THE REAL COST

Costs and gains are concepts that stretch beyond the limit of money.

The story of a sustainable evolving centre...

MSc04 ARC
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Project group 9
Arianna Vacchi Suzzi
Sara Fausti
Peter Deir

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Main Supervisor:
Mads Dines Petersen

Technical supervisor:
Andreas Grøntvedt Gjertsen

WHAT:	EVOLVING KNOWLEDGE CENTER
WHERE:	BUENOS AIRES PUNTARENAS, COSTA RICA
FOR WHO:	THE COMMUNITY
LOCATION:	SITE OF 31 000 sqm
FOCUS:	SUSTAINABILITY

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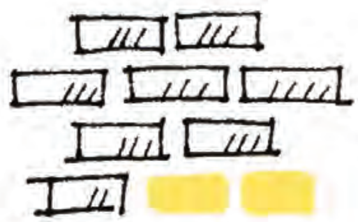
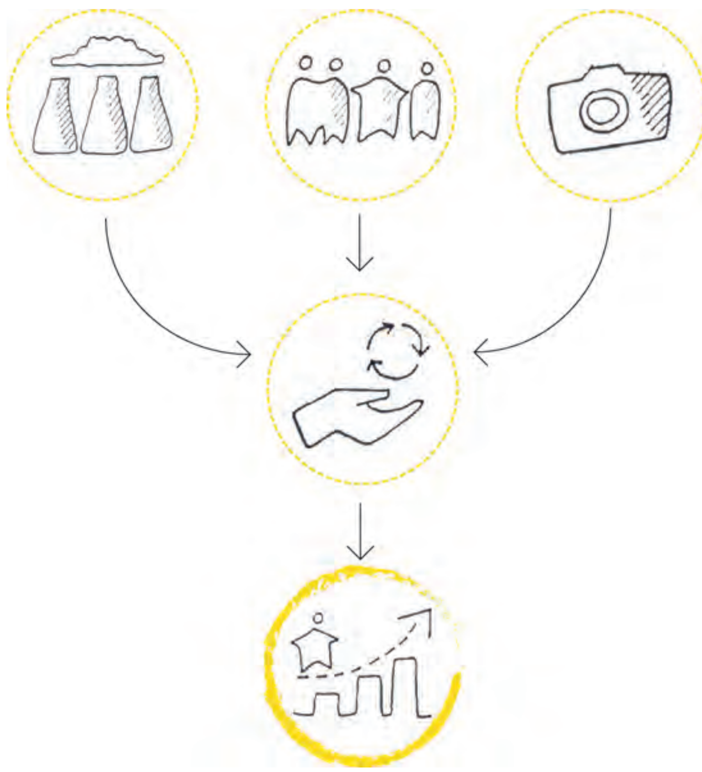
PREFACE





Ill.1 - Sustainaible development

ABSTRACT

The presented thesis project aims to develop a sustainable and evolving architecture, serving the community of Buenos Aires as a cultural, educational and visitor centre, promoting collective and individual growth.
The town of Buenos Aires is situated in the South of Costa Rica, a particularly underdeveloped region, heavily exploited for pineapple plantations.
The present situation and the nature of our goal, ask for a different approach to sustainability, which includes social and environmental concerns.
From the use of local materials to the application of design strategies aiming for an optimal energy performance, traditional and innovative means will be used in symbiosis in order to achieve the best sustainable solutions in respect of the natural environment and the culture of its inhabitants.
As this centre is to provide evolving facilities able to keep up with changing actors, three user typologies are presented, as part of a building's timeline, that will affect the management of spaces in different stages of the building's life.

READER GUIDE

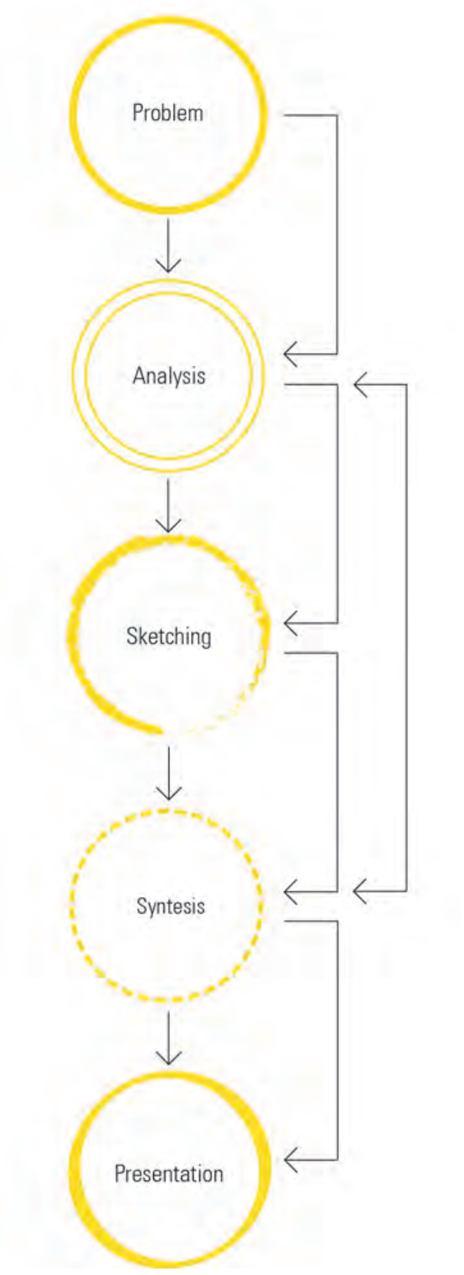
The following booklet guides the reader through each stage of the design process starting from the theory and method used as general principles of the work.
Secondly, Buenos Aires and the main actors involved in the intervention, are presented, together with the formulation of the problematic at the base of the project.
Afterwards, the reader will find an overview on sustainability and an outline of our following approach to the topic.
An analysis is later presented in order to gather important information about location and peculiarities of the area together with some architectural reflections.
The case studies introduce to the design process, followed by the presentation of the final output and a brief chapter with the technical concerns.
In the end, conclusion and reflection summarize the long process that brought us till the final result.

METHODOLOGY & THEORY

The process used to approach this thesis is the IDP, (Integrated Design Process), a repetitive mechanism consisting of five phases connected to each other: Problem Statement, Analysis, Sketching, Synthesis and Presentation.
Each step taken leads the design to the following one and to the discovery of new solutions, giving another light to the previous passages.
A theoretical background is the foundation of a virtuous process since it defines the basic starting criteria to approach each problematic.

"The purpose of theory is to set goals and objectives and to provide criteria for making the choices among alternatives that are involved in the design. The purpose of such criteria is to guide the answer to the question: what should be done and why. "
(Rapoport,1983)

Growth, what kind and how to stimulate it, is a concept fundamental to this design process. The thematic of development has been studied for centuries under different lights. Being it related to the exchange of goods and knowledge, the individual greatly depends on the community, therefore social, economic and space studies reflect on each other in a deeply connected circle.



Ill.2 - Design Process

On philosophy of personal and social growth

In 1821, in his "Philosophy of Right", G.W.F. Hegel identified in "civil society" the chance for the satisfaction of personal needs and desires, as the individual's well being strictly depends by one of others since each person requires others to define himself in activities as commerce and trade.
Therefore there is no room for individual development without a collective growth, and the development of the single individual needs to have a positive impact on the growth of the community in order to achieve a virtuous cycle; it is then of primary importance to inspire positive wishes to citizens as a whole and as singular elements.
According to G. Leibniz, the nature of desires, their achievements and the following growth of each individual is directly related to the amount of knowledge possessed: a state of ignorance leads to blind choices and confused, unproductive desires; positive choices come from education and awareness.
(Iep.utm.edu, 2018)
Leibniz's thinking has lately been re-elaborated by John Dewey when, in his "Philosophy of education", he argues about the importance of education in sociological and cultural growth, identifying the "educative process as a continuous process of growth [...]", in a never-ending cycle as growth is the "characteristic of life".
(Garrison, Neubert and Reich, n.d.)
For a personal development, it is necessary a collective one, the needs of the community come together with personal ones and sharing knowledge is fundamental to an individual and cultural development.

Ill.3 - Individual and collective development

To achieve a collective development, a closer look must be taken to the needs of different community types, where the, where the act of sharing is fundamental to the individual and cultural progress.
According to Grodach & Loukaitou-Sideris in "Cultural development strategies and urban revitalization", there are three main strategies to endorse cultural development, depending on the targeted audience, the project pursued and geographical focus.
(Grodach and Loukaitou-Sideris, 2007)
While entrepreneurial and creative class strategies are mainly concerned about an economic growth, through the private sector and the creative communities, progressive strategies approach growth by providing benefits to citizens, in order to reduce social disparities and raise the living standards by the citizens' participation.
(Fitzgerald and Green Leigh, 2002; Clavel 1986)
For a cultural development, the priority of progressive strategies is to broaden the community's access to arts, local products, to strengthen its identity, stimulating interest in the local heritage, finally regenerating disadvantaged areas, impacting the community, also on an economic level.
(Evans 2001)
Development must be set in a way to serve the individual, the family, and the community:

- social well-being is a constant interplay between the individual and the environment, about influencing, expressing and being influenced and expressed. This interaction is only sustainable when an individual is consciously and actively pursued and engaged with. It is a foundation of self-choice responsibility and action;

- the family is a primary medium in cultural continuity and social context. Traditionally, elders play a central role in transferring culture and knowledge to younger generations within the family and extended families, they detain the role of passing language, skills, and experience.
(Hughes, 1990)

- When experience is accumulated from each individual, then shared among others, a community is formed, with comparable thoughts and visions. The group phenomena of language, traditions and actions, develop a shared purpose and community participation, absorbed naturally and collectively; a kind of learning in which everyone progresses together and put participants in touch with their roots and identity, achieving development, a better use of resources and providing opportunities for more human-centered services.

When concrete actions are achieved, groups are considered not as individuals but rather as agents of improvement of living conditions, improving the participation and commitment to the development process.

According to the progressive approach, to stimulate a cultural growth, it is essential that each has the opportunity to express themselves based on his/her vision, through different means.

The integration of services and opportunities for interaction between sectors, ages, and cultures, requires finding a common language in the current context; thus a conversation between the actors must be generated.

This is done by emphasizing the process of learning (values, attitudes, practices, and choices), addressing what and how, as well as why and by whom, decisions are taken.

Sensible personalities into the society deserve extra care, those who are part of it but are refused by the community or cannot have a healthy interaction with it. A common example is the indigenous population or migrant farm-workers, often considered as the most disadvantaged actors, transient individuals, usually living in isolation, where their needs and aspirations are kept unfulfilled.

(Prewitt-Diaz, Trotter and Rivera, 1990)

Strategy type	Goals	Type of cultural projects and programs	Geographic focus	Target audiences
Entrepreneurial	- Economic growth through tourism, city image - Catalyze private sector investiments	Cultural projects, events, promotional activities	Downtown	Tourists, residents and suburbanites
Creative class	- Economic growth through quality of life - Attract new residents/employees in the "creative economy"	Arts and enterteinment, collaboration with private sector	City centre, historic urban neighborhoods	Residents, young urban professionals and workers
Progressive	- Community develop. - Art education and access - Local cultural product	Community art centers, art education programs	Inner-city, under-served neighborhoods	Underserved residential population

Ill.4 - Cultural development strategies (Grodach and Loukaitou Sideris, 2007)

How can architecture approach cultural development?

In recent years universities, non-profit organisations, architects and designers started promoting "humanitarian" and "participatory" design projects as means to bring significant benefits in underdeveloped and developed countries around the World.
Humanitarian interventions, aim to improve the quality of life through a basic design accessible for everybody and that endorse equity.
These projects engage people by supporting social interactions, cooperation and interdisciplinary exchange. Moreover, the majority of these interventions are non-profit oriented; people involved offer their time and effort for a cause they believe in to reach a successful result. For projects having a strict a budget, this means more time is spent on analysis and research that could later benefit and improve other works. Multiple infrastructural projects in Africa have adopted this methodology; proving that a single successful project can be used as an example in other similar contexts.
As Zaretsky mentions in his book "New directions in sustainable design","The best criteria to judge the success of a community architecture comes once the construction work is completed and can be measured in terms of community development" . In fact, humanitarian interventions are often based on experimental approaches that can be verified only when the building is completed.
(Parr and Zaretsky, 2011)
The involvement of people in a participatory process stimulates the exchange of ideas and raises the individual knowledge; each person involved learns something, becoming conscious of his abilities and the impact they have in the collectivity.
On the other hand, some risks can damage the community and compromise the success of the project.
It is fundamental to understand the culture, who are the users and their primary needs.
A profound qualitative and quantitative research is required in addition to a look to the project in short and long-term.
Designing an architecture that doesn't dialogue with the place where it is situated, could create either a sense of alienation or influence the population negatively.
Moreover, the impact of advanced technology in an underdeveloped location is another aspect to be aware of; the main risks could be to create an unhealthy dependence on it, other than an incorrect use or maintenance by users due to a lack of knowledge.
Advanced building systems require knowledge and it is crucial, before introducing them, to inform and educate people on the right use of these tools.
Appropriate technology must be applied in relation to local, cultural, political and economic conditions; strategies as using local materials and energy sources, making sure that the local population is able to take advantage from it, are solutions that should be favoured above others.
(Parr and Zaretsky, 2011)

Ill.5 - Potentials and risks of cultural development in underdeveloped countries

The architect A. Rapoport developed a methodology based on four aspects in order to ensure the achieving of an efficient design, especially applicable in developing countries:

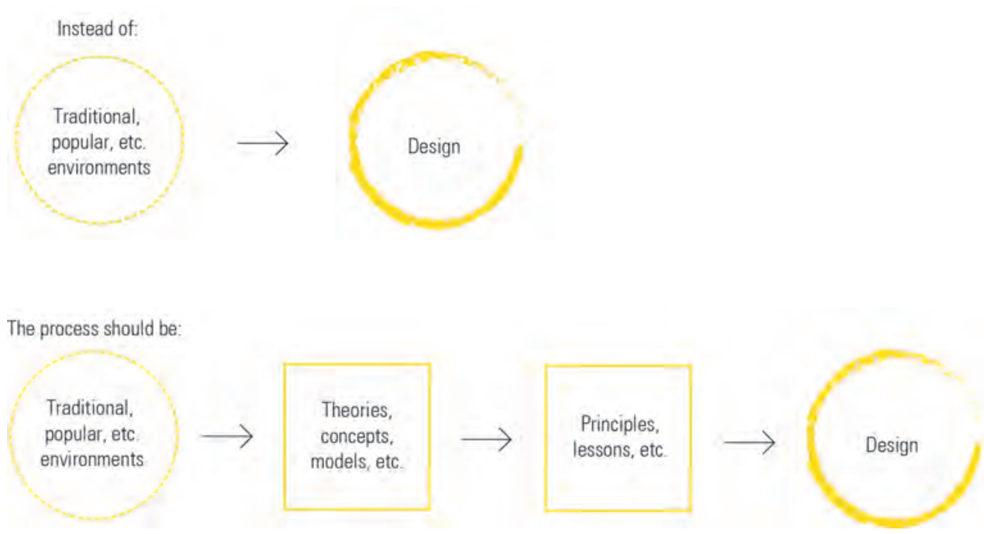
1. *" Designing is seen as being concerned with providing settings for people. It is thus a problem-solving activity which must be based on an understanding of man-environment relations (MER).*
In other words, design is not a free, capricious, "artistic" or "creative" activity based on whims, guesses or designers likes or preferences. It is rather a responsible attempt to help provide settings appropriate for specific groups of people. Conceivably, a designer might design an environment which intensely dislikes personally if it were appropriate and desirable for the group in question"

2. "In order to be useful, an MER approach must be based on theory."

3. "In order to be valid, such theory must be based on generalizations"
"Generalizations can only be made with confidence on the basis of sufficient evidence."

4. "Such evidence, in order to be sufficiently broad, must include:
a) All historical periods
b) All cultural traditions
c) All forms of design"
(Rapoport, 1983)

In his essay, A. Rapoport reflects upon the role of the analysis which must be based on theory and generalizations first, in order to make the design clear and successful.
Rapoport supports the peculiarity of the analysis of every single project and he takes distance from the act of imitating which usually refers to aesthetical appearance, as shape, geometry, etc. and can't be sustainably adapted to new circumstances.



Ill.6 - Based on Rapoport (1970, in ptws).

VISION

How to create an evolving architecture that promotes sustainable development and responds to the need of changing actors through time?

APPROACH

Sustainability

Sustainability is a concept that can have several meanings, depending on the context and period of time in which the terminology has been used.
A common and shared definition of the term was only forged in 1987, by the Brundtland Commission of the United Nations, in an attempt to start an international effort to approach sustainability.
Sustainable development was then defined as a *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs."*
(Brundtland, 1987)
Three are the main thematics, or "pillars", to consider, in order to approach a sustainable development:
Environmental
Social
Economic
(Anon, 2005)
These three points are not mutually exclusive and should all be considered in evaluating sustainability, as it is in many building certification systems around the world.
When approaching a project, the focus is placed mainly on one of the three pillars of sustainability, depending on the location of the intervention, the nature of the designing company and the client's expectations.
The main client chosen for this project are the citizens of Buenos Aires, an underdeveloped region with many deficits and a big potential to improve in a sustainable way.
A healthy environment leads to a sustainable behaviour that can quickly evolve in a sustainable town, for this reason, social and environmental sustainability is a main focus of the project.

Ill.7 - Sustainable approach diagram

Environmental sustainability

Ill.8

It refers to the way and speed at which natural resources are used with a focus on carbon dioxide emissions, pollution and fossil fuels usage.

The building industry has a relevant impact on emissions and pollution, even more in the developing countries, undergoing the process of industrialisation. The environmental footprint of the construction sector is measurable under different aspects:

- consumption of energy and greenhouse gas emissions

Steel, Iron and concrete have a water-intensive production, the first two alone are responsible for 4.1% of global energy use.

Toxic gases and fluids discharged during the production and transportation greatly contribute to marine and atmospheric pollution.

Most of the buildings in Costa Rica are built in concrete and steel plates, the cheapest materials available. Local materials are mainly used by the indigenous populations.

- waste material from construction and demolition

A high material waste rate leads to high material consumption, and the highest waste rates records belong to Portland cement, concrete and ceramic, broadly used in Costa Rica.

Especially in developing countries, leftover material is often abandoned in illegal dams and river courses; if left there to rot, these materials give life to nests of mosquitoes and vermins.

- land degradation

Due to mining and mineral-related sectors, land degradation and use and natural loss are a main problematic, worsened by the lack of programmes and regulations for the rehabilitation of mining-sites.

The dramatic land use brought on in developing countries affect the permeability of the land and determine an unrepairable land loss; In Costa Rica the main use of single-family housing, leading to massive sprawl expansion, is directly related to this issue.

(United Nations Environment Program, International Environmental Technology Centre, UNEP-IETC, 2002)

Most of the choices with a high impact on the successfulness, damage or pollution of a project, are to be taken from the formulation of the concept when deciding on how to give shape to it through materials and methodologies. Understanding the natural, social and cultural environment of Buenos Aires is therefore of primary importance given their direct and indirect contribution to achieving an environmentally sustainable building.

Social sustainability


Ill.9

It brings a humanistic approach to the subject, relating people's well-being to their living environment; taking into account both, the physical design of spaces, infrastructures and social initiatives aimed to promote personal and social growth.
Social relationships and interactions are encouraged in order to improve the level of coexistence between people separated by income, gender, culture, age and profession through design solutions and policies.
To inspire interaction and cohesion it is important, at the same time, to propose a variety of spaces and ways to enjoy them, integrating the society into the management of the designed space.
(More than green, 2018)
When it comes to face projects in undeveloped countries, social sustainability is an important and sensible topic which must be treated with care.
The involvement of entire community results to be more effective than the action of the individual for several reasons: participatory projects strengthen the value of the collectivity, highlighting the abilities of the individual and empowering the objective of community.
Unlike the individual, a community can easily affect crowds and promote direct actions which can address both social and environmental problematics.
In this frame, the architect is called to guide the community starting from setting clear goals based on real needs. Each stage of the design must be organized by priority and faced step by step in concordance with the community's development.
The success of an architecture, especially in a humanitarian context, depends both by the interaction between architect and future users and by the contribution of the community.
In a case like the one faced in Buenos Aires, a project involving the community would help to empower their sense of belonging, with the aim of repairing the social fractures, offering at the same time an opportunity of development with a new approach towards sustainability.

Economic sustainability

Ill.10

An economically sustainable intervention has a higher value than its cost, in order to achieve this, a strategic management of budget and resources is fundamental.
Not overexploiting the available resources, in order to avoid overconsumption and money loss are crucial aspects that present consequences also regarding the aspect of environmental sustainability of the project.
Exploiting of workers and resources are some of the reasons competing in making Buenos Aires a town with an unsustainable economy, extremely dependent by multinationals. The spread inequality, lack of services, of touristic facilities and of foreign investors are some of the causes for the slow economic growth of the area.
The development of services, such as tourism, health and education, together with a correct legislation is essential to a sustainable economic growth.
The service sector is crucial for economic development and job opportunities other than being a significant contribution to the GDP, Gross Domestic Product, even in underdeveloped countries where it often reaches as far as 50% of it.
(The contribution of services to development and the role of trade liberalization and regulation, 2008)

To address these problematics affecting the area, one of the first actions to be taken is to implement missing facilities in the service sector in order to promote the economic and cultural growth of the town.
Accurate analysis and the implementation of passive and active strategies in the new facilities are important in order to avoid useless waste of energy and resources during the construction, use and the demolition of buildings.
(more than green, 2018)

01
INTRODUCTION

BUENOS AIRES FACTS

The canton of Buenos Aires Puntarenas is situated in the Southern region of Costa Rica.
"Buenos Aires", good breeze, has been used as a name to address this area since in 1860, for the constant, pleasing breeze blowing on these lands; however, Buenos Aires town, was officially founded only in 1940.
(Eumed.net, 2018; Puntarenas, 2018)
According to INEC, the Instituto Nacional de Estadìstica y Censos, the growth in population, was facilitated by the construction of the Interamericana route in 1961 and by the arrival of the Pindeco company in 1978 ; in fact from 7'633 people, in 1980, when the company first started to sell its products on the market, there has been a violent growth that brought Buenos Aires to a population of 23'540 in 2015.
(Bixby, 2002)
The rate of immigration and the incapability of the municipality to keep up with changes, determined a lack of services and an identity loss that nowadays still heavily affect the citizens' daily life in the relationship with each other, with their source of work and their personal growth.
However, the town has a strategic position, well connected and closeby different tourist attractions. Nonetheless, the city mainly survives on the Pindeco pineapple company.

Ill.11 - Buenos Aires Municipality

Ill.12 - Buenos Aires centre

Ill.13 - Buenos Aires centre

Ill.14 - Costa Rica

Ill.15 - Buenos Aires

Ill.16 - Main church

Ill.17 - Steet in the town centre

Ill.18 - Street outside the town centre

Ill.19 - Market


Ill.20 - Main public park


Ill.21 - Airport


Ill.22 - Street outside the town centre

ACTORS OF BUENOS AIRES

Town is the house of a community, made by different actors and their relationships with each other; therefore, an initial understanding of Buenos Aires, requires an introduction of the different personalities present on site.

Pindeco

Ill.23

In 1990 Del Monte, launches a high intensive farming, research, and development, investment in pineapple project in Costa Rica under its subsidiary pineapple company Pindeco, as it was searching for alternative agricultural land to compete with the high costs of land and labour in Hawaii where they had stationed.
(Suryanata, 2000)
Nowadays Pindeco supplies for 80% of the European market fresh pineapple.
(CBI Product Factsheet: Fresh Pineapples in Europe, 2015)
Pindecoland ownership currently covers the largest regional area, concentrating in three districts: Potrero Grande, volcano and Buenos Aires with approximately 12,000 ha, with 6700 hectares in Buenos Aires town alone.
(Arauz Beita, 2010; Environmental Justice Atlas, 2014)
With the rapid development of pineapple production, traditional farming became vulnerable against the shift in production and increased prices. The lands and homes adjacent to the pineapple plantations were affected by the slate fly plague, caused by the untreated pineapple waste, and property devaluation leading to a crisis to hit the traditional agricultural market.
(Cuadrado and Castro, 2009)
Pindeco's development was unplanned by the government since the company uplifted Costa Rican economy substantially to be the leading exporter of fresh pineapple exports. Such rapid and extensive expansion caused a lot of environmental deprivation in cultural heritage and natural resources such as wood and wildlife population. Moreover, the company is criticized for its cheap labour schemes, and for creating a financial dependency scheme in the community.
Based on an interview to Costa Rican workers of Pindeco, aged between 27 and 49 workers indicated that they receive the legal minimum salary of approximately 580 colonies per hour (1$), generally working 6 days a week for an average of 10-12 hours per day.
(González, 2004)
The long hours and the work pressure directly affect the family, neighbourhood and community experiences with low human capital to develop a healthy community.
During its reign Pindeco created a dependency cycle where citizens were forced to accept its presence, terms and conditions, especially since it became the biggest working reality, providing at the present a wage for 2/3 of the total population of Buenos Aires, with 5000 direct and 3000 indirect jobs.
(Environmental Justice Atlas, 2011)

Ill.24 - Pindeco- Del Monte

Ill.25 - Pineapple plant

Ill.26 - Pineapple fields

Ill.27 - Pineapple fields

Ill.28 - Pineapple plantation map

Inhabitants : citizens & indigenous

Ill.29

According to a census made by INEC in 2011, the majority of the inhabitants of Buenos Aires live in houses in bad conditions; however, the 93% of the population is involved in educational programs and invest time and resources in learning.

The population is very religious and there are numerous christian communities.

The main source of work comes from the primary sector, especially from the pineapple cultivation. Due to the lack of proper facilities, the dependency by Pindeco and a poor management by the municipality, the community has faced a slower growth than expected. (INEC, 2011)

The population of Buenos Aires consists of regular citizens and indigenous communities, already on this territory before the arrival of the Spaniards in 1561, but now ostracized in clusters outside the town.

These populations traditionally live in agricultural activities, hunting, fishing and craft working, using self-built houses made of wood and local materials.

However, after the Spanish invasion, farming became unfit to sustain the tribe who experienced extreme poverty. As a result, in 1970 a group of women led by Margarita Moralez formed a handcraft association called “La Flor de Boruca”, to promote tra-

Ill.30 - Old church

Ill.31 - Indigenous community

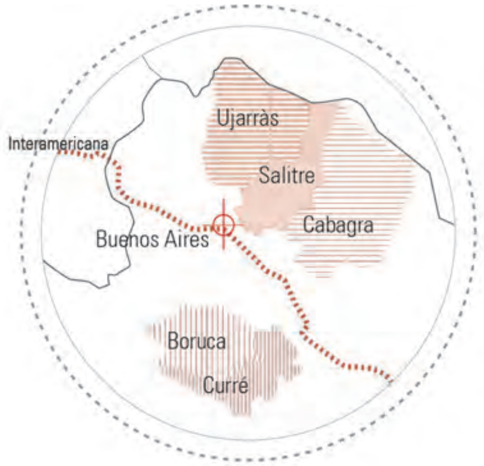
ditional artisanal products as tribal masks, textiles and craft objects, a format of business that has spread since across the numerous tribes.
(Boruca.org, 2018)
Seven of the main indigenous settlements of the country is located in the canton of Buenos Aires and they occupy approximately 37% of the canton representing an important tourist attraction.
(Costa Rica, 2018)
They are respectively Ujarràs, Salitre, Cabagra, Terraba, Curré, Boruca and Guaymí. (Villanueva Beita, 2017)
Nowadays some of these communities are still struggling with defending their territories and traditions.
Indigenous people are forced to educational systems and political ideologies that don't respect their tradition. Their original languages and cultures are being taught in local schools but this is insufficient to avoid the slow weakening of their identity.
(Travelcostarica.nu, 2018)
Boruca and Bribri de Salitre villages are located in reserves in the canton of Buenos Aires and managed to obtain, from the Government, the right to self-governance in their land.
A visible fracture between the indigenous

Ill.32 - Inhabitants using the airport as public space

Ill.33 - Indipendence Day Parade

communities and the citizens of Buenos Aires subsists. Indigenous people are often excluded from civic roles in the city and rarely take part in community activities.
In the past, episodes of violence and conflicts between the tribes and the citizens contributed to increasing the social tensions between the two parties.
The rights on the land are one of the causes of conflict and strong aversion. The Government is struggling with making the situation clear as measures to face the problem continue to suffer delays, mainly due to strong racist resistance from the private sector, which considers the self-management of indigenous territories a risk for their investments. (Iwgia.org, 2018)

Ill.34



Ill.35 - Indigenous tribes around Buenos Aires

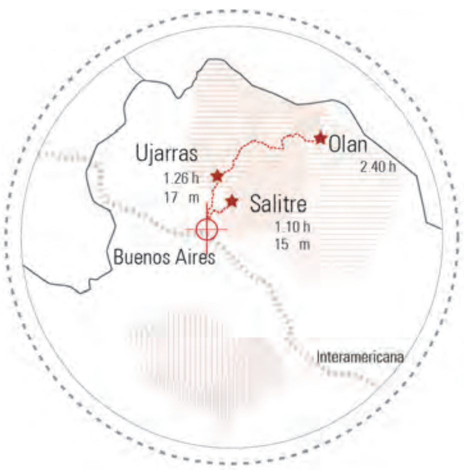
Ill.36 - Boruca village in the past

Ill.37 - Boruca village nowadays

Potential tourists

Ill.42

Buenos Aires represents a place of transit between the capital San Josè and a few famous tourist attractions in the Southern part of Costa Rica, capable of attracting tourism and that represent a potentiality for the future development of this area.
The road passing adjacent to the project site brings to three significant tourist hot spots: the indigenous village of Salitre, towards East, the indigenous village of Ujarras and the Chapel of Olan towards North.
The Chapel in the Clouds is a suggestive and peaceful spiritual place located in the mountains. It was built by John Howard, an English expat, in the 1960s in the middle of the cloud forest.
(Go Visit Costa Rica, 2018; Frontiercostarica.com, 2018)
These sites have a great potential that could be exploited to promote an international tourism and endorse the development of Buenos Aires.
Moreover, the natural resources of this territory are countless, and Buenos Aires has a privileged access to all of them, making the town increasingly interesting for the tourism development.



Ill.38 - Touristic attractions around Buenos Aires

Ill.39 - Access to indigenous reserva

Ill.40 - Boruca traditional masks

Ill.41 - The Chapel in the Clouds

INTERVIEWS

A questionnaire was made and distributed to some inhabitants of Buenos Aires for a better understanding of their needs, the use of public spaces and their knowledge about the pineapple production of Pindeco.
The aim of the project developed through time and some questions become less crucial for the design.
Due to this the following illustration summarizes the main relevant information collected thanks to the questionnaire, giving an idea of the current local situation.

The questionnaire was made on November 2017.

A range of inhabitants differing in age, sex and job were involved.
The research shows how the main daily transportation used in the town is the car, however students and housewives mostly move by foot.
Regarding the perception of the public spaces it seems that the majority of the people prefers his personal spaceto meet friends and to play activities instead of common areas such as parks and squares. This choice is caused by the lack of functional and pleasant public spaces in town.
The central market, some cafès, and restaurants are other places where citizens are used to meeting and spend time.

At the question: "What public space do you think is missing in Buenos Aires and you would like to have?", a high number of respondents agreed on similar places, as a central square, equipped playground for children and areas for sports and activities as cinema, clubs, and pool.
Finally, some questions, regarding the relation with Pindeco and the pineapple production, proved that the majority of the people doesn't have much knowledge regarding the production, but it is interested in learning more about it.

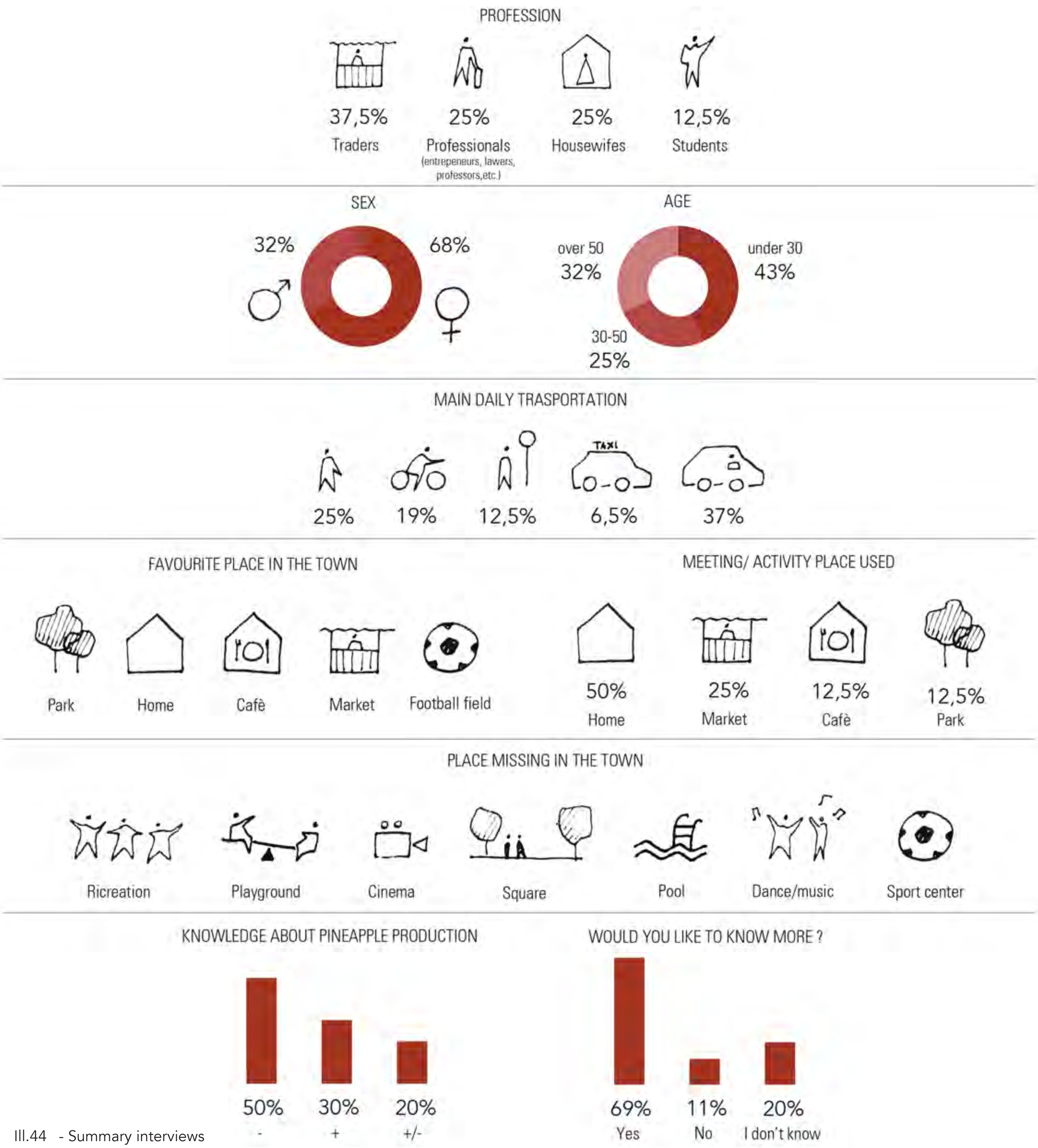
QUESTIONS:

- Profession
- Age
- Sex
- Were you born in Buenos Aires?
- If not, how long have you been leaving in Buenos Aires?
- What transportation do you use in the town?
- Do you have any favorite public space?
- Where do you meet your friends?
- Do you have hobbies and where do you practice them?
- What public space do you think is missing in Buenos Aires and you would like to have?

DO YOU AGREE WITH THE FOLLOWING: (yes, a bit, no)

- I know well the production process of pineapple (grouth, collection, selection, kinds, packaging, export)
- I would like to know more about it
- I would like others to know more about this process
- Pineapple production is a value for the area
- Pineapple plantation is eco-friendly

Ill.43 - Questionary



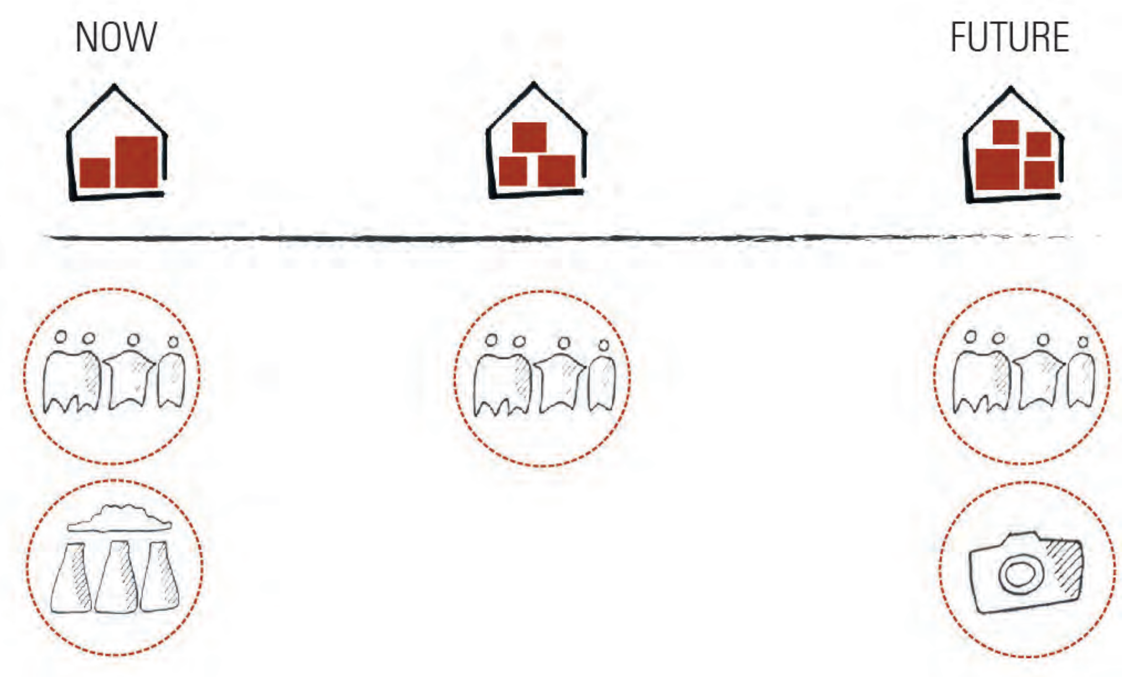
Ill.44 - Summary interviews

PROBLEM DEFINITION

Buenos Aires presents a series of different problematics. The underdevelopment of the town, unawareness of citizens and its lack of services represent main issues.
On a social level, the community has a high financial dependence on large corporations and suffers from cultural fractures, the lack of social interaction and sustainability awareness.

AMBITION

Architecture has an important role in promoting individual and collective cultural development through sustainable means and processes. The proposal of an evolving knowledge centre aims to provide services to the population, organizing activities that encourage meeting and exchanging, thus improve their level of education and awareness. The centre is meant to evolve with Buenos Aires' community along different milestones, and it will later act as a tourist attraction providing a variety of job opportunities, aiming to create an alternative economic reality. The building will be designed in respect of the natural environment as a means to educate the community on sustainable approaches.

