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Indoor Relative Humidity Characteristics in Selected Low-Income Buildings in the Different Ecological Belts of Rivers State: Implication for Thermal Comfort Condition

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Abstract

This study examined the indoor relative humidity (RH) characteristics of selected low-income residential buildings across three ecological belts (Derived Savannah, Coastal Vegetation, and Rain Forest) of Rivers State, Nigeria. The thrust of the study was to examine RH observed and implications for thermal comfort in low-income buildings in the area. The study deployed the experimental research design to establish the variation in Relative humidity characteristics in the area. RH data were collected from 15 three-bedroom bungalows (five per ecological belt) for a period of six months (January to June 2024). The Acurite 00613 data loggers with ±1% precision was used. Data were logged at four climatological hours daily (00:00, 06:00, 12:00, and 18:00). ANOVA was applied to determine the spatial variations in RH across the ecological belts. Results revealed that RH was high across all belts, and exceeded ASHRAE's recommended 30–60% comfort range. Peak RH was recorded in June in the Derived Savannah (81.4% ± 1.11), followed by Coastal Vegetation (78.3% ± 1.17) and Rain Forest (76.9% ± 1.03). The lowest RH was in April in the Rain Forest (65.1% ± 1.24). Notably, March RH was highest in the Coastal belt (73.2% ± 1.14), with standard deviations ranging from ±0.89 to ±2.11 across the sampled months. ANOVA results showed statistically significant spatial RH difference in March (F = 8.4, p = .000) and June (F = 7.0, p = .001), but not in January, February, April, or May (at p > .05). A consistent diurnal RH pattern emerged with RH peaked at 00:00 hrs. (85% in June) and dropped by 12:00 hrs. (68%). Performed spatial mapping revealed highest RH in Khana, Andoni, and Ahoada West (69.58%), and lowest in urbanized LGAs like Port Harcourt (65.72%). These findings emphasize the urgent need for ecologically responsive building designs targeted at managing the excess indoor humidity, while enhancing thermal comfort in low-income housing.

Keywords: Thermal-Comfort; Relative-Humidity; Indoor-Comfort; Ecological-Belts

1.0 Introduction

Thermal comfort is a fundamental criterion in the design and assessment of indoor environments, particularly in residential buildings (He et al., 2022; Ozabor and Ajukwu, 2023). According to ASHRAE Standard 55 (Mustapha et al., 2024), it is defined as "the condition of mind that expresses satisfaction with the thermal environment." While temperature has traditionally received the most attention in thermal comfort studies, relative humidity (RH) is equally important due to its significant influence on comfort perception, occupant health, and energy use (Zuo et al., 2021).

Relative humidity (which is the ratio of actual moisture in the air to the maximum possible at a given temperature) plays a pivotal role in shaping how occupants experience indoor conditions (Salthammer and Morrison, 2022). In tropical regions, such as Rivers State, Nigeria, where both high temperatures and humidity prevail, RH levels often fluctuate in response to regional climate patterns and building characteristics (Akinnubi et al., 2024). Indoor climate is highly susceptible to the specific climatic condition being faced within any of these zones (Living-Jamala et al., 2024). Addressing zone-specific thermal comfort problems requires a thorough comprehension of the manner in which relative humidity differs from one belt to another (Haochen et al., 2024). There is a sufficient amount of low-income housing in Rivers State, and it is mostly made with cheap material, and is characterized by poor ventilation, and poor insulation (Jegede and Taki, 2022). Because of these characteristics, the structures are very susceptible to inclement weather from outdoors, and this makes indoor relative humidity high (Kenny et al., 2024). Allergens and pathogens can be amplified, growth of mould can be encouraged, and discomfort can be experienced when there is excessive humidity indoors (Guarnieri et al., 2023). Besides these, RH also contributes to building material degradation.

Physiological adaptation and cultural preference, which differ by location (Lam et al., 2021), also influence the correlation between relative humidity and thermal comfort (Yao et al., 2022). Relative humidity indoors should be maintained between 30% and 60% for health and comfort reasons, according to ASHRAE and other thermal comfort guidelines (Carlucci et al., 2021, Kayode, 2023). However, in the Niger Delta Region where Rivers State is located, keeping such levels in lightly insulated naturally ventilated houses presents several thermal comfort challenges (Iyegere, 2023). While temperature-focused studies in tropical climates are common (Abuseif, 2023; Requia et al., 2023; Requia et al., 2024), research specifically examining indoor RH and its spatial variability across ecological zones remains limited. Most available studies are either short-term or do not consider the ecological diversity of the region. This leaves a critical gap in knowledge. This lack of data hampers efforts by policymakers, planners, and designers to implement humidity-sensitive and climate-responsive housing solutions in the region.

The ecological diversity of Rivers state rangesfrom the wet, densely vegetated Rainforest to the humid Coastal lowlands and the relatively drier Derived Savannah, and creates varied ambient conditions that directly shape indoor RH levels (Gbadegesin et al., 2023). Housing in these zones, particularly in low-income settlements, is often not designed with climate sensitivity in mind. On the other hand, land rent pushes the developers to put economics ahead of in-dwellers comfort. As a result, many buildings regularly fall outside of the recommended RH comfort range, which leads to thermal discomfort, degraded indoor air quality, and increased susceptibility to heat-related illnesses such as heat strokes, heat rashes, and heat cramps (Narocki, 2021). Moreover, rapid urbanization and growing demand for affordable housing have led to widespread construction that overlooks environmental quality (Ichendu and Irimiagha, 2024; Ozabor et al., 2024). Inadequate building codes and the absence of region-specific design standards further exacerbate the risk of thermally unsuitable housing, especially in urban areas of Rivers State (Tanko et al., 2024).

