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ORIGINAL ARTICLE

Reducing our Ecological Footprint: Developing Sustainability Scenarios for the College of Forestry and Environmental Science, Central Mindanao University, Philippines

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ABSTRACT
The study was conducted as an effort to obtain a glimpse of the impact of the activities of the College of Forestry and Environmental Science in Central Mindanao University, Philippines through ecological footprinting. The Ecological Footprinting (EF) approach was undertaken to estimate the amount of bioproductive land needed to provide for the annual operations of the College. Based on EF conversion factors from previous life cycle analysis (LCA) studies, a partial ecological footprint of the College was estimated based on the following components: electricity consumption, water consumption, fuel use, air travel, built up land, paper consumption, and waste generation. The ecological footprint of the College was found to be higher than its occupied land area. This necessitates the need for sustainability planning to limit the increasing impact of the development activities of the College in terms of its demand for ecological resources. Hence several sustainability scenarios were developed such as off grid solar energy generation, manual lawn mowing, rainwater harvesting, paper reuse, and waste recycling. Such measures were found to decrease the ecological footprint of the college at a minimal level. Nonetheless, the study was able to demonstrate how EF can be a useful educational tool as well as an aid to policy and decision making in an academic institution.
Keywords: *Sustainability, Ecological Footprint, Scenario Building, Philippines.*

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INTRODUCTION

The important role of higher education in the achievement of sustainable development has been openly accepted nowadays [1, 2, 3, and 4]. However, there is a difficulty in the monitoring and evaluation of campus sustainability programs due to the varied means to measure and determine the success and failure of such green initiatives towards achieving sustainability [2]. This calls for further development of new tools or plainly enhancing existing ones which could lead us into successfully integrating sustainability in higher education.

On the other hand, the ecological footprint (EF) has been found to be a simple yet effective tool to determine ecological impact. EF is measured in terms of the amount of bioproductive land needed to support the consumption of a country or an individual as well as for absorbing their waste. Thus, a higher EF is interpreted as an unsustainable scenario. Therefore, reducing one's EF is a path towards sustainability. First used in 1996 to compare environmental performance of countries [5], EF has now been used to determine the environmental impact of subsystems such as cities, industries, companies, individuals, or products. Previous studies have dealt with the use of EF in determining the ecological impact of the consumption behavior of students in a university [6, and 7]. Furthermore, other studies have dealt with measuring the EF of whole academic institutions [8, 9, 10, and 11].

However, due to the inconsistency of the EF components measured in schools and universities, a comparison of EF among institutions is impossible. This leads to questions and criticisms regarding the practicality of using EF for academic institutions. Thus, to address these research difficulties, other studies developed innovations for utilizing EF in the academic setting. One of these studies used EF to predict increase of ecological impact due to climate change [10]. EF was also used to determine ecological benefits from several sustainability initiatives in a university [9], which was based on a previous

technique applied to a city [12]. Furthermore, EF was also used to determine the sustainability of living within the campus compared to off campus residence [7].
It is with the above path that this study is geared upon. In this context, EF is used to test the viability of several programs and projects aiming for campus sustainability. With this, it is hoped that EF can be an effective educational tool to promote environmental awareness among the university populace. Furthermore, this will pave the way for university administrators to consider EF as an aid to policy and decision making.

METHODOLOGY

The study area

Central Mindanao University (CMU) is an agricultural state university in the Philippines. It is located in Bukidnon, a prime agricultural province in the island of Mindanao. Since its establishment by the Americans in 1910 as an agricultural elementary school, it has gradually progressed into a state university in 1965 by virtue of Republic Act 4498. To date CMU, is considered by the Philippine government as a Level IV (highest level) state university. CMU is also awarded by the Commission on Higher Education (CHED) with centers of excellence in agriculture, veterinary medicine, and forestry education as well as centers of development in biology and mathematics education.
CMU's College of Forestry and Environmental Science (CMU-CFES) is one of the 9 colleges in the university. Currently, the College offers 2 undergraduate programs (BS in Forestry and BS in Environmental Science) and 2 graduate programs (MS in Forestry and MS in Environmental Management). CMU-CFES is currently manned by 15 faculty members and 9 support staff attending to around 500 students per semester.

