitious intentions sound positive. However, commentators such as Moe Thuzar (2010) have pointed out in reports such as the United Nations Regional Outlook for Urbanisation in South East Asia that if economic development is prioritised above all else, then global capital increasingly determines the form of urban land use. Sheng (2011) points out that an 'entrepreneurialist urban agenda', as many believe KL is following, like many South East Asian cities, pays little attention to the public interest in the environment or to the needs of the urban poor. The result is likely to create imbalanced economic development within the country and social injustices within the city. Central to this study is Sheng's (2011) argument that when there is a disconnect between planners working in a traditional planning mode and the prevailing market-based mechanisms for urban development, green spaces important for maintaining the 'liveability' of the urban environment are often sacrificed for economically more productive land uses. In the light of these criticisms, a comprehensive strategic plan that involves all aspects of development and which also includes improvement of the environment and quality of life needs to be set out and properly implemented and enforced by the Malaysian government.

9.2 The City Government of Kuala Lumpur ('City Hall' or DBKL)

DBKL is the local authority given responsibility to administer the city of Kuala Lumpur. Its roles are becoming more complex and challenging as the city tries to promote more equitable and sustainable urban development. Similar to many local authorities in UK, DBKL has to develop the city according to development guidelines, in this case the guidelines formulated in the Kuala Lumpur Structure Plan and the Kuala Lumpur City Plan, along with other guidelines that have been developed from time to time by the authority.

9.2.1 DBKL's Vision and Goals

DBKL's vision and goals have evolved over time since its establishment. In the early 1970's, the singular vision was to promote urban development. According to Mohamad Shaid (2003), an urban development strategy of the 'sky is the limit' was adopted and developers could build as high (as regards plot ratio and residential density) as they wished, provided they paid the development charges.

However, according to Siti Zakiah and Noraini (1999), as urban development became more rapid in the mid 1980's, concerns began to arise about the quality of the urban living environment. Consequently, DBKL began to pay increased attention to the development of more urban green spaces. These concerns increased further in the mid 1990's, as DBKL's focus shifted more towards creating a balance between fostering economic development and maintaining a good quality of life for its residents. At this time, DBKL started to implement their vision to turn Kuala Lumpur into a ‘Tropical Garden City’ by the year 2020 (DBKL, 2000).

To many of the urban planning professionals interviewed in this study, the ‘Tropical Garden City’ vision seeks to create overall conditions whereby the citizens and the authorities work hand in hand to improve the quality of life for city residents. To help achieve the preceding vision, the latest structure plan has formulated the following goals and objectives:

i. To create a ‘Garden City’ image by greening the city with lush green spaces and a green network that portrays an overall natural setting;
ii. To achieve minimal ecological footprint;
iii. To establish a landscape with an integrated and an inter-linked network of green spaces;
iv. To conserve natural heritage for the future so it is protected and maintained for generations to come;
v. To enhance the resident’s experience with the city’s unique character;
vi. To have full community participation;
vii. To have good governance with an efficient and equitable use of available financial, organisational and human resources to manage green assets.

(Source: Section 15 – Kuala Lumpur Structure Plan 2020 (DBKL, 2003)

In trying to achieve their 'Tropical Garden City' vision successfully, DBKL has listed four key aspects in their strategic approach. Figure 3.4 below summarises these four key aspects.

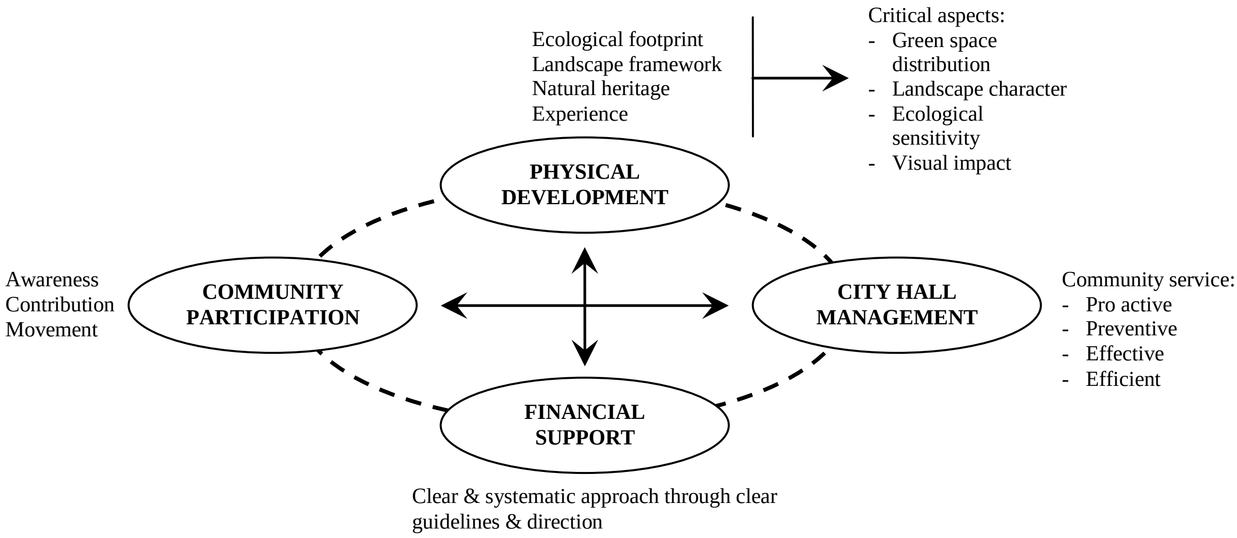


Figure 3.4: Strategic Approach to Developing a Tropical Garden City: Factors Critical for Success
(Source: DBKL, 2003)

DBKL confirms its concern to balance urban development whilst maintaining the quality of the urban environment in order to fulfil the demands of its residents for better quality living (Mohamad Shaid, 2003). The vision of turning Kuala Lumpur into a 'Tropical Garden City' can be seen as an appropriate urban greening initiative which captures public sentiment and mobilises both municipal and private resources towards achieving this effort.

9.2.2 The Kuala Lumpur Structure Plan 2020 (KLSP 2020)

The 1984 Kuala Lumpur Structure Plan was the first strategic plan published and adopted by DBKL; it helped to provide direction for the city planning authority ensuring that its future development was in line with the aims of national development. In the opinion of Mohamad Shaid (2003), since then the city has developed according to this structure plan, although others such as Sreetheran and Adnan (2007) argue there has been a divergence between what has been planned and what has actually occurred on the ground.

In 2000 the 1984 Kuala Lumpur Structure Plan was revised and The Kuala Lumpur Structure Plan 2020 (KLSP 2020) formulated. This still outlines predominantly economically driven development strategies and sector policies aimed at galvanising the growth of the city in new and exciting ways (Mohamad Shaid, 2002). The plan does, however, recognise that one aspect of being a 'world class city' will be to provide adequate green spaces and other recreational spaces for city residents. This is in line with the national vision of becoming a fully developed nation over the same period, as discussed earlier in Section 3.1.2. The structure plan indicates that the city of Kuala Lumpur will be considered 'world class' if it is able to provide the highest quality living, working and business environment, benchmarked against the best in the world (DBKL, 2003).

The following goals are formulated in the 2020 Structure Plan:

i. To enhance the role of Kuala Lumpur as an international commercial and financial centre
ii. To create an efficient and equitable city structure
iii. To enhance the city living environment and the quality of life
iv. To create a distinctive city identity and image
v. To have efficient and effective governance

(Source: Kuala Lumpur Structure Plan 2020 (DBKL, 2003)

It can be observed from the goals above that besides targeting the future economic development of the city, KLSP 2020 is also focused on enhancing the living environment and the quality of life. Among specific objectives stated in the Kuala Lumpur Structure Plan 2020 (DBKL, 2003) are the necessity to maintain urban greenery and the natural environment and to provide the green infrastructure and facilities that will create a better quality of life in the city. With these aspirations more clearly prioritised in the new plan, there is an urgent need for the local authority and also the related professionals to seriously scrutinise the procedures used in urban planning for dealing with applications for development and to scrutinise all the information required in this process.

9.2.3 The Kuala Lumpur City Plan 2020 (KLCP 2020)

Kuala Lumpur City Plan 2020 **(**KLCP 2020) is DBKL's primary document for setting out its planning and development strategy. Published in 2008, it is effectively a local plan for Kuala Lumpur prepared under provision of Section 13 of the Federal Territory (Planning) Act 1982. The Plan sets out in a twelve year plan what must be done to achieve the vision for the City of Kuala Lumpur by the year 2020. This will guide decision makers, urban planners, designers and builders about the direction and planning presumptions that will shape the direction of growth for Kuala Lumpur in the decade or so ahead.

The KLCP 2020 is broadly in line with the aspirations of the KLSP 2020 and further strengthens its proposals to ensure these policies are translated into development strategies for the city. In KLCP 2020, the policies of KLSP 2020 are translated into initiatives, actions, programmes and development control principles, which are centred on the five main goals of the KLSP 2020 just discussed in Section 3.2.2. KLCP acknowledges that its greatest challenge is the implementation of the goals and policies it sets out in order to achieve environmental, social and economic development simultaneously, hence ensuring that the improvement of one shall not be to the detriment of the others (DBKL, 2008).

Crucially for this thesis, the KLCP 2020 (2008) emphasises "the liveability and quality of life for its local communities". It promotes planning and development that is sustainable and places priority on the three main elements of:

(i) Environmental quality;
(ii) Social equity; and
(iii) Economic prosperity

(Source: Kuala Lumpur City Plan 2020 (2008)

These three elements are intended to encourage innovative solutions to land development and at the same time aim to control certain activities and the intensity of development permitted. The City Plan proposes strategies that will develop a quality living environment as well as ensuring opportunities for wealth creation, framing its plan with five core guiding principles:

(i) Planning for wealth creation;
(ii) Planning for safety and comfort;
(iii) Planning for connectivity and accessibility;
(iv) Planning for greener standards;
(v) Planning 'for and with' the people.

(Source: Kuala Lumpur City Plan 2020 (DBKL, 2008))

KLCP 2020 claims to promote planning and development in a sustainable manner, where environmental quality, social equity and economic prosperity are joint goals in its long term plan. The plan also professes to promote good quality living environments where quality of life is of the utmost importance to the urban dwellers. It plans to achieve that by ensuring communities have access to the necessary infrastructure, to a clean urban environment and also to parks and green spaces. This can be seen as a mandate for urban greening, or at least a planning system that will actively promote this. Nevertheless, realising this vision will require greater cooperation from all those who have a stake in the city and the plan must be well translated into proper and efficient mechanisms for implementation. Private land developers are also seen as part of the plan with developers now basically required to have at least 10% of the area of plots they develop as green space (or more if the building is above a certain number of storeys). Thus there is now a statutory requirement placed on developers to create open and green space as part of all new private developments.

3.3 Legislation and Policies Related to Urban Green Spaces

Currently, there are no specific legislative acts on Urban Green Spaces in Malaysia. However, efforts have been made by the National Landscape Department (JLN), with the help of the Institute of Landscape Architects Malaysia (ILAM) and other individuals, professionals and experts, to develop a Landscape Act and a National

Landscape Policy for the country (JLN, 2002), which will include legislation to protect and strengthen urban green spaces as one of its components.

Although there is no formal legislation regarding urban green spaces in the country, Mutalib (1997) claims that the urban development system in Malaysia does not neglect green or open spaces in its land use planning since urban green or open spaces are included as one of the components to be considered and addressed under the Town and Country Planning Act, 1976 (Act 172). This Act has been amended twice, in the years 1995 (Act A933) and 2001 (Act A1129). The green or open space issues that have been directly addressed in this Act are in Section 12(3) dealing with the preparation of draft local plans, Section 21(A) (d) on development proposal reports, Section 21(B) (1a) on layout plans, and Part VA Section 35 dealing with Tree Preservation Orders (Act A1129 2001).

Section 12(3) of the Town and Country Planning Act (amendment) 2001 (Act A1129) requires that in preparing drafts of local plans, their content should formulate in detail, among other issues, any aspects dealing with the protection and improvement of the physical environment, preservation of the natural topography, improvement of the landscape, preservation and planting of trees and the make-up of green or open spaces. Section 21(A) (d) of the Act requires that in addition to the documents and plans required to be submitted for planning permission, the applicant should submit a development proposal report containing among other items:

i. A description of the land, including its physical environment, topography, landscape, geology, contours, drainage, water bodies and catchments, and natural features;
ii. A survey of the trees and all forms of vegetation; and
iii. The particulars of buildings which may be affected by the development.

Furthermore, in Section 21(B) (1a) the applicant in preparing the layout plans for the development proposal report needs to show that the proposed development (in particular where the development is in respect of any land) includes:

i. Measures for the protection and improvement of its physical environment;

ii. Measures for the preservation of its natural topography;

iii. Measures for the improvement of its landscape;

iv. Measures for the preservation and planting of trees;

v. The location and species of trees with a girth exceeding 0.8 metres and other vegetation;

vi. The make-up of green or open spaces;

vii. The proposed earthworks;

viii. A description of the works to be carried out.

In addition to the above requirements, Part VA Section 35 of Town and Country Planning Act (amendment) 2001 (Act A1129) gives specific directions to preserve existing trees during the development of an area. Under this Section, the local planning authorities are given power to preserve any tree, trees or group of trees that are involved in any development project in its area in the interests of amenity. The local planning authorities can issue a tree preservation order with respect to a particular tree, specific trees or a group of trees, which may make provision:

i. For prohibiting the felling of trees except with the written permission, and subject to conditions, if any, imposed by the local planning authority;

ii. For securing the planting of trees or the replacement of trees by replanting in such a manner as may be determined by the local authority.

According to this Act, a person who contravenes any provision in the tree preservation order is committing an offence and is liable on conviction to a fine not exceeding One Hundred Thousand Malaysian Ringgit (RM100,000), currently equivalent to just over 20,000 pounds Sterling, or imprisonment for a term not exceeding 6 months, or both.

For the time being, the Town and Country Planning Act, 1976 (Act 172) is what is mostly used by the local authorities and other implementation agencies across the country with reference to landscape or green and open space issues. Its principles and provisions are also used for reference, together with the national landscape guidelines which have been introduced by the Town and Country Planning Department of the Federal Government, alongside other guidelines and policies that are being produced by each individual local authority. It has also been observed that Kuala Lumpur does not have any legislation specifically for urban green spaces. Nevertheless, during the planning and development of the city's urban green spaces, the city authorities have referred to related legislation such as the Parks (Federal Territory) By-Law 1981 which falls under the Local Government Act, 1976. Although this by-law is specifically for parks, its emphasis is in fact on controlling usage by the public rather than on protecting green spaces.

However, despite various provisions in the regulations and laws just outlined above for preserving or planting trees and the penalties for contravening tree preservation orders, critics of the existing institutional arrangements can argue that in reality the present laws either do not have enough force to protect public or private urban green spaces adequately or they are too weak in relative terms and are therefore difficult to enforce against external social or political or economic pressures. Thus planning permission, particularly on green spaces which are privately owned, seems to have been granted relatively easily in recent decades and, it can be argued, with insufficient consideration to their current status as green spaces that might be valuable in terms of environmental, economic and/or social benefits. The apparent weaknesses of these existing regulations can be seen as one of the reasons why many urban planners in Malaysia seem to be having difficulty in enforcing control of development on this kind of land (Teh, 1994; Nor Akmar et al., 2011).

In Malaysia 'gazetting', defined briefly in Chapter 1, can in fact be used generally to preserve buildings or land from development e.g. because of the historical or cultural or architectural significance of the former or the environmental quality or scientific interest of the latter and is probably the most effective means of conservation available to public bodies.

Consequently, environmentalist critics of the existing arrangements may argue that none of the existing regulations seem to address the possible need to gazette more (or even most) good quality urban green space, even if privately owned. The existing situation, however, is that in practice private green space can rarely be gazetted unless the owner applies for this to happen, except in rather special circumstances. Private owners are very unlikely to do so because gazetting weakens or removes the development potential of land and therefore reduces its market value. In reality, therefore, private green spaces are only likely to be gazetted if they are first purchased by the city or another government body less concerned with economic gain from land, which can then arrange to have the green land gazetted in the public interest. Indeed, the final decision on gazetting essentially lies with the appropriate local government authority. It is not surprising therefore that in 2007 a substantial proportion, at least 48.3%, of the green spaces in DBKL's inventory of officially recognised green space was owned by government bodies of various kinds with 78.8%, at a minimum, of these gazetted. This connection between ownership and gazetting will be discussed in more detail in Section 5.3.1 of Chapter 5.

The purchase of private green land by the city can only happen on any significant scale, however, if funds are available to make this possible. Unfortunately, with high land values in Kuala Lumpur and, as elsewhere, the financial resources of the city likely to be under pressure from various directions, it is difficult for DBKL to be able to do this on any extensive scale, unless the Federal Government allocates substantial funds for this purpose. To the best of the author's knowledge, this has not happened on any significant scale. At bottom, the preservation and extension of urban green space is therefore to a fair degree a question of economic priorities.

In contrast, the gazetting of specific buildings of cultural significance may present fewer problems than green spaces because they are less extensive in area and perhaps fewer in number in KL, though all this might be debated. Also, even when a building is privately owned, if there is general social support for its conservation on heritage grounds, it seems local authorities can take the initiative to gazette it, even if the owner opposes this. However, there can still be considerable legal and political conflict in such cases, especially if the building concerned is on valuable land near the city centre with potential for development.

3.4 Evolution of Urban Green Spaces in Kuala Lumpur and Pressures for Development

The first public park in Kuala Lumpur, and also the first in Malaysia, was proposed in 1888 by Alfred Venning, a planter from Ceylon, according to Ayoub (1989). This park then became a reality in 1898 when 70 hectares of land were identified and later it was established as a public park, originally called the Lake Garden, but now known as Perdana Lake Garden, situated just to the west of the centre of the city.

In the late 19th century a town council was established to govern Kuala Lumpur. During that time the city's greening programmes were undertaken by municipal engineers, with roadside planting and periodical maintenance activities (Ayoub, 1989). Then in the early 20th century Kuala Lumpur established a Department of Town Planning (Shamsudin, 2005) and eventually started more formal procedures and mechanisms to allow control of development. By the 1970's a more comprehensive development plan was being developed by DBKL. However, rapid urban development and the growing urban population have put pressure on the city to permit development on various urban green spaces and this then started to be of some general concern in Kuala Lumpur.

This was further brought into focus when Kuala Lumpur was given city status in 1972. A major city greening programme was initiated in 1973 followed by a massive city greening campaign in 1974 with the objective of rehabilitating the urban environment (Ayoub, 1989). The aim of this campaign was to make the city green by embarking on a tree planting programme (Ayoub, 1989). The success of this campaign can be gauged from the fact that its initial target was to plant 10,000 trees per year and records show that the city in fact successfully managed to plant 130,000 trees during the first ten years of the campaign with a further 100,000 trees planted between 1983 and 1988 (Ayoub, 1989).

Planting of mature trees has been carried out in several phased programmes throughout the city in order to produce a fast impact from the campaign. According to Ayoub (1989), most of the planting was carried out using fast growing trees which include Angsana (*Pterocarpus indicus*), Rain tree (*Entrolobium saman*), Tabebuia

(*Tabebuia pentaphylla*), Flame of the forest (*Delonix regia*), Yellow flame (*Pelthophorm pterocarpum*) and Madras thorn (*Pitchellobium dulce*). In 1985 DBKL began planting flowering shrubs and annual plants, followed by the development of theme parks in the city, including the Orchid Garden, Hibiscus Garden, Mouse Deer Park and Bird Park. Other projects and measures were introduced in the late 1980's such as some new public open spaces and playing fields, more mini-gardens and pocket parks, the riverside beautification project, the preservation of nature reserves and the improvement of recreational facilities around the city (DBKL, 2000).

The first and, to the author's knowledge, only previous comprehensive mapping of green space in Kuala Lumpur was carried out in 1989 by Teh (1989). This exercise in mapping green space was part of the Urban Green Project led by Prof. Lim Teck Ghee (Lim, 1995) and it was funded by United Nations Development Programme (UNDP) through the Urban Management Programme for Asia Pacific (UMPAP), by the University of Malaya and by Malaysia's Ministry of Science. The mapping was based on the 1987 panchromatic aerial photo mosaics of about 0.5 meter resolution and scale of 1:10,000. This project thus identified and mapped areas of green space in excess of 0.5 hectares and of a width of at least 20 metres. Four broad classes of green space types were mapped, namely natural/semi-natural areas (subdivided into forest, scrub, grassland and wetland), managed areas (mostly plantation silviculture, horticulture, city parks and golf courses), abandoned areas and bare surfaces. A very rough similarity with the present thesis is that we also tried to identify such categories as bare ground, water, grassland and trees, though we used 'shrub' as a further type of vegetation, whereas Teh used 'scrub'. It may be worth noting here, though, that in Teh's scheme of classification trees, for instance, could appear under the natural/semi-natural, managed or abandoned (e.g. abandoned plantations) categories.

As a further brief comparison at this point, it may be worth mentioning that the present author's typology is also largely based on types of land use, but includes a number of functional types of green space such as garden nurseries, cemeteries and places of worship apparently not recognised with separate categories by Teh. Thus Teh notes that within his grassland category a sub-category of coarse grassland was found mainly in Chinese cemeteries, whereas using the land parcel data provided by DBKL (to be discussed in more detail in Chapter 5), we were able to identify cemeteries as a category in their own right. We would have liked also to identify such civic spaces as city squares and courtyards which do not appear in Teh's scheme, possibly because they are really open spaces rather than green spaces. However, DBKL's parcel-based land use data did not provide information on these spaces so we could not implement this wish. Thus the categories used here to map KL's green spaces can be seen as extending Teh's, mainly through land use information derived from digital data on land parcels, and perhaps as also covering a broader set of types of urban green space.

From his work on the Urban Green Project, Teh found out that 45.2% of the KL Federal Territory was still covered with vegetation (Teh, 1989). However, he raised the issue of these green spaces *"rapidly being replaced by development projects".* In a subsequent article Teh (1994) mentioned several examples of green space being replaced for residential and commercial developments. These include the large extent of 'rubber land' adjacent to the Sungai Penchala Malay Reserve, which has been developed into major housing estates such as Taman Tun Dr. Ismail (about 9 km west of the city centre), Bukit Maluri and Bandar Manjalara and also include the Selangor Turf Club (Teh calls this the Kuala Lumpur Turf Club), which has now been transformed into the 'Kuala Lumpur City Centre' (KLCC), where the existing Petronas Twin Towers are located (Teh, 1994), albeit a development keeping 24 hectares of its 39.3 hectares for a park with interlinked lakes and recreational facilities. A somewhat similar scenario happened with the Bukit Nanas Forest Reserve where 4.4 hectares at the top of the hill were lost to construct the 420 meter high Kuala Lumpur Tower. Admittedly, this still left some 10.5 hectares of forest reserve on the site, but the loss is a significant intrusion on what has been claimed to be the only remaining patch of tropical rain forest that still stands in the middle of a city and also has remnants of indigenous dipterocarp species.

Critics can cite these examples, taken together, as further evidence that existing statutes and policies over recent decades were not sufficiently strong as regards the protection they afforded to green space in KL, though defenders of DBKL's policies may well counter this criticism by emphasising the value of each of the projects just mentioned to the city. At the same time, the latter may also point out that the sustained efforts of DBKL in protecting green space through gazetting a substantial proportion of it, possibly sometimes in the face of strong pressures for development, should be taken into account here. In addition, DBKL's inventory of officially recognised green spaces, discussed earlier in Chapter 1, shows that in 2007 it had ambitious plans to create 246 new green spaces, increasing the area of officially recognised green space by 752.4 hectares, nearly a 50% increase in area. It is particularly notable that the DBKL records show that 478.4 hectares of these planned new green spaces (63.6%) were already gazetted in advance (DBKL, 2007), which seems to suggest quite a strong commitment by DBKL to increase the protected green area of the city and may even have been designed partly to redress the general loss of green space of previous decades.

Teh's view in 1994 was that, unless there were sufficient legal or statutory mechanisms for monitoring and protecting these spaces more effectively, he could foresee the oncoming situation where further losses in green area would occur, arguably to the detriment of the quality of environment and quality of life for KL's citizens, a worry which seems to have been at least partly justified, albeit with DBKL clearly trying to counter this loss by 2007, if not earlier.

Thus the 1990s and 2000s witnessed further changes in the situation of urban green space as DBKL started to assert more explicitly that it was promoting and prioritising quality of urban environment, quality of life and focusing more on sustainability. It was during this period of time that DBKL also started to introduce their vision of turning Kuala Lumpur into a 'Tropical Garden City' by the year 2020 (DBKL, 2000).

In 2003 the then mayor of KL, Mohamad Shaid, stated that it was the city's target to achieve a ratio of 1.1 hectares of open space per 1000 people. In 1980 the total area of open space in KL was approximately 706 hectares or 0.6 hectares per 1000 people, according to Teh (1989), i.e. slightly over half of the minimum target that DBKL would like to achieve. Kuala Lumpur seems to have selected a target of 1.1 hectares per 1000 population partly on pragmatic grounds, taking into account the limited amount of further land that it perceives will be made available as green space in future in the central city area. Currently, according to DBKL's records for 2007, the city has an open space ratio of 0.93 hectares per 1000 people, slightly lower than the targeted figure. However, this figure is much lower than the standard set by the National Playing Field Association in UK (NPFA), which was 2.43 hectares (6 acres) per 1000 population for outdoor playing space. This is known as the 'NPFA 6 Acre Standard'.

Devising a local target is quite consistent with the approach taken by the UK government when setting its open space standards in Planning Policy Guidance 17 (PPG 17: Planning for open space, sport and recreation). According to PPG 17 paragraph 6, "*the government believes that open space standards are best set locally. National standards cannot cater for local circumstances, such as differing demographic profiles and the extent of existing built development in an area"* (PPG 17, 2002). Although it would very probably have been much easier to attain the 'NPFA 6 acre standard' in the planned new towns surrounding KL, much of the area within the city itself is already so densely built up that in many districts it is not easy to identify sufficient public space to achieve anything like these standards in that district.

To help assess how well the existing arrangements for protecting green space have worked and the role of DBKL in this, it is helpful to examine the data in DBKL's inventory of recognised green space, already discussed briefly in Chapter 1, more closely. The basic breakdown for these recognised green and open spaces in 2007 is shown in Table 3.1 with their distribution shown in Figure 3.5 (DBKL, 2007). Of Kuala Lumpur's 645 recognised existing green and open spaces in 2007 with a total area of 1556.2 hectares, calculations using the inventory records show that at least 308 (47.7%) of these existing green areas covering at least 869 hectares (55.8%) were gazetted. As noted in Chapter 1, the data in DBKL's inventory is rather sparse in some columns, including the 'status' (i.e. gazetted or not) of green spaces. Thus, on status it has 'no information' on 216 of its 891 existing or planned green spaces and another 255 are described as 'not yet applied'. These figures of 308 existing spaces and 869 existing hectares gazetted therefore have to be taken as minima for how much of this 'official' green space enjoys the protection of gazetting; the final 'true' figures, if all entries were complete, could be much higher.

From its 246 green spaces proposed by 2020, consisting mainly of parks of various sizes, playgrounds and sports complexes with a total area of 752.4 hectares, at least 112 (some 45% of the latter total) extending over at least 478.4 hectares (63.6% of the total proposed area) already have the status of being gazetted, as noted earlier. For spaces that were not yet in existence in 2007, this latter figure in particular again seems quite an impressive proportion and suggests a significant commitment by DBKL to extending and conserving green space.

Overall, Table 3.1 refers to a total of 891 existing and planned green areas consisting of a total of 2308.6 hectares of which a minimum of 420 (47.1%) with at least 1347.4 hectares (58.4% of the total recognised green space) are gazetted. Thus of the city's 645 existing green spaces recognised officially, at most 337 or 52.3% are not at present gazetted and these cover a maximum of 687.2 hectares or 44.2% of the total existing green area (DBKL, 2007).

Weighing up all the preceding examples and evidence of loss of green space against the results of examining data from DBKL's inventory which appear to show definite, continuing attempts by DBKL to protect extensive areas of green space through gazetting, it is not easy to come to a clear conclusion about the effectiveness of existing arrangements for protecting green space without much more information on exactly what kinds of green space were lost, say over the last decade, and without examining case studies discussing the pros and cons of a range of examples where green space was lost or was successfully protected. This would entail a separate research project, beyond the scope of the present work.

However, a balanced assessment would need to take account not only of DBKL's possible successes and failures in protecting green spaces, but the whole situation in which DBKL has to operate, particularly the strong pressures of various kinds, including political, for development in a rapidly growing city and the likely lack of funds to permit purchase of good quality, valuable green areas in private hands so they can be gazetted. A preliminary conclusion, when all these factors are considered, might at least be that in 2007 DBKL was doing better than many of its critics might have realised or admitted.

No	Types of Green Space	No. of Existing Green Spaces	Total Existing Area (Hectares)	No. of Proposed Green Spaces	Proposed Size (Hectares)	Expected Total Area (Hectares)
1.	District Parks	8	441.08	5	145.17	586.25
2.	City Parks	11	103.52	2	170.98	274.50
3.	Local Parks	36	66.37	24	52.36	118.73
4.	Neighbourhood Parks	2	33.02	24	270.46	303.48
5.	Playgrounds/Playing Lots	551	162.81	172	63.74	226.55
6.	Sports Complexes	23	169.75	12	44.80	214.55
7.	Fields/Golf Courses/Polo Fields	11	519.57	-	-	519.57
8.	Forest Reserves	3	60.04	-	-	60.04
9.	Green Areas	-	-	7	4.90	4.90
	TOTAL	**645**	**1556.16**	**246**	**752.41**	**2308.57**

Table 3.1: Statistics for Presently Recognised Green Spaces in Kuala Lumpur City (Source: DBKL, 2007)

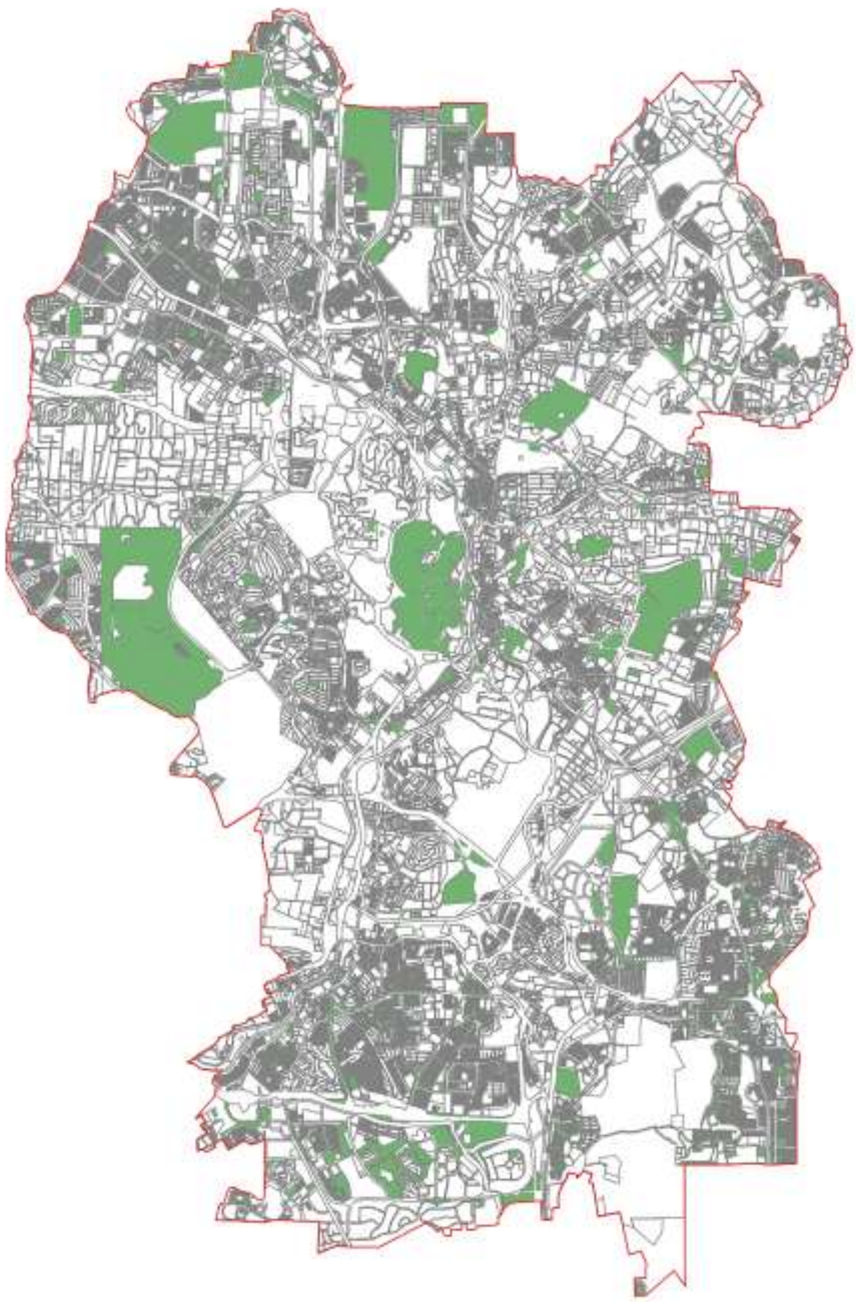


Figure 3.5: Distribution of areas in Kuala Lumpur that formally classified as green and open spaces and forest in the parcel based data
(Source: DBKL, 2007)

3.5 Kuala Lumpur's Typology for its Green Spaces

The main body of the KLSP 2020 document frequently refers to 'public open spaces'. It is not entirely clear what this means precisely, but it seems reasonable to assume that in this document it must certainly include those district parks, city parks, local parks, neighbourhood parks and playgrounds which are officially recognised by DBKL as green and open spaces and whose basic attributes are set out in Table 3.1. It may well also include the categories of 'forest reserve' and 'sports complexes'.

In fact, the map of 'public open spaces' provided in KLSP 2020 is very similar to Figure 3.5 which simply maps the 'green and open spaces' category from the land parcel data provided by DBKL (and which will be explained in more detail in Section 5.3.1 of Chapter 5). Thus on both maps the two 18 hole and one 9 hole courses of the Royal Selangor Golf Club (RSGC) stand out prominently to the east of the city centre in their splendid expanse of parkland (Teh (1989) calls it 'savannah'), as does the Bukit Jalil Golf and Country Club Resort with its 18 hole course near the southern boundary of the city. Thus KLSP 2020's concept of public open space clearly also includes the category comprised of 'sports fields, golf courses, polo fields, horse racing tracks' etc, though nearly all of the latter are private (DBKL, 2003). In KLSP 2020's usage therefore the term 'public open space' seems not to be confined to spaces which are publically owned and freely accessible to the public. It is fairly clear from the preceding discussion that, very probably, it simply means all officially recognised green and open spaces i.e. all those comprising Table 3.1 As noted in Section 3.4, at least 48.3% of these 'recognised' spaces are owned by DBKL, 'government' ('kerajaan' in DBKL's inventory) or other government or public bodies with 78.8% of the latter gazetted.

The glossary appended to the main text of the KLSP 2020 document does include the term 'green spaces' among the various terms listed and these are defined as areas that are generally covered with natural or planted vegetation, including not only the open spaces previously mentioned, but also the utility and infrastructure corridors, buffer zones, forest reserves, agricultural areas, cemeteries, nurseries, areas covered by shrubs and residential compounds (DBKL, 2003). DBKL does not use this broad definition in the main body of this text at all, for instance, in auditing the distribution of their urban green spaces.

As stated earlier in Section 3.4 and shown by Table 3.1, generally for official purposes DBKL only appears to recognise the 4 types of park and 3 types of recreational spaces that are mainly for recreational purposes plus forest reserves and 'green areas' (none of which actually existed in 2007) as the sole types of 'official' green space in the city. In many ways this is understandable as DBKL has till recently probably been primarily concerned with the parks and recreational areas it owns and manages and its typology has naturally reflected this. However, as the wide range of benefits conferred by urban green spaces becomes better known and appreciated, especially the environmental benefits, and as society places a higher premium on quality of environment, a more comprehensive view seems desirable. It can thus be argued that DBKL's typology tends to underestimate the quantity of Kuala Lumpur's existing urban green spaces and the range of benefits they bestow on the city. Since many of these recognised spaces are managed by DBKL, however, the more sceptical critics can pose the question of whether DBKL is worried that formally recognising a wider and rather more diverse range of green spaces might encourage demands for DBKL to exercise some management responsibilities over some of these, which might put extra demands on their limited resources and might even stimulate requests to have them gazetted, thus restricting sites available for development.

In Section 2.11 of Chapter 2, the restricted range of green spaces that are formally recognised and accounted for by DBKL was discussed. Evidence from research on green spaces (Section 2.5 and elsewhere in Chapter 2) showed that, in its truest sense, green space should not only include spaces for recreational purposes, but should also cover far more than parks and gardens. Recognising that the benefits of green space cover the whole range of social, environmental, economic and health and well-being aspects, we argue here for a typology of green spaces for Kuala Lumpur that should include most types of vegetated areas (such as agricultural land, cemeteries, infrastructure corridors, residential compounds etc.). Extending this recognition to other types of spaces as potential green spaces could enable other land that is serving green functions to be protected, which otherwise might be developed for other purposes in the future.

To explore further types of land that might also be recognised and thereby possibly protected as green spaces in Malaysia, a review of several definitions and typologies of green spaces from a number of other countries was carried out in Section 2.11. Although some types of green spaces identified in other countries are not relevant for Malaysia, evidence was found to support the inclusion of several further types of green space that are not presently recognised by the Malaysian policy documents. Based on this broader analysis, a revised and expanded typology has been developed by the author for recognising green spaces in Malaysia generally, but also intended specifically as a basis for mapping green space in the city centre of Kuala Lumpur. This typology will be 'sense-checked' against the views of planners (to be discussed in Chapter 4). In Chapter 5, we then assess which of these types of land use may be identified by remote sensing.

A typology of green spaces proposed for Kuala Lumpur, expanding on DBKL's presently used existing categories is presented in Table 3.2. The additional categories are selected from typologies used by organisations or local authorities in other countries as reviewed in Section 2.9.

Main Category	Sub-Category
Public open space	District parks
	City parks
	Local parks
	Neighbourhood parks
	Playgrounds/ Playing Lots
	Playing fields
Private open space	Private residential areas including houses with gardens
	Private recreational areas including: golf courses, polo fields, driving ranges, outdoor sports centres, outdoor pools
Infrastructure and utilities corridors	Road reserves
	River reserves
	Rail reserves
	Electric line reserves
	Reservoirs
Natural or semi-natural green spaces	Forest Reserves
	Wetland
	Water
	Vacant / derelict land
	Former mining land
Civic spaces	City squares
	Boulevards
	Waterfronts, river and lake embankments
Other functional green spaces	Community facilities
	Educational areas
	Places of worship
	Cemeteries
	Agricultural land
	Garden nurseries

Table 3.2: Suggested typology of green space for Kuala Lumpur City

In KLSP 2020, it seems that the land considered as eligible to be classed as officially recognised green or open space is mainly publically owned land. However, the new suggested typology listed above includes a greater number and diversity of urban green spaces, privately as well as publicly owned. Some categories that are not in other countries' typologies, but found in Malaysia, are also added, namely the classes of ex-mining land, derelict land, garden nurseries and agricultural land. Previously mined and derelict land is widespread in some parts of the city. Although these areas may not have high amenity or aesthetic value, many are colonised by semi natural vegetation and wildlife which contributes to biodiversity and perhaps to improving air quality as well.

Garden nurseries constitute another type of green space that should be included in this new expanded typology. Quite extensive areas of land in the peri-urban areas are covered temporarily by trees, shrubs and other plants which are being sold commercially for both private and public usage. Some land use categories from other typologies (i.e. European typologies) which are not found in Malaysian cities were not included, such as garden allotments because allotments of the kind common in British cities are simply not found in Kuala Lumpur. However there are still some agricultural areas or rather plantations that have remained cultivated between expanding built-up areas, particularly towards the outskirts of the urban area; since these consist mainly of palm oil trees they particularly merit inclusion as green space.

These amendments and adaptations create a typology that arguably describes more completely the types of green and open spaces encountered in Kuala Lumpur city centre and its environs. It is hoped that this process of developing a broader way of defining and categorising green space may help to lay a foundation through which a wider set of land that serves green functions may be recognised and protected.

3.5 Summary and Discussion

KL has been chosen as the subject for this research since it has been one of the most rapidly developing cities in South East Asia over the last forty years. The literature review has revealed a reasonable base of existing literature about the city's attempts at urban greening within the framework of strategic urban planning. Exploratory work by the author further established that adequate, although slightly dated, sets of remotely sensed, land parcel and population data were available for KL that seemed sufficient to permit a 'proof of concept' study.

Walking around any city in Malaysia, it is obvious that Malaysia is still undergoing a period of rapid economic development. Urban areas in this country have been developing progressively since independence in 1957 with population increasingly concentrated into urban areas. As a consequence of this rapid urbanisation, the central city area of Kuala Lumpur in particular has lost a lot of its green spaces. A number of authors have contended that there is now an urgent need for the government to redress this imbalance and to develop a comprehensive means of monitoring the provision, extent and condition of green space more thoroughly as the population continues to rise, and to conserve green space more pro-actively against development pressure. Although newer suburban and satellite new towns have been constructed around KL, some with ample green space, ratios of green space for residents in the central city are below international standards.

During the official opening ceremony of Malaysia Green Forum 2010, the Prime Minister of Malaysia stressed that the government and the country in general disapprove of promoting economic development without considering its environmental consequences and that an awareness of conserving the environment through systematic planning must now be a major priority (Prime Minister's Office, 2010). However, these positive statements, enshrined in the 2020 Structure Plan for KL, require firm action, enforcement by legislation and a solid base of up to date information about green spaces in order for them to be implemented successfully (Sreetheran and Adnan, 2007).

Through a close reading of policy documents and commentary upon these by independent researchers, this chapter has shown that the government has carefully and explicitly outlined its vision and strategies for developing the country economically. At the same time there is more evidence in planning at various levels since around 2000 that the government is now considering urban environmental sustainability more seriously. Vision 2020 emphasises balanced development, stressing enhancing the quality of life and the importance of conserving the environment as integral to becoming a developed nation by the year 2020. Malaysia's proclamation of becoming the 'Most Beautiful Garden Nation' by 2020 is a widely supported vehicle by which the state and the private sector can be encouraged to conduct urban greening actions as part of the wider economic development programme for the country.

Considering the old city centre of Kuala Lumpur, there have been successive phases of urban development since the city was founded. It started as a small town, then grew into a metropolitan city and now has a clear intention of becoming a world class city. The city's policies and strategies in the Kuala Lumpur Strategic Plan and the

Kuala Lumpur City Plan have also evolved in line with these changes. DBKL has localised the ‘Garden Nation’ idea into the ‘Tropical Garden City’ concept. Issues related to environmental quality and quality of life have been taken into consideration as a matter of concern in both the strategic plan and the local plan. Urban greening is proposed as one way to turn Kuala Lumpur into a more liveable and sustainable city and in ways considered compatible with economic development. The fact that 55.8% of the existing hectares of DBKL’s recognised green spaces and 63.6% of those proposed in 2007 were gazetted (the latter in advance of their creation) can perhaps be seen as significant steps towards that greening and towards the vision of a ‘Tropical Garden City’ through protecting KL’s existing green spaces and extending them in a secure way, though this can only be part of what is really needed.

The issues of enhancing the living environment and improving quality of life are stated as a main focus in both strategic and city plans. Nevertheless, there are some implementation weaknesses in how the greening and the ‘green infrastructure’ of the city are approached in both these strategic and local plans. For example, although strategies for enhancing urban green space are included, no clear definition has been proposed for which types of urban green spaces should or should not be included. The identification of the actual distribution of existing urban green spaces in both these plans is rather restrictive and does not represent the ‘real picture’ of all the functioning green spaces that exist in the city, possibly mainly because DBKL has till now been primarily concerned with the parks and recreational areas it owns and manages, which is understandable. However, as the range of benefits conferred by urban green spaces becomes better recognised and understood, particularly environmental benefits, and as quality of environment becomes more important to city dwellers, a more holistic view of green space seems to be timely. It has thus been argued that DBKL’s somewhat restrictive typology tends to underestimate the extent of Kuala Lumpur’s existing urban green spaces and the diverse benefits they bring the city. It is also difficult to use this more restrictive framework in trying to develop forward looking strategies e.g. proposing strategies for conserving and protecting any particular examples of the additional types of green space just discussed which particularly merit preservation before they are developed for other uses.

Given the projected growth of Kuala Lumpur's city centre population, the need for effective planning of urban green space is critical. Some evidence was presented suggesting that the existing approach taken by DBKL could perhaps be more pro-active and could be enhanced by considering the use of at least some of the same information resources that are now used in some other countries, especially the more developed countries, as highlighted in Chapter 2.

As well as the greater enforcement and the better co-ordination of responsibility for development control and green space planning advocated by Sreetheran and Adnan (2007) and others, revised practices should take into consideration all information potentially available to planners. As part of this requirement for information on green spaces, it would seem prudent to map not only the presently recognised areas but also areas that may be recognised as green spaces in the future and to do this more frequently and comprehensively than has been done previously. Adapting a typology such as PAN-65 to the culture of Malaysian cities is one way to begin the debate about whether a wider range of green spaces should perhaps be recognised in Kuala Lumpur. Such efforts should enable more comprehensive auditing of the 'real picture' of Kuala Lumpur's green spaces and, we argue, have the potential to provide a more complete picture on which to base future plans. If the land uses that should be included in full or in part within any future auditing of the pool of available green space can be agreed, one is then in a better position to produce both a more realistic current picture of green space in the city and a foundation for a forward looking and strategic assessment of potential areas that may need to be considered in future.

Chapter 4

RESULTS OF THE QUESTIONNAIRE ON THE NATURE, FUNCTIONS AND MANAGEMENT OF GREEN SPACES IN KUALA LUMPUR

4.0 Introduction

This chapter discusses the results of the social survey of relevant professionals (mostly urban planners and landscape architects) in Kuala Lumpur whose work involves them in various ways with the city's landscape and its built environment. As outlined in discussing the basic questions addressed in this thesis in Section 1.4 of the first chapter, the basic purpose of this survey was to investigate the nature of urban green space in KL as these professional workers understand it and to examine how they perceive its various roles, functions and benefits, including KL's aspirations for its green spaces and their possible role in KL's ambition to be seen and accepted as a 'Tropical Garden City'. The survey also tried to gain insight into the general situation regarding the protection and loss of green space in KL, including the difficulties of preserving it in the light of pressures for its development, and followed on from that to ask the respondents to evaluate a number of environmental and social criteria that might be considered in assessing how strong was the case for a particular green space to be preserved.

A few of the survey's respondents may have been involved in formulating, implementing or administering Kuala Lumpur's policies concerning its green spaces in recent years so their views, opinions and insights have the potential to be of particular value from the fairly close and continued involvement concerned. It is also possible that some of the respondents may be able to some degree to influence policy formulation about the conservation or development of urban green spaces in the future, but this is of less significance here as the author is mainly concerned with their past experience and their current views held when completing the survey.

This chapter begins with an account of the rationale underlying the social survey, the method and procedures through which it was carried out and possible sources of bias resulting from the nature of the sample of respondents obtained. The discussion of the results then starts by characterising the respondents' professional backgrounds. Next, their ideas and opinions about various aspects of urban green spaces in Kuala Lumpur are analysed in some depth, including their thoughts about what the phrases 'Tropical Garden City' and 'green space' mean and about what they perceive to be the main roles and functions of green spaces in Kuala Lumpur, considering both their benefits and negative aspects. The respondents' views on Kuala Lumpur's aspirations and goals for its green spaces and on how important various possible objectives should be in any future policy or plan for green spaces in Kuala Lumpur are then discussed.

The next section in this chapter is then focused on the respondents' opinions about how vulnerable green spaces are in Kuala Lumpur, including their assessments of development pressures on these spaces, of the amount of green spaces that Kuala Lumpur has lost over the last ten years and of how difficult it is to protect and preserve green spaces in Kuala Lumpur. Finally, the chapter explores the respondents' evaluations of how important certain environmental and social criteria should be for retaining particular green spaces.

4.1 Methods: The Design of the Main Social Survey and its Implementation

As just noted, a social survey using a questionnaire was carried out to gather opinions from certain relevant professionals regarding their views on the nature, functions and management of Kuala Lumpur's green spaces and various problems related to those topics. The questionnaire for this survey was developed in several stages before finally being implemented during the field trip to Kuala Lumpur in April 2009.

The first stage in developing the main questionnaire occurred at a relatively early stage in the research during the summer of 2007 when a series of interview schedules were prepared to be used as part of exploratory field work in Kuala Lumpur during a short field visit. This field visit was carried out mainly to try to secure appropriate remotely sensed data, but it gave the opportunity to try out early drafts of the questionnaires or interview schedules that might eventually be used to interview planners and other professionals in DBKL. When these initial interview schedules were drafted the author had no previous experience in designing or carrying out social surveys and had only read a limited amount of the extensive literature, not only on this topic but also on the wide range of benefits provided by urban green space. As a result, in retrospect the interview schedules devised in a relatively short period now appear rather naive and imprecise in the way some of the questions were worded and also limited in the range of topics covered as compared to the final questionnaire implemented in April 2009.

Three interview schedules were designed for this exploratory study: one to interview planners and landscape architects working in DBKL; a fairly similar one for staff in other organisations; and a shorter one to interview members of the public which was mainly concerned with how people used different kinds of green spaces, how accessible they found these, their activities when they reached the green space and their comments on the facilities provided and on the condition of the green spaces they used, usually parks. The interview schedule used for DBKL staff is shown in Appendix A. One obvious limitation of this is that it fails to ask any questions about what the respondents think the roles, functions and benefits of green spaces actually are, though it asks more questions about the information collected on green spaces and its possible availability, since obtaining data on green spaces was a prominent concern at that stage.

The inexperience of the author at that time in wording questions is particularly shown in Section D of the latter interview schedule on the protection of green spaces. Here the first question asks "Are you protecting your urban green spaces from land use change (e.g. land development?" In reply, respondents were asked to tick boxes marked 'Yes', 'No', 'Sometimes' or 'Don't know'. If they had ticked 'Yes' they were then asked 'If yes, how?' In fact, the wording of this question almost implied that a substantial part of the onus for protecting green spaces lay with the individual being interviewed, which could possibly be somewhat intimidating to that individual and is clearly naive in a large complex organisation like DBKL, even if quite senior staff were being interviewed, which was never the case. In reply, if respondents had some involvement in their work for DBKL with green space, they tended to describe what they themselves actually did, which often did not give any insight into the real policies and actions of DBKL as an institution. If respondents had no direct responsibility at work for green space, they naturally tended to say “no” or “don’t know” in reply, even though they might have had informative, and possibly critical, views or insights about DBKL’s role on this issue through being planners interested in the topic who were also working in DBKL and had possibly discussed the topic with colleagues. To avoid these problems with this topic in the final questionnaire, respondents were given a list there of 8 statements such as ‘KL is trying hard to retain and protect its existing green spaces’, ‘KL is enforcing its policies for protecting its existing green spaces’ etc. and asked to indicate to what extent they agreed or disagreed with these statements by using a scale from 1 to 5 (Question 26 in Appendix B) i.e. a Likert scale. This tried to ensure that respondents would state their own views about DBKL’s enforcement of its policies etc., whether their work involved green spaces or not. For similar reasons, Question 17 in the exploratory interview schedule, which was intended to clarify KL’s aspirations and objective for its green spaces in the future, was also converted to a Likert scale as Question 20 in the final questionnaire (Appendix B). Thus, though it was not really a pilot study in any strict sense, valuable lessons were learned from the draft interview schedule on the wording and style of questions and on a number of the other problems of conducting social surveys which were invaluable in formulating the main questionnaire for the survey carried out in April 2009.

The initial content and concerns of the exploratory interview schedule were essentially based on a list of the environmental and social benefits which urban green spaces had been found to confer on users and on the city as a whole, derived from an initial study of the research literature discussed in Sections 2.5 – 2.10, though when the exploratory interview schedule was being drafted only a limited amount of this literature had been studied. After referring to several examples of questionnaires previously used to study green spaces (greenSTAT, 2007), an initially limited set of beneficial effects was expanded and reformulated and the interview schedule was redesigned into a ‘semi-structured’ format (Appendix A) which was then used to interview a small number of urban planners (16 in total) in Kuala Lumpur City Hall in August 2007, as just noted.

This interview schedule could be described as 'semi-structured' in that it consisted of a list of questions to be asked but these were not always asked in the same order, as would happen in a structured interview. Instead, since this was still an exploratory stage in the study, these interviews followed a more conversational style, sometimes allowing the scheduled questions to be asked as each topic of interest cropped up in the flow of dialogue, which was often informative, especially at this early stage of the research. This also meant that extra questions not on the schedule could be asked in some cases to try to gain further information or insight from particular respondents. It should also be noted that because of the limited amount of time available for these interviews, some of the respondents were interviewed in pairs or, in one case, as a group of three, which probably further fostered a more conversational style of dialogue.

Thus this flexible, exploratory schedule of questions was used in August 2007 to interview 16 urban planners, hoping to ascertain and try to understand better the current situation and planning practices related to urban green spaces in Kuala Lumpur, as well as to try out the interview schedule. The responses from the survey were then used to improve and redesign the schedule of questions, as previously mentioned. Finally, after undergoing several stages of redrafting, a structured questionnaire was developed for the main survey (Appendix B) in which an identical set of questions was presented to each respondent, always set out in the same order, to complete on their own following a workshop for DBKL staff on the potential of remotely sensed images of high resolution from satellites (hence the term 'questionnaire' rather than 'interview schedule' is appropriate here as interviews were not involved). The broad topics covered by these questions and the choice of specific questions under each broad heading in the questionnaire follow on fairly naturally from some of the main elements focused on in the research as outlined in Section 1.4, i.e. the questions stated there at item (iv). The questionnaire was thus divided into five sections which accord roughly with its main aims as further elaborated at the start of the present chapter:

(i) Section A consisting of questions about a respondent's professional background, qualifications and experience;

(ii) Section B mainly asking respondents about their ideas on what green spaces are and their functions and benefits in Kuala Lumpur;

(iii) Section C seeking respondents' views on Kuala Lumpur's aspirations for its green spaces and on how important they think certain goals for green spaces should be;

(iv) Section D attempting to obtain information on pressures for development and on how vulnerable green spaces are in Kuala Lumpur; and

(v) Section E asking respondents how important they believe certain environmental and social characteristics should be in informing decisions about whether to retain a particular green space.

Both the interview schedule employed in the initial exploratory study of urban planners in August 2007 and the questionnaire used in the main survey in April 2009 used a mixture of 'closed' and 'open-ended' questions plus some questions using Likert scales. In giving the respondent a choice between specified categories for response, 'closed' questions have several advantages. Firstly, they are more convenient for the respondent and can therefore save valuable time when investigating a large and potentially complex topic which can easily lead to interviews or questionnaire completion times becoming too long, resulting in the respondent being reluctant to give the interview or failing to complete and return the questionnaire, thereby lowering the response rate and size of sample obtained. Secondly, they facilitate quantitative analysis by allowing the number of responses in each category for the sample or sub-sections of it to be counted and possibly subjected to further statistical analysis which can, arguably, add more rigour to the analysis (Gardner, 1978).

The disadvantage of closed questions, however, is that they can sometimes involve the researcher imposing his or her own terminology or conceptual framework for analysis on the respondent to whom this may be unfamiliar, understood differently or even alien to their thought processes (Gardner, 1978). This may not be a danger when a fairly straightforward question can clearly be answered by 'yes', 'no', 'no opinion' or 'do not know', but it has to be kept in mind in more complex or sensitive questions.

Such danger can be avoided or reduced by initially broaching a topic through an open-ended question such as "what do you think are the main benefits of green spaces to Kuala Lumpur" (Question 15 in Appendix B), which allows the respondent to express their own ideas and opinions freely in their own terms (Gardner, 1978). The disadvantage of such open-ended questions in this context is that they can produce longer, more discursive answers which take time to transcribe and be more difficult to analyse, though they may be particularly illuminating about individuals' viewpoints and the diversity of these in the sample. Another disadvantage of open-ended questions is that replies may fail to mention aspects or topics which the researcher regards as important but have somehow been forgotten by a respondent who might have had definite views on it, had that aspect or topic been raised. It can therefore be helpful to introduce a topic through an open-ended question but follow it up by closed types of questions which ask for comments on the importance or significance of specific aspects of it. Thus, in the main questionnaire survey open questions about the roles and functions (Question 14 in Appendix B) and about the main benefits (Question 15 in Appendix B) of green spaces in Kuala Lumpur are followed later by questions asking respondents how important they think various specific objectives should be in future policies or plans for green spaces (Question 20 in Appendix B) and how important specific characteristics should be in informing decisions about retaining green spaces (Question 28 in Appendix B). Thus, a number of the objectives and characteristics listed in the latter two questions can be seen as functions or benefits of green spaces and therefore ask for comment or further comment on topics which may or may not have been commented on in the related open questions earlier in the questionnaire.

As well as the 'open' and 'closed' questions, a small number of questions in the main survey used Likert scales which can be employed to ask the respondent (e.g. on a scale from 1 to 5) how important a particular objective or attribute is in a specific context or how strongly they agree or disagree with a particular statement or judgement (e.g. Question 26, as already noted). Questions using Likert scales can be seen as sharing the advantages of convenience and ease of quantitative analysis of closed questions. While they also have the disadvantage of being composed of terms, attributes or categories ultimately selected by the researcher, they can allow the respondent to indicate that some of these are not important to her or him.

The final questionnaire employed a balance of open, closed and Likert scale questions: 11 questions could be characterised as essentially of an open type, 5 were basically ‘closed’, 4 used Likert scales and 1 involved ranking the 3 most important objectives (Question 21 in Appendix B). It is therefore hoped that by employing such a mixture of question types, sometimes covering similar or closely related topics by both main types of question, the main disadvantages of both open and closed questions could be avoided, while keeping the questionnaire of manageable length. It is also worth noting that consideration of replies to some of the open questions asked in the exploratory interview schedule allowed these to be reformulated more appropriately as closed questions in the final questionnaire. For instance, open Questions 18, 19 and, to some extent, 20, about the protection of green space in the former schedule of questions (Appendix A) were replaced by Question 26 in the latter questionnaire. The latter allowed respondents to give a more comprehensive and impartial assessment of how well or badly Kuala Lumpur was doing as regards protecting its green spaces, as discussed earlier. Some of the main benefits from the use of the exploratory interview schedule in 2007 were that it gave the author a much better idea of the advantages and disadvantages of open and closed questions and also of the advantages of Likert style questions which had not been used at all in the exploratory study.

For the main survey, questionnaires were distributed to two different groups of potential respondents with replies being obtained in somewhat different ways in each case. The first group of respondents was obtained from participants in a workshop held in Kuala Lumpur City Hall (DBKL) on 10th April 2009. This workshop had several purposes. The first was to make DBKL staff from relevant departments aware of how useful remotely sensed images from satellites with a high resolution could be to planners and landscape architects at acceptable cost in certain contexts, including assessment of green spaces in cities. This involved a presentation using appropriate images by Dr. Neil Stuart of Edinburgh University and Duncan Moss of the Ordnance Survey, followed by questions from the thirty to forty participants, mostly from the Master Plan and Planning Departments plus a smaller number from the Landscape Department. Altogether this part of the workshop lasted around two hours.

After a break, a short talk was given to introduce and explain the second aim of the workshop i.e. the distribution and completion of the main questionnaire on how green spaces are viewed and valued by the workshop participants. This part of the workshop was attended by a much smaller number of participants with the consequence that only 13 completed questionnaires were returned at the end of the workshop (8 from urban planners, 4 from landscape architects and 1 from an agricultural officer), probably mainly a result of the pressure of time on busy staff who had already given a significant amount of time to the first part of the workshop. After a very short introductory talk, participants could ask questions about the questionnaire, which a few did. Each questionnaire was then completed on their own in the workshop by the respondents, so no interviews were involved. Respondents could have asked questions while they were actually completing the questionnaire but none did. An attempt was made to obtain more completed questionnaires after the workshop by e-mailing senior staff in DBKL and asking them to circulate this questionnaire, but no further returns were received from DBKL staff. This set of replies are potentially of particular value for the research due to them coming from staff who were directly involved with day-to-day planning in Kuala Lumpur.

The third part of the workshop involved an attempt to see how successful these DBKL staff would be in estimating the values of certain characteristics for a number of green spaces in Kuala Lumpur (e.g. the proportion of that site where trees provide shade and shelter), using images derived from the IKONOS satellite. To make these estimates the 13 participants who had completed the main questionnaire were each given a compact disc with images of 12 green spaces, each delimited from its surrounding area by red lines on the image. They were then asked to estimate the relative values for a series of characteristics using 5 point Likert scales from ‘very low’ to ‘very high’ for each attribute and asked to record their results for each site on questionnaires designed for that purpose. These participants were asked to complete the latter questionnaire later in their own time when convenient using the images supplied and return them in due course. The intention was to see how these estimated values would compare with values estimated from field work at each site and also to see how confident the respondents would feel in making their estimates (these site questionnaires asked them to indicate how confident they were in the evaluating each attribute).

Again, probably due to time pressures only four of the 13 participants in the latter part of the workshop returned site questionnaires, each for only 4 sites, despite reminders being sent by e-mail. With such limited and sparse data it was felt there would be little academic value derived from analysing these responses. Nevertheless, given more time to obtain a larger and more complete set of responses, in future research it could be illuminating to see how well such professionals could estimate certain attributes of green spaces, whether they could identify particular categories of green spaces and whether they felt they learned anything new about a particular green space from such images even when they already had some familiarity with that site.

The second set of respondents to the main questionnaire involved a broader group of professionals (28 in total) with experience in urban planning (9 in total), landscape architecture (16 altogether) or related environmental fields (one architect, one urban forester and one GIS professional) from various organisations in Kuala Lumpur outside DBKL. These included staff from academic and research institutions i.e. Universiti Malaya (UM), Universiti Putra Malaysia (UPM), Universiti Kebangsaan Malaysia (UKM), Universiti Teknologi MARA (UiTM), the Forest Research Institute of Malaysia (FRIM), Lagenda College plus those working in various departments of the national government such as the National Department of Town Planning (JPBD), the National Landscape Department (JLN) and the Public Works Department (JKR) and also one working in a private consulting agency. The questionnaires were distributed to this group of respondents by targeted email. The responses from this sub-group are potentially very useful in getting a wider set of opinions from respondents who are not working directly for the city administration but are probably indirectly involved with city planning to some degree (at least in the broad sense) and may have some experience with or knowledge of policy formulation and practice. The mix of responses from the two groups may thus allow a more balanced and wider diversity of views to be obtained and thus enrich the results and findings of the research.

Essentially, as just noted, the sample of respondents in the main survey was obtained firstly by distributing the main questionnaire to participants in the workshop held in DBKL on 10th April 2009 and, secondly, by circulating it as widely as possible by email to staff in academic and research institutions, various departments of the national government and some private consulting agencies. In all this the main aim was to make the questionnaire available to as many people as possible in Kuala Lumpur who had professional training in urban planning or landscape architecture or in other disciplines dealing with the environment or built environment in cities and also to others who might have experience in dealing with such topics through work or other responsibilities, even if they did not have formal academic training in the latter disciplines. To ensure all respondents had reasonably good knowledge of Kuala Lumpur, questionnaires were only distributing to people working in Kuala Lumpur, most of whom probably also live in Kuala Lumpur or its suburbs.

Since the resulting sample consisted of individuals from the targeted groups who opted to reply, the respondents were self-chosen rather than consisting of individuals selected by random numbers or other probability methods from a clearly defined population or sampling frame designed to ensure the sample was unbiased and as representative as possible of the population it was drawn from. Instead, the sample could be characterised broadly as a kind of purposive sample (Gardner, 1978; de Vaus, 1996) where the sample is drawn from people judged to be appropriate to answer the questions involved because they are thought to be fairly typical of the wider population of interest which, in our case, could be considered as all the relevant professionals with knowledge of or experience with the situation and nature of green space in Kuala Lumpur. Clearly the sampling method used does not therefore allow us to estimate accurately the proportions of professionals in Kuala Lumpur who hold particular views or allow us to attach a sampling error to such proportions. However, as de Vaus (1996) notes, when researchers are mainly interested in finding out the range of opinions in a population (which was essentially one of our main objectives), non-probability methods (not least purposive sampling) can yield very useful information.

In our circumstances it would have been difficult and time consuming to compile a sample from listing all the relevant professionals so that an appropriate number could be selected by probability methods. It is also uncertain how many selected in this way would have completed the questionnaire since questionnaires distributed by mail (and probably by email too) generally have low rates of response, often only around 10%.

In contrast, distributing questionnaires and collecting returns in the workshop probably helped to ensure replies from a third or more of the participants, though more had been hoped for. Thus, the methods used to obtain the sample were strongly influenced by practical considerations and by the limited time and resources available.

It is quite possible that a sample consisting of individuals who themselves made the decision to reply, especially in the case of those receiving it by email, could have some biases. Unfortunately, the nature of the purposive sampling method makes it difficult to assess such biases. However, the examination of the backgrounds and experience of the respondents, which follows shortly, shows there are no conspicuous or particular reasons to suggest that these respondents were unrepresentative or untypical of the whole population of relevant professionals in Kuala Lumpur. In fact, it can be argued that those most motivated to reply were likely to be those most interested by virtue of having relevant work experience or responsibility or an inherent interest in green spaces. Generally such people are likely to be better informed and more knowledgeable about the topic. This particular 'bias' may therefore have helped to ensure the questionnaire was more likely to be answered by those most appropriate to do so.

Nevertheless, in assessing the results from the main questionnaire, it must be borne in mind that there may be biases in the sample and that the picture it gives of respondents' views may not necessarily be exactly representative of the whole population of relevant professionals in Kuala Lumpur (Stuart et al., 2009). However, the sample does provide a range of information, views and insights from these professionals in Kuala Lumpur likely to be knowledgeable and fairly well informed about the topic and related planning policies and practices, particularly those working in DBKL. Since there has been little research on green spaces in cities outside the developed countries, a sample which yields a range of relevant information and opinion on the topic is potentially very useful, even if it may not be entirely representative.

It would have been interesting to pose most, though not all, of the preceding questions to a wide range of members of the public i.e. a broad spectrum of the users of, say, a selection of various public parks in Kuala Lumpur, asking for instance what they understand by ‘urban green space’, what benefits they think these confer and what characteristics make particular green spaces more attractive or less so. However, such investigation would have inevitably required a social survey using interviews to collect such information and this would have had to take account of the possibility that respondents of different genders, age groups and religious and ethnic backgrounds might view green spaces in the city differently and that responses might also vary according to which space respondents were interviewed in. To gain an accurate picture of how such variables affected the results would have required a fairly large sample of interviews at several locations. The substantial amount of time needed to carry out such interviews and to analyse the results thoroughly precluded such an undertaking within the present thesis. Such a survey could well be a very worthwhile direction for future research.

Nevertheless, as part of the exploratory survey work done in KL in the summer of 2007 and as a rough kind of pilot to test questions for possible use in a later questionnaire, a limited number of users in various public parks were interviewed, posing questions about how people used different kinds of green spaces, how accessible they found these, their activities when they reached the green space and their comments on the facilities provided and on the condition of the green spaces used, usually parks. As with the exploratory interview schedule for planners in DBKL, it was subsequently realised that some of the questions in this interview schedule were not well worded and a few were possibly not appropriate for those interviewed. In addition the sample involved was too small to allow systematic statistical analysis. As with the exploratory interview schedule for planners in DBKL, however, some of the responses from these interviews were quite informative for the research in some way and useful in refining some of the questions posed in the main questionnaire for professional respondents in April 2009. For instance, it seemed fairly clear that to those members of the public interviewed, ‘urban green space’ almost exclusively simply meant parks of various types and sizes, so in any further investigation their replies regarding the functions and benefits of urban green spaces would probably have been mainly confined to that category of green space.

The principal advantages of confining the main social survey to professional respondents were that it saved time by concentrating on a smaller group of potential respondents who were mostly quite easy to contact by various means and it obtained information on how green spaces were viewed by a particularly knowledgeable and possibly quite influential group who could possibly articulate a wider range of views on certain aspects more fluently than many members of the public. It also meant that a number of important but somewhat technical questions could be asked e.g. about the data professionals thought were needed on green spaces and the extent to which these needs could be met by remotely sensed data; these would probably have been inappropriate for most members of the public. In addition, it was possible to ask the professionals questions about such topics as pressures on green spaces and where these were felt, the factors which make it difficult to preserve green spaces and whether the city is or is not trying hard to retain and protect its green spaces. Most members of the public would probably have found it more difficult to provide the useful insights on such questions obtained from the urban planners and landscape architects who responded.

Thus the latter were probably able to provide better information and generally richer insights on a number of important questions for the research than most members of the public. While there were therefore several reasons to confine the social survey to the former group in the time available, it should be emphasised that a fuller understanding of how green spaces are viewed, evaluated and used in Kuala Lumpur will require the perceptions of the public to be known and examined; the views of the professional respondents cannot be taken as a substitute for the latter.

The replies obtained in the main survey were coded and collated, and then tabulated using SPSS, for the purposes of quantitative analysis of data where appropriate. The replies to the open-ended questions were transcribed by the author, using the respondents' original words. An attempt was then made to extract themes from the latter answers to facilitate some qualitative analysis of those data. The analysis is presented in detail in this chapter in broadly the same sequence as the questions in the main questionnaire with the hope that organising the discussion in this way will give a clearer view of the respondents' attitudes to and opinions about Kuala Lumpur's green spaces. Where it may be helpful, the number of the question which generated a particular set of responses or data is given in the text. These question numbers always refer to the questionnaire as listed in Appendix B.

4.2 Respondents' Backgrounds

A total of 41 respondents (21 male and 20 female) returned completed questionnaires and can be grouped according to their professional backgrounds as shown in Table 4.1.

Group	**Number**	**Percentage (%)**
Urban planners	17	41.6
Landscape architects	20	48.8
Research officer	1	2.4
GIS officer	1	2.4
Architect	1	2.4
Agriculture officer	1	2.4
Total	**41**	**100.0**

Table 4.1: Respondents' professional backgrounds

As expected, the respondents represented a range of professional backgrounds that are involved with urban planning, landscape design and the urban environment. The respondents included urban planners, landscape architects (practising and academic), a GIS officer, an architect and an agricultural officer. Table 4.2 shows the respondents' academic qualifications. Ninety five percent of the respondents were holders of degrees or postgraduate qualifications. These professional backgrounds and levels of academic qualification should help to ensure that the respondents had a relatively high level of knowledge and expertise relevant to the field. A few of the respondents were actually directly or indirectly involved in decision making related to development of urban land, possibly including green spaces, which indicates that they may have had some influence over policy and/or practices relating to urban green spaces on the ground.

Qualification	Number	Percentage (%)
Diploma	2	5.0
Bachelor's Degree	19	46.3
Master's Degree	19	46.3
PhD	1	2.4
Total	**41**	**100.0**

Table 4.2: Respondents' academic qualifications

Respondents' years of relevant professional experience are shown in Table 4.3. The majority (68.3%) of the respondents have relevant professional experience of more than five years. This indicates that their views and evaluations can probably be taken as quite reliable as they are likely to be based on several years of working experience.

Years	Number	Percentage (%)
0-5	13	31.7
6-10	18	43.9
11-15	8	19.4
More than 20	2	5.0
Total	**41**	**100.0**

Table 4.3: Respondents' years of relevant professional experience

Table 4.4 shows the respondents' involvement in particular aspects of urban planning (Question 9 in Appendix B). It should be noted that respondents could indicate that they worked in more than one aspect of urban planning by ticking more than one of the aspects listed in Question 9. The most commonly mentioned area of involvement was the broad topic of 'environment' (31.7%). Over a quarter of respondents (26.8%) reported they were directly involved in land use and development strategy whilst a similar proportion said that they were involved with urban design. Another 19.5% (8 in total) of the respondents were involved with landscape. This helps to confirm that the desired target groups for the research have been reached in this survey.

Involvement in particular aspects of urban planning	**Number**	**Percentage (%)**
Land Use and Development Strategy	11	26.8
Commerce	3	7.3
Tourism	4	9.8
Industry	2	4.9
Transportation	3	7.3
Infrastructure and Utilities	5	12.2
Housing	2	4.9
Community Facilities	5	12.2
Urban Design	11	26.8
Environment	13	31.7
Special Areas	6	14.6
Strategic Zone	6	14.6
Implementation	4	9.8
Other (please describe)	17	41.5
Maintenance	(1)	
Research	(1)	
Landscape	(8)	
Regional planning	(2)	
Legal and legislative	(1)	
Lecturing on housing planning	(1)	
Education in urban design	(1)	
Application development	(1)	
GIS	(1)	

Table 4.4: The aspects of urban planning that the respondents were mostly involved in.

The backgrounds of respondents also seem to confirm that they represent quite well the range of professionals relevant to a study of green spaces in urban Malaysia. Perhaps, employees in the private sector were the only group not well represented in the responses obtained. Nevertheless, given the limited size of the pool of individuals and organisations involved with green spaces in Malaysia, it can be provisionally concluded that a basis for capturing a broad range of views has probably been obtained through this set of responses. In a nutshell, this survey would seem to have reached the desired target group of respondents.

4.3 Respondents' opinions about green spaces and their functions in Kuala Lumpur

Section B of the questionnaire focused on respondents' opinions about green spaces and their functions in Kuala Lumpur. In Question 10 and 11, we began by asking some open-ended questions about the phrase 'Tropical Garden City' and what they believed Kuala Lumpur was doing currently to implement its ideas and aspirations of being a 'Tropical Garden City'. We were interested to discover if urban green spaces were considered more peripheral or central to this concept and how people saw the relationship (if any) between the two concepts. The following (Questions 12, 13, 14 and 15) sought to understand respondents' views about green spaces, their main roles and functions and the benefits that green spaces provided to the city. For balance, Question 16 probed whether green spaces in Kuala Lumpur were believed to have any negative aspects. The last question in this section (Question 17) asked respondents which specific types of land use from a list of categories recognised in the city plan they considered to be green spaces.

4.3.1 Kuala Lumpur as a 'Tropical Garden City'

Question 10 asked respondents "What does the phrase 'Tropical Garden City' mean to you?" Two main themes were commonly found in their answers: a city with lush green and open spaces; and the idea of spaces planted with local vegetation species.

i. A city with lush green and open spaces

46.4% of the respondents mentioned ideas of 'green' and/or 'open spaces' in their answers. Many therefore described a 'Tropical Garden City' as a city with lots of green and open spaces within it. It was interesting that the 'Tropical Garden City' concept was most frequently associated with green spaces.

One respondent from an institute of higher education quantified the link by stating his opinion that a 'Tropical Garden City' must have at least 50% of its area allocated to green spaces. Another respondent also from an institute of higher education did not quantify the amount of green spaces required, but felt that a 'Tropical Garden City' is "*a city which implements a concept of* *greenery with lots of plants and green spaces in it*". These responses typified the trend of associating green and/or open spaces with the concept of a 'Tropical Garden City' in Malaysia generally and when thinking about Kuala Lumpur specifically, even though the original concept of a 'Garden City' by Ebenezer Howard (Howard, 1946) makes no explicit reference to or requirement for 'green spaces' in its definition.

ii. Idea of spaces planted with local vegetation species

A number of respondents believed that a 'Tropical Garden City' would be a city where the green and open spaces were planted with local species of plants or vegetation, suited to the local climate and environment. 39% of the respondents expressed ideas along the lines that in a 'Tropical Garden City', the green and open spaces should have a tropical character, perhaps by including in its elements either tropical plants or tropical landscape features.

A closely related set of ideas were views from the respondents which associated the concept of a 'Tropical Garden City' with a city where landscaping or planting were somehow adapted to create a particular aesthetic or visual identity. This identity was often articulated by the idea that planting should be related to the local tropical climate. A respondent from an institute of higher education stated that, a 'Tropical Garden City' is a city with "*the image of greenery and with lots of local plants that suit the local climate, which is a tropical climate*". The above responses suggest that most of the respondents associate the concept of 'Tropical Garden City' with the planting and landscaping of the city environment to create a particularly localised aesthetic.

It was also interesting to see how some of the staff in the City Hall clearly recognised and were apparently trying to adapt Ebenezer Howard's original concept of a 'Garden City' to local environment and climate. Four respondents with backgrounds in urban planning answered to this question by associating the 'Tropical Garden City' concept directly with Ebenezer Howard's 'Garden City' concept as discussed in Section 2.3. A respondent

> from an institute of higher education asserted that "*Tropical Garden City is a city based on the 'Garden City' concept developed by Ebenezer Howard. The difference is that the city is developed using tropical plants in relation to the tropical climate which is famous with lush green identity and many shade plants*".

When asked in Question 11 what they considered Kuala Lumpur was doing currently to implement the idea and aspirations of being a 'Tropical Garden City', the most frequent reply (from 31.7% of the respondents) was that tree planting was mostly what was being done in order to achieve the vision of being a 'Tropical Garden City'. Another 19.5% of the respondents mentioned that organisations in Kuala Lumpur were creating and designing more green and open spaces in order to achieve this vision. A smaller number (7.3%) mentioned a variety of other initiatives such as improving maintenance works, preserving and protecting existing green spaces within the city and seeking to enforce the quota of 10% to 30% of green space that is legally required in any new development. These various actions were felt to contribute in some way toward implementing the idea of a 'Tropical Garden City'.

The above responses lead to the conclusion that many of the relevant professionals in Kuala Lumpur are aware of and some are actually involved in actions to achieve the vision of being a 'Tropical Garden City'. For instance, the tree planting programme was initiated in 1973 and it is recorded that Kuala Lumpur successfully managed to plant 130,000 trees during the first ten years of the campaign, and a further 100,000 trees between 1983 and 1988 (Ayoub, 1989). It is believed that this programme is still continuing and more trees continue to be planted across the city. It was interesting to see that the responses indicate that many of the respondents (either working directly or indirectly with the city administration) are aware of the tree planting programme organised by the DBKL. This awareness might give a positive indication to the City Hall that their programme is successfully supported and acknowledged not only by their own staff but also by the professionals outside the management bodies for the city. The responses can also be seen as a reminder that tree planting alone is not the only way in which the city is working towards this vision.

In Question 13, respondents were asked whether Kuala Lumpur needs green spaces within it and if so, why? All the respondents agreed that it did and gave reasons for their positive responses. Four main themes emerged as to why they believed green spaces to be beneficial.

i. To balance the physical urban environment and the natural environment

26.8% of the respondents suggested green spaces were needed to act in some way to counter-balance urban development. Many respondents also believed that natural elements such as green and open spaces were needed to soften or naturalise the man-made character of the city. A respondent from the City Hall explained this by saying "*Kuala Lumpur needs green spaces within it in order to soften the 'concrete jungle' especially in the city centre*".

Some respondents also suggested that it is important for a city like Kuala Lumpur to have green spaces within it to create what respondents described as a more 'sustainable' environment for the population living there. In this context it was not always clear what exactly they meant by 'more sustainable'. Possibly they simply meant a more pleasant environment or one they saw as 'greener' both in a political and ecological sense or some mixture of these meanings. A respondent from City Hall suggested "*developments have to be balanced and in balancing it, the green spaces like pocket parks have to be located in the city centre*". These responses suggested that the City Hall should seek a balanced approach that controls the rapid development of the city, protects the remaining green spaces from development and pays more attention to the need to create development which they saw as 'more sustainable' across the city. There was some recognition of the importance of the need to improve the city environment and of the need for conserving the remaining natural elements in city centre areas.

ii. To mitigate possible adverse changes in the city's internal physical environment

24.4% of the respondents suggested that Kuala Lumpur needs green spaces within it in order to help mitigate current or future problems of its micro-climate such as further warming of the urban heat island and worsening air pollution. Several respondents suggested that green and open spaces would help to "*improve the air quality*", "*reduce surface temperature*", control pollution and prevent flash floods.

Many of the respondents also seemed to believe that through positive modification of the environment, green spaces in Kuala Lumpur would provide a more pleasant environment for them to live in. The above responses indicate that most of the respondents understood something about the benefits to the micro-climate and other specific environmental benefits provided by green and open spaces. It was, for example, interesting to see how many of the respondents directly associated green spaces with the resilience of the city towards the negative effects of possible changes in its internal physical environment, particularly its micro-climate.

iii. To contribute to people's social well-being and quality of life

21.9% of the respondents suggested that the city needs green spaces within it in order to provide a better social environment and that in turn this might improve their quality of life. Respondents believed that green spaces can provide places for healthy living, thereby creating places conducive to a better quality of life. Green spaces were felt to "*act as breathing spaces*" and places that can reduce feelings of tension. A respondent from one of the universities mentioned "*Kuala Lumpur needs green spaces within it for recreational purposes and that can contribute to healthy lifestyle*". The respondents also identified not only that green spaces were needed but also that these should be of 'high quality'. These high quality green spaces were thought able to provide users with a variety of opportunities to improve their health as well as their quality of urban living. Ways of evaluating the components or characteristics that may create a green space of high quality or high value will be investigated further in Section 4.5.

