

AI-DRIVEN URBAN HEAT ISLAND MAPPING FOR GREEN BUILDING DESIGN AND SUSTAINABLE INFRASTRUCTURE PLANNING

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Abstract : The Urban Heat Island (UHI) effect intensifies rising temperatures in cities, leading to increased building cooling demand, reduced outdoor thermal comfort, and environmental stress on urban infrastructure. This study presents an Artificial Intelligence-driven framework to support green building design and sustainable infrastructure planning through high-resolution thermal mapping. The proposed model integrates ground-based temperature observations, Sentinel-2 and Landsat satellite imagery, local weather parameters, and urban built-form indicators such as vegetation cover, surface reflectivity, and construction density. Machine learning techniques are employed to generate fine-scale spatial predictions of heat exposure across urban regions and to quantify the influence of green infrastructure and high-albedo materials on local temperature patterns. The resulting thermal suitability assessment enables identification of heat-vulnerable construction zones and potential locations for green roofs, reflective roofing systems, and vegetative buffers. These insights assist planners, architects, and policymakers in adopting heat-resilient building strategies that reduce energy consumption and improve urban microclimatic conditions. The framework is scalable and adaptable to different cities using open geospatial datasets, supporting data-driven decision making for sustainable urban development. By linking AI-based thermal analysis with green building interventions, the study provides a practical planning support tool for climate-responsive infrastructure and contributes to the advancement of environmentally responsible construction practices in rapidly urbanizing regions.

Keywords: Urban Heat Island (UHI), Green Building Design, Sustainable Infrastructure, Machine Learning, Thermal Suitability Mapping, Cool Roofs, Urban Vegetation

INTRODUCTION

A so-called Urban Heat Island (UHI) effect is defined as the significantly higher temperature in cities than in the rural environment. The cause of this temperature difference is mainly due to the high concentration of buildings, paved surfaces and other impervious surfaces that absorb and trap heat better when compared to the natural landscapes. Having a surface that is less moist due to substitution of vegetation with a concrete constructions and less air movement among buildings that are close to each other adds more heat to the heat. With urban growth and increasing rates of extreme heat events due to climate change, the identification and reduction of UHI have taken center stage as a major concern of urban planners, environmental scientists and infrastructural developers.

