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# Sustainable design strategies in hotel buildings in downtown Guayaquil, Ecuador

**Estrategias de diseño sostenible en edificaciones hoteleras del Centro de Guayaquil, Ecuador**

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## ABSTRACT

This article, starting with the general concept of green areas and an analysis of their current state in hotel buildings in downtown Guayaquil, examines their impact on the city's urban development. It aims to interpret and categorize the current urban green space index and its influence on sustainable design towards bioclimatic vision. Guayaquil's urban green space index is one of the lowest in Latin America, at just 2.54 m² per inhabitant, far from the WHO's recommended minimum of 9 m² per inhabitant. This significantly

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affects air quality and the overall well-being of the city's residents. This scarcity of vegetation is a consequence of the city's booming commercial and informal development, which relies almost exclusively on main avenues and streets. The objective of this article is to increase the urban green space index by integrating green roof models into buildings in Guayaquil's urban center, thus creating an interconnected network of green roofs to rethink the city's urban design. A mixed-methods approach was used, employing both qualitative and propositional perception data. Quantitative data was analyzed using temperature and heat measurements systematized in ArcGIS to generate graphs and percentages for identifying urban heat islands. In conclusion, the study found that by proposing sustainable design strategies for hotel buildings in downtown Guayaquil, incorporating green roofs and vertical plant panels, the green space index could be increased to 5.64 m² per inhabitant, closely aligned with the WHO's minimum recommendation of 9 m² per inhabitant.

**RESUMEN**

El presente articulo busca a partir de la concepción general de áreas verdes y el análisis de su situación actual de las edificaciones hoteleras del centro de Guayaquil y su impacto en el desarrollo urbanístico de la ciudad en donde se puede interpretar y categorizar el índice del verde urbano actual y su incidencia en el diseño sostenible hacia una visión bioclimática. El índice verde urbano de la ciudad de Guayaquil es uno de los más bajos de América Latina, rozando los 2,54 m2 por habitante, lo que dista mucho del mínimo recomendado por la OMS de 9m2 por habitante, lo que afecta significativamente las condiciones y la calidad del aire. de la vida general de una sociedad integral. Esta escasez de vegetación es producto del auge del desarrollo comercial e informal de la ciudad, que solo cuenta con áreas verdes urbanas en avenidas o calles principales. El objetivo de este artículo científico es incrementar el índice verde urbano mediante la integración de modelos de techos verdes en edificaciones del casco urbano de Guayaquil, configurando así una red interconectada de techos verdes para repensar el diseño urbano de la ciudad. Se utilizan una metodología con enfoque mixto basada en datos de percepción como cualitativos y propositivos; mientras que se analizan datos cuantitativos mediante los análisis de temperatura y calor sistematizados en la aplicación ArcGIS para obtener gráficas y porcentajes para la identificación de islas de calor. En conclusión, se obtiene que, al proponer estrategias de diseño sostenible en las edificaciones hoteleras con integraciones de cubiertas verdes y paneles

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vegetales verticales en el centro de Guayaquil, se puede elevar el índice verde concentrado hasta 5,64 m2 por habitante, lo que estaría muy alineado con el mínimo permitido por la OMS. de 9m2 por habitante.

**Keywords / Palabras clave**

Green areas, urban greenery, public spaces, environmental axes, sustainable design.

Áreas verdes, verde urbano, espacios públicos, ejes ambientales, diseño sostenible

## Introduction



Guayaquil faces a serious heat island problem due to uncontrolled urban growth, sparse vegetation, and heat-retaining materials. This phenomenon raises local temperatures, affecting quality of life, health, and sustainability. This study focuses on the feasibility of mitigating heat islands in downtown Guayaquil by implementing green walls and roofs on buildings exposed to higher solar radiation. The methodology included examining thermal images of the city, obtaining a broad sample of thermal variations in different urban areas of downtown Guayaquil. Detailed analyses of buildings in downtown Guayaquil were carried out, using measuring instruments to associate heat accumulation with the use of materials. The structures most exposed to solar radiation were identified, evaluating their suitability for the installation of green panels and green roofs. In addition, data on costs, energy efficiency, and effects on ambient temperature were collected, allowing for the formulation of standard and flexible design proposals for these interventions.

These actions proved effective in reducing the internal temperature of buildings, decreasing the need for energy for air conditioning and improving air quality. Despite the benefits, challenges such as initial investment and training for long-term maintenance must be addressed. This strategy will not only revitalize downtown Guayaquil, but could also become a model for other cities seeking sustainable solutions to emerging climate challenges.