Data collection and sources

The identified components used in the EF computation of CMU-CFES are the following: electricity consumption, water consumption, fuel use, air travel of personnel, built up land, paper consumption, and waste generation. Table 1 shows the data that were collected and the different sources where they were gathered. The 2013 consumption data of CMU-CFES were used in the study.

Table 1: Data Used in the Study and its Sources

Component	Units	Sources
Electricity	Kilowatt-hour (KWh)	First Bukidnon Electric Cooperative (FiBECo)
Water	Cubic meters (m^3)	CMU-General Services Office
Fuel	Liters (L)	Key Informant Interviews
Air Travel	Passenger-kilometers (pkm)	CMU-CFES Dean's Office
Built up Land	Square meters (m^2)	Google Earth
Paper	Reams	CMU-CFES Property Custodian
Waste	Kilograms (kgs)	Tinam-isan (2013)[13]

EF conversion

Using the component method of EF calculation, the consumption data were subjected to conversion using EF factors from previous literature [14, and 15] (Table 2). The resulting units after the EF conversion are expressed in global hectares (ghas). One global hectare is equivalent to a hectare of land with an annual productivity equal to the world average. Thus, the EF of CMU-CFES is interpreted as the amount of productive land needed to supply the materials consumed by the College as well as the amount of forest land needed to absorb the greenhouse gases emitted from such consumption. A more detailed procedure in the computation of EF prior to the derivation of the EF conversion factors can be found in Kitzes et al [16].

Table 2: EF Conversion Factors for each Component

Component	EF Conversion Factor (ghas)	Sources
Electricity	0.0000958 ghas/KWh	Chambers et al (2000)
Water	0.00008 ghas/m^3	Chambers et al (2000)
Fuel	*Diesel* = 0.000867 ghas/L *Gasoline* = 0.000774 ghas/L	Chambers et al (2000)
Air Travel	0.000049 ghas/pkm	Acosta & Moore 2009
Built up Land	0.000283 ghas/ m^2	Chambers et al (2000)
Paper	0.003645 ghas/ream	Chambers et al (2000)
Waste	*Paper* = 0.0028 ghas/kg *Glass* = 0.001 ghas/kg *Aluminum* = 0.0094 ghas/kg *Plastic* = 0.0036 ghas/kg	Chambers et al (2000)

Development of sustainability scenarios

The EF calculation procedure used in this study is limited by the fact that not all consumption data can be readily collected (e.g. food, beverage, student commuting behavior, etc.). Therefore, not all were accounted for in the study and thus, EF can be interpreted here as an underestimate of ecological impact. Nevertheless, EF's importance for environmental awareness and sustainability policy cannot be neglected. With this in mind, the study resorted to analyzing the influence of some sustainability programs/policies on the possible EF reduction. In this context, five (5) practical sustainability scenarios were developed which can be probable policy options for CMU-CFES in the future. These are the following:

1. *50% Off Grid Solar Electricity Generation* – to understand the EF reduction potential of investing in an alternative solar powered electricity for the CMU-CFES buildings, an analysis was done to measure how much EF will be reduced in case such project is implemented.

2. Shift to Manual Lawn Mowing – the current landscaping activities of the College deals with the use of gasoline powered grass cutters. Sixteen (16) liters of gasoline is allocated by the CMU-General Services Office monthly for maintaining the grass covered lawns of the three CMU-CFES buildings. An alternative option is to employ the help of students as part of their civic work for their National Service Training Program (NSTP) course to do the manual cutting of grasses. It is interesting to know how much EF will be reduced from this. This will serve to educate the students about the ecological contribution of such program/project.

3. *50% Rainwater Harvesting* – based on interviews with maintenance personnel of the College, around 50% of the water consumption is used mostly for the maintenance of toilets and urinals in the CMU-CFES buildings as well as for watering plants. Since water used for cleaning toilets and urinals as well as for watering plants doesn't need to be treated, rainwater harvesting can be a viable option for reducing water consumption sourced out from the CMU water distribution system. It is helpful to know how much impact is reduced in terms of EF on top of the economic benefits of saving water.