In response, this study seeks to explore the following questions; what are the indoor relative humidity characteristics across the different ecological belts of Rivers State? How do RH levels vary spatially and seasonally among the Rainforest, Coastal Vegetation, and Derived Savannah zones? What are the implications of these RH patterns for achieving thermal comfort, in the study area? As a result of these questions this study aims to assess the indoor relative humidity characteristics in selected low-income buildings in the different ecological belts of Rivers State, with a view to identifying the implication of relative humidity for thermal comfort conditions.

2.0 Materials and Methods

2.1 Study Area

This study was carried out in Rivers State. Rivers State is located on latitudes 4.75° to 5.50° north and longitude**s** 6.50° to 7.50° (Figure 1). This area is located in the coastal zone of the southern part of Nigeria. The area is a tropical region and experiences rains all year round. The annual rainfall is high (ranging from 1895mm to 2105mm) (Ifuwe and Onosemuode, 2024). This rainfall is accompanied with a relatively high mean annual temperature amount that ranges between 27^{o}C and 30^{o}C (Dan-Jumbo, 2018). The relative humidity is also high considering the tropical nature of the environment. The Relative Humidity ranges from, 68% in January to 89% in the wet months of June, July and August (Eludoyin et al., 2013).

The environmental characteristics of the state has been greatly altered due to the concentration of people, urbanization processes and the beehive of anthropogenic activities. Consequently, that affects the micro climate of the area (including relative humidity) (Weli et al., 2017). This changes in the microclimate, combined with the shoddy residential building designs (occasioned by the demand for housing in the area) affected indoors weather conditions and by extension the thermal comfort characteristics.

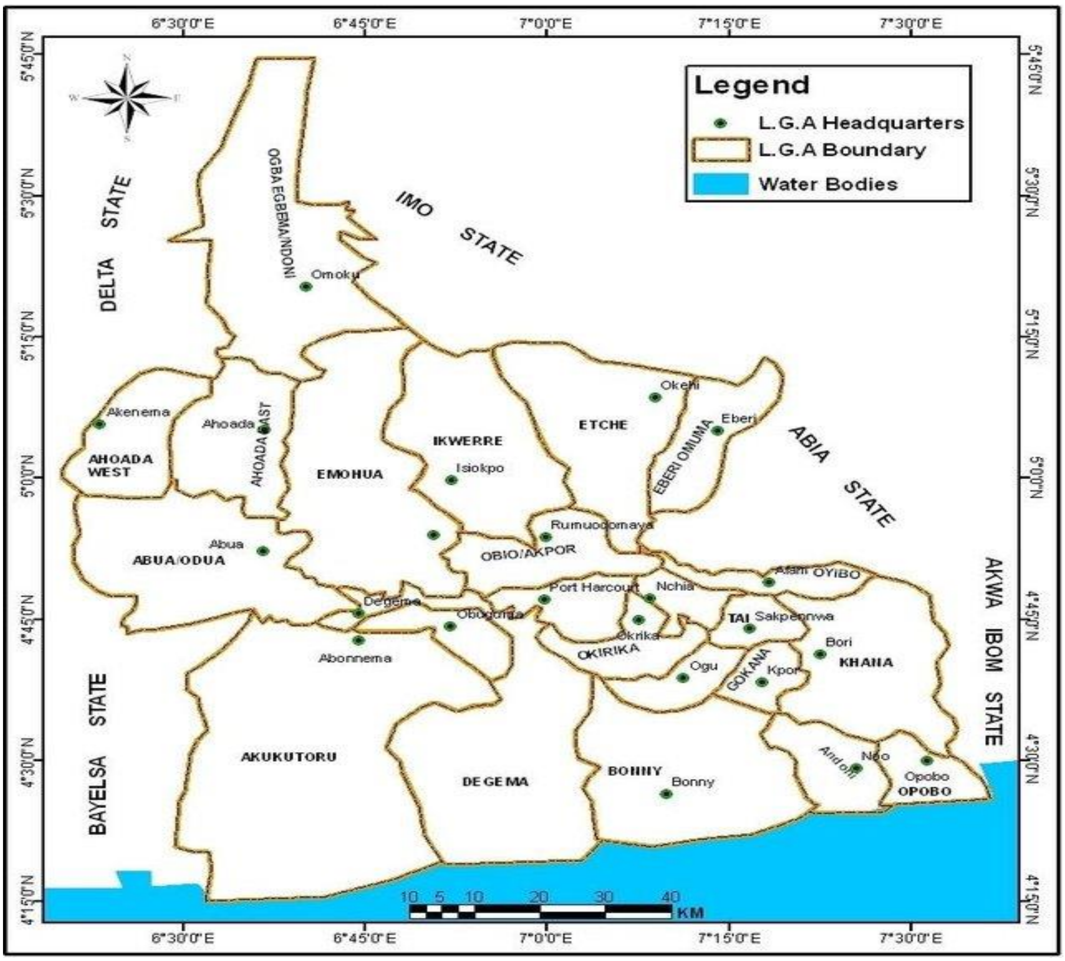

Figure 1. Rivers State showing the Local Government areas
Modified after Rivers State Ministry of Land and Surveys (2019)

