Ecological Footprint of Research University Students: A Pilot Case Study in Universiti Teknologi Malaysia

Tan Ang See[1,a], Choong Weng Wai[1] and Irina Safitri Zen[2]

[1]*Department of Real Estate, Faculty of Geoinformation and Real Estate, Universiti Teknologi Malaysia, Johor Bahru, Malaysia*
[2]*Department of Urban and Regional Planning, Faculty of Built Environment, Universiti Teknologi Malaysia, Johor Bahru, Malaysia*

Abstract. Ecological footprint (EF) is potential to be applied in universities to assist building management units to coordinate in order to reduce environmental impact and to achieve sustainable resource consumption from its main activities including teaching-learning, research and operations. As many Malaysian universities declare to become sustainability campus, the adoption of ecological footprint in measuring campus sustainability will provide insight and better understanding about the performance of campus sustainability efforts. The main concept of ecological footprint which convert levels of consumption into the amount of land needed, will able to reveal the average student performance and impacts towards the campus. Further, a study is conducted to determine the average ecological footprint level of students in research universities Malaysia considering students formed the majority of the community in a campus. A pilot study has been conducted in Universiti Teknologi Malaysia (UTM) among students staying in hostel together with staffs from UTM Office of Student Affairs and Alumni (HEMA) and UTM Office of Asset and Development (PHB). Then, Redefining Progress (RP) ecological footprint online calculator is used in computing the ecological footprint of UTM students.

1 Introduction

University consumes resources to fulfill its core functions of teaching-learning, research and operation. A sustainable university should be able to address, involve and promote the minimization of the adverse environmental, economic, social and health impacts from the three core functions and to help society make the transition to sustainable lifestyles [1]. As worldwide universities are increasingly focused on promoting campus sustainability, thus there is a need to develop methodologies to measure a campus level of sustainability. [2, 3] suggested EF as a potential approach to measure campus sustainability. The rationale is to improve university sustainability by decreasing their ecological footprint (EF) [4].

EF has been applied at various levels, from global, regional, nation to city level. Previous researcher developed the EF at the national level [5, 6], regional and city level [7, 8] and university or campus level [2, 9-13]. Other EF studies cater the product and service needs, such as wines [14], ethanol [15], mobile phones [16], tourism [17], international trade [18] and others. EF also can be used to compare the impacts of different lifestyles [10]. There is a need to measure how much is consumed by the community in Malaysian universities. The EF field is still in its infancy stage and currently widespread debate over the methodology for calculating an organizational EF [19]. The major challenge is that there is no commonly accepted method for EF calculation [20].

To date, EF is widely used for raising awareness of environmental impacts, education tool, resource management tool, policy tool, sustainability development measurement and scenario development. This paper aims to discuss the pilot study of EF assessment which has been carried out in Universiti Teknologi Malaysia (UTM).

2 Overview of ecological footprint

Individual activity has an impact on the Earth to a whole city or country [21]. The urgency to protect the Earth is getting more crucial recently due to the accelerating global economy and population continuity to grow and the Earth yet remains the same size [22]. The concept had encouraged some sustainability indicators, including EF in determining the milestone and capacity in the context of sustainability.

In general, the EF is an indicator of human impact on nature. It is often referred as eco footprint or environmental footprint. EF was developed in the early of 1990s by Professor William Rees and Dr. Mathis Wackernagel at the School for Community and Regional Planning, University of British Columbia in Vancouver, Canada [20, 23]. EF is defined as the area of biologically productive land and water ecosystems required to produce the resources that the population consumes and

[a] Corresponding author: angsee88@hotmail.com

assimilate the wastes that the population produces, wherever on Earth the land and water is located [21].

The EF evaluates the impact of an individual, groups or nation lifestyle on the planet by converting levels of consumption into the amount of land needed to sustain necessary production levels and lifestyle choices. It is measured in a standardized unit [area/individual] namely hectare (ha) per capita or global hectare (gha) per capita or global acre (ga) per capita. A hectare is equivalent to 2.5 acres and an acre is approximately the size of a football field. A global hectare is a hectare of biologically productive space with world average productivity of the given year. Most of the EF reports and applications expressed EF in global hectare per capita [24]. Another purpose of EF is to inform the individual's unsustainable behavior which further influence the consumers' consumption patterns towards sustainability lifestyles, thus reducing the impact to the environmental [25].

