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Green Infrastructure Design for Connectivity in the Villa Wetlands Wildlife Refuge

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Abstract

The research aims to propose a green infrastructure design that allows us the connectivity in the Pantanos de Villa Wildlife Refuge located in the district of Chorrillos - Lima. This proposal aims to improve the connectivity of the ecological area through bike paths and eco-friendly spaces in order to have a greater interest of visitors and tourists, to also contribute to the conservation of this natural area by taking advantage of the appreciation of the landscape since it serves as rest of migratory birds, this area is a natural reserve that allows the nesting and transit of migratory and resident birds. With this proposal, we can improve the landscape of the area and increase the flow of visitors to the Pantanos de Villa Wildlife Refuge.

Keywords: Connectivity, Green design, wetland, bike line, eco friendly

1 Introduction

On the coast of Peru, where human activities are proliferating and the population increase grows exponentially, people lack comfort and relaxation zones. Because of this and for the conservation of biological diversity,

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natural protected areas are designated by the National Service of Protected Areas by the State [1].

Currently, Lima's city has increased the use of automobile transportation. Due to population growth, these areas are being affected by productive activities or establishments in urban spaces in the vicinity and by the incompatibility of land use in the vicinity of the protected natural area.

According to estimated statistics, in the district of Chorrillos, presented by the INEI every June 30th for 2015 is 325,547 inhabitants, which indicates a population increase of 38,570 inhabitants, unlike the last census in 2007, the population was 286,977 inhabitants and a population density of 7,369.70 inhabitants/km2. It is estimated that in the area surrounding the protected area, there is a population of 116,200 inhabitants in 21,200 occupied homes, which represents 5.5 people per home. [2]

Green Infrastructure Green infrastructure can be defined as "an interconnected network of green spaces that conserves the functions and values of natural ecosystems and provides associated benefits to the human population" [3], and although this idea goes back to the term green infrastructure only appears strongly during the last decade in the design and planning of urban and peri-urban environments. Green areas can enrich the lives of people in cities by generating multiple benefits, such as improved air quality, noise reduction, thermal regulation, improved non-motorized connectivity, and the provision of recreational spaces, among many others. Although the concept of green infrastructure does not have a unique definition, it is clear that it proposes the re-conception of urban and rural landscape elements, aiming at ecosystem connectivity, nature conservation, and multifunctionality, in order to maintain and increase the provision of ecosystem services (ES), generating more significant social, economic and ecological benefits. Furthermore, this type of infrastructure emphasizes connectivity and multifunctionality since it is based on the principle that an integrated landscape delivers many more benefits than the sum of its isolated parts. The elements with potential for the development of green infrastructure are very diverse and can be classified according to the spatial scale in which they are frequently observed: neighborhood scale, city scale, and regional scale. Table 1 shows the components that can usually serve as green infrastructure (or for its development), which have been added those relevant to Santiago's case. Besides, those linear landscape components with potential for the development of multifunctional green corridors have been distinguished (indicated with [*]). [5]

Green infrastructure and its contributions to the resilience of territories, Urban growth can represent a threat to urban green areas and an opportunity to recognize the contribution of adequate PIVI to human welfare and health, species protection, adaptation to climate change, and sustainable urban development. 6] The need to review the processes of uncontrolled urban growth with undesirable social and urban effects, severe climate events, and environmental hazards represent opportunities to implement innovative forms of planning and management of the IV, to contribute productively to link the following urban challenges with the unrealized potential of green and blue spaces: protection of biodiversity, adaptation to climate change, increasing social cohesion and promoting local economies based on local and sustainable production.

Table 1 Componentes del paisaje con potencial de Infraestructura Verde

NEIGHBORHOOD SCALE	CITY SCALE	REGIONAL SCALE
Tree-lined streets [*]	Rivers and flood plains [*]	Protected Wildlife Areas
Green roofs and walls	Intercommunal Parks	Rivers and flood plains [*]
Neighborhood squares	Urban Channels [*]	Coastal borders and beaches
Private gardens	Lagos	Strategic and long distance paths [*]
Institutional open spaces	Urban forests	Forests
Ponds and streams [*]	Natural Parks	Safety strip on high voltage lines
Road rights of way [*]	Continuous water front [*]	Road and rail networks [*]
Pedestrians and cycle routes	Municipal squares	Designated green belt [*]
Cemeteries	Island Hills	Agricultural land
Sports tracks [*]	Large recreational spaces	National Parks
Flood ditches	Mats [*]	Channels [*]
Small forests	Abandoned land	Mountain ranges [*]
Play areas	Community Forests	Common Property Territory
Local Nature Reserves	Abandoned mining sites	Aqueducts and gas pipelines [*]
Schoolyards	Agricultural land	Geological faults [*]
Orchards	Landfill	
Abandoned land		
Gullies[*]		