Respondents also suggested that Kuala Lumpur needed green spaces within it in order to provide places for social activities as well as recreation. They suggested that these spaces provided areas for gathering, socialising and relaxation. Respondents mentioned green spaces "*provide places to socialise*", "*a place where people can interact*" and that they can act as a focal point and centre for people's activities.

iv. To attract tourists into the city

Two of the respondents mentioned a further purpose for which Kuala Lumpur needed green spaces. This was in order to attract tourists to visit the city. This small group of replies argued that the attractiveness of green spaces within Kuala Lumpur can thereby help economic growth and create business opportunities for the surrounding community. They believed green spaces made the city a more attractive destination for both tourists and for business investors.

4.3.2 Views and opinions on green spaces and their roles, functions and benefits

Question 12 asked the respondents "what does the term 'green space' mean to you?" Respondents were then asked to provide their opinions and views about green spaces' roles and functions and their benefits (Questions 14 and 15). Their responses are discussed below.

i. 'Green spaces' terminology

When asked about the meaning of the term 'green space', 41.5% of the respondents described green spaces as spaces or places for leisure activities (either active or passive). A typical response (in this case by a respondent from DBKL) defined green spaces as "*space which allows activities such as recreation and sports*". The recreational use of these spaces was characterised variously, as many respondents considered green spaces as a place for "*jogging*", doing fitness, "*for kids to play*", and "*for leisure with no charges*", or simply as a space for chatting with friends. Respondents also described green spaces as a place to serve the needs of the local community. Overall, this social and recreational function was the most frequently reported.

The second most common response emphasised the physical structure and environmental landscaping or planting of these areas. 34.1% of the respondents suggested that green spaces to them meant vegetated areas or spaces that consisted of natural elements such as trees, shrubs, flowering plants, and water bodies. A further 12.2% of the respondents emphasised the need for green spaces to be accessible and functional (rather than purely decorative). The specific ways in which these spaces were thought to be functional included both the social and environmental functions. For example, one respondent argued that green spaces should be "*freely accessible*" and "*provide opportunity for public to use*", whilst a second valued their environmental functions commenting "*a space which function primarily as absorption of water and reduce pollution through vegetation as well as a space for recreational*". Like this last response, it was interesting to note that in many cases both the social and environmental functions were described together in response to questions about their benefits and roles.

One interpretation of the above responses is that the respondents have quite a rich and varied view of what green spaces are and what functions they serve. The above responses reinforced the finding from the review of the literature that there is no single definition used for 'green spaces', either by professionals working in city administration or by the wider group of professionals in Malaysia outside DBKL. One conclusion supported from these responses to Question 12 is that the respondents' views and opinions about what constitutes a green space do match the definitions used in most of the green spaces literature (Chapter 2.1). Although that set of working notions was mostly developed in a European context, the responses to Question 12 show that, in general, the same concept and values appear in the opinions of our respondents about urban green spaces in Kuala Lumpur.

ii. Roles or functions and benefits of green spaces

Respondents were asked in Question 14 and 15 about what they believed are the main roles or functions and benefits of green spaces in Kuala Lumpur. Nearly 55% of the respondents suggested that green spaces provide environmental or ecological roles and benefits. Out of these 55% responses, nearly half mentioned a role of green spaces in reducing the effects of pollution (i.e. air, water, or noise pollution). These responses indicate respondents' concern about the current environmental problems faced by developing cities like Kuala Lumpur and a positive value given to green space in helping to mitigate such problems.

Additionally, some respondents suggested that green spaces may help to alleviate the adverse effects of the built environment on the local climate of the city. As an example, some respondents from the City Hall mentioned that green spaces have functions in "*maintaining the air quality in the city*" and can "*clear the city air*". A respondent from an academic institution suggested that green spaces can "*offset climate problem like heat islands and the discomfort of living in the city*".

Although environmental benefits were most often described first, about 40% of the respondents again mentioned here that green spaces typically offered social and health benefits too. It was interesting to see that nearly half of this 40% of respondents focused on benefits to health and well-being. Some of these respondents suggested that green spaces in a city can provide a place to relieve stress and tension and also that these spaces can "*give restorative and health benefits*". These responses indicate that professionals in Kuala Lumpur are not only focusing on the physical environmental factors or only on the direct amenity value to the city population, but they were also including more intangible benefits to health and well-being. In general, the responses to Questions 14 and 15 thus covered the range of environmental, social, health and well-being benefits that have been reported by previous research studies, as noted earlier in Sections 2.5 – 2.9 of Chapter 2.

A further and rather unanticipated discovery was that nearly 15% of the respondents suggested that green spaces had an intrinsic aesthetic value that this was also beneficial. These responses indicate that the respondents, including a mix of landscape architects and urban planners, do additionally appreciate the purely aesthetic values of green spaces in a city. This was a new finding, as previous research investigating the values of urban green spaces had not reported much recognition of the purely aesthetic values of these spaces. Further research might explore the nature of this aesthetic value.

4.3.3 Opinions about the negative aspects of green spaces

At present, there is a wealth of research that discusses the benefits or positive aspects of urban green spaces (Sections 2.5 – 2.10 of Chapter 2). The negative aspects of green spaces have been discussed much less frequently. Question 16 therefore asked a counter question to the previous one by asking if respondents felt green spaces had any negative aspects, particularly in Kuala Lumpur.

	Number	**Percentage (%)**
Yes	11	26.8
No	30	73.2
Total	**41**	**100.0**

Table 4.5: Respondents' opinions on the negative aspect of green spaces

Interestingly, from Table 4.5 it can be seen that 26.8% of the respondents did agree that Kuala Lumpur's green spaces had negative aspects. However, most of the respondents did not associate green spaces with anything negative.

The minority of the respondents who agreed that there were negative aspects were then asked to describe what these might be. 14.6% suggested that poorly maintained green spaces could have negative aspects. A respondent from the DBKL mentioned that "*if these green spaces are not managed properly, they caused nuisance".* This respondent then explained that poorly maintained (possibly also meaning poorly supervised) green spaces are often poorly utilised and that in some cases could become a hazard to someone's personal safety.

The above responses indicate that whilst most people see green spaces as having only positive values, 26.8% felt there could be negative aspects. This observation may help to explain the discussion in Chapter 2 which implied that there has only been a small amount of research discussing the negative aspects of urban green spaces, but it also indicates that more attention should be paid to this.

4.3.4 Views on a possible typology of Kuala Lumpur's green spaces

An expanded typology of green spaces for Kuala Lumpur city has already been suggested in Sections 2.11 and 3.5. In order to ascertain their views on which specific types of land use they considered to contribute to green space in Kuala Lumpur, this expanded list of particular types of land use (Table 4.6) was given to the respondents in Question 17. The number of respondents who believed the given types of land use should be considered as urban green space is shown in Table 4.6.

In Table 4.6, 14 of the 27 sub-categories were considered by at least 30 of the 41 respondents (73.2%) to contribute to green space within Kuala Lumpur City. These included all types within the category of public open space (district parks, city parks, local parks, neighbourhood parks, playgrounds/playing lots and playing fields). Many respondents also considered private residential areas (28) and private recreational areas i.e. golf courses, polo fields, driving ranges, outdoor sports centres and outdoor pools (37 respondents) to contribute to green space. Other types of areas considered by 30 or more respondents to contribute to green space were the semi natural areas of river reserves (32), forest reserves (39) and wetland (39), as well as the more formally designed city squares (34), boulevards (34) and waterfronts (36). Finally, agricultural areas that remained within the city were also considered by most respondents (34) to contribute to green space, even if they were not publicly accessible.

Of these fourteen sub-categories, nine were considered by more than 90% of the respondents to contribute to green space in the city. These nine include all sub-categories of public open space and two sub-categories of natural or semi-natural green spaces (forest reserves and wetland) plus the sub-category of private recreational areas. These responses seen to indicate that the majority of the respondents were considering the first category plus the latter 3 sub-categories as core green space. It is informative to see significant numbers of respondents are reluctant to consider some other types of land use as urban green space, notably educational areas and places of worship. We may thus observe that these results are broadly consistent with the practice in most local authorities in developed countries. As we noted in Sections 2.11 and 3.5, most of the latter seem to consider most of the categories listed in Table 4.6 as their urban green space.

Six types of land use were considered by less than 60% of the respondents to be green space within Kuala Lumpur. These six sub-categories were electricity line reserves, vacant or derelict land, former mining land, community facilities, educational areas, and places of worship. In fact, educational areas and place of worship were considered by a majority of respondents as areas that are not having any function as green space. This perception contrasts with a number of recent research studies identifying and discussing the contribution these types of land use can make to improve the quality of life of urban dwellers.

Category	Sub-Category	Number of +ve responses	Percentage (%)
Public open space	District parks	**40**	**97.6**
	City parks	**38**	**92.7**
	Local parks	**40**	**97.6**
	Neighbourhood parks	**38**	**92.7**
	Playgrounds/ Playing Lots	**38**	**92.7**
	Playing fields	**39**	**95.1**
Private open space	Private residential areas including houses with gardens	**28**	**68.3**
	Private recreational areas including: golf courses, polo fields, driving ranges, outdoor sports centres, outdoor pools	**37**	**90.2**
Infrastructure and utilities corridors	Road reserves	**29**	**70.7**
	River reserves	**32**	**78.0**
	Rail reserves	**26**	**63.4**
	Electric line reserves	**24**	**58.5**
	Reservoirs	**26**	**63.4**
Natural or semi-natural green spaces	Forest reserves	**39**	**95.1**
	Wetland	**39**	**95.1**
	Water	**28**	**68.3**
	Vacant / derelict land	**22**	**53.7**
	Former mining land	**23**	**56.1**
Civic spaces	City squares	**34**	**82.9**
	Boulevards	**34**	**82.9**
	Waterfronts, river and lake embankments	**36**	**87.8**
Other functional green spaces	Community facilities	**23**	**56.1**
	Educational areas	**18**	**43.9**
	Places of worship	**15**	**36.6**
	Cemeteries	**27**	**65.9**
	Agricultural land	**34**	**82.9**
	Garden nurseries	**27**	**65.9**

Table 4.6: Land uses which the survey respondents considered to be green spaces

4.4 Respondents' views on Kuala Lumpur's aspirations and goals for its green spaces

This section summarises the results from Section C of the questionnaire, where respondents were asked for their opinions about aspirations and goals for Kuala Lumpur's green spaces, beginning with Question 18 which asked respondents what they thought the main aspirations and goals of Kuala Lumpur should be for its green spaces. Then, in Question 19, we sought to find if there were any goals related to green spaces that the respondents felt should be given higher priority than had previously been the case. In the second part of this section, Questions 20 and 21 presented the respondents with a list of objectives for green spaces. The respondents were then asked to evaluate how important they thought each objective ought to be as part of any future policy or plan for green spaces in the city, using a Likert scale. Respondents were then asked to identify what they thought were the three most important of these objectives.

4.4.1 Aspirations and goals of Kuala Lumpur for its green spaces

Respondents were asked what they believed the aspirations and goals of Kuala Lumpur should be for its green spaces (Question 18). About 20% of the respondents suggested that improving urban dwellers' quality of life should be the main goal of Kuala Lumpur for green spaces. Another 15% recommended that providing more functional open and green spaces should be one of the city's goals. About 8% of the responses suggested that it was important for the city to ensure existing green spaces be preserved and conserved. A double aspiration in a few responses was that the city of Kuala Lumpur should provide more green spaces while at the same time preserve the existing ones. The respondents concerned seemed to believe that by doing so, this might improve and enhance the quality of life of city dwellers. This further confirms that at least a few respondents made a connection between urban green spaces and the well-being of the population.

It is also interesting to note that a respondent suggested Kuala Lumpur should aspire to strengthen the laws and regulations about the protection of existing green spaces. A respondent from DBKL stated "*stringent law needs to be practiced to protect and preserve existing green spaces in Kuala Lumpur*". This response is illuminating: whilst laws and regulations do exist to protect green spaces (such as the Town and Country Planning-Act 172, the Tree Preservation Order, Planning Guidelines 21/97 and 7/2000), as noted in Section3.3, it suggests that at present such laws and regulations on green spaces are seen by one respondent as not being enforced firmly enough. This shows that at least one of the staff within the city's administration is aware of the limitations of their current level of enforcement of protection for Kuala Lumpur's green spaces.

Respondents were also asked (Question 19) of any particular aspiration or goal related to green spaces that should be given higher priority than had previously been the case. About half (46.4%) felt that more priority needed to be given to some existing goals. Of those who answered affirmatively, 41.5% of them described what these aspirations and goals needing more priority were. Most of the DBKL staff answered this question in the affirmative and many indicated that greater priority should be given to controlling and restricting development on existing green spaces. Amongst the other respondents, some suggested that the city officials should listen more to the voices and opinions of the city dwellers about their wishes for green spaces, but did not give many specific details on what these wishes were.

In summary, there seems to be significant concern among some respondents about the need to provide more green spaces while at the same time enhancing the power of legal enforcement to protect the existing ones. Furthermore, some respondents also indicated their aspirations for city dwellers to be offered a better environment through the expansion of urban green spaces.

4.4.2 Respondents' views about the importance of specific objectives in the future policy and planning of green spaces

A list of hypothetical objectives (Table 4.7) were specified in Question 20, in order to ascertain respondents' views about how important or otherwise each was considered to be in guiding any future policy making or planning for green space in Kuala Lumpur. In this question, respondents were asked to indicate how important they considered each of the listed objectives to be using a 5 point Likert scale where '1' was 'not important' and '5' was 'extremely important' but where respondents could also indicate their uncertainty about that objective's importance by instead ticking a box for 'not sure'. Table 4.7 shows the mean value for each of the sixteen proposed objectives as regards its importance and the number of replies in each category of importance.

From the values in Table 4.7, the only objective that was not generally accepted as very or extremely important by most respondents was *"retaining only a minority of the existing green spaces i.e. the largest, best or most attractive"* (Objective 5). This proposition received a much lower mean score (2.76) than any other, confirming that the group generally believed it was not enough simply to protect a minority of high profile green spaces. In contrast, the mean scores for Objective 1 of *"Increasing the number of green spaces"* (4.37), Objective 3 of "*Increasing the variety of types of green space*" (4.22), Objective 2 of *"Increasing the proportion of green spaces within the city etc"* (4.15) and Objective 4 of *"Retaining all the existing areas of green spaces as they are"* (4.05) and the high proportions in each case which saw these objectives as very important or extremely important indicates that these latter goals, associated broadly with conserving existing green spaces or expanding them, attracted much more support.

Almost all of the objectives were considered to be important by the majority of the respondents but there were some points of difference. As Table 4.8 indicates, the objective that was actually deemed most important (based on having the highest mean value) was *"Improving the maintenance standards of existing green spaces"*. A very high mean score with 38 respondents (92.7%) feeling it was very or extremely important was also achieved by the goal of *"Providing a greater number of green spaces where there is a greater density of residential and/or working population"*. Similarly, *"Providing new green spaces in areas which lack green spaces within a convenient distance"* (4.46) and *"Ensuring everyone has a green space of satisfactory quality within a convenient distance"* (4.27) also had very high mean values.

	Objectives	Not Important	Not very Important	Quite Important	Very Important	Extremely Important	Not sure	Mean Value
1	Increasing the number of green spaces.		3(7.3%)	2 (4.9%)	13 (31.7%)	23 (56.1%)		**4.37**
2	Increasing the proportion of green space within the city as a percentage of the total land area of the city		3(7.3%)	3 (7.3%)	20 (48.8%)	15 (36.6%)		**4.15**
3	Increasing the variety of types of green space.			7 (17.1%)	18 (43.9%)	16 (39%)		**4.22**
4	Retaining all the existing areas of green space as they are.	1 (2.4%)	2 (4.9%)	8 (19.5%)	13 (31.7%)	17 (41.5%)		**4.05**
5	Retaining only a minority of the existing green spaces i.e. the largest, best or most attractive.	5 (12.2%)	8 (19.5%)	11 (26.8%)	11 (26.8%)	3 (7.3%)	3 (7.3%)	**2.76**
6	Retaining all the existing areas of green space which have water features in or near to them.		1 (2.4%)	8 (19.5%)	21 (51.2%)	11 (26.8%)		**4.02**
7	Improving the facilities and activities available within existing green spaces.			4 (9.8%)	14 (34.1%)	23 (56.1%)		**4.46**
8	Improving the maintenance standards of existing green spaces.			3 (7.3%)	13 (31.7%)	25 (61%)		**4.54**
9	Creating quieter, more restful environments within existing green spaces.		2 (4.9%)	8 (19.5%)	19 (46.3%)	12 (29.3%)		**4.00**
10	Providing more trees and bushes for shade and shelter, even in small clumps, in as many places as possible.		4 (9.8%)	3 (7.3%)	19 (46.3%)	15 (36.6%)		**4.10**
11	Increasing the variety of habitats in existing green spaces.	1 (2.4%)	1 (2.4%)	17 (41.5%)	13 (31.7%)	9 (22.0%)		**3.68**
12	Linking existing green spaces together to form networks.			6 (14.6%)	12 (29.3%)	23 (56.1%)		**4.41**
13	Ensuring everyone has a green space of satisfactory quality within a convenient distance.			7 (17.1%)	16 (39.0%)	18 (43.9%)		**4.27**
14	Providing a greater number of green spaces where there is a greater density of residential and/or working population.			3 (7.3%)	15 (36.6%)	23 (56.1%)		**4.49**
15	Providing new green spaces in areas which lack green spaces within a convenient distance.			4 (9.8%)	14 (34.1%)	23 (56.1%)		**4.46**
16	If a green area is developed ensuring that the site and buildings retain some green elements.	1 (2.4%)		2 (4.9%)	18 (43.9%)	20 (48.8%)		**4.37**

Table 4.7: Results giving mean values and percentages for the importance of each of sixteen objectives

These responses indicate that most of the respondents think positively about most of the suggested objectives, which they generally consider are very or extremely important in formulating or revising any future policy related to green spaces. Interestingly, high mean scores on importance and high percentages in the very or extremely important categories were consistently accorded to ideas or objectives concerned with allocating provision of green spaces more equitably, by increasing provision for example in areas of either high population and/or which presently have fewer green spaces. Objectives which called for simply increasing the number of green spaces and the proportion of the city's land they occupy also scored highly, but not quite as high generally as the latter objectives concerned with equity of provision.

Objectives		**Mean Value**	**Rank**
8	Improving the maintenance standards of existing green spaces.	**4.54**	**1**
14	Providing a greater number of green spaces where there is a greater density of residential and/or working population.	**4.49**	**2**
7	Improving the facilities and activities available within existing green spaces.	**4.46**	**3**
15	Providing new green spaces in areas which lack green spaces within a convenient distance.	**4.46**	**3**
12	Linking existing green spaces together to form networks.	**4.41**	**5**
1	Increasing the number of green spaces.	**4.37**	**6**
16	If a green area is developed ensuring that the site and buildings retain some green elements.	**4.37**	**6**
13	Ensuring everyone has a green space of satisfactory quality within a convenient distance.	**4.27**	**8**
3	Increasing the variety of types of green space.	**4.22**	**9**
2	Increasing the proportion of green space within the city as a percentage of the total land area of the city	**4.15**	**10**
10	Providing more trees and bushes for shade and shelter, even in small clumps, in as many places as possible.	**4.10**	**11**
4	Retaining all the existing areas of green space as they are.	**4.05**	**12**
6	Retaining all the existing areas of green space which have water features in or near to them.	**4.02**	**13**
9	Creating quieter, more restful environments within existing green spaces.	**4.00**	**14**
11	Increasing the variety of habitats in existing green spaces.	**3.68**	**15**
5	Retaining only a minority of the existing green spaces i.e. the largest, best or most attractive.	**2.76**	**16**

Table 4.8: Ranking of the most important objectives for green spaces in the opinion of the planning professionals

When respondents were asked in Question 21 to list in order, what they believed were the three most important objectives mentioned in the preceding question, the largest number of respondents (24.3%) listed "*Increasing the number of green spaces"* as the most important. "*Linking existing green spaces together to form networks"* and "*Improving the maintenance standards of existing green spaces"* come joint second with 21.6 % of the respondents selecting them as most important. The idea of linking green spaces together had not been mentioned very often in responses to open questions. However, when respondents chose from a list of given objectives, this idea appeared as the second most popular objective to consider when formulating future policies to protect and enhance green spaces in the city.

4.5 Respondents' views about the protection and preservation of green spaces in Kuala Lumpur

Section D of the questionnaire focuses on responses to questions regarding the protection and preservation of green spaces. It describes respondents' views about the current pressures to permit development on Kuala Lumpur's green spaces (Question 22). This was followed by asking the respondents how difficult they believed it was to preserve green spaces in the city (Question 23) with Question 24 next trying to ascertain what the main difficulties in preserving green spaces appeared to be. Question 25 then asked if they could identify any data or information about green spaces that might help them to manage or to protect green spaces better. Subsequently, the strength of the different respondents' agreement or disagreement with a series of statements about how well KL is protecting its green spaces or how much it should protect them (Question 26) was requested. The final question of this section asked respondents (Question 27) to estimate the amount of green space they believed had been lost over the previous ten years within Kuala Lumpur.

4.5.1 Pressure to permit development on green spaces

When asked if they believed there were pressures to permit development on any of Kuala Lumpur's existing green spaces (Question 22), 58.5% of the respondents answered positively, that such pressure did exist (Table 4.9).

	Number	Percentage (%)
Not sure	9	22.0
Yes	24	58.5
No	8	19.5
Total	**41**	**100.0**

Table 4.9: Respondents' opinions on pressure to permit development on green spaces

Respondents were then asked to summarise what they thought these pressures were and to indicate in what types of locations these pressures commonly occur. Of 24 respondents who answered yes, 20 provided some elaboration. The most commonly mentioned pressures to permit development were for new infra-structure, residential schemes and for commercial areas. Interestingly, the responses indicated that these pressures for development were focused mainly on privately owned lands. When asked about the types of locations within the city where these pressures commonly occur, about 40% of the respondents mentioned city centre areas and 25% referred to hilly areas at the periphery of the city centre which are recognised as sensitive zones for any new development (JPBD Hillside Development Guidelines, 2001 and KLCP 2020 – Guideline 4.7).

The above results led to the conclusion that some green spaces in Kuala Lumpur are felt to be under significant pressures for development into other land uses. One factor contributing to this present situation is the ownership of land: most of the remaining green spaces concerned are privately owned. A developer can propose any type of development on privately owned green land and, as noted in Section 3.4 of Chapter 3, it seems that planning permission is then quite easy to get, regardless of the particular benefits that site may have as green space. Generally, it seems more difficult to get planning permission on green land which is publicly owned, even if not gazetted. These responses concur with what a number of authors have observed, including Teh (1989 and 1994).

4.5.2 Respondents' views about the difficulties of preserving green spaces in Kuala Lumpur

Respondents were asked in Question 23 how difficult they believed it was to preserve green spaces in Kuala Lumpur. Table 4.10 shows the majority of the respondents (65.9%) thought it was very or extremely difficult to preserve green space in the city and only around 5% thought it was not difficult. About 12% of them were not sure and these respondents were mostly academics and researchers who were not involved in any decision making concerning land development in Kuala Lumpur and therefore did not have any direct experience or knowledge of this issue.

	Number	**Percentage (%)**
Not sure	5	12.2
Not difficult	2	4.9
Quite difficult	7	17.1
Very difficult	17	41.5
Extremely difficult	10	24.4
Total	**41**	**100.0**

Table 4.10: Respondents' opinions on how difficult it is to preserve green spaces

Respondents were then asked in an open question (Question 24) to describe the main difficulties in preserving green spaces in Kuala Lumpur. 33 of the respondents provided some explanation here, with about 43% of them mentioning some form of political involvement as the main difficulty for preserving green spaces in the city. A respondent from the DBKL talked about "*political intervention*" affecting decisions about the approval of developments on green spaces. It seemed to be believed that politicians were influencing decision makers about whether or not to approve developments on green spaces in the city. This level of intervention in the planning process, if it is indeed as prevalent as suggested by the respondents, may cause serious difficulties to any initiative to preserve green spaces, since it suggests that the degree of political interference in the process is quite high.

In addition to the issues of political intervention, the second main difficulty identified (by some 23% of the respondents) related to the inability to control or restrict developments on privately owned land. Others identified the economic drivers for development as the high land prices paid for some areas of green spaces, since these areas are desirable for development, especially for residential schemes. A second factor identified to be driving up the value of green spaces and hence creating pressure for the land to be sold for development, was the limited supply of remaining undeveloped land close to the city centre.

This combination of high economic demand to develop land that is presently green space for residential and commercial functions, combined with a relatively weak enforcement of planning control (or at least the relative ease by which these controls appear to be bypassed by developers with appropriate political support) highlights the fragility of the protection for the remaining green spaces in Kuala Lumpur. It suggests that, despite an apparently strong base for protecting the remaining green spaces and their value to the public as whole, officials and administrators feel relatively weak and disempowered to make this protection effective in the face of politically supported development of these areas. This section has thus started to reveal a much more realistic and pragmatic rather than aspirational picture of the situation of urban green spaces in Kuala Lumpur as compared to Section 4.3. The next section continues this with respondents asked to give a realistic assessment of how much green space has recently been lost.

4.5.3 Respondents' views about the loss of green spaces within Kuala Lumpur City

In order to summarise the situation about policies being used towards the protection of green spaces in Question 26 respondents were given eight different statements about the protection of green spaces in Kuala Lumpur. They were asked to assign a value from 1 (strongly disagree) to 5 (strongly agree) to indicate their level of agreement with each of eight statements. The mean value was then calculated for each statement (Table 4.11). A striking result was that most of the respondents (90.3%) agreed or strongly agreed with the statement that Kuala Lumpur's loss of green space in recent years had had a significantly negative effect on the quality of environment. The statement that Kuala Lumpur has lost a large amount of green space over the last 10 years also had a very high mean score (3.93) with a clear majority (78%) agreeing or strongly agreeing that this has been the case.

Another important finding from this question implied that the professionals felt that the loss of green spaces was not due to a lack of policies or legislation for protecting green spaces since 70.8% believed that Kuala Lumpur had such policies. There was somewhat less certainty or agreement about how well or how far these policies were being enforced, however, with only 41.5% agreeing or strongly agreeing that these policies were being enforced, whereas 41.5% neither agreed nor disagreed, 9.8% were not sure and 7.3% disagreed or strongly disagreed that they were being enforced.

	Statements	Strongly Disagree (1)	Disagree (2)	Neither Disagree or Agree (3)	Agree (4)	Strongly Agree (5)	Not sure	Mean value
1	KL is trying hard to retain and protect its existing green spaces.	1 (2.4%)	3 (7.3%)	11 (26.8%)	17 (41.5%)	8 (19.5)	1 (2.4%)	**3.61**
2	KL has policies for protecting its existing green spaces from development.	1 (2.4%)	2 (4.9%)	5 (12.2%)	22 (53.7%)	7 (17.1%)	4 (9.8%)	**3.49**
3	KL is enforcing its policies for protecting its existing green spaces.	1 (2.4%)	2 (4.9%)	17 (41.5%)	13 (31.7%)	4 (9.8%)	4 (9.8%)	**3.12**
4	KL only needs to retain and protect the majority of its existing green spaces, not all of them	11 (26.8%)	15 (36.6%)	8 (19.5%)	7 (17.1%)			**2.27**
5	KL only needs to retain and protect a minority of its existing green spaces.	14 (34.1%)	18 (43.9%)	5 (12.2%)	3 (7.3%)	1 (2.4%)		**2.00**
6	KL should allow its smallest green spaces to be developed for other uses as they are less valuable.	12 (29.3%)	18 (43.9%)	4 (9.8%)	4 (9.8%)	2 (4.9%)	1 (2.4%)	**2.10**
7	KL has lost a large amount of green space over the last ten years.	3 (7.3%)	1 (2.4%)	4 (9.8%)	16 (39.0%)	16 (39.0%)	1 (2.4%)	**3.93**
8	KL’s loss of green space in recent years has had a significantly negative effect on the quality of environment.		3 (7.3%)	1 (2.4%)	22 (53.7%)	15 (36.6%)		**4.20**

Table 4.11: Respondents’ opinions on various statements about the protection of green spaces by Kuala Lumpur

To estimate the amount of green space respondents thought had been lost in recent years, respondents were asked in Question 27 to indicate from a range of percentage values the amount of green space that they believed Kuala Lumpur had lost over the preceding ten years. Table 4.12 shows the majority of the respondents (about 58.5%) estimated offhand that Kuala Lumpur had lost 25% or more of its green space over the previous ten years. These results highlight the fact that few of the respondents are under any illusion about how rapidly the loss of green spaces is occurring at the present time.

Loss of green spaces	**Number**	**Percentage (%)**
5%	3	7.3
10%	2	4.9
15%	7	17.1
20%	5	12.2
25%	8	19.5
More than 25%	16	39.0
Total	**41**	**100.0**

Table 4.12: Respondents' estimate of the amount of green space had been lost in Kuala Lumpur over the preceding 10 years

The above results may also help to explain some of the replies of the respondents about the loss of green space in Question 26. The respondents' strong agreement with the statement in Question 26 that *"Kuala Lumpur's loss of green space has had a negative effect on the quality environment"* is probably partly a result of most respondents considering that there had been a substantial loss of green spaces in just ten years. Hence they felt that the quality of the city's environment had deteriorated noticeably.

4.6 Possible environmental and social criteria for informing decisions about retaining green spaces

The final section of the survey focused on the more modest goal of how to retain existing green spaces. Respondents were asked to think about how they would value and use information to help decide whether to retain one particular green space over another. The results help us to consider what kinds of data or information could actually be used in such decision making.

A list of environmental and social criteria for evaluating green spaces was specified in Question 28 and respondents were asked to rate how important they believed each of these criteria should be in informing a decision about whether to retain a particular green space, again using a five point Likert scale. Five main groups of environmental criteria were presented and were broken down into a total of 28 sub-criteria (Table 4.14). Similarly, Table 4.15 shows the four main groups of social criteria with 21 sub-criteria to be evaluated by the respondents.

Environmental criteria	**Overall Mean value**
1.1 Quantity and availability of green spaces	4.06
1.2 Biodiversity	3.70
1.3 Fragmentation and connectivity	3.96
1.4 ‘Atmosphere’	4.08
1.5 Air and water quality	4.40
Total mean value	**4.04**

Social criteria	**Overall Mean value**
1.1 Social functions	4.12
1.2 Educational functions	4.07
1.3 Quality of experience	4.41
1.4 Location and accessibility	4.31
Total mean value	**4.23**

Table 4.13: Respondent’s ratings for most important criteria for assessing green spaces

Table 4.13 summarises the overall results as mean scores for the main groupings of environmental and social criteria. As this table shows, some of the main groups of environmental criteria such as Criteria 1.5 *(air and water quality)* and Criteria 1.1

(quantity and availability of green spaces), would appear to be considered as particularly important in arguing to retain a green space (i.e. a green space that provided these benefits would be very desirable for retention). On the other hand, the environmental criteria grouped under *'biodiversity'* (Criteria 1.2) were not rated as quite so important. Turning to the social criteria, all the main groups of social criteria scored above 4.0 on an average of all responses, suggesting that the social functions that a green space could provide were generally considered to be as important as the environmental attributes, if not more so in informing any decision about retaining a particular green space.

Among the social criteria presented, the more intangible criteria concerning *the quality of experience that users had in a green space* (Criteria 1.3) were considered the most important. Such information concerning the users' experiences in green spaces could presumably only be collected by interviews or by surveys of the users of green spaces and so would be difficult or time consuming to collect for a large number of green spaces. However, social criterion 1.4 *(the location and accessibility of the green spaces)* also had a very high mean score and was therefore also considered as very important in this context. In addition, this criterion is a property that could more easily be quantified from existing geographical data.

Some of these criteria will be discussed further in Chapter 6 when examining whether data can be collected and analysed which measure and monitor areas of the city's green spaces on some of these criteria using methods of GIS.

4.6.1 Detailed evaluation of the environmental criteria

Table 4.14 presents more detailed assessments for each of the specific environmental criteria within the broad groups. The majority of the respondents assessed environmental criteria related to reducing air and water pollution (Criteria 1.5) as very important, believing that spaces filling this function should have some priority for retention. Criteria such as *capacity of the site to produce oxygen* (1.5.3), *capacity of the site to provide better air quality* (1.5.1) and *capacity of the site to absorb carbon dioxide* (1.5.2) were all considered to be particularly important. These criteria were considered extremely important by most of the respondents, presumably partly due to some problems currently faced by Kuala Lumpur concerning its poor air and water quality.

An article (refer to Appendix C) in The Star (a national newspaper) on 6th March 2009 reported that Kuala Lumpur is approximately 5^{o}C hotter than any other city in Malaysia. This is considered to be due to lack of tree coverage plus the dominance and density of concrete, brick and asphalt in its built environment. This way may help to explain why Criteria 1.4.1 *(the proportion of the site that is vegetated)* and 1.4.2 *(the effectiveness of the arrangement of the vegetation cover for providing shade and shelter)* were also considered very important in this context. Respondents probably believed that those sites with substantial vegetation cover could provide shade and could also provide other environmental functions such as improving the air quality or reducing the pollution.

Within the first group of Criteria (1.1), sub criteria 1.1.5 *(the quality or condition of the green area within the site)* was thought to be the single most important attribute by which to judge whether to retain a green space (mean score of 4.24). This might not have been thought by some to be so important, since the quality and condition can often be changed by regular maintenance or investing in redesigning the green spaces. However, respondents (particularly from DBKL) considered this sub-criterion as a very important criterion in informing any decision about retaining a green space. This result can be seen as consistent with the replies from the respondents in Section 4.3.2 where the majority considered improving the maintenance standards of existing green spaces as of prime importance. The consistency of the replies in both questions might partly reflect the day to day operational work of most of the DBKL staff who are mainly concerned with the maintenance of these green spaces. If so, these responses may indicate that the current concern of the city administration (as described in the Kuala Lumpur Structure Plan 2020) is more for the operational maintenance of these green spaces rather than for their strategic protection or preservation. A somewhat surprising result which emerged from Table 4.14 was the strong importance assigned to connectivity of the site to other nearby green areas (Criteria 1.3.1) which was given a mean score of 4.22.

Interestingly, although the respondents attached high importance to most of the main groups of environmental criteria, Criteria 1.2 *(biodiversity)* seemed to score somewhat lower than many others with many more respondents rating it only as 'not very important' than generally happened with the other groups of criteria. Despite the lower average scores of this group of criteria, it should still be noted that many respondents rated the biodiversity criteria as very or extremely important. The lower scores, however, may suggest that some respondents were uncertain about whether information on green spaces' biodiversity would help them to decide whether to retain any particular green spaces or not. As something of a contrast, in other countries such as the United Kingdom and in some European countries, information on biodiversity is now routinely used as a strong argument for protecting an area from development (Section 2.6.3).

Reflecting on the overall responses, environmental criteria were generally assessed to be very important (4.04 overall mean score across all sub-criteria) by a clear majority of the respondents in virtually every case with the lowest mean value for any of the 28 sub-criteria being as high as 3.59 i.e. closer to the value of 4 (very important) than the value of 3 (quite important). It had been anticipated that some of the respondents (especially urban planners) might give less weight to environmental criteria when forming a decision about retaining green spaces. However, this hypothesis seems to be disproved, with most of the respondents giving relatively high importance to nearly all of the environmental criteria.

1.1	Quantity and availability of green spaces	Not Important	Not very Important	Quite Important	Very Important	Extremely Important	Mean value
1.1.1	The total size of green areas contained within the site.		1	10	19	11	3.98
1.1.2	The proportion of the site which is green space.		1	8	21	11	4.02
1.1.3	The proportion of the site which is vegetated.		1	14	13	13	3.93
1.1.4	The arrangement of the green areas within the site.		3	7	18	13	4.00
1.1.5	The quality or condition of the green areas within the site.			5	21	15	4.24
1.1.6	The potential demand for green space from the local residential and working population.			6	20	15	4.22
1.1.7	The presence of other nearby green spaces which also serve the local residential and working population.		2	7	20	12	4.02
						Overall mean value	**4.06**
1.2	**Biodiversity**						
1.2.1	The number of different types of green space within the site.		4	8	22	7	3.78
1.2.2	Proportion of the site's area which is water.		4	16	13	8	3.61
1.2.3	Proportion of the site's area which has a waterfront character.		5	13	17	6	3.59
1.2.4	The number of different kinds of habitats within the site.		8	10	12	11	3.63
1.2.5	The diversity of species of flora within the site.		5	9	13	14	3.88
1.2.6	The number of indigenous species of flora within the site.		9	6	13	13	3.73
1.2.7	The number of endemic species of flora within the site.	2	6	7	14	12	3.68
1.2.8	The number of endangered species of flora within the site.	3	6	5	13	14	3.71
						Overall mean value	**3.70**
1.3	**Fragmentation and connectivity**						
1.3.1	Connectivity of the site to other nearby green areas.			5	22	14	4.22
1.3.2	Connectivity of the site to other land uses nearby.			7	20	14	4.17
1.3.3	The relative isolation of the site from other green areas.	1	7	10	17	6	3.49
						Overall mean value	**3.96**
1.4	**Atmosphere**						
1.4.1	Proportion of site's area occupied by vegetation providing shade and shelter.			8	20	13	4.12
1.4.2	The effectiveness of the arrangement of the vegetation covers for providing shade and shelter within the site.			6	24	11	4.12
1.4.3	The capacity of the type of ground cover within site to absorb surface water.		2	4	21	14	4.15
1.4.4	The capacity of the site to provide a quieter environment within its boundary than in surrounding areas.		1	12	19	9	3.88
1.4.5	Capacity of the site to provide a more pleasant, relaxing and restful atmosphere within its boundary than in surrounding areas.		1	5	23	12	4.12
						Overall mean value	**4.08**
1.5	**Air and water quality**						
1.5.1	Capacity of the site to provide better air quality than surrounding areas.			4	15	22	4.44
1.5.2	Capacity of the site to absorb Carbon Dioxide (CO_2).			4	15	22	4.44
1.5.3	Capacity of the site to produce Oxygen (O_2) production			3	15	23	4.49
1.5.4	Proximity of the site to sources of pollution for which it provides a remedial function.			2	25	14	4.29
1.5.5	Capacity of the site to act as buffer against noise and air pollution from adjacent land uses e.g. transport and industry.			4	20	17	4.32
						Overall mean value	**4.40**
						TOTAL MEAN VALUE	**4.04**

Table 4.14: Detailed results of respondents' evaluation of the importance of environmental criteria

4.6.2 Detailed evaluation of the social criteria

Table 4.15 presents the detailed assessments by the respondents of the importance of social criteria in informing a decision about whether to retain a particular green space in the city. From the mean values the respondents clearly believed that criteria such as *value in serving its local community* (Criteria 1.4.7), *feeling of safety of users of the site* (Criteria 1.3.5) and *general quality of maintenance in the site* (Criteria 1.3.2) take first place among the criteria that would need to be considered in making a decision about whether to retain one green space over another. Interestingly, these three criteria scored highest in terms of their importance not only among the group of social criteria but were also considered to be at least slightly more important than any specific attributes in the group of environmental criteria, except *capacity of the site to produce oxygen* (Criterion 1.5.3), whose score (4.49) equalled that for *general quality of maintenance*.

In addition to the latter factors, many other attributes such as the criteria from 1.1.1 to 1.1.4 (value for sport and recreational activities, value for general amenity, value for children play area and mix facilities offered) were also considered very important, as well as several criteria relating to the general accessibility of a site. Accessibility of a site to nearby residential population and to nearby workplaces and accessibility of the site by public and private transport, were all generally considered to be very important (Criteria 1.4.3 to 1.4.6). It is worth noting that these criteria are also emphasised in the agenda and objectives listed in the city and structure plan documents (KLSP 2020 and KLCP 2020) which mostly focus on improving quality of life for citizens. Hence, it was not unexpected that these criteria would be assessed as generally very important by most of the respondents. In the above documents the amenity value and accessibility to local populations are seen as key criteria by which to evaluate green spaces. Thus, spaces scoring highly on amenity value and accessibility are quite likely to be retained as planners can use these criteria to argue that such areas provide good quality environment for people to use and that they will therefore improve the quality of life of Kuala Lumpur's population.

Among the groups of social criteria, the group of criteria relating to the *educational functions of green spaces* (Criteria 1.2) were thought to be somewhat less important (overall mean score 4.07). This might be due to the tendency for green spaces in Malaysia to be used generally for leisure activities either active or passive. Knowledge and understanding of how green spaces can be used to educate users about the environment is quite limited among Malaysians, if it is present at all. In contrast, green spaces in developed countries such as USA and United Kingdom are now commonly being used as places for exploring and understanding nature. For instance, a report by Greenspace Scotland encourages users of all ages to explore their local environment through visiting their local green spaces (Greenspace Scotland, 2004).

In summary, social criteria were generally assessed to be of very or extremely high importance in informing reasons to protect a green space (with 4.23 as overall mean value) by most respondents. This result indicates that most of the respondents would be primarily concerned with social factors when determining whether to retain a particular green space. Like most of the local authorities in Malaysia, DBKL has been mainly focusing on maintaining or developing the social and amenity functions of green spaces rather than promoting their environmental functions. This may have partly influenced some respondents' replies to this question.

Taken together these findings suggest that there is significant interest and awareness among respondents for considering not only the social and amenity values but also the environmental benefits of green spaces before making decisions in the future to approve any new development on existing green spaces. Currently, these values seem not to influence decisions taken at a high level in DBKL when considering future development on any parcel of land. If this wider range of attributes were more actively taken into consideration, this might lead to more green spaces being protected and preserved. The reasons for this apparent inability to take such factors into account when considering applications to develop green spaces seem to relate mainly to:

(a) DBKL perceiving its main responsibility with respect to green spaces as using these to provide recreational areas;
(b) the perceived limited power of DBKL to control such development;
(c) the lack of up-to-date data on the nature and condition of green spaces; and

(d) limited resources to undertake field surveys.

Of course, to implement these ideas so they can be used to identify and prioritise areas for protection implies a need to consistently identify and measure some of the relevant properties. Some, such as social Criteria 1.3 *(quality of experience)* in Table 4.13 are difficult to measure by any means, requiring repeated and extensive ground surveys. Others such as the capacity of green spaces to provide shade and shelter and the capacity of green spaces to provide better air quality (Table 4.13) could be measured by installation of sensor networks. Several environmental criteria within the 1.1 group *(quantity and availability of green spaces)* and within the 1.3 group *(fragmentation and connectivity of green spaces)* as well as social criteria in the 1.4 group *(location and accessibility of green spaces)* as in Table 4.13 are criteria for which data could feasibly be gathered comprehensively across cities by remote sensing and GIS.

1.1	**Social functions**	**Not Important**	**Not very Important**	**Quite Important**	**Very Important**	**Extremely Important**	**Mean value**
1.1.1	Value of the site for sport and recreational activities.		1	6	20	14	4.15
1.1.2	Value of the site for general amenity and leisure activities (e.g. walking etc.).			7	18	16	4.22
1.1.3	Value of the site as an area for children to play.			7	17	17	4.24
1.1.4	Mix of facilities offered by the site either for active or passive activities.			9	14	18	4.22
1.1.5	Suitability of the site for community events and activities.			15	10	16	4.02
1.1.6	Suitability of the site as a meeting place e.g. through provision of facilities like benches and seats etc.		3	12	13	13	3.88
						Overall mean value	**4.12**
1.2	**Educational functions**						
1.2.1	Capacity of the site to aid exploration and understanding of the natural world.		3	8	16	14	4.00
1.2.2	Capacity of the site to aid understanding of the local environment.			10	18	13	4.07
1.2.3	Capacity of the site to aid understanding of local heritage.			8	19	14	4.15
						Overall mean value	**4.07**
1.3	**Quality of experience**						
1.3.1	Overall cleanliness of the site.			4	15	22	4.44
1.3.2	General quality of maintenance in the site.			4	13	24	4.49
1.3.3	The value of the site for health and well-being.			3	20	18	4.37
1.3.4	Level of usage of the site.			5	22	14	4.22
1.3.5	Feeling of safety of users of the site.			2	15	24	4.54
						Overall mean value	**4.41**
1.4	**Location and accessibility**						
1.4.1	Clarity of information and signs provided to guide people to the site and to guide them within it.			4	20	17	4.32
1.4.2	Number of entrances and their convenience of use from areas nearby		1	10	17	13	4.02
1.4.3	Accessibility of site to nearby residential population (i.e. whether this site has a low or high population in the residential areas around it from which users are likely to come).			3	21	17	4.34
1.4.4	Accessibility of site to nearby workplaces (i.e. whether this site has a low or high number of people in local workplaces).			8	16	17	4.22
1.4.5	Accessibility of site by public transport.		1	3	14	23	4.44
1.4.6	Accessibility of site by private transport.		2	5	15	19	4.24
1.4.7	Value in serving its local community.			3	12	26	4.56
						Overall mean value	**4.31**
						TOTAL MEAN VALUE	**4.23**

Table 4.15: Detailed results of respondents' evaluation of the importance of social criteria

4.7 Summary and discussion

Several of the main findings of the questionnaire may be summarised as follows:

i. Opinions about green space and its functions

Question 12 revealed quite a varied picture of what might constitute green spaces, with the respondents expressing a similar richness of ideas to those expressed in the research literature reviewed in Chapter 2, very largely dealing with developed countries. This is a positive indication that the general thoughts and working notions of the local planning community in Malaysia are actually well aligned with current thinking in more developed countries, even if the terminology articulated in the published planning documents suggests a more limited working definition is being used operationally by city planners.

Most of the respondents took a broad view about the types of spaces that constitute urban green spaces. Almost all the types of spaces listed in the questionnaire were considered by the majority of the respondents to be green spaces. However, several of these spaces are not yet listed nor considered as categories of green spaces in the official legal documents of Kuala Lumpur city (such as KLSP 2020 and KLCP 2020). Although private green land clearly lies outside the direct authority and control of City Hall, there is also some public green land that is not presently gazetted as green spaces. In their replies to a number of questions, particularly those in Section D about the vulnerability of green spaces, some respondents showed awareness that, without the degree of protection that comes from the gazetting process, many of these other unrecorded green spaces remain vulnerable to development in future.

Question 13 also revealed that most of the respondents believed that green spaces were needed in Kuala Lumpur and saw the importance of protecting these remaining green spaces in city areas. Ideas about how the roles and functions of green spaces affect urban dwellers both environmentally and also socially were well recognised in the respondents' replies. Replies to Question 14 recognised many positive environmental functions for green spaces in cities, possibly mitigating some of the negative effects of densely built up environments on the local micro-climate, as well as providing pleasant spaces for recreational amenities. Respondents also saw an important functional role in that green spaces were needed to act as a counter balance against the effects of intense urban development. This counterbalancing property of green spaces was sometimes expressed as their capacity to mitigate current or future risks to the city's physical environment that might arise or be exacerbated by future climate change. Thinking further about other functions, green spaces were seen to provide more natural, relaxing places where urban populations could interact socially and find an escape from the stresses of urban life. The purely aesthetic function of creating more natural and more beautiful areas was also identified.

Whilst Question 14 about the roles and functions of green spaces tried, as an open question, to elicit unprompted answers about the whole possible range of roles and functions, Question 15 asked directly what were the main benefits of green spaces to Kuala Lumpur city. As well as the environmental benefits which were mentioned most frequently, almost as many social, amenity and health and well-being benefits were articulated. Beyond the conventionally understood amenity and recreational values of green spaces, the benefits of these spaces for health and well-being were often mentioned, and a number of respondents also associated the presence of green spaces with more pleasant neighbourhoods. Some evaluated these benefits economically, in terms of the increased property values that might be found in areas with more green space, whilst a rather unanticipated finding was that several of the respondents believed that green spaces should also be valued purely for their aesthetic properties.

These ideas about the roles, functions and benefits to the city from green spaces are broadly in line with current research findings from studies in several countries of the developed world where a wider range of types of green spaces are recognised and these spaces appear to be generally afforded greater levels of protection from development through the processes of city planning and development control.

ii. Links between the concept of the 'Tropical Garden City' and urban green space

The Malaysian concept of the 'Tropical Garden City' has been articulated in a number of ministerial speeches and has consequently permeated some planning documents. In Question 10, the survey found that most respondents associated urban green space and open space closely with this concept, together with the idea that a 'Tropical Garden City', had spaces that were landscaped and planted with local species of plants which were suited to the local climate and environment. A less anticipated finding was that some of the respondents (mostly the urban planners) associated this Malaysian initiative with the original socially inspired concept of the 'Garden City' as advocated by reformers such as Ebenezer Howard in the UK. Although Howard's original discussion of the concept of the Garden City makes little explicit reference to the particular roles and benefits of urban green space, Raymond Unwin as the practical designer of the first Garden City at Letchworth seems to have been very much aware of some of the social, environmental and aesthetic benefits of green spaces in cities, as noted in Section 2.3 of Chapter 2. These responses suggest that, depending on their background, the professionals may have quite differing understandings of what the vision of turning Kuala Lumpur into a 'Tropical Garden City' might involve and presumably would therefore define differing objectives for achieving this. In their responses, some of the respondents felt the key idea of the vision was to reduce the sense of overcrowding, particularly in the most densely populated areas in Kuala Lumpur. Some saw a social benefit in giving urban dwellers access to more natural surroundings in the city, hence improving their quality of life.

Kuala Lumpur's vision of being a 'Tropical Garden City', whatever this might mean in practice is, however, accepted as a positive initiative by most of the respondents. Their responses indicate that they are aware of actions being taken around the city to implement this vision, such as the well-established tree planting programme promoted by former Prime Minister, Dr Mahathir Mohamed. However, schemes which can be seen to be the personal initiative of an individual or political party are vulnerable to being abandoned following changes of government in Malaysia, when any scheme championed by a previous administration is often shelved by the new incumbents. Besides that, such replanting programmes are often rather retrospective actions, aimed at restoring some green character to city centre areas where the majority of green spaces have been lost.

iii. Aspirations for green spaces in Kuala Lumpur

Nevertheless, and as expected, when asked in Question 18 about any goals and aspirations that should be encouraged, most of the respondents suggested actions to increase the number of green spaces and protect the existing ones. Whilst many respondents thought the city should aspire to provide more green spaces (perhaps to counter balance a perception that lots of green spaces were being lost), in some respects this idea could be seen as somewhat at odds with responses elsewhere stating that existing spaces needed to be well maintained or they would fall into disuse (Question 16). The idea of increasing the amount of green space also appeared rather idealistic given the difficulties that the urban planners reported they were presently experiencing in retaining existing green spaces. They appeared to be advocating a dual approach involving both increases in the provision or designation of green spaces and at the same time working to enhance the powers of enforcement to protect existing ones.

iv. Issues and problems with protecting green spaces

Clearly, respondents felt that preventing the loss of green space in KL was a serious problem. In Question 22, respondents believed that there were lots of pressures to permit development on green spaces. They then further identified in replies to Question 24, several specific difficulties which together undermined the existing processes that sought to protect and preserve urban green spaces. This combination of factors is summarised in Figure 4.1. Many respondents felt that it was difficult to resist market forces, with privately owned green space land often sold at high prices for development to other land uses such as residential schemes or commercial developments. Some respondents also disclosed that planning policies to control development were at best weakly enforced. When combined with frequent reports of inappropriate political intervention to enable former green spaces to be re-zoned and then sold for development, the vulnerability of the remaining green spaces in the city, including those that are presently afforded some measure of protection under the gazetting process, is highlighted. This backdrop of powerful economic and political forces favouring development of green spaces helps explain to why some planners perhaps feel rather powerless to stop the loss of green spaces in Kuala Lumpur.

When asked in Question 25 what information or data would help to manage or protect green spaces better, only some responded to the question, perhaps thinking that data collection alone will not stop these processes and may bring planners more into conflict with politicians.

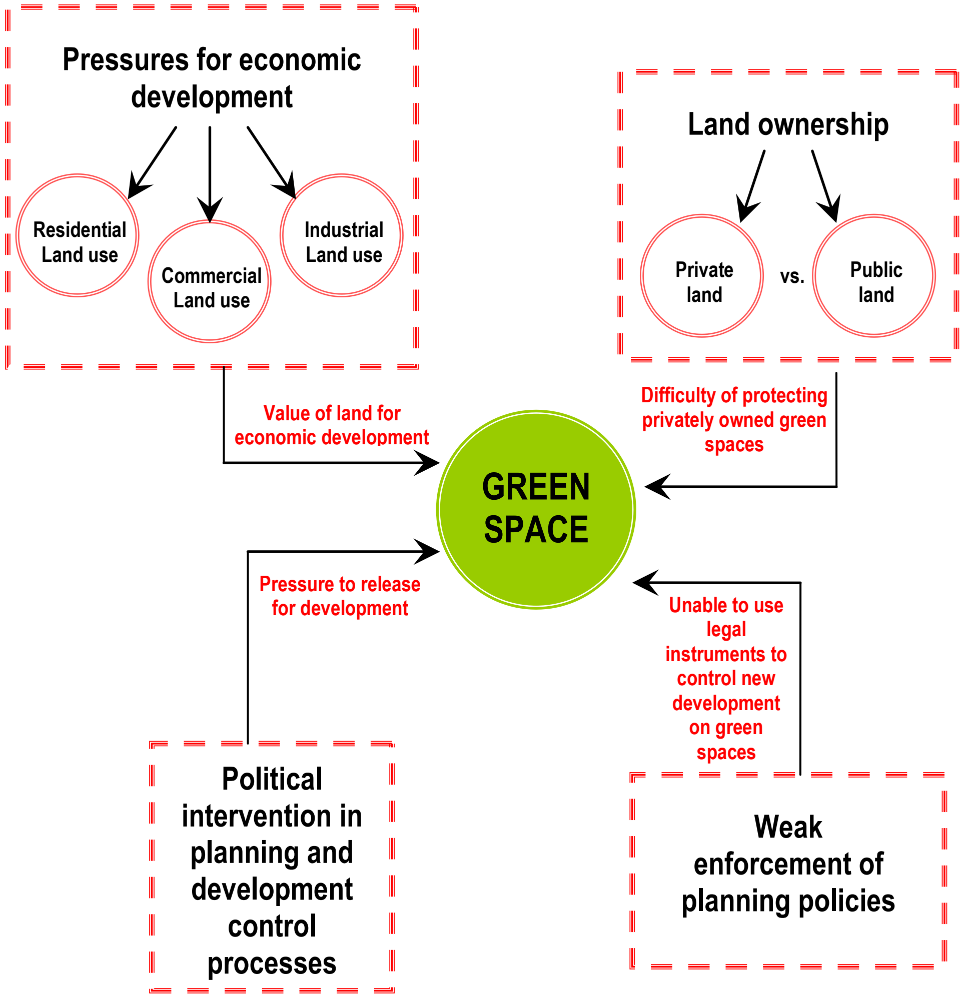


Figure 4.1: Summarising some of the problems respondents recognised as making it difficult to protect urban green spaces in Kuala Lumpur

v. Information needed to identify priority green spaces for protection

Figure 4.2 attempts to bring together the information obtained from various questions in the survey to form the basis of an approach for recognising existing green spaces that are highly valued and which should be protected and retained. In Question 20, almost all the objectives listed were considered to be very or extremely important for formulating or revising any future policy related to green spaces. Most of the objectives proposed in the questionnaire were drawn from or inspired by policies being advocated both by governmental organisations and NGOs in European countries (such as GreenSpace, Greenspace Scotland, CABE Space, URGE-European Commission) that conduct research into the value of green space in cities and formulate objectives for their planning and protection. Most of these principles have not as yet been specified in any legal documents produced by the Kuala Lumpur city authority, even though ideas about enhancing public facilities and improving quality of life for urban dwellers are mentioned in rather general and somewhat vague terms in those documents (such as KLSP 2020 and KLCP 2020). Generally, it seems that ideas of valuing and protecting urban green spaces are less well enshrined within urban planning documents in Malaysia. The establishment of organisations (either governmental or non-governmental) that promote the value of green spaces to the public and campaign for their protection may therefore provide assistance and support to the local authorities in Malaysia, through such means as developing appropriate mechanisms, encouraging best practices and obtaining public support to ensure that green spaces are managed properly and, where possible, are protected and preserved.

The findings also revealed that many of the social and environmental criteria proposed in Question 28 were considered by the respondents as important attributes that could be used in making decision about retaining particular green spaces. Although most of the criteria were considered very or extremely important by the respondents, some of the environmental criteria such as the biodiversity of a site were seen as somewhat less important. In Malaysia, legislation and guidelines related to biodiversity do exist (e.g. regulations related to protection of endangered species) but they are rarely used to protect an area such as a green space or derelict land from development. In contrast, countries such as United Kingdom and some other developed countries often use information on biodiversity (e.g. English Nature, RSPB, Natural England) to build a case for protecting land from development. There would seem to be a need to effect protection and preservation of green spaces by using these environmental and ecological factors or regulations as well as by using the conventional development control instruments used by planners. It will also be helpful to encourage the professional decision makers, as well as the public they represent, to see green spaces as places for fostering biodiversity as well as spaces that provide physical environmental benefits like flood control or air cooling.

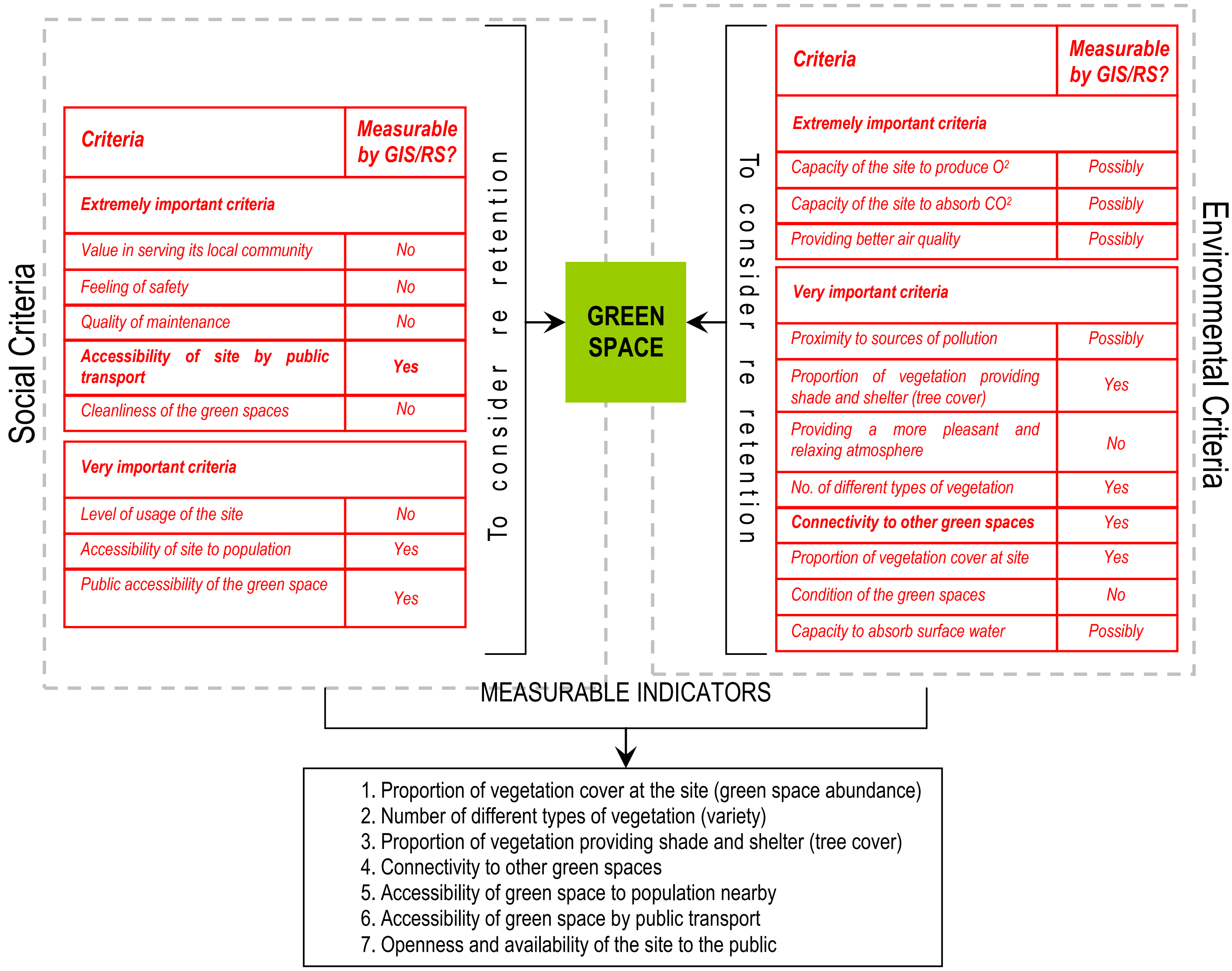


Figure 4.2: Information needed or that could be considered for use in trying to establish priorities for preserving green spaces

It seems from the survey of these professionals from the various cognate disciplines that the future protection of green spaces from development will require a multi-faceted approach that considers a fuller range of green spaces than only those types of space identified within the present structure plans. Any approach to the protection of green spaces would seem to require as a first step a reasonably comprehensive understanding of the current geographical distribution of the existing green spaces within the city, whether these spaces are public or private, gazetted or not. Once this basic inventory has been assembled, the criteria in Figure 4.2 help to outline some of the types of information about the various social, environmental and other properties of these spaces that would ideally be required to inform decisions about which existing spaces have the highest value from various perspectives. From this a reasoned case for conserving particular spaces as green spaces could be advanced.

As discussed in this chapter, information about the criteria in Figure 4.2 would require to be collected from a variety of sources. The gathering of some of this information comprehensively for all the green spaces across the city would require very significant resources (social criteria 1.2 concerning educational functions and social criteria 1.3 concerning quality of experience in Table 4.13 for example) and would probably involve conducting and analysing large volumes of social surveys of users of parks. Access to some of the green areas to conduct surveys of users or of site conditions would be problematic, with the possibility that only partial information might be available. Also significant time would be required for analysing these data. On the other hand, some of these criteria (such as the environmental criteria grouped under 1.1 i.e. quantity and availability of green spaces in Tables 4.13 and 4.14) may now be captured using technologies of remote sensing, whilst others (such as the environmental criteria grouped under fragmentation and connectivity in Tables 4.13 and 4.14) could be derived through analysis of data held in a geographic information system. Figure 4.2 gives an outline of some of the environmental and social criteria in Tables 4.14 and 4.15 which could potentially be measured by using information obtained from remote sensing or held in a GIS (e.g. census data on population and data on points of access to public transport).

The following chapters of the thesis explore the possibilities outlined in Figure 4.2 by examining the degree to which an understanding of the distribution and nature of urban green spaces could be developed from data that can now be acquired from remote sensing and also by using the latter results to help examine whether the green spaces requiring the most protection could subsequently be identified or determined from these data and other data sets held or derived in geographic information systems.

The results would be of necessity a partial solution to the complex problem of how to recognise and evaluate urban green space, but if such a solution could be made operational, it would nevertheless represent a significant advance in the consistency, currency and comprehensiveness of information that could be made available to urban planners about green spaces across the city in forms that they could assimilate into their existing urban planning processes.

Chapter 5

A COMPARISON OF DIGITAL LAND PARCEL DATA AND REMOTE SENSING DATA FOR CREATING AN INVENTORY OF GREEN SPACES IN KUALA LUMPUR

5.0 Introduction

Chapter 5 compares the use of digital land parcel data with classified remotely sensed imagery to try to understand the benefits and limitations of the two sources of data for identifying green spaces in Kuala Lumpur. Firstly, the chapter will present a means of identifying the green spaces in KL and of estimating their area by using land parcel data originally compiled by the Department of Survey and Mapping Malaysia (JUPEM) and subsequently updated by DBKL with information on the dominant land use in each parcel. Some of this land use information will be used to give different perspectives on the overall distribution of 'green land' and 'grey land' by land parcel across the city by trying to match the categories in the land use data with the categories in the typology of green space proposed by the author, where the categories of the land use data permit this and seem to be broadly equivalent.

This presents a view of green space using a nomenclature and geographical mapping units that are meaningful to land use planners, but a number of reasons will be discovered why this parcel-based method for creating a city wide inventory of green space can generally lead to either over or under estimation of the actual green space on the ground. Primarily, this depends on how closely some of the classes in the digital data on land parcels (which were created for the different purpose of cadastral mapping) can be matched with meaningful and appropriately detailed categories of urban green space, in our case that modified from PAN-65 and presented in Table 3.2 in Section 3.5. A particular concern here is how well the data on land use for the parcels allows us to distinguish meaningfully between 'green spaces' (i.e. essentially 'vegetated') and 'grey spaces' (i.e. essentially 'built up' or 'unvegetated').

The second part of this chapter then develops an alternate means of identifying the city's green spaces by using object-oriented software for classifying the high resolution IKONOS imagery to try to identify green spaces. This classification was further refined by visual comparison against a natural colour presentation of the imagery and by manual editing to correct areas that had evidently been misclassified by the object-based software. This approach based on remotely sensed data has the potential benefit that it can be applied in cities of the developing world where no current land parcel data may exist. It will be argued that it can allow green spaces to be identified relatively consistently across large areas. During the classification process the imagery is converted into discrete spatial units (or segments) based solely on the reflectance of the ground cover. However, this creates a new geography of seemingly arbitrary polygons each containing a somewhat distinctive type of land cover, which may not initially appear to be meaningful to planners or to form units recognisable on the ground. Hence these polygons are unlikely to match closely the areal units familiar to planners and for which planning information, if it exists, will have been recorded.

The chapter concludes by comparing the results of using the data for pre-defined land parcels and the data from satellite imagery as two bases for identifying Kuala Lumpur's green spaces. The relative utility of these different approaches and the quality of the results they produce are compared and this leads us to consider how far a city's green spaces can be assessed from land parcel data and what extra insights the remote sensing approach may yield. It is hoped that the findings of this chapter may inform planners and other professionals about different approaches to compiling inventories for mapping, auditing and managing their urban green spaces.

5.1 Methods

As just outlined, two different methods were employed for identifying Kuala Lumpur's green spaces:

(a) Using the land use information recorded in the city's land parcel database to try to implement as much of the expanded typology of green space suggested in Table 3.2 (Section 3.5) as possible;

(b) Developing a classification of green spaces from high resolution IKONOS imagery using automated object-oriented image analysis to create discrete areal units allocated to distinct vegetation types and then using secondary manual refinement to check the attribution made.

These approaches are summarised in Figure 5.1. How these approaches relate to each other is explained further in the following section.

5.1.1 Identifying Green Spaces from the Land Parcel Dataset

In Section 3.5, Table 3.2 identified the further types of green space that were suggested for possible recognition within Kuala Lumpur city as a step towards a more comprehensive and inclusive identification and description of the actual range of vegetated green space in the city i.e. towards a fuller ‘ontology’. An attempt will be made to map out the distribution of some of these possible additional green spaces using the land parcel dataset. This allows us to explore how many of the suggested further types of green spaces could be identified by using the land parcel data already available to the planning authorities in Kuala Lumpur.

The land parcel data acquired from DBKL contains for each land parcel an attributed type of land use made by DBKL staff which was current as of 2006. For land parcel units of residential, industrial, commercial and educational land uses, there is usually only one polygon, whereas for many of the other land use types, such as road and rail reserves, the land use polygons are typically larger and may be a composite of several individual land parcels. In the land use data layer, land parcels had been assigned to one of 18 land use classes (including agriculture, residential, commercial, industrial, educational, institutional, community facilities, forests, green and open spaces, vacant land and cemeteries). These 18 land use classes and their distribution across the city are shown in Figure 5.2.

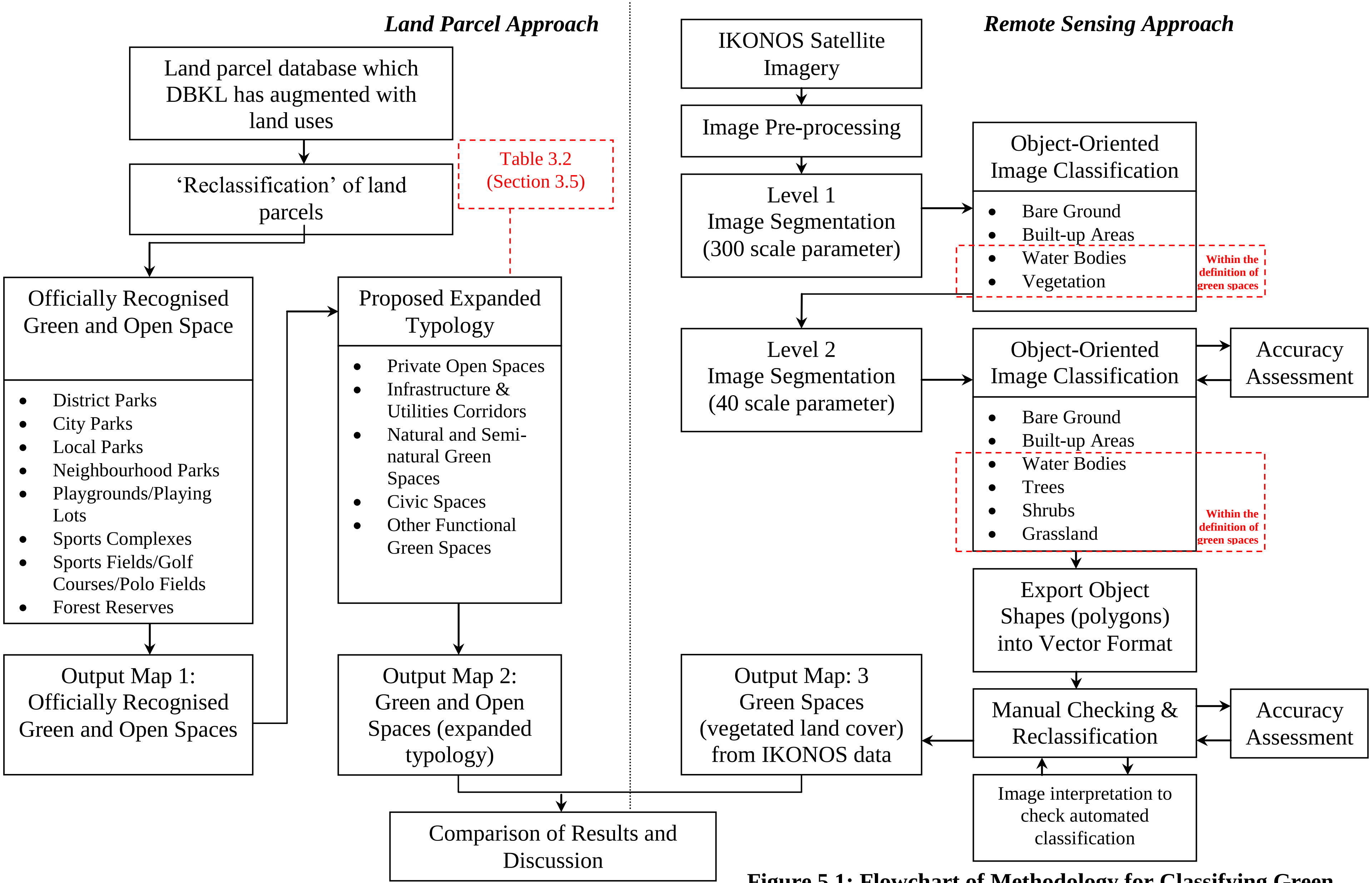


Figure 5.1: Flowchart of Methodology for Classifying Green Spaces using the Land Parcel Database and Remote Sensing Imagery

The land use data shown in Figure 5.2 appears at first sight to only directly recognise 3 types of green space i.e. ‘Agriculture’, ‘Forest’ and ‘Green and Open Space’, a somewhat restricted set of categories, even though it is simply a general map of all types of land use for the city, which cannot by its nature go into much detail for any of the particular broad categories involved. Obviously, this set of 3 categories and, arguably, the 9 categories currently recognised in the standard typology used by DBKL for its inventory of officially recognised green spaces (from which ‘Forest’ and ‘Green and Open Spaces’ in the parcel based land use data are probably derived) are somewhat narrow in that they do not provide an adequate representation of all the ‘functional’ or vegetated green spaces in the city.

Therefore, an ‘experiment’ was undertaken to see how the land parcel data would portray the distribution of green space if more of the 18 land use categories likely to contain some green vegetated space were included. Several of these additional categories match some of the categories of green space proposed in the expanded typology in Table 3.2, so this experiment can be seen as applying part of that proposed typology. However, some of the categories in our expanded typology have no equivalent in the parcel based land use data, notably all 3 of those under the broad heading of ‘civic spaces’ (city squares, boulevards and waterfronts) and 3 out of 5 in our broad category of ‘natural or semi-natural green spaces’ (i.e. wetland, water and former mining land), though the land use data does include 2 of the 5 sub-categories (forest and vacant/derelict land) in this broad class. Similarly, our ‘Garden Nurseries’ does not appear among the 18 land use types but may well be included within the ‘Agriculture’ class in Figure 5.2.

It is not evident how civic spaces are treated in the land use data but they may well be subsumed under ‘Community Facilities’ or possibly even ‘Institutions’. In addition, former mining land in our typology is probably treated as part of the ‘Vacant Land’ class in this map. Thus ‘Vacant/derelict land’ in our typology is probably narrower than the ‘Vacant Land’ class in the land parcel database, which has to be borne in mind when using the information on ‘Vacant Land’ from the latter database to estimate the extent of our corresponding category. It is not clear where land which would be classified as 'Wetland' in our typology appears on the land use map, but it could be under 'River Reserves', 'Green Space', 'Vacant Land' or perhaps even 'Forest' in Figure 5.2. Similarly, our 'Reservoirs' sub-category does not appear among the land use types but may be mapped as part of 'River Reserves' or 'Community Facilities'. Inspection of Figure 5.2 in an area of parkland with fairly large bodies of water, Desa Waterpark on the southern edge of the city, suggests that our sub-category of 'Water' is classed there as 'River Reserve'.

Since our typology has 27 specific sub-categories but the land use database only has 18 classes, it is inevitable that many of the latter would contain a wider range of specific types of land use than ours. From the examples just discussed, it seems clear that 'Vacant Land' in the latter will probably contain a wider range of specific types of land than our equivalent sub-category, as will 'River Reserves'. This means that when we try to use the land use data provided by DBKL to estimate our sub-categories, the latter will tend to be over-estimated in extent. Other sources of over-estimation will be detected shortly. This has to be borne in mind when we consider the results of this attempt to implement our typology with the latter data.

Other differences between our proposed typology and DBKL's 18 broad classes obviously include the fact that our typology has 4 different types of parks and separates local play areas, playing fields and private recreational areas, whereas in DBKL's land use data all 7 of the equivalent sub-categories simply form part of the 'Green and Open Spaces' class on Figure 5.2. However, DBKL's data for the latter category seems to be based on its inventory of officially recognised green and open spaces (set out in Table 3.1) which has seven sub-categories covering parks (4 types) and recreational areas (3 types). Our typology for parks and recreational areas (also 7 sub-categories) was designed to match DBKL's for 6 of these kinds of green space, but we created a sub-category for private recreational areas mainly to distinguish the 5 private golf courses in KL plus the polo field and horse racing track, but had no category for the sports complexes in the DBKL typology because the author felt that in KL the latter were more like built up areas than green spaces. Thus the total extent of green and open space in Figure 5.2 should roughly match what our typology would produce if our 7 equivalent sub-categories were aggregated, because our private recreational areas would be part of DBKL's 'Fields/Golf Courses/Polo Fields' category, though their 'Sports Complexes', occupying 169.8 hectares with a further 44.80 hectares planned, would be missing from our total. In fact, when the author was checking the 891 areas of existing and proposed green space from DBKL's inventory (which includes a category for 'Forest Reserves') against the land parcel data, he found that a very high proportion of the 891 green spaces from the inventory, at least 95%, were placed in land parcels which were already classed as 'Green and Open Space' (or 'Forest' as appropriate), which helped to confirm a fairly strong correspondence between the two sets of classes (or sub-categories) at this aggregate level and also provided a way of cross checking the two sets of data against each other.

During this checking of the data-sets it was relatively easy to select the land parcel polygons for the 13 green areas described in DBKL's inventory as privately owned. Since all of these were recreational in character, it was then easy to calculate the total area of private recreational space, which is included in Table 5.2. The total of 658 hectares from an overall total for existing green space of 1556.2 hectares seems to indicate that these 13 areas occupy quite an extensive proportion of KL's green space; in fact on this calculation they account for some 42.3% of KL's officially recognised green space. However, when the areas for these 13 green spaces listed in DBKL's inventory are aggregated, this produces a total of only 289.8 hectares or 18.6% of the officially recognised green space, so it may be the case that using the land parcel data has somehow led to an over-estimate here, as in other places.

Of the 5 private golf courses that constitute the biggest proportion of this recreational green space, 3 are actually gazetted: both the Old and New Courses of 18 holes at the Royal Selangor Golf Club (RSGC), founded in 1893, plus the club's adjoining 9 hole course, perhaps reflecting their historic significance or possibly even partly because their owners wish to avoid their being developed in the way the Selangor Turf Club was in the 1990s, but this latter possible explanation is only speculative. It should be noted here that the DBKL inventory seems to treat the 3 courses of the RSGC together and gazette them as one with the club houses, or one of them, gazetted separately, producing only two gazetted entries in the inventory. This areal prominence of an outdoor game like golf in such a hot and humid climate may be partly a result of the British legacy and the fact that the first 3 of Malaysia's prime ministers after independence were keen golfers, all from a royal or aristocratic background (Wain, 2012).

The two schemes of classification also appear to match each other as regards most of the sub-categories found in our typology under the broader headings of 'Infrastructure and utilities corridors' and 'Other functional spaces', except that in practice some of the corresponding DBKL categories (e.g. River Reserves') probably also contain areas from other categories in our typology, because the DBKL scheme of classification does not recognise all the latter as separate classes, as just noted. Despite the lack of a fairly complete set of 'one to one' matches between our typology and the land use classes, there are thus a sufficient number of categories in the DBKL land use data that match or roughly correspond to many of those in our typology to warrant using the former as a basis for exploring the consequences of implementing our typology, albeit in a limited manner.

From these 18 land use categories, only two classes ('Forest' and 'Green and Open Space') were selected at the initial stage of this experiment, as these allow us to establish the basic extent of green spaces currently recognised by DBKL in its inventory of green spaces (DBKL, 2007). Ten further land use classes (namely 'Agriculture', 'Cemeteries', 'Community Facilities', 'Electric Line Reserves', 'Educational', 'Places of Worship', 'Rail Reserves', 'River Reserves', 'Road Reserves' and 'Vacant Land') were then selected from the land parcel data and the effect of progressively adding sub-sets of these to an overall inventory of green space was assessed in terms of the resulting distribution and the additional areas created.

Various sub-sets of these ten classes of land use, each potentially containing some green vegetated surface areas, were thus extracted from the land parcel database and mapped using ArcMap (ArcGIS 9.3) in an attempt to successively produce what can be claimed arguably as more realistic approximations to the actual distribution of green spaces. Four maps resulting from this will be presented later in Section 5.2.1 in Figures 5.9 (a) – (d), since they can be discussed more appropriately at that point.