2.1 The world ecological footprint

Conceptually, EF must not exceed the biocapacity of the Earth to sustain human society. Figure 1 tracked the world EF and biocapacity since 1961 to 2011. Both EF and biocapacity are measured in gha per capita. The upper right corner of Figure 1 showed the quality of the assessment which is scored on a 1-6 scale. Data quality 6 means that the results are reasonably reliable. From Figure 1, it is clearly shown that humanity only used about two-third of Earth available resources in 1961. When population increased, human demand for resources began outstripping what the planet could renewably produce during the early 1970s. In 2011, the global EF was 2.7 gha per capita but what is available on the Earth is only 1.7 gha per capita. The result implicated that humanity consumption has exceeded the amount of resources Earth provided by 50%. Furthermore, the Earth needs 1.5 years to regenerate resources that people are using in a single year. It is predicted that two planets will not be enough to support the demand on resources by 2030.

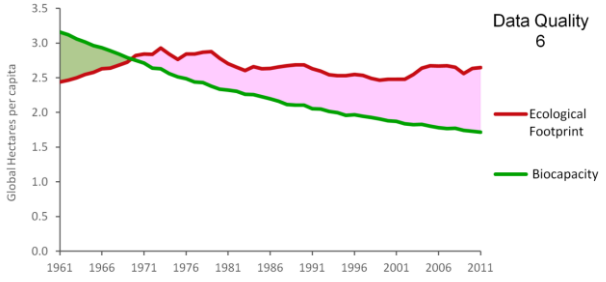

Figure 1. World ecological footprint and biocapacity (1961-2011) [26]

2.2 Malaysia ecological footprint

In global context, the Malaysia EF is smaller compared to the developed countries such as United States, Canada and United Kingdom. However, within the region, Malaysia has larger EF than other ASEAN countries such as Thailand, Indonesia and Philippines [27-29]. Currently, the Malaysia EF calculation is provided by Living Planet Report (LPR) and National Footprint Accounts (NFA).

LPR is published every two years by World Wide Fund for Nature (WWF) in cooperation with the United Nations Environmental Programme (UNEP) and Global Footprint Network (GFN). It is the world's leading, science-based analysis on the health of our planet and the impact of human activity. The latest edition of LPR was released in 2014.

Another significant report, NFA is released by GFN annually. It provides comprehensive data on human demand on resources as to support their activity. They track how this demand compares across several over 200 countries, territories and regions and how it relates to planet's biocapacity to meet this demand. The NFA 2015 is the most current published edition where EF and biocapacity observed data results from 1961 to 2011 has been documented.

The Malaysia EF and biocapacity from 1961 to 2011 is presented in Figure 2. The upper right corner of Figure 2 showed the quality of the assessment which is scored on a 1-6 scale. Data quality 3B means that the results are cleared for both latest year and overall time series. According to the figure, Malaysia EF has exceeded its biocapacity since 1995. The Malaysia EF recorded at 2.9 gha per capita and biocapacity at 2.3 gha per capita in 2011. In other words, each Malaysian would require about three hectares of land to sustain their current living standards. Malaysia's EF ecological deficit reached about 0.5 gha per capita in 2011. Up to now, Malaysia EF has exceeded the global average of 2.7 gha per capita.

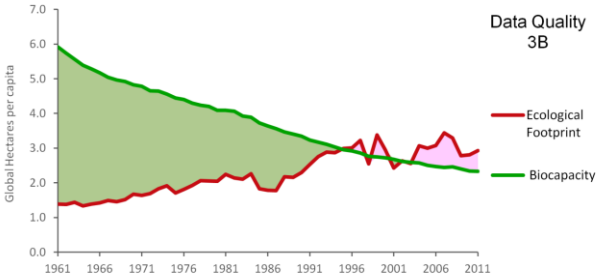

Figure 2. Malaysia ecological footprint and biocapacity (1961-2011) [26]

3 Ecological footprint for university

Universities are very similar to small cities [30]. They have large land area, growing populations and increasing number of traffics to cater the needs of research and education activities. The physical built environment of universities covers a range of building types such as office, classroom, hostel, laboratory, health care and large assembly hall. It will have impact to the environment and sustainability through the resources consumption such as energy and water as well as waste generation [31]. Furthermore, universities considered as the largest consumers where they use large amount of paper, energy and water. In addition, research-intensive university

consumes more resources than a conventional university [32] based on education activities.