Connectivity, Networks as a set of geographic locations interconnected in a system by some routes, and widely developed network analysis based on the consideration that the different functional systems of flows, which are dealt with by both physical and human geographers, have in common the fundamental property that they occur through a channel or a network of channels. [9]

Sustainable urban transport is a system that allows the transport of people and goods at lower social and environmental costs than the current ones, reducing the weight of the private vehicle as a means of transport and oil as an energy source. Sustainable mobility implies profound changes in human behavior to guarantee the quality of life for today and future generations. It is not a simple change of energy source and involves the use of other means of transport. Sustainable mobility is based on three pillars: Rationalization and restriction of private vehicles' use; Promotion of public transport. [10]

Ciclovia, today most of the bicycles stopped being a means of fun to become a means of transport already in some cities a current of circulation. [11] In mobility studies, cyclists are taken into account more often, but in cities, they are exposed to many risks such as accidents, insecurity, and the climate and geography of the place. [12] The ciclovía is a generic name given to the part of the public infrastructure, to spaces reserved exclusively for the safe transit of bicycles on one side of the streets or parallel to the cities' access roads. [13]

Importance of Wetlands, Wetlands are among the most productive ecosystems on earth and are sources of biological diversity, providing the water and primary productivity on which countless species of plants and animals depend for their survival. The wetlands support high concentrations of birds, mammals, reptiles, amphibians, fish, and invertebrate species. Of the twenty thousand fish species in the world, more than forty percent live in freshwater. Wetlands are also important storage sites for plant genetic material. Rice, for example, a common wetland plant, is the staple food of more than half humanity. [15]

2 Method

2.1 Study Area

Pantanos de Villa is located in the district of Chorrillos, in the Department of Lima, south of Lima, the capital of Peru (12° 12' LS and 76° 59' LW). It is the only protected area within the urban area of the city of Lima. The total area is 276 hectares.

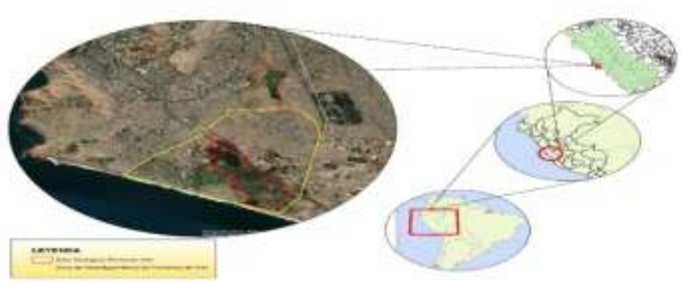
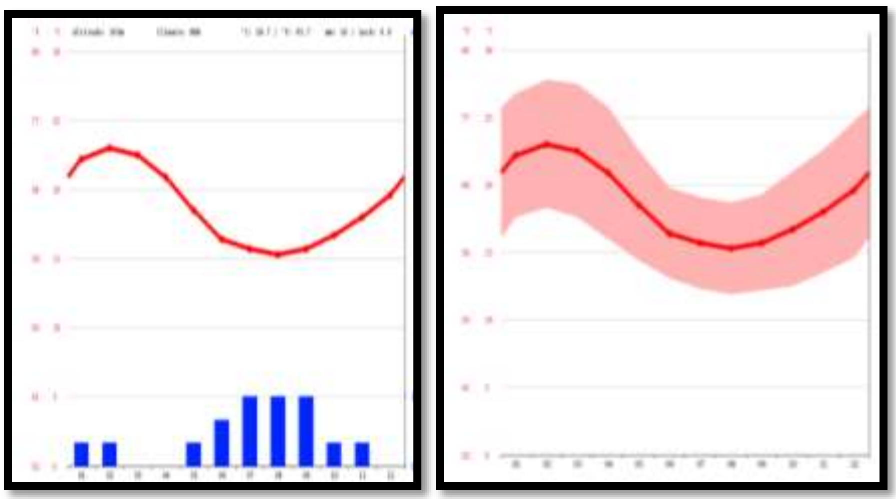


Figure 1 Location of the Study Area

2.2 Climatología

This area has low rainfall throughout the year, and the winds that occur in the area go from south to southeast, which, together with the Peruvian Current, produce a characteristic fog. The temperature during the summer ranges between 15 and 26°C and during the winter between 14 and 19°.



