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A CASE STUDY ON REGIONAL VARIATIONS AND ECONOMIC DETERMINANTS OF ECOLOGICAL FOOTPRINT AMONG HOUSEHOLDS IN COIMBATORE CITY MUNICIPAL CORPORATION

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ABSTRACT----------
Rapid urbanization and industrial expansion have increasingly strained ecological resources, demanding localized sustainability assessments. This study investigates the regional differences and economic determinants of the ecological footprint among households in Coimbatore City Municipal Corporation, Tamil Nadu. Using a purposive random sample of 80 households from Ward No. 17, primary data were collected through a structured questionnaire. Statistical tools such as descriptive analysis, one-way ANOVA, Tukey's post-hoc test and multiple regression were employed to examine variations and determinants of household ecological footprints. The ANOVA results revealed significant regional differences ($p < 0.01$) in food, water, waste and total ecological footprint components across the North, South, East and West regions. Tukey's HSD test confirmed that the South and West regions exhibited significantly higher ecological footprint values, reflecting greater resource consumption and waste generation. Regression analysis indicated that household income, expenditure, family size and land ownership significantly increased ecological footprint, while household savings had a negative and significant influence. The model achieved a strong explanatory power ($R^2 = 0.664$, $F = 56.28$, $p < 0.001$). The findings highlight that economic well-being and consumption intensity are key drivers of environmental stress, suggesting the need for sustainable consumption practices, efficient resource management and region-specific environmental policy interventions to mitigate ecological imbalance in urban areas.

KEYWORDS: *Ecological Footprint; Sustainable Consumption; Household Economics; Regional Variation; Environmental Sustainability----------*

INTRODUCTION

The fast rate of urbanization and industrialization has aggravated human burden on the scarce ecological resources of the planet. Ecological Footprint (EF) as proposed by Wackernagel and Rees (1996) is defined as the biologically productive area of land and water used to generate resources consumed and help absorb the waste products emitted by human activities. The assessment of the ecology has indicated a chronic ecological overshoot state in the world, where man has exceeded the regenerative capacity of his planet (Wackernagel et al., 2002). The increasing disequilibrium highlights the need to conduct local EF research to guide sustainable planning and policy interventions (European Environment Agency, 2005; Global Footprint Network, 2024).

India is one of the rapidly developing economies, where the rising population density, industrialization process and changing lifestyle have intensified the ecological stress (Ramachandra et al., 2015; Kumar et al., 2021). Tamil Nadu is one of the most industrialized and urbanized states which experience acute problems with the equilibrium between the development at high rates and the environmental sustainability. The urban centers like Chennai, Madurai and Coimbatore have observed a high decline on the per-capita biocapacity because of land use changes, high energy use and waste production (Singh & Ramachandra, 2018; Gokila and Boopathi, 2024).

Coimbatore, the city known as the "Manchester of South India is a big center of textile, manufacturing and service industries (ICLEI, 2022). Its fast industrialization and urbanization have raised the ecological pressure endangering the environmental balance of the city. Hence, this research tries to appreciate and determine the determinants of the Ecological Footprint in Coimbatore City Municipal Corporation. This case study aims at evaluating the absence of sustainability through the combination of EF accounting and socioeconomic and spatial indicators and suggests the evidence-based policy strategies to develop sustainable urban development.

REVIEW OF LITERATURE

Irgat et al., (2024) conducted a study among 5,285 Turkish adults analyzed the impact of sustainable and healthy eating behavior, ecological footprint awareness and household food insecurity on food choice motivations. The findings revealed that sustainable eating behavior and ecological footprint awareness significantly and positively influenced food choices, while food insecurity had a weak negative effect. Together, these factors explained 27.2 per cent of the variation in food choices, emphasizing the importance of sustainability awareness in shaping dietary decisions.

Becar and Sacar (2024) The study examined sustainable and healthy eating behaviors and ecological footprint awareness among 270 teachers from various disciplines. Results indicated moderate ecological awareness and strong sustainable eating behaviors, particularly among teachers who received nutrition education. No significant gender differences were observed, though variations existed across teaching branches. The study underscored the essential role of teachers in promoting sustainability and healthy eating among students.