The application of EF to university is neither new nor novel. EF calculations have been undertaken in campuses such as University of Newcastle, University of Redlands, University of Toronto at Mississauga and others. The EF of these universities is shown in Table 1.

Table 1. Ecological footprint of universities.

University	Period	EF	
		Value	Unit
University of Newcastle [10]	1998	0.19	ha/capita
University of Redlands [12]	1998	1.00	
School of Physics (SoP) in University of Sydney [13]	1997	6.80	
Holme Lacy College [9]	2001	0.57	
University of Toronto at Mississauga [2]	2005	1.07	
Northeastern University at China [11]	2003	1.06	
Universiti Pendidikan Sultan Idris (UPSI) [3]	2008	0.31	
University of Illinois at Chicago (UIC) [33]	2008	2.66	gha/capita

In Malaysia, studies of EF are limited notably at the national level and absent at the state and city levels. The absence of studies is partly attributable to data limitation [20]. Literature search revealed that the only EF calculation at university level was conducted in the Universiti Pendidikan Sultan Idris (UPSI) by [3]. Other EF articles including [20], [27] and [28] did their EF research at national level based on input-output (IO) analysis for Malaysia. Other EF application in Malaysia include high rise condominium residential area [34] and Malaysian palm oil industry [35].

In conjunction with sustainable development, Malaysian universities such as Universiti Malaya (UM), Universiti Sains Malaysia (USM), Universiti Kebangsaan Malaysia (UKM), Universiti Putra Malaysia (UPM) and Universiti Teknologi Malaysia (UTM) have their campus sustainability initiatives. However, without measurement of the environmental impact, it would be difficult to manage sustainable development [5]. Knowing the current level of environmental impact would allow the universities to know how far they are from achieving sustainability.

EF is one of the sustainable indicators that could help to assess the environmental impact for universities. The EF could serve as metric to support sustainability activities for campus. Firstly, it highlights the current level of environmental impact for the university. Secondly, EF is presented on a single arrogated scale that allows for direct comparison of the impacts of different components against one another [36]. Thirdly, the EF assessment could assist sustainable development decision making for the management of university. Calculating EF could be the first step for Malaysian university to become a more sustainable campus.

4 Pilot study

A study is conducted to determine the average EF level of research university students in Malaysia as students formed the majority of community in a campus. A pilot study has been conducted in UTM among students who are staying in hostel together with staffs from UTM Office of Student Affairs and Alumni (HEMA) and UTM Office of Asset and Development (PHB). Data such as room size, energy sources, building materials, energy and water saving features can only be acquired from staffs because students do not have access to these types of information. Then, Redefining Progress EF online calculator is used to compute the EF of UTM students after the data collection has been completed.

Over the last few years, several popular websites of non-governmental organization (NGO) like WWF, GFN, Best Foot Forward (BFF) and Redefining Progress (RP) have offered personalized EF calculators which allow individuals and firms to enter information on their lifestyle to assess own environment impact. Individuals need to report information on personal consumption habits and activities via resources use or waste assimilation such as food consumption, housing, energy, transportation and others. The comparison of EF online calculators is shown in Table 2.

RP is one of the original and most influential EF online calculators. Besides, RP is more location-specific compared to other EF online calculators [37]. The EF quiz in RP was first developed in 2002 with Earth Day Network (EDN) to provide simple yet powerful way for people to measure their impact on the Earth. In 2008, RP updated the EF quiz with a revised methodology and current statistics. RP has 27 questions in its EF quiz. However, the questions in RP were slightly modified to increase its applicability to university students and avoid confusion in this pilot study.

Table 2. Comparison of ecological footprint online calculators.