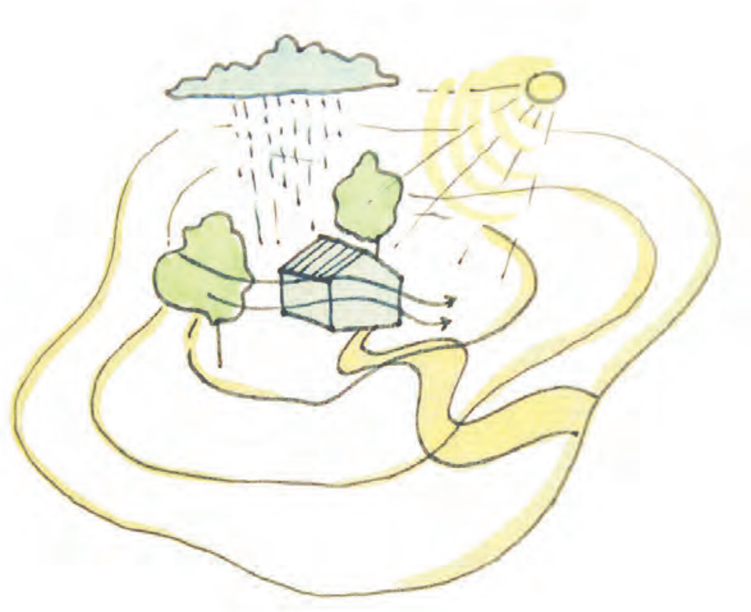


Ill.45 - Project & actors timeline

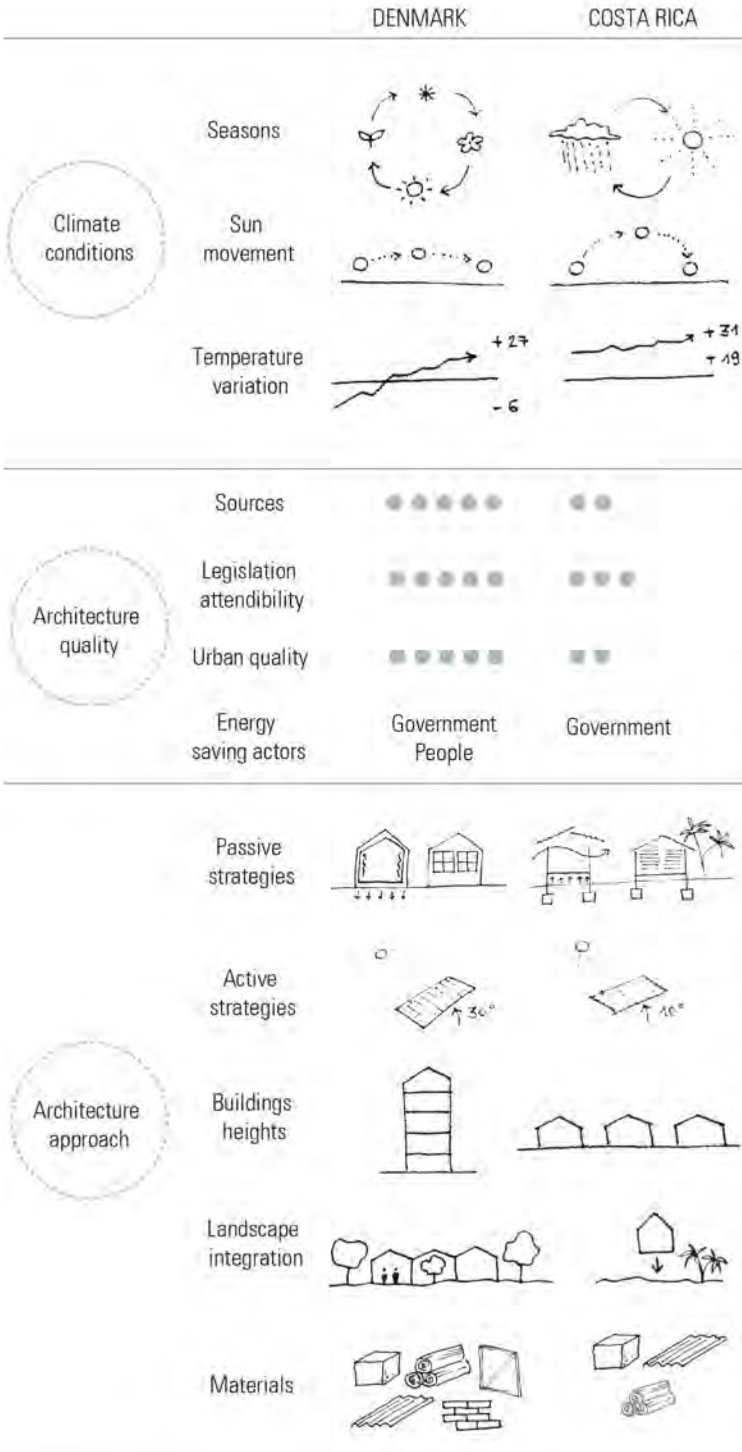
02
ANALYSIS

BIOCLIMATIC DESIGN

Bioclimatic sustainable design requires specific design strategies depending on the site's peculiarities. In tropical environments, the compendium of solutions profoundly differs from the Scandinavian one since the climate conditions and culture are poles apart.
A preventive analysis on the climate conditions of the area surrounding the site is therefore crucial to the development of the successful architectural intervention.
Scandinavian countries, such as Denmark, are characterized by low temperatures and precipitations all year rounds, with a slight improvement during summer.
However, Costa Rica is annually affected by high humidity and solar radiation and has two main seasons: a dry season and a rainy one. Natural hazards such as flooding and earthquakes are the daily reality of the population.
Many of buildings' characteristics not only depend on weather, location, and climate, but also by the activity level foreseen in each room that requires a different amount of ventilation and shading.
Last but not list, the architecture culture needs to be considered and to influence the project aesthetic and functional strategies to opt for the best solutions and have the users to recognize the building as the fruit of their own culture.



Ill.46 - Bioclimatic design



Due to the different location in the emisphere there is a consistent difference of climate between Denmark and Costa Rica which affects architecture in different ways.
Firstly in Denmark the year is divided in four seasons: winter, spring, summer and autumn, while Costa Rica is characterized by two periods: the rainy season (May-Nov) and the dry season (Dec-Apr). Despite this in the country the temperature are constant over the year, with an annual average of 25°C , max of 31 °C and min of 19 °C. Differently in the scandinavian country the temperature change during the year with values that can reach -6 °C in winter and around 27 °C in summer.
Also the position of the sun depends on the location: in Denmark it rises from the wider angle and it is more diffused in summer, while it is lower during the winter. In Costa Rica the sun rises quickly and it is high and direct all over the day.

The lack of updated maps and information, in addiction to the unclear local legislation makes the collection of datas and the analysis harder in a country as Costa Rica compared to Denmark. Sometimes it is necessary to do some assumption and work with the few sources available.
In a developed country as Denmark the cities have a qualitative urban life style. The Governement supports sustainability and educates its inhabitants to a correct approach to the energy consumptions.
In Costa Rica this aspect is still weak in the common opinion of people, moreover the urban centers are affected by a uncontrolled and rapid grow.

Architecture is affected by climate, culture and local sources.
While in Denmark the main issue is to isolate the building and catch solar radiation through the use of large openings, in a tropical environment cooling and screening the building are the main strategies adopted to guarantee the comfort.

Moreover, due to the risk of flooding and earthquakes, the buildings are usually rised up to pillars and they do not exceed of one or two storey high.

The position of the sun influenced also the efficiency of solar panels.

The approach to the landscape varied in the two contexts: danish architecture is more sensitive to integrate the building in the topography and the natural environment compare to Costa Rica.

Architecture in Denmark leaves space for the use of different materials thanks to the availability of resources; wood and brick are especially used in construction. The market encourages the use of recycled and local materials.
In Costa Rica, despite the large availability of wood, concrete and steel are most used in buildings because considered safer, cheaper and easy to be found.

Ill.47 - Summary Costa Rica vs Denmark

ARCHITECTURE IN COSTA RICA

Nowadays the capital San Josè is a fusion of architectural styles: colonial-era private houses, Art Deco apartments and modern skyscrapers.
(Build Abroad, 2018)
However, the average of Costa Rican cannot afford luxury houses. Cheap concrete dwellings rise in many towns and cities, meanwhile, in rural areas, the model of "Tico" home continues to be built. This house typology is generally characterized by a box shape where a covered porch leads inside the building. The interior collects few regular rooms and a small covered outdoor area. The roof is made of steel plates as its cheap, easy to be built and efficient during the rainy season.
(Costarica-information.com, 2018)
The new Costa Rican architectural trend is moving towards a tropical modern style based on a sustainable approach and a design integrated with the natural environment.
Dwellings aim to a high energy performance through the implementation of natural and local materials, the use of solar and geothermal energy sources and the efficiency of natural ventilation.
The buildings present white walls, expansive windows, steel support structures, and tall ceilings.
(Build Abroad, 2018; Costarica-information.com, 2018)
However, Costa Rican buildings are defined in three main typologies can be identified: the indigenous architecture, the traditional local architecture of the Ticos and the emergent modern style pushed by the cultural development.


Ill.48 - Tipical Tico house


Ill.49 - Tipical Tico house


Ill.50 - Tipical Tico house

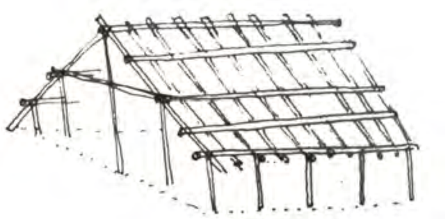
Ill.51 - Tipical Tico house

Ill.52 - Tipical Tico house

Ill.53 - Tipical Tico house

Architecture of the indigenous

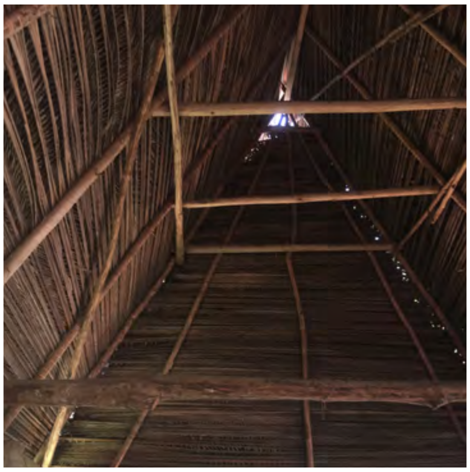
Ill.54 - Conic structure



Ill.55 - Rectangular structure

The past indigenous villages consisted of complex of buildings based on Indigenous based on ancient first settlement traditions with different purposes: for domestic or collective, as well as for ceremonial and funerary functions. constructions were self-made with local materials, using different shapes: conic, cylindrical, oval or rectangular, depending on the tribe or the function.
"The Ranch" A typical indigenous dwelling, presented in either a square or a rectangular plan, is a simple and flexible structure made by a wood skeleton of branches or twigs where the joints weren't fixed to withstand earthquake damages.
The hip roof is made out of thickly woven sheaves, bundles of grasses or banana leafs tied with lianas, two openings were places at the top of the cone to improve the natural ventilation through the chimney system.
Light walls are the result of an intertwining of cane rods reinforced with a horizontal guide. making the interior conceived as a single room with an earth compressed floor. internal space is characterized with A cooking stove and a bunch of hammocks hung the upper part due to the lower temperatures above and as protection against the attack of animals at night.some traditional dwellings can still be found in different villages as the one of Boruca.
Nowadays the architecture has changed especially in the use of materials: wooden walls and floor, straw or palm roofs or roofs made of zinc or cement replaced the traditional materials.
Modern furniture like pots, firewood kitchens or vents, table and wooden seats were introduced.
(Sanou Alfaro, 2010; Southerncostarica.biz, 2018; Visit the Boruca village, 2017)

Ill.56 - Traditional ranch structure



Ill.57 - Traditional ranch structure

Ill.58 - Traditional ranch structure

	TYPOLOGY	MATERIALS	STRUCTURE
Architecture of Ticos	Private single houses	Walls: cinder blocks and prefab cement panels, plaster Roof: steel and zinc corrugate plates Floor: wood and tiles	Steel structure, concrete foundation
Modern Architecture	Eco-tourism houses	Walls: local natural materials, concrete, plaster, glass windows Roof: steel and zinc plates	steel or bamboo structure
Indigenous architecture	Domestic dwellings Collective buildings, ceremonial and funerary buildings	Walls: local wood, grasses, lianas, cane Roof: straw, banana and palm leafs Floor: pressed earth	Wood skeleton, flexible joints

Ill.59 - Summary architecture in Costa Rica

Ill.60 - Tipical Tico house

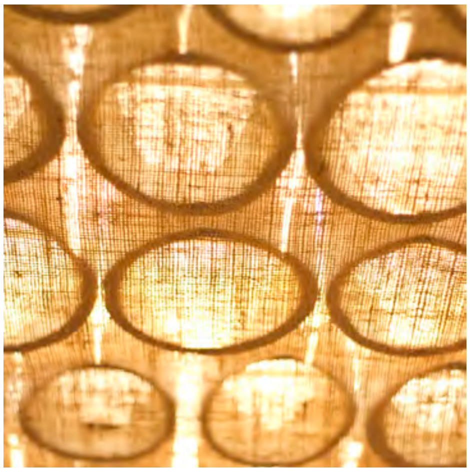
Ill.61 - Modern architecture, Casa Flotanta, Studio Saxe

Ill.62 - Indigenous architecture, traditional ranch

MATERIALS

In past years, wood was the primarily used material but nowadays has been replaced by cinder blocks or prefab cement panels. This choice of material found its route in the colonial period when the Europeans introduced new solutions in the continents, but it also represents a social statement that classifies wood as a poor and low-quality material.
The effort of the government in preserving the environment and reducing the deforestation, by raising its price and forcing to purchase it from South America, also contributed in cutting the use of wood in construction.
Despite this, recently wood and bamboo are being rediscovered by architects and builders. The potential of bamboo was especially noticed at the beginning of the '70s by the Costa Rican president Rodrigo Carazo who, after a trip in Asia where he recognized the properties of this material and started to promote it in the country. Carazo encouraged a project to build low-cost bamboo housing in the province of Limón. The dwellings proved to withstand earthquakes and to be an excellent response to the country's deforestation crisis. Unfortunately, besides its quality, the project did not obtain enough success because the houses were still identified as a symbol of the unfortunate social class.
Nowadays bamboo finds its revival in architecture and construction thanks to its exceptional properties; It is a local material, available in Costa Rica, environmental friendly because it grows fast moreover it fits the climate and the soil conditions due to its flexibility and resistance.
Furthermore, the use of wood is increasing and perceived as eco-friendly material.
(Times et al., 2018)
Another alternative material comes from the earth. Although adobe bricks are not highly used in Costa Rica, this environmentally friendly material can keep the shelter colder than its homonymous in concrete. Recently an eco-bricks took place in the construction field because of high energy efficient, durable, fire resistant and soundproof in addition to the advantageous cost and the pleasing aesthetic. On another hand, its earthquake resistance is still uncertain.
(Costa Rica Star News, 2018)
Finally, recycled materials such as tires and fabric from plant waste is an experimental material rarely used in construction but can be great potential in the future. As new resources found a way to replace cotton with recycled pineapple stems, banana leaves, and coconut husks, making the material readily available in Costa Rica.
While Currently, the investigations developed prototypes of such fabric and leather are only used in the fashion industry, These materials have a potential to be used in architecture.
(McEachran, 2018)

Ill.63 - Wood self-constructed house



Ill.64 - Bamboo

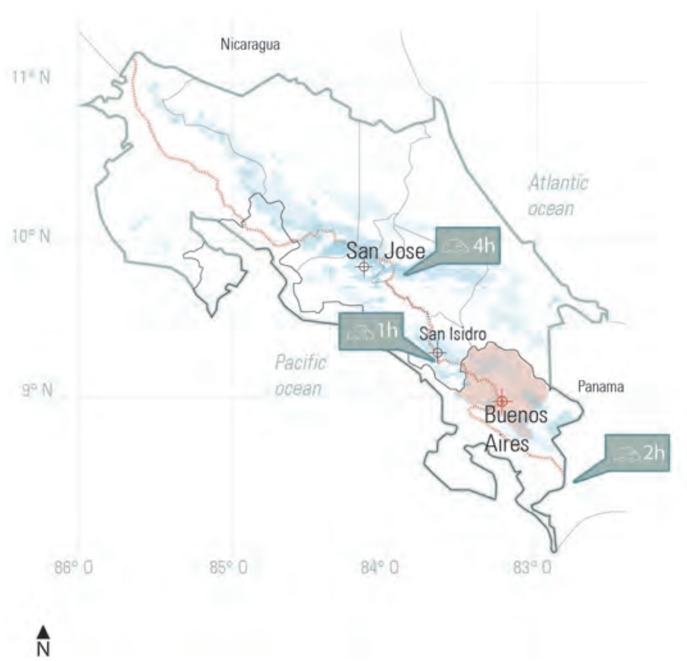
Ill.65 Tire pot

SITE LOCATION

Costa Rica is a country with 4 805 000 inhabitants, situated in Central America with San Jose as a capital city; it faces two different oceans: the Atlantic towards East and the Pacific towards West. Land wise, it touches the countries of Nicaragua and Panama, respectively towards North and South.
This country has different virtuous aspects, from the abolishment of the workforce since 1949, to the investment in renewable resources, from which, in 2016, 98.1% of their energy demand was covered, to having one of the best universities in Central America and beyond. (Walker, 2018)

Buenos Aires town gives the name to the district and the canton into which is situated, in the region of Puntarenas, an area that includes western territories, running from north to the south of Costa Rica.

According to the statistics by INEC, the Canton of Buenos Aires appears to be in disadvantage compared to the neighboring ones, with more population with low education and no access to essential technology services.
(Indicatore cantonales censos nacionales de población y vivienda 2000 y 2011, 2011)



Ill.66 - Costa Rica regions and orography

Ill.67 - Costa Rica regions and orography

Buenos Aires town

Buenos Aires town has a population of around 12'000 inhabitants, estimated by the municipality on a span of 6 km from the city center. It is located in the northern part of the canton, and it's directly connected to the Interamericana.
(Tramitesconstruccion.go.cr, 2018)
The area is famous for having an optimal climate and soil for the cultivation of pineapple, in fact, the company Pindeco has its headquarters in the city and pineapple plantations surround it from N-NE to S-SW.
Looking North of Buenos Aires, just beyond the pineapple plantations, starts the mountainous area, that hosts some indigenous reserves and it's a perfect viewpoint towards the city and beyond.
(Tramitesconstruccion.go.cr, 2018)

Ill.68 - Accessibility to the site

with an area of 31000 sqm of land plot, the Project site is located at the northern border of Buenos Aires town, in a neighborhood called "Barrio el Mirador" (viewpoint district); indeed this area is slightly elevated compared to the rest of the town, functioning as a viewpoint and as a safe area in case of flooding. Surrounding the location, there are a variety of landscapes: the mountains towards North, with peaks of 2 500 meters, covered by wild vegetation; the colorful town towards South, with a flat skyline; various pineapple fields, very low and characterized by bright green color and the subdivision in sectors. This site was also chosen for its strategic position next to a crossroad of paths connecting the town, the mountains and the closeby indigenous communities, functioning as a gate between the three.

The site is reached only through one of the poorest areas in town, connotated by worn down houses and roads. By placing close by an attraction point, the project aims to endorse the urban development sustainability of such a district.

01

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03

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Ill.69 - Site pictures

Ill.70 - Site aerial view

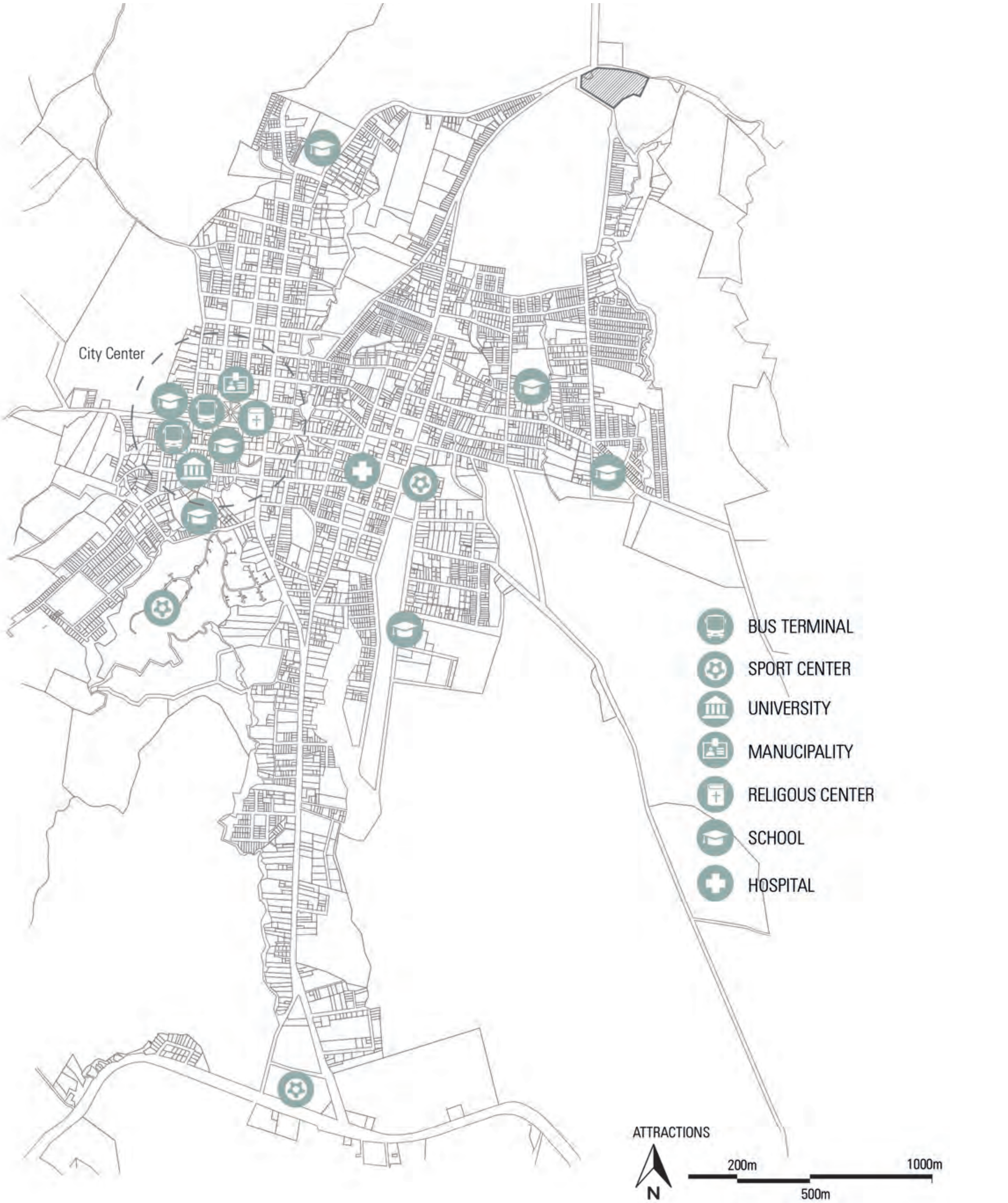
INFRASTRUCTURE

Service

In years, Buenos Aires grew mainly horizontally, by sprawl, this affected the accessibility, number and quality of services for the population.
There are eight schools, covering the age from kindergarten until high school, while for a higher education citizens have to attend it online, in the cities close by like San Isidro, or directly in the capital.
Four different sports centers are distributed in the town. Two of them are private, managed by the company Pindeco and available for workers of a particular social level. The remaining two are a football court for rental and a small indoor gym.
The area lacks Parks with only two main: one located in the center and the other towards the south, small and hardly accessible for people not leaving in the area.
The shortage in ludic areas pushed the population to abusively occupy private ones, such as the airport, which otherwise would be hardly used, and other abandoned spots, as the project' site, to practice their activities.
Religion is a central part of most of Costa Ricans' lives, the town has nine main religious buildings distributed around the town, with one hospital situated not far from the center, and multiple private clinics around the town. Libraries and bookshops are not yet present in this area.
There are two different bus terminals in the town center, easily accessible but that causes a frequent passage of large vehicles next to areas with many pedestrians of different ages; however, buses are the primary vehicles used to reach and leave Buenos Aires.
The main terminal belongs to Tracopa and is adjacent to a market that sells food and cleaning products.
A weekly market takes place every Saturday on the street in the center, that is closed down to cars for the occasion.
The municipality, national bank, red cross, bus terminals, markets and other services all concentrate around the central park, in the city center, situated in the North-East side of the town.

Project site

The project' site is situated at a walking distance from the town center but can be easily reached by other means as bikes, cars, horses or busses.
In the immediate surrounding area there aren't any public services; however, the presence of two water filtration centers represent a point of interest of the place. One of the two water facilities is situated just underneath the project's site and is doted of a big open parking lot where cars and shuttles could comfortably fit.

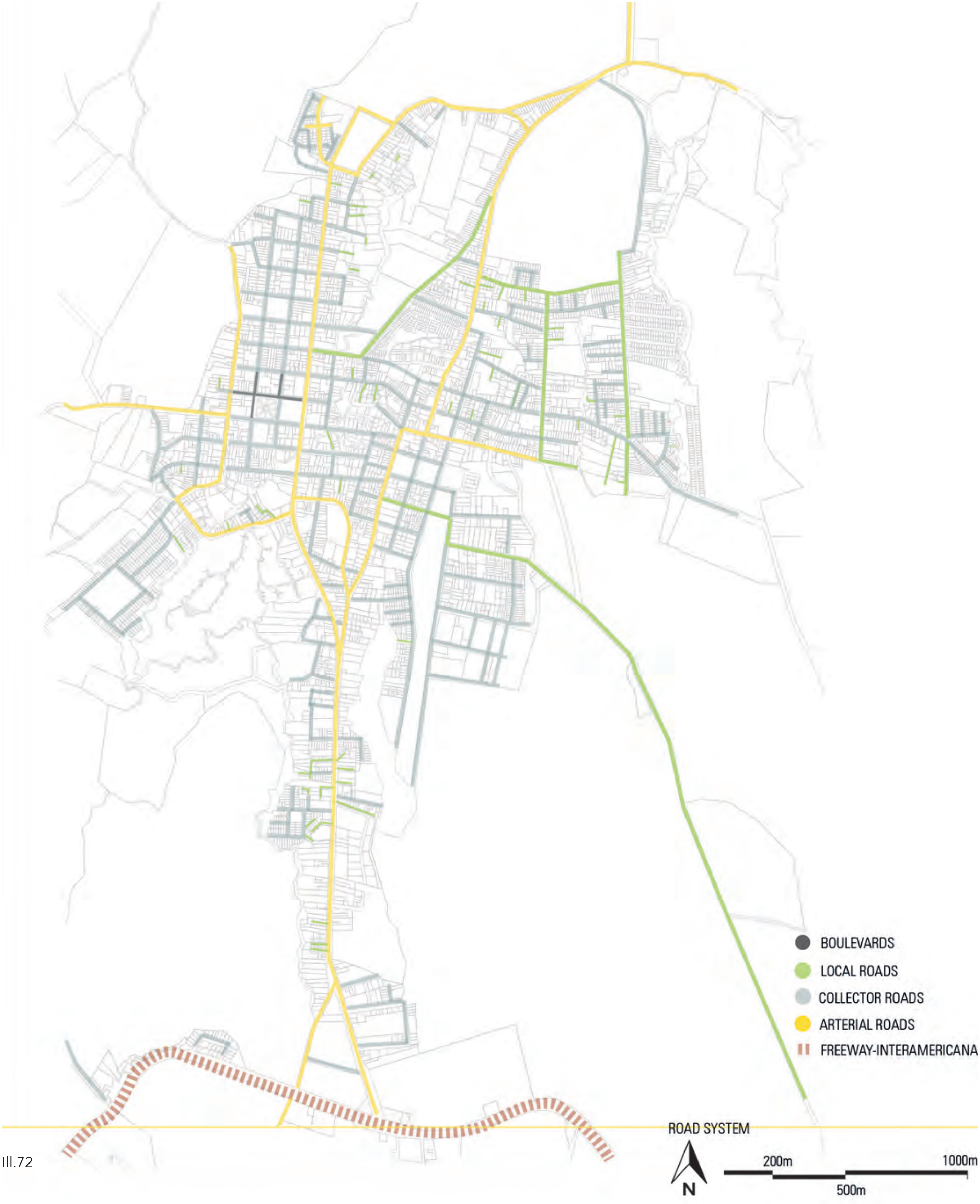

City Center
BUS TERMINAL
SPORT CENTER
UNIVERSITY
MANUCIPALITY
RELIGOUS CENTER
SCHOOL
HOSPITAL
ATTRACTIONS
N
200m
1000m
500m
Ill.71

Roads system and mobility

Buenos Aires has a clear road system that still shows a strong Roman influence in the presence of a cardo and decumanus arrangement, in the collector roads.
The town is connected to the Interamericana towards the south, then expanding north, around an arterial main street, enlarging around the center.
There aren't any cycling routes or pedestrian paths.
The primary roads, as the Interamericana and the arterial, are cemented, while most of the collectors and local connections, mainly out of the town center, are dirt routes, connecting some of the least trafficked areas.
Primary observed means of transportation are cars, followed by busses and bikes; in the rural areas, a small number of horses is still used for the scope.

Project site

The project' site is easily reachable from the town through the arterial road, which gets unpaved towards the last, poorest housings.
The area is well connected with the city center but is also placed at a crossroad of three roads in good state but unpaved: the first going south, connecting to Buenos Aires and ending in the Interamericana; one going north, towards the mountains and the Ujarras indigenous village; the third running towards east, still a mountainous area that gives home to the Salitre indigenous settlement.
Other minor dirt routes can be used to reach the site but they are part of the pineapple plantation and could be used only in case of emergency.


BOULEVARDS
LOCAL ROADS
COLLECTOR ROADS
ARTERIAL ROADS
FREEWAY-INTERAMERICANA
ROAD SYSTEM
N
200m
1000m
500m

Ill.72

Land use

Buenos Aire's majority of outskirts lands are planned for the agricultural industry, agricultural parcels bound by a human-made forest border. The entrance to the city from the inter Americana highway is surrounded by mixed trade and commercial land plots and gets concentrated as it connects to the city center where most of the city facilities are located. The surrounding land plots off the center are considered mixed use trade or residential.

Buildings' height

As typical in Costa Rica, most of the buildings in Buenos Aires are between one, maximum two storey height. In extremely rare occasions they can reach three floors, for a few commercial buildings, located only around the town center.
The overall skyline is low and uniform; main leaps are given by the height difference between fields and housings and the presence of mountains towards the North.

Ill.73 - Diagram general building's height in Buenos Aires


LEGENDA
AGRICULTURAL PARCELS
URBAN DEVELOPMENT
ENERGY INDUSTRY
PUBLIC INSTITUTION
RESIDENTIAL
COMMERCIAL
INDUSTRIAL
MIXED-TRADE
MAN MADE FOREST
EXISTING FOREST
AGRICULTURAL INDUSTRY
RECREATIONAL PARKS
LAND USE
N
200m
500m
1000m

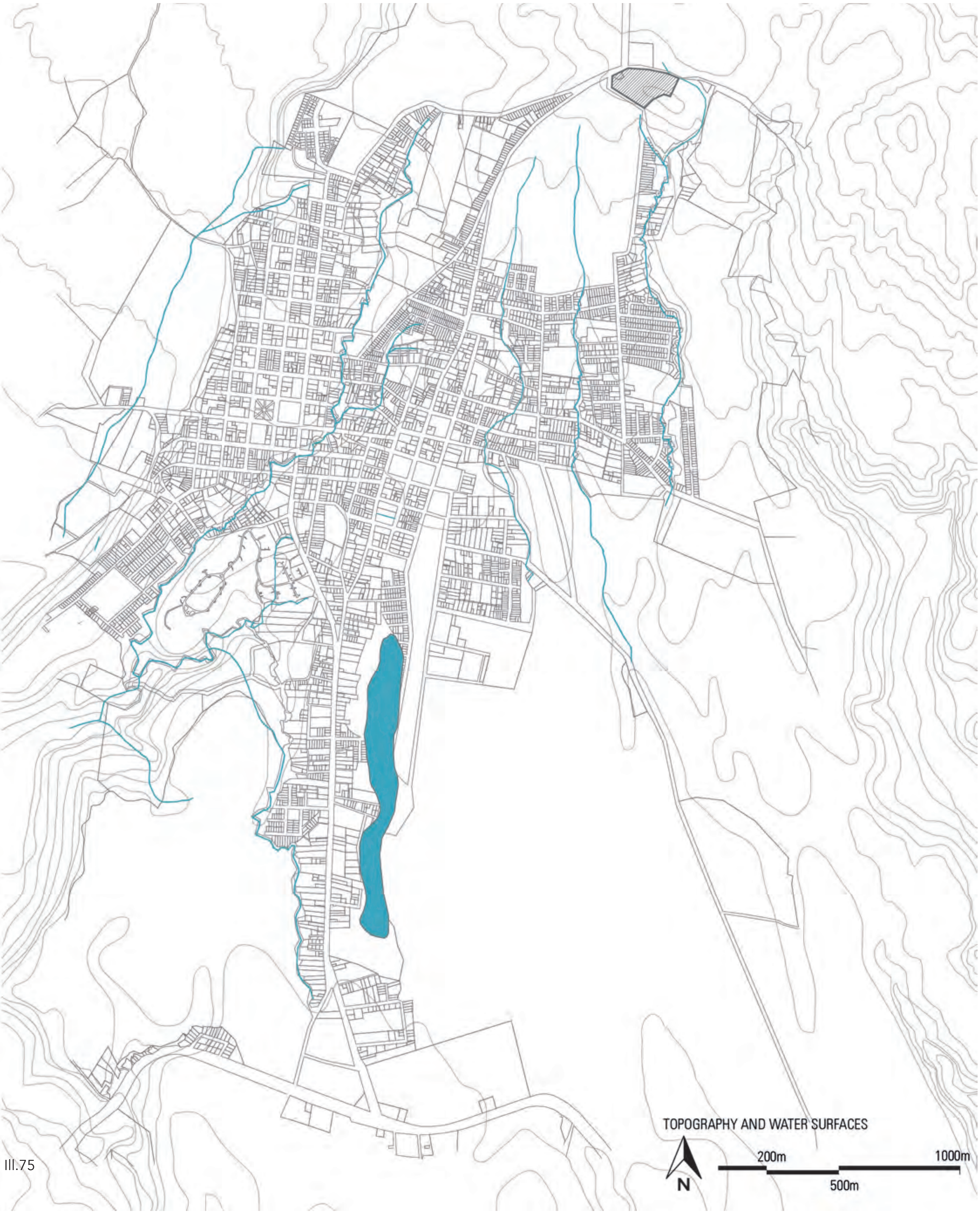
Ill.74

Topography & hidrology

Being located in a pre-mountain area, Buenos Aires is built mainly on a quick-changing slope with few exceptions where there are flat areas as the town center of the residential area towards East.
Generally the height rises from South to North and from West to East, towards the mountain area; however, the slope of the land has often been affected by its use for housing or plantations.

Project site

The building' site is situated towards North-East, in a privileged area that functions as a panoramic viewpoint over the inhabited land and surrounded by pineapple plantations.
Being a hill, the site itself has a height difference between the highest point, central to the lot, and the lowest point, on the southern border, of 13 meters.
Given the land confirmation, the land surrounding the site goes upward towards North-East and downwards towards South-West. The terrain is mainly composed of clay soil, rich in minerals, giving it its intense red color.



Ill.75

CLIMATE

Macroclimate

Costa Rica is located in the Tropical Zone of the Northern Hemisphere with a latitude of 10° North. Therefore it presents a high position of the sun and solar radiation of 12 hours.
(Herrera, 1986)
Due to its position in the Intertropical Convergence Zone, the climate of Costa Rica is characterized by various climate zones influenced by the Pacific and the Caribbean sea. The country has two different seasons, a dry one when it rarely rains, and a wet one when heavy rain daily occur in the afternoon hours. The dry season lasts from December to April, and the rainy season lasts from May to November.
The mountain chain, Cordillera de Talamanca, dividing the country in two, from North to South has a significant influence on the local climate conditions by blocking air and humidity flows.Along the north Pacific coast, the weather is drier than the southern part characterized by a humid climate. Meanwhile, the Caribbean coast has no clearly defined dry season but is very humid and wet weather with rain throughout much of the year.
The dry season lasts from December to April, and the rainy season lasts from May to November.

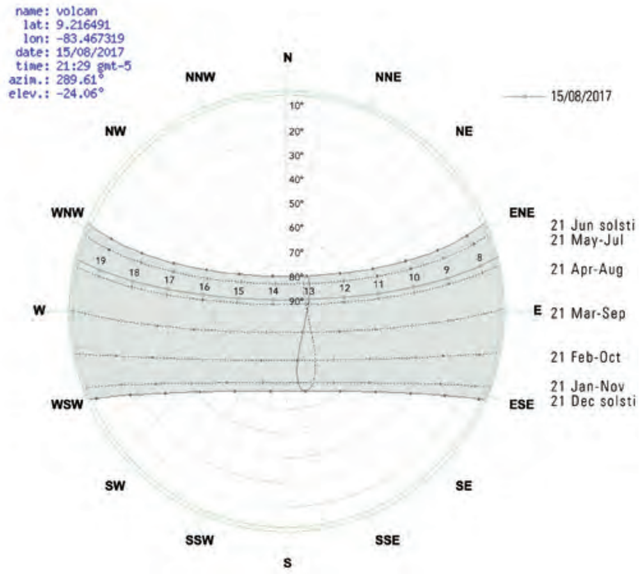
Ill.76 - Climate zones Costa Rica

Sun

Architecture qualities

Costa Rica's position on the globe enables the territory to be affected by intense solar radiation given by the high sun's position over the horizon (90° at 12 am) and an average of 12 hours of daylight per day.
At this latitude, the amount of illumination over the year remains mostly unchanged, and it is affected primarily by the climate conditions.
The differences between winter and summer solstice are minimal; in fact, there is a change of just 70 minutes in the daytime hours.
(Herrera, 1986)

Sun radiations are equal to heat gains, that tropical countries try to avoid as much as possible without giving up to an adequate internal illumination.
The optimal orientation for the project's area follows the east-west axis. The longest facades should face North and South, the most efficient arrangement for the reduction of unfavorable solar impacts in the internal spaces. As a consequence of this orientation and the solar trajectory, the major openings should be located on the north and south facades, occupying 40 to 80% of the vertical envelope and provided with solar control devices to avoid thermal gain.
Spaces that face East will be affected by the sun at a time when the air temperature is still low.
Openings towards West are not recommended and should be avoided whenever possible since the thermal gain by direct radiation must be reduced when the air temperature has reached its daily maximum.
Based on the observation of vernacular housing, the most used configuration is the inclined plane, with the northern slope bigger. Each 10 ° inclination of the roof plane from the horizontal represents between 10 to 15% lower heat gain; the roofing slopes varies, ranging from 20% to 60% in colonial architecture.
(Salomón, 1982 cited by Gozáles, 2009)
An inclination of 25% or more is recommended, to achieve a lower incidence of perpendicular rays of the sun, generate a good runoff from the rain and allow the living space to be cooler when expanding internal volumes.
Curved envelopes, although solar exposure is continuous, have a low heat gain, as long as the East-West layout is maintained since the incidence of solar radiation in them is perpendicular to the arc in a single point.