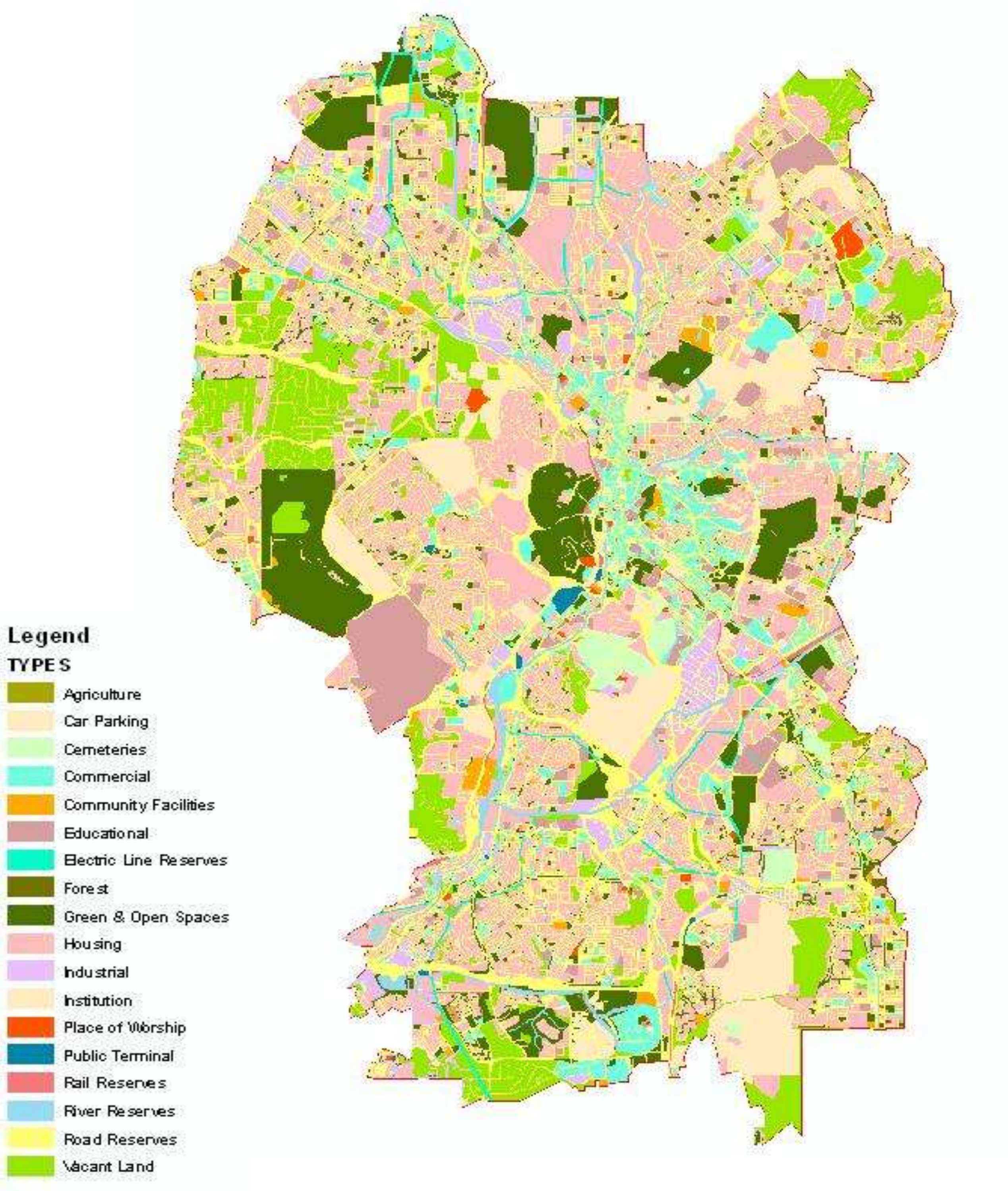


Figure 5.2: Land use in Kuala Lumpur based on the 18 land use categories of the land parcel data

5.1.2 Classification of Kuala Lumpur's Green Spaces from IKONOS Imagery

5.1.2.1 Sources of Data

The image data used were 18 IKONOS Panchromatic image extracts shot or captured by the satellite in 2002. Efforts were made by the author during data collection at DBKL in August 2007 to acquire satellite images captured in more recent years (i.e.: 2006 or 2007), but only the 2002 IKONOS images were made available through DBKL from the Malaysian Remote Sensing Centre (MACRES) at that point in time. These extracts had already been combined into a mosaic to cover the City (Federal Territory) of Kuala Lumpur. These images were then divided by the author into 11 zones in order to complete the classification tasks (Figure 5.3). The total mosaic covers an area of approximately 243 square km. The IKONOS images were acquired from MACRES with band width of 0.45-0.90 μm and with initial geo-rectification complete. The multi-spectral images have a spatial resolution of one meter, include the three visible spectral bands (red, green and blue) and a radiometric resolution collected as 11 bits per pixel (2048 gray tones). Because the near infra-red (NIR) band was not supplied, this did limit the ability to classify the land cover of vegetation and also prevented the author from carrying out some standard image processing operations, such as atmospheric correction of the images. However, some spectral enhancements of these images were done by Reyes-Firpo (who used the same imagery in her M.Sc. dissertation in 2008) to improve contrast, to increase the ease of visual interpretation and to enable more consistent results from automatically segmenting the images.

5.1.2.2 Image Pre-processing

Image enhancement and visual inspection were conducted using ERDAS Imagine software. As some haze was found in many of the images, a 3x3 kernel convolution filter (for low-haze conditions) was applied before any other spectral enhancement was done. Having only the three visible bands available limited the analysis that could be carried out, since according to Cleve et al. (2008), classifying only using the three visual bands may increase confusion between classes as these three visible bands tend to be highly inter-correlated. However, according to Lillesand and Kiefer (2000), decorrelation stretching can be useful when displaying multi-spectral data that is highly correlated. For these reasons, a decorrelation stretch was applied by Reyes-Firpo to improve discrimination of features using only these three visible bands.

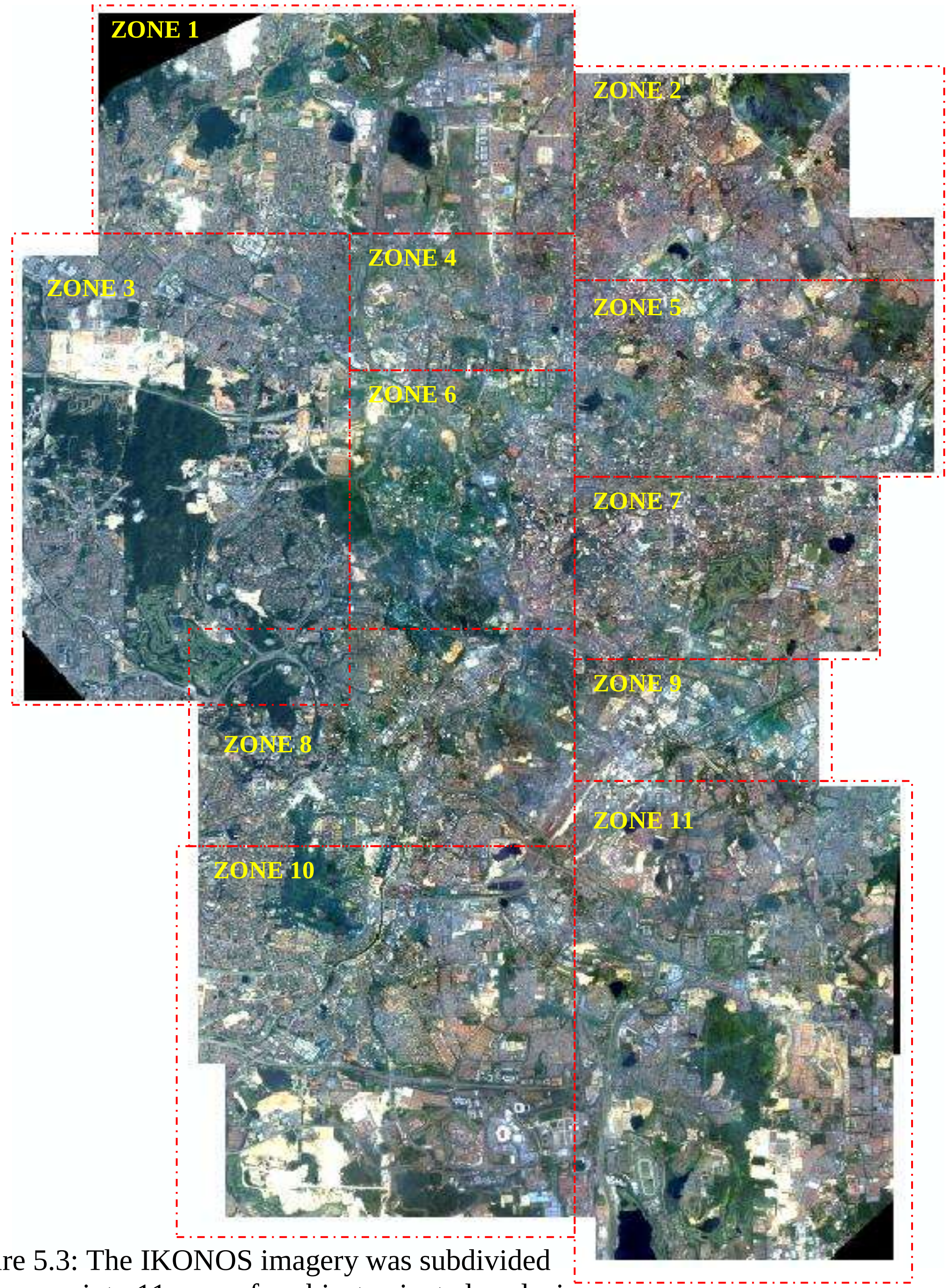


Figure 5.3: The IKONOS imagery was subdivided into 11 zones for object-oriented analysis and classification.

5.1.2.3 Image Segmentation

As indicated by Figure 5.1, the object-oriented approach was carried out in two consecutive steps. Firstly the image was segmented into a series of smaller image objects. This was followed by a classification of the objects (Baatz et al. 2004). Both steps were conducted using Definiens eCognition software.

Segmentation is the process of grouping adjacent pixels with similar spectral and textural characteristics. These groups of pixels represent meaningful entities or objects for example trees, houses, roofs or water (Cleve et al., 2008). In the present study, a multi-scale segmentation algorithm was used. This segmentation approach, which is also known as 'bottom-up segmentation technique' merges smaller image objects (starting with one pixel) into bigger image objects until a threshold size is achieved (Definiens, 2004).

There are five parameters influencing the result of image segmentation: scale, colour, shape, smoothness and compactness. The *scale* parameter is used to define the average size of the objects to be detected in the image. The larger the scale parameter value, the larger the image object detected. *Colour* determines the spectral homogeneity of the objects whereas *shape* controls the degree of object shape homogeneity. According to Lackner and Conway (2008) and Fung et al. (2008), colour is generally more effective at differentiating land cover types than shape. Shape is controlled by two further parameters, *smoothness* and *compactness*. There is some disagreement as to which is the best value for smoothness and compactness. However, according to Mathieu et al. (2007), Su et al. (2008) and Fung et al. (2008) the most effective smoothness and compactness values tend to range from 0.5 to 0.7 for smoothness and 0.1 to 0.5 for compactness. Generally, smoothness is given a higher value for extracting longer objects whilst compactness is favoured more for image objects that are more self-contained. Figure 5.4 shows a flow diagram of these five parameters that influence the overall results of image segmentation.

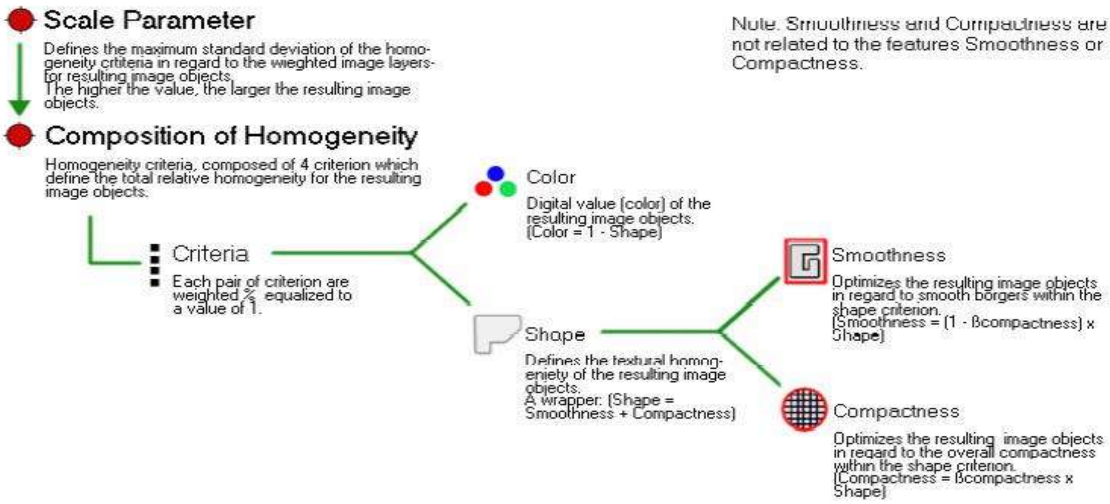


Figure 5.4: Diagram of concept flow for the five parameters that influence the results of image segmentation.
(Source: Definiens, 2007)

After undergoing several processes of experimentation and after examining numerous segmentations with different scale and shape parameters and also by visually comparing these to the original IKONOS images, the following segmentation parameters were chosen based on how clearly and accurately the segments delineated the boundaries of both the small and large objects visible in the image. Table 5.1 presents the parameters chosen and used in this study.

Segmentation Level	Scale Parameter	Colour	Shape	Compactness	Smoothness
Level 1	300	0.7	0.3	0.8	0.2
Level 2	40	0.7	0.3	0.8	0.2

Table 5.1: Segmentation parameters used

As shown in Table 5.1, the images were segmented at two different scales. An example of this segmentation is shown in Figure 5.5. The overall segmentation for all 11 zones is shown in Appendix D. The first level of segmentation was produced using a scale parameter of 300 and the second and finer level of segmentation was carried out using a scale parameter of 40. In both levels of segmentation, a greater weight was given to the colour values (0.7), rather than to the shape of features (0.3). This weight value was chosen from previous studies which claimed that colour generally was more effective in differentiating land cover type than shape. A value of 0.8 was used for compactness and consequently, a weight of 0.2 was allocated to smoothness in both levels of segmentation. The higher value was given to compactness as it was thought that it might extract vegetation patches that mostly have a nucleated form rather than an elongated shape. These two hierarchical levels of segmentation help to facilitate the extraction of meaningful objects. This logic permitted the early recognition and subsequent masking out of some types of larger non-green objects that were not relevant for the research such as bare ground and built-up areas.

(a)

(b)

(c)

Figure 5.5: An example of segmentation:

(a) An IKONOS image extract in a false colour display (upper left);

(b) Segmentation using a scale parameter of 300 (upper right) leads to large objects that may still contain considerable variability within them; and

(c) Segmentation using a scale value of 40 (left) allows smaller and more spectrally homogenous objects to be identified from the image.

5.1.2.4 Class Hierarchy and Object-Based Classification

According to Baatz et al. (2004), image classification is the task of assigning image objects recognised during the segmentation process into user-defined classes. Hence, meaningful classes need to be developed before any image classification process can begin. In this study, the class hierarchy developed by Reyes-Firpo (2008) was used to assign the image objects. Reyes-Firpo used a small extract of the same satellite images in her study and developed a class hierarchy divided into two levels according to the level of segmentation, with parent and child classes at both levels of the hierarchy. Thus parent classes were further subdivided by Reyes-Firpo into more detailed child classes at both levels. Figure 5.6 below summarises these two levels of the hierarchy of classes at different levels of segmentation.

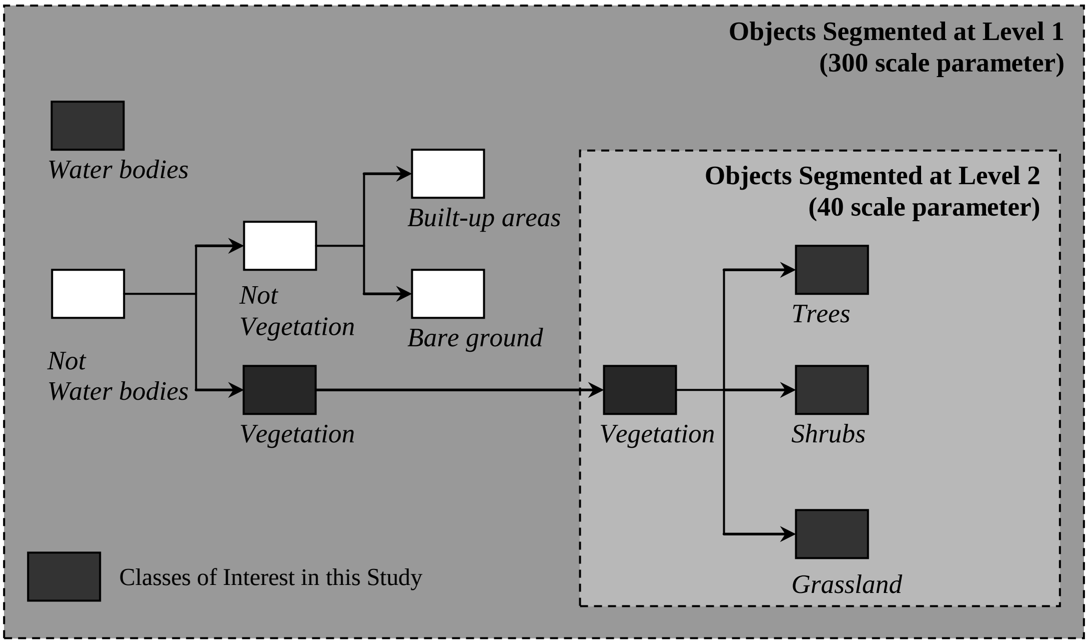


Figure 5.6: Diagram showing an example of the workflow for the class hierarchy developed by Reyes-Firpo for segmenting the image into meaningful objects.

As shown in Figure 5.6, at the first level of the class hierarchy (level 1 of segmentation), water bodies and 'non-water' bodies are the parent classes. As Figure 5.6 shows, this first level of segmentation thence classified the study area into the four broad classes (large image objects) of water bodies, vegetation, built-up areas and bare ground. This would allow some of the large objects to be masked out of the image and not segmented further at the lower levels, for instance water bodies, built-up areas and bare ground, as we are not primarily concerned with them. Subsequently, in level 2 segmentation, trees, shrubs and grassland are the child classes of their parent, vegetation. The smaller objects created at this second level permitted smaller patches of vegetation to be extracted. Within the larger class of open vegetated areas, more information was extracted to characterise the mixtures of vegetation occurring internally. For instance, this allowed areas of trees, shrubs and grassland to be separately distinguished, thus classifying the study area into three classes: trees, shrubs and grassland. Thus the two levels of the class hierarchy developed by Reyes-Firpo were used in this study to classify the entire image mosaic into meaningful objects.

Based on the class hierarchy created, Reyes-Firpo developed a rule-set for each class in order to assign image objects to the appropriate class. According to Mathieu et al. (2007) and Blacker (2009), the object-based membership function allows a user to establish values between 0 and 1, where 0 indicates complete exclusion from the class and 1 means complete membership in a particular class.

By using these basic rules, Reyes-Firpo classified two test sites within the city, which are shown in Figure 5.7. The rule-set developed by Reyes-Firpo was then modified and used to classify all the images for the whole area of Kuala Lumpur City by the author. The same basic rule-set which includes parameters such as the mean, ratio and standard deviation, brightness, area and asymmetry of the different image objects was used. However, the exact threshold values required for the rules had to be adjusted by the author. This was mainly due to differences in the illumination and haze characteristics of the different images comprising the mosaic. Figure 5.8 shows some of the examples of these rule-sets.

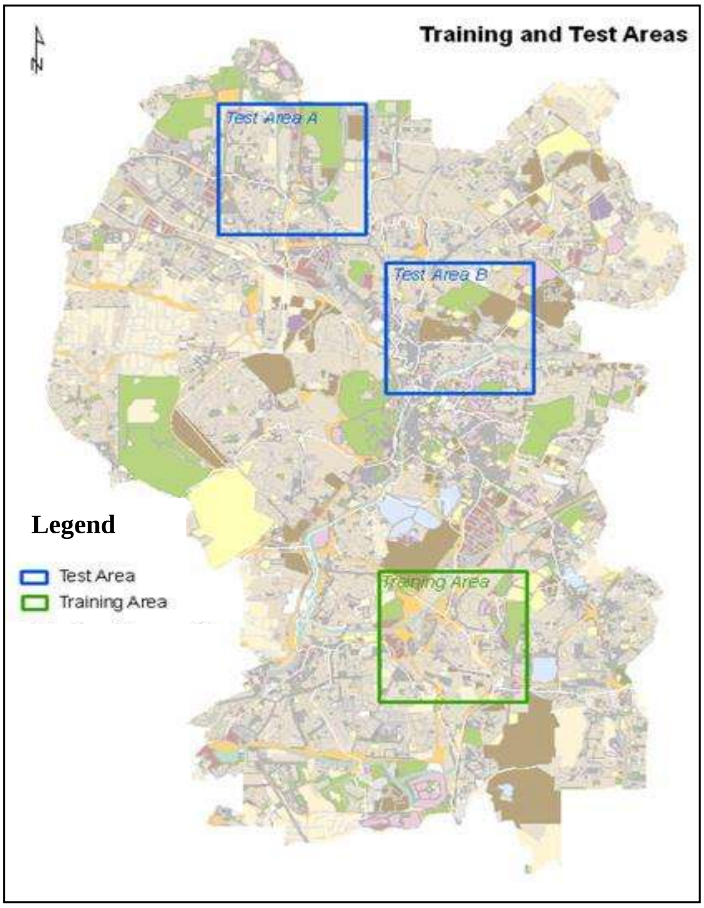


Figure 5.7: Location of the training and two test areas classified by Reyes-Firpo. A locally modified version of the same basic rule-set was used in this study to classify the entire city area.

(a) (b)

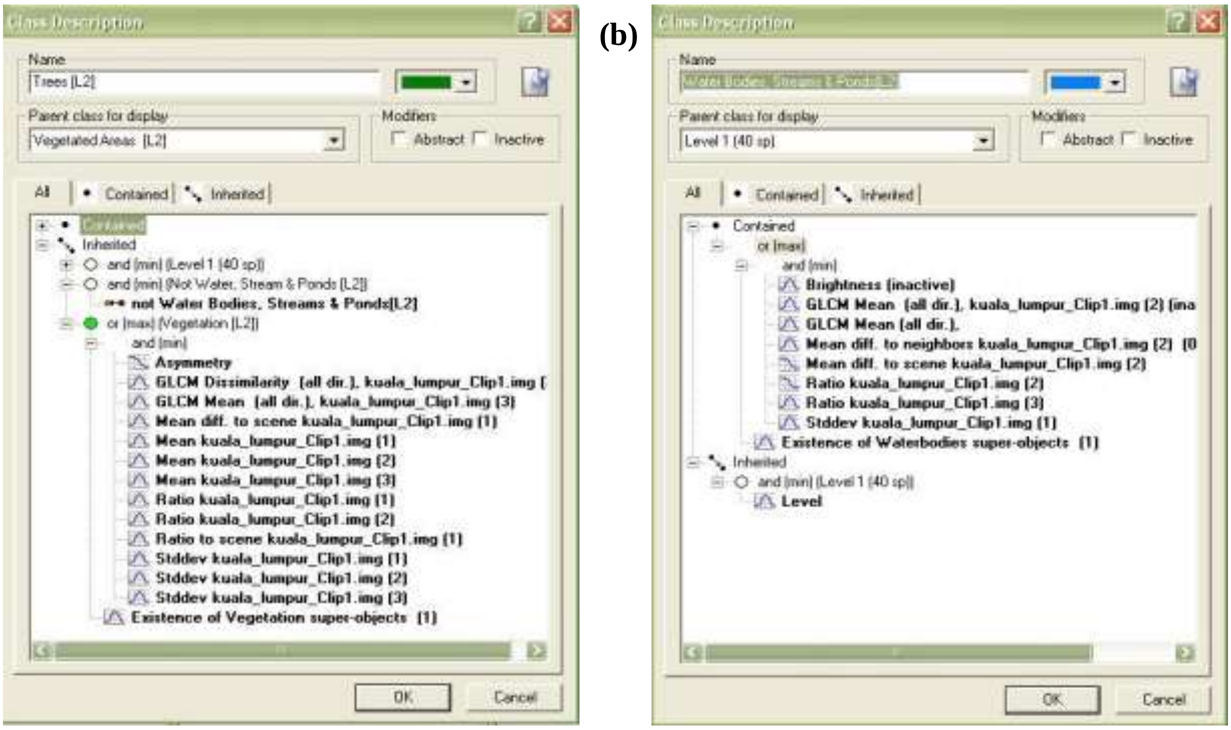


Figure 5.8: Examples of the rule-set developed by Reyes-Firpo which was used in this study for classifying image objects of Kuala Lumpur city:

(a) rule-set for 'tree' class (left);

(b) rule-set for 'water bodies' class (right).

5.1.2.5 Sampling Design and Accuracy Assessment

In this research, a stratified 'random' sampling design was used in order to produce a statistically reliable assessment of the accuracy of the results. One of the most important factors in a sampling design is the independence of the reference data that will be used in the accuracy assessment. The need for independent reference data presented a problem since totally independent reference data were not available for the study area. As a result of this constraint, a comparison of the predicted classes from the output of the automated classification procedure against samples that were visually interpreted by the author from the IKONOS imagery in the selected zones was carried out. To maintain the independence of the reference data, the sample area to be used for the accuracy assessment was chosen and interpreted *before* the imagery was classified. This was done to eliminate any potential bias in the subsequent classification process.

According to Congalton (2001) and Sydenstricker-Neto et al. (2004), it has been proposed that there are three common sampling units for creating reference data for assessing the accuracy of remote sensed data, which are:

(i) the pixel;

(ii) a group of pixels; and

(iii) the polygon.

In this research, the sample unit selected was the polygon. The image objects that are formed by segmentation were the basic spatial units in this research; thus the class (attribute) assigned to a polygon was used to build the confusion matrices. Therefore, once the segmentation process and the classification process were finished, the sample polygons for testing were chosen for each of the 6 classes of land cover i.e. the sampling was stratified by class of land cover. Within each class, an attempt was made to select polygons 'randomly' by clicking with the 'mouse' at a somewhat 'randomly' dispersed set of points well spread across the surface areas of that class on the screen. This was not a strict random process of sampling in the classic statistical sense of the term but in the circumstances it seemed an appropriate and fairly unbiased way of selecting polygons to check the allocated class against our judgement of the true class from inspection of the true colour image for that polygon.

Zones 2, 6 and 10 (Figures 5.11, 5.12 and 5.13) were chosen to test the accuracy of the results of the automated classification. These three zones were chosen because they contained most of the land cover classes found in the city. Approximately 50 objects or polygons (or more) from each class were chosen because, according to Green and Congalton (2004), such volumes are required to adequately populate an error matrix. Definiens eCognition software enables users to create a TTA (training or test area) mask of samples, which can then be used to generate an error matrix for the classification. TTA masks were generated for Zones 2, 6 and 10, using the samples as a reference to check the classification quality.

A confusion matrix and a Kappa statistic were calculated for each of these zones to report the classification accuracy. The error matrix is the most widely accepted format for the classification accuracy of remote sensing imagery (Congalton, 2001; Thomas et. al., 2003; Lunetta, 2004). The matrix allows not only the total accuracy to be shown but also the accuracy of each class and thus shows the confusion between classes (Green and Congalton, 2004). These statistics were calculated using a Definiens eCognition software tool, which generates estimates of the overall accuracy and the accuracy per class as well as the Kappa statistic.

5.2 Results

Results from both the above methods for mapping green space are now discussed.

5.2.1 Identifying Green Spaces from the Land Parcel Dataset

Figure 5.9 presents four successive stages in expanding the definition of green space using the land use information in the land parcel data:

(a) the presently recognised green and open spaces included in DBKL's inventory (and also in the 2020 Structure Plan for Kuala Lumpur) i.e. including both existing and planned green space (KLSP, 2007; KLSP, 2020; and KLCP, 2020);

(b) the incorporation of seven further categories of possible green land use from the expanded typology being proposed here (i.e. agriculture, cemeteries, community facilities, electric line reserves, places of worship, rail reserves and river reserves);

(c) the incorporation of two further categories (educational areas and vacant land); and

(d) the effect of considering the road reserves as a predominantly vegetated green land use.

Comparison of Figures 5.9 (a), (b), (c) and (d) shows the progressive effects of adopting a successively wider definition of urban green space. The effect of adopting more of the classes from the new typology is to significantly increase the overall area of the city considered to be green space by stage (c); as well as creating the impression of a generally more even distribution of green spaces than indicated in (a), whilst (d) also reveals scope for a more connected pattern of green spaces throughout the city. The results can also be compared in terms of the area added by studying Table 5.2.

Main Category	Sub-Category	(a) Area of green space presently recognised by DBKL (in Hectares)	Incremental area of green space recognised by successive inclusion of further categories (in Hectares)		
			(b) Including 7 further categories	(c) Including 9 further categories	(d) Including 10 further categories
Public open space	District parks	1,556	1,556	1,556	1,556
	City parks				
	Local parks				
	Neighbourhood parks				
	Playgrounds/Playing lots				
	Playing fields				
Private open space	Private recreational areas including; golf courses, polo fields, driving ranges, outdoor sports centres, outdoor pools	658	658	658	658
	Private residential areas including houses with gardens				
Infrastructure and utilities corridors	Road reserves				5,747
	River reserves		445	445	445
	Rail reserves		74	74	74
	Electric line reserves		222	222	222
	Reservoirs				
Natural or semi-natural green spaces	Forest reserves	12	12	12	12
	Wetland				
	Water				
	Vacant / derelict land			2,273	2,273
	Former mining land				
Civic spaces	City squares				
	Boulevards				
	Waterfronts, river and lake embankments				
Other functional green spaces	Community facilities		272	272	272
	Educational areas			1,062	1,062
	Places of worship		125	125	125
	Cemeteries		270	270	270
	Agricultural land		8	8	8
	Garden nurseries				
ESTIMATED GREEN SPACE IN EACH SCENARIO (IN HECTARES)		**2,226**	**3,642**	**6,977**	**12,724**

Table 5.2: Successive estimates (in hectares) of green areas in KL based on incrementally including a further 7, 9 and 10 types of land use to those presently recognised in KL's inventory of officially recognised green and open space.

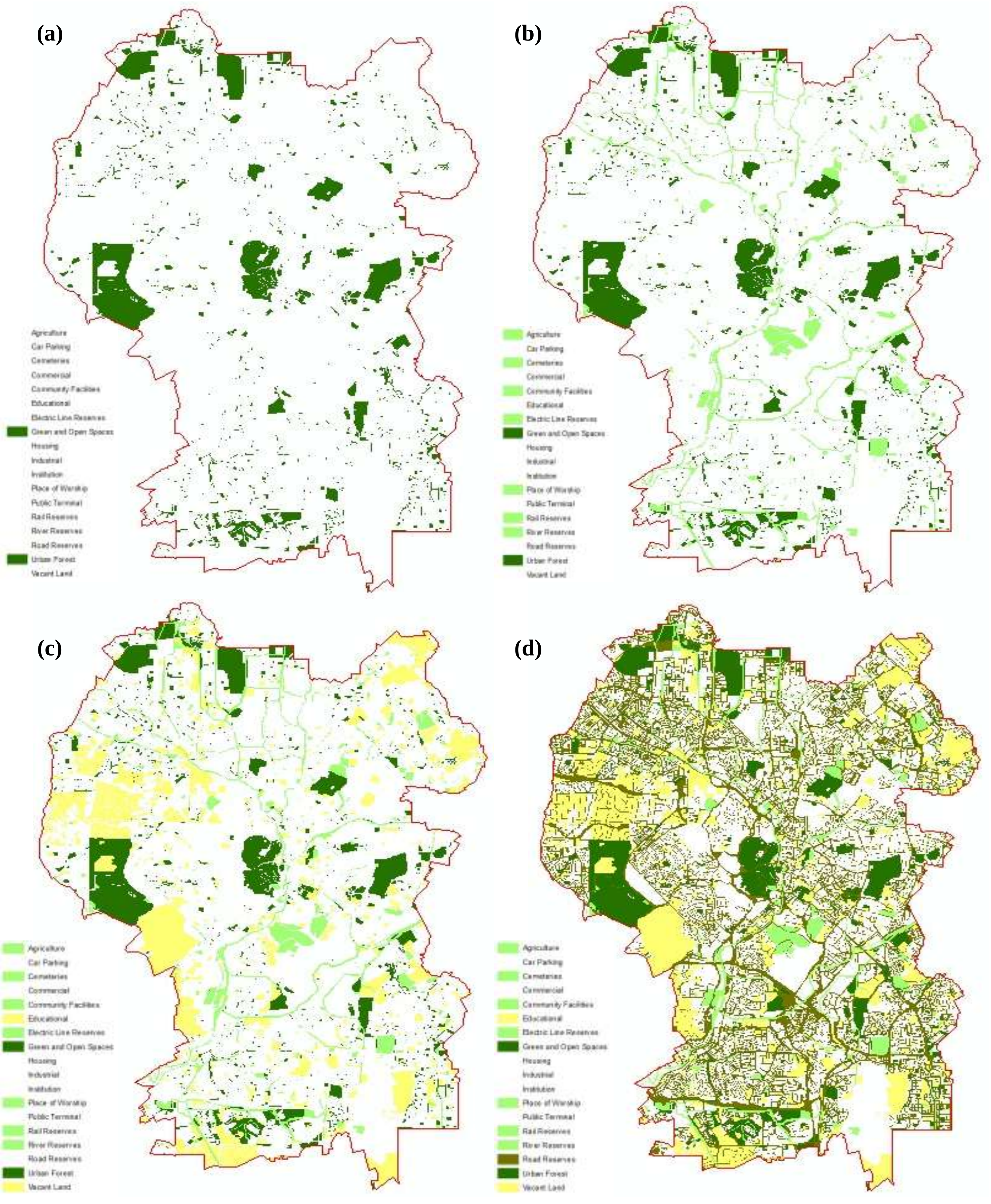


Figure 5.9: Green space identification using land parcel data:
(a) based on DBKL's current typology of green and open spaces (upper left);
(b) based on (a) with the addition of seven types of land from the expanded typology (agriculture, cemeteries, community facilities, electric line reserves, places of worship, rail reserves and river reserves) (upper right);
(c) addition to (b) of two further land use types (vacant land and educational areas) (lower left); and
(d) addition to (c) of road reserves (lower right).

By examining Figure 5.9 (b) and by studying Table 5.2, it can be seen that the extent of recognised green space would be increased from 2,226 hectares to 3,642 hectares by the inclusion of the seven further types of land - agriculture, cemeteries, community facilities, electric line reserves, places of worship, rail reserves and river reserves. Similarly, the area of recognised green space is nearly doubled (to 6,977 hectares) by the further addition of two more categories (vacant land and educational areas) as green spaces. The final addition of the road reserves category (Figure 5.9 (d)), which is perhaps the most debateable addition to the green space inventory, would lead to almost a further doubling again in the total area of green space identified using this land parcel data, since there is a total area of 5,747 hectares in the road reserves category alone. Road medians, verges and roundabouts occupy a surprising 23.6% of the land area of Kuala Lumpur. These areas have been a focus for some urban greening campaigns such as tree planting, but many of the major arterial roads and flyovers still have few marginal trees and are essentially 'grey' spaces (Sreetheran & Adnan, 2007).

The scenarios presented in Figures 5.9 (a) to (d) illustrate just one set of approximations and show how a typology combined with a geography or geometry can be used to map green spaces. This expanded typology of green spaces is certainly more comprehensive compared with the one that is currently used by DBKL. Although Figure 5.9 (b) or even 5.9 (c) probably give a more realistic impression about the total amount of green spaces in Kuala Lumpur city than Figure 5.9 (a), the use of the land parcel polygons as the basis for mapping the extent and distribution of green space is not without its problems. For example, the road reserves which, if they were all included would contribute a significant increase in the area of green space, in reality often have relatively little green value or vegetation cover, although all of these or none would have to be included as green spaces if one were using the land parcel data on its own. On the other hand, some other categories such as residential areas are not considered as green spaces in Figure 5.9 (d), yet these areas often include vegetated gardens and grounds.

If one looks at aerial imagery or conducts ground surveys, it is clear that there are still many areas of green space, both small and large, that remain unidentified by simply adding these new categories of land use, however appropriate it may be to use the land parcel data in this way. The parcel data is also geographically coarse in places, where the smaller individual lots have been aggregated together. In reality of course many areas are, at best, only partially acting as green spaces, when in using a classification based on the land parcel data, we are forced into an all-or-nothing assignment of parcels as green, or not. Therefore, Section 5.2.2 explores the potential to extract more detailed information at a finer resolution about land cover to pick out and to delineate in more detail green spaces by interpreting and classifying high resolution optical satellite imagery. The use of remote sensing offers the possibility to pick up further detail about areas that function as green spaces, but which may be omitted from the parcel based classification because they occupy only a fraction of a land parcel that is predominantly 'grey'. Hence remote sensing potentially offers one way to correct the problem of overestimation of green space which can occur when 100% of a land parcel is classified as green space, when in reality it is only partly green space.

5.2.2 Interpretation of Kuala Lumpur's Green Spaces from IKONOS Imagery

Figure 5.10 (b) presents the results of the IKONOS classification at level 2 (40 scale parameter) for Kuala Lumpur city. The classification identifies most of the vegetated spaces that visually appear 'green' to the eye. However, some problems are evident with the classification of the IKONOS imagery. Some types of open space such as civic spaces or boulevards which are not vegetated could not be discriminated from grey urban surfaces, since they have a similar spectral response in the visible bands. Although the IKONOS sensor captures data in three visible plus one infra red (IR) band, only the three visible bands were provided to DBKL and hence to the author. Without the IR band, it was not possible to derive indices of vegetation vigour, such as the NDVI which would have enabled a more reliable separation of the vegetated and non-vegetated surfaces (Lillesand and Kiefer; 2000). A second limitation of the image data made available was that the image mosaic had been completed before data was distributed and no metadata was provided describing the nature of the atmospheric correction that had been applied. Whilst the data set could therefore still be used for visual interpretation and segmentation according to features in the visible bands, the imagery may not have been corrected for shadow, or for different haze conditions in the different image extracts. Whilst it was possible to develop a few land cover classes that matched fairly closely with the definitions of green spaces used in various typologies, most of the detailed land use classes e.g. in Table 3.2 could not be reliably discriminated by the automated classification.

These results will be discussed in further detail in the following sections. As examples, the discussion will focus on three of the 11 zones into which the IKONOS image mosaic was divided in order for the classification to be completed with the computing resources available (Zone 2, Zone 6 and Zone 10 in Figure 5.3). In general, all the 11 zones produced generally similar classification or misclassification and discrimination issues.

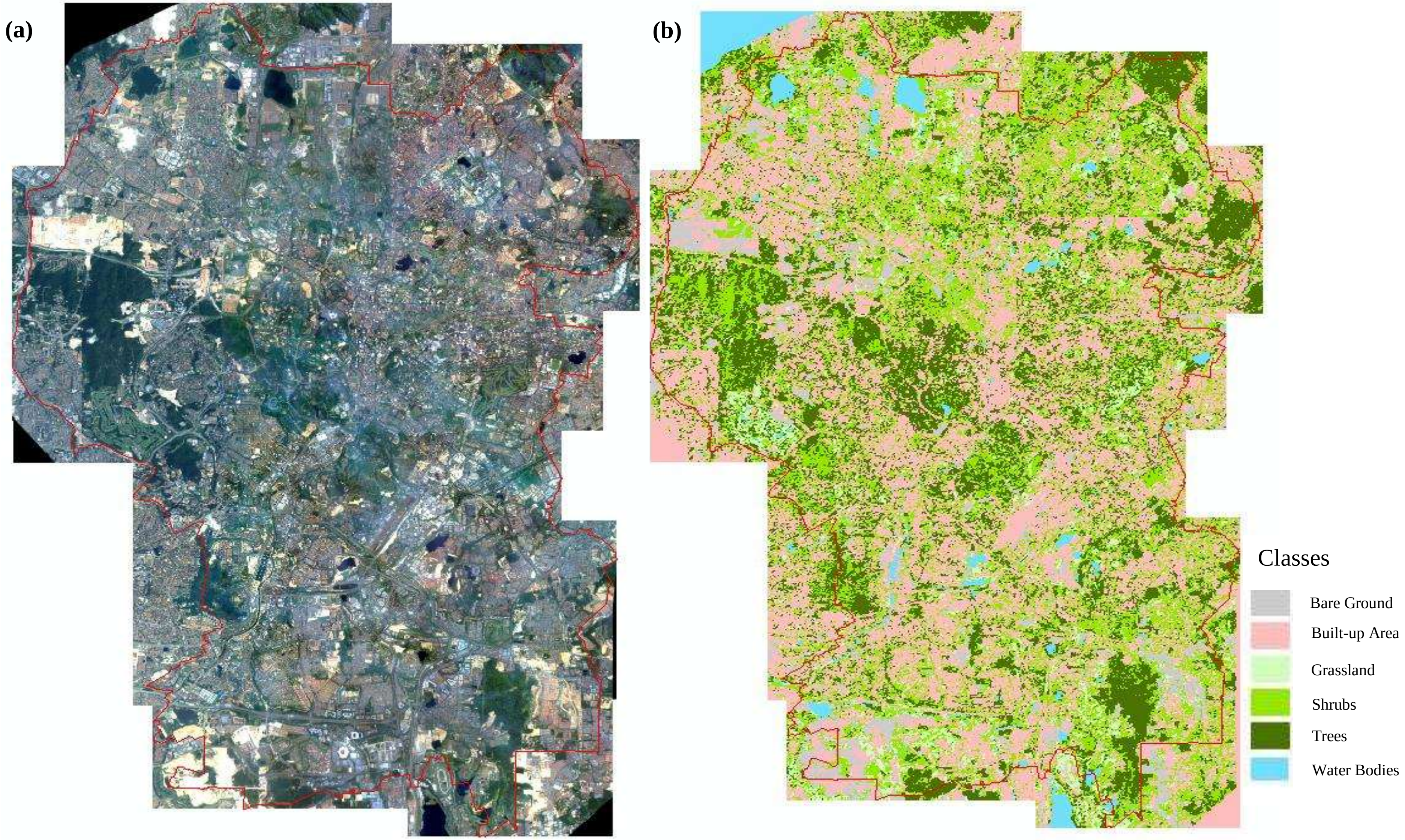


Figure 5.10: (a) IKONOS mosaic covering the whole of Kuala Lumpur city (left); and
(b) Image classification result for Kuala Lumpur city (Level Two - 40 scale parameter) (right).

5.2.2.1 Zone 2: Automated Classification Result and Accuracy Assessment

Figure 5.11 shows the classification results for Zone 2, which includes areas of residential and commercial land use in Gombak Setia, Kuala Lumpur. It can be observed from the classification result that shrubs were over-estimated (highlighted in red circles labelled (a) in Figure 5.11). The shrub class was mainly confused with some built-up areas due to the similar spectral values of these objects in the visible optical wavelength, thus limiting the capability of the membership rules to differentiate them.

Similarly, some areas of bare ground were not correctly extracted from the image. These were mainly confused with built-up areas. The bare ground areas (shown in two red circles - upper right labelled (b) in Figure 5.11) were under-estimated in this classification. Visual interpretation of the imagery and some ground checking could be used to resolve these misclassifications and possibly determine more effective threshold values for separating these classes using the available optical bands. If the infra red band had been available, this would probably have allowed easier separation of the vegetated from non-vegetated areas (Lillesand and Kiefer; 2000) and this may have improved the identification of shrub lands.

Classes	Confusion Matrix and Classification Accuracy for Zone 2							
	Bare Ground	**Built-up Areas**	**Trees**	**Shrubs**	**Grassland**	**Water Bodies**	**Total**	**User's Accuracy**
Bare Ground	**17**	2	0	0	0	0	19	89.5%
Built-up Areas	6	**108**	4	0	1	0	119	90.8%
Trees	0	0	**70**	6	0	0	76	92.1%
Shrubs	0	21	4	**55**	5	2	87	63.2%
Grassland	0	2	0	4	**31**	0	37	83.8%
Water Bodies	0	0	0	0	0	**4**	4	100.0%
Unclassified	0	0	0	0	0	0	0	
Total	23	133	78	65	37	6		
Producer's Accuracy	73.9%	81.2%	89.7%	84.6%	83.8%	66.7%		
KIA Per Class	72.4%	71.2%	86.8%	79.4%	81.8%	66.3%		
Overall Classification Accuracy	**83.3%**							
Kappa Statistic	**77.8%**							

Table 5.3: Classification Accuracy for Zone 2 (as shown in Figure 5.11)

Table 5.3 presents the confusion matrix and classification accuracy for Zone 2. The accuracy assessment quantifies the confusion between shrubs and built up areas, and between built-up areas and bare ground. Although the overall accuracy for the classes identified in this zone is fairly high (83.3%) and the more important tree and grassland classes are accurately mapped, the confusion between shrubs and some built-up areas leads to a lower user's accuracy (63.2%) for the shrubs class which is a potentially important class for green space mapping. This confusion with built-up areas also lowered the producer's accuracy (73.9%) for the bare ground class which may or not be important for green space evaluation in this neighbourhood, depending on whether it is bare ground that is cleared for development, in which case it is already effectively 'lost' as a green space, or merely vacant land which might be re-vegetated or developed as a green space in future. There is increasing interest in temporarily developing even so called 'vacant' land areas as green spaces in cities, since some such areas can remain vacant for several years (Kattwinkel et al.; 2011).

Figure 5.11: Image classification result for selected area in Zone 2 (Level Two – 40 scale parameter). Red circles labelled (a) and (b) illustrate some areas of misclassification.

5.2.2.2 Zone 6: Automated Classification Result and Accuracy Assessment

Zone 6 covers the area of the city centre which includes the popular Perdana Lake Garden (formal parks and recreational areas) and Bukit Bintang (the main commercial area). The classification result for this zone (shown in Figure 5.12) indicates that the shrubs class again was not correctly extracted from the image, being mainly confused with taller trees. In addition, some water bodies were under-estimated. For instance, very short stretches of both the River Gombak and the River Kelang, near their confluence in the oldest part of the city close to Dataran Merdeka (Independence Square), were misclassified as built-up surfaces (indicated by two red dotted circles at (b) in Figure 5.12). In contrast to Zone 2, this time the bare ground class was over-estimated and was mainly confused with built-up areas. Examples of all these misclassifications are indicated by red dotted circles in Figure 5.12.

These misclassifications of shrubs with trees and bare ground with built-up areas (these types of error are shown by two red dotted circles labelled (a) in the middle left of Figure 5.12) are thought to be mainly due to the similar spectral values of these pairs of objects. However, confusion of built up areas with water bodies (as just noted, examples of this apparent mis-classification are indicated by two red dotted circles labelled (b) in the middle right part of Figure 5.12) is probably due to the shape of the narrower rivers and streams, giving them a similar response to built-up surfaces because of the pavements and concrete walls and floors of many river channels in the city, which have essentially been 'canalised'. Furthermore, some of the water bodies such as the rivers are also partly covered by low density tree canopies which may have led to some confusion in the classification process and may have caused the water signal to be confused with the signal from the trees. Visual interpretation may help to resolve some of these misclassifications, or alternatively a contextual classifier might be developed, as is possible in some object-based software, for instance to recognise a series of narrow linear green strips and connect these together to identify avenues of trees with discontinuous tree cover.

Classes	Confusion Matrix and Classification Accuracy for Zone 6							
	Bare Ground	**Built-up Areas**	**Trees**	**Shrubs**	**Grassland**	**Water Bodies**	**Total**	**User's Accuracy**
Bare Ground	**12**	13	0	0	0	0	25	48.0%
Built-up Areas	7	**61**	4	1	1	1	75	81.3%
Trees	0	0	**81**	7	0	0	88	92.1%
Shrubs	0	2	9	**30**	0	0	41	73.2%
Grassland	0	0	0	0	**32**	0	32	100.0%
Water Bodies	0	0	0	0	0	**1**	1	100.0%
Unclassified	0	0	0	0	0	0		
Total	19	76	94	38	33	2		
Producer's Accuracy	63.2%	80.3%	86.2%	79.0%	97.0%	50.0%		
KIA Per Class	59.3%	72.4%	79.2%	75.0%	96.6%	49.8%		
Overall Classification Accuracy	**82.8%**							
Kappa Statistic	**77.1%**							

Table 5.4: Classification Accuracy for Zone 6 (Figure 5.12)

Table 5.4 presents the confusion matrix for Zone 6. Despite the relatively high overall accuracy of 82.8% for this zone, it can be observed that some confusion has again occurred between the shrubs class and the trees class. This leads to a reduced, although still acceptable, user's accuracy for shrubs of 73.2%. Similarly, the assessment also shows that bare ground was often confused with built-up areas and that led to a lower user's accuracy for bare ground (48.0%). The fact that there were only two areas of water in the sample and one was wrongly classed as a built up area resulted in a relatively low producer's accuracy for the water class (50.0%).

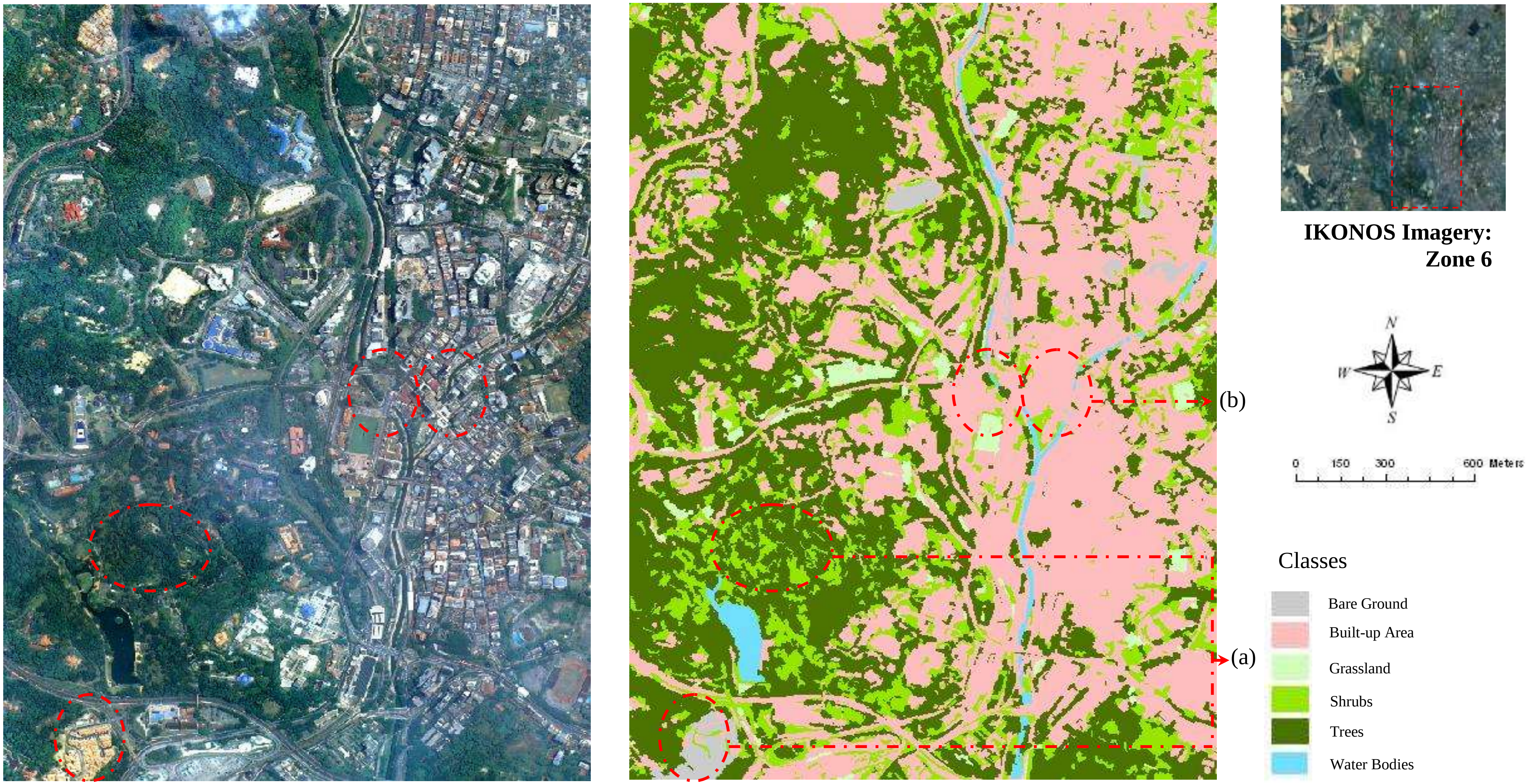


Figure 5.12: Image classification result for selected area in Zone 6 (Level Two – 40 scale parameter). Red circles labelled (a) and (b) illustrate some areas of misclassification

5.2.2.3 Zone 10: Automated Classification Result and Accuracy Assessment

Figure 5.13 shows the classification results for Zone 10, which includes the areas of Pantai Dalam and Sri Petaling. Both areas are mostly occupied by residential neighbourhoods and small areas of commercial activity. As before, it can be seen from the classification results that areas of scattered shrubs were not accurately extracted from the image, again being confused with the trees class (examples are shown in two red dotted circles labelled (a) in the upper left of Figure 5.13). Very surprisingly, misclassification of the latter two areas as ‘shrubs’ occurred within the forest reserve area of Bukit Gasing, which is actually covered by lush areas of trees, yet was only mapped as shrubs. The results also show that water bodies were again under-estimated with some very small stretches of river once more confused as built-up areas (examples are shown in the red circle labelled (b) in Figure 5.13). Both types of misclassification also occurred in Zone 6, but not in Zone 2, where shrubs were actually confused with built up areas (as already noted in Sections 5.2.2.1 and 5.2.2.2).

These issues of incorrect extraction and misclassification are sometimes explicable by the similar spectral values of the objects in the images. On the other hand, some of the misclassifications could be due to the shape parameter that was chosen or because the segmenting scale may have been too big, especially for some of the smaller water bodies such as rivers and streams which are long and thin in shape. Segmenting at a finer scale or choosing a different shape parameter might resolve some of these problems and increase the accuracy of the classes for shrubs and water bodies. However, since the parameters once chosen are applied to segment the whole image, this improvement might be achieved at the expense of reducing the accuracy of some of the other classes.

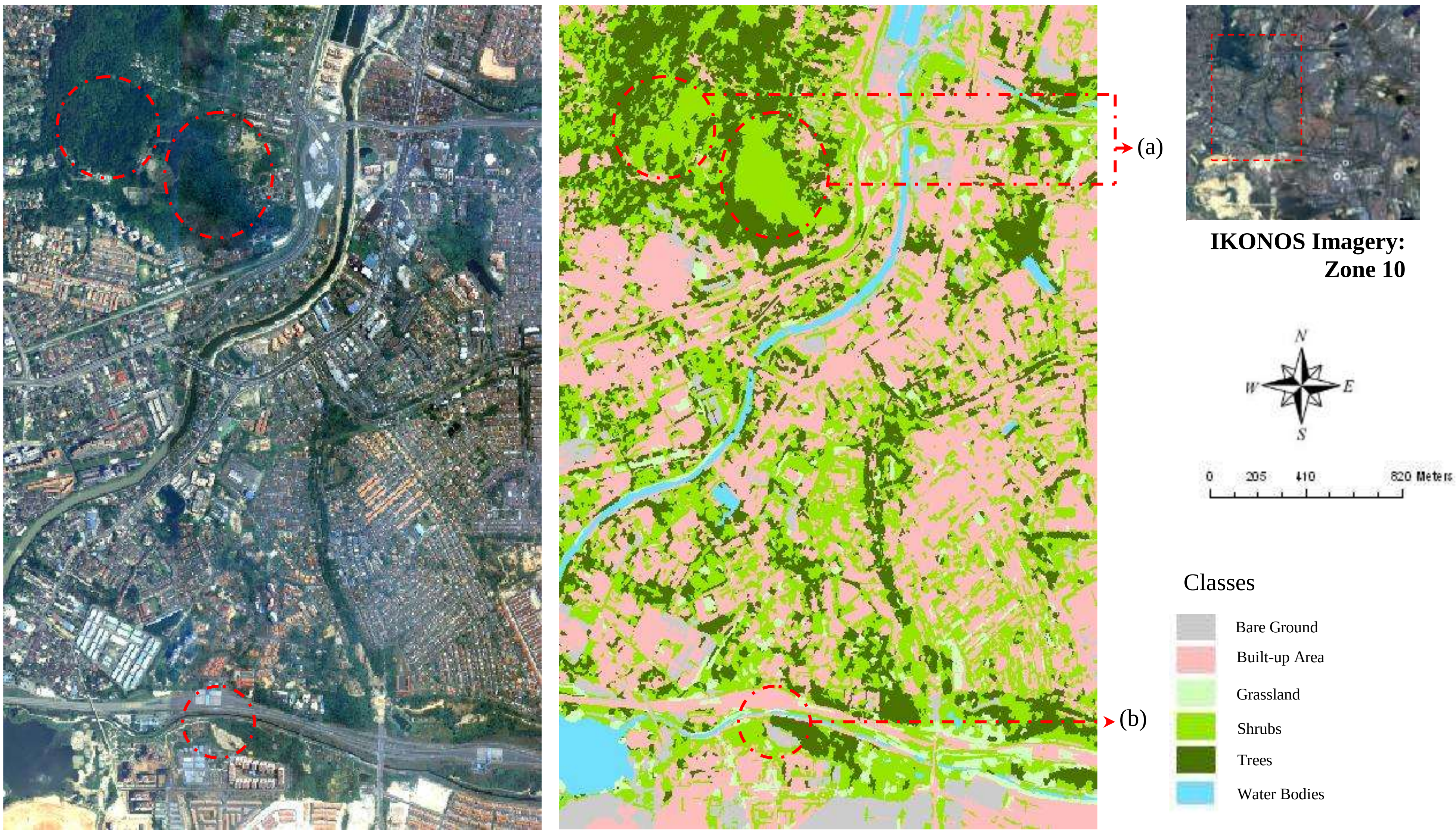


Figure 5.13: Image classification result for selected area in Zone 10 (Level Two – 40 scale parameter). Red circles labelled (a) and (b) exemplify areas of misclassification.

An accuracy assessment was also carried out for Zone 10 and Table 5.5 below shows the confusion matrix. Confusion between shrubs and trees has again led to a lower user's accuracy of 57.1% for the shrubs class. Similarly, due to the confusion with built-up areas, a fairly low producer's accuracy (52.9%) for the water bodies' class occurred in this assessment. However, the overall classification accuracy for this zone is fairly high (78.8%).

Classes	Confusion Matrix and Classification Accuracy for Zone 10							
	Bare Ground	**Built-up Areas**	**Trees**	**Shrubs**	**Grassland**	**Water Bodies**	**Total**	**User's Accuracy**
Bare Ground	**88**	1	0	0	0	0	89	98.9%
Built-up Areas	39	**83**	0	0	2	1	125	66.4%
Trees	0	0	**74**	15	0	2	91	81.3%
Shrubs	0	4	12	**28**	0	5	49	57.1%
Grassland	0	0	0	3	**30**	0	33	90.9%
Water Bodies	0	0	0	0	0	**9**	9	100%
Unclassified	0	0	0	0	0	0		
Total	127	88	86	46	32	17		
Producer's Accuracy	69.3%	94.3%	86.1%	60.9%	93.8%	52.9%		
KIA Per Class	60.4%	91.7%	81.9%	55.3%	93.2%	51.9%		
Overall Classification Accuracy	**78.8%**							
Kappa Statistic	**73.0%**							

Table 5.5: Classification Accuracy for Zone 10 (as shown in Figure 5.13)

5.2.2.4 Discussion of the Automated Classification Result

High resolution imagery is a valuable source of information, especially in an urban environment. The spatial resolution (less than five meters) allows different features and objects in an urban setting to be distinguished visually. However, the amount of detail at such image resolutions leads to a large variability of spectral responses from one pixel to the next, due to the complexity of urban surfaces. For an example, a single roof area of the same material could have at least two different spectral responses depending on the illumination angle. Similarly, a patch of grass that could be considered as a single area would appear in the image as many individual pixels that may each have slightly different spectral responses depending upon factors such as the slope, degree of shadowing and general condition of the grass in different parts of the area.

Although the human brain may be able to recognise such areas as visually distinct features by their colour, shape and context, many automatic classifiers are unable to consistently extract these features from such an image. A further difficulty in this research was that the IKONOS imagery conveyed to the author through DBKL, although it was the only data they had themselves received from Malaysian Remote Sensing Agency (MACRES), contained only the three bands of visible red, green and blue (RGB bands), but lacked the infra-red band that is well-known to be useful for facilitating the extraction of vegetated areas (Lillesand and Kiefer, 2000).

Because some types of green spaces could not be reliably differentiated automatically from the high resolution imagery (just discussed in Sections 5.2.2.1 – 5.2.2.3), a complete mapping of all the proposed green spaces could not be achieved by automated classification procedures. Thus, after careful inspection of the RGB image, further reclassification based on visual interpretation was carried out to manually correct the misclassified areas that had clearly been assigned to the incorrect land cover class by the automated procedure.

This limitation of automated classification was not entirely unexpected as a number of studies have found that only some types of green spaces can be reliably determined automatically from high resolution imagery (Lillesand and Kiefer, 2000). Nevertheless, the automated classification provides a good summary of the extent and quantity of total green spaces in the city, which can be used to derive a further series of indicators about the relative supply of green spaces and the particular contribution of certain spaces. This will be explored further in Chapter 6.

5.3 Manual Reclassification of the Automated Classification of IKONOS Images

When the results of the automated IKONOS imagery classification were compared against ground reference data (Section 5.2.2), some of the classes assigned were found to be in error. Therefore, further reclassification was carried out to correct and improve these automated classification results. Post-classification inspection and manual reclassification by visual interpretation is widely practised as an empirical means of improving the results of image processing when the final required result is often a map for some practical purpose. In the UK, green space mapping is still undertaken by visual interpretation and classification of aerial photography at 25cm resolution (Greenspace Scotland, 2006). In the present research further reclassification was done visually by examining the underlying IKONOS imagery presented as an RGB composite. This process corrected a number of repeated misclassifications which occurred (discussed in Section 5.2.2).

The exercise of visually reclassifying the automated classification results was carried out based on the author's first-hand familiarity with many parts of the city gained from living and working in the city for the last 30 years. Besides, many of the areas had also been observed recently by the author during travelling across the city on site assessment visits. Furthermore, the knowledge acquired by the author of how different land cover types typically appeared on the IKONOS imagery also helped in visually reclassifying the results. This checking exercise and reclassification in certain instances was carried out solely by the author for the entire city area to ensure consistency, so that the resulting reclassification more reliably represented the actual distribution of green spaces known to exist.

Although this exercise was a labour intensive process, a number of misclassified classes was repeatedly identified and corrected. It was found that several cover types, which had been misclassified repeatedly by the automatic classifier, could be corrected this way. During this process, the author found that it was possible to identify visually within the IKONOS imagery most of the types of green space listed in the PAN 65 and the extended typology that the author proposed for Kuala Lumpur. However, a complete visual interpretation and classification of all the individual types of green spaces across the city would have been too time consuming and so the work was restricted to correcting errors in the automated classification.

5.3.1 Results of the Manual Reclassification and Their Use in Separating Officially Recognised and Non-Recognised Green Space

Figure 5.14 (b) shows the result of this manual reclassification. It can be observed that the widespread confusion between the *shrubs* and *trees* classes and of both the *trees* and *shrubs* classes with the *built-up areas* class has been largely corrected. Similarly, the confusion of *bare ground* and *water bodies* with *built-up areas* has also been corrected. This has resulted in a more accurate classification of Kuala Lumpur's green spaces, not so much in terms of overall extent but rather by providing a more geographically accurate division of space between *trees, shrubs, grassland* and other types of land cover. As shown in Figure 5.14, overall the land covered by green space (consisting of trees, shrubs, grassland and water bodies) has decreased from approximately 14,490 hectares (before the reclassification task was carried out) to approximately 14,386 hectares.

The result of this manual reclassification is still essentially a checking and correction of the automated classification of land cover, and as such is, unfortunately, not able to discriminate between green spaces which are officially recognised in DBKL's inventory and those which are not. As a generalisation it seems reasonable to argue that most of the officially recognised green spaces are likely to be essentially public in character and therefore accessible to all citizens. In fact, the information on ownership in DBKL's inventory, shows that at least 48.3% of the existing green spaces it contains are owned by government or other public bodies. Recalling the research findings reported in Sections 2.7 and 2.8, it therefore also seems clear that these officially recognised green spaces (mostly parks and playgrounds) are likely to contribute significant social benefits to the city's residents, simply through being accessible to the public and so generally improving their quality of life.

Hence it would be very helpful if there was some means of readily distinguishing officially recognised green spaces and 'unofficial' green spaces, available preferably in digital form. The satellite based classification of land cover is of no direct assistance in this respect, though it is nevertheless very useful for identifying the overall distribution of green space, which can then provide a basis for developing an inventory focusing on the environmental contributions of green space (rather than their social benefits), where distinctions pertaining to official recognition are largely immaterial.

Because of the importance ascribed by DBKL planners to distinguishing officially recognised green spaces, an attempt was made to roughly separate areas that had DBKL's formal recognition (and therefore more likely to be accessible to the public) from those without such formal recognition and therefore likely to have a more private character, possibly being less accessible or even inaccessible to the public. As a parallel exercise to the latter attempt, detailed data on land ownership could have allowed publically owned green spaces to be differentiated from those privately owned (and therefore unlikely to be accessible to the public) but such data could not be obtained due to concerns about confidentiality and privacy.

Notwithstanding these difficulties, DBKL's inventory of green spaces, kindly made available to the author by Mrs Noraini Kassim, Head of the Green Space Division of DBKL (DBKL, 2007), which was discussed earlier in Chapter 1 and Sections 3.3 – 3.5 of Chapter 3 casts some light on the relationship between ownership and gazetting. An immediate problem, however, is that over half of the entries (334 or 51.7%) in the column on the ownership of the 645 existing green spaces are blank; the entries for the others indicating that 11.9% are owned by DBKL, 2.0% by Rizab DBKL ('DBKL Reserve'), 29.0% by 'government' ('kerajaan'), 3.4% by the Director of Land and Mines (KPTG) and 1.9% by 'Management Council'. It is useful to note in passing here that, of the 311 green spaces where there is an entry for ownership, overall 78.8% are gazetted. When this is broken down by type of public body, the percentage gazetted is highest for 'government' at 98.4% and somewhat lower for

DBKL with 62.3% of its green spaces gazetted. These figures include the 13 (i.e. 2.0%) shown as ‘privately owned’, though 3 of the latter are shown there as owned by ‘KPTG’, a department of the Federal Government. Again, because of so many blank entries these figures have to be taken as minima. Although illuminating, the ownership information in the DBKL inventory is therefore too sparse to allow us to distinguish the green areas which are publically owned and available from those which are not. However, despite so many blank entries, there seems to be a reasonably clear pattern that very few of these recognised green spaces are privately owned with a high proportion of those known to be publically owned being gazetted.

The process of separating the ‘officially recognised’ and ‘unrecognised’ green spaces ‘on the ground’ was done by firstly identifying the appropriate polygons in the land parcel data for each of the 645 existing green and open spaces and the 246 planned by 2020 in the DBKL inventory. This inventory provides information on what type of green or open space each is (using the 9 categories of DBKL’s own typology), its size, its ‘status’ (i.e. whether gazetted or not) with some ownership information given for slightly less than half (48.3%), including 3 of the 5 privately owned golf courses. As just noted, the large majority of the green spaces which are explicitly stated to be owned by government of one kind or another were also gazetted (78.8%), whereas only 4 of those spaces in the separate list of 13 privately owned green spaces were gazetted, 2 of them being golf courses. In addition, it is perhaps worth mentioning that KLSP 2020 and KLCP 2020 both contain maps displaying the areas of officially recognised green and open space in the city, presumably based on the same source of data.

To check this information so it could be used more confidently in further analysis, each of the green areas listed in the inventory was matched with the appropriate polygon in the land parcel data, which allowed us to check that the appropriate land parcel polygon was characterised as officially recognised green space. To ensure this matching of the green and open spaces named in the DBKL document with the land parcel polygons was as accurate as possible, the author used further sources of information as a guide, including visual inspection of the satellite imagery and maps produced from it, a detailed map of the city with a street guide, fieldwork in 2007 and again in 2009 and the author's knowledge of the city.

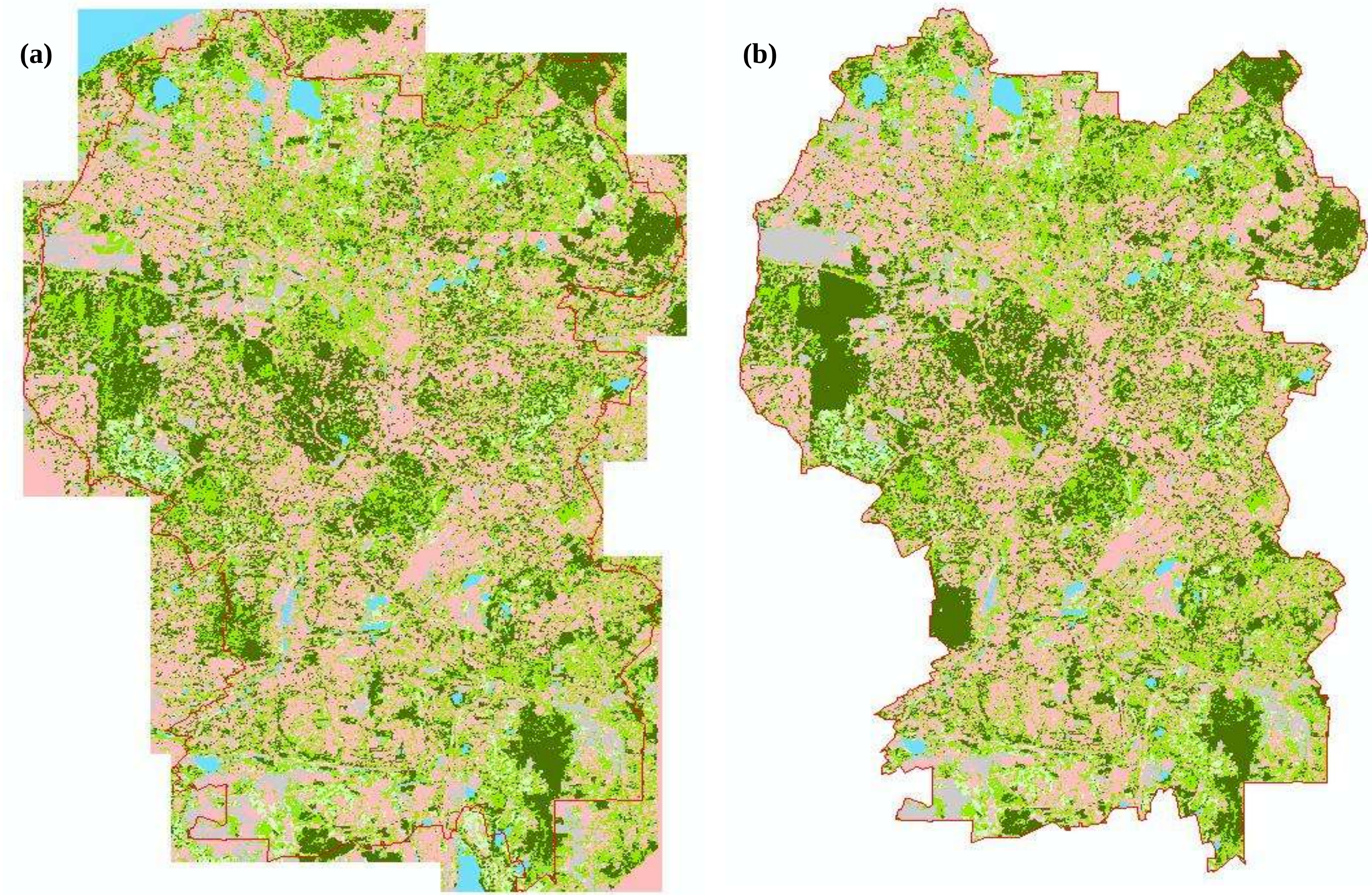
Figure 5.15 (a) shows the resulting map estimating the location and extent of all areas of formally recognised green space, including the 3 areas with large privately owned golf courses (there are 3 adjacent courses run by the RSGC on its grounds just east of the city centre, as noted earlier, with another 18 hole course well to the south at Bukit Jalil and a 9 hole course north of the city centre at Titiwangsa). A rough estimate for the whole city of the extent of green space which is not officially recognised can be obtained by subtracting the areas of recognised green space shown in Figure 5.15 (a) from all the green land cover polygons that were extracted from the satellite imagery. By 'clipping' the polygons on which Figure 5.15 (a) is based out of all the green cover polygons identified by IKONOS in Figure 5.14 (b), this yields Figure 5.15 (b). To the best of the author's knowledge, Figure 5.15 (b) represents the first attempt to use satellite imagery and other collateral information to estimate the respective extents of officially recognised and non-recognised green spaces in different parts of the city. In fact, Figure 5.15 (b) illustrates strikingly how extensive areas of non-recognised green space really are in the city and thereby gives an obvious indication of how significantly they benefit the city in environmental terms and possibly also in terms of health and well-being and even positive economic effects.

Further analysis of DBKL's inventory shows that of the 308 existing green spaces which are known to be gazetted, all are either stated to be on publicly owned land (a total of 245 or 79.6%) or have a blank entry for ownership (59), apart from the 4 gazetted areas with private recreational clubs all of which seem to be special cases where the gazetting has occurred for particular historical or cultural reasons e.g. the 2 areas associated with RSGC, plus the mock Tudor clubhouse of the Royal Selangor Club building, partly dating from 1890, plus the National Stadium (Stadium Negara) built in 1962. With these 4 exceptions, there are no existing green spaces in the 2007 inventory which are explicitly stated to be gazetted and are privately owned. In short, from the data actually given in the inventory nearly 80% of the existing gazetted spaces are known to be on publicly owned land; again this is a minimum figure because there are 59 gazetted areas with no ownership information, most of which could be (and probably are) on public land.

Similarly, 311 of the 645 existing green spaces have entries on ownership with the other 334 entries blank. Only 13 of the 311 are explicitly stated to be privately owned, so it can be inferred that as many as 298 of the 311 could be on public land. Since 245 (78.8%) of the 311 are known to be gazetted, the remaining 53 sites must have entries of 'no information' or 'not yet applied' as regards their gazetted status. Again, 245 or 78.8% are minimum figures in this context because some of the 53 'missing' entries here could confirm gazetting. Thus, approaching 80% at least of these 'official' green spaces where ownership is available are gazetted. While these further results suggest a considerable overlap between publically owned land and gazetted sites, it has to be borne in mind that just over half (51.7%) of the 645 existing sites have no ownership information attached and a similar proportion (52.3%) effectively do not give information on status with respect to gazetting, so this picture could change significantly, if all the missing information could be obtained.

Despite the preceding, necessary caveats, this analysis gives clear evidence of a strong overlap between publicly owned land and gazetted land and gives a more concrete picture of this relationship than was possible up to now e.g. it seems to confirm that very little private green land is likely to be gazetted and little gazetted green land is likely to be private. In the light of all the previous discussion, it seems also seems reasonable to assume fairly confidently that any gazetted green land in KL must be regarded as being already 'officially recognised' (indeed, well recognised!) as green space and must therefore be in DBKL's inventory of such land. Therefore, since the green areas shown in Figure 5.15 (b) are by definition not part of officially recognised as green space, it seems to follow fairly automatically that none of them could have been protected by gazetting in 2007. Most of the latter are also likely to be on private land partly because most land in any city outside the communist world is likely to be privately owned, but also because the preceding analysis suggests that any publicly owned green land in the city is likely to be gazetted. Since we can be confident that very little of this land is gazetted, a corollary is that it is very probably not publicly owned and is therefore more vulnerable to development. An examination of Figure 5.15 (b) seems to indicate that there are extensive green areas in the several parts of the city which are vulnerable to development on both counts, so this analysis may serve some useful purpose in directing more attention to these areas.

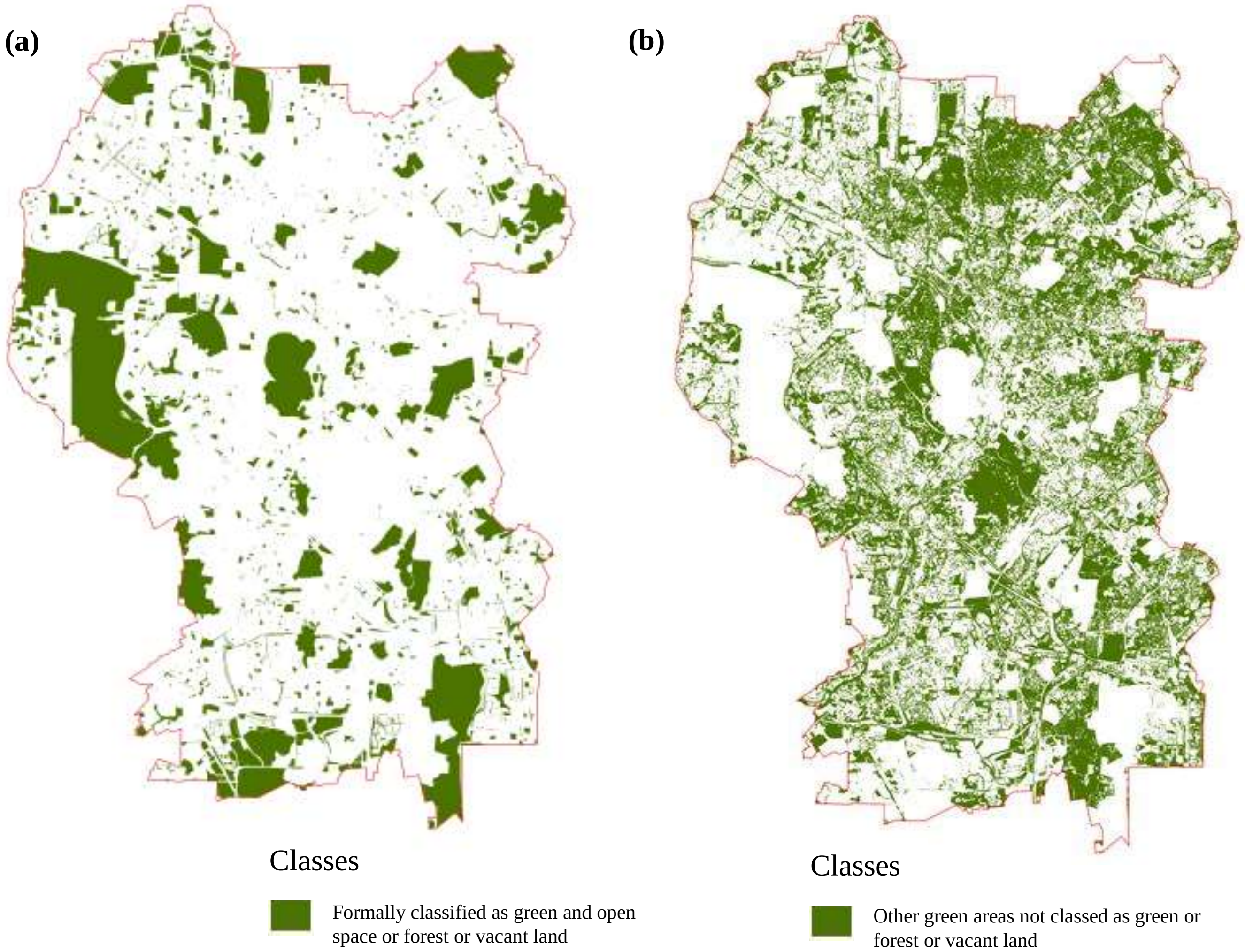
Figure 5.15 (a) probably gives a rough but useful picture of which green spaces are actually available to the public and of which areas of the city are well provided with public green space (like the areas west of the city centre) or less well provided (like the city centre and some areas immediately north of it), though it must be borne in mind that a certain proportion of this green space is actually controlled by 3 private golf clubs and other private recreation clubs and therefore not fully accessible to the public.



Techniques and data used to map and identify Kuala Lumpur's green spaces	Total area of green spaces identified (in hectares)
Automated IKONOS image classification (see Figure 5.14 (a))	14,490.61
Manual reclassification of automated IKONOS image classification (see Figure 5.14 (b))	14,386.45

Total area (in hectares) of Kuala Lumpur's existing green spaces using different techniques

Figure 5.14: (a) Automated image classification before manual reclassification (left); and (b) Result after visual checking and manual reclassification (right).



Types of green spaces	Total area of green spaces (in hectares)
Formally classed as green and open space or forest or vacant land (see Figure 5.15 (a))	4,832.29
Other green areas not classed as green and open space or forest or vacant land (see Figure 5.15 (b))	9,554.16
TOTAL	14,386.45

Total (in hectares) of Kuala Lumpur's formally recognised and 'unrecognised' green areas

Figure 5.15: (a) Areas formally classified as green and open space or forest or vacant land in the parcel based data (left); and (b) Other green areas (right) but not formally classed as green and open space or forest or vacant land in the parcel based data, obtained by subtracting (a) from Figure 5.14 (b)

5.3.2 Accuracy of Semi-Automated Image Classification and Benefits of Applying Post-Classification Correction by Manual Editing

To support the green space mapping, it was important that an overall statement of the accuracy of the map be produced, not least for possible future users of this kind of data and the approach that lay behind it - at DBKL and elsewhere.. Two further accuracy assessments were carried out to evaluate the accuracy of the city-wide green space mapping produced firstly by the semi-automatic classification using Ecognition and secondly as a result of the further manual reclassification which was guided by visual inspection of the raw imagery and comparison with the classified result. By providing a quantitative estimate of the accuracy of the mapping produced by each technique, the benefit of the additional effort spent on post-classification improvement can be assessed. It is also useful to have a quantitative statement of the accuracy of the entire green space map produced by remote sensing, since further data sets are derived from this map in Chapter 6, although specific and localised accuracy assessments have already been carried out for three of the smaller zones used for executing the classification procedure in Ecognition. Whilst these provided information about the quality of the classification in certain areas of the city, an overall assessment of the accuracy for the entire map was required, once all the zones used to process the classification had been stitched together.

