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If a university is a planet, does it have enough resources for its inhabitants? The case of the ecological footprint and biocapacity of Central Mindanao University

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Abstract

This study was done to determine the ability of the landholdings of Central Mindanao University in providing for the needs of its populace (students, faculty, and staff). Biocapacity was used to measure how much land is available for the demand of the CMU populace to provide for its needs. Using land area data of the different land uses in CMU as well as calculation values from the Global Footprint Network, the biocapacity of CMU was computed. It was found out that CMU's biocapacity is equivalent to 6,928.61 ghas which can be used to allocate 0.693 ghas for every member of the CMU populace. Based on ecological footprint calculation of the CMU populace from previous studies, it is revealed that although CMU lands won't be enough for the lifestyle of the whole populace, it can be able to sustain its food requirements from agricultural crops. Furthermore, changes in some aspects of the ecological footprint of the populace (reduced consumption of animal based food, lessened dependence on wood, cutting down carbon footprint, etc.) and conversion of some crop lands and grazing lands into forest lands can lead to the sustainability of CMU in terms of independently and continuously providing for the resource needs of its inhabitants.

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Introduction

The ecological footprint is the measure of biologically productive and mutually exclusive land necessary to continuously provide for people's demand for resources and the absorption of their wastes (Wackernagel *et al.*, 1999). On the other hand, biocapacity describes the supply side or the productive capacity of the biosphere and its ability to provide a flux of biological resources and services useful to humanity (Moran *et al.*, 2008). Ecological footprint and biocapacity is measured in terms of "global hectares" (ghas). One global hectare is a hectare that is normalized to have the world average productivity of all biologically productive land and water in a given year (Kitzes *et al.*, 2007).

It has been understood that for a planet or a nation to be sustainable, its ecological footprint should not exceed its biocapacity (Monfreda *et al.*, 2004). Currently, based on the latest National Footprint Accounts (http://data.footprintnetwork.org), the average global ecological footprint is 2.8 ghas/capita while the mean global biocapacity is 1.7 ghas/capita. This means a deficit of around 1.1 ghas, thus the supply side of nature is not enough for the population's demand for natural resources. In fact, for the Earth's population to continue with such consumption (without degrading the planet's regenerative capacity), it needs to have 0.7 more of the Earth with the same biocapacity.

The ecological footprint was originally used in the measurement of countries (Wackernagel *et al.*, 1999; Moran *et al.*, 2008). However, lately, ecological footprint was used for corporations (Barret and Scott, 2001; Holland, 2003; Millan *et al.*, 2008), local governments (Wackernagel, 1998; Wackernagel *et al.*, 2006), and products (Huijbregts *et al.*, 2008: Limnios, 2009) to measure their impact to nature. Recently, universities started to compute their own ecological footprints (Venetoulis, 2001; Flint, 2001; Conway *et al.*, 2008; Nunes *et al.*, 2013; Lambrechts and Liedekerke, 2014). However, there is a lack of literature with regards to the measurement of a university's biocapacity. It would be interesting to find out if higher education institutions (especially land-grant universities or the likes) could survive if they only have their own land to depend on.

To answer the above question, the author conducted this study. In the case of Central Mindanao University (CMU), several studies have been conducted to measure its ecological footprint (Medina, 2015; Medina and Catalon, 2015; Medina and Toledo-Bruno, 2016, Toledo-Bruno *et al.*, 2016; Medina and Belcena, 2018). However, the author thinks it's necessary to calculate its biocapacity to find out if it can be able to support the consumption and lifestyle (ecological footprint) of CMU stakeholders. This is an attempt to illustrate the concept of sustainability in the academic sector.

Materials and methods

Location of the Study Area

The study area is the whole land area managed by Central Mindanao University (CMU). CMU is a Level 4 state university situated in Bukidnon, an agricultural province in the Philippines. Formerly established by Americans as an agricultural elementary school in 1910, CMU became a state university by virtue of Republic Act 4498 in 1965. CMU is presently located in Maramag Town (Fig. 1) nested in an approximate land area of 3,080 has. Currently it was awarded by the Commission on Higher Education (CHED) as centers of excellence in agriculture, veterinary medicine, and forestry education and at the same time centers of development in environmental science, mathematics and biology.

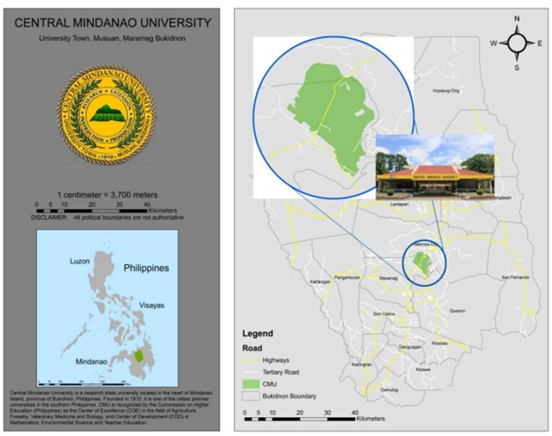

Fig. 1. Location map of the study area.