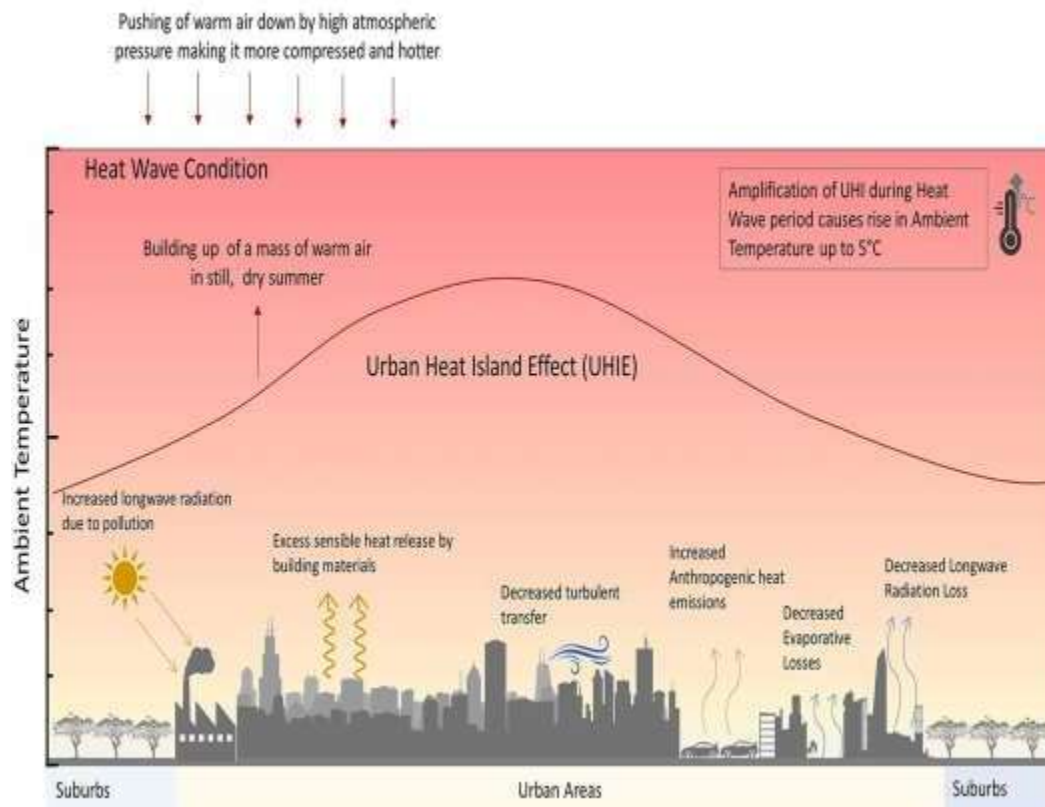


FIG-1 : Urban Heat Island Effect

The UHI effect has direct building performance and energy consumption implications in addition to its effect on the environment. Higher surface and air temperature bring the effect that more electricity is needed to cool the building, thereby increasing the cost of operation and the emission of greenhouse gases. The long-term heat exposure also influences the comfort of thermoregulation outdoors, human health, as well as the sustainability of urban environment infrastructure. In this regard, to have an environmentally sustainable development, buildings and urban planning must include thermal risk assessment during planning and design. The application of high-albedo roofing material, implementation of green roofs and vegetative buffers, optimization of building spacing and maintenance of urban vegetation cover have been recognized as some of the strategies that can be adopted to decrease the intensity of localized heat.

This paper offers an empirical model of remote sensing data, meteorological measurements, urban built-form predictors, and machine-learning methods to model and study spatial patterns of urban heat. The major aim is to produce high-resolution thermal maps that will be useful in the design of green buildings and planning to realize sustainable infrastructure construction. Connecting the trends in surface temperatures and vegetation density with the density of the built-up areas and the area surface reflectivity, the research provides an opportunity to locate the areas where the process of construction can be thermally optimal and the ones that are vulnerable to heat and need mitigation measures.

The project will combine several datasets, such as land surface temperature based on the Sentinel-2 and Landsat satellite data, ground weather stations, and building footprint data based on geospatial data to reach this goal. Such datasets are analyzed to derive useful environmental variables like the Normalized Difference Vegetation Index (NDVI) as a measure of the green cover, the Normalized Difference Built-up Index (NDBI) and Index-based Built-up Index (IBI) as a measure of the intensity of the construction density, and surface albedo as an estimator of the reflectivity of the roofing and paving materials. Combined together, these variables act as proxies of important green building parameters such as the vegetative cooling potential, material thermal behavior, and urban form.

The planned machine learning model is a supervised model that is designed to predict a high-resolution thermal exposure index over the area of study. The model emulates complex nonlinear correlations between the surface features of the land and the variation of temperature, so that the localized heat intensity can be predicted properly. The spatial outputs that result are usable to planners and architects as they indicate areas in which the application of green roofs, reflective roofing systems, shaded corridors, and more vegetation can help produce the greatest cooling effect. Besides predictive mapping, the framework can facilitate scenario-based analysis according to which changes in the vegetation cover or surface reflectivity may be considered to approximate possible decreases in the heat exposure.

This study is unlike the conventional UHI studies which are mainly concerned with temperature mapping since the study focuses on the use of thermal intelligence as a tool in the planning of sustainable construction and innovation of infrastructure. The suggested solution helps to close the gap between geospatial heat assessment and green building strategies by converting environmental indicators into recommendations about designs. By combining AI-based analytics and open geospatial data, the framework also guarantees the ability to scale and adjust to various urban settings, and in turn, the infrastructure system is more likely to be heat-resilient and address the demand to build new and more effective systems in quickly growing regions.

This study has three critical contributions. To begin with, it establishes a high resolution machine learning model that associates urban thermal with built environment features applicable in green building design. Second, it measures cooling affect of vegetation and high-reflectance surfaces to aid in the decision-making of material and landscape planning. Third, it offers a geospatial decision-support strategy that can help the stakeholders locate areas of sustainable development of infrastructure that are thermally appropriate. The suggested framework will help to minimize the energy requirement of a building, enhance the comfort of indoors, and encourage green development of cities by taking thermal considerations into consideration at the initial planning stage.

LITERATURE REFERENCES

The formation mechanisms of urban heat islands were initially described systematically by Oke [1], who provided evidence that the urban geometry, surface coverings and less evapotranspiration on urban surfaces greatly enhanced thermal retention within the built urban environment. His pioneering study created a baseline on the fact that the impervious surfaces like concrete and asphalt modify energy balance mechanisms which result in sustained urban warming. This theoretical knowledge is the scientific foundation of the current material-based mitigation approaches in the planning of sustainable infrastructure.