The existence of public green spaces in cities goes beyond a purely decorative purpose, as they play a fundamental role in improving air quality. These areas not only transform a significant portion of carbon dioxide (CO2) into oxygen, but also play an essential role in the exchange of air, heat, and humidity within the urban environment. In

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addition to their aesthetic and landscaping benefits, green spaces improve quality of life by providing visual enjoyment.

The World Health Organization (WHO) considers it essential for cities to have at least 9 square meters of green space per inhabitant to ensure a better quality of urban life. These recommendations seek to establish standards that protect and maintain a balance in the quality of life of city dwellers, as green spaces are often neglected and overlooked.

However, innovations in urban design are increasingly replacing public green spaces with urban pavements, creating what are known as “heat islands” within the city. This leads to a noticeable increase in temperature as the city develops, with average increases of 4 to 6 degrees Celsius during the day and up to 10 degrees Celsius at night. These effects are harmful to the environment and, above all, affect society. A case in point is the city of Guayaquil, Guayas, characterized by its hot and humid tropical climate, where its inhabitants experience high temperatures and high levels of humidity.

This leads to a distancing from outdoor spaces and an interest in remaining in enclosed spaces with more comfortable thermal conditions, resulting in a decrease in the use of public spaces due to the anthropized environment that surrounds them. These spaces are often perceived as insufficient and abandoned, preventing people from enjoying the natural landscapes that are related to the development of the city.

Public green spaces in cities offer a wide range of social and ecological benefits, which are closely linked to environmental quality and are considered key elements in improving quality of life. The World Health Organization (WHO) estimates that at least nine square meters of green space per inhabitant is needed to consider a place environmentally friendly.

The Urban Green Index of the National Institute of Statistics and Census (INEC) showed that, in 2010, Guayaquil had only 2.54 square meters of green space per inhabitant. However, two years later, no information was obtained from the Municipality to update the study.

The city as an organism is a frontier that is no longer utopian in cities such as Singapore, where the built environment can be approached as an organism that is mutually dependent on the natural world. Buildings that were once barriers to the environment can be an integral part of the natural landscape, as if they were a living organism.

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An organism metabolizes on many scales, from cells and organs to bodies and ecologies. Cities also thrive on multiple levels of structures, where material composition has as much impact on the urban landscape as transportation networks. The built environment drives the evolution of ecologies, as they need to constantly adapt to humans, and not the other way around. Bio-integrated cities must involve other organisms and respond to different scales by co-creating sustainable ecologies with nature.

This concept is adopted through natural elements implicit in the building, including vertical gardens, urban gardens, and green roofs. The latter have great potential for coverage and the creation of new public spaces serving commercial or hotel buildings that can generate spaces of resilience within them, as envisaged in the approach to urban organisms or the city as an organism.

Green roofs can reduce heat by reflecting solar radiation and generating shade, something very typical in the subtropical climate of the city of Guayaquil, which generates an average relative humidity of 65 to 85%, affecting the conditions of users who travel through the city center. Another benefit related to relative humidity is the reduction of heat through the process of transpiration, which lowers the temperature inside and outside the building, thereby improving air quality by eliminating pollutants and trapping particles in its leaves. In this way, green roofs are gaining increasing recognition as a modern and environmentally friendly technology for addressing climate change and the most common environmental problems in urban environments.

## Materials and Methods

a. Green spaces and their importance in urban areas

Urban green spaces provide benefits that are vital to a city, such as nature, biodiversity, complexity, and connectivity, as well as sociocultural advantages such as health, well-being, landscape beauty, culture, and the promotion of socialization.

Understanding the development of green areas within a space is generally related to the insertion of vegetation into a space. However, the issue is developed through several aspects to be taken into account, which are not only capable of causing an impact at the spatial level,

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understood as a dimensionally delimited space. On the contrary, the true development of green areas as spaces or, often, within architecture, as spatial criteria, stems from the need to link benefits in all possible areas of society, some with more prudent accessibility than others.

An example of the conceptualization and contextualization of green areas within an urban structure is framed in Green Infrastructure and Biodiversity Plans, which operate as instruments for the planning of green areas. These plans are based on a diagnosis of values, characteristics, functions, and types of spaces, in order to establish a process of internal and general participation, where objectives and goals are set.

The following illustration demonstrates concepts and functions of certain types of green areas translated into different types of spaces.

Within the urban perspective focused on an urban center, measures are implied that, when analyzing a neighborhood study space, would not have sufficient data to analyze and propose a design that optimizes or resolves said measure. However, the definition of the values for which a green area proposal is necessary in an environment is part of the same analysis and interpretation of the state of the site, understanding it not only as the physical space, but also as the set of sensory, physical, cultural, and urban perceptions of the place.