Determining the Area of Different Land Uses in CMU

The different land uses in CMU were categorized into the following: Crop Land, Forest Land, Grazing Land, Built Up Land, and Fishing Ground. These categories are based on biocapacity land uses specified in the Global Footprint Network (GFN) Methodology (Borucke *et al.*, 2013). The Global Footprint Network is an organization which developed the Ecological Footprint and Biocapacity methodology.

The area in hectares of each specified land uses were extracted from the Land Use/Land Cover map of CMU which was taken from the CMU Land Use Development Plan (LUDeP). A previous study utilized this map to extract the different land use/land cover (LULC) of CMU (Paquit and Mindaña, 2017). Subsequently, this was the basis in this study in determining the specific areas of the GFN land use categories in CMU.

Biocapacity Calculation

For the biocapacity of CMU land, the following equation was used (Borucke *et al.*, 2013):

$$BC = \Sigma A_{N,i} \cdot YF_{N,i} \cdot EQF_i \quad (1)$$

where $A_{N,i}$ is the bioproductive area that is available for the production of each product *i* in CMU, $YF_{N,i}$ is the country-specific yield factor for the land producing products *i,* and EQF_i is the equivalence factor for the land use type producing each product *i*. Specific *YF* values for the Philippines as well as the default EQF values were taken from the GFN website (https://data.world/footprint). Consequently, biocapacity per capita (ghas/capita) was calculated by dividing the total CMU land biocapacity by the number of the CMU populace (N = 9,996) which includes the faculty, staff, and students.

Evaluation of CMU Biocapacity against Ecological Footprint of CMU

After calculating for the biocapacity of CMU. The Ecological Footprint of the CMU populace (Faculty, Staff, and Students) were then used to evaluate if the biocapacity of CMU is enough to provide for the amount of land required to supply for the needs of the said inhabitants. Ecological Footprint values of CMU populace were taken from results of previous studies (Medina, 2015; Medina and Toledo-Bruno, 2016; Toledo-Bruno *et al.*, 2016).

Results and discussion

Area of Different Land Uses in CMU

As shown in Table 1, majority of the land use in CMU is crop land. This refers to land used for the production of food and other agricultural crops in CMU. Most of CMU land is utilized for rice and sugarcane, which is the main agricultural crop produced in the province of Bukidnon. Other agricultural crops grown in CMU are rubber, coffee, cacao, fruits, and corn. The next largest land use in terms of area is forestland which comprises the natural forests, as well as tree plantations of the university.

Table 1. Area of different land uses in CMU.

Land Use Type	Area (has)
Crop Land	1,499.04
Forest Land	843.25
Grazing Land	469.37
Built Up Land	243.86
Fishing Ground	25.3
TOTAL	3,080.82

A large tract of land is also intended for grazing land. CMU raises livestock such as cattle, goat, and sheep which are dependent upon pasture/grazing land. Built up land is just half of grazing land in terms of area. This comprises land utilized for the academic and administration buildings of CMU as well as structures used for the income generation programs. The least type of land use in terms of area is the fishing ground which is composed of the CMU Fishpond and the rivers and streams within CMU land. Bukidnon, where CMU is located is a landlocked province thus there are no coastal areas and only inland water bodies are considered fishing grounds.

Biocapacity of Different Land Uses in CMU

As shown in Table 2, the total biocapacity of CMU is 6,928.61 ghas. This is around 2 ¼ times than its actual area (3,080.82 has) which means a 125% productivity of CMU lands. In fact it can be assumed that CMU is ~10% more productive compared to the whole country (Global Footprint Network, 2013).

Furthermore, majority of CMU's biocapacity comes from cropland which is almost 70% of the total biocapacity of CMU. Forest land is only around 15% of CMUs biocapacity. Built up land has a greater biocapacity than grazing land although the former has lesser actual area (243.86 has) than the latter (469.37 has). This is understandable since based on the EQF, built up land is equally productive with agriculture compared to grazing land which is comparably lower. Moreover, fishing grounds has the lowest contribution to the biocapacity of CMU. CMU's fishing grounds comprises small creeks as well as a fishpond area.

Table 2. Biocapacity of different land uses in CMU.

Land Use Type	Area (has)	Yield Factor	Equivalence Factor	Biocapacity (ghas)
Crop Land	1,499.04	1.24133	2.52	4,689.22
Forest Land	843.25	0.919749	1.29	1,000.50
Grazing Land	469.37	2.16155	0.46	466.70
Built Up Land	243.86	1.24133	2.52	762.83
Fishing Ground	25.3	1	0.37	9.36
Total	3,080.82			6,928.61

Table 3. Per capita biocapacity of different land uses in CMU compared to country and global average (ghas/capita).

