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THE SELECTION OF RIVER INDICATORS TO ASSESS THE ECOLOGICAL STATUS OF IIUM RIVER

BY

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ABSTRACT

The concept of sustainable campus has emerged from the social, economic and environmental impacts due to anthropogenic activities around the world. One of the initiatives of sustainable campus is the application of ecological indicators. The indicators provide information about the current condition and early warning on the possible risks of environmental impacts to the campus environment. However, lack of understanding on the values of natural ecosystem in campus and the lack of proper planning has led to the depletion of natural ecosystem. The study seeks to examine river degradation in IIUM campus and to propose a framework of selecting river indicators towards achieving IIUM as an ecologically sustainable campus. For this purposes, three objectives were formulated, (i) to identify the significance of river indicators in campus physical planning, (ii) to examine the river ecosystem in IIUM campus and the factors that contribute to its depletion, and (iii) to propose a selection process to identify suitable physical indicators to assess IIUM river condition in achieving ecologically sustainable campus. Data were gathered using a qualitative approach involving three methods of data collection namely: (i) document analysis, (ii) semi-structured interview and (iii) site inventory. The finding reveals that the application of river channel morphology indicators is an important basis for physical planning in making a campus ecologically sustainable. Furthermore, it is reported that the sedimentation in the river is caused by anthropogenic activities namely the construction activity, sand mining activity and clogged culvert. Consequently, the physical environment of the river was found to be mostly affected by the anthropogenic activities. Further analysis suggests that the suitable indicators to assess the condition of IIUM River are the river channel morphology indicators such as width, depth, channel pattern and slope ratio. The process of selecting the indicators are carried out based on six criteria of good indicators discussed in this study. The study concluded that the application of river channel morphology indicators is a critical process in physical planning of a sustainable campus as it contributes in preventing the loss of natural ecosystem and it offers a credible basis for creating a conducive place for campus residents.

ملخص البحث

لقد برز مفهوم الحرم الجامعي المستدام نتيجة للآثار الاجتماعية والاقتصادية والبيئية الناتجة عن الأنشطة البشرية حول العالم. إضافة إلى ذلك، أدى سوء التخطيط داخل الحرم وبجواره إلى استنزاف النظام البيئي الطبيعي. تسعى هذه الدراسة لبحث تدهْوُر النهر في حرم الجامعة IIUM واقتراح إطار لاختيار مؤشرات تعين على تحويل حرم IIUM إلى حرمٍ مُستدامٍ بيئيًا. لهذا الغرض، صيغت ثلاثة أهداف: (أ) التعرف على أهمية النهر بوصفه مؤشرًا في التخطيط العمراني للحرم الجامعي، (ب) فحص النظام البيئي المتعلق بالنهر في حرم IIUM والعوامل التي تسهم في استنزافه، (ج) واقتراح إطار يظهر عملية اختيار مؤشرات مناسبة لتقويم حالة النهر في IIUM من أجل تحقيق حرم مُستدام بيئيًا. وقد جرى جمع البيانات باستخدام أسلوب نوعي يتضمن ثلاث طرق لجمع البيانات، وهي تحليل الوثائق، والمقابلة شبه المنظّمة، ومخزون المواقع. وتكشف النتائج أن تطبيق مؤشرات النهر يمثل أساسًا مهمًّا للتخطيط العمراني في جعل الحرم مُستدامًا بيئيًا. وعلاوة على ذلك، تبين أن الترسُّب في النهر ناجمٌ عن الأنشطة البشرية، خاصة نشاط البناء، ونشاط استخراج الرمال، وانسداد المجري المائي. ونتيجة لذلك، تبين أن بيئة النهر الطبيعية تتأثر في الغالب بالأنشطة البشرية. ويشير المزيد من التحليل إلى أن المؤشرات المناسبة لتقويم حالة النهر في IIUM هي مؤشرات التشكل لمجرى النهر مثل العرض، والعمق، ونمط المجرى، ونسبة المنحدر. وجَرَت عملية اختيار المؤشرات استنادًا إلى ستة معايير للمؤشرات الجيدة التي نوقشت في هذه الدراسة. وتخلص الدراسة إلى أن تطبيق مؤشرات النهر مهمٌ في التخطيط العمراني للحرم الجامعي حيث يساهم في الوقاية من فقدان النظام البيئي الطبيعي، الذي يخلق مكانًا ملائمًا لسكان الحرم الجامعي.

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion; it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master of Science (Built Environment)

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DECLARATION

I hereby declare that this dissertation is the result of my own investigation, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

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This thesis is dedicated to my beloved husband, Hairi Jamaludin

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Firstly, I would like to express my *tahmid* to Allah S.W.T. for His blessing and *salawat* and *salam* to my beloved Prophet Muhammad P.B.U.H. for me to be able in completing my research of Master of Science in Built Environment.