Akbari et al. [2] have researched the application of cool surfaces and shade trees as mitigation measures to decrease energy use in towns. They found that increasing the roof albedo and the use of urban plants can lead to a considerable decrease in cooling loads in buildings and the enhancement of outdoor thermal comfort. The paper is a direct contributor to green building materials and reflective roofing solutions as passive cooling methods in sustainable buildings.

Rosenfeld et al. [3] further developed urban heat mitigation by looking at the extensive effect of reflective material and vegetation programs on the urban temperature. They revealed that peak temperatures in ambient air can be reduced in cities with increase in surface reflectivity and that this reduction in temperature can lower peak electricity demand, thus the relationship between urban climatic mitigation and energy-efficient infrastructure development.

Sailor [4] created a green roof model of energy simulation to analyze the thermal performance of the vegetative roofing. The research showed that energy consumption on cooling buildings can be measured to be reduced when green roofs are well incorporated into the design of buildings. This study offers quantitative support to the evaluation of green roofs as a responsive performance to climate building models.

Mirzaei and Haghighat [5] conducted a review of various methods of urban heat island research and emphasized the significance of combining the models of microclimate with material and vegetation policies. Their review also highlighted that mitigation processes should not be limited to detection but should be stepped up to actionable planning resolutions, and so design oriented thermal mapping frameworks are imperative.

Santamouris [6] has given an extensive overview of reflective and green roof technologies as an urban heat mitigation measure. This paper has concluded that high-albedo materials play a major role in decreasing the temperature of roofing surfaces and play a role in reducing ambient temperatures in urban settings. The present work is especially valuable to the sustainable infrastructure planning as the material science directly links to environmental performance.

Shen et al. [7] used the Random Forest models to forecast the intensity of surface urban heat islands in future based on the landscape configuration variables. Their model was very predictive; however, the experiment was mainly on the spatial prediction and not the translation to the level of building design. This illuminates a research gap in the incorporation of the outputs of machine learning into green construction strategies.

In their study, Miniandi et al. [8] created a machine learning model based on Landsat indices, e.g., NDVI, NDBI, and albedo, to determine the effectiveness of urban heat mitigation in Kuala Lumpur. Even though this is an effective approach to identify UHI patterns, the paper failed to directly relate thermal outputs to infrastructure material planning or building-level interventions, and there is a need to apply AI models to applications.

Tanoori et al. [9] used the best machine learning method such as XGBoost and deep neural networks to model the patterns of land surface temperatures in the cities. Their analysis showed that they had high predictive performance and morphological analysis capacity but there is still the limitation of interpretability of complex models to translate the prediction into practical green building principles.

Mokarram et al. [10] studied the neural network-based modelling of urban heat tendencies and spatial assessment. The research was very accurate in defining the temperature dynamics but it was on a macro-level to assess climatic conditions and not infrastructure oriented mitigation measures.

Cafaro et al. [11] proposed a GIS-based ISODATA-based clustering model of identifying the presence of urban heat islands in Naples. Their work found high-risk heat zones successfully but failed to go as far as evaluate alternatives of cooling materials and the possibility of vegetation retrofit, which means that there is the opportunity to apply integrated AI-planning systems.

Yu et al. [12] examined how the parameters of urban morphology were related to the outside air temperature and employed regression analysis to identify the correlation. The results of their work showed that the construction structure and landscape cover can have a significant impact on the microclimatic conditions. The study justifies the fact that morphological indicators should be integrated in AI-based thermal suitability mapping to sustainable urban design.

Li et al. [13] studied how the urban green infrastructure affects the building energy performance and the local microclimate. The research established that vegetation that is properly placed will lead to decreased heat entry into the buildings, and consequently, reduced peak cooling loads, which supports vegetation planning as a passive approach to saving energy through the development of green infrastructure.

Innocenti et al. [14] used convolutional neural networks along with satellite to obtain high-resolution temperature prediction of cities. They showed that their AI-driven methodology was very spatial-accurate, which suggests the promise of deep learning models in creating actionable thermal maps to support climate-responsive planning of infrastructure.

Zou et al. [15] used Long Short-Term Memory (LSTM) networks to assess the efficiency of the nature-based solutions to mitigate urban overheating. Their findings supported the idea that vegetation-based mitigation measures have a huge impact in terms of local heat intensity reduction. Nonetheless, the fact that the research is focused on one city highlights the necessity of the ability to scale AI structures that would be applicable to urban settings across the board.

