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Institutional Ecological Footprint Analysis - Case Study of Bangalore University Campus, South India

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ABSTRACT

The purpose of doing Ecological Footprint analysis for any University is to understand and have a clear view of the Institution's Ecological impact and sustainability practices. To make staff and students realize the importance of sustainability and motivating them to get into action. It serves as a base for future policymaking. The Objective of the study is to carry out an inventory on Food, Energy, Water, Waste generation, Land use pattern and to estimate the Ecological Footprint of the Campus. The methodology, Equivalent and yield factors required for the estimations were taken from Wackernagel and Rees. From the Ecological Footprint analysis, it was found that the Bangalore University campus was weakly sustainable. By making use of the unused potential, there is still scope for adopting sustainability practices in the University making it strongly sustainable. Food followed by energy consumption was the major contributing factor for the Ecological Footprint of the campus. It is the first case study on Ecological Footprint analysis done for Bangalore University, Jnana Bharathi campus and very few studies are available in Indian universities. University can reduce the waste generation and implement solar project to reduce Ecological Footprint. Also, restoration of bio-park becomes essential to strengthen the Biocapacity of the campus.

Key words : *Sustainability, Ecological footprint (EF), Biocapacity, Global hectares (GHA), Bangalore University*

Introduction

Dating back to the 20th century, in the era of the 'Industrial Revolution', there had emerged two factions in the society, the conservationists and the preservationists. It was around the same period the idea of "Sustainability" stepped in. The conservationists had believed in using nature properly, whereas the preservationists focused on protecting nature and eliminating human interference (Luke, 2002). Losing renewable resources was of much concern than that of losing the non-renewable resources. With this concern, there was a need for a 'resource management tool,' which can aid in conceptualizing and develop sustainability and also act as a 'planning tool' which can translate it to public action (Wackernagal, 1994; Thattai, 2007). One such tool is "Ecological Footprint", which was proposed by Canadian ecological economist, William Rees, in 1992 and later improved and developed by relevant researchers, notably Wrakenagel. Ecological Footprint analysis is a common account for bioproductive area used as a resource and that is needed to assimilate the waste or the pollutant. It is used to evaluate the total appropriation of the bioproductive space and resources consumed (Ecological Footprint) in the context of total available sources and resources (Biocapacity). Both Ecological Footprint and biocapacity are expressed in global hectares-globally comparable, standardized hectares with average world productivity. If a population's Ecological Footprint exceeds the region's Biocapacity, that region runs an ecological deficit, which is unsustainable; whereas on the other

hand, if a region's biocapacity exceeds its Ecological footprint, it has an ecological reserve (Wackernagel, 1994; Wackernagel and Rees, 1998).

University campus holds great value in the development of a city in the physical, socio-cultural, and economic dimensions, without losing its privacy, the university campus could also act as the public space of the city (Rashidi, 2013). Universities act as a "micromeres" of the society wherein the sustainability in the campus will consequently address, involves and promotes the regional or a global scale. All the teaching, research, outreach and partnership, and stewardship has to function to fulfil the minimization of negative environmental, economic, societal, and health effects generated in the use of their resources in order to help society make the transition to sustainable lifestyles. It actively engages the knowledge of the university community to address the ecological and social challenges that we face now and in the future. In this context, a supporting study was conducted to frame the 'key leverage' points for the actions that can increase the sustainability of the campus. Campus sustainability was found to be strengthened by critical, innovative thinking and an organizational culture committed to continuous improvements and improved ways of doing business based on environmental and social, as well as institutional benefits (Posner and Stuart, 2013).

In the Indian Higher Education Institutes, it can be observed that there is a lack of monitoring and reporting mechanisms for sustainable development, in a majority of the cases, parameters such as waste, water, transportation, grounds and food is neglected. The only concept being addressed in Environmental sustainability is energy. Most campuses also lack sustainability-related activities in planning, administration, teaching, research, and engagement. Employee education and awareness towards sustainability are neglected; though sustainability courses are provided at all the institutes, very few are being delivered formally there is no inclusion of sustainability learning in their daily lives. However, these issues were addressed better in IITs in India (Parvez and Agarwal, 2019).

By applying the concept of Ecological footprint at the University campus will help to understand resource consumption patterns at global scale University ranking which is based on sustainability practices. This study will encourage the community at the individual and Institutional levels to adopt sustainable practices (Cole and Wright, 2003; Velazquez *et al.,* 2006 and Brinkhurst *et al*., 2011). The Objective of the study is to carry out an inventory on Food, Energy, Water, Waste generation, Land use pattern and to assess the Ecological Footprint of the campus. To make staff and students of the University understand the importance of sustainability and motivating them to get into action. It also serves as a base for future policymaking in a sustainable way.

Methodology

Study area

Bangalore University (Jnana Bharathi campus) is located on the western side of Bangalore city and spreads over in 1100 acres (www.bangaloreuniversity.ac.in). It lies between 12° 55′59" and 12° 57′33" latitude and lies between 77° 29′45" and 77° 31′12" longitude. The campus entrance is adjacent to the Bangalore- Mysore Highway and ring road passes around the campus. The campus is an undulating terrain having Vrishabhavathi River flowing North-South direction. The cumulative length of the asphalted road network of the campus is about 11.9 km and approach roads of 2.8 km connecting to all departments, administrative offices, and residential areas. About 131 buildings on the campus comprise a rooftop area of about 97,850 m^2 (Renuka and Chandan, 2019).

