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SITE SUITABILITY ANALYSIS OF PARKS FOR ENHANCING BALANCED THEMAL BUDGET IN ISKANDAR MALAYSIA

Alhajihussaini* KabiruShehu Mohammed AdamuDogonYaro*****
** Department of Geography, Aminu Saleh College of Education Azare,Bauchi State, Nigeria.*
*** Department of Geography, Aminu Saleh College of Education Azare, Bauchi State, Nigeria.*
****Department of Surveying and Geoinformatics, AbubakarTafawaBalewa University, Bauchi,Bauchi State, Nigeria.*

Abstract
This study analyzed site suitability for parks development in Iskandar Malaysia (IM) with the view of opening up avenues for low carbon cities supported by tree species needed to be planted to consume carbon. The data for this research were mainly generated fromfield survey and landuse of Iskandar Malaysia which were used in producing site suitability map of IM using integrated method of Analytical Hierarchy Process (AHP) and Geographic Information System (GIS). This enable site suitability analysis in Iskandar Malaysia for finding suitable locations for urban parks development and proposing tree species suitably needed for the parks. The result depicted that six (6) different types of parks including Recreational, Playground, Neighbour, Local and urban parks as well as playground lots were suitable for parks development in IM. Further to that species with large trunk diameter and dense wood were found suitable for balancing thermal budget in IM. It was recommended among others that development and utilization of playground parks, local parks, playground lots and urban park should effectively and efficiently be maintained for enhanced environmental benefits in IM.

Key Words: Site Suitability Analysis and Parks Development.

Introduction

The world economy is rising day by day making the urban population rising directly proportional to it. One of the most salient features that characterize human development during the past millennium is accelerating urbanization (Jianguoet al., 2014). It is predicted that in the next 30 years starting the year 2000 until 2030, the population will double its numbers adding 2 billion more people The same thing goes to the urban regions, as population rising, the built- up urban areas is spreading too. It is stated that these areas will increase by 1.2 million kilometer squares making it triple the amount of global land area in the previous year 2000 (World Bank Organization, 2014). In addition, more than 50% world population now live in urbanized areas and almost all future global population growth will be in the urbanized areas. By 2050 (the next 35 years), it is forecasted that the developing and developed areas will cover 64.1% and 85.9% in the world urbanization. If the human population knows how to handle the urbanization properly, sustainable development can be guaranteed worldwide.

Urbanization confronts man-kind with many environmental challenges. This is due to the facilities high demand, jobs, real estate value and housing. As cities develop and urbanization is taking place, more people will be needed to accomplish the development. Majority of humans will live in the cities, refining human well- being while preserving the environment inside and outside urban areas is a great encounter. This is particularly exact for the developing countries because the cities are encountered with more badly environmental and socioeconomic problems and because their small- and medium-sized cities will be the base to the future urban growth (Jianguoet al., 2014).

As all these activities of urban development increases, this will lead to increasing population, transportation and industrial activities. Different problems also occur along this increment such as social problem, infrastructural and environmental problems. The exposure to climate and disaster risk also increases. Environmental problems happened as increasing population, transportation and industrial activities will release much greenhouse gases(GHG) for instance carbon dioxide (CO2) , nitrogen dioxide (NO2), sulphurdioxide (SO2) and carbon monoxide (CO) causing high polluted gas filling the world generally and urbanized area specifically, then increase the land surface temperature (LST) which lead to the urban heat island (UHI) phenomenon.

For the phenomenon of UHI, most cities and villages create their own heat island. This happens as the temperature inside a city is higher than outside area due to climatic factors as well as less concealed heat in a city because of less transpiration due to inadequate green zones or green spaces. It is also because of man-made precipitation drainage, bigger heat capacity of building walls and asphalt covering, changes of radiation balance in cities including industrial haze (Lokoshchenko, 2014). Climatic change and the UHI phenomenon, can lead to increment of cities temperature for instance. Weakening of comfortable condition, vulnerable exposure to the population and increasing the pollution problem are some of the effects of high ambient temperature (Santamouris, 2012). Built- up areas are the high vulnerable areas which then lead to temperature rise, energy intake and air pollution (Chun &Guldmann, 2014).

