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Investigating the correlation between Land Surface Temperature, Vegetation Coverage, Methane (CH4) concentration, precipitation, and wind, and their effects on the tourism rate in Bangkok and London using Google Earth Engine (GEE)

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ABSTRACT

Background and objective: Tourism, a key factor in sustainable development, faces challenges like air pollution and urban heat islands. Land Surface Temperature (LST), affected by factors such as surface type, weather, and solar radiation, is critical in understanding local climate dynamics. This study aims to examine the relationship between LST, vegetation cover, wind patterns, precipitation, and methane (CH4) levels, and their impact on tourism in Bangkok and London
Materials and methods: The study utilized satellite data from Sentinel-5P, Sentinel-2, Global Precipitation Measurement (GPM), and Sentinel-3A images, processed through Google Earth Engine (GEE). Online platforms like Weatherspark provided supplementary data. The Normalized Difference Vegetation Index (NDVI), wind, precipitation, and CH4 concentrations were analyzed to assess their influence on LST distribution and their subsequent impact on tourism in both cities.
Results and conclusion: : The results reveal a strong correlation between LST and vegetation cover. Bangkok's higher LST, especially in central areas, is linked to sparse vegetation, whereas London's consistent vegetation coverage results in lower LST and a cooler climate. Methane pollution in Bangkok is concentrated in the northeast, with a general decline in emissions in both cities. London, with more favorable temperatures and weather conditions, received a higher tourism rating (7.1) compared to Bangkok (6.1). This study highlights the importance of urban planning and environmental management to mitigate the effects of heat islands, providing valuable insights for sustainable tourism development.

1. Introduction

During the last half century, the surface of the earth has undergone many changes caused by human

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activities through deforestation and development of cities (Addae & Dragićević, 2023). The reduction of vegetation is one of the important elements of the change in albedo and as a result, the reduction of the net reflectance of the soil surface (Zheng et al, 2019). The temperature of the earth's surface in each specific area is dependent on the characteristics of its constituent materials and the absorption of solar energy (Granqvist & Niklasson, 2018). Accordingly, one of the causes of changes in air temperature in the microclimate of any location is the alteration in land use and vegetation cover. The Land surface temperature (LST) serves as a crucial indicator in assessing the thermal dynamics of terrestrial environments, with its variations deeply intertwined with topography, vegetation cover, precipitation, and overall weather patterns (Tan et al., 2020). This intricate relationship has been extensively studied in environmental research, highlighting the multifaceted influences of topography and vegetation on LST distribution (Tan et al., 2020). Furthermore, these factors play a pivotal role in shaping local climate conditions, influencing precipitation patterns, and regulating water availability.

The interplay between LST, topography, and vegetation cover has significant implications for air pollution dynamics, particularly in the context of methane (CH4) emissions (Jodhani et al., 2024). Studies have shown that elevated LST, often associated with urban heat islands exacerbated by topographic features, can lead to increased CH4 emissions from various sources, including landfills and agricultural activities (Mokarram et al., 2023; Sultana et al., 2022). Such emissions contribute to air pollution and exacerbate the challenges of mitigating climate change and maintaining air quality in urban environments.

Understanding the complex interactions between LST, topography, vegetation cover, and air pollution is essential for sustainable urban development and environmental management (Suthar et al., 2024). Identifying socio-economic opportunities and factors influencing climatic conditions, including water basin management, through promoting and formulating scientific strategies and environmentally friendly approaches, can lead to the preservation of natural landscapes and the enhancement of ecotourism (Jamali et al., 2021). By prioritizing sustainable land use practices, green infrastructure development, and pollution control measures, cities can create more appealing environments for tourists, contributing to both economic growth and environmental conservation efforts (Di Marino et al., 2019).

Remote sensing data provides valuable insights into analyzing key indicators such as LST and the Normalized Difference Vegetation Index (NDVI) (Guha & Govil, 2022). Additionally, it enables the monitoring of precipitation and pollutants. LST, derived from satellite or aerial sensors such as Sentinel, Landsat, MODIS, and radar images, signifies the actual surface temperature and is influenced by various factors including solar radiation, land cover, and atmospheric conditions.

On the other hand, NDVI, calculated from the difference in reflectance of visible and near-infrared light by vegetation, serves as a critical indicator of vegetation cover and biological activity (Guha & Govil, 2022). The range of variations in these indices depends on environmental conditions and the time period under consideration (Jaber & Abu-Allaban, 2020). For instance, LST variations may range from negative values in cool and moist areas to positive values in hot and dry regions. Similarly, NDVI typically ranges from 0 to 1, with higher values indicating greater vegetation cover and health (De La Iglesia Martinez & Labib, 2023). The applications of these indices in the tourism sector are diverse. Analyzing LST and NDVI changes can assist tourism authorities in selecting suitable tourist destinations by providing accurate information about climatic and environmental conditions. Additionally, these indices can aid local authorities in planning and developing green spaces and open areas in tourist regions, enhancing tourism attractiveness and contributing to environmental preservation.

