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Environmental Accounting of Educational Institutes during Pre-COVID-19 and COVID-19 in Kangra district of Himachal Pradesh, India

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Abstract: Environmental accounting is one of the most effective methods for assessing environmental management and sustainability. Educational institutes provide a clear image of the footprint of such micro-level organizations. To estimate the environmental accounting, it becomes necessary to assess the biocapacity and ecological footprint. In this paper, the kinds of resources used are listed and estimated with the formula and component-based approach to assessing the sustainability of educational institutes. This research employs a novel approach to communicate the concept of sustainability, demonstrating the influence of communal behaviors on the natural environment. The descriptive method was used to analyze the ecological footprint of six selected educational institutes of the Palampur region of Kangra district (HP) during 2019-2020 (pre-COVID-19) and 2020-2021 (COVID-19 period). With the help of suitable formulae, assessment of components like energy, water, food, solid waste, material, biocapacity is done. Results indicated that the average ecological footprint in all the selected educational institutes during pre-COVID-19 and during COVID-19 was found to be 0.3380 gha and 0.1356 g ha respectively. During pre-COVID-19 and during COVID-19 campuses were found to be sustainable. Further, there's a need to reduce the environmental footprint to the maintenance of the sustainability of the institutes.

Keywords: Ecological footprint, Biocapacity, Ecological deficit or reserve, Sustainability

Humans play a crucial role in the world's ecology. In India with a population of 1.36 billion and still counting, we are gradually depleting our natural resources very quickly without thinking about the next generation's survival. Our natural resources becoming obsolete like groundwater and issues with the food security of the country challenges us, environmental accounting become essential to check our needs and greed. It acts as a management tool that measures the area in global hectares per capita (GHA). A global hectare is equivalent to one hectare of land with global average productivity (Kitzes et al 2007). The ecological footprint calculates the amount of area required to generate and absorb the resources that a population consumes its wastes (Sudarsan et al 2019). It is also a method for communicating the principle of sustainability in educational institutes (Gottlieb et al 2012). The general concept of ecological footprint study is that all energy and material consumption, as well as all waste discharge, need a finite amount of land and water area for resource production and waste absorption over a certain length of time. A study in Iran shows that Sitan and Baluchestan province having high ecological footprint. With increase in urbanization, demand for natural resources enhances and framed policies to implemented to optimize the industrial structure, economic transformation, and ecological restoration of resources, to achieve sustainable use of natural capital and economic growth (Mir et al 2022). Japan's ecological footprint which mainly focused on sustainability management for calculating the subnational ecological footprint used a methodology, which was developed by a global footprint network. It was done in three steps; 1) calculation for national level carbon footprint for production; 2) maintaining multi-regional input-output relation and 3) scaling down EF to prefecture level with household level. The total Ecological Footprint per capita was highest in Tokyo i.e., 5.24 g ha. (Tsuchiya et al 2021). Ecological accounting done in Czech Republic and they conducted a survey and found that humanity's ecological footprint (20.6 billion g ha) was greater than bio-capacity (12.2 billion g ha), indicating that human consumption has outpaced the planet's regenerative and assimilative ability. This means that there is a worldwide environmental.

MATERIAL AND METHODS

The environmental accounting of selected six educational institutes of Palampur region in Kangra district was taken to examine their absorption pattern in the campus during the period of 2019-2020 (before COVID-19). The components considered for examining the ecological footprint were

energy, water, food, solid waste, and material (paper usage). The necessary data required to calculate the EF values were collected with the help of a survey. The institute's administration staff provided data on annual electric power, water, material consumption, and office paper use. A survey was carried out among students and staff to estimate paper consumption, water use, food and material and waste generated

Energy analysis: The energy used in selected educational institutes was estimated by the formula given by Gottlieb et al (2012).