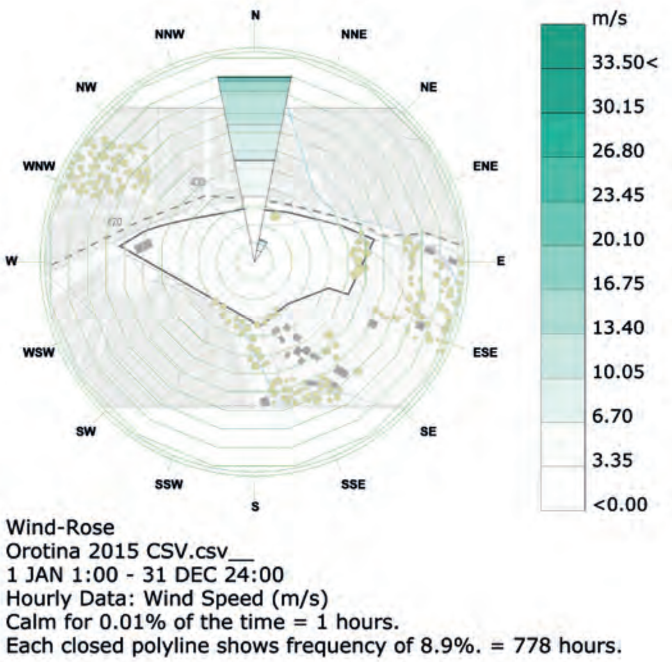
Ill.77 - Sun chart Costa Rica

Wind

The average wind in Buenos Aires dominantly blows from the northeast with speed that doesn't have significant variation over the year, remaining within light air at 2 m/s up to gale at 30m/s.
The analysis is based on a whether file supplied by the University of Costa Rica that differs from the actual situation having prevailing wind from the north. such dataset difference may affect the comfort levels slightly especially that wind is activated to improve the level of comfort. However, for this study, the strategies applied in the wind analysis can be based on the EPW file.

Architecture qualities

It is important to maintain constant ventilation throughout the year, so the southwest winds and the Alisios should be taken into account.
It is necessary to simplify the configuration, thus promoting the cross ventilation.
For this reason, closures should be established mainly parallel to the direction of the air. Perpendicular enclosures should be mobile (allowing passage during the day and closing it during the night), or with openings or grilles in their upper part to allow the air to escape.
The air intake openings must be upwind, with an area equal to or smaller than 25% the area of the exit openings. As the distance between the entrance and exit opening is recommended 5 times the height of the living space. As for the double spacing configurations, it is recommended a distance, between the entrance and the exit opening, of 2.5 times the height of the living space.
To create effective cross ventilation, openings are arranged at 90 degrees to each other; it is recommended to maintain spacing dimensions of no less than 4.5 m x 4.5 m. in case of lower dimensions, inlet air speed control devices should be applied to avoid high air velocities, speeds of 0.25 m / sec. At 0.50 m / sec, are the most recommended. (Frixanet, Víctor, Bioclimatic Architecture)
The proportion of openings in this area should occupy 40% to 80% of the area of the vertical envelope and should be provided with solar control strategies.



Ill.78 - Wind chart project site

Precipitations

According to data of the Instituto Meteorològico Nacional the site of the project is subjected to the Pacific regime which is characterized by substantial and frequent precipitations from May to November; the most affected months are September and October.
During the day it is more likely to experience rain in the early afternoon or evening after all the surrounding humidity has been gathered in dense clouds.
(Herrera, 1986)
The average amount of rain per year can reach 3000 mm.
(Instituto Meteorológico Nacional Gestión de Desarrollo, n.d.)

Architecture qualities

Covered passages and connections around the buildings are useful strategies in case of precipitation as well as intense solar radiation.
Stagnant water should be avoided, encouraging a smooth flow through the site. Thus The roof, if tilted less than 25%, should have more layers to ensure its waterproof quality, draining water to platform connected channels, following the slope to be collected in underground tanks

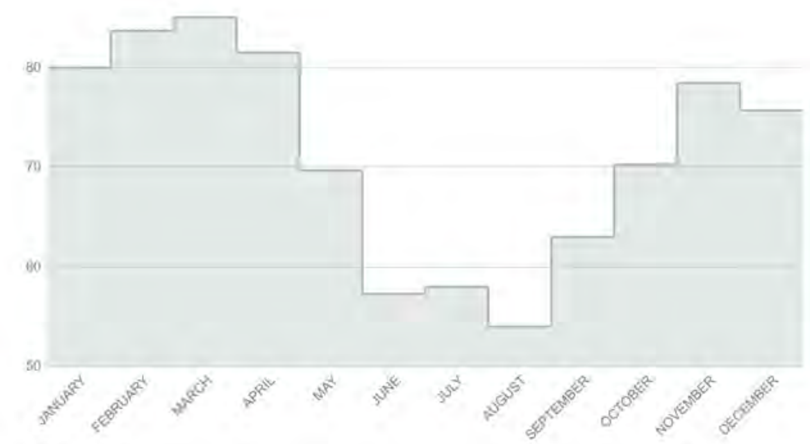
Ill.79 - Precipitations diagram Buenos Aires, year 2017

Humidity

The site is located in the region known as Valle del General; the orography of this area,
with the closeness of the Cordillera de Talamanca, favors the incoming of humidity from the Pacific ocean and obstacles flow of the trade winds into the site.
(Instituto Meteorológico Nacional Gestión de Desarrollo, n.d.)
These conditions lead to a short dry season, around December and February, with a level of humidity that gravitates around 20%, and a long wet one that can reach levels of humidity of 90% between May and June.
The dew point is an indicator of the humidity comfort level, and it shows whether perspiration can evaporate from the skin, cooling the body;
In the studied environment the feeling of the visitors will be considered:
dry < 12°C
comfortable < 16°C
humid < 19°C
muggy< 21°C
oppressive< 24°C >miserable
The region of Buenos Aires is mainly above 21°C and reaches peaks of 31°C.
(Weatherspark.com, 2017)

Architecture qualities

Given the typical harsh climate of Buenos Aires, it is of primary importance to encourage ventilation to keep the building elements as dry as possible, preventing deterioration. moreover, avoiding water infiltrations and proper maintenance for the shaded buildings is essential actions to preserve the construction. Sparing space between the building, the roof and the soil also assures that each component the possibility to keep as dry as possible.
It is essential to keep the indoor temperatures as low as possible using passive and active means to achieve user thermal comfort
The proximity with water streams and vegetation can increase higher the humidity level of a site.



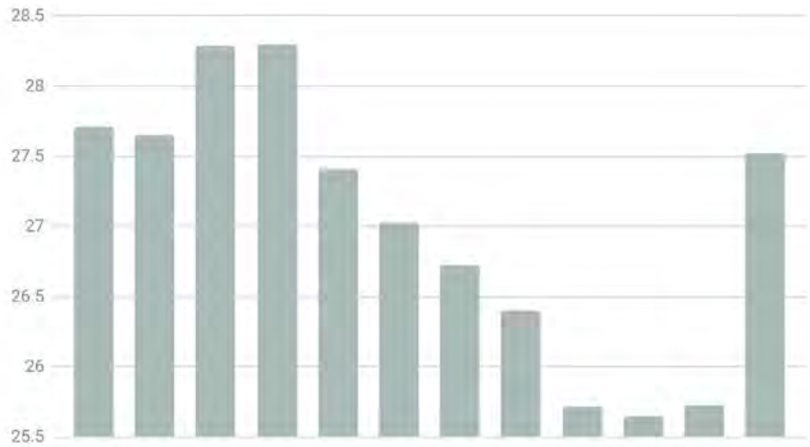
Ill.80 - Relative humidity diagram Buenos Aires, year 2015

Temperature

Due to the southern location, the area of Buenos Aires presents a hot and humid climate with an annual average of temperature of 25 °C with a max of 31 °C and min of 19 °C, without relevant variations over the year. March and April are the warmest months where the temperature can reach over 32°C, meanwhile, the lowest temperature is recorded in January and February with a minimum of 19°C.
Overall the temperature is constant over the year. (Imn.ac.cr, 2017)
mid-hours of the day are the warmest, while the temperature became more comfortable at the end of the day despite the high level of humidity, which increases the human perception of hot. (Weatherspark.com, 2017)

Architecture qualities

In a tropical climate, the persistence of high temperatures during all day can represent a cause of overheating and compromise the thermal comfort inside of the building.
Therefore the particular strategy of wall's insulation is not necessary.
However, it is essential to cool the space through natural ventilation and if necessary introduce mechanical ventilation. The control of the solar radiation through solar shading and vegetation can decrease the indoor temperature.
The internal distribution of activities should take into consideration the qualities of the orientation and its qualities.



Ill.81 - Temperature diagram Buenos Aires, year 2015

Vegetation

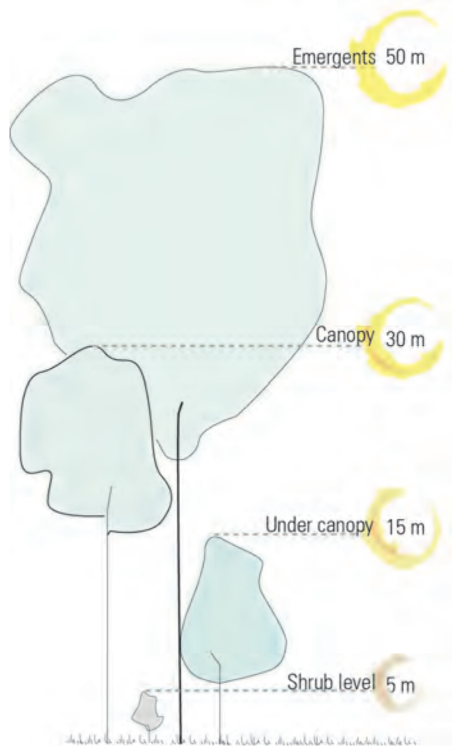
The undisturbed natural vegetation of the humid Premontane forest is characterized by being medium density; from two to three layers, evergreen, with some deciduous species during the dry season and an abundant amount of unnoticeable epiphytes.
The climbing herbaceous vines are very abundant while other trees, for the most part, are covered by a dense layer of moss.
The dominant species of this zone have thin trunks, are tall, and their canopy is moderately dense to dense in the upper part.
The natural vegetation of the forest is constituted by species such as: Schefflera morototoni (phosphoryl), Vochysia allenii (botarrama), Roupala montana (carne asada), Cedrela odorata (bitter cedar), Turpinia occidentalis (false cristóbal), Ulmus mexicana (tirrá).
(Quesada, 2007)

Site

On the project's site, there is not significant amount of trees or bushes present; the area is mainly covered in wild grass, interrupted only by the paths created by the informal frequent passage of people.
On the Eastern and Southern border, however, there are small areas with trees that reach the height of around 20 meters.
The low vegetation of the pineapples fields surrounding the site allows a clear view of the town and make the site visible from afar.

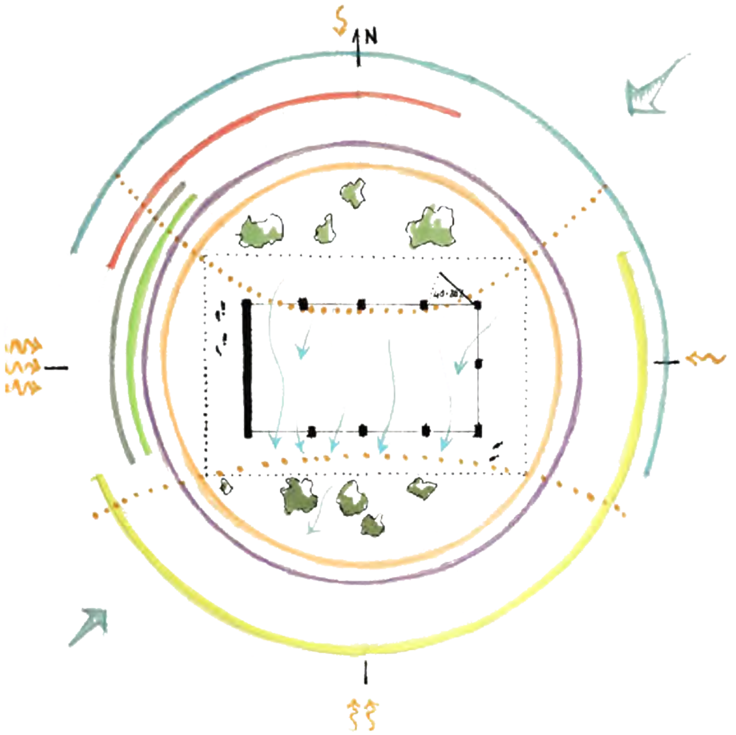
Architectural qualities

The vegetation allows for shading, to filter the dust in suspension, to screen the winds favoring the same time ventilation, it cleans the atmosphere, oxygenates the air and refreshes it by evapotranspiration.
(Ugarte, 2007)
Species found in each site should be favored.
Vegetation is an effective tool to avoid heat gains since plants absorb solar radiation and dissipate the remaining heat to the environment through evapotranspiration.
Vegetation can help to obstruct and to endorse the passage of the wind or channeling it towards a volume.
The dense foliage of a tree works as a block that, when air passes, the wind speed increases below it. Bushes or screens also have their influence on the pattern of the air flow, according to their proximity and height to the openings.



Ill.82 - Vegetation density

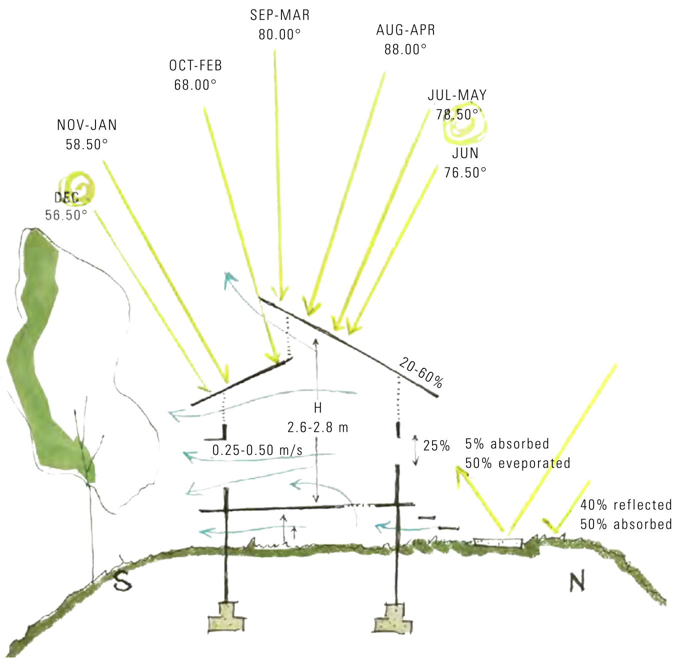
ANALYSIS : SUMMARY



Ill.83 - Architectural respond to the climate

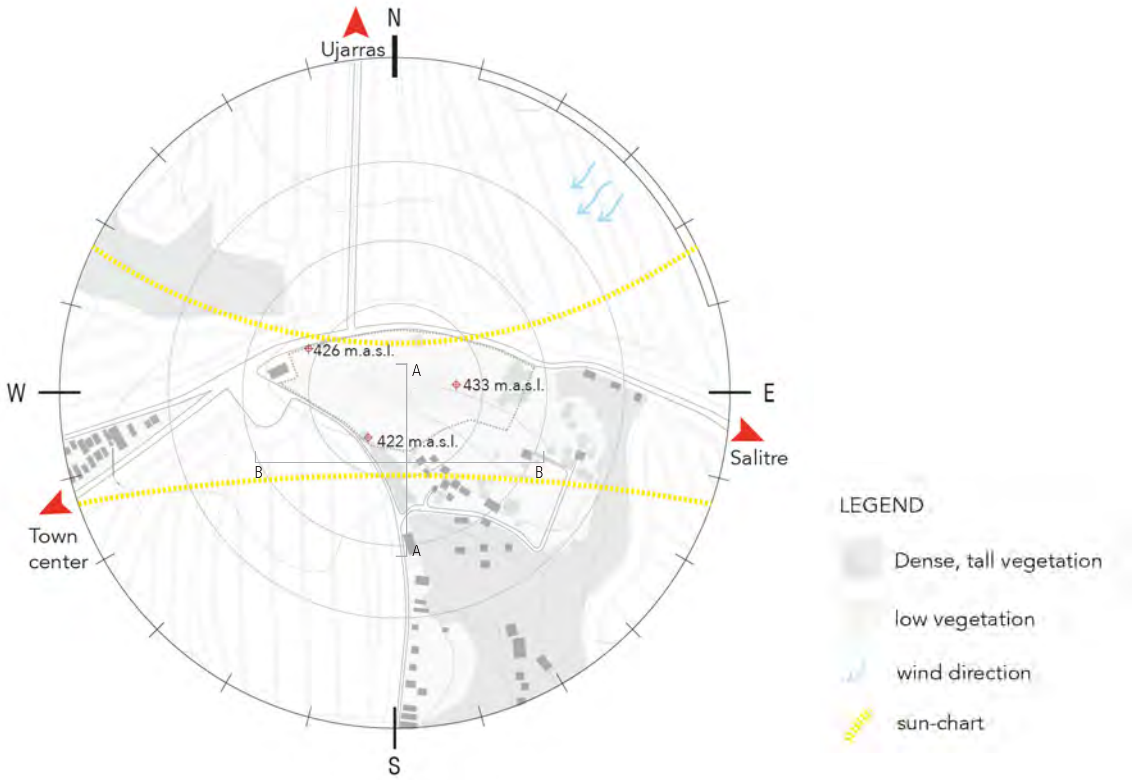
LEGEND:

- Wind
- Overhang
- Sunpath
- Social spaces
- Private spaces
- Kitchen
- Service area
- Vertical circulation
- Horizontal circulation
- Passages
- Deciduos trees
- Evergreen trees
- Ventilation
- Solar radiation



Ill.84 - Architectural respond to the climate

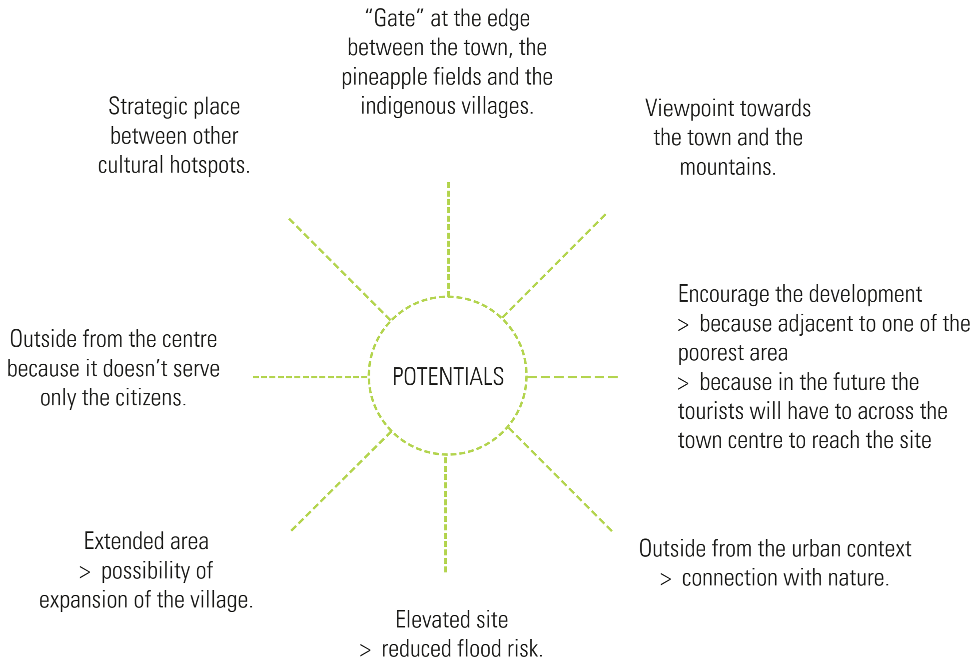
SITE LOCATION : SUMMARY

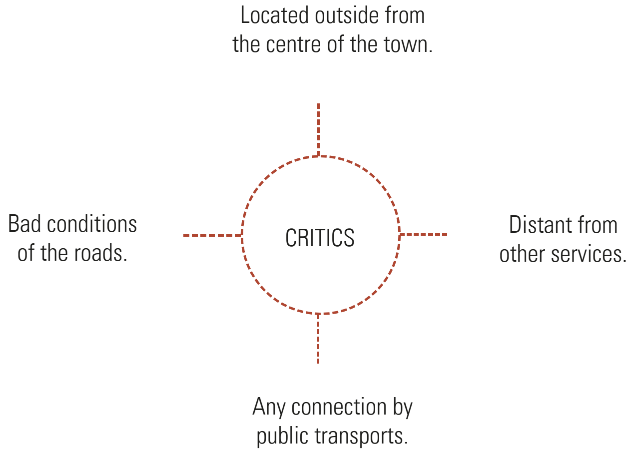


Ill.85 - Summary site qualities

Ill.86 - section AA

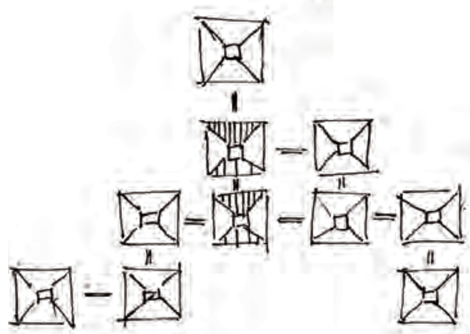
Ill.87 - section BB





Ill.88 - Summary potential and critics project site

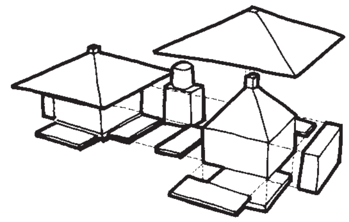
03
CASE STUDIES

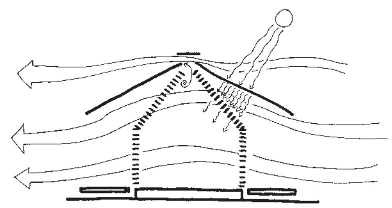


Project: A forest for a moon dazzler
Architects: Benjamin Garcia Saxe
Location: Guanacaste, Costa Rica
Year: 2010
Building period: Aug - Nov 2011
Cost: 10.000-50.000 Euro
first prize - private house category 2010 world architecture festival, Barcelona.

KEY WORDS:
bamboo
privacy shutters
double roof
ventilation

The house designed for moon viewing is a gift to the architect's mother made from a steel structure, corrugated sheet roofing, and facade bamboo fittings to respond with light movements throughout the day. The house consists of a bedroom and a kitchen circulating a central courtyard. The house features options to expose or enclose to the outside using shutter doors. The simple organizational needs and the connection to nature are the main features of the house.
The house projects Costa Rica's environment sustainable approaches; from the double roofing system to the solar shading and natural ventilation systems. Moreover, the reflection to the flood season by raising the structure on steel pillars.
The project also reflects on the privacy and openness by using mashrabiya systems from bamboo pieces and the old traditional housing of a middle courtyard and surrounding functions, mimicking the village structure.





Ill.89


Ill.90

Project: CASSIA CO-OP TRAINING CENTRE
Architects: TYIN architects
Location: Sungai Penuh, Kerinchi, Sumatra, Indonesia
Year: 2011
Building period: August – November 2011
Cost: 30.000 Euro

KEY WORDS:
ethics
partecipatory architecture
natural ventilation
local materials
earthquakes resistence

The aim of the project is to provide a training centre to workers and farmers of the cinnamon plantation in the forest of Sumatra.
The intervention faced the condition of the local workers exploited, with no rights and forced to work underpaid in an unsafe and unsanitary place.
The aim of the centre is to improve the condition of the inhabitants providing a new opportunity for work, healthcare service, and education.
The building realized by the team of TYIN in collaboration with the local community which based the intervention on the use of craft techniques, passive strategies, and local materials.
Crafted brick and cinnamon wood were mainly used in the construction while the natural ventilation was improved through the use of thermal mass which gave more stability to the building against earthquakes.
The project was characterized by simple details and a short time frame of three months of construction thanks to the involvement of a motivate local community.
This example is significant either for its meaning as for its architectural approach and ability to obtain a good quality with few resources.

Project: KÄPÄCLÄJUI INDIGENOUS TRAINING CENTER
Architects: Entre Nos Atelier
Location: Grano de Oro, Turrialba, Costa Rica
Year: 2014
Project area:470.0 m2

KEY WORDS:
sustainable community
partecipatory architecture
passive strategies
light
earthquakes and flooding resistence
open high shelter
relation indoor-outdoor

The project is a relevant example of an architecture which strengthens the relationship between the local indigenous community and visitors. The construction was, in fact, realized through a series of participatory design workshops which involved the community in understanding their own needs and the importance of cohesion with the environment.
Moreover, the case study offers several inspirations of architectural strategies that could be adopted in our project. The building is raised on pillars for more stability and safety against earthquakes and flooding. The light laminated roof is fragmented to improve the natural ventilation while the high interior space is designed as an open shelter to offer comfort, light and direct contact with the natural environment. The relation with the outdoor is remarked continuously by perforated wood facades and glazed walls.
The project represents a meeting point for the community where function, comfort, and atmosphere are combined in a dynamic and modern building.

Ill.91

Project: FAZER VISITOR CENTRE
Architects: K2s
Location: Helsinki, Finland
Year: 2016
Building period: construction Jul 2015 - Sep 2016
Dimension: 5 100 m2

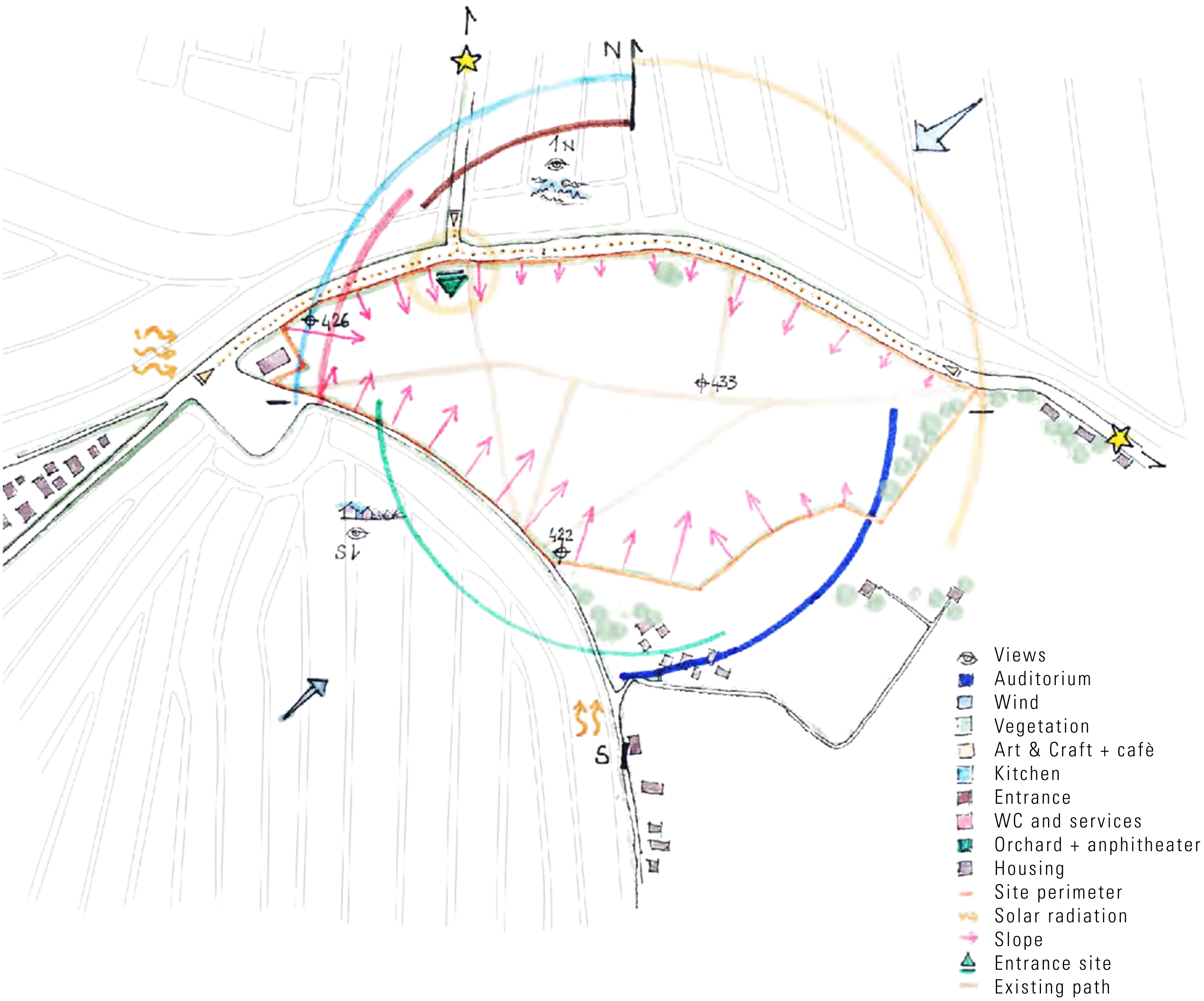
KEY WORDS:
room program
flexible spaces
raw material - identity

The Fazer visitor centre has been chosen as a case study for the functional distribution of the spaces and for its ability to promote a product through architecture and activities.
The identity of the centre is framed by the use of raw materials. the external garden, for example, contains several types of grains; the green room housing hosts cocoa plants, sugar cane, vanilla that is used for experiments and activities to promote chocolate and entertain the public alongside several proposed workshops. The ceiling and walls are mostly covered in wood.
The indoor space is made by flexible and multifunctional rooms which are design as “box in a box” with the result of an open, light and dynamic space.


Ill.92

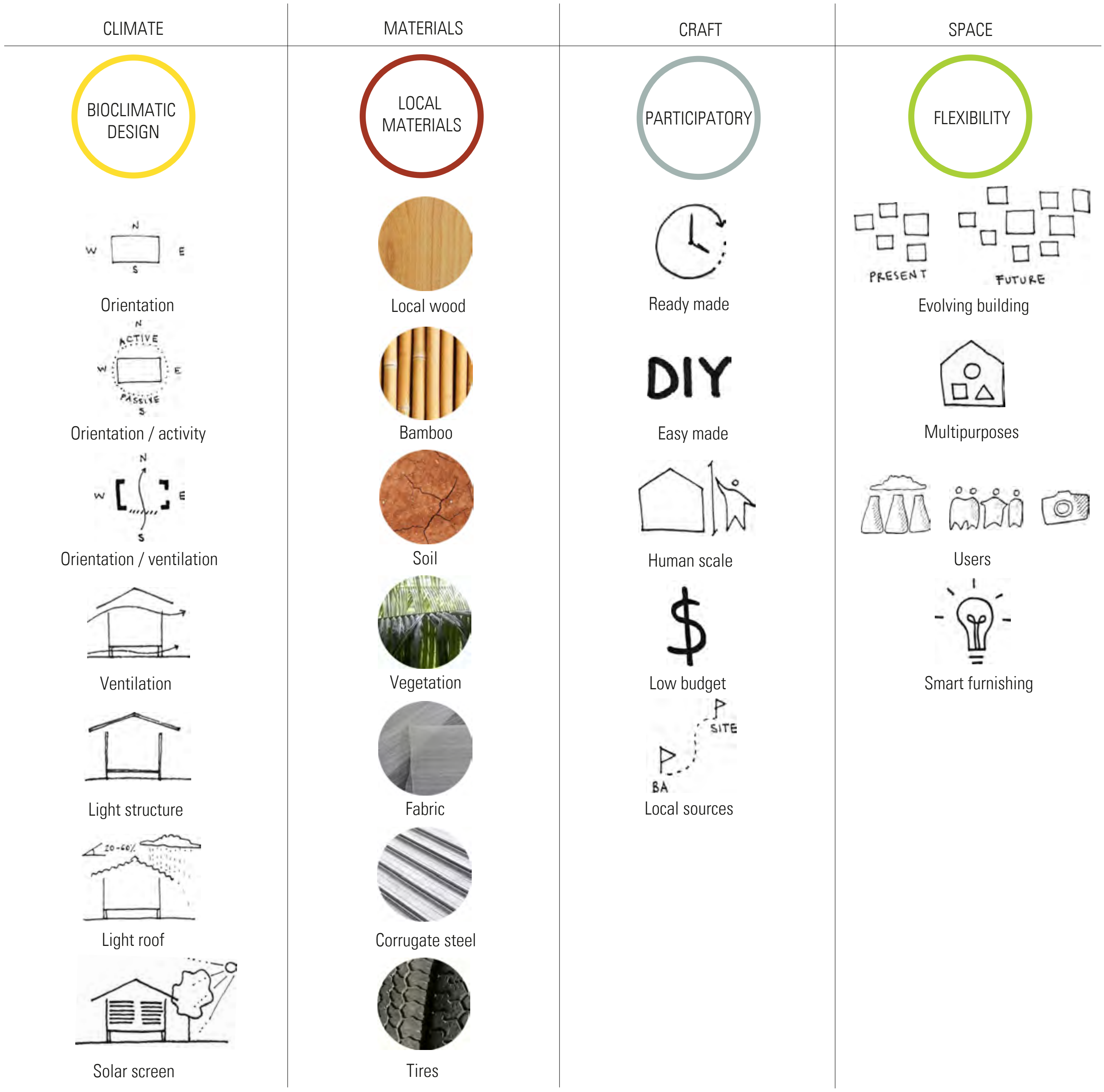
04
DESIGN PROCESS

STRATEGIES



Ill.93 - Design strategies

PRINCIPLES



Ill.94 - Design principles

PROJECT TIMELINE

Considering the presence of different actors in the lifespan of this project, the kind of interactions taking place on the site will evolve together with the architecture hosting them.

The first substantial contact between the project and the population takes place during the designing and construction process; this phase is crucial to creating a building that satisfies the needs of people, to start a learning process on sustainable means and to build an attachment between the future users.

At first, the center will be an educational space serving the three major actors of Buenos Aires: citizens, indigenous and Pindeco. In order to build and use the proposed facilities, they will have to work together, sharing knowledge and means. During the construction process Pindeco may provide necessary construction materials for the center to find later spaces for their expositions and activities in a way to get closer with the locals, displaying the pineapple production process and their contribution to the community of Buenos Aires; citizens, as well as the indigenous communities, will have areas to share manual and theoretical knowledge through the use of workshops, cafè, public areas and the auditorium for conventions, projections of movies or documentaries, activities for schools, children, and families

After an eventual departure of Pindeco from this area, the project is meant to turn into a cultural center, where spaces and functions are to be used mainly by the population composed by Spaniards and indigenous. Here they will be able to learn from each other, develop new constructions, work on the expansion of the center and will find areas where to exchange, sell their products, have courses and organize activities.

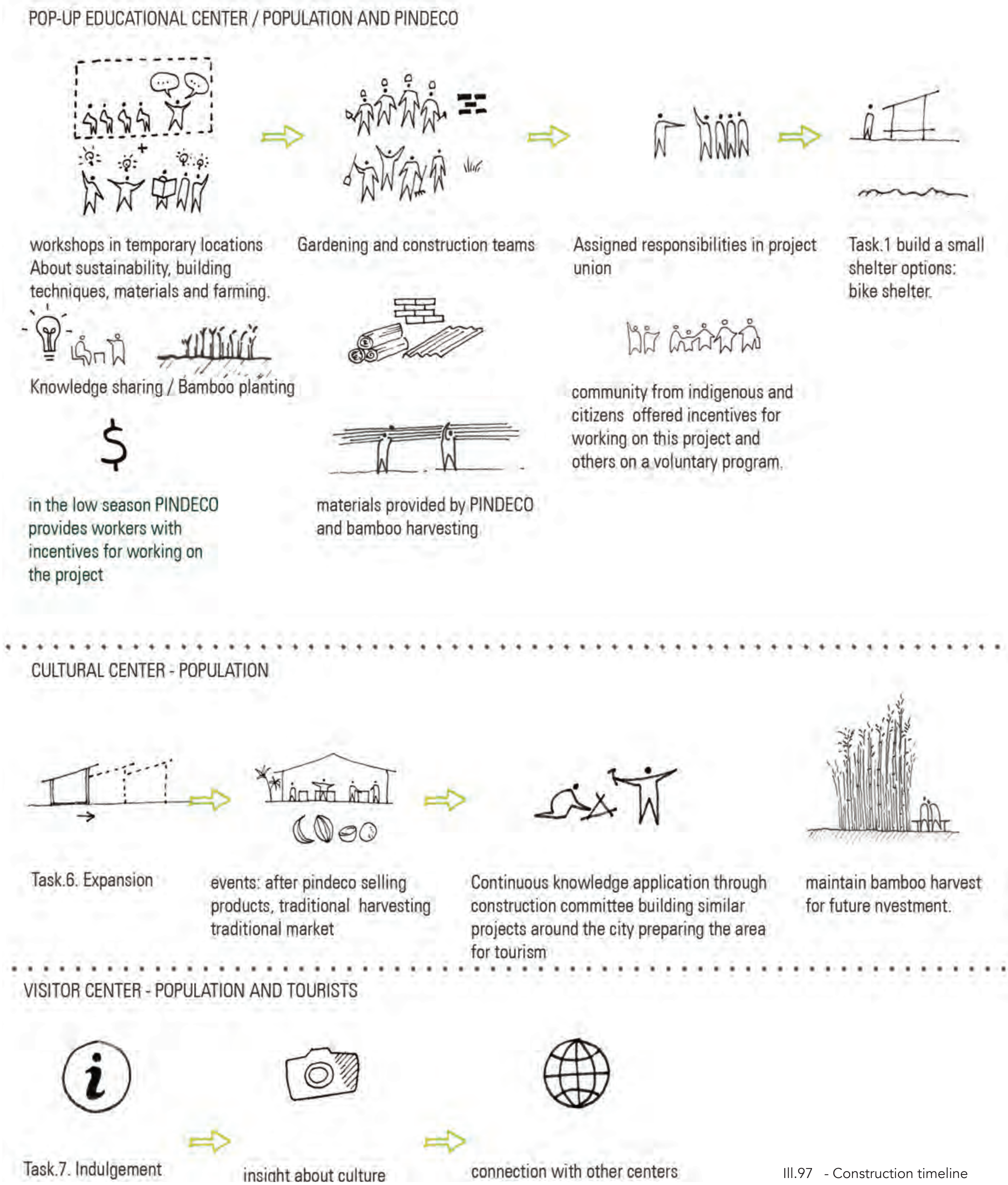
When people have learned to work in symbiosis and accept one another, they will be ready to share their knowledge with foreigners, visitors coming to learn about sustainable building constructions, art-craft, local cuisine and cultural heritage. The center will at this point be turning into a visitor center, connected with those already existing in the nearby indigenous communities, able to host long-term workshops on sustainable living and building. Small self-built housings will be designed and implemented to the program To host the visitors.

Ill.95 - Project timeline

LEGEND

	I- Educational center	II- Cultural center	III- Visitor center
	Paths	Paths	Paths
	Orchards	Orchards and installations	Orchards and installations
	Low raise park	High raise park	Housings for visitors
	Center's facilities	Center's facilities	Center's facilities
	Park	Park and pavillions	Park, pavillions and sport equipement
	Flooding safety distance		

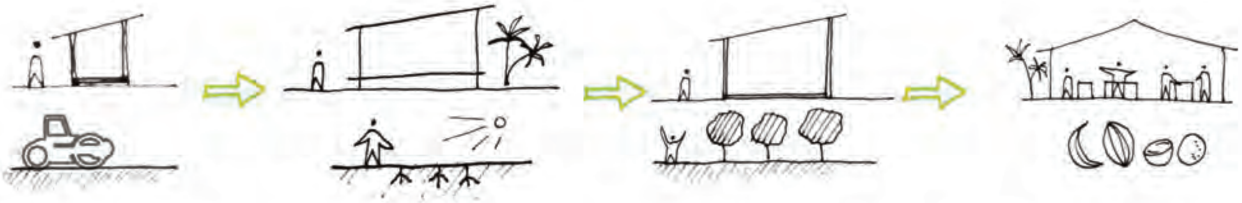
Ill.96 - Map timeline



Ill.97 - Construction timeline

APPLICATION OF KNOWLEDGE

NOW



Task.2. build a small envelop and prepare terrain .options:storage, toiletts

Task.3. build a large shelter and plant orchards options:Auditorium

Task.4. build a large envelop and harvest treesoptions: event hall

Task.5. open plaza for public events and goods market.