PROPOSED METHODOLOGY

Preparation of Data Acquisition and Sustainable Design

Several geospatial and environmental datasets were combined to form a single analytical structure to facilitate the green building design and sustainable infrastructure planning. Not only the intensity of Urban Heat Island (UHI) was to be predicted, but also actionable indicators of construction planning and material choice were to be obtained.

The datasets included:

Satellite Imagery: to obtain land surface temperature and spectral indices: Sentinel-2A and Landsat imagery was used to achieve this. Those pictures containing over 30% of cloud cover were removed in order to have reliable data.

Meteorological measurements: Ground-based measurements were used to confirm the surface temperature using meteorological parameters like ambient air temperature, humidity and solar radiation.

Urban Infrastructure Data: Data on built-form density and spatial structure were included by adding layers of building footprint, land-use maps and GIS-based spatial data.

The preprocessing involved georeferencing, cloud masking, transforming data of GeoTIFF into numerical arrays, spatial co-location of satellite and meteorological data and normalization of environmental variables.

Contrary to the case of conventional UHI studies, preprocessing stage in this framework was specially developed to draw out the indicators particular to the green building parameters like vegetative cooling potential, surface reflectivity and construction density.

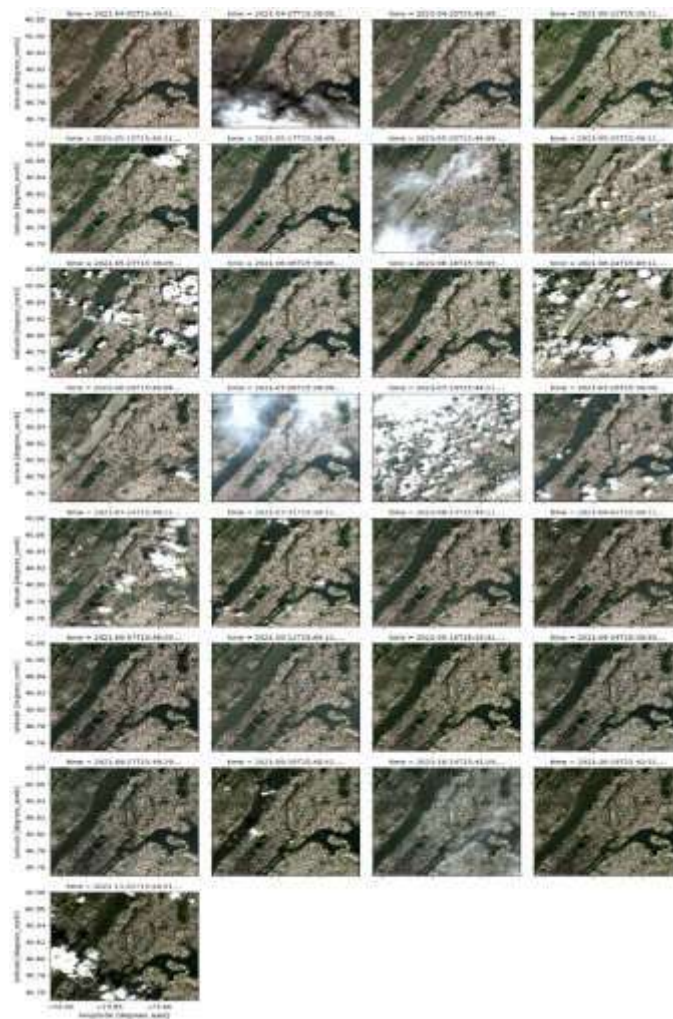


FIG-2 : Sample Data from the Dataset

Green Building Assessment Feature Extraction:

The most important environmental indicators were calculated in order to describe such parameters as building thermal performance and infrastructure resilience:

NDVI (Normalized Difference Vegetation Index): mc ohms-potential of vegetative cover and cooling.

NDBI (Normalized Difference Built-up Index): The density of built-up.

NDWI (Normalized Difference Water Index): Is used to indicate the presence of moisture.

IBI (Index-based Built-up Index): This is used to identify impervious surfaces.

Albedo (Surface Reflectivity): It is used to estimate the behavior of roofing and pavement to absorb heat.

Brightness Temperature Approximation: The thermal bands are used to estimate the measurements of localized heat intensity.

