APPROACH TO DESIGN METHOD FOR MICRO-SCALE LANDSCAPE IN HOT AND HUMID CLIMATE:
A CASE STUDY OF NEW HOUSING AREA IN JOHOR, MALAYSIA

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ABSTRACT

The purpose of this study is to address a micro-scale environmental-friendly landscape design methods in consideration of hot and humid climate with a combination of spatial data and physical environmental data in the new residential area in Johor, Malaysia. In this study, we showed research achievements so far as a first step as follows. 1. Literature review has cleared current research situation and necessity of effective investigation for environmental-friendly design methods in Malaysia. 2. We have gathered relevant spatial and climate observation data and improved data format for integrated database to develop the GIS (Geographic Information System) environment for quantitative spatial analysis. 3. Several candidate design elements for the next step investigation became clear through the physical comparative study of the target sites using GIS-generated thematic maps.

1. INTRODUCTION

Malaysia is located in the tropical wet climate zone. However, building form, site plan and road layout in most new housing development area have been unconsidered strongly a hot and humid climate for their master design, urban landscape strategies and methods (B. Givoni, 1998). In general, environmental-friendly design methods have been actively discussed and researched based on the microclimate analysis especially in Europe. However, it is quite difficult to apply these accumulated findings and skills to an urban development or landscape design in tropic countries directly (B. Givoni, 1998), because of each country's climate and general culture are totally different obviously.

To reflect the physical environmental and climatic information in landscape design effectively, it is necessary to analyze the spatial and environmental information of the target area and around adequately. However, fully quantitative analysis and assessment of outdoors environment on micro-scale using information technology such as GIS and computer simulation have not shown substantial progress in South-East countries.

Our final target through this research is to consider and propose an environmental-friendly design method for landscape in a micro-scale housing area in tropic based on the results. In this paper, we set the objects as a first step as follows:

1. To choose and collect relevant of spatial and environmental information such as digital-maps and meteorological data. And to develop the GIS environment for providing useful spatial analysis tools.
2. To grasp the configuration features of the research target housing area through the quantitative physical study using GIS and relative IT technologies based on the results of object 1.

2. Research and Methodology

2.1 Literature Review

A. Physical environmental data collection

As a heat island or climate change issues addressed more and more in the several research fields, meteorological observation technologies related research are becoming an active area centered in Western countries. Consequently, accumulation and disclosing of climate-associated data is widely proceeding. In recently years, because of heat island or air pollution issues especially in an urban region have been featured, in the urban or regional scale research aimed at development and standardization of climate measurement method is progressing (T. Oke 2004, 2006).

B. Relationship between urban / landscape design and physical environment

In the research fields of environmental-friendly-based design method in the scale of urban or regional, there are many practical projects as a sustainable urban development or design especially in Western countries (A. Ritchie, 2003). However, the previous studies dealing with application the findings of technologies of climate observation or accumulated climatic data to urban design or landscape design fields are very limited currently (M. R. Emmanuel, 2005).

C. Environmental-friendly design in Malaysia

In the research fields of related to climate in Malaysia, there are several references dealing with temperature change and its tendency based on actual measurement from 60's in major cities (S. Sani, 2005). These researches indicated the impact on climate change such as UHI (Urban Heat Island) after 70's rapid-urbanization. In the scale of urban or neighborhood area, Kubota, T et al. dealt with natural ventilation in a residential district in major cities (Kubota, T, 2006) based on actual field survey and measurement. However, actual consideration of applying these proposal indexes to concrete urban models has been made yet so far.

D. General housing situation in Malaysia

Situation of the property stock in Malaysia, as of fourth-quarter 2008, the terrace houses in Malaysia and in Johor state are account for approximately 40% and 47% respectively in the existing stocked residential units as shown in Table 1. It means that the terrace house is majority-housing type in Malaysia. Of the terrace house, the type of single storey terraced is account for 55.2%, the 2-3 storey terraced is account for 44.8% in Johor state. It is characterized by great economy in the used of land, moderate construction cost and low maintenance operation cost.