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It is hoped that my research could benefit the public and the person involved in sustainable campus development. *Insyaallah.* Lastly, I pray to Allah that all of us can achieve the balance in every development which can meet the sustainability of the environment, social, and economic. *Amin* ...

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CHAPTER ONE

INTRODUCTION

1.0 INTRODUCTION

The study focuses on the selection of suitable indicator that can be applied to assess the condition of river physical in International Islamic University Malaysia. Accordingly, this chapter sets out to provide an overview of the structure of the research. Section 1.1 provides a background of study concerning ecological sustainable campus and the application of river channel morphology indicator. Subsequently, problem statement is explained in Section 1.2. Then, research questions derived from the research problem are structured in Section 1.3. Later on, in Section 1.4 and 1.5 research aim and objectives are developed which answering the research questions. The significance of study is identified in Section 1.6. Next, in Section 1.7 scope of the study is listed down as it will direct this research more specifically. Then, Section 1.8 elaborates on the research methodology and followed by structure of whole research in Section 1.9. Finally, Section 1.10 summarizes the chapter of the research.

1.1 RESEARCH BACKGROUND

The concept of sustainable development is an ultimate approach of making economic, social and environmental resources available for current and future generations. This concept has been implemented throughout the world as a respond to many environmental degradation that leads to the lost of human civilization. Nowadays, the world faces numerous challenges that threaten to undermine the welfare of people all over the world. Issues like urban sprawl, congestion, waste and global warming has

alarmed many planners and encourage them to apply evolving notions of sustainability in city planning. As a result, many actions and policies have been developed to cater the issues of social, environmental and economic sustainability, especially in the urban contact.

The concept of sustainable urban development can be applied at any scale of development all over the world from a global scale to as small as institutional scale such as a campus or higher learning institution. Accordingly, a campus today is recognised as a vital platform where all new information and efforts to improve quality of life without compromising the needs for future demands can be disseminated (United Nations Environment Programme, 2013). Significantly, an ideal campus is supposed to be an entity that can be an inspiration for many organizations in implementing effort towards achieving sustainable development.

The wellbeing of the campus residents can be achieved through effective planning and management of three aspects of campus sustainability namely the economy, social and environment. Currently, most academic institutions emphasize the importance of maintaining the environmental aspect of a campus operation through the implementation of policies and actions as it gives direct impacts to the social and economic balance to a campus. Environmental sustainability has become increasingly relevant to institutions of higher education in recent years and it is seen as the most critical aspect to be looked into in order to achieve the goal of sustainability.

With regards to the environmental aspect of a campus operation, one of important considerations is the incorporation of ecological knowledge into the physical planning of a campus. It is essential to the implementation of policies and actions with regards to sustainable development. One way to promote environmental sustainability in campus is through the implementation of ecological indicator as a

method for strategic planning in order to measure the current condition of environmental aspects in campus. Kamarudin et. al, (2011) supported that the use of these indictors can help to achieve campus sustainability as promoted by Agenda 21. The Agenda urges to advocate countries, organization and non-govermental organizations to develop and use ecological indicators.

In Malaysia, three campuses have implemented the use of ecological indicator for their sustainable campus development are Universiti Kebangsaan Malaysia, Universiti Malaysia Sabah and Universiti Sains Malaysia. Among the three universities, four aspects that are oftenly highlighted in the their sustainability efforts are energy, water, transportation, and waste management (Zen et al., 2013; Omar et al., 2010).

Like many other local higher learning institution, International Islamic University Malaysia is also working towards achieving eco campus. This can be seen from the vission and mission of the campus which is to be liveable, environmental friendly, and effectively functional (http://www.iium.edu.my/dev/about-us/vision-mission). The profusion of natural ecosystems in the campus make it a suitable place for learning activities as there are many ecosystem services provided by the natural setting that give good impact to the campus residents. These natural ecosystems seem to be very precious sources and it is the role of the university management to keep them in good condition in order to maintain its equilibrium.

This study contends that a tool for assessing the current condition of the natural ecosystems could help to predict any changes of the ecosystem state, as it is significant to maintain the natural ecosystem in order to create a conducive environment that supports learning, teaching, innovation, and research. However, lack of awareness and consideration in maintaining the health of the natural ecosystems in

IIUM such river, has led to river ecosystem degradation, which contributes to many environmental impacts such as flash flood and the lost of ecosystem. In this case, the need of a tool to assess the river condition is vital to provide information, in order to avoid severe environmental impact in campus. Initial study revealed that the main trigger of the degradation of the river is because on the physical changes of the river. Therefore, this research was set out to identify the condition and factors of river changes and the framework of selecting ecological indicator for sustainable campus by concentrating on the river channel morphology.