These indicators are proxies to the assessment of:

Green roof implementation suitability

Demand of reflective roofing materials

Priority areas of vegetation enhancement

Heat vulnerability on infrastructure.

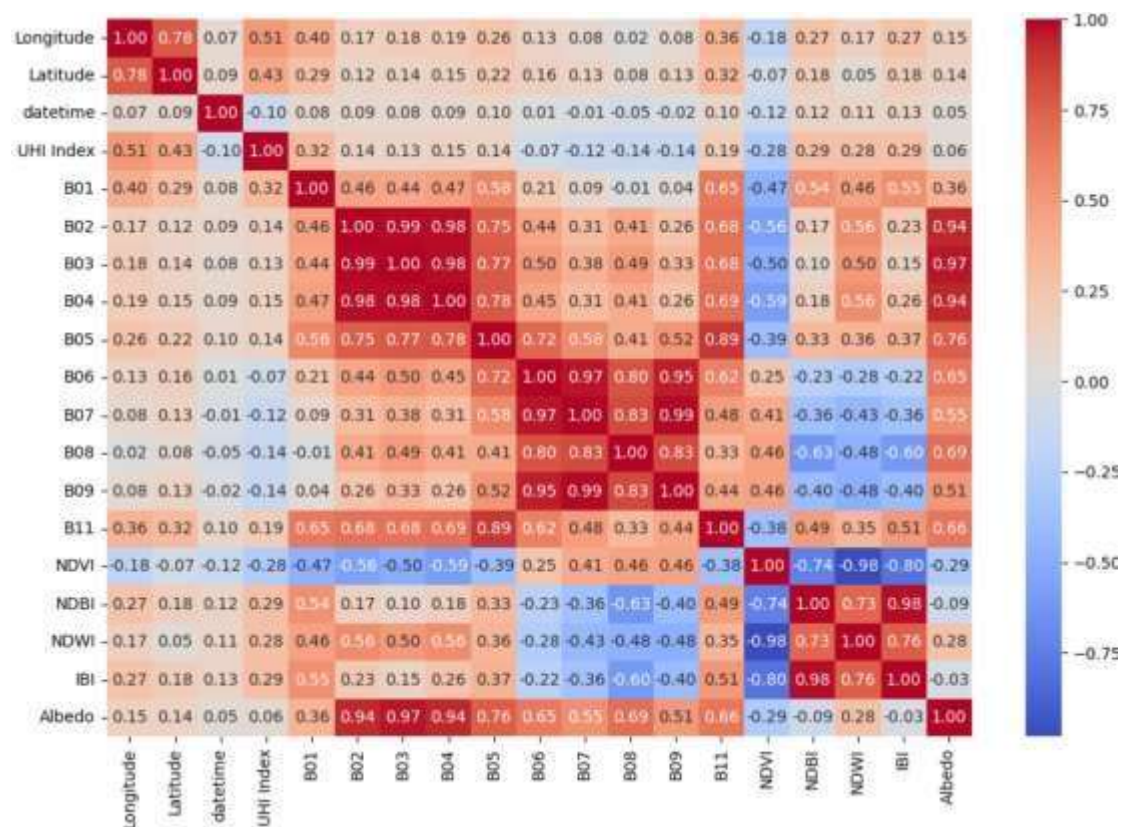


FIG-3 : Correlation Matrix

Thermal Suitability Mapping Machine Learning Model

The nature of a Random Forest Regression model was taken because it is strong in dealing with nonlinear associations between environmental parameters and changes in temperature.

The workflow of the modeling consisted of:

Division of the dataset into 70 and 30 training and testing sets respectively.

Normalization of input features by means of standardization.

Optimal predictive performance hyperparameter tuning.

The model does not only forecast some type of UHI index, but rather creates a High-Resolution Thermal

Exposure Index (HTEI), which categorizes urban areas into:

High thermal stress zones

Moderate suitability zones

Thermally optimized zones

Through this categorization, the planners are able to give priority areas where sustainable construction interventions will be done.

Entry into Sustainable Infrastructure Planning Framework

The expected thermal maps were converted into planning layers that could be acted on by:

Determining areas of construction that need high-albedo materials.

Identification of rooftops to support green retrofitting of roofs.

Indicating areas where vegetation buffers must be placed.

Endorsing plan orientation to the energy-efficient buildings.

The structure was incorporated within a GIS based decision support system which enables the use of spatial queries of the thermal suitability measures. This will allow architects, civil engineers and urban planners to model intervention situations and test what temperature can be lowered to before implementation.