PINDEOC products are sold at the cafe along with exhibition space to share knowledge about pineapple planting and harvesting

events: meeting activities workshops, installations temporary pavilions

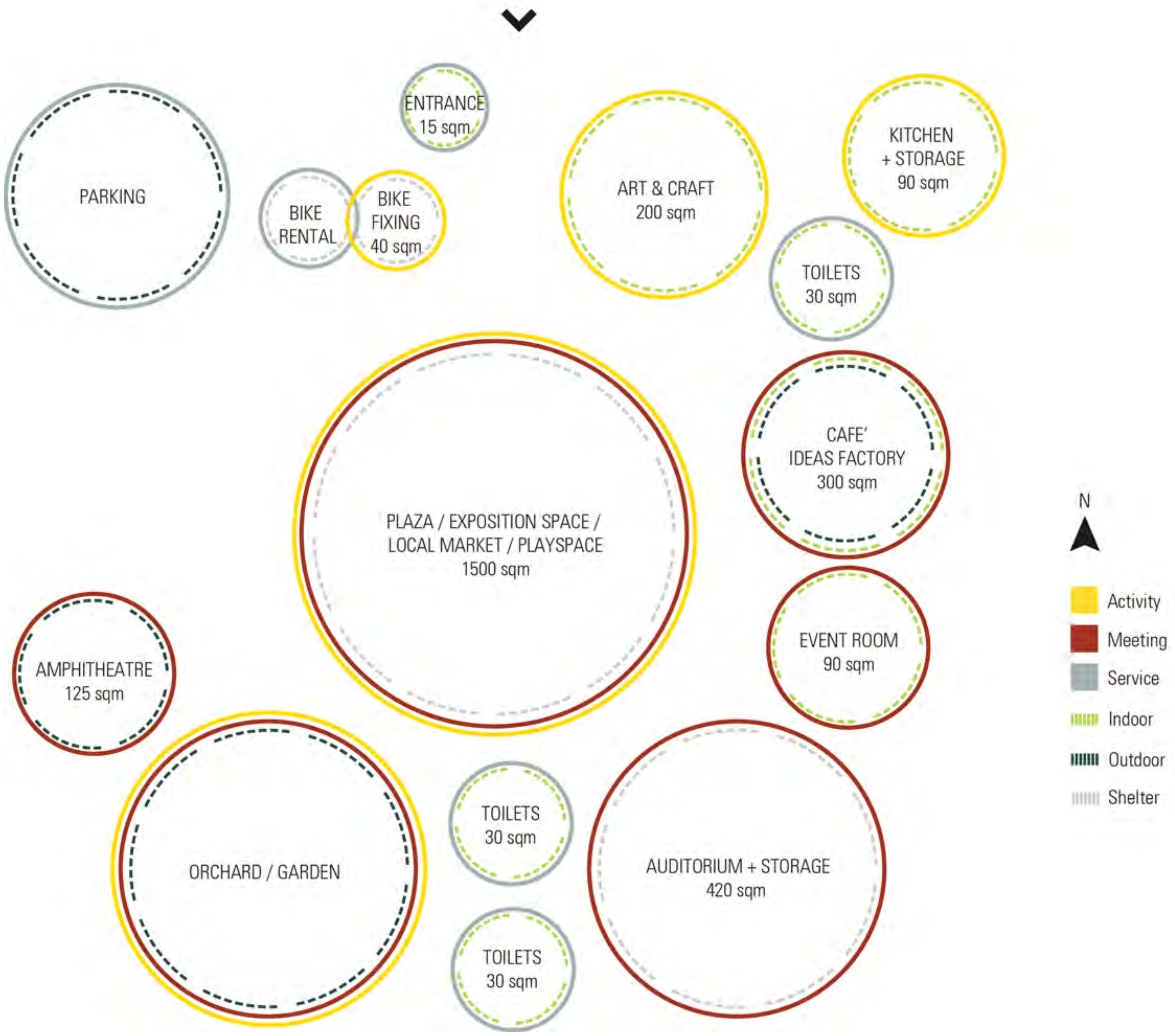
PINDECO

TOURISTS

POPULATION

FUTURE

ROOM PROGRAM



Ill.98 - Room program diagram

DAILY USE OF FACILITIES

The room program was studied in order to ensure a continuous use of the centre throughout the day.
Most of the buildings open in the morning and can support different activities until closing for cleaning and safety reasons, at night time.
The public open spaces are always accessible, provided of a night-time artificial lighting to enable the use of the site in the darkest hours, allowing the visitors to enjoy it in different atmospheres and level of privacy. At night time the attention of users will be drawn to the Skyview, the lights of Buenos Aires and the view of mountains in the landscape.
Each element of the program has to satisfy the principle of flexibility by being able to host a range of uses, depending on the needs. This way likely the site will be kept alive for longer time spans.

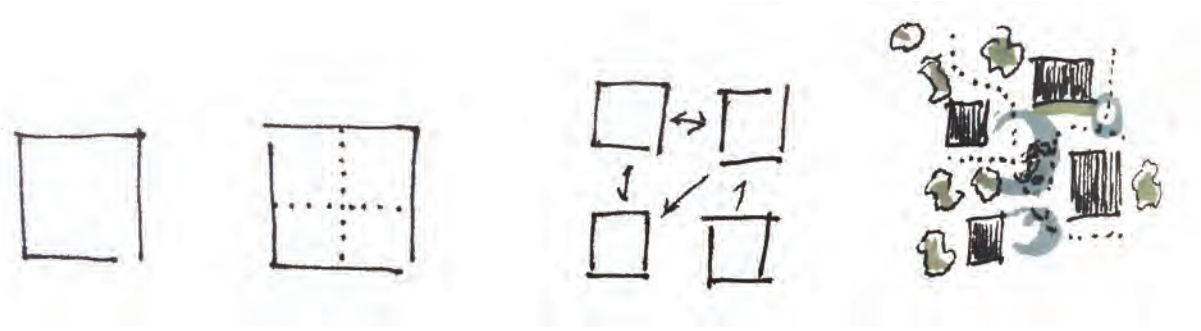
Ill.99 - Dayly use facilities diagram

CONCEPT

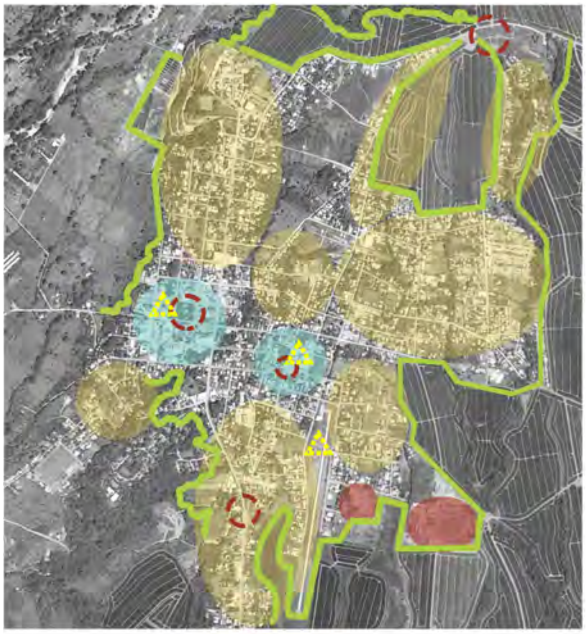
This project's aim is to heal a social fracture by creating a space of interaction and exchange that connects all the actors and reform diversity into unity.
The new center should represent the culture of the place and be recognized by people as a part of their own tradition.
Our humanitarian approach focuses on embedding the center in the community, indulging people through the different project phases, aiming to inspire a feeling of ownership through physical and organizational engagement.

The strategies adopted to achieve this level of involvement can be summarized in:
- participatory architecture
- use of available, sustainable craftsmanship and materials
- easy construction
- evolving design with different actors

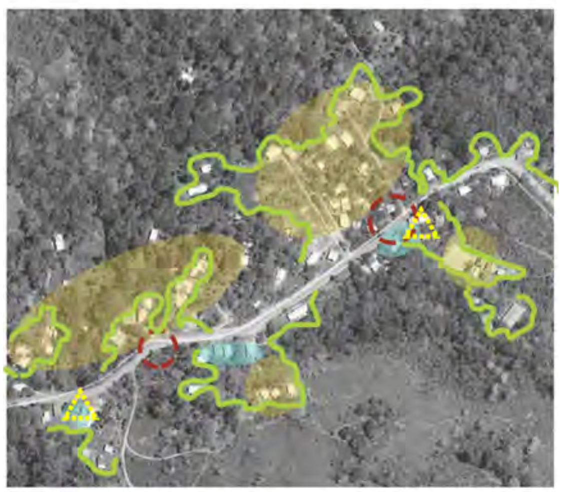
Our concept takes shape in a village layout, familiar to the different actors, endorsing a dynamic, continuous interaction and knowledge exchange, finally integrating nature with a ever evolving modular system.



Ill.100 - Concept diagram



Buenos Aires

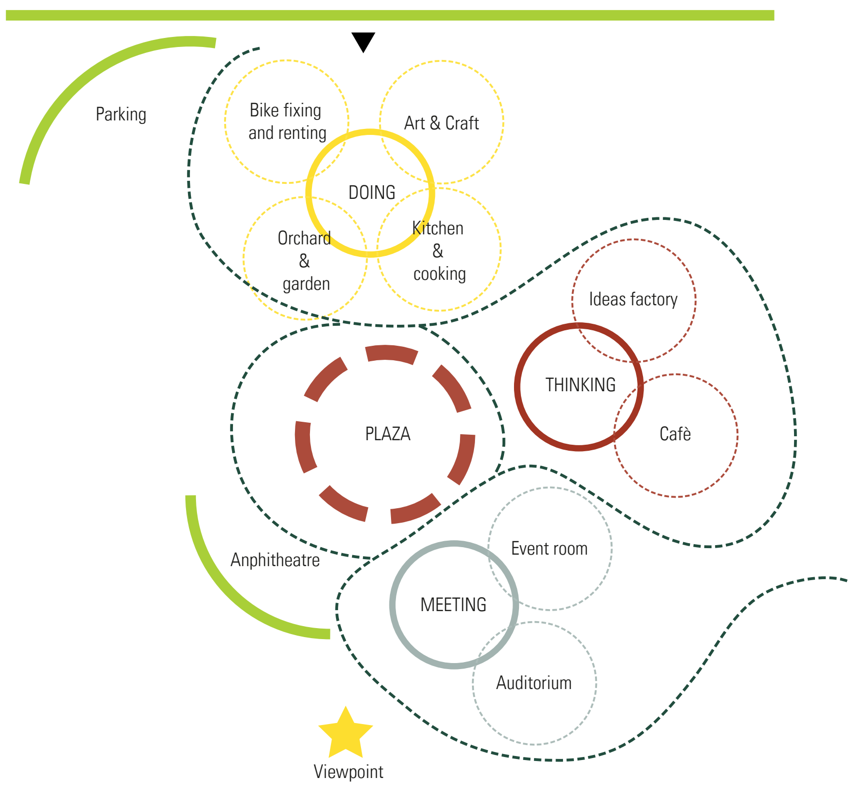


Salitre's indigenous village

Features by Kevin Lynch:
Nodes
Districts
Landmarks
Edges
Paths

DISTRICT- residential
EDGES
NODES
LANDMARK
DISTRICT- commercial
DISTRICT- industrial

In the project:

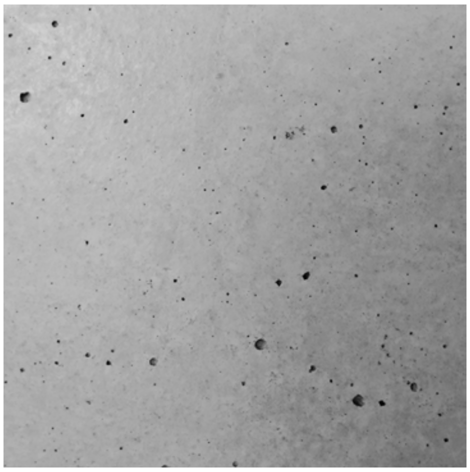


Ill.101 - Lynch's theory applied to the the project

MATERIALS INVESTIGATION

LCA

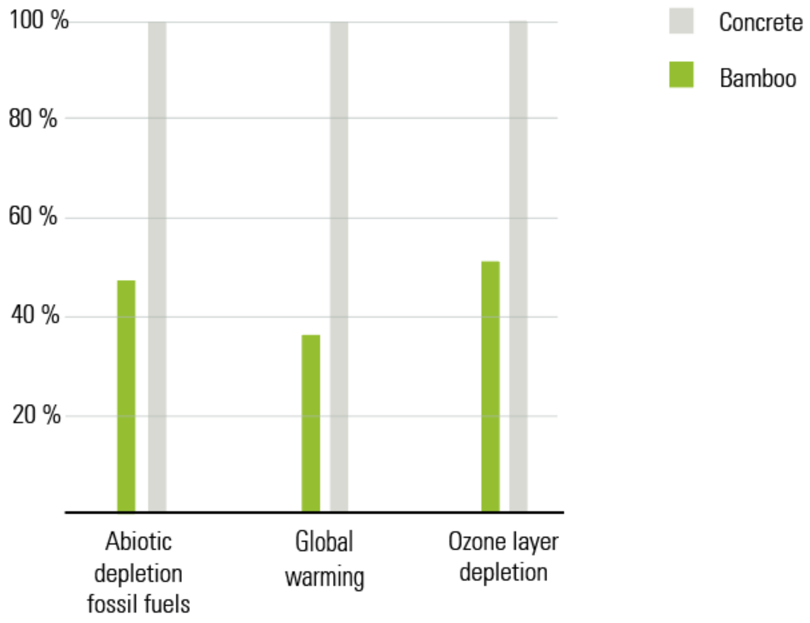
This project aims to be sustainable concerning economic, environmental and social factors; as such, the choice of materials and building techniques has to consider all the different factors included in the mentioned three pillars of sustainability.
Nowadays, the typical Tico (local) house, is built in concrete. This material requires skilled workers, it uses only unsustainable materials and can result costly; moreover, its role as a thermal mass is not exploited since the temperature remains quite stable throughout the day.
To unite the different actors and rediscover the values of ancient buildings, indigenous strategies, together with a modern distribution of spaces, were chosen to construct the center, this implies the use of local skills and materials such as timber and earth.
A way to quantify the different impacts of a material is the LCA (Life Cycle Assessment), an evaluation method that considers the whole lifecycle of a product, taking into account activities such as extraction, processing, transportation, usage, and disposal.
An LCA study was made in 2014 as a thesis project for the Cornell University, by the student Carolina A. Pardo, which compares the results of two different wall constructions in Colombia: a normal concrete one and bamboo and earth one built with the bahareque method. The results are of particular interest for this project, given the proximity with Costa Rica and the similarities in building culture and legislation with Colombia.
The impact categories chosen to evaluate the LCA of these two different structures are the Global Warming Potential, the Ozone Depletion Potential and the abiotic depletion of fossil fuels; moreover, the study concentrates on the cradle-to-gate assessment calculation, therefore considering the life cycle of each material, from extraction to construction.
From the results it appears that in both cases material's transportation has a considerable impact on the environmental loads of the case studies; however many of the elements of the bamboo structure can be produced on site and bamboo itself is much lighter than concrete.
Regarding the abiotic depletion, the obtained results are very similar with each other since bamboo has to undergo through some treatments before being used; in fact, the extraction of the acids used for the



Ill.102 - Concrete texture

Ill.103 - Bamboo

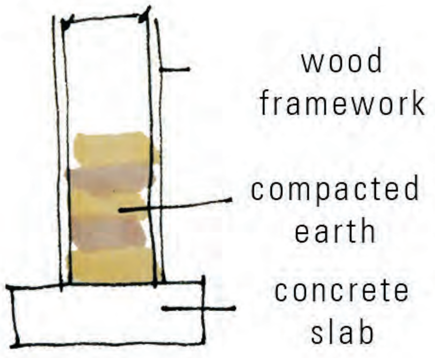
scope (boric acid and borax) have a more significant impact on the abiotic depletion than Portland cement.
Overall the Bamboo structure still has a lower environmental impact, contributing to only 36% of the CO2 produced by the concrete structure, and consuming only 47% of the embodied energy required for it.
Another positive aspect to consider when analyzing bamboo is its rapid growth, that makes it a fast renewable timber material, that occupies contained spaces and has a positive impact on the soil consistency; if used in large scale, the use of bamboo could, therefore, reduce forestry pressures.
As for what concerns wood, Costa Rica has severe legislations protecting its forests; the inhabitants are therefore forced to purchase wood from the neighboring countries making it a less sustainable material in terms of transportation and deforestation factor.
Under these considerations, it appears that construction with a majority of local materials such as bamboo and earth its overall more sustainable and often has a positive incidence on the indoor comfort.
(Acevedo Pardo, 2014)



Ill.104 - Impact assessment results concrete vs bamboo

Use of materials

Earth



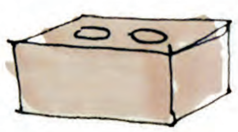
Ill.105 - Rammed earth wall

Rammed earth

This construction technique consists of a mixture of sand, gravel and clay compressed together with natural stabilizer or cement and compacted in a wooden frame which is removed when the mixture gets hard.
Wood, bamboo or rebar can be added for major earthquake resistance.
The thickness of the wall varies between 30 and 55 cm.
(Anon, 2018)

Properties:

- High thermal mass
- Fire and waterproof
- Sound insulation
- Earthquake resistant
- Termite resistant
- Made from natural and local material
- Adapt to semi-arid and tropical climates
- Low-time construction
- Easy construction method



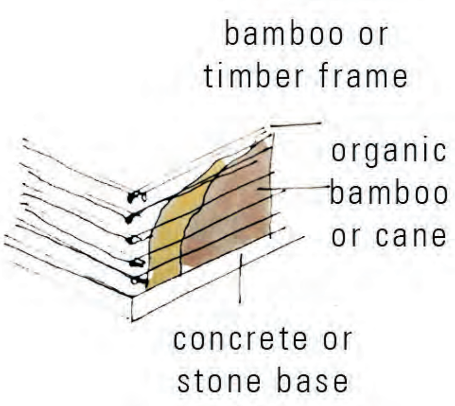
Ill.106 - Eco bloques

Eco bloques

This block, made out of the available natural compacted soil and 10% or less cement, is produced in Costa Rica and it is suitable for any construction. Moreover, the blocks will be produced on-site with a consistent reduction of transportation costs.
(Eco-bloques.com, 2018)

Properties:

- High thermal mass
- Fire and waterproof
- Sound insulation
- Earthquake resistant
- Termite resistant
- Made from a non-toxic readily available natural raw material.
- Low cost
- Easy construction method



Ill.108 - Bahaque wall

Baharaque

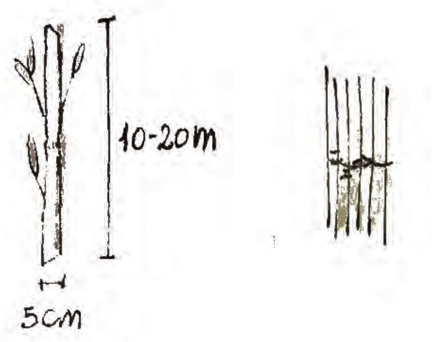
This vernacular technique is still used for housing constructions in Costa Rica and it allows people to build their own house with simple capability.
(Pdfs.semanticscholar.org, 2018)

Properties:

- Durability over 50 years
- 1-2 max story height
- Fire and waterproof
- Sound insulation
- Earthquake resistant
- Termite resistant
- Made from natural and local material
- Vernacular craft
- Low cost
- Easy construction method

Bamboo

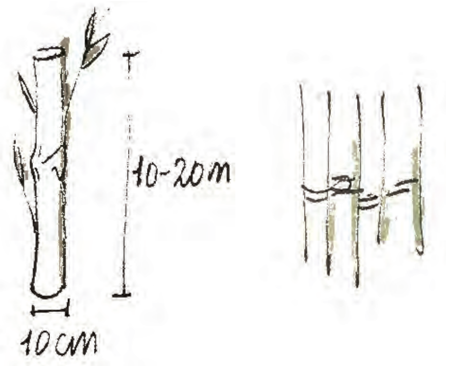
Bamboo is a widely used construction material in tropical countries such as Central and South America. It is a sustainable option to use instead of wood since it's fast growing (3-5 years) and its plantations occupy much less space.
This material is lightweight and has a high strength, with qualities that can be compared to steel and concrete.
Since ancient times, bamboo has been known to be a versatile resource, resilient to wind and seismic activities, easy to manipulate through simple tools.
Nonetheless, there is a lack of knowledge in structural joints, and the material has relatively low durability, especially in case of fire. Therefore, it needs to be treated; moreover, each element is characterized by different qualities and needs to be tested and evaluated to guarantee its structural or aesthetical qualities.
A study on treatments and connections is crucial during the design process, and on-site selection of each bamboo is necessary.
According to the research made, the bamboo family chosen for the project is the Guadua angustifolia. That however different plant variation presents different qualities, each indicated for particular uses:
"onion," withstands tension forces thanks to the long internodes;
"club," efficient in compression;
"castle," suitable for the elaboration of planks.
(Minke, 2016)



Ill.109 - Chusquea pitteri bamboo

Chusquea pitteri

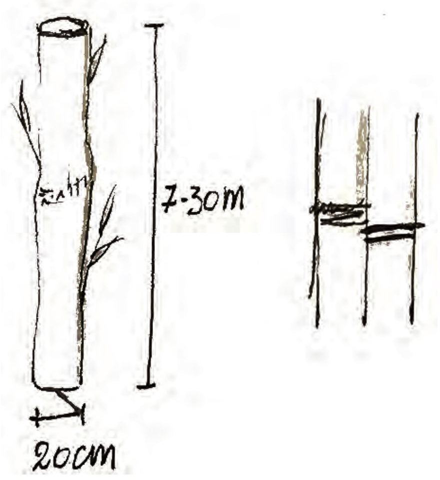
- Used in light structures and furnishing
- Autoctone of Costa Rica



Ill.110 - Guadua amplexifolius

Guadua amplexifolius

- Used in constructions
- Alloctone, from South America



Ill.111 - Guadua angustifolia

Guadua angustifolia

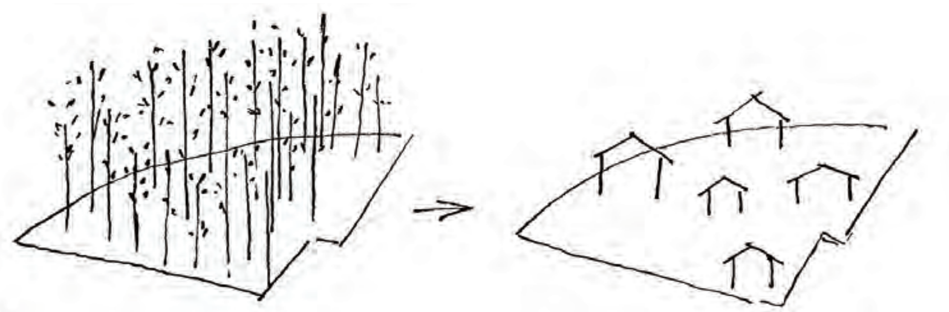
- Used in constructions
- Alloctone, from South America
- Good resistance to wood-eating insects and decay fungi

Supply vs demand

An overall estimation of bamboo has been done to cover the demand of material on site for a more sustainable approach.
The use of local bamboo would first reduce the cost and pollution of transportation. Moreover, it would add value to the project by educating people about the potential and real cost of this material.
The Guadua angustifolia can be planted with a spacing between one element and the other of 7m x 6m; for structural elements, a section of only 15 meters can be used, the remaining part of the plant has a thinner section and can be used for non-structural functions such as roofing coverage.
The project site has an area of 31000 sqm, allowing the plantation of 738 different plants.
Only for the roofing coverage, 230 bamboos elements with a diameter of 10 cm are needed;
The earth walls require an average number of 338 bamboos with a diameter of 20 cm.
Finally, for the bearing structure of the largest roofs, 130 elements with a diameter of 20 cm are needed. 698 plants are required to satisfy the demand, therefore a bamboo plantation that covers 31000 sqm, the project site, will be able to fulfill the initial request for the material.

Bamboo durability

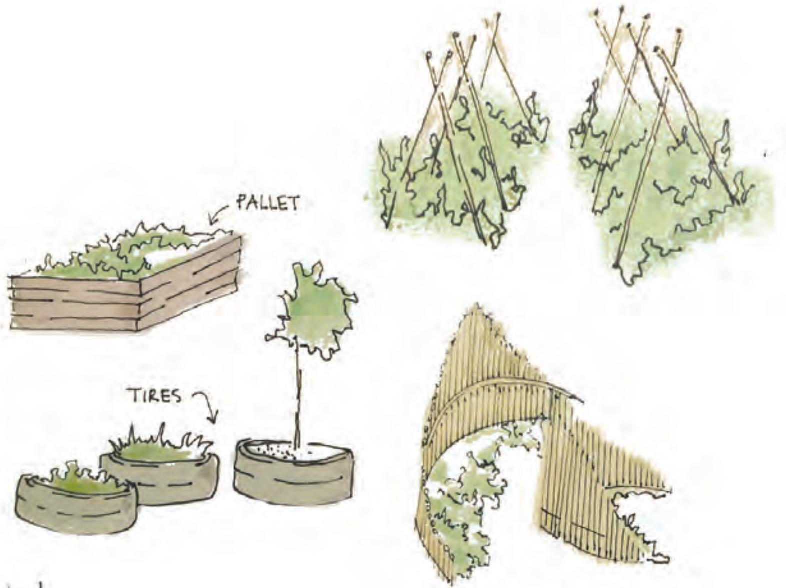
Bamboo has a low natural durability, which can be increased by applying preservative substances that protect it against the attack of fungi and insects, extending its life in service. The preservatives must be injected into the walls of the culms or stems of the bamboo so that they are distributed through the cells that form their woody tissue.
Unlike wood, bamboo has its vessels and cells oriented longitudinally, not radial ones that would facilitate the movement of liquid preservatives in the transverse direction. Therefore the preservation methods must be specialized for this material.
The water-soluble substances used to preserve bamboo are the same as those used for wood: CCA salts and boron compounds (boric acid and borax).
The protection against fungal attack is also achieved with good drying and good design in construction.
To protect bamboo from insect attack, preservation methods with chemicals can be used.
Anyhow the life expectancy of the structural elements varies between 20-30 years, depending by the treatments, exposure to weather conditions and bamboo quality.

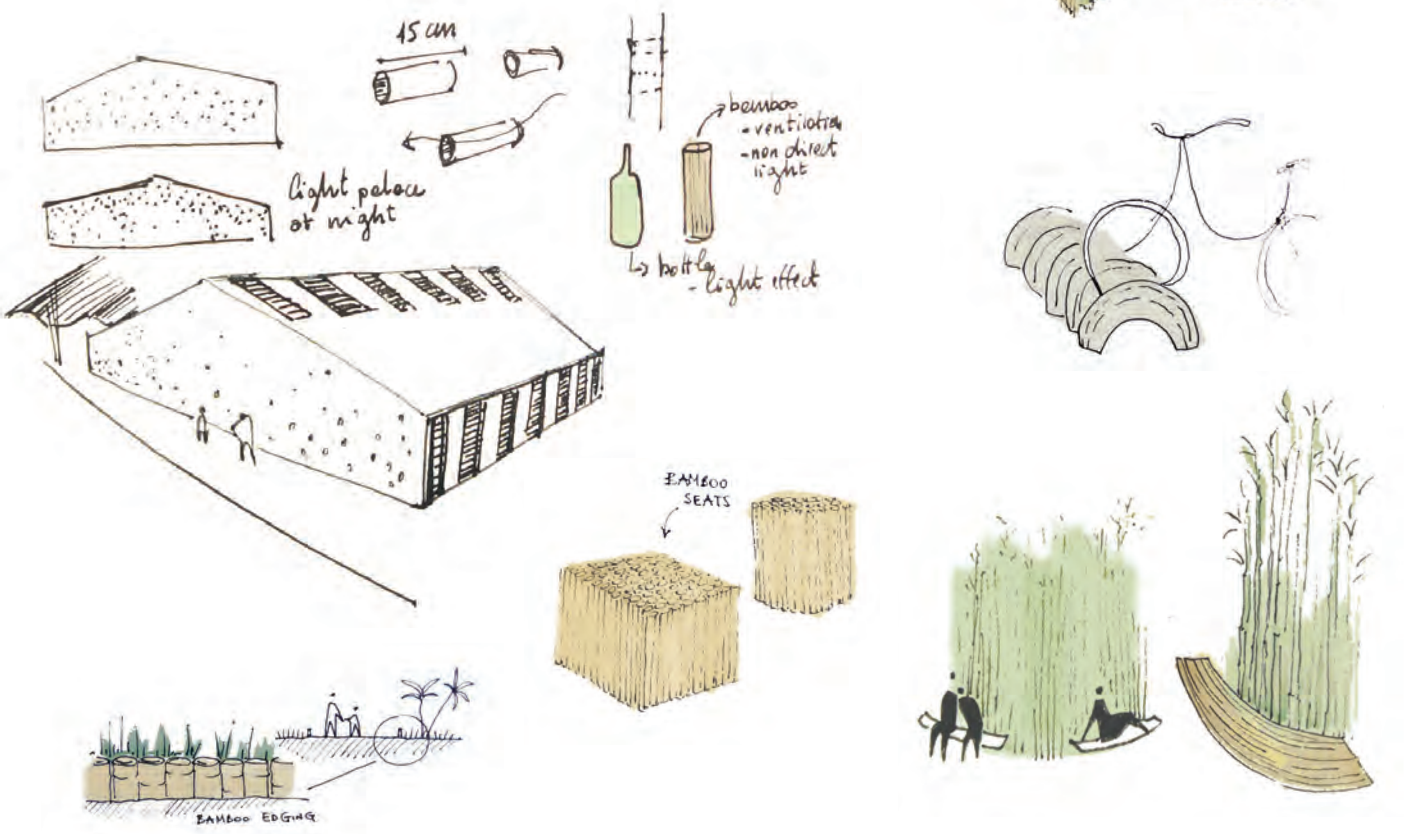


Ill.112 - Bamboo from production to construction

Use of alternative materials

Recycled tires and pallets are materials locally available which can be integrated into the project through alternative solutions.
Combined with bamboo, these objects have the potential to become original furniture, outdoor elements for orchards and playgrounds.
Bamboo cylinders and recycled glass bottles are integrated into the western walls of the buildings to protect the indoor from the solar radiation without compromising ventilation. Moreover, this solution offers a pleasing aesthetic value to the facade.



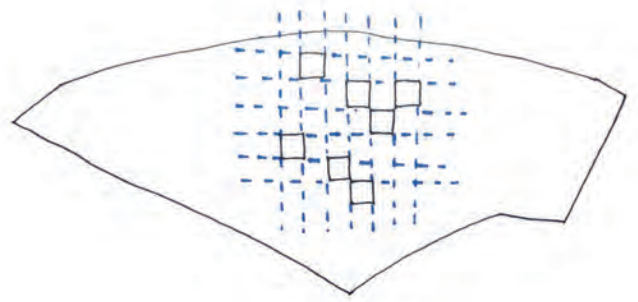


Ill.113 - Drawings inspirations

MASTERPLAN ITERATIONS

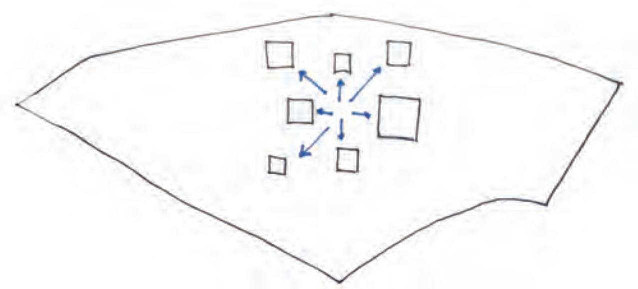
1. GRID SYSTEM & MODULES

Buildings are organized in a regular grid following a standard square module based on the village concept.
This solution provided a rigidity unsuitable for this topography, determining unnecessary constraints in the building's structure.



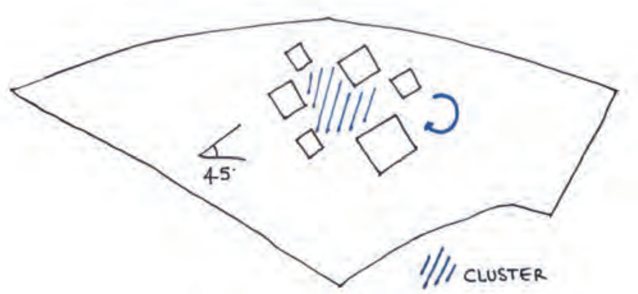
2. DECONSTRUCTION

Deformation and shifting the grid allows the buildings to create a more dynamic space that would take into account topography, sunlight, ventilation, connections, and flow.
The technical analysis helped to place the buildings according to the wind and sun radiation.



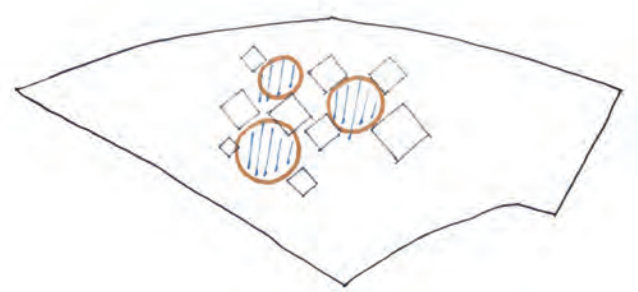
3. ROTATION & CENTRAL CLUSTER

The buildings have been organized around a central square and rotated of 45° to improve ventilation between them.



4. THREE CLUSTERS AND CIRCULAR CONNECTIONS

The buildings are grouped in three clusters divided by functions: doing-meeting-thinking.
Each cluster is reachable by a circular covered passage. This solution revealed several issues in connecting the buildings with the pathways.



5. HORIZONTAL GRID

Based on wind analysis results, the volumes have been rotated back to the initial position. (see Annex)
Further studies led to reconsider the grid system. Four different square structures containing a central volume are adopted as a repetitive module.

6. RECTANGULAR PLAN & SHIFTED VOLUMES

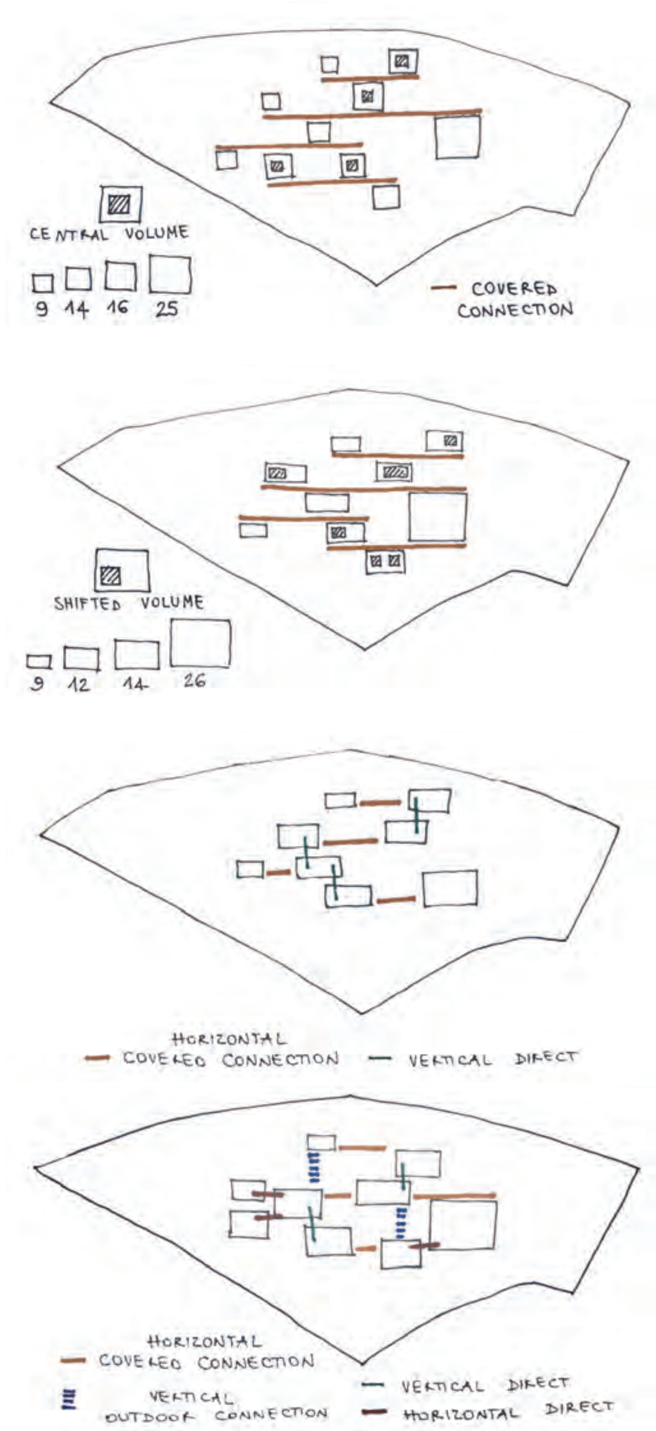
The sunlight analysis revealed a better performance by using a rectangular plan. Moreover, the central core volumes had to be shifted closer to the edges since they didn't receive enough natural light and to allow better circulation.

7.DIRECT & UNDIRECT CONNECTIONS

To avoid using excessive space for the connections,
vertical connections have been integrated inside of the structures, keeping the horizontal covered corridors.

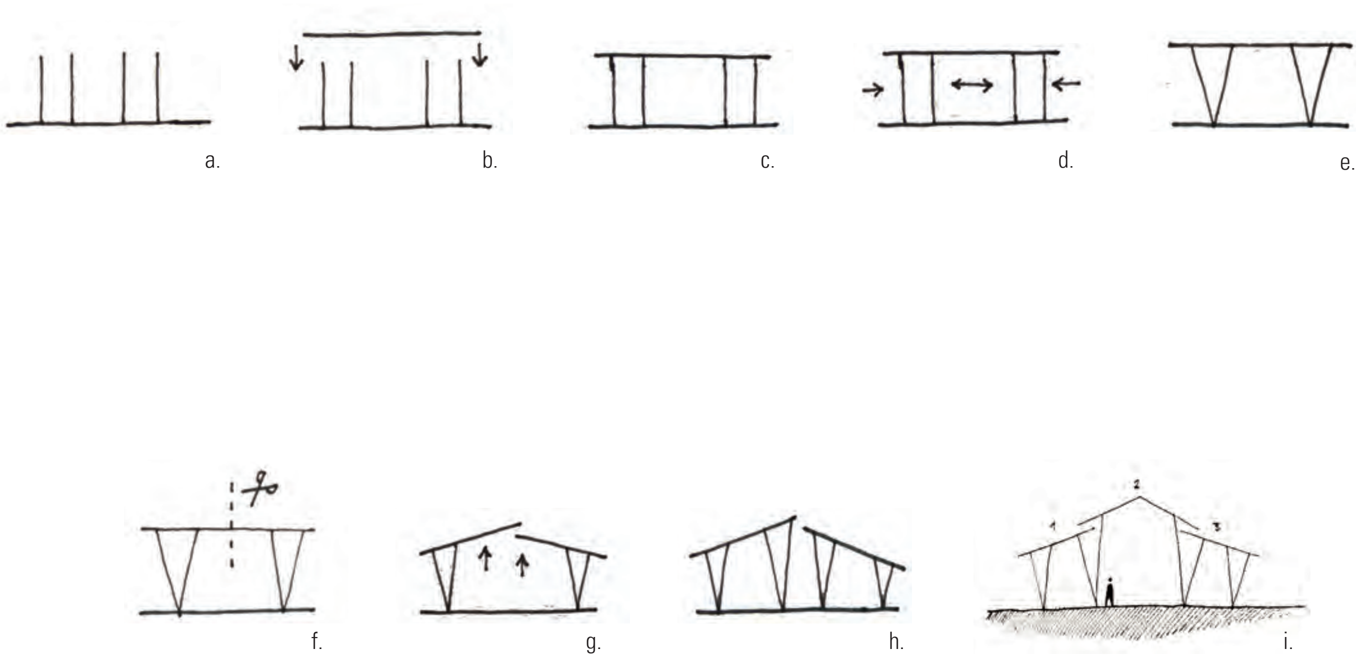
8.HORIZONTAL & VERTICAL CONNECTIONS

Finally, a system of horizontal and vertical connections has been refined according to functions, flow and the need for covered or outdoor pathways.