Google Earth Engine (GEE) is a powerful cloud-based geospatial analysis platform developed by Google for planetary-scale environmental data analysis (Ghosh et al., 2022). It provides access to an extensive archive of satellite imagery and geospatial datasets, along with a suite of tools for processing, analyzing, and visualizing these data (Ganjirad & Bagheri, 2024; Ghosh et al., 2022). GEE has revolutionized the way researchers, scientists, and developers access and analyze Earth observation data, enabling them to conduct complex geospatial analyses at scale and speed that were previously impractical or impossible.

1.1. Domestic-related works:

Kazemi Garajeh et al. (2023) utilized Sentinel-5 data with GEE to monitor air pollution in Arak, Iran. The study concluded that integrating remote sensing data with automated approaches like GEE is practical for pollution monitoring, providing more accurate spatially distributed data. Ebrahimy et al. (2021) conducted a study using GEE to product MODIS LST for a 19-Years Spatiotemporal Trend Analysis over Iran. Spatiotemporal analysis revealed significant positive LST trends in Iran during full year (25.08%), spring (10.05%), summer (56.68%), fall (1.04%), and winter (32.84%). Negative trends were noted during full year (3.09%), spring (23.84%), summer (7.54%), fall (17.38%), and winter (18.77%).

Shafizadeh-Moghadam et al. (2020) utilized Landsat 8 data to simulate urban LST, NDVI, and land use land cover classification in Tehran, Iran. The findings indicated lower LST values near major roads, which were attributed to the presence of vegetation along streets and highways.

1.2. Foreign-related works:

Liu et al. (2022) utilized Landsat satellite imagery to assess urban development and ecological environment in Guilin, a tourist city in China, using LST and NDVI. Findings revealed rapid urbanization in Guilin over the past two decades, attributed to increased tourism. Moreover, the relationship between urban development and the ecological environment has shown improvement.

Atwah (2021) employed Landsat satellite imagery and GEE to assess LULC changes' effects on sustainability and well-being in the urban environment over a 20-year period. Findings indicated that human-environmental interactions in urban settings significantly influence sustainability.

Guo et al. (2013) utilized Green House Gases (GHG) data, NDVI from the Moderate Resolution Imaging Spectroradiometer (MODIS), and land-cover data to examine the correlation coefficients between land cover and GHG concentrations. Findings suggested that forests and croplands may act as CH_4 sources, while scrublands and grasslands could be considered CH_4 sinks.

Bangkok, the bustling capital city of Thailand, is renowned for its vibrant street life, rich cultural heritage, and delectable cuisine, which collectively draw millions of visitors each year (Ngamsiriudom et al., 2024). However, the city's tropical climate, characterized by high temperatures and humidity year-round, coupled with its dense urbanization and limited green spaces, presents challenges for tourists seeking outdoor activities (Fakfare et al., 2022). The prevalence of the urban heat island effect exacerbates heat-related discomfort, while air pollution issues persist, particularly during certain periods, impacting the overall tourist experience.

On the contrary, London, the historic capital city of the United Kingdom, offers a markedly different tourism experience. Boasting iconic landmarks, a diverse cultural scene, and extensive green spaces such as parks and gardens, London attracts visitors from across the globe (Smith et al., 2022). Its temperate maritime climate, characterized by moderate temperatures and frequent rainfall, provides favorable conditions for outdoor exploration and sightseeing throughout the year. The presence of well-maintained green spaces not only enhances the aesthetic appeal of the city but also helps mitigate the urban heat island effect, offering respite from the hustle and bustle of urban life (Elliott et al., 2020). While both Bangkok and London offer distinct cultural experiences and attractions, their divergent climates, urban landscapes, and environmental conditions shape unique tourism experiences for visitors. Bangkok's lively atmosphere and culinary delights contrast with London's historical charm and verdant landscapes, catering to diverse preferences and interests among tourists. Awareness of these differences allows travelers to make informed choices and maximize their enjoyment of these vibrant cities while also recognizing the importance of environmental preservation in sustaining their appeal for future generations.

This research investigates two fundamental hypotheses:

- 1. The frequency and duration of precipitation in large cities contribute to a reduction in land surface temperature.
- 2. Precipitation patterns and wind direction exhibit a direct correlation with methane concentration levels.

The main aim of this study is to investigate the correlation between LST, vegetation cover, and topography in two urban centers Bangkok and London. Additionally, this research will explore the influence of meteorological factors such as precipitation, wind patterns, and pollution (specifically CH4) on these variables. To achieve this, Geographic Information System (GIS) tools GEE is utilize, alongside Capture Faststone software, for the assessment of LST, CH4 levels, and NDVI.

2. Materials and Methods

2.1. Study Area

London, the vibrant capital of the United Kingdom, and Bangkok, the bustling metropolis of Thailand, are two cities of significant global importance. London, situated in the southeastern part of England, is characterized by its rich history, diverse culture, and iconic landmarks such as the Tower Bridge and the Houses of Parliament. With geographical coordinates of approximately 51.5074° N latitude and 0.1278° W longitude, London stands as a major touristy, cultural, and political hub on the world stage.