4. *50% Paper Reuse* – currently there is an existing administrative memorandum to maximize the use of paper and office supplies. The memo encourages the utilization of back pages of used papers for interoffice communications. However, there is a difficulty in monitoring the compliance of university personnel to the memorandum. The success of such endeavor greatly relies on the voluntary adherence of personnel to the policy. Thus, to heighten the voluntary compliance of university staff to this memorandum, a substantial knowledge of the EF reduction potential of paper reuse will be helpful.

5. *Recycling of Waste* –recycling of waste not only results to cleanliness of the campus but can be an economically viable venture because recyclables can be sold in junk shops. Furthermore, in this context, it is also interesting to find out how much EF can be reduced if CMU-CFES recycles its wastes.

Data Analysis

Descriptive statistics in the form of percentage was primarily used in the analysis of data.

RESULT AND DISCUSSIONS

EF of CMU-CFES

As shown in Table 3, the total EF based on the identified consumption components of CMU-CFES is equivalent to 7.39 ghas. Roughly, this is equivalent to 170 Olympic size basketball courts. This gives us an idea that the amount of bioproductive land needed by CMU-CFES for its annual operations is higher than the physical area it occupies (~0.4 hectares). In fact, the EF of the College is ~18 times its actual physical area. This gives us the magnitude of the ecological impact of the operations of CMU-CFES.

In terms of the individual components, electricity consumption of the College is equivalent to 1.20 ghas. This means that for the annual electricity consumption of CMU-CFES, it takes 1.2 hectares of forest with an annual productivity equal to the world average to absorb the amount of greenhouse gas emitted from producing the electricity consumed annually by the College.

For water consumption, the equivalent EF is 0.63 ghas. EF of water consumption is based on the energy needed to extract and distribute water from source to user.

In terms of fuel use, the EF of the College is equivalent to 2.36 ghas, Fuel use specifically diesel and gasoline has a corresponding amount of greenhouse gases produced once consumed. In this context, fuel use EF refers to the amount of forest land needed to sequester such greenhouse gases produced from fuel use.

Air travel EF is equivalent to 1.51 ghas. EF from air travel is an indirect impact in terms of the forest land needed to sequester the greenhouse gases from fuel consumed in an air travel on a kilometer basis per passenger.

Built up land EF refers to the amount of land occupied by the buildings of the College. The total area occupied by the three buildings of the College (Administration, Main, and Annex) corresponds to 1.11 ghas.

Paper consumption EF is attributed to the amount of forest needed to supply the trees used to produce the paper consumed by the College. Consequently, it also includes the amount of forest land needed to sequester the greenhouse gases produced from the generation of energy used in manufacturing the said amount of paper. The CMU-CFES EF for paper consumption is 0.40 ghas.

Solid waste EF corresponds to the amount of land needed to accommodate waste for landfills. Furthermore, it also includes the forest land needed to absorb the greenhouse gases emitted by the decomposition of waste in landfills [17]. Solid waste EF for CMU-CFES is equal to 0.17 ghas.

In terms of the distribution of the different components, majority of the EF is attributed to fuel use. This is around 1/3 of the total EF of the College. Most of the fuel use comes from the transportation of faculty members who own private vehicles. Previous studies attribute majority of carbon emissions in the academic setting from transportation of faculty, staff, and students [18, and 7]. Thus, it is just normal that in this context, the single component with the highest EF in CMU-CFES is from fuel use. However, a small part of the fuel use EF comes from fuel consumed for landscaping (grass cutter, lawn mower, etc.) rather than for transportation.

Air travel constitutes 1/5 of the total EF of the College. These travels however, are necessary for the operations of CMU-CFES as these are official travels by personnel for attending meetings, conferences, and other such activities needed for the development of the College [19].