A stratified random sampling design was used to select reference data from the IKONOS imagery. Where sufficient examples could be identified confidently, 50 or more reference polygons were extracted for each land cover class (hence the stratification of the sample) by visual inspection of the imagery in different areas, well distributed throughout the city. Many of these reference polygons (Figure 5.16) were located within the twenty or so areas which had been visited on the ground and where site visits had been conducted. The same reference data samples were then used to compute two confusion matrices, one for the results of the automated classification and one for the map produced following the further manual reclassification.

Table 5.6 presents the accuracy assessment for the semi-automated classification produced for Kuala Lumpur using ecognition, whilst Table 5.7 shows that following the manual reclassification of polygons whose assignment was found to be incorrect by visual inspection of the raw imagery and application of local knowledge about the ground conditions. Table 5.6 shows that the semi-automated method delivered an overall accuracy of around 70%, which is generally considered a minimum acceptable level for many thematic mapping applications (Foody, 2008). Whilst water bodies are well discriminated, the use of the reference data reveals several instances where areas of trees have been misclassified as shrubs and vice-versa, as well as some less important cases where bare ground has been erroneously classified as built up area. As a result, the accuracy for the tree and shrub classes is only 62% and 65% respectively. This may limit the use of this result as the basis for deriving further products where the correct differentiation of these two classes is important, such as for example, producing maps of areas where trees provide an important source of shade and shelter.

	Automated Classification							
Reference Data	**Bare Ground**	**Built-up Areas**	**Trees**	**Shrubs**	**Grassland**	**Water Bodies**	**Total**	**Accuracy Percentage**
Bare Ground	**8**	11		1			20	40.0%
Built-up Areas	6	**50**	2	5			63	79.4%
Trees		1	**46**	27			74	62.2%
Shrubs		2	12	**35**	5		54	64.8%
Grassland		2		7	**33**		42	78.6%
Water Bodies						**29**	29	100%
Overall Classification Accuracy	**70.8%**							

Table 5.6: Classification accuracy for the initial green space map created by semi-automated classification of IKONOS imagery

	Manual Reclassification							
Reference Data	**Bare Ground**	**Built-up Areas**	**Trees**	**Shrubs**	**Grassland**	**Water Bodies**	**Total**	**Accuracy Percentage**
Bare Ground	**17**	3					20	85.0%
Built-up Areas	3	**55**		5			63	87.3%
Trees		1	**69**	4			74	93.2%
Shrubs			5	**46**	3		54	85.2%
Grassland		1		3	**38**		42	90.5%
Water Bodies						**29**	29	100.0%
Overall Classification Accuracy	**90.2%**							

Table 5.7: Classification accuracy for the revised green space map produced after manual reclassification

Table 5.7 presents the corresponding results for the accuracy of the mapping produced after the manual reclassification task. The accuracy percentages for all classes are now above 85% and the overall accuracy of the mapping following the manual reclassification has increased to 90.2%. The result of conducting the visual checking and manual reclassification has therefore been to increase the overall accuracy statistic by nearly 20% above that for the automated classification technique.

By comparing Tables 5.6 and 5.7, it can also be observed that the accuracy for all the individual classes has also increased. The bare ground class shows the greatest improvement of accuracy from 40% to 85%. This bare ground class was mostly confused with built-up areas and this had led to a very low accuracy in the automated classification. Similarly, by comparing these two tables it can also be observed that the confusion that had occurred between the tree and shrub classes has mostly been resolved by the visual checking and manual reclassification. The accuracy of both these classes has improved significantly, from 62.2% to 93.2% for the tree class and from 64.8% to 85.2% for shrub class.

The confusion between the tree and shrub classes might have been resolved more easily if the NIR band of the IKONOS sensor had been available, since the two classes might have been more easily differentiated from their differences in biomass by an index such as the NDVI (Rouse et al., 1974). If the NIR band had been provided, the accuracy that might be achieved by the semi-automated method alone could have been higher than was achieved here. The results in Table 5.6 in part reflect the limitations of the data that were available and the skills of the author as still something of a novice at image processing. Nevertheless, the manual reclassification procedure that was carried out was shown to provide an acceptable means by which misclassified areas could be corrected and it delivered an acceptable mapping accuracy of over 90% for the final product.

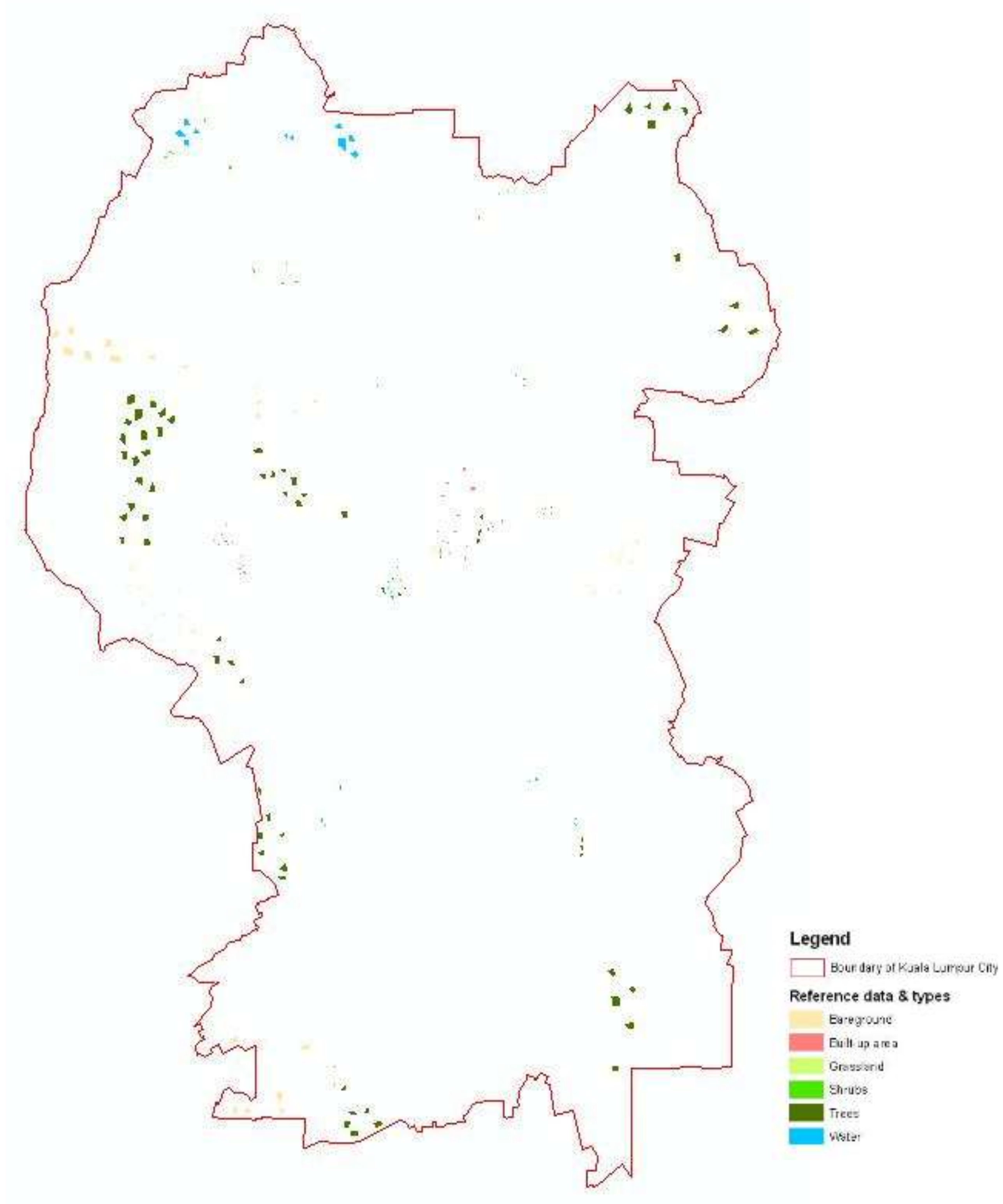


Figure 5.16: Locations of the reference data used for calculating the accuracy assessment

5.4 Comparison of the Land Parcel and Remote Sensing Information for Providing a Green Space Map

This chapter aimed to identify the distribution of Kuala Lumpur's existing and planned green spaces by exploring and combining several techniques that could offer city planners and others greater detail about these spaces. Both land parcel data and high resolution satellite imagery were used as alternative means to map the city's green spaces. The land parcel data were first used to map Kuala Lumpur's green spaces using the current typology accepted by DBKL and then used to identify areas that would be included if the proposed expanded typology was adopted.

The IKONOS satellite data were used to identify the broad categories of vegetated land cover found across the whole city by adopting a semi-automated method. These broad groups only correspond very roughly to some of the 'top-level' green space types identified in PAN-65 (see Section 2.11 and Table 2.2) because the latter is based on the function of the green space, not its vegetative cover. Thus the PAN 65 typology does not contain such categories as water bodies, trees, shrubs and grassland which are fundamental to the classification derived from the IKONOS data and to a holistic understanding of urban green space. Although inspection by the author of the imagery at specific locations (such as those visited on the ground) revealed it was actually possible to identify most of the more detailed types of green space listed in PAN-65 by visual interpretation of the true-colour imagery, it would have been enormously time consuming to do this for the whole city area. For this reason, the method of automated classification followed by visual checking was used to create a city-wide mapping from the IKONOS data.

Although seeming to provide a more realistic first approximation to the overall amount of green spaces in KL, the use of the land parcel data solely to map the distribution of green space was shown to have some serious limitations. Using only the attributes of the land parcels, it was difficult to decide whether certain land parcels should be classified as predominantly green spaces or not. Although some classes such as residential and educational land uses may (or may not) have a significant amount of their area which is green, such parcels are not classed as green spaces in the current typology used in DBKL. Similarly, the inclusion of all transport corridors such as road reserves within the category of green spaces in a new typology may be debatable, since some of these corridors only have a small amount of land area which is 'green'. Consequently, these scenarios presented either an under-estimate or an over-estimate of the distribution of green spaces. This is illustrated in Figure 5.17 (an example of an educational area) and Figure 5.18 (an example of road reserves). Figure 5.19 (b) shows one portrayal of green space for the whole city using the land parcel data. This is based on scenario '(d)', including ten further classes from Table 5.2 (i.e. including the road reserves).

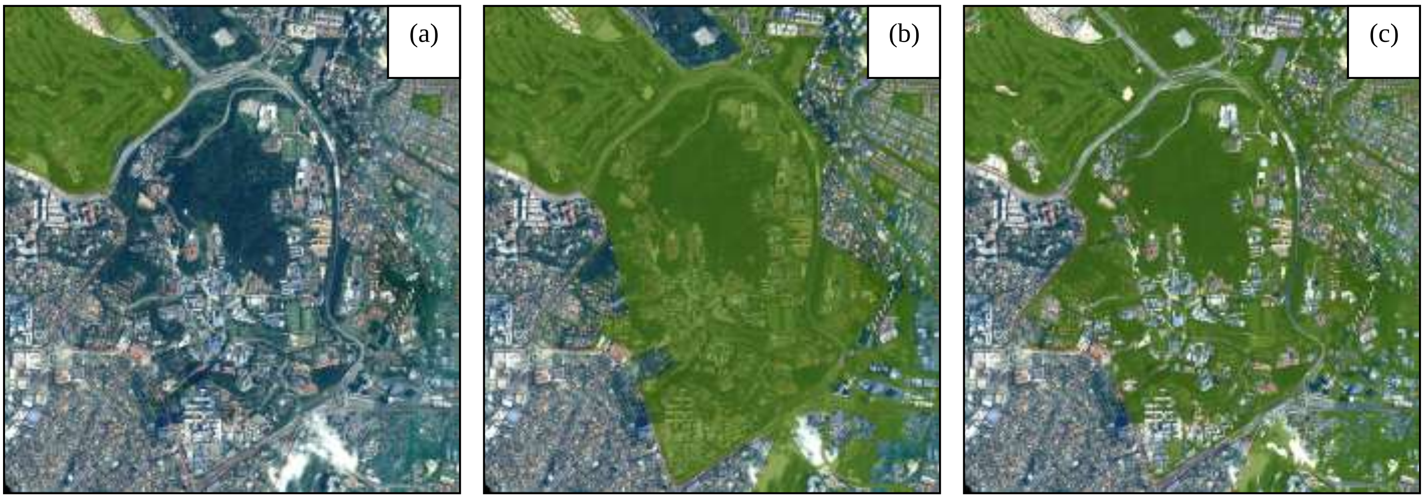


Figure 5.17: Three different classifications for one part of an educational area (Universiti Malaya) using different methods:
(a) land parcel data classification based on current typology used by DBKL;
(b) land parcel data classification based on scenario '(d)'' in Table 5.2 and Figure 5.9 (b); and
(c) IKONOS satellite image classification of green and blue spaces.

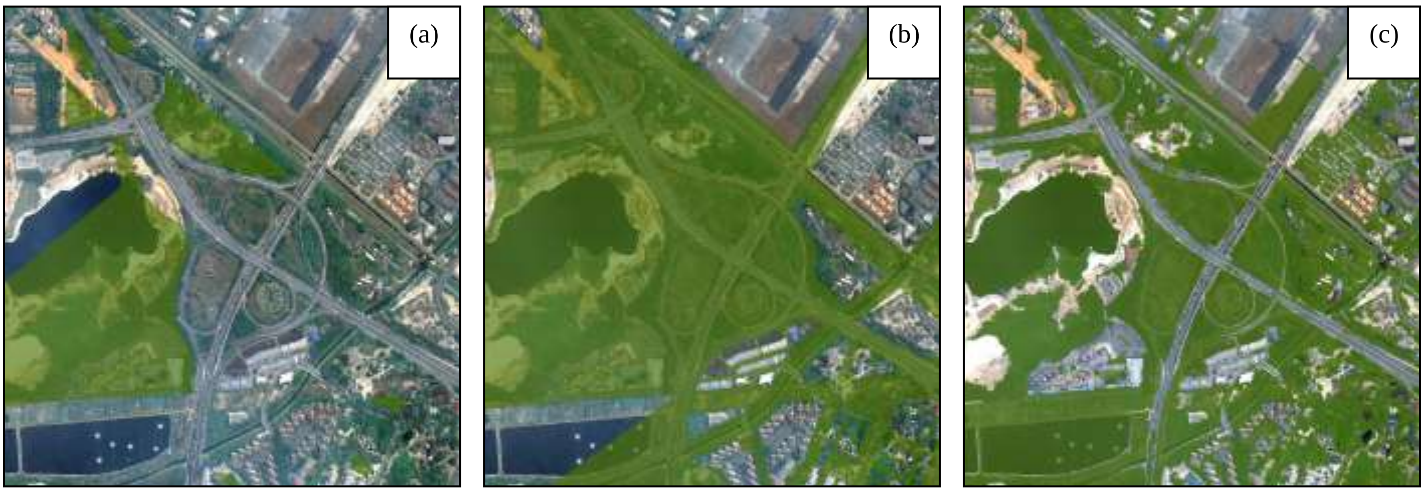


Figure 5.18: Three different classifications for an example of road reserves (Bulatan Desa Water Park) using different methods:
(a) land parcel data classification based on current typology used by DBKL;
(b) land parcel data classification based on scenario '(d)' in Table 5.2 and Figure 5.9 (d) and
(c) IKONOS satellite image classification of green and blue spaces.

From Figure 5.17, by inspecting the level of detail shown by the 3 maps of the University of Malaya campus, which is central to Figure 3.17 and in fact occupies a large part of its area, the disadvantages of the land parcel data are evident. Because the basic DBKL typology for green space does not include educational areas, none of the campus is treated as green space in (a), apart from the University's Botanical Garden, Rimba Ilmu, which is mostly forest and, along with other smaller groups of trees, is classed as such. When land parcels classed as educational areas are included in green space as in Figure 5.17 (b), then the whole campus is classed as green with only Rimba Ilmu and other areas of trees separated out as forest. In contrast, the map derived from the Ikonos data, Figure 5.17 (c), differentiates buildings and groups of buildings, areas of grass and areas of trees on the campus in much finer detail.

A similar conclusion can be drawn from Figure 5.18: the roads and adjoining areas of reserve at this major road intersection are either all excluded from green space as in Figure 5.18 (a) or entirely lumped into it as in Figure 5.18 (b), whereas the Ikonos data in Figure 5.18 (c) distinguishes between the hard surfaces of the major roads and the different types of vegetation on the land enclosed within the 'clover leaf' of the junction and also provides finer detail on other features. Interestingly, it seems to treat the actual surfaces of some of the slip roads of the 'clover leaf', but not the major roads, as green space, presumably because these surfaces are shaded by trees. Therefore the IKONOS imagery may actually be able to differentiate roads which are shaded by trees or shrubs and those which are not. Thus it seems clearly evident that the IKONOS imagery has the potential to overcome some of the problems caused by the coarseness of the land parcel data and can be quite effective for resolving some of these. Moreover, green spaces 'hidden' within low density residential areas can be identified and their extent reported by the automated classification produced from IKONOS imagery. The proportion of a parcel that is actually 'green' could then be estimated by overlaying the classified imagery upon the land parcel data set. This result could be incorporated as an additional attribute of the parcels in the parcel-based land information system (LIS). The remote sensing imagery can also be used to determine more detailed properties of particular parcels of land, such as the extent, density or possibly even the variety of different vegetation types that exist within a parcel of land.

However, certain problems remain with the automated classification generated from the IKONOS imagery. Whilst it was possible to develop some classes that matched broadly with a description of green space as vegetated or water areas, many detailed green space land uses could not be discriminated by the automated technique, whereas others were misclassified (as discussed in Section 5.2.2). Even using a visual interpretation and including contextual information, some land cover types remained difficult to differentiate, for instance the bare ground class and some types of hard surfaces within built-up areas. As expected, although the automated technique had the advantage of allowing large areas of the city to be classified with a very fine spatial texture, it was not possible to achieve a detailed matching between the classes obtained automatically from the imagery and the land use classes in the expanded typology based on PAN-65. In order to obtain this, detailed visual inspection of the imagery, along with other collateral data sets would be required.

Nevertheless, the results from the object-oriented classifications were encouraging and suggested that a variety of useful information about the overall nature and extent of green spaces could be extracted at several levels of resolution. This could permit a more detailed mapping and monitoring of total green space than was possible previously using the land parcel data set alone.

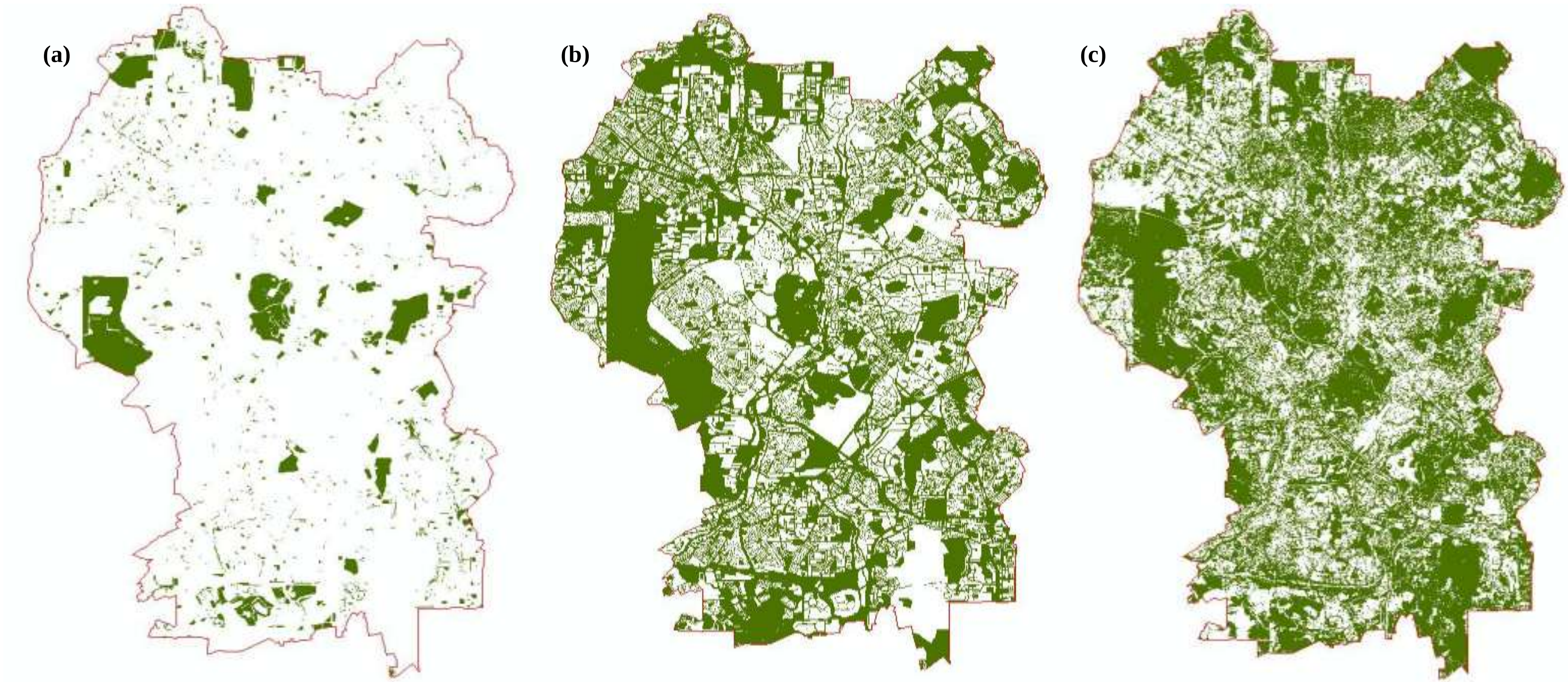


Figure 5.19: Three pictures of the distribution of green space in Kuala Lumpur city using different types of data:
(a) land parcel data classification based on the typology currently used by DBKL (left);
(b) land parcel data reclassification based on the proposed expanded typology (middle); and
(c) automated classification with manual reclassification of the IKONOS imagery (right).

Techniques and data used to map and identify Kuala Lumpur's green spaces	Total area of green spaces identified (in hectares)	Difference (in hectares & percentages)
Land parcel data classification based on present typology used by DBKL (see Figure 5.19 (a))	2,225.98	
Land parcel data reclassification based on proposed expanded typology (see Figure 5.19 (b))	12,722.46	10,496.48 (471.54%)
IKONOS image reclassification showing all types of green space (see Figure 5.19 (c))	14,386.45	12,160.47 (546.30%)

Not all the possible areas of land use potentially containing some green space identified in Figure 5.9 using the land parcel data would or, indeed, could be officially adopted as recognised green space, not least because DBKL does not have the resources to monitor or manage them where this is needed and most are probably privately owned and would therefore be difficult to gazette. However, one benefit of the experiment of including further categories of green space is that it provides planners and others with responsibility for urban green space with information about the potential connectivity between these spaces. The composite picture of how all these spaces relate to each other is revealed more clearly and this could create some interesting opportunities to plan for conserving more meaningful areas of green space. For example, by comparing Figure 5.9 (a) and Figure 5.9 (c), some areas of vacant land can be found adjacent to some green and open spaces that are already recognised by DBKL (one example is shown in Figure 5.20). This suggests opportunities for DBKL to examine the possibility of expanding these recreational spaces by considering gazetting the nearby vacant land as additional green spaces before they are lost to development.

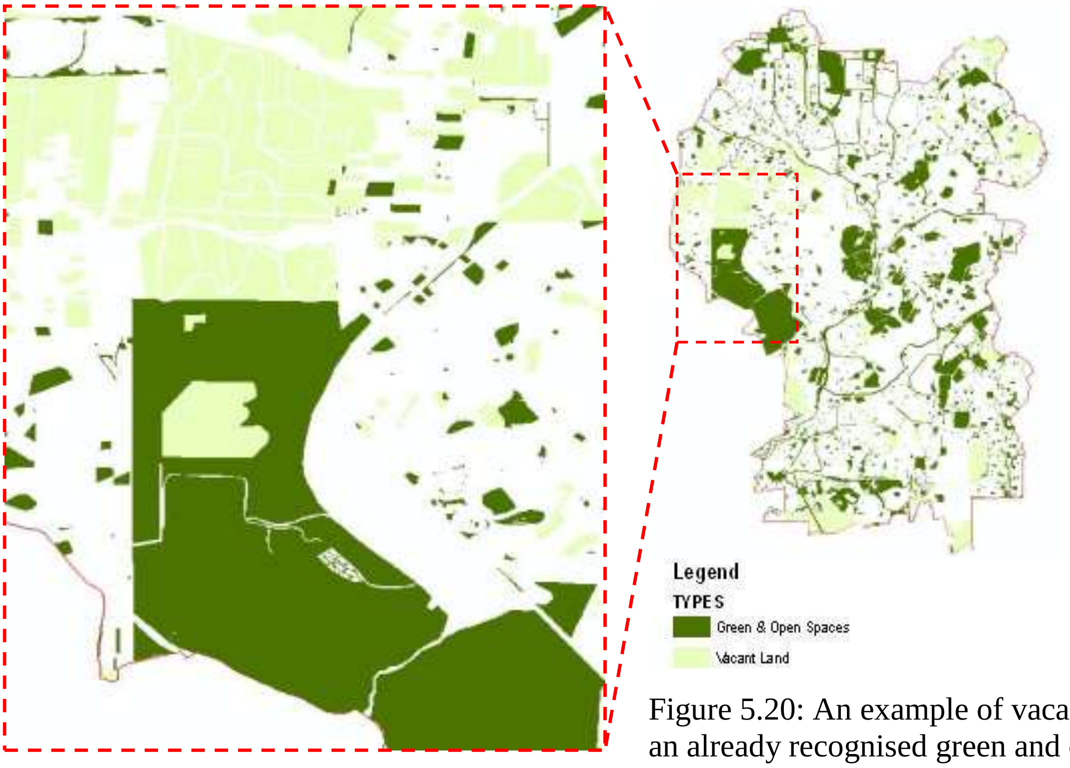


Figure 5.20: An example of vacant land adjacent to an already recognised green and open space in Bukit Kiara suggests an opportunity to expand the latter green space.

Seeing the fuller picture may also allow planners and other decision makers to recognise how a number of green chains or corridors could be created by connecting these spaces together. For example by studying Figure 5.9 (d), the potential is revealed to develop a green corridor from Bukit Gasing running north to the University of Malaya and then towards Bukit Kiara (Figure 5.21 (a)). Another example is found in the central area, where a potential green corridor could perhaps be contemplated starting at the KLCC Park and extending west to Bukit Nanas Forest-KL Tower and continuing west, potentially incorporating grassed areas around the civic spaces such as Padang Merdeka, the National Mosque, the bird park, through the museum area to the Perdana Lake Garden (Figure 5.21 (b)). Developing these park connectors is congruent with the vision expressed in the Kuala Lumpur City Plan (KLCP 2020), although the practical difficulties of implementing the latter corridor of green space in the intensely built up areas of the city centre have to be acknowledged.

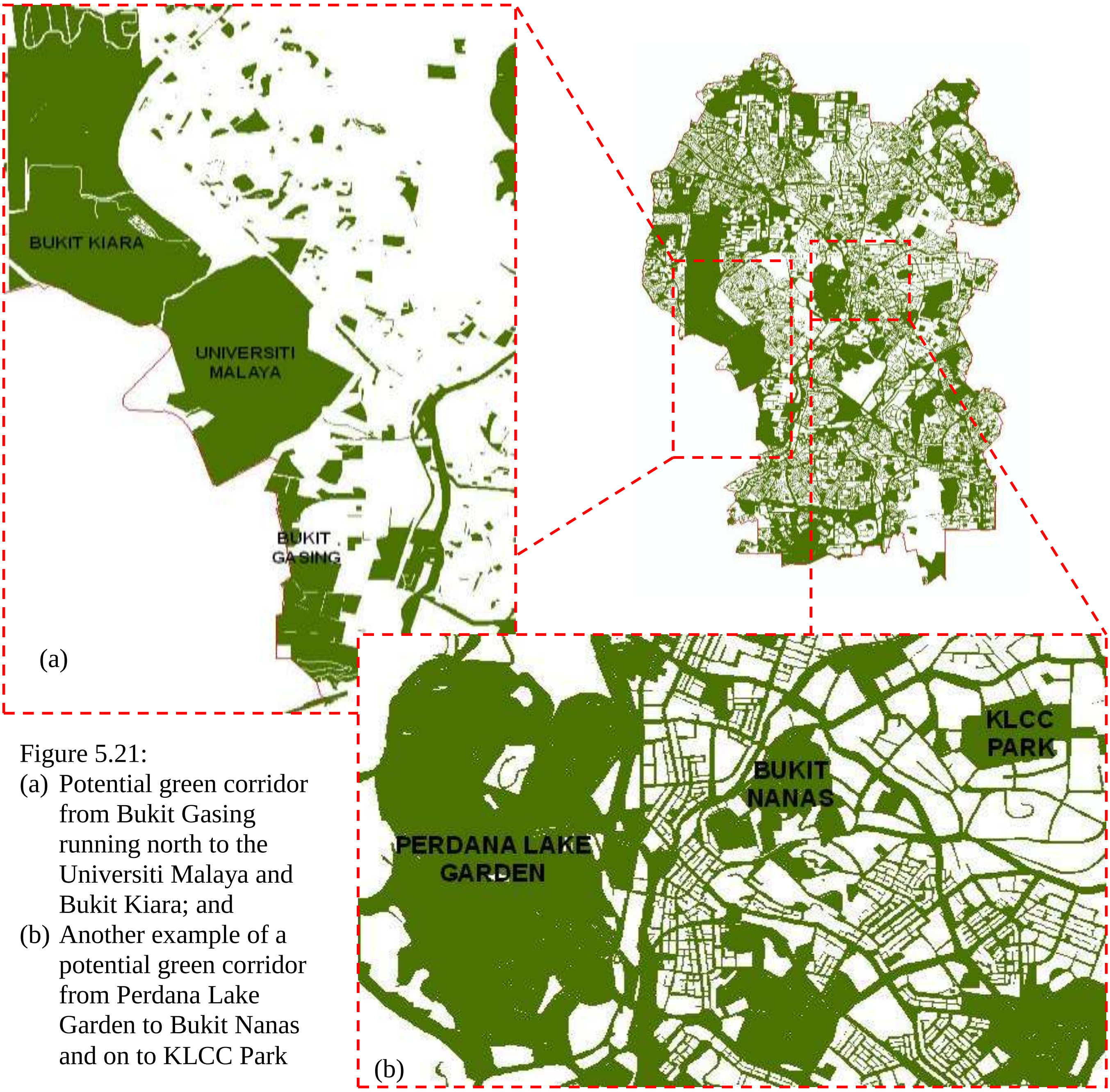


Figure 5.21:
(a) Potential green corridor from Bukit Gasing running north to the Universiti Malaya and Bukit Kiara; and
(b) Another example of a potential green corridor from Perdana Lake Garden to Bukit Nanas and on to KLCC Park

5.5 Summary and Discussion

Overall, this chapter has proposed and compared two means for producing a more comprehensive and up-to-date inventory of the green and open spaces existing in Kuala Lumpur than is presently recognised formally by the DBKL Planning Office. The first method uses land parcel data which is more familiar to planners and is already available digitally for some cities. The type of current, detailed and well maintained land parcel data used here can provide a means to estimate, by the successive inclusion of more land use classes, further areas that have the potential (either based on their type or their location) to be acknowledged in some way as actual functioning green spaces with some of these possibly worthy of consideration for being formally recognised as such where appropriate or possibly even being considered for gazetting if the land is publically owned and is particularly valuable as green space.

However, although land parcel data provides some very rough approximations to the overall amount of land that might actually function as green space in Kuala Lumpur, this technique has been shown to have some limitations. The findings have shown that land parcel data provides either an over-estimated or under-estimated areal extent of green spaces, depending mainly on the classes that are included or excluded and depending on the number of other particular types of land use from our proposed typology happen to be subsumed in its broad classes. Another limitation of the land parcel method is obviously that many parcels are neither wholly grey nor green, but a mixture. Nevertheless, such an analysis is a useful starting point for discussions about particular combinations of land units that could be amalgamated to create or at least acknowledge and recognise in some appropriate manner larger areas of green space or to create ‘small islands’ of green space in areas where there is little.

The use of remote sensing has been shown to have the potential to overcome some of these limitations. Remote sensing imagery can reveal the overall extent of green and ‘blue’ surfaces, but the segmented areas created by some automated classifications may not follow any pre-existing geography and so it can be troublesome for the planners to assimilate and combine these data with other cadastral or land ownership data. Whilst it was possible to automatically develop broad classes for land cover that matched the general definition of green spaces, many specific land use classes in the expanded green space typology could not be correctly identified by an automated classification of the imagery. It is recognised that the accuracy statistics quoted for recognising some of the green land cover types using the automated classification technique could be seen as disappointing because of some weaknesses noted in the imagery supplied.

Nevertheless, the findings from this automated classification were able to provide a gross overall estimate for total green cover, which was more accurate than using the land parcel data by itself, although it was not differentiated into each land use type. Visual interpretation of the imagery, although it is time consuming, could be used by planners to provide more information about the various types of green space and their present condition; this could be used to monitor specific green spaces that have been identified as potential sites for further investigation. It was found that the overall accuracy of the automated classification (which was 70.8%) was increased to 90.2% when visual interpretation was used to improve the classification. With this level of accuracy for recognising areas of 'green' land cover, it was postulated that remote sensing may be used to enrich land parcel data, allowing planners to understand how 'grey' or 'green' different land uses actually are in different parts of the city.

Combining the benefits of a green space typology adapted for the Malaysian context with digital land parcel data and satellite imagery, we have illustrated how city planners could gain a more realistic picture of the distribution of existing green spaces. Although both techniques have their limitations, which have been examined in this chapter, combining the strengths of the two methods could offer city planners a more realistic picture of total urban green space than maps which show only officially recognised or gazetted green space which are apparently used at present as a basic source of data informing many planning decisions.

Showing potential areas of green space near to those that are already protected, by using a combination of land parcel data supplemented by remote sensing imagery, creates opportunities for planning to consider extending the protection and conservation of green space city-wide. If remote sensing data can be repeatedly updated, this would permit any possible loss of green space to be monitored and measured more objectively. Both methods explored in the present chapter hence offer city planners and other decision makers the beginnings of operational methods for monitoring the nature and condition of the existing green spaces in the city. The choice of which dataset would be preferred as the primary source of information for any analysis of urban green space would then depend on the specific planning purpose and the currency of data available or on how they could be combined. Moreover, by combining analysis of the IKONOS data with the parcel-based data on land use and the data from DBKL's inventory of recognised green space, it was possible to focus attention on the green areas shown in Figure 5.15 (b) as being at higher risk of being lost because they are almost certainly not gazetted and are very likely to be on private land.

Chapter 6

ASSESSING KUALA LUMPUR'S GREEN SPACES

6.0 Introduction

The previous chapter has shown how maps of the whole city showing, variously, existing green spaces, then all of the latter plus various other land uses that could potentially be recognised as being partially green in character, can be approximated by using a land parcel database and by adopting a series of more inclusive sets of those land uses which could contain within them a significant proportion of urban green space. The author then explored how far higher resolution remote sensing data can be used to provide more comprehensive and detailed maps of the distribution of the main kinds of green cover in the city.

Chapter 4 revealed that some of the respondents thought some means to produce an inventory of green space would be desirable. An implication of their various other responses, given the strong awareness they expressed of the pressure that can exist to develop green spaces, is that there seems to be a general need for some way of evaluating green spaces that would help to establish priorities for protecting or conserving them and which might then also assist politicians and planners in decision making. Tables 4.14 and 4.15 in Sections 4.6.1 and 4.6.2 respectively show how important the respondents thought various environmental criteria (28 of these) and various social criteria (21 of these, yielding 49 criteria altogether) should be in informing decisions about whether particular green spaces should be retained or not. It should be emphasised at this point that the 41 respondents considered a large majority of these criteria to be at least 'very important', awarding 16 of the 28 environmental criteria and 20 of the 21 social criteria mean scores of 4.0 or above, where 4 was described as 'very important' and 5 as 'extremely important' on the 5 point Likert scale used for replies to this question (Question 28). In fact, the criterion ('relative isolation of the site from other green areas') with the lowest mean score (3.49) of all 49 criteria still had a mean score midway between 'quite important' (3) and 'very important' (4).

Thus if all the criteria the 41 respondents thought very important were to be included in evaluations of green spaces, a great deal of information would need to be collected with a few of the environmental criteria possibly requiring scientific instruments (e.g. capacity of the site to produce oxygen). Whilst some of the information that might be needed for this (e.g. standard of safety or maintenance of green areas) could only really be assessed by site visits, attempts could be made by professional staff (or other analysts, consultants or researchers) to assess or estimate some of the other relevant factors identified in Figure 4.2, Section 4.7 (e.g. percentage shade and shelter, accessibility of a site) using data sets already held or obtainable which could readily be entered into a geographical information system (GIS), possibly obviating or at least reducing the need to visit those sites on the ground to collect information on those specific criteria.

Consequently, in this chapter, the author explores two fundamentally different ways in which some of the information needed to assess green areas as regards their priority for preservation might be obtained and analysed, namely field-based site assessments and 'desk-based' GIS methods, which will therefore be examined and compared as ways of estimating certain of the criteria considered important. Although field observation and assessment can provide a rich set of information about environmental conditions and the usage of individual green spaces, field-based assessments are time consuming and require consistency of audit. Furthermore, when one individual site assessment has to be weighed against another (e.g. for comparing the relative advantages of two different green spaces) those involved (e.g. planners) need to have consistent procedures for carrying out the field evaluations and consistent ways of 'measuring' the relevant criteria. If general assessments of green spaces across the whole city are also being made from 'remote' data sets, it is obviously desirable that there should be some consistency in how this is done too, not least because it may well need to be repeated regularly. In 2009, DBKL did not conduct a regular programme of field-based monitoring of its officially recognised green spaces for the whole city (as the author recalls, something to this effect was stated by Mrs Noraini Kassim, Head of the Green Space Division of DBKL, in an interview she kindly gave to the author in April 2009). Rather, information is gathered in relation to specific issues or locations as needed. DBKL also does not yet appear to have a formal field assessment protocol as, for example, has been adopted recently in some cities in the UK.

So, in this chapter, firstly the author designs and implements an auditing methodology for site observation and assessment of green spaces ‘on the ground’. The author then explains more fully the concept of a repeatable ‘desk-based’ survey of some attributes of green spaces as a means by which planners could perhaps keep updated on changes in those attributes without relying solely on time consuming site assessment as their only method. As a possible way of applying this concept of a ‘desk-based’ survey, the author subsequently explores whether the macro scale remote sensing data can be combined with other data in a geographical information system (GIS) to evaluate for the whole of KL city a small and limited, but possibly useful, set of the attributes of green spaces considered important or very important by the questionnaire survey respondents. The author then discusses whether the latter less resource intensive but repeatable ‘desk-based’ method is able to produce a partial assessment of sites that is broadly consistent with the more detailed assessments produced by field surveys, generally more resource intensive.

It was not expected that the indicators derived from the remote sensing data could provide as comprehensive or detailed information as the data from site observation, or remove the need for ground assessment. Rather, the intention was to explore whether it was at least possible to produce useful estimates of some of the characteristics of green spaces which were seen as important by the respondents in Chapter 4 (Tables 4.14 and 4.15) and which would typically form part of a site assessment, from the remote sensing data. As well as offering a possible basis for remotely monitoring some characteristics of urban green space, the remote sensing approach might also offer a partial solution to another difficulty faced by DBKL i.e. comparing green spaces across the whole city at a single point in time.

In Chapter 4 as a group the respondents indicated clearly that they felt there was a strong need to protect all the existing areas of green space in KL. In Question 28 of the main social survey we asked respondents to indicate how important various environmental and social criteria should be as regards informing a decision about whether an existing green space should be retained. It was hoped that posing the question in this way, i.e. implying that there could be further losses of green space and asking them which criteria needed to be prioritised in this context, would help them to think more clearly about what really mattered about green spaces. The assessments respondents made of the 28 environmental and 21 social criteria in Tables 4.14 and 4.15 respectively form the background to the field survey and, to a lesser extent, to the desk-based survey.

To implement the field based assessments, a method for assessing green spaces through site visit and direct observation is presented in Section 6.1.1 of the present chapter. This method is based on an assessment sheet involving 13 environmental and 18 social criteria to be evaluated for each site by the surveyors involved; the very large majority of these 31 criteria are essentially sub-sets respectively of the 28 environmental and 21 social criteria evaluated in Tables 4.14 and 4.15. Site assessments for these 31 criteria were then carried out at 17 different green spaces selected to represent the diversity of Kuala Lumpur's green areas.

As regards the desk based analysis, if it is possible to use the priorities of the respondents to help devise a 'desk based' method of assessing and monitoring some of the important characteristics of urban green spaces, as noted earlier, this could be useful as part of a more comprehensive and more easily repeatable system of monitoring and assessing these spaces. This could then assist DBKL in management and policy making. In addition, despite the clear wishes of respondents to retain all green space (and, indeed, to increase it), reluctantly it may have to be accepted that in a growing and dynamic city some loss of green space is inevitable, at least occasionally in special circumstances. In such circumstances the 'desk based' approach proposed could perhaps form part of assessing those green spaces under threat in the context of their role within the whole city or, conversely, perhaps of even helping to make the case for retaining all or most of them and asserting their value in the face of pressures to develop them, especially if this information is made available in the public realm.

At the outset, however, it is obvious but worth emphasising that the desk based analysis had to be limited to criteria that could be estimated from the IKONOS data or the other data-sets on land use and population that could be entered into our GIS, as indicated in Figure 4.2 and discussed in the final part (part (v)) of Section 4.7. Of the 28 environmental criteria listed in Table 4.14 and discussed in Sections 4.6.1 and 4.7, from a rough estimate around 10 could probably be estimated in this way; from these we have selected 4 which are most readily 'GIS-able', namely the proportion of the area covered by vegetation, the variety of vegetation in the area, the proportion of the area with trees providing shade and shelter (all these 3 are of fundamental importance to our basic concern to describe the nature of green space in KL and can be estimated from the IKONOS data) plus the green area's connectivity to surrounding green areas.

In contrast, only 4 at most of the 21 social criteria listed in Table 4.15 and discussed in Sections 4.6.2 and 4.7 could potentially be estimated using GIS methods and these are all concerned with the various measures grouped under 'Location and accessibility' in the latter table. Of these 4, only 2 could be computed in a GIS using information obtainable by the author with the resources available. Information on population from the census and on points of access to KL's system of 'rapid transit' public transport from DBKL allowed the number of people in the residential areas surrounding a green space and the accessibility of the green area to this form of public transport to be calculated by GIS methods. Some of the other criteria grouped under 'Location and accessibility' in Table 4.15 would have required information which was difficult or impossible to obtain (e.g. population employed in nearby workplaces) or prohibitively time consuming to set up in a GIS with the resources available (e.g. the road network for accessibility by private transport). To the 2 measures of accessibility judged to be manageably 'GIS-able', a third was added, namely the openness and availability of the green area to the public, which does not appear in Table 4.15 because it had not been included in the questionnaire survey as all sites were implicitly assumed in that survey to be open and available to the public. Thus the desk based analysis includes only two of the 20 social criteria considered very important in Table 4.15 and is only really an attempt to evaluate some important aspects of accessibility, which were manageable with the time and resources available. Details of how these 3 measures of accessibility were estimated by GIS methods are described in Section 6.1.2.2.

The desk based analysis therefore involved only 7 criteria: 4 which can be considered 'environmental' and 3 which fall under the heading of 'social' but could be more accurately labelled simply as measures of different aspects of accessibility. Nevertheless, as regards the importance of the 7 criteria used in the desk based analysis, the four environmental criteria used all had scores within the 'very important' range (i.e. from 3.5 to 4.5) as regards the survey respondents' evaluations, gaining scores of 3.93, 3.78, 4.12 and 4.22 respectively in Table 4.14. Similarly, the 2 accessibility criteria which appear in Table 4.15 both received very high scores on their importance: 4.34 for accessibility to population in the surrounding area and 4.44 for accessibility to public transport which means these criteria were ranked 7th and 4th equal respectively among all the social criteria in Table 4.15. Thus, although the criteria used in the desk based analysis were restricted to a relatively small number by the need to be 'GIS-able' and were not necessarily the most highly ranked by survey respondents, their use is given support by the scores obtained from the evaluations of the urban planners and landscape architects who mainly completed the questionnaire survey.

The detailed implementation of the 'desk based' analysis is explained in Section 6.1.2. This part of the analysis is mainly based on the map of green spaces produced in the latter part of Chapter 5 from the satellite data, which basically distinguishes 3 types of vegetated land cover (trees, shrubs and grass) but also recognises 3 non-vegetated types of land surface (bare ground, built up and water bodies) in its classification; this was presented in Figure 5.14 (b) and later in Figure 5.19 (c), though the latter only distinguishes between all types of green space on one hand and all other surfaces on the other. The data exhibited in Figure 5.14 (b) and the classification of land cover associated with it are used in creating the set of 7 indicators for the 'desk based' assessment for all the green spaces across the whole of Kuala Lumpur with the latter data being augmented by data on population and on points of access to KL's system of 'rapid transit' in the case of the first 2 measures of accessibility, as outlined earlier. As just noted, with one exception, these 7 indicators are based on seven criteria from among the much larger number of environmental and social criteria considered very important by survey respondents, outlined in Figure 4.2 of Chapter 4 and briefly discussed in Section 4.7 (v). These 7 indicators were thus computed using available digital datasets collected or generated by the author. Each is calculated on a gridded basis for the whole of the city. These data sets and the results produced from them are recognised to be relatively simplistic at this stage but are intended to help to build a prototype and to explore the basic principle that more sophisticated indicators could be developed using more comprehensive data sets that might be available to the staff in DBKL or obtainable by them.

After discussion of the results from the two types of analysis (Section 6.2), the chapter concludes with a discussion of the relative advantages and limitations of the results obtained from the desk-based remote method of assessment compared to data obtained from site assessments conducted on the ground (Section 6.3). The two methods are not presented as alternatives, but rather as complementary techniques that together may provide urban planners and managers with useful information with which to assess green spaces both individually and collectively. Such information may assist them in managing green spaces or possibly in making decisions when prioritising particular green spaces in the city for future conservation. We will argue that combining the more detailed information that ground surveys provide about particular sites with the benefits of the coarser GIS-based screening technique, which can, nevertheless, give a more comprehensive picture of certain significant criteria for the whole city, enables the properties of individual sites to be considered in a wider context, thereby allowing both the site-specific and the broader benefits that a given green space may confer on the wider neighbourhood of the city to be considered together.

6.1 Methods

The methods of field based assessment and desk based analysis have already been outlined in the introduction and the main reasons why the latter had to be restricted to 4 environmental criteria and 3 measures of accessibility have been discussed. The first part of the present section, Section 6.1.1, explains how the 17 sample sites of urban green space were chosen and describes in more detail the method that was developed and used to assess the 13 environmental and 18 social characteristics selected for evaluation at each site in the field. It also discusses how the latter environmental and social criteria were selected from the 28 environmental and 21 social criteria in Tables 4.14 and 4.15 and gives further explanation of why only a very small subset of the latter variables could be used in the desk based analysis i.e. 4

environmental criteria and 3 measures of accessibility. The second part, Section 6.1.2, describes how the map of green space produced from the satellite data (Figure 5.14 (b) in Chapter 5) was analysed together with other GIS data such as population and land parcel data sets to estimate the 4 environmental and 3 accessibility criteria for the desk based analysis of all green spaces over the whole city. These two complementary methods are illustrated in Figure 6.1 to give an overview of this chapter.

6.1.1 Site Observation and Selection of Environmental and Social Criteria for Field Assessment

Site visits were planned to be carried out at more than 20 different green spaces during the second field trip to Kuala Lumpur in April 2009. The purpose of these site visits was to observe and to assess these green spaces according to certain of the typical environmental and social benefits that they may provide, as already noted. However, due to problems such as some sites being inaccessible and unsafe to enter (e.g. because they were found to be thick forest with no paths), only 17 of the green space sites were inspected (Table 6.1). Of these 17 sites, 12 were assessed by four site assessors, one of whom was the author and another three were research team members, namely Stefanie Blacker (an M.Sc. student at Edinburgh University), Duncan Moss of Ordnance Survey and RICS and Dr Neil Stuart, the main supervisor of the present thesis. Another five sites were only assessed by the author and Duncan Moss, who had more time available for conducting site surveys than the other two assessors.

Thus, in conducting the field assessments, it was thought desirable to have more than one person's opinion about each of the sites. Hence, as well as the author, all 17 sites were also assessed independently by at least one other researcher with experience of land use or land cover surveys (i.e. Duncan Moss,). It had been intended to have the other two researchers also assess all 17 sites, but due to time limitations, the two other assessors were only able to visit 12 of the 17 sites. Site assessments were undertaken by each assessor independently and the scores combined to produce mean scores for each site either from four or two assessors. The 5 sites which were only surveyed by two assessors were Kepong, Pudu Jail, Bukit Jalil Park, Batu River Reserve and Desa Water Park. In considering the results for those sites, it should be borne in mind that their mean scores for the various criteria are averages of 2 estimates rather than 4 and may therefore be more sensitive to the subjectivity or idiosyncrasies of the two surveyors involved. However, in most cases, comparison of the scoring showed that the different assessors were broadly in agreement about the observed criteria, so this does not seem to be a major cause for concern.

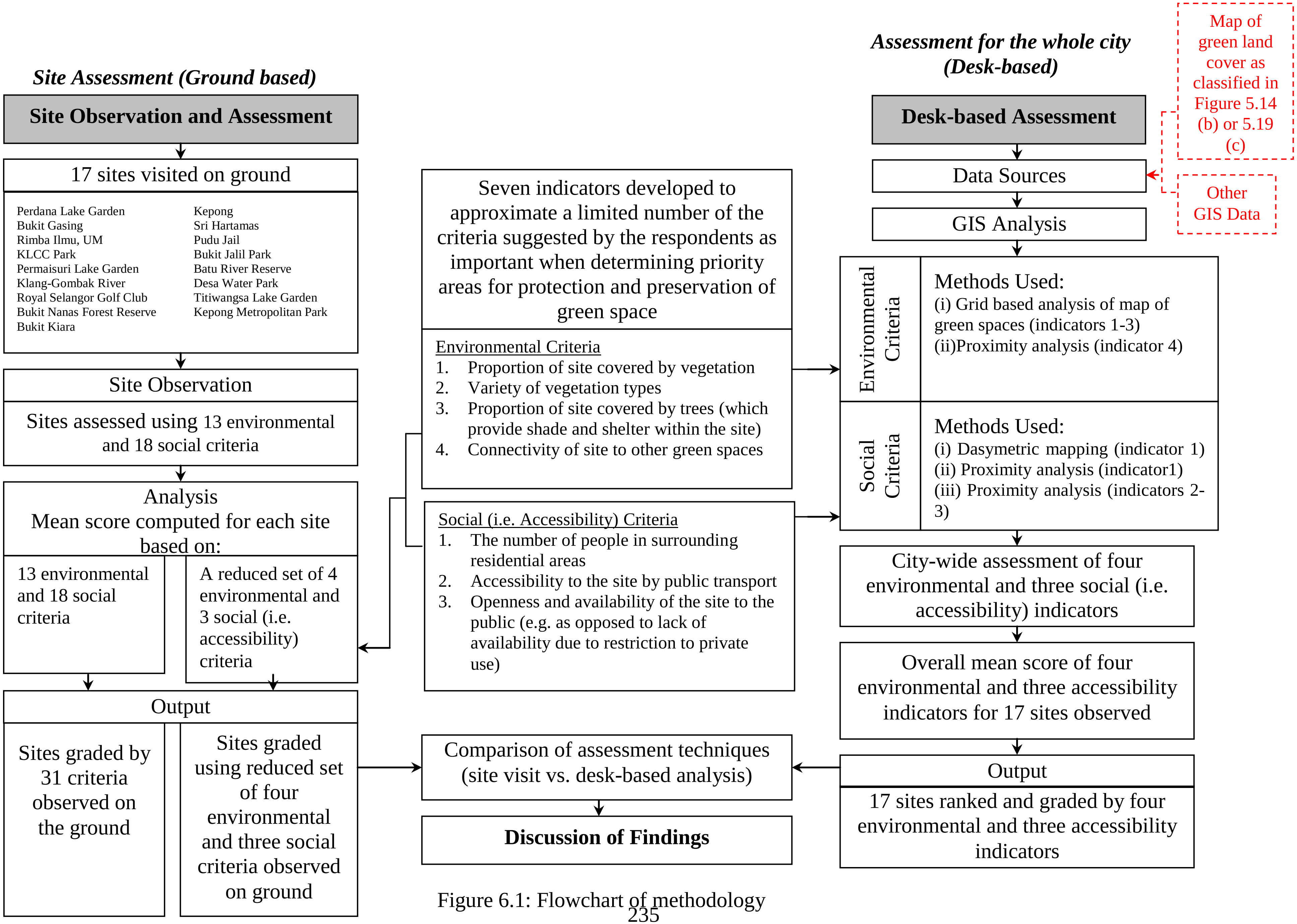


Figure 6.1: Flowchart of methodology

In preparation for conducting these site assessments, the author had previously undergone training organised by Greenspace Scotland in field techniques for assessing and evaluating green space sites. This training was on the Place Making Course and Seminar Series organised by Greenspace Scotland in April 2008. During this training the author learnt how to evaluate the green spaces of the Blaeberryhill Park in West Lothian, Scotland through site visit and observation. The 'Placemaking' technique and method taught there has now become widely adopted in the UK by many local authorities and others undertaking site assessments of green and open spaces. The same basic method was then adapted to formulate the field protocol to be used to evaluate each of the green space sites selected in Kuala Lumpur.

Category	Sub-categories	Sites Visited in April 2009
Public open space	District parks	Bukit Jalil Park Permaisuri Lake Garden Titiwangsa Lake Garden Kepong Metropolitan Park
	City parks	Perdana Lake Garden
	Local parks	Desa Water Park
	Neighbourhood parks	KLCC Park
	Local play areas (including playing fields)	Kepong
Private open space	Private residential open space	Sri Hartamas
	Golf courses, polo fields, driving ranges, sports centres (tennis, badminton etc.)	Royal Selangor Golf Club
Infrastructure and utilities corridors	Road reserves	
	River reserves	Batu River Reserve
	Rail reserves	
	Electric line reserves	
	Reservoirs	
Natural or semi-natural green spaces	Forest reserves	Bukit Nanas Forest Reserve
	Wetland	
	Water	
	Vacant/derelict land	Bukit Gasing Forest Bukit Kiara Pudu jail
	Former mining land	
Civic spaces	City squares	
	Boulevards	
	Waterfronts	Gombak and Klang Rivers
Other functional green spaces	Community facilities	
	Educational areas	Rimba Ilmu, University of Malaya
	Places of worship	
	Cemeteries	
	Agricultural land	
	Garden Nurseries	

Table 6.1: The 17 green spaces visited for site observation and assessment, chosen to represent examples of many of the types of green space in the proposed new typology

The 17 sites that were chosen for ground visits were selected to include many of the different types of green spaces in the expanded proposed typology (Table 6.1). As well as the public open spaces, sites encompassing forest reserves, golf courses, river reserves, educational areas and vacant land were all included in the site selections for observation on the ground. The location of specific sites was chosen using maps and local knowledge to ensure they were well distributed throughout many different parts of Kuala Lumpur. Two of the sites were located in the north of the city, whilst another four were located in the southern suburbs of the city. The other sites were mostly around the central area of the city but in areas with different types of land use, ranging from mainly commercial areas to more residential areas. This careful selection of different types and location of sites was carried out so that the selected sites might represent as well as possible the variety of Kuala Lumpur's green spaces. Table 6.1 shows the list of sites visited for the site assessment task and which sub-category of green or open space they accord with.

During the visits to these 17 locations, the site evaluations were carried out using an assessment sheet as a survey guide or instrument. The purpose of this assessment sheet was to consistently observe and score the same criteria at all sites. This site assessment sheet was designed by referring initially to the sheet designed for the Place Making Course by Greenspace Scotland (Appendix E). It was supplemented by reading the literature about other similar site assessment protocols that had been devised by UK local authorities. As a result, some modifications and quite extensive additions were made, especially for assessing the environmental criteria of sites. The modifications were necessary because the assessment sheet used in the Place Making course only assessed the social criteria of a place, whereas here we are equally interested in assessing the environmental qualities of these spaces.

The assessment sheet that was developed consisted of questions designed to obtain information on 13 environmental and 18 social characteristics which allowed the qualities of these 17 green spaces to be appraised fairly comprehensively given the limitations of time and resources. As noted earlier, the 13 environmental and 18 social criteria included (listed in Figure 6.2 and, more clearly, in part (d) of Figures 6.13 – 6.29), with one exception, were all derived from the 28 environmental and 21 social criteria listed in Tables 4.14 and 4.15 which respondents were asked to assess in Question 28 of the questionnaire survey as regards their importance in making decisions about whether particular green spaces should be preserved. As discussed in Section 4.1, these 28 environmental and 21 social criteria were designed to include a broad range of the environmental, social and other benefits of urban green spaces discussed in the research literature reviewed in Sections 2.6 – 2.9 of Chapter 2, particularly Sections 2.6 and 2.7. In choosing the latter criteria, general reviews of research on the range of benefits conferred by urban green spaces and of gaps in the research literature by Bell et al. (2007), Ward Thompson (2002), Morris (2003), CABE Space (2004), Nowak (2006) and Haq (2011) were particularly helpful, as well as numerous studies of particular benefits. The final choice of these criteria and their formulation was also influenced by study of a number of questionnaires previously used in other studies of urban green spaces (greenSTAT, 2007). The 13 environmental and 18 social criteria used in the field survey are thus derived essentially from the same sources as the 49 criteria evaluated in the questionnaire survey of professional respondents. The reasons that not all the latter could be included in the field survey will be explained in the following paragraphs.

A number of the 28 environmental criteria included in the questionnaire survey could not be assessed from this kind of field survey because of various practical reasons. For instance, measuring the capacity of the site to produce oxygen or to absorb carbon dioxide or the capacity of the ground cover to absorb surface water would have required careful and sustained monitoring by scientific instruments or use of special equipment. Assessment of some of the criteria grouped under 'Biodiversity' in Table 4.14 (e.g. diversity of species of flora, number of indigenous species of flora and number of endangered species of flora) would have required lengthy investigation by surveyors with specialised knowledge of botany or ecology. Because of their special requirements these and some other criteria could not therefore be evaluated on site in the circumstances of the field survey by the surveyors involved. Nevertheless, it was felt that the surveyors could try to make some general assessment of the 'capacity of the site to provide better air quality than surrounding areas' so this was included in the list of criteria to be evaluated. Thus, 15 of the 28 environmental criteria in Table 4.14 could not be assessed in the field for various practical reasons. Of the 13 environmental criteria included, all had mean scores of over 3.5 and 7 had mean values above 4 in Table 4.14, which indicates that the respondents to the questionnaire survey generally considered all of them to be at least ‘very important’ in the context of assessing the case for retaining a particular green space. In addition, the 13 environmental criteria for field observation were drawn from all 5 broad categories of environmental criteria in Tables 4.13 and 4.14, though only one of those grouped under ‘Air and water quality’ could be included, as just noted.

Of the 21 social criteria evaluated by respondents in the questionnaire survey, 15 were directly included in the site assessments using identical or virtually identical forms of wording to those posed to respondents in Question 28 in the survey questionnaire and in Table 4.15. A further 2 of the social criteria in Table 4.15 were included with some rewording. Thus ‘Level of usage of the site’ was reworded to ‘Presence of people/users (busy or quiet)’ and ‘Value in serving its local community’ in Table 4.15 was revised to ‘Value in serving a neighbourhood of the city which generally lacks green space’, which gives the somewhat different emphasis to this criterion of meeting the needs of an area which is generally deficient in green space. In addition, the field assessors were asked to appraise the overall attractiveness of the green space as this seemed possible to do on the site, though it had not been included in the questionnaire survey as probably too general for respondents to consider when completing their replies in offices or other places remote from any green site.

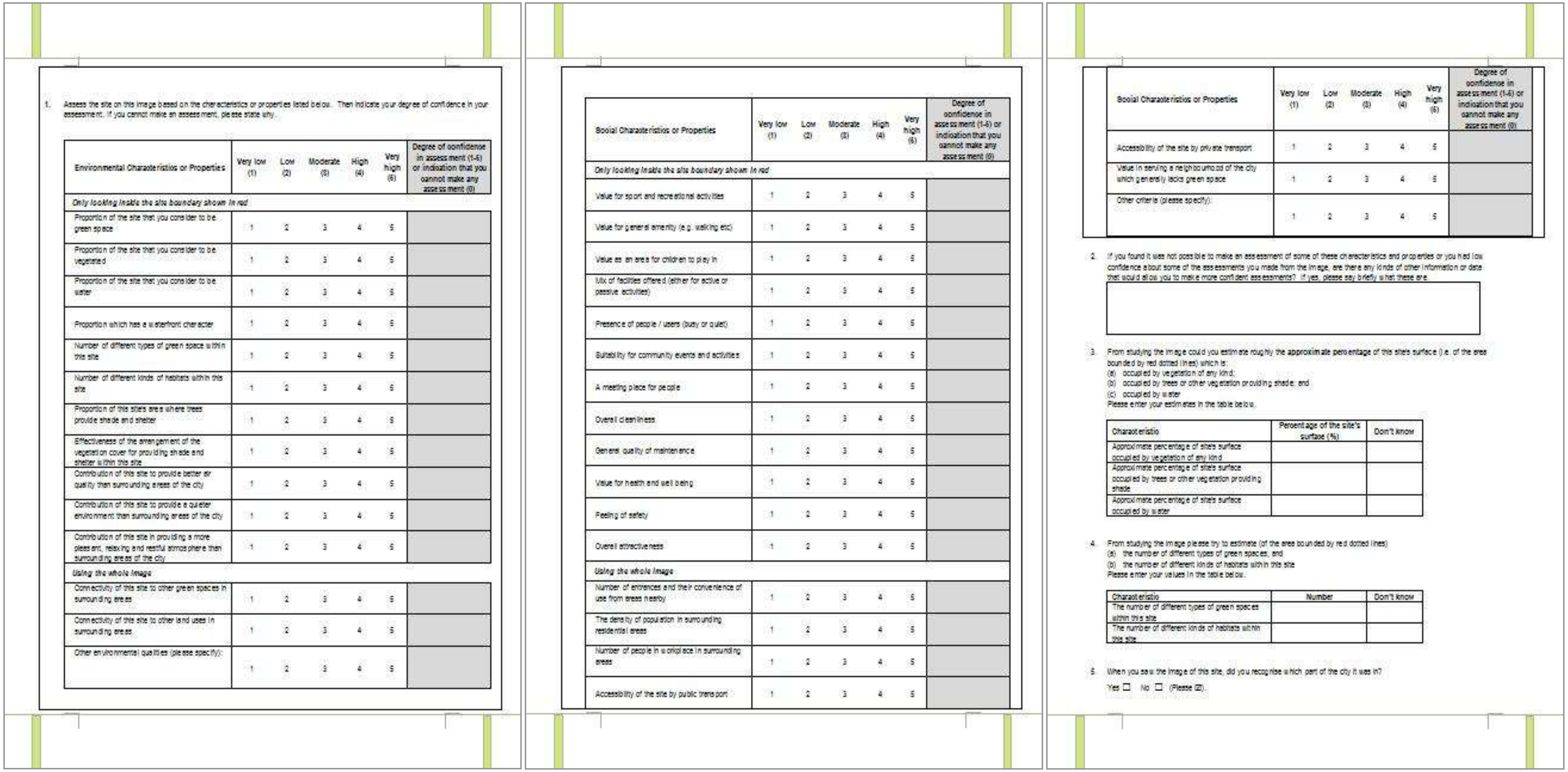
In the questionnaire survey respondents were asked to state how important the educational functions of a site would be as regards its capacity to aid exploration and understanding of the natural world, its capacity to aid understanding of the local environment and its capacity to aid understanding of local heritage. Although these 3 criteria all scored mean values of just over 4.0, they were all omitted from the field survey because it was felt they could only be assessed satisfactorily from a survey of park users for that site or by surveyors with appropriate background and training. Although all 3 criteria included under the broad heading of ‘Educational functions’ were thus omitted from field observation, the 18 social criteria included in the field survey covered all of the specific criteria grouped under the headings of ‘Social functions’, ‘Quality of experience’ and ‘Location and accessibility’ in Table 4.15 with the exception in the latter case of ‘Clarity of information and signs provided to guide people to the site and to guide them within it’, which would have required investigation of the area surrounding the site and possibly some knowledge of the Malay language. All 18 social criteria included enjoyed mean scores of 4.0 or above in Table 4.15 and were therefore seen to be at least 'very important' in the context of assessing the case for retaining a particular green space, with the exception of 'Suitability of the site as a meeting place' (reworded to 'A meeting place for people') whose mean score of 3.88 still indicates it was seen as relatively important.

When the 5 broad groups of environmental criteria and the 4 broad groups of social criteria in Table 4.13 are compared as regards their mean scores, with the exception of 'Biodiversity' with its mean score of 3.70, one of the most striking features of these results is that the mean values for all the groups fall into the relatively narrow range from 3.96 for 'Fragmentation and connectivity' to the highest values of 4.41 for 'Quality of experience', 4.40 for 'Air and water quality' and 4.31 for 'Location and accessibility'. In fact, the mean scores for all 9 groups fall within the range of values covered by the 'very important' category (i.e. 3.5 to 4.5) on the Likert scale used. As discussed in the early part of Section 4.6, respondents seemed to attach somewhat more importance to the 21 social criteria as a general group (overall mean 4.23) than to the 28 environmental criteria as a group (overall mean 4.04). Although this confirms the strong importance attached to the social functions of green spaces and to their social attributes, probably the most striking feature of all the results given in Tables 4.13, 4.14 and 4.15 is the roughly equal importance attached by respondents to both social and environmental functions and attributes. For instance, many of the individual criteria with the highest mean scores in the latter 2 tables are found either in the broad social group labelled 'Quality of experience' or in the environmental group headed 'Air and water quality'.

Further support for the general conclusion that respondents showed strong appreciation of both environmental and social benefits in roughly equal measure was also found in replies to the questions asking respondents why they felt KL needed green spaces, what they thought the main roles and functions of green spaces in KL were and what they thought were the main benefits of these spaces (Questions 13, 14 and 15). Since these were posed as unprompted, open ended questions it was significant that respondents seemed to express a roughly balanced appreciation of both environmental and social benefits in reply (Sections 4.3.1 and 4.3.2). These results therefore provide strong support for including a range of both environmental and social criteria in the field survey. Ideally, in a desk based survey, it would also be desirable to include a similar range of criteria. However, such attributes as the cleanliness, quality of maintenance or feeling of safety at a site (and many of the other 'social' criteria) cannot be captured by IKONOS satellite data and are not held in the parcel based data made available by DBKL or any other data sets available to the author. For these and other reasons discussed earlier, the desk based assessment had to be restricted to 3 measures of accessibility as regards social criteria. It may be worth noting here that the results just discussed help to answer one of the basic questions of the research posed in Section 1.4 as part of question (iv) i.e. what functions of green spaces do the professional respondents to the questionnaire most value?

In assessing each of the sites, for all environmental and social criteria assessors were asked to score the degree to which they believed each site generated or conferred each environmental or social benefit or how strongly it displayed a particular attribute, using a Likert scale with a rating score from 1 (very low) to 5 (very high). For certain environmental attributes, where appropriate, assessors were also asked to make particular quantitative estimates at each site, e.g. of the approximate percentage of the site covered by vegetation, the number of vegetation types and habitats that could be observed and the approximate percentage of site occupied by water. The latter estimates were designed to allow some comparison with equivalent measures that would be computed in the desk based analysis from the remotely sensed data for the corresponding attributes. A list of all the different categories of green and open space being proposed in our suggested typology for Kuala Lumpur (Table 3.2 in Section 3.5) was also provided in this assessment sheet and site evaluators were asked if they could recognise (by ticking one or more categories) the types of green space they had observed within the site according to this typology. Although the site assessment sheets included an IKONOS image extract showing the site (outlined by a red line), assessors used this imagery only for navigation or for ensuring they were within the site boundary. Excerpts of the assessment sheet used in this study are shown in Figure 6.2 (an example of a full assessment sheet is in Appendix F).

During each site visit, photographs were also taken as a record and an aid to memory. Some of these photographs which capture some of main properties of the sites are presented along with selected results from the assessment survey in Section 6.2.1. The results of the site assessments by each observer were subsequently coded, collated and then tabulated using SPSS for quantitative data analysis.



1. Assess the site on this image based on the characteristics or properties listed below. Then indicate your degree of confidence in your assessment. If you cannot make an assessment, please state why.

Environmental Characteristics or Properties	Very low (1)	Low (2)	Moderate (3)	High (4)	Very high (5)	Degree of confidence in assessment (1-5) or indication that you cannot make any assessment (0)
Only looking inside the site boundary shown in red						
Proportion of the site that you consider to be green space	1	2	3	4	5	
Proportion of the site that you consider to be vegetated	1	2	3	4	5	
Proportion of the site that you consider to be water	1	2	3	4	5	
Proportion which has a waterfront character	1	2	3	4	5	
Number of different types of green space within this site	1	2	3	4	5	
Number of different kinds of habitats within this site	1	2	3	4	5	
Proportion of this site's area where trees provide shade and shelter	1	2	3	4	5	
Effectiveness of the arrangement of the vegetation cover for providing shade and shelter within this site	1	2	3	4	5	
Contribution of this site to provide better air quality than surrounding areas of the city	1	2	3	4	5	
Contribution of this site to provide a quieter environment than surrounding areas of the city	1	2	3	4	5	
Contribution of this site in providing a more pleasant, relaxing and restful atmosphere than surrounding areas of the city	1	2	3	4	5	
Using the whole image						
Connectivity of this site to other green spaces in surrounding areas	1	2	3	4	5	
Connectivity of this site to other land uses in surrounding areas	1	2	3	4	5	
Other environmental qualities (please specify):	1	2	3	4	5	

Social Characteristics or Properties	Very low (1)	Low (2)	Moderate (3)	High (4)	Very high (5)	Degree of confidence in assessment (1-5) or indication that you cannot make any assessment (0)
Only looking inside the site boundary shown in red						
Value for sport and recreational activities	1	2	3	4	5	
Value for general amenity (e.g. walking etc)	1	2	3	4	5	
Value as an area for children to play in	1	2	3	4	5	
Mix of facilities offered (either for active or passive activities)	1	2	3	4	5	
Presence of people / users (busy or quiet)	1	2	3	4	5	
Suitability for community events and activities	1	2	3	4	5	
A meeting place for people	1	2	3	4	5	
Overall cleanliness	1	2	3	4	5	
General quality of maintenance	1	2	3	4	5	
Value for health and well being	1	2	3	4	5	
Feeling of safety	1	2	3	4	5	
Overall attractiveness	1	2	3	4	5	
Using the whole image						
Number of entrances and their convenience of use from areas nearby	1	2	3	4	5	
The density of population in surrounding residential areas	1	2	3	4	5	
Number of people in workplace in surrounding areas	1	2	3	4	5	
Accessibility of the site by public transport	1	2	3	4	5	

Social Characteristics or Properties	Very low (1)	Low (2)	Moderate (3)	High (4)	Very high (5)	Degree of confidence in assessment (1-5) or indication that you cannot make any assessment (0)
Accessibility of the site by private transport	1	2	3	4	5	
Value in serving a neighbourhood of the city which generally lacks green space	1	2	3	4	5	
Other criteria (please specify):	1	2	3	4	5	

2. If you found it was not possible to make an assessment of some of these characteristics and properties or you had low confidence about some of the assessments you made from the image, are there any kinds of other information or data that would allow you to make more confident assessments? If yes, please say briefly what these are.

3. From studying the image could you estimate roughly the approximate percentage of this site's surface (i.e. of the area bounded by red dotted lines) which is:
(a) occupied by vegetation of any kind;
(b) occupied by trees or other vegetation providing shade; and
(c) occupied by water
Please enter your estimates in the table below.

Characteristic	Percentage of the site's surface (%)	Don't know
Approximate percentage of site's surface occupied by vegetation of any kind		
Approximate percentage of site's surface occupied by trees or other vegetation providing shade		
Approximate percentage of site's surface occupied by water		

4. From studying the image please try to estimate (of the area bounded by red dotted lines)
(a) the number of different types of green spaces; and
(b) the number of different kinds of habitats within this site
Please enter your values in the table below.

Characteristic	Number	Don't know
The number of different types of green spaces within this site		
The number of different kinds of habitats within this site		

5. When you saw the image of this site, did you recognise which part of the city it was in?
Yes ☐ No ☐ (Please ☑).

Figure 6.2: Excerpts from the assessment sheet used during the survey to observe and assess the 17 sites in April 2009 (refer to Appendix F for the full version of the assessment sheet)

6.1.2 Desk Based Analysis Using Remotely Sensed and Other GIS Data

Whilst site assessments can provide rich information about the detailed composition and condition of particular spaces, such site assessments cannot by themselves effectively capture contextual information about the role that a particular green space plays in the wider surrounding area and even in the city as a whole. As discussed in the introduction to the present chapter, however, using a desk based analysis, it may be possible to produce maps from remotely sensed data and other data in a GIS which can characterise variations in the nature, size and some other attributes of green spaces across the whole city or parts of it and may therefore be of assistance in trying to understand the role(s) played by a particular green space in its neighbourhood, district or in the wider urban system. Such maps, derived ultimately from the satellite data, are not presented therefore as ways of discovering the particular benefits of one green space, but rather as a means of building up a broader picture of the nature and stock of green space across the city which may help to define the context(s) within which individual green spaces can be viewed and which may possibly help in understanding the role of particular spaces in their own district of the city.

The introductory section of this chapter and the later part of Section 6.1.1 also explained why the desk based analysis had to be restricted to 4 environmental criteria and 3 measures of accessibility which essentially formed small subsets of the 13 environmental and 18 social criteria assessed by field observation. This was mainly because most of the latter criteria were inherently not GIS-able or was not manageably GIS-able, given the time and resources available. Section 6.1.2.1 now presents the methods used for calculating the four environmental indicators of green space. Section 6.1.2.2 then describes the techniques used for calculating the three measures of how accessible a particular green space is to potential users in the surrounding area or further afield in the city.

6.1.2.1 Environmental Criteria

Two main GIS methods were used for estimating the 4 environmental indicators for green spaces throughout the city. These two methods both use grid-based analysis to identify local differences and carry out proximity analysis by buffering. Grid-based analysis was used first to compute three environmental indicators for grid cells covering the whole city, namely, *1 - the relative abundance of green spaces, 2 - the number of different types of vegetation and 3 - the proportion of tree cover*. Proximity analysis employing buffering was then used to create a fourth indicator showing *the relative connectivity between the city's green spaces.* Although only 4 environmental criteria were included in the desk based analysis, the first three are concerned with the nature, extent and variety of vegetated surfaces in the city and therefore relate to the first of the 6 sets of basic questions addressed by the thesis (Section 1.4).

As described by Artimo et al. (1996), grid-based analysis on data which is normally in raster format allows operations on one pixel location at a time within certain zones or within a defined neighbourhood. Tomlin (1990) described this type of analysis as a form of map algebra and divided it into four groups of functions: local, focal, zonal and incremental. According to Tomlin (1990), a local function only affects one pixel in the map matrix at a time, whereas a focal function calculates a new value for a pixel for a defined neighbourhood. Importantly for this study, he also described zonal functions which can assign a newly computed value to entire areal divisions or regions identified on some appropriate basis (Tomlin, 1990).

In this study, zonal functions were used upon the gridded map of green space produced from the satellite data (Figure 5.14 (b)) to compute the first three environmental criteria which we call *green space abundance, vegetation variety and proportion of trees.* Details of the use of this zonal function method will be discussed further in Sections 6.1.2.1 (i) to 6.1.2.1 (iii).

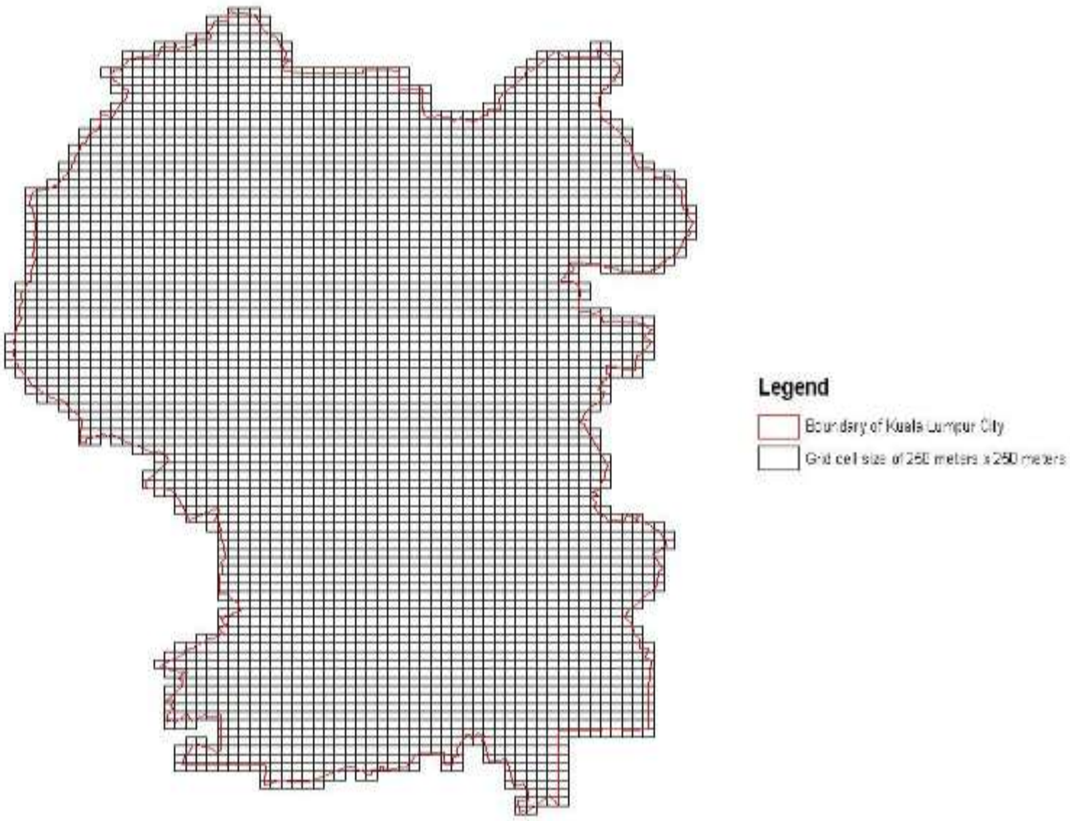


Figure 6.3: A grid cell size of 250 meters by 250 meters was used in computing the various indicators.

To generate the gridded data sets, a vector outline of the Kuala Lumpur local authority boundary was used to create a grid with a cell size of 250 meters by 250 meters. This grid size was chosen in relation to the overall extent of Kuala Lumpur city (which is approximately 244 square kilometres) and this grid size also allows 100 by 100 smaller cells or pixels of 2.5 meters for the satellite image data to nest in one larger grid cell of 250 meters. A grid size of 250 meters by 250 meters also seems appropriate to provide sufficient resolution so that differences in the scores computed can be seen in different areas of the city without the data becoming too smooth or having so much local variance that it is difficult to see any pattern emerging. This new data set for 250 meter grid cells (Figure 6.3) will be used to compute the first three environmental criteria using as input the data from the remotely sensed image of land cover for the city as classified and expressed in Figure 5.14 (b).

To compute a measure of *the connectivity between the green spaces*, buffering and proximity analysis were conducted. This process allows features that lie inside or outside a particular buffer distance around a given feature to be selected. As green spaces, the features to be buffered here are represented as vector polygons. However, a series of buffer zones could in fact be generated at defined distances around various other geographic features (e.g. other polygon, line or point features) such as lakes, land use types, rivers etc. to evaluate the proximity of certain green spaces to these features.

In this study, buffer zones were generated at a series of increasing distances around specific areas of green space. The distances used to create these buffer zones were defined according to existing guidelines or standards for access to green space. However, as regards determining how 'far' or 'near' two green spaces should be in order to be considered connected, no definitive answer can really be given. Rather, by drawing on relevant ecological literature it can be seen that connectivity distances vary and will differ depending on whether this is being estimated for insects or small mammals or birds or humans etc.

The land cover classification portrayed in Figure 5.14 (b) was used as the main input dataset for deriving the environmental indicators for all green space over the whole city using the above mentioned techniques. The following section describes the techniques used to compute each of the four environmental indicators used for the whole city.

(i) Indicator of Green Space Abundance

Figure 6.4 summarises the procedures used to compute an indicator for green space abundance throughout the city. The Zonal Statistics operations of ArcGIS were used to compute the indicator. Zonal Statistics calculates a summary statistic (such as mean, median, sum, variety, majority or standard deviation etc.) for each zone based on input scores from another data set (ESRI, 2001). This function performs operations on a zonal basis (i.e. it produces one output value for each zone based on the values of all the input cells making up that zone).