On the other hand, Bangkok, located in the central region of Thailand, is renowned for its dynamic street life, ornate temples, and natural and historical attractions. With geographical coordinates of around 13.7563° N latitude and 100.5018° E longitude, Bangkok emerges as a key economic and touristy center in Southeast Asia, attracting millions of visitors each year with its vibrant street markets, bustling nightlife, and rich cultural heritage. Despite their geographical and cultural differences, both London and Bangkok serve as focal points for various research endeavors, offering unique insights into urban dynamics, environmental factors, and societal trends on a global scale.

2.2. Data Collection

2.2.1. Remote Sensing Data

This study utilized remote sensing data for Bangkok and London, with a focus on topographical, climatic, vegetation, and Land Surface Temperature (LST) maps. These outputs were generated using satellite data and image processing tools available on the Google Earth Engine (GEE) platform. Precipitation maps, Normalized Difference Vegetation Index (NDVI), LST, and methane (CH4) distribution maps were processed and monitored through the platform’s available functions.

Additionally, to analyze wind patterns and their impact on LST and the tourism industry in both cities, wind speed and direction data were sourced from the online platform Windfinder. Windfinder provided detailed wind rose charts and historical wind data for Bangkok and London, offering valuable insights into local climate dynamics. These wind data were integrated into the study to investigate correlations between wind patterns, vegetation cover, and CH4 concentrations, contributing to a comprehensive analysis of urban climate influences on tourism.

2.2.1.1 Precipitation

For collecting precipitation data for the cities of Bangkok and London, we utilized data from the Global Precipitation Measurement (GPM) satellite. GPM is a global remote sensing mission carried out by the Japan Aerospace Exploration Agency (JAXA) and NASA (National Aeronautics and Space Administration) in collaboration with other space agencies (Watters & Battaglia, 2021). This mission comprises a series of satellites that measure global precipitation with high accuracy using microwave radars. Due to the high precision and resolution of this data, we employed it to gather precipitation information in our study areas.

2.2.1.2. NDVI

GEE platform utilizes remote sensing data (Sentinel-2) to calculate the NDVI. NDVI is computed using near-infrared (NIR) and red band reflectance values from satellite imagery. The formula for NDVI is (NIR - Red) / (NIR + Red), where higher values indicate denser vegetation. The output of this process is a thematic map representing vegetation density, with values ranging from -1 to 1. Vegetated areas typically have higher NDVI values, while non-vegetated or sparse vegetation areas have lower values (De La Iglesia Martinez & Labib, 2023).

2.2.1.3. LST

In this study using GEE platform, LST is generated using Sentinel-3A data. These data include thermal images captured by specialized sensors. Subsequently, image processing algorithms are applied to convert thermal data from satellite imagery into land surface temperature. The output of this process typically consists of a thermal map illustrating the temperature of the Earth's surface at each point (Hu et al., 2019).

2.2.1.4 CH4

In GEE platform, methane (CH_4) concentrations can be analyzed using Sentinel-3A data, which we employed in this study. These data are processed using image processing algorithms and data analysis techniques to visualize methane concentrations in various locations. The output of this process may include maps, charts, or numerical data displaying methane concentrations at different points (Pandey et al., 2023) .

2.2.1.5 Wind rose

Wind rose were sourced from the Windfinder platform, which provides reliable wind data based on weather models and satellite observations. Wind rose charts from Windfinder illustrate wind direction and speed for specific locations, such as Bangkok and London. These charts were utilized to analyze the distribution of wind patterns, offering valuable insights into how wind direction and speed influence local climate dynamics and the tourism industry in the two cities. The use of Windfinder data complements the remote sensing analysis carried out in GEE, contributing to a comprehensive understanding of climatic impacts on urban environments (Gharibvand et al., 2023).

2.2.1.6 Tourism Score Chart

To extract tourism scores and statistical information for the cities of Bangkok and London, a reputable online source was utilized. The website used provides the capability to compare tourism scores based on weather conditions and other relevant factors (https://weatherspark.com/). Given the accuracy and reliability of this website, tourism scores for both cities were meticulously examined, and the results were comparatively discussed in the article.

3. Result

3.1. LST

In Fig. 1, panels (a) and (b) illustrate the LST maps for Bangkok and London, respectively. LST maps represent surface temperature using colors, allowing us to analyze temperature variations across Bangkok and London. According to panels (a) and (b) the warmer temperatures are typically depicted by warmer colors such as red, while cooler temperatures are represented by cooler colors such as blue or green. By examining these color variations, we can identify areas in Bangkok and London with higher or lower temperatures. Additionally, specific features such as urban heat islands or areas with significant temperature gradients in both Bangkok and London can be discerned based on the colors.

