AES BIOFLUX
Advances in Environmental Sciences - International Journal of the Bioflux Society

The sustainability of on campus residence: a utilization of ecological footprinting in a state university in Mindanao, Philippines

Michael Arieh P. Medina

Department of Environmental Science, College of Forestry and Environmental Science, Central Mindanao University, Musuan, Bukidnon, Philippines. Corresponding author: M. A. P. Medina, mapmedina@cmu.edu.ph

Abstract. To provide evidence on the sustainability of providing on campus residence to university students, an ecological footprinting study was done on a sample of college students in Central Mindanao University, a state university in southern Philippines. A survey questionnaire was utilized to gather data needed for calculating the personal ecological footprint (EF) of the respondents using a web based tool created by the Global Footprint Network. Propensity Score Matching (PSM) was used to obtain a matched sample of off campus and on campus residents of the university. This was done to reduce the biases due to socio-demographic variables. Comparison of EF was then done between the two groups of students using t-test for independent groups. Results showed that off campus residents have significantly higher mean EF than on campus residents. The differences are mostly attributed to food consumption rather than from transportation. The results provide a proof that living inside the campus is an ecologically sustainable option for students in the university.
Key Words: ecological footprint, on campus residence, propensity score matching, Philippines.

Introduction. The role of higher education institutions (HEI's) in the achievement of sustainable development has been recognized since the previous decade (Shriberg & Tallent 2003). As Cortese (2003) asserted, HEI's have the moral obligation to raise the awareness, knowledge, skills, and values of future professionals towards the achievement of sustainability. Aside from that, academia is thought to be socially acceptable and technically credible to spearhead the achievement of sustainability even outside of its realm (Segovia & Galang 2002).

However, budgetary constraints are seen to be the main reason for the unwillingness of universities to work for sustainability in its campuses. This is attributed in part to the lack of awareness on the economic advantages of sustainability initiatives as well as by the hesitation of institutions for change. It is thus necessary that environmental awareness is raised within campuses to remove these obstacles (Dahle & Neumayer 2001).

Furthermore, the incorporation and institutionalization of sustainability principles in universities is only achievable with the necessary approaches and tools (Lozano 2006; Velasquez et al 2006). One of these approaches is the assessment and reporting of the sustainability efforts of universities. Such initiative provides a pathway for HEI's towards becoming "sustainable colleges or universities" (Shriberg 2002). This type of endeavor requires the use of these so called "institutional assessment tools" both for use as an educational and as a policy tool for sustainability.

The ecological footprint (EF) is one of these tools that can be able to educate the university populace as well as push for sustainable policies in the campus (Rees 2003). EF provides an estimate of the amount of land used by countries, organization, or individuals to provide for the resources needed for their consumption as well as for absorbing their waste (in terms of carbon emissions). This tool was pioneered by Rees & Wackernagel (1996). Furthermore, another measure associated with EF is biocapacity

(the amount of productive land available for consumption and absorption of waste). Both EF and biocapacity can be utilized to determine if our current lifestyle and activities are within the bounds of the earth's capacity to support it.

EF accounting was originally used for the comparison of countries. However, in recent studies, individual EF were calculated using online personal EF calculators specifically on students (Ryu & Brody 2006; Solar 2011; Raj et al 2012). Such measurement motivated the author to advance the utility of EF, in this case, by providing evidence that additional residence halls and dormitories on campus (although a budgetary burden) will help in the achievement of a university's sustainability goals.

Material and Method

Data gathering procedure. A survey questionnaire (Annex 1) was constructed based on the necessary responses needed to compute for a personal ecological footprint on an online calculator created by the Global Footprint Network (GFN), an organization of scientists, governments, NGO's, and other partners working together for the improvement, application, and communication of ecological footprinting. The calculator can be accessed at http://www.footprintnetwork.org/en/index.php/GFN/page/calculators/.

The questionnaire is composed of 12 multiple choice, single response questions related to consumption and lifestyle characteristics of the respondents in terms of food, goods, shelter, and mobility. Prior to the final administration, the questionnaire was pilot tested to a sample of students to determine and correct certain inconsistencies, errors, and confusing questions.

