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Urban strategies applying green and blue infrastructure focused on sustainable development. Case study: 3rd stage Malecón Villamil Playas

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***Abstract*— The Linear Boardwalk of the Villamil Playas Canton was an urban-architectural project executed by the Prefecture of Guayas in conjunction with the Municipality of Playas. This recreational space consists of a long coastal extension; for this reason, the project was divided into three stages, of which 2 of 3 are completed; this last stage is an opportunity for urban regenerative intervention. Floods in the Esterillo sector, Villamil Playas, Ecuador, have been increasing exponentially in recent decades due to several influencing factors, such as the waters and the rains. This has affected trade, tourism, health, and even the sector's security. For this reason, this study proposes sustainable development strategies by implementing blue and green infrastructure. The methodology used was qualitative, with a descriptive scope. The research design was non-experimental-transactional, and the observation sheet and the survey were used as instruments. The most important results indicate that implementing blue and green infrastructure can bring multiple benefits in which efficient resources are used for the use of bodies of water and protection through plant cover expressed in 4 strategic proposals. It is concluded that implementing strategies focused on sustainable development configures a landscape environment that elevates the urban image and integrates the directed uses of the population.**

Keywords: Sustainable development; urban regeneration; urban strategies; green and blue Infrastructure.

I. Introduction

THE creation of recreational spaces is part of the objectives of sustainable development towards the quality of life of people since they promote social interaction within a healthy space of common interest. This article addresses the conditions of the third stage of the Malecón General Villamil Playas, recognized as a tourist destination in the province of Guayas, Ecuador. The Playas Canton has had a long evolution, combining its streets, squares, and gray infrastructure forming a linear boardwalk in its coastal profile, which has attracted a constant influx of visitors in its stages of development. Still nevertheless, the third stage has not been planned in the same way. The third stage has been appropriated by the inhabitants for trade and fish slaughter, which has led to a deterioration of the urban image of the boardwalk. The proposal is to improve the conditions of the third stage of the boardwalk through the application of urban design strategies with the use of green and blue infrastructure to develop a conceptualization of a sustainable boardwalk.

The present study acquires importance by using the blue structure as a transition of blue elements and generation of ecosystems of transmission of bodies of water. Green infrastructure is seen as an element of protection of the coastal profile and generation of microclimates through the use of vegetation that promotes biodiversity. Elements that make up a natural development of the boardwalk.

In the third stage of the Malecón Villamil Playas, floods are generated by the overflow of the natural undermining called watercourses that floods at least 200 meters of this stage. There is a risk that this undermining will continue to erode and expand and cause a greater degree of flooding and instability of the coastal profile. Hence, its intervention is of importance to determine the sustainability and sustainability of the boardwalk in general.

As an anthropic consequence, there is a situation, the unhealthiness generated at first by the stagnation of water and waste that are stored inside the mat, directly affecting the health of merchants and passers-by who stipulate that there are bad odors and infectious effects due to the presence of pests.

II. Materials and Methods

Study Area. - The third stage of the Malecón Villamil Playas is located southwest of the Province of Guayas, Ecuador. This stage has a length of 826 meters and an average width of 15 meters, thus occupying an area of 12. 390 m2. - Polygon 1 and the area of the watercourses was also considered 660 m2. – Polygon 2 (22 meters * 30 meters) from Av. Jaime Núñez to Calle C. R-2, as shown in Fig 1.

Fig. 1. Location study area1. Note: Prepared by the authors

Since the beginning of the creation of the linear boardwalk, the inhabitants havelooked for ways to adapt to the conditions of the environment and the natural environment [1]. This has allowed him not only to live and develop but during the adaptation process, he has learned to use the elements that nature offers to survive and make better use of resources. According to Ibargüen, one of the biggest challenges is integrating natural systems with the built environment [2].

Green and blue infrastructure in the face of floods. - To face these challenges, alternatives have been proposed that are becoming increasingly important in urban and architectural planning due to the positive impact on the ecological and social field with a vision of sustainable and intelligent growth [3]. This is where the terms green and blue infrastructure come in.

