Climaxion: Climatic Maximum Collaboration

Proposal for a climatic park in Argentina

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Abstract:

The following project proposes the recreation of diverse climate zones from Argentina in an 18 hectares park in the center of Buenos Aires. The research investigates the particular climatic conditions of different biomes (subtropical, semi desert, glacier, humid forest) and the requirements for their introduction in the outdoor climate context of Buenos Aires. Precise targets, with specific humidity and temperature ranges are defined for each case, as well as tolerance ranges that take into account daily swings that different species of plants need for their growing conditions. Once the indoor targets for each biome are defined and the outdoor climate conditions are analyzed, diverse strategies (passive & hybrid) are evaluated to achieve optimized envelopes and boundary conditions that minimize their individual energy demands. The particular energy drivers (sensible and latent heating and cooling) help inform their location within the site, and guide a general evaluation to select the most suited individual variations which best fit the global system. The potential for flows is considered, as a mean to balance the sometimes opposite drivers required by the different biomes. In this way the Climaxion park proposes an integrative clima-engineered concept for a performance based landscape design which relies on technical collaboration between its different environments.

Introduction

At the southern portion of South America (Figure 1), lies Argentina. With a mainland area of 2,780,400 km^2, it is the eighth-largest country in the world.

Figure 1 : Argentina location

Argentina holds a population of approximately 42 million people, distributed unequally throughout the territory. Roughly 90% of the population is concentrated in urban areas out of which 40% is settled in the capital city of Buenos Aires. It is surprising to find that people living in this political, economic and social gravitational center have a far inaccurate perception of the country's biodiversity when compared to the richness that it actually hosts (Figure 2).

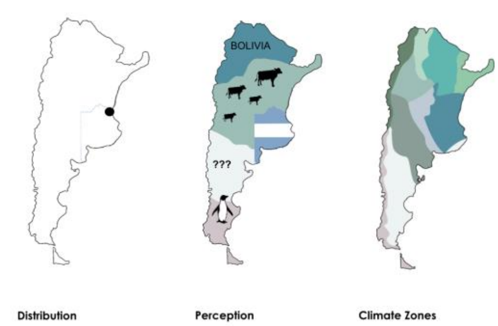

Figure 2 : Maps of Argentina respectively showing its population distribution, the perception from the capital residents and the climate zones of the country.

Vision

Within this geographical, climatic, and socio-cultural context, the following design project intends to propose a new national landmark: an educational and recreational park that celebrates Argentina's biodiversity & promotes its conservation. The introduction of a climatic park composed of different climates and landscapes from Argentina, coexisting in a new public landscape which will host the various environments (Figure 3), aims to question the centralized and hierarchical logic under which the country operates today. The proposal is based on a decentralized, balanced and synergetic system, translated both in the design of the landscape as well as in the technical climate engineered approach of the park. Different biomes become interdependent and need to coexist and interact thermodynamically to achieve their optimal efficiency (Figure 4).

Figure 3: Climates from Argentina to be reproduced.

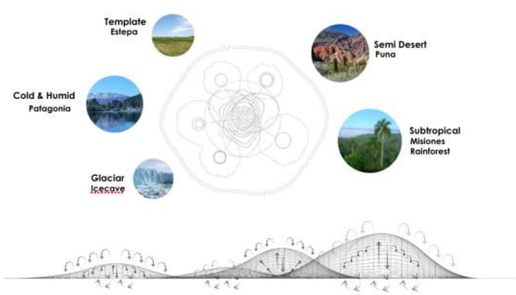

Figure 4: Concept diagram for a climatic park.

Site

The selected initial site for the introduction of this park is an 18 hectares plot in the center of Buenos Aires, which used to host the old city Zoo; one of the first metropolitan infrastructures of the city (Figure 5). The Zoo, which has been recently closed (2017) arose as an exponent of scientific, aesthetic and technological criteria that marked the design of natural science parks opened in the nineteenth century. It was created according to the principles of the scientific view of its time, the impulse of public education and the subordination of the natural environment to the interests of society.