The scarcity of so-called urban green areas can be measured in terms of the quality of infrastructure and biodiversity installed in ecosystems or microclimates within an urban area. This limitation can be caused by several reasons, such as population growth, lack of planning, depletion of natural resources, unequal distribution of resources, and other factors.

b. Importance of green areas and their relationship to urban density

Humanity has had a close relationship with nature for millions of years, especially with plant species, which is why their impact on our health is so important. And it is this attachment to trees, passed down from generation to generation through our genes, that the mere presence of a tree or plant near where we live brings back.

Green spaces are important for several reasons. First, they provide a natural environment where people can relax, exercise, and enjoy the outdoors. These spaces also encourage social interaction and foster a

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sense of community among residents. In addition, green spaces play a vital role in health and well-being by improving air quality, reducing noise pollution, and helping to regulate urban temperatures.

Urban sprawl is often considered a problem in developing areas around the world. Many planners see the densification of urban areas as a way to achieve sustainability, but it has also been questioned as a planning ideal.

Urban density refers to the concentration of land use and living aspects (people, buildings, and infrastructure). An increase in these can mean a large socioeconomic and demographic increase in the area. However, the development of green infrastructure is not proportional to this densification; in fact, it becomes much more complicated. The main reasons for this are:

- Competitiveness of land use: Urban density attracts demand for different political, economic, and social services, which will translate into the need to establish new land uses territorially.
- Limited availability of space: In dense urban areas, the space available for new infrastructure is limited, and in the case of spaces intended for public use, these are generally occupied by buildings, streets, sidewalks, etc., exponentially increasing gray areas.

Overcoming these types of challenges requires careful city planning that takes into account the different interests and future problems that an environment may present.

Densification can be achieved through different approaches and must be adapted to each context, which may include the need to densify green structures.

The provision of urban green spaces and their associated benefits are important for sustainable urban development from an ecological, economic, and social point of view and are considered “a key ingredient for the sustainability of cities,” especially in compact cities.

c. Urban green

Urban green space is the open space in cities used as parks or other green spaces and defined by the World Health Organization as “urban land with any vegetation cover,” which may be accompanied by

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artificial elements such as playgrounds, blue spaces (water), or natural landscapes.

Urban green space would be the ideal relationship between the gray urban spatial infrastructure, as we know it, and the insertion of green urban infrastructure. However, all these additional spaces as such are integrative in nature, which is why they need design criteria that promote social, urban, and ecological inclusion, such as the size and extent of this space, accessibility and its connection to other points of socio-urban connectivity, biodiversity and environmental quality, and community participation that will be immersed in this urban environment.

Another important aspect when designing urban green spaces is the design and landscaping. However, this criterion must be carefully analyzed and worked on. An architect must be able to propose harmonious green areas with plant species that are suitable for the environment.

The appropriation of the environment as such must be reflected in this urban green space; the social circle immersed in the environment must be able to identify with the use of this space. “When evaluating the accessibility of urban residents to green spaces, most authors have defined that urban parks should be less than 400 m, or a 5-minute walk, from residences.”

This accessibility criterion is related to the activities that are expected to take place in this space, that is, its functions focused on city dwellers.

Therefore, it can be traditional and multifunctional, already focusing on a target population, such as residents and visitors.

In line with the state of the art of research and theory, we can cite the contributions of Green Spaces and Public Health in Urban Contexts, which specifies that there is currently no universally accepted definition for urban spaces. Urban green spaces can be defined as areas with vegetation found in urban environments and referred to as semi-natural areas of a city. These areas may be covered with natural or artificial vegetation, but they are present in urbanized areas. The term “urban green space” is used to refer to formal and informal green places, as well as to “open spaces” that have the potential to provide ecological functions (such as sports clubs, playgrounds, open vacant lots, etc.).

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d. The impact of urban greenery on quality of life

Urban greenery plays a central role in debates on quality of life in urban areas. The particular needs in terms of urban greenery, understanding which is key when planning infrastructure and design aspects in cities. To support the spatial planning of child- and youth-friendly cities, including urban greenery, a few questions must first be answered:

- What type of urban greenery is important?
- What type of infrastructure elements are needed?
- What are the core characteristics and design aspects of urban greenery and its elements?
- How are they valued?

The social problems of a given territory are aspects related to the state of the environment and its psychological effects on a certain population. A group of inhabitants who grow up in an environment that is enclosed and weakly connected to nature will have a higher number of mental disorders.