Green architecture, according to di Marino and Lapintie, refers to the set of green spaces that make up an elementary system for the conservation of ecological processes [4]; likewise, blue architecture seeks adequate planning and management of water and its associated ecosystems that has positive psychological and emotional effects on citizens [5]. In this sense, by combining both elements, growing cities could design solutions for the rehabilitation and harmonization of the urban image with natural spaces, promoting the protection of ecosystems and making efficient use of strategic resources based on planning and sustainable territorial development.

On the other hand, one of the causes of the problem raised in this study is the floods that have been generated in the study area. Therefore, it is recognized that flooding not only covers the overflow of a river caused by some rainfall, but other natural risks such as soil erosion, the dragging of woody waste, and landslides also interact, but this term of flood tolerance continues to be studied in different areas such as: geomorphological, hydrological and hydraulic [6].

Regarding this, we can cite the research of Gavrilidis, which analyzed the use of green infrastructure as an alternative for reducing the risk of flooding in a type of cuencas analyzed around [7] and take advantage of its advantages for the efficient use of water. As part of the improvements, it was proposed to increase vegetation cover along the basin to prevent soil infiltration, the creation of concrete geotextile pockets, and create a flood prevention system that also serves as a recreation space and covered spaces for sun protection. In addition, it was also proposed the creation of roads respect the natural spaces. The results of this research indicate that using nature-based solutions, through the implementation of good practices, this type of infrastructure can reduce flood damage.

As a topic of discussion, it is mentioned that the characterization of flood risk must be a continuous and sequenced process to determine the vulnerable elements that allow for generating prevention, mitigation, and adaptation strategies to flood risk. It is concluded that territorial planning is an essential tool to promote land use consistent with the geographical reality [8]. It should be noted that the approach of the urban project is systematized by the green and blue infrastructure, contributing to and satisfying the needs, such as flood mitigation and the negative influencing factors that occur in the sector. The qualitative and quantitative bases taken are the starting point. IMMRDC

In this sense, Ajrina, in her research on green and blue infrastructures as a strategy for adaptation and mitigation to climate change, described the need to reduce the risk of floods for which an environmental corridor is planned in the city of Madrid [9]. In the same way, Toribio and Ramos, demonstrated that the natural elements in a tropical city promote a healthy, efficient city and

constitute a significant improvement in the quality of life of people; that is, the benefits can include better urban control, conservation of ecological processes, reduction of heat, energy saving, increase in accessibility to open public spaces and recreation among others [10]. That is why when it comes to urban regeneration, it must be focused on repairing the social and economic problems in an urban area by planning the rehabilitation of the "social space," improving its physical and environmental aspects of it [11].

Approach and design of the research. - This research article was carried out under a qualitative, descriptive approach. Through this approach, an initial diagnosis of the needs of the active population was structured , taken from observation sheets, defined by merchants and tourists (3rd stage Malecón Villamil Playas), considering the perceptions of distribution of the boardwalk, management of the esterillo and mass distribution (consideration of people).

Regarding the research design, it is considered experimental since two variables described as problems inherent to the flood were tested, such as insecurity and unhealthiness, to formulate recommendations within the strategies. For the visualization of the perceptions of the active population, distribution schemes and clusters will be used to determine unsafe and unhealthy points.

Multispectral analysis method. - The photometric spectral analysis method is used to identify water flows and vegetation cover [12]. With this analysis, coloration ranges were established based on the capacity and caloric emission to define the vegetation (red color), and blue coloration for defined water courses, light blue for flood zones, and blue lines is for underground courses at a depth of no more than 2 meters. An RGB multispectral camera was used to establish coloration ranges; the photos will be analyzed in the ArcGIS program to obtain a base frame of distribution of elements that correspond to possible green and blue infrastructures, as shown in Fig 2.