In this analysis, the areal framework for output is the map of grid cells of 250 meters by 250 meters created earlier (Section 6.1.2.1), now regarded as the data set for output. In Zonal Statistic, ***sum*** was used and green space abundance was calculated as the sum of the green vegetation pixels from the map of green space for the city shown in Figure 5.19 (c), now aggregated to 'zones' of 250 meters by 250 meters. The output of this analysis, (A (i) in Figure 6.4) indicating the relative abundance of green space across the city by 250 meter grid cells, is shown in Figure 6.31 (a) in Section 6.2.2.1 (i), and will be more appropriately discussed in detail in that section.

This output was then regrouped into classes from 1 to 5, where a score of 1 was assigned to areas that have 'very low abundance of green spaces' and a score of 5 was for areas that have 'very high green space abundance'. The output of this process (B (i) in Figure 6.4) can then be used to produce a map of green space abundance across the whole city giving a value between 1 and 5 to each local vicinity i.e. to each 250 metre grid cell (Figure 6.31 (b)).

The gridded output gives a picture of green space abundance which can be used for a number of purposes. One specific use is to place each of the 17 sites observed through site visits into the wider context of the city's overall distribution of green space. By overlaying the 17 sites onto the grid for the whole city, the relative abundance of green space both inside and around the locality of each of these sites can be extracted from the gridded data and attached as an inherited attribute to each of the 17 sites (operation C (i) in Figure 6.4) and hence mapped; the results for this are shown in Figure 6.31 (c). This allows each site to be given contextual information about its surroundings in a manner which involves relatively consistent assessments through GIS analysis, but which we discovered can be rather difficult to do consistently on the ground during a local site visit.

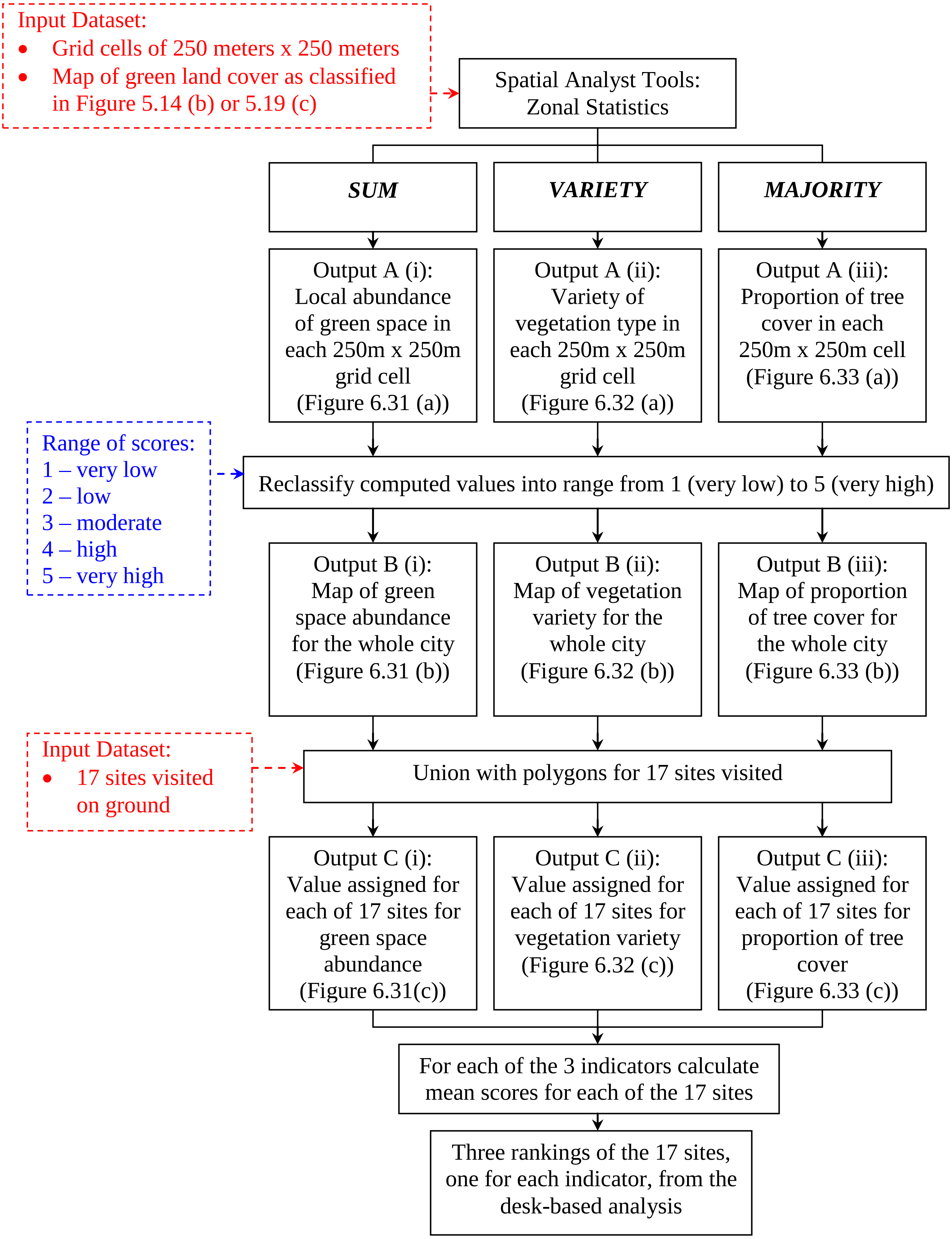


Figure 6.4: Flow chart of procedures that were carried out in measuring the environmental criteria of *green space abundance, vegetation variety and proportion of tree cover*, using GIS operations on the IKONOS satellite data.

(ii) Indicator of Vegetation Variety

Similar procedures were carried out to compute a measure for the variety of types of vegetation cover in the green spaces in different parts of the city. In measuring the vegetation variety, the Zonal Statistics ***variety*** function was used which computed the variety in types of vegetation in each 250 meter cell over the whole city (operation A (ii) in Figure 6.4) with Figure 6.32 (a) illustrating the basic map output from this analysis.

As before, this output was reclassified into five classes from 1 to 5. A score of 1 was assigned to grid cells that have 'very low variety of vegetation cover' with 5 for grid cells that have 'high variety' which means all three types of vegetation cover (operation B (ii) in Figure 6.4 with the resulting map in Figure 6.32 (b)). Then, as before, each of the 17 field sites was overlaid on the output grid and through this process a mean score for the variety of vegetation on that whole site and then for each of the other whole sites was computed (operation C (ii) in Figure 6.4 with map results in Figure 6.32 (c)).

(iii) Indicator of Tree Cover

To find which parts of the city were relatively well provided with shade and shelter for humans and other creatures, in Zonal Statistics the ***majority*** function was used with the map of the different types of land cover (Figure 5.14 (b)) again as input (Figure 6.4). This function (operation A (iii) in Figure 6.4) was used because it allows the majority type of land cover within each cell of 250 meters to be identified. The resulting map (Figure 6.33 (a)) can be read to identify the areas of the city where trees provide the largest share of land cover in Figure 5.14 (b). Since there can be 6 different types of land cover within each 250 meter cell, the type identified as 'majority', however, may cover much less than 50% of that cell's area.

Again, this result was reclassified into five classes. A score of 1 was assigned to grid cells where the majority form of land cover provided little or no shade or shelter i.e. built-up areas, bare ground, water bodies or grass land; a score of 3 was given to grid cells where shrubs formed the largest area of land cover and perhaps therefore provided a moderate degree of shade and shelter; and a score of 5 was assigned to areas with tree cover forming the largest part of the surface (operation B (iii) in Figure 6.4). The results of this operation are shown in Figure 6.33 (b). Again, Figure 6.33 (c) separates out the 17 sites from the rest of the city on this indicator.

(iv) Indicator of Green Space Connectivity

Buffering was carried out to measure *the connectivity of green spaces in the city*. This technique was used in measuring their connectivity because it allows other green spaces that lie next to or outside the boundary of a particular green space to be identified. By using this technique, the proximity of one particular green space to the next nearest green space can be measured and the amount of green space within these buffer distances can be calculated.

Figure 6.5 summarises the procedures carried out in measuring the connectivity of the city's green spaces. This task was carried out by first creating multiple buffer zones around the 17 sites. Five buffer zones with different widths (shown in Figure 6.34 (a)) with the first extending from the green space itself to a distance of 100 meters away and the furthest running from a distance of 901 metres to 1200 meters from the green area were created. The different widths with intervals in the range from 100 meters to 300 meters were chosen according to reported evidence that green spaces connected within these distances can provide multiple benefits such as sustaining and improving biodiversity and a range of functions encompassing wildlife havens and allowing their joint or combined use for recreational activities.

A considerable amount of literature has discussed the benefits of connecting green spaces (Bennett and Mulongoy, 2006; Crooks and Sanjayan, 2006; Noss and Daly, 2006; Opdam and Wiens, 2002; and Taylor et al, 2006). However, few of these studies have identified specific threshold distances between green spaces within which two areas could be considered to function together as a connected habitat which enables exchange between their species' populations. This might be due to different species needing different habitat requirements to sustain their populations.

In this study, habitat surveys were not carried out. Rather, a range of buffers from 100 meters to 300 meters wide were computed. The multiple buffer zones were then merged with the dataset on green spaces (as presented in Figure 5.14 (b)). This task of merging created output B in Figure 6.5 showing how each of the 17 green spaces connected with green spaces in the surrounding areas of the city (Figure 6.34 (b)). Then the proportion of green space within each of the concentric buffer zones was calculated. Areas where green spaces were separated by 901 – 1200 meters were classified as less well connected (score 1) while green spaces within 100 meters of each other were given a score of 5 as highly or well connected. Output C (Figure 6.34 (c)) shows the map of green space connectivity for the 17 green sites visited and their overall scores (detailed scores for each of these 17 sites are shown in Appendix G).

The connectivity score for each of the 17 sites (output C in Figure 6.5) was then standardised on to the range from 1 (very low) to 5 (very high connectivity). Figure 6.35 and Table 6.11 give the final mean scores on connectivity for the 17 sites.

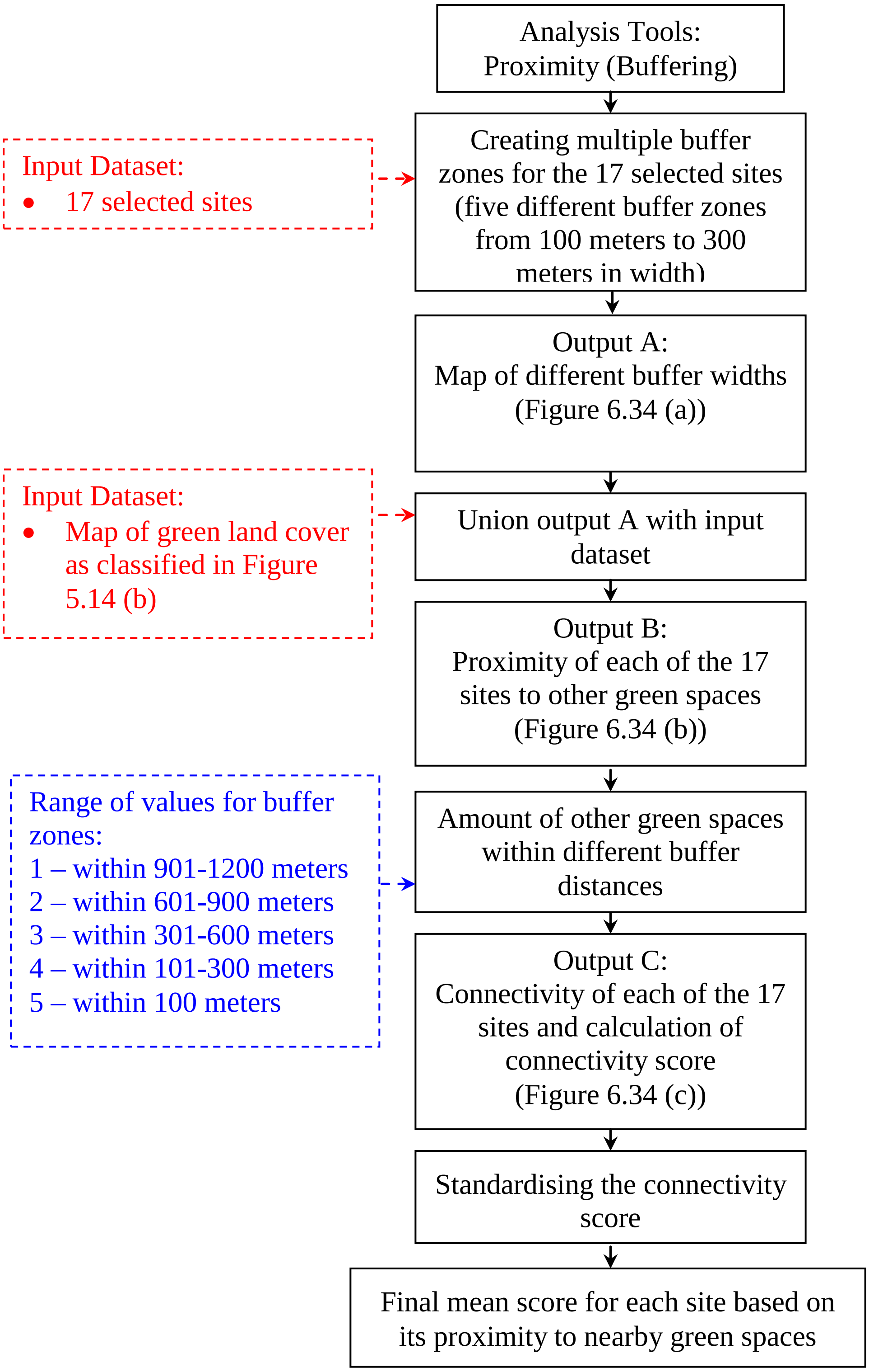


Figure 6.5: Flow chart of procedures used to create an indicator for the connectivity of each of the 17 green spaces to other green spaces

6.1.2.2 Estimation of Measures of Accessibility Using Desk Based Methods

As explained in the introductory section of the present chapter and in the latter part of Section 6.1.1, the large majority of the 18 social criteria selected for field observation and assessment (all but one based on the 21 social criteria in Table 4.15 as noted earlier) simply could not be observed from the IKONOS satellite data or could not be computed from the data sets available and held in a GIS with the time and resources available, so it was not possible to use them in the desk based analysis. As a result the desk based analysis for social criteria had to be restricted to 3 measures of accessibility, which could be computed from the data sets available, as noted previously. These measures had equivalents among the 18 social criteria observed on the ground for the 17 sites concerned.

The first two of the accessibility measures were both included among the criteria assessed by respondents in the questionnaire survey. Both (accessibility of the green site to nearby residential population and accessibility of the site by public transport) were given very high mean scores (4.34 and 4.44 respectively) by the respondents for their importance when determining which green spaces should have priority for protection, placing them 7th and 4th/5th equal in importance among the 21 social criteria in Table 4.15. The importance of accessibility or distance as a general factor influencing the use of green spaces designed for public leisure and recreation is also confirmed by Aziz (2012). In an extensive review of research literature on the use, management and importance of urban green space in the developed and some of the developing countries, which forms the background to a study of factors influencing the use of urban green space in the Klang Valley of Malaysia, the latter author notes that distance to a green space is stated by several authors to be the most important factor influencing its use and that many studies consistently confirm that frequency of use tends to decline as distance from the individual's residence increases. Although this part of the analysis is restricted to 3 measures of just one out of 4 of the broad categories of social criteria discussed at various points in Chapter 4, accessibility can be seen as a particularly important factor influencing the use of many types of urban green space.

The present section explains how the 3 measures of accessibility used in the 'desk based' analysis were computed. Buffering was again used to compute indicators for two of these criteria: (a) *accessibility of green spaces to their surrounding populations* and (b) *accessibility of green spaces to nearby public transport*. A dasymetric mapping technique was used because the first of these criteria requires population data and the dasymetric mapping technique is a useful means of redistributing population into geographically more plausible areas (such as actual residential areas) than the standard polygons generally used for outputting census data (Martin, 1996).

(i) Accessibility of Green Spaces to their Surrounding Population

To implement this general concept of accessibility, two different means of assessing the accessibility of a green space to the surrounding population were used. Firstly, a somewhat coarse evaluation of the provision of green space with respect to the population of the surrounding district was carried out. This assessment was modelled on the '6 acres (2.4 hectares) standard' in UK, where the National Playing Fields Association (NPFA) recommends a minimum standard for outdoor play space of 2.4 hectares (6 acres) for 1000 people. Since this standard is widely used in the UK, it seemed appropriate to use it as a kind of 'test measure' for the actual provision of green spaces (i.e. officially recognised ones) in Kuala Lumpur. This was carried out by calculating the ratio of the total area of 'official' green space to total population in each of the city's zones. A map of the result showing which zones meet or do not meet this '6 acres standard' is thereby produced (Figure 6.36).

Secondly, at a finer scale, an assessment of the accessibility of green spaces to the surrounding population was carried out. This involved firstly using dasymetric mapping to redistribute the population more finely than according to the census enumeration blocks, and then counting up the population within various distances around each green space to estimate the demand from nearby population for that space.

Figure 6.6 shows the procedure involved. Firstly, by using dasymetric mapping, the city's population distribution was mapped at a finer scale. This technique was used because it intelligently distributes population data into what should be considered as habitable areas such as residential areas or other built-up areas. This method uses census enumeration units (i.e. blocks or zones) as the input geography for the population numbers (Mennis, 2003).

The reason for preferring the dasymetric method to the use of census blocks for mapping the city population is because there are known problems associated with using census blocks for population distribution maps. Thus the commonly used method of choropleth mapping of census blocks, sometimes called a shaded area map, distributes the population homogenously throughout the entire areal unit i.e. enumeration blocks or zones which can sometimes be quite large areas on the ground. This coarseness of the mapping unit can create an unrealistic representation of where the population is actually located, especially when significant portions of land within the areal unit are uninhabitable - for example areas of water or open spaces (Langford, 2003). As a solution, dasymetric mapping was used to distribute the city's population into only those target zones that can feasibly be inhabited (using ancillary information to aid the interpolation). According to Mennis and Hultgren (2006), dasymetric mapping provides a more accurate and realistic picture of the actual population distribution, since this technique redistributes coarse resolution population data to a finer scale of resolution, assigning people only into 'inhabitable' areas or spaces within a city.

In this thesis, a dasymetric mapping for Kuala Lumpur city was carried out by the author using a Dasymetric Mapping Tool produced by Dr. Jeremy Mennis of Temple University, Philadelphia, US. This software is created as an extension in ArcGIS 9.2 which provides tools to create a dasymetric map by using an input population layer (demographic data in a geospatial format that has a population count representing each areal unit i.e. here enumeration blocks or zones) and an ancillary layer, in our case a raster layer derived from the land use or land cover maps representing habitable or uninhabitable areas. By using the original census data set containing 881 enumeration blocks provided by the Malaysian Department of Statistics (shown in Figure 6.7) as the input population layer and using the IKONOS classification of land cover (shown in Figures 5.14 (a) and 5.14 (b)) as the ancillary layer, a dasymetric map was produced redistributing the population of Kuala Lumpur into the built-up areas only (output A in Figure 6.6 with the resulting map in Figure 6.37 (a)).

In the dasymetric software used, key parameters normally have to be supplied to estimate the relative difference in population density between the various 'habitable' classes (known as the 'population density fraction') and between those and the other classes, here essentially the 'non-habitable' classes. This is used to indicate what proportion of the area of the various habitable classes was actually habitable. In our case only the built up area was treated as habitable and 90% of its surface was specified as habitable whereas the five other types of land cover (i.e. all 3 types of green spaces plus bare ground and water bodies) were allocated a value of '0' (zero) so that no population was distributed into these zones.

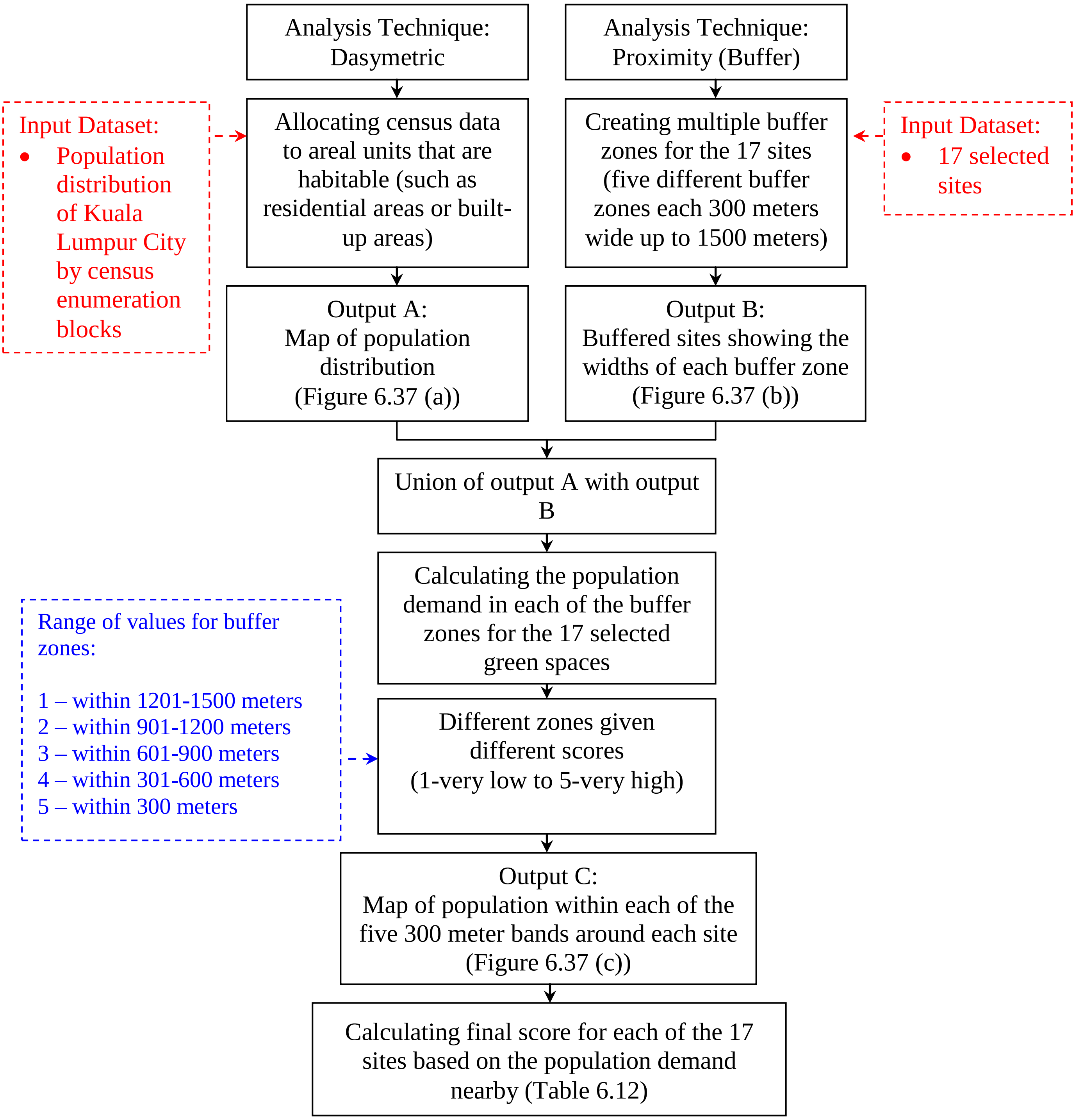


Figure 6.6: Flow chart of procedures that were carried out in measuring the population in the area surrounding each site

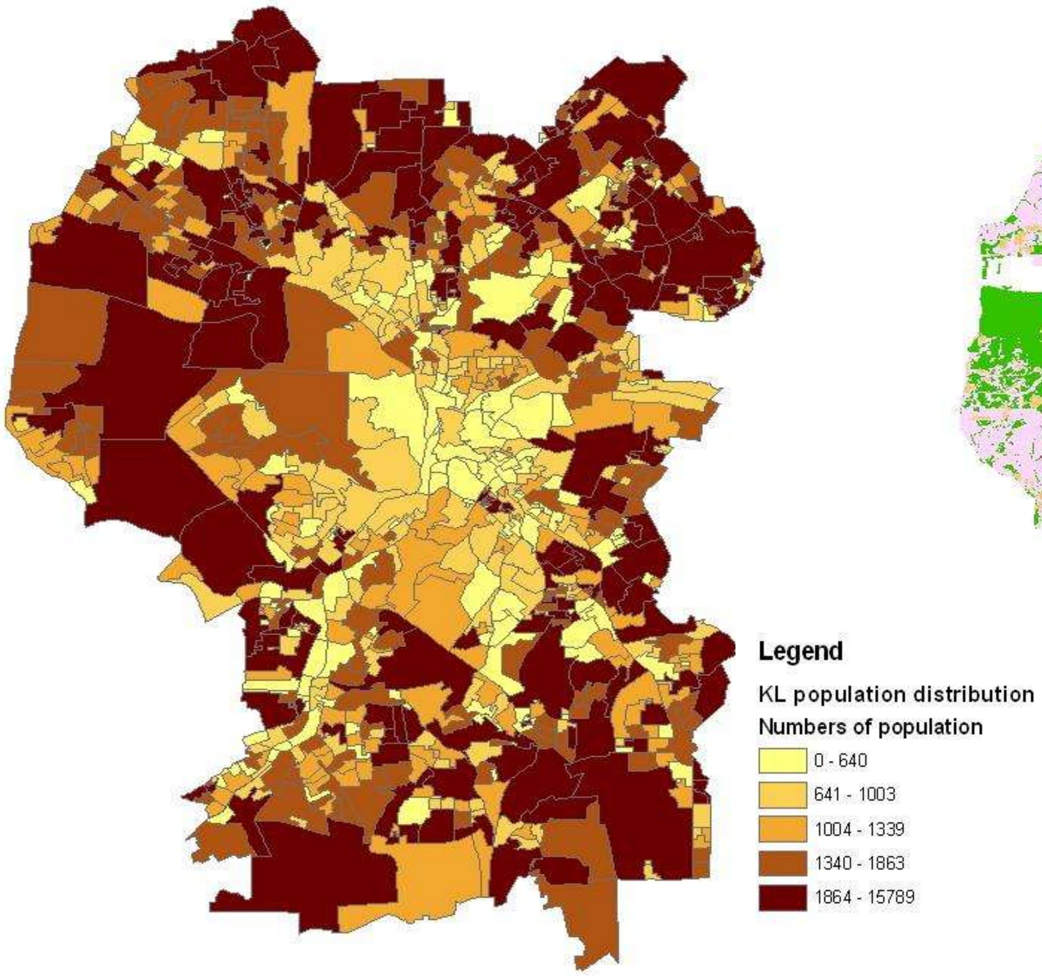


Figure 6.7: Population of census enumeration blocks used as the input layer

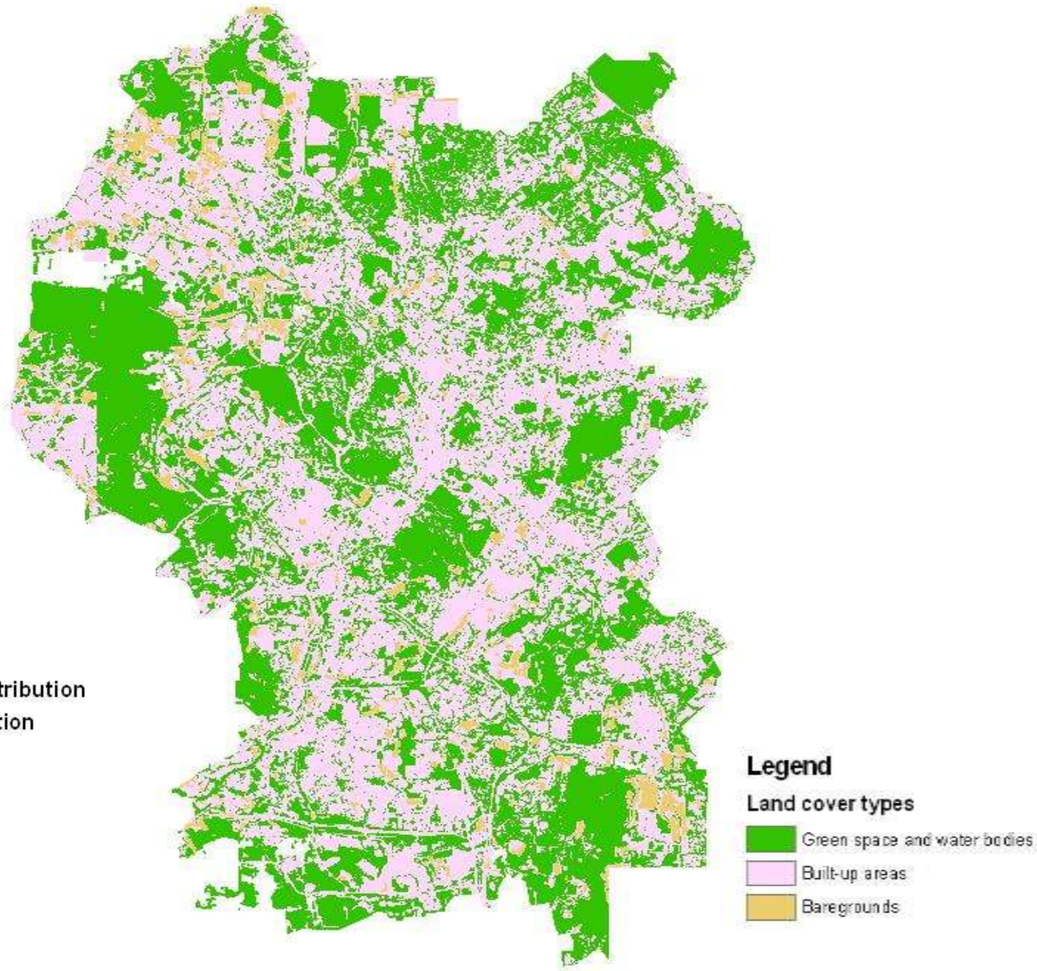


Figure 6.8: Population distribution from using data on land cover (Figure 5.14 (b)) as the ancillary layer

As mentioned earlier, Aziz (2012) states that in a large number of studies, conducted in different contexts including her own study of the use of 3 urban parks in Kuala Lumpur and 2 in Kuching in Sarawak, distance has been found to be associated with the frequency of use of urban green spaces. The studies confirming this 'distance decay' effect all seem to be concerned with green spaces designed for recreational and leisure use by the public (though this is evident in her own study of urban parks, Aziz does not state this explicitly when commenting on studies by other authors). At least 14 of our 17 sites are clearly designed or intended in some sense to be visited by the public, the exceptions being the Royal Selangor Golf Club which is private and, possibly, Bukit Gasing and Bukit Kiara, which are generally classified as 'vacant' in the land use data, though Figure 5.14 (b) shows both to be extensively covered by trees and shrubs. Despite these 3 possible exceptions, it is relevant to consider how many people live near all 17 sites, partly for comparison and consistency and partly to assess the potential demand on that location or area in analytical terms. In considering the accessibility of these 17 green spaces to population in the surrounding area and the number of people likely to use them, it seems most important to take some account of the strong probability that those residing further away are likely to be less frequent users or not to use them at all.

Aziz (2012) gives an impressively comprehensive review of studies from different contexts, including a few countries in Asia, which show how frequency and patterns of park use may be influenced to some degree by a wide range of socio-demographic and cultural factors, including ethnicity, age and educational background. For instance, in Aziz's own study of park use in KL and Kuching, Chinese people were less likely to bring their families to parks compared to Indians and Malays. Of the 1,692 respondents who returned his postal questionnaire, 61.2% usually travelled by car to a park while 26.6% usually walked. Presumably the remaining 12.2% travelled by public transport or motor cycle or bicycle, though a further breakdown is not given. As she observes, the popularity of car use, even for short distances to a park, may be a reflection of Malaysia's hot and humid climate, relatively high car ownership and use in urban Malaysia (plus the fact that air conditioning is a standard feature of vehicles in Malaysia). A recent paper on vehicle ownership and transportation planning in Malaysia states that vehicle ownership in the Klang Valley (essentially the KL conurbation) was 994 vehicles per 1,000 persons in 2002, with 47% of motor vehicles in Malaysia as a whole being motorcycles (Shariff, 2012). She also notes that another adaptation to climate is that the early morning and late afternoon are the most common times for Malaysians to visit parks.

From both cities studied Aziz's data showed clear evidence of 'distance decay': the number of people who had visited a park more than 20 times in the previous 3 months decreased as the distance from park to residence increased; moreover, the proportion of respondents who were non-users increased with distance. Since over 60% of his respondents were car users, it seems fairly safe to conclude that some kind of distance decay effect must apply to car users or this evidence of a general distance effect she observed would not be found in her data.

Given Malaysia's climate it seems very probable that there will also be a distance decay effect for those who walk to a park and that the decrease in use for walkers will be steeper for than for drivers. However, Aziz does not give any quantitative, statistical results to indicate what the gradient of a general overall distance decay effect may be or how it may vary between such modes of travel. Similarly the research literature reviewed in Section 2.7 provided very little evidence of how strong this distance decay effect for use of green spaces is or how its strength may be affected by such factors as car ownership, climate, the attractiveness of the green space or the intended purpose or use by the individual concerned or other socio-demographic factors. A very interesting recent paper by Mitchell (2012) on whether physical activity in natural environments is better for mental health than physical activity in other environments did find some evidence in quite a large multivariate study that there was significant benefit to one measure of mental health when exercise was performed in a natural environment, but found less strong evidence for such benefits on a second index of mental wellbeing. However, although the study included a variable capturing the amount of green space in a respondent's area of residence, this was only used as a control variable, so the research did not investigate whether the latter variable had any effect itself. More important for the present research, it involved no consideration of distance or accessibility to green spaces.

Similarly, the preceding sources give very little evidence of what might be appropriate cut-off distances or travel time limits beyond which people are very unlikely to travel to a park or other recreational green space and how such limits may vary by mode of travel and other factors. In her own study of parks, Aziz limited her questionnaire survey to people living within 2 km of the parks concerned "based on early research that suggests most park visitors to live nearby". In estimating the population within an accessible distance of a green space we have used a limit of 1.5 km. While this is less than Aziz's limit, if use by car users decreases with distance, this limit should still capture the majority of car users likely to visit a green space and should serve as a useful rough limit in a prototype study like the present, to be reconsidered in future work if more evidence on travel behaviour suggests it should be changed. In Malaysian conditions, this limit should certainly capture virtually all those likely to walk to a green space.

While it clearly seems essential to incorporate the concept of distance decay into calculating this index of accessibility, the research literature provides little guidance on how to do this in practice or what numerical parameters might be appropriate. A relatively simple approach was therefore used in which the area surrounding each green space was divided into five bands or zones at intervals of 300 meters with the innermost band formed by the whole area within 300 meters of the green space and the outermost band extending from 1201 meters out to 1500 meters from the green space concerned, as shown in Figures 6.6 and 6.37 (b). The distance decay effect was then implemented by giving the zones weights from 5 for the innermost to 1 for the outermost band. While this is a somewhat arbitrary way of incorporating distance decay and does not distinguish between those walking and those driving (which would not be possible without much more detailed research being carried out on these relationships per se), it does allow us to take account of the population in the area surrounding each green space in a consistent way which gives some indication of the potential number of users of the space. This index should be a useful measure of accessibility, but its limitations have to be borne in mind.

In terms of GIS operations, proximity analysis using buffering was again employed by first creating five buffer zones at intervals of 300 meters around each of the 17 green sites up to a distance of 1500 meters (output B in Figure 6.6 with the resulting map shown in Figure 6.37 (b)). With the population redistributed on a dasymetric basis, the local population within each of five 300 meter bands was calculated. Once the multiple buffer zones were created, a union task was carried out where output A (dasymetric mapping) was merged with output B (buffer zones). This union task created output C (Figure 6.6) which identifies the population within five belts each 300 meters wide extending up to 1500 meters from these 17 green spaces (Figure 6.37 (c)). A population count was then carried out within each of these 5 buffer zones and, as just described, weights for distance decay were given to the zones, ranging from 1 for distances from 1201 to 1500 meters (very low accessibility to the green space therefore fewest potential users) to 5 within a distance of 300 meters (very high accessibility to the green space therefore highest potential level of use). The sum of the population in the bands around each green space with each band weighted by distance was then calculated. Finally, the overall mean score for this criterion for each of the 17 sites was calculated to give the results shown in Table 6.12.

As discussed in Section 2.7.2, in 1996 English Nature in their model for Accessible Natural Greenspace Standards (ANGSt) have asserted that *no person should live more than 300 meters (approximately five minutes walking distance) from their nearest area of natural green space of at least two hectares in size* (Harrison et al., 1995). It should be noted, however, that English Nature did not put forward any quantitative evidence of how use of green spaces of various sizes decreases with distance to justify this distance as a significant threshold. While it seems intuitively appealing and even desirable that urban dwellers should have a sizable area of green space within roughly 5 minutes leisurely walk, in the absence of data to justify this as a meaningful threshold, this standard must still be seen as somewhat arbitrary.

Since no explicit distance standards of this kind appear to have been adopted officially yet in Malaysia, it may be seen as convenient perhaps that the limit of 300 metres for the inner belt in our method corresponds to English Nature's recommended standard. In considering the use of this threshold in a Malaysian context, it can be argued that climatic differences may mean that 300 metres feels longer to Malaysians than to residents of N.W. Europe. On the other hand, as noted earlier, Malaysians seem to adapt to their climate by using parks more often in the early morning or late afternoon or by driving there or, possibly, by walking at a more leisurely pace. Previous observations by the author and some pilot interviews conducted by the author in certain parks confirmed that most people asked preferred to walk less than 20 minutes to reach the park, which suggests that, while time and distance may be factors in park use, to some citizens of KL a walk of 5 or 10 minutes or more is not an insuperable barrier.

It should be emphasized, however, that the correspondence between 300 metres as a recommended standard by English Nature and as used in our analysis is of little real significance for our analysis here since our concern is to use this as an interval in setting out 5 zones to implement a distance decay effect, which is the most important element in our measure of accessibility. It can be debated whether it makes sense to transfer 300 metres as any kind of standard distance from UK to Malaysia, but the concept of distance decay is certainly transferable as regards use of urban green spaces and is well established by empirical research. A general concept of distance decay was also used implicitly in the preceding section in measuring the connectivity of green spaces.

(ii) Accessibility of Green Spaces to Public Transport

A buffering technique was also used to produce an indicator of accessibility of the green spaces to 'mass public transport'. In KL the latter term is widely used where the term 'public transport' is used in Britain. In KL 'mass public transport' seems to cover all forms of public transport including light rail, monorail and buses and therefore seems to be broadly synonymous with 'public transport' in UK. The two terms will therefore be used interchangeably here. As before, multiple buffer zones around the 17 selected sites were created. Five buffer zones each with a width of 300 meters extending up to 1500 meters were again used (Figure 6.38 (a)) and the number of stations on the monorail or light rail networks of public transport within these five buffer zones was calculated (Figure 6.38(b)). The bus network was not included because data on it was not readily available and such data would have been prohibitively time consuming to collect.

Scores were again given to each of these five different buffer zones ranging from 1 for the rather low access to these rail stations of the outer band to 5 for the very high access of the innermost band. Finally, the overall mean score for this criterion was calculated. Figure 6.10 summarises the procedures involved in computing this accessibility index. This implies a distance decay effect akin to that discussed for the previous measure i.e. a green space with more monorail or light rail stations within the adjacent 300 metres will tend to be more used than one with fewer or one which has a similar number but in a more distant zone. However, there is very little (if any) evidence available in the research literature regarding how access to public transport affects use of green spaces which would allow us to assess how realistic this weighting for public transport is.

The author recognises that more sophisticated and comprehensive measures for accessibility to public transport could have been developed. For instance, data sets for the locations of monorail stations and bus stops could be used to create more complex and comprehensive indices. The data needed for this may be available within DBKL, so it is possible this kind of analysis could be done in a more satisfactory and realistic way within DBKL.

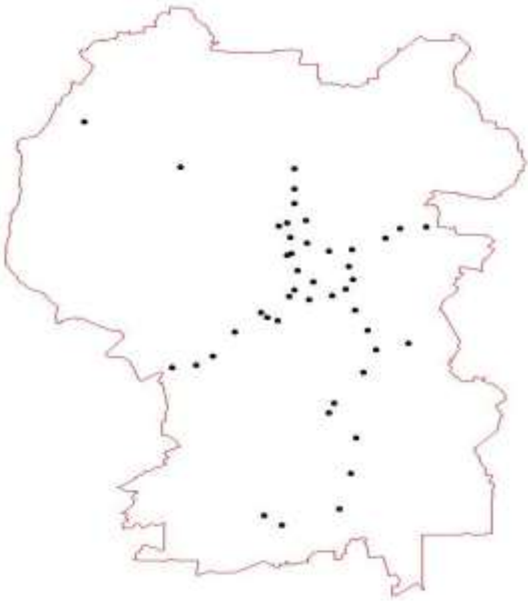


Figure 6.9: Input data set of the locations of public transport stations

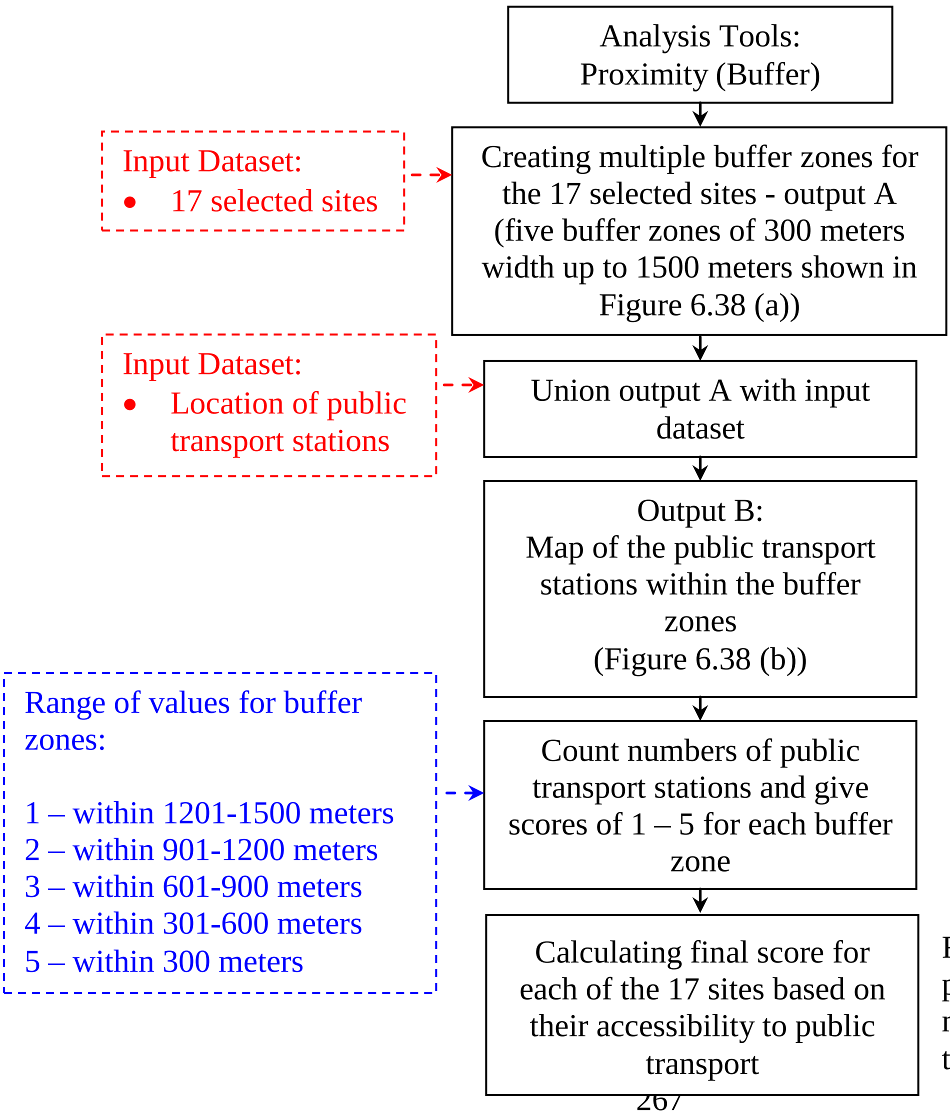


Figure 6.10: Flow chart of procedures carried out in measuring accessibility to public transport

(iii) Openness and Availability of the Green Space to the Public

To develop the third indicator of accessibility, GIS analysis was again used (Figure 6.11 summarises the procedures involved). Five sub-criteria (as shown in Table 6.2) were used to assess how open and available the 17 green spaces were to the public, as these five sub-criteria were believed to be significant aspects of this dimension of accessibility. These site attributes could either be attached through a GIS overlay (e.g. by overlay with the green areas layer) or were directly observed from the site visits and so were manually attributed to each site in the GIS.

Sub-criteria	**Available data set**
Gazetted vs. non-gazetted green spaces	Local knowledge of researcher & inventory of DBKL's officially recognised green spaces
Publicly owned vs. privately owned	Local knowledge of researcher
Publicly vs. privately managed and maintained	Local knowledge of researcher plus site visits
Gated vs. not gated sites	Site visits
Available 24 hours vs. not available 24 hours	Site visits

Table 6.2: Five sub-criteria that were considered in measuring how open and available the green space was to the public and the data used in evaluating this criterion

Scores ranging from 1 (very low) to 5 (very high) were given to each of the 17 sites for each of these five sub-criteria. Maps were then produced showing green spaces that have very low to very high scores on each of these sub-criteria. Overall scores were then calculated for each of the 17 sites as shown in Figure 6.11.

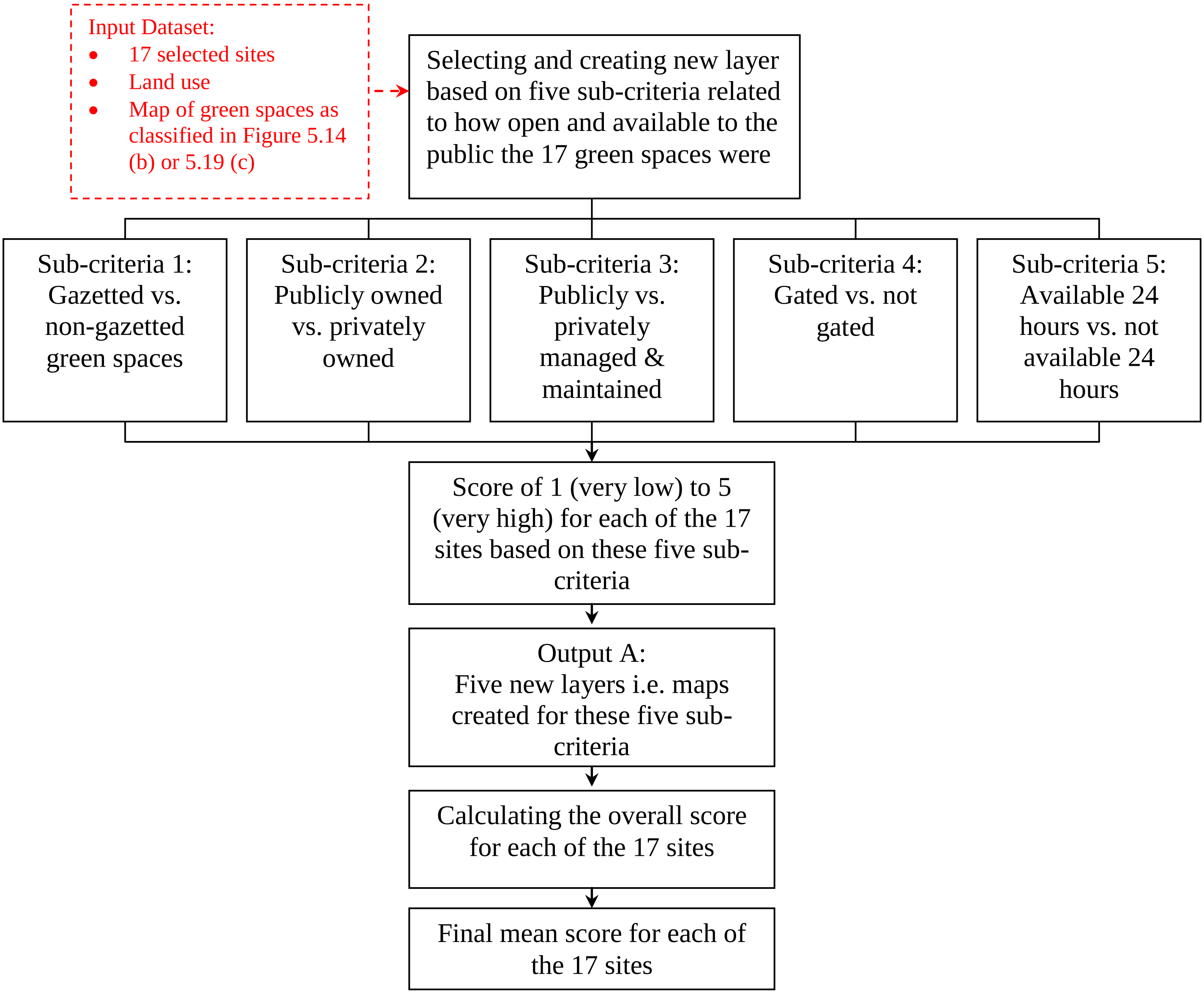


Figure 6.11: Flow chart of procedures that were carried out in assessing how open and available to the public the 17 green spaces were

The final task using desk-based methods here involved calculating one overall mean score across all four environmental and three accessibility indicators for each of these 17 sites.

6.2 Results

The first part of this section will discuss the results of the site assessments for the 31 indicators observed on site at the 17 green spaces selected. The second part discusses the results for the desk-based indicators for the 7 indicators calculated remotely, which had equivalents or at least rough equivalents in a sub-set of 7 of the 31 indicators observed on the ground at each site and which therefore formed a kind of 'common ground' between the two approaches. The results for the estimates of these 7 attributes from the two different approaches are then compared to identify similarities and differences in what each method recognises about the green spaces.

6.2.1 Site Observation and Assessment

The 17 sites were grouped according to two overall mean scores: that for all the 13 environmental criteria and that for all the 18 social attributes. The four groups that emerged were then examined in turn using all the information collected at each site to 'sense-check' the proposed groupings. In the figures which follow, the boundary of each site is shown overlaid on IKONOS imagery to give an understanding of the nature, extent and local situation of each site. The position of each site within the city as a whole is also shown by locating each site on the map of green spaces produced in Chapter 5 (Figure 5.14 (b)).

Table 6.3 summarises the site assessment results using the overall mean scores either from four assessors (12 sites) or two assessors (5 sites) for both the environmental and social criteria for all the 17 sites that were visited. As shown in the table, Perdana Lake Garden, Permaisuri Lake Garden and KLCC Park were considered by the assessors to provide strong positive environmental benefits (all scored above 3.7 in the overall mean). Interestingly, these three sites, together with Titiwangsa Lake Garden, were also evaluated highly in terms of their scores on the social criteria, with all these sites receiving mean scores from the assessors above 3.9.

On the other hand, two sites were evaluated as providing rather few environmental benefits: the sites at Pudu Jail and Batu River Reserve both scored below 2.5. When considering their social characteristics, the same two sites together with three further sites (Bukit Gasing, Bukit Kiara and Kepong) were all considered to provide rather few benefits in terms of social amenities and other social attributes, with all five sites scoring below 2.5 on average for the social criteria.

Site Name	Environmental Criteria (Overall Mean Scores)	Social Criteria (Overall Mean Scores)
1-Perdana Lake Garden	3.88	3.92
2-Bukit Gasing	3.29	2.00
3-Rimba Ilmu, Universiti Malaya	3.62	3.50
4-KLCC Park	3.75	4.57
5-Permaisuri Lake Garden	3.87	4.15
6-Klang-Gombak River	3.15	3.13
7-Royal Selangor Golf Club	3.02	3.22
8-Bukit Nanas Forest Reserve	3.60	3.36
9-Bukit Kiara	3.31	2.26
10-Kepong	2.79	2.29
11-Sri Hartamas	2.95	3.08
12-Pudu Jail	1.81	2.00
13-Bukit Jalil Park	3.31	3.61
14-Batu River Reserve	2.08	2.28
15-Desa Water Park	2.73	2.50
16-Titiwangsa Lake Garden	3.27	4.17
17-Kepong Metropolitan Park	2.88	3.42

Table 6.3: Overall mean scores for the environmental and social criteria for the sites from site observation.

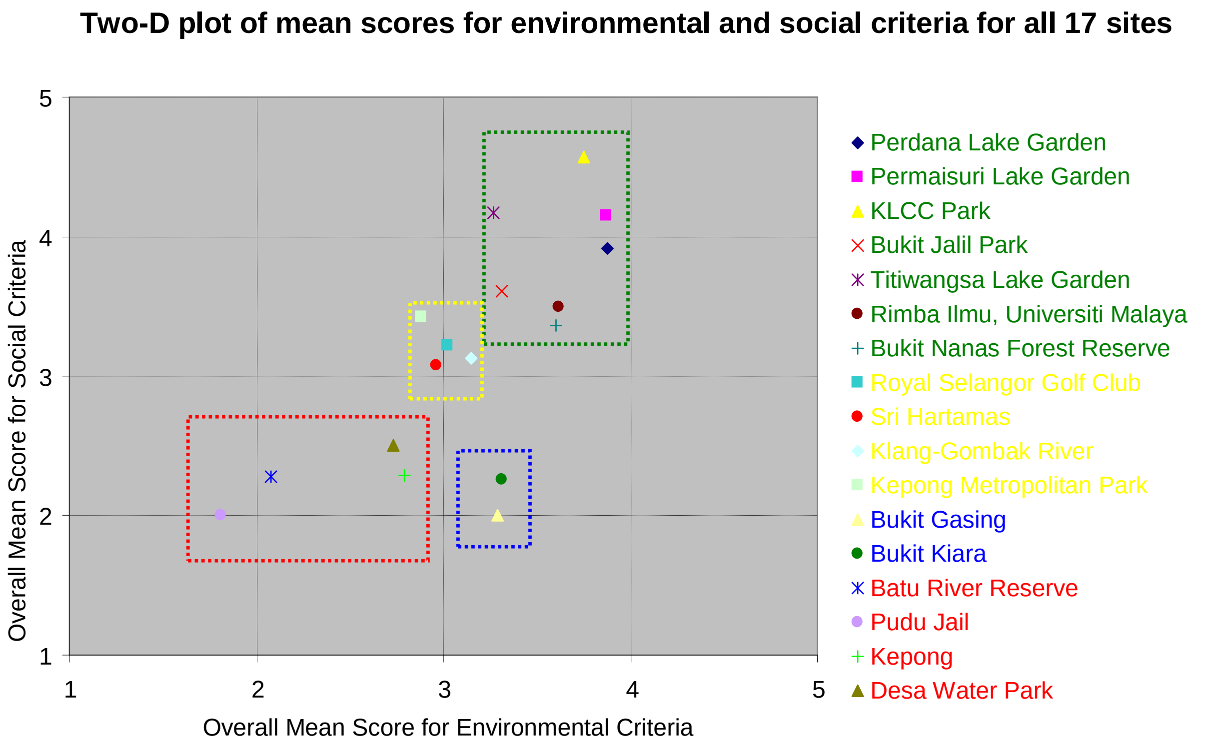


Figure 6.12: The 17 sites plotted in two dimensions according to their combination of mean scores for social and environmental criteria. These sites can be arranged into four groups: (i) sites with high environmental and high social scores (green rectangle); (ii) sites with average environmental and social scores (yellow rectangle); (iii) sites with high environmental but low social scores (blue rectangle); and (iv) sites with low environmental and low social scores (red rectangle).

As shown in Figure 6.12, the 17 sites were then plotted as a 2-D scatter plot based on the combination of their mean scores for environmental and social criteria. Four main groups of sites can be identified with mostly similar pairings of environmental and social scores. These groups are shown as four differently coloured dotted rectangles on Figure 6.12.

(i) Group 1: Sites with High Environmental and High Social Scores

Group one (identified by the dotted green rectangle) consists of seven sites that were assessed as having both high environmental and high social scores (the average overall mean score for this group was 3.61 on environmental criteria and 3.9 on social criteria). These seven sites were Perdana Lake Garden, Permaisuri Lake Garden, KLCC Park, Rimba Ilmu, Bukit Nanas Forest Reserve, Bukit Jalil Park and Titiwangsa Lake Garden. In the following figures for these sites, Figures 6.13 to

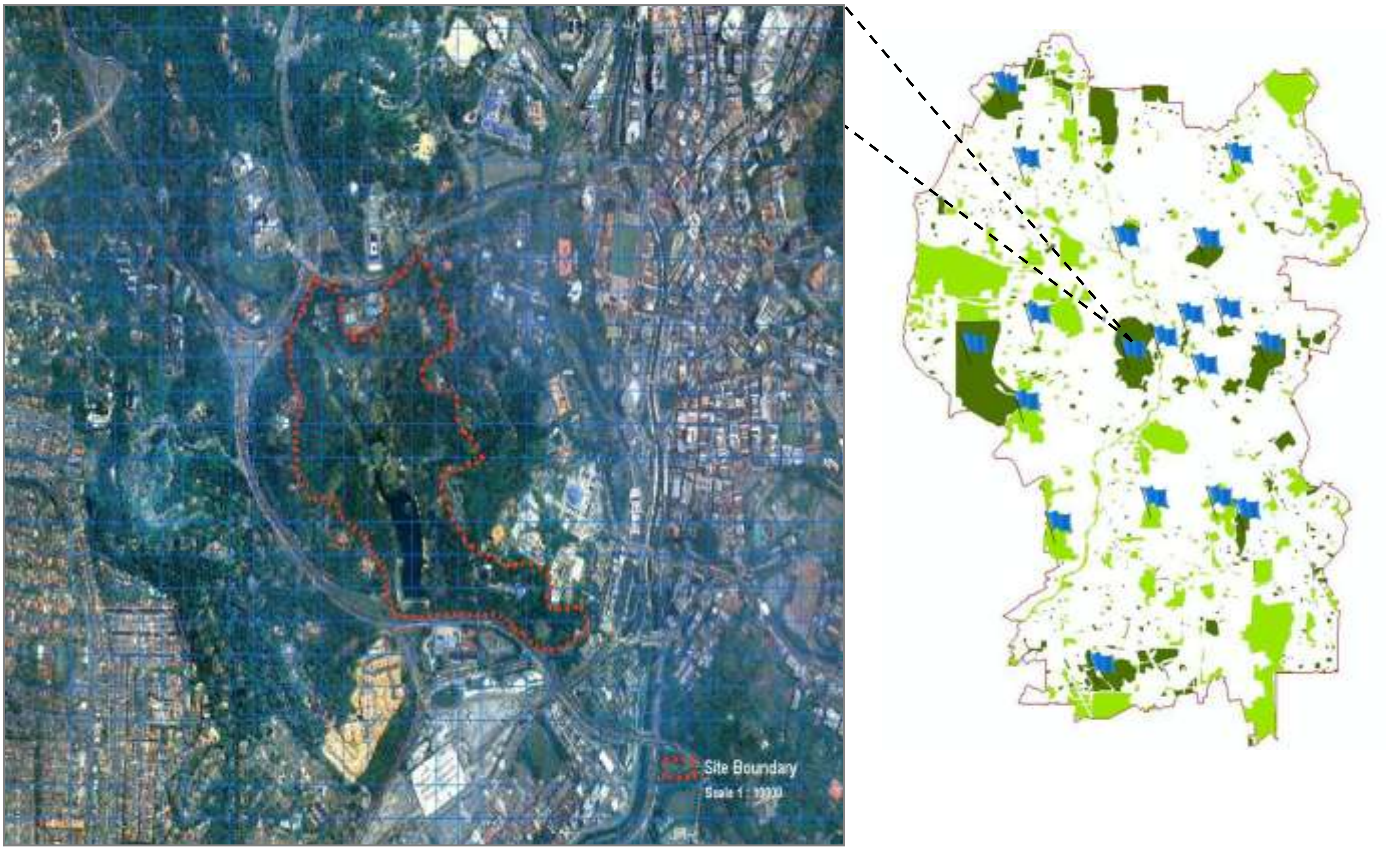
6.19, part (a) in the top left shows the extent of the site with the boundary marked by a red dotted line overlaid on the IKONOS natural colour image to give context, while its location within KL is indicated on the map of green spaces in the top right.

A review of Figures 6.13 to 6.19 reveals that these seven sites do share several similar physical characteristics, which may explain why they were scored similarly on several environmental and social criteria. This group of sites are all ‘manicured’ parks and gardens and were all assessed highly for most of the environmental criteria. In terms of social criteria, the sites which are most intensively maintained i.e. Perdana Lake Garden, KLCC Park, Titiwangsa Lake Garden, Bukit Jalil Park and Permaisuri Lake Garden also scored highly. However, sites such as Bukit Nanas Forest Reserve and Rimba Ilmu were not as highly scored as the other sites in terms of their social characteristics. Figures 6.13 (b) – 6.19 (b) summarise the overall mean scores for each site in terms of the environmental and social criteria.

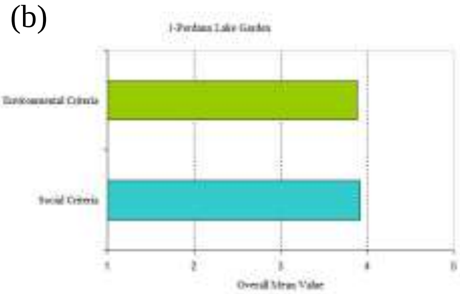
During the site visits, it was observed that most of these green spaces were well vegetated and consisted mostly of mature trees (environmental criteria numbers 1 and 2). Besides that, lakes and areas of a waterfront character with aquatic plants such as water lilies were seen in all of these sites except Rimba Ilmu and Bukit Nanas Forest Reserve (environmental criteria numbers 3 and 4). Animals such as monkeys, lizards, birds and fishes were also observed at most of these sites; photos showing typical examples of each site’s features and setting are presented in Figures 6.13 (c) – 6.19 (c). The naturalistic settings and features were believed to contribute to the high environmental scores awarded to these sites (average mean score of 3.61 for environmental criteria).

Turning now to the assessment of the social and amenity value of this group of sites, from the site visits, all of these sites were openly available to the public (social criterion number 13) and most of these sites had fairly good recreational facilities such as jogging tracks, outdoor exercise equipment, seating areas and childrens’ playgrounds (social criteria numbers 1, 2 and 3). This led to the assignment of high scores for these sites (average mean score of 3.9 on social criteria). The details of the particular scores for each of the environmental and social criteria are shown in the bar charts in Figures 6.13 (d) to 6.19 (d).

(a)

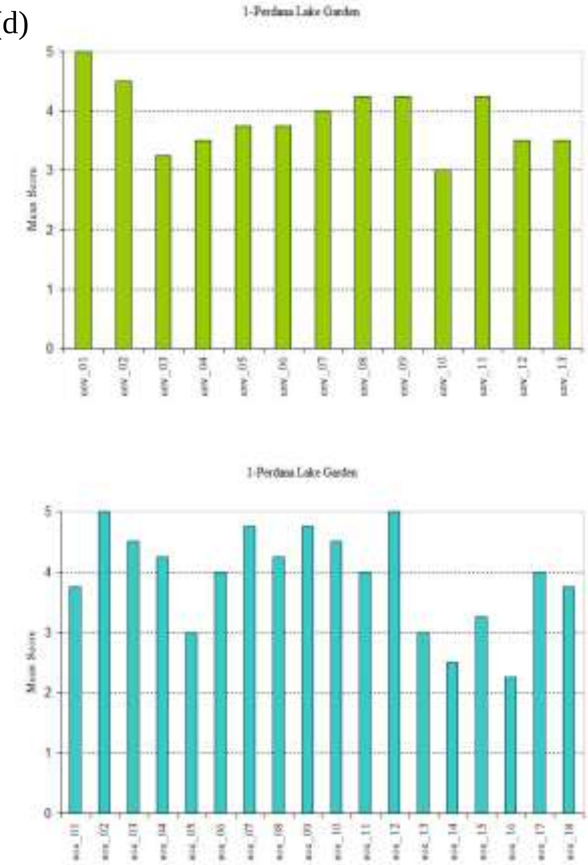


(b)



(c)

(d)



env_01	Proportion of the site that you consider to be green space
env_02	Proportion of the site that you consider to be vegetated
env_03	Proportion of the site that you consider to be water
env_04	Proportion which has a waterfront character
env_05	Number of different types of green space within this site
env_06	Number of different kinds of habitats within this site
env_07	Proportion of this site's area where trees provide shade and shelter
env_08	Effectiveness of the arrangement of the vegetation cover for providing shade and shelter within this site
env_09	Contribution of this site to provide better air quality than surrounding areas of the city
env_10	Contribution of this site to provide a quieter environment than surrounding areas of the city
env_11	Contribution of this site in providing a more pleasant, relaxing and restful atmosphere than surrounding areas of the city
env_12	Connectivity of this site to other green spaces in surrounding areas
env_13	Connectivity of this site to other land uses in surrounding areas

soc_01	Value for sport and recreational activities
soc_02	Value for general amenity (e.g. walking etc)
soc_03	Value as an area for children to play in
soc_04	Mix of facilities offered (either for active or passive activities)
soc_05	Presence of people / users (busy or quiet)
soc_06	Suitability for community events and activities
soc_07	A meeting place for people
soc_08	Overall cleanliness
soc_09	General quality of maintenance
soc_10	Value for health and well being
soc_11	Feeling of safety
soc_12	Overall attractiveness
soc_13	Number of entrances and their convenience of use from areas nearby
soc_14	The density of population in surrounding residential areas
soc_15	Number of people in workplace in surrounding areas
soc_16	Accessibility of the site by public transport
soc_17	Accessibility of the site by private transport
soc_18	Value in serving a neighbourhood of the city which generally lacks green space

Figure 6.13:

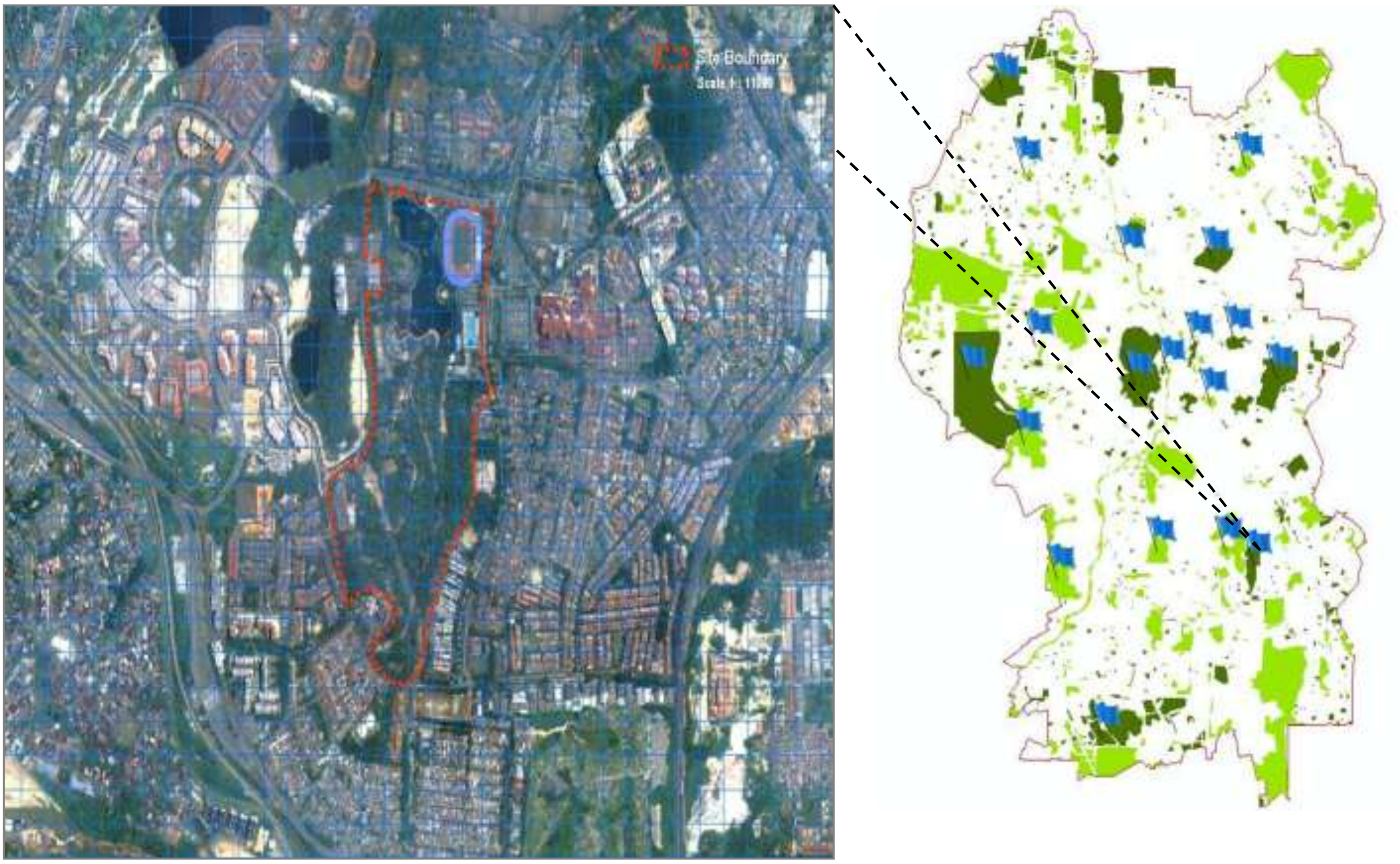
(a) Perdana Lake Garden: boundary of the site (shown in red dotted lines) and surroundings;

(b) The overall mean scores for the environmental and social criteria for Perdana Lake Garden;

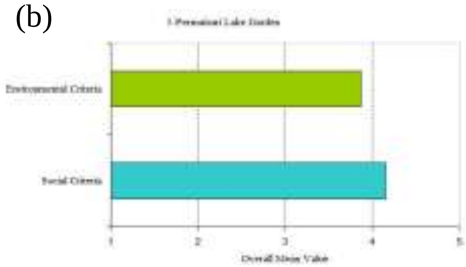
(c) Sample of photographs showing the nature of Perdana Lake Garden;

(d) Mean scores from the site assessments of Perdana Lake Garden for each of 13 environmental and 18 social criteria.

(a)

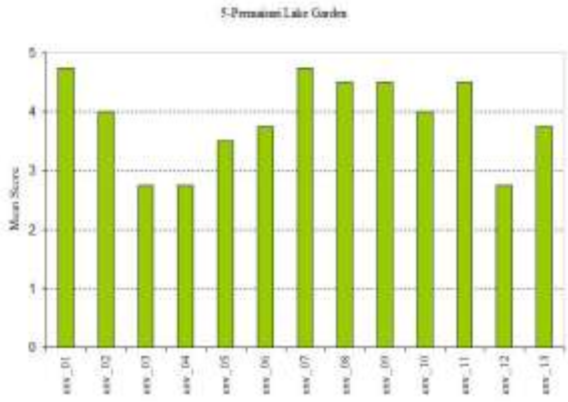


(b)

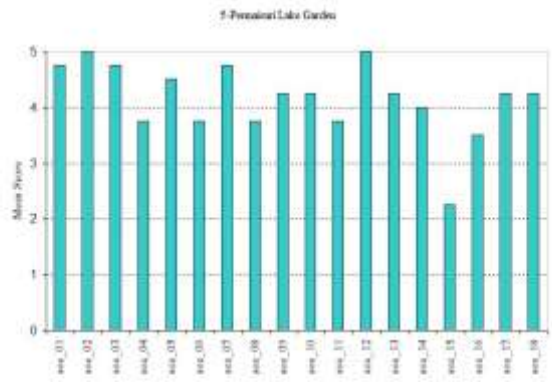


(c)

(d)



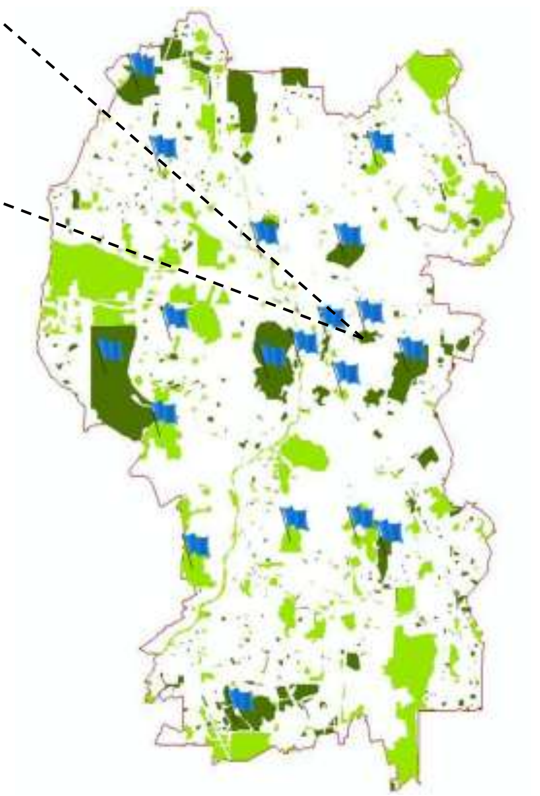
env_01	Proportion of the site that you consider to be green space
env_02	Proportion of the site that you consider to be vegetated
env_03	Proportion of the site that you consider to be water
env_04	Proportion which has a waterfront character
env_05	Number of different types of green space within this site
env_06	Number of different kinds of habitats within this site
env_07	Proportion of this site's area where trees provide shade and shelter
env_08	Effectiveness of the arrangement of the vegetation cover for providing shade and shelter within this site
env_09	Contribution of this site to provide better air quality than surrounding areas of the city
env_10	Contribution of this site to provide a quieter environment than surrounding areas of the city
env_11	Contribution of this site in providing a more pleasant, relaxing and restful atmosphere than surrounding areas of the city
env_12	Connectivity of this site to other green spaces in surrounding areas
env_13	Connectivity of this site to other land uses in surrounding areas



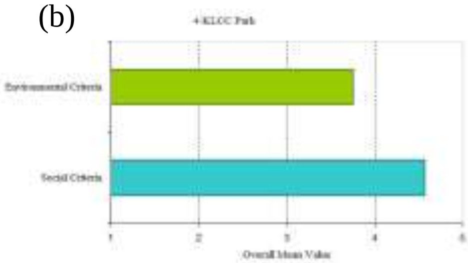
soc_01	Value for sport and recreational activities
soc_02	Value for general amenity (e.g. walking etc)
soc_03	Value as an area for children to play in
soc_04	Mix of facilities offered (either for active or passive activities)
soc_05	Presence of people / users (busy or quiet)
soc_06	Suitability for community events and activities
soc_07	A meeting place for people
soc_08	Overall cleanliness
soc_09	General quality of maintenance
soc_10	Value for health and well being
soc_11	Feeling of safety
soc_12	Overall attractiveness
soc_13	Number of entrances and their convenience of use from areas nearby
soc_14	The density of population in surrounding residential areas
soc_15	Number of people in workplace in surrounding areas
soc_16	Accessibility of the site by public transport
soc_17	Accessibility of the site by private transport
soc_18	Value in serving a neighbourhood of the city which generally lacks green space

Figure 6.14:
(a) Permaisuri Lake Garden: boundary of the site (shown in red dotted lines) and surroundings;
(b) The overall mean scores for the environmental and social criteria for Permaisuri Lake Garden;
(c) Sample of photographs showing the nature of Permaisuri Lake Garden;
(d) Mean scores from the site assessments of Permaisuri Lake Garden for each of 13 environmental and 18 social criteria.

(a)

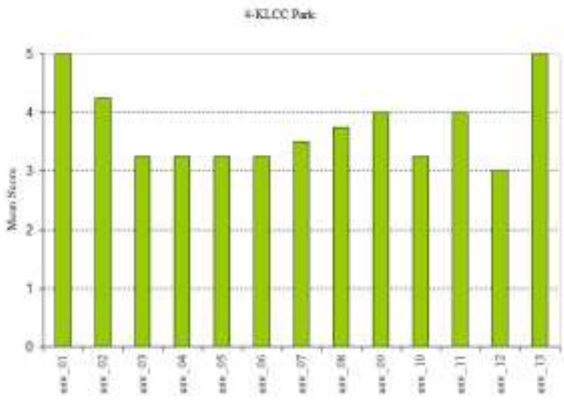


(b)

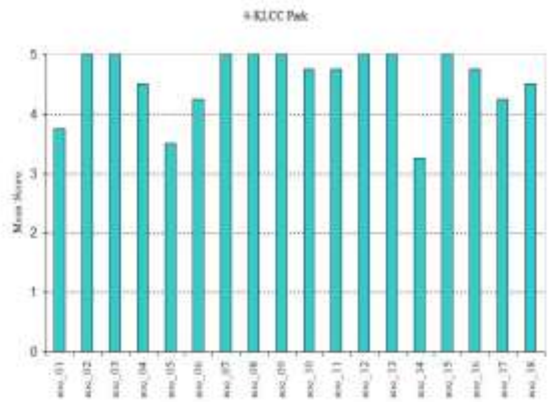


(c)

(d)



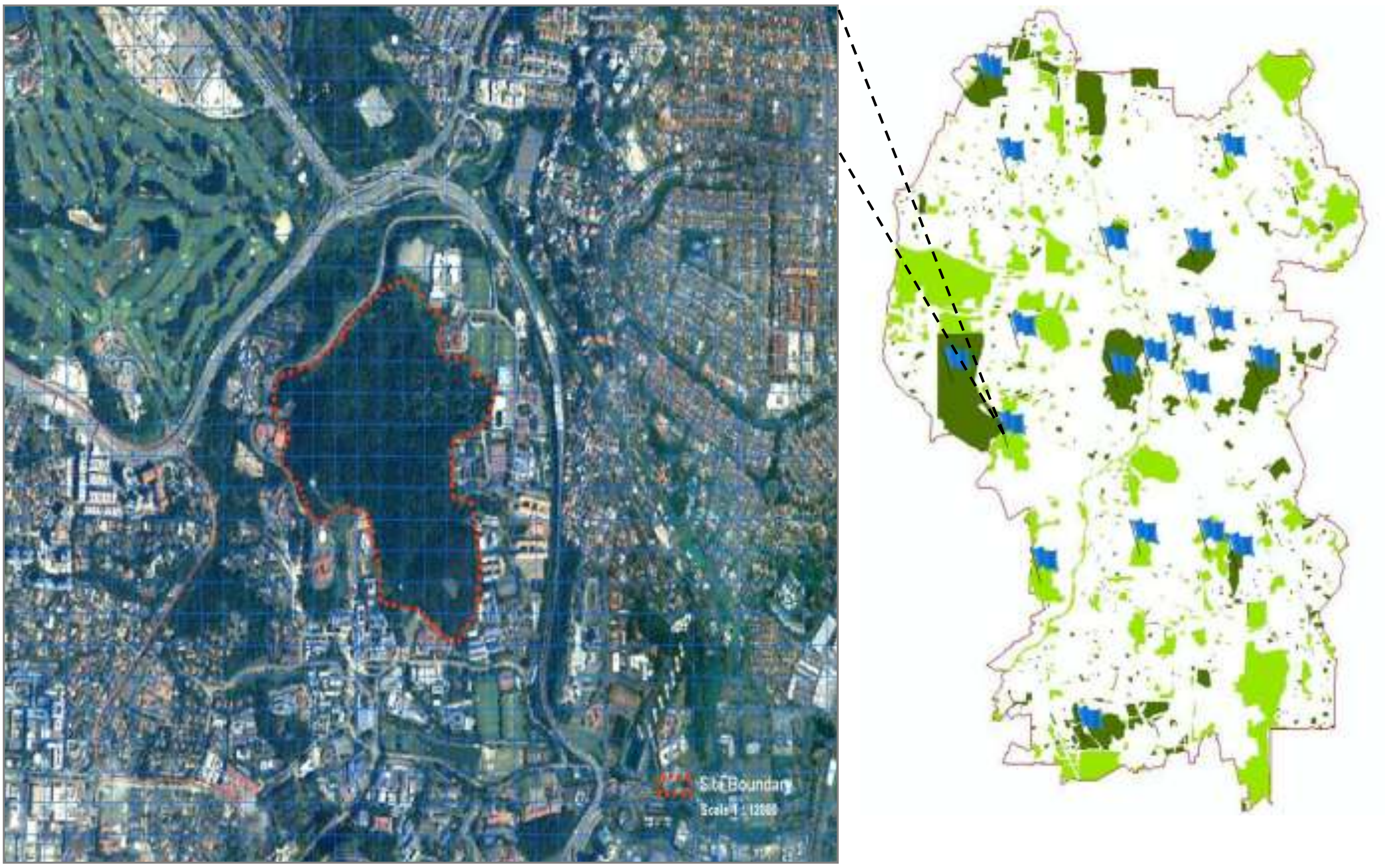
env_01	Proportion of the site that you consider to be green space
env_02	Proportion of the site that you consider to be vegetated
env_03	Proportion of the site that you consider to be water
env_04	Proportion which has a waterfront character
env_05	Number of different types of green space within this site
env_06	Number of different kinds of habitats within this site
env_07	Proportion of this site's area where trees provide shade and shelter
env_08	Effectiveness of the arrangement of the vegetation cover for providing shade and shelter within this site
env_09	Contribution of this site to provide better air quality than surrounding areas of the city
env_10	Contribution of this site to provide a quieter environment than surrounding areas of the city
env_11	Contribution of this site in providing a more pleasant, relaxing and restful atmosphere than surrounding areas of the city
env_12	Connectivity of this site to other green spaces in surrounding areas
env_13	Connectivity of this site to other land uses in surrounding areas



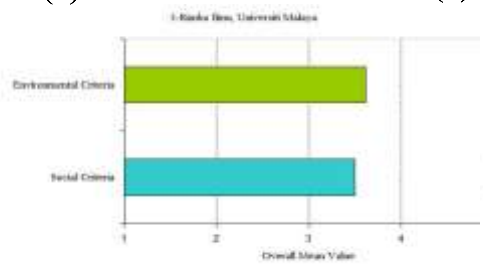
soc_01	Value for sport and recreational activities
soc_02	Value for general amenity (e.g. walking etc)
soc_03	Value as an area for children to play in
soc_04	Mix of facilities offered (either for active or passive activities)
soc_05	Presence of people / users (busy or quiet)
soc_06	Suitability for community events and activities
soc_07	A meeting place for people
soc_08	Overall cleanliness
soc_09	General quality of maintenance
soc_10	Value for health and well being
soc_11	Feeling of safety
soc_12	Overall attractiveness
soc_13	Number of entrances and their convenience of use from areas nearby
soc_14	The density of population in surrounding residential areas
soc_15	Number of people in workplace in surrounding areas
soc_16	Accessibility of the site by public transport
soc_17	Accessibility of the site by private transport
soc_18	Value in serving a neighbourhood of the city which generally lacks green space

Figure 6.15:
(a) KLCC Park: boundary of the site (shown in red dotted lines) and surroundings;
(b) The overall mean scores for the environmental and social criteria for KLCC Park;
(c) Sample of photographs showing the nature of KLCC Park;
(d) Mean scores from the site assessments of KLCC Park for each of 13 environmental and 18 social criteria.