Social problems and environmental stressors generally occur more frequently in large urban centers. These problems are often associated with a higher recurrence of psychiatric disorders. Studies in the field of psychology have shown links between the presence of green spaces and mental health. Mental health is understood as a state of well-being that allows individuals to realize their abilities, cope with the normal stresses of life, work productively and fruitfully, and make a meaningful contribution to their communities.

e. Urban green index of buildings in downtown Guayaquil

The urban green index has been broadly considered to be any green area established within a space; which cannot be conceived in this way since urban greenery must follow a special treatment that integrates with the ornamentation and complies with a categorical typology of urban greenery within the urban center. Referencing this conceptualization in downtown Guayaquil, residences and heritage buildings, commercial buildings, administrative buildings, and hotel buildings could be distributed.

The buildings follow a colonial design concept that includes vernacular materials that have retained aspects of sustainability in terms of ventilation and natural lighting and that have now changed their

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structure into high-rise hotel buildings that have influenced the so-called heat islands that are common in downtown Guayaquil.

The intensity of the heat sensation ranges from 30 to 38°C in summer and drops to between 27 and 30°C in winter, but with humidity that worsens the climatic comfort conditions in large areas of downtown Guayaquil.

In view of these problems, it is considered imperative to establish, as a contribution to the sustainability and improvement of the city's urban green indices, an increase in the number and quality of green spaces in buildings and their immediate surroundings in order to provide a comfortable space for users.

The study was conducted using a mixed approach, combining qualitative and quantitative analysis of the central structure of Guayaquil, using a study sample of 5000*10000 meters that frames the downtown area of Guayaquil with massive hotel coverage in order to analyze data on hotel coverage, surface temperature, heat islands, and green area deficit analyzed through the Sentinel-3 satellite and synthesized in ArcGIS to obtain heat clusters in the central area of Guayaquil for tracking heat patterns.

Specific data will include the analysis of the heat intensity of heat islands generated by a solar intensity calorimeter around a daily sample over a month, which will provide sufficient data to establish sustainable design strategies for hotel buildings. Analyzed as an area where thermal influence is high. This is a central area of Guayaquil known for its unique combination of heritage, administrative, commercial, and hotel buildings.

This analysis will culminate in the development of an action plan to establish strategies that promote the sustainable design of hotel buildings that contribute to the growth of the urban green index in downtown Guayaquil.

## Results

a. Thermal analysis of hotel zones

Downtown Guayaquil functions as an urban thermal core, where compact morphology and a lack of green infrastructure intensify heat accumulation. There is a tendency for heat islands to form patterns in areas where high-rise hotel buildings are concentrated and there are

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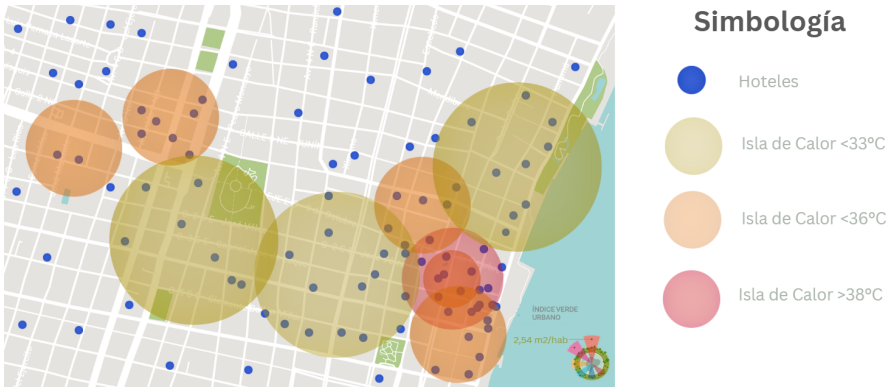
no wide roads or sidewalks, as can be seen in the following analysis of heat islands by clusters.

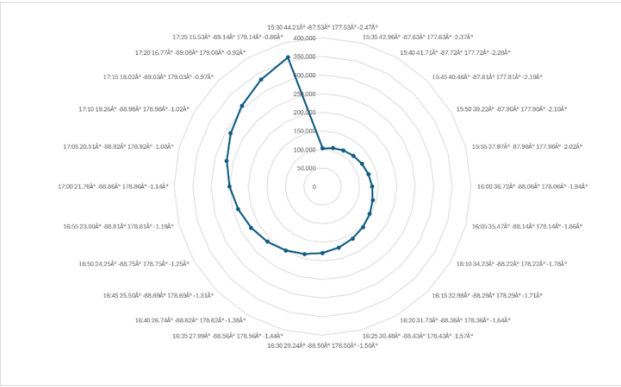
***Figure 1.*** Heat islands and hotel distribution in the study area




Note. Own elaboration

In accordance with the connotation of heat islands, an additional in situ measurement was taken of the facades, roofs, and random measurements on the roadway and sidewalk, generating a scatter diagram of the perceived caloric measurements on critical days, reaching up to 359. 89 Kelvin (K), which establishes a high perception of over 44°C, creating unusual peak sensations that generate high UV radiation, added to the lack of established vegetation cover of 2.54 m2/inhabitant.