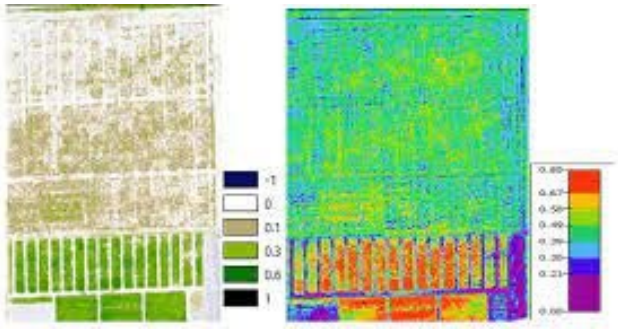

Fig. 2. RGB frame study comparison. Note: Taken from spectral frame study

This method will be the basis for the analysis of strategies that will pass to a comparative study of strategic analysis of green and blue infrastructure applied at a theoretical level using analogous models obtained from scientific bases such as Scopus, Web of Science, and Google Scholar.

The strategies are evaluated by means of tables to characterize the form, condition of the problem, and use applied to areas of coastal profile and boardwalk. This process allows obtaining comparative schemes and a framework of green and blue infrastructure strategies.

III. RESULTS

Distribution and clustering schemes

For the determination of the active population, the observation sheet was taken into account with a daily periodicity for two weeks (first usual week and second holiday week) that determined its activity by time of stay per hour per day and preponderant recurrence to the substages >33% (distributed in 3 substages; substage 1 - Jaime Núñez to Calle L-2, substage 2 – Calle L-2 to Calle Pedro Harb and subetapa 3 – Calle Pedro Harb to Calle R-2), those evaluated were distributed by type (merchants and tourists). The observation sheet was used as a method of calculating the study sample.

TABLE 11
WORKING POPULATION

Week	Periodicity	Guy	Quantity	Stay (hours prom.)	Recurrence (substages)
WEEK 1	Monday	Merchants	24	6,00	1
		Tourists	110	3,50	3
	Tuesday	Merchants	21	5,00	1
		Tourists	102	2,00	1
	Wednesday	Merchants	27	5,00	2
		Tourists	82	3,00	2
	Thursday	Merchants	24	6,00	3
		Tourists	91	4,00	3
	Friday	Merchants	30	7,00	1
		Tourists	138	5,00	2
	Saturday	Merchants	28	10,00	2
		Tourists	132	5,00	1
	Sunday	Merchants	30	8,00	1
		Tourists	135	5,00	2
WEEK 2	Monday	Merchants	32	7,00	1
		Tourists	145	4,00	2
	Tuesday	Merchants	30	7,00	3
		Tourists	148	4,00	3
	Wednesday	Merchants	38	7,00	1
		Tourists	128	4,00	1
	Thursday	Merchants	38	8,00	2
		Tourists	152	5,00	1
	Friday	Merchants	40	12,00	2
		Tourists	230	8,00	2
	Saturday	Merchants	42	12,00	2
		Tourists	146	8,00	2
	Sunday	Merchants	40	11,00	2
		Tourists	250	7,00	2

Note: Prepared by the authors

According to the data obtained from Table 1, there are occupancy constants in recurrence to substage 2 and 3 and an average stay of 8 hours by merchants and 6 hours by tourists; for the determination of the probability variables, a distribution scheme is used that allows to locate problems such as insecurity and unhealthiness in a sample type averaged with the data in table 1 thus obtaining the trend of occupation and spatial distribution.

