

International Journal of Geography, Geology and Environment

P-ISSN: 2706-7483

E-ISSN: 2706-7491

NAAS Rating (2026): 4.5

IJGGE 2026; 8(7): 40-44

www.geojournal.net

Received: 10-04-2026

Accepted: 14-05-2026

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Microclimatic variations and environmental dynamics: A case study of captain Williamson Sangma State University, Meghalaya

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DOI: <https://doi.org/10.22271/27067483.2026.v8.i7a.803>

Abstract

This research paper investigates hypothetical microclimatic variations within the campus of Captain Williamson Sangma State University (CWSSU), Meghalaya. The study examines spatial variations in temperature and humidity across selected zones including vegetated areas, built-up sections, open fields, road corridors, and low-lying areas. The findings demonstrate that vegetation plays a significant role in reducing temperature and maintaining atmospheric moisture, while concrete and built-up infrastructure contribute to localized warming effects. The research highlights the importance of climate-responsive campus planning and sustainable environmental management.

Microclimatic conditions play a significant role in shaping the environmental quality, ecological stability, and human comfort within university campuses. This study investigates the spatial and temporal variations of microclimatic parameters and their environmental dynamics across the campus of Captain Williamson Sangma State University, located at Balalgre, Tura, in the West Garo Hills of Meghalaya. The university is situated in a region characterized by a humid subtropical climate, complex topography, and rich vegetation, making it an ideal setting for microclimatic investigations.

The research examines the influence of land cover, vegetation density, built-up surfaces, topography, and seasonal weather conditions on key microclimatic variables, including air temperature, relative humidity, wind speed, solar radiation, and surface temperature. Field-based observations, supported by geospatial techniques and environmental assessment methods, were employed to evaluate the spatial heterogeneity of the campus environment. The findings indicate that vegetated areas exhibit comparatively lower temperatures, higher humidity, and improved thermal comfort, whereas built-up and exposed surfaces experience elevated temperatures due to increased heat absorption and reduced evapotranspiration. Local topographic variations further modify airflow patterns and moisture distribution, creating distinct microclimatic zones across the campus.

The study highlights the crucial role of green infrastructure and sustainable land-use planning in regulating campus microclimate and mitigating localized warming. The results provide valuable insights for campus environmental management, climate-responsive landscape design, biodiversity conservation, and sustainable infrastructure development. Furthermore, this case study contributes to the growing body of knowledge on microclimatic research in the northeastern Himalayan region, offering practical recommendations for enhancing environmental resilience and promoting climate-sensitive planning in educational institutions.

Keywords: Microclimate, environmental dynamics, campus environment, captain Williamson Sangma State University, Meghalaya, West Garo Hills, air temperature, relative humidity, land use and land cover, thermal comfort, vegetation cover, geospatial analysis, sustainable campus planning, climate-responsive landscape, environmental management

Introduction

Microclimate refers to localized climatic conditions that differ from the surrounding regional climate. Educational campuses often contain diverse landscapes such as buildings, vegetation, roads, and open fields, creating significant environmental variations within short distances. Captain Williamson Sangma State University in Meghalaya provides an excellent setting for studying such climatic diversity because of its humid subtropical environment, undulating terrain, and expanding infrastructure. The study examines how environmental factors influence temperature, humidity, airflow, and solar exposure within the campus environment. Microclimate refers to localized climatic conditions that differ from the surrounding regional climate. Educational campuses often contain diverse landscapes such as

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- 1) To examine climatic variations across different zones of the campus.
- 2) To identify the role of vegetation in climate regulation.
- 3) To analyze thermal characteristics of built-up infrastructure.
- 4) To assess environmental sustainability within the university campus.
- 5) To propose climate-responsive planning recommendations.

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areas showed the highest thermal intensity because concrete surfaces absorb and retain heat. Humidity was highest in low-lying and tree-covered areas where moisture accumulation remains high. Open fields experienced strong wind circulation and greater solar exposure. The vegetated zone recorded the lowest temperature due to shading and evapotranspiration. Built-up areas showed the highest thermal intensity because concrete surfaces absorb and retain heat. Humidity was highest in low-lying and tree-covered areas where moisture accumulation remains high. Open fields experienced strong wind circulation and greater solar exposure. The vegetated zone recorded the lowest temperature due to shading and evapotranspiration. Built-up areas showed the highest thermal intensity because concrete surfaces absorb and retain heat. Humidity was highest in low-lying and tree-covered areas where moisture accumulation remains high. Open fields experienced strong wind circulation and greater solar exposure.