***Figure 2.*** In situ heat measurements (K)



Note. Own elaboration

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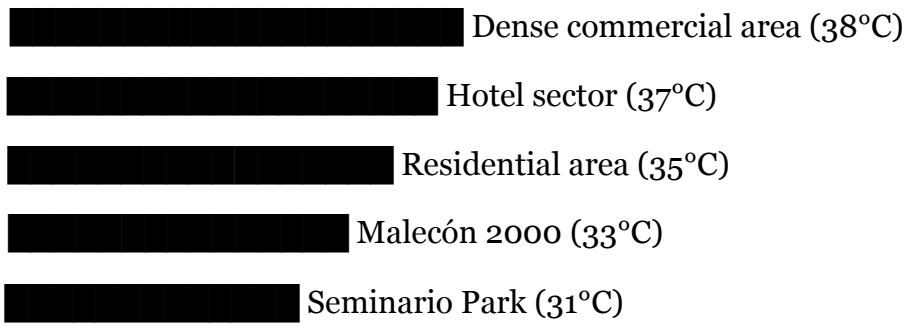
For the categorization of the terrain, a table of temperature measurements by zone was generated, which highlights the relevance of heat islands in areas of high population accumulation and the hotel sector, which denotes apparent climatic discomfort, reaching temperatures above 26 °C, in addition to which there is an oscillation of between 3 and 6°C higher than that established in the Sentinel-3 satellite heat map. The highest solar incidence occurs from the southeast to the northwest, forming a solar threshold of higher incidence during the solstice hours between 12:02 pm and 3:37 pm.

Figure 3. Surface thermal analysis of the study area




Note. Own elaboration

b. Sustainable design strategies

The study area was analyzed using a mixed-method approach that, as an action plan, characterized the important indicators of the territory with possible design strategies, in which the urban structure of the area can be seen in a first qualitative-quantitative analysis polygon. In the territory, this approach allowed the strategic framework to be prioritized. Through this analysis, two strategies were obtained that generate minor intervention in the building, are economically viable, and are in line with current municipal regulations. To characterize the sustainability indicators, the strategy prioritization method was used through a mixed analysis of each variable corresponding to the development of the green roof plan. To characterize the sustainability indicators, the strategy prioritization method was used through a mixed analysis of each variable corresponding to the development of the green infrastructure plan.

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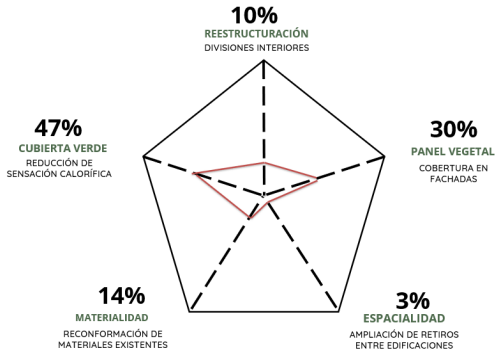
Figure 4. Qualitative/quantitative polygon of the study area




Note. Own elaboration



c. Action plan

For the action plan, it is proposed to place a network of interconnected green areas in direct and indirect categories between the network of hotel buildings, as they will offer multiple benefits in conjunction with the climatic comfort of the area, which contributes to improving the deficient indicators of the urban green index. These spaces will promote climatic comfort and increase the dynamism of the surrounding social and economic spectrum by reducing pollution and increasing the value of nearby properties.

In addition, they will facilitate social cohesion by serving as meeting points, support biodiversity, enrich cultural life with recreational and educational activities, and reduce urban noise, creating a more pleasant and comfortable environment as the materiality to articulate urban areas and influence the climate comfort of the sector. As a guideline for the development of the green infrastructure action plan, we have the following:

**Table 3.** *Green infrastructure action plan*

| Eje | Preparación | Diagnóstico de Análisis | Priorización | Plan de Acción | Sub-Planes |
|---|---|---|---|---|---|
| Recuperación de espacios públicos y áreas verdes mediante el diseño de techos verdes y paneles verticales. | Implementar un programa que integre áreas verdes en terrenos baldíos y espacios públicos. | Desarrollar espacios públicos flotantes como corredores verde | Interconectar espacios públicos y áreas verdes mediante techos verdes. | Plan de techos verdes interconectados. | Plan de reforestación<br><br>Reconfiguración del espacio público |

Note. Own elaboration

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The inclusion of green areas in both the home and public spaces is due to the analysis of heat island dynamics as an articulator of climate functionality both indoors and outdoors. Inside, a green courtyard with urban furniture will be created, providing a space for recreation and relaxation. Outside, green areas will be strategically distributed, some of which will serve as guides for vehicle traffic, improving the functionality and aesthetics of the environment.