Referring to National Aeronautics and Space Administration official website (NASA, 2014), pointed out that the global temperature and global CO2 content level keep increasing year by year. The latest measurement made by NASA in November 2014 shows the reading of 399.3 parts per million (ppm) of globalCO2 contents compared to the year 2005 which shows the reading of 378 ppm.It is a worrisome increment of 22 ppm of CO2 level in a decade period. This general background understanding makes it relevant to analyze site suitability of parks in Iskandar Malaysia.

Review of Related Literature

Low Carbon Society (LCS)

Low carbon society (LCS) is the condition where actions are taken to be well-suited with development, where the needs are met within society and contribution still be made towards global effort in stabilizing high atmospheric CO2 contents and lowering GHG emissions avoiding the dangerous climate change (Kainumaet al., 2012). Generally, measurement of CO2 content observed by NASA 2014showed gradually increase in almost a decade period. Further to that the latest measurement of global CO_2 content recorded was 399.6 parts per million (ppm) in December 2014. If these conditions are still being abandoned now, it will continue create a more terrible condition afterwards.

Rising concern about the effect of GHG emissions on climate change is forcing the national governments and international community to realize the sustainable development in economy that is less reliant on carbon emitting activities is a vision that is usually termed as LCS (Toshihikoeet al.,2011) LCS bring the more comfortable and ideal condition to the countries where their economic development are increasing, while the earth is preserved, so that the high temperature places filled with GHG emitted can be neutralized.

For LCS in Malaysia's aspect, Putrajaya city has the vision of "Putrajaya Green City 2025" and through this vision Putrajaya has set to achieve a 45% GHG emissions reduction before 2025 compared to the level of 2005 (Ali et al., 2013). The city planners are mainly working on three visions which are a low- carbon Putrajaya targeting to lower carbon emissions by 60%. The second vision is a cooler Putrajaya with the target to reduce temperature by 21°C whereas the third vision is a 3R Putrajaya targeting to reduce final solid waste disposal by 50% and GHG emissions from waste by 50%. For these purposes, the Putrajaya city has already been in action, designing buildings, roads and infrastructure as well as transport system ina way that can really help in lowering GHG emissions and lead towards a model and ideal city.

Similarly, IM (Iskandar Malaysia), came up with set targets, action plans which will accepted by the local government,the implementation of which is still ongoing since the year 2011 in order to achieve the desired emission levels and sustainability within the specified time period. One of the subactions for LCS concept in IM is that of the green and blue infrastructure. For this purpose, the urban parks are one of the medium to achieve this sub action as they urban parks can act as the medium for greening and cooling Iskandar.

Definition of Urban Parks

Urban parks are built from the open spaces. Which are land that were undeveloped and have no building or any built structure which is accessible by the public and party include green space and completely covered with grasses, trees and other vegetation (USEPA, 2014). Green space includes parks, community gardens, cemeteries, schoolyards, playgrounds, public seating areas, public plazas and vacant lots.

Urban parks can also be defined as urban territory part consisting of organized and unorganized vegetation consequence from human, environmental and socio economic activities (Anca, 2013). From this definition, the quality of urban parks can be viewed as the collective positive atmosphere to the biological and socio economical needs, not only in an urban existence, but in the ambient urban of cultural landscape.

In Malaysia, there are six types of park that can be developed in theurbanized area. These parks consists of smallest size of park which isRecreation Park, followed by Playground Lot, Playground Park, NeighbourPark, Local Park and the largest park is Urban Park. Although all the parks aredifferent in their sizes, they still have to follow the rules of size, accessibilitydistance from the main road, slope degree allowed and residents' population size.These rules and parameters must be satisfied in order to select the best locationof urban park that is going to be developed. The park must be easily access andlocated in suitable location so that the benefits of the parks can be enjoyed by allsurrounding citizens over time.

Types of Parks and their selecting criteria in Malaysia

No	Types of Park	Size (square meter)	Accessibility Distance from Main Road (m)	Slope (º)	Residents Population Size (peoples)
1	Recreation Park	1,000 - 2,000	200	7 (4%)	< 300
2	Playground Lot	2,000 - 6,000	500	7 (4%)	300 – 1,000
3	Playground Park	6,000 - 20,000	1000	7 (4%)	1,000 – 3,000
4	Neighbour Park	20,000 - 80,000	1500	11 (6%)	3,000 – 12,000
5	Local Park	80,000 - 400,000	3000	11 (6%)	12,000 – 50,000
6	Urban Park	400,000 - 1,000,000	10000	No Limit	> 50,000

Town and Regional Planning Department of Peninsular Malaysia, 2013

Importance/Roles of Urban Park

Parks from open spaces provide tremendous or numerous functions and benefits. In general, they can provide both active and passive recreational opportunity, direct health activities and safety benefits such as flood control, protection for water supply and cleansing of air. Moreover, Parks can also protect wildlife species as their habitat, commercial job of forestry and also enhancing the real estate values as one of the feature to increase tourism among people inside and outside of countries as well as investors and retirees.