Discussion

[illegible]

conditions. Vegetation functions as a natural cooling mechanism, while infrastructure development without ecological planning may increase localized warming. The findings align with established microclimatology theories emphasizing the role of vegetation in environmental regulation. The results demonstrate that land cover and surface characteristics significantly influence microclimatic conditions. Vegetation functions as a natural cooling mechanism, while infrastructure development without ecological planning may increase localized warming. The findings align with established microclimatology theories emphasizing the role of vegetation in environmental regulation. The results demonstrate that land cover and surface characteristics significantly influence microclimatic conditions. Vegetation functions as a natural cooling mechanism, while infrastructure development without ecological planning may increase localized warming. The findings align with established microclimatology theories emphasizing the role of vegetation in environmental regulation. The results demonstrate that land cover and surface characteristics significantly influence microclimatic conditions. Vegetation functions as a natural cooling mechanism, while infrastructure development without ecological planning may increase localized warming. The findings align with established microclimatology theories emphasizing the role of vegetation in environmental regulation.

Recommendations

The university should prioritize afforestation, green roofing, rainwater harvesting, and passive building design. Preservation of natural drainage systems and biodiversity-rich landscapes is necessary for sustainable campus planning. Climate awareness programmes should also be introduced among students and staff. The university should prioritize afforestation, green roofing, rainwater harvesting, and passive building design. Preservation of natural drainage systems and biodiversity-rich landscapes is necessary for sustainable campus planning. Climate awareness programmes should also be introduced among students and staff. The university should prioritize afforestation, green roofing, rainwater harvesting, and passive building design. Preservation of natural drainage systems and biodiversity-rich landscapes is necessary for sustainable campus planning. Climate awareness programmes should also be introduced among students and staff.

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Table 1: Primary field climatic data

Zone	Temperature (°C)	Humidity (%)
Vegetated zone	24.5	88
Built-up area	31.2	67
Open field	29.4	72
Road corridor	30.1	69
Low-lying area	25.8	91

Temperature variation graph

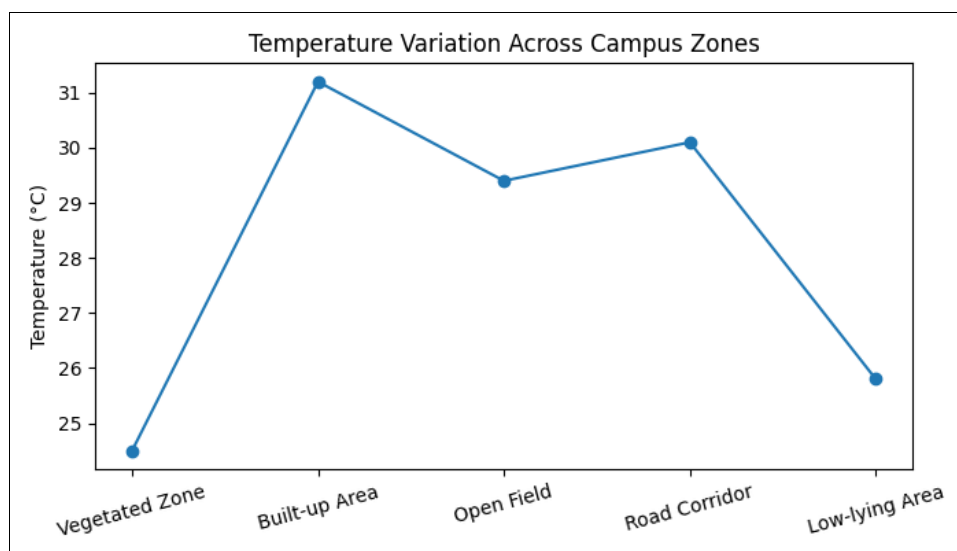


Fig 1: Temperature variation across campus zones