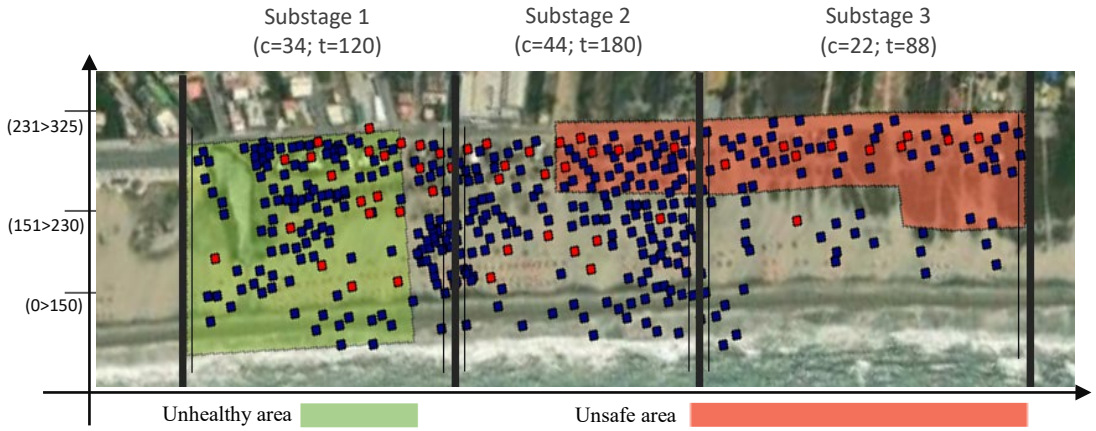

Fig. 3. Analysis of mass distribution and clusters of the problem. Note: Prepared by the authors

It is visualized that the problem of unhealthiness product of the stagnation and overflow of the water courses directly affects 85% of substage 1 with a sample occupation (c = 34; t = 120) and the problem of insecurity due to lack of luminaires and furniture occurs in 50% of substate 2 (c = 44, t = 180) and the entire substate 3 for being a site in abandonment (c = 22; t =88). It demonstrates a distribution of masses between 231 to 325 in the area of malecón, from 151 to 230 in the beach area, and a spa occupation of between 0 to 150 people, so the distribution of merchants occurs with greater preponderance in areas of boardwalk and beach. Of particular note is the use of the current furniture intended for trade fully occupied by traders but which does not meet a recurring demand of between 32 and 48 merchants per day. According to the distribution of the water courses, it is surrounding, but no less critical since it welcomes 25% of tourists and 10% of merchants.

A multispectral analysis

In Fig. 3, the image was processed from an RGB raster generated by a photometric camera that accumulated weights determined by red, green, and blue colorations, thus obtaining a modified data image from the ArcGis program having special considerations for red color such as heat accumulation of vegetation, light blue for flood zones and blue for underground watercourses; additionally, a green coloration was obtained. The intersection of calorific points of vegetation and flood zones express protection towards the coastal profile, which is prone to a decisive strategy for the study that would lead to its proven use from the multispectral analysis.

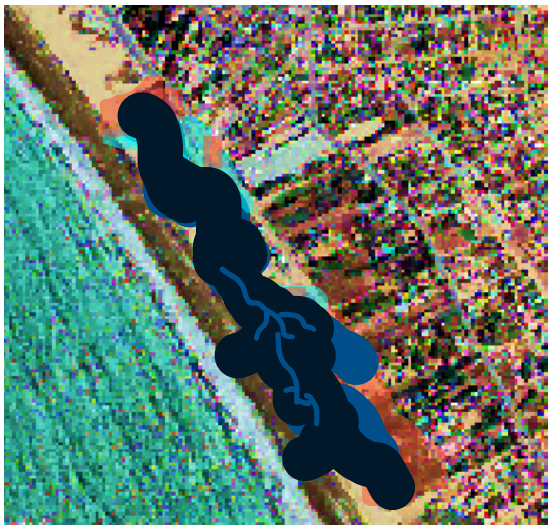

Fig. 4. Multispectral analysis using rgb application
Note: Prepared by the authors

Strategic analysis

A framework of relevant projects was formed due to their similarity in terms of form (terrain), condition of the problem, and use applied to areas of coastal profile and boardwalk selected from scientific bases of analysis. Table 2 shows the analogous models, criteria, and finally, strategies analyzed from the architectural design to establish a hybrid proposal applied to the study sector (3rd Stage Malecón Villamil Playas).