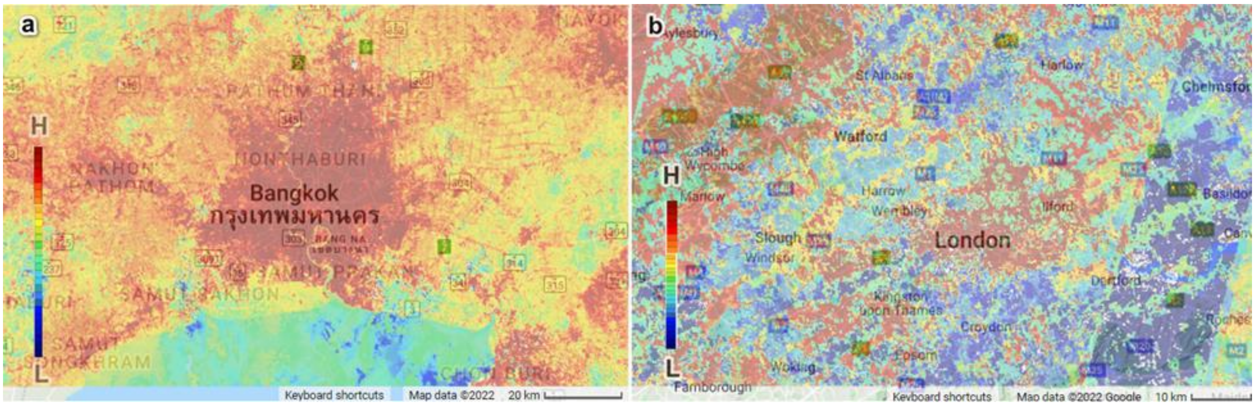

Fig.1- (a) Land Surface Temperature of Bangkok, (b) Land Surface Temperature of London

3.2. NDVI

In Fig. 2, panels (a) and (b) illustrate the NDVI maps for Bangkok and London, respectively in 2022. NDVI maps represent vegetation cover using colors, enabling us to analyze variations in vegetation density across both cities. Higher vegetation density is typically depicted by brighter shades of green or yellow, while lower vegetation density is represented by darker shades or even bare soil, as indicated by red and white colors. By examining these color variations, we can identify areas with abundant vegetation cover as well as those with sparse vegetation or bare soil in both Bangkok and London. Additionally, specific features such as forests, agricultural fields, or urban areas can be distinguished based on the NDVI colors in both cities.

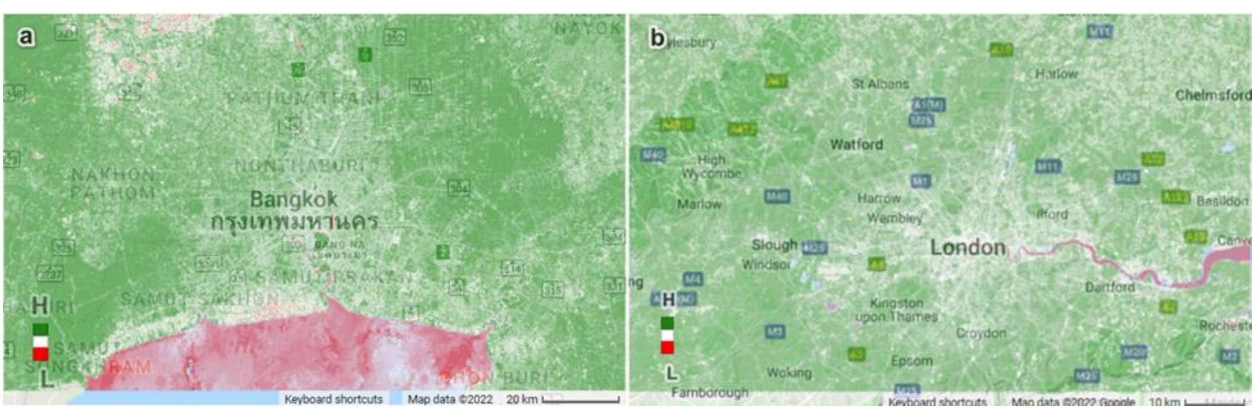

Fig. 2- (a) NDVI of Bangkok, (b) NDVI of London

3.3. Precipitation

In Fig. 3, panels (a) and (b) illustrate the precipitation graphs for Bangkok and London, respectively, from 1985 to 2020. Analyzing these graphs reveals distinct patterns in precipitation behavior for each city during the specified time period. While yearly fluctuations in precipitation can be observed, an overall pattern of precipitation for each city becomes evident. In the precipitation graph for Bangkok, variations in yearly precipitation levels are noticeable. The peak of precipitation occurred between 2010 and 2015, where the total precipitation amounted to approximately 0.006 (m). Conversely, in the London precipitation graph, an annual pattern of precipitation is evident. The total amount of precipitation in London, measured in millimeters, is higher compared to Bangkok. For instance, between 2010 and 2015, the total precipitation in London amounted to 0.015 (m).