Besides, the beneficial roles of parks have greatly increased in the recent years including the environmental, psychological, physical and also social benefits. This is because individuals that enjoy parks are three times more likely to achieve the joy of physical activity level rather than the non users of parks (Stodolskaet al., 2011). Physical activities ensures healthy living and has been related to lower the obesity risk, diabetes and to the extent heart diseases.

From psychological aspect, parks can be a medium of rising positive moods and joy as well as reducing anxiety, angriness and sadness. In addition to the psychological benefits people derive from visiting parks, the presence of the park itself delivers a variety of mental health benefits with the presence of attractive and calm flora and fauna, the greenness in the eyes and the freshness of the parks surrounding (Makworo&Mireri, 2011).

Furthermore, parks also act as natural features in defining the image of communities and societies and also act as unique character between the boundaries of rapid and crowded development. Additionally parks can be built and shape land use to create more comfortable, efficient and compact services to the communities. Besides, park can also balance the temperature in urbanized areas by enhancing, the cooling effect of the area. The park's relative coolness can be substantial even in hot and humid cities. In Kuala Lumpur parks are 4°C to 5°C cooler than nearby commercial areas in the afternoon (Smith &Oke, 2010).

Site Selection Criteria for Parks in Malaysia

A community engagement which can work by individuals and communities in improving their cities environment is through the use of their open spaces and parks (Francis, 2006). This engagement can allow public workers or officials to involve directly in the process of planning, designing and managing the resources. From the results, the residents will feel better connected to their societies and help in improving better living in the cities.

Community engagement is supported by the parks in a way of participation and attachment to the communities as parks provide a better place and offer enhanced life qualities, helping not only the individual but also the communities. By understanding the community benefits of parks, decision makers and planners can develop publics that can support and sustain their urban park systems over time. To provide such parks, they must be aware that the location of the parks must be easily accessed to the community nearby. If the locations are not suitable from the start, then the park will be of no use and cannot achieve the purpose to connect the communities.

In Malaysia, there are six types of park that can be developed in the urbanized area. These parks consists from the smallest size of park which is Recreation Park, followed by Playground Lot, Playground Park, NeighbourPark, Local Park and the largest park is Urban Park. Although all the parks are different in their sizes, they still have to follow the rules of size, accessibility distance from the main road, slope degree allowed and residents' population size. These rules and parameters must be satisfied in order to select the best location of urban park that is going to be developed. The park must be easily accessible and located in suitable location so that the benefits of the parks can be enjoyed by all surrounding citizens over time.

Integration of Geographical Information System (GIS) and Analytical Hierarchy Process (AHP)

(AHP) is the method or a structured technique deals with (MCDM) Multi-Criteria Decision Method. It is one of the fuzzy logic techniques which is important for a complex decision to be made. Rather than prescribing a correct decision, the AHP method helps decision makers find the best decision which suits their goal and their understanding often problem. The method was developed by Thomas L. Saaty in 1980s and has-been extensively studied and refined since then. It provides a comprehensive and rational framework for structuring a decision problem to represent and quantify the elements for relating those elements to overall goals and evaluating alternative solutions.

The integration of GIS and fuzzy logic technique is very important for site selection. Developments in GIS have led to substantial improvements in the ability of decision making processes. In GIS site selection context, the decision making is being made regarding the most potential and suitable location where suitability is considered a fuzzy concept expressed as a fuzzy set membership (Burroughet al., 1992). By applying fuzzy logic in any GIS application, it may let users to view and have a multi range of choices and help them in a better decision making. A fuzzy multi criteria decision analysis will help to develop a ranking from 0% to 100% based on the criteria which will give a result of a fuzzy map of potential and suitable location.

In addition, by using GIS, site suitability analysis can be improved since it has a capability to manage large amount of spatial data which comes from various sources. GIS is possible to process huge amount of spatial data in a short time. Furthermore, GIS is capable to combine the attributes of thematic layers and conducting additional layer- based analysis such as the buffer analysis, path analysis, slope analysis and many others (Reza, 2009).