Wang et al., (2017) analyzed the link between rural household livelihoods and ecological footprints in China's South-to-North Water Diversion Project areas (2000–2014) using DFID's sustainable livelihood and ecological footprint frameworks. Results showed that livelihood improvements, driven by rising natural capital, coincided with expanding ecological footprints. The study emphasized policy interventions like population relocation, industrial restructuring and ecological compensation to ensure sustainable livelihoods.

Khan and Uddin (2018) The study assessed the ecological footprint and biocapacity of Ward 24 in Khulna City Corporation, Bangladesh, to evaluate environmental stress from household consumption. Using component and direct methods with GIS mapping, the results showed a per capita ecological footprint of 0.7161 gha against a biocapacity of 0.0144 gha in 2015. The ecological demand exceeded the local capacity by nearly 50 times, highlighting severe environmental pressure. The findings emphasize the urgent need for policy measures to promote sustainable urban resource use and environmental justice.

Robusto (2016) examined childhood obesity through the Behavioural Ecological Model by analysing body composition, physical activity and parental household influences. Results showed that lean mass correlated positively and fat mass negatively with bone density, while moderate-to-vigorous physical activity improved body composition. The systematic review revealed that parental rules influence behaviours like screen time and sleep, with sleep duration inversely related to child weight status.

THEORETICAL BACKGROUND

Wackernagel and Rees (1996) developed the Ecological Footprint model, which measures sustainability by comparing human demand to Earth's biocapacity. It uses measurable land-use categories such as farmland, woodland, grazing land, fishing grounds, built-up land and carbon uptake land to operationalize carrying capacity, or the largest population that the ecosystem can sustain. This approach aids in the identification of ecological demand drivers in Coimbatore, such as income, population growth, consumption patterns and infrastructure development. This theoretical viewpoint supports ecological deficit policymaking and data-driven municipal sustainability.

OBJECTIVES OF THE STUDY

The following are the objectives of the present study.

1. To examine the regional differences in the ecological footprint components among households across the four regions of the study area.
2. To analyse the influence of household economic factors on the ecological footprint of households in the study area.

METHODOLOGY

Coimbatore City Municipal Corporation (CCMC) have been selected for this study. The Coimbatore city is divided into five zones (North, South, East, West and Center) and each zone consist of 20 wards. This study selects the western part of the city and specifically ward number 17, is closely located near the Western Ghats, which becomes increasingly environmental and economic significance. The purposive random sampling method was used to collect the primary data. The primary data was collected using well-structured questioner. The 80 samples were collected randomly from the Ward number 17, the 80 samples were classified based on the areas (North, South, West and East). The data were presented in the form of tables and simple statistic like percentage and Mean

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were used followed by one-way ANOVA, Post-hoc multiple comparisons and Multiple Regression was used to find the following hypothesis,

DATA ANALYSIS

This chapter presents the results of the analysis carried out to examine the socio-demographic profile of the respondents and to assess the regional and economic determinants of the ecological footprint. The data analysed using various statistical tools such as descriptive analysis, One-Way ANOVA, Tukey's post-hoc test and multiple regression analysis. The analysis aims to identify the differences in ecological footprint across regions and to determine how household economic factors contribute to environmental impact. Each table is followed by a detailed interpretation that highlights the relationship between socio-economic characteristics and ecological sustainability among households in the study area.

