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ORIGINAL RESEARCH PAPER

Ecological footprint of university students: Does gender matter?

M.A.P. Medina, A.G. Toledo-Bruno*

Department of Environmental Science, College of Forestry and Environmental Science, Central Mindanao University, University Town, Musuan, Bukidnon, Philippines

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ABSTRACT: To determine if there is a gender difference in the resource consumption activities of students in Central Mindanao University, a Philippine state university, an ecological foot printing study was conducted in August 2014. Consumption data from 380 student respondents were gathered using a survey questionnaire. A web-based software created by the Global Footprint Network was used to convert the consumption data into its equivalent ecological footprint value. Sample size was reduced to 324 (male = 162; female = 162) through a 1:1 nearest neighbor matching without replacement method for propensity score matching. Subsequently, unpaired t-test was employed for comparing the difference in ecological footprint between the male and female student respondents. Results reveal that the students' ecological footprint is slightly lower than the national average. Furthermore, most of their ecological footprint comes from their carbon footprint. Male respondents were found to have a significantly higher ecological footprint compared to female respondents. This implies gender difference in terms of resource consumption.

KEYWORDS: *Ecological footprint (EF); Gender comparison; Resource consumption; Sustainability; University student*

INTRODUCTION

Several studies have been performed to determine gender difference in environmental concern and behavior. In general, the abovementioned studies revealed that females tend to be more environmentally concerned than males. (Blocker and Eckberg, 1997; Hunter, *et al.,* 2004; Lee, 2009). As was previously emphasized, in contrast to men, women are highly socialized and thus more socially responsible thereby resulting to a higher environmental concern. (Zelezny, *et al.*, 2000).

On the other hand, some studies found no significant differences in environmental behavior based on gender (Chen and Chai, 2010; Solar, 2011; Raj, *et al.*, 2012). In fact, a Chinese study even revealed that females are less environmentally concerned than males (Shen and Saijo, 2008). However, it should be noted that although women can be more environmentally concerned than men, several constraints on their part such as limited mobility due to domestic responsibilities leads them also to have limited environmental activities (Tindall, *et al.,* 2003). However, the most important question is if these differences (if any) could lead to actual differences in environmental impact. Environmental impact being a more concrete measure of environmental behavior seems to convey more meaning to gender differences than just merely comparing their environmental concern. Several approaches have been employed to compare environmental impacts between men and women. Carbon emission was primarily used as a basis for gender comparison of environmental impacts in Europe (Godoy, 2011; Räty and Carlsson-Kanyama, 2009). In the Asian context, the ecological footprint (EF) was used for this particular purpose (Solar, 2011; Raj, *et al.*, 2012).

In the same way as mentioned above, this study uses the ecological footprint approach to compare the environmental impacts between genders. Students were used as subjects because they are understood to be the

*Corresponding Author Email: *mapmedina@cmu.edu.ph*
Tel.: +63 905 850 1716 Fax: +63 905 850 1716
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future managers of our natural resources (Rees, 2003). The university as the setting of this study manifested the idea that higher education institutions (HEIs) such as colleges and universities are principally tasked to promote and practice sustainability initiatives within its premises (Segovia and Galang, 2002; Cortese, 2003).

The ecological footprint measures impact in terms of how much land is needed to support the demand for ecological resources of countries, corporations, organization, and individuals. EF is expressed in global hectares (ghas). A global hectare is equivalent to one hectare of land with a global average productivity (Kitzes, *et al.*, 2007). To put it simply, EF is a concrete measure of someone's natural resource consumption. In past studies, EF of students in a university setting were measured and compared in terms of gender (Solar, 2011; Raj, *et al.*, 2012). In the case of this study, propensity score matching (PSM), an advanced statistical tool, was used to remove the bias from socio demographic characteristics of the students (Rosenbaum and Rubin, 1983) which may unknowingly taint the real differences in their EF. For example, female students in a study may be found to have higher EF results than male students when in fact if you look at their income variables, female subjects may have higher income than males. In this case the real reason for the higher EF could be income rather than gender. PSM removes this bias by extracting a matching sample from both genders with statistically equal, thus, non biased socio demographic background. Previous studies (Solar, 2011; Raj, *et al.*, 2012) did not take the above bias into consideration (leading presumably to the non significant results) in which this study will try to correct. This study was conducted in Central Mindanao University in 2015.

