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Ecological Footprint of Residents in a University Town in Mindanao, Philippines

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ABSTRACT

One of the tools to measure the environmental impacts of the utilization of natural resources is determining ecological footprint (EF). The study assessed how one's lifestyle could have impacts on the condition of our natural resources. EF study was conducted among households within the premises of Central Mindanao University, Bukidnon, Philippines. One hundred (100) households were interviewed using a pre-constructed questionnaire based on the data needed for the downloadable EF spreadsheet program. EF of the respondents was analyzed using descriptive statistics and multiple linear regression. The results revealed a higher per capita EF among the respondents (3.81 global hectares) compared to the national as well as the global EF averages. Based on the findings, there is a negative relationship between household size and EF and a positive relationship between income and EF.

Keywords: *Ecological footprint, Resource consumption, University EF*

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INTRODUCTION

Ecological footprinting (EF) is a method of measuring environmental impact in terms of the demand for global biological resources. It has been used to measure the impact of nations (Wackernagel et al., 1999; Monfreda et al., 2004; Ewing et al., 2010), individuals (Medina, 2015; Medina & Toledo-Bruno, 2016; Verhofstadt et al., 2016), as well as products (Folke et al., 1998; Huijbregts et al., 2008; Niccolucci et al., 2008). EF measures the amount of land needed (cropland, grazing land, forest land, built-up land, and fishing ground footprint), to support someone's lifestyle as well as absorb someone's waste (carbon land footprint) in a year. The unit of measurement for EF is in terms of global hectares. One global hectare is equivalent to a hectare of land with productivity equal to the global average (Kitzes et al., 2007).

Recently, the EF methodology has been applied to organizations and companies. Universities are engaged in activities congruent with corporations and organizations and thus can be considered for the application of such methodology. Several published literature find ecological footprinting in universities as doable (Venetoulis, 2001; Flint, 2001; Klein-Banai & Thies, 2011; Gottlieb, et al., 2012). In fact, previous studies on ecological footprint have been done in CMU for students (Medina, 2015; Medina & Toledo Bruno, 2016) and an academic unit (Medina & Catalon, 2015).

Universities have an essential role towards sustainability. The Talloires Declaration states that as institutions that develop future managers of other institutions, universities have the role to educate and create tools for sustainable development (Shriberg & Tallent, 2003). As emphasized by Segovia and Galang (2002), universities have the edge in terms of social acceptability, technical credibility, and moral ascendancy to realize sustainable development goals. Cortese (2003) emphasized that one of the key roles of universities in the achievement of sustainable development is to practice sustainability itself. Rees (2003) even argued that well-educated individuals, who are products of universities, are the cause environmental problems in the world today. With this in mind, it is just timely that we take heed of the call for global sustainability by starting within the premises of higher education institutions.

Central Mindanao University's (CMU) vision reflects its commitment to sustainable development. In fact, its recent achievement as the recipient of the regional award of the National Search for Sustainable and Eco-friendly Schools in Region 10 is proof to that. However, like any other institutions, CMU caused several environmental impacts derived from realizing its fourfold function in

instruction, research, extension, and production. Though its administration is readily responsive to mitigate or even avoid such impacts, the fact that these impacts remain unmeasured creates uncertainty as to what sustainable policies can further be implemented to move towards a sustainable university.

As such, this study aims to determine the per capita ecological footprint of the respondents and identify the socio-demographic determinants of ecological footprint among the household respondents of CMU.

METHODOLOGY

The ecological footprint was calculated for residents within the Central Mindanao University (CMU), a state university located in Bukidnon, Philippines. CMU is in between an urban Valencia City and the semi-urban Maramag Municipality. CMU occupies a total land area of 3,080 hectares, which are categorized as an academic campus, forest/upland and agriculture/lowland land use as per CMU Land Use Plan (2015).

Through convenience sampling, 100 households within the CMU campus were interviewed using a prepared questionnaire based on a spreadsheet program designed by Wackernagel et al., (2003). The questionnaire is composed of questions detailing the household's socio-demographic data (e.g. age, gender, household size, occupation, and monthly income) as well as purchases and consumption for food, housing, transportation, goods, and services. The questionnaire was content validated.

The gathered data were then entered into the "Assessing Your Household's Ecological Footprint Version 3.2" spreadsheet program (Wackernagel et al., 2003). The program is capable of converting the consumption data into its EF equivalent through globally accepted equivalence and correction factors (Kitzes et al., 2007).

The consumption categories comprise five (5) components: food, housing, transportation, goods, and services. Food consumption data include food purchases in terms of rice and other cereal products, meat, poultry, fish, fruits and vegetables and dairy products. On the other hand, housing consumption refers to housing materials used as well as the floor area. This also includes monthly water and electricity consumptions of the household. The goods category includes purchases for clothing, appliances, toiletries, and other personal and/or health products. Transportation refers to ownership of a private vehicle or other forms of transportation. Services include telephone and internet subscriptions. This category also includes spending on medical services, education, and other related items.