Data gathering was done on August 11 to 22, 2014 to a convenient sample of college students (n = 380) of Central Mindanao University, a Level 4 state university situated in Bukidnon in southern Philippines. After the data gathering, the responses from the questionnaires were then used as inputs for the GFN personal ecological footprint calculator.

EF measurement. Consumption characteristics from each choices in the survey questions has a corresponding "footprint factor" based on the amount of land needed to provide for such consumption and to absorb the carbon produced by the energy being used. These footprint factors were pre-calculated by GFN based on national production data.

Each respondent's consumption level is multiplied with the footprint factors to come up with an equivalent value in terms of the quantity of land or sea space. EF is usually expressed in units of global hectares. One global hectare is equivalent to a hectare of land with an annual productivity equal to the world average. Details of the EF calculation method can be found in Kitzes et al (2007).

Data treatment and analysis. To obtain an unbiased sample of respondents from both groups of respondents (off campus and on campus residents), propensity score matching (PSM) was done using a 1:1 nearest neighbor matching without replacement. PSM ensures that the difference in EF among the matched sample are caused by membership on either group of respondents (off campus and on campus) and not by socio-economic variables (covariates) which can lead to a biased result. The PSM procedure was based on Thoemmes (2012).

Results of the PSM yielded a reduced sample size (n = 248) comprising of an equal number of off campus (n = 124) and on campus (n = 124) residents extracted from the original number of respondents (n = 380). Descriptive statistical analysis using the mean, frequency, and percentage was used to characterize the respondents and describe their EF. Comparison between the two groups of respondents in terms of EF was then done through a t-test for independent groups using the matched sample (n = 248).

Results and Discussion

Profile of the respondents. The age of the respondents ranges from 15 to 27 years old. The average age of the these respondents is 18.44. This reflects a usual age characteristic of college students. There are more female respondents (63.7%) than male respondents (36.3%) out of the total sample size of 248. The average years of residence of the respondents in the university is 2.44 years which ranges from 1 to 6 years. In terms of their mode of transport, 39.5% of the respondents rely on public transportation while 60.5% rely on private transportation. The average monthly allowance of the respondents is Php 2,493.13 (~US$55). These ranges from Php 300.00 to Php 15,000.00 (~US$7 to ~US$334).

Ecological footprint of the respondents. As shown in Figure 1, the mean EF of the respondents is 1.29 global hectares. This means that an average respondent in the study uses up about 1.29 global hectares of land annually to support their lifestyle. This is almost equivalent to the EF of the average Filipino citizen (1.3 global hectares per capita) though it is lesser than one-half of the world average EF (2.7 global hectares per capita).

Both the respondents' and the national average are within the global biocapacity (amount of productive land available for consumption) of 1.8 global hectares per capita. However, it should be noted that the national biocapacity of the Philippines is only 0.6 global hectares per capita, thus the average Filipino including the respondents are exceeding the national biocapacity. The national and global EF averages are based on Ewing et al (2010).

Off campus residents have higher mean EF (1.37 global hectares) than on campus residents (1.21 global hectares). Furthermore, the mean EF of off campus residents are higher than the average EF of all the respondents (1.29 global hectares). Consequently, on campus residents have lower average EF than the average EF of all the respondents. Moreover, off campus residents are considered to have a higher EF than the average Filipino in contrast to on campus residents which has lower mean EF than the national average.