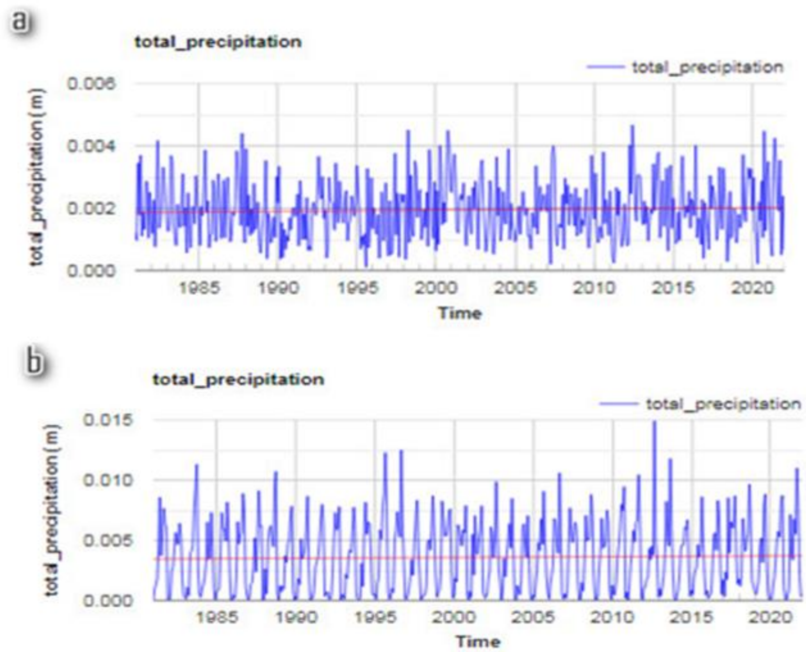

Fig. 3- (a) Precipitation graph for Bangkok, (b) Precipitation graph for London

3.4. Wind rose

In Fig. 4, panels (a) and (b) illustrate the precipitation graphs for London and Bangkok, respectively. A wind rose is a graphical representation of wind speed, direction, and frequency for a specific location over a defined period of time. Typically displayed in a circular format, the wind rose consists of radial spokes or lines representing different wind directions, with the length of each spoke indicating the frequency or percentage of time that the wind blows from that particular direction. The wind speed is often represented by color or shading, with higher wind speeds depicted by longer or darker segments. Wind rose graphs for London and Bangkok were obtained using the Windfinder platform with a time domain of February 1, 1988, to February 28, 2021, for London, and April 1, 1970, to April 30, 2021, for Bangkok (Fig. 4, panels (a) and (b)).

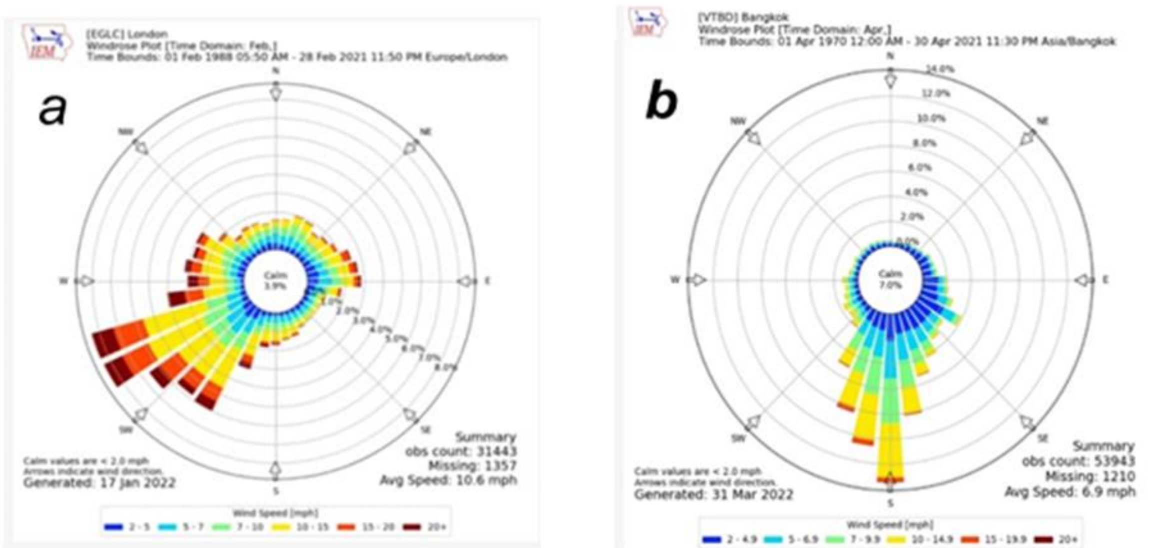

Fig. 4- (a) Wind rose chart for London, (b) Wind rose chart for Bangkok

3.5. Methane (CH4)

In Fig. 5, panels (a) and (b) illustrate the amount of CH4 concentration for Bangkok and London, respectively. In this study methane (CH4) concentration and variations extracted from GEE. The color-coded output map from Google Earth Engine (GEE) representing Methane (CH4) concentration levels requires an understanding of the color scheme and its correlation with CH4 concentration values (Fig. 5, panels (a) and (b)). Based on the figure different colors represent varying levels of CH4 concentration, with each color corresponding to a specific range of concentration values. For example, shades of dark or blue indicate lower CH4 concentrations, while shades of yellow, orange, or red may represent higher concentrations.