Data were then analyzed using descriptive statistics (mean, frequency, percentage) to describe the EF of the household respondent. Multiple linear regression (MLR) analysis was employed to determine the influence of socio-demographic factors on the EF of households. The MLR analysis was done using the Statistical Package for the Social Sciences (SPSS) Version 16 (Demo Version). Statistical probability was set at 0.10 level of significance.

RESULTS AND DISCUSSION

Socio-demographic Determinants

Table 1 shows that most of the respondents are male. The average age of the respondents is 46 years old, the youngest being 20 years old while the oldest respondent is 74 years old. On the average, the respondents have resided in CMU for about 27 years. Most of the respondents are the non-teaching staff of CMU (85%) while the rest are faculty members (15%). The average monthly income of the respondents is PHP 18,000.00. The average household size is 6.

Table 1.
Socio-demographic Characteristics of the Respondents and their Households (N=100)

Characteristics	Description	Value
Gender (%)	Male	61
	Female	39
Age (in years)	Mean	45.6
	Range	20 - 74
Occupation (%)	Faculty	15
	Staff	85
Household size (number)	Mean	5.5
	Range	1-11
Residency (in years)	Mean	26.7
	Range	4 - 60
Monthly Income (in Pesos)	Mean	18,000.00
	Range	3,000 – 70,000

Per capita EF of the Respondents

Table 2 presents, the average per capita EF of the respondents is 3.81 global hectares per capita (ghas/capita). This is almost thrice the 2010 national EF average of 1.3 ghas/capita and even higher than the global EF average of 2.7 ghas/capita (Ewing et al., 2010). Consistently, the respondents also have higher EF than its student counterparts in CMU (1.29 ghas/capita) based on a previous study of

Table 2.
Average per capita EF Consumption Components of Respondents Compared with the National Average in Global Hectares (ghas/capita)

EF Component	Respondents' Average (N=100)	National Average
Gender (%)	Male	61
	Female	39
Age (in years)	Mean	45.6
	Range	20 - 74
Occupation (%)	Faculty	15
	Staff	85
Household size (number)	Mean	5.5
	Range	1-11
Residency (in years)	Mean	26.7
	Range	4 - 60
Monthly Income (in Pesos)	Mean	18,000.00
	Range	3,000 – 70,000

Medina (2015). However, the mean EF per capita of respondents is a bit lower than the average EF per capita of the National Capital Region (NCR), which is 4.67ghas/capita (Serafico et al., 2012). This means that the average respondent of the study has a lifestyle that is more resource-use intensive than the average Filipino as well as the global citizen in terms of EF. However, the average EF of respondents in this study has lower resource consumption than the average EF of residents in NCR.

The majority of the respondents' EF comes from the housing category (82%). This means that most of their high consumption of resources is caused by their intensive use of resources related to housing, i.e. construction materials, energy, and floor area. Most of the houses in CMU are made of both concrete and wood materials, which constitute higher EF.

Furthermore, high consumption of energy, especially electricity, also leads to high EF. Another reason of high EF is that some households still use wood for cooking that entails a higher ecological footprint than low carbon emitting cooking fuel, such as liquefied petroleum gas (LPG). Floor areas of houses tend to be bigger given that the location is within CMU campus. CMU housing services use the standard floor area and space (an average of 150 m2 per household), which tend to be noticeably bigger than those found in private houses outside of CMU.

Food component has the highest percentage of the total EF in terms of the national average (61%). Similarly, in this study, food comes in as the second highest

resource consumption category of the respondents amounting to 0.55 ghas/capita, which accounts for 14% of the total EF. This is equivalent to the average per capita food consumption EF of residents in Marikina City in 2012 (0.55 ghas/capita) (Serafico et al., 2012) but lower than the average national food EF per capita in 2010 (0.79 ghas/capita) (Ewing et al., 2010).

The consumption category with the lowest percentage of the total EF is the services component with 0.04 ghas/capita average. This is only 1% of the total EF of the respondents. Compared to the national average, services category also has the lowest percentage of only 5%, out of the total EF (Ewing et al., 2010). This is contrary to the case of NCR in which services amounts to 0.13 ghas/capita, which is second highest component out of the total EF. This could be explained by the fact that utilization of the services sector such as cable television, phone, or internet services are more efficient and reliable in NCR than in the study area. As such, households in CMU do not fully avail of such services. Furthermore, respondents in this study avail the education services at CMU or other public schools. Education services of public sectors are cheaper and entail less resource intensive operations compared to private education, which is mainly offered in urban areas such as NCR.