1.2 PROBLEM STATEMENT

The implementation of ecological indicator in campus to assess natural ecosystem to reduce the risk of natural disaster is not popularly used by many campuses. Several studies reveal that, indicators to assess ecosystem health or condition receive low attention as compared to energy, water, waste and transportation (Howitt & Rickards, 2013; Gottlieb et. al, 2012; Cole, 2003; Rodriguez et. al, 2002). The importance of the available natural ecosystem seems to receive low attention in monitoring campus sustainability. Mostly, the reason for this issue is because of lack of understanding on the value of natural ecosystem in campus, limited framework for natural ecosystem such as river for campus, and lack of ecological approach for campus physical planning

1.2.1 Lack of understanding of value of natural ecosystem in campus ground

Firstly, the benefits of natural ecosystem are precious and valuable. However, fewer campuses implement ecological indicator for natural ecosystem due to the lack of understanding on the place and value of ecosystem in campus environment (Utaberta

and Handryant, 2012). Accordingly, many sustainable campuses regard the component of landscape or ecosystem as important elements in creating comfort in campus (Klein-Banai and Theis, 2011; Omidreza et al., 2009; Zuhairuse et al., 2009). However, they are only seen as elements of beautification instead of functional (Utaberta and Handryant, 2012) where most campus managers only appreciate available landscape and ecosystems as elements that can beautify their campus ground without acknowledging the utilitarian and functional aspects like regulation of temperature, and providing crucial services for the residents. Therefore, the necessity of applying ecological indicator to assess current condition of available ecosystem such as river seems to be given little attention in campus development.

Among the advantages benefited from the river ecosystem services are the protection from environmental hazard because it helps in regulation of flood flows, reduces storm damage downstream, maintaining topographical variation, regulate clean water passing through soil, air quality improvement, and maintenance of biological integrity. Other than regulating service, others services provided by river are source of water supply, representative of personal intangible value, recreational activities, spiritual contemplation, aesthetic values, and provide fresh environment and interesting outdoor learning area (Millennium Ecosystem Assessment Board, 2003).

While there are many benefits demonstrated from ecosystem, the important ecosystem services of river to campus residents seems to receive low response in campus sustainability assessment eventhough its significance are recognized by many (Armstrong, 2011; Sofer & Pottern, 2008). For that reason, the condition of river ecosystem and its inhabitants should be monitored accordingly through the implementation of river indicator in order to sustain the services.

1.2.2 Limited framework for the river ecosystem

Secondly, the implementation of ecological approach like ecological indicators in assuring the health of natural ecosystem, comprehensive frameworks of ecological indicator have rapidly developed long ago (Landres et al., 1988). Unfortunately, most of the frameworks are developed for natural sensitive areas such as stream (Stoddard et al., 2006; Del Arco et al., 2011; Pander and Geist, 2013), forest (Lindenmayer et al., 2002; Weidema, 2008), wetlands (Faber-Langendoen et al., 2006) and estuaries (United States Environmental Protection Agency, 2013). Indeed, some campuses have considered the use of ecological indicator in campus planning and development, but less focus is given to assess river ecosystem condition as preventive way to any environmental risk. Most of the focus areas are on the social, economical and general environmental aspects of sustainability such as water, air and waste management. Ultimately, the limited number on the use of ecological indicator to assess natural ecosystem for eco campus has contributed to the depletion of natural ecosystem that leads to environmental hazards in the campuses.

Even though there are a limited number of ecological indicators for eco campus assessment, the earlier studies on the development and implementation of ecological indicators for natural sensitive areas can be applicable as long as the components of ecosystems available in campuses are the same. Even though studies on the development of ecological indicator are abundant, several issues still hamper its development. Continuing debate on the development of ecological indicator is on the process and the selection of ecological attributes to be set as indicators (Niemeijer and de Groot, 2008; Doren, 2009). Dale & Beyeler (2001) argue the selection of ecological indicators because of the complexity of the ecosystem. This is stemmed from the lack of understanding of ecological information to evaluate local ecosystem,

thus creating a big gap because not all places have the same ecological attributes (Faber-Langendoen et al., 2006; Bossel, 1999). Therefore, the choice of elements of the ecosystem to be set as potential indicators for eco campus need to be examined thoroughly by understanding specific issue and local in order to get suitable selection of ecological indicators.