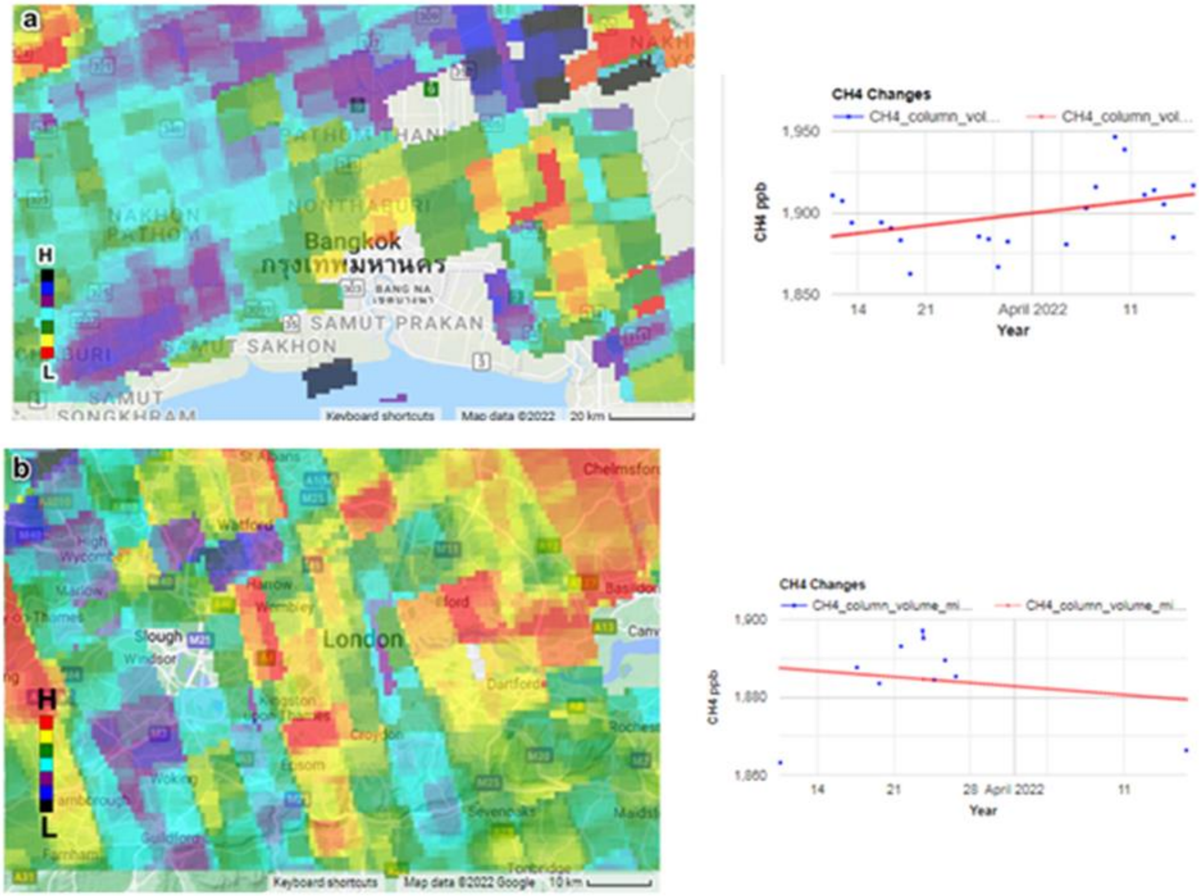

Fig. 5- (a) Methane (CH4) concentration levels for Bangkok, (b) Methane (CH4) concentration levels for London

3.6. Compare the Wind Speed, Temperature, Precipitation and Tourism score in London and Bangkok

This Fig. 6, panel (a) illustrates that wind in London is generally stronger and more variable. Wind in the city ranges from 21.4 kilometers per hour in January to 15.5 kilometers per hour in July. Conversely, Bangkok experiences less wind overall, with minimal variation throughout the year, peaking at 12.9 kilometers per hour in March. For London, the average high temperatures range from 9°C in January to 23°C in July, with a gradual decrease towards December. Conversely, Bangkok experiences consistently high temperatures throughout the year, with average highs ranging from 31°C to 35°C. In terms of average low temperatures, London sees a range from 4°C in January to 15°C in July, gradually declining towards December.

Meanwhile, Bangkok maintains relatively warm lows, fluctuating between 22°C and 27°C throughout the year. These data highlight the stark contrast in temperature patterns between the two cities, with London exhibiting more seasonal variation compared to the consistently warm climate of Bangkok (Fig.6, panel (b)). London experiences a relatively consistent number of days with precipitation, ranging from approximately 6.5 days in April to 9.4 days in November and December. Conversely, Bangkok's precipitation patterns show distinct wet and dry seasons, with the wettest months being August and September, experiencing around 16.9 and 20.1 days of precipitation, respectively. This highlights the contrasting precipitation patterns between the two cities (Fig.6, panel (c)). The peak travel season for London spans from April to the end of July, with the highest peak occurring in July at a Tourism Score of 7.1. In contrast, for Bangkok, the lowest and highest tourism levels occur in May with a score of 2.0 and December with a score of 6.1, respectively. The Tourism Score favors clear, rainless days with perceived temperatures between 18°C and 27°C (Fig.6, panel (d)) (https://weatherspark.com/).