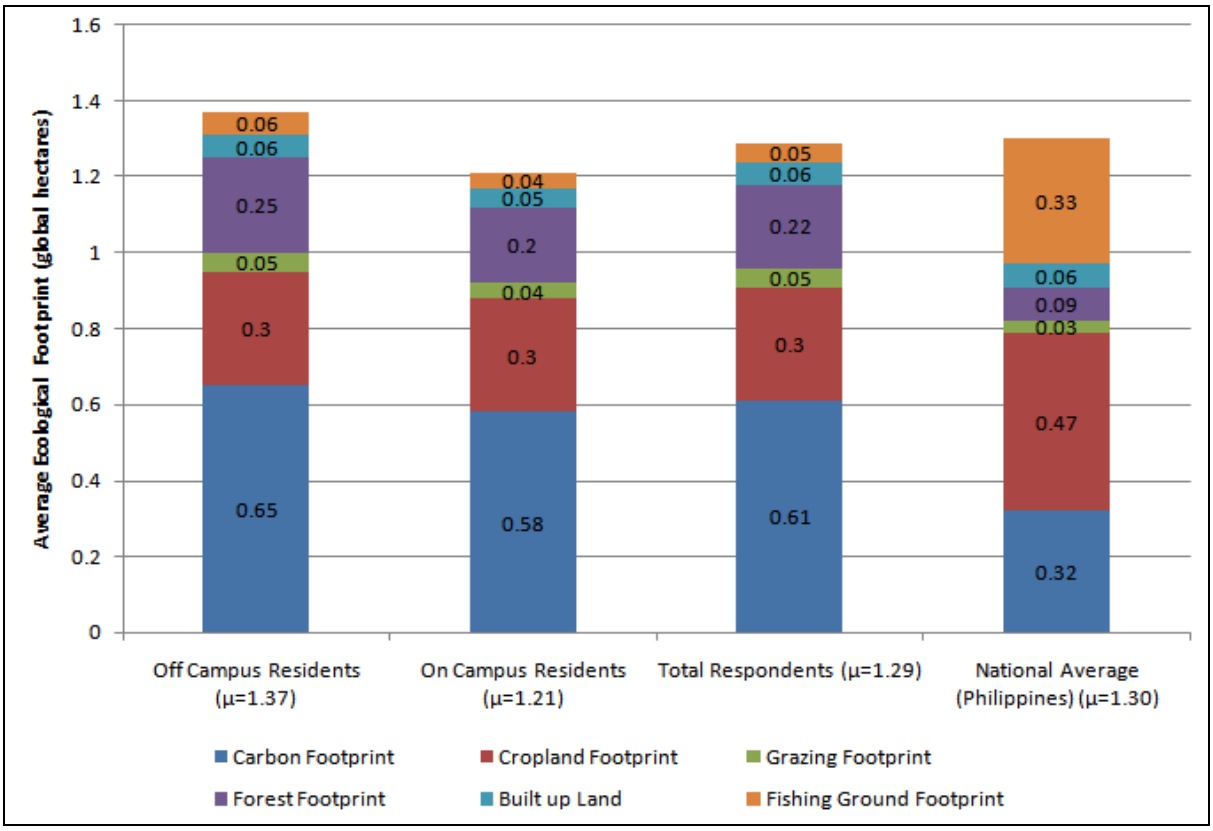

Figure 1. Mean ecological footprint of respondents compared with the national average.

In terms of EF components, majority of the EF of the respondents comes from their carbon footprint (0.61 global hectares). This is almost twice the average carbon footprint of Filipinos (0.32 global hectares). This means that the respondents produce more carbon emissions (mostly from transportation) than the average Filipino citizens. This could be expected because being a student require more travelling either from home to the university or within the university premises as the buildings within the CMU campus are far from each other.

However, in terms of cropland footprint, the respondents have lower EF (0.3 global hectares) than the national average (0.47 global hectares). This means that the respondents eat lesser food from crops which includes fruit, vegetables, and grains than the average Filipino.

On the other hand, based on the EF from grazing land, the respondents have a higher EF (0.05 global hectares) than the average Filipino (0.03 global hectares). This means that generally the respondents consume larger quantities of meat products than the average Filipino.

The respondents' forest land EF (0.22 global hectares) also exceeds the national average (0.09 global hectares). This means that the respondents uses more forest based products than the average citizen of the country. Paper products can be considered as one of these forest based products that is generally used more by respondents as students compared to the majority of the population in the country.

In terms of built up land EF, the repondents have the same value with the national average (0.06 global hectares). This means that the respondents uses the same amount of land for their housing/accomodation with an average Filipino citizen.

In terms of fishing ground EF, the average value for the respondents (0.05 global hectares) is extremely lower than the national average (0.33). This means that the respondents consume lesser marine based food products than an average Filipino.