MATERIALS AND METHODS

Local of the study

The study area is in Central Mindanao University (CMU), a state university situated in the province of Bukidnon, Philippines. Founded by Americans in 1910, CMU was primarily established as an agricultural elementary school. In 1965, as sanctioned by Republic Act 4498, CMU was instituted as a state university. Presently, CMU is recognized by the Philippines Commission on Higher Education (CHED) as center of excellence in forestry, veterinary medicine, agriculture, and biology and center of development in the fields of education, mathematics, and environmental science.

Data gathering procedure

A survey questionnaire based on the data needed to calculate an individual's ecological footprint was constructed. Gathered data from the questionnaire served as inputs for the online calculator created by the Global Footprint Network (GFN), an organization that aims to develop and communicate the use of ecological footprint (http://www.footprintnetwork.org/en/index.php/GFN/page/calculators/).

The questionnaire contains multiple choice questions about the consumption patterns and lifestyle of the student respondents in CMU. The questions are categorized into the following: food, goods, shelter, and mobility. The survey questionnaire was administered to a convenience sample of 380 college students of CMU. The survey was done on August 11 to 22, 2014. After which, the data gathered were entered into the GFN personal ecological footprint calculator. The calculator is capable of converting the resource consumption data from the respondents into its EF equivalent (in global hectares) through internationally accepted equivalence and correction factors (Kitzes, et al., 2007). A previous article made use of the same dataset used in this study but with a totally different objective (Medina, 2015). The outcome of the calculator is based upon six EF land use components namely: a) carbon (forest land needed to sequester/absorb carbon emissions), b) cropland (land used for growing food), c) grazing land (land used for raising animals for meat and other livestock related products), d) forest land (land used for harvesting wood and timber products), e) built up land (land used for infrastructure), and f) fishing grounds (freshwater and marine fishing grounds for harvesting marine and freshwater products).

Data analysis

It is expected that due to the differences in their socio demographic factors, direct comparison of male and female respondents' EF may yield biased results. Thus, it is highly recommended that the respondents should be reduced to a matched sample from both genders with almost the same socio demographic characteristics. Propensity Score Matching (PSM) was thus employed to acquire an unbiased sample of respondents from both genders (Rosenbaum and Rubin, 1983). PSM makes sure that the EF differences between the matched sample can be attributed to the gender of respondents (male/female) and not by socio-demographic factors (covariates) leading to a biased result. Specifically the 1:1 nearest neighbor matching without replacement was employed (Thoemmes, 2012). The PSM technique reduced the sample size from 380 to 324 which comprise an equal number of male (n = 162) and female (n = 162) respondents. Descriptive statistics such as the average, frequency

counts, and percentage were used as analytical tools in the study. Furthermore, comparison of EF between the male and female respondents was then done through an unpaired t-test of the matched sample (n = 324).

RESULTS AND DISCUSSION

Profile of the respondents

Based on Table 1, there is an equal number of male and female respondents. This is expected since the propensity score matching technique (PSM) used was the 1:1 ratio which asks for an equal number of samples from both genders. Their average age is 18 years old. The average age is expected given that the respondents are students. The youngest respondent is 15 years old while the oldest is 26 years of age. The mean residency of the respondents is around 2 years which range from 1 to 6 years. Furthermore, the mean monthly allowance of respondents is 2,668.87 pesos (~$60) which range from 300.00 pesos (~$7) to 15,000.00 (~$334). There is an almost equal distribution of respondents that represents each year level with the exception of seniors which only comprises less than 1/5 of the respondents.

Table 1: Socio-demographic profile of the respondents (N=324)

Characteristics	Description	Value
Gender (%)	Male	50
	Female	50
Age (in years)	Mean	18.41
	Minimum	15
	Maximum	26
Residency in CMU (in years)	Mean	2.31
	Minimum	1
	Maximum	6
Monthly Allowance (in $)	Mean	60.00
	Minimum	7.00
	Maximum	334.00
Year Level (%)	Freshmen	27.8
	Sophomore	26.9
	Junior	27.5
	Senior	17.8

Average EF of Respondents

Based on the Fig. 1, the average personal EF of the respondents (1.21 ghas) is slightly lower than the Philippine average (1.30 ghas) meaning; the respondents have a lower resource consumption compared to an average Filipino. Genderwise, male respondents have higher personal EF (1.27 ghas) than female respondents (1.15). It should be noted that most of the EF from all respondents (both male and female) is attributed to their carbon footprint (46%). This is different from the country's EF distribution in which the highest percentage comes from cropland footprint (47%). This could be explained by the fact that students are more likely to travel as well as purchase goods (which entails a larger share of resource consumption which produce