The inclusion of green areas both in the home and in public spaces is due to the analysis of heat island dynamics as a factor in the climate functionality of both the interior and exterior. Inside, a green courtyard with urban furniture will be created, providing a space for recreation and relaxation. Outdoors, green areas will be strategically distributed, some of which will serve as guides for vehicle traffic, improving the functionality and aesthetics of the environment.

## Conclusions

The development of green roofs and vertical plant panels, depending on their location, will improve the urban green index and thermal comfort of the hotel zone by up to 20%. The existing urban index was increased by 60%, from 5.64 $m^2$/inhabitant, This is a progressive proposal for sustainable building design in downtown Guayaquil, thanks to the interconnections of green roofs that can become new green corridors, increasing the climate comfort of the sector.

As part of the additional benefits, according to the climate comfort simulation sampling, it has been proven that the noise emission level has decreased by up to 20 decibels in the commercial and hotel sector. Overall, the use of green roofs in Guayaquil supports environmental sustainability, improves urban resilience, and contributes to improving the quality of urban life. As the study area continues to develop, green roofs could play a key role in creating new connections for public spaces within ecological corridors, denoting new avenues for urban development while providing ecological and social benefits.

The use of green roofs in hotel buildings in downtown Guayaquil is a sustainable, technically and economically justifiable strategy with a positive impact on thermal comfort, energy efficiency, and urban image. If implemented in a planned manner and supported by public policies, it can become a key tool for climate adaptation in the historic center.

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eISSN: 2600-5743

## References

Adibhesami, M. A., Karimi, H., Sharifi, A., Sepehri, B., Bazazzadeh, H., & Berardi, U. (2023). Optimization of Urban-Scale Sustainable Energy Strategies to Improve Citizens' Health. *Energies*, *16*(1), 119. https://doi.org/10.3390/en16010119

Agudelo-Castañeda, D., Arellana, J., Morgado-Gamero, W. B., De Paoli, F., & Carla Portz, L. (2023). Linking of built environment inequalities with air quality: A case study. *Transportation Research Part D: Transport and Environment*, *117*. https://doi.org/10.1016/J.TRD.2023.103668

Almeida-Cerino, C. M., Bertolini, V., Martínez-Trinidad, T., Almeida-Cerino, C. M., Bertolini, V., & Martínez-Trinidad, T. (2024). Estructura y diversidad florística en áreas verdes urbanas de la ciudad de Tapachula, Chiapas, México. *Revista Mexicana de Ciencias Forestales*, *15*(83), 131–154. https://doi.org/10.29298/RMCF.V15I83.1457

Anderson, P. M. L., Avlonitis, G., & Ernstson, H. (2014). Ecological outcomes of civic and expert-led urban greening projects using indigenous plant species in Cape Town, South Africa. *Landscape and Urban Planning*, *127*, 104–113. https://doi.org/10.1016/j.landurbplan.2014.03.007

Ashokkumar, V., Palaniappan, S., & Venkataraman, A. (2020). Sustainability indicators of GRIHA certified green buildings in India. *Construction Research Congress 2020: Infrastructure Systems and Sustainability - Selected Papers from the Construction Research Congress 2020*, 590–598. https://doi.org/10.1061/9780784482858.064

Costanzo, V., Evola, G., & Marletta, L. (2021). Urban heat stress and mitigation solutions: An engineering perspective. *Urban Heat Stress and Mitigation Solutions: An Engineering Perspective*, 1–412. https://doi.org/10.1201/9781003045922

Daniel, I., Cabrera, J. B., & Arias, P. (2018). Solar Energy Supply for the Rural Parish GAD's of Ecuador. *2018 IEEE ANDESCON, ANDESCON 2018 - Conference Proceedings*, *1*(2), 8. https://doi.org/10.1109/ANDESCON.2018.8564659

Received October 15, 2025/ Approved November 22, 2025 Pages: 43-54
eISSN: 2600-5743