As a result of the reviewing, it become clear that **1.** In tropic countries including Malaysia, although there are several earlier study that treated with climatic interannual data collection of wide-area related to urban heat island or measurement survey-based study for indoor thermal comfort, there has been no study that tried to deal with relationship between landscape design elements such as building layout, road layout or planting situation and surrounding physical environment such as temperature, humidity or wind speed from the scientific perspective. **2.** Newly developed housing area including terrace house as majority-housing type are designed with standardized design methods and lack of sufficient attention to present local environment and environmental-friendly aspects.

Through these findings, we reconfirmed necessity of this study focusing on relationship between design methods and natural physical environment in outdoor space on a micro-scale especially in tropic countries.

2.2 Target Area Selection

Two research target areas in the Johor state (Fig. 1, Fig. 2) in Malaysia are selected in consideration of the built year, block and building layout, and size. (Fig. 3)

2.3 Spatial and Relative Data Collection

We have collected several data (Block, Lot, Road, River and so on) and physical environment data including meteorological data (temperature, humidity, sunshine duration, precipitation, wind speed, and so on) from public agencies. After that, appropriate spatial database and GIS environment were established with data format conversion and developing necessary unavailable data such as building footprint, land-use, and planting through the field site survey. Data inventory is shown in the Table 2. GIS environment can be used for creating several thematic maps and analysis of microclimate combining other software with location information in the further stage.

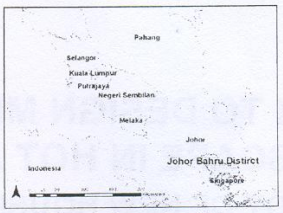


Fig. 1 Location Map

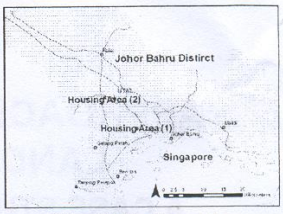


Fig. 2 Site Location

Fig. 3(a) Housing Area (1)

Fig. 3(b) Housing Area (2)

Table 2. Data Inventory List

Category	Type	Source from
2D Vector (Polygon)	Cadstral Data (Lot)	JUPEM
	Block	Original
	Building Footprint	Original
	Landuse	Original
2D Vector (Line)	Road	JUPEM
	River	JUPEM
2D Vector (Point)	Planting	Original
Image data	Aerial Photo	Digital Globe (Google Earth)
Paper-based	Planting Plan	Housing Developer (Sri Pulai Perdana)
Observatory data (Meteorological data)	24 Hour Mean Temperature	Malaysian Meteorological Department
	24 Hour Mean Relative Humidity	Malaysian Meteorological Department
	Monthly Maximum Surface Wind	Malaysian Meteorological Department
	Mean Surface Wind Speed	Malaysian Meteorological Department

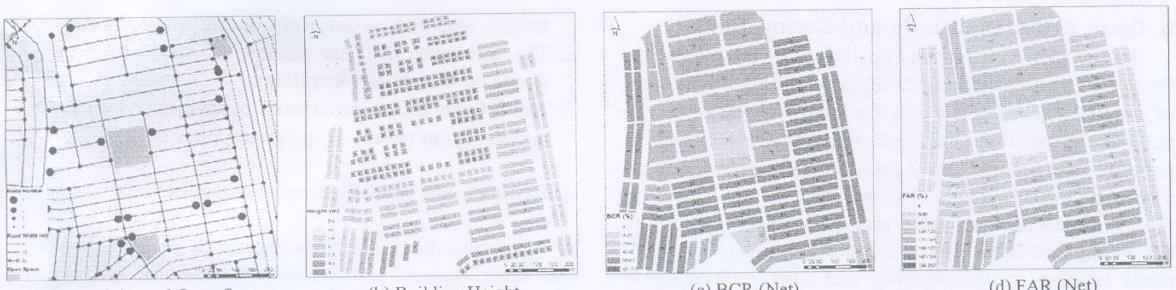
JUPEM :Department Survey and Mapping Malaysia