Figure 5: Proposed new topography for the old city zoo site with embedded biomes in the climatic park.

The vision of sustainability, the energy crisis, the current consumption habits, and climate change, modify the acceptance of urban processes as they occurred in the beginning. Among those, the confinement of non-domestic animals and their detention in areas not well adapted, to serve mostly for recreation without any interest in the conservation vision. The new park intends to be a center for metropolitan rapprochement to biodiversity issues, and worldwide experience regarding practices, methodologies and technologies for conservation. The strategic location, size and exposure of this site provides a great opportunity to offer an updated benchmark for the city, that will redefine the terms of our relationship to our natural environment.

Climate context

Argentina: Given the country's enormous extent, as well as its latitudinal and altitudinal development, Argentina presents a huge variety of climates; containing more than half of the worlds' climate zones, according to the Köppen classification system (Figure 6)

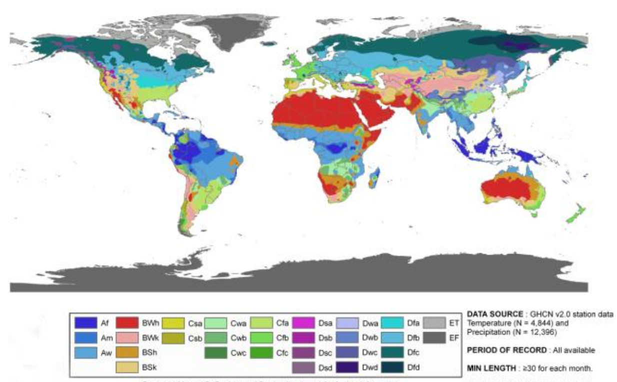

Figure 6: Köppen classification system map

Argentina stretches for more than 33° latitude between its extreme north (21° 46'S) and the southernmost point of the Argentine emergent continental territory (55° 03'S), from La Quiaca to Ushuaia, making it one of the longest countries in the world. The country is crossed at its western end, from north to south by the Cordillera de los Andes, which largely marks the border with Chile. Its geography is very varied, being mainly plains in the east, serranías in the center and mountains in the west. The country is crossed at its western end, from north to south by the Cordillera de los Andes, which largely marks the border with Chile. As the Southern Cone is surrounded by huge oceanic masses, the variations between summer and winter are low in relation to many regions in the middle latitudes of the northern hemisphere**.**

Buenos Aires: Buenos Aires has a temperate climate, which is classified as a humid subtropical climate (Cfa) under the Köppen climate classification (Figure 6) with four distinct seasons. It has a mean annual temperature of 17.8°C (65.5°F). Summers are hot and humid with frequent thunderstorms while winters are cool and drier with frosts that occurs on average twice per year. Spring and fall are transition seasons characterized by changeable weather. Being located in the Pampas, Buenos Aires has variable weather due to the passage of contrasting air mass – the cold, dry Pampero from the south and warm, humid tropical air from the north. The coastal location results in a strong maritime influence, causing extreme temperatures) to be rare**.**

Methodology & Approach

Four enclosed biomes have been selected to be introduced in the outdoor context of Buenos Aires. The local climate has been analysed and considered for the general approaches and specific strategies for all biomes. Once targets where set, strategies and boundary conditions have been evaluated through thermal simulation analysis (Trnsys 18). The fittest variants where selected according to their potential within the energy network, aiming for a balance of total demands. The most convenient location of each biome within the park according to their role in the network, and the translation of their boundary conditions into a sculpted topography have informed the design of the landscape.

Climate Targets & Strategies

Specific temperature and humidity targets have been defined for the recreation of each biome within the outdoor conditions of Buenos Aires' climate. These were determined according to the desired experience to be brought in each case. The enclosed environments do not reproduce a yearly cycle of the climate, but allow for a selected and specific climate domain, representative of each region. However, tolerance ranges for both temperature and humidity have been considered, as well as daily swings needed for the growing conditions of the hosted plants. Different added strategies were evaluated to achieve the desired indoor conditions through efficient passive and hybrid means.