Ill.114

STRUCTURE PROCESS

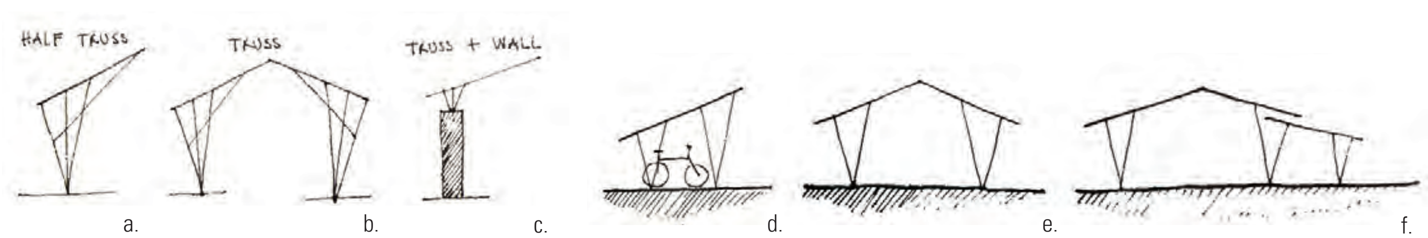


Ill.115 - Structure process

As the aim was to use an uncommon material, such as bamboo, there have been different concerns regarding the structure, its relation with the roofs and indoor spaces.

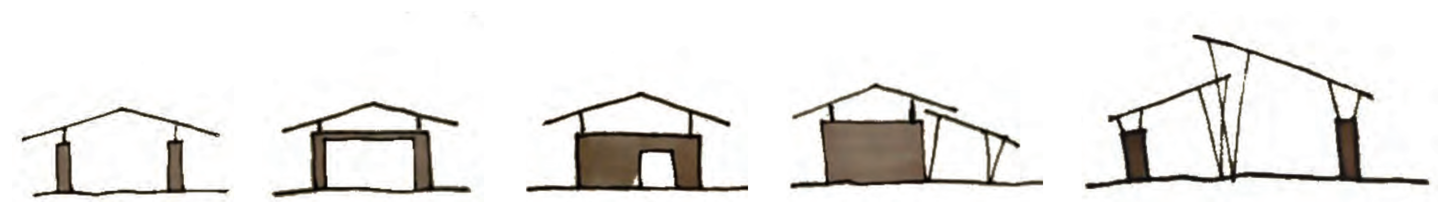
The structure had to satisfy the need of big covered spaces, without influencing negatively flow and internal distribution. A vertical pillars grid (c) would require many elements and would perforate, or imitate the area of the earth volumes meant to be underneath the main roof; this concern pushed for an alternative solution that would merge the lower edge of different pillars (e), generating a wider space underneath. The resulting mono pitched roof had than to be adapted to buildings of different dimensions, therefore the structure was exploded (f), and another central volume added (i) in order to get a wider space meant to host the auditorium.

STRUCTURE TYPOLOGIES



a. b. c. d. e. f.

Structural principle — Shelter — Medium size shelter — Large size shelter



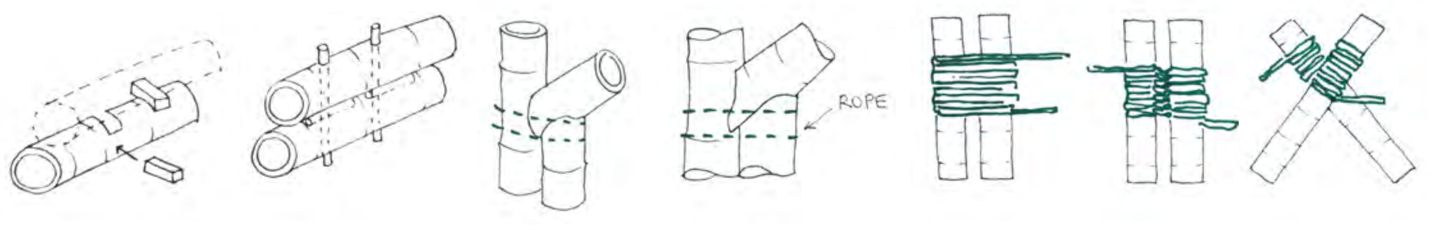
g. h. i. j. k.

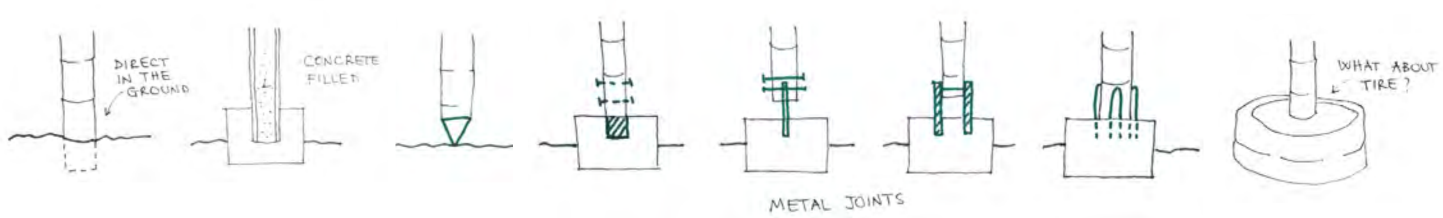
Middle size shelter in earth — Middle size envelope in earth — Envelope in earth + porch — Large shelter in earth

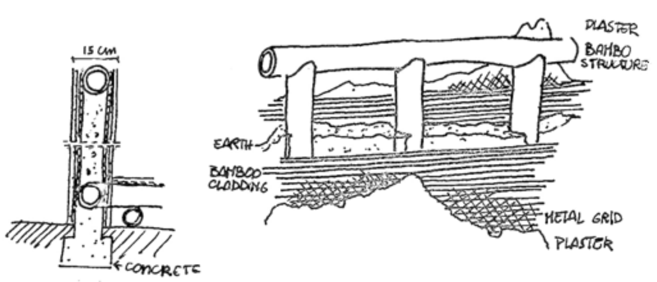
Ill.116 - Structure typologies

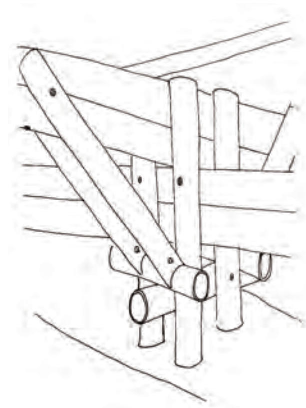
As a result of the village structure, the master plan of the project is made up by different shattered volumes of variable dimensions that had then to be connected under a series of impermeable second roofing systems. The language of this second skin had to be the same for each different covered dimensions, therefore, a compendium was assembled that would have had an answer for the various spaces requirements and joints between elements (a).
At first, one of the solutions considered connecting the bearing structure of the outer roof to the bamboo structure inside the walls (g-k); this option was then discharged since the project site is situated in an earthquake area and the elements should be left free to move separately from each other.

DETAILS & JOINTS





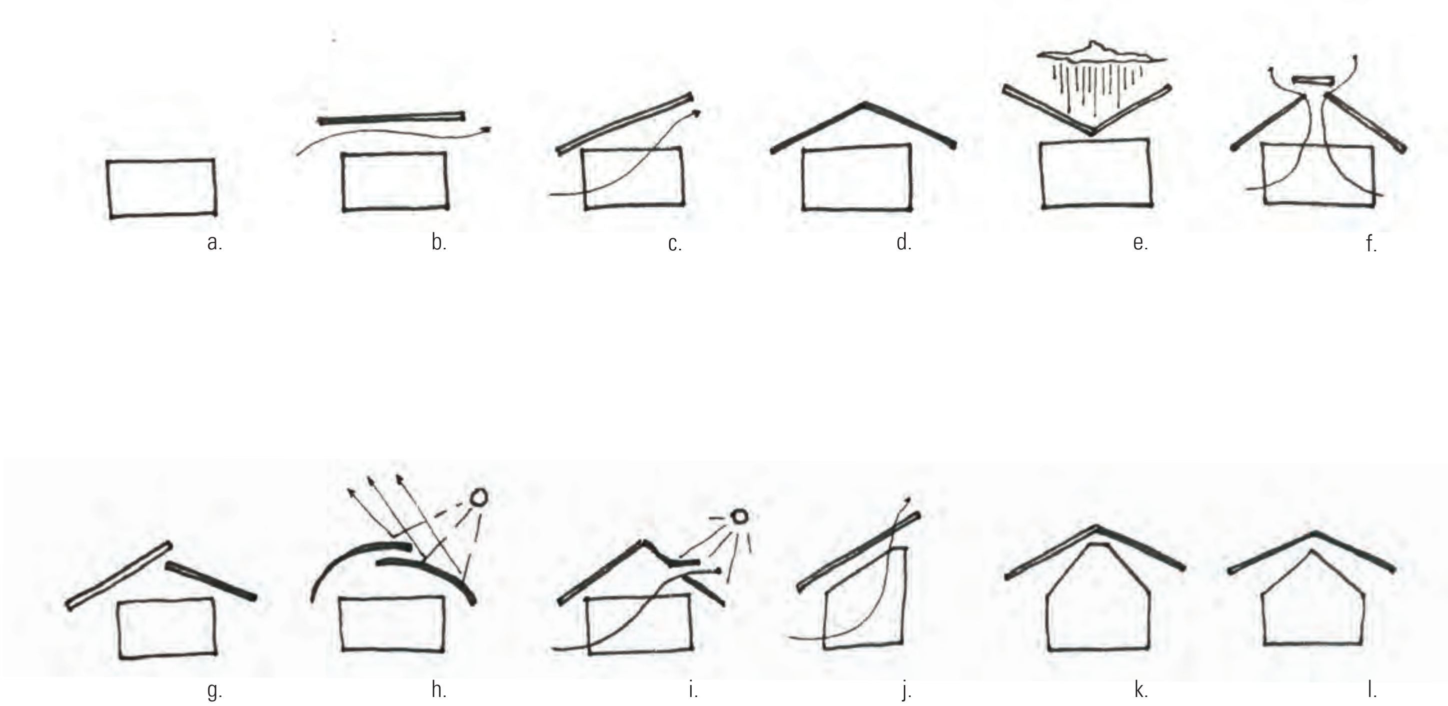




Ill.117 - Details & joints investigations

The connections between elements and different materials have been studied through different iterations. Materials such as bamboo and earth offer a wide range of possibilities regarding joints solutions implying mostly natural or recycled elements.
An example can be seen in the bamboo to bamboo connections that can be made by making specific holes in the elements and using bamboo splinters with ropes to fix them. Other interesting detail regards the connection of the bamboo pillar with the ground; several solutions have been taken into account. (Minke, 2016)

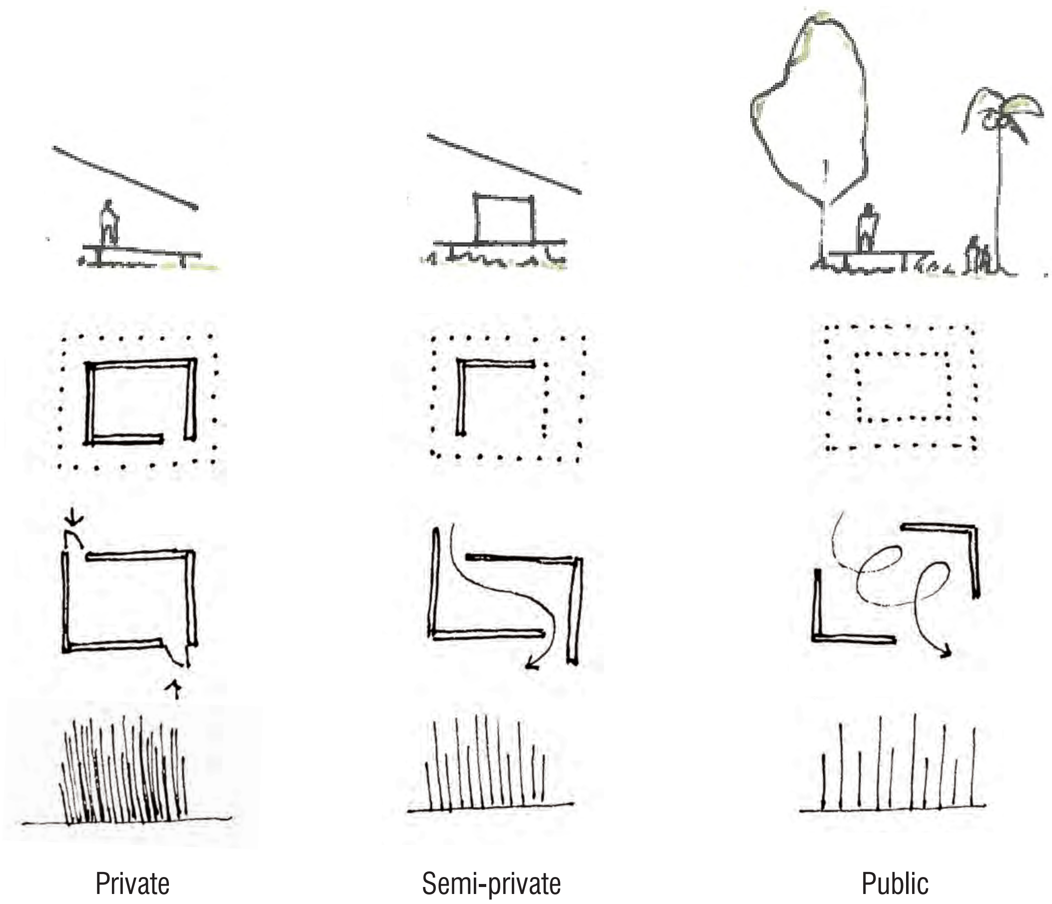
ROOF ITERATIONS



Ill.118 - Roof iterations

The shape of the roof required a particular attention in the design process in order to improve the natural ventilation as possible, provide diffuse light and avoid the direct one while protecting the building from the heavy rain. Several iterations were studied starting from the introduction of a double roof (b), a technique often used in tropical environments in order to avoid overheating. Different solutions with a tilted surface were discussed, considering factors as the possibility to collect rainwater (e). A curvy shape would increase the reflection of the sun rays (h). Meanwhile, a cut or perforated roof would improve the ventilation as a chimney system. (f,g,i).
Finally, different options of the ceiling were considered in relation to the roofing and the shelter structure (j,k,l).

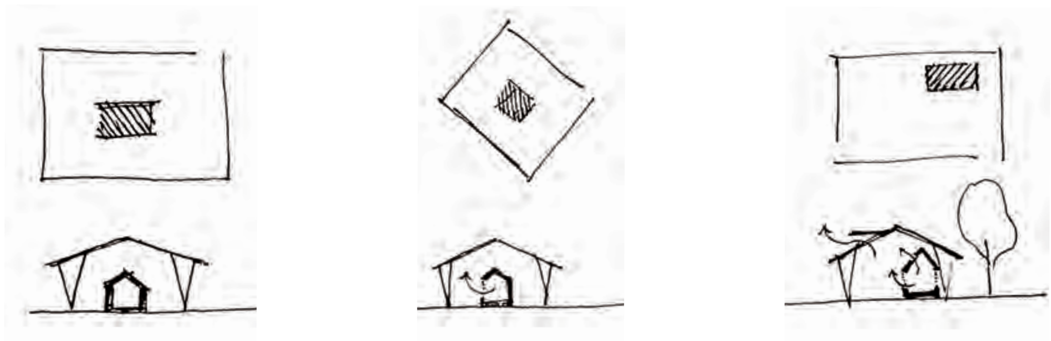
WALLS TYPOLOGIES



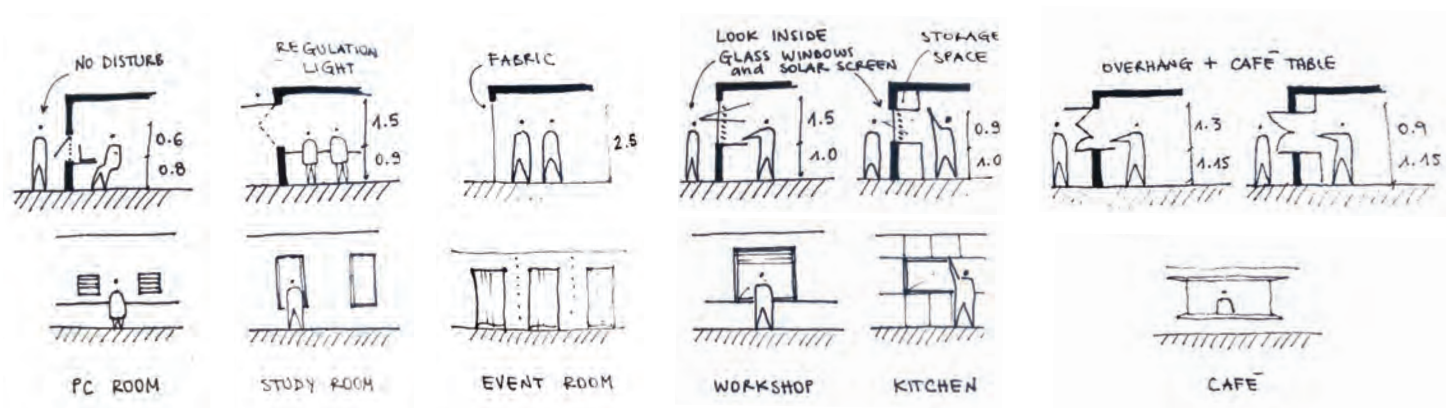
Ill.119 - Walls typologies

The enclosed areas where activities take place have different enclosing solutions.
Privacy, light, acoustic and furnishing are some of the factors that determined if an activity had better take place in a more enclosed or open area.
A variety of materials, bamboo, fabric and earth, as well as the relations with each other has been considered in order to satisfy the demands.
Areas that are meant to host particular tools such as kitchen, IT lab and handcraft workshop need to be able to be secured when needed and could require a particular ventilation. For such a cases the earth wall system will be used together with glass windows; otherwise lighter and more permeable materials will be chosen, the openings will be left without any glazing but dotated with a filtering net in order to keep insects out.
Regardless the presence of glass, every opening will be having shading devices able to be directly controlled by users.

LIGHT & OPENINGS ITERATIONS



Ill.120 - Light iterations



Ill.121 - Windows typologies

The light quality has been the main concern while shaping the project; Buenos Aires has a tropical climate and shelter from direct solar radiation (or rain) is vital. However, enough diffused light must be guaranteed for the different daily activities introduced in the center.

Daylight factor and illuminance were the parameters assessed to have a grip on the natural light quality in the buildings; For spaces that required a high visibility, such as the workshop, the target was around 500 lux and a daylight factor close to 5%; lower values are acceptable for areas that host more relaxing activities, such as the cafe, with a lower limit of 200 lux of illuminance and a 1.5% of daylight factor.

The strategies adopted to satisfy such results, much depend on the orientation of the buildings and the overall master plan. However, the big impermeable roofing is a considerable overcast on the indoor spaces, compromising its daylight and illuminance values, raising the need to be perforated, without compromising the structural qualities.

Beside the light quality, the openings were also studied following the privacy needs of users through different iterations.

D I Y

An essential aspect of the project is the DIY (Do It Yourself) approach. Therefore the construction method needs to be easy enough in order to be understood and applied by unspecialized workers.

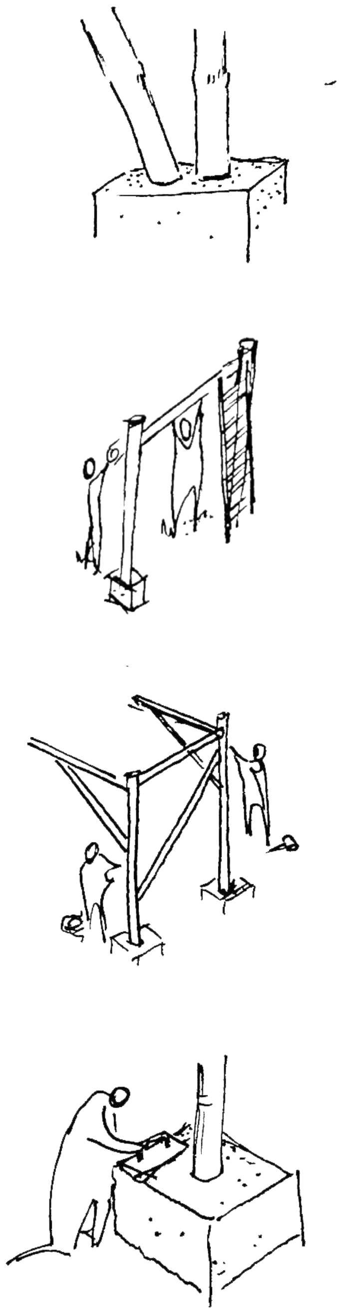
Roof structure construction guide:

1- *Foundation*
Once foundations have been made with extruding metal rods, the columns should be placed on the rods.

2- *Place beams*
The thick transversal bamboo beams are attached to the columns, connecting and stabilizing them through joints.

3- *Place diagonals*
To avoid the lateral movements of the structure (caused by loads, earthquakes and winds) diagonals are placed according to the structural design. They are located in the corners or vertices of buildings. For this, flute beak joints are usually used. Before securing them, the vertical elements have to be plumped and the horizontal elements aligned.

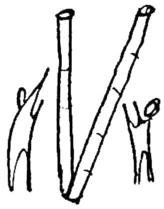
4- *Fix columns*
after the structure has been assembled The columns must be now fixed to the foundation and extruding rods with a mixture of sand and cement, verifying the leveling and plumb of each element.



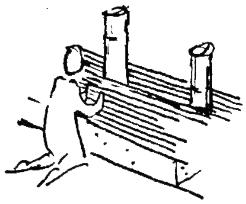
Ill.122 - Bamboo construction step by step

Walls construction guide:

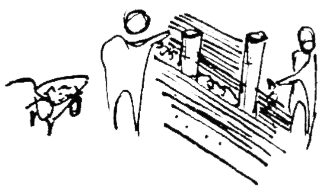
1- *Assemble the bamboo skeleton*
The cane skeleton of the bahareque walls can be constructed on-site element by another, or prefabricated on the ground and then connected to the others.



2- *Attach the crushed cane*
Canes are split in half; halves are horizontally nailed to the supporting structure with the rough side facing the outside. Afterward, metal wire in order is nailed to the cane structure to make a base for the plaster.



3- Fill the wall progressively
The part of the wall that has been closed with the split cane is filled with mud composed of clay and soil. The filler must be moistened and not too loose to prevent it from coming out through the cane barrier. The filling is done progressively (50cm at a time). Once the first layer has dried out, new crushed canes are attached above the first row to allow its filling and compaction.



4- Apply the final coating
A mortar is applied as a final coating on the outer or both sides of the wall. Previously constructed elements including nailed canes and earth wall must have been dried out thoroughly before proceeding with other activities. Two layers of mortar are applied added to the final finish. each layer should be completely dry before applying the next.

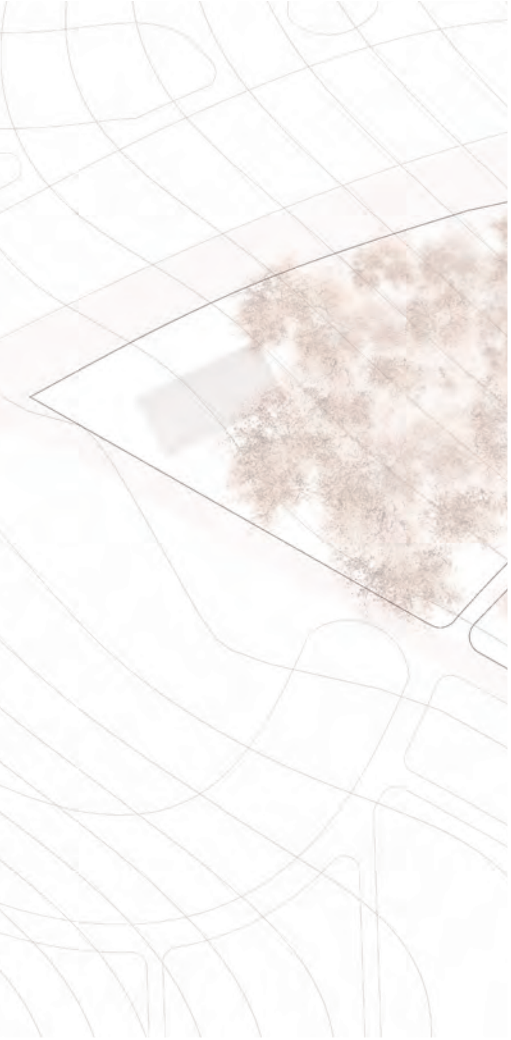
Ill.123 - Baharaque wall construction step by step

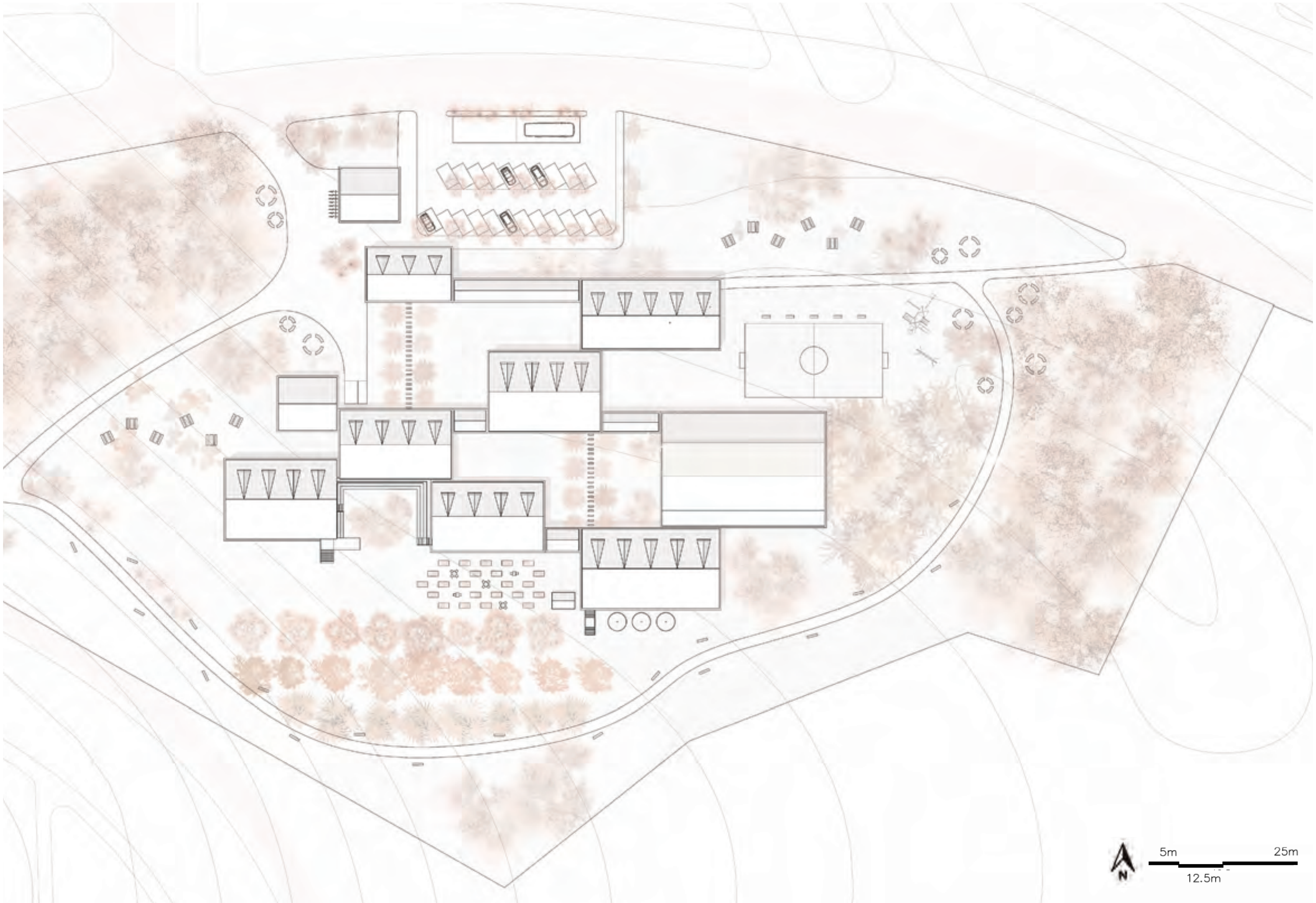
05
PRESENTATION

Ill.124 - Night bird view of the buildings complex

INTRODUCTION

The center is born by the desire to encourage and inspire development in users and the whole community of Buenos Aires Puntarenas (Costa Rica).
The project is built by local residents, and most of the building materials are locally available, sponsored or can be produced onsite at a low cost.
The site is located on nodal routes; to facilitate these connections and the entrance to the project, four different accesses have been designed, three dedicated for green circulation and one for cars and busses in a designated parking lot.
The built-up area is located in the middle part of the site with the optic of future expansion on the remaining available land.
On the eastern side of the auditorium, an area has been dedicated to the plantation of bamboo for new constructions and the future development of the center. In the western and southern areas, green parks and orchards are meant to be implemented to reconnect users with nature on different levels.
The layout of each building provides significant covered areas in bamboo protecting from solar radiation and heavy rain. Covered connections between spaces were implemented for the same reason and to allow visitors to enjoy nature while being sheltered.
The singular plans have been kept relatively clean and easy to adapt to the specific use.
Natural ventilation is optimized to create a comfortable indoor environment, to minimize the energy consumption. However, mechanical ventilation is limited to two functions: the kitchen and the wood workshop; other enclosed spaces are supplied with a fan and adjustable openings.
The enclosed volumes are distributed under the main roofs to facilitate covered circulation and provide a comfortable environment inside the enclosed spaces as well as the sheltered areas. Moreover, walls are greatly perforated to provide sufficient daylight while not compromising the solar gain, endorsing ventilation. For opaque enclosures, earth walls and fabrics have been used together with vegetation to improve the atmosphere concerning aesthetics and environmental qualities. The shading system of each opening can be manually regulated by the users according to their comfort preferences and climate conditions.




5m
25m
12.5m
N

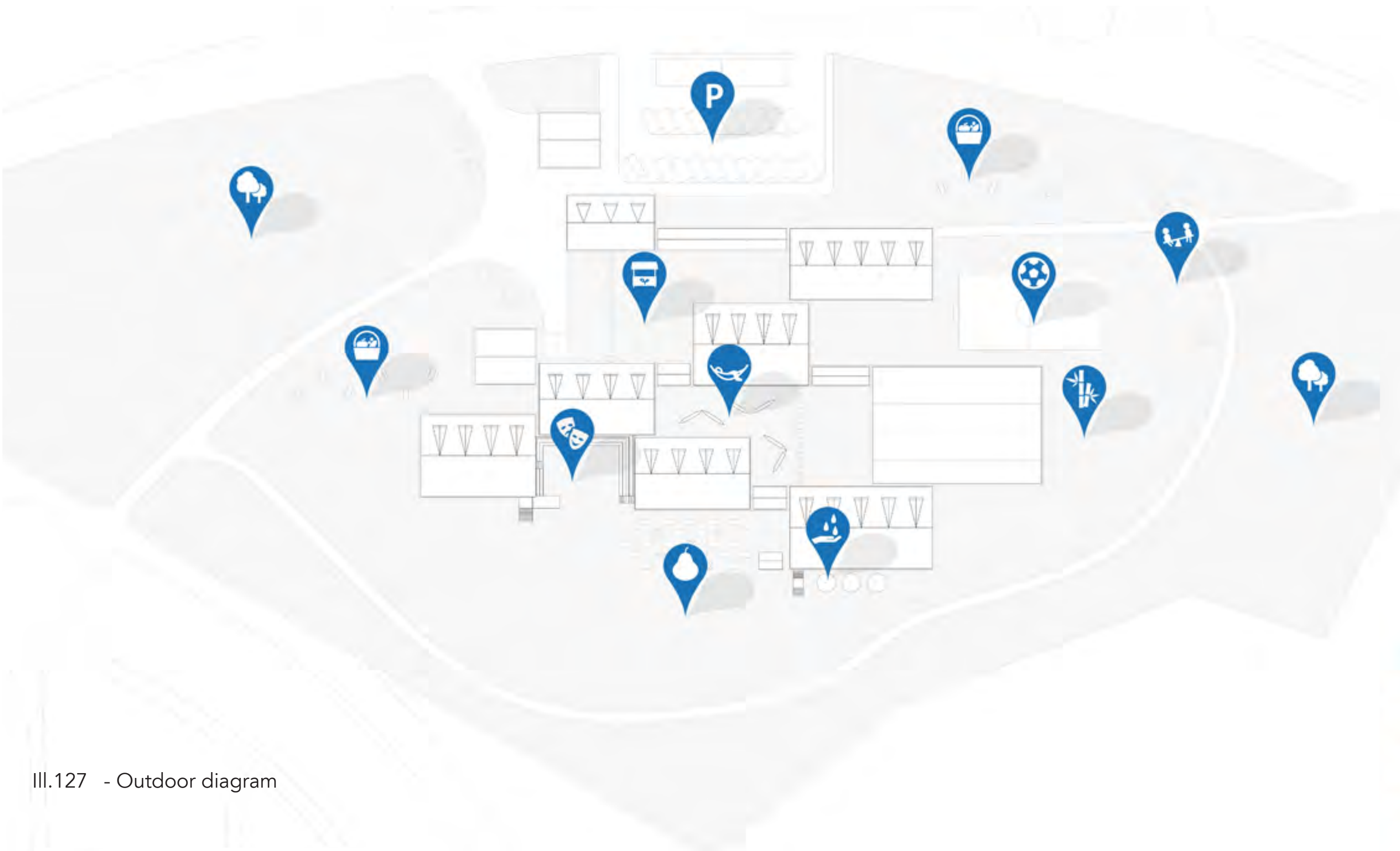
ZOONING

Ill.126 - Zooning diagram

LEGENDA

- Ideas factory
- Craft workshop
- Event room
- Auditorium
- Art workshop
- Kitchen
- Café
- WC
- Bike park & workshop
- Entrance lobby

OUTDOOR



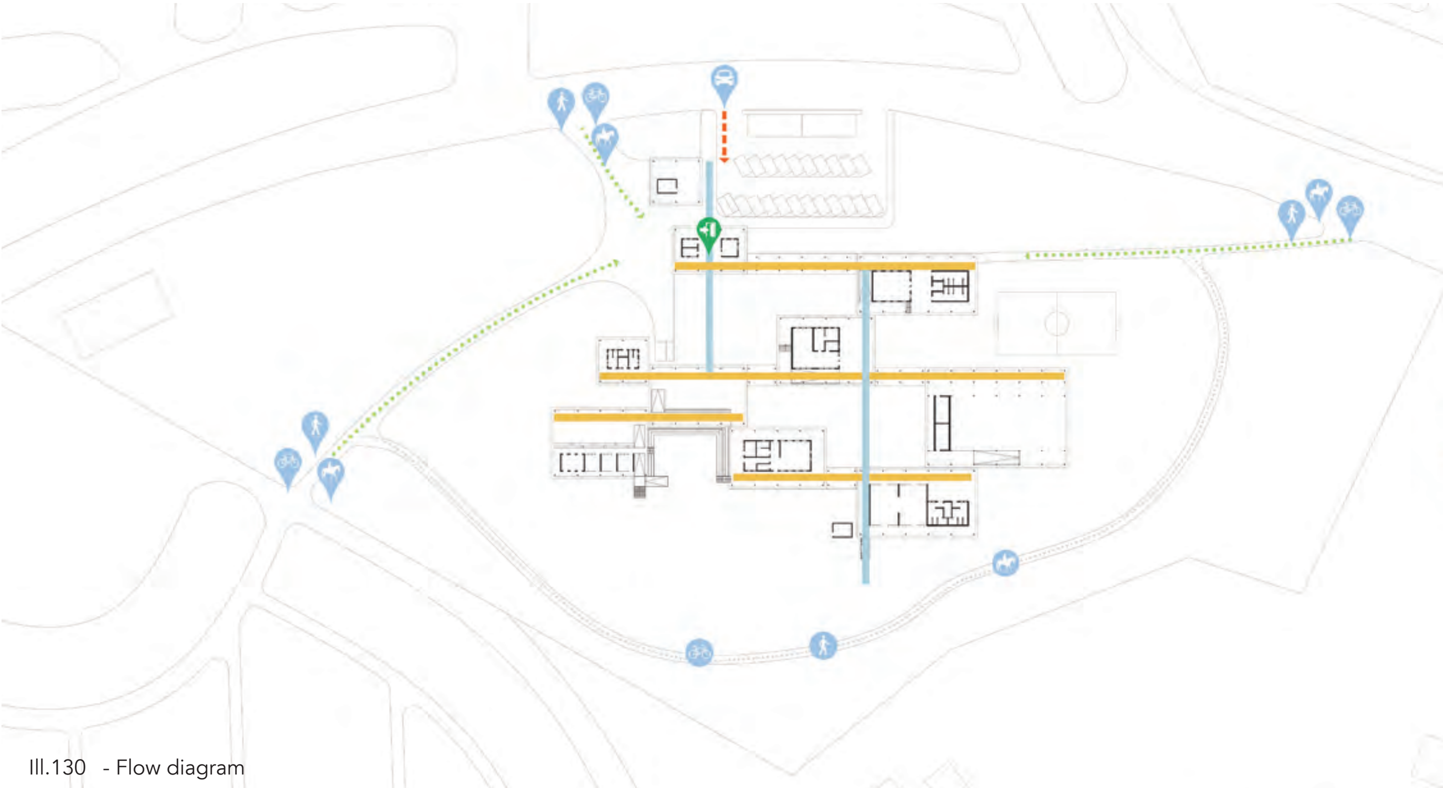
Ill.127 - Outdoor diagram

The outdoor areas are directly connected to the covered spaces, to offer different sensories between the enclosed and the sheltered, Offering natural shading with its tropical vegetation. For example; There is a relaxing area connected to the cafe, with hammocks and resting spots on the northern and eastern side squares. The southern area of the cafe is the amphitheater dedicated to smaller outdoor displays or recreation when the weather allows its use.
The southern area of the site is orchards of vegetables and fruit trees; which harvest is to be used in the kitchen/cafè or sold in the market that is located by the entrance, promoting people to sell their products or services. On the western and eastern side are located two parks and playground, to get in touch with the tropical wilderness reintroduced in the area;
Finally, a football field is found on the North-East side of the site; it can serve its purpose but also functions as a flat area where new constructions can be preassembled.

Ill.128 Outdoor, orchards (b)

Ill.129 Outdoor, anphitheater (a)

FLOW



Ill.130 - Flow diagram

The primary connections between buildings are distributed on the N-S and E-W directions. However informal pathways are endorsed and can be created through the vegetation in each user's way. The primary access to the complex is situated North West, connected to two pedestrian paths, branching to the bike parking and the parking lot. From there, visitors can move inside the center following the covered paths or freely across the green areas.