(a) **(b)**

Figure 2 In figure (a), the least amount of rain occurs in March. The average for this month is 0 mm. In July, the precipitation reaches its peak, averaging 3 mm. In figure (b), the temperatures are higher on average in February, around 23.0 °C. At 15.3 °C on average, August is the coldest month of the year.

Table 1 Climate

	Jan	Feb	Mar	Apr	May	Jun	Jul	Ago	Sep	Oct	Nov	Dec
Temperatura media (°C)	22.2	23	22.5	20.9	18.5	16.4	15.7	15.3	15.7	16.7	18	19.6
Temperatura min. (°C)	17.6	18.3	17.6	16	14.4	13.1	12.3	11.9	12.2	12.5	13.5	14.6
Temperatura máx. (°C)	26.8	27.8	27.5	25.8	22.6	19.8	19.1	18.7	19.3	21	22.6	24.7
Temperatura media (°F)	72.0	73.4	72.5	69.6	65.3	61.5	60.3	59.5	60.3	62.1	64.4	67.3
Temperatura min. (°F)	63.7	64.9	63.7	60.8	57.9	55.6	54.1	53.4	54.0	54.5	56.3	58.3
Temperatura máx. (°F)	80.2	82.0	81.5	78.4	72.7	67.6	66.4	65.7	66.7	69.8	72.7	76.5
Precipitación (mm)	1	1	0	0	1	2	3	3	3	1	1	0

In the table 2 show the variation in precipitation between the driest and wettest months is 3 mm. The variation in annual temperature is around 7.7 °C

2.3 Physiography

The area occupied by Pantanos de Villa has a flat or slightly undulating relief and an alluvial plain; it is surrounded by hills between 100 and 300 m of altitude and a straight beach line; giving it very special microclimate characteristics of humidity, formed by a great number of water bodies, as a product of the infiltration and outcrop of subway water that goes to the sea. [16]

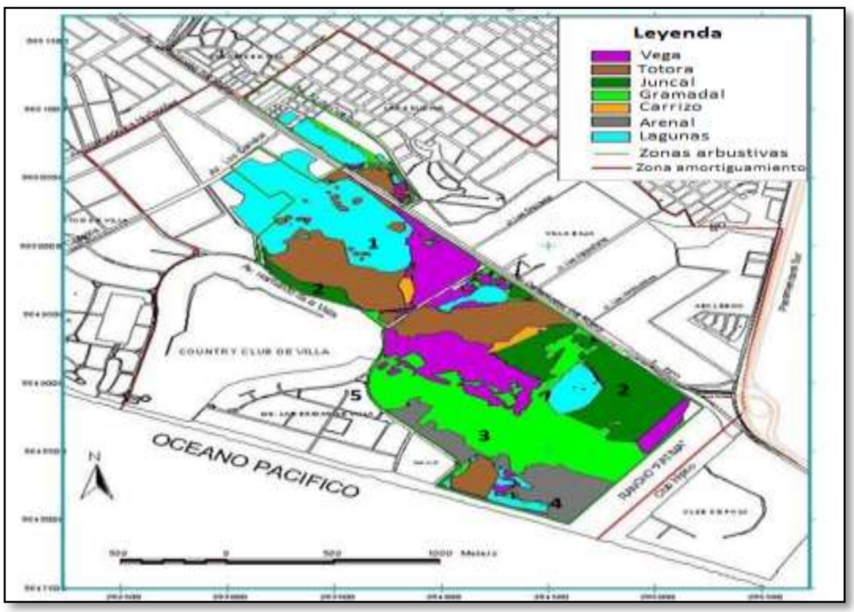


Figure 3 A Physiographic Map of the Study Area

2.4 Soil Science

The Villa swamps are formed by moderately deep alluvial deposits, poorly drained soils, an outcropping of the water table very close to the surface, and slow surface runoff, being susceptible to flooding, with problems of excessive salinity.