Methodology

The major focus of this work is site suitability analysis, accordingly a set of methods were selected to be applied in this study to identify suitable areas for urban parks development in IM. Each of the steps was adopted to achieve the objectives often study which are to conduct site suitability analysis in IM finding the most potential areas to be developed as parks and to determine and propose via literature survey tree species that can act to lowering CO2 content in the urban atmosphere.

All the steps have been examined in assessment for analysis of site suitability. These include the selection of criteria, the data management, the criteria map reclassification process, scoring and ranking to express the degree of suitability, Analytical Hierarchy Process (AHP) method to determine the relative importance, the criterion weight as well as the consistency ratio after computing the percentage influences, the analysis of site suitability of the parks until the process of literature survey to proposed the tree species suitable to be planted in urban parks in IM.

Results and Discussions

Parks Site Suitability Analysis

The parks Site Suitability analysis Map in Iskandar Malaysia is depicted in (Fig. 1)

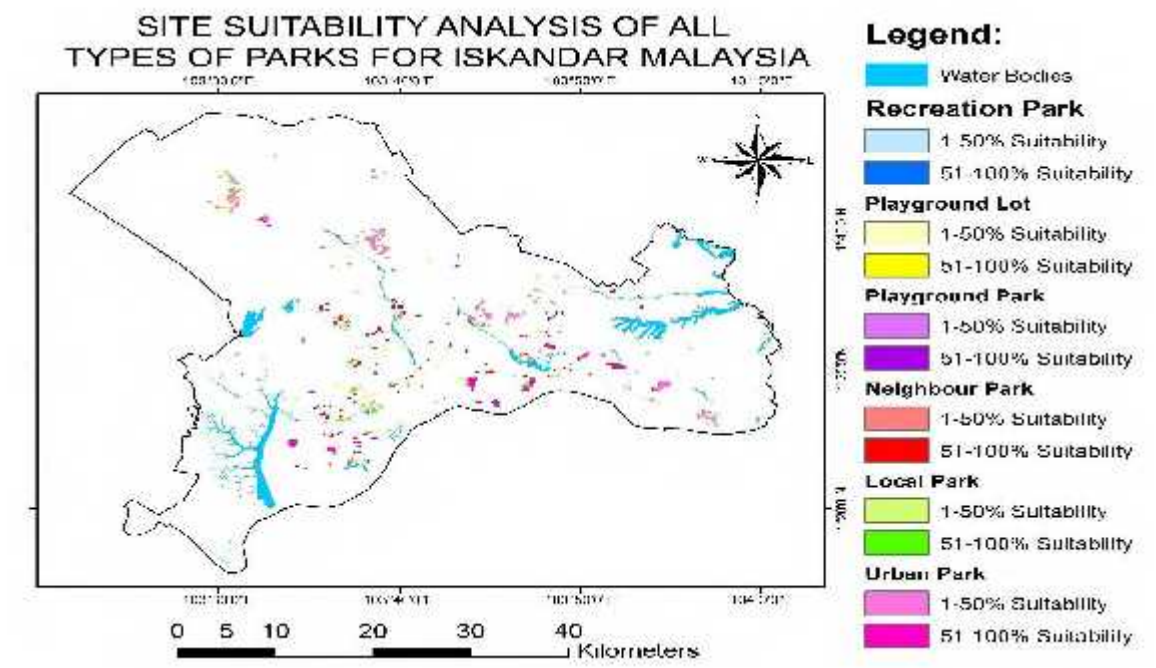

Figure 1: Site suitability Map for Iskandar Malaysia.

Combining all types of parks, quite a number of areas show high suitability for park development in Iskandar Malaysia The summary of which are shown in (Table 1)

Table 1: Summary of Parks Statistics

Parks	Suitability class		Suitability to near water bodies	
	1% to 50%	51% to 100%	1% to 50%	51% to 100%
Recreation Parks	16	10	1	0
Playground Lots	14	27	1	1
Playground Parks	41	49	6	2
Neighbour Parks	80	94	4	1
Local Parks	70	58	5	2
Urban Parks	97	67	3	1

Source: Field Survey, 2016.