2.2 Methodology

The study deployed the experimental research design. Relative humidity data was collected using the Acurite data logger (model 00613). The area was first divided using the quadrat sampling techniques. After stratifying the area, 15 houses were selected from the vegetal belts (5 for each belt) see Figure 2. The data for Relative Humidity was collected for a period of 6 months (January to June 2024). This data was collected using the climatological hours of 00:00hrs, 00:06hrs, 12:00hrs and 18:00hrs and in the locations listed in Table 1; on a daily scale for a period of six months.

To eliminate bias from the data, only houses with similar characteristics were selected (see Table 2). Three-bedroom bungalows were selected in every ecological belts. The Acurite sampler possess a precision of 1% for relative humidity. The sampler can log data for two weeks (a characteristic that made it easy for the research to amass data for the period). For efficient data collection the data logger was placed at a height of 4 feet in all the sampled houses and in the living rooms only; which were located in the north direction. The northward facing living rooms were chosen to eliminate solar interference with collected data. Additionally, the chosen houses had only electronic fans with no air conditioners.

The data collected were analyzed using the Analysis of variance (ANOVA). The ANOVA was used to test for significant variation in the Relative humidity characteristics of residential buildings in the study area. This analysis was done in the environment of the statistical package for the social sciences (SPSS) version 20.

Table 1: Selected towns and low-income buildings from the calibrated quadrants across Rivers State

	Selected Towns and vegetal belts		
S/N	**Coastal vegetation**	**Lat**	**Long**
1	Bonny Town	6.621497	5.141986
2	Ogboloma	6.903796	5.044641
3	Kono	7.205565	5.018682
4	Utu	7.231523	4.742872
5	Mbiama	6.637721	5.388592
	Derived Savana		
6	Soku	7.20881	4.51249
7	Idama	6.501438	4.814259
8	Okpo	7.481375	4.652017
9	Bodo	7.513823	4.489776
10	Bakana	6.676659	6.75129
	Rain forest		
11	Ahoda	5.093186	6.651469
12	Ozuaha	5.054883	4.749362
13	Egbelu	6.897307	4.765586
14	Gbam	7.28344	4.645528
15	Omoku	7.117955	4.674731

Table 2: The characteristics of the buildings across the ecological belts in Rivers State

S/N	Materials	Classes
1	Walling characteristics	Blocks, concrete, bricks
2	Window type	Aluminum
3	Door characteristics	2100 x 900mm
4	Roofing type	Aluminum, zinc, asbestos
5	Ceiling type	Asbestos or polyvinyl chloride
6	Sitting room characteristics	4200 x 4800mm
7	Window characteristics	900 X 1500mm of 1200 x 1200mm or 900 x 1800mm
8	Cooking fuel source	Stove or gas
9	Same outdoor characteristics	Concrete floor, inter locks or bare ground
10	Same meteorological conditions	Temperature and humidity

