

Praça do Papa

Creating a lively public space through design for climate adaptation



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Abstract

The Pope's Square (Vitória, Brazil) is currently considered an unfavourable public space due to its full exposure to climate factors. The objective of this thesis is to improve the use of the square through climate adaptive design interventions. Map analysis and GIS-data provide an analysis of the current problems and opportunities for the site. A literature review identifies key concepts in climate adaptive design and user preference for urban public spaces. Design guidelines from literature are used to build up the final design for Pope's Square in design software. This results in a lively public urban space that is time-resistant due to its adaptation to climate factors.

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Preface

Dear reader, before you lies the bachelor thesis on Praça do Papa. This climate adaptive design forms my graduation project for the bachelor Landscape Architecture and Spatial planning.

This thesis has been shaped by a strong interest in the psychology of people combined with public urban space. It being the final project for the bachelor, made me challenge myself to include climate adaptation to broaden my knowledge.

I would like to thank Dr. Homero M. Penteadó for the tutoring sessions and feedback on design decisions. Guiding students through this project has not been easy due to unusual Covid-19 work circumstances.

Thanks to the Praça do Papa thesis group as well. Always ready to help each other and open to share useful information. Motivating, but always critical of each other's work. Enjoy reading the end result.



Noëlle Dielissen

1. Introduction

1.1 Vitória

The Brazilian city of Vitória with its Praça do Papa (Pope's square) currently counts about 355.000 inhabitants (História de Vitória :: Imprensa :: Prefeitura de Vitória, no date) (Figure 1,2,3). The city houses an active export of iron ore, steel, paper, and coffee through the port of Tubarão (Vitória | Brazil | Britannica, no date). This active trade, however, does not mean that there are proper jobs for the entire population. In fact, the differences in income for certain parts of the city are significant ((legado.vitoria), no date a). This results in a patchwork of gated communities and high-rise buildings mixed with cramped 'favelas'. The level of inequality and uncertain circumstances for favela inhabitants ranked Vitória as the 50th most dangerous city in the world.

The Praça do Papa is not a safe place to visit at night due to the risk of violence and robbery, but there are other factors that make it an unfavourable place to spend time during the day. The oceanic climate results in an average summer temperature of 34.4°C and during winter months this drops to 24.4°C combined with an unpleasant wind from the south (Vitória em Dados - Dados Geográficos, no date). Without shelter or facilities people visiting the square are fully exposed to the elements (Figure 4).

Vitória is home to several parks containing natural elements which provide examples for the Praça do Papa ((legado.vitoria), no date b). Opportunities were taken in turning the current 'blank' square into a favourable public place by adapting it to climatic factors. Design building blocks which provide shelter from exposure to heat and wind, combined with elements favoured in public park design helped contribute to create a genius loci for the square.



Figure 1: location in the world (Author, 2020)



Figure 2: location in Brazil (Author, 2020)



Figure 3: location in Vitória (Author, 2020)



Figure 4: current situation at Praça do Papa (www.folha.uol, 2009)

1.2 Thesis statement

Goal

The goal of this thesis report is to create a design for the Praça do Papa that makes it a lively public space. The current lack of design elements makes it into a blank canvas which is fully exposed to the elements. This creates an opportunity to make a design which is adapted to climate change and through this creates a more pleasant public space in an urban area.

Objective

The objective of this thesis report is to create a design for the Praça do Papa that reduces the influence of climatic factors to turn the square into a usable space for the community.

Design Question (DQ)

How can design for adaptation to climate factors be combined with stimuli which contribute to an increase in the use of the public space?

Sub Questions (SQ's)

1: Which factors currently obstruct the use of the Praça do Papa?

2: Which design guidelines can be applied to overcome the impact of climate at the Praça do Papa?

3: Which design interventions are preferred by people in public spaces / parks?

1.3 Methods and materials

Methods

The method used to answer the research questions is the Complex Intellectual Activity Model (Ledewitz, 1985). The research is divided into different phases starting off with exploratory research and the formulation of research questions. Literature study and map analysis will form the eventual framework for the design Figure 5 illustrates the methods.

Materials

The research will be conducted with the following materials:

- Landscape analysis: maps and GIS-data.
- Literature review: identify key concepts and guidelines.
- Design: Adobe Creative Cloud and drawing materials.