The smallest contributor to the total EF of CMU-CFES is waste generation. This comprises ~2% of the total EF. Paper consumption on the other hand is the next lowest EF contributor with ~5% of the total EF. Water consumption is also considered as having a low contribution to the total EF of CMU-CFES which is ~8% of the total EF.

Table 3: Ecological Footprint of CMU-CFES (2013)

Component	Consumption (2013)	Ecological Footprint (ghas)	%
Electricity	12,516 KWh	1.20	16.24
Water	7,884 m^3	0.63	8.53
Fuel	*Diesel* = 900 L *Gasoline* = 2,052 L	2.37	32.07
Air Travel	30,808 pkm	1.51	20.43
Built up Land	3,938.21 m^2	1.11	15.02
Paper	110 reams	0.40	5.41
Waste	*Paper* = 10.40 kg *Glass* = 3.64 kg *Aluminum* = 12.48 kg *Plastic* = 6.24 kg	0.17	2.30
TOTAL		7.39	100.00

EF reduction from sustainability scenarios

As shown in Table 4, five sustainability scenarios were tested in terms of the amount in EF reduction. Rainwater harvesting is shown to have the greatest EF reduction potential which is equivalent to ~4% reduction from the total EF of CMU-CFES. EF reduction from rainwater harvesting (0.31 ghas) is even equal to the combined EF reduction from off grid solar electricity generation (0.15 ghas) and shift to manual lawn mowing (0.16 ghas).

Paper reuse has the lowest EF reduction potential among the five scenarios (0.10 ghas). However, it should be pointed out that this is the most cost efficient sustainability scenario with cost equivalent to zero. In fact off grid solar electricity generation (a cost intensive option) will only achieve ~38% higher reduction from total EF than paper reuse.

Waste recycling is the component with the second highest EF reduction potential (0.17 ghas). Waste recycling is also considered as a cost efficient option compared to solar electricity generation. Interestingly, recycling of waste has a higher EF reduction potential (~12% higher) than solar electricity generation. Furthermore, compared to manual lawn mowing (a labor intensive option), waste recycling has a higher EF reduction potential by ~5%.

The total EF reduction potential of the five sustainability scenarios is ~12% or 1/8 of the total EF. Thus, the said sustainability options may not be enough to reduce EF substantially. Furthermore, the high cost of off grid solar electricity generation which only equates to around 2% of EF reduction may not warrant justification of such cost intensive project. There is however a good potential for rainwater harvesting which entails a substantially lesser cost but with comparably twice the EF reduction potential than solar electricity generation. Moreover, the total EF reduction from the "zero-cost" sustainability options (manual lawn mowing, paper reuse, and waste recycling) is equivalent to ~5% total EF reduction, which is higher than the EF reduction from rainwater harvesting.

Table 4: Sustainability Scenarios and Corresponding EF Reduction

Sustainability Scenarios	EF reduced	% EF reduction from total EF
Off Grid Solar Electricity Generation	0.15	2.03
Shift to Manual Lawn Mowing	0.16	2.17
Rainwater Harvesting	0.31	4.19
Paper Reuse	0.10	1.35
Waste Recycling	0.17	2.30
TOTAL	0.89	12.04

CONCLUSIONS

The total EF of CMU-CFES which is equivalent to 7.39 ghas which is extremely higher than its actual land area occupied. This gives us an idea of the ecological impact of CMU-CFES to land resources. Fuel use is found to be the component with the highest ecological pressure on land. This however could mean that reduction of fuel use will have a greater potential for EF reduction. In fact just a mere shift from gasoline powered grass cutters toward manual lawn mowing has a greater EF reduction potential than off grid solar electricity generation. A more substantial EF reduction however entails a larger reduction in fuel use such as carpooling, mass transportation, or use of hybrid cars. These however are difficult to legislate in CMU-CFES because car ownership among faculty, staff and students are more of a personal choice rather than institutional. However, further environmental awareness and education especially with the use of EF may provide a guarantee of influencing personal choices of CMU-CFES constituents.