E= 1/KJ × 1G÷ 20 Kj

One plant has a coal yield of 31.4%. Coal required to generate electricity EC = E÷ 0.314

Since 85% of coal is carbon. Therefore, plant coal yield (Ey in ton)

Ey = Ec × 0.85÷100000

1 ha of land can absorb 1.8 ton of carbon

EF (power) = Ey÷1.8 = EF (g ha)

Water footprint: Water footprint was estimated by the formula given by Habibi et al (2015)

Water footprint (gha m^{-3} yr^{-1}) = Total consumption (gha m^{-3} yr^{-1}) × land area (ha) × 1000000

Food footprint: This methodology was given by Habibi et al (2015)

Food requirement (ton) = (total population of the institutes × total consumption per capita) 1000 kg

Land (ha) required for the production of 1 ton crop = arable land total agriculture crops grown

Ecological footprint of food (g ha) = food requirement × land for the production of 1 ton crops

The data on arable lands and their crops in the agricultural year 2019-2020 was obtained from District Agriculture Plan, Kangra, Himachal Pradesh Volume-IV to calculate land used to produce one ton of crops.

Material footprint: The formula for material analysis was given by Gottlieb et al. (2012)

Material footprint (gha $year^{-1}$) = items $year^{-1}$ (kg) × EF per item (g ha kg^{-1})

Biocapacity is productive hectares of an area

Solid waste footprint: The formula to estimate solid waste EF was given by Habibi et al (2015)

Solid waste EF (gha) = (SW × 8×10000) ÷ 450

where SW = Solid waste generated (kg)

Ecological deficit or reserve: The formula to determine ecological deficit or reserve was given by Monfreda et al (2004)

Ecological deficit or reserve (g ha) = biocapcity (g ha) – ecological footprint (g ha)

Per capita ecological footprint

EF per capita (g ha) = Ecological footprint (EF) Total population of the institutes

Due to the high rate of consumption and modern infrastructure that adversely affect the sustainability of that area, the average ecological footprint was maximum in St. Paul's school of Kangra district of Himachal Pradesh (Table 1). Energy EF was maximum in A.B.M. school (7.277 g ha) as compared to other institutes and least was in Dr. G.C. Negi College. Water EF was maximum in KLB DAV (Girl) College (0.05000 g ha) and minimum was in A.B.M school (0.00010 g ha). Food EF was maximum in SCVB Govt. Degree College (359.0000 g ha) and least was in GSSS (Girl's) (2.0365 g ha). Packaged food consumption, especially dairy products lead to an increase in the ecological footprint of that area. Japan's ecological footprint was assessed, and policy was formulated to check food consumption. (Tsuchiya et al 2021). Material EF was most in SCVB Govt. Degree College (440.22gha) and least in GSSS (Girl's) (100.00 g ha). Solid waste EF was most in Dr. G.C. Negi College (7.0440 g ha) and least was in A.B.M school (0.0025 g ha). The SCVB Govt. Degree College and Dr. G.C. Negi College were close enough in their average ecological footprint. The least ecological footprint was found to be in GSSS (girls). The lifestyle is followed and components management is done ethically and proper regulations are invested to treat their wastage which gradually decreases the ecological footprint. The ecological footprint of five components in selected educational institutes during COVID-19 is presented in Table 2.

Due to the complete and partial lockdown during the various months of the academic year 2020-2021, the

Table 1. Educational institute-wise ecological footprint (g ha) during pre-COVID-19

Educational institutes	Energy EF	Water EF	Food EF	Material EF	Solid waste EF
GSSS (Girls)	1.754	0.00025	2.0365	100.00	0.0032
A.B.M School	7.277	0.00010	120.0000	260.40	0.0025
St. Paul's School	1.461	0.00050	150.0000	440.20	0.0128
SCVB Govt. Degree College	1.266	0.00080	359.0000	440.22	0.0512
Dr. G.C. Negi College	1.041	0.01200	110.2690	296.06	7.0440
KLB DAV (Girls) College	4.590	0.05000	167.2500	140.00	1.0200