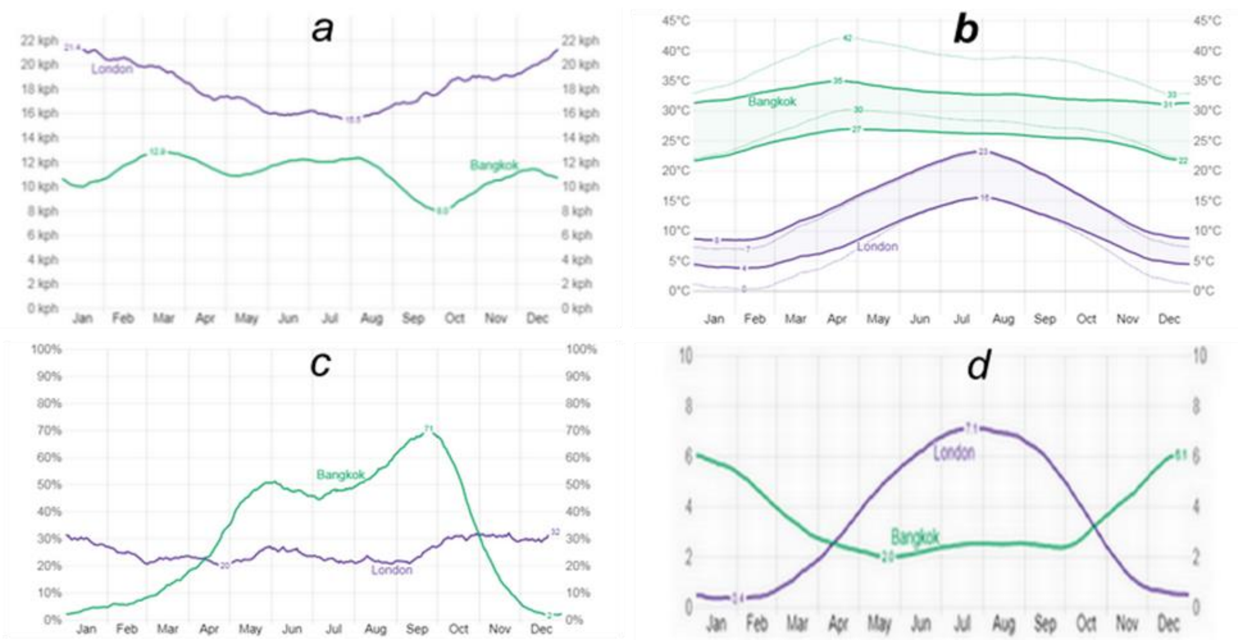

Fig. 6- (a) Average wind speed, (b) Average high and low temperatures, (c) Daily precipitation probability, (d) Tourism score

4. Discussion

Today, urbanization is advancing globally, driven by a multitude of social, demographic, and environmental factors. However, the manifestation of this phenomenon varies significantly between developing and developed nations. In sprawling and highly developed metropolises, which serve as popular destinations for tourists worldwide, the continued expansion of urban areas has profound social and environmental repercussions. The primary objective of this study is to explore the interplay between LST, vegetation cover, topography, and their influence on two distinct cities, Bangkok and London. In pursuit of this objective, various parameters such as LST, pollution levels (including CH4), climatic variables (including precipitation and wind patterns), and vegetation indices are meticulously considered. By analyzing these factors, we aim to gain insights into the complex dynamics shaping the tourism landscape of these cities.

In this study, we utilized remote sensing data such as Sentinel-5P, Sentinel-2, Global Precipitation Measurement (GPM) images, and Sentinel-3A obtained through GEE to analyze various environmental factors. Specifically, we extracted data on LST, precipitation patterns, wind patterns, trends in methane levels (CH4), CH4 concentration, and the NDVI. The utilization of GEE and its associated products proved to be highly effective in our analysis. By leveraging remote sensing images, we were able to uncover valuable insights into the environmental dynamics of the study area.

Furthermore, our findings were corroborated by comparisons with previous research that demonstrating the reliability and validity of our methodology (Liu et al., 2024; Mutimba et al., 2024). LST analysis provides valuable insights into local climate patterns, land cover characteristics, and environmental conditions.

The increase in LST in major cities like Bangkok and London is influenced by both human and natural factors (Khamchiangta & Dhakal, 2019). Urbanization, industrial activities, transportation emissions, and the heat island effect are significant human factors contributing to higher LST levels. Additionally, natural factors such as weather patterns, geographic location, and terrain characteristics also play a role in determining LST variations in these urban areas (Khamchiangta & Dhakal, 2019). Understanding the interplay between these human and natural factors is crucial for effective urban heat management strategies.

Based on Fig. 1, the study reveals that LST in Bangkok exhibits higher readings concentrated in its central regions, denoted by red hues, indicating elevated temperatures. Conversely, in London (Fig.1, panel (b)), high temperatures are more dispersed throughout the city, resulting in a cooler overall climate.