Duan, J., Wang, Y., Fan, C., Xia, B., & de Groot, R. (2018). Perception of Urban Environmental Risks and the Effects of Urban Green Infrastructures (UGIs) on Human Well-being in Four Public Green Spaces of Guangzhou, China. *Environmental Management*, *62*(3), 500–517. https://doi.org/10.1007/s00267-018-1068-8

Ferreira, J. C., Costa dos Santos, D., & Campos, L. C. (2024). Blue-green infrastructure in view of Integrated Urban Water Management: A novel assessment of an effectiveness index. *Water Research*, *257*, 121658. https://doi.org/10.1016/j.watres.2024.121658

Galati, A., Coticchio, A., & Peiró-Signes, Á. (2023). Identifying the factors affecting citizens' willingness to participate in urban forest governance: Evidence from the municipality of Palermo, Italy. *Forest Policy and Economics*, *155*, 103054. https://doi.org/10.1016/j.forpol.2023.103054

Giaimo, C., Giudice, B., Pantaloni, G. G., & Voghera, A. (2023). Ecosystem Services and Territorial Resilience: The Role of Green and Blue Infrastructure. *Urban Book Series*, *Part*, 45–59. https://doi.org/10.1007/978-3-031-33894-6_4

Heim, A., & Lundholm, J. (2022). Functional trait database for Nova Scotian coastal barren, green roof, and ruderal flora. *Ecology*, *103*(6), e3678. https://doi.org/10.1002/ecy.3678

Hidalgo Silva, D. (2025). Guayaquil: Management Model and Implementation of the Market City. In *Urban Book Series: Part F1152* (pp. 247–263). Springer Science and Business Media Deutschland GmbH. https://doi.org/10.1007/978-3-031-94235-8_10

Karimnejad, M., Malekian, M., Pourmanafi, S., Mobarakeh, Z. M., Keramati, S., Ghased, R., & Ahmadi, M. (2024). Forest edge encroachment by rural orchards shifts bird communities in favor of understory birds: Forest birds as indicators of landscape changes in agroecosystems. *Ecological Indicators*, *167*. https://doi.org/10.1016/j.ecolind.2024.112698

Lauria, A. (2023). Green Spaces and Public Health in Urban Contexts. In *SpringerBriefs in Applied Sciences and Technology* (pp. 93–99). Springer Science and Business Media Deutschland GmbH. https://doi.org/10.1007/978-3-031-09439-2_9

Liu, S., Pang, Y., Zhang, H., Wang, B., Ye, B., Jiang, Z., Xie, H., Niu, X., Wang, D., Ding, Y., Wu, S., Song, Q., Wang, X., &



Received October 15, 2025/ Approved November 22, 2025 Pages: 43-54
eISSN: 2600-5743

Zhang, C. (2021). Evaluation indicator system and method designed for natural forest protection program of China. *Shengtai Xuebao*, *41*(13), 5067–5079. https://doi.org/10.5846/stxb202103040591

Mboup, G., Diongue, M., & Ndiaye, S. (2017). Smart City Foundation—Driver of Smart Cities. In *Advances in 21st Century Human Settlements* (pp. 841–869). Springer. https://doi.org/10.1007/978-981-10-1610-3_30

Meng, D., Zhang, J., Cai, Z., & Xu, S. (2024). Evaluating the Accessibility of Seniors to Urban Park Green Spaces. *Journal of Urban Planning and Development*, *150*(3), 05024021. https://doi.org/10.1061/JUPDDM.UPENG-4851

Moreno, C., Allam, Z., Chabaud, D., Gall, C., & Pratlong, F. (2021). Introducing the "15-minute city": Sustainability, resilience and place identity in future post-pandemic cities. *Smart Cities*, *4*(1), 93–111. https://doi.org/10.3390/smartcities4010006

Mualam, N., & Sotto, D. (2020). From progressive property to progressive cities: Can socially sustainable interpretations of property contribute toward just and inclusive city-planning? Global lessons. *Sustainability (Switzerland)*, *12*(11). https://doi.org/10.3390/su12114472

Naranjo Ramos, Y. G., & Arellano Ramos, B. (2017). Impact of the Metrovía System in the Center of Guayaquil[Impacto del Sistema Metrovía en el Centro de Guayaquil]. *Espacios*, *38*(57).