consumption rate of various components on the campus decreased which ultimately lower the ecological footprint as compared to other academic years. As compared to other educational institutes the energy EF was maximum in KLB DAV (Girl's) College (0.0020 g ha) and GSSS (Girl's), A.B.M school and St. Paul's School with EF 0.0001gha. Sudarsan et al (2019) also found results along the same lines, per capita EF (0.00500 g ha) of energy in educational institutes of South India. Water EF was maximum in Dr. G.C. Negi College (0.011000 g ha) and least in GSSS (girls) 0.000004 g ha. Food EF was maximum in Dr. G.C. Negi College (1.0270 g ha) and least in A.B.M school (0.0100 g ha). KLB DAV (Girl's) College with maximum EF 2.89000 g ha and least in GSSS (Girl's) (0.00211 g ha). Solid waste EF maximum in St. Paul's School (0.21400 g ha) and least in KLB DAV (Girl's) College (0.00010 g ha).

The average ecological footprint during pre-COVID-19 was higher than during COVID-19 (Table 3). Due to lesser usage of material (paper), packaged food items, electricity usage, and water consumption during COVID-19, decreased the EF. Shifting to online mode leads to lesser usage of paper. Food manufacturing in canteens and mid-day meal food (in Govt. institutions) leads to a decreased food EF. Water requirements and solid waste generation ultimately decreased.

The average ecological footprint per capita during pre-COVID-19 and during COVID-19 was 0.33805gha and 0.135600 gha respectively (Table 4). Components like food and material have high EF per capita during pre-COVID-19 as compared to other components. The results are found same as in Habibi et al. (2015). Water and energy contribute the least to EF per capita. During the COVID-19 period, material and solid waste have high EF per capita, and energy and water contribute the least.

Ecological deficit or reserve (gha) and biocapacity (gha) during the pre-COVID-19 period: To calculate the ecological deficit or reserve, biocapacity (BC) in hectares was converted into global hectares as prescribed by Lin et al (2018). The difference between biocapacity per capita (gha) and ecological footprint per capita (gha) is ecological deficit if -ve or reserve if +ve. The average EF per capita was found to be 0.33805 g ha. The highest biocapacity per capita was 2.9gha in the case of Dr. G.C. Negi College followed by GSSS (Girl's) (2.55 g ha) and lowest (0.131 g ha) was in SCVB Govt. Degree College. The per capita EF in each institute was lesser than the biocapacity of the respective institute which shows that every institute has an ecological reserve. The highest ecological reserve (2.692 g ha) was in Dr. G.C. Negi College followed by Dr. G.C. Negi College and the least (0.084 g ha) was in SCVB Govt. Degree College (Fig. 1).

Ecological deficit or reserve (gha) and biocapacity (gha) during the COVID-19 period: During COVID-19, the average EF per capita was 0.135600 g ha, which was quite lower than during the pre-COVID-19 period. EF per capita

Table 3. Educational institutes wise average ecological footprint (g ha) during pre and COVID-19

Educational institutes	Pre- COVID-19	COVID-19
GSSS (Girls)	20.757	0.001
A.B.M School	77.535	0.027
St. Paul's School	118.334	0.247
SCVB Govt. Degree College	88.390	0.257
Dr. G.C. Negi College	82.885	0.407
KLB DAV (Girl's) College	62.580	0.603

Table 4. Component-wise per capita ecological footprint (g ha) during the pre-COVID-19 and COVID-19 period

Components	Per capita EF	
	Pre-COVID-19	COVID-19
Energy	0.15110	0.000037
Water	0.00009	0.002733
Food	0.81280	0.021400
Material	0.56000	0.451300
Solid waste	0.16630	0.202700
Average EF	0.33805	0.135600

Table 2. Educational institutes wise ecological footprint (g ha) during pre-COVID-19