The approach to the prediction of UHI using AI-supported thermal intelligence and infrastructure design variables can be used to convert traditional UHI prediction into a useful planning instrument to respond to climate-responsible urban development.

Development of the model and Thermal Suitability

A Random Forest Regression model has been used because it is a powerful model that is capable of nonlinear association of environmental variables and urban thermal performance. The proposed model was developed to produce a High-Resolution Thermal Exposure Index (HTEI) as opposed to traditional UHI prediction models that only approximate the intensity of temperatures to facilitate the green building design and sustainable infrastructure planning.

The stages in the modeling pipeline were:

To have the ability to ensure the generalization, the dataset was split into 70 percent training data and 30 percent testing data.

To normalize environmental variables this was done by feature normalization to normalize variables which included NDVI, NDBI, albedo and brightness temperature.

Cross-validation was employed in order to optimize hyperparameters such as depth of the trees, estimators and feature selection.

The trained model was used to obtain spatially iterative thermal exposure results over the kitchen area.

Instead of just estimating a UHI index, the model outputs were categorized into three categories that describe infrastructure related to the results:

High Thermal Stress Zones - Those areas that need urgent mitigation measures such as cool roofing surfaces and vegetative retrofitting.

Moderate Thermal Zones - Those zones are allowed to be developed with passive cooling incorporation.

Thermally Optimized Zones - Areas that are naturally favored with vegetation or high reflectivity surfaces are sustainable construction areas.

Through this classification, the planners and engineers can be able to transform AI predictions into viable building and material selection plans.

Evaluation Metrics

To determine model performance, the following criteria were used:

Measure of explanatory power Coefficient of Determination (R^2).

Mean Absolute Error (MAE) to measure the deviation of prediction.

Testing on training and unseen test sets to make sure it is robust.

In addition to statistical accuracy, the reliability of models was determined through its ability to indicate areas where vegetation cover and surface reflectivity play a major role in lowering temperature. This assessment helps to confirm that the model can be used to make decisions at the infrastructure level of planning.

Decision-Support Visualization and System Integration

In order to resolve the disconnect between the AI predictions and the real-life practices, the designed model was incorporated into a GIS-supported decision-making framework.

User Interface

Frontend Planning Interface The interactive web-based dashboard was made and it enabled the users, including the urban planners, architects and civil engineers to:

Choose certain geographical locations.

visualize thermal exposures classifications.

Determine green roofs, reflective surfaces and increase in vegetation suitability.

Determine thermal risk levels in proposed areas of construction.

Backend Analytical Engine The backend system takes the geospatial inputs and runs the Random Forest model that was trained to complete generation of the high resolution thermal suitability maps in real time. The model accommodates scenario-driven simulations that allow users to assess the potential of the vegetation cover or the alteration of the surface albedo to lower the heat intensity of local areas.

GIS Integration

Spatial alignment and Raster processing were done with geospatial processing packages such as Rasterio, GeoPandas and OpenCV. The framework facilitates the incorporation of other urban data, including the building height, land-use zoning, and infrastructure layers.

It has a scalable, modular system architecture that can support future upgrades of more complex machine learning models, like Convolutional Neural Networks (CNNs) or Transformer based architectures to achieve better results on spatial prediction.

The proposed system can be used to support planning by integrating AI-intelligent thermal mapping with interactive spatial visualization which can help in:

Energy-efficient locating of buildings.

Material choice in response to climate.

Zoning of sustainable infrastructure.

Urban heat mitigation strategy.

RESULTS

Thermal suitability analysis and results

The created AI-based framework was able to produce high-resolution thermal exposure maps in the study area. The Random Forest model had a good predictor unit in the description of the nonlinear relationship between vegetation density, the intensity of built-up, the reflectivity of the surface, and the local temperature change.

Model Performance

The model had a high coefficient of determination (R^2) which means that the predicted and observed thermal values are in high agreement. Analysis of Mean Absolute Error (MAE) also established that the deviations in prediction were within reasonable levels in the applications of the prediction in the planning of the urban level.

Model testing on hidden data sets indicated that the model was consistent and capable of generalizing the performance to use in other urban areas at scale.

The estimated High-Resolution Thermal Exposure Index (HTEI) allowed dividing the study area into three categories that are related to infrastructure:

High Thermal Stress Zones

Low vegetation cover (low NDVI) characterizes it.

The density of built-up is high (high NDBI/IBI).