Bangalore lies in seasonally dry tropical Savannah climate with four seasons. Namely, dry season with clear, bright weather from December to February, Summer season from March to May, Southwest monsoon from June to September and post-monsoon season from October to November. The mean temperature is about 33 ″C and 14 ″C in summer and winter respectively. The mean annual rainfall is around 860 mm (Nagaraja *et al.,* 2005). Humidity is between 35 - 80%. It lies on the Deccan plateau at an elevation of 875-900msl in Karnataka, India (Rajashekar and Venkatesha, 2017).

Methods

Based on the consumption patterns, the present study includes energy, water, built-up land, waste generation and food consumption. Secondary data on electricity, water, land use were obtained from the University authorities. The data on total popula-

tion, food consumption, waste generation were collected from concern stakeholders and was verified by taking appropriate sampling. The methodology for Ecological footprint estimation was taken from Chen and Hsieh (2011) which was built based on the work of Wackernagel (1994). Equivalent and yield factors required for calculations and formulas of Biocapacity were taken from Wackernagel *et al*., (2005).

Ecological footprint for the food consumption was in the sub-categories of cereals, pulses, egg, vegetables, aquatic products, meat, fruits, oil, milk products, sugar, coconut for which individual world average yield factors were calculated using world yield production. The related statistical data was taken from Statista (2019) and FAO (2018).

According to Ministry of power, the sources of Electricity in India come from Coal (57%), Gas (7%), diesel (<1%), Nuclear (2%), Hydro (13%), Renewables (20%) (Renie, 2018). Based on this, the Global Average Energy yield factors required for the calculations were estimated for the same and LPG. The required statistics were taken from authenticated global sources such as International Energy Agency (2018), World Nuclear Association (2019), Energypedia (2018), CNG Europe (2011) and IEA (2019).

Results and Discussion

Inventory on Resource consumption, Waste generation and land use

To know the total population of the University, information related to the number of teaching, non-teaching, students and Research Scholars were collected from University authorities. The total student, scholars, staff and quarters population in the University was found to be 5123, 865, 1620 and 318 respectively. Which adds up to 7926. The floating population of the University is not taken into consideration in the present study.

On-campus, food consumption was estimated for canteen, hostels, quarters and guest houses separately. There were eight hostels on the campus which consisted of 1320 students, 106 quarters consisting of 424 residents, four canteens and one guest house from which the annual food consumption was collected. The type of food consumed was categorized into cereals, pulses, oil, meat, fish, egg, fruits, vegetables, milk and its products, coconut, sugar. Packaged food and the food carried from outside sources to University werenot included in the study. The maximum consumption comes from the type of vegetables, followed by cereals and pulses. Least consumption is of fish and egg. Of the total amount of food consumed, 5.49% of it goes as food waste, which is deducted under this category to avoid duplication with the waste print.

Energy consumption was estimated by taking Electricity and LPG cylinders consumed. The annual electricity bills were obtained from the Engineering Department of University. Data related to LPG cylinders used in hostels and quarters were collected through hostel wardens and residents. The annual electricity consumption in the year 2017 was found to be 2,881,500 kWh. Furthermore,the approximate number of cylinders used in hostels, quarters, and canteen were around 7,313/year, which produces energy of 2,179.74 GJ.

The source of water for University includes water supplied from Bangalore Water Supply and Sewerage Board (BWSSB) and the borewells in the University. There are 38 bore wells on the campus, of which only 11 are yielding water. The annual water consumption was calculated by taking the annual water bills and water extracted from bore wells was collected from the University Engineering Department.

Waste generated in each department was collected by visiting individual departments. For the canteens, health care centres, complex visits were done and data were gathered. Regarding hostels, the warden of hostels was met and information was gathered. The hostel is the major contributor of waste of 75.98 t/yr followed by departments (38.83 t/yr), Quarters (26.77 t/yr), Canteens (18.69 t/yr), and others (5.54 t/yr). The total area of the Bangalore University, Jnana Bharathi Campus, is 320.42 ha. Of which Biopark is around 192.23 ha, the built-up area including buildings and roads, is 12.63 ha and the open area is around 115.56 ha (Table 1).

Table 1. Components wise consumption in Bangalore University Campus

Components	Total amount consumed/year
Energy	2881500 kWh
Food	848104.6 Kg
Water	510,260,000liters
Waste generation	165.83 t
Population	7926

Ecological Footprint of University Campus

The total footprint of the campus was found to be 21,918.68 gha, wherein the total per capita footprint was found to be 2.7 gha/capita (Table 2). Food (93.02%) is found to be the major contributing factor to the footprint, followed by total energy consumption including the energy required for treatment of wastewater (4.45%), waste generation (2.44%) and built-up land (0.08%). The campus footprint was found to be 2.25 times that of the National Footprint (1.2 gha/capita) and 0.9 times lesser than the Global Footprint (2.8 gha/capita). The biocapacity of the campus was found to be 372.9 gha, wherein the campus footprint exceeded the biocapacity of the campus by 58 times. The footprint of the campus is found to be less than the global footprint making it weakly sustainable (Ventoulis, 2011). But still, there is a lot of scope for improvement in the sustainability practices.