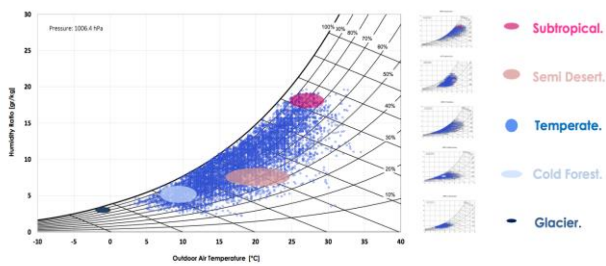

Figure 7: Buenos Aires Psychometric chart with selected targets for the 4 Biomes to be introduced, embedded in an outdoor temperate climate.

Subtropical Biome: Target Temperature 25°C-30°C / Humidity 70%-90%. Achieving a subtropical biome in Buenos Aires requires heating and humidification all year round. The heating driven biome maximizes solar gains (by orientation and glazing selection), and naturally ventilates when possible. Adiabatic cooling effect by the plants covers most of the latent heating-humidification demand needed.

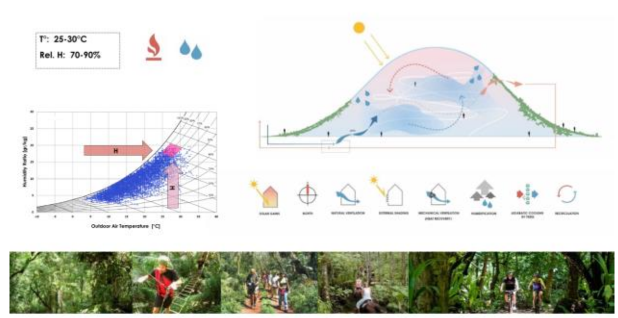

Figure 8: Strategies for a Subtropical Biome

Semi desert Biome**:** Target Temperature 12°C-22°C / Humidity 35%-60%. Introducing a semi desert from the high Puna mountains, located close to the Cordillera de los Andes where insolation levels are extremely high (aprox. 1400 kWh/m²); instigates a strategy that aims for an Operative Temperature. Radiative heating surfaces compensate for the lack of solar radiation in Buenos Aires, compared to the original climate levels. However, it is driven by cooling and yearly dehumidification demands**.**

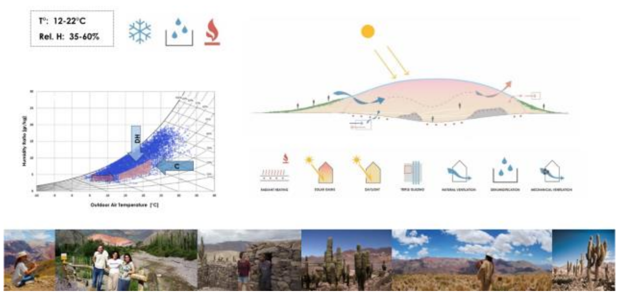

Figure 9: Strategies for a Semi desert Biome

Cold Forest Biome: Target Temperature 7°C-12°C / Humidity 60%-90%. This biome introduces a cold & humid forest from the western Patagonia region. It aims to minimize solar gains, while maximizing daylight for plant requirements. The design proposes the enhancement of diffused light, working with thermal mass and night flushing to keep the cool temperature targets

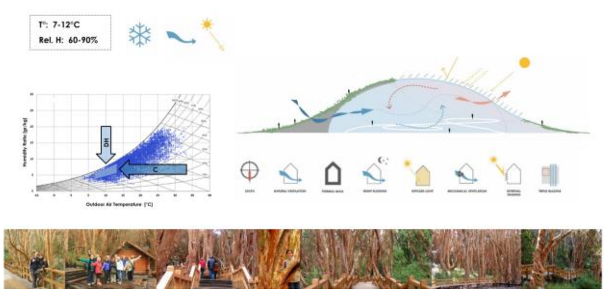

Figure 10: Strategies for a Cold Forest Biome

Ice-cave Biome: Target Temperature -2°C / Humidity 70%-100%. Buried underground, with a 2% WWR in its horizontal surface, this biome requires 24/7 mechanical systems, mainly activated through radiative cooling surfaces –using glycol as a fluid.