Low surface reflectivity

These areas are defined as priority areas in:

Cool roof implementation

Green roof retrofitting

Hypotrophic development of the vegetative corridors.

Strategic pavement reflection.

Moderate Thermal Zones

Combinatory vegetation and urban features.

Passive cooling integration is suitable and controllable development.

Recommended as ideal building orientation and shading.

Thermally Optimized Zones

High vegetation density

Higher albedo surfaces

It leads to naturally reduced surface temperatures.

Appropriate in the expansion of infrastructure on a sustainable basis with little mitigation conditions.

The classification has shown that green cover and reflective materials play a critical role in climate responsive design as vegetative cover and surface material properties are highly important in determining thermal exposure.

Effects to Green Building Planning

The results indicate that:

Regions that had high NDVI values had lower surface temperatures.

Areas that had elevated albedo showed temporal moderation of heat.

The thermal level of stress was very high in the densely populated areas.

These findings confirm that:

Extensive vegetation cover will directly decrease the intensity of heat at the local level.

Reflective roofing could reduce the surface heat build-up by a great deal.

Thermal suitability maps can be used to locate buildings where cooling is minimized.

With the incorporation of these findings into the planning decision making, it is possible to:

Less energy used to construct buildings.

Greater comfort in the outdoor conditions.

More infrastructural resiliency to extreme heat.

Decision-Support Visualization

The GIS-based interface (Fig-4 and Fig-5) enables the user to:

Select a specific location

Retrieve results of thermal classification

Determine the green roof appropriateness.

Determine areas that need mitigation in terms of materials.

The developed system is appropriate to architects, civil engineers and urban planners, unlike the traditional UHI maps that only show gradients in terms of temperature and do not give translations of thermal data into planning guidance infrastructural development.

Practical Implications

These findings indicate that thermal mapping based on AI can be used as a decision aid in:

Design of climate-sensitive buildings.

Zoning of sustainable infrastructure.

Saving energy in the construction planning.

Urban development that is heat resistant.

The connection between predictive analytics and design-oriented recommendations propels the framework beyond temperature detection moving directly to formulating a green building strategy that should be taken.



FIG-4 : User Interface



FIG-5 : UHI Index Result

CONCLUSION

This paper introduced an artificial intelligence-based model of high-resolution mapping of urban heat islands and direct use in making guidelines on green buildings and sustainable infrastructures. The proposed system was able to produce spatially detailed thermal suitability maps in urban settings with the help of satellite-derived thermal indicators, meteorological data, urban morphology parameters, and machine learning techniques.

This study turned thermal analytics into infrastructure-oriented decision support, as opposed to traditional UHI studies, which make use of temperature prediction alone. The High-Resolution Thermal Exposure Index developed, made it possible to classify the urban areas in terms of thermal stress levels and this enabled planners and engineers to pinpoint areas where cool roofs should be implemented, green roofs retrofitted, vegetation strengthened and reflective materials to be adopted.

The findings proved that vegetation density and surface reflectivity play a major role in the localized thermal characteristics, which prove the utility of passive cooling measures in lowering heat build-ups. The framework can be used to ensure energy-efficient site placement of buildings, material choice that is responsive to climatic conditions, and infrastructure development that is resistant to heat, by combining AI-enabled predictive modeling with geospatial visualization tools.

Machine learning that will be combined with GIS-based planning systems will guarantee scalability and flexibility in a variety of urban settings. This will help in minimizing cooling energy requirements, enhance the thermal comfort outside and the resilience of urban areas to extreme heat events.

On the whole, the paper fills the gap between the analytical and practical approaches to urban climate and sustainable construction by converting uncooked thermal data into practical planning knowledge. The suggested framework has the potential to be utilized as a convenient decision-supporting framework by architects, civil engineers, and urban planners that are interested in integrating thermal factors into the early-stage design and infrastructure development procedures.

FUTURE ENHANCEMENTS

To extend the value of the proposed framework, real-time satellite imagery and data provided by the IoT-based environmental sensors to build a dynamic thermal monitoring system in urban settings can be introduced. The use of such advanced deep learning models as CNNs and Transformer-based ones might help to enhance the accuracy of spatial prediction and feature extraction.

Construction level parameters like roofing, facade materials and height of building may also be incorporated in the future work by using 3D GIS and LiDAR data to assist the finer energy performance analysis. By creating a scenario-based mitigation simulator, the planners would be able to assess how green roofs, more vegetation, and high-albedo materials will influence the reduction of the temperature and conservation of cooling energy.