It was found that either energy or mobility were major contributing factors in many of the Universities across the world indifferent from the Indian case studies, where the major contribution coming from the food sector. Still, when compared with the many other Western Universities having a comparable amount of land area and population, the footprint of the university was found to be many times smaller than them. Even when comparing with the Indian Case Study of SRM Engineering College, Tamil Nadu which had a footprint of 3.1gha/capita, the footprint of the campus still remained small (Thattai, 2007). University of Toronto, Canada and KHLeeuven University, Belgium have Ecological Footprint of 1.07gha/capita and 0.35 gha/capita respectively (Comway *et al.*, 2008; Lamberchets and Van, 2014), which have found to have comparatively better sustainable practices with the other Universities listed (Table 3).

By having a comparative analysis of Ecological Footprint of Bangalore University with other Universities across the world it was found that major part of resource consumption was going with the energy or mobility sector, whereas the current study had food to be a major contributor, which was also reflected in another Indian case study. Still, when compared with the many other Western Universities having a comparable amount of land area and

Table 2. Ecological Footprint of Jnana Bharathi Campus, Bangalore University

Sl. No.	Component	Total Footprint (gha)	Population	Per capita Footprint (gha)
1	Food	20388.04	7926	2.572
2	Energy	952.02	7926	0.120
3	Waste waterDisposal	25.17	7926	0.003
4	Waste generation	535.757	7926	0.067
5	Built-up Area	17.682	7926	0.002
	Total	21918.677	7926	2.765

Table 3. Overview of Ecological Footprint with different Universities across the world

Sl. No.	University	Reference Year	Total EF (gha)	Per capita EF (gha/capita)	Major Contributing Factor	Country	Source
1	Bangalore University	2019	21918.677	2.7	Food (93.02%)	India	Self
2	SRM University	2007		3.1	Food (96.77%)	India	Thattai, 2007
3	University of Toronto	2008	8744	1.07	Energy (69.40%)	Canada	Comway *et al.*, 2008
4	KHLeuven University	2014	2663	0.35	Mobility (44.22%)	Belgium	Lamberchets & Van, 2014
5	Ohio State University	2007	6,50,666	8.66	Mobility (72.2 %)	US	Janis, 2002
6	Colorodo University	2002	5603	2.24	Energy (87%)	USA	Wright, 2002
7	University of East Anglia	2009	23,455	7.30	Waste (72.30%)	UK	Wright *et al.*, 2009
8	Willamette University	2011	7804	2.3	Mobility (43%)	USA	Torregrosa-Lopez *et al.*, 2011

population, the footprint of the University was found to be many times smaller than them. It can be evident from the review of literature that, sustainability is much neglected in most of the Indian Higher education institutions. On the other hand, it is notable that the average Indian Ecological footprint was found to be 1.2gha/capita which is less than average per capita of the world (2.8gha/capita). Though the individual footprint is smaller than the per capita footprint of the world, the ecology is severely degraded due to population explosion and developmental activities which is shooting up the total national ecological footprint making it fall under ecologically deficient countries, which is a common scenario in many developing countries. This makes it evident that there is a huge void to be filled concerning sustainable practices in India. With global comparisons for both campus and national Ecological footprint, it can be seen that India occupies an intermediate position being weakly sustainable, which leaves a ray of hope for strengthening the sustainability in the future run.

Conclusions and Recommendation

From Ecological footprint analysis of the campus, it was found that the Ecological footprint of Bangalore University was weakly sustainable. By making use of unused potential, there is still scope for adopting sustainability practices in the University, making it strongly sustainable by reducing the Ecological Footprint of campus equivalent or less than that of average National footprint. There is a huge potential for exploiting solar energy on the campus which can fulfil energy needs. There is no proper sewage management on the campus, which is polluting surface water bodies and alter the aesthetic beauty of the landscape. Hence, the present study recommends the university to establish a sewage treatment plant that can be run through solar energy. The treated water can be reused in the campus for developing biopark and domestic purposes, which inturn reduces the demand for freshwater.

Around 168 tonnes of waste is generated in the campus, out of which around 80% is found to be organic. This can be used for the production of biogas, wherein LPG cylinders usage can be minimized. A significant amount of food is wasted in hostels and canteens daily, the reduction of which can bring down the footprint of waste and energy components. The wastewater which is reaching the check dams are polluting surface water bodies and create waterlogging along its course, in turn facilitating mosquito breeding. Restoration of bio-park becomes essentialto strengthen the biocapacity of the campus and also protection of the forest which is home to numerous flora and fauna having great ecological significance. If all these concerns are looked for and addressed, the campus willturn out to be a more sustainable place. Finally, both 'top-down', as well as 'bottom-up' approaches, are essential for strengthening the Sustainability of the campus.

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