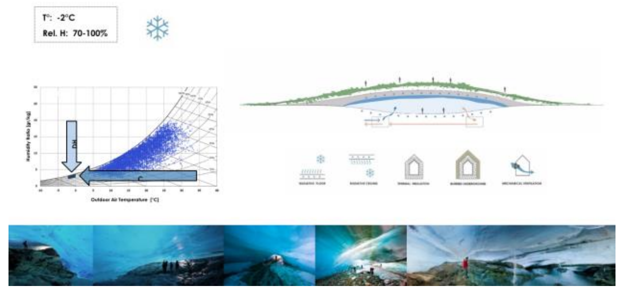

Figure 11: Strategies for an Ice-cave

Model Geometry & Boundaries Evaluation

The definition of boundary conditions and the evaluation of the proposed strategies was done through thermal simulation analysis (Trnsys 18). A thermal 'shoe box' representative model was defined with a set of various parameters to be modified and evaluated for different variants (Figure 12). The representative model geometry was set to inform the biomes' envelope which was then translated into the design of the final landscape and topography (Figure 13).

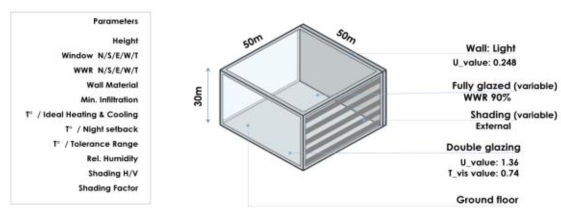

Figure 12: Thermal shoe box model.

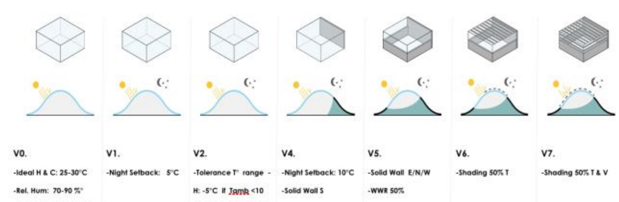

Figure 13: Example of study for different variants and their boundaries evaluation for the subtropical biome.

These evaluations allowed for the selection of the most convenient variant in each case, which was not always the least energy demanding but the variant that better fit the system as a whole; considering the overall need for a total balanced energy demand (Figure 14)

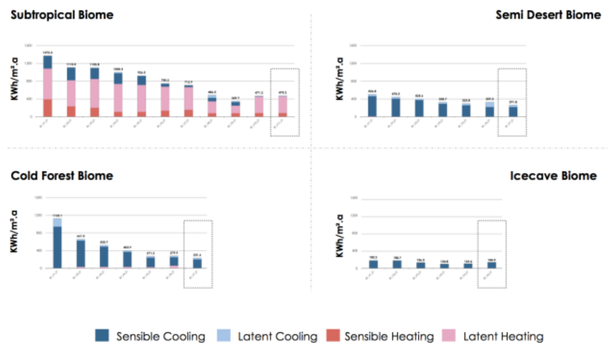

Figure 14: Selected variant for each biome.