Furthermore, the single most promising EF reduction option is rainwater harvesting. This can lead to a 4% decrease in the total EF of CMU-CFES once implemented. However, implementing waste recycling, paper reuse, and manual lawn mowing (all of which can be implemented at almost no cost) altogether can lead to ~5% EF reduction which is higher than rainwater harvesting.

Though the sustainability scenarios developed and analyzed in the study only provided a minimal EF reduction, it should be noted that the importance of EF lies in its ability to educate the populace on the impact of their activities on our ecological resources. Furthermore, it can provide us with insights on how even a minimal change of lifestyle can reduce the pressures we exert on nature. The results add to the growing literature dealing with the usefulness of EF as both an educational tool as well as an aid to policy making.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

REFERENCES

1. 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.
2. 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(3): 254–270.
3. Cortese A.D. (2003). The critical role of higher education in creating a sustainable future. *Planning for Higher Education*; 31: 15–22.
4. Rees W.E. (2003). Impeding sustainability? *Planning for Higher Education*; 31: 88–98.
5. Rees W.E., Wackernagel, M. (1996). Ecological footprints and appropriated carrying capacity: measuring the natural capital requirements of the human economy (Eds. Johansson A. M., Hammer M., Folke C., Costanza R.) Investing in natural capital: the ecological economics approach to sustainability, Island Press, Washington D.C., pp. 362-391.
6. 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(1): 23–26.
7. Medina MAP (2000). The sustainability of on campus residence: a utilization of ecological footprinting in a state university in Mindanao, Philippines. *AES Bioflux*; 7(1): 1-10.

8. Flint K. (2001). Institutional ecological footprint analysis: a case study of the University of Newcastle, Australia. *International Journal of Sustainability in Higher Education*; 2(1): 48-62.
9. Conway T.M., Dalton C., Loo J., Benakoun L. (2008). Developing ecological footprint scenarios on university campuses: a case study of the University of Toronto at Mississauga. *International Journal of Sustainability in Higher Education*; 9(1): 4-20.
10. Klein-Banai C., Theis T.L. (2011). An urban university's ecological footprint and the effect of climate change. *Ecological Indicators*; 11: 857- 860.
11. Gottlieb D., Kissinger M., Vigoda-Gadot E., Haim A. (2012). Analyzing the ecological footprint at the institutional scale – The case of an Israeli high-school. *Ecological Indicators*; 18: 91- 97.
12. Barrett J. (2001). Component ecological footprint: developing sustainable scenarios. *Impact Assessment and Project Appraisal;* 19(2): 107-118.
13. Tinam-isan J. (2013). Recharacterization and Analysis of Solid Waste in Academic Units of Central Mindanao University, Musuan, Bukidnon.. Unpublished Undergraduate Thesis, Central Mindanao University, Philippines*.*
14. Chambers N., Simmons C., Wackernagel M. (2000). Sharing Nature's Interest: Ecological Footprints as an Indicator of Sustainability. Routledge, New York, USA.
15. Acosta K., Moore J. (2009). Creating an Ecological Footprint Assessment: Using Component and Compound Economic Input Output Methods. British Columbia Institute of Technology, Canada pp. 27.
16. Kitzes J., Peller A., Goldfinger S., Wackernagel M., (2007). Current Methods for Calculating National Ecological Footprint Accounts. *Science for Environment & Sustainable Society;* 4(1): 1-9.
17. Medina MAP, Forten RRC. (2015). Estimating Methane Gas Emissions from Solid Waste Generated by Households in an Urban Village in Bukidnon, Philippines. *American-Eurasian Journal of Agriculture and Environmental Sciences;* 15(5): 837-842.
18. Ozawa-Meida L., Brockway P., Letten K., Davies J., Fleming P. (2013). Measuring carbon performance in a UK University through a consumption-based carbon footprint: De Montfort University case study. *Journal of Cleaner Production;* 56: 185-198.
19. Larsen H.N., Pettersen J., Solli C., Hertwich E.G. (2013). Investigating the Carbon Footprint of a University - The case of NTNU. *Journal of Cleaner Production;* 48: 39-47.

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