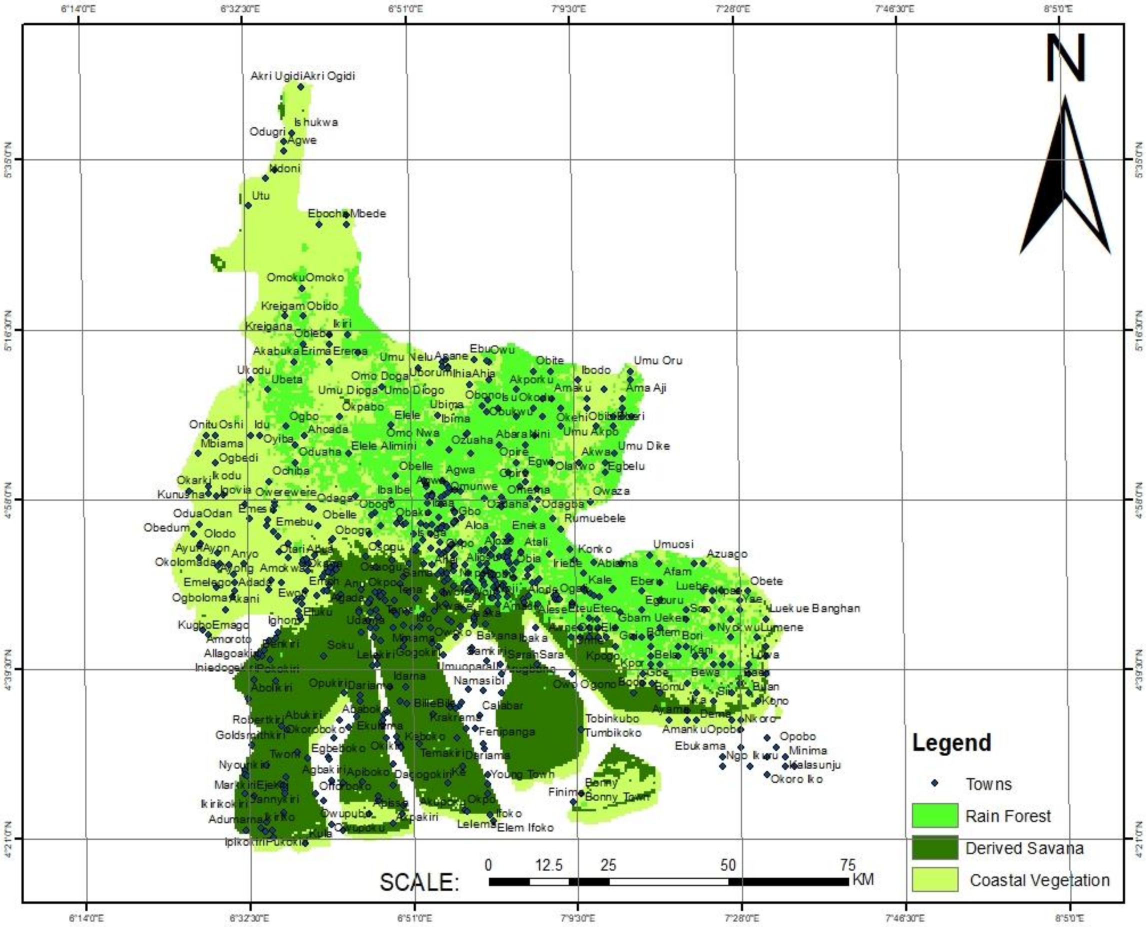

Figure 2. Ecological map of Rivers state showing the grids sampled

3.0 Results and Discussion

Table 2 presents a comparative summary of mean monthly indoor relative humidity (RH) and their standard deviations (SD) across three ecological belts (Derived Savannah, Coastal Vegetation, and Rain Forest) from January to June. Relative humidity plays a significant role in determining indoor thermal comfort, especially in low-income housing with limited passive cooling infrastructure.

Across the months observed, the Derived Savannah zone exhibited the highest RH in June (81.4% ± 1.11) (Table 3), reflecting the onset of the rainy season. This peak aligns with the expected climatological patterns in southern Nigeria where June typically marks the beginning of sustained rainfall (Ibebuchi and Abu, 2023). The Coastal Vegetation belt also recorded a relatively high RH in June (78.3% ± 1.17) (Table 3), followed by the Rain Forest (76.9% ± 1.03) (Table 3). The comparatively lower RH in the Rain Forest belt during the same month may suggest better ventilation or housing characteristics that mitigate indoor humidity build-up.

The Coastal Vegetation belt had the highest relative humidity values in March (Table 3), at 73.2% ± 1.14, outcompeting the Derived Savannah with 70.9% ± 1.15 and the Rain Forest with 67.7% ± 1.33. The closeness of the coastal region to massive bodies of water may be the cause of these variations, as this determines the ability of the air to retain water (Zheng et al., 2022; Sasanya et al., 2024). The modest standard deviations of ±0.89 to ±2.11 show that there was minimal variation between the zones.

Table 3 Mean monthly indoor relative humidity in the different vegetal belts in the study area

Months	RH (Derived Savannah) ±SD	RH (Coastal Vegetation) ±SD	RH (Rain Forest) ±SD
January	70.3±1.31	70.2±1.13	67.3±1.13
February	69.0±0.94	68.5±2.11	65.9±1.10
March	70.9±1.15	73.2±1.14	67.7±1.33
April	65.6±1.10	66.7±0.89	65.1±1.24
May	68.4±1.19	67.8±1.13	68.4±1.22
June	81.4±1.11	78.3±1.17	76.9±1.03

In April, the Rain Forest belt recorded the lowest relative humidity (65.1% ± 1.24), even though the area is normally more humid because of the great amount of vegetation. This was also recorded in all the belts. This anomaly may be attributed to increased temperatures and transitional dry spells that typically precede the wet season (Basse et al., 2024). Interestingly, April RH in the Derived Savannah was 65.6% ± 1.10, marginally higher than in the Rain Forest, which indicates possible indoor retention of moisture due to poorer ventilation design or materials with low thermal diffusivity (Iyegere, 2023).

In terms of monthly consistency, the Derived Savannah showed relatively low standard deviations, particularly in February (±0.94) and April (±1.10), suggesting minimal intra-month variability. In contrast, Coastal Vegetation showed greater variability, particularly in February (±2.11), possibly indicating inconsistent indoor environmental control or variable external moisture levels.

When compared to ASHRAE 2020 (McFarlane, 2021) guidelines, which suggest that indoor RH should ideally remain between 30% and 60% for thermal comfort and mould prevention, all observed RH values in this study exceeded the upper comfort limit. This suggests that occupants in all three vegetation zones may be experiencing discomfort due to excessive indoor humidity, particularly during the peak wet months. Excessive RH can contribute to microbial growth, thermal discomfort, and the deterioration of building materials (Guarnieri et al., 2023). Moreover, previous studies in tropical regions have documented similar indoor RH patterns. For instance, Handayani et al. (2024) observed that RH values in naturally ventilated low-income housing in humid tropical regions often surpass comfort thresholds, especially during the rainy season. Similarly, Unegbu et al. (2025) noted that RH levels in low-cost housing in Nigeria regularly ranged between 65% and 85%, which closely mirrors the findings presented in Table 3.