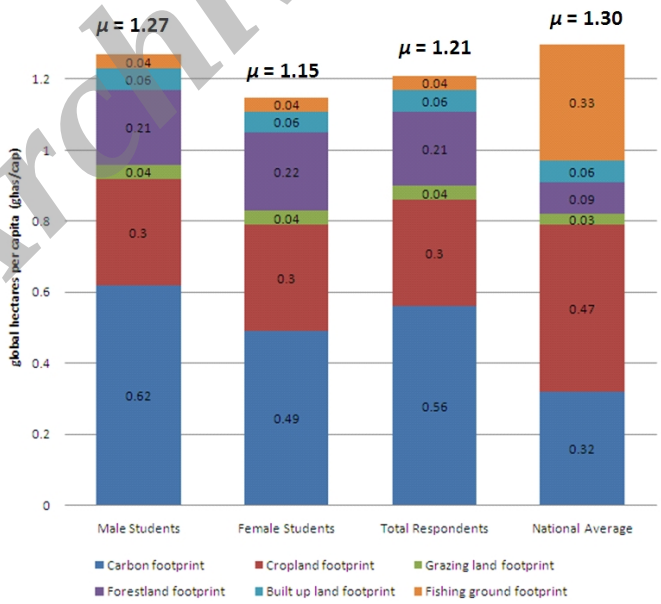

Fig.1: Average per capita EF land use components of respondents compared with the national average in global ha. per capita (ghas/capita)

carbon emissions), whereas on the average, Filipino citizens' consumption comprise more of food purchases relying heavily on crops, thus revealed by the highest percentage of EF coming from cropland in the Philippine average. The national EF average is based on Ewing, *et al*., (2010). It is also prominent that the national average has an extremely higher percentage of EF from fishing grounds (25%) compared to a very small amount of fishing ground EF (3%) among the respondents. The main reason for this is that the Philippines, being an archipelago with tremendous length of coastlines, rely on fish and other marine products for consumption. However, Bukidnon Province (where the respondents reside) is a landlocked area in which fish and other marine products are not as cheap compared to the national setting. Thus, the respondents probably don't consume much fish as the average Filipino, hence the above results.

Furthermore, it is also noticeable that the respondents EF percentage coming from forestland footprint (17%) is higher compared to the percentage of the same EF component in the national average (7%). This can be explained by the nature of the occupation of students which tend to consume more paper products (leading to higher forestland footprint) compared to an average Filipino citizen. Moreover, almost equal (if not the same) percentage distribution can be observed in terms of the rest of the EF components measured (grazing land and built up land). This means that in terms of resource consumption based on grazing/pasture land (i.e. beef and dairy products) and consumption of built up land (i.e. shelter) the respondents consumption behavior is representative of an average Filipino citizen.

Based on gender, there is an almost equal percentage distribution of EF components from the total EF of both gender group except in carbon footprint wherein the male respondents have a higher percentage of EF coming from this component (49%) compared to female respondents (43%). This difference largely contributed to the statistical difference in the EF among male and female respondents in the study as will be explained later in the next section.

Comparison of student EF in terms of gender

In Table 2, in terms of the total EF, it is revealed that the total EF of male respondents in the study is significantly higher than female respondents. This means that males have higher environmental impact in terms of their demand for land area needed to support their resource consumption. A study in Sweden found out that men tend to have more resource-intensive and unsustainable lifestyles than women (Johnsson-Latham, 2006). The above results however, are contrary to results of previous studies (Solar, 2011; Raj *et al.*, 2012). However, these previous studies did not employ PSM, thus variations in socio-demographic characteristics among gender was not accounted for which probably leads to the non significant difference.

Furthermore, in terms of the specific land use components, the male respondents have significantly higher carbon footprint than female respondents of the study. This means that the male respondents have a higher demand than females for forests needed to sequester the carbon emissions based on their lifestyle. This indicates a more carbon intensive consumption pattern for males compared to females. This is consistent with a previous report in France where it is estimated that the lifestyle of an average woman in that country causes an emission of 32.3 kg CO_2e (kg of carbon dioxide equivalent) on an average daily basis while men's lifestyles causes an average daily emission of 39.3 kgCO_2e (Godoy, 2011). Consumption has always been construed as gender-based. For instance, in terms of mobility, men's travels are more due to work or business reasons while women mostly take trips that involve household chores, hence they use public transport more often (Johnsson-Latham, 2006). It was also previously proven in the Netherlands that women tend to have shorter commuting time compared to males which is

Table 2: Statistical comparison of ecological footprint between male and female respondents