TABLE 2
ANALOG MODELS IN URBAN REGENERATION

Referential Cases	Location	Objective	Strategies
Design of the preliminary project of the urban architectural regeneration of the Gualaceo River boardwalk at the confluence with the San Francisco River	Basin	Carry out, at the urban level, the design of the preliminary project of the Malecon of the Gualaceo River with the influence of the Santa Bárbara River, through new urban concepts, to control floods and thus improve the quality of life of users.	1. Construction of retaining walls to control flooding. 2. The embankment is designed in the form of a terrace to control flooding sustainably. 3. Construction of elevated bridges and resilient landscapes in such a way that it resists water currents and flows, connecting the city with nature, allowing users to explore freely
Manzanares River Linear Park: project of recovery and regeneration of the ring road of the manzanares river as an urban piece of santa marta.	Bogota, Colombia	Recover and regenerate the ring of the Manzanares River to generate its structuring and harmonious-environmental character of public space and human experience of the city of Santa Marta, accompanied by a complementary and necessary infrastructure system in the city, corresponding to technological issues, mobility and public space, a network of equipment and an important environmental component that will make the project an integral and sustainable scenario.	1. Generate mitigation on the channel and the hydraulic-environmental round of the Manzanares River to recover this protagonist's environmental character. 2. Relocate people who live within 30m of the hydraulic round of the Manzanares River according to the regulations outlined in the POT of Santa Marta. 3. Create a technological structure along the river to control and avoid the floods caused and, in turn, maintain it always with a balanced channel and that does not present water problems in its dry seasons. 4. Create a public space strategy based on pedestrian paths, cycle routes, viewpoints, flood pools, meeting and relaxation areas, strategically located service points

Note: Prepared by the Authors

It is highlighted that the use of retaining walls is a very common infrastructure to mitigate the effects of floods.

The collection of analogous models of the green and blue infrastructure criteria shown in Table 3 has had a positive impact on urban regeneration.

TABLE 3
GREEN AND BLUE INFRASTRUCTURE CRITERIA

Referential Cases	Location	Objective	Strategies
Green and blue infrastructures	Madrid, Spain	Climate change adaptation and mitigation strategies	1. Management and adaptation measures for river nature reserves (RNFs). 2. Adaptation to extreme events. 3. Assessment of the impact of climate change on water resources and development of adaptation strategies. 4. Development of climate change adaptation projects in the public hydraulic domain.
Green infrastructure and landscape: the greater London experience	London, England.	Existing parks and green spaces will be part of an integrated, planned, designed, and managed green infrastructure network to provide strategic functions and local needs.	1. Streets, including major ones, will become greener public domain spaces, where walking and cycling will take precedence. 2. London's hidden rivers will be removed from concrete pipes or canals to control flooding. 3. identification and articulation of 4 elements (bodies of water, opportunities to create new parks, ecological connectors, and define and protect landscapes) 4. Using a geographic information system (GIS), thematic maps will be created to identify the multiple layers of your landscape: to characterize the existing open spaces, their scales of focus (regional, metropolitan, neighborhood, local, to map disabilities, having the watershed as a basis). 5. Address and map the territory based on some themes: access to nature (which defines areas of great biodiversity and preserved), points that affect the health of the community (related to open spaces and public facilities for recreation and schools), green belt areas and urban periphery, heritage sites and architectural landscapes, access to open spaces.

Note: Prepared by the Authors

It was observed that having free access to the cartography of the territory allows for obtaining reliable data for their respective analysis of the existing open spaces.

As practical strategies shown in Table 4, it was possible to identify articles that highlight architectural redesigns that manage to recover spaces by adapting them to the new needs of the human being, improving their quality of life.

TABLE 4
APPLICABLE REGENERATION STRATEGIES

Referential Cases	Location	Objective	Strategies
Tourism planning in urban areas	São Paulo, Brazil	The implementation of tourism	Positioning of places of consumption of space appears as a fundamental condition of urban policies.
Study redesign architectural extension of the boardwalk of the Cantonal head of Catarama, Los Ríos	Catarama, Los Ríos	Propose the redesign and expansion of the Catarama boardwalk	The conception of the new process begins with the redesign team reviewing all the work done in the previous steps. Change the focus of the internal procedure to meet demands. Eliminate all losses due to delays; administrative obstacles, and reduce variation in process performance.