Bukidnon, where CMU is located, is a landlocked agricultural province thus, fish products in this part of the country is more expensive than in coastal provinces. This could be the reason why the respondents have lower fishing ground EF than the national average. To compensate for this, livestock meat is one of the main food products of the province. This could be the reason why the respondents have higher grazing land EF mean value than the country average.

Comparison of EF between off campus and on campus residents. The t-test for independent groups was used to compare the average EF values of off campus and on campus residents. As shown in Table 1, there is a significant difference in the total EF between the two groups ($\alpha = 0.05$). Off campus residents have higher total EF than on campus residents.

Significant difference between both groups of respondents exists in their mean grazing land EF ($\alpha = 0.01$). Off campus residents have significantly higher mean grazing land EF than on campus residents. Therefore, off campus residents can be considered to consume more meat products compared to on campus residents.

In terms of forest land EF, off campus residents also have a significantly higher mean value than on campus residents ($\alpha = 0.01$). This means that off campus residents consume more forest based products compared to on campus residents.

In terms of built up land EF, off campus residents also have significantly higher mean value than on campus residents ($\alpha = 0.01$). This means that off campus residents consume more land for their housing and shelter than on campus residents. This is because most off campus residents live on their parents' home which would understandably have bigger space per person compared to university housing such as residence halls, dormitories, and private boarding houses.

In terms of fishing ground EF, off campus residents also have significantly higher mean EF than on campus residents ($\alpha = 0.01$). This means that off campus residents consume more fish products compared to on campus residents.

As observed, differences in the EF of both groups can be attributed to the difference in food consumption especially of meat and fish. Meat is found to be less frequently consumed by students living on campus based on previous studies in Brazil

(Alves & Boog 2007), Europe (Ansari et al 2012), and the United States (Gonzales 2013). However, a study by Laska et al (2010) contradicts these results. Although the latter explains that in the case of on campus residents, the university involved has a structured meal plan services for these students.

In the context of the study, students who live off campus are generally living with their parents. In this case, food availability can be a function of financial capability as well as supervision of parents (Ansari et al 2012). Those living on campus have to deal with financial limitations as well as availability of time for shopping because they are living on their own. Majority of on campus residents also prefer to eat out in food services establishments as in the case of Gonzales (2013) which may not offer a variety of food choices for the students. Furthermore, the lack of food preservation appliances such as refrigerators and freezers in university dormitories and private boarding houses also hinders on campus residents to buy perishable items (such as meat and fish) in bulk.

Table 1

Statistical comparison of EF between off campus and on campus residents

Ecological footprint	*t-value*	*p-value*	*Mean difference (off campus – on campus)*
Carbon footprint	1.174	0.242	0.076
Cropland footprint	1.561	0.120	0.005
Grazing footprint	3.194	0.002*	0.013
Forest footprint	4.401	0.000**	0.047
Built up land	3.278	0.001**	0.009
Fishing ground	4.282	0.000**	0.020
Total EF	2.282	0.023*	0.160

* Significant at $\alpha = 0.05$; ** Significant at $\alpha = 0.01$.

On the other hand, the statistical analysis never revealed any significant difference between off campus residents and on campus residents in terms of carbon footprint. Same results were also revealed in the comparison of both groups of respondents in with regards to crop land EF. This means that being either an off campus resident or an on campus resident does not have an influence on a student's carbon footprint and cropland footprint.

It may seem that off campus residents would have a higher carbon footprint because they travel a longer distance from home to the university than on campus residents (Brand et al 2013). However, on campus residents also have their own share of travelling especially within the campus. College buildings in CMU are generally far from each other which motivates students to ride in public transportation such as tricycles which ply around the campus. Furthermore, in terms of shopping, CMU being situated in the outskirts of the town, is far away from the central business district (Valencia City and Maramag Town) where the on campus residents usually shop.