EF of Respondents by Land Use Components

Table 3 reveals that the EF land use component of the respondents with the highest percentage is the forestland footprint, which is 63% of the total per capita EF. The forestland footprint refers to consumption that uses forest resources such as wood and paper. This is consistent with the high percentage of the housing component of respondents, which depends on wooden materials for the construction of their houses. In terms of the national average, the forestland footprint is the fourth among the six EF land use component. This means that the respondents are more dependent on forest resources than the average Filipino citizen. In fact, the forestland footprint of the respondents (2.39 ghas/capita) is more than 26 times the national average (0.09 ghas/capita) (Ewing et al., 2010). This could be due to the accessibility of timber and furniture that are produced by CMU from its production/plantation forest and processed through the University Income Generation Projects. Residents occupy CMU-owned cottages, which are largely made of wood, as part of housing privileges offered by CMU for its employees.

Table 3.
Average per capita EF Land Use Components of Respondents Compared with the National Average in Global Hectares (ghas/capita)

EF Component	Respondents' Average (N=100)	National Average
Carbon footprint	0.62 (16%)	0.32 (25%)
Cropland footprint	0.19 (5%)	0.47 (36%)
Grazing land footprint	0.06 (2%)	0.03 (2%)
Forestland footprint	2.39 (63%)	0.09 (7%)
Built up landfootprint	0.35 (9%)	0.06 (5%)
Fishing ground footprint	0.21 (5%)	0.33 (25%)
Total EF	3.81 (100%)	1.30 (100%)

The second highest EF land use component among the respondents is carbon footprint amounting to 0.62 ghas/capita, which is 16% of the total EF. Carbon footprint refers to the amount of forestland needed to absorb all the carbon dioxide equivalent emissions from the respondents' lifestyle. This is consistent with the carbon footprint of the students in CMU of 0.61ghas/capita based on the study of Medina (2015). In fact, the carbon footprint component comprises the largest share of the students' total EF (Medina, 2015).

The respondents' EF land use component with the lowest percentage out of the total EF is grazing land footprint, which is 0.06 ghas/capita accounting for 2% of the total EF. This is contrary to the results of the study in NCR in which grazing land footprint is the highest EF land use component accounting to 48% of the total EF (Serafico et al., 2012). This means that the NCR are practically meat eaters (e.g. beef) and are heavily dependent on grazing land. However, the respondents in CMU have higher grazing land footprint compared to the national average of 0.03 ghas/capita (Ewing et al., 2010).

Determinants of Per Capita EF among Respondents

Table 4 shows the results of the stepwise regression procedure conducted with average EF per capita as the dependent variable. The final regression model shows that household size and monthly income are viable predictors of EF per capita among the respondents. The standardized coefficient (B) means that every additional household member leads to a decrease of 0.517-ghas/per capita ($p<0.10$). Furthermore, for every PhP 1,000.00 increase in monthly income, there is an increase in the respondents' EF by 0.034 ghas/capita ($p<0.10$).

Table 4.
Average per capita EF Land Use Components of Respondents Compared with the National Average in Global Hectares (ghas/capita)

Determinants	B	*B*	t	p-value
Household Size (number of members)	-0.517	-0.418	-4.574	0.000
Monthly Income (in PhP 1,000)	0.034	0.171	1.870	0.064

*R = 0.491, F = 15.39, p = 0.000

The results are consistent with the previous studies on the influence of household size and income on resource consumption among households. The study of Deaton and Paxson (1998) using household expenditure data from the United States, Great Britain, France, Taiwan, Thailand, Pakistan, and South Africa revealed that per capita consumption of food decreases with household size. However, Liu et al. (2013) reported that the decreasing household size of families globally has led to the increased resource consumption, which will result to higher EF, and diminished biodiversity worldwide. Serafico et al. (2012) also found out that household size is significantly associated with EF in residents of NCR. On the other hand, income has consistently been positively associated with resource consumption such as food (West & Price, 1976) as well as energy use (Qu et al., 2013).

In terms of the standardized coefficients (β), household size has a higher value than monthly income. This means that household size is a better predictor of per capita EF than monthly income.

CONCLUSION

Based on the findings, the average per capita resource consumption of the CMU household respondents is greater than the national average as well as the global average in terms of ecological footprint (EF). Furthermore, it is considered even greater than CMU student. The component with the greatest contribution to the respondents' EF is housing due mainly to the construction materials as well as the land area used. This is validated by their high forestland footprint value. Some socio-demographic factors (household size and monthly income) were found to influence significantly the per capita EF of the respondents, which validates the results of previous studies. Household size negatively influences per capita EF, i.e. an increase in household member decreases the EF. On the other hand, household income positively contributes to per capita EF.

RECOMMENDATION

The results could provide the needed information in promoting resource conservation and sustainability policies and practices among households within the CMU premises. CMU can strategize initiatives for resource conservation such as recycling, sustaining production forests, and grazing land and build durable houses to lessen the use of wood materials for housing. The higher forestland and carbon footprint of CMU can be countered through sustaining and enhancing the forestland of CMU for production and biodiversity conservation. This is an avenue for CMU to uphold its vision of a globally sustainable environment.

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