Educational institutes	Energy EF	Water EF	Food EF	Material EF	Solid waste EF
GSSS (Girls)	0.0001	0.000004	0.0511	0.00211	0.00103
A.B.M school	0.0001	0.006400	0.0100	2.00500	0.00011
St. Paul's School	0.0001	0.000200	1.0200	0.00200	0.21400
SCVB Govt. Degree College	0.0002	0.000500	0.0220	1.25000	0.01250
Dr. G.C. Negi College	0.0010	0.011000	1.0270	1.25000	0.00700
KLB DAV (Girls) College	0.0020	0.000400	0.1270	2.89000	0.00010

was very much lower than that of biocapacity which gives a positive sign of a sustainable environment. Consumption patterns during COVID-19 should be followed to retain a balanced environment. The educational institute with a maximum (2.9 g ha) BC per capita was Dr. G.C. Negi College and the minimum (0.131 g ha) BC per capita was in SCVB Govt. Degree College (Fig. 2). The EF per capita ranged from 0.0015 to 0.0646 g ha. The maximum (0.0646gha) EF per capita was in SCVB Govt. Degree College and the minimum in GSSS (Girl's) (0.0015 g ha).

Sustainability of educational institutes: Agenda 21 of UNCED, 1992 was adopted to act globally, nationally and locally in areas where the environment can be affected by humans. To meet SDGs 12, 15 and 16 the present study was conducted. To assess the sustainability of educational institutes a questionnaire-based survey was conducted among the students and school staff (teaching and non-teaching staff). The selected institutes were less sustainable during the pre-COVID-19 period and more sustainable during COVID-19. During pre-COVID-19, the more frequent use of private vehicles and paper usage was high in offices and by students leading to high usage and more ecological footprints. The packed food and dairy products consumption were quite high, more food was prepared in canteens and mid-day meals with improper disposal of waste resulting in more footprints. During COVID-19, due to the complete and partial lockdown during the year 2020-2021, office work was conducted through online mode, decreased paper usage, and private vehicle movement was restricted, lowering the ecological footprint of the campuses and making it more sustainable. Now knowing these scenarios there's a need to make students more aware of healthy consumption habits to further reduce or maintain sustainability. In the current scenario, the concept of EF was incorporated in the high schools and made them familiar with the footprint calculators to calculate their own footprint on daily basis to change their attitude towards resources and make daily smart decisions to live sustainably. This requires students to think critically and have systematic thinking skills to unfold the complexity and implications of sustainability.

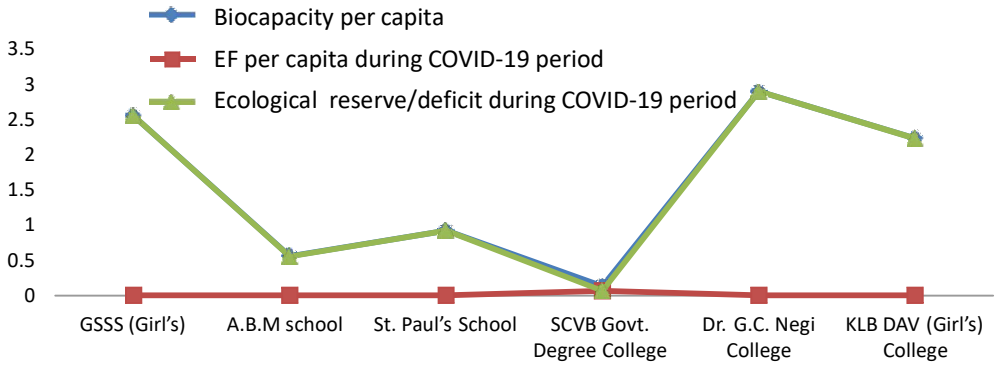

Fig. 2. Variation in ecological deficit or reserve (g ha) and biocapacity (g ha) during the COVID-19 period