Generally, most students at CMU chose to live off campus due to the limited availability of on campus housing. Thus, additional residence halls, dormitories, and cottages can be a viable option which can help reduce the EF of students. However, given that most of the reduction is attributed to food consumption, a problem regarding nutrition among on campus residents is expected. This could be addressed by compelling university food establishments including those privately owned to adhere to nutritional standards with the foods they serve. Promotion of health and nutrition should also be conducted through information, education, and communication (IEC) campaigns among university students especially those living on campus. Research should also be conducted to recommend nutritious meals which can be prepared by on campus residents who cook their own food.

To reduce the carbon footprint of students within the campus, promotion of environmentally friendly travel such as walking and biking should be promoted. This can be achieved by further landscaping of pathways, construction of covered walks, and setting up of bicycle lanes. Educational trails can also help promote walking among students which could provide interesting learning opportunities while they transfer from

one building to the other for their classes. Furthermore, to reduce the travel of on campus residents when they shop out of town, the development of a university shopping center is a sustainable option. This can be beneficial to students (in terms of convenience), the university administration (in terms of income), and to the environment in (terms of the reduction in EF).

Conclusions. Based on the findings of the study it is found out that the respondents are comparable to the average Filipino citizen in terms of their total EF. However, in terms of the distribution of the different components of EF, the largest percentage comes from their carbon footprint which is almost twice the national average. This signifies the intensive use of energy especially for transportation among the respondents compared to the average Filipino citizen. A higher forest land footprint is also observed among the respondents which is more than twice the average Filipino citizen. This is attributed to the increased use of paper products by the respondents as students compared to the national average.

Consequently, there is a lower consumption of crop based food among the respondents as signified by a lower crop land EF compared to the national average. This is compensated by a higher consumption of meat products based on a higher grazing land footprint compared to the national average.

Furthermore, it was found out that total EF of on campus residents are lower than on campus residents. This is attributed to differences in protein-based food consumption (meat and fish) as signified by the differences in both their grazing land footprint as well as fishing ground footprint. Built up land footprint as well as forest land footprint is also lower among on campus residents which could be attributed to lower requirements for housing space and materials in university residences compared to family or parents' homes where most off campus residents usually live.

It is thus recommended that additional dormitories/residence halls be constructed not only for the convenience of the students but also to reduce their EF. Furthermore, carbon footprint can be reduced by promoting walkability inside the campus along with other related programs that reduces motorized travel among students.

Acknowledgements. The author would like to thank the ENS 95 (Environmental Research Methods) students of Central Mindanao University (School year 2014-2015) for gathering the data for the study and Ms. Chelo M. Beltran who served as research assistant. This study is made possible through a university research grant (R-0076) awarded by Central Mindanao University.

References

Alves H. J., Boog M. C. F., 2007 [Food behavior in student residence halls: a setting for health promotion]. Revista de Saúde Pública 41:197-204 [in Portuguese].

Ansari W., Stock C., Mikolajczyk R. T., 2012 Relationships between food consumption and living arrangements among university students in four European countries - a cross-sectional study. Nutrition Journal 11:28.

Brand C., Goodman A., Rutter H., Song Y., Ogilvie D., 2013 Associations of individual, household and environmental characteristics with carbon dioxide emissions from motorized passenger travel. Applied Energy 104:158-169.

Cortese A. D., 2003 The critical role of higher education in creating a sustainable future. Planning for Higher Education 31:15-22.

Dahle M., Neumayer E., 2001 Overcoming barriers to campus greening: a survey among higher educational institutions in London, UK. International Journal of Sustainability in Higher Education 2:139-160.

Ewing B., Moore D., Goldfinger S., Oursler A., Reed A., Wackernagel M., 2010 The ecological footprint atlas 2010. Oakland: Global Footprint Network, 110 pp.