Land Use Type	CMU	Philippines	World
Crop Land	0.469	0.343	0.550
Forest Land	0.100	0.093	0.709
Grazing Land	0.047	0.016	0.209
Built Up Land	0.076	0.060	0.064
Fishing Ground	0.001	0.066	0.151
Total	0.693	0.578	1.682

CMU Biocapacity vs. Country and Global Biocapacity

Per capita biocapacity was used to compare CMU with the national and global average. As shown in Table 3, the biocapacity of CMU for each member of its population is 0.693 ghas/capita. This is a bit higher than the Philippine average (0.578 ghas/capita). Based on the latest National Footprint Accounts (http://data.footprintnetwork.org), CMU's per capita biocapacity is comparable to the biocapacity of South Korea, Malawi, Mauritius, and Nigeria.

However CMU has a very low biocapacity per member of its population compared to the global average. In fact CMU's per capita biocapacity is even less than half of the world average per capita. However, it should be noted that it has a higher forest land per capita than the national as well as the global average.

Table 3. Comparison between CMU's biocapacity and the ecological footprint of its populace (ghas/capita).

Land Use Type	Ecological Footprint			Biocapacity
	Students	Faculty and Staff	Average	
Crop Land	0.30	0.19	0.25	0.469
Forest Land	0.22	2.39	1.31	0.100
Grazing Land	0.05	0.06	0.06	0.047
Built Up Land	0.06	0.35	0.21	0.076
Fishing Ground	0.05	0.21	0.13	0.001
Carbon Footprint	0.59	0.62	0.61	*
Total	1.25	3.82	2.54	0.693

*Biocapacity does not include carbon footprint because it is incorporated in forest land

Sustainability of CMU based on Biocapacity vs. Ecological Footprint

Based on previous studies (Medina, 2015; Medina and Toledo Bruno, 2016), the average ecological footprint of CMU students is 1.25 ghas. When compared to the available biocapacity for each students, CMU's land won't be enough to provide for the lifestyle of CMU students. This has the same implications with CMU faculty and staff, which has an average ecological footprint of 3.82 ghas (Toledo-Bruno *et al.*, 2016). This means that if CMU is a planet, it won't be able to provide the needed resources of its populace for the whole year. This is called "ecological overshoot" (Wackernagel *et al.*, 2002), a term used when a population's utilization of natural resources exceeds the capacity of nature to regenerate the resources being consumed and to absorb its wastes.

However, on the positive side, it can be noticed that CMU's cropland has more biocapacity (0.469 ghas/capita) than the crop land ecological footprint of the students (0.30 ghas) as well as the faculty and staff (0.19 ghas).

This means that CMU's cropland can be able to provide for the needs of the CMU populace in terms of food from agricultural crops. In fact CMU's cropland biocapacity is 47% more than then the needs of the average CMU populace. Furthermore, grazing land of CMU is almost enough for its populace.

On the other hand, there won't be enough forest land for the population of CMU both as source of wood (and other forest products) as well as sink for its carbon footprint. Furthermore, built up land would also be a deficit in CMU (although it can be compensated by the surplus crop land which strategically can be converted into built up land). Consequently, there won't be enough fish for the population of CMU since there is a deficit in its fishing grounds.

Conclusion

In this study it was found out that CMU's biocapacity is equivalent to 6,928.61 ghas, a value which is more than twice its actual area. On a per capita basis, biocapacity allocation of CMU populace is 0.693 ghas/capita. Although this is lower than the global average it is however higher than the national average. It is also noteworthy that its forest land biocapacity is higher than the national and global average on a per capita basis for the same land use category. Furthermore, CMU's biocapacity is not enough for the ecological footprint of CMU. However, it should be noted that crop land biocapacity is more than enough for the crop based food requirements of the CMU populace. However, in order to survive and avoid ecological overshoot, CMU should do the following: a) reduce consumption of pasture-based livestock by half so as not to overburden its grazing land, b) convert excess crop land into forestland but also reduce by at least half of the dependence on wood products (especially faculty and staff), c) design high-density residential buildings and space efficient institutional infrastructure to cut back on demand for built up space, d) reduce fish consumption and use plant-based protein as substitute, and e) reduce carbon footprint.

Although this study may seem a bit more unrealistic in the present times, nevertheless it demonstrates the possibility and relevance of the ecological footprint and biocapacity as an aid to decision making and policy making in addition to its being an education tool in the context of sustainability. The author hopes that in the near future, environmental systems analysis tools such the ecological footprint will be a mainstream basis for legislative actions and executive decisions of the academe as well as the private/corporate and government sectors in its efforts to achieve sustainability.

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