EF component	Male Respondents' Average EF (N=162)	Female Respondents' Average EF (N=162)	t-value	p-value
Carbon footprint	0.62	0.49	2.507	0.013*
Cropland footprint	0.30	0.30	0.916	0.361^{ns}
Grazing land footprint	0.04	0.04	1.143	0.254^{ns}
Forestland footprint	0.21	0.22	0.486	0.627^{ns}
Built up land footprint	0.06	0.06	0.959	0.338^{ns}
Fishing ground footprint	0.04	0.04	0.547	0.585^{ns}
Total EF	1.27	1.15	2.092	0.037*

*Significant at 0.05, ^{ns} = Not significant

attributed to the former being more connected to their household responsibilities than the latter (Gimenez-Nadal and Molina, 2016). However, an opposite result was found in Bulgaria where men tend to have shorter commuting time than women. This was explained to be caused by private vehicle driving by men in the country (Kwan and Kotsev, 2014). In the case of CMU, male students are noticeably the ones who drive themselves to school i.e. motorcycles, while female students mostly use public transport.

Furthermore, as observed in some European countries, men consume more energy compared to women in Norway and Germany, twice more in Sweden, and even up to 3.5 times more in Greece (Räty and Carlsson-Kanyama, 2009). An Indonesian household survey also revealed that women are good household energy managers and that men are careless with respect to energy consumption in the home (Permana, *et al.*, 2015). Furthermore, based on a study in Bhutan, women heads of household are more inclined to consider buying fuel from cleaner sources which implies a higher sense of environmental responsibility compared to males (Rahut, *et al.*, 2016). Moreover, there were no significant differences found between male and female respondents in terms of the rest of the EF land use components (cropland, grazing land, forestland, built up land, and fishing ground). This means that there is an equal degree of ecological impact among the male and female respondents of the study in terms of their demand for the said land use components.

CONCLUSION

The study results showed that the respondents are within the national EF average which could mean that their impact to the environment is equal to the average Filipino based on lifestyle and resource consumption. However, the major contributor of their EF is their carbon footprint which is totally different on a national scale in which cropland is the highest contributor in the national EF average. This means that the CMU students' consumption pattern is characterized by a more carbon intensive lifestyle than majority of Filipinos. Furthermore, it should be noted that CMU students also demand more forest based products compared to an average Filipino. This calls for the CMU students to be more responsive to the call for resource conservation. This is an opportunity for the CMU administration to realize its vision for sustainability through relevant programs and projects based on the above results. Furthermore, in terms of gender, it was found out that male students are more resource intensive compared to female students. Though they are revealed to have no differences in their demand for most of the different land use components, they differ significantly in their carbon footprint (land needed to absorb carbon emissions). Thus, this study confirms the results of previous studies that men have higher carbon emissions than women. Driven probably by a more mobile lifestyle (e.g. driving their own vehicle) this leads to males having a higher carbon footprint.

Hopefully, the above information revealed in the study will help CMU in its future directions for a more sustainable university. Moreover, students need to contemplate on a personal level on how they can reduce their impact to nature. As the study suggests, reduction of carbon intensive activities and consumption as well as decrease in the dependence for forest based products can be a viable way to reduce their personal ecological impact. In the light of our present dilemma with the emergence of climate change in which greenhouse gases are the main culprit, it is alarming that students in the university are shown to have a greater impact in terms of carbon emissions compared to other types of environmental impacts. This essentially calls for a thorough and massive information dissemination with regards to carbon footprint reduction as well as the promotion of sustainable lifestyles around the campus such as walking or biking rather than driving, consuming organic foods, energy conservation, etc. In this context, EF can be an educational tool aside from being a policy tool especially for climate change mitigation as well as for addressing natural resource degradation.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

REFERENCES

Blocker, T. J.; Eckberg, D. L., (1997). Gender and environmentalism: Results from the 1993 General Social Survey. Soc. Sci. Quart., 78 (4): 841-858 (**18 pages**).

Chen, T.B.; Chai, L.T., (2010). Attitude Towards the Environment and Green Products: Consumers' Perspective. Manage. Sci. Eng., 4 (2): 27-39 (**13 pages**).