Gonzalez K., 2013 The impact of residence on dietary intake, food insecurity, and eating behavior among university undergraduate students. Undergraduate Research Journal at the University of Northern Colorado 3:111-128.
Kitzes J., Peller A., Goldfinger S., Wackernagel M., 2007 Current methods for calculating national ecological footprint accounts. Science for Environment & Sustainable Society 4:1-9.
Laska M. N., Larson N. I., Neumark-Sztainer D., Story M., 2010 Dietary patterns and home food availability during emerging adulthood: do they differ by living situation?. Public Health Nutrition 13:222-228.
Lozano R., 2006 Incorporation and institutionalization of SD into universities: breaking through barriers to change. Journal of Cleaner Production 14:787-796.
Raj S., Goel S., Sharma M., Singh A., 2012 Ecological footprint score in university students of an Indian city. Journal of Environmental and Occupational Science 1:23-26.
Rees W. E., 2003 Impeding sustainability?. Planning for Higher Education 31:88-98.
Rees W. E., Wackernagel M., 1996 Ecological footprints and appropriated carrying capacity: measuring the natural capital requirements of the human economy. In: Investing in natural capital: the ecological economics approach to sustainability. Johansson A. M., Hammer M., Folke C., Costanza R. (eds), Island Press, Washington D.C., pp. 362-391.
Ryu H. C., Brody S. D., 2006 Examining the impacts of a graduate course on sustainable development using ecological footprint analysis. International Journal of Sustainability in Higher Education 7:158-175.
Segovia V. M., Galang A. P., 2002 Sustainable development in higher education in the Philippines: the case of Miriam College. Higher Education Policy 15:187-195.
Shriberg M., 2002 Institutional assessment tools for sustainability in higher education: strengths, weaknesses, and implications for practice and theory. International Journal of Sustainability in Higher Education 3:254-270.
Shriberg M., Tallent H., 2003 Beyond principles: implementing the Talloires Declaration. Paper presented at: Greening of the campus V: connecting to place. Ball State University, Muncie, Indiana, USA.
Solar V. A., 2011 Gender and natural resource consumption. International Journal of Environmental Science and Development 2:399-401.
Thoemmes F., 2012 Propensity score matching in SPSS. Arxiv preprint arXiv:1201.6385.
Velazquez L., Munguia N., Platt A., Taddei J., 2006 Sustainable university: what can be the matter?. Journal of Cleaner Production 14:810-819.
*** http://www.footprintnetwork.org/en/index.php/GFN/page/calculators/.

Received: 28 November 2014. Accepted: 29 December 2014. Published online: 02 January 2015.
Author:
Michael Arieh P. Medina, Department of Environmental Science, College of Forestry and Environmental Science, Central Mindanao University, 8715 University Town, Musuan, Maramag, Bukidnon, Philippines, e-mail: mapmedina@cmu.edu.ph

How to cite this article:
Medina M. A. P., 2015 The sustainability of on campus residence: a utilization of ecological footprinting in a state university in Mindanao, Philippines. AES Bioflux 7(1):1-10.

Annex 1

THE SUSTAINABILITY OF ON CAMPUS RESIDENCE: A UTILIZATION OF ECOLOGICAL FOOTPRINTING IN A STATE UNIVERSITY IN MINDANAO, PHILIPPINES

Survey Questionnaire

(This information will only be used for scientific research purpose)

Part I. Socio-demographic profile. Kindly fill up the blank spaces below.
Name (optional):_____
Age:_____Sex:_____
Household size:_____ Religion:_____
Home Address:_____
[ ] On campus resident [ ] Off campus resident
Civil Status: [ ] Single [ ] Married [ ] Separated [ ] Widow
Length of Residency in CMU: _____(years)
Course:_____ Academic Year Level:_____
Estimated Monthly Allowance:_____

Part II. Personal Consumption Patterns. These questions are based on the Personal Ecological Footprint Survey Questionnaire from the Global Footprint Network (http://www.footprintnetwork.org/en/index.php/GFN/page/calculators/).

Procedure: Complete each of the questions indicating your actions on a typical day in your life by checking the appropriate brackets [ ].