FUTURE EXPANSION

Ill.131 - Future expansion diagram

The project is an evolving center, according to the ever-changing demand and users typology where a regulation plan has been defined to guide its future growth, transforming the cultural center gradually into a visitor center bridging and sharing knowledge and technologies between the locals and tourists. The western part of the site is firstly dedicated to the plantation of slow-growing trees, among which small housing cabins will be then integrated within for tourism and attending long-term courses.

The eastern part, however, is to remain a park area among which new workshops and offices will be built. The parking lot will be extended towards East, to facilitate the increasing number of visitors and finally, some pavilions, designed and built during workshops, will be distributed in the green areas to enjoy nature through exclusive spots.

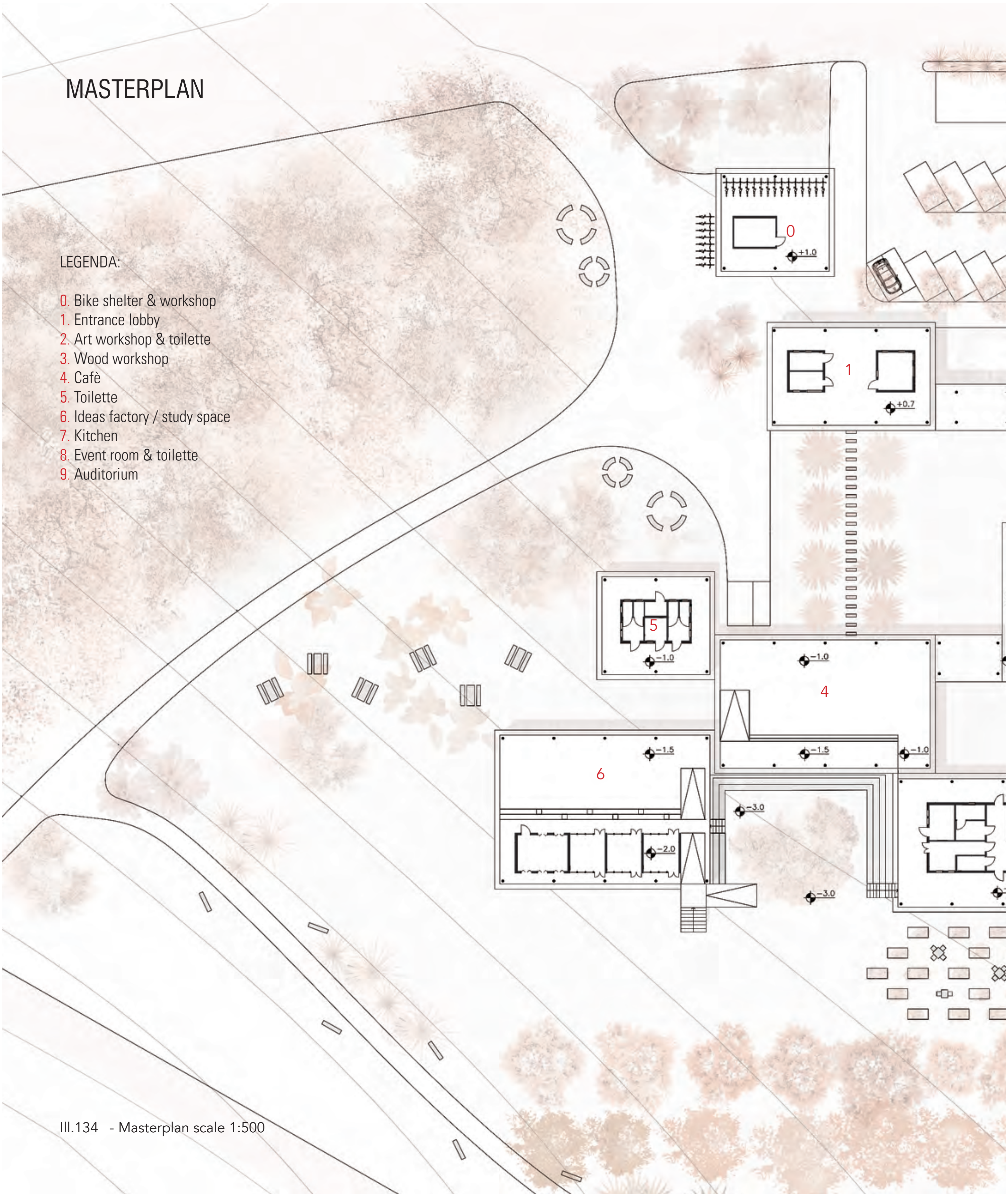
Ill.132 - Night view entrance building complex (c)

Ill.133 - Day view entrance building complex from the lobby (d)

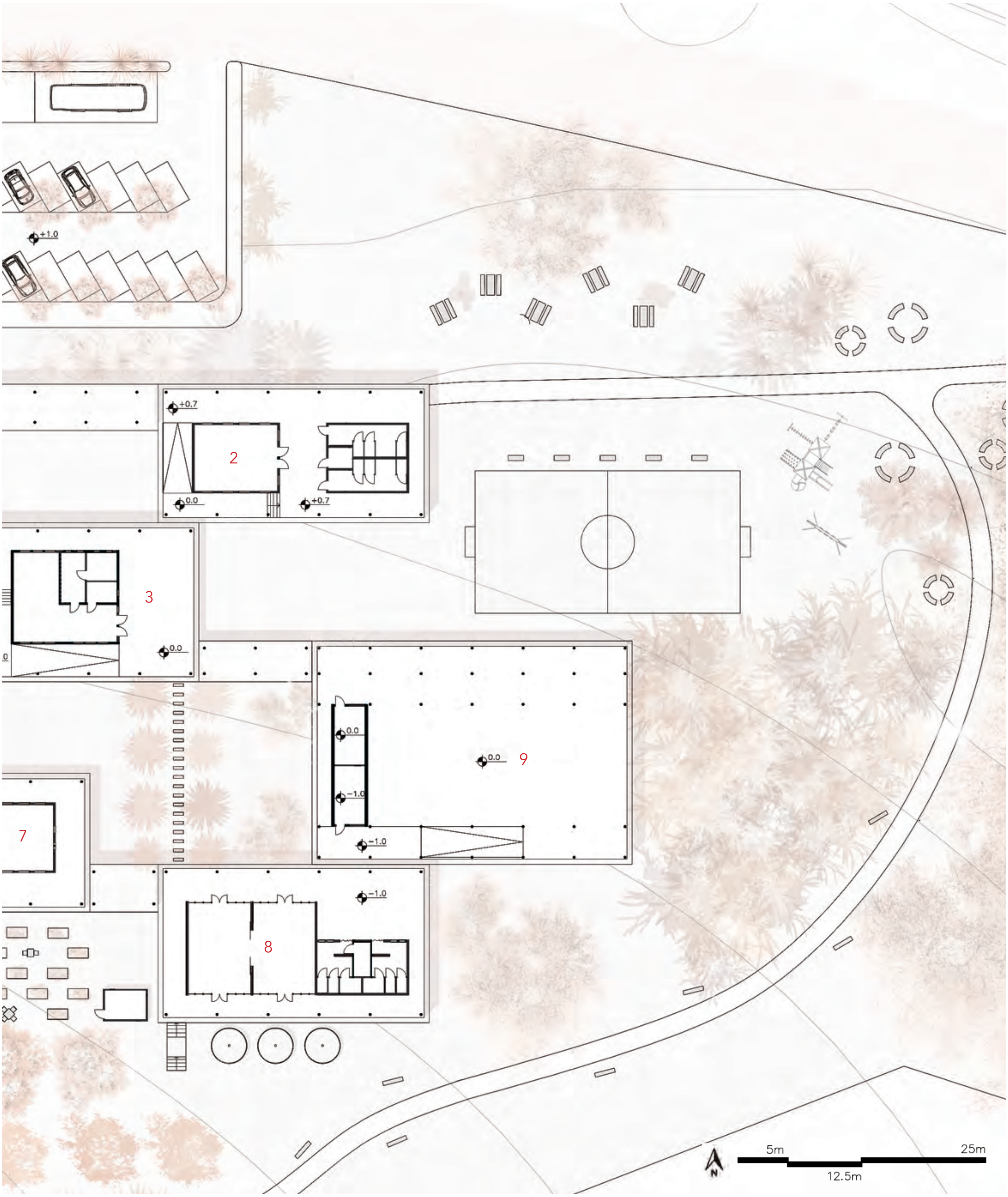
MASTERPLAN

LEGENDA:

0. Bike shelter & workshop
1. Entrance lobby
2. Art workshop & toilette
3. Wood workshop
4. Cafè
5. Toilette
6. Ideas factory / study space
7. Kitchen
8. Event room & toilette
9. Auditorium



Ill.134 - Masterplan scale 1:500



+1.0
+0.7
2
0.0
+0.7
3
0.0
9
0.0
-1.0
-1.0
7
8
-1.0
5m
12.5m
25m
N

Ill.135 - View toward from the workshop to the auditorium (e)

Ill.136 - Hammock outdoor space (f)

BUILDINGS PLANS

The plans are disabled friendly and defined by a linear, clean design that allows free furnishing and use of spaces.
Furniture and vegetation, are important elements regarding indoor comfort and atmosphere, therefore have been studied accordingly to reach functional solutions which differ between buildings.
For each closed envelope the west facade has been kept relatively enclosed, perforated by glass bottles or bamboo sections to endorse ventilation and shelter from direct solar radiation; their colors create a pleasant interplay; perceived In the indoor spaces during the day and the outdoor ones during the night.
Northern and Southern facades are the most permeable ones to favor natural ventilation moreover are favorable directions concerning solar radiations.

1. *Entrance* - the volume has been divided in two to endorse ventilation and to create a welcoming passage regardless of the visitor's approach direction. The plan contains a lobby, an office, and a toilette.

2. *Art workshop* - here as well the volume has been divided into two, one for the workshop, the other containing toilette and changing rooms shared with the users of the nearby football court.

3. *Wood workshop* - secured room with specialized machinery, connected to semi-outdoor tables; the room has mechanical ventilation. Therefore, all the openings are enclosed by glazings or a bamboo panel.

4. *Cafè* - open sheltered space with hanging curtains, green panels and vegetation dividing the space and limiting the solar gains, creating a relaxing environment. The cafe kiosk has been placed towards South-East, close to the main paths and easily accessible from storage and kitchen. To this area has also been provided a close by parking spot for ambulances and to simplify the transportation of goods.

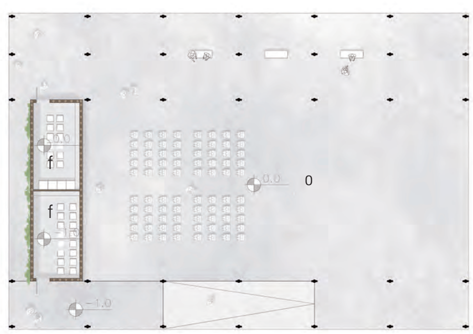
5. *Toilette* - The plan is divided into male, female and handicap; easily accessible from both study room and Cafè. Openings towards west were this time necessary to provide the necessary light. The windows openings are closed only by a net and some bamboo sticks horizontally placed for privacy reasons.

6. *Ideas factory* - The floor is here divided into two levels, the southern one dedicated to a quiet studying and the IT room, towards West; the northern part is more for interactive learning in a zone more in contact with their surroundings. The study rooms but a textile light in color instead of walls, hanging from the bamboo structure, granting light control and visual privacy.

7. *Kitchen* - An area consisting of kitchen, storage, refrigerating room and staff toilette. Able to host small cooking workshops as well. Mechanical ventilation has been integrated therefore the window openings are closed by the glass. Accessibility to the storage is concealed to the amphitheater thanks to a thin green barrier placed in front of the opening door.

8. *Event room* - two connected rooms, that can be separated if needed and are designed to host private and public events. The enclosures are in fabric, creating a relaxing atmosphere with diffuse light, easily manually regulated and opened to the view on the outdoor park or the central square; connected are the toilette, shared with the auditorium with a pleasant buffer zone in the front.

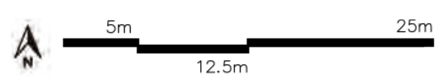
9. *Auditorium* - covered open space for events such as speeches, celebrations, and movies. The western side is sheltered by the two storages volume, one for the event room and the other for the auditorium, also acting as a projection wall and a stage background, while the eastern side is sheltered by the bamboo forest growing right next to the building.



Ill.137 - Buildings plans scale 1:500

LEGENDA:

a. toilette
b. lobby
c. office
d. art workshop
e. wood workshop
f. storage
g. changing room
h. technical room
i. cafè
j. IT room
k. study room
l. play room
m. kitchen
n. event room
o. auditorium



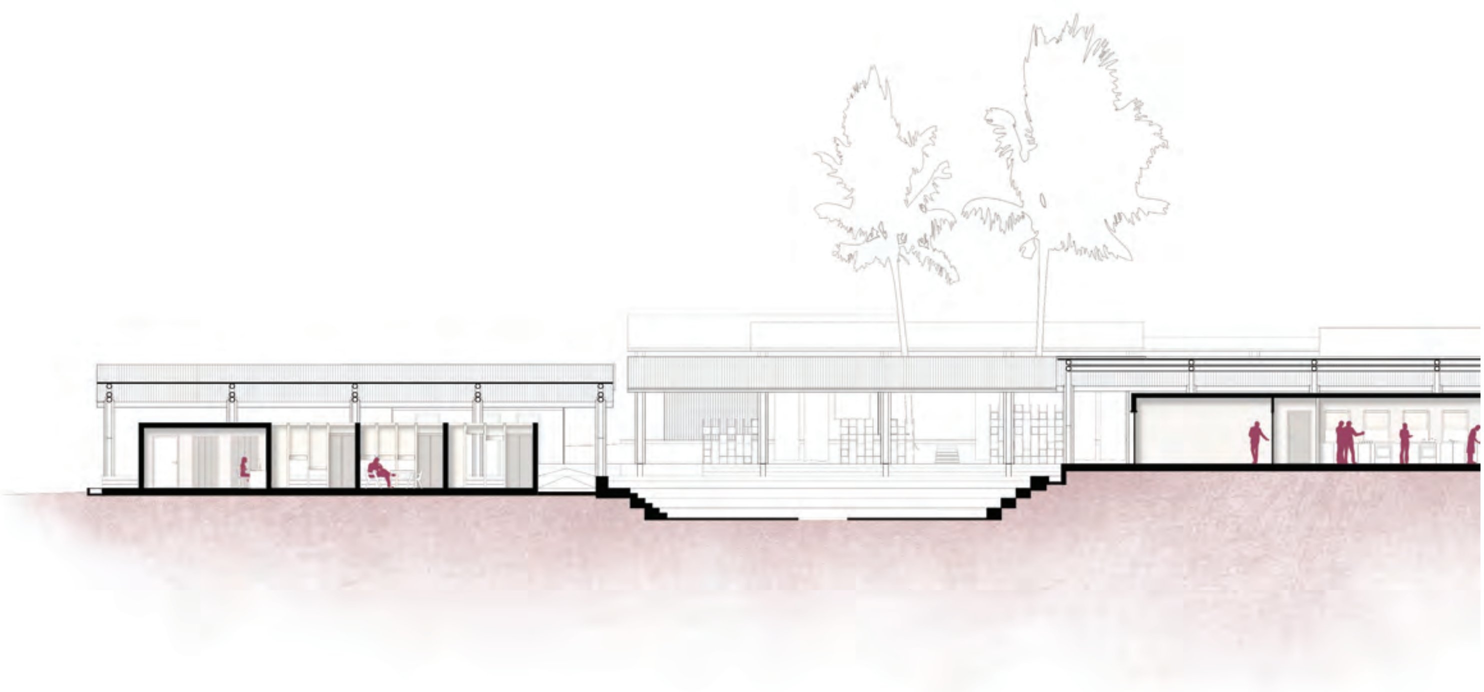
Ill.138 - Auditorium (i)

Ill.139 - Cafè (h)

Ill.140 - Night view ideas factory (g)

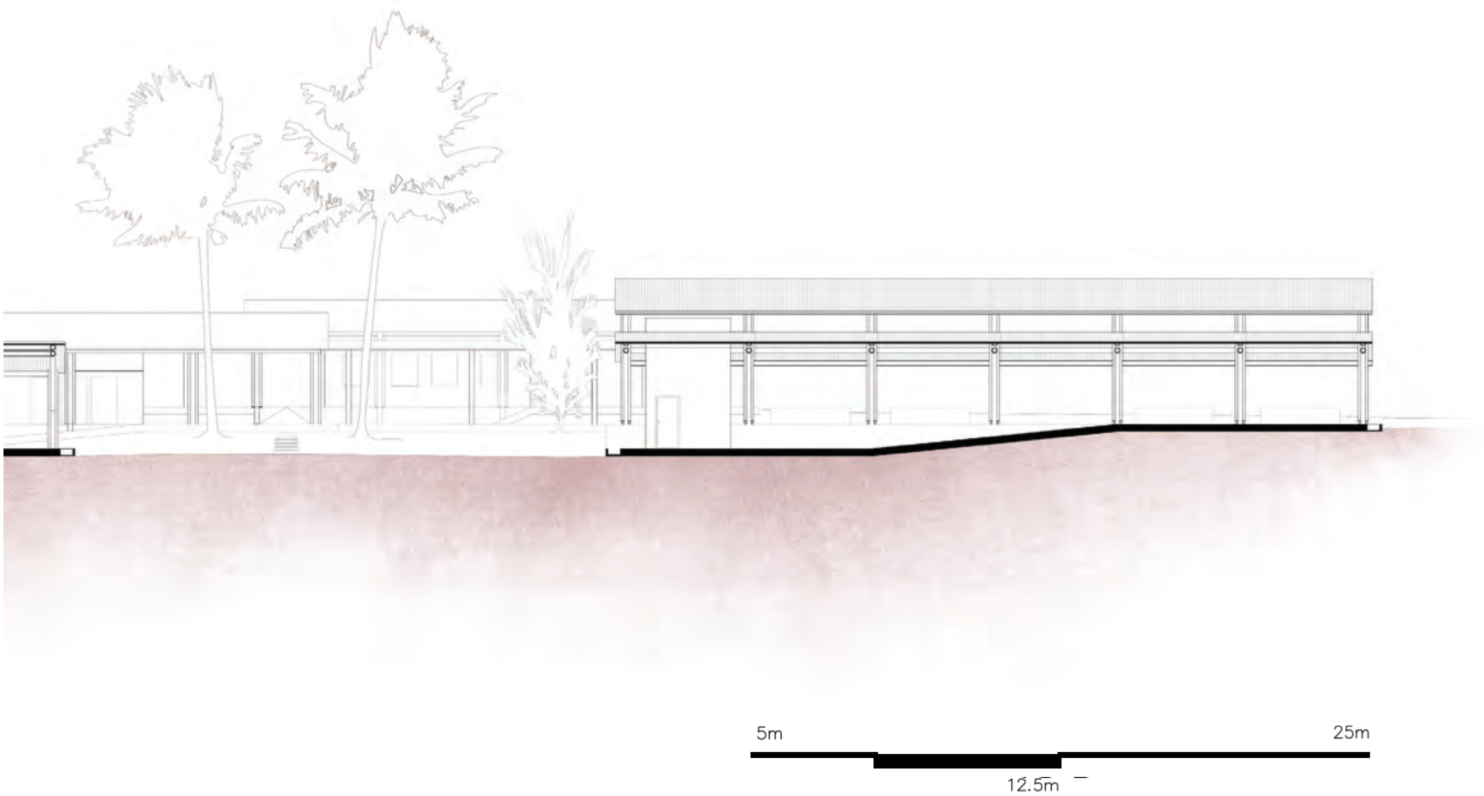
ELEVATIONS & SECTIONS

Ill.141 - South elevation

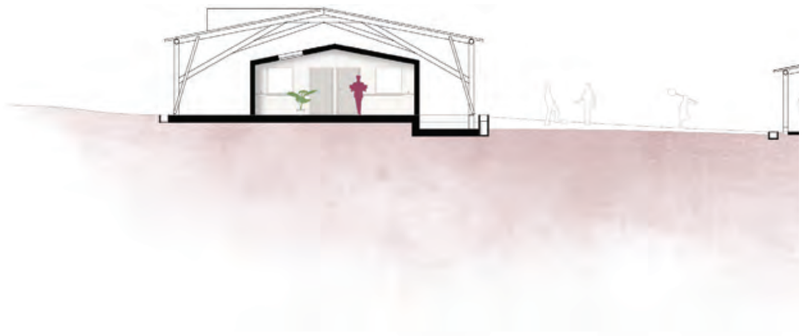


Ill.142 - Section AA


B
A
A
B

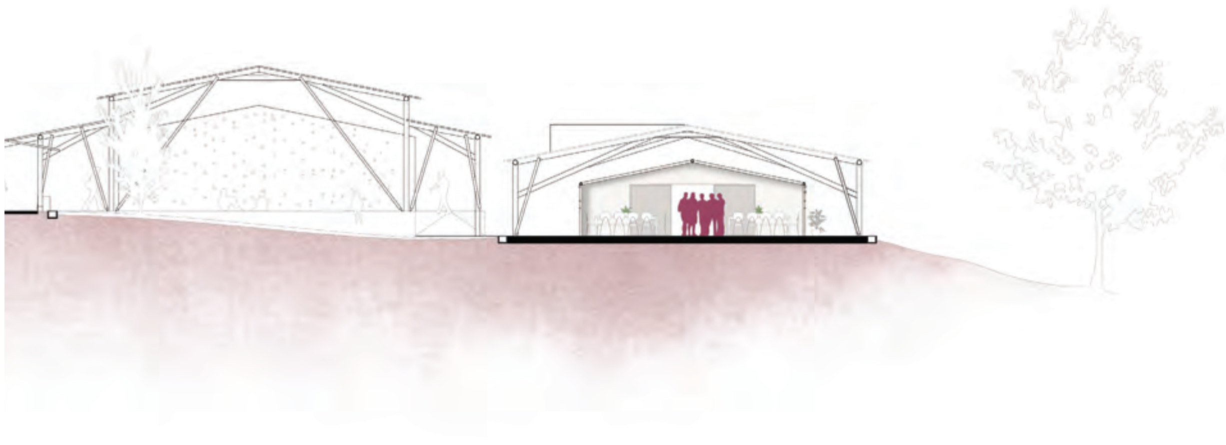

5m
25m
12.5m

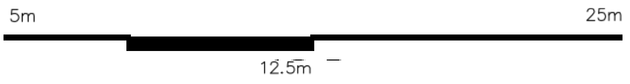
Ill.143 - West elevation



Ill.144 - Section BB


B
A
A
B

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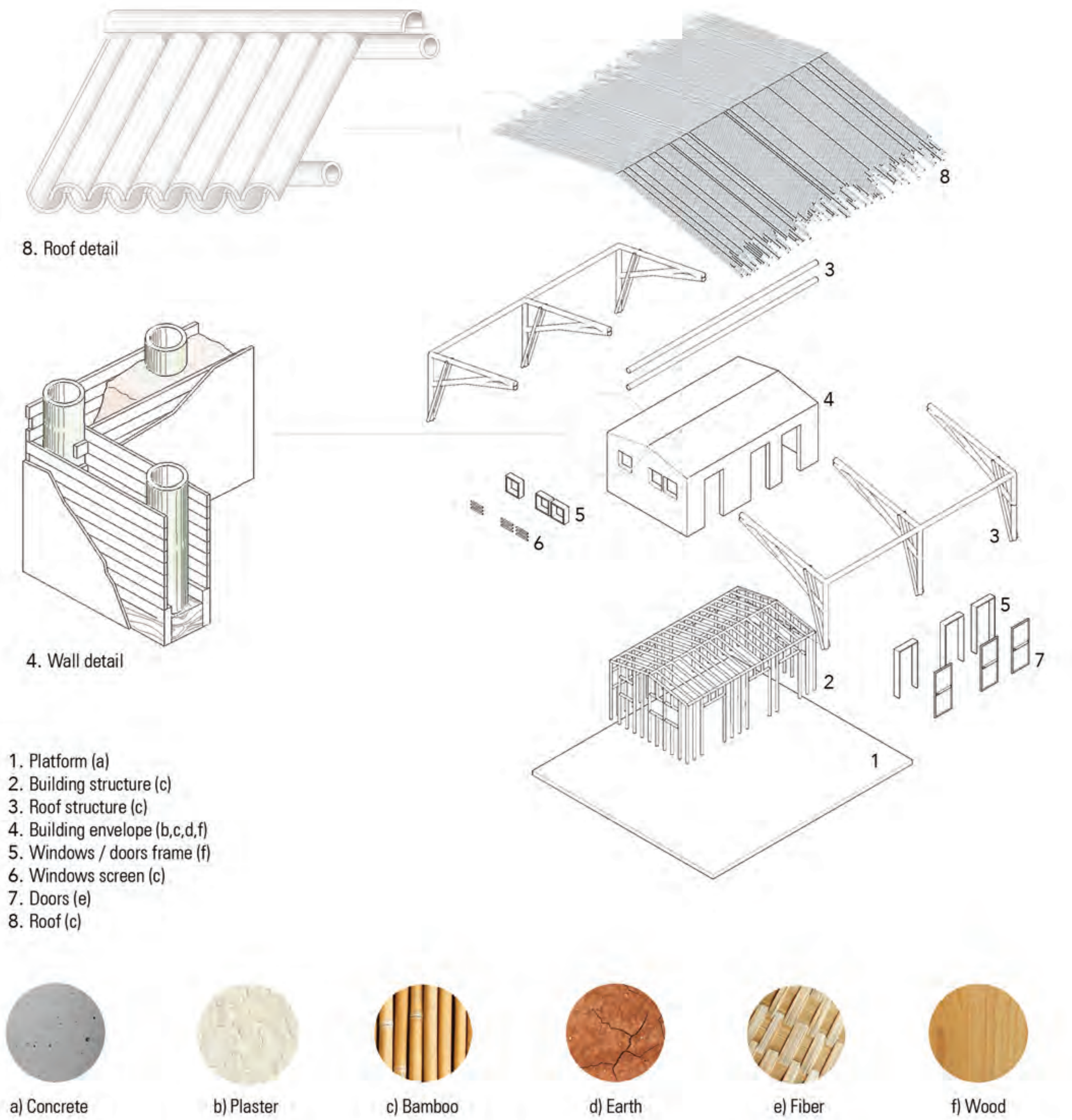
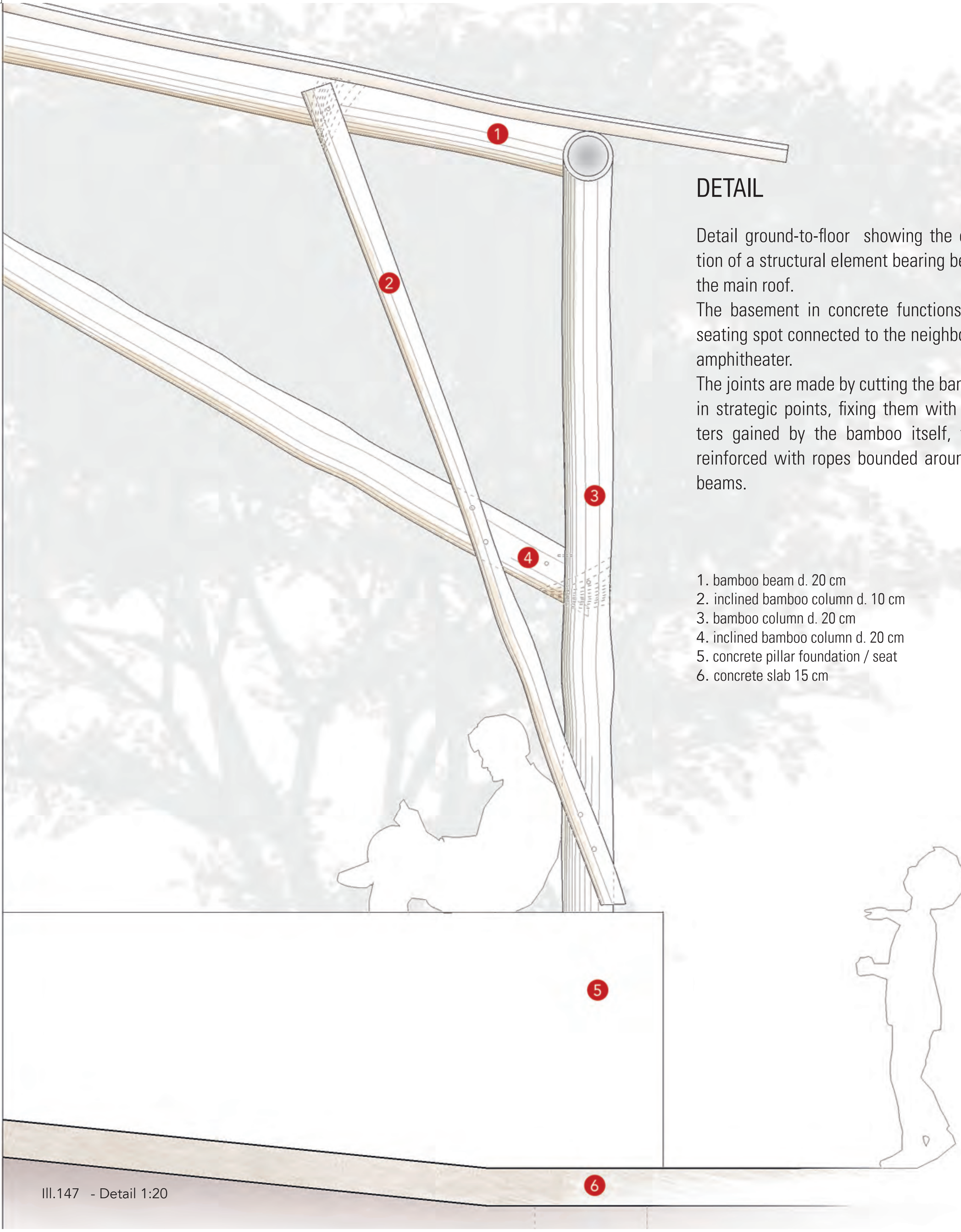
Ill.145 - Structure detail from the anphitheater

STRUCTURE & MATERIALS DETAIL



Ill.146 - Structure and materials detail



Ill.147 - Detail 1:20

DETAIL

Detail ground-to-floor showing the evolution of a structural element bearing bearing the main roof.
The basement in concrete functions as a seating spot connected to the neighbouring amphitheater.
The joints are made by cutting the bamboos in strategic points, fixing them with splinters gained by the bamboo itself, finally reinforced with ropes bounded around the beams.

1. bamboo beam d. 20 cm
2. inclined bamboo column d. 10 cm
3. bamboo column d. 20 cm
4. inclined bamboo column d. 20 cm
5. concrete pillar foundation / seat
6. concrete slab 15 cm

Ill.148 - Day bird view of the buildings complex

CONCLUSION

How to create an evolving architecture that promotes sustainable development and responds to the need of changing actors through time?

To answer this contemporary question we rediscovered traditions and simple materials, addressing a holistic concept of sustainability, which goes beyond the limits imposed by the singular disciplines.

The presented architecture has its roots in the social, political and cultural conflicts of Buenos Aires; problematics that shaped program and methodology with the aim of forging an intimate bond between population and construction through the honest and direct use of materials. Thanks to the mutual attachment created between users and space, the center becomes an integrated part of the community, a virtuous element born from it, that would grow, together with the inhabitants of Buenos Aires.

An architecture which shapes and is shaped by people, guiding them towards the rediscovery of their traditions, always with a look towards the future by responding to the current and evolving needs of the community.

As a living being in its gestation period, we believe the preparation and construction of this project are steps crucial to the success and integration of the center in the community; this process requires time and active participation from every individual, but with the hope of yielding revolutionary results.

In fact, the whole design process includes the locals in each stage of the life of the center; from the designing and building workshops to its construction, expansion, and dismantling, raising the feeling of ownership in the users.

Besides its social aspects, sustainability has also been addressed in terms of materials, economy and energy consumption; locally available and natural materials were favored, and a specific bioclimatic design has been studied to better respond to the microclimate of the site.

The results obtained are only a starting point for much broader research that needs to be insistently persecuted and addressed by officials and individuals, especially considering the environmental and social problematics faced nowadays by a generation that is willingly ignoring them.

REFLECTION

The nature of this project has been evolving since it first started taking shape into our minds: what to do and for who? How and when?

The site and clients were identified after visiting the area, experiencing its problematics, meeting the population and getting personally involved with the community and its development. Therefore, it was apparent that any possible solution can never be prioritized to its present needs on the future ones.

This dualism added a certain complexity to the program formulation and led us to try getting even deeper into the population's culture, speculating on how it would eventually evolve from the current situation.

How to address casual and daily driven development, with the different opinions about it? . The help from different theoreticians and the sporadic contribution of the local municipality were greatly beneficial in shaping our ideas forming the design.

Indeed the culture difference between the locals and us has proved to be a test when trying to define the needs and a defined program for the project.

Due to the choice of materials, uncommon in areas with higher latitudes, the lack of related scientific studies, and the broad approach we adopted on sustainability, both energy, and structural studies were proven in the calculations.

Evaluating the performance of the designed buildings has been challenging on many levels, due to the lack of data and the different climate conditions compared to the Danish ones. However, several studied measures and estimations were taken based on our references, when none better could be found. Such data were shaped based on a personal four months experience in Costa Rica, in contact with local people, expertise, and professors.

Renewable resources were only partially included in the project for different reasons:

the limited efficiency of strategies like solar panels due to the extreme climate conditions

the complexity of handling such a technology the prohibitive cost, unsuitable for this kind of low-cost participatory intervention

Water collection tanks were implemented, but a more in-depth study on their capacity and water consumption would be necessary to quantify specific areas and costs

With more time we would have wanted to deepen multiple aspect faced in the thesis, especially the technical studies, through tools more suitable for these tropical areas.

Besides the problematics faced we had a great chance to discover about alternative architectures and cultures; learning how to overcome challenges not usually faced in an academic environment and experiencing the PBL (Problem Based Learning) method to its maximum extent.

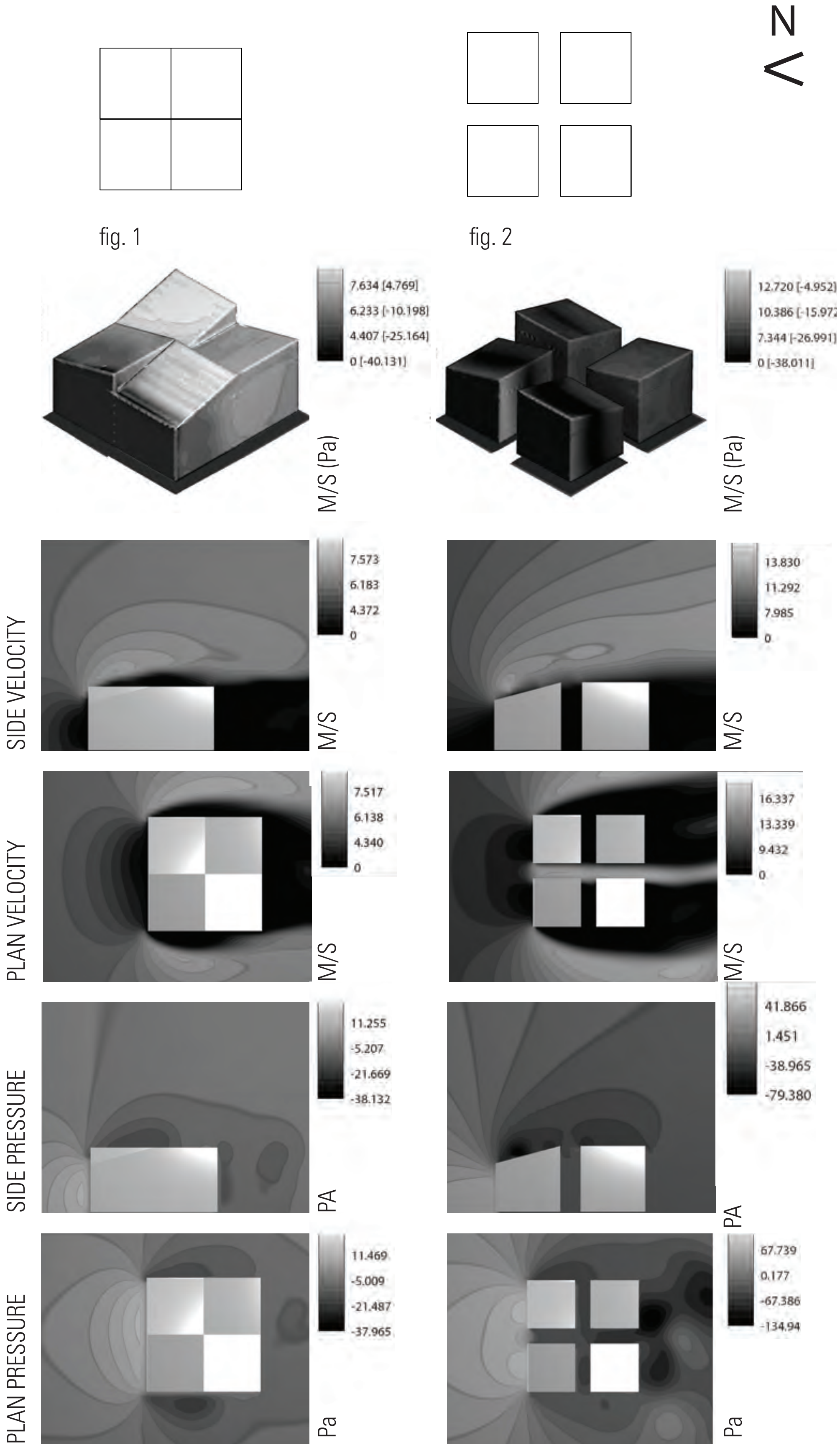
ACKNOWLEDGEMENTS

This thesis would not have been possible without having been through our past adventures, accompanied by the beloved people surrounding us.
Therefore we would like to thank our families, friends, and professors for inspiring, supporting and guiding us all the way through, until this page, today.

06
ANNEX

WIND FLOW ANALYSIS

The wind simulation was done on simple clusters of blokcs in order to to measure how, different distributions of volumes across the site, affect the wind flow. For better air circulation functions where detached from each other, creating narrow corridors that would increase the wind speeds along the wind direction (fig 2), a wider detachement would allow more ventilation to reach the second row of buildings but with a lower pressure, enabling them to disperd more heat (fig 3). However, wind movement is still needed against the southern facades due to their solar exposure, shifting the buildings led to an increased suction along the sides of each unit (fig 4) while keeping the flow at normal speeds in between. This last iteration therfore was chosen as optimal.