(a)



(b)



(c)

(d)

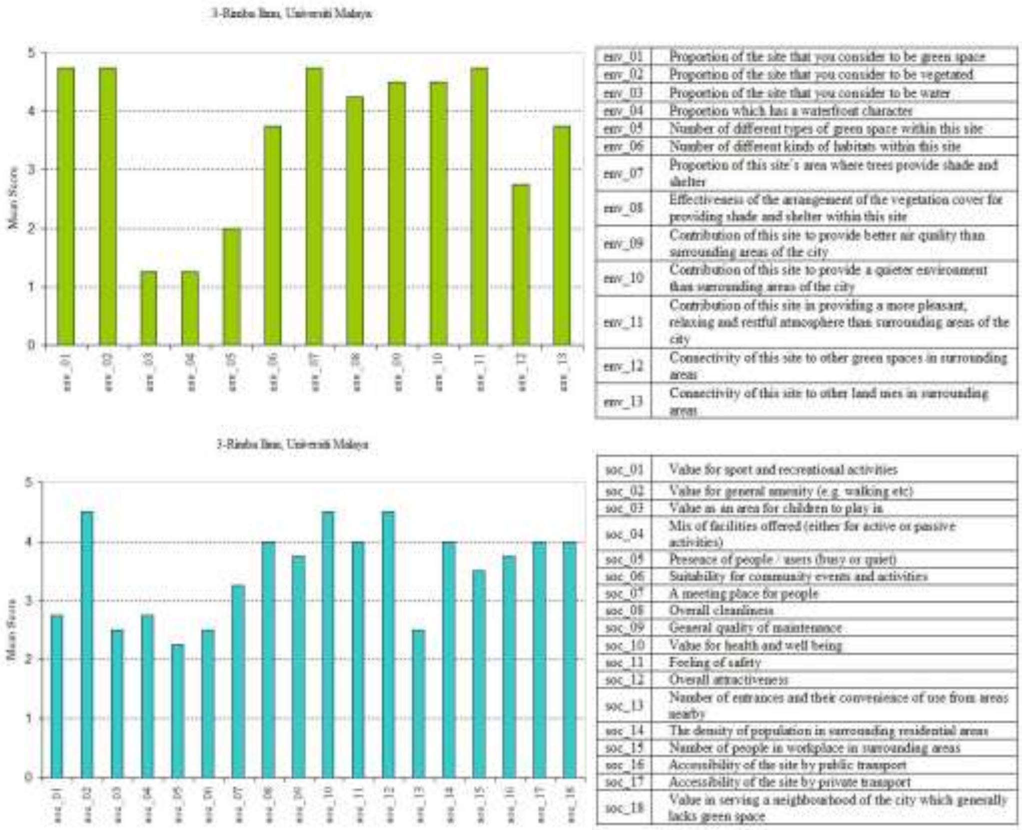
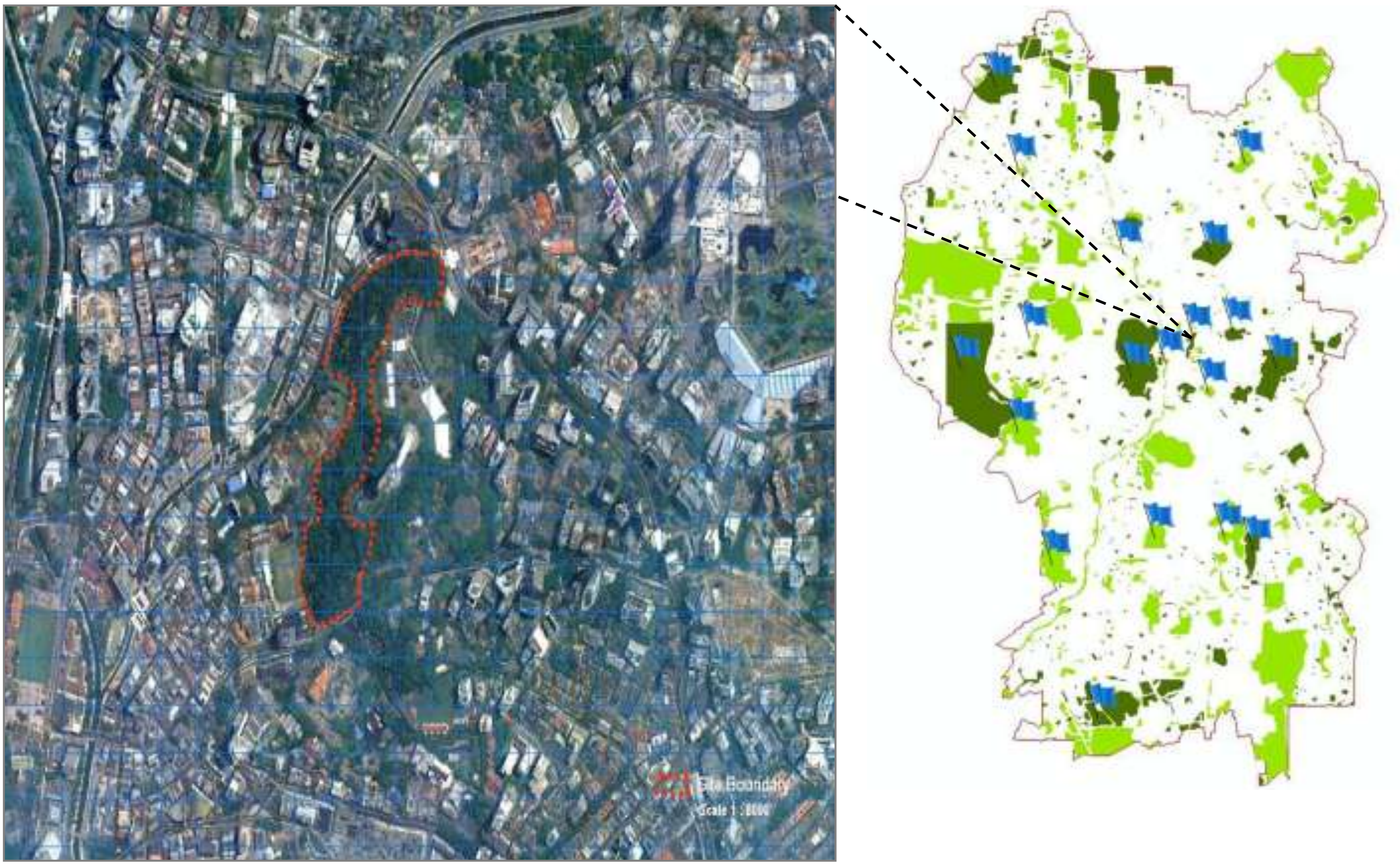


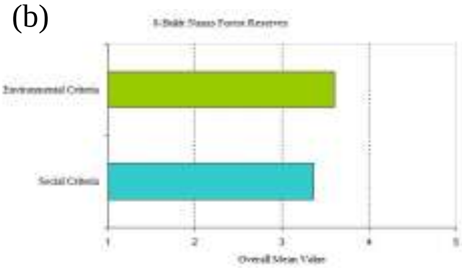
Figure 6.16:

(a) Rimba Ilmu: boundary of the site (shown in red dotted lines) and surroundings;
(b) The overall mean scores for the environmental and social criteria for Rimba Ilmu, UM;
(c) Sample of photographs showing the nature of Rimba Ilmu, Universiti Malaya;
(d) Mean scores from the site assessments of Rimba Ilmu, UM for each of 13 environmental and 18 social criteria.

(a)



(b)



(c)

(d)

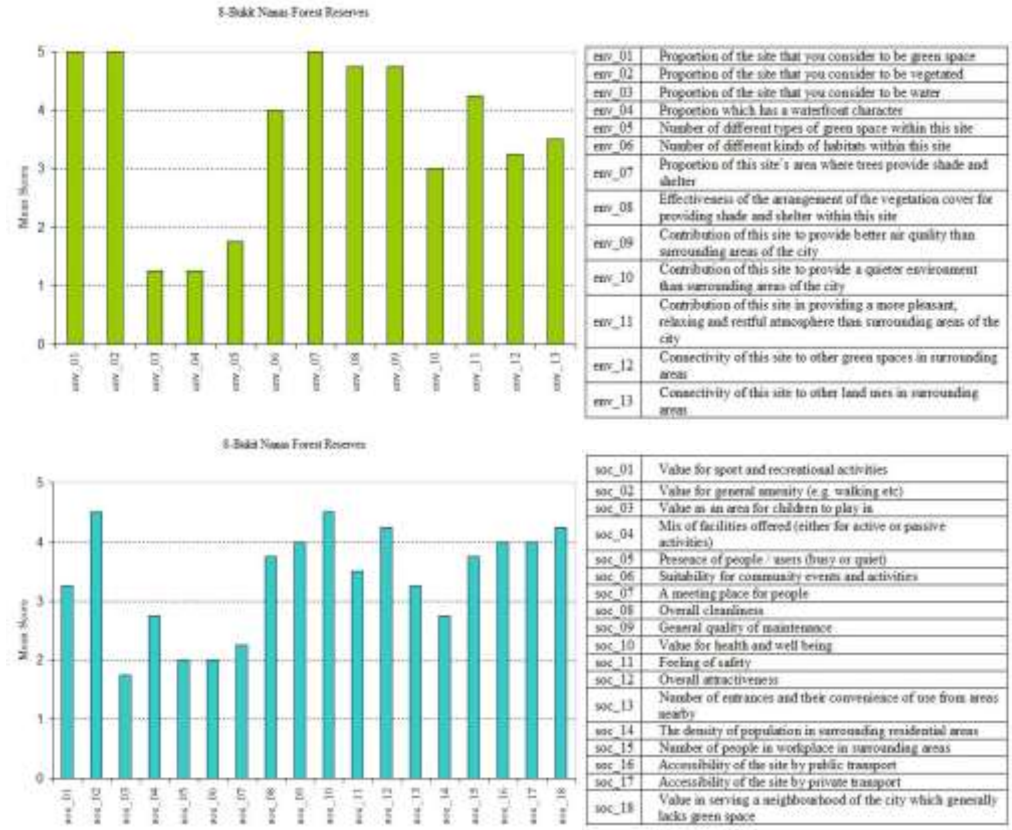
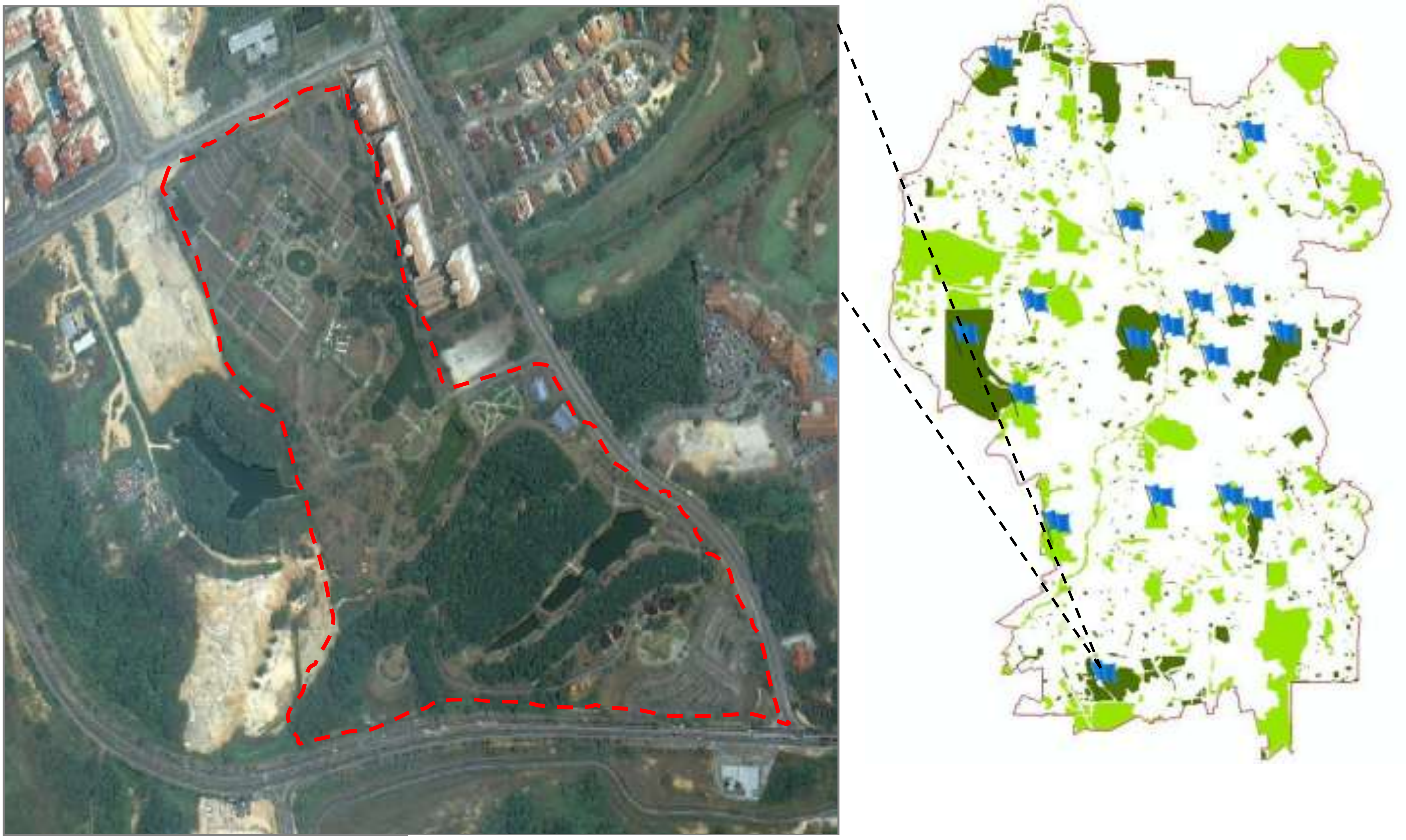
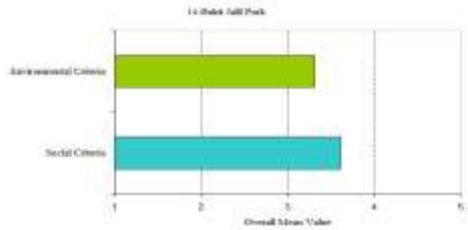


Figure 6.17:
(a) Bukit Nanas Forest Reserve: boundary of the site (shown in red dotted lines) and surroundings;
(b) The overall mean scores for the environmental and social criteria for Bukit Nanas Forest Reserve;
(c) Sample of photographs showing the nature of Bukit Nanas Forest Reserve;
(d) Mean scores from the site assessments of Bukit Nanas Forest Reserve for each of 13 environmental and 18 social criteria.

(a)

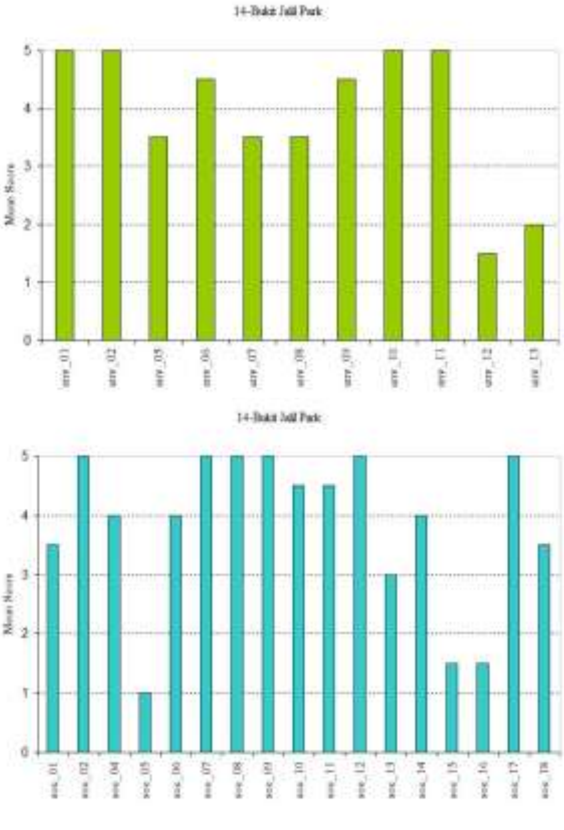


(b)



(c)

(d)

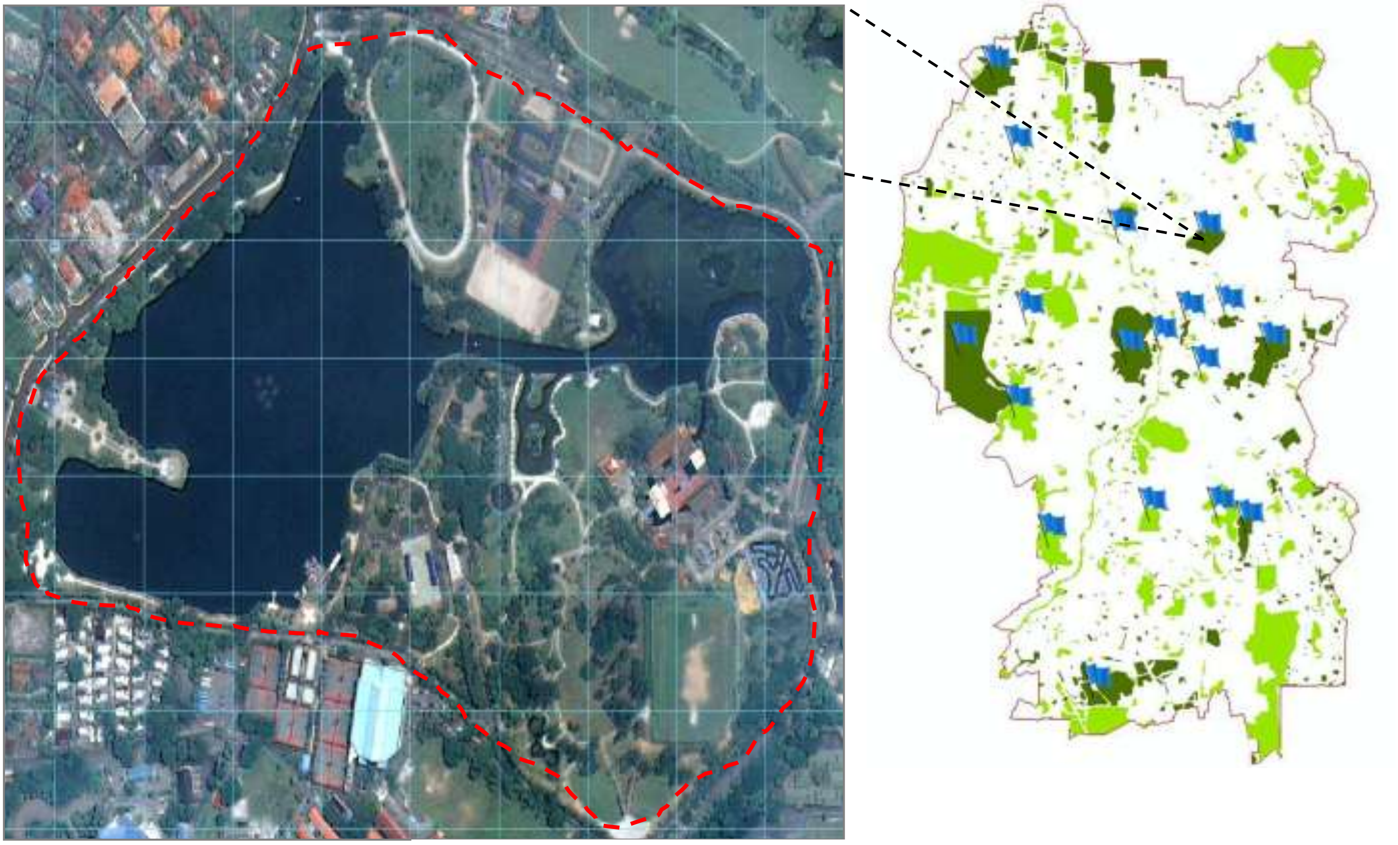


env_01	Proportion of the site that you consider to be green space
env_02	Proportion of the site that you consider to be vegetated
env_03	Proportion of the site that you consider to be water
env_04	Proportion which has a waterfront character
env_05	Number of different types of green space within this site
env_06	Number of different kinds of habitats within this site
env_07	Proportion of this site's area where trees provide shade and shelter
env_08	Effectiveness of the arrangement of the vegetation cover for providing shade and shelter within this site
env_09	Contribution of this site to provide better air quality than surrounding areas of the city
env_10	Contribution of this site to provide a quieter environment than surrounding areas of the city
env_11	Contribution of this site in providing a more pleasant, relaxing and restful atmosphere than surrounding areas of the city
env_12	Connectivity of this site to other green spaces in surrounding areas
env_13	Connectivity of this site to other land uses in surrounding areas

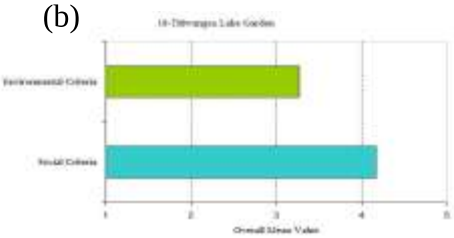
soc_01	Value for sport and recreational activities
soc_02	Value for general amenity (e.g. walking etc)
soc_03	Value as an area for children to play in
soc_04	Mix of facilities offered (either for active or passive activities)
soc_05	Presence of people / users (busy or quiet)
soc_06	Suitability for community events and activities
soc_07	A meeting place for people
soc_08	Overall cleanliness
soc_09	General quality of maintenance
soc_10	Value for health and well being
soc_11	Feeling of safety
soc_12	Overall attractiveness
soc_13	Number of entrances and their convenience of use from areas nearby
soc_14	The density of population in surrounding residential areas
soc_15	Number of people in workplace in surrounding areas
soc_16	Accessibility of the site by public transport
soc_17	Accessibility of the site by private transport
soc_18	Value in serving a neighbourhood of the city which generally lacks green space

Figure 6.18:
(a) Bukit Jalil Park: boundary of the site (shown in red dotted lines) and surroundings;
(b) The overall mean scores for the environmental and social criteria for Bukit Jalil Park;
(c) Sample of photographs showing the nature of Bukit Jalil Park;
(d) Mean scores from the site assessments of Bukit Jalil Park for each of 13 environmental and 18 social criteria.

(a)

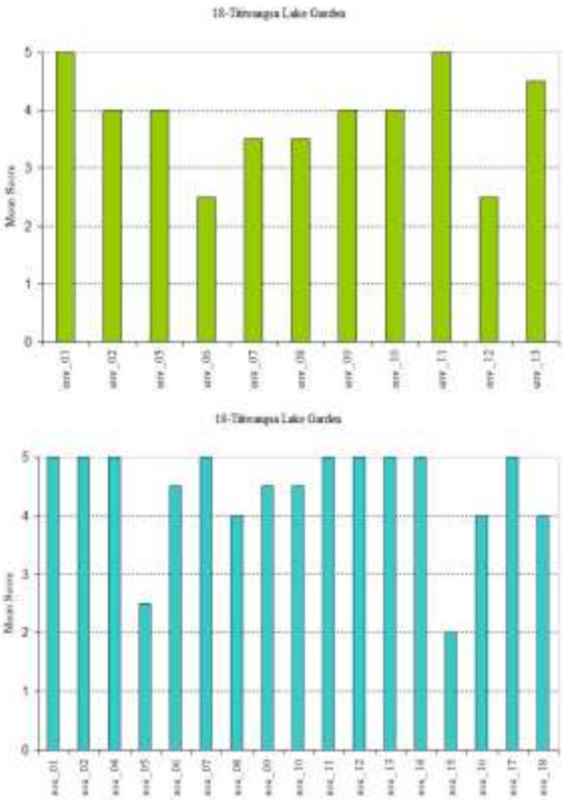


(b)



(c)

(d)



env_01	Proportion of the site that you consider to be green space
env_02	Proportion of the site that you consider to be vegetated
env_03	Proportion of the site that you consider to be water
env_04	Proportion which has a waterfront character
env_05	Number of different types of green space within this site
env_06	Number of different kinds of habitats within this site
env_07	Proportion of this site's area where trees provide shade and shelter
env_08	Effectiveness of the arrangement of the vegetation cover for providing shade and shelter within this site
env_09	Contribution of this site to provide better air quality than surrounding areas of the city
env_10	Contribution of this site to provide a quieter environment than surrounding areas of the city
env_11	Contribution of this site in providing a more pleasant, relaxing and restful atmosphere than surrounding areas of the city
env_12	Connectivity of this site to other green spaces in surrounding areas
env_13	Connectivity of this site to other land uses in surrounding areas

soc_01	Value for sport and recreational activities
soc_02	Value for general amenity (e.g. walking etc)
soc_03	Value as an area for children to play in
soc_04	Mix of facilities offered (either for active or passive activities)
soc_05	Presence of people / users (busy or quiet)
soc_06	Suitability for community events and activities
soc_07	A meeting place for people
soc_08	Overall cleanliness
soc_09	General quality of maintenance
soc_10	Value for health and well being
soc_11	Feeling of safety
soc_12	Overall attractiveness
soc_13	Number of entrances and their convenience of use from areas nearby
soc_14	The density of population in surrounding residential areas
soc_15	Number of people in workplace in surrounding areas
soc_16	Accessibility of the site by public transport
soc_17	Accessibility of the site by private transport
soc_18	Value in serving a neighbourhood of the city which generally lacks green space

Figure 6.19:
(a) Titiwangsa Lake Garden: boundary of the site (shown in red dotted lines) and surroundings;
(b) The overall mean scores for the environmental and social criteria for Titiwangsa Lake Garden;
(c) Sample of photographs showing the nature of Titiwangsa Lake Garden;
(d) Mean scores from the site assessments of Titiwangsa Lake Garden for each of 13 environmental and 18 social criteria.

(ii) Sites with Average Environmental and Average Social Scores

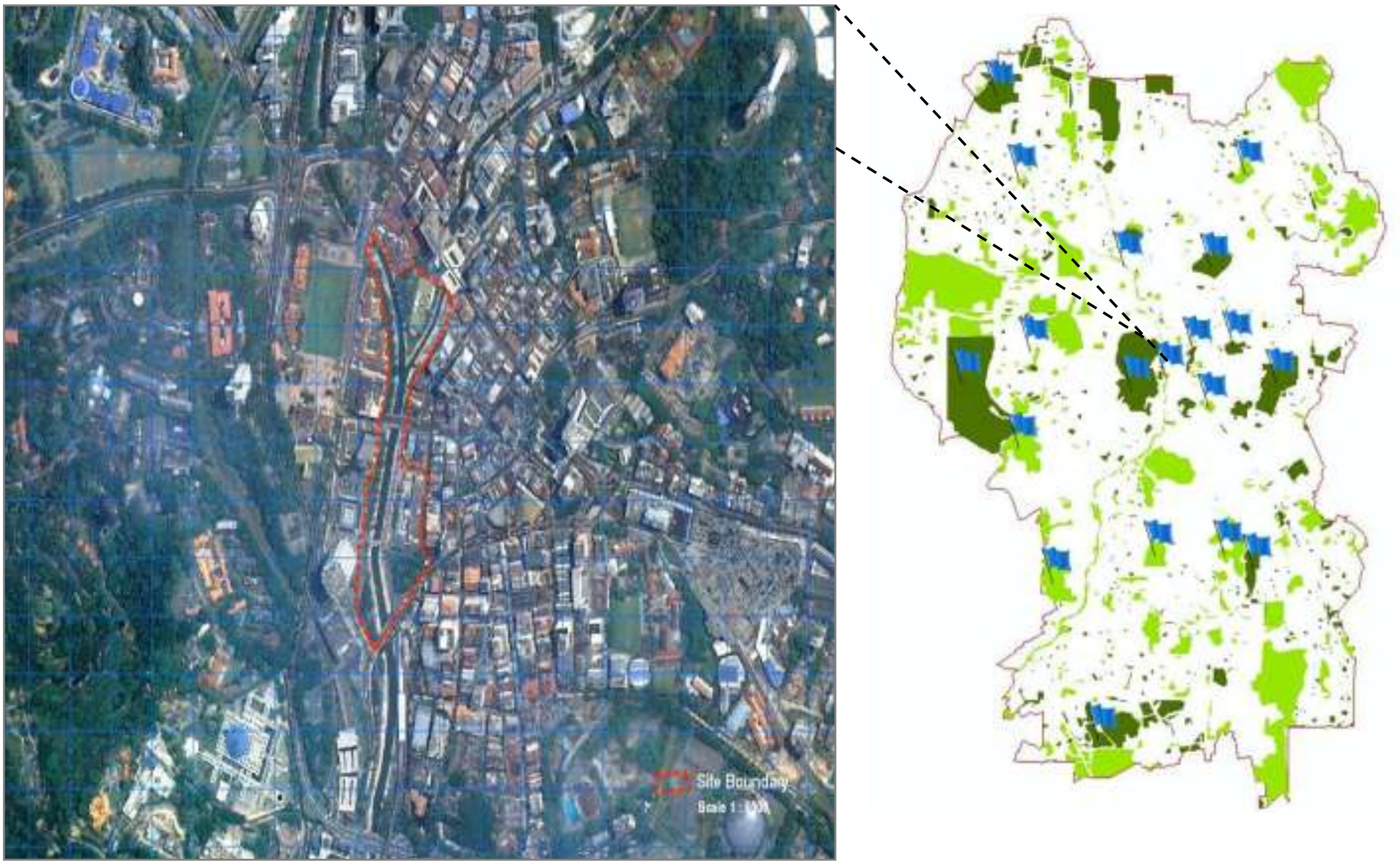
The second group (within the dotted yellow rectangle) consists of four sites that were evaluated as generally having moderate scores on both the environmental and social criteria. These four sites were Sri Hartamas, Royal Selangor Golf Club, Klang-Gombak River and Kepong Metropolitan Park. The following Figures, 6.20 to 6.23, show in turn the extent of each of these sites, with their boundaries marked by red dotted lines overlaid on the IKONOS natural colour image to give an impression of the nature, extent and local situation of each site. Again, the position of each site within the city as a whole is also shown by locating it on the map of green spaces produced in Chapter 5 (Figure 5.14 (b)) and shown in the top right of each figure. .

One unexpected finding was that some of the sites in this group which had rather different individual characteristics were assessed similarly to have both average environmental and average social scores. There were many different types of green spaces in this group, consisting of residential neighbourhood greenery (Sri Hartamas), a golf course and club (Royal Selangor Golf Club), a river reserve (Klang-Gombak River) and a well maintained and manicured lake garden (Kepong Metropolitan Park). These were all rated only moderately on their environmental and social scores (average mean score of 3 on environmental criteria and 3.21 on social criteria).

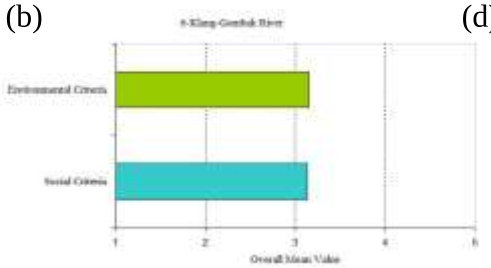
As just mentioned, sites in this group had very different characteristics but scored similarly on their environmental and social scores. Nevertheless, these scores seem realistic based on the observations made during the site visits to each. For instance, during the site visits to all of these sites, it was observed that almost all of these sites were occupied by vegetation (environmental criterion 2). Besides that, it was also observed that most of these sites provided a more pleasant, relaxing and restful atmosphere than their surrounding areas (environmental criterion 11).

In terms of the social criteria, almost all of the sites in this group were evaluated to have moderate social scores. All four sites were considered to provide a meeting place for people (social criterion 7). Besides that, these sites were also assessed to have average scores in terms of the feeling of safety when in the site (social criterion 11) and as regards their benefits to health and well-being (social criterion 10). The full list of these criteria and the details of how the sites scored on each of them is given in Figure 6.20 (d) to 6.23 (d).

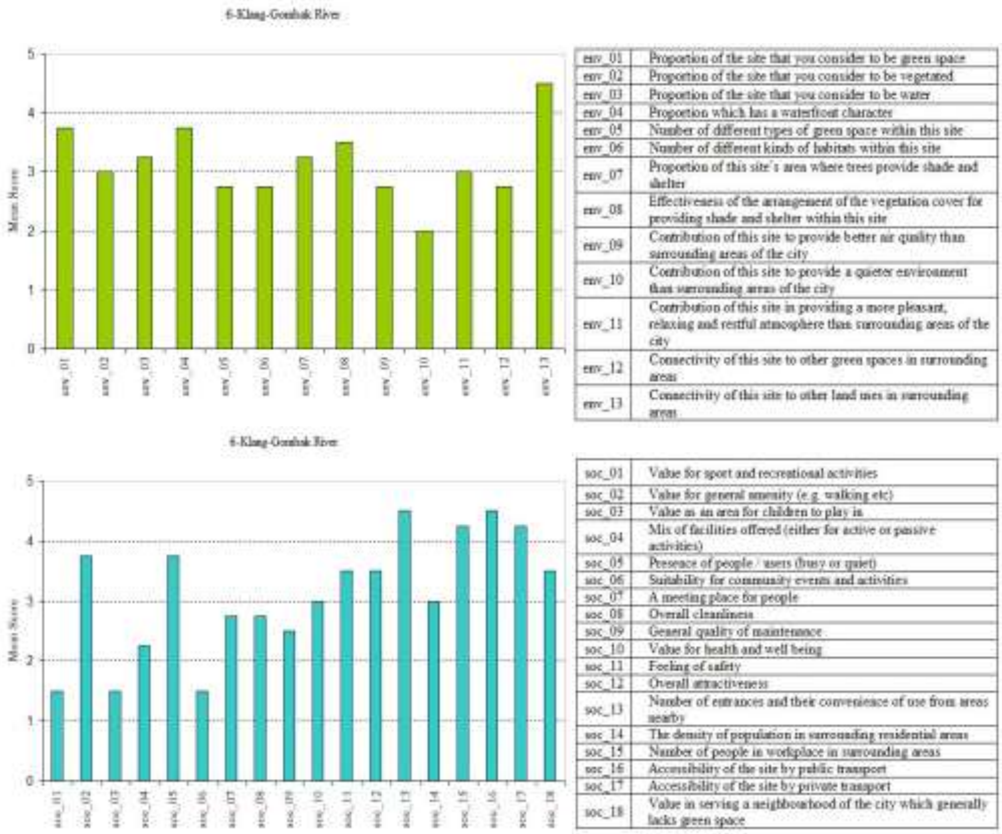
(a)



(b)



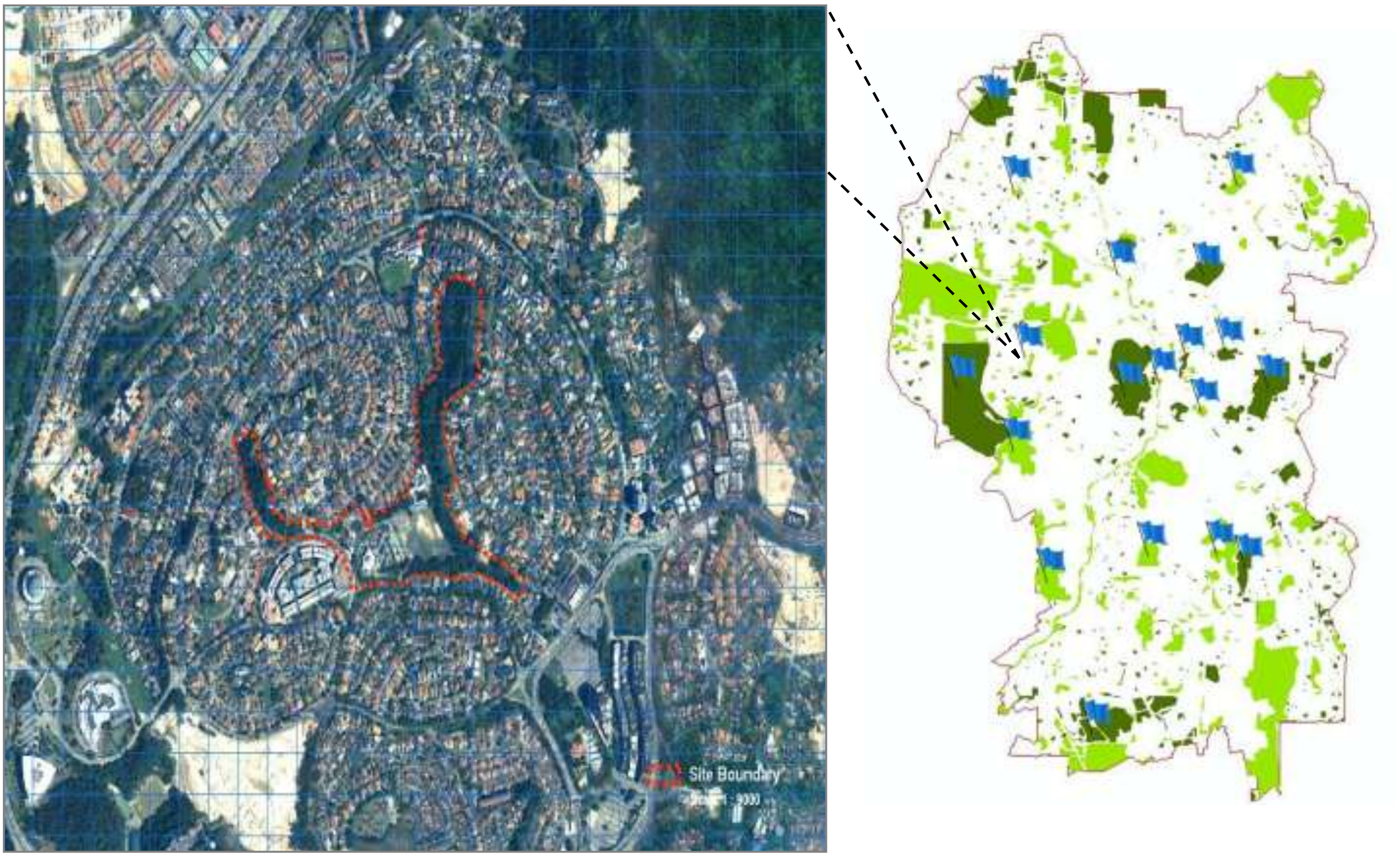
(d)



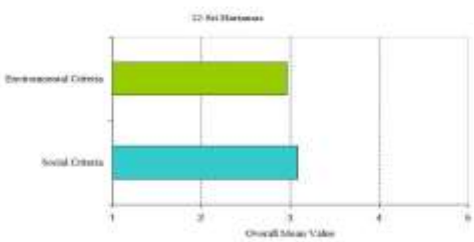
(c)

Figure 6.20:
(a) The Klang-Gombak River: boundary of the site (shown in red dotted lines) and surroundings;
(b) The overall mean scores for the environmental and social criteria for the Klang-Gombak River,
(c) Sample of photographs showing the nature of the Klang-Gombak River;
(d) Mean scores from the site assessments of the Klang-Gombak River for each of 13 environmental and 18 social criteria.

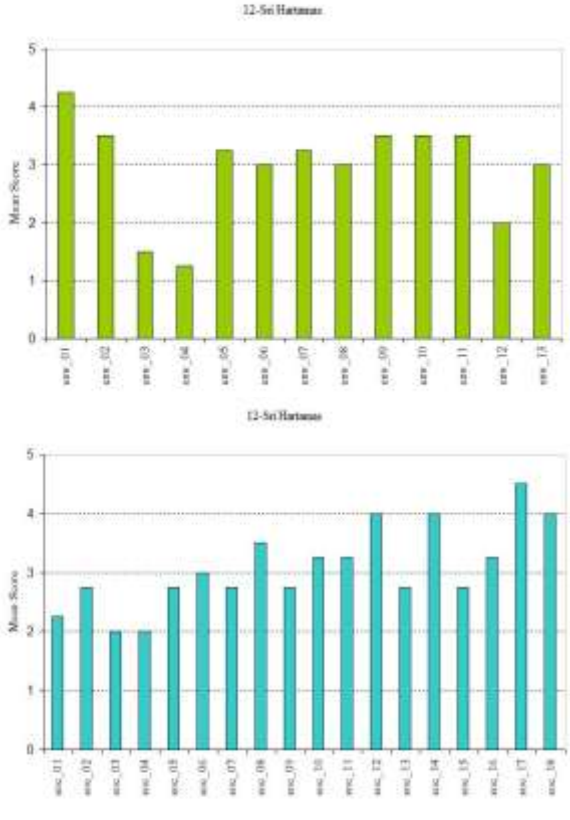
(a)



(b)



(d)



env_01	Proportion of the site that you consider to be green space
env_02	Proportion of the site that you consider to be vegetated
env_03	Proportion of the site that you consider to be water
env_04	Proportion which has a waterfront character
env_05	Number of different types of green space within this site
env_06	Number of different kinds of habitats within this site
env_07	Proportion of this site's area where trees provide shade and shelter
env_08	Effectiveness of the arrangement of the vegetation cover for providing shade and shelter within this site
env_09	Contribution of this site to provide better air quality than surrounding areas of the city
env_10	Contribution of this site to provide a quieter environment than surrounding areas of the city
env_11	Contribution of this site in providing a more pleasant, relaxing and restful atmosphere than surrounding areas of the city
env_12	Connectivity of this site to other green spaces in surrounding areas
env_13	Connectivity of this site to other land uses in surrounding areas

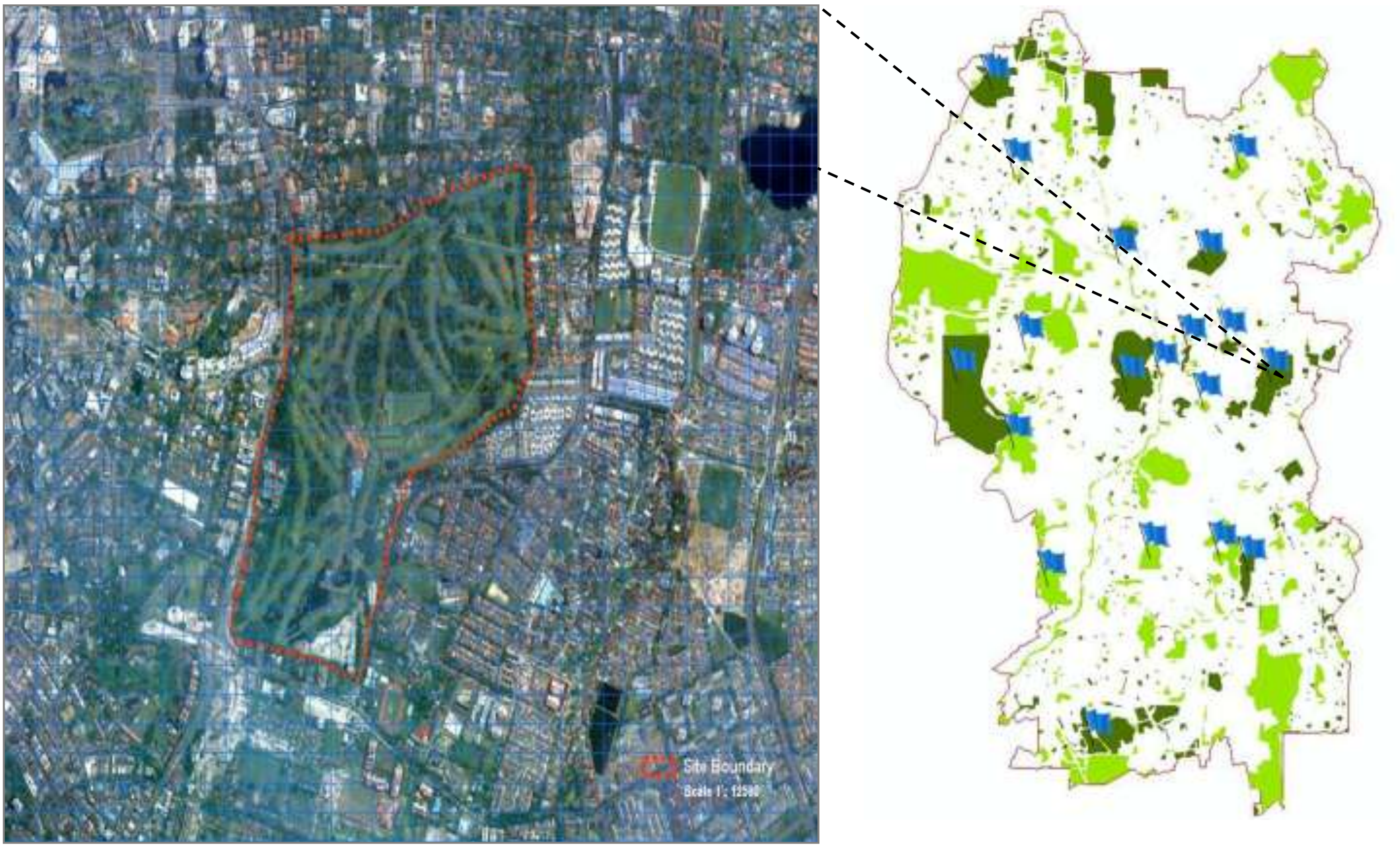
soc_01	Value for sport and recreational activities
soc_02	Value for general amenity (e.g. walking etc)
soc_03	Value as an area for children to play in
soc_04	Mix of facilities offered (either for active or passive activities)
soc_05	Presence of people / users (busy or quiet)
soc_06	Suitability for community events and activities
soc_07	A meeting place for people
soc_08	Overall cleanliness
soc_09	General quality of maintenance
soc_10	Value for health and well being
soc_11	Feeling of safety
soc_12	Overall attractiveness
soc_13	Number of entrances and their convenience of use from areas nearby
soc_14	The density of population in surrounding residential areas
soc_15	Number of people in workplace in surrounding areas
soc_16	Accessibility of the site by public transport
soc_17	Accessibility of the site by private transport
soc_18	Value in serving a neighbourhood of the city which generally lacks green space

(c)

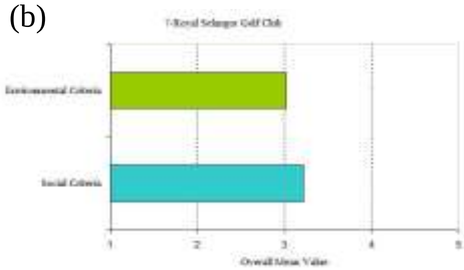
Figure 6.21:

(a) Sri Hartamas: boundary of the site (shown in red dotted lines) and surroundings;
(b) The overall mean scores for the environmental and social criteria for Sri Hartamas;
(c) Sample of photographs showing the nature of Sri Hartamas;
(d) Mean scores from the site assessments of Sri Hartamas for each of 13 environmental and 18 social criteria.

(a)



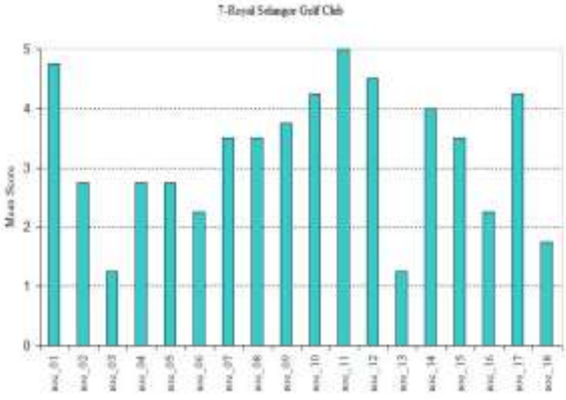
(b)



(c)

(d)

env_01	Proportion of the site that you consider to be green space
env_02	Proportion of the site that you consider to be vegetated
env_03	Proportion of the site that you consider to be water
env_04	Proportion which has a waterfront character
env_05	Number of different types of green space within this site
env_06	Number of different kinds of habitats within this site
env_07	Proportion of this site's area where trees provide shade and shelter
env_08	Effectiveness of the arrangement of the vegetation cover for providing shade and shelter within this site
env_09	Contribution of this site to provide better air quality than surrounding areas of the city
env_10	Contribution of this site to provide a quieter environment than surrounding areas of the city
env_11	Contribution of this site in providing a more pleasant, relaxing and restful atmosphere than surrounding areas of the city
env_12	Connectivity of this site to other green spaces in surrounding areas
env_13	Connectivity of this site to other land uses in surrounding areas

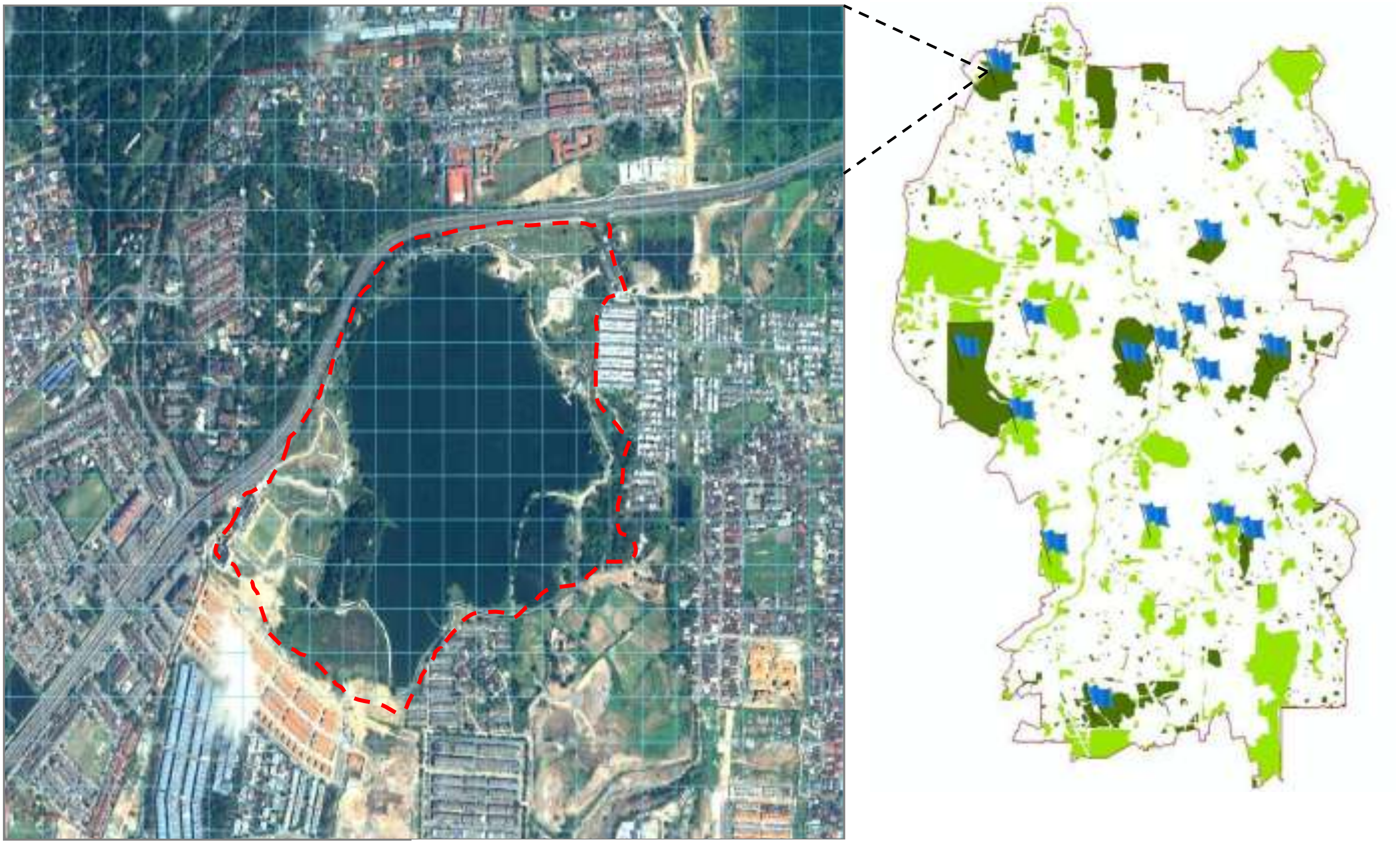


soc_01	Value for sport and recreational activities
soc_02	Value for general amenity (e.g. walking etc)
soc_03	Value as an area for children to play in
soc_04	Mix of facilities offered (either for active or passive activities)
soc_05	Presence of people / users (busy or quiet)
soc_06	Suitability for community events and activities
soc_07	A meeting place for people
soc_08	Overall cleanliness
soc_09	General quality of maintenance
soc_10	Value for health and well being
soc_11	Feeling of safety
soc_12	Overall attractiveness
soc_13	Number of entrances and their convenience of use from areas nearby
soc_14	The density of population in surrounding residential areas
soc_15	Number of people in workplace in surrounding areas
soc_16	Accessibility of the site by public transport
soc_17	Accessibility of the site by private transport
soc_18	Value in serving a neighbourhood of the city which generally lacks green space

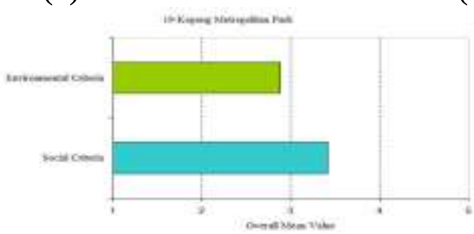
Figure 6.22:

(a) The Royal Selangor Golf Club: boundary of the site (shown in red dotted lines) and surroundings;
(b) The overall mean scores of the environmental and social criteria for the Royal Selangor Golf Club;
(c) Sample of photographs showing the nature of the Royal Selangor Golf Club;
(d) Mean scores from the site assessments of the Royal Selangor Golf Club for each of 13 environmental and 18 social criteria.

(a)

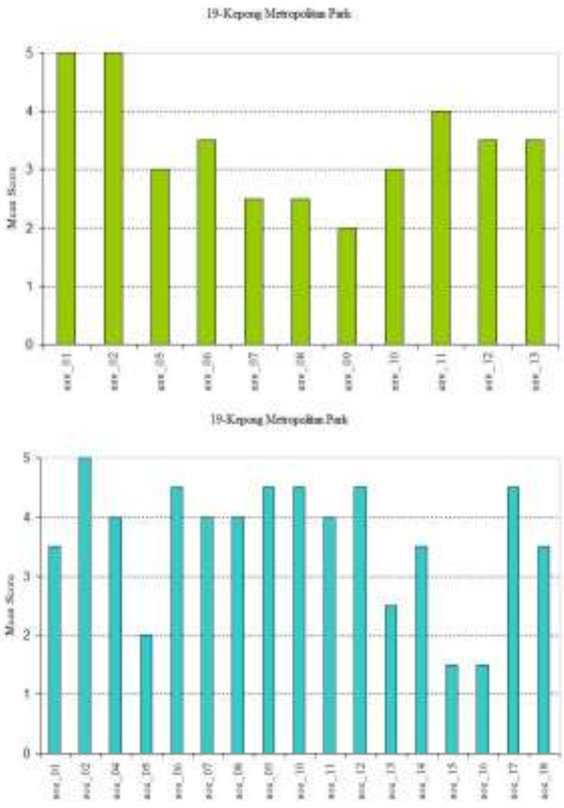


(b)



(c)

(d)



env_01	Proportion of the site that you consider to be green space
env_02	Proportion of the site that you consider to be vegetated
env_03	Proportion of the site that you consider to be water
env_04	Proportion which has a waterfront character
env_05	Number of different types of green space within this site
env_06	Number of different kinds of habitats within this site
env_07	Proportion of this site's area where trees provide shade and shelter
env_08	Effectiveness of the arrangement of the vegetation cover for providing shade and shelter within this site
env_09	Contribution of this site to provide better air quality than surrounding areas of the city
env_10	Contribution of this site to provide a quieter environment than surrounding areas of the city
env_11	Contribution of this site in providing a more pleasant, relaxing and restful atmosphere than surrounding areas of the city
env_12	Connectivity of this site to other green spaces in surrounding areas
env_13	Connectivity of this site to other land uses in surrounding areas

soc_01	Value for sport and recreational activities
soc_02	Value for general amenity (e.g. walking etc)
soc_03	Value as an area for children to play in
soc_04	Mix of facilities offered (either for active or passive activities)
soc_05	Presence of people / users (busy or quiet)
soc_06	Suitability for community events and activities
soc_07	A meeting place for people
soc_08	Overall cleanliness
soc_09	General quality of maintenance
soc_10	Value for health and well being
soc_11	Feeling of safety
soc_12	Overall attractiveness
soc_13	Number of entrances and their convenience of use from areas nearby
soc_14	The density of population in surrounding residential areas
soc_15	Number of people in workplace in surrounding areas
soc_16	Accessibility of the site by public transport
soc_17	Accessibility of the site by private transport
soc_18	Value in serving a neighbourhood of the city which generally lacks green space

Figure 6.23:
(a) Kepong Metropolitan Park: boundary of the site (shown in red dotted lines) and surroundings;
(b) The overall mean scores of the environmental and social criteria for Kepong Metropolitan Park;
(c) Sample of photographs showing the nature of Kepong Metropolitan Park;
(d) Mean scores from the site assessments of Kepong Metropolitan Park for each of 13 environmental and 18 social criteria.

(iii) Sites with High Environmental but Low Social Scores

Group three (within the dotted blue rectangle) consists of two sites, i.e. Bukit Gasing and Bukit Kiara, which were given high environmental but low social scores with mean scores for this small group of 3.3 for the environmental criteria and 2.13 for the social criteria. Part (a) of Figures 6.24 and Figure 6.25 shows the extent of each of these sites with their boundaries marked by a red dotted line overlaid on the IKONOS natural colour image (top left) to show context, while their locations within KL are indicated on the map of green spaces in the top right of these figures.

As anticipated, these two sites of somewhat like character scored similarly on both the environmental and social criteria. During the site visits, it was observed that both Bukit Gasing and Bukit Kiara were occupied with lush greenery and mature trees (environmental criteria numbers 1 and 2 with the mean score for both criteria for these two sites being 4.75). These sites were also seen as green spaces that provide shade and shelter (environmental criterion number 7 with a mean score for these two of 4.75) and hence contribute to better air quality in the city (environmental criterion number 9 where their mean score is 4.63). The current condition of these sites clearly underlay their high overall mean score on the environmental criteria. The details of their particular scores for each of the environmental and social criteria are shown in the bar charts in Figures 6.24 (d) to 6.25 (d).

Both Bukit Gasing and Bukit Kiara were given low scores for their social character i.e. amenities provided. It was observed during the site visits that neither of these sites had any recreational facilities for the public to use (social criterion number 1 where the mean score for these 2 sites was 1.50). Both of these sites were very quiet (social criterion number 5: mean score of 1.25) but were considered to be not entirely safe to be used by the public (social criterion number 11: mean score of 1.75) as their current condition is akin to secondary forest. The low social scores given to these sites no doubt reflected these current conditions. In terms of accessibility to nearby population (social criterion number 14 where their mean score was 3.63), however, these sites were surrounded by residential areas with a high-density of population. This might create an opportunity in future to improve these spaces by turning parts of them into public parks and gardens or developing them into amenity forest areas that might increase their social utility.

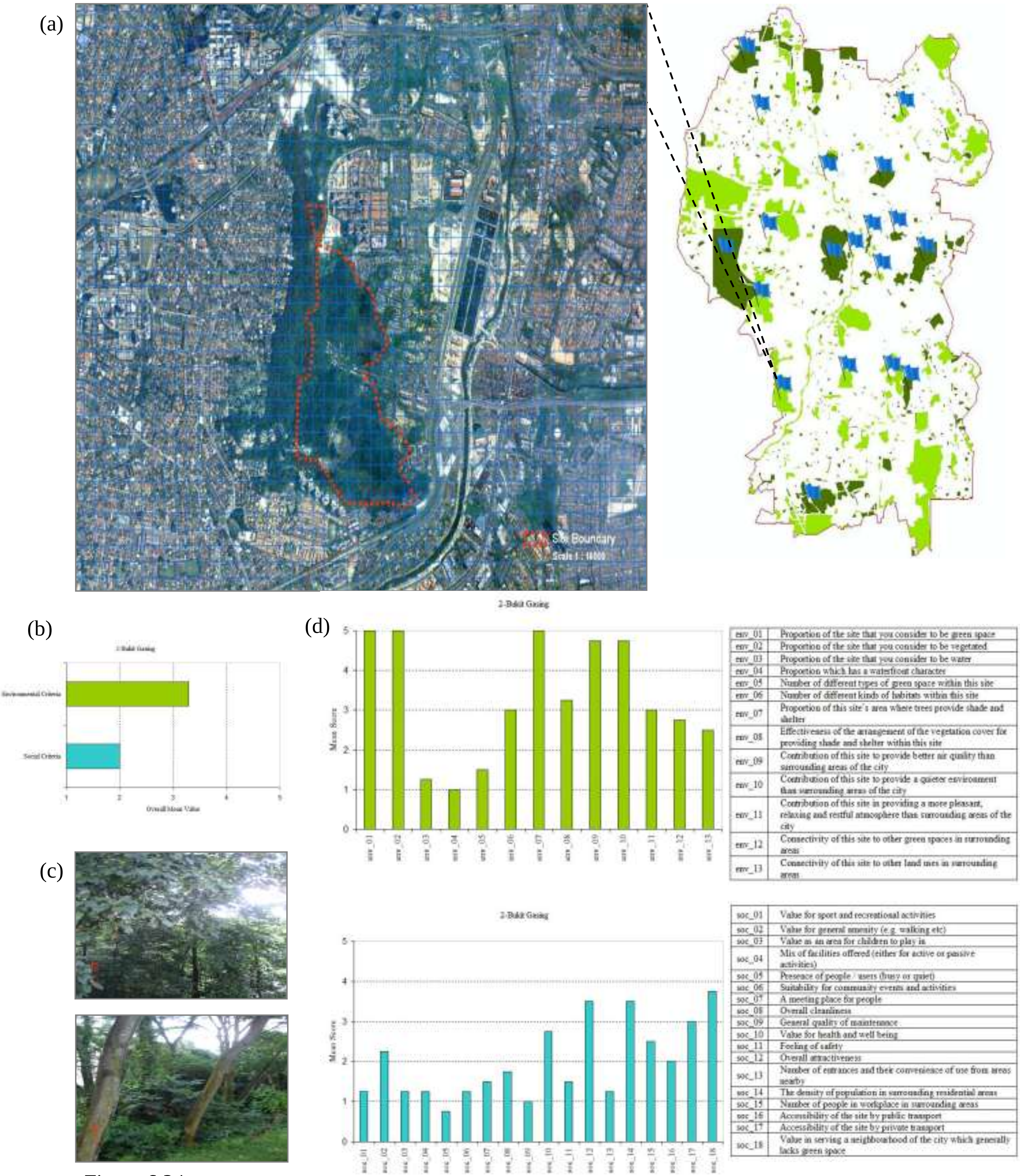
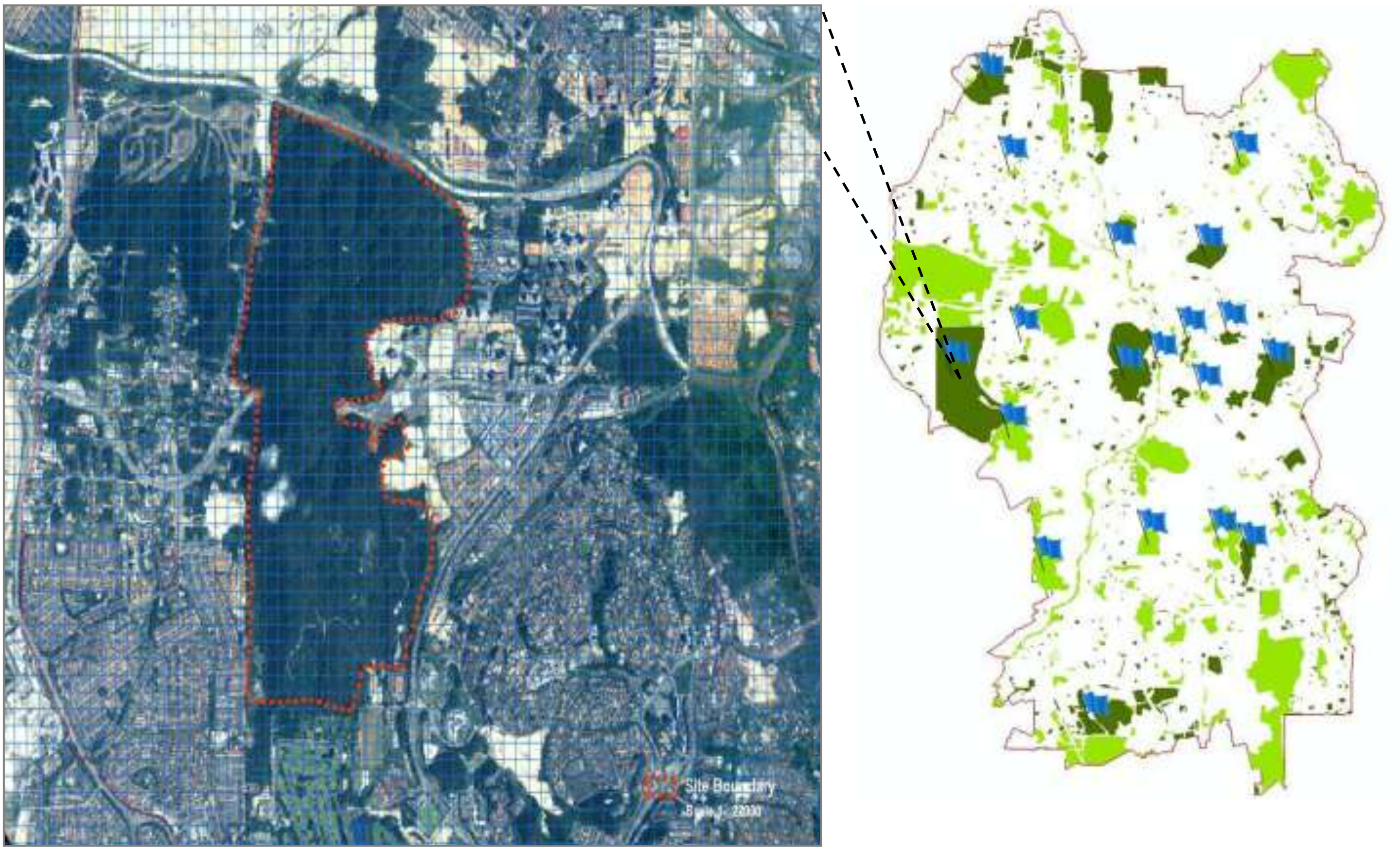
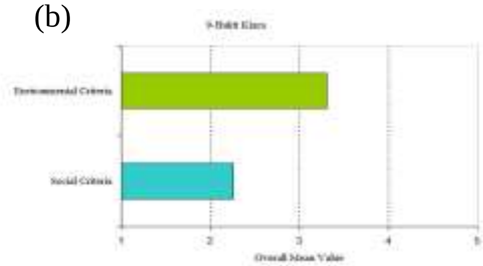


Figure 6.24:
(a) Bukit Gasing: boundary of the site (shown in red dotted lines) and surroundings;
(b) The overall mean scores of the environmental and social criteria for Bukit Gasing;
(c) Sample of photographs showing the nature of Bukit Gasing;
(d) Mean scores from the site assessments of Bukit Gasing for each of 13 environmental and 18 social criteria.

(a)

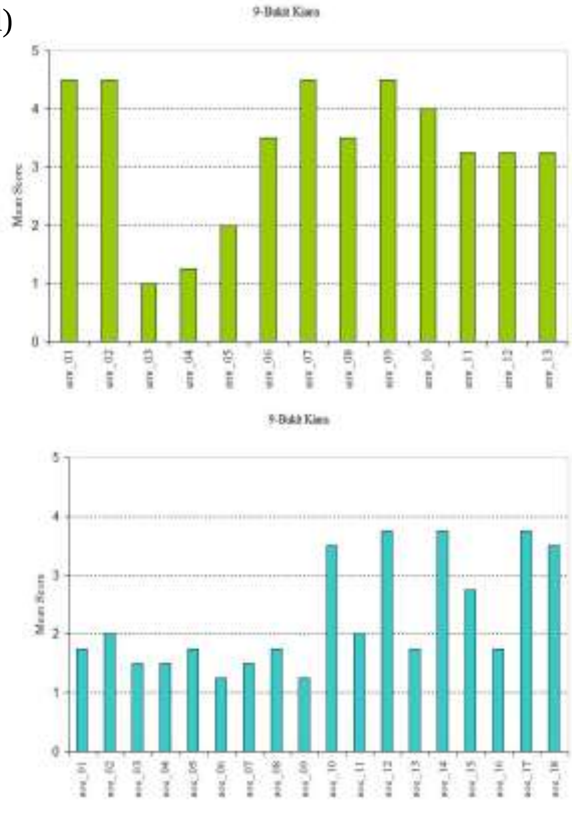


(b)



(c)

(d)



env_01	Proportion of the site that you consider to be green space
env_02	Proportion of the site that you consider to be vegetated
env_03	Proportion of the site that you consider to be water
env_04	Proportion which has a waterfront character
env_05	Number of different types of green space within this site
env_06	Number of different kinds of habitats within this site
env_07	Proportion of this site's area where trees provide shade and shelter
env_08	Effectiveness of the arrangement of the vegetation cover for providing shade and shelter within this site
env_09	Contribution of this site to provide better air quality than surrounding areas of the city
env_10	Contribution of this site to provide a quieter environment than surrounding areas of the city
env_11	Contribution of this site in providing a more pleasant, relaxing and restful atmosphere than surrounding areas of the city
env_12	Connectivity of this site to other green spaces in surrounding areas
env_13	Connectivity of this site to other land uses in surrounding areas

soc_01	Value for sport and recreational activities
soc_02	Value for general amenity (e.g. walking etc)
soc_03	Value as an area for children to play in
soc_04	Mix of facilities offered (either for active or passive activities)
soc_05	Presence of people / users (busy or quiet)
soc_06	Suitability for community events and activities
soc_07	A meeting place for people
soc_08	Overall cleanliness
soc_09	General quality of maintenance
soc_10	Value for health and well being
soc_11	Feeling of safety
soc_12	Overall attractiveness
soc_13	Number of entrances and their convenience of use from areas nearby
soc_14	The density of population in surrounding residential areas
soc_15	Number of people in workplace in surrounding areas
soc_16	Accessibility of the site by public transport
soc_17	Accessibility of the site by private transport
soc_18	Value in serving a neighbourhood of the city which generally lacks green space

Figure 6.25:
(a) Bukit Kiara: boundary of the site (shown in red dotted lines) and surroundings;
(b) The overall mean scores for the environmental and social criteria for Bukit Kiara;
(c) Sample of photographs showing the nature of Bukit Kiara;
(d) Mean scores from the site assessments of Bukit Kiara for each of 13 environmental and 18 social criteria.

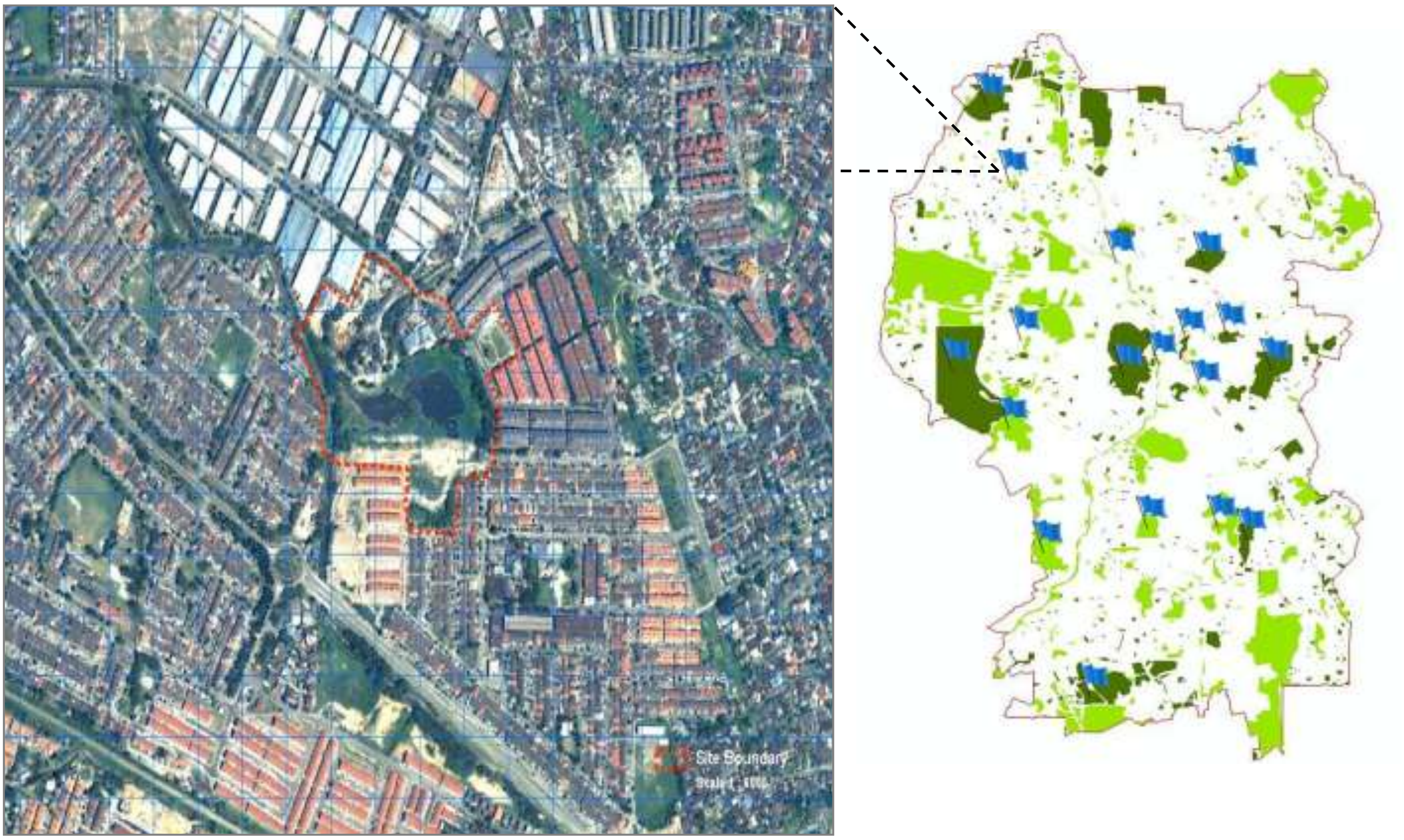
(iv) Sites with Low Environmental and Low Social Scores

The fourth group (shown within the dotted red rectangle) consists of four green spaces that were evaluated to have low scores both in terms of their environmental and social characteristics: Pudu Jail, Kepong, Batu River Reserve and Desa Water Park. In the figures which follow, the boundary of each site is again overlaid on IKONOS natural colour imagery to give an understanding of the nature, extent and local situation of the site. The position of each site within the city as a whole is also shown by locating it on the map of green spaces produced in Chapter 5 (Figure 5.14 (b)). Again, in each of the ensuing figures, Figures 6.26 to 6.29, part (a) always displays the extent of each of these sites, with their boundaries marked by a red dotted line. It is interesting to see that such a mixture of types of green space of quite different character were all assessed similarly in terms of environmental and social criteria.

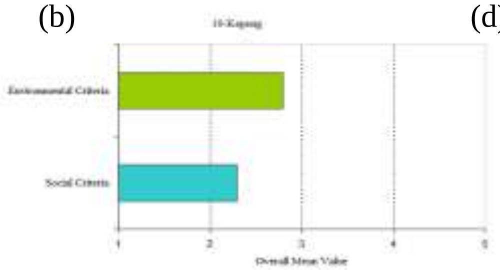
Almost all the sites in this group are abandoned areas (except some part of Desa Water Park). During the site visits, it was observed that these sites were occupied with grass and bushes and not well maintained; thus they all lacked tree cover for shade and shelter (environmental criterion 7). In addition, these abandoned sites were also given low scores on environmental criterion 9 because the absence of trees meant the arrangement of their vegetation could only make a minor contribution to the improvement of air quality in surrounding areas. The detailed scores on all 13 environmental criteria for each of these sites are shown in Figures 6.26 (d) to 6.29 (d).

In terms of the social criteria, all of the sites in this group were appraised as conferring only low social benefits with respect to social criteria 5-11. As abandoned sites these green spaces were all noted to have a low presence of people (social criterion 5) and hence were not considered safe to use (social criterion 11). They were also seen as having low quality of maintenance (social criterion 9) and so had an untidy appearance (social criterion 8) and were not therefore considered suitable to be used for community events (social criterion 6) or as appropriate meeting places for people (social criterion 7). These conditions, observed in most of the sites in this group, were naturally reflected in their low social ratings. Figures 6.26 (d) to 6.29 (d) display the detailed scores on each of these particular social criteria for each site.

(a)

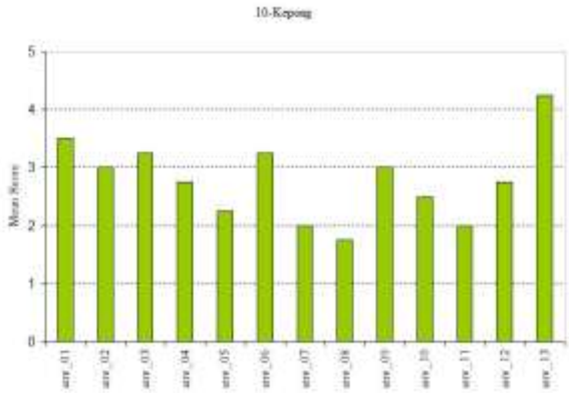


(b)

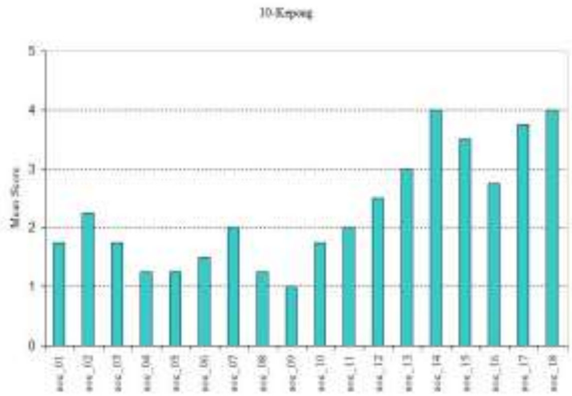


(c)

(d)



env_01	Proportion of the site that you consider to be green space
env_02	Proportion of the site that you consider to be vegetated
env_03	Proportion of the site that you consider to be water
env_04	Proportion which has a waterfront character
env_05	Number of different types of green space within this site
env_06	Number of different kinds of habitats within this site
env_07	Proportion of this site's area where trees provide shade and shelter
env_08	Effectiveness of the arrangement of the vegetation cover for providing shade and shelter within this site
env_09	Contribution of this site to provide better air quality than surrounding areas of the city
env_10	Contribution of this site to provide a quieter environment than surrounding areas of the city
env_11	Contribution of this site in providing a more pleasant, relaxing and restful atmosphere than surrounding areas of the city
env_12	Connectivity of this site to other green spaces in surrounding areas
env_13	Connectivity of this site to other land uses in surrounding areas



soc_01	Value for sport and recreational activities
soc_02	Value for general amenity (e.g. walking etc)
soc_03	Value as an area for children to play in
soc_04	Mix of facilities offered (either for active or passive activities)
soc_05	Presence of people / users (busy or quiet)
soc_06	Suitability for community events and activities
soc_07	A meeting place for people
soc_08	Overall cleanliness
soc_09	General quality of maintenance
soc_10	Value for health and well being
soc_11	Feeling of safety
soc_12	Overall attractiveness
soc_13	Number of entrances and their convenience of use from areas nearby
soc_14	The density of population in surrounding residential areas
soc_15	Number of people in workplace in surrounding areas
soc_16	Accessibility of the site by public transport
soc_17	Accessibility of the site by private transport
soc_18	Value in serving a neighbourhood of the city which generally lacks green space

Figure 6.26:
(a) Kepong site: boundary of the site (shown in red dotted lines) and surroundings;
(b) The overall mean scores for the environmental and social criteria for Kepong;
(c) Sample of photographs showing the nature of Kepong;
(d) Mean scores from the site assessments of Kepong for each of 13 environmental and 18 social criteria.