In Fig. 2, vegetation cover appears depleted in the southern regions of Bangkok due to pronounced heat, while London (Fig. 2, panel (b)) retains a more consistent vegetation cover. Thus, vegetation reduction significantly contributes to the formation of urban heat islands and correlates directly with the increase in LST and vice versa. Additionally, the data presented in Fig. 3 demonstrate that Bangkok experiences more frequent, longer, and more intense precipitation events compared to London. Hence, this study concludes that the frequency, duration, and intensity of rainfall, as observed in cities like Bangkok, do not consistently mitigate the formation of urban heat islands or reduce LST. Other factors such as vegetation loss, air pollution, or wind direction could also influence these phenomena.

The relationship between wind patterns and the concentration, dispersion, and fluctuations of methane (CH4) and pollutants in large tourist cities is complex. Winds can play a crucial role in dispersing CH4 and pollutants, affecting their spatial distribution and concentrations. Additionally, wind speed and direction influence the transport of pollutants from emission sources to other areas, impacting air quality and public health. Understanding these interactions is essential for effective air quality management and environmental protection measures in urban tourist destinations.

Based on Fig. 4, the prevailing wind in Bangkok predominantly blows from the southern areas, indicating their significant role in pollutant accumulation. Conversely, London experiences prevailing southwest winds, resulting in higher pollution levels in this part of the city. Examining Fig. 5, methane (CH4) concentrations are notably higher in certain northeastern areas of Bangkok, albeit showing a declining trend over time. Conversely, London exhibits decreasing CH4 levels, with some areas showing minimal to no presence of pollutants. In these maps, colors such as red, yellow, and green denote higher methane concentrations, while blue and black represent lower levels of methane presence.

Based on the Fig. 6, London appears to be more suitable for tourism. London experiences stronger and more variable winds, offering a diverse travel experience. Additionally, London exhibits more variability in temperature, providing tourists with a seasonal and diverse experience. On the other hand, Bangkok has consistently high temperatures and minimal wind variation, which may not appeal to all tourists. Furthermore, Bangkok's precipitation patterns tend to be seasonal, potentially impacting the travel experience. Therefore, considering these factors, London emerges as the more suitable tourist destination.

Pollution, insufficient green spaces, adverse weather conditions, and uncontrolled changes in Land Use and Land Cover (LULC) in urban environments and tourist destinations often result in disorder and exacerbate socio-economic issues (Bokhari et al., 2022). The urban expansion observed in modern and developed cities like London and Bangkok underscores environmental concerns such as ecological imbalance, deteriorating air quality, and the depletion of natural resources (Almulhim et al., 2024). Another important factor in sustainable development and environmental conservation is determining the correct scientific strategy and appropriate socio-economic strategies for ecotourism, which increase economic opportunities and mitigate environmental impacts (Jamali et al., 2021). As global tourism hubs, Bangkok and London are experiencing rapid transformations, presenting significant challenges in managing the spatial ramifications of population growth and urban sprawl, driven by intricate urban development patterns. The surge in population, accompanied by infrastructural developments and altered rainfall patterns, negatively impacts arable lands and diminishes tourist appeal in both cities. The conversion of vacant land into urban zones is anticipated to yield adverse environmental and urban outcomes, including heat islands, escalated infrastructure expenses, diminished biodiversity, soil erosion, flooding, and depletion of natural resources. Moreover, the substantial population influx due to tourism exacerbates urban landscape alterations, leading to denser urban structures and heightened globalization pressures in urban settings (Petrişor et al., 2020).

5. Conclusion

In conclusion, our study sheds light on the intricate relationship between LST, vegetation cover and topography factors, and it clarifies the impact of these factors on tourism in two distinct cities, Bangkok and London. Through the analysis of various parameters including LST, vegetation cover, precipitation patterns, wind patterns, and pollutant concentrations, we have uncovered significant insights into the environmental dynamics shaping these urban landscapes.

The utilization of remote sensing data through GEE has proven to be instrumental in this analysis, providing reliable and comprehensive information for our study. Our findings underscore the importance of understanding the interplay between human-induced factors such as urbanization, alongside natural variables like weather patterns and geographic features, in determining environmental conditions in urban areas. Moreover, the implications of these environmental dynamics extend beyond mere climatic changes, impacting crucial aspects such as tourism and public health. Moving forward, effective urban management strategies must take into account these complex interactions to ensure sustainable development and environmental protection in urban tourist destinations.

Decision makers can utilize these findings to advance sustainable urban development and facilitate the growth of smart cities, all while managing the impacts of factors such as high LST, air pollution, and reductions in vegetation on the tourism industry. Future efforts could improve the analysis by including broader datasets, but this study offers valuable insights into urbanization dynamics, not only in Bangkok and London, but also in other cities.

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Consent to Publish (Author consent to publishing)

Authors Contributions (The author contributed to data collection, analysis, and interpretation. Both authors critically reviewed, refined, and approved the final manuscript.)

Code availability (Not applicable)

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