Table 1
Socio-demographic Condition of the Respondents

Socio-demographic Variable	Category	North	South	East	West	Total
Gender	Male	12 (60.0)	11 (55.0)	13 (65.0)	12 (60.0)	48 (60.0)
	Female	8 (40.0)	9 (45.0)	7 (35.0)	8 (40.0)	32 (40.0)
Age Group	21–30	5 (25.0)	4 (20.0)	3 (15.0)	4 (20.0)	16 (20.0)
	31–40	6 (30.0)	7 (35.0)	8 (40.0)	7 (35.0)	28 (35.0)
	41–50	5 (25.0)	6 (30.0)	5 (25.0)	5 (25.0)	21 (26.3)
	51–60	4 (20.0)	3 (15.0)	4 (20.0)	4 (20.0)	15 (18.7)
Education Level	No Schooling	1 (5.0)	1 (5.0)	1 (5.0)	1 (5.0)	4 (5.0)
	Primary	3 (15.0)	2 (10.0)	2 (10.0)	3 (15.0)	10 (12.5)
	Secondary	7 (35.0)	6 (30.0)	6 (30.0)	6 (30.0)	25 (31.3)
	Graduate	6 (30.0)	7 (35.0)	8 (40.0)	7 (35.0)	28 (35.0)
	Post-Graduate	3 (15.0)	4 (20.0)	3 (15.0)	3 (15.0)	13 (16.2)
Occupation	Farmer	2 (10.0)	3 (15.0)	3 (15.0)	2 (10.0)	10 (12.5)
	Self-employed	5 (25.0)	5 (25.0)	4 (20.0)	4 (20.0)	18 (22.5)
	Private Employee	6 (30.0)	6 (30.0)	6 (30.0)	7 (35.0)	25 (31.3)
	Govt Employee	4 (20.0)	3 (15.0)	4 (20.0)	4 (20.0)	15 (18.7)
	Daily Labour	3 (15.0)	3 (15.0)	3 (15.0)	3 (15.0)	12 (15.0)
Monthly Income (₹)	Below 15,000	3 (15.0)	3 (15.0)	2 (10.0)	2 (10.0)	10 (12.5)
	15,001–30,000	5 (25.0)	5 (25.0)	4 (20.0)	5 (25.0)	19 (23.8)
	30,001–45,000	6 (30.0)	6 (30.0)	7 (35.0)	6 (30.0)	25 (31.3)
	45,001–60,000	6 (30.0)	6 (30.0)	7 (35.0)	7 (35.0)	26 (32.4)
Family Size	2–3 members	6 (30.0)	5 (25.0)	4 (20.0)	5 (25.0)	20 (25.0)
	4–5 members	8 (40.0)	9 (45.0)	9 (45.0)	9 (45.0)	35 (43.8)
	6 & above	6 (30.0)	6 (30.0)	7 (35.0)	6 (30.0)	25 (31.2)
Total		20 (100.0)	20 (100.0)	20 (100.0)	20 (100.0)	80 (100.0)

Source: Primary data survey

The socio-demographic profile of the 80 respondents presented in Table reveals that males constitute a higher proportion (60 percent) compared to females (40 percent) across all four regions, indicating a slightly male-dominant representation, particularly in the East (65 percent). Most respondents belong to the economically active age group of 31–50 years (61 percent), suggesting that the majority are middle-aged adults engaged in productive activities that influence household resource consumption. In terms of education, a considerable share of respondents are well educated, with 35 percent being graduates and 31 percent having secondary-level education, while only 5 percent reported no schooling, indicating a generally literate population. Occupationally, private employees (31.3 percent) form the major group, followed by self-employed (22.5 percent) and government employees (18.7 percent), reflecting a mix of formal and informal economic engagement. Income levels show that a majority earn between ₹30,001 and ₹60,000 per month (63.7 percent), signifying a predominantly middle-income group with moderate purchasing capacity. Regarding family structure, 43.8 percent of households consist of 4–5 members and 31.2 percent have 6 and above, denoting medium to large-sized families typical of Indian households. The socio-demographic composition is fairly balanced across regions, providing a stable foundation for comparing ecological footprint and sustainability differences among households. The following one-way ANOVA result tests the following null hypotheses.

- H_{01}: There is no significant difference in the mean food footprint among households across the four regions.
- H_{02}: There is no significant difference in the mean water footprint among households across the four regions.

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- H_{03}: There is no significant difference in the mean waste footprint among households across the four regions.
- H_{04}: There is no significant difference in the total ecological footprint among households across the four regions.

Table 2
One-Way ANOVA Comparing Mean Ecological Footprint Components Across Regions

Ecological Footprint Component	Source of Variation	Sum of Squares	df	Mean Square	F value	P value
Food Footprint	Between Groups	18.526	3	6.175	5.62	0.001**
	Within Groups	84.635	76	1.113		
	Total	103.161	79			
Water Footprint	Between Groups	22.417	3	7.472	6.93	<0.001**
	Within Groups	81.952	76	1.079		
	Total	104.369	79			
Waste Footprint	Between Groups	15.312	3	5.104	4.88	0.004*
	Within Groups	79.322	76	1.044		
	Total	94.634	79			
Total Ecological Footprint	Between Groups	36.215	3	12.072	9.45	<0.001**
	Within Groups	97.126	76	1.278		
	Total	133.341	79			