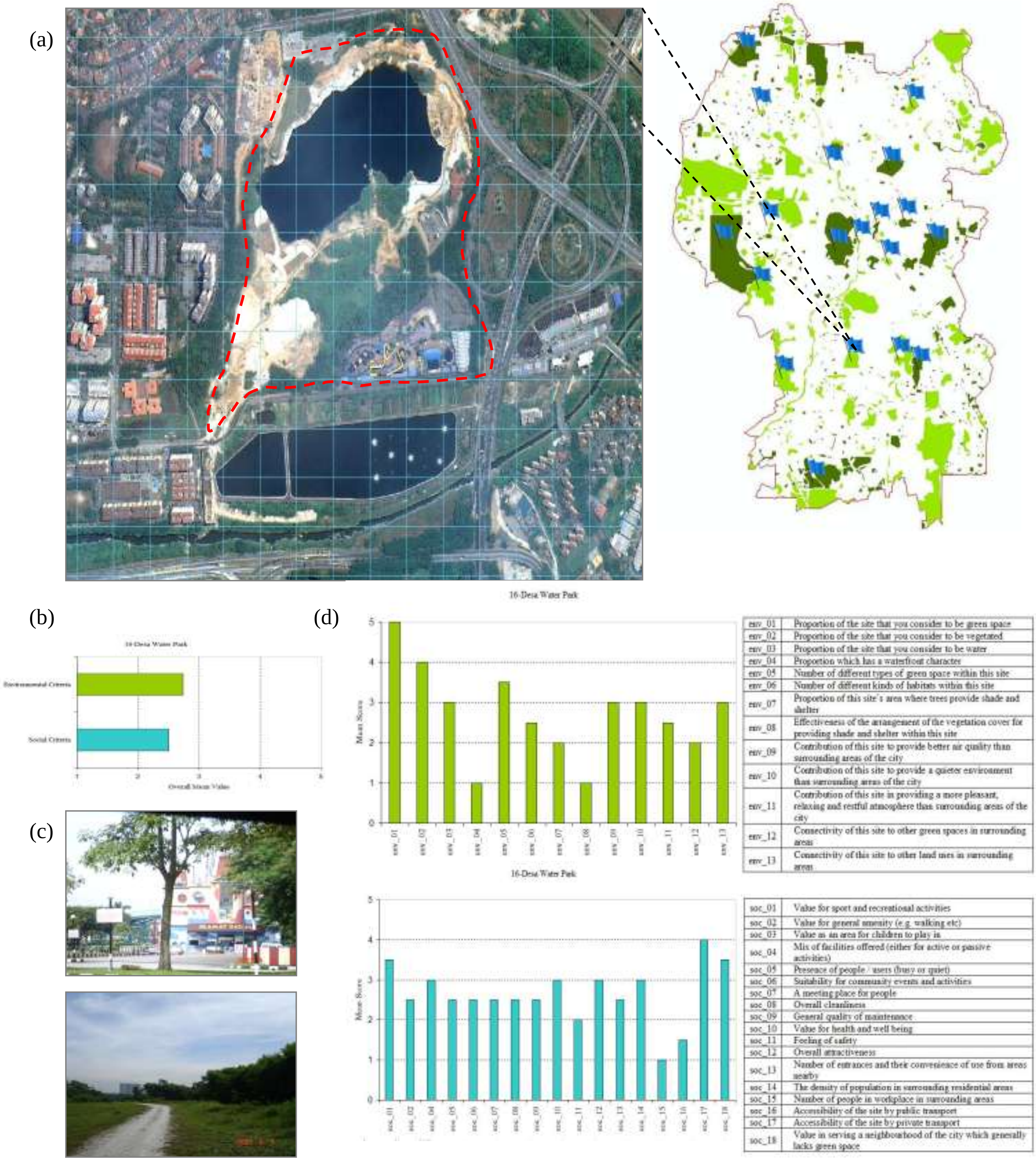
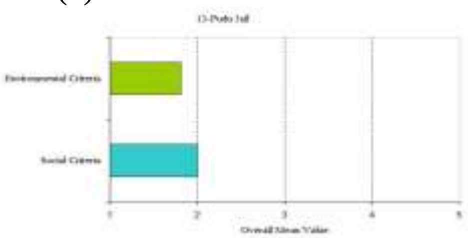


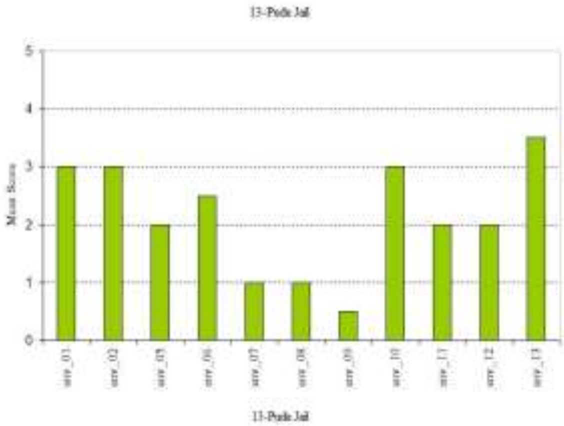
Figure 6.27:
(a) Desa Water Park: boundary of the site (shown in red dotted lines) and surroundings;
(b) The overall mean scores for the environmental and social criteria for Desa Water Park;
(c) Sample of photographs showing the nature of Desa Water Park;
(d) Mean scores from the site assessments of Desa Water Park for each of 13 environmental and 18 social criteria.

(a)

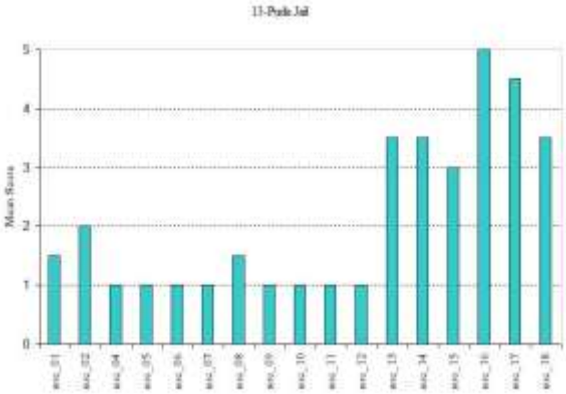
(b)



(d)



env_01	Proportion of the site that you consider to be green space
env_02	Proportion of the site that you consider to be vegetated
env_03	Proportion of the site that you consider to be water
env_04	Proportion which has a waterfront character
env_05	Number of different types of green space within this site
env_06	Number of different kinds of habitats within this site
env_07	Proportion of this site's area where trees provide shade and shelter
env_08	Effectiveness of the arrangement of the vegetation cover for providing shade and shelter within this site
env_09	Contribution of this site to provide better air quality than surrounding areas of the city
env_10	Contribution of this site to provide a quieter environment than surrounding areas of the city
env_11	Contribution of this site in providing a more pleasant, relaxing and restful atmosphere than surrounding areas of the city
env_12	Connectivity of this site to other green spaces in surrounding areas
env_13	Connectivity of this site to other land uses in surrounding areas



soc_01	Value for sport and recreational activities
soc_02	Value for general amenity (e.g. walking etc)
soc_03	Value as an area for children to play in
soc_04	Mix of facilities offered (either for active or passive activities)
soc_05	Presence of people / users (busy or quiet)
soc_06	Suitability for community events and activities
soc_07	A meeting place for people
soc_08	Overall cleanliness
soc_09	General quality of maintenance
soc_10	Value for health and well being
soc_11	Feeling of safety
soc_12	Overall attractiveness
soc_13	Number of entrances and their convenience of use from areas nearby
soc_14	The density of population in surrounding residential areas
soc_15	Number of people in workplace in surrounding areas
soc_16	Accessibility of the site by public transport
soc_17	Accessibility of the site by private transport
soc_18	Value in serving a neighbourhood of the city which generally lacks green space

(c)

Figure 6.28:
(a) Pudu Jail: boundary of the site (shown in red dotted lines) and surroundings;
(b) The overall mean scores for the environmental and social criteria for Pudu Jail;
(c) Sample of photographs showing the nature of Pudu Jail;
(d) Mean scores from the site assessments of Pudu Jail for each of 13 environmental and 18 social criteria.

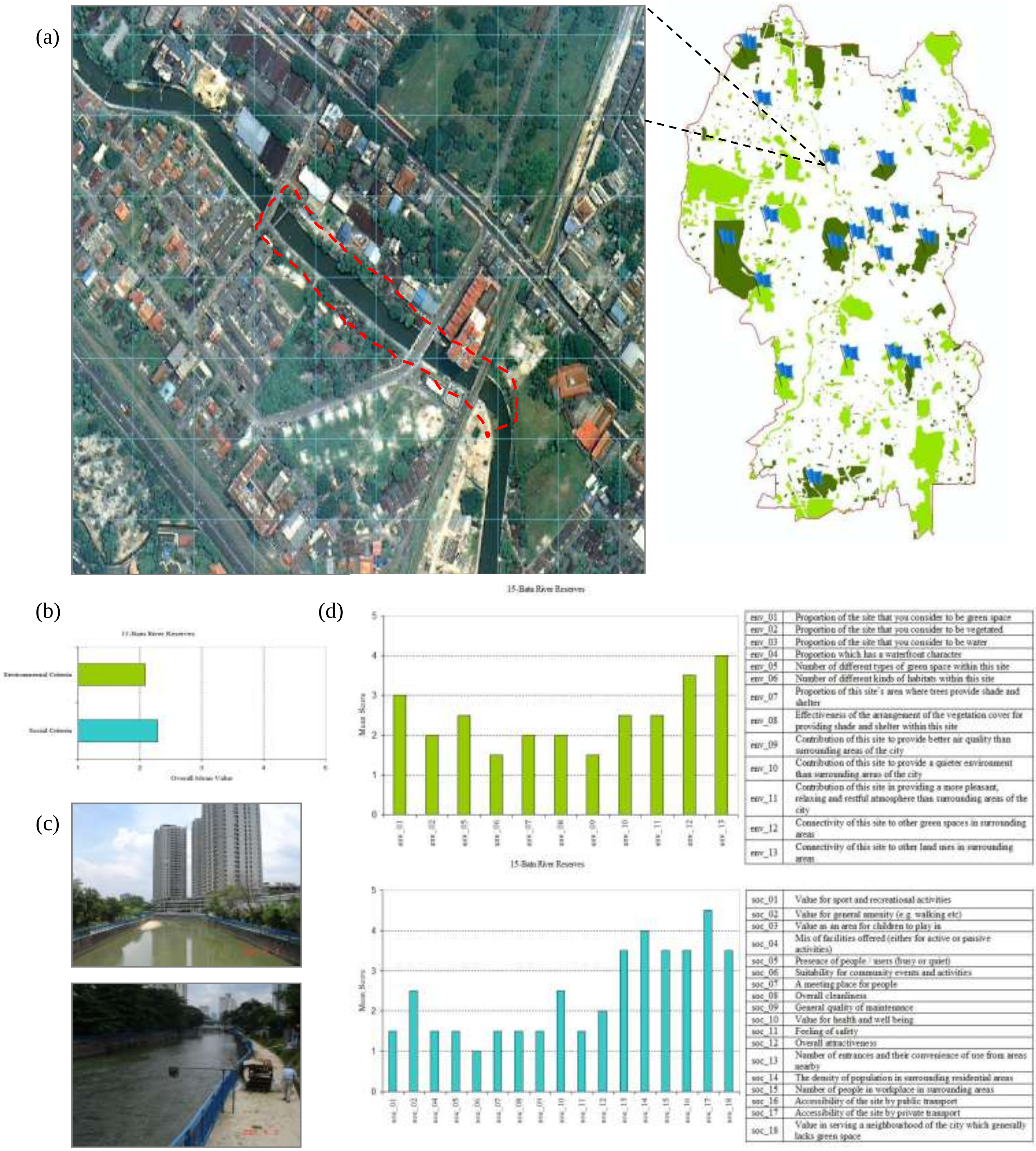


Figure 6.29:
(a) Batu River Reserve: boundary of the site (shown in red dotted lines) and surroundings;
(b) The overall mean scores for the environmental and social criteria for Batu River Reserve;
(c) Sample of photographs showing the nature of Batu River Reserve;
(d) Mean scores from the site assessments of Batu River Reserve for each of 13 environmental and 18 social criteria.

(v) Examining Similarities Between the Ground-based Observations and the Desk-based Indicators

Following on from some of the main discussion in Chapter 4 (Sections 4.6 and 4.7), we selected seven criteria (four environmental and three from among the broad range of ‘social attributes and amenities’ as discussed in Chapter 4, but all three concerned with different aspects of accessibility) from among the large number which were considered by the survey respondents to be very important in determining priorities for green space protection and conservation (summarised in Figure 6.1). Tables 6.4 and 6.5 restate these criteria which were quantified by combining the satellite data, the parcel-based data on land use or other ancillary data fed into our GIS (e.g. population from the census), as appropriate, for the desk based part of the analysis. Since the data involved were all held in our GIS which covers the whole city (using various vector based geographies plus some raster based spatial units), it was possible to produce maps for these indices showing their distribution across the whole city. As a convenient shorthand, when these 7 indices are quantified and mapped in this ‘desk based’ fashion they are often referred to here as ‘city wide indicators’. Further analysis was then carried out to examine how the 17 sites would be appraised if they were to be assessed only on these seven criteria estimated: (a) firstly by field observation; and then (b) through using the data sets from remote sensing and other sources held in our GIS.

Although the ‘desk-based indicators’ are not meant to measure exactly the same properties as the 7 corresponding criteria evaluated through ground-based observations, the purpose was, nevertheless, also to see if this reduced set of 7 indicators could be used to generally identify sites that had received higher or lower environmental or social (i.e. accessibility) scores for the corresponding criteria from the site visits. If so, that could allow planners to consider making initial ‘remote’ estimates of the rough values those attributes would get from site visits without incurring the time and cost involved in the latter.

Environmental Criteria
Proportion of the site that you consider to be vegetated
Number of different kinds of vegetation within this site
Proportion of this site's area where trees provide shade and shelter
Connectivity of this site to other green spaces in surrounding areas

Table 6.4: Four of the 27 environmental criteria that were considered 'very important' by the respondents in determining priorities for the protection and conservation of green spaces (see Table 4.14 in Chapter 4)

Social (i.e. Accessibility) Criteria
The number of people in nearby residential areas
Accessibility of the site by public transport
Openness and availability of the site to the public (e.g. as opposed to lack of availability due to restriction to private use)

Table 6.5: Three of the 21 social criteria that were considered 'very important' or 'extremely important' by the respondents in determining priorities for the protection and conservation of green spaces (see Table 4.15 in Chapter 4)

Table 6.6 summarises the overall mean scores from the site assessors for the 17 sites based on just selecting the four environmental criteria and the three social (i.e. accessibility) criteria most similar to the 7 computed from the remotely sensed and GIS data. As shown in the table, the sites of Perdana Lake Garden, Bukit Gasing, Rimba Ilmu, Permaisuri Lake Garden, Bukit Nanas Forest Reserve and Bukit Kiara were evaluated on the ground to have high scores for these four environmental criteria (all of these green areas scored more than 3.8 for overall mean scores). On the three social criteria, only three sites were given high scores for their accessibility characteristics; these were Titiwangsa Lake Garden, Permaisuri Lake Garden and KLCC Park (all 3 sites gained above 4 for their overall mean scores).

Site Name	Four Environmental Criteria (Overall Mean Scores)	Three Social i.e. Accessibility Criteria (Overall Mean Scores)
1-Perdana Lake Garden	3.94	3.25
2-Bukit Gasing	3.94	2.5
3-Rimba Ilmu, Universiti Malaya	4	3.92
4-KLCC Park	3.5	4.33
5-Permaisuri Lake Garden	3.81	4.17
6-Klang-Gombak River	2.94	3.5
7-Royal Selangor Golf Club	2.94	2.75
8-Bukit Nanas Forest Reserve	4.31	3.58
9-Bukit Kiara	3.94	2.83
10-Kepong	2.75	2.58
11-Sri Hartamas	2.94	3.08
12-Pudu Jail	2.13	3.5
13-Bukit Jalil Park	3.63	3.5
14-Batu River Reserve	2.25	3.5
15-Desa Water Park	2.63	2.5
16-Titiwangsa Lake Garden	3.13	4.67
17-Kepong Metropolitan Park	3.63	3.33

Table 6.6: Overall mean scores for the four environmental and for the three social criteria (i.e. accessibility) for the 17 sites based on scores from site observation.

With only the four environmental criteria, two sites were found to have particularly low environmental scores i.e. Pudu Jail and Batu River Reserve which both scored below 2.5 on average. Interestingly, these two sites were the same sites given particularly low environmental scores on the means for all 13 environmental criteria (Section 6.2.1). Interestingly, on the social criterion of openness and availability of the site to the public, very different sites of the Bukit Gasing forest reserve and Royal Selangor Golf Club were allocated mean scores below 2.5.

Figure 6.30 presents a 2-D scatter plot based on the combination of how the sites scored for the four environmental and three accessibility criteria. It can be observed that these sites can still be grouped fairly naturally into the same classes as they were in previously in Figure 6.12 with the groups again picked out in Figure 6.30 using the same coloured dotted polygons as before to facilitate comparison of these two sets of results.

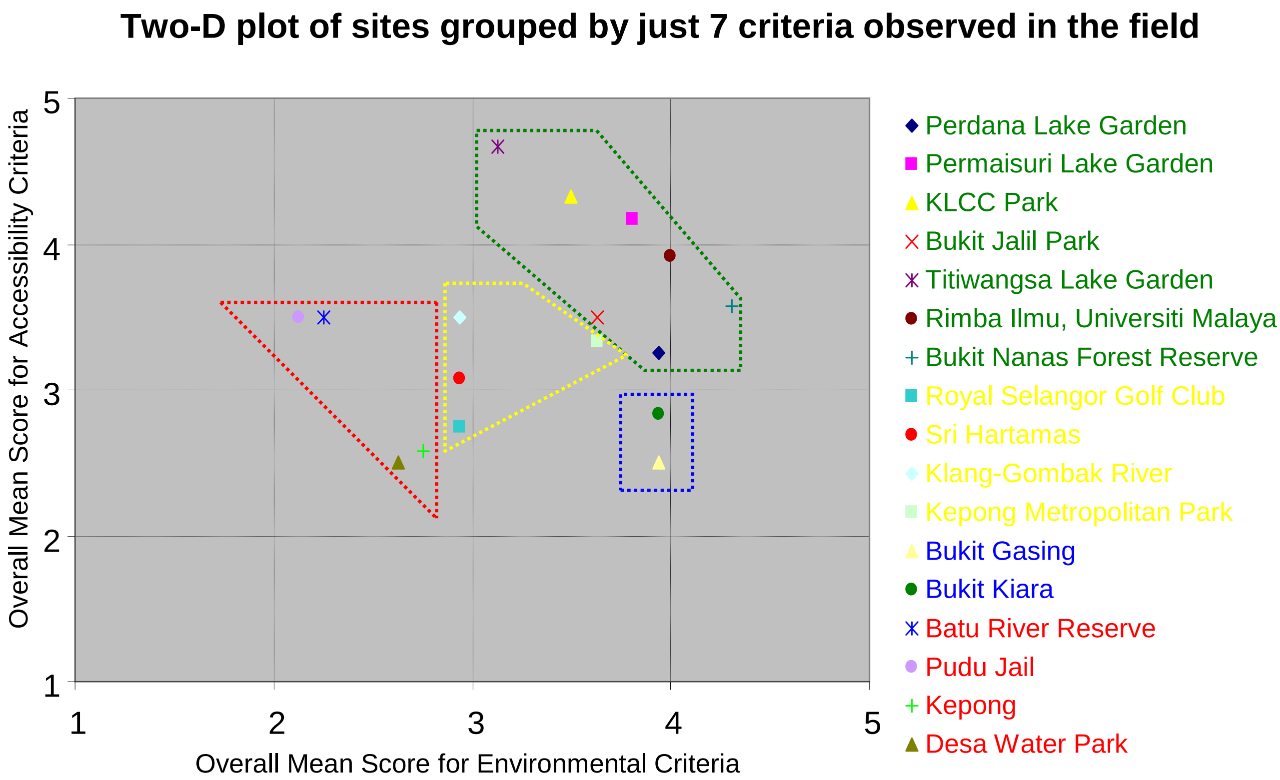


Figure 6.30: Sites grouped using only four environmental and three social (accessibility) criteria estimated through site observations.

As can be seen from Figures 6.12 and 6.30, although the same grouping of sites again emerges, the absolute scores and hence the positions of the sites does change somewhat in the 2D plot. Only group three, consisting of Bukit Gasing and Bukit Kiara (shown in the dotted blue rectangle), still scored similarly on both the environmental and social (i.e. accessibility) scores. Both of these sites were still evaluated to have high environmental scores but rather low accessibility scores (average mean score of 3.94 on environmental criteria and 2.38 on accessibility attributes). It was observed during the site visit that these two sites were occupied with lush vegetation providing shade and shelter. However, they are not meant for public recreational purposes and hence accessibility to the sites is limited. With the reduced set of social factors used to create Figure 6.30 limited to accessibility to the exclusion of other types of social attributes, it was inevitable that these 2 sites would be awarded low scores on the latter axis. Sites where the 'social' score is less affected by the site's accessibility may be poorly represented by this reduced set of social criteria.

However, some of the sites in the other three groups (groups one, two and four) were scored somewhat differently when they were evaluated only on the four environmental and three accessibility criteria. In group one (shown in the dotted green polygon in Figure 6.30), three sites scored differently when compared to their scores using all the environmental and social criteria, namely Rimba Ilmu, Bukit Nanas Forest Reserve and Perdana Lake Garden. Perdana Lake Garden previously scored highly on social attributes using all 18 social criteria, but was awarded only moderate scores (mean of 3.19) when only the three accessibility criteria were used. Although Perdana Lake Garden has high intrinsic beauty and good facilities, it is located far from residential areas and is not very accessible by public transport. Differences also were observed for the Rimba Ilmu and Bukit Nanas Forest Reserve. Both of these sites were now scored more highly (average mean score of 4.16) using only four environmental criteria which were focused more on the vegetative cover of a site, rather than a fuller assessment of all the 13 environmental variables incorporated in the site survey.

In group four (within the dotted red triangle in Figure 6.30), two sites scored differently when only four environmental and three accessibility criteria were used, viz. Pudu Jail and Batu River Reserve with both sites awarded moderate accessibility scores (average of 3.38) using only the three accessibility criteria, whereas both sites previously scored poorly when all the 18 social criteria were used. This might be due to these sites being easily accessible by public transport with both sites located very close to stations on the public transport system. Although they contain few amenities to make them attractive places to visit at the present time, their accessibility indicators, however, suggest these sites have the potential to be developed into green and open spaces that could serve a large number of people.

In group two (within the dotted yellow quadrilateral shape in Figure 6.30), all sites (except Sri Hartamas) scored differently when compared to their scores on all 31 criteria. It can be seen in Figure 6.30 that both the Klang-Gombak River and the Royal Selangor Golf Club were evaluated differently when only the three 'accessibility' oriented criteria were used. The Klang-Gombak site which previously had been seen as having only moderate social resources was now assessed to be of higher worth in accessibility terms, whilst the Royal Selangor Golf Club was now considered to have lower scores because of its private character. Recent transport improvements have made the Klang-Gombak River much more accessible by public transport, but on the other hand, the Royal Selangor Golf Club is for club members only and restricts public access to the site for that reason.

The main conclusion from this comparison is that, using only the reduced set of 7 site assessment criteria, the sites are still found to group together in a similar way to when the extended set of 31 factors were considered. This suggests that a reduced set of observations could be used to determine the general environmental advantages of many of the sites. In cases where the accessibility of the site is among the more important factors in assessing its social utility as a green space, the reduced set remains useful. However, in cases where other amenity or recreational attributes are more important, for example through the provision of important or attractive facilities within a green space, further criteria from a larger check list clearly need to be retained for making site assessments.

6.2.2 Estimating the Sub-set of 7 Attributes from Remotely Sensed and Other GIS Data

As discussed in Section 6.1.2, a variety of desk-based techniques were used in trying to estimate the contribution that the existing areas of green space were making across the whole of KL to the city's quality of environment and to the social lives of its citizens. The indicators devised for this tried to match the four environmental and three social criteria which were selected from a large list of attributes considered to be important by the Malaysian respondents when attempting to determine the overall importance of a green space, as Tables 4.14 and 4.15 in Section 4.6.1 indicate clearly. These seven were selected mainly because it was possible to estimate them using the remotely sensed data and other data held in our GIS, but all were awarded fairly high scores as regards their importance in considering whether a particular green space merited preservation or not. These desk-based indicators were then applied to all the existing green areas in the city including the 17 sites that were observed during the site visits. Results for the 'indicators for the whole city' (also referred to as 'city-wide indicators') and results of the site specific assessments are presented, compared and discussed in this next section.

6.2.2.1 Environmental Criteria

Each of the four environmental indicators, created as described in Sections 6.1.2.1 (i) to 6.1.2.1 (iv), is presented in this section and their significance as indicators of green space is discussed.

(i) Indicator for Green Space Abundance

Figure 6.31 presents the results of trying to measure green space abundance. Part (a) of this figure shows the map of green space abundance for the whole city where the total amount of green space (based on pixel count) was calculated for each 250 meter grid cell. The darkest grid cells therefore represent areas with the highest amount of green space. The map of green space produced from the satellite data (Figure 5.14 (b) in Chapter 5), which was used as an input data set in this measurement, gives the distribution of green spaces for the whole city by pixel and so the abundance of these spaces by grid cell can be measured using it. This calculation (which has not apparently been carried out before) might be especially useful to city planners in indicating the abundance of the existing green spaces in different parts of the city.

In part (b) of Figure 6.31, scores of 1 to 5 were given to each of these cells, where a score of 1 represents grid cells that have very low abundance and 5 represents grid cells that have very high abundance of green space. Thus a similar scale as in ground survey was used for scoring to enable comparison of results. Part (c) of Figure 6.31 shows how each of the 17 sites rates on abundance of green space. Table 6.7 shows the mean score for each of the 17 sites on this environmental criterion. As one might expect, sites known to have a denser cover of trees and shrubs such as Bukit Kiara, Permaisuri Lake Garden, Titiwangsa Lake Garden, Bukit Jalil Park, Bukit Gasing, Bukit Nanas Forest Reserve and Rimba Ilmu were correctly indicated to have very high green space abundance (all of these sites scored above 4 in their mean scores). All of the sites at the opposite extreme such as the Klang-Gombak River, Kepong and Pudu Jail, which have little vegetation cover, were also correctly evaluated as having very low green space abundance; all of these scored below 2. This cross-checking of this indicator of abundance for the whole city against known sites gives us confidence in the reliability of the results for this variable.

Site Name	**Mean Score**
Perdana Lake Garden	3.85
KLCC Park	3.06
Permaisuri Lake Garden	4.23
Bukit Nanas Forest Reserve	4.09
Rimba Ilmu Universiti Malaya	4.08
Sri Hartamas	2.32
Bukit Kiara	4.53
Kepong	1.67
Klang-Gombak River	1
Royal Selangor Golf Club	3.93
Bukit Gasing	4.18
Pudu Jail	1.67
Bukit Jalil Park	4.14
Batu River Reserve	2.9
Desa Water Park	3.5
Titiwangsa Lake Garden	4.1
Kepong Metropolitan Park	3.74

Table 6.7: Mean score for all the 17 sites on the environmental criterion of abundance of vegetation cover.

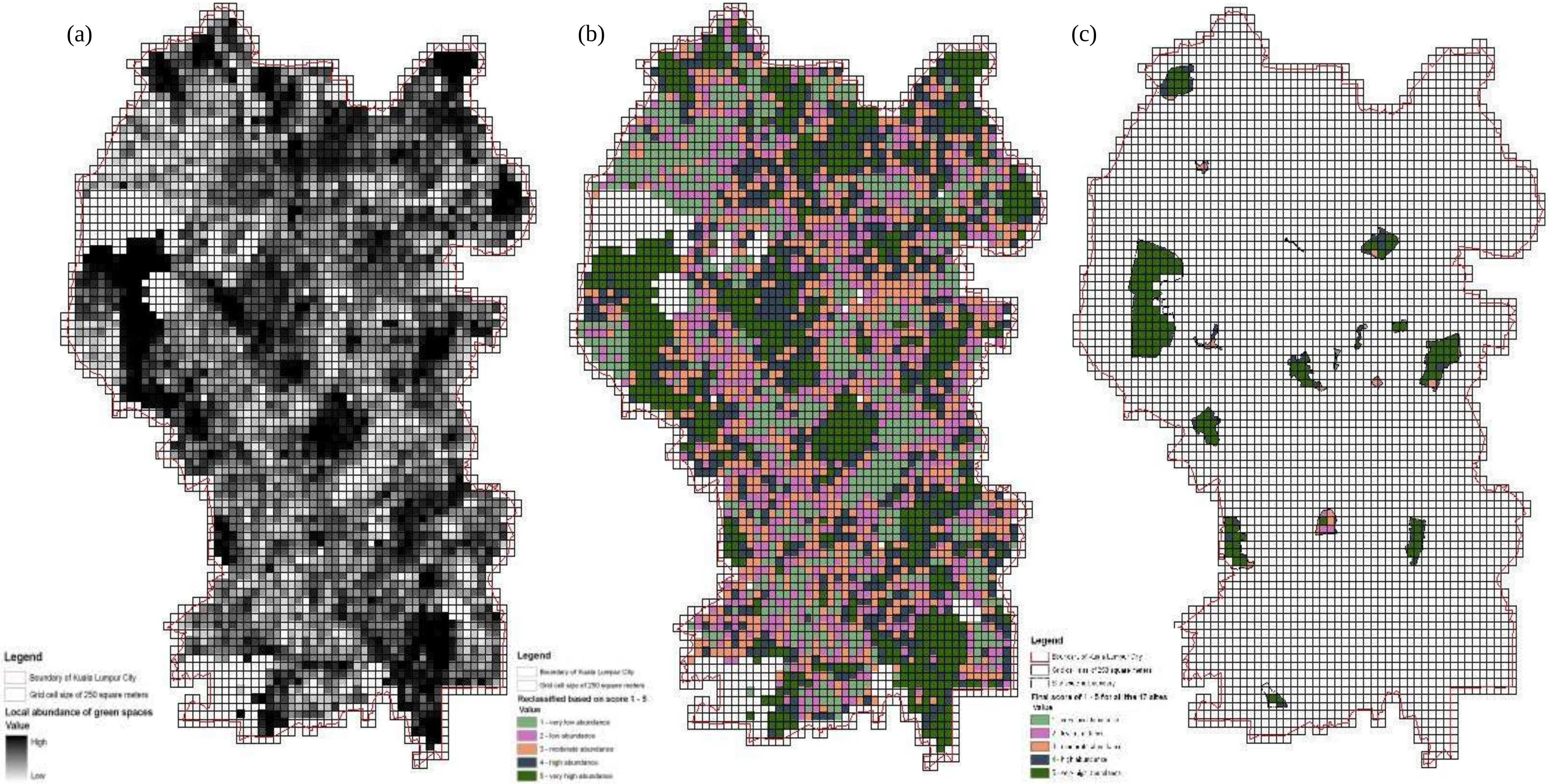


Figure 6.31:
(a) Map of green space abundance in the city;
(b) Map showing the computed scores from 1 (very low abundance) to 5 (very high abundance) for each of the grid cells in the city; and
(c) Map showing the mean scores for each of the 17 sites visited on the ground (shown in Table 6.7).

(ii) Indicator of Vegetation Variety

Figure 6.32 shows the results from trying to quantify the variety of vegetation throughout the city. For part (a) of this figure the number of different types of vegetation in each 250 meter grid cell was counted and reported, so (a) simply shows the variety of vegetation across the city. Three types of vegetation were considered to indicate a high degree of variety, two types were reported as moderate and where only one type was found, this was considered as low variety. These evaluations were based on considering only the three types of vegetation classified in Figure 5.14 (b) on land cover (trees, shrubs and grassland).

In part (b) of Figure 6.32, each of the grid cells is given a score from 1 (very low) to 5 (very high). A score of 1 was given to grid cells that reported only one type of vegetation, while a score of 3 was given to grid cells with two types of vegetation with the highest score of 5 given to any cells that had three types of vegetation. Part (c) of Figure 6.32 shows these results for vegetation variety for the 17 sites with Table 6.8 summarising the mean scores on this criterion. In fact, all the sites were assessed as having very high vegetation variety (all scored above 4). Within their boundaries five sites were actually fully carpeted by vegetation cover (trees, shrubs and grassland). These were KLCC Park, Permaisuri Lake Garden, Kepong, the Royal Selangor Golf Club and Kepong Metropolitan Park, which all scored the maximum of 5 for their mean scores here.

Site Name	Mean Score
Perdana Lake Garden	4.08
KLCC Park	5
Permaisuri Lake Garden	5
Bukit Nanas Forest Reserve	4.75
Rimba Ilmu Universiti Malaya	4.29
Sri Hartamas	4.53
Bukit Kiara	4.09
Kepong	5
Klang-Gombak River	4.33
Royal Selangor Golf Club	5
Bukit Gasing	4
Pudu Jail	4.11
Bukit Jalil Park	4.24
Batu River Reserve	4.71
Desa Water Park	4.2
Titiwangsa Lake Garden	4.73
Kepong Metropolitan Park	5

Table 6.8: Mean score for all the 17 sites on the environmental criterion of vegetation variety

As just noted, all the 17 green sites scored very highly for variety of vegetation type contained within them. Although they have different levels of maintenance ranging from being well maintained to abandoned green spaces, all are entirely or almost entirely covered by vegetation. Nearly all 17 sites contain at least small areas of man-made structures such as buildings. Often there are small gardens or landscaped areas around these buildings with shrubs, flowers, grass or trees. These relatively small areas may thus contribute to the high mean scores for a few of the grid cells within each site for vegetation variety.

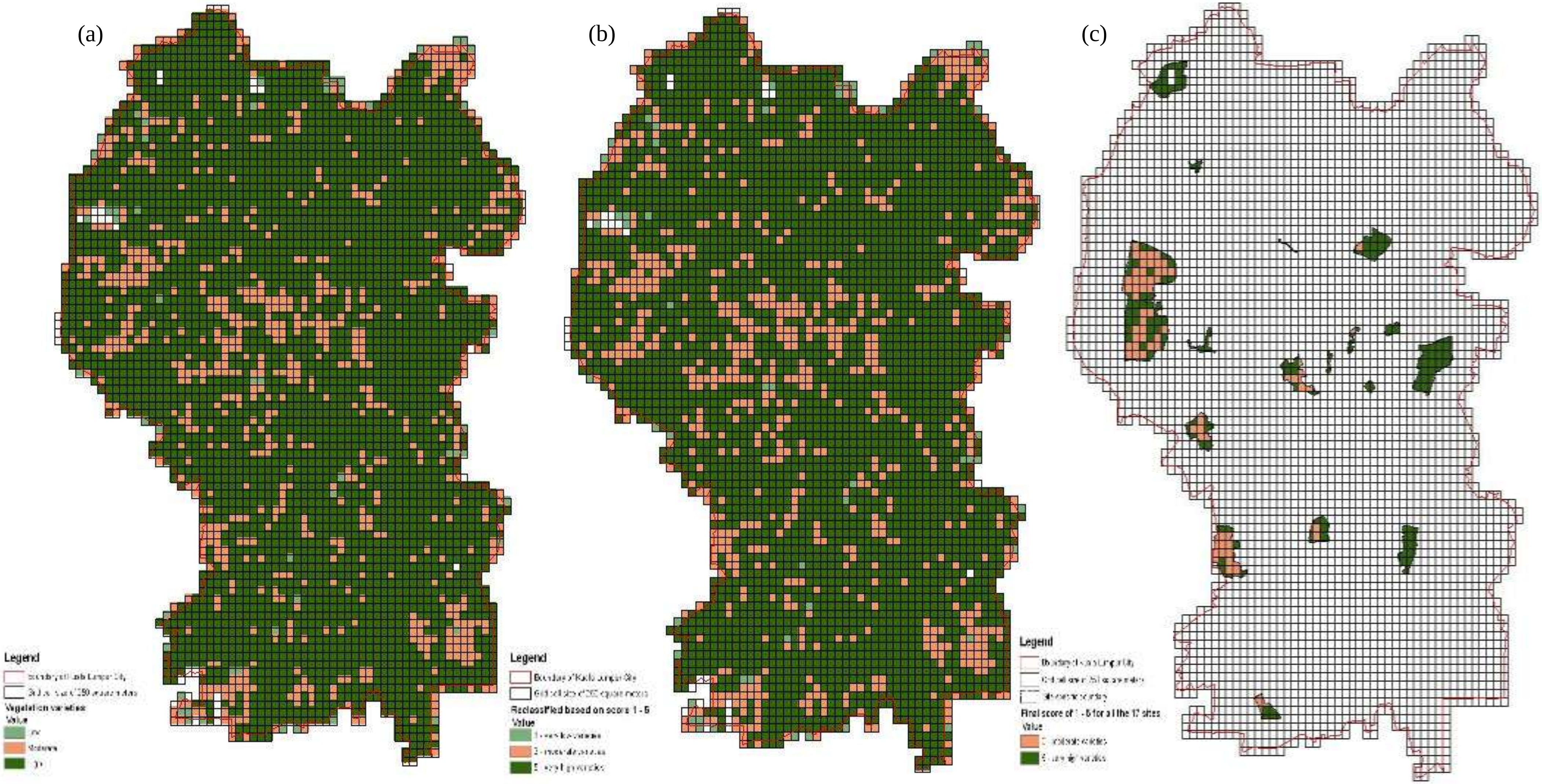


Figure 6.32:
(a) Map of vegetation variety in the city;
(b) Map showing the given scores from 1 (very low variety) to 5 (very high variety) for each of the grid cells in the city; and
(c) Map showing the mean scores for each of the 17 sites visited on the ground (shown in Table 6.8)

(iii) Indicator of Tree Cover

Figure 6.33 shows the results for the third environmental criterion assessed using the desk-based technique where the zonal function of majority was used to find cells which had a majority land cover of trees. In this figure part (a) shows the majority type of land cover with every cell in the grid classified into one of the six different types of land cover, namely bare ground, built-up areas, trees, shrubs, grassland and water bodies (here the GIS simply reports the most prevalent land cover type in each 250 meter grid cell).

Cells that were mostly occupied with bare ground, built-up areas, water bodies or with grassland were given a very low score of 1 because none of these land cover types provide any natural shade or shelter. A score of 3 (moderate) was given to grid cells where shrubs formed the majority class since shrubs provide some shade and shelter (depending on the species), with the highest score of 5 given to grid cells where trees covered more ground than any of the other classes. Figure 6.33 (b) shows the resulting map.

Part (c) of Figure 6.33 portrays the distribution of scores on this indicator of tree cover for the 17 sites visited on the ground with Table 6.9 summarising these results through the appropriate mean scores. It can be observed that four sites scored very highly (all four above 4 in their mean scores) for their proportion of tree cover: Perdana Lake Garden, Bukit Kiara, Bukit Gasing and Bukit Nanas Forest Reserve. These high scores seem appropriate and reasonable because on the site visits, these sites were observed to be occupied mainly by lush trees. In fact, all of these sites (except Perdana Lake Garden) are either mostly covered by secondary forest or are forest reserves within the city.

At the opposite extreme, four sites were found to have a very low proportion of tree cover, including two abandoned green spaces (Kepong and Pudu Jail), a river reserve (Klang-Gombak River) and a water theme park (Desa Water

Park). These scores also seem appropriate, as the ground surveys confirmed that all these sites had a low proportion of tree cover.

Site Name	Mean Score
Perdana Lake Garden	4.69
KLCC Park	2.43
Permaisuri Lake Garden	3.4
Bukit Nanas Forest Reserve	4.09
Rimba Ilmu Universiti Malaya	2.94
Sri Hartamas	2.33
Bukit Kiara	4.24
Kepong	1
Klang-Gombak River	1
Royal Selangor Golf Club	2.77
Bukit Gasing	4.12
Pudu Jail	1.5
Bukit Jalil Park	2.57
Batu River Reserve	2.5
Desa Water Park	2
Titiwangsa Lake Garden	2.17
Kepong Metropolitan Park	2.2

Table 6.9: Mean score for all the 17 sites on the environmental criterion of majority tree cover

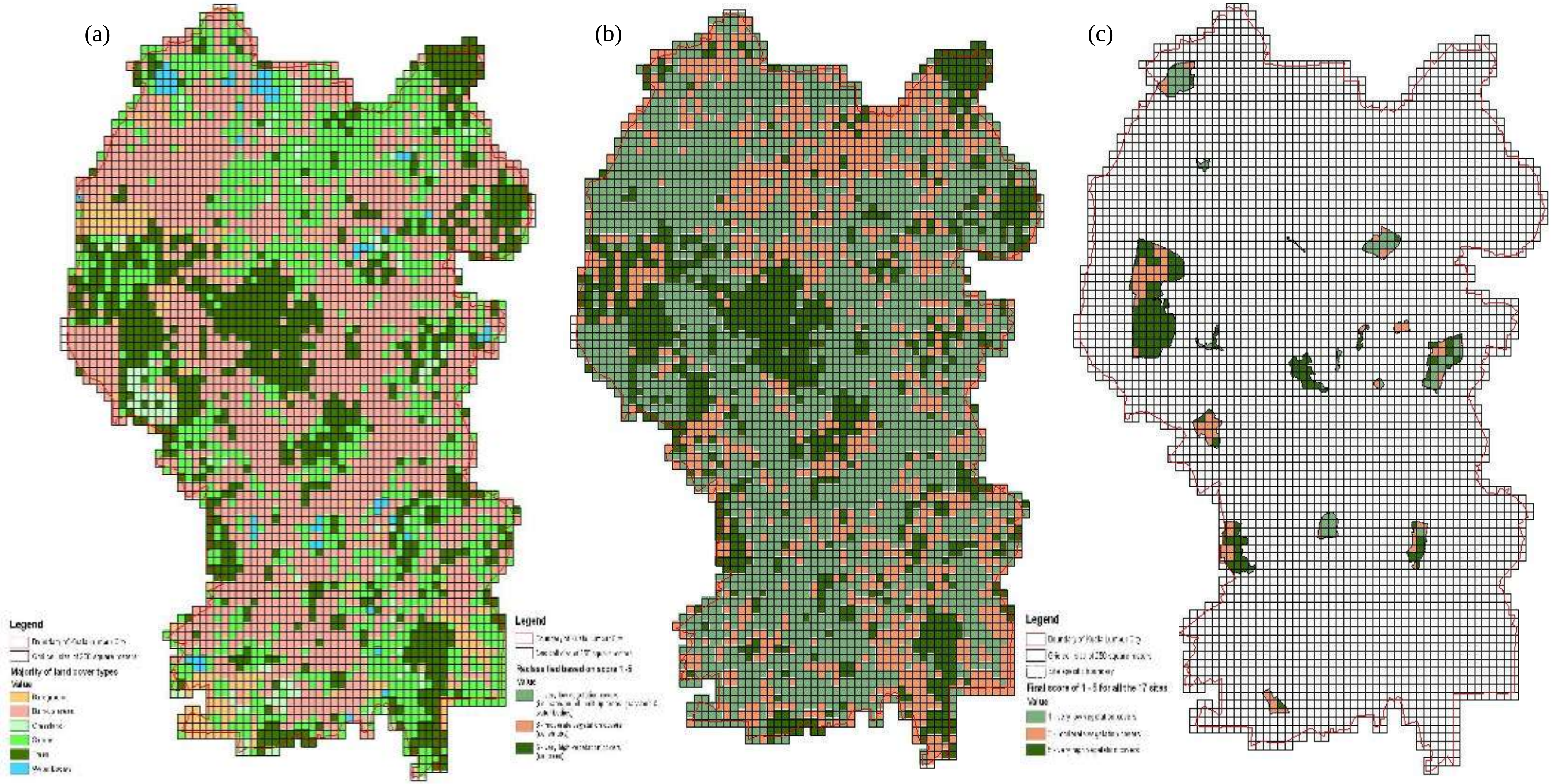


Figure 6.33:
(a) The majority land cover type within each grid cell;
(b) Scores from 1 to 5 for provision of shade and shelter by tree cover for each grid cell in the city; and
(c) Final mean score for general extent of shade and shelter from trees at each of the sites (also shown in Table 6.9)

(iv) Indicator of Green Space Connectivity

The final environmental criterion that was implemented from among the substantial number the professional Malaysian respondents considered important (discussed in Section 4.7 (v)) and for which an indicator could be derived from the available digital data sets was green space connectivity. Figure 6.34 shows the results for this environmental indicator. Part (a) of this figure shows the five different buffer zones involved with differing widths with the first extending from the green space itself to a distance of 100 meters away and the furthest running from a distance of 901 metres to 1200 meters from the green area. As discussed earlier, the different belt widths ranging from 100 meters to 300 meters were chosen according to reported evidence that green spaces connected within these distances can provide multiple benefits in sustaining biodiversity etc. These buffer zones were created around all the 17 sites in order to identify other green spaces that lay near to the boundary of these sites.

Figure 6.34 (b) indicates the general connectivity throughout the city in terms of how proximate or remote the 17 green spaces are from neighbouring green spaces. Some sense of the connectivity between the city's green spaces can be interpreted from this figure. From scrutinising Figure 6.34, it seems that several possible 'corridors' or possible ways to connect up individual green spaces can be identified. Several green spaces form green corridors, for instance starting from Bukit Jalil Park (in the southern part of the city) towards Bukit Gasing (in the western part of the city) a green corridor could continue to Rimba Ilmu and on to Bukit Kiara (in the west part of the city). Such green corridors are believed to enhance and encourage species diversity and also to provide a variety of spaces for recreation for city dwellers (discussed in Section 6.1.2.1 (iv)).

A calculation was made to quantify the amount of green space lying within the five different buffer zones around these 17 sites. This calculation was based on the proportion of each buffer zone that contained green space, weighted so that any green space found in the nearest buffer zone (0-100 meters) scores more highly than green space in more distant buffers. Then scores between 1 (very little nearby green space) and 5 (much more nearby green space) were given to each of the 17 sites.

Part (c) of Figure 6.34 illustrates the areal weighting for each of the buffer zones surrounding the sites. From this spatially weighted calculation, scores for each of these 17 sites were produced; Table 6.10 summarises the results of these calculations (Appendix G presents these results in detail). It is evident from this table that the scores computed from this proximity weighting are small (range 0 – 0.5) compared with the mean scores computed for the three previous indices. This arises because, as Figure 6.34 (c) shows, most of the sites do not have large amounts of green space nearby. These scores, however, do validly identify sites with more green space nearby such as Bukit Jalil and Perdana Lake Garden, and also highlight those with little green space nearby, such as Sri Hartamas. To allow comparison and combination with the previous three indicators, the proximity weighted scores were then rescaled on to the same range from 1 to 5 as used for the other indicators.

Site Name	Scores based on weighting given
Perdana Lake Garden	0.326
KLCC Park	0.115
Permaisuri Lake Garden	0.193
Bukit Nanas Forest Reserve	0.079
Rimba Ilmu Universiti Malaya	0.256
Sri Hartamas	0.101
Bukit Kiara	0.335
Kepong	0.039
Klang-Gombak River	0.217
Royal Selangor Golf Club	0.055
Bukit Gasing	0.048
Pudu Jail	0.067
Bukit Jalil Park	0.478
Batu River Reserve	0.076
Desa Water Park	0.045
Titiwangsa Lake Garden	0.015
Kepong Metropolitan Park	0.2

Table 6.10: Proximity scores for all 17 sites based on the weighting given to green space in each of the buffer zones

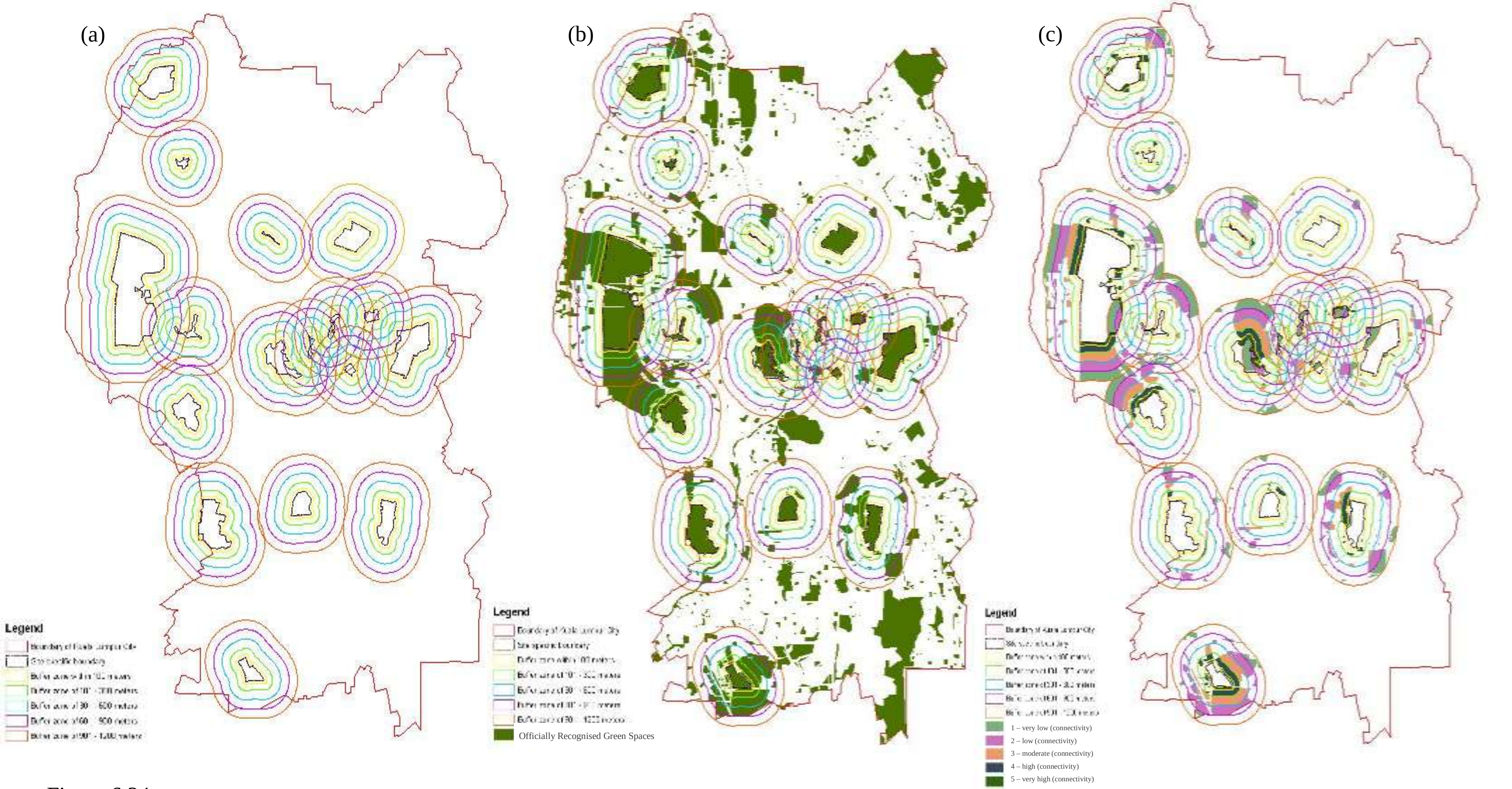


Figure 6.34:

(a) Five different buffer zones varying in width from 100 meters to 300 meters and extending up to 1200 meters from each of the 17 sites;

(b) Green spaces throughout the city overlaid on the buffer zones; and

(c) Map showing the scores given for buffer zones surrounding these 17 sites from 1 for more distant green spaces (901 – 1200 meters) up to 5 for areas of green space within 100 meters of a site.

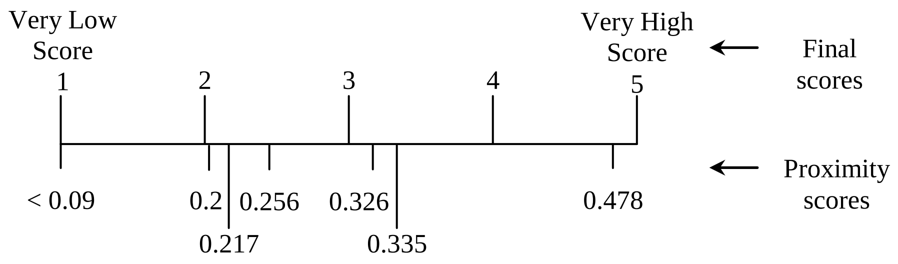


Figure 6.35: Scale from 1 (very low) to 5 (very high) connectivity to other green spaces used in re-scaling the raw proximity scores

Figure 6.35 shows how the proximity scores for each of the 17 sites were re-scaled in order to have the scores for all the criteria on a standard scale. Table 6.11 presents the final scores for each of the 17 sites after the re-scaling procedure: Bukit Jalil Park, Bukit Kiara and Perdana Lake Garden clearly stand out as having much higher connectivity with other green spaces within 1200 meters than the other green areas, which only evince moderate to low potential connectivity to any other green spaces.

Site Name	Final Score
Perdana Lake Garden	3.27
KLCC Park	1.15
Permaisuri Lake Garden	1.94
Bukit Nanas Forest Reserve	1
Rimba Ilmu Universiti Malaya	2.57
Sri Hartamas	1.01
Bukit Kiara	3.36
Kepong	1
Klang-Gombak River	2.18
Royal Selangor Golf Club	1
Bukit Gasing	1
Pudu Jail	1
Bukit Jalil Park	4.8
Batu River Reserve	1
Desa Water Park	1
Titiwangsa Lake Garden	1
Kepong Metropolitan Park	2.01

Table 6.11: Final score for all the 17 sites on the environmental criterion of connectivity

6.2.2.2 Social (i.e. Accessibility) Indicators

This section will discuss the results through which the three social criteria (i.e. accessibility) of the green space 'indicators for the whole city' were evaluated.

(i) Accessibility of green and open Space to the Surrounding Population

The first measurable social indicator examined for the whole city was the accessibility of green space to the surrounding population. As discussed in Section 6.1.2.2(i), this assessment was carried out at two different scales. The first was an assessment on a coarser scale of the provision of officially recognised green and open space in KL in relation to the population numbers within each District. The second was a finer scale assessment of the accessibility of green space to the surrounding local population, which used dasymetric mapping to produce a more detailed distribution of the city population.

Figure 6.36 indicates the provision of officially recognised green space in each District of the city according to whether the '6 acre (2.4 hectare) standard' (discussion of this standard is in Section 6.1.2.2(i)) has been met or not. It can be observed from the figure that only two Districts met this standard: Damansara Penchala and City Center, which are both known to have lower density of population. In contrast, the four Districts which did not meet the standard are known to be highly populated areas. These results may be of interest to the city planners as this seems to be the first time the '6 acre standard' has been evaluated in KL and the results presented. These results provide a first impression of the relative provision throughout the city of officially recognised green space, indicating areas where more green spaces seems to be needed in relation to a high population and/or where the existing provision of green space does not currently meet this standard. Although one could debate whether this standard should be applied in Malaysia, at the present time no other standard has gained acceptance or become established so the 'six acre' target seems a reasonable starting point. For calculating this index, only the areas of green and open space officially recognised by DBKL, whether owned by public government bodies or privately owned, were used (not all the types of green space in the expanded typology).

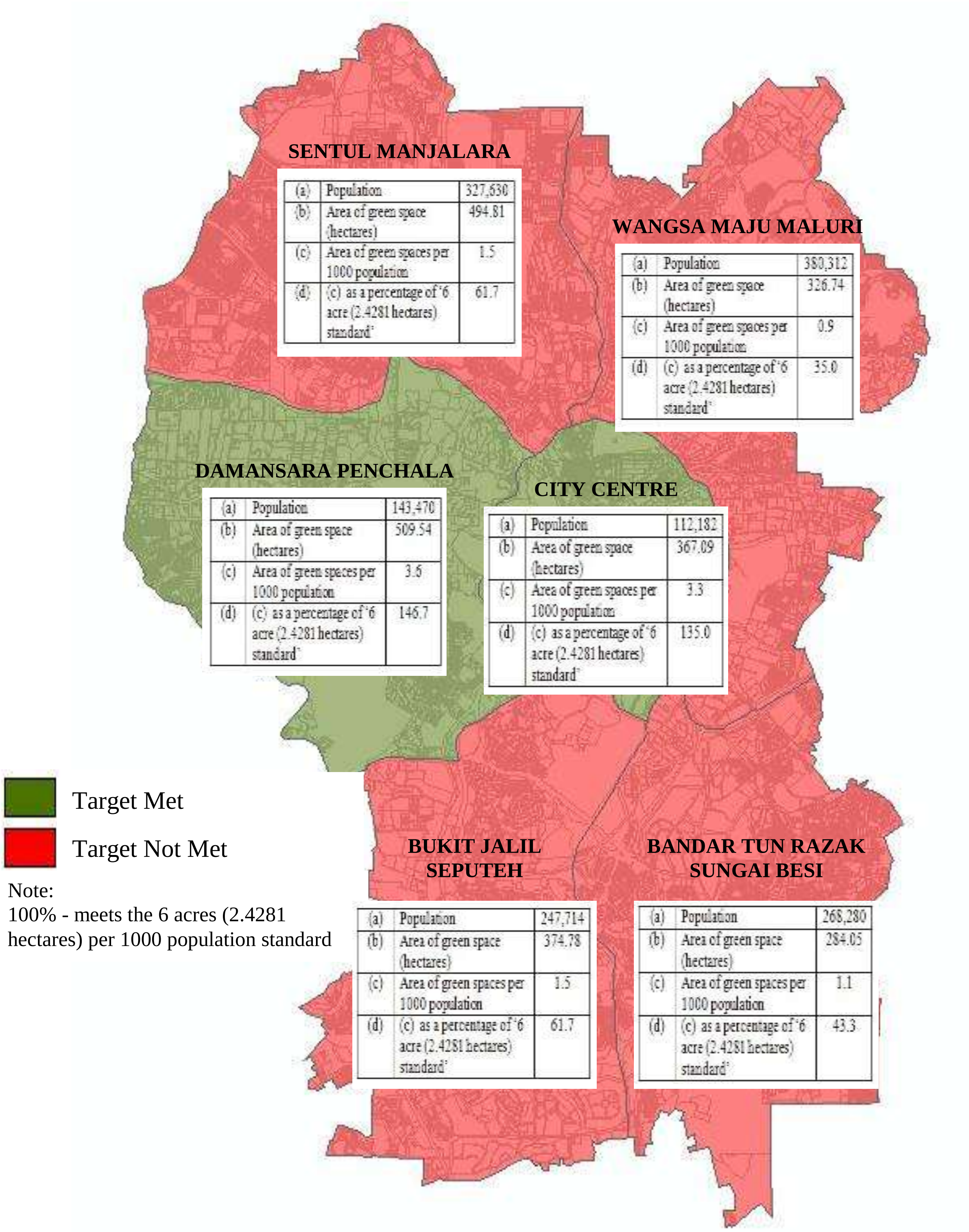


Figure 6.36: Actual provision of green and open space as recognised officially by Kuala Lumpur City Hall compared to the '6 acre (2.4281 hectare) standard'

Turning to the finer scale, Figure 6.37 shows the maps that were produced in evaluating the accessibility of the surrounding population to green spaces with Figure 6.37 (a) showing the estimated distribution of population for the whole city resulting from the outcome of the dasymetric mapping technique. As explained earlier in Section 6.1.2.2 (i), this technique helps to map the population distribution 'intelligently', as it distributes the population into only habitable areas. This finer scale mapping of population distribution was required to enable a more accurate calculation of the number of people that resided e.g. within 300 meters distance or, say, between 1200 and 1500 meters distance from each of the 17 green spaces (the 5 buffer zones used are shown in Figure 6.37(b)). Appendix H presents the detailed results and Figure 6.37 (c) shows the finer scale population distribution within the five different buffer zones. Using this population data, values were calculated for the population in the areas surrounding each of the 17 sites (shown in Appendix I).

The raw totals of population near to each site were then reclassified so that sites with the least population in the outermost zone up to 1500 meters were scored towards 1, whilst sites with a high population within 300 meters were scored towards 5. Table 6.12 presents the final scores showing that Kepong and Bukit Kiara had the highest accessibility scores to their surrounding population of all 17 sites with Permaisuri Lake Garden and Desa Water Park coming next with moderately high scores on accessibility to their surrounding populations. Since Kepong and part of Bukit Kiara are located in the District of Sentul Manjalara which does not meet the '6 acre standard' and Permaisuri Lake Garden and Desa Water Park are respectively located in the Districts of Bandar Tun Razak Sungai Besi and Bukit Jalil Seputeh, which also do not meet the '6 acre standard', it can be argued that this is a further reason why these green spaces may need to be retained or strongly protected as it appears to serve a high population demand in an area of the city which is generally deficient in green space.

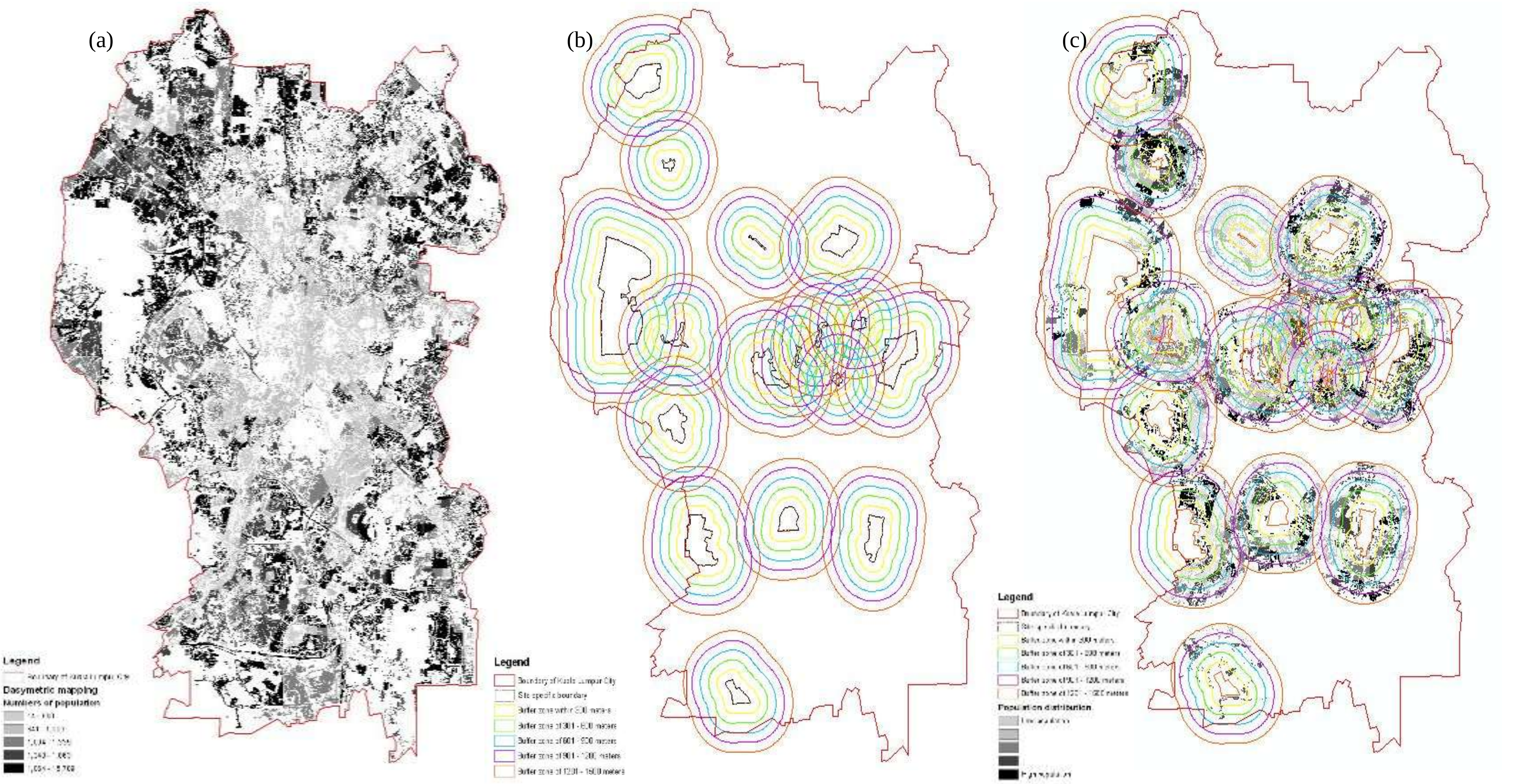


Figure 6.37:

(a) Finer scale distribution of population within the city using dasymetric mapping;

(b) Five buffer zones around each site with each zone 300 meters wide; and

(c) Population within these buffer zones.

Site Name	Final Score
Perdana Lake Garden	1.27
KLCC Park	1.66
Permaisuri Lake Garden	3.36
Bukit Nanas Forest Reserve	1
Rimba Ilmu Universiti Malaya	1.77
Sri Hartamas	1.81
Bukit Kiara	4.52
Kepong	4.84
Klang-Gombak River	1
Royal Selangor Golf Club	2.77
Bukit Gasing	1.53
Pudu Jail	1.41
Bukit Jalil Park	1.17
Batu River Reserve	1.1
Desa Water Park	3.26
Titiwangsa Lake Garden	2.99
Kepong Metropolitan Park	1.34

Table 6.12: Final score for the 17 sites based on population surrounding each site.

In contrast, sites such as Bukit Nanas Forest Reserve, Klang-Gombak River, and Batu River Reserve are among sites that were assessed to have a relatively low population in the immediately surrounding area. An obvious explanation for this lower demand might be that these sites are located in the central area of the city where the resident night-time population densities are low. Although these sites are popular during the day with tourists and office workers and ideally the number of people working in particular areas of the city should be taken into account in making these assessments of accessibility, little information on place of employment of population at a suitable geographical scale is available. Thus all our calculations here have to be based on where people reside. The results of these assessments of accessibility at both coarser and finer scales may well be of interest to planners or others making decisions about whether to retain a parcel of green space or to allow it to be developed and need to take account of the numbers of people for whom the green space may be providing a service.

(ii) Accessibility of Green Spaces to Rail Transport

The second measure of accessibility is how accessible a green space is by public transport. As a simple indicator of this, the number of light rail and monorail stations located within five buffer zones each 300 metres wide up to 1500 meters from each of the 17 sites was calculated. Figure 6.38 (a) shows the five buffer zones which were created.

Figure 6.38 (b) shows the distribution of light rail and monorail stations within the five different buffer zones around each site. The number of stations lying within each of these buffer zones was counted and weighted with a weighting of 1 given if the station was in the most distant buffer zone and 5 given for stations within 300 meters of a site.

From Table 6.13 three sites scored highly in terms of their accessibility from nearby public rail stations. These sites are Klang-Gombak River, Bukit Nanas Forest Reserve and Pudu Jail. These scores seem quite plausible because these sites are all located in the central area of the city where the provision of public transport is very good as compared to more remote areas. Sites assessed to have much lower accessibility from public rail stations included Sri Hartamas, Bukit Kiara, Kepong, Kepong Metropolitan Park, Bukit Jalil Park and Desa Water Park, all located outside the central area of the city in areas where there is no rail network.

Site Name	Final Score
Perdana Lake Garden	2.55
KLCC Park	2.39
Permaisuri Lake Garden	1.14
Bukit Nanas Forest Reserve	3.6
Rimba Ilmu Universiti Malaya	1.02
Sri Hartamas	1
Bukit Kiara	1
Kepong	1.01
Klang-Gombak River	3.86
Royal Selangor Golf Club	1.32
Bukit Gasing	1.03
Pudu Jail	3.34
Bukit Jalil Park	1.01
Batu River Reserve	1.13
Desa Water Park	1.02
Titiwangsa Lake Garden	1.53
Kepong Metropolitan Park	1

Table 6.13: Final scores for the 17 sites on accessibility to monorail and light rail transport.

These results confirm that many of the green spaces located outside the centre of the city are not well linked with KL's internal rail network. Therefore, in order to access many of the green spaces outside the central area, one needs to use other means of transportation (such as private transport or other forms of public transportation like buses or taxis). Furthermore, if a more comprehensive index using more modes of transport (particularly buses) was developed, a fuller picture of how accessible each site is by all means of public transport could be drawn. This could provide information to the authorities regarding whether areas with high density of population outside the central district could increase their use of the more remote green spaces if they were provided with better links by public transport, especially in the urban rail network. With good rail links, increased use might then come not just from areas nearby but also from different parts of the city further afield from people conveniently connected by public transport.

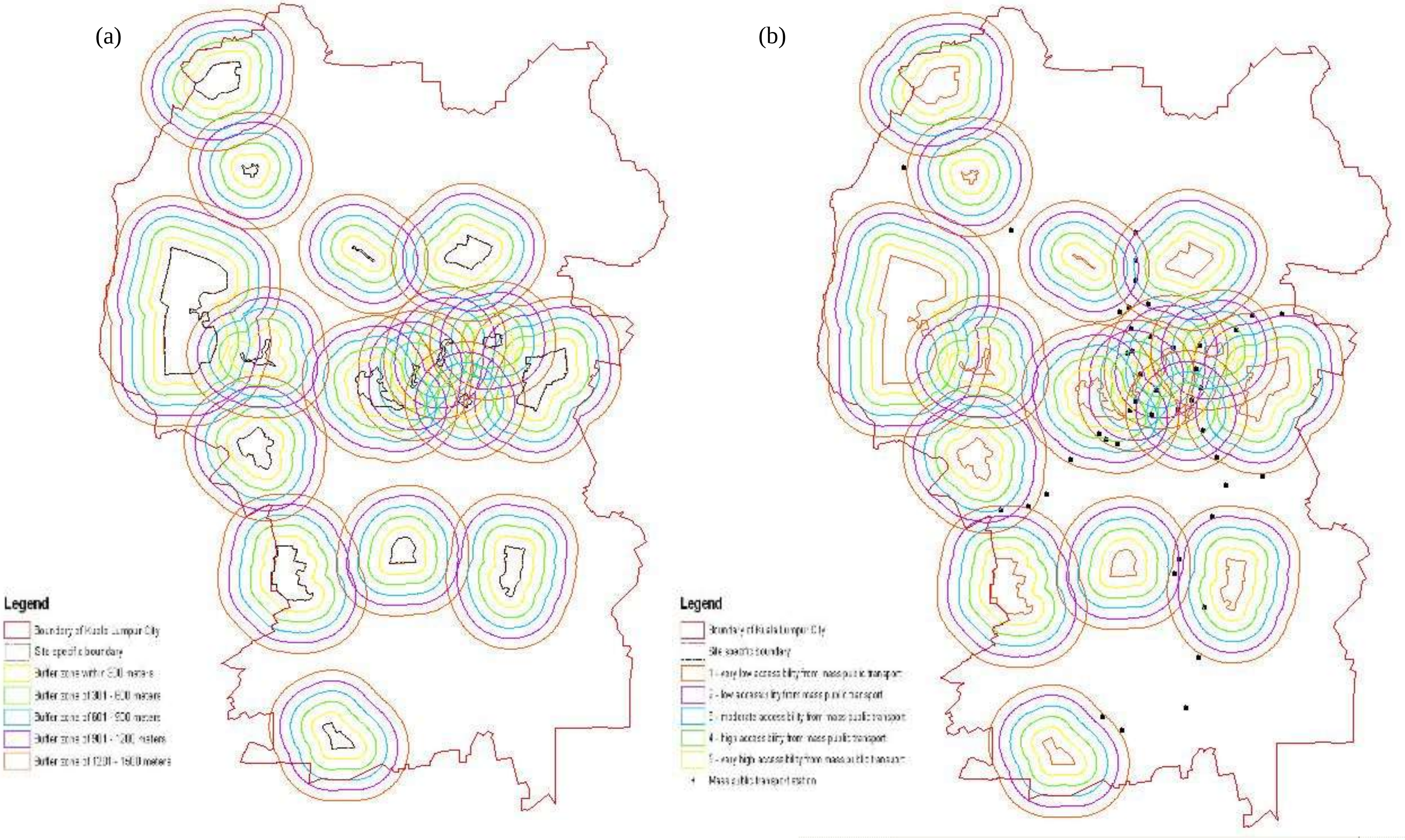


Figure 6.38:
(a) Five buffer zones around each site with each zone 300 meters wide; and
(b) Rail stations within each of the buffer zones surrounding the 17 sites.

(iii) Openness and Availability of Green Spaces to the Public

The final index of accessibility was concerned with trying to gauge, however roughly, how open and available each green space really was to the public. To understand this, five sub-criteria (discussed in Section 6.1.2.2(iii) and shown in Table 6.2) were taken into consideration. These sub-criteria were believed to have some bearing on how open and available to the public each green space actually was, but their selection was also based partly on the availability of data for all sites across the city with which to measure or interpret some facets of this dimension of accessibility.

Figure 6.39 (a) shows the status of each of the 17 sites as regards whether it was gazetted or not in 2006. The maximum score of 5 was given to 8 sites, namely Perdana Lake Garden, KLCC Park, Permaisuri Lake Garden, Bukit Nanas Forest Reserve, Royal Selangor Golf Club, Bukit Jalil Park, Titiwangsa Lake Garden and Kepong Metropolitan Park, which have been protected as green spaces by gazetting and hence can be expected to remain open and available to the public for the foreseeable future. A few of the sites with part of their area gazetted were assigned scores of 3; areas not gazetted were given scores of 1.

Figure 6.39 (b) indicates which sites are publicly owned as opposed to privately owned; a score of 5 was given to publicly owned sites as these are naturally more likely to be available to the public compared to privately owned sites which scored 1. Where some restriction was implied in terms of access to the site or if they were only partly in public ownership, the sites were scored 3. Figure 6.39 (c) shows whether sites were publicly or privately managed and maintained. Sites scoring the maximum of 5 were not only maintained by the local authority but neighbourhood communities were also involved in maintaining and managing these sites. Such arrangements allow the public to enjoy a greater sense of involvement with and 'belonging' to the sites and hence tend to increase the perception of their availability and openness.

Figure 6.40 (a) indicates sites that are gated, as opposed to sites that do not appear to have any kind of gate or controlled entrance, whilst Figure 6.40 (b) indicates sites that were accessible 24 hours a day, thereby gaining scores of 5, compared to sites with less than 24 hour access, which scored 3 for at least 12 hours of access per day or 1 for less than 12 hours of access per day. Both of these results highlight sites such as KLCC Park, Klang-Gombak River and Batu River Reserve as areas which do not have gates and can be accessed at all times of the day. Being very open and available to the public, these sites therefore scored 5 for both sub-criteria. In contrast, sites such as the Royal Selangor Golf Club and Pudu Jail are gated sites and cannot be accessed at any time except if permission is granted by the relevant authorities. Thus these two criteria were found to be very significant and influential in determining how accessible each of the sites really is to the general public.

Table 6.14 summarises the final mean scores for each of the 17 sites from combining these five sub-criteria (detailed scoring is shown in Appendix J) and reveals that Klang-Gombak River, the Batu River Reserve, Perdana Lake Garden and Permaisuri Lake Garden appear to be the sites most open and available to the public according to the approach used here with all these sites achieving mean scores above 4. On the other hand, Pudu Jail, the Royal Selangor Golf Club and Desa Water Park all emerge with mean scores below 2 and therefore appear to display low availability to the public. In gathering the information needed to calculate these results, it was in fact found that some municipal parks such as Bukit Jalil Park, Titiwangsa Lake Garden and Kepong Metropolitan Park, which are intended for public recreational purposes, were actually not fully available to the public due to some restrictions such as not being open 24 hours; hence these sites were evaluated as having moderate availability to the public.

Site Name	**Mean Score**
Perdana Lake Garden	4.2
KLCC Park	3.4
Permaisuri Lake Garden	4.2
Bukit Nanas Forest Reserve	3.8
Rimba Ilmu Universiti Malaya	2.6
Sri Hartamas	2.2
Bukit Kiara	3.8
Kepong	2.2
Klang-Gombak River	4.6
Royal Selangor Golf Club	1.8
Bukit Gasing	2.6
Pudu Jail	1
Bukit Jalil Park	3.8
Batu River Reserve	4.6
Desa Water Park	1.4
Titiwangsa Lake Garden	3.8
Kepong Metropolitan Park	3.8

Table 6.14: Mean scores for the 17 sites on their openness and availability to the public

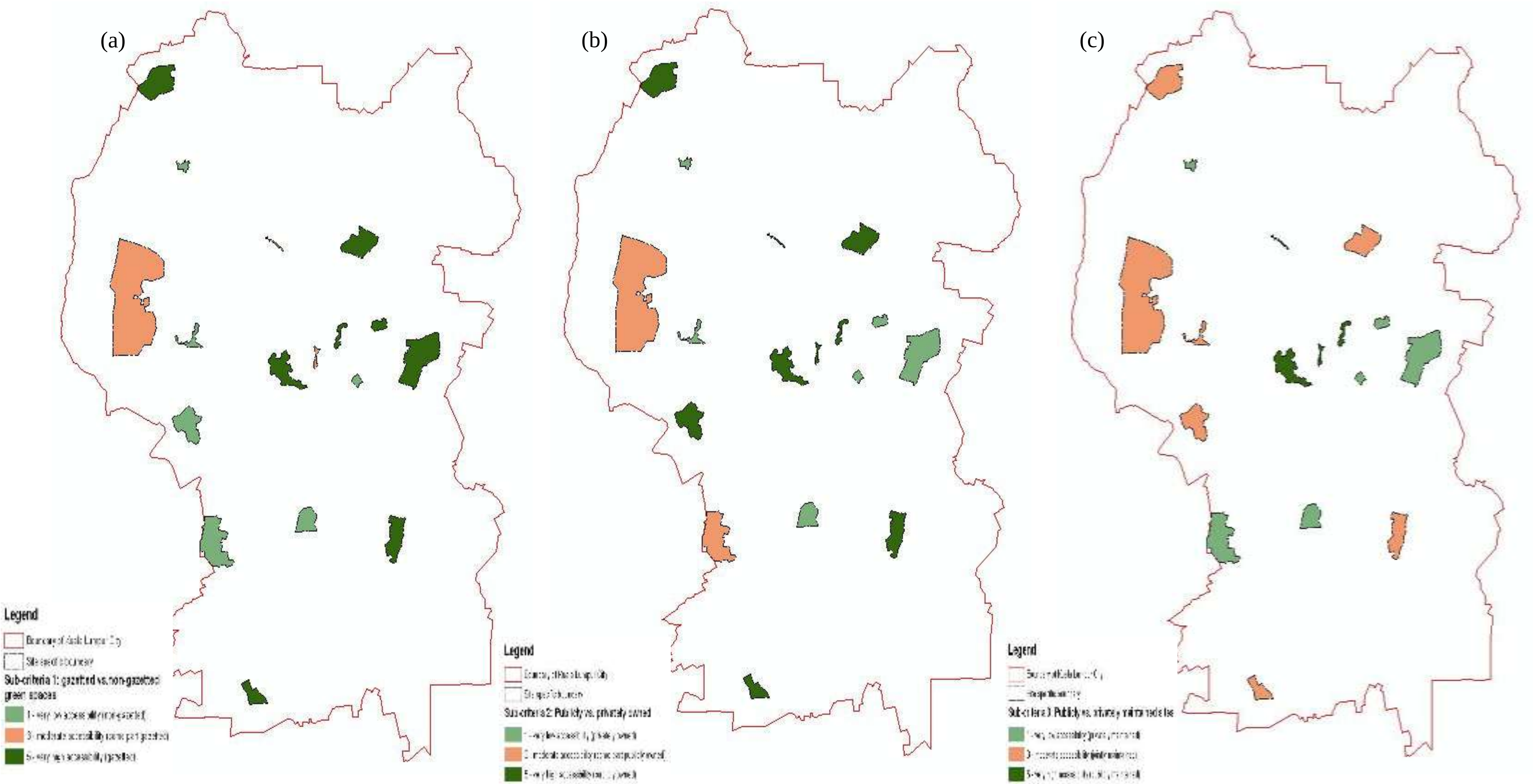


Figure 6.39:

(a) Status of 17 green spaces as regards gazetting;

(b) Status of 17 green spaces as regards whether ownership is public or private; and

(c) Status of 17 green spaces as regards whether management and maintenance are public or private.