	WWF	GFN	BFF	RP
Location	Australia	Calgary, United States of America (USA), Ontario, Colombia, Ecuador, Peru, Argentina, Brazil, Luxembourg, Switzerland, Italy, Turkey, South Africa, India, China, Japan and Australia	United Kingdom (UK)	147 countries including Malaysia
Question	30	Different for every country	12	27
Unit	gha	gha	gha	gha or ga
Income	-	-	-	√
Food	√	√	√	√
Housing	√	√	√	√

Energy	√	√	√	√
Transport	√	√	√	√
Goods	√	√	-	√
Water	-	√	-	√
Waste	√	√	√	√

The result of the pilot study is shown in Figure 3. The graph shows a comparison of average EF between Malaysian and UTM students. There are 50 UTM students involved in the pilot study. EF represents the consumption of resources which consists of carbon, food, housing, goods and services. EF, carbon footprint, food footprint, housing footprint, goods and services footprint are measured in gha.

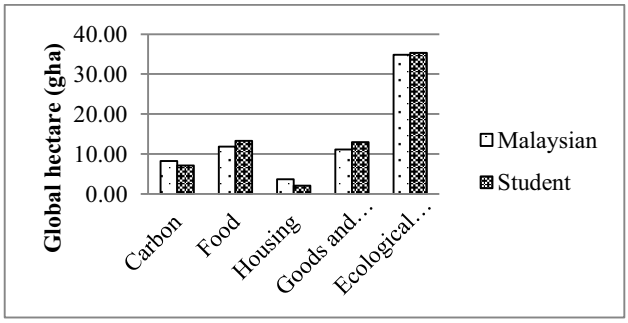

Figure 3. Pilot study

The average EF of UTM students is slightly higher than average EF for Malaysian which are 35.34 gha and 34.80 gha respectively. Lower score on EF indicate more sustainable while higher score on EF indicate less sustainable [38]. EF of the university is greater as it is considered a net importer of consumption items [10]. In the average EF of UTM students, the largest component is the food footprint, next is goods and services footprint, followed by carbon footprint and housing footprint is the least. In terms of carbon and housing, UTM students recorded lower consumption compared to Malaysian. UTM students consumed 7.10 gha for carbon while Malaysian consumed 8.22 gha. For housing, UTM students recorded 2.05 gha while Malaysian recorded 3.65 gha. This is because UTM students who participated in this pilot study are staying in university campus rather than off-campus housing [2]. The travel distance to academic and administration buildings for students staying in university campus is shorter than students who are staying off-campus. According to [39], transportation mode and travel distance contributing to the size of an EF. Travel longer distance have significantly larger footprint. Housing footprint of UTM students is lower than Malaysian because the university provides apartment type accommodation as hostel. [40] stated that apartment has lower impact to the environment. However, UTM students consumed higher consumption in food, goods and services compared to Malaysian. For food, UTM students consumed 13.26 gha while Malaysian consumed 11.83 gha. From the findings, most of the UTM students in the pilot study are omnivore. Omnivore has an assortment of meat, seafood, vegetables, dairy and grains. Based on [33], diet of food that is higher up on the food chain such as meat and seafood required more resources to support them than the lower one like vegetables. As UTM does not allow cooking in hostel, UTM students have no other choice but to obtain food from supermarkets, convenience stores and prepared foods from restaurants. This is similar to findings in [41]. [9] said that large value for food footprint implies that many items are sourced from far away. Thus, food footprint of UTM students is higher than Malaysian. For goods and services, UTM students recorded 12.93 gha and Malaysian recorded at 11.10 gha. The findings show that UTM students do not practice recycling habits frequently. Paper and plastic are the most recycled items by the UTM students. Most of them do not recycle aluminium, glass and electronics. This is due to recycle bins are not provided in every hostel in UTM.

5 Conclusion

The pilot study result showed that the average EF of UTM students by using RP is 35.34 gha. The average EF of UTM students is considered higher in comparison with previous studies. The pilot study result is promising and reveals that EF is a useful sustainability assessment tool to measure current university activities. The result can be utilized to improve community awareness and to assist the university management in decision making. This would enable policy makers to plan sustainable efforts with more informed decision. It is recommended that the study to be carried out on a larger scale considered this is only a pilot study. As Malaysian universities are pursuing campus sustainability, the application of EF would contribute and in parallel with the effort. Universities that are interested may find the larger scale of such study is needed as the data can be used to help them in developing strategies action plans to improve the level of campus sustainability.

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