Results show there are 3 cooling driven & 1 heating driven biome, with mainly latent heating demand. The effect of vegetation has not been considered in the thermal model, but is assumed to cover the humidity demand by adiabatic cooling from the plants and by additional water jet nozzles. This consequently decreases the air temperature; therefore, it is translated from latent into sensible heating demand. (Figure 15)

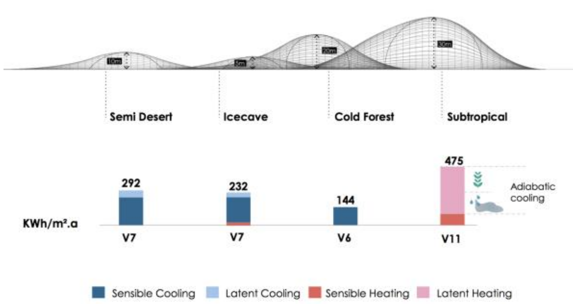

Figure 15: Total annual energy demands.

Synergies

The following energy concept (Figure 16) proposes specific flows between the enclosed biomes. The subtropical biome can be achieved for ‘free, with its demand being covered by the energy waste of the three-resting cooling driven biomes. Cooling and Heating demands require to be equal for an ideal performance of the system.

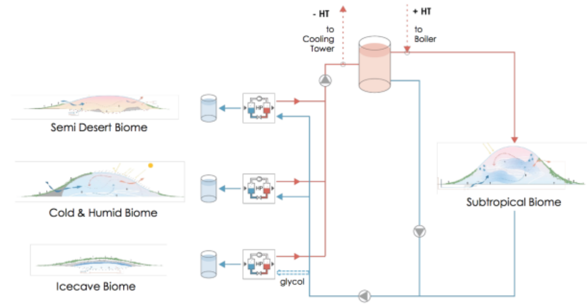

Figure 16: Concept for energy network.

Optimization

The results obtained for the selected site considered in Buenos Aires show that the demands for cooling and heating are not equal. Two approaches are considered to achieve this balance: 1) Increase the size of the heating driven biome by 25%, or decrease the cooling driven biomes by 20%. 2) Question Buenos Aires‘climate as an optimal location for the introduction of this park, and evaluate its performance if situated in other locations along the country (Figure 17) (Figure 18).

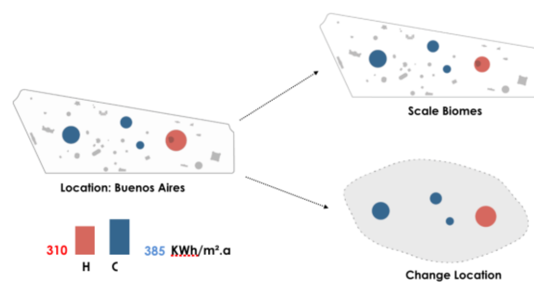

Figure 17: Approaches to achieve total energy demands balanced (Heating and Cooling).

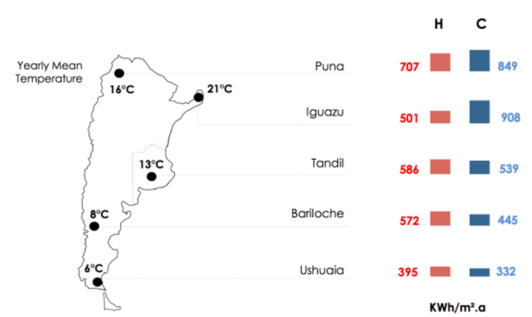

Figure 18: Total annual energy demands evaluation for different locations along the country.

Figure 18 shows Ushuaia, with a mean yearly temperature of 6°C, as the best location in which to insert this climatic park, being that the local climate better copes with the specific selected targets for each biome, resulting in an overall energy reduction and a more naturally balanced system.

Conclusions

As it can be observed in the results, the vision for a sustainable climatic park in Argentina could be introduced in Ushuaia for an optimal location based-performance of the system. However, the operation viability and construction feasibility for such a park is highly questionable when considered to be introduced in a remote area. Introducing the Climaxion park in Buenos Aires, specifically in the original considered site, would allow for a much higher level of exposure and impact. Therefore, scaling the biomes (Figure 17) to achieve an energy flow balance would be the further step to be studied.

Acknowledgments

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