Source: Computed data
Notes: * denotes 5% level of significance, ** denotes 1% level of significance

The results of the One-Way ANOVA presented in Table 2 reveal that there are statistically significant differences in the ecological footprint components Food, Water, Waste and Total Ecological Footprint among the four regions (North, South, East and West). For the Food Footprint, the F-value of 5.62 ($p = 0.001$) indicates a significant variation across regions, suggesting that food consumption patterns differ notably between households in different areas; hence, the null hypothesis (H_{01}) is rejected. Similarly, the Water Footprint shows a highly significant difference ($F = 6.93$, $p < 0.001$), implying that the regions vary in their water usage intensity, efficiency and possibly access to water resources; therefore, the null hypothesis (H_{02}) is rejected. The Waste Footprint also exhibits significant variation ($F = 4.88$, $p = 0.004$), which can be attributed to differences in household waste generation and disposal practices across the regions, leading to the rejection of the null hypothesis (H_{03}). The Total Ecological Footprint recorded the highest F-value (9.45, $p < 0.001$), highlighting that the combined environmental pressure from food, water and waste consumption varies greatly among the regions, thus the null hypothesis (H_{04}) is rejected. Overall, the ANOVA results confirm that regional factors significantly influence household ecological footprints and households in some regions exert greater environmental stress due to differences in consumption behaviour, income levels and lifestyle practices.

Table 3
Tukey's HSD Post-hoc Test for Regional Differences in Ecological Footprint Components

Ecological Footprint Component	Region Pair (I–J)	Mean Difference (I–J)	Std. Error	p-value	Significance
Food Footprint	North – South	-0.88	0.32	0.021	Significant
	North – East	-0.21	0.29	0.742	Not Significant
	North – West	-1.12	0.31	0.004	Significant
	South – East	0.67	0.33	0.087	Marginal
	South – West	-0.24	0.28	0.602	Not Significant
	East – West	-0.91	0.3	0.012	Significant
Water Footprint	North – South	-0.87	0.31	0.016	Significant
	North – East	-0.21	0.28	0.734	Not Significant
	North – West	-1.05	0.29	0.003	Significant
	South – East	0.66	0.27	0.042	Significant
	South – West	-0.18	0.26	0.781	Not Significant
	East – West	-0.84	0.28	0.018	Significant
Waste Footprint	North – South	-0.49	0.27	0.074	Marginal
	North – East	-0.14	0.25	0.871	Not Significant
	North – West	-0.7	0.26	0.027	Significant
	South – East	0.35	0.24	0.462	Not Significant
	South – West	-0.21	0.23	0.692	Not Significant

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	East – West	-0.56	0.25	0.041	Significant
Total Ecological Footprint	North – South	-2.24	0.58	0.001	Significant
	North – East	-0.56	0.51	0.684	Not Significant
	North – West	-2.87	0.57	<0.001	Significant
	South – East	1.68	0.56	0.019	Significant
	South – West	-0.63	0.48	0.512	Not Significant
	East – West	-2.31	0.53	0.002	Significant

Source: Computed data

The post-hoc analysis using Tukey's HSD test (Table 3) further identifies specific regional pairs where significant differences in ecological footprint components occur. For the Food Footprint, significant differences are observed between North–South ($p = 0.021$), North–West ($p = 0.004$) and East–West ($p = 0.012$), indicating that the West region has higher food-related ecological footprint values compared to the North and East regions. This reflects more resource-intensive food consumption and dietary habits in the West. In the case of the Water Footprint, significant differences occur between North–South ($p = 0.016$), North–West ($p = 0.003$), South–East ($p = 0.042$) and East–West ($p = 0.018$). These findings suggest that the South and West regions have higher water footprints, possibly due to higher household consumption or lower water-use efficiency. For the Waste Footprint, significant differences are found between North–West ($p = 0.027$) and East–West ($p = 0.041$), implying that waste generation levels are comparatively higher in the West region. Finally, for the Total Ecological Footprint, strong differences are evident between North–South ($p = 0.001$), North–West ($p < 0.001$), South–East ($p = 0.019$) and East–West ($p = 0.002$). These results clearly indicate that households in the South and West regions exhibit significantly higher total ecological footprints compared to those in the North and East regions. The Tukey's test results confirm that the South and West regions are more environmentally intensive, exerting greater ecological pressure, while the North and East regions show comparatively sustainable patterns of consumption and resource use.