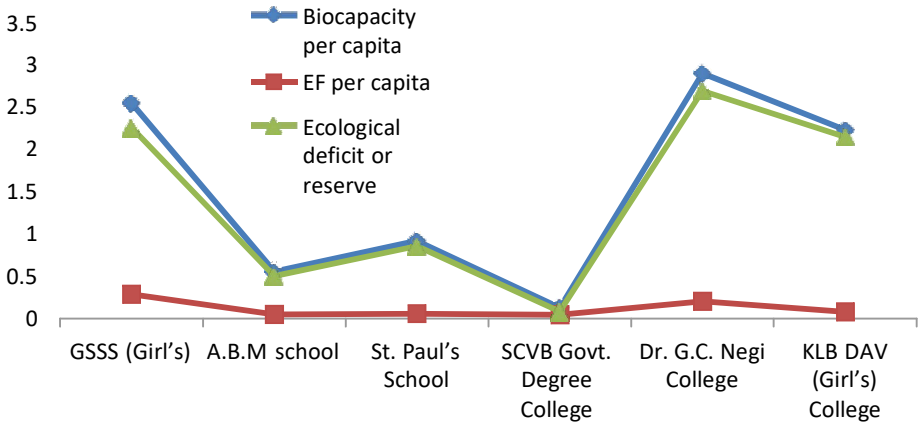

Fig 1. Variation in ecological deficit or reserve and biocapacity during the pre-COVID- 19 period (g ha)

CONCLUSION

The main motive behind the environmental accounting of educational institutes is to assess the current usage of natural resources and the sustainability of the institutes. The average ecological footprint per capita during pre-COVID-19 was higher than during COVID-19. The EF and food EF were the major contributors to the ecological footprint. The biocapacity per capita was 0.258 ha. The biocapacity per capita was higher than the EF per capita during the pre-COVID-19 and during the COVID-19 period. The selected educational institutes were in ecological reserves during the pre-COVID-19 and COVID-19 periods. Keeping in view of consumption of natural resources presently, the institutes are likely to become unsustainable. The awareness regarding the use of electric vehicles or pooling the vehicle for transportation and reducing waste & its management should be made to reduce the ecological footprint to meet SDGs 12, 15, and 16.

REFERENCES

Gottlieb D, Kissinger M, Vigoda-Gadot E and Haim A 2012. Analyzing the ecological footprint at the institutional scale: The case of an Israeli high-school. *Ecological Indicators* **18**: 91-97.

Habibi K, Rahimi A, Shahmoradi B and Abdi H 2015. Analysis of ecological footprint at educational institute scale: A case of an Iranian high school. *Advances in Research* **4**: 114-121.

Kitzes J, Peller A, Goldfinger S and Wackernagel M 2007. Current methods for calculating national ecological footprint accounts. *Science for Environment and Sustainable Society* **4**: 1-9.

Lin D, Hanscom L, Murthy A, Galli A, Evans M, Neill E, Mancini MS, Martindill J, Medouar F, Huang S and Wackernagel M 2018. Ecological Footprint Accounting for Countries: Updates and Results of the National Footprint Accounts, 2012–2018. *Resources* **7**: 1-22.

Mir A, Sobhani P and Sayahnia R 2022. Assessment of ecological footprint associated with consumption resources and urbanization development in Sistan and Baluchestan province, Iran. *Results in Engineering* **16**: 1-6.

Monfreda C, Wackernagel M and Deumling D 2004. Establishing national natural capital accounts based on detailed ecological footprint and biological capacity accounts. *Land Use Policy* **21**: 231-246.

Sudarsan JS, Srihari V, Jaisal D and Jyesta W 2019. Environmental footprint assessment of educational campus in south India from a food-water-energy nexus perspective. *International Journal of Recent Technology and Engineering* **8**: 118-122.

Tsuchiya K, Iha K, Murthy A, Lin D, Altiok S, Rupprecht CDD, Hisako K and McGreevy SR 2021. Decentralization & local food: Japan's regional ecological footprints indicate localized sustainability strategies. *Journal of Cleaner Production* **292**: 1-13.

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