The soil is made up of a clay-sandy, silt-clay, or silt-gritty material. It has pebbles of various hierarchies and with a sandy matrix, interspersed with layers of clayey to loamy material in some areas. The substrates that contain much organic matter are of importance, formed mainly by decomposing plant material, deposited underwater, mixing with sand, silt, or clay. In general, these are corrosive soils with a soft or moderately compacted consistency and are very humid. [17]

2.5 Topography

The topography of the district of Chorrillos (contour lines at an interval of every 1m), the villa marshes are located within a flat depression of 1530 ha, between 0 and 5 m.a.s.l and surrounded by low hills between 100 and 278 as the Morro Solar, Cerro Zigzag, and Lomo Corvina.

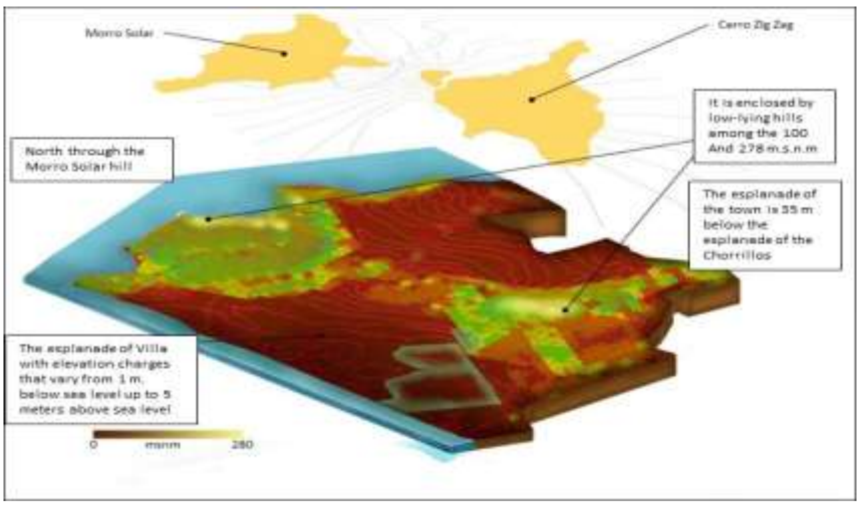


Figure 4 Elevation Map

In the figura 4 show the origin of this area as the outcrops of underground water coming from the Rimac River Basin and other sources such as lagoons, puddles and muddy lands.

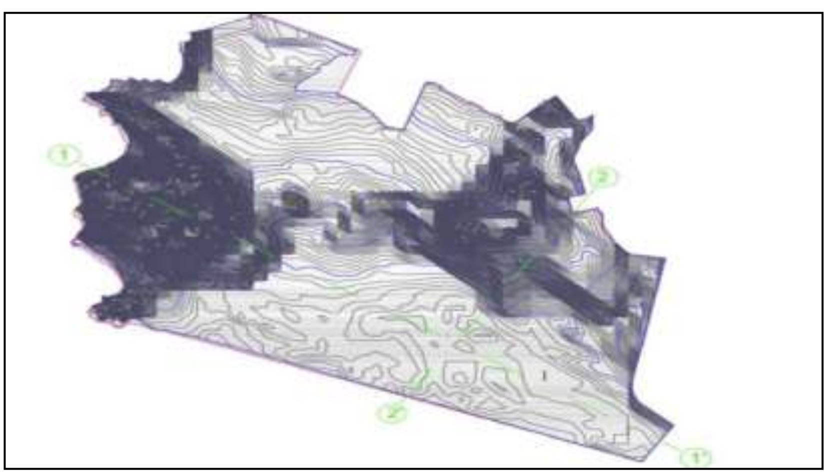


Figure 5 Topographic Map

In the figura 5, show the contour lines of the topography of the study area is very important for the design of the connectivity infrastructure, the delimitation is visualized with the green lines.