Cortese, A. D., (2003). The critical role of higher education in creating a sustainable future. Plann. High. Educ., 31(3): 15-22 (**8 pages**).
Ewing, B.; Moore, D.; Goldfinger, S.; Oursler, A.; Reed, A.; Wackernagel, M., (2010). The ecological Footprint atlas 2010. Oakland: Global Footprint Network.
Gimenez-Nadal, J.I.; Molina, J.A., (2016). Commuting time and household responsibilities: Evidence using propensity score matching. J. Reg. Sci., 56(2): 332-359 (**28 pages**).
Godoy, J., (2011). Men's and women's different impact on climate. Retrieved February 18, 2016, from http://www.wecf.eu/english/articles/2011/02/gender-climateimpact.php
Hunter, L. M.; Hatch, A.; Johnson, A, (2004). Cross national gender variation in environmental behaviors. Soc. Sci. Quart., 85 (3): 677-694 (**18 pages**).
Johnsson-Latham, G., (2006). Initial study of lifestyles, consumption patterns, sustainable development and gender: Do women leave a smaller ecological footprint than men?. Swedish Ministry of Sustainable Development.
Kitzes, J.; Peller, A; Goldfinger, S.; Wackernagel, M., (2007). Current methods for calculating national ecological footprint accounts. Sci. Environ. Sustain. Soc., 4(1): 1-9 (**9 pages**).
Kwan, M.; Kotsev, A., (2014). Gender differences in commute time and accessibility in Sofia, Bulgaria: a study using 3D geovisualisation. Geog. J., 181(1): 83-96 (**14 pages**).
Lee, K., (2009). Gender differences in Hong Kong adolescent consumers' green purchasing behavior. J. Consumer Market, 26 (2): 87-96 (**10 pages**).
Medina, M.A.P. (2015). The sustainability of on campus residence: A utilization of ecological foot-printing in a State University in Mindanao, Philippines. Adv. Environ. Sci., 7(1): 1-10 (**10 pages**).
Permana, A.S.; Aziz, N.A.; Siong, H.N., (2015). Is mom energy efficient? A study of gender, household energy consumption and family decision making in Indonesia. Ener. Res. Soc. Sci., 6(1): 78-86 (**10 pages**).
Rahut, D.B.; Behera, B.; Ali, A., (2016). I Household energy choice and consumption intensity: Empirical evidence from Bhutan. Ren. Sus. Ener. Revs., 53(1): 993-1009 (**17 pages**).
Raj, S.; Goel, S.; Sharma, M.; Singh, A., (2012). Ecological Footprint score in university students of an Indian city. J. Environ. Occup. Sci., 1(1): 23-26 (**4 pages**).
Räty, R.; Carlsson-Kanyama, A., (2009). Comparing energy use by gender, age and income in some European countries. Research Support and Administration, Swedish Defence Research Agency (FOI).
Rees, W. E., (2003). Impeding sustainability. Plann. High. Educ., 31(3): 88-98 (**11 pages**).
Rosenbaum, P. R.; Rubin, D.B., (1983). The central role of the propensity score in observational studies for causal effects. Biometrika., 70(1): 41-55 (**15 pages**).
Segovia, V.M.; Galang, A.P., (2002). Sustainable development in higher education in the Philippines: The case of Miriam College. High. Educ. Pol., 3(3): 288-297 (**10 pages**).
Shen, J.; Saijo, T., (2008). Reexamining the relations between socio-demographic characteristics and individual environmental concern: Evidence from Shanghai data. J. Environ. Psychol., 28(1): 42-50 (**9 pages**).
Solar. V.A., (2011). Gender and natural resource consumption. Int. J. Environ. Sci. Dev., 2(5): 399-401 (**3 pages**).
Thoemmes, F., (2012). Propensity score matching in SPSS. arXiv preprint arXiv:1201.6385.
Tindall, D. B.; Davies, S.; Mauboules, C., (2003). Activism and conservation behavior in an environmental movement: The contradictory effects of gender. Soc. Nat. Resour., 16(10): 909-932 (**22 pages**).
Zelezny, L. C.; Chua, P. P.; Aldrich, C., (2000). New ways of thinking about environmentalism: Elaborating on gender differences in environmentalism. J. Soc. Issues., 56(3): 443-457 (**15 pages**).

AUTHOR (S) BIOSKETCHES

Medina, M.A.P., Ph.D., Assistant Professor in the Department of Environmental Science, College of Forestry and Environmental Science, Central Mindanao University, University Town, Musuan, Bukidnon, Philippines
E-mail: *mapmedina@cmu.edu.ph*

Toledo-Bruno, A.G., Ph.D., Associate Professor in the Department of Environmental Science, College of Forestry and Environmental Science, Central Mindanao University, University Town, Musuan, Bukidnon, Philippines
E-mail: *agtbruno@cmu.edu.ph*

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