FOOD

1. How often do you eat meat?
    1. Never [ ]
    2. Infrequently (a serving every week) [ ]
    3. Occasionally (four or more servings a week) [ ]
    4. Often (two or more servings per day) [ ]
    5. Very often (a serving per meal) [ ]

2. How often do you eat fish?
    1. Never [ ]
    2. Infrequently (a serving every week) [ ]
    3. Occasionally (four or more servings a week) [ ]
    4. Often (two or more servings per day) [ ]
    5. Very often (a serving meal) [ ]

3. How often do you eat eggs, milk and dairy?
    1. Never [ ]
    2. Infrequently (one every few weeks) [ ]
    3. Occasionally (once or twice a week) [ ]
    4. Often (nearly every day) [ ]
    5. Very often (nearly every meal) [ ]

GOODS

1. How much do you spend per month on household consumer goods (clothing, home furnishing, etc.)?
    1. Not much, I get by with very little – about Php345 [ ]
    2. About average – around Php550 [ ]
    3. More than average – around Php800 [ ]
    4. Much more than average – around Php1,500 [ ]

SHELTER

1. How many people live in your household/boarding house/dormitory room?
    1. 1 person [ ]
    2. 2 people [ ]
    3. 3 people [ ]
    4. 4 people [ ]
    5. 5 people [ ]
    6. 6 people [ ]
    7. 7 or more people [ ]

2. What is the size of your home/boarding house/dormitory room?

Table 1

Practical approximation of floor area

Area	*Comparable to*	*Area*	*Comparable to*	*Area*	*Comparable to*
25 m^2	~4 medium sized car	55 m^2	~9 medium sized car	150 m^2	~1 volleyball court
45 m^2	~7 medium sized car	90 m^2	~half of a volleyball court		

1. Very small – less than 25 m^2 [ ]
2. Small – 25 to 45 m^2 [ ]
3. Average – 45 to 55 m^2 [ ]
4. Medium – 55 to 90 m^2 [ ]
5. Large – 90 to 150 m^2 [ ]
6. Very large – 150 m^2 or larger [ ]

MOBILITY

Table 2

Approximate distance from CMU to other destinations in Bukidnon

CMU to	*Distance (km)*	*CMU to*	*Distance (km)*	*CMU to*	*Distance (km)*
Lumbo, Valencia	7.4	Dologon	3.3	BUSCO	8.1
Pob., Valencia	4.8	Bayabason	11.2	Pob.,Quezon	18.4
Malaybalay	34.4	Pob., Maramag	14.4	Dangcagan	33.5
Pangantucan	42.1	Pob., Don Carlos	24.45	Kibawe	39.0
Kalilangan	61.7	Kitaotao	31.1	Kadingilan	47.5

1. How far do you travel by **PRIVATE** vehicle each week (as a driver or passenger)?
    1. I never ride in a private car/vehicle [ ]
    2. 1 to 20 km [ ]
    3. 20 to 40 km [ ]
    4. 40 to 60 km [ ]
    5. 60 to 80 km [ ]
    6. 80 km or more [ ]

2. **(For Private Vehicle Travelers only)** What is the fuel consumption of the car/vehicle you travel in most often?
    1. I do not know [ ]
    2. ~6 km L^{-1} [ ]
    3. ~6 to 9 km L^{-1} [ ]
    4. ~9 km to 14 km L^{-1} [ ]
    5. ~14 km to 20 km L^{-1} [ ]
    6. More than 20 km L^{-1} [ ]

3. **(For Private Vehicle Travelers only)** How often do you drive in a car/vehicle with someone else?
    1. Almost never (1% of the time) [ ]
    2. Occasionally (25% of the time) [ ]
    3. Often (50% of the time) [ ]
    4. Very often (75% of the time) [ ]
    5. Almost always (90% of the time) [ ]

4. How far do you travel by **PUBLIC** transit each week (bus, jeepney, tricycle, etc.)? (refer to table 2)
    1. 0 km [ ]
    2. 1 to 40 km [ ]
    3. 40 to 80 km [ ]
    4. 80 to 120 km [ ]
    5. 120 km or more [ ]

5. How many hours do you fly in an airplane each year?
    1. I never fly [ ]
    2. 3 hours round trip [ ]
    3. 5 hours round trip [ ]
    4. 16 hours round trip [ ]
    5. 34 hours round trip [ ]
    6. Greater than 34 hours multiple international flights [ ]

Signature of respondent: _____

Interviewed by: _____