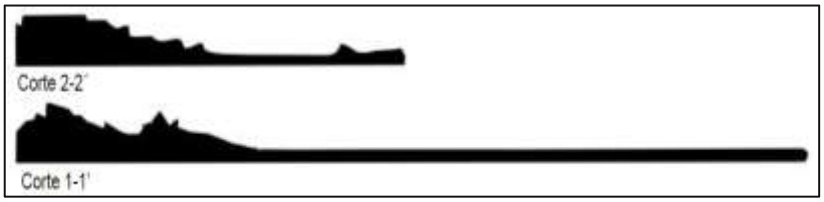


Figure 6 Topographic profile

In the figure 6 shows the terrain profiles, in which the terrain relief is observed in cuts 2-2 and 1-1.

2.5 Materials

In this present research study, to make the maps for the cycle track connectivity, we used the Geographic Information System (GIS) with Arcmap 10.5, Arcscene 10.5, Autocad 2018, Google Earth software, and in the 3D design the SketchUp 2019 software. [18,19]

2.6 Procedures

In the first stage of the research, a general diagnosis of the current connectivity situation in the Pantanos de Villa Wildlife Refuge was made, identifying the geometric and hierarchical characteristics of the road network, conflicting intersections and crossings, vehicle congestion, parking deficit, means of transport, and urban transport network. Likewise, research was carried out on future projects to be implemented by the Municipality of Lima. [20,22,23]

3 Results and Discussion

The present investigation includes the implementation of cyclical connectivity in the Pantanos de Villa as it can be appreciated in the figure.

First instance: Maravilla Circuit towards Alameda las Garzas - in this instance, the green design is proposed to connect these areas, implementing bicycle and pedestrian lanes. [21]

It can be seen that in the desert area a green corridor is proposed, which allows to regenerate the spaces for the recovery of green areas and generate microclimates for the improvement of environmental quality, as well as the regeneration of ecosystems.

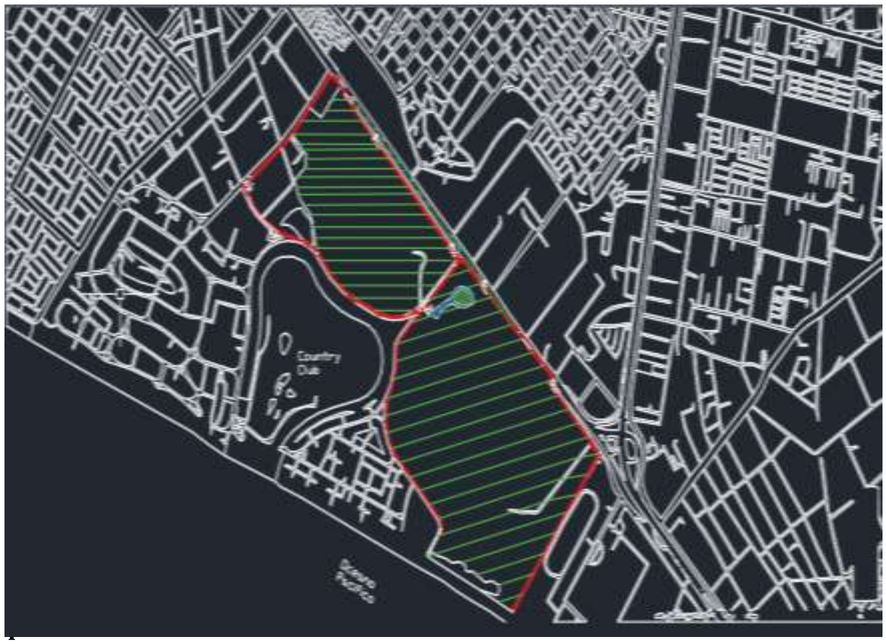


Figure 7 Cyclic Road Connectivity

Figure 8 Bicycle Lane, Current and Proposed Status in Alameda Las Grazas

4 Conclusion

The green infrastructure achieves a better harmonization of the landscape in the Pantanos de Villa Wildlife Refuge by which it improves for the neighbors and those who visit this area.

The research hypothesis is fulfilled since it allows asserting that the implementation of the bicycle paths will help the visitors to have greater accessibility to the areas, being able to consider the implementation of the present work as one of the best options to promote sustainable mobility using the bicycle in the natural protected areas.

The bicycle network proposed in the area of Pantanos de Villa will allow promoting tourism in the natural area, considering that three circuits cross that you can appreciate the bird sightings.

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