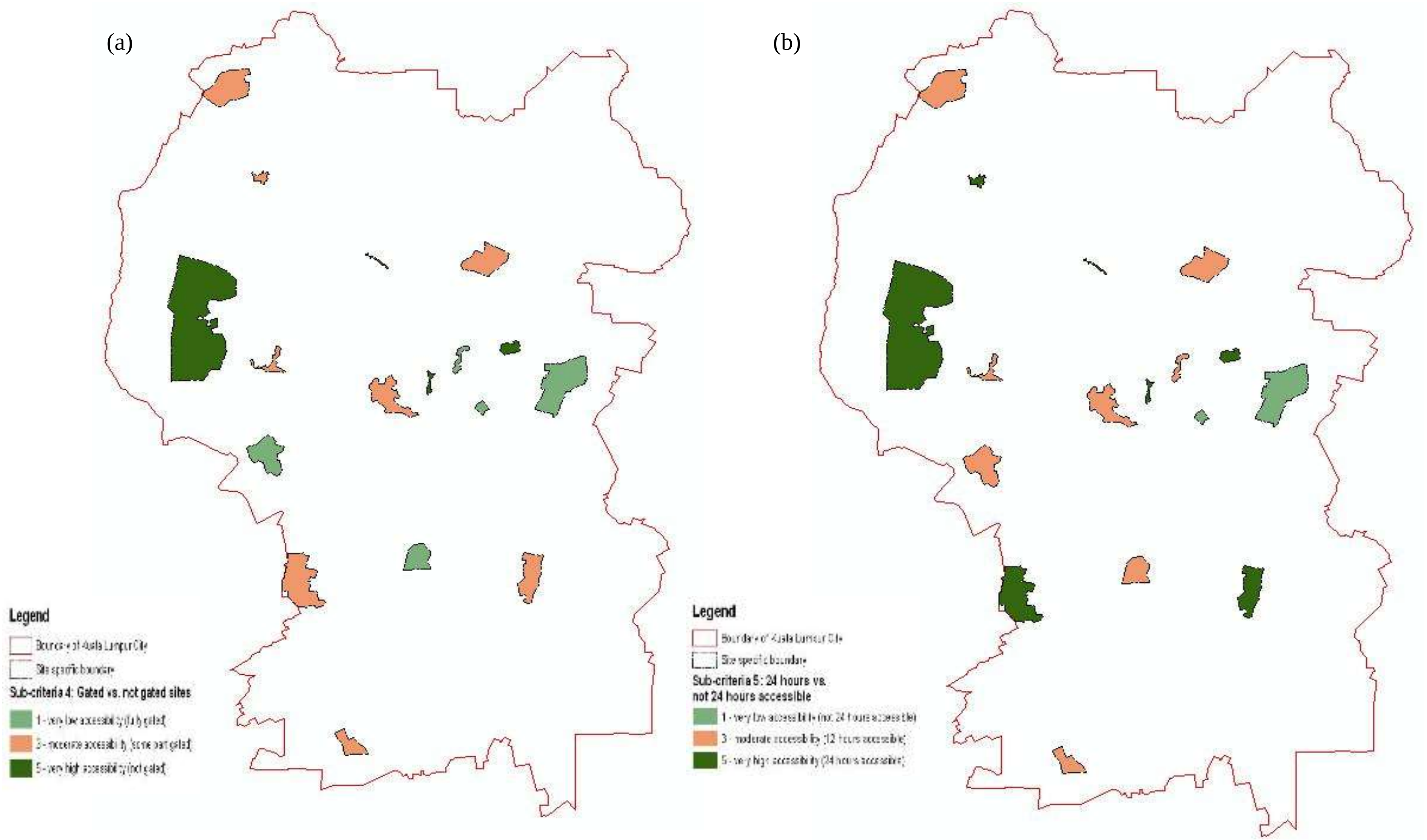


Figure 6.40:
(a) Status of 17 green spaces as regards gated entry ; and
(b) Status of 17 green spaces as regards whether they are open and available for 24 hours or for less than 24 hours.

(iv) Evaluation of Sites on Environmental and Accessibility Indicators Compared to Evaluation in the Field

Two overall 'desk based' scores for each site were calculated: an overall mean score across all four environmental criteria and an overall mean score across all three accessibility indicators. Table 6.15 gives these 'desk-based' assessment results for the 17 sites.

Bukit Kiara, Perdana Lake Garden and Bukit Jalil Park were evaluated highly on the mean for the four environmental indicators (all enjoyed overall mean scores of more than 3.9). Interestingly, these three sites are also among the sites that were also evaluated highly for their environmental qualities from ground survey (Table 6.3). In contrast, on the overall mean for the three accessibility indicators, Bukit Jalil Park and Perdana Lake Garden were assessed to have quite low mean accessibility attributes. However, Bukit Kiara and also the Klang-Gombak River were evaluated on this desk based mean indicator as having moderate accessibility scores (both sites scored 3.2).

On these desk-based indicators, three sites were assessed to have low overall mean environmental scores. These sites were Pudu Jail, Klang-Gombak River and Kepong (all of these sites scored below 2.2 for mean score). Pudu Jail and Kepong were also assessed to have lowish (below 3.0) mean environmental scores by site survey (Table 6.3). In terms of the accessibility indices, seven sites were found to have low overall mean scores: Sri Hartamas, Bukit Gasing, Rimba Ilmu, Royal Selangor Golf Club, Pudu Jail, Bukit Jalil Park and Desa Water Park (all these were awarded mean scores below 2 in Table 6.15).

Site Name	Four Environmental Criteria (Overall Mean Score)	Three Accessibility Indices (Overall Mean Score)
1-Perdana Lake Garden	3.97	2.67
2-Bukit Gasing	3.33	1.72
3-Rimba Ilmu, Universiti Malaya	3.47	1.8
4-KLCC Park	2.91	2.48
5-Permaisuri Lake Garden	3.64	2.9
6-Klang-Gombak River	2.13	3.15
7-Royal Selangor Golf Club	3.18	1.96
8-Bukit Nanas Forest Reserve	3.48	2.8
9-Bukit Kiara	4.06	3.11
10-Kepong	2.17	2.68
11-Sri Hartamas	2.55	1.67
12-Pudu Jail	2.07	1.92
13-Bukit Jalil Park	3.94	1.99
14-Batu River Reserve	2.78	2.28
15-Desa Water Park	2.68	1.89
16-Titiwangsa Lake Garden	3	2.77
17-Kepong Metropolitan Park	3.24	2.05

Table 6.15: Overall mean scores for the 4 environmental and 3 accessibility indicators for each of the 17 sites, using desk based estimates.

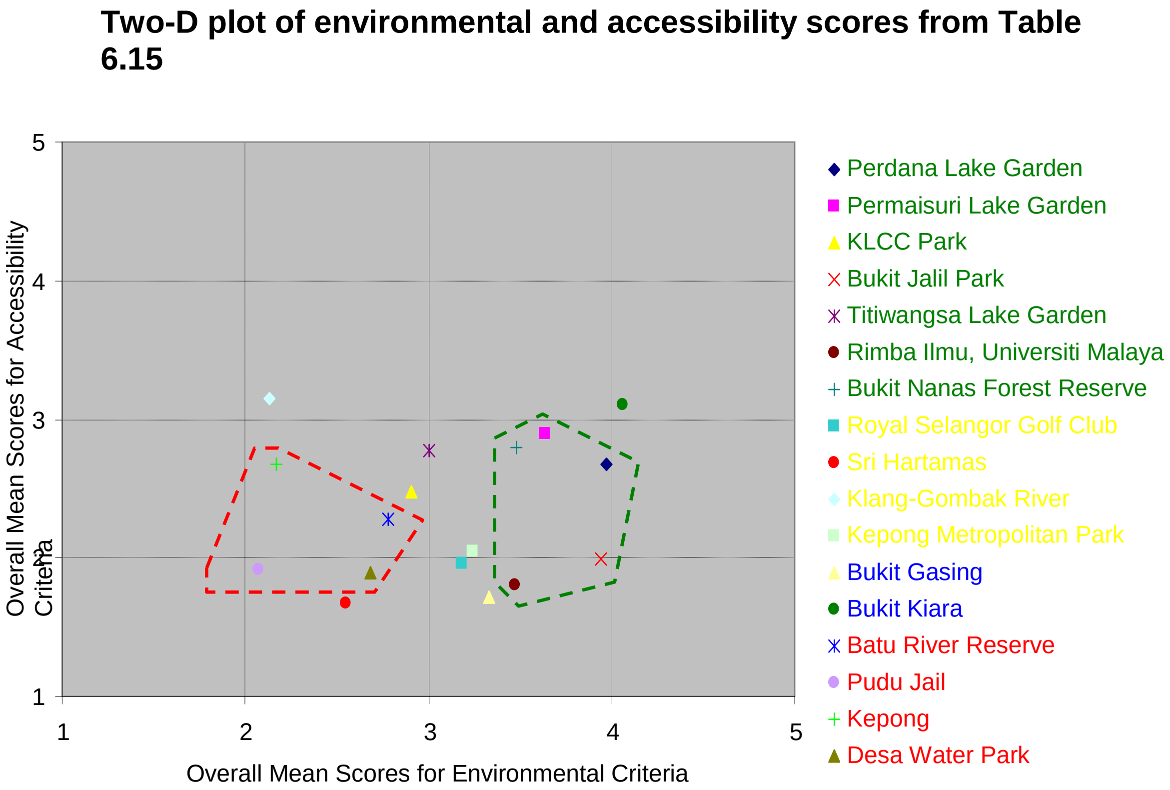


Figure 6.41: Sites plotted according to their combination of mean scores for 4 environmental criteria and 3 measures of accessibility, using desk based estimates (values from Table 6.15).

Figure 6.41 shows the sites plotted on their combined scores for the overall means for both environmental and accessibility indicators. On first appearance, this plot seems dissimilar to the plot of the 2 equivalent mean scores derived from the seven corresponding criteria observed from the site visits (Figure 6.30). One immediately obvious difference is that most of the sites that were evaluated to have higher mean scores for accessibility from field assessment were only given moderate to low scores on the desk-based indicators. Indeed, only two sites scored above 3.0 on overall mean accessibility in Figure 6.30.

Nevertheless, there are some similarities in the groups produced by these two techniques of assessment. For instance, there are four sites that had low environmental and low accessibility scores on both the ground survey and the desk-based indicators: Batu River Reserve, Pudu Jail, Kepong and Desa Water Park (group shown by the red dotted line in Figure 6.41). In these cases, the same reasons for the sites being rated poorly in the field (their low vegetation cover and poor scores on various aspects of accessibility) are also detected by the desk based indicators. For similar reasons, most of the well vegetated sites that were awarded high environmental scores from the field survey also scored highly on the desk-based indicators, namely Perdana Lake Garden, Permaisuri Lake Garden, Bukit Jalil Park, Rimba Ilmu and Bukit Nanas Forest Reserve (this group is contained within the green dotted line in Figure 6.41).

Other than these two groups of sites, however, the other groups of sites that emerged from the site visits (Figures 6.12 and 6.30) are not evident in Figure 6.41. This is thought to be due to the limitations of the 7 simple indicators which seem to be better for scoring the environmental benefits of the sites; obviously, the accessibility indicators alone do not capture the full range of social, amenity and recreational benefits of many of the sites since they simply take no account of these.

Table 6.16 compares the rankings of the 17 sites on:

(a) overall mean scores across all 13 environmental criteria assessed using ground survey;

(b) overall mean scores across the reduced set of four environmental criteria assessed using ground survey (as noted earlier, these four environmental criteria were considered important by the respondents in prioritising green spaces along with several other environmental and social criteria); and

(c) overall mean scores across all four environmental indicators estimated from desk-based analysis.

It can be seen from columns (a) and (b) in Table 6.16 that the first nine ranks identifying the sites with the highest environmental scores on both (a) and (b) are occupied by the same sites in the two columns, with only one exception. Thus the first nine sites from Perdana Lake Garden to Titiwangsa Lake Garden in column (a) appear in the first 9 ranks, although in slightly different rank order, in column (b), except for Titiwangsa Lake Garden which is ranked 10th in (b). Moreover, the rankings for columns (a) and (b) for the four sites with lowest environmental scores (from Kepong to Pudu Jail) are exactly the same on the two sets of field survey criteria. The strong correspondence between the ranks in (a) and (b) is confirmed by the high value of 0.8550 computed for them on Spearman's rank correlation coefficient.

When a similar comparison is made between the mean overall scores for the four criteria estimated first from ground survey and then through the four desk-based indicators (columns (b) and (c)), the rankings appear slightly less similar, although the desk-based indicators are still broadly separating out the sites with higher environmental benefits from those recognised to be of lower environmental quality (one exception is KLCC Park which was ranked 11 on the desk-based indicators). In fact, the correspondence between the ranks in (b) and (c) may be somewhat stronger than first appears because Spearman's rank correlation coefficient produces a slightly higher value (0.8632) for these two columns than for (a) and (b). A Spearman value of 0.7859 between columns (a) and (c) further confirms the strong similarities between all 3 sets of evaluations of the environmental characteristics of the 17 sites, using the overall means.

Turning now to the results of evaluating the social criteria, Table 6.17 presents the results of ranking the 17 sites on:

(a) overall mean scores across all 18 social criteria rated by field survey;
(b) overall mean scores across the reduced set of three 'social' (i.e. accessibility) criteria rated by ground survey (these three accessibility criteria were considered important by the respondents in prioritising green spaces for preservation along with a larger number of other social and environmental criteria); and
(c) overall mean scores across the three accessibility criteria that were used in assessing each of the 17 sites by desk-based analysis.

In Table 6.17 the correspondence between the rankings of the two sets of field based mean scores in columns (a) and (b) at first sight seems somewhat weaker than was the case with the environmental criteria. Nevertheless, the rankings on the field criteria in (a) and (b) show some broad similarity, with eight of the top 10 sites in column (a) also appearing among the first ten for the overall means from the reduced set of three social criteria, all concerned with accessibility, in column (b). In addition the rankings in columns (a) and (b) for the six sites with the lowest social indices (from Desa Water Park to Pudu Jail) also show some correspondence, except for the Batu River Reserve and Pudu Jail which were ranked 6th equal when only the indicators of accessibility were used. This broad correspondence between (a) and (b) is confirmed by a value for the Spearman correlation between them of 0.7188; although lower than the 3 rank correlations among the environmental criteria, this still indicates quite a strong similarity between the two sets of criteria from the field

However, it seems fairly clear in Table 6.17 that there is only a very weak correspondence between the rankings of the sites as regards overall mean scores for the accessibility criteria observed in the field and the overall mean scores for accessibility from desk based analysis i.e. between columns (b) and (c), an impression confirmed by a much lower value for the Spearman correlation of 0.4690. This weak correspondence is perhaps due to only indices of accessibility being used in (b) and (c) compared to the much wider range of factors evaluated by site visits in (a). Consideration of the different rankings of some of the individual sites in columns (b) and (c) provides further evidence of only a weak correspondence at best. For instance KLCC Park is ranked low (8th) on the mean of the desk-based indicators of population accessibility (which only take account of the night time location of population) but was highly rated (2nd) on the number of physical entrances and exits observed by field survey. This may also be partly due to these two sets of 7 measures not always evaluating exactly the same characteristic or property. Other sites which show considerable differences in rank in columns (b) and (c) of Table 6.17 include Bukit Kiara (ranks of 13 and 2), Rimba Ilmu (ranks of 4 and 15) and Kepong (ranks of 15 and 6).

As anticipated, these results suggest that many social attributes of green spaces other than accessibility still need to be assessed on the ground or possibly interpreted visually from imagery of appropriate resolution. Clearly, many, if not most, of these site-specific attributes cannot easily be measured using desk-based indicators alone. Observations on the ground still need to be carried out in order to determine such characteristics as the perceived safety, the levels of maintenance and the cleanliness of particular green areas. Social surveys of users and visits to the sites will still be needed to gather such data; thus desk-based indicators should not be seen as potential replacements for these procedures.

The desk-based indicators have been shown to be able to indicate some sites, such as the former Pudu Jail site, which despite their present poor amenity value, nevertheless have an accessible situation which would allow them to serve a significant local population if the site amenities and facilities were improved. High values on accessibility measures may also be used to suggest sites that may need to be prioritised for protection as officially recognised green or open space, since their accessibility is likely to make them more attractive for development. In fact, since this analysis was undertaken, housing development has actually begun on the Pudu Jail site, as a means of increasing city centre population and accommodating population influx.

No	Site Name	(a) Mean score on 13 environmental criteria from ground survey	Ranking of (a)	(b) Mean score using only 4 environmental criteria from ground survey	Ranking of (b)	(c) Mean score using only 4 environmental indicators from desk-based analysis	Ranking of (c)
1	Perdana Lake Garden	3.88	1	3.94	3	3.97	2
2	Permaisuri Lake Garden	3.87	2	3.81	6	3.64	4
3	KLCC Park	3.75	3	3.5	9	2.91	11
4	Rimba Ilmu Universiti Malaya	3.62	4	4	2	3.47	6
5	Bukit Nanas Forest Reserve	3.6	5	4.31	1	3.48	5
6	Bukit Kiara	3.31	6	3.94	3	4.06	1
7	Bukit Jalil Park	3.31	6	3.63	7	3.94	3
8	Bukit Gasing	3.29	8	3.94	3	3.33	7
9	Titiwangsa Lake Garden	3.27	9	3.13	10	3	10
10	Klang-Gombak River	3.15	10	2.94	11	2.13	16
11	Royal Selangor Golf Club	3.02	11	2.94	11	3.18	9
12	Sri Hartamas	2.96	12	2.94	11	2.55	14
13	Kepong Metropolitan Park	2.88	13	3.63	7	3.24	8
14	Kepong	2.79	14	2.75	14	2.17	15
15	Desa Water Park	2.73	15	2.63	15	2.68	13
16	Batu River Reserve	2.08	16	2.25	16	2.78	12
17	Pudu Jail	1.81	17	2.13	17	2.07	17

Table 6.16: Overall mean scores for each of the 17 sites and their ranks on:

(d) Thirteen environmental criteria evaluated from ground survey;
(e) Four environmental criteria evaluated from ground survey; and
(f) Four environmental indicators estimated by desk-based analysis

No	Site Name	(a) Mean score on 18 social criteria from ground survey	Ranking of (a)	(b) Mean score on 3 accessibility criteria from ground survey	Ranking of (b)	(c) Mean score on 3 accessibility criteria from desk-based analysis	Ranking of (c)
1	KLCC Park	4.57	1	4.33	2	2.48	8
2	Titiwangsa Lake Garden	4.17	2	4.67	1	2.77	5
3	Permaisuri Lake Garden	4.15	3	4.17	3	2.9	3
4	Perdana Lake Garden	3.92	4	3.25	11	2.67	7
5	Bukit Jalil Park	3.61	5	3.5	6	1.99	11
6	Rimba Ilmu Universiti Malaya	3.50	6	3.92	4	1.8	15
7	Kepong Metropolitan Park	3.42	7	3.33	10	2.05	10
8	Bukit Nanas Forest Reserve	3.36	8	3.58	5	2.8	4
9	Royal Selangor Golf Club	3.22	9	2.75	14	1.96	12
10	Klang-Gombak River	3.13	10	3.5	6	3.15	1
11	Sri Hartamas	3.08	11	3.08	12	1.67	17
12	Desa Water Park	2.50	12	2.5	16	1.89	14
13	Kepong	2.29	13	2.58	15	2.68	6
14	Batu River Reserve	2.28	14	3.5	6	2.28	9
15	Bukit Kiara	2.26	15	2.83	13	3.11	2
16	Bukit Gasing	2.00	16	2.5	16	1.72	16
17	Pudu Jail	2.00	17	3.5	6	1.92	13

Table 6.17: Overall mean scores for each of the 17 sites and their ranks on:
(d) Eighteen social criteria assessed using ground survey;
(e) Three social (i.e. accessibility) criteria evaluated using ground survey; and
(f) Three social (i.e. accessibility) indicators estimated by desk-based analysis.

6.3 Summary and Discussion

In this chapter, the author assessed green spaces in Kuala Lumpur city using two different methods, firstly by site observation and assessment and secondly by desk-based analysis using GIS. This chapter set out to firstly understand the information that could be obtained from each method, and secondly to determine whether the less resource intensive desk-based method might be able to produce an assessment of green spaces that was broadly similar to the assessment produced by field survey which requires much greater resources.

A method of auditing green space was developed and tested for site observation and assessment. This auditing method extends significantly the 'place making' assessment technique learned from Greenspace Scotland by adding in some environmental properties of a site such as vegetation cover, shade and shelter and other factors considered important by the respondents to our social survey of mainly planners and landscape architects. This method allows sites to be evaluated on many of the criteria listed in Tables 4.14 and 4.15 in Chapter 4 as important criteria to consider when assessing green spaces from both a social and an environmental perspective.

Whilst some of the criteria can best be observed by site visits, for instance assessing the quality of maintenance, cleanliness, degree of safety or air quality, other criteria considered to be important might be interpreted 'remotely' from using high resolution remote sensing imagery or be estimated by an analysis of collated and ancillary GIS data. Seven such indicators were developed in this study; these were indices of the abundance and of the variety of vegetation, of the provision of shade and shelter from trees and of the connectivity of green spaces with other vegetated areas. Additionally, three further indicators were derived relating to different aspects of accessibility, namely the number of people in the areas nearby a green site, the proximity of sites to rail stations and the degree to which a site is actually open and available to the public.

Although the indicators, especially those for accessibility, could be made more comprehensive (e.g. by adding in other modes of public transport), the indicators did provide a useful starting point and did illustrate the potential of this general approach for producing some relatively objective means for assessing the provision of green space across the whole city. Many of the indicators, for example environmental indicators such as green cover abundance can be evaluated both at the district level and within smaller neighbourhood areas to determine appropriate standards for the provision of green space and to detect areas that do and do not reach certain levels of provision.

Disaggregating population data to a finer scale through using land cover data to estimate the 'habitable' areas of the city enabled us to investigate the supply of green space with respect to the local population distribution within the city. Results such as those in Table 6.12 suggested that some of the more isolated areas of green space such as Kepong in the District of Sentul Manjalara may particularly merit protection of the site itself in its present condition, even though it is somewhat derelict, simply because of its general location within the city. Although the site itself presently does not have a high amenity value, it is one of few remaining officially recognised green space areas in a district which has a deficit of green space relative to its population (only 62% of the '6 acre' standard is met) in this district. Also, once such a site is protected, it could always be improved if required through local action e.g. by the local community.

Developing indicators for connectivity allows the strategic importance of several existing and potential sites to be assessed together. For example, Figure 6.34 indicates potential for a West to East green space corridor. This is important as this corridor may act as a 'stepping stone' connecting the western green spaces of Bukit Kiara and Bukit Gasing to the more central green spaces of Perdana Lake Garden, Bukit Nanas and KLCC Park. Furthermore, by using various forms of proximity analysis and taking into account the high levels of surrounding population (as in Table 6.12), Permaisuri Lake Garden in the South East District of Sungai Besi is revealed to be an important area of publicly accessible green space in a densely populated part of the city that is generally deficient in green space (only 43% of the 6 acre standard is met). The site also provides potential green connectivity to the south of the city through its proximity to other existing but not presently gazetted spaces to the south.

There was some similarity between the rankings on environmental criteria and environmental indicators given to the sites firstly by field assessment and then by 'desk based' methods mainly using data derived from high resolution imagery. This suggests that some idea about the extent of vegetated area, provision of shade and shelter, and variety of vegetation cover can be obtained from remote sensing, although some other environmental properties such as air quality are more difficult to assess remotely.

Many social criteria could only be assessed by site visits. Although a trained image interpreter might be able to infer some characteristics of a site by visual image interpretation (such as making the inference that sites with more tree cover might have better air quality, or that sites with more built facilities might have more recreational benefit), it was not possible or meaningful to develop indicators for the whole city for many of the criteria that are very site-specific (e.g. maintenance, cleanliness or feeling of safety). Although visual interpretation of high resolution imagery could possibly be used to extract some information about green sites which is of a social nature or even quite site specific, for example the volume of people using the site, the number of entrances, the variety of infrastructure within the site etc., such information is likely to be very limited in relation to the wide range of social attributes discussed earlier or those listed in Table 4.15. In contrast, some of the contextual information about a site, such as the number of people resident in the surrounding area or its potential accessibility by public transport, can actually be difficult to gauge by a site visit or field inspection; hence this kind of information is better suited to assessment by the kind of desk-based analysis developed in this study.

In conclusion, the two methods are not presented as alternatives, but rather as complementary techniques that together may provide urban planners and other decision makers with useful information with which to assess green spaces both individually and collectively. Such information may assist in making assessments about which particular green spaces in the city to prioritise for protection or, if a number of proposed new civic green spaces are under consideration, some of the methods developed here could assist in deciding which of the proposed areas would most improve accessibility to green space over the whole city or bring the greatest benefits of the various kinds discussed in Chapter 2 to its neighbourhood. We therefore conclude that combining the more detailed information that ground surveys provide about particular sites with the benefits of a coarser, screening technique for application across the whole city enables the properties of individual sites to be evaluated within this wider context, thereby allowing both the site-specific and the wider benefits which a green space confers on its ‘neighbourhood’ and the whole of the city to be considered together.

Chapter 7

DISCUSSION OF RESULTS

7.0 Introduction

This chapter discusses the main results of the study. In Chapter 1 (Section 1.2) the broad aims set for the research were to develop as comprehensive an understanding of the nature, diversity and value of green spaces in Kuala Lumpur as the limits of time and resources permitted and to assess how far remote sensing and GIS plus a ground survey and a social survey of relevant professionals could help to achieve these aims. A second broad aim was to develop and assess methods that could provide a basis for informing strategic planning about the case for conservation of the remaining areas of green space within the city and for examining the relative merits of particular spaces. With these broad aims in mind, in Section 1.4 six sets of related research questions were formulated to clarify the focus of the research and it is now helpful to restate these more briefly than in the latter section:

(vii) What is the nature of green space within Kuala Lumpur?; How many different types of green spaces exist in the city?;

(viii) How well does the typology of green spaces used in this study capture or characterise the diversity of green spaces actually encountered in the city?;

(ix) What types of urban green spaces are currently recognised by DBKL and what further types of green spaces should DBKL consider recognising when trying to protect the most valuable existing or potential green spaces from development?;

(x) Which types of green spaces are recognised as such by the urban planners and landscape architects who completed the main survey questionnaire?; What characteristics, roles and functions of green spaces do they most value and can their evaluations be used to assess the case for conserving particular green spaces?;

(xi) Which types of green space in Kuala Lumpur can be identified from the high resolution remote sensing imagery?; How well does the remotely sensed data help in characterising the variety of green spaces found in Kuala Lumpur, for example their extent, distribution and main attributes?;

(xii) Which of the attributes of green space found to be important from the social survey can be observed through site visits and can any be measured using remotely sensed imagery and GIS?

The discussion is organised around these six groups of questions. In considering these broad aims and questions, it was emphasised in Chapter 1 that, in many respects, the focus of the thesis was primarily 'ontological' in being concerned with trying to establish what kinds of green spaces actually do exist in Kuala Lumpur i.e. the most fundamental questions underlying the research are those set out above in (i). It was argued that addressing such basic ontological questions is a necessary and important task for research in this field, particularly in the cities of the developing world. The progress made in addressing these questions will be discussed in Section 7.1.

The questions grouped under (ii) and (iii) are concerned with typologies of green space: that in (ii) is concerned with the new typology proposed for KL in Section 3.2 and set out in Table 3.2; those in (iii) are concerned with the types of green space that are currently formally recognised and used by KL City Hall, for instance in planning documents, and with other types of green space that might and perhaps ought to be recognised and recorded. As these questions are concerned with typologies, they will be discussed together under Section 7.2. This section is therefore partly concerned with the first research objective outlined in Section 1.2, which was '*to review the existing research literature and use that to construct an appropriate, more comprehensive typology for identifying and describing the green spaces that might be found within the boundaries of Kuala Lumpur'*. The second specific objective for the research defined in Section 1.2 was '*to investigate the extent to which the different types of green spaces set out in the typology are actually recognised by urban* *planners and landscape architects in Kuala Lumpur as 'urban green space' and whether the latter identify any not in the typology and to discover how these different types are evaluated by this group of professionals'.* This objective was met by conducting the questionnaire survey of the planning professionals, which sought answers to the questions listed above in (iv). These results will be brought together and discussed in Section 7.3.

The last two groups of research questions in (v) and (vi) concern the potential use of remote sensing as a means to assess and to monitor urban green space. The corresponding objective in Section 1.2 was to '*identify which of the different types of green spaces …… can be identified from the high resolution optical satellite imagery'.* The questions in (v) examine how the satellite imagery might be used to map the overall extent and distribution of the green infrastructure across the city, as opposed to mapping by reclassifying the existing land parcel data to include different types of land as green space, which can also be seen partly as more specific forms of the questions set out in (i). The answers to these questions are discussed under Sections 7.4 but are also addressed in Section 7.1. The questions posed in (vi) involve a more localised examination of how effectively particular types or particular functions of green spaces that the professional respondents to the questionnaire survey had reported to be important could be identified from the satellite imagery as opposed to requiring observation from ground survey. These questions corresponded closely with objective (iv) in Section 1.2; answers to this last set of questions are discussed under Sections 7.4.

The remainder of the chapter will then discuss possible further research arising from this work and in particular will reflect on how the techniques that have been developed here could form the basis of operational methods for city planners in Kuala Lumpur to use in monitoring green space and in targeting their limited resources in a more focused and effective way in carrying out any detailed ground observations and site visits they may need to do. Finally, the contributions of this study to the enlargement of knowledge about urban green spaces and particularly to the conservation and monitoring of these spaces in developing countries will be summarised.

7.1 The Nature, Extent and Diversity of Urban Green Space in KL

In substantive (i.e. essentially ontological) terms, the most important and, in many respects, most surprising result was the finding from analysing the IKONOS satellite data that 14,386 ha out of KL's total surface area of 24,400 ha (i.e. 59.0%) displayed some kind of vegetative cover when viewed from above. Since the total area of 'officially recognised' green and open space in DBKL's inventory is some 1,556 ha (Table 3.1) and the total area of polygons classified as green and open space or forest in the parcel based data on land use is 2,226 ha (Figure 5.2 and Table 5.2), the actual vegetated surface area is 9.2 times greater than the area of officially recognised green and open space in DBKL's inventory or 6.5 times the area of polygons classified as green and open land or forest in DBKL's database on land use. The apparent discrepancy between the values of 1,556 ha and 2,226 ha is probably due mainly to the fact that the parcel based data may tend to overestimate the extent of green area, as discussed in Section 5.4. In considering these results the difference in dates between the satellite data of 2002 and the inventory and land use data of around 5 years later has to be kept in mind. It is therefore quite possible that with some continuing loss of green space in the intervening period, satellite data for 2007 might have detected somewhat less than 14,386 ha of green land. However, even if the latter figure was several per cent lower in 2007 and some allowance is made for the inaccuracies of IKONOS data as discussed in Section 5.3.2, KL must be seen as still quite a green city in 2002 (and probably 2007) in the light of these results.

Thus the city clearly has very extensive areas of 'other' vegetated land or green infrastructure than the parks, sports fields, playgrounds and recreational areas listed in Table 3.1. These 'other' green areas can be seen as somewhat 'unrecognised' or even neglected in official planning documents and they have also received little attention in the research literature on KL. Thus a recent paper by Nor Akmar et al. (2011) provides a valuable analysis of greenspace planning and management in 6 municipalities in the Klang Valley, including KL, but concentrates almost entirely on municipally owned green spaces, i.e. it focuses effectively on parks, playing fields and other recreational areas. Though they discuss the concept of 'urban green infrastructure' in the introduction and at later points in their paper, the authors show no real awareness that the kinds of green areas they are focusing on probably form less than 25% of KL's green infrastructure and could conceivably be less than 50% in the 5 other municipalities.

The finding that there appears to be much more green infrastructure in KL than generally recognised is new and significant. There appear to be very few studies using remotely sensed data at such a fine level of resolution as IKONOS which cover entire urban areas in the developing countries. As noted in Section 2.12, published studies of cities in the developing world have tended to use data at coarser levels of resolution or have only studied part of an urban area in 'proof of concept' research and are therefore unable to assess the full extent of a city's green infrastructure. A comprehensive study of KL by Teh (1989), using 1987 aerial photo mosaics of high resolution, estimated that 45.2% of KL's surface had a green cover, but he only identified green areas larger than 0.5 ha and at least 20 metres wide. There appear to be no other studies of cities in the developing world or the tropical world with which these results could be compared to assess whether KL is unusual or not in the extent of its green infrastructure.

This result is surprising because at first sight it seems to conflict with the general views of survey respondents. For instance, some 58% thought that 25% or more of KL's green space had been lost in the previous decade (Table 4.12) and many felt that green space was difficult to protect for economic and political reasons and was therefore vulnerable to pressures for development (Section 4.5). It also seems to conflict somewhat with Teh's fear expressed in a subsequent article (Teh, 1994) of green spaces "rapidly being replaced by development projects" and his citing of a number of examples where green spaces of various kinds were being replaced by residential and commercial developments (Section 3.4).

This seeming paradox may be partly resolved when the nature of the 'other' green space is considered. In Figure 5.2 most of the 14,386 ha of green land detected from satellite data must be found outside the 2,226 ha of land classified as 'green and open space' or 'forest'. Within the scope of the present research it is not possible to determine accurately the types of land use where the remaining 12,160 ha of 'other' green land are to be are found on the latter map, though this is a future research project. However, some clues to where this 'other' (and larger) part of KL's green infrastructure is likely to be found can be found in various results in Chapter 5 e.g. in Table 5.2, Figure 5.9, Figure 5.14 (b), Figure 5.15 (b), Figure 5.17 and Figure 5.18. Some conclusions can also be inferred from the author's knowledge of the city or from general principles.

Firstly, it seems reasonable to argue that a significant portion of this 'other' green land must be found in the gardens which are very commonly found in residential areas, particularly those of low and medium density. Secondly, from knowledge of the city and from Figures 5.18 (b) and (c), where it is clear from the latter satellite image that much of the major road junction and adjacent verges shown is vegetated, it seems reasonable to assume that a significant proportion of the 5,747 ha of road reserves in Table 5.2 must be vegetated. Thirdly, in KL vacant land, often on ex-mining sites, quickly becomes vegetated, often firstly with rough grasses of various kinds then with shrubs and trees, depending on soil and drainage conditions. Thus a fair proportion of the 2,273 ha of vacant land in Table 5.2 is probably vegetated. Fourthly, as discussed in Section 5.4, Figures 5.17 (a), (b) and (c) suggest a certain proportion of land used by educational institutions will be greened for recreational or landscaping purposes. In addition, for similar reasons, some contribution to the green total estimated from IKONOS must come from vegetation along river reserves, rail reserves, electric line reserves and in cemeteries. Since the total area for scenario (d) in Table 5.2, which includes all of the latter types of land use (except residential) plus a few smaller categories, is 12,724 ha, substantially less than 14,386 ha, it is within the constraint set by the latter total that all the polygons of land use in the latter categories could be likely to make significant contributions to this green total. Even if, say, 30% of residential land was green, that conclusion would still be valid, allowing for the likelihood that most of the land uses in scenario (d) would be less than 50% green.

The preceding conclusions also accord quite well with the visual evidence of the maps which display the results obtained from satellite data i.e. Figures 5.14 (a) and (b) and, to a lesser extent, Figure 5.15 (b) and Figure 5.19 (b). These give a broad picture of a mosaic of green areas being scattered widely across the city, sometimes in a texture of small specks which could be gardens, sometimes in quite large patches of woodland or woodland and shrubs or mixtures of these and grass and sometimes in areas of intermediate size or in roughly delineated corridors, which seem to coincide in a few cases with discernible corridors in scenario (d) of the land use analysis given in Figure 5.19 (b).

To gain some further insight into the nature of vegetation on the 'other' green land, it is worth recalling here that the green land parcels officially classified as such or as forest plus land parcels classed as vacant in the land use data (Figure 5.15 (a)) were subtracted from all the green areas captured by satellite data (Figure 5.14 (b)) to give Figure 5.15 (b), which therefore shows where the 'other' or non-recognised green land is located (with the exception of vacant land which was thus excluded from the latter for various reasons on this occasion). When this latter area of 9,554 ha was broken into the 3 types of vegetation discernible from the satellite data, 1,191.4 ha (12.5%) were found to be grassland with 5,863.7 ha (61.4%) of shrubs and 2,499.1 ha (26.2%) of trees. Thus 87.6% of this considerable area provided some degree of shade and shelter and should also therefore provide many of the other environmental benefits associated with trees and to a lesser extent with shrubs. This helps to confirm the important environmental functions provided by this 'other' part of KL's green infrastructure. It is therefore appropriate to emphasize here that the various maps from satellite data just discussed are in many respects the most valuable and illuminating products of this research and constitute a key part of the answer to the first set of research questions in (i) above by revealing the extent and distribution of virtually all of KL's urban green space and by giving basic insights into its nature and diversity.

Had Teh (1989) employed a level of spatial resolution fine enough to capture very small areas of green space such as even small gardens he would have undoubtedly found that much more than 45.2% of KL's surface had a green cover in 1987. To help resolve the paradox noted earlier, suppose for the sake of argument he had done so and found a figure nearer to 70% was green space in 1987, which is not completely implausible given the areas of oil palm and rubber plantations he noted were then still within KL's boundary. With such plantations being developed and some public open green spaces in or near the city centre being lost or reduced in area by development (e.g. the race course of the Selangor Turf Club), by 15 years later in 2002 the overall reduction of total green infrastructure to the 59% found here could understandably seem rapid and worrying to many.

Moreover, when the attention of the public and planners is focused mainly on parks and recreation areas for public use and for various social activities and when these cover a relatively small area, any significant or noticeable reduction in their area is naturally of concern. The fact that green areas still occupy a considerable area in KL may be of little consolation if many of these are not accessible to the public because they are privately owned or are unsuitable for public use for reasons of topography, drainage or other physical reasons or provide no facilities for the public or are earmarked for development, as may well be the case for much of the 'other' green infrastructure identified by IKONOS data. Table 4.6 showed that sizable proportions of respondents did not perceive such categories as 'vacant/derelict land', 'former mining land', 'educational areas' and 'electric line reserves' as green space. For these respondents significant areas of such land nearby would understandably be of little help if a green space they used or liked, whatever its character had been lost or reduced in area. For these and other reasons the 'other' green land just discussed cannot be seen as a substitute for the conventional parks and playing fields needed by the public for recreation, leisure and social activities, but which many planners feel are presently underprovided in KL. Thus when many of the survey respondents express concern about the loss of green space, they are probably mainly concerned with the latter and may justifiably regard the extensive areas of 'other' green infrastructure as largely irrelevant in this context or be unaware of how extensive they are and how significant their environmental functions may be to the city as a whole. This may help to explain the apparent paradox remarked on earlier of concern for loss of green space in a city which still appears from a satellite to be quite green.

Thus the satellite imagery was effective in giving a fuller picture of the nature of KL's green infrastructure and how it is distributed across the city and, in combination with the parcel based data, how it may actually be concealed within other broad types of land use. Although many of these additional areas of green space will not be publicly accessible, they contribute environmental benefits to the city as a whole, such as improving air quality, reducing noise, providing urban cooling and slowing down runoff. Important implications of these ontological finding are that the city government and other interested parties firstly need to be aware of how important and how extensive this 'other' green infrastructure is and, secondly, need to consider quite comprehensively how to protect and foster it, however difficult that may be because of its fragmented and diverse character, past neglect and its mostly private ownership.

7.2 The New Typology of Green Space Proposed for KL and the Existing Typology of DBKL

Urban development in most of the developing countries seems to have become more rapid in recent decades partly through the general increase of population in these countries being concentrated in urban areas. It seems clear that maintaining and protecting not only high quality urban green space but urban green infrastructure in general is an important priority in cities of the developing countries. The critical review of the literature in Chapter 2 suggested that in the latter contexts it is important to have a common understanding of which particular spaces in an urban area are to be recognised as green space and classified as such. Study of the research literature also suggested that it is also important to know what particular types of green space exist in different places within the city and that it is very useful to be able to categorise them appropriately, since different types of green space may provide different, but partly overlapping, sets of environmental, social, health and economic benefits to urban populations. Constructing or adopting a suitable typology of green spaces is therefore a very important early stage in this kind of analysis.

It was also observed from examining the literature that there is at present a significant gap between the types of green space that are now officially or formally classified as green spaces in developed countries such as the UK and other European and North American countries and the narrower definition of green spaces which still appears to prevail in developing countries such as Indonesia and Malaysia (and to a fair extent also in Singapore), noted in Section 2.11. In many developing countries, often only parks and recreational areas are recognised as green spaces, whereas in developed countries in recent years a more comprehensive set of spaces which include civic spaces, green corridors, allotments and private gardens have increasingly been gaining recognition as part of urban green space. One way to close this gap is by expanding the typology of green spaces presently used in developing countries such as Malaysia.

Drawing on the literature reviewed in Chapter 2 and the results just highlighted in Section 7.1, this thesis argues that in fact a whole range of different types of green space help to form the green fabric or 'green infrastructure' of urban areas, some of which are not yet always recognised, even in developed counties. Hence planners should consider giving greater recognition not only to green land which is serving a clear social or amenity function like parks but also to those areas which are ameliorating the environment and possibly conditions for health through improving air quality or providing flood protection or attenuation, even if they appear derelict and unattractive to many.

However, when the typology is expanded, it has to be borne in mind that not all types of green space are equally vegetated or vegetated in the same way, so their environmental contributions vary accordingly. For example, urban forest reserves might provide greater environmental benefits than public parks in terms of improving air quality and enhancing the biodiversity of habitats. The extent and actual condition of these diverse green spaces also need to be considered because the environmental functioning of some green spaces may be less than what it might be. Similarly, when the current typology is expanded, not all the newly recognised green spaces will be directly accessible by the public. For instance, some green spaces such as new private golf courses and clubs are only open and usable to club members and thus do not provide direct amenity value to many of the local residents, though they may provide some aesthetic pleasure to non-members as a rather beautiful green area in the midst of an intensely built up urban landscape, like the golf courses of the RSGC near the city centre. This study has found that expanding the typology appropriately (Table 5.2, Figure 5.9 and Section 5.2.1) can produce a more complete and realistic picture of where green spaces are providing environmental functions and services to the city, but it has to be conceded that not all these newly recognised green spaces will be accessible or available to the public or provide direct or appreciable amenity benefits to all the urban population (Section 5.4, Figures 5.17, 5.18 and 5.19).

A critical review of Kuala Lumpur's structure plan for 2020 (DBKL, 2003) and its city plan for 2020 (DBKL, 2008) in Sections 3.2.2 and 3.2.3 revealed that, like nearly all cities in the developing world, KL currently only recognises a limited number of recreational open spaces officially as green and open spaces (Table 3.1 and Figure 5.2). Thus these planning documents have a strong emphasis on the social and amenity values of green and open space. However, as just stated, evidence from the wider international review of literature suggested that green space should not only be considered as space for recreational or social amenity purposes (as is mainly the case for Table 3.1). It should cover more than simply parks and gardens, since other green spaces contribute a whole range of benefits to the environment, to the health and well-being of citizens as well as to the economy and to urban society more generally. Through the review of several different typologies of green space used in various countries (Section 2.11), a more comprehensive typology, recognising a wider range of green spaces, was developed (Table 3.2).

These amendments to the typology currently used within DBKL are suggested by the author to provide a more complete description of the types of green space encountered within the city environment of Kuala Lumpur. Although study of the various planning documents showed little evidence of a wider view of green space being considered at present by DBKL, some of the urban planners working in City Hall in fact recognised the need for extending the types of land seen as green space (Table 4.6). These respondents recognised a growing need to value the environmental benefits that the green spaces provide to the functioning of the city as a whole, including their function of mitigating aspects of the urban micro-climate discussed in Section 2.6 of Chapter 2. This finding is consistent with a recent survey of municipal greenspace officers working in six urban areas within Malaysia by Aziz et al (2011), which reported that whilst the recreational functions of green spaces were identified by staff in all the municipalities, the contribution of green space to providing environmental services such as urban cooling and water regulation was also emphasised by staff in each municipality and was particularly highlighted by respondents from four of the six urban areas (KL, Putrajaya, Petaling Jaya and Klang).

Many of the categories in this new typology could be matched quite well with categories of land use in the parcel based database on land use provided by DBKL (Section 5.1.1). This allowed various scenarios to be explored (Table 5.2, Figure 5.9 and Section 5.2.1) which produced valuable perspectives on the possible extent and distribution of green spaces in the city. In combination with the satellite data this new typology then helped to provide useful indications as to the likely extent, distribution and diversity of KL's 'other' green infrastructure not formally identified as green space in the database on land use (Figures 5.15 and 5.19), as discussed in the previous section. Thus the new typology played a vital role in helping to answer the questions posed in (i), perhaps its most important practical contribution to this study. For these and other reasons, it is argued here that this typology or a simpler version of it would be more appropriate in many ways for use in understanding the green infrastructure of Malaysian cities such as Kuala Lumpur (and possibly cities elsewhere in the developing world) than the typologies these cities use at present in their planning documents and reports.

7.3 The Views of Survey Respondents about the Nature, Function, Value and Problems of Protecting Green Spaces in Kuala Lumpur

The results of the questionnaire survey of respondents (mainly urban planners and landscape architects) have already been summarised in Section 4.7. However, it may be helpful to review here some of those which are particularly significant for the subsequent discussion in Chapter 5 of the expanded typology of green space and the analysis in Chapter 6 of the results from field survey and desk based analysis. The questionnaire survey revealed that most respondents seemed to recognise the validity of acknowledging the roles of a broader variety of green spaces in Kuala Lumpur (Table 4.6 and Section 4.3), which seems to be something of a new finding in this field. The respondents as a group also expressed a much wider and richer range of perspectives (particularly about the different types of green spaces that they felt were in need of recognition) than is included in the KL written structure plan (KLSP, 2010). To a certain extent this is inevitable as planning documents everywhere probably tend to set out agreed 'official' viewpoints and policies in rather dry language rather than articulate debate, diversity of views and subjective statements from individuals. The respondents also showed a clear and strong consensus about how valuable many of these green spaces are, particularly for their environmental functions in making city life more pleasant (Sections 4.3.1 and 4.3.2).

The survey findings also revealed that the respondents' general views (possibly influenced by their work experience) often corresponded fairly well with current thinking in developed countries about green space, even though the terminology articulated in the current planning documents is rather different and suggests a more limited conception of green space (e.g. in the structural plan for the city, as just noted). The survey findings also revealed that most of the respondents in Kuala Lumpur had a fairly broad view about the types of land uses and activities that contribute to urban green spaces. In fact, almost all land use types in the expanded typology were considered by varying majorities of the respondents to be worthwhile recognising as green spaces (Table 4.6 and Section 4.3.4).

The importance of protecting the existing green spaces within the city was also recognised by the majority of the respondents. The findings also revealed that these respondents believed green spaces were needed in Kuala Lumpur, but they felt that preventing the loss of green spaces in the city was difficult. Several specific difficulties such as political pressure to support economic development, difficulties of controlling development on private land and general problems in the development control processes, combined with weak enforcement of planning policies perhaps explained why some city planners feel rather powerless to stop the loss of green spaces in Kuala Lumpur (Section 4.5).

The social survey also revealed that besides the amenity benefits provided by parks and gardens to the population, the respondents also recognised the many positive environmental functions of green spaces in the city. The environmental functions and benefits to the city from green spaces mentioned by the respondents were basically in line with some of the research findings reported in the literature. The survey findings also confirmed that both the environmental and social properties of green spaces were generally considered valuable by respondents and of roughly equal importance in the context of evaluating particular green spaces as regards priority for preservation. This perception of the equivalent importance of environmental and social contributions was also established by Nor Akmar et al (2012) in the five other urban areas in Malaysia where she conducted interviews with municipal planning officers as well as with the staff of KL City Hall.

The replies to Question 28 in the survey revealed more clearly and explicitly that the respondents recognised the need to consider both the environmental as well as social characteristics of green spaces when making decisions about whether to retain or preserve particular green spaces (Section 4.6). An implication of the survey findings is that ideally a wide range of environmental and social criteria need to be considered when decisions are being made about which green spaces should be prioritised for conservation. To collect the relevant range of social and environmental information suggested as relevant by the respondents (Tables 4.14 and 4.15) might well require observations or measurements to be made from a variety of different sources. Much of this probably requires comprehensive field surveys and site visits (e.g. to assess the level of maintenance of green spaces, the relative safety of green spaces and their general cleanliness). However, with contemporary technology for remote sensing allied to geographic information systems, it is now possible to try to estimate a number of important characteristics of green land cover such as how abundant is the vegetative cover, how many different kinds of vegetation are present, how much of the area benefits from shade provided by trees and how well connected is a particular green space to other green spaces in neighbouring areas by using remotely sensed data captured from satellites or aircraft and then processed and analysed in a GIS.

Developing a strategy to protect the whole range of types of existing green space in a city requires, as a first step, a reasonably comprehensive understanding of the current geographical distribution of all the green space within a city. Proposed methods by which such an inventory might be developed are summarised in Section 7.4.

7.4 The Contribution of Higher Resolution Remote Sensing for Mapping and Evaluating Kuala Lumpur's Green Infrastructure.

This study explored two particular techniques for identifying green space that seemed to offer sufficient detail about the distribution and types of green space that occur within the city. The first technique used the city's digital land parcel database and matched its classes of land use to the set of land uses in the new typology which might be considered as green space to varying degrees, as explained in Section 5.1.1 and outlined more briefly in Section 7.2. The results from Chapter 5 showed that a current, detailed and well maintained land parcel data set, such as is available in KL, could provide a rough first approximation of the overall amount of urban green space in different parts of the city. Although the land parcel mapping was of lower spatial resolution than the satellite imagery, it gave a first impression of the general distribution of green space in the city. Figure 5.9 (b), for example, shows the important contribution of river corridors (small in terms of their area) for connecting green spaces together within the city while scenario 5.9 (c) shows how many vacant sites adjoin existing green spaces and could be used to consolidate and expand green spaces. To our knowledge, this is the first reported use of this approach of exploring different mappings of green space by matching classes from a typology based on PAN-65 to an existing land parcel database. Subsequently, Butlin et al (2011) devised a similar approach of matching green space classes set out in the Planning and Policy Guidance note (PPG17) to land use parcels in the OS Mastermap database to generate an inventory of green infrastructure based on land parcels for the Mersey Forest area of Northwest England.

However, using the land parcel data to map the distribution of green spaces was shown to either over-estimate or under-estimate the areal extent of green spaces, depending partly on whether some of the most extensive land uses, such as road corridors or private residential areas were included or excluded.

Compared to the relatively crude picture of total green space provided by the land parcel analysis, the IKONOS imagery was found to provide a more detailed and finely textured picture of the distribution of particular parcels of green land cover, from which the extent, density and even approximate variety of different vegetation types could be derived for different areas of the city. High resolution data such as IKONOS also has the potential to be used in monitoring the total number and extent of green spaces, especially if no land parcel data exists. If the latter data does exist for a city, remotely sensed imagery can then provide an alternative (and possibly more accurate) perspective on the distribution of green space or an independent way of checking the land use data. However, checking the semi-automated classification revealed that there were some problems with the classification based upon satellite data. Whilst it was possible to develop broad land cover classes (e.g. 3 basic types of vegetation, water, bare ground and built up) that match the highest level definition of green spaces, many specific land use classes in the proposed green space typology (such as cemeteries, vacant land and playing fields) could not be correctly identified from the classification rules used on the IKONOS imagery. Although an overall classification accuracy of around 70% was achieved, the cover classes for trees vs. shrubs, or built-up areas vs. trees were sometimes confused by the spectral classification rules. Also using an object-based classification, Lackner and Conway (2008) achieved an overall accuracy of 80% for a ten class map of land use using IKONOS data, using a more complex rule set and for a much smaller extent than the area classified in this study. The majority of the studies reviewed in Chapter 2 which used higher resolution imagery only classified relatively small areas such as individual neighbourhoods (e.g. Zhou et al, 2008; Reyes-Firpo, 2008); city-wide mapping was mostly conducted using 15m resolution ASTER or SPOT data (Chen, 2007; Fung et al., 2008). This detailed mapping of KL at a resampled image resolution of around 2m is therefore relatively unique in the literature.

Even though it was not possible to identify many of the specific land use types listed in the expanded typology for green space, the results from this automated classification of satellite imagery were, nevertheless, found to be encouraging. The study showed that an estimate could be produced of the areas covered by trees, shrubs, grassland and water (which together represent the bulk of the green space in the city) which were more accurate than using the land parcel data by itself. Chapter 5 also suggested that some of the limitations of the semi-automated classification could be corrected by using visual checking and manual revision of the polygon assignments. The accuracy of the mapping could then be increased towards the 90% level by this manual reclassification supported by visual interpretation of satellite imagery. This two-stage approach delivered a satisfactory overall mapping accuracy, but due to the lower spatial resolution of IKONOS imagery, could not deliver the detailed discrimination of all the green space types that could for example be identified from the 25 cm aerial photography used to create the green space map of Scotland (Greenspace Scotland, 2010).

As already noted in Section 7.1, a principal finding of the satellite mapping was that, as of 2002, Kuala Lumpur was still a relatively green city, if we take account of all types of green space. According to the satellite estimation, some 14,386 ha (with a maximum error of +/- 4,315 ha) or about 59% (+/- 17.6%) of the city area still supported green land cover. Given that the majority of the inaccuracy in the classification was among different green space types (e.g. confusion between shrubland and grassland areas), rather than between green and non-green classes, one may reasonably assume that, although the per class accuracies for trees, shrubs and grassland areas individually may be up to 30% in some areas where the land cover types are very intermixed, the total areas of 'green' versus grey' land cover across the city (i.e. the extent of the green infrastructure) of 14,386 ha is probably estimated more accurately than the error estimates suggest.

The only previous mapping of the city by Teh (1989), using aerial photography had estimated that 45.2% of the city still supported vegetation cover in 1987. The two figures are not directly comparable because, as was discussed in Chapters 2 and 3 and Section 7.1, the previous mapping used panchromatic aerial photo mosaics of about 0.5 meter resolution and only mapped areas of green space greater than 0.5 hectares and wider than 20 metres. Consequently, many small areas of green space such as residential lawns and gardens would not have been mapped for 1987, but would have been detected by the IKONOS sensor in 2002 and so the satellite mapping was expected to include the addition of these smaller patches of green cover due to its higher resolution.

Such resolution differences can have a significant influence on green space estimates produced by satellite imagery. For example, analysis by Yaakup et al. (2004) using a series of LANDSAT satellite images with a resolution of 30m, estimated that the total green (i.e. vegetated) land cover within KL appeared to have been reduced by 48.5% over the ten-year period from 1988 to 1998. This substantial loss of vegetation cover is not confirmed by this study. Part of the difference could be due to sensor resolution and map class differences. Working with 15m SPOT data of KL, Blacker (2009) was not able to classify many of the smaller areas of green cover, such as river and road reserves and some smaller private gardens. LANDSAT only detects larger vegetated areas, where the response from a 30 x 30m area is dominated by vegetation. Areas with denser tree cover and larger parks would therefore be the most common areas detected at LANDSAT resolution, whilst many smaller patches of green space would not be detected as the 30m pixels would show a mixed pixel response which would lead to them not being classified as green areas. Yaakup's (2004) results probably highlighted the loss of some of the larger green areas within the city, such as some areas of urban forest, rubber plantations and some recreational green spaces such as the racecourse that were notably converted in full or in part to commercial development during this period (Teh, 1994). However, given the known limitations of medium resolution sensors such as LANDSAT for urban land cover mapping (Donnay et al., 2001), it is probable that many smaller areas of green cover were not identified by that study.

The objective of using the remote sensing in this research was to create an estimate of the overall green land cover of KL as of 2002, rather than a change detection study. Whilst it is useful to compare the estimate for green land cover produced here with those reported previously, this study has not examined the nature of the green land cover present in each time period. Working in KL, Teh (1994) and Webb (1998) both observed the loss of several urban forest areas, former rubber and oil palm plantations and other tree covered areas, which were converted during the 1990s into residential and commercial developments. In some cases the land use change resulted in a complete loss of green cover, whilst in other cases the conversion was from predominantly tree cover to scrubland or 'urban savanna' – a term Teh used for lawns, golf courses and other green areas of high social and amenity value, but relatively low biodiversity value. Therefore, whilst the satellite imagery suggests that gross total area of green land cover may not have declined as much as some previous researchers have suggested, there is evidence from the literature, from the responses to the questionnaire survey and from observations made at some fieldwork sites surveyed by the author that in certain locations the environmental quality, as well as the size and coherence of green areas that are part of the green infrastructure but are not presently under protection, have probably declined over the last ten years.

Although this study found substantial further areas of green infrastructure which probably fulfil a positive environmental role, most of these areas are privately owned and some of the lots that are classified as 'vacant' on the City Hall land parcel database are already earmarked for development, whilst many are not accessible to the public. For these and other reasons this 'other' green land cannot be seen as a substitute for the conventional parks and playing fields needed by the public for recreation, leisure and social activities, but which many planners feel are presently underprovided in KL. Thus, the city authorities could consider converting appropriate parts of it (e.g. some of the still derelict ex-mining land) to public recreational uses and in future may well need to consider more comprehensively how to protect much of this rather unrecognised green infrastructure from development to ensure its environmental role is fostered and sustained. The satellite imagery therefore gives the city planners a valuable way to look beyond their limited inventory of presently protected green spaces in order to plan more effectively for the strategic acquisition of green space as urban development continues.

Whilst the precise limits of what types of green space can be extracted from IKONOS imagery have not been determined by this study, it has provided sufficient evidence to claim with some confidence that an object based classification of IKONOS imagery, followed by some manual post-classification improvement could form the basis of a method for more detailed mapping and accounting of green spaces than was possible previously with land parcel data alone. If it is necessary to map all the types of green land use in our expanded typology, this will need to be implemented using firstly the digital land parcel data subsequently augmented with satellite imagery. If, on the other hand, the goal is for urban planners to gain a more realistic picture of the overall distribution of the existing green spaces then this could be done by starting with the satellite imagery. Both techniques explored in the thesis therefore offer city planners the beginnings of operational methods for monitoring the nature and condition of existing green spaces in the city. The choice of which dataset would be the primary source of information depends very much on the particular purpose planners prioritise in the context involved.

7.5 The Relative Contribution of Remote Sensing and Ground Surveys for Observing Relevant Environmental and Social Characteristics of Green Spaces

This part of the study compared remote and ground-based techniques for collecting some of the information about green spaces that the respondents reported in the survey might assist them in making decisions about prioritising particular green spaces for retention. The ground-based technique used a method of site observation and evaluation for which a fairly comprehensive field assessment protocol was designed which included 31 criteria, 13 of which were environmental indicators and 18 were social indicators. By including the environmental indicators, the field assessment protocol used in this research significantly extended a questionnaire schedule developed from 2008 to 2010 by Greenspace Scotland that was ultimately published in their *Urban Greenspace Mapping and Characterisation Handbook* (Greenspace Scotland, 2010). The fieldwork confirmed that a rich a set of information about the social and environmental benefits of particular green spaces could be collected by ground survey. However, the ground survey work also demonstrated that site visits are time consuming, cannot easily be conducted for all the types of green spaces in the city that constitute the wider green infrastructure that was mapped in Chapter 5 and therefore often cannot be repeated regularly enough to enable comprehensive monitoring of green spaces over time. The logistical difficulties of obtaining sufficient and unbiased responses from ground surveys alone were noted by Sreetheran (2010) who interviewed 420 randomly selected users in three urban parks in Kuala Lumpur in order to develop a single performance indicator for public safety, which was applicable only within the formal parks.

Recognising these limitations of site surveys of green space is an important finding, since until now site assessment on the ground has been regarded by KL City Hall as a ‘gold standard’ which any desk-based method of assessment had been compared to. Whilst monitoring the green spaces they own and manage will remain an operational need, this thesis has argued that the city planners and managers need to widen their observations beyond the formal parks and gardens already on their inventory of green space in order to plan proactively to protect the ‘other’ parts of the city’s green infrastructure. Since resources for conducting frequent site visits of the existing spaces are already limited, scaling up their activities to accommodate this wider range of green infrastructure may well require the city planners to find other means for monitoring many of these areas.

Chapter 6 examined whether information derived from remote sensing could be employed to provide useful estimates or indicators for some of the criteria thought to be significant by the respondents for assessing a green space. As was summarised in Figure 4.2, several environmental characteristics or functions of green spaces, such as their capacity to provide shade and shelter, to provide a diversity of vegetation cover, to absorb water, to provide cooling and to improve air quality, could in principle be monitored or estimated from the remotely sensed data. This is an important finding, demonstrating that remote sensing of the type used is able to provide significant information about a number of environmental functions that green spaces can provide and which contribute to the overall 'liveability' of cities for their population and thereby help to make them more sustainable in social and economic terms (Laquian, 2008). This research also found that a number of site characteristics are in fact quite difficult to observe directly during a site visit (e.g. proportion of different types of green spaces within a park or amount of shaded area). Further, it can be difficult when on the ground to describe a site in relation to its surroundings (e.g. to assess its accessibility to population in areas nearby). These types of characteristics were in fact much more easily and more objectively estimated by referring to the satellite imagery or GIS data. These wider perspectives given by the 'remote' method provided information that was difficult to obtain from ground survey.

The statistical analysis in Chapter 6 confirmed that the 4 environmental indicators for the 17 green spaces surveyed could be estimated by using remotely sensed data in a way that was quite consistent with the results from ground surveys (Table 6.16 and Part (iv) of Section 6.2.2.2). However, as expected, remotely sensed imagery was generally much less suitable for deriving the majority of the social criteria in Table 4.15, such as the quality of maintenance of a park or its level of safety and cleanliness, because these are intrinsically more difficult characteristics to infer or interpret through observation from satellite. Nevertheless, three indicators relating to the accessibility of the parks to their surrounding populations, two of which were identified as important criteria by the respondents in Chapter 4, were estimated using GIS techniques. These produced a ranking of sites that was only weakly correlated with the ranking of similar measures of accessibility recorded during site visits (Table 6.17 and Part (iv) of Section 6.2.2.2). Evaluating a recent questionnaire-based study in which he investigated how people accessed parks and green spaces in KL, Aziz (2012) concluded that he believed there was considerable scope to use GIS to analyse accessibility to these public parks and to display the results in map form. The three indices of accessibility developed did illustrate the relative accessibility of different green spaces and showed how well each served its local population in relative terms.

This was one of the central questions which Aziz (2012) sought to study using postal questionnaire surveys, a method chosen because that author had concluded that accessibility and park usage could not be assessed sufficiently comprehensively or in an unbiased way by using only ground-based observations and assessment.

The thesis therefore suggests that field survey is required to observe and record many important characteristics of green spaces, but that it is increasingly possible to observe a useful range of environmental characteristics of green areas by remote sensing. This can be particularly valuable when the priority is to review the entire landscape of green spaces across the whole city as regards their roles in the urban system or to consider the case for protecting and preserving particular green spaces or to find appropriate locations for designating new green spaces. In all these situations evaluations by remote sensing can capture key information about certain environmental and a few social characteristics of all green areas across the whole city, especially the former criteria. The study therefore concludes that the two methods, site assessment and 'remote assessment', should be regarded as complementary techniques that can be used together to allow urban planners to monitor and, hopefully, make more informed decisions about the city's existing green spaces.

7.6 Outline of Possible Future Research

Since this is, to the author's best knowledge, the first attempt to use data from satellite remote sensing for mapping green space in Kuala Lumpur, this pilot study needs to be examined critically and refined to develop more fully operational techniques. A number of obvious refinements and extensions will now be discussed.

(i) One of the limitations of the present study was the lack of a near infra-red (NIR) band in the IKONOS imagery provided via DBKL to the author for this research project. This limited the author's ability to classify land cover of vegetation and to generate various vegetation indices such as NDVI which would probably have enabled the green or non-vegetated areas to be more quickly differentiated. For any further follow-up study, all four bands of

IKONOS data should be obtained if at all possible so that classifications using such indices can be explored.

(ii) Future classification of green spaces using other types of higher resolution sensor data now available such as from the Geo-eye and ORB-View satellites should be explored. If resources were available to commission it, aerial photography would probably deliver more comprehensive and accurate mappings of green spaces for the whole city. One of our field trials not discussed in this thesis showed that DBKL staff who knew the areas and who had some familiarity with aerial photography were able to identify many areas of green space from the IKONOS data. However, DBKL staff presently lack in-house capability and skills to process and classify satellite imagery and arguably should not need to develop this capacity extensively themselves. Given the present high cost to the user of commissioning dedicated flights and of processing and interpreting aerial photography, higher resolution satellite imagery such as that explored here can arguably provide a more cost-effective alternative.

(iii) A number of other data sets for recording further important environmental benefits provided by green spaces (such as remotely sensed measures of air quality or field based surveys of biodiversity) could be included in future research on urban green space. These additional measurements could be very useful in assessing the environmental value of a particular green space. Whilst biodiversity and habitat data would need to be collected on the ground, air quality data or data about the urban cooling effect provided by green space could be observed by networks of ground or near ground sensors and related to present or future maps showing inventories of green space.

(iv) The present study produced a more spatially detailed and, we argue, more realistic distribution map of KL's population by night-time residence than what was previously available. The dasymetric mapping of the city's population has allowed a continuous representation of the city population to be produced at a finer scale and with population distributed only into the areas of the city that can reasonably be considered inhabited. Such finer scale population data creates opportunities for further population-related analysis to be conducted. For instance, future research could extend the analysis of population demand for specific green spaces based on further analysis of residential populations within different walking or driving distances or conversely could assess the amounts of green space available to the populations living within certain neighbourhoods. This would be possible with the population data sets that are presently published by the Department of Statistics in Malaysia using the existing 881 enumeration zones to represent the population of the entire city area, but would be much more realistic with a finer breakdown using many more zones as is available now for cities in UK and elsewhere in the developed world.

(v) In this study, due to the time limitations of fieldwork, the site observation and assessment protocol was carried out at only 17 green sites. However, DBKL would probably desire to conduct further site assessments using either the full or the reduced protocol in many other green spaces throughout the city, especially if a wider range of green infrastructure is under consideration, provided both time and cost permitted this. Since field visits are a relatively resource intensive activity, however, this study has shown how a reduced set of criteria observable by field survey can still capture several of the main characteristics of a green space.

Some elements of the site observation and assessment methodology developed here may also be applicable in other cities. The site assessment protocol developed in this thesis represents a significant enhancement and a more comprehensive instrument than that presently used by Greenspace Scotland, for example, and is quite possibly more comprehensive and consistent internationally than any equivalent presently in use by DBKL. If DBKL conducted some trials using this protocol, DBKL staff could get a chance to test the protocol in the field. It is possible that staff carrying out such trials could then help to inform and educate their colleagues and the public about the equal importance of the environmental functioning of green space as well as its well-recognised amenity benefits.

(vi) Remote sensing could be used with land parcel data to target field survey and site assessment to areas where change can be seen (if imagery from a series of dates exists) or where there is a difference between the land use recorded in the land parcel database (e.g. vacant land or forest reserve) and that visible on the ground (for example, where trees have evidently been cleared for development). Such regular monitoring, which could possibly be afforded by using remote sensing, would enable city planners to recognise any illegal activities and this may provide them with the evidence to help enforce legislation on development control.

On a self-critical note, in retrospect and perhaps with the wisdom of hindsight, there were some limitations and weaknesses in the work other than those already discussed at various points in the text. Firstly, had more time been available, the data in DBKL's inventory of officially recognised green space could have been used more fruitfully, if it had been fully integrated into the GIS holding the land parcel and IKONOS data. Had this been done, it would potentially have been possible to produce maps showing where gazetted green spaces in the inventory were located and also the location of green areas owned by various public bodies, though matching the locational data in DBKL's inventory of green and open spaces (Table 3.1) to the polygons in the land parcel database might not have been straightforward and could have been time consuming. It would potentially also have been possible then to map sites described as having 'no data' or 'not yet applied'. In addition, it would also have been possible from this to separate the green and open spaces in DBKL's inventory which were already in existence from those which were planned for 2020, as DBKL's inventory made this distinction clearly. Had this been done, separate analyses could then also have been carried out for existing and planned green spaces by gazetting status and type of ownership, which might have been illuminating This limitation or failure to exploit the inventory of officially recognised green space more fully was partly a result of limitations of time and space and also perhaps because the data in the inventory was sometimes seen, somewhat misguidedly, as secondary to the IKONOS and parcel based data on land use. It is hoped to exploit the inventory data more fully in future research.

7.7 Contributions of the Study

The outcomes of this study may offer some useful basic steps towards a solution to some of the issues and problems that are faced in protecting and conserving urban green spaces, especially in the cities of the developing world. At the same time it is hoped that it has extended and even enriched, at least a little, knowledge in this field. The study has demonstrated that efforts to conserve green spaces in developing cities like Kuala Lumpur are hampered by a number of difficulties, one of which is the need for a consistent and repeatable set of methods for observing and recording existing green space. The experience of developed countries such as the United Kingdom can act here as a useful example for those that are trying to follow in a similar direction. One can argue that the need for planning the provision of urban green spaces and the protection of the city's green infrastructure with its 'sustainability' and that of the city in mind is axiomatic, if a country is to make progress in maintaining and improving the quality of life of its citizens.

In the author's view this thesis presents five particular contributions which advance knowledge and represent useful additions to the research literature on green spaces in developing countries:

(i) This work has expanded the typology of green spaces that is presently applied and used in Malaysia by drawing upon examples of green space typology used in developed countries. The expanded typology that is proposed here helps to provide a more complete 'ontology' for green spaces encountered within the Kuala Lumpur city environment. Furthermore, the proposed expanded typology is argued to be adaptable and appropriate for use not only in Malaysian cities but it may, with some modifications, also be applicable and appropriate for use in other developing cities in the world.

(ii) This study has provided some new insight into the perceptions of people involved with urban planning in Malaysia regarding the recognition of these broader definitions and hence of 'other' types of green space. The awareness and understanding of the benefits that green spaces provide to the city's population shown by respondents to the social survey was both revealing and encouraging as regards possible future arrangements for providing and protecting urban green spaces and rather more encouraging in some respects than the texts of the city's present structure and local plans.

(iii) This thesis has presented a means of producing a more comprehensive and up-to-date identification, recognition and inventory of the distribution of green spaces at a very fine spatial scale for the whole city using higher resolution remote sensing i.e. it has succeeded to a certain extent in producing a better 'ontology' of green space, its most important goal. This offers KL's urban planners a more realistic picture of the location and the 'true colours' of the city's green spaces. Furthermore, the study has been able to differentiate between officially recognised green space and the even more extensive but complex mosaic of 'non-recognised' green space over the whole city which, to the best of the author's knowledge, is the first time such a data set has been created for this city.

As a result it has produced a new and rather surprising picture of KL as a city with a much more extensive and diverse green infrastructure than generally realised. This is the thesis's most important substantive result. It does not refute or invalidate widely expressed concerns about the city's loss of formal green spaces for public recreation and leisure in recent decades and the under provision of such spaces. However, it does suggest that a more comprehensive approach to the protection and fostering of green space based on a more holistic understanding of all the city's green infrastructure and its diverse roles would now seem to be desirable from the city's government, planners and other interested parties.

(iv) The thesis has also produced a more comprehensive protocol for conducting field assessment which includes both environmental and social characteristics when evaluating a particular green space on site. The field assessment protocol designed for this research also records additional characteristics which can be used not only in the Malaysian context but may also be applicable to ground surveys of green space in other parts of the world.

(v) Finally, the dasymetric mapping method used to map the distribution of KL's population can be seen as enhancing current understanding of the urban population distribution to a certain extent and as providing, possibly for the first time, a finer scale mapping of the population of KL by night-time residence which is more realistic and useful. This creates a basis for further population related analysis of the provision, accessibility and use of green spaces to be conducted.

Taken as a whole, the author believes that this thesis makes a contribution to improving our understanding of the nature of KL's green spaces and of how to collect and analyse geographic information relevant to improving our understanding of those green spaces and their benefits to the city. The substantive results and the methods explored and 'pilot tested' should be relevant also to planning the protection of these green areas more effectively.

Chapter 8

CONCLUSIONS

8.0 Final Conclusions

The main conclusions that can be drawn from the preceding analysis and discussion are summarised below.

(i) The thesis has argued that a common recognition and understanding of which particular spaces should be considered as urban green space is desirable. From reviewing the international literature on green space, the PAN 65 typology was adapted for Malaysia's green spaces; this adapted typology more comprehensively described the types of green spaces actually encountered within Malaysian cities than the typologies in current use in planning documents in KL. Being grounded in the current international literature, this typology should be applicable not only to other cities in Malaysia but also, with some adaptations, to other cities in the developing world.

(ii) Interestingly, the 41 respondents questioned in the social survey mostly shared quite a broad perspective on what constitutes urban green space in which a majority accepted all the 27 specific types of land use set out as parts of the urban green fabric in the above typology with the exception of only 2 specific types, though the degree of acceptance varied for the different sub-categories of green land use. Most of the respondents in the survey recognised the importance of both the social and environmental benefits of green spaces and seemed to accept the need to take into account both of these functions in considering the protection and conservation of green space. The questionnaire results also suggested there was a need for more comprehensive and current monitoring of existing green spaces due to continuing threats from development, usually for commercial or residential use. There was consensus among the 41 respondents that it was and had been difficult to protect green spaces in KL. Whilst more effective monitoring could assist with the processes of development control and could thus perhaps aid the conservation of some green spaces, this may only be the case to a limited extent because KL's apparent difficulties in protecting existing green space seem to be a result of powerful economic pressures and possibly also the exercise of political influence in some quarters to undermine policies for the protection and preservation of green spaces, not a lack of monitoring *per se*.

(iii) The study explored and compared two practical methods for compiling a comprehensive, accurate, detailed and up-to-date set of data on existing green spaces which could augment and complement the inventory maintained by KL City Hall which was made available early on in the research. One method was based on using data on land parcels which are typically obtainable from the government's land department, while the other more novel method used data from high resolution remote sensing, in this case the IKONOS satellite data.

By matching the categories in the adapted typology of green land use to the categories of land use in the land parcel data, where this was possible, and by then selecting various combinations of types of land use from the latter database, a series of estimates for the amount and overall extent of green space under each combination or scenario across the city were produced. Although each of these scenarios provided a rough picture of where further green areas that were not formally classified as such in the land parcel data might be found across the city, the coarseness of the geography of land parcels in some areas and the simple assumption that parcels were either entirely green or grey meant that the land parcels were unable to provide either a very accurate overall estimate of the total amount of green space in KL or an accurate, spatially detailed map of the distribution of green (i.e. vegetated) space across the city.

Using the mosaic of IKONOS images, a more detailed mapping of the extent of green infrastructure in the city was produced. From a semi-automated classification of the imagery with limited user intervention, a map of the city's green infrastructure was produced that had an overall accuracy of 70% when evaluated against ground reference data. Although there was some misclassification between trees, shrubs, grass and non-vegetated surfaces such as built-up areas, the map derived from the IKONOS imagery revealed that as of 2002, Kuala Lumpur was still relatively green, with some 59.0% of the city still appearing to support some form of vegetation cover.

A number of benefits from using the remote sensing data synergistically with the land parcel data were also recognised. By using both data sets together, areas of green space and forest which were formally classed as such in the parcel based database were separated and then subtracted from the detailed IKONOS based map to reveal that the land parcels occupied by green and open spaces or forest and classified as such accounted for only some 2,226 ha or 15.5% of the total area of the city's entire green infrastructure as estimated from the satellite data i.e. a total of 14,386 ha.

The preceding analysis thus revealed quite strikingly how extensive were these 'other' green areas not identified as green in the parcel based data. Although these 'other' parts of the city's green infrastructure probably mostly fulfil a positive environmental role, it has to be recognised that most of these areas are probably privately owned and some are probably already earmarked for development, whilst many are not accessible to the public. For these and other reasons this 'other' green land cannot be seen as a substitute for the conventional parks and playing fields needed by the public for recreation, leisure and social activities, but which many planners and others feel are presently underprovided in KL.

(iv) The study compared remote and ground-based techniques for collecting some of the information about green spaces that the respondents reported in the survey might assist them in making decisions about prioritising particular green spaces for retention. As expected, this revealed that field survey can generally provide richer information than remote sensing, particularly about the social characteristics of green spaces, such as the perception of safety or the quality of maintenance of particular green areas. Whilst the majority of the social characteristics of green spaces could not therefore be measured or monitored directly from the satellite imagery, the study showed how three indices relating to the accessibility of the parks to their surrounding populations, identified as important criteria by the survey respondents, could be estimated using GIS techniques. However, this remote method of assessing accessibility was found to produce a ranking of the 17 sites that was only weakly correlated with a ranking of similar measures of accessibility recorded during site visits. In contrast, when the rankings for 4 environmental criteria from remote desk based evaluations and from site observation were compared they were quite highly correlated which suggests remote estimates of these 4 environmental criteria would be more successful as possible alternatives to on site observation than would be the case for the measures of accessibility.

The ground survey work also demonstrated that site visits are time-consuming, cannot be conducted for all the types of green spaces in the city that constitute the ‘other’ part of the city’s green infrastructure and often cannot be repeated regularly enough to enable comprehensive monitoring of green spaces over time. A conclusion from this was that other means of collecting information about green spaces more regularly, comprehensively and repeatedly than by ground survey are needed and that remote sensing may be one means to achieve this.

It can be argued that several environmental characteristics or functions of green spaces, such as their capacity to provide shade and shelter, to provide a diversity of vegetation cover, to absorb water, to provide cooling and to improve air quality, can in principle be monitored or estimated using high resolution remotely sensed data. The overview of the sites provided by the satellite data was in fact shown to produce estimates of certain criteria such as the proportion of shaded areas or the diversity of vegetation within a site, which were found to be difficult for ground based observers to estimate objectively.

In summary, the study has not only argued for a widening of the types of green spaces recognised by city planners in Malaysia but has also advanced a series of empirical methods by which urban green spaces can be identified, monitored and evaluated. Although this is only a prototype solution at this stage, it shows the value of combining the capabilities of remote sensing for city-wide synoptic measurements with the local details gained by site visits conducted using a harmonised reporting protocol. The combined use of the two approaches was shown to provide a means to augment site visits with information about site surroundings that is difficult to capture when on the ground and had the potential to allow site visits to be more focused on specific areas where changes are detected by remote sensing.

Considering the increasing availability and decreasing cost of data obtained from high resolution remote sensing, together with an anticipated growth in the likely future demands upon city planners to provide quantifiable and verifiable information on the full extent of the city's green infrastructure, the techniques developed here potentially offer quite practical contributions towards developing repeatable methods for monitoring and auditing significant aspects of the quantity, nature and quality of much of a city's green infrastructure, especially as regards its environmental characteristics. If this monitoring helps to protect urban green spaces over the longer term, that may help to make cities more congenial places to live and therefore, in a number of ways discussed in Chapter Two, more sustainable.

In a recent paper on 'Greenspace Planning and Management in Klang Valley', involving a study of 6 municipalities of the Kuala Lumpur conurbation including the city of KL itself, Nor Akmar et al. (2011) has drawn attention to how the discourse on green space in Malaysia changed after independence in 1957 from meeting the needs of British colonial society to one focusing on efforts to green and beautify cities as part of nation building, particularly in KL as national capital. She argues that in recent years the national discourse has been shifting again to one concentrating on green space as an essential part of the social and environmental infrastructure of cities.

As noted in the previous chapter, Nor Akmar et al.'s paper is almost entirely focused on public parks, gardens, sports and recreational grounds and leisure places which are municipally owned. Among other topics, her paper provides much illuminating analysis on the interactions between policy, planning and management of these spaces in Malaysia and on how policies, institutional arrangements and priorities between the different functions of their green spaces varies across the 6 municipalities. However, if this discourse in KL is to focus properly on the green infrastructure of the city and give adequate consideration to all its functions, particularly its environmental functions, then more attention must surely be paid to the ‘other’ green spaces which Nor Akmar et al. is not concerned with and which this thesis has shown to be such a large component of the city’s green infrastructure. If research in other cities of the developing world yields results comparable to those for KL, perhaps the discourse elsewhere will also have to be rebalanced more broadly in this respect, as well as shifted in focus. If the present thesis plays a part in broadening that discourse in Kuala Lumpur and elsewhere, then it may have served a useful purpose.

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