Pérez-Sanchez, L., Ojeda-Revah, L., Rivera-Torres, C., & Espejel, I. (2023). Co-design of green infrastructure in the Valley of Guadalupe, Ensenada, Baja California[Codiseño de INFRAESTRUCTURA VERDE EN EL VALLE DE GUADALUPE ENSENADA, BAJA CALIFORNIA]. *Legado de Arquitectura y Diseno*, *18*(33), 59–72. https://doi.org/10.36677/legado.v18i33.17757

Quimis Gómez, A. J., Rivas, C. A., González-Moreno, P., & Navarro-Cerrillo, R. M. (2023). Forest Plantations in Manabí (Ecuador): Assessment of Fragmentation and Connectivity to Support Dry Tropical Forests Conservation. *Applied Sciences (Switzerland)*, *13*(11). https://doi.org/10.3390/APP13116418

Revich, B. A. (2023). THE SIGNIFICANCE OF GREEN SPACES FOR PROTECTING HEALTH OF URBAN



Received October 15, 2025/ Approved November 22, 2025 Pages: 43-54
eISSN: 2600-5743

POPULATION. *Health Risk Analysis*, *2023*(2), 168–185. https://doi.org/10.21668/health.risk/2023.2.17.eng

Robles, M. D. C., Martinez, C. F., & Boschi, C. (2019). Green spaces as mitigation strategy to control sound pollution. Assesment and analysis of o'higgins park in Mendoza City, Argentina[Los espacios verdes como estrategia de mitigación de la contaminación sonora. Evaluación y análisis del parque o'higgins de la ciudad de mendoza-Argentina]. *Revista Internacional de Contaminacion Ambiental*, *35*(4), 889–904. https://doi.org/10.20937/RICA.2019.35.04.09

Sabet, P., Ciampi, G., Scorpio, M., & Sibilio, S. (2023). A preliminary review of case studies window view quality in building. *AIP Conference Proceedings*, *2928*(1), 060003. https://doi.org/10.1063/5.0170764

Sánchez Padilla, M. L., Hechavarría Hernández, J. R., & Portilla Castell, Y. (2021). Systemic Analysis of the Territorial and Urban Planning of Guayaquil. *Lecture Notes in Networks and Systems*, *271*, 411–417. https://doi.org/10.1007/978-3-030-80624-8_51

Shan, J., Huang, Z., Chen, S., Li, Y., & Ji, W. (2021). Green Space Planning and Landscape Sustainable Design in Smart Cities considering Public Green Space Demands of Different Formats. *Complexity*, *2021*. https://doi.org/10.1155/2021/5086636

Torres-Espinoza, J., & Delgado-Bohórquez, A. (2023). Sustainability evaluation and densification proposals in the center of Guayaquil city[Evaluación de sostenibilidad y propuestas de densificación en el centro de la ciudad de Guayaquil]. *Estoa*, *12*(24), 92–108. https://doi.org/10.18537/est.v012.n024.a08

Velastegui-Montoya, A., Guerrero-Cabrera, G., Marquez, J. O., Saad El Imanni, H., Galarza, C. E., & Hidalgo-Crespo, J. (2023). GEOSPATIAL ANALYSIS OF GUAYAQUIL'S SOUND LANDSCAPE AFTER THE COVID-19 ISOLATION PERIOD. *International Geoscience and Remote Sensing Symposium (IGARSS)*. https://doi.org/10.1109/IGARSS52108.2023.10283239

Xiao, X. D., Dong, L., Yan, H., Yang, N., & Xiong, Y. (2018). The influence of the spatial characteristics of urban green space on the urban heat island effect in Suzhou Industrial Park. *Sustainable Cities and Society*, *40*, 428–439. https://doi.org/10.1016/J.SCS.2018.04.002



Received October 15, 2025/ Approved November 22, 2025 Pages: 43-54
eISSN: 2600-5743

Xu, C., Tang, T., Jia, H., Xu, M., Xu, T., Liu, Z., Long, Y., & Zhang, R. (2019). Benefits of coupled green and grey infrastructure systems: Evidence based on analytic hierarchy process and life cycle costing. *Resources, Conservation and Recycling*, *151*. https://doi.org/10.1016/j.resconrec.2019.104478

Yang, Y., Ignatieva, M., Gaynor, A., & Chen, C. (2024). Urban biodiversity in design: Insights into the debate on native versus non-native plants and bees in Western Australia. *Urban Forestry and Urban Greening*, *98*, 128391. https://doi.org/10.1016/j.ufug.2024.128391

Zambrano-Monserrate, M. A., Ruano, M. A., Yoong-Parraga, C., & Silva, C. A. (2021). Urban green spaces and housing prices in developing countries: A Two-stage quantile spatial regression analysis. *Forest Policy and Economics*, *125*, 102420. https://doi.org/10.1016/j.forpol.2021.102420



Received October 15, 2025/ Approved November 22, 2025 Pages: 43-54
eISSN: 2600-5743