3. Physical Comparative Study

Firstly physical features of hard surface including target areas are discussed in this chapter. This comparative study is intended to come up with the several indices such as temperature, humidity or wind speed to be connected with the microclimate in the

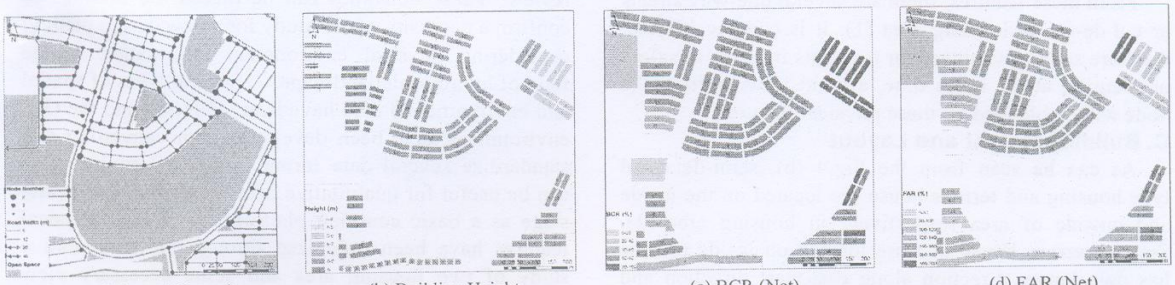
Table 1. Property stock in Johor State, Malaysia (2008)

States	Single Storey Terraced	2-3 Storey Terraced	Single Storey Semi-Detached	2-3 Sotrey Semi-Detached	Detached	Town House	Cluster	Low Cost House	Low Cost Flat	Flat	Service Apartment	Condo-minium/Apartment	Total
MALAYSIA	801,045	885,920	139,051	124,334	392,897	22,753	23,904	566,087	435,374	348,900	28,693	434,302	4,203,260
	19.1%	**21.1%**	3.3%	3.0%	9.3%	0.5%	0.6%	13.5%	10.4%	8.3%	0.7%	10.3%	100%
Johor	169,856	137,370	25,262	14,084	84,589	1,165	1,338	123,407	44,353	19,162	3,292	24,722	648,600
	26.2%	**21.2%**	3.9%	2.2%	13.0%	0.2%	0.2%	19.0%	6.8%	3.0%	0.5%	3.8%	100%



(a) Connectivity and Open Space (b) Building Height (c) BCR (Net) (d) FAR (Net)

Fig. 4 Thematic Maps of the Housing Area (1)



(a) Connectivity and Open Space (b) Building Height (c) BCR (Net) (d) FAR (Net)

Fig. 5 Thematic Maps of the Housing Area (2)

building, block and road were compared between two the housing area. Concretely we focused on the several aspects including building height, district density, road layout and block information.

A. Overview of the target district

As can be seen from the Table 3, the overview features about both housing area are as follow:

[Building] In housing Area (1) consists of "Semi-Detached housing type" (66% of total) and "Terrace house type" (28%). On the other hand, 78% of total is the "Terrace house type" in housing area (2).

[Land-use] District road ratio is over 35% in both housing area.

[Open Space] In housing area (2) developed in most recently, there are designed open spaces about 36% of total land-use, in contrast, only 3% green space in housing area (1).

[Density] District BCR (Building Coverage Ratio) is about 59% of area (1) and about 67% of area (2).

From these features, it is conceivable that although road base development has been sufficient in both housing area, there is a lack of enough open space especially in each lot and block as well. In response, there is over 35% of common open space in housing area (2), however the area (1) is heavily built-up judging from these numerical values.