Further, association of building energy consumption data with socio-economic indicators has the potential of enhancing the framework in sustainable infrastructure planning and fair heat mitigation. The implementation of the system as a scalable cloud-based decision-support service would also help in the smart city and climate-resilient development projects.

ACKNOWLEDGMENTS

We are pleased to convey our deep appreciation to our internal guide, **Naga Manasa Karlapudi, Assistant Professor, Dept of IT** for her valuable encouragement, constructive comments and full support to complete our paper.

Our heartfelt thanks to Dr.Y.J. Nagendra Kumar IT Head, and coordinators Ms. A. Pavithra for their constant support and encouragement for the entire completion of the paper.

We are especially thankful to Dr. Jandhyala N. Murthy, Director of GRIET & Dr. J. Praveen, Principal of GRIET for their support and encouragement that enabled smooth delivery of academic work and paper work.

Our sincere thanks also go to all the teaching and non-teaching staff of GRIET College, Hyderabad, for their support and encouragement extended during our academic and paper work.

REFERENCES

- [1] T. R. Oke,
“City size and the urban heat island,”
Atmospheric Environment, vol. 7, no. 8, pp. 769–779, 1973.
- [2] H. Akbari, M. Pomerantz, and H. Taha,
“Cool surfaces and shade trees to reduce energy use and improve air quality in urban areas,”
Solar Energy, vol. 70, no. 3, pp. 295–310, 2001.
- [3] A. Rosenfeld, H. Akbari, S. Bretz, B. Fishman, D. Kurn, D. Sailor, and H. Taha,
“Mitigation of urban heat islands: Materials, utility programs, updates,”
Energy and Buildings, vol. 22, no. 3, pp. 255–265, 1995.
- [4] D. J. Sailor,
“A green roof model for building energy simulation programs,”
Energy and Buildings, vol. 40, no. 8, pp. 1466–1478, 2008.
- [5] P. Mirzaei and F. Haghighat,
“Approaches to study urban heat island – Abilities and limitations,”
Building and Environment, vol. 45, no. 10, pp. 2192–2201, 2010.
- [6] G. Santamouris,
“Cooling the cities – A review of reflective and green roof mitigation technologies,”
Solar Energy, vol. 103, pp. 682–703, 2014.
- [7] R. Zou, B. Lin, Y. Xu, and M. Ghahramani,
“Long-term prediction of urban overheating using LSTM networks and nature-based solutions,”
Sustainable Cities and Society, vol. 91, Art. no. 104376, 2025.
- [8] C. Shen, H. Hou, Y. Zheng, Y. Murayama, R. Wang, and T. Hu,
“Future prediction of surface urban heat island intensity using random forest modeling,”
Sustainable Cities and Society, vol. 75, Art. no. 103266, 2022.
- [9] N. D. Miniandi, M. H. Jamal, M. K. I. Muhammad, L. Sharrar, and S. Shahid,
“Urban heat island mitigation using machine learning and remote sensing in Kuala Lumpur,”
Remote Sensing Applications: Society and Environment, vol. 31, Art. no. 100976, 2025.
- [10] G. Tanoori, A. Soltani, and A. Modiri,
“Machine learning approaches for urban land surface temperature prediction and morphology analysis,”
Urban Climate, vol. 54, Art. no. 101832, 2024.
- [11] M. Mokarram, S. Azari, and M. Alavi,
“Neural network-based modeling for urban heat island trend analysis and spatial assessment,”
Environmental Monitoring and Assessment, vol. 195, no. 6, pp. 1–18, 2023.
- [12] A. Cafaro, F. A. Aversano, and M. T. Gaglione,
“A GIS-based ISODATA clustering approach for urban heat island detection,”
Urban Climate, vol. 48, Art. no. 101440, 2024.

- [13] Y. Yu, W. Chen, L. Yao, and D. Lee,
“Outdoor air temperature prediction based on urban morphology parameters,”
Building and Environment, vol. 160, pp. 106–118, 2019.
- [14] K. Li, X. Zhou, and Y. Wang,
“Impact of urban green infrastructure on building energy performance and microclimate,”
Energy and Buildings, vol. 158, pp. 113–125, 2018.
- [15] F. Innocenti, G. Bianchi, L. Poli, and S. Tartarini,
“High-resolution urban temperature forecasting using CNN and Sentinel-3 data,”
Remote Sensing, vol. 16, no. 4, Art. no. 812, 2024.