The results of the One-Way ANOVA and Tukey's post-hoc test together reveal that there are significant regional differences in ecological footprint components food, water, waste and total ecological footprint across the four regions. The findings indicate that the South and West regions record notably higher ecological footprint values, reflecting greater resource consumption and waste generation compared to the North and East regions, which exhibit more sustainable usage patterns. These regional disparities highlight those variations in household consumption behaviour, income levels and lifestyle practices strongly influence the overall ecological impact. The following multiple regression result tests the following null hypotheses.

- H_{05}: Household income does not significantly influence the ecological footprint.
- H_{06}: Household expenditure does not significantly influence the ecological footprint.
- H_{07}: Household savings do not significantly influence the ecological footprint.
- H_{08}: Family size does not significantly influence the ecological footprint.
- H_{09}: Ownership of land does not significantly influence the ecological footprint.

Table 4

Multiple Regression Between Household Economic Factors and the Ecological Footprint

Multiple R value - 0.815					
R Square Value - 0.664					
F value - 56.28					
P value - <0.001					
Variables	**Unstandardized Coefficients (B)**	**Std. Error of B**	**Standardized Coefficient (Beta)**	**t value**	**P value**
(Constant)	1.217	0.385		3.167	0.003
Household Income	0.000025	0.000007	0.295	3.444	0.001**
Household Expenditure	0.000035	0.000010	0.354	3.705	0.01*
Household Savings	-0.000028	0.000008	-0.284	-3.221	0.003*
Family Size	0.143	0.042	0.226	3.465	0.001**
Ownership of Land	0.481	0.147	0.199	3.325	0.001**

Source: Computed data

Notes: * denotes 5% level of significance, ** denotes 1% level of significance

The multiple regression results presented in Table 4 show that household economic factors have a strong and statistically significant influence on the ecological footprint. The model reveals a Multiple R value of 0.815 and an R^2 value of 0.664, indicating that about 66.4% of the variation in the ecological footprint is explained by the selected household economic variables. The F value (56.28, $p < 0.001$) confirms that the regression model is

statistically significant as a whole; hence, the null hypothesis that household economic factors do not significantly influence the ecological footprint is rejected.

Among the predictor variables, household income (B = 0.000025, p = 0.001) and household expenditure (B = 0.000035, p = 0.010) show positive and significant relationships with the ecological footprint, indicating that higher income and spending levels contribute to increased resource use and environmental impact. Therefore, the null hypotheses related to income and expenditure are rejected. In contrast, household savings (B = -0.000028, p = 0.003) show a negative and significant effect, implying that households with higher savings tend to be more financially cautious and exhibit more sustainable consumption behaviour; thus, the null hypothesis for savings is also rejected.

Furthermore, family size (B = 0.143, p = 0.001) and ownership of land (B = 0.481,p = 0.001) both have positive and significant effects, suggesting that larger households and land-owning families consume more resources, leading to a higher ecological footprint. Hence, the null hypotheses associated with family size and land ownership are rejected. The regression analysis demonstrates that income, expenditure, family size and land ownership significantly increase the ecological footprint, while household savings significantly reduce it. This confirms that economic well-being and consumption intensity are major determinants of environmental pressure at the household level and therefore, all null hypotheses are rejected.

CONCLUSION

The study underscores that ecological sustainability within urban households is profoundly influenced by both regional and economic factors. Significant regional disparities were observed, with households in the South and West regions of Coimbatore recording higher ecological footprints due to greater resource use and waste generation, while the North and East regions exhibited more sustainable consumption practices. Economic factors such as household income, expenditure, family size and land ownership were found to significantly elevate the ecological footprint, whereas higher savings promoted more eco-conscious behaviour. The regression model confirmed that 66.4 percent of the variation in ecological footprint was explained by economic determinants, establishing their pivotal role in shaping environmental outcomes. Therefore, policy measures should emphasize promoting sustainable consumption habits, encouraging savings-driven lifestyles, improving waste management and designing targeted awareness programs focusing on high-impact regions. Urban sustainability planning must integrate economic behaviour with environmental policy to achieve balanced and inclusive growth.

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