In this study, 1% to 50% suitability portrayed the lesser suitability area of park development. These areas are still suitable to be developed as parks but some criteria are not satisfied. Probably the size is great and the surface is undulated but the area was quite far from the main road and different for users to access. Maybe the size and the accessibility distance from main road is good but the slope in that particular area is steep, these therefore become less suitable to develop parks in the area. Meanwhile 51% to 100% suitability portrayed the highly suitable area to be developed as parks. All the criteria are fulfilled with high score given in the beginning during scoring and ranking step in AHP method. In this study, near water bodies means the distance of less than 100 meters from the park sites.

In the final site suitability map, it was revealed that quite a number of areas show high suitability for park development, but only a few of them lies near water bodies. This showed that the suitable area for parks near water bodies is not many in Iskandar Malaysia. This is important because natural water bodies in a park can reduce ambient temperature. The alternatives

for water bodies of course can be done for example man- made fountain or ponds but the process to build the man- made features itself can increase the temperature with the use of bricks, steel and cement. The suitable area was checked using Google Earth for the validation process and some of the areas were already developed. The location and coordinates of the suitable area were detected for each type of park in IM. Accordingly, there were no suitable locations for recreation parks to be developed. This was because recreation parks consist of only small area and usually these areas lies in residential area and far from the water bodies or river.

Upon the playground lots in IM, only one area was found suitable to be developed as parks. The coordinates of the area is 1º28´50.65´´N 103 º52´51.58´´E. This location is situated in Masai area which is quite nearPasirGudang Highway and lies near SungaiMasai. The playground park gives two suitable location to be developed as parks which is located on coordinates 1°30'1.70"N 103°41'9.01"E and 1º35´13.45´´N103º53´11.89´´E. The first location situated in Tampoi which is quite nearPersisiran Perling and lies near Sungai Sekudai. Meanwhile the second location can be traced to UluTiram town which lies near Sungai Tiram. The location is suitable for the development as Neighbour Park;it is located on 1º29´3.65´´N 103º47´12.28´´E. This location situated in Plentong and near to EDL Highway.

The local parks give two suitable areas to be developed as parks which are 1º32´34.73´´N 103º39´50.90´´E, 1º33´6.65´´N 103º44´20.70´´E and1º28´58.21"N 103º47´9.41"E. This first location is situated in Skudai and liesnear Sungai Sekudai while the second location is situated in Nasa City Tebrau andnear Sungai Tebrauin the whole. Urban parks give only one suitable location to be developed as park which is on located on 1º30´9.24´´N103º52´12.05"E. This location is situated in Bandar Baru Seri Alam and near Sungai Masai.

Suitable Tree Species for Parks

Apart from trees in parks, a study by Smith and Oke (2010) showed that relatively small clumps of shade trees in the commercial area of a city can be far more effective in moderating afternoon temperatures than large grass covered fields with isolated trees. This proved that trees in parks or along roadsides can help in reducing the temperature in urban areas especially in the afternoon where temperature is high. However, to ensure that these trees can really help in moderating the temperature, the amount of carbon that they store and sequestered must be known so that the temperature can be reduced to the maximum rate. For example, if many trees are planted but the amount of carbon sequestered is less, the trees will not help much and not in the maximum rate of temperature reduction.

According to the United States Forest Service (USFS) (2013), the best trees for carbon sequestration are those with the large trunk diameters and dense wood. The trees with those features can be planted more while increasing the green spaces in urban areas. Mitigation techniques must be taken so that it can always balance the thermal budget of cities by increasing thermal losses and decreasing the corresponding gains. Among the more important techniques are those targeting to increase the able do of the urban environment, to expand the green spaces in cities and to use the natural heat sinks in order to dissipate the excess heat (Santamouris, 2012).

(Table 2) shows the tree species based on field survey conducted in Hutan Bandar Mutiara Rini and Hutan Bandar Johor Bahru in the district of Johor Bahru which lies in the Flagship Zone-A of Iskandar. This survey was conducted by observing every single tree in the parks and recording the name and species of the trees (Figure 2). Not all trees in the parks are tagged as some of the trees lost their tags over time and they were not replaced with new tags.

Conclusion

Areas between 1% to 50% suitability classifications were found less suitable for parks development in IM. This was a result of their longer proximity from the main road and difficulty in accessibility. On the other hand, suitability classifications ranging between 51% and 100% were termed suitable for parks development in IM. This stance was based on the fact that they satisfy the criteria for scoring and ranking steps in Analytical Hierarchy Process (AHP) method. Furthermore, very few areas were discovered to be near water bodies, limiting the number of suitable areas for parks development in IM, to the extent that there were suitable locations for the development of recreational parks.