The monthly RH trends across the three ecological zones indicate consistently high indoor moisture levels, with slight inter-zonal variation. The Coastal Vegetation and Derived Savannah zones showed slightly higher RH averages in the transition into the wet season (March–June), while the Rain Forest zone consistently exhibited slightly lower RH values. While standard deviations remained low—suggesting stable RH conditions—values exceeding ASHRAE's comfort threshold indicate a potential public health and comfort concern in these low-income dwellings. Natural ventilation, hygroscopic construction materials, and moisture management practices should be the focus of future interventions, particularly in the rainy season.

The one-way ANOVA tests was conducted to assess how the relative humidity varied among the three vegetal belts within Rivers State: Derived Savannah, Coastal Vegetation, and Rain Forest. Results are presented in Table 4. Indoor relative humidity variations statistically significant were recorded in March (F = 8.4, p =.000) and June (F = 7.0, p =.001). January (F = 1.5, p =.222), February (F = 1.9, p =.164), April (F = 0.6, p =.567) and May (F = 0.3, p =.783), on the other hand, were not characterized by significant changes. These results show that indoor relative humidity was consistent throughout four of the six months in question, but showed significant variation in two cases of the month. As evidenced by the F-values for March and June, indoor relative humidity differed greatly between the biological belts in those months. The chances of the differences occurring by chance are extremely small because both p-values are significantly smaller than the conventional alpha of .05. Climate or housing factors that distinguish between these zones in transitional or maximal climatic times are suggested by such seasonal changes in statistical significance (Shrestha et al., 2025).

In the southern parts of Nigeria, the month of March marks the end of dry season and the beginning of rainy season in April. This is a time when microclimatic differences among the plant zones could perhaps be more evident. June is usually most often the wettest month in the area, leading to the biological and structural conditions that affect interior humidity to become even more pertinent. Wang et al. (2024) averred that spatial variation in indoor air quality during the rainy months are geographically regarded as seasonal extremes.

The months of January, February, April, and May showed no significant difference in the ANOVA results (Table 4), indicating that indoor relative humidity (RH) was more or less equal in various ecological belts. The F-values ranged from 0.3 to 1.9 (Table 4) without associated p-values not significance at the .05 level.

During the dry season (January and February) and early rain onset (April and May) the difference in external moisture input and thermal gradients between the ecological belts are not significant enough to influence variation in relative humidity (Kocik et al., 2024). In addition, in these generally steady months, building designs and materials properties may demonstrate similar performance throughout zones, preferring to reduce indoor microclimatic fluctuations (Hong et al., 2021).

Table 4. ANOVA summaries of the spatial variation in the indoor relative humidity across the various ecological belts in Rivers State

Months	df	*F*	Sig	Remark
January	2	1.5	.222	Not significant
February	2	1.9	.164	Not significant
March	2	8.4	.000	Significant
April	2	0.6	.567	Not significant
May	2	0.3	.783	Not significant
June	2	7.0	.001	Significant

NB: Relative humidity being compared across the vegetal belts of Derived Savannah; Coastal vegetation; and Rain Forest

It is clear that indoor temperature control measures are geographically more localized in Rivers State since statistically significant geographical differences do occur in some months. For

March and June, when geographical differences are most extreme, there may be necessity to adjust building orientation, material, and ventilation design according to ecological zone. Particularly in climate-sensitive and resource-constrained areas, the implication of these results lends support to the argument that indoor RH control regional strategies need to be localized (Ibrahim et al., 2025).