Note: Prepared by the Authors

It was possible to determine that green spaces are important within a city which mitigates the island effect of human heat in addition to carbon capture and oxygen expulsion, improving air quality and, therefore, that of the human being. One of these examples is represented in Table 5.

TABLE 5
ARCHITECTURAL DESIGNS BASED ON GREEN INFRASTRUCTURE CONCEPTS

Referential Cases	Location	Objective	Strategies
Planned architectural rehabilitation	Santiago, Chile	A comprehensive method for the evaluation of architectural adaptability in homes in typical urban areas, in the face of new requirements for use	In general, they are developed in buildings with a horizontal property regime when it is necessary to improve the image of the building or enable necessary facilities in common spaces.
Green and blue infrastructure in the face of climate change Anna	Brazil	Presentation of the importance of teaching landscaping in the undergraduate career in architecture and urbanism as a tool to plan the landscape of cities and the implementation of green and blue infrastructure in them.	The attitude adopted by the group was the placement of bins for the separation of recyclable material. Considering that the predominant use in the surroundings is residential, such an attitude can help in the environmental education of the local public and, thus, minimize the amount of garbage that is disposed of irregularly.

Note: Prepared by the Authors

IV. DISCUSSION

The method of subdividing the stages within the study area allowed to expand the knowledge of the distribution of masses and visualization of the study problems determined by the unhealthiness in 85% of substage one and insecurity in 100% of substate 3 and 50% of substate 3; it is obtained that the predominant use of the 3was stage of the boardwalk is focused on substate 2 (c = 44, t=180).

The blue infrastructure must be used since it runs along the entire length of the territory, so it must be used for the use of landscape connectors that generates overspill of the water courses to generate a redistribution through the elaboration of a channel and vegetation cover to protect the surrounding coastal profile.

Through multispectral analysis, it can be obtained that the territory has been vital in the conformation of natural elements so that its use would form a strategy oriented to the deployment of protective green areas. The 3rd stage of the Malecón Villamil beaches focuses on sustainable boardwalks interacting with the natural environment.

As a strategy in the face of insecurity, strategies for the use of furniture are implemented with the use of renewable materials and vegetation that adapts to the environment; the blue infrastructure will be used in addition to electricity generation.

The study reveals that results are based on the configurations of the analog models type so that variations are obtained in the final taking of criteria that are supported by the lack of green infrastructure in substage 2 of the third Stage of the Malecón Villamil Playas. It is expressed that architectural designs based on planned architectural rehabilitation subject to a criterion of care of green spaces would increase the comfort conditions of the study area.

V. CONCLUSION

In the diagnosis of the needs for urban and architectural regeneration in the area, the importance of solving these problems is highlighted since they cause serious consequences in the lives of the inhabitants of the sector, not only in the field of public spaces but also negatively affects the health and economy of those who depend on tourism on the Malecón Gral. Villamil Playas.

By theoretically analyzing the contribution of green and blue infrastructure through the study of analogous models, it was possible to determine that there are multiple benefits and different strategies that can be implemented to meet the requirements and needs of the population, making efficient use of resources and guaranteeing the protection of ecosystems and the environment.

Regarding the design of urban regeneration strategies, it is considered pertinent to build a terrace or elevated bridges to allow pedestrian passage, build a canal to avoid water stagnation and avoid undermining and erosion, and create new recreational spaces such as trails, bicycle routes, altering the natural environment as little as possible and improving hygienic and waste collection services.

It is concluded that sustainable development has become essential for territorial planning, the management of resources, and urban space. Therefore, sustainability implies improving the quality of life in accordance with the carrying capacity of the natural and urban environment.

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Our research group is a multidisciplinary group interested in developing new technologies within the field of architecture and territorial planning to provide an optimal solution to problems within urban planning, construction, city development and people's ways of living. Our group is made up of three academics and we have extensive experience in executing research projects published in high-impact journals and books, laboratory, experimental, longitudinal studies, and qualitative approaches. And how many. These approaches have allowed us to develop a linear knowledge model that improves the ability to understand and manage new technologies to improve the quality of life and sustainability in the territory.