Playground gives two suitable locations to be developed as parks in IM. These locations were situated in in Tampai near Persisiran Perling (1º35´13.45´´N and 103º41´9.01´´E) and UluTiram near Sungai Tiram (1º35´13.45´´N and 103º53´11.89´´E). Similarly, two local parks were termed suitable for park development in IM. These areas can be traced to Skudai near Sungai Skudai (1º32´34.73´´N and 103º39´50.90´´E) and Nasa city Tebrau, near Sungai Tebrau (1º33´6.65´´N and 103º44´20.70´´E). In the whole, only one area was discovered suitable for development of parks from playgrounds in Masai, near PasarGudang(1º28´50.65´´N and 103º52´51.58´´E), on one hand and from urban parks in Bandar BaruSeri Alam, near Sungai Masai (1º30´9.24´´N and 103º52´21.05´´E), on the other.

It was further discovered that, tree species that were planted in Hutan Bandar MutiaraRini and Hutan Bandar johorBahru of flagship zone-A of Iskandar, were with large trunk diameter and dense wood. Hence they were found suitable for balancing the thermal budget of those areas by increasing thermal losses and decreasing the corresponding thermal gains. In fact, these trees served the purpose of both aesthetic and recreation.

Table 2: Existing Tree Species in Johor BahruParks

Tree Species (Hutan Bandar MutiaraRini)		
S/N	**Scientific Name**	**Local Name**
1	Shoreaglauca	Balaulaut
2	Shoreasumatrana	Balausekawang air
3	Calaphyllumsp	Bintangorspp
4	Malaleuca cajuput	Gelam
5	Samaneasaman	Hujan- hujan
6	Dryobalanops aromatic	Kapur
7	Aquilariamalaccensis	Karas/ gaharu
8	Pterygotaalata	Kasha
9	Dipterocarpuschartaceus	Keruingkertas
10	Dipterocarpus	Keruingneram
11	Maingayamalayana	Maingayamalayana
12	Cinnamomuminers	Medangteja/ Kayumanishutan
13	Shoreaovalis	Merantikepong
14	Shoreaspp	Meranti
15	Shorealeprosula	Merantitembaga
16	Hopeaodarata	Merawansiputjantan
17	Anisoptera	Mersawaspp
18	Palaqulumspp	Nyatahbulu
19	Alstoniaangustiloba	Pulai
20	Pulai	Keruinggombang
Tree Species (Hutan Bandar Mawar, Johor Bahru)		
No.	**Scientific Name**	**Local Name**
1	Azadiracha excels	Sentang
2	Azadiracha excels	Tembusupadang
3	Saracacauliflora	Gapis
4	Alstonia	Pulai
5	Samaneasaman	Hujan- hujan
6	Polyalthialongifolia	Asoka
7	Cinnamomun inners	Medangteja/ Kayumanishutan
8	Shorealeprasula	Merantitembaga
9	Spondiaspinnata	Kedondonghutan
10	Mimosupaelengi	Bungatanjung

Source: Field Survey, 2016.

Figure 2: Tagged tree species in Hutan Bandar MutiaraRini, Johor

Recommendation

Based on the outcomes of this work, it was recommended that,

1. Areas with 51% and 100% suitability classification are highly considered for parks development in Iskandar Malaysia and beyond. This was because the relevance of suitability class in satisfying the criteria for scoring and ranking steps in Analytical Hierarchy Process (AHP) method.
2. Areas/Location that was found near water bodies in IM should be developed into parks. This might enhance in the demand of increased number of suitable areas for parks, such as the recreational parks. In a way construction or alternatives for water bodies should be avoided as bricks, steel and cementcan increase temperature.
3. Effective and efficient utilization of playground parks and local parks in IM, as well as, those parks discovered to be suitable for development of playground lots and urban parks is highly recommended. This way proper utilization of park and environmental benefit can greatly be realized in IM.
4. Adherence to planting tree species with large trunk diameter and dense wood hereby recommend. This will pave away for a balance thermal losses and decrease corresponding thermal gains.
5. To overcome the problem of high CO_2concentration in environments, low carbon society (LCS), usage of hybrid cars, low carbon cars and low carbon building materials were strongly suggested to be maintained.

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