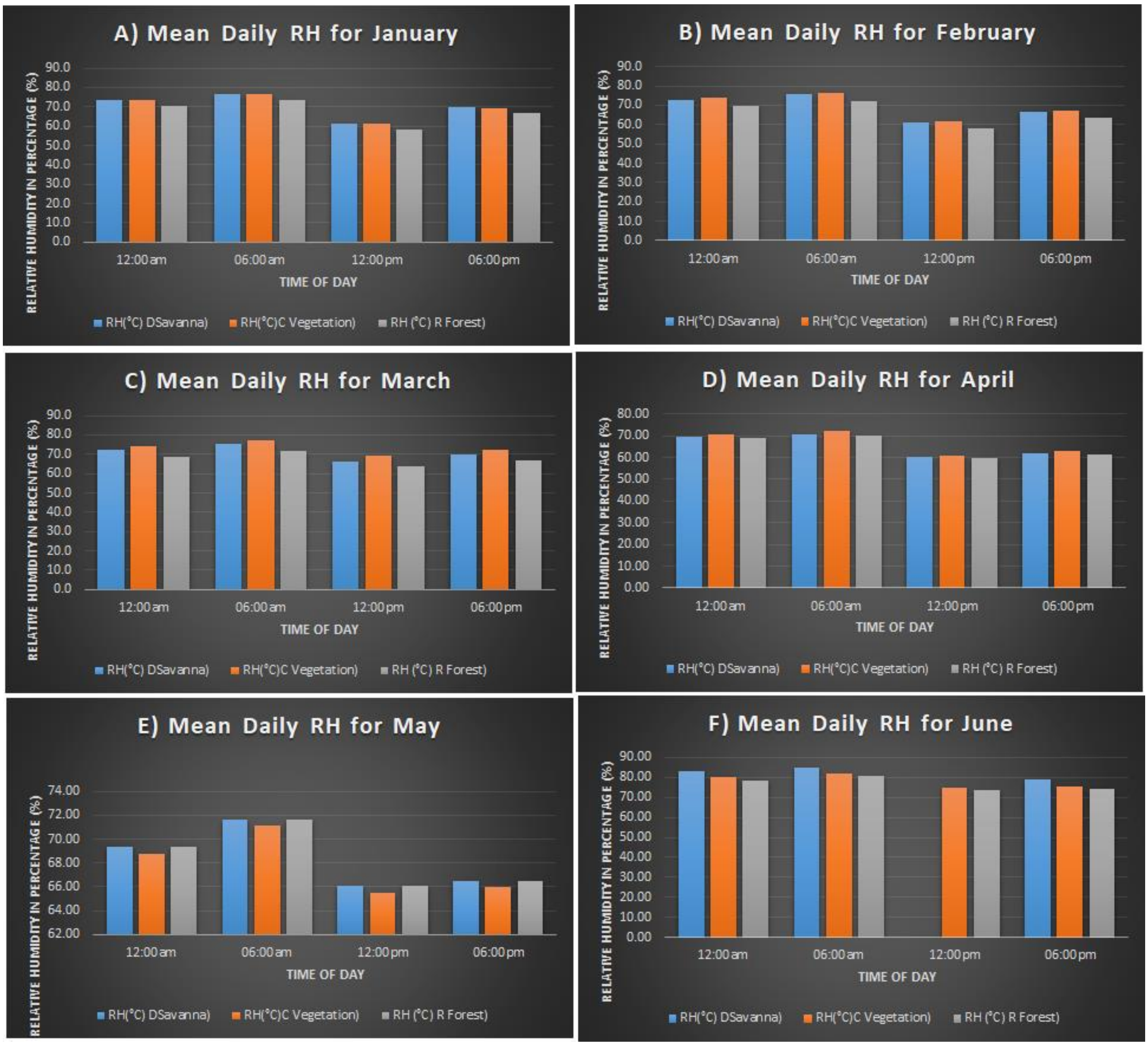

Fig. 3: Mean daily humidity amount for January to June in residential buildings in the different vegetal belt in Rivers State

Figure 3 displays the average day-by-day relative humidity within residential houses from January to June at four-time intervals per day: 12:00 am, 6:00 am, 12:00 pm, and 6:00 pm. The three ecological belts taken into consideration are Derived Savannah, Coastal Vegetation, and Rain Forest. From the results, it is evident that relative humidity changes throughout the day within each month, with ecological belt-related variations being most apparent between March and June.

A consistent diurnal pattern is observed across all months: RH peaks during the early morning hours (12:00 am and 6:00 am) and declines towards midday (12:00 pm), before a slight rebound or stabilization by 6:00 pm. This inverse relationship between RH and time of day aligns with established thermal dynamics, where increasing temperatures during the day decrease RH due to rising air capacity for moisture, and cooler nighttime temperatures cause RH to rise again (Lakra and Avishek, 2022). This trend underscores the thermodynamic principle governing indoor air moisture retention. In January (Fig. 3A) and February (Fig. 3B), indoor RH is relatively uniform across the ecological belts, with all zones exhibiting high midnight RH values (80–85%) that drop to 60–65% by midday. The similarity across zones reflects the dry season's ambient stability and minimal ecological divergence in moisture availability. This pattern corresponds with the non-significant ANOVA findings for these months (Table 3), suggesting that location had limited influence on indoor RH during this period.

By March (Fig. 3C), spatial divergence becomes more noticeable. The Coastal Vegetation belt records higher RH throughout the day, especially at 6:00 am and 12:00 pm, compared to Derived Savannah and Rain Forest. This variation coincides with the transition from dry to rainy season, when the coastal belt begins receiving more moist air from the Atlantic, affecting indoor microclimates differently than in inland belts. The observed divergence is statistically supported by March's significant ANOVA result (F = 8.4, p = .000), confirming that ecological zone significantly influenced indoor RH during these transitional months. In April (Fig. 3D) and May (Fig. 3E), RH values converge again across the ecological belts. Indoor RH fluctuates within a narrower range (65–72%), with minimal spatial deviation. This uniformity could be attributed to the dominance of overcast skies and steady rainfall patterns, creating relatively homogeneous ambient moisture levels that override microclimatic differences between zones (Shetty et al., 2022). The non-significant ANOVA results for both months (Table 3) support this observation, indicating a temporary equalization of indoor RH conditions across the state.

By June (Fig. 3F), spatial differences in RH reappear strongly. The Derived Savannah zone records the highest RH values at all times of the day, peaking near 85% at 12:00 am, while the Rain Forest zone lags with slightly lower values (75–78%). This pattern coincides with the peak of the rainy season, where geographical features—such as forest density, soil moisture retention, and wind flow—begin to influence indoor microclimates more significantly. The statistically significant ANOVA result for June (F = 7.0, p = .001) validates this spatial divergence. These findings are consistent with Russel et al. (2022), who noted that indoor environments in different ecological zones respond differently to peak-season atmospheric moisture due to variations in building ventilation, insulation, and exposure. The variations seen in Figure 3 highlight the complex interplay between time of day, month, and ecological zone in determining indoor RH in residential buildings. While diurnal RH fluctuation is predictable, the ecological influence varies seasonally, being more pronounced during transitional and peak moisture periods (March and June). These findings emphasize the need for ecologically informed indoor climate management, particularly in housing design for low-income populations, where building materials and ventilation strategies should be tailored to the local moisture dynamics (Adeyemi et al., 2024).