Ill.1. windflow simulation

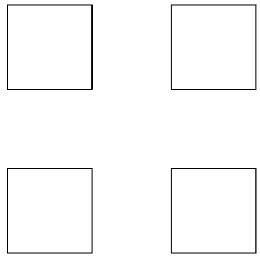


fig. 3

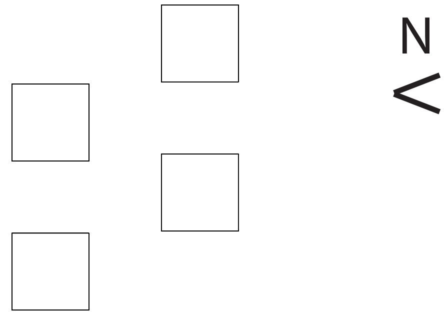
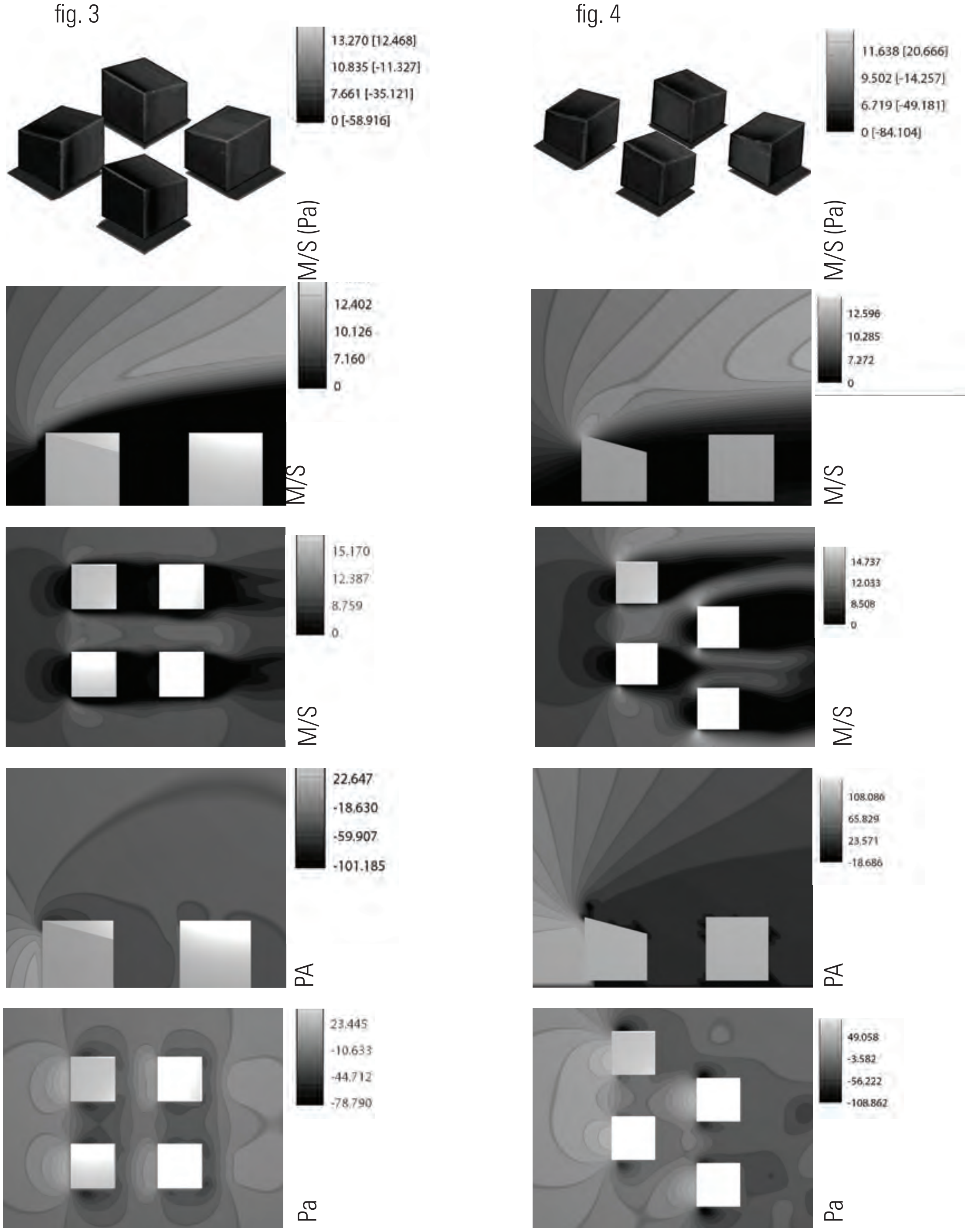


fig. 4



Ill.2. Windflow simulation

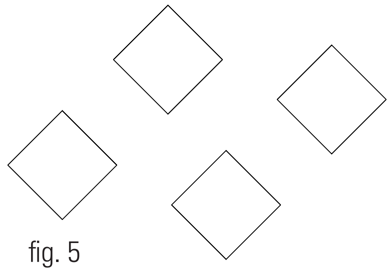


fig. 5

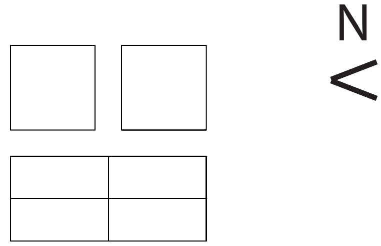
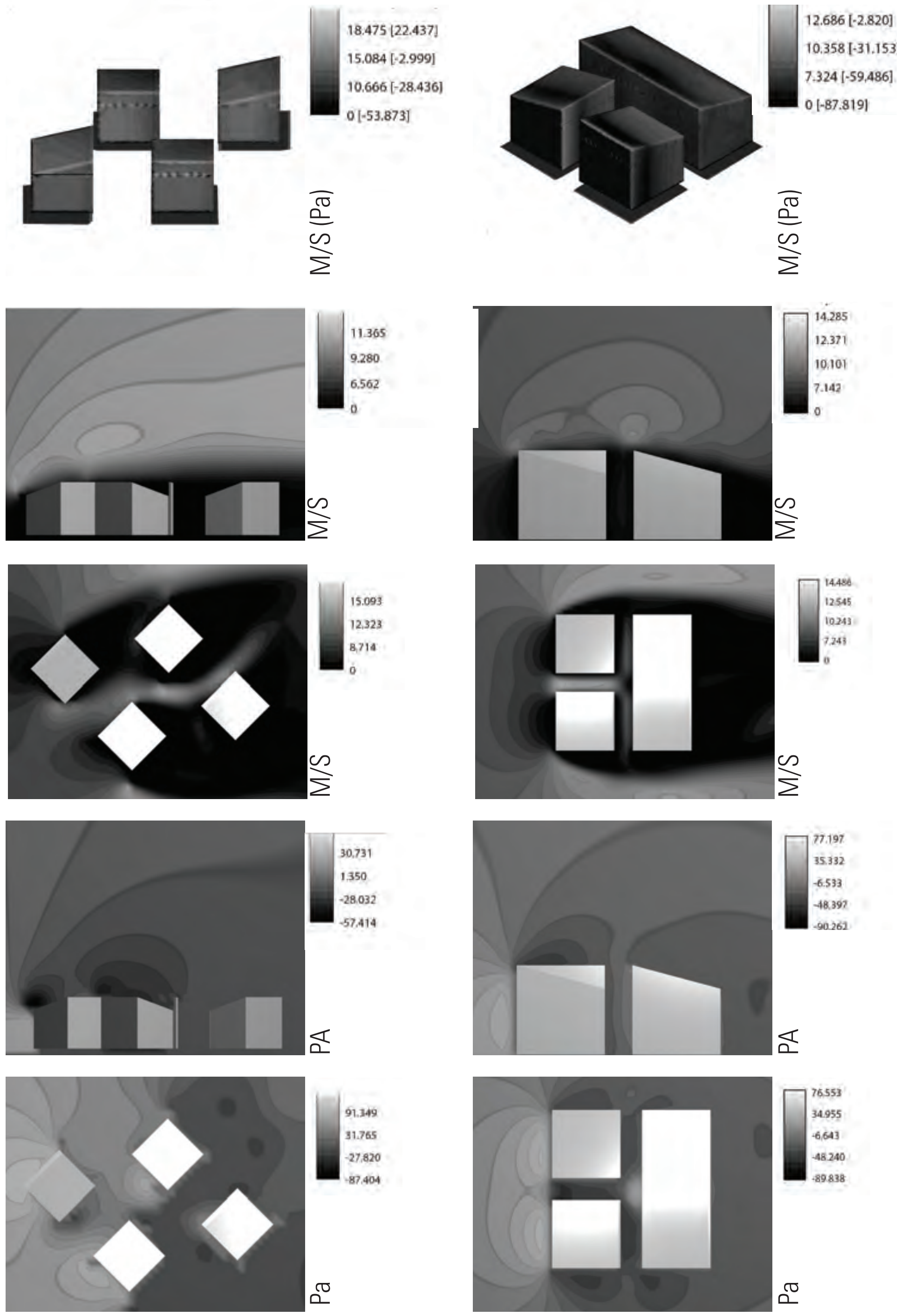


fig. 6



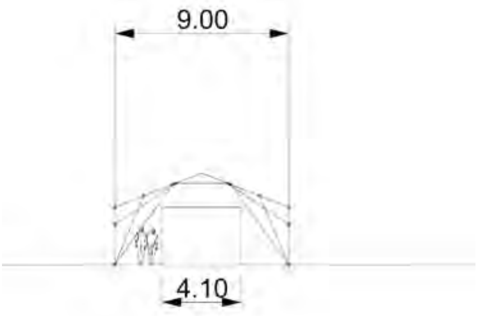
Ill.3. Windflow simulation

STRUCTURAL ANALYSIS

The structure was simulated through the use of grasshopper and karamaba plugins, trough the variation of different parameters including:
- distance between the columns base points;
- number of columns at each base and their location in connection with other members;
- the height of different keypoints of the structure and the difference between the two roofs;
- roof angle;
- member diameter;
- roof thickness;
- spacing between trusses;

Automated mass trials were done to find the optimum structure shape that fits the desired space and fall within the maximum displacement of beams L/240. Based on the relation strength/unit weight (bamboo vs steel), the tensile strength of bamboo is 3- 4 times the one of steel (GRIFFIS, 2003); thus the equation of displacement was taken from the servicability limit of steel design standards form (AISC 2003) followed in Costa Rica for steel structures.

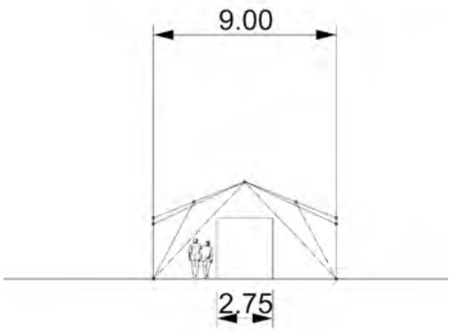
The structural variations were made with different variables, trying to reduce the amount of different beams. Similar members of bamboo, with a 20 cm diameter, were used for most members to reduce the complexity. The wind load calculation was calculated for the auditorium (18 x 25) and one of the medium structures (12 x 20).



Maximum displacement L/260 = 0.7 cm

Member diameter

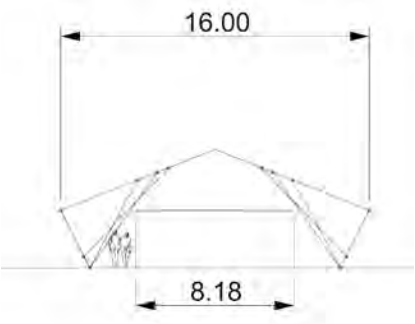
Columns 10 cm
Beamsn 12 cm
Horizantal bean=ms 12 cm



Maximum displacement L/260 = 0.9 cm

Member diameter

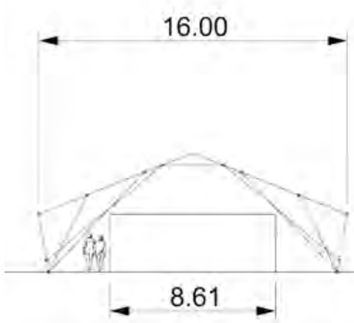
Columns 10 cm
Beamsn 10 cm
Horizantal bean=ms 10 cm



Maximum displacement = 1.9 cm

Member diameter

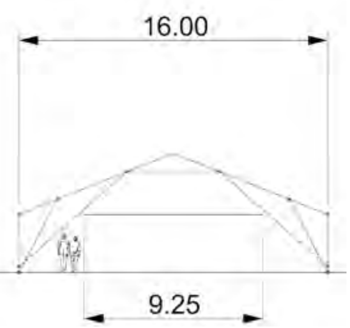
Columns 10 cm
Beamsn 9 cm
Horizantal bean=ms 13 cm



Maximum displacement = 1.2 cm

Member diameter

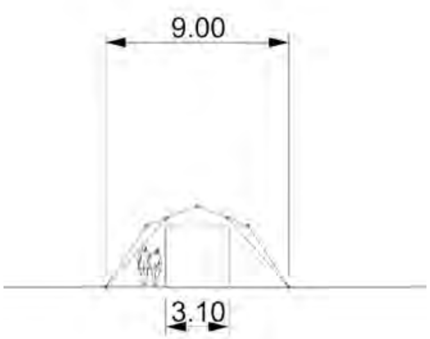
Columns 10 cm
Beamsn 11 cm
Horizantal bean=ms 11 cm



Maximum displacement = 1.2 cm

Member diameter

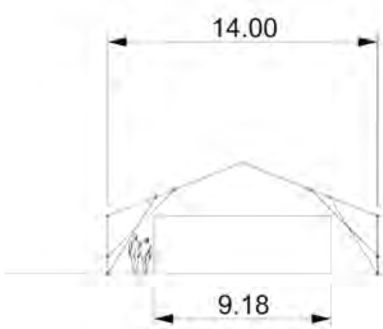
Columns 10 cm
Beamsn 12 cm
Horizantal bean=ms 11 cm



Maximum displacement = 0.4 cm

Member diameter

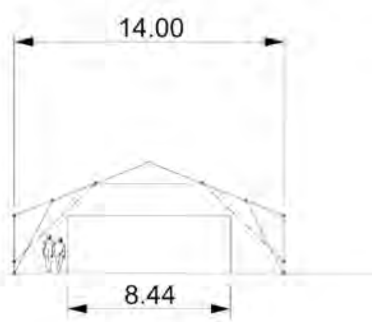
Columns 10 cm
Beamsn 10 cm
Horizantal bean=ms 15 cm



Maximum displacement = 3.1 cm

Member diameter

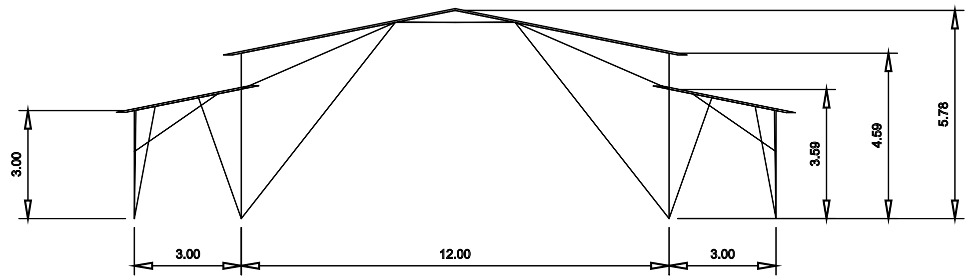
Columns 10 cm
Beamsn 12 cm
Horizantal bean=ms 11 cm

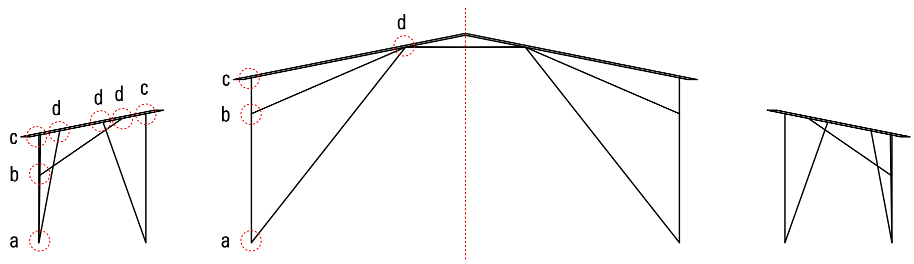


Maximum displacement = 3.4 cm

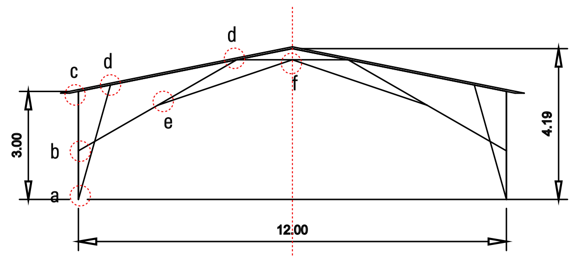
Member diameter

Columns 9 cm
Beamsn 12 cm
Horizantal beanms 11 cm





structure 2 structure 1 structure 2



structure 3

Parametric Variables:

a.location of column base point across the x axis the distance between column base points and the number of columns.
b.location of tilted beam joint across the z axis
c.location of roof connection across the x and z axis and roof angle
d.location of column roof joint across the top beam
e. location of tilted beam joint across connected member
f. location of tilted beam joint across the horizantal beam
g. truss spacing interval
h. member diameter in categories; column , tilted beams, horizantal beams.
i. roof cover bamboo diameter

Ill.4. Structural diagram

Structure 1

Type of structure : DUOPITCH CANOPY
Length d= 25000 mm
Width b = 12000 mm
Height of structure h = 6600 mm
Structural spacing ss= 5000 mm

Structure 2

Type of structure : MONOPITCH CANOPY
Length d= 25000 mm
Width b = 3000 mm
Height of structure h = 4100 mm
Structural spacing ss= 5000 mm

Basic wind velocity vb.o = 7 m.s
Season factor cseason = 1.0
directional factor cdir = 1.0
Basic wind velocity vb.o . cseason . cdir = 7M/S

Density of air p:=1.25 kg.m-3
Refrence mean velocity pressure qb=0.61 . v2 = 29.89 N / m2
Orthography factor Co 1.0

Terrain category		z_0 m	z_{min} m
0	Sea or coastal area exposed to the open sea	0,003	1
I	Lakes or flat and horizontal area with negligible vegetation and without obstacles	0,01	1
II	Area with low vegetation such as grass and isolated obstacles (trees, buildings) with separations of at least 20 obstacle heights	0,05	2
III	Area with regular cover of vegetation or buildings or with isolated obstacles with separations of maximum 20 obstacle heights (such as villages, suburban terrain, permanent forest)	0,3	5
IV	Area in which at least 15 % of the surface is covered with buildings and their average height exceeds 15 m	1,0	10
NOTE: The terrain categories are illustrated in A.1.			

Ill.5. Terrain categories EN 1991-1-4:2005

Roughness length z0	z0 = 0.05 m (II) = 50 mm
Roughness length zmin	zmin = 2 m (II) = 2000 mm

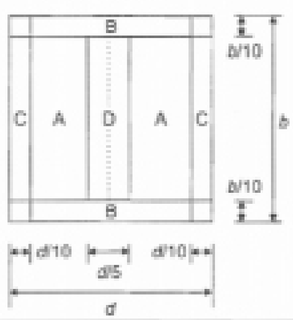
Peak wind velocity pressure

Refrence height	ze = height of midpoint at surface = 6.575/ 3.5
Velocity pressure exposure coefficient	Kz= 0.85 (0-4.6 m) / 0.9 (7.1 m)
Maximum height	zmax = 200 m
Factor Z0,II	Z0,II = 50 mm
Terrain factor	Kr = 0.19 . (z0 /z0.II .)0.07 = 1
Roughness factor	Cr = Kr . In (zmin/z0) = 3.68
Mean wind velocity	vm = cr . co . vb = 3.68 . 1 . 7= 25.76 m.s
Turbulance factor	KI = 1.0
Turbilance intensity	Iv = KI / co . In (zmin / zO) = 0.271
peak velocity pressure	qp = (1+ 7. Iv) . qb . Kz= 86.745 N.m2 . Kz

Table 7.7 — $c_{p,net}$ and c_f values for duopitch canopies

Net pressure coefficients $c_{p,net}$

Key plan



Roof angle α [°]	Blockage φ	Overall Force Coefficient c_f	Zone A	Zone B	Zone C	Zone D
+ 10	Maximum all φ	+ 0,4	+ 0,7	+ 1,8	+ 1,4	+ 0,4
	Minimum φ = 0	- 0,7	- 0,7	- 1,5	- 1,4	- 1,4
	Minimum φ = 1	- 1,3	- 1,3	- 2,0	- 1,8	- 1,8

Ill.6. Net pressure coefficient EN 1991-1-4:2005

Wind pressure for module at 10 degrees

Wind suction - upward acting action

External pressure coefficient for zone A cp.net.A.up.10 = - 0.7

Wind pressure for zone A we.A.up.10 = qp. Kz . cp.net.A.up.10= - 54.648 N.m2

External pressure coefficient for zone B cp.net.B.up.10 = -1.5

Wind pressure for zone B we.B.up.10 = qp. Kz . cp.net.B.up.10= -117.09 N.m2

External pressure coefficient for zone D cp.net.D.up.10 = -1.4

Wind pressure for zone D we.D.up.10 = qp . Kz. cp.net.D.up.10= - 109.3 N.m2

Wind suction - downward acting action

External pressure coefficient for zone A cp.net.A.do.10 = +0.7

Wind pressure for zone A we.A.do.10 = qp. Kz . cp.net.A.do.10= + 54.64 N.m2

External pressure coefficient for zone B cp.net.B.do.10 = +1.8

Wind pressure for zone B we.B.do.10 = qp. Kz . cp.net.B.do.10= +140.5 N.m2

External pressure coefficient for zone D cp.net.D.do.10 = +0.4

Wind pressure for zone D we.D.do.10 = qp. Kz . cp.net.D.do.10= +32.1 N.m2

Wind loads for module at 10 degrees

Overall factor coefficient for upward wind action cf.up.10 = - 0.7
Overall factor coefficient for downward wind action cf.do.10 = + 0.4

Effective area between supports Aref.mid = b. Ss = 12 . 5 = 60 m2
Effective area of edged supports Aref.edg = Aref.mid /2 = 30 m2

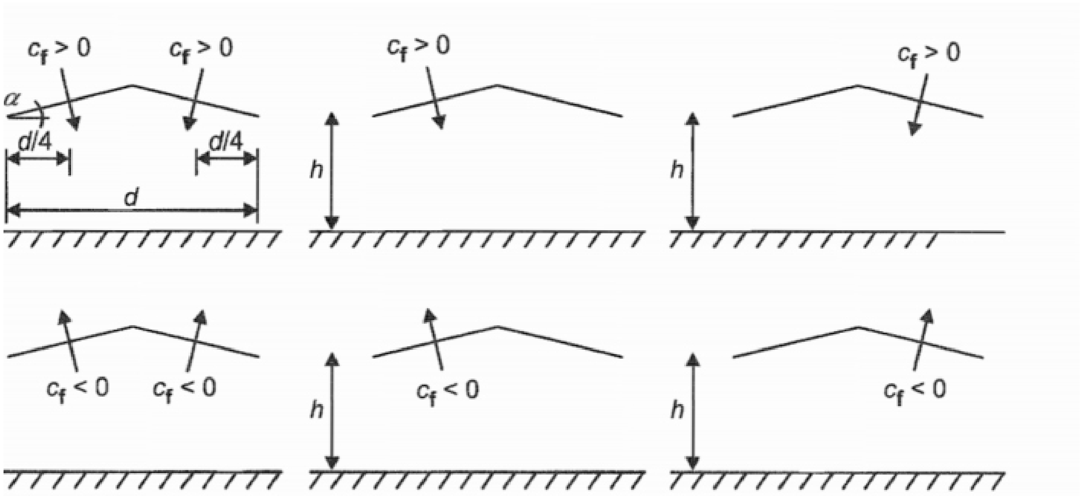
Downward acting wind force at edge of frame
Fw.ed.do.10 = cs.d . cf.do .. qp . Kz. Aref.edg = 1 . 0.4 . 86.745 . 0.9 . 30= 936.8 N.m2

Downward acting wind force at middle of frame
Fw.mid.do.10 = cs.d . cf.do .. qp. Kz . Aref.mid = 1 . 0.4 . 86.745 . 0.9 .60 = 1873 N.m2

Upward acting wind force at edge of frame
Fw.ed.up.10 = cs.d . cf.do .. qp. Kz . Aref.edg = 1 . -0.7 . 86.745 . 0.9 .30= - 1639 N.m2

Upward acting wind force at middle of frame
Fw.mid.up.10 = cs.d . cf.do .. qp. Kz . Aref.mid = 1 . - 0.7 . 86.745 . 0.9 . 60 = - 3278 N.m2

Resultant = -3278 -1873 = 1405 N.m2
Location of force = d/4 = 12/4 = 3 m



Ill.7. Arrangements of loads obtained from force coefficients for duopitch canopies EN 1991-1-4:2005

Structure 2

Wind pressure for module at 10 degrees

Wind suction - upward acting action

External pressure coefficient for zone A cp.net.A.up.10 = - 1.5

Wind pressure for zone A we.A.up.10 = qp. Kz . cp.net.A.up.10= - 110.5 N.m2

External pressure coefficient for zone B cp.net.B.up.10 = -2.0

Wind pressure for zone B we.B.up.10 = qp. Kz . cp.net.B.up.10= -147.4 N.m2

Wind suction - downward acting action

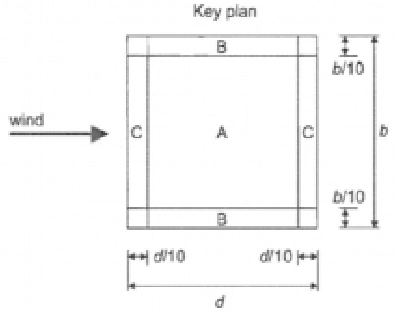
External pressure coefficient for zone A cp.net.A.do.10 = +1.2

Wind pressure for zone A we.A.do.10 = qp. Kz . cp.net.A.do.10= + 88 N.m2

Table 7.6 — $c_{p,net}$ and c_f values for monopitch canopies

Net Pressure coefficients $c_{p,net}$

Key plan



Roof angle α	Blockage φ	Overall Force Coefficients c_f	Zone A	Zone B	Zone C
10°	Maximum all φ	+ 0,5	+ 1,2	+ 2,4	+ 1,6
	Minimum φ = 0	- 0,9	- 1,5	- 2,0	- 2,1
	Minimum φ = 1	- 1,4	AC2 - 1,6 AC2	- 2,6	- 2,7

EN 1991-1-4:2005

Ill.8. Net pressure coefficients EN 1991-1-4:2005

External pressure coefficient for zone B cp.net.B.do.10 = +2.4

Wind pressure for zone B we.B.do.10 = qp . Kz. cp.net.B.do.10= +176.8 N.m2

Wind loads for module at 10 degrees

Overall factor coefficient for upward wind action cf.up.10 = - 0.9
Overall factor coefficient for downward wind action cf.do.10 = + 0.5

Effective area between supports Aref.mid = b. Ss = 3 . 5 = 15 m2
Effective area of edged supports Aref.edg = Aref.mid /2 = 7.5 m2

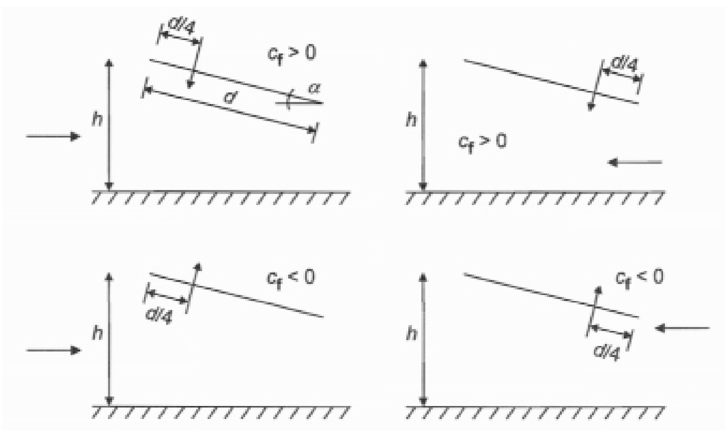
Downward acting wind force at edge of frame
Fw.ed.do.10 = cs.d . cf.do .. qp. Kz . Aref.edg = 1 . 0.5 . 86.745 . 0.85 . 7.5= 276.5 N.m2

Downward acting wind force at middle of frame
Fw.mid.do.10 = cs.d . cf.do .. qp. Kz . Aref.mid = 1 . 0.5 . 86.745 . 0.85 . 15 = 553 N.m2

Upward acting wind force at edge of frame
Fw.ed.up.10 = cs.d . cf.do .. qp . Kz. Aref.edg = 1 . -0.9 . 86.745 . 0.85 . 7.5= - 497.7 N.m2

Upward acting wind force at middle of frame
Fw.mid.up.10 = cs.d . cf.do .. qp . Kz. Aref.mid = 1 . - 0.7 . 86.745 . 0.85 . 15 = - 774 N.m2

Resultant = -774 -553 = 221 N.m2
Location of force = d/4 = 3/4 = 0.75 m



Ill.9. Location of the centre of force for monopitch canopies EN1991-1-4:2005

Structure 3

Wind pressure for module at 10 degrees

Wind suction - upward acting action

External pressure coefficient for zone A cp.net.A.up.10 = - 0.7

Wind pressure for zone A we.A.up.10 = qp. Kz . cp.net.A.up.10= - 54.648 N.m2

External pressure coefficient for zone B cp.net.B.up.10 = -1.5

Wind pressure for zone B we.B.up.10 = qp. Kz . cp.net.B.up.10= -117.09 N.m2

External pressure coefficient for zone D cp.net.D.up.10 = -1.4

Wind pressure for zone D we.D.up.10 = qp . Kz. cp.net.D.up.10= - 109.3 N.m2

Wind suction - downward acting action

External pressure coefficient for zone A cp.net.A.do.10 = +0.7

Wind pressure for zone A we.A.do.10 = qp. Kz . cp.net.A.do.10= + 54.64 N.m2

External pressure coefficient for zone B cp.net.B.do.10 = +1.8

Wind pressure for zone B we.B.do.10 = qp. Kz . cp.net.B.do.10= +140.5 N.m2

External pressure coefficient for zone D cp.net.D.do.10 = +0.4

Wind pressure for zone D we.D.do.10 = qp. Kz . cp.net.D.do.10= +32.1 N.m2

Wind loads for module at 10 degrees

Overall factor coefficient for upward wind action cf.up.10 = - 0.7
Overall factor coefficient for downward wind action cf.do.10 = + 0.4

Effective area between supports Aref.mid = b. Ss = 12 . 5 = 60 m2
Effective area of edged supports Aref.edg = Aref.mid /2 = 30 m2

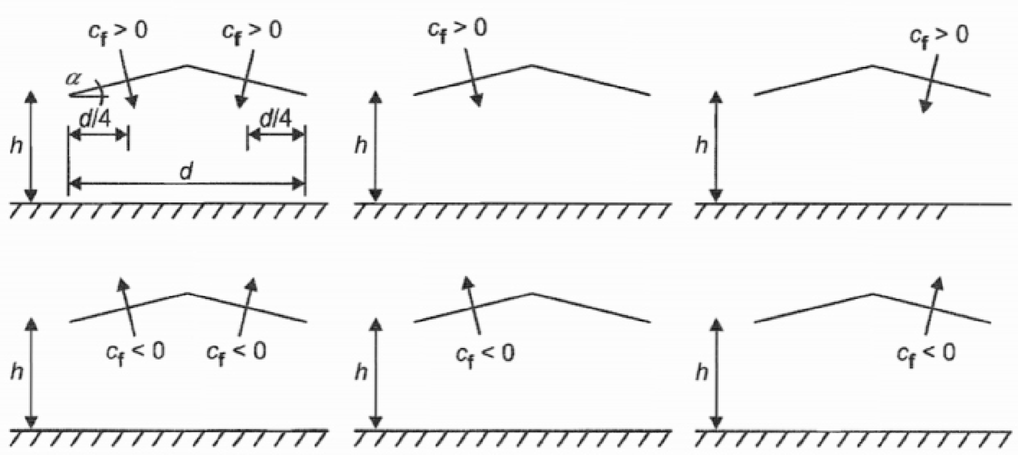
Downward acting wind force at edge of frame
Fw.ed.do.10 = cs.d . cf.do .. qp . Kz. Aref.edg = 1 . 0.4 . 86.745 . 0.85 . 30= 884.8 N.m2

Downward acting wind force at middle of frame
Fw.mid.do.10 = cs.d . cf.do .. qp. Kz . Aref.mid = 1 . 0.4 . 86.745 . 0.85 .60 = 1769.6N.m2

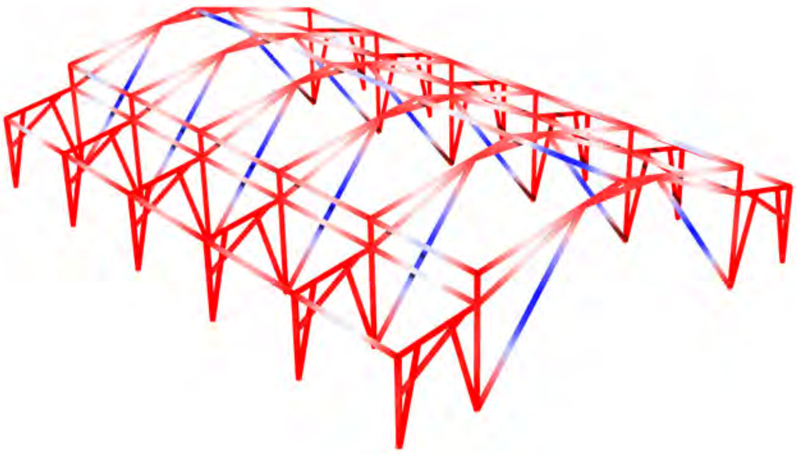
Upward acting wind force at edge of frame
Fw.ed.up.10 = cs.d . cf.do .. qp. Kz . Aref.edg = 1 . -0.7 . 86.745 . 0.85 .30= - 1548.4 N.m2

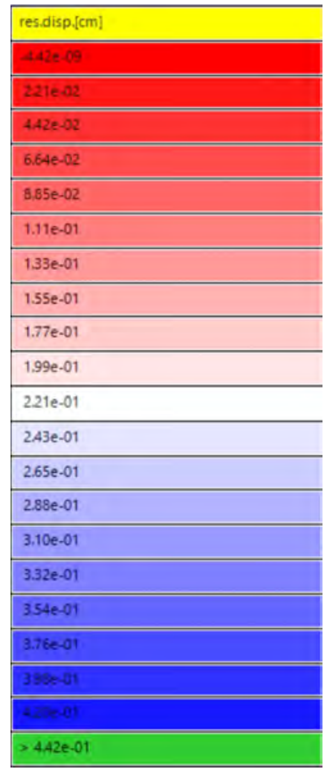
Upward acting wind force at middle of frame
Fw.mid.up.10 = cs.d . cf.do .. qp. Kz . Aref.mid = 1 . - 0.7 . 86.745 . 0.85 . 60 = - 3096 N.m2

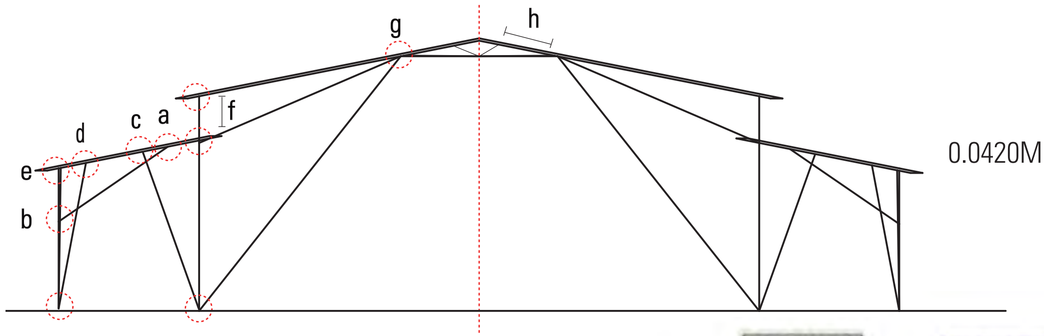
Resultant = -3096 -1769.6 = 1327.2 N.m2
Location of force = d/4 = 12/4 = 3 m

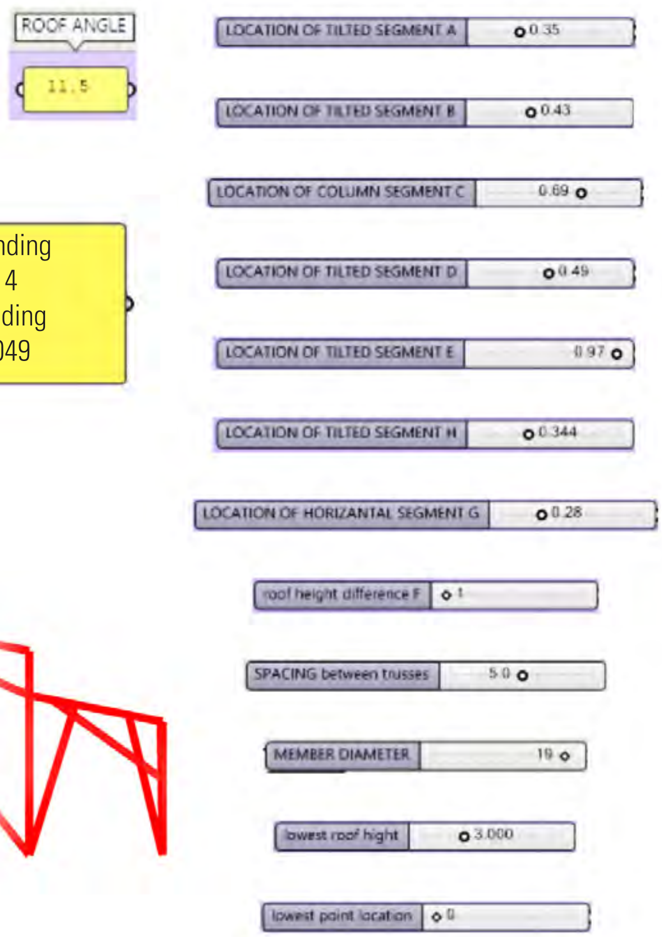


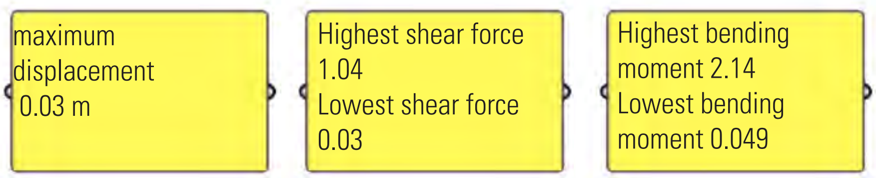
Ill.10. Arrangements of loads obtained from force coefficients for duopitch canopies EN1991-1-4:2005

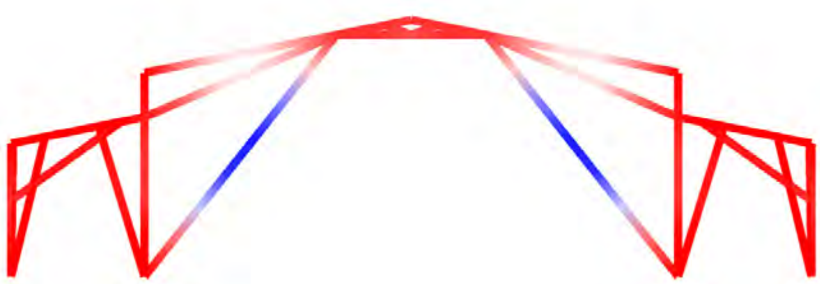




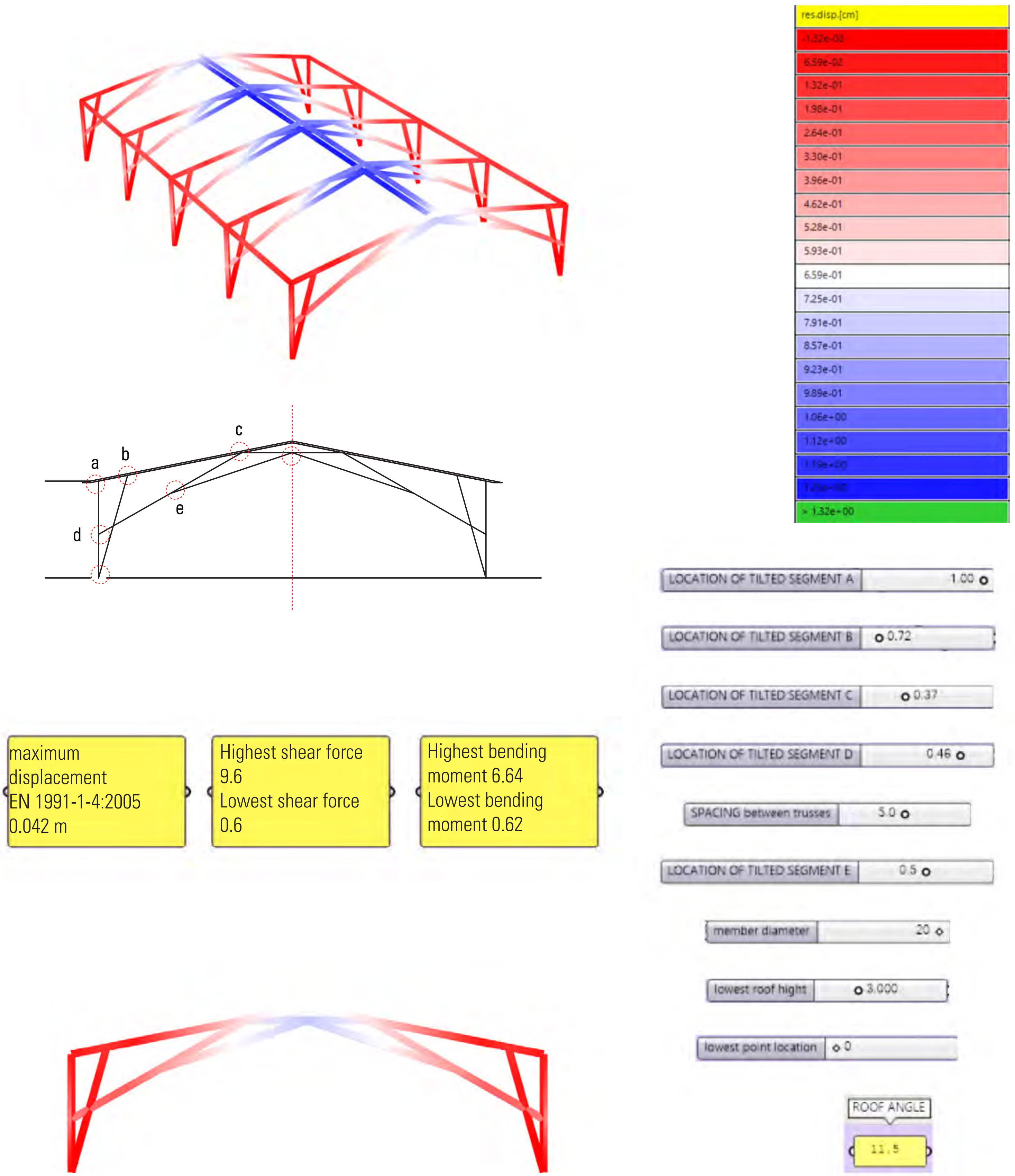








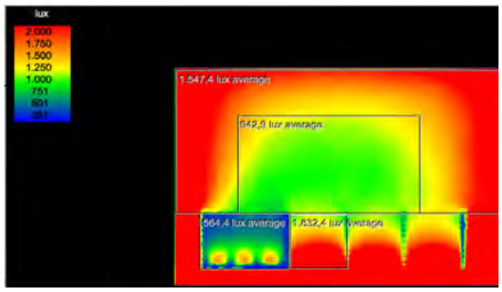
Ill.11. maximum displacement graph



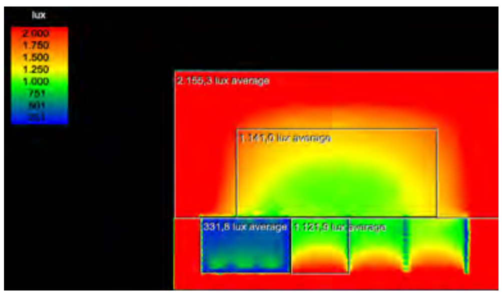
Ill.12. maximum displacement graph

LIGHT ANALYSIS

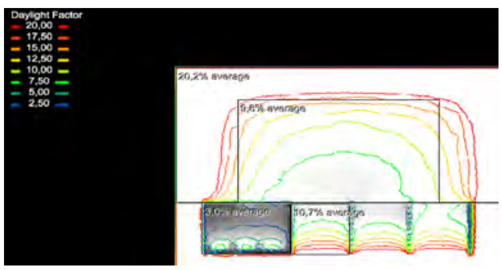
The light quality was tested in most of the buildings throughout different iterations; Rhino, SketchUp and Velux daylight visualizer were used in order to construct the 3d model, assign the different materials and test the illuminance (lux) and Daylight factor (%) in the covered areas.
Light quality and atmosphere were set as a target in the early iterations and the aim was to have the most frequented spaces with an illuminance between 300-500lux and 2-5% of Daylight factor.
In the early models all the buildings had hearth walls, however the indoor quality of light was not up to the requirements, this led to the design of bigger openings and the substitution of some walls with fabric.
The reported results are the maximum obtainable at 12:00 in the day on the 21st of December and the 21st of June, considering every opening unshaded; however the amount of light can be filtered with the shading elements applied to every door and windows.
For open space elements such as the cafe and the auditorium, a big part of the shading comes from the outdoor green elements and some indoor furnishing.
In order to improve the light amount filtering on the main platforms, the different roofs were perforated, preferably towards North.
The wall amount has been kept to a minimum since the climate is suitable for permeable materials and doesn't require any insulation.
Attached will follow the light analysis of the Ideas Factory and a table of the obtained results.
From the results it appears that the spaces are overly illuminated, but this is only the extreme case in which all the openable shades will be kept open; however with closed curtains, in the study room the results show a maximum illuminance of 173 lux and a Daylight factor of 1%; the whole regulations of the light depends therefore by the users's preferences.