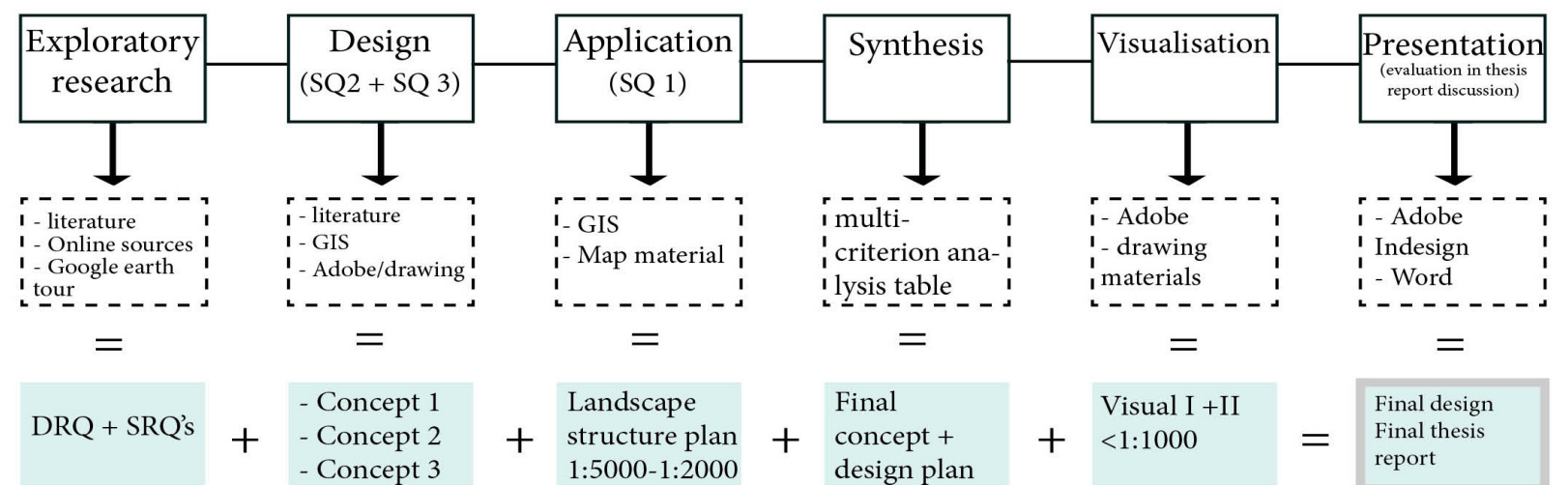


Figure 5: illustration of methods and materials (Author, 2020)

2. Theoretical Framework

2.1 Key concepts

To focus the design on a specific subject, key-concepts are identified together with design guidelines to build a framework. These concepts support the goal of the design, to create a more lively place through design for climate adaptation.

Biophilia

Biophilia is defined as the inherent inclination to affiliate with nature in human beings (Berman, Jonides and Kaplan, 2008). This is not limited to natural elements but includes interaction with all living beings. For this thesis, the focus is upon the natural elements which include vegetation and water bodies.

That this affiliation with nature has positive effects on human beings is underwritten by Grinde and Patil (2009). Even in people who do not express a positive attitude towards plants and nature, an unconscious benefit of such an environment exists.

The positive effects of nature are not limited to just the experience of it. Experiments by Berman, Jonides and Kaplan (2008) proved that nature improves cognitive performance. These results were obtained by having subjects perform a task in both urban and natural environment as well as performing a task in a quiet room with pictures of either natural or urban areas.

As the Praça do Papa contains few natural elements, it is considered a place to which people feel no affiliation and do not experience cognitive benefits.

Thermal comfort

Thermal comfort is a term which is hard to define as 'comfort' is described differently by individuals and many factors play a role in its measurements. For this thesis it is considered as the following:

the environmental condition related to air temperature, humidity, air movement, activity, and clothing under which most people feel comfortable (Mallick 1996).

In highly urbanised cities with a large built surface and few natural elements, thermal comfort is many times associated with the Urban Heat Island Effect. This is "the occurrence of higher temperatures in metropolitan areas in comparison to temperatures of suburban and rural areas" (dos Santos et al., 2017 p. 947).

Pedestrian wind comfort

This is again a term that is difficult to fully define due to its subjective aspects. It is considered as "people's experience of the urban environment by studying meteorological data combined with comfort criteria" (Jacob and Sagaut 2018).

The influence of wind on people and spaces can be categorised in several experiences. Up to 4 metres per second, wind discomfort can be experienced as clothing starts to blow around. From 4 to 15 metres per second, wind nuisance as walking and cycling becomes more difficult. Speeds above 15 metres per second cause acute wind danger as people can be blown over. (Lenzholzer, 2013)

2.2 Design guidelines

Useful guidelines for this design are explored by looking into how urban green space design affects residents' social interaction (Rasidi, Jamirsah and Said, 2012). ryThis research also identifies which park elements are preferred by individuals. They find people prefer spaces with difference in height, shaded walkways and clear functions for sports and playgrounds.

Research by Ryan et al., (2014). provides aspects related to biophilia, providing guidelines for a pleasant space. These include the presence of water, access to thermal and airflow variability and mystery.

In their research, Cooper Marcus and Francis (1998) propose guidelines for designing urban plaza's. These include creating contrast with the scale of surrounding environment, making sure it does not look empty during off-hours and providing shelter and shade.

In her book "Het Weer in de Stad" (The weather in the city) (Lenzholzer, 2013) provides many design guidelines for successfully dealing with climate factors. Wind protective street furniture, decreasing the effect of short-wave radiation and multi-functional elements.

The specific guidelines which are used for the design are displayed in section 4.1 "Design Principles".

3. Analysis

This chapter analyses the relevant surrounding factors of the Praça do Papa which have to be taken into account for the design. It identifies current obstructions and problems which the design can solve.

3.1 Landscape characteristics

Accessibility and facilities

Figure 6 displays the map for analysis of accessibility and facilities. The Av. Nossa Sra. Dos Navegantes leads people along the north edge of the square. This is a big road which connects to highways leading to adjacent cities of Serra and Villa Velha, eventually connecting to the highway that runs along the entire coast of Brazil. There is a bus stop right at the square which means that accessibility by public transport is not an issue. A bicycle path runs along the Av. Nossa Sra. Dos Navegantes, but it ends west of the square. This creates difficulty when accessing the square. There are pedestrian options to cross the large road as sidewalks and crossroads are in place. However, this crossing can be considered unsafe as at least 5 lanes need to be crossed. As far as facilities, the only useful items in place for visitors are trans cans. There is one restaurant in the higher price segment and an access road to the TAMAR project (The Brazilian marine turtle project TAMAR in Vitória, Espírito Santo, no date), but these features do not have a direct link to the square.