Figure 3 shows that indoor relative humidity is strongly seasonal and geographical variation exists for months most prone to extremes of weather. March and June show strong biological differences, with the variations between seasons and the maxima moist periods enhancing spatial heterogeneity within the indoor space, unlike the majority of months (for example, January, February, April, and May) where RH is the same for all belts. These findings are important in the design of adaptive housing that reduces RH-related problems, e.g., mould, and respiratory problems, and enhances occupant thermal comfort.

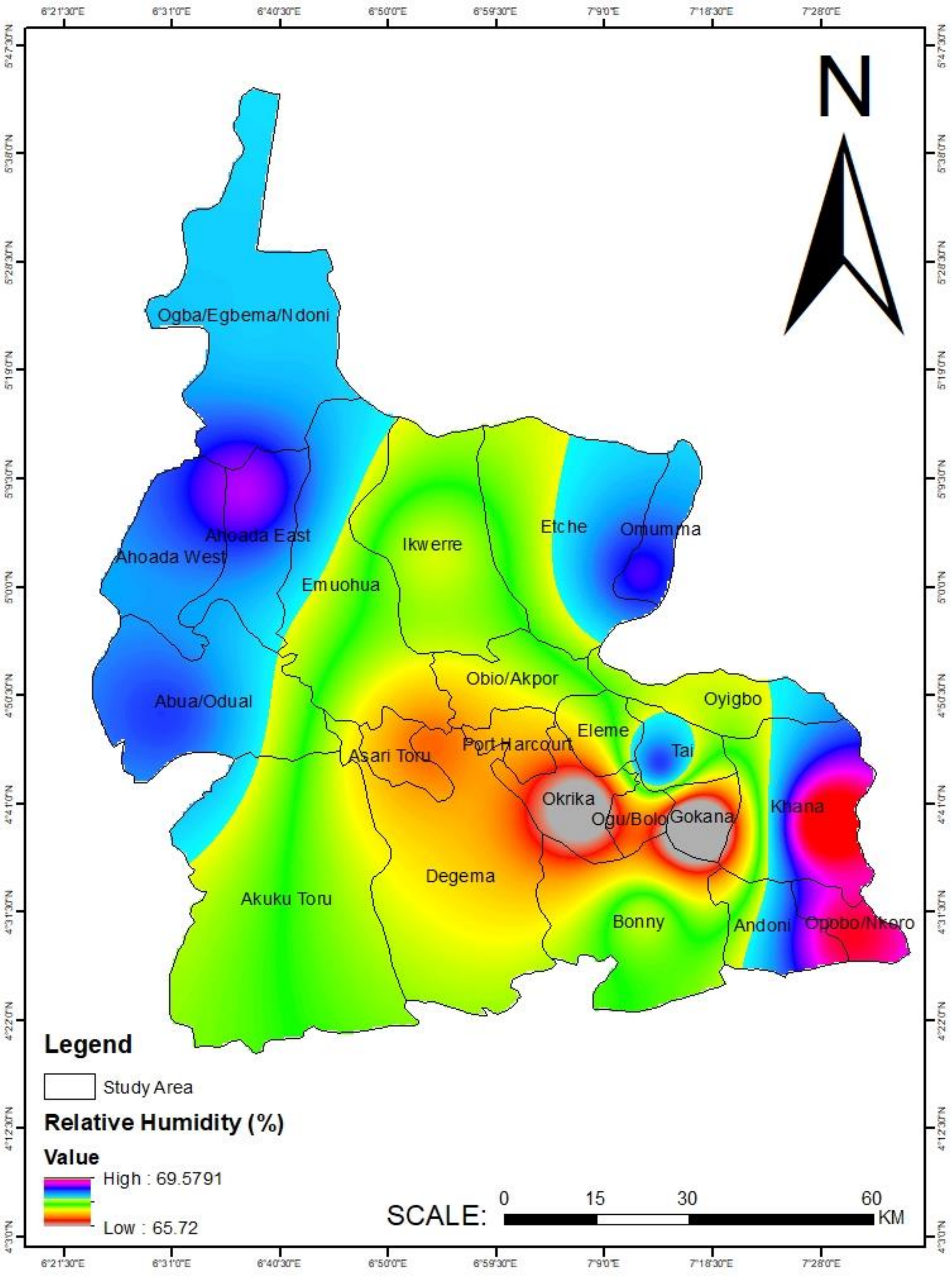

Figure 4: Spatial pattern of relative humidity in the residential buildings in Rivers State

Figure 4 shows the geographical spread of relative humidity in Rivers State residential area buildings in Nigeria. As seen in the chart, the relative humidity percentages vary widely between the various LGAs, with rates fluctuating from 65.72% to 69.58%. This range is shown with a colour gradient; the colder colours (like blue and purple) indicate relatively higher relative humidity values, and warmer colours (such as red and yellow) indicate relatively lower relative humidity values. LGAs like Khana, Opobo/Nkoro, Andoni, and sections of Ahoada West and Ogba/Egbema/Ndoni had the highest relative humidity values, although these areas are riverine and coastal in nature typified by lush vegetation and closeness to major water bodies in Rivers State. Moisture-laden air is an offshoot of a plethora of climatic conditions, which in turn boosts relative humidity. Another factor responsible for the high humidity in these areas is the dominance of humid air masses and the less urbanized land cover. The minimum relative humidity values, which fall within the range of 65.7% to 66.5%, are found in LGAs such as Port Harcourt, Obio/Akpor, Eleme, Okrika, Ogu/Bolo, Gokana, and some parts of Degema. They have drier air because of the degree of urbanisation and industrialisation. LGAs with lots of concrete, little vegetation, and the urban heat island phenomenon probably have hotter temperatures and lower humidity.