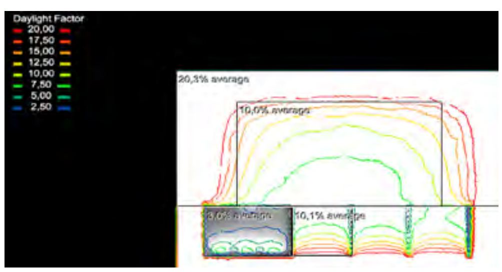
Ill.13. Illuminance December 21 at 12:00



Ill.14. Illuminance June 21 at 12:00



Ill.15. Daylight factor December 21 at 12:00



Ill.16. Daylight factor June 21 at 12:00

ENTRANCE	Light quality	Illuminance (lux)	Requirements (lux)	Daylight factor (%)	Requirements (%)
Office	Diffused light in order to allow office work but also rest to the eyes compared to the outdoor	Dec 21- 526 June21- 368	300-500	Dec 21- 3% June21- 2,6%	4%
Changing rooms	deem daylight since the area doesn't require to focus	Dec 21- 165 June21- 183	150	Dec 21- 2% June21- 1,5%	1,5%
ART & CRAFT WORKSHOP					
Office	Diffused light in order to allow office work but also rest to the eyes compared to the outdoor	Dec 21- 378 June21- 553	300-500	Dec 21- 4,6% June21- 4,5%	4%
Workshop	Diffused light strong enough to allow hands craftsmanship	Dec 21- 292 June21- 345	500	Dec 21- 3% June21- 3%	5%
WOOD WORKSHOP					
Workshop	Diffused light strong enough to allow hands craftsmanship	Dec 21- 360 June21- 380	500	Dec 21- 3,4% June21- 3,4%	5%
CAFE					
Open space	Diffused light that allows eyes-rest	Dec 21- 350 June21- 380	150	Dec 21- 3,2% June21- 3,3%	3%
EVENTS AND GATHERINGS					
event room	Diffused light that allows eyes-rest and gatherings	Dec 21- 1341 June21- 820	250	Dec 21- 7,8% June21- 7,7%	3%
AUDITORIUM					
open space	Diffused light that allows eyes-rest but also easy activities and displays	Dec 21- 215 June21- 273	100-150	Dec 21- 2,4 % June21- 2,3 %	3%
IDEAS FACTORY					
IT room	Diffused light that allows eyes-rest	Dec 21- 603 June21- 387	500	Dec 21- 3,3% June21- 3,4%	2%
study rooms	Light that enables to focus but avoid direct solar radiation	Dec 21- 1341 June21- 820	250	Dec 21- 7,8% June21- 7,7%	3%
open space	Diffused light that allows eyes-rest but also easy activities	Dec 21- 1366 June21- 1900	500	Dec 21- 18 % June21- 18 %	4%

Ill.17. Light analysis results expectations and results, requirements by INEC 2014

ENERGY SIMULATION

The grasshopper definition starts by assigning a function for both zone and program; as chose to run the simulation on the study room, the program was set to a secondary school and office function in order to include the energy radiated from electrical equipments in the calculation.
The wall construction was set to bahareque wall, with technical specifications similar to an adobe wall the specifications were set to medium-rough roughness.
The simulation is set in the hottest week of the year; the second week of may.

0.2 m thickness
1.25 W/m.k thermal conductivity
2200 kg/m3
900 j/kg.k specific heat
0.9 thermal absorption
0.6 solar absorption

The ground construction was set to concrete
0.2 m thickness
1.95 W/m.k thermal conductivity
2240 kg/m3
900 j/kg.k specific heat
0.9 thermal absorption
0.7 solar absorption

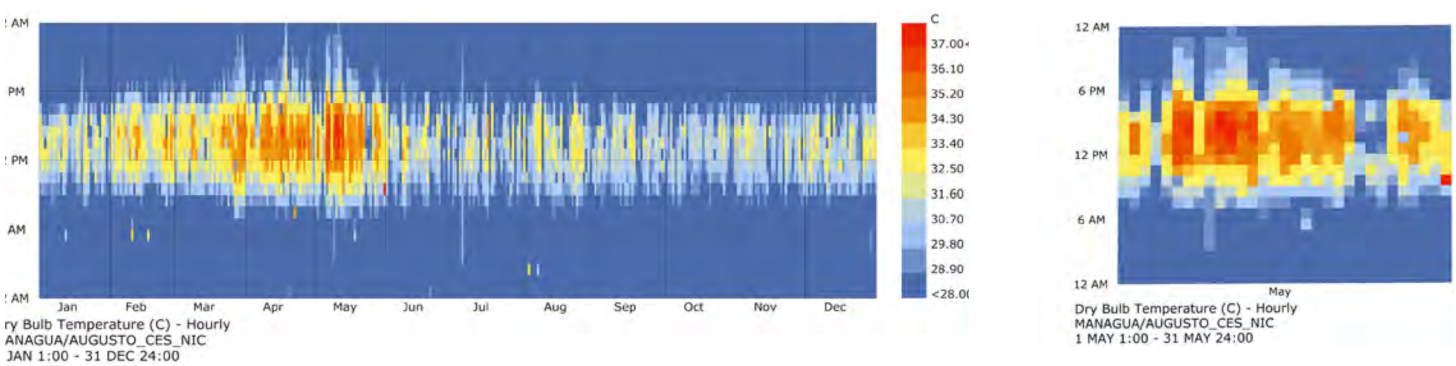
Openings are set for each zone, using a 0.6 opening/wall ratio, with additional ceiling windows in option 3 and 4.

The program ladybug limits the possibility to control the ratio of operatable part of a window, considering as openable area, half of the total one, thus not simulating accurately. One possible solution was changing the height of the window and increasing its ratio, so we calculate the thermal comfort without any added solar gain. Since the constrution method is based on a participatory approach, thus we expect a high % of infiltrations through the different buildings components, another option studied was taking it into account in the calculations. Alongside setting the windows to "open" all year round.
The windows selected have a glass pane of 3mm to simulate minimal interruption of solar gain.
The schedule of occupancy was set according to possible class times, with 0.5 people per area and 3w/m2 lighting density of LED bulbs

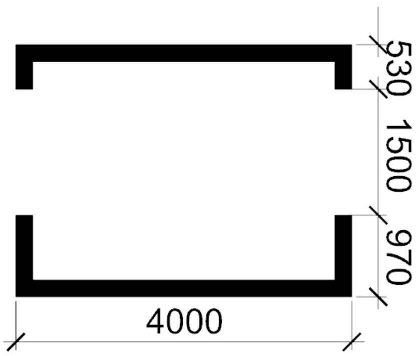
The computer room was chosen for the symulation as it presents the worst case, facing south and west and having multiple computers with no mechanical ventilation.

Four building typologies where tested in order to study which strategy could be the most effective. Building A is an enclosed earth unit, building B is the same typology as the first but with a double bamboo roof to reduce the solar gain through the ceiling of the earth volume. Building C has no roof , simulating the cealing as a big window; Buiding D has a pitched roof with a window in order to endorse stack ventilation. Building C and D are shaded by the same double roof as building B.
4 cases where introduced

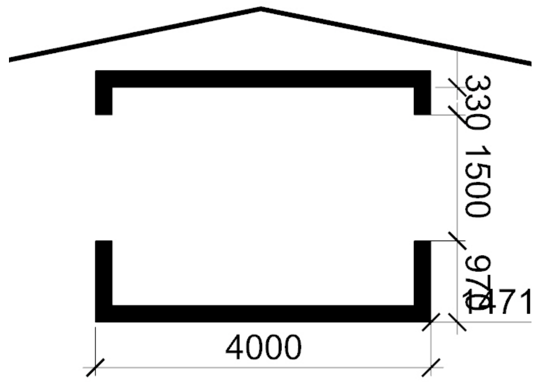
case A, 60 % window to wall ratio one window
case B, 60 % window to wall ratio separated windows 1m sill height
case C, case b with fan
case D, case c with less infiltration through construction



Ill.18. Hourly dry bulb temperature diagram

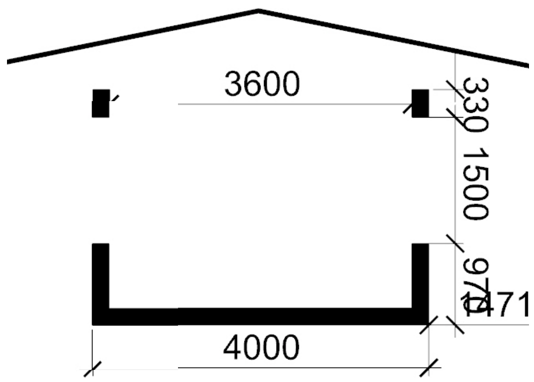


BUILDING A

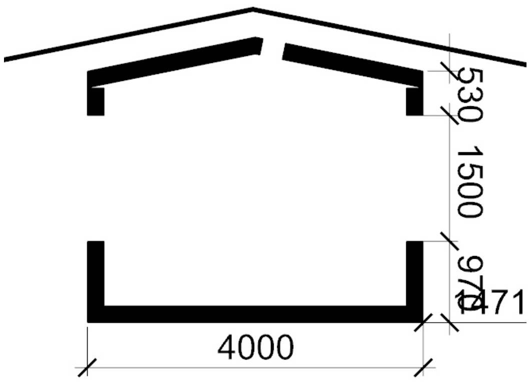


BUILDING B

	case A	case B
outdoor dry air temprature	30.322	
indoor operative heat * BUILDING A/B/C/D	30.38/29.56/29.46/29.62	30.38/29.55/29.45/29.60
mean radiant temprature ** BUILDING A/B/C/D	30.39/28.79/28.59/28.89	30.40/28.76/28.57/28.86
relative outdoor humidity	64.87	
relative indoor humidity BUILDING A/B/C/D	64.75/64.85/64.87/64.84	64.78/64.89/64.90/64.97
notes		- beter operative heat - higher humidity level than case a
energy consumption in may		
electric lights	23 kW	
electric equipment	41 KW	
fan electric	0 KW	
people gains in may	963 KW	
total solar gain	381 KW	
infiltration energy	-79.6 KW	



BUILDING C



BUILDING D

case C	case D
30.39/29.56/29.46/29.6	30.53/29.64/29.54/29.74
30.4/28.76/28.58/28.86	30.4/28.79/28.6/28.92
64.72/64.84/64.85/64.83	64.23/64.62/64.67/64.58
- fan inclrese the indoor operative temprature	- a tighter building increses the indoor temprature
126 KW	

* the average of the mean radiant and ambient air temperatures.

** the weighted mean temperature of the temperatures of the surfaces that form the boundary of the room, including the effect of incident solar radiation.

Case A shows higher window surface temperature for the bigger glass facade, transferring more solar radiation from the bottom unshaded part of the window, thus increasing the indoor temperature.

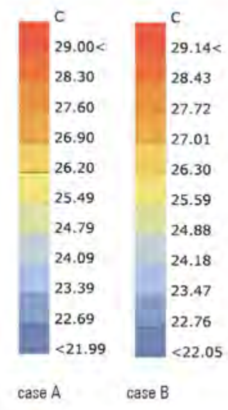
The graph displays the efficiency of the double roofing system with around 2 to 3 degrees difference. As presented in building A and B. In building C there is more air flow thus reduced temperature but increased humidity.

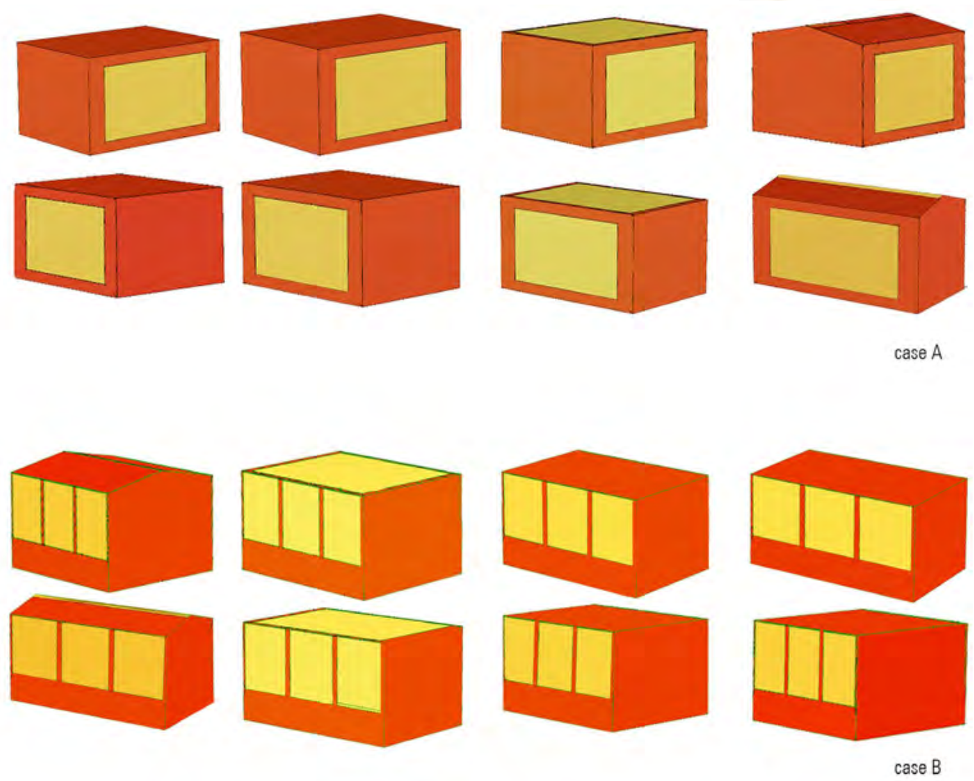
If the buildings where to be rated according to performance the rating from best to worse would be :
building C
building B
building D
building A

Therefore the double roof is the most efficient approach towards the indoor thermal comfort. Decreasing the wall thickness will add to the internal heat. By decreasing the infiltration rate would increase the indoor temperature and humidity. Adding a fan in case C would slightly increase the operative temperature but reduce the humidity.

Natural ventilation and mechanical cooling seem the most effective approaches in such climates. Our choice to minimize the use of energy and rely on sustainable solutions is a characterizing feature of the project.

In the article “Thermal comfort temperature range for factory workers in warm, humid tropical climates” the author studies the comfort level of workers in humid climates to reach up to 30 degrees with no air movement is considered tolerable. Thus making the room comfortable in the hottest month of the year.

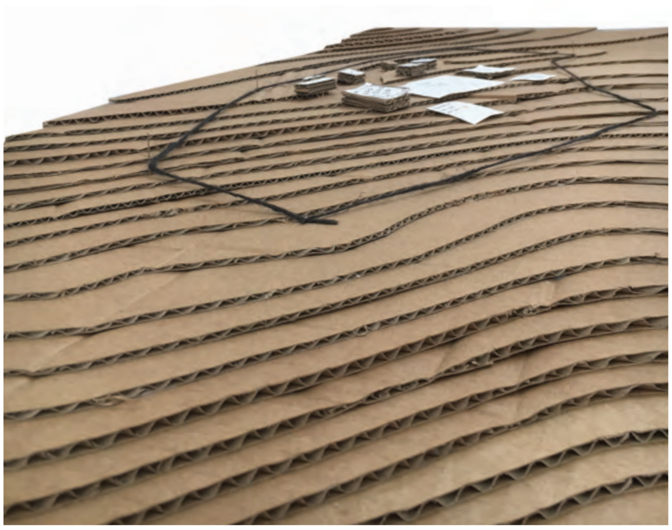




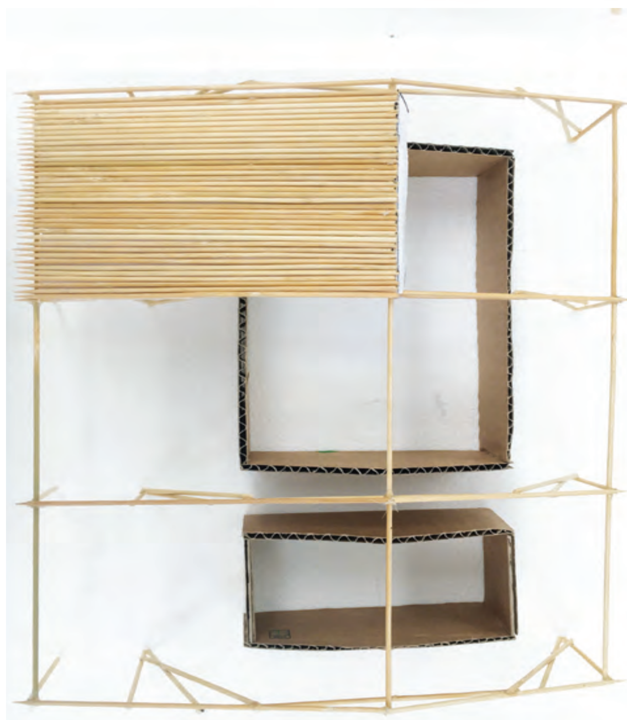
Ill.19. Surface temperature diagram

MODELS ITERATIONS

Numerous study models, in recycled materials, where made during the design process, in order to gain a better perception of spaces, colors and materials.



Ill.20. Site model 1:500



Ill.21. Workshop building model 1:50

REFERENCES

PREFACE

Rapoport, A. (1983). Development, culture change and supportive design. Habitat International, 7(5-6), pp.249-268.

Iep.utm.edu. (2018). Hegel: Social and Political Thought | Internet Encyclopedia of Philosophy. [online] Available at: https://www.iep.utm.edu/hegelsoc/#SSH6c.ii [Accessed 13 Feb. 2018].

Iep.utm.edu. (2018). Leibniz, Gottfried Wilhelm | Internet Encyclopedia of Philosophy. [online] Available at: http://www.iep.utm.edu/leib-ove/ [Accessed 13 Feb. 2018].

Garrison, J., Neubert, S. and Reich, K. (n.d.). John Dewey's philosophy of education.

Carl Grodach & Anastasia Loukaitou Sideris (2007) CULTURAL DEVELOPMENT STRATEGIES AND URBAN REVITALIZATION, International Journal of Cultural Policy, 13:4, 349-370,

Hughes, K. (1990). You took my talk. [Ottawa]: Queen's Printer for Canada.

Prewitt-Diaz, J., Trotter, R. and Rivera, V. (1990). The Effects of Migration on Children: An Ethnographic Study. Division of Migrant Education, Pennsylvania Department of Education.

(Chesterfield, 1997)
Chesterfield, R. (1997). Alpha 94: Literacy and Cultural Development Strategies in Rural Areas. Jean Paul Hautecoeur. Comparative Education Review, 41(1).

O'toole, L. and Gordon, J. (2014). Learning for Well-being: Creativity and Inner Diversity. Cambridge Journal of Education.

Clavel, P. (1986). The progressive city. New Brunswick, N.J.: Rutgers University Press.

Fitzgerald, J. and Green Leigh, N. (2002). Economic Revitalization: Cases and Strategies for City and Suburb.
Evans, G. (2001) Cultural planning: an urban renaissance? London, Routledge Chp8, p.212-258

INTRODUCTION

Actors Buenos Aires: (facts on the present situation of the singular actors)

Dyer, L., Fendt, L., Times, T., Delfino, D., Times, T., Madrigal, A. and Stanley, K. (2018). Farmers invading Costa Rica indigenous reserve chase out families, burn crops. [online] The Tico Times Costa Rica. Available at: http://www.ticotimes.net/2014/07/07/farmers-invading-costa-rica-indigenous-reserve-chase-out-families-burn-crops [Accessed 8 Feb. 2018].

Villanueva Beita, F. (2017). Reflexiones de Buenos Aires. [pdf] Buenos Aires Puntarenas Costa Rica.

Beita Villanueva, F. (2017). Datos Generals del Cantòn. [pdf] Buenos Aires Puntarenas, Costa Rica.

Costa Rica. (2018). Indigenous Communities. [online] Available at: https://www.costarica.com/trip-ideas/indigenous-communities [Accessed 8 Feb. 2018].

Go Visit Costa Rica. (2018). Buenos Aires, Costa Rica - City Guide. [online] Available at: https://www.govisitcostarica.com/region/city.asp?cID=275 [Accessed 7 Feb. 2018].

Bribripakaneblo.com. (2018). Bríbripa Kanèblö. Culture and Tradition in Indigenous Salitre Territory.. [online] Available at: http://www.bribripakaneblo.com/index.php/en/ [Accessed 7 Feb. 2018].

Costa Rica Star News. (2018). Chapel in the Clouds - Costa Rica - Costa Rica Star News. [online] Available at: https://news.co.cr/chapel-clouds-costa-rica/64052/ [Accessed 7 Feb. 2018].

Frontiercostarica.com. (2018). Chapel-in-the-Clouds. [online] Available at: http://www.frontiercostarica.com/Chapel-in-the-Clouds.htm [Accessed 7 Feb. 2018].

Kniivilä, M. (2002). Industrial development and economic growth: Implications for poverty reduction and income inequality. [online] New York: United Nations, pp.298, 299, 318, 319. Available at: http://www.un.org/esa/sustdev/publications/industrial_development/3_1.pdf [Accessed 8 Feb. 2018].

The contribution of services to development and the role of trade liberalization and regulation. (2008). Global forum on international investment, VII, pp.3, 4, 6, 16.

Hecht, R.M., 1983. The Ivory Coast economic 'miracle': what benefits for peasant
farmers? The Journal of Modern African Studies 21 (1), 25–53.

Willems, 2006. The Ivorian Pineapple Market – Social action within the international pineapple commodity market, Wageningen University.

Loeillet, D. 1997. Panorama du marché mondial de l'ananas: L'importance de l'Europe. In: Proceedings of the 2nd International Pineapple Symposium, Acta Horticulturae.

FAO. 2009. The State Of Food And Agriculture 2009 – Livestock in the balance. (2010). Animal Genetic Resources/Ressources génétiques animales/ Recursos genéticos animales, 47.

Denis, L. (2008). Dossier du mois. L'ananas. Fruitrop, 154.

Guevara, A., Arce, R. and Guevara, P. (2017). Economic, Social and Environmental Impact of Pineapple Farming in Costa Rica. La Cámara Nacional de Productores y Exportadores de Piña – CANAPEP.

Bach, O. (2007). Agricultura e implicaciones ambientales con énfasis en algunas cuencas hidrográficas principales. Estado de la Nación en Desarrollo Humano Sostenible.

Campos, L., Céspedes, J., Sandí, D. and Rivera, L. (2017). Los nuevos frutos de oro. Aparato productivo de piña y naranja en la Zona Norte, Costa Rica (1974-2015). REVISTA RUPTURAS, Vol. 8(Num. 1), pp.101-129.

Suryanata, K., 2000. Products from paradise: The social construction of Hawaii crops. Agriculture and Human Values 17 (2), 181–189.

CBI Product Factsheet: Fresh Pineapples in Europe. (2015). .

Sandoz, M. (2013). DESARROLLO DE LAS PIÑERAS EN COSTA RICA Y SUS IMPACTOS SOBRE ECOSISTEMAS NATURALES Y AGRO-URBANOS. Biocenosis, 27.

Cuadrado, G. y Castro, S. (2009). La expansión del monocultivo de piña en detrimento de los derechos humanos.

González, G. (2004). Pineapple production in the Atlantic and South Pacific Regions of Costa Rica: Characteristics, organization, and labor conditions. ASEPROLA ASOCIACIÓN SERVICIOS DE PROMOCION LABORAL.

Echeverría-Sáenz, S., Mena, F., Pinnock, M., Ruepert, C., Solano, K., de la Cruz, E., Campos, B., Sánchez-Avila, J., Lacorte, S. and Barata, C. (2012). Environmental hazards of pesticides from pineapple crop production in the Río Jiménez watershed (Caribbean Coast, Costa Rica). Science of The Total Environment, 440.

Acosta, E. (2008). Impacto ecológico del monocultivo piñero. Ambientico, (177)

Quijandría, G., Berrocal, J. and Pratt, L. (1997). La Industria de la Piña en Costa Rica Análisis de Sostenibilidad. Centro Centroamericano de desarrollo Sostenible.

Arauz Beita, I. (2010). Análisis del Sistema Turístico del Cantón de Buenos Aires: Insumo para un Diseño de Plan de Desarrollo en Turismo Rural.

Baltodano, J. (2007). Decimotercer Informe Estado de la Nación en Desarrollo Humano Sostenible. Informe final. Bosque, cobertura y uso forestal. San José, Costa Rica.

PUNTARENAS. (2018). Buenos Aires – PUNTARENAS. [online] Available at: http://puntarenas.com/puntarenas-information/by-city/buenos-aires/ [Accessed 6 Feb. 2018].

Bixby, L. (2002). Estimaciones y proyecciones de población por distrito y otras áreas geográficas. Costa Rica 1970-2015. p.20.

INEC, (2011).

Villanueva Beita, F. (2017). Una Breve Historia de Buenos Aires. pp.1-3.

Eumed.net. (2018). Generalidades del cantòn de Buenos Aires. [online] Available at: http://www.eumed.net/libros-gratis/2012b/1199/generalidades_canton_buenos_aires.html/ [Accessed 8 Feb. 2018].

Villanueva Beita, F. (2017). Una Breve Historia de Buenos Aires. pp.1-4.

Boruca.org. (2018). about | Boruca. [online] Available at: http://www.boruca.org/en/about-boruca/ [Accessed 8 Feb. 2018].

Iwgia.org. (2018). Costa Rica. [online] Available at: https://www.iwgia.org/en/costa-rica [Accessed 8 Feb. 2018].
Travelcostarica.nu. (2018). Indigenous People: The "Indians" of Costa Rica. [online] Available at: http://www.travelcostarica.nu/indigenous-costa-rica [Accessed 8 Feb. 2018].

Del Monte denuncia boicot. (2000). La República. Costa Rica.

Thanos, N. (2000). ECONOMIC DEVELOPMENT, CORPORATE ACCOUNTABILITY AND THE ENVIRONMENT: COMPARATIVE CASE STUDIES FROM COSTA RICA AND LOUISIANA. Tulane University.

Environmental Justice Atlas. (2011). EJAtlas | Mapping Environmental Justice. [online] Available at: http://ejatlas.org [Accessed 9 Feb. 2018].

Environmental Justice Atlas. (2014). EJAtlas | Mapping Environmental Justice. [online] Available at: http://ejatlas.org [Accessed 9 Feb. 2018].

ANALYSIS

Sanou Alfaro, O. (2010). Costa Rica. [Sevilla]: Junta de Andalucía, Consejería de Obras Públicas y Vivienda, pp. 12-15, 65-73

Build Abroad. (2018). An Introduction to Costa Rican Architecture | Build Abroad. [online] Available at: https://buildabroad.org/2017/07/13/costa-rican-architecture/ [Accessed 13 Feb. 2018].

Guidetocostaricarealestate.com. (2018). The Tico Home — The Guide to Costa Rica Real Estate. [online] Available at: http://guidetocostaricarealestate.com/christopher-howards-guide-to-real-estate-in-costa-rica/christopher-howards-guide-to-real-estate-in-costa-rica/chapter-3-a-menu-of-real-estate-options-architectural-styles-and-legal-structures-1/architectural-styles/the-tico-home [Accessed 13 Feb. 2018].

Costarica-information.com. (2018). Architecture — costarica-information.com. [online] Available at: http://costarica-information.com/about-costa-rica/art-history/costa-rica-art/architecture [Accessed 13 Feb. 2018].

Sanou Alfaro, O. (2010). Costa Rica. [Sevilla]: Junta de Andalucía, Consejería de Obras Públicas y Vivienda, pp. 84-85, 530-531

Southerncostarica.biz. (2018). Brunca Indigenous Reservation Reserva Indigena Boruca. [online] Available at: http://www.southerncostarica.biz/

Reserva-Indigena-Boruca/cat-conservation-areas/Brunca-Indigenous-Reservation/156/ [Accessed 12 Feb. 2018].
Visit to the Boruca village. (2017).

Times, T., Lang, E., Times, T., AFP, R., Times, T. and Galante, K. (2018). An unbeatable building material for Costa Rica? Stick to bamboo. [online] The Tico Times Costa Rica. Available at: http://www.ticotimes.net/2011/09/30/an-unbeatable-building-material-for-costa-rica-stick-to-bamboo [Accessed 5 Mar. 2018].

Times, T., Lang, E., Times, T., AFP, R., Times, T. and Galante, K. (2018). Creating with nature: Green building basics. [online] The Tico Times Costa Rica. Available at: http://www.ticotimes.net/2012/06/01/creating-with-nature-green-building-basics [Accessed 5 Mar. 2018].

Costa Rica Star News. (2018). Ecologically Friendly Construction Techniques in Costa Rica - Costa Rica Star News. [online] Available at: https://news.co.cr/ecologically-friendly-construction-techniques-in-costa-rica/33569/ [Accessed 5 Mar. 2018].

McEachran, R. (2018). Forget about cotton, we could be making textiles from banana and pineapple. [online] the Guardian. Available at: https://www.theguardian.com/sustainable-business/sustainable-fashion-blog/2015/mar/03/wearable-pineapple-banana-fruit-fashion-material [Accessed 5 Mar. 2018].

Walker, P. (2018). Costa Rica's electricity was produced almost entirely from renewable sources in 2016. [online] The Independent. Available at: http://www.independent.co.uk/environment/costa-rica-renewable-energy-electricity-production-2016-climate-change-fossil-fuels-global-warming-a7505341.html [Accessed 6 Mar. 2018].

Indicatore cantonales censos nacionales de población y vivienda 2000 y 2011. (2011). San Jose: Estado de la Nación, INEC, pp.156, 157.

Tramitesconstruccion.go.cr. (2018). MAPAS OFICIALES. [online] Available at: http://www.tramitesconstruccion.go.cr/mapas-oficiales.html [Accessed 9 Feb. 2018].

Eumed.net. (2018). Generalidades del cantòn de Buenos Aires. [online] Available at: http://www.eumed.net/libros-gratis/2012b/1199/generalidades_canton_buenos_aires.html/ [Accessed 8 Feb. 2018].

Herrera, W. (1986). Clima de Costa Rica. San José, Costa Rica: Editorial Universidad Estatal a Distancia.
-Instituto Meteorológico Nacional Gestión de Desarrollo (n.d.). REGIONES Y SUBREGIONES CLIMÁTICAS DE COSTA RICA. San José: Instituto Meteorológico Nacional, pp.11-13.

Weatherspark.com. (2017). Average Weather in Buenos Aires, Costa Rica, Year Round - Weather Spark. [online] Available at: https://weatherspark.com/y/16155/Average-Weather-in-Buenos-Aires-Costa-Rica [Accessed 15 Aug. 2017].

Imn.ac.cr. (2017). Cita un Sito web - Cite This For Me. [online] Available at: https://www.imn.ac.cr/documents/10179/31165/PacificoSur.pdf/e9ff2013-e30e-46a3-ad39-934200753fff [Accessed 19 Aug. 2017]

CASE STUDIES

Tyinarchitects.com. (2018). Cassia Co-op Training Centre | TYIN tegnestue Architects. [online] Available at: http://www.tyinarchitects.com/works/cassia-coop-training-centre/ [Accessed 15 May 2018].

K2s.fi. (2018). Arkkitehtitoimisto K2S Oy | K2S Architects Ltd.. [online] Available at: http://www.k2s.fi/k2s.html [Accessed 15 May 2018].

ArchDaily. (2018). Fazer Visitor Center & Meeting Center / K2S Architects. [online] Available at: https://www.archdaily.com/796321/fazer-visitor-center-and-meeting-center-k2s-architects [Accessed 15 May 2018].

ArchDaily. (2018). Käpäcläjui Indigenous Training Center / Entre Nos Atelier. [online] Available at: https://www.archdaily.com/580439/kapaclajui-indigenous-training-center-entre-nos-atelier [Accessed 15 May 2018].

DESIGN PROCESS

Pdfs.semanticscholar.org. (2018). [online] Available at: https://pdfs.semanticscholar.org/4399/e11b7f43e47c98a075a7bdef1fa662631e42.pdf [Accessed 25 March 2018].

Anon, (2018). [online] Available at: http://www.greenspec.co.uk/building-design/rammed-earth/ [Accessed 25 March 2018].

Eco-bloques.com. (2018). Eco-Bloques. [online] Available at: http://www.eco-bloques.com/ [Accessed 25 March 2018].

Acevedo Pardo, C. (2014). A COMPARATIVE LIFE CYCLE ASSESSMENT OF A SOCIAL INTEREST HOUSING BUILDING: BAMBOO VS. CONCRETE. Master of Arts. Cornell University.
Bamboo
Minke, G. (2016). Building with Bamboo. Basel: Birkhäuser, pp.10, 11.

Ubidia, J. (2015). Construir con Bambú. 3rd ed. Lima: Red Internacional de Bambú y Ratán, INBAR, pp.30-75.

PRESENTATION

Icons
-Bamboo by Clockwise from the Noun Project
-Pear by Xinh Studio from the Noun Project
-Rain harvest by yuvaraj from the Noun Project
-picnic basket by Vicons Design from the Noun Project
-Seesaw by BomSymbols from the Noun Project
-market by arif fajar yulianto from the Noun Project
-Parking by Ahmed Elzahra from the Noun Project
-trees by Guilherme Furtado from the Noun Project

ILLUSTRATIONS LIST

Ill. 1 Own production
Ill. 2 Own production
Ill. 3 Own production
Ill. 4 Carl Grodach & Anastasia Loukaitou Sideris (2007) CULTURAL DEVELOPMENT STRATEGIES AND URBAN REVITALIZATION, International Journal of Cultural Policy, 13:4, 349-370,
Ill. 5 Own production
Ill. http://rochehealthcenter.weebly.com/ [Accessed 14 Feb. 2018].
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Ill. 30-31 Villanueva Beita, F. (2017). Buenos Aires Puntarenas Municipality
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REFERENCES ANNEX

GRIFFIS, L. (2003). Serviceability Limit States Under Wind Load. ENGINEERING JOURNAL / AMERICAN INSTITUTE OF STEEL CONSTRUCTION.

Ogunbiyi, A, M., Olawale, O, S., Tudjegbe, E, O. and S. R, A. (2015). Comparative Analysis Of The Tensile Strength Of Bamboo And Reinforcement Steel Bars As Structural Member In Building Construction. INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH, 4.

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