Table 3. Physical Comparative Study - Hard surface

Building Information	**Housing Area (1)**	**Housing Area (2)**
Average Building Area (m^2)	606	953
Average Block Size (m^2)	2,842	2,077
Total Buidling Area (m^2)	216,357	127,798
Total Floor Area (m^2)	358,723	253,578
Number of Building	357	134
Building Type Ratio (Number)	T/SD/D/F/O: 100/235/20/0/2	T/SD/D/F/O: 104/19/0/10/1
Building Type Radio (%)	T/SD/D/F/O: 28%/66%/6%/0%/0%	T/SD/D/F/O: 78%/14%/0%/7%/1%
	T:Terrace, SD:Semi Detached, D:Detached, F:Flats, O:Others	
Land use Ratio (Target Area: 722,500m^2 (850x850m))		
OpenSpace Ratio	3% (220,18m^2)	35.9% (259,631m^2)
Road Ratio	35.2% (254,284m^2)	35.4% (256,123m^2)
Block Ratio	61.8 %(446,197m^2)	28.7% (207,710m^2)
District Density		
BCR (Net)	58.7%	66.8%
FAR (Net)	97.3%	132.5%

B. Open Space Distribute and Connectivity

As can be seen from the Fig. 4(a), in housing area (1), the whole grid pattern is arranged with deflection angle of around 20 degrees towards the west. According to the number of roads on the each node, there are several points connected with only one or two roads regardless district inside or outside. On the other hand, from Fig. 5(a), the road patterns have varied direction in the area (2). Compared with area (1), there are several primary roads running in the district, and also each node is connected with three or four secondary roads.

From these features, there are several one-way streets or cul-de-sac in housing area (1). It is conceivable that there are some advantages for residents in terms of safety or security, at the same time, a wind flowing from the node will be blocked by these physical features.

C. Building Height and Layout

As can be seen from the Fig.4 (b), semi-detached type housing and terrace house are located on the inside and outside of area respectively in housing area (1). Several terrace house that are located on inside of area has own longer direction along east-west direction and are range in height about 7 to 9 meters. On the other hand, terrace house that are located on outside of area are has own longer direction along north-south direction and are range in height about 4 to 6 meters.

From these features, in housing area (1), It is conceivable that the long continuous wall of the terrace house are disturbing air movement and trapping humidity and heat in the surrounding atmosphere. In the next stage, these hypothesis based on physical features will be cleared by microclimatic numerical simulation.

D. District Density

As can be seen from the Fig. 4(c) and 4(d), the BCR (Building Coverage Ratio) index indicates around 50% in the Detached and Semi-detached housing type, and 60-70% in the terrace house type. The FAR (Floor Area Ratio) index in the blocks including the terrace house are also relatively high rather than other blocks. From Fig. 5(c) and 5(d), the majority of the block is the terrace house type and the BCR index indicates 60-80% in there.

From these features, as with the features of building height, the BCR and FAR indicate at high level especially in the certain blocks that have terrace house type building in the housing area (1), meaning that this area is high density for a residential district. On the other hand, in the housing area (2), although there is distributed the BCR and FAR with uniformity relatively, these values are high, because of the terrace house type are located as majority housing type in this district.

E. Overall Features

From the physical features of both housing area mentioned above, the possible several indices and landscape elements that may affect the surrounding physical environment became clear with a qualitative and quantitative viewpoint. In the further stage, several notable points to link these physical features to result of microclimatic simulation are as follows:

1. The influence that the difference between the building height, type and layout exerts on the microclimate.
2. The influence that the number of street on a node exerts on the natural-ventilation
3. The influence that the amount of common open space and its layout exerts on the microclimate.

4. Conclusion and Future Prospects

We have discussed throughout this study following the three topics. 1. The current situation of related previous research became clear through the literature review. These outcomes can be placed the findings to confirm a necessity of our study for a new design method considering physical environment information in the field of micro-scale landscape. 2. Several types of spatial and environmental data have been collected and the GIS environment have been developed with converting and standardize several data format. This GIS environment can be useful for quantitative data acquisition for further stage as a basic common platform. 3. Several physical features have been organized through the comparative study of two housing area and some necessary view points and candidate parameters became clear for numerical microclimate simulation in the next stage.

Currently, we have prepared to digitize vegetation and green space data on the each lot and overall area in the housing district. In the further stage, we are going to proceed to compare between physical features that became clear through this study and the result from microclimate simulation about the element of hard-surface and landscape for acquisition of new findings for more comfortable housing environment in the tropic countries.

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