Large geographic areas (LGAs) like Ikwerre, Etche, Emuoha, and Oyigbo have moderate relative humidity, which is aggravated by the built environment of the urban centres. This has the tendency to trap heat and hinder natural exchange of moisture. Located halfway between the coastal and interior regions, these zones have a transition from high to low humidity (Weli and Famous, 2018). As a consequence of being located within the biological belt, they experience a climate that is a combination of conditions found in the interior and the coast. Correspondingly, these areas experience moderate precipitation and are probably representative of a more moderate thermal comfort condition compared to the coastal and urbanised areas, which are at the extreme (Weli et al., 2017).

There is a distinct east-west and coastal-inland gradient in the relative humidity distribution, as indicated by the geographical pattern marked on the map. Normally, the relative humidity decreases as one proceeds from the wetter, more urbanized core areas of the state to the drier inland heartland. This is as a result of the vegetation transitions from coastal regions and mangrove swamps to derived savannah environments inland, concurring with the greater biological zonation of Rivers State (Edwin-Wosu et al., 2020). There are important implications for home comfort and urban design from these spatial variations. High relative humidity, particularly in poorly ventilated homes, has the effect of increasing thermal discomfort by restricting the body's capacity to radiate heat away from the body through sweating evaporation. On the other hand, heat stress is more likely to occur in hot, dry environments (Luan and Vico, 2021). In humid areas, structures must have good natural ventilation and use moisture-resistance materials as their priority. However, urban greening and reflective surfaces can contribute to decreasing humidity as corroborated by Jay et al. (2021).

The spatial variation in relative humidity across Rivers State showed the influence of ecological zones, urbanization, and proximity to water bodies on indoor thermal conditions. Coastal and riverine LGAs show significantly higher humidity levels, while more urbanized regions experience relatively lower values due to built-up land surfaces and reduced vegetation. These findings indicates that there is need for developers to contextualize buildings in line with the revealed climatic patterns (relative humidity in perspective), to improve residential thermal comfort.

4.0 Recommendations and Policy Implication

Based on the findings on indoor relative humidity (RH) across Rivers State, four key policy implications and recommendations emerge to guide thermal comfort planning and housing interventions, particularly in low-income residential areas. The significant spatial variations in RH observed in months like March and June suggest the need for zone-specific building codes and thermal comfort regulations. Building orientation, ventilation openings, and material choices should be tailored to the ecological characteristics of each zone—whether it be the high-moisture coastal regions or the relatively drier derived savannah. State and local governments should develop or revise housing standards to integrate ecological zoning into residential design requirements. For example, housing in high-RH belts like Khana or Opobo/Nkoro should prioritize passive cross-ventilation and use of moisture-resistant walling and roofing materials.

RH consistently exceeded ASHRAE’s upper thermal comfort limit (60%) across all zones and months, underscoring the urgent need for improved building performance in low-income settlements. Policies must require that new affordable housing projects undergo hygrothermal simulations and assessments. Public housing schemes and NGO-supported housing initiatives should incorporate low-cost hygroscopic materials—like treated earth blocks or composite panels with moisture-buffering capacity—that help moderate indoor RH fluctuations. Encouraging the use of breathable wall finishes and elevated flooring in design schemes can further support indoor moisture regulation.

The urban LGAs (e.g., Port Harcourt, Obio/Akpor) showed relatively lower RH but are likely subject to high temperatures due to the urban heat island effect. As a mitigation measure, urban planning policies should mandate the integration of green infrastructure—such as tree-lined streets, green roofs, and open vegetated buffers—especially in densely built-up areas. These interventions can help stabilize local microclimates, improve air exchange, and reduce overall heat load on buildings. In parallel, local authorities should incentivize retrofitting of existing low-income housing with shading devices and reflective roofing materials to counteract thermal discomfort caused by both high temperature and humidity.

Given the seasonal and ecological variability in indoor RH, Rivers State should establish a permanent indoor environmental quality monitoring system. This framework could involve partnerships between academic institutions, housing authorities, and health agencies to gather long-term data on indoor temperature and humidity in residential areas. Data collected would inform housing interventions, track thermal risk hotspots, and support evidence-based policy decisions on climate-resilient infrastructure. Such a monitoring system would be particularly useful in identifying vulnerable communities during peak wet or dry seasons and planning emergency interventions during extreme weather events linked to climate change.

These recommendations emphasize the importance of aligning housing design, public policy, and climate science to ensure healthier and more thermally comfortable living environments for all residents across Rivers State’s diverse ecological zones.

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