The current scenario in Malaysian campus reveals the efforts of local campuses towards achieving eco campus. Several campuses like Universiti Kebangsaan Malaysia (UKM), Universiti Universiti Teknologi Malaysia (UTM) and Universiti Sains Malaysia (USM) (Mohd Zulhanif et al., 2011; Yap, 2011) have implemented planning for physical development which integrates the care for the existing natural environment and have considered the application of indicators. However, the set of indicators developed offer less attention to the assessment for the natural ecosystems (Zuhairuse et al., 2009). Most of the indicators proposed only stressed on certain elements such as energy efficiency, waste management, transportation, water management, building and academics, with less focus is given to the campus ecosystem condition (Zuhairuse et al., 2009; Stratton, 2010; Khor, 2012; Omiredza, 2009).

1.2.3 Lack of ecological approach for campus physical planning

Finally, another issue that hampers in Malaysian campus is its planning on physical development activities which is less sensitive to change and fail to predict potential environmental issues (Mohd Tajuddin, 2003). Many developments are made without considering the consequences on health of natural ecosystems (Asmawi et al., 2011). Lack of ecological concern on campus natural ecosystems has caused many environmental hazards such as ecosystem depletion, flash flood, erosion and landslide.

Recently, flash flood has occurred in International Islamic University Malaysia (The Star Online, 2014) which is caused by anthropogenic activities such as sand-mining and physical development taking place on the upper reaches outside of the campus boundaries (Zaki, 2014). Data gathered from Malaysian Remote Sensing Agency also provides clear evidence that part of the river and lake has been depleted and reduced. Taken into consideration of the above issues, it is timely for the research to focus on IIUM as its case study.

1.3 RESEARCH QUESTIONS

Research questions are important that contribute the content of the whole thesis. It is based on the problem statement of the research. Three research questions are developed as follows:

a. Key research question:
    i. What are suitable indicators that can be used to monitor river ecosystem in IIUM as an approach towards achieving ecological sustainable campus?

b. Sub-research question
    i. What are the significance of river indicator in campus physical planning?
    ii. What are the condition of river ecosystem in IIUM and the factors that contribute to its depletion?
    iii. How to select suitable indicators to assess IIUM river condition in achieving ecologically sustainable campus?

1.4 RESEARCH AIM

The aim of the research is to propose a framework of selecting river indicators towards achieving IIUM as an ecologically sustainable campus.

1.5 RESEARCH OBJECTIVES

To achieve the aim, three research objectives have been formulated which are:

i. to identify the significance of river indicator in campus physical planning;

ii. to examine the river ecosystem in IIUM campus and the factors that contribute to its depletion;

iii. to propose a framework that shows the process of selecting suitable indicators to assess IIUM river condition in achieving ecologically sustainable campus.

1.6 SIGNIFICANCE OF STUDY

Research in river indicator for ecological campus is important to ensure the health of river ecosystem. The health of ecosystem is important to maintain its service in order to reduce any potential environmental risk in campus area. Besides that, a healthy river will help in providing a conducive learning environment where students can enjoy the services or benefits of ecosystem for free.

Lack of ecological indicator for natural ecosystem such as river has led to many environmental risks in campus. This is because of lack of awareness on the functional aspect of the river to campus residents. By filling the gap, the research is hoped to contribute to a better understanding on the benefits of river ecosystem in campus and the application of ecological indicator as a tool to predict the condition of the ecosystem for current and future needs that suits with local context. In addition, the research is also hoped could contribute to a new perspective in providing a framework that shows the process of selecting suitable river indicator for many Malaysian campuses that have the similar issue towards achieving eco campus in line with the effort of the government that support the call for sustainable environment.

Furthermore, it is increasingly recognised that more sustainable approaches are needed for planning and managing landscape worldwide including campus ground. Therefore, ecological knowledge is essential when planning for sustainability in campus by applying new tool that can effectively used to enhance campus sustainability. The proposed framework can be applied in physical development planning in many campuses that poses natural ecosystem. Building on existing ecological planning methods, this framework for sustainable landscape planning in campus is considered as a good way to be incorporated in campus planning because it applies landscape ecological concepts and explores the potential of river channel morphology indicators as ecological planning tools which can enhance the functional aspect of the ecosystem and to avoid environmental risks in the campus.

Ecological indicator for landscape architecture and planning is a relatively a new phenomenon and is a response to ecosystem depletion and deterioration of quality of a natural system. In campus, the problem of land use intransigence and the absence of documented ecological indicator create a difficult environment for maintaining a healthy campus natural ecosystem. Therefore, the incorporation of ecological approach like river channel morphology indicators could contribute to an improvement in ecological value especially in planning processes in order to make a campus ecologically sustainable.

1.7 SCOPE OF STUDY

The scope of study is limited to the study of river indicators that is applicable for ecosystem depletion in IIUM. This study is focusing on the selection of suitable indicators in order to assess the condition of river ecosystem in IIUM. The study focuses on three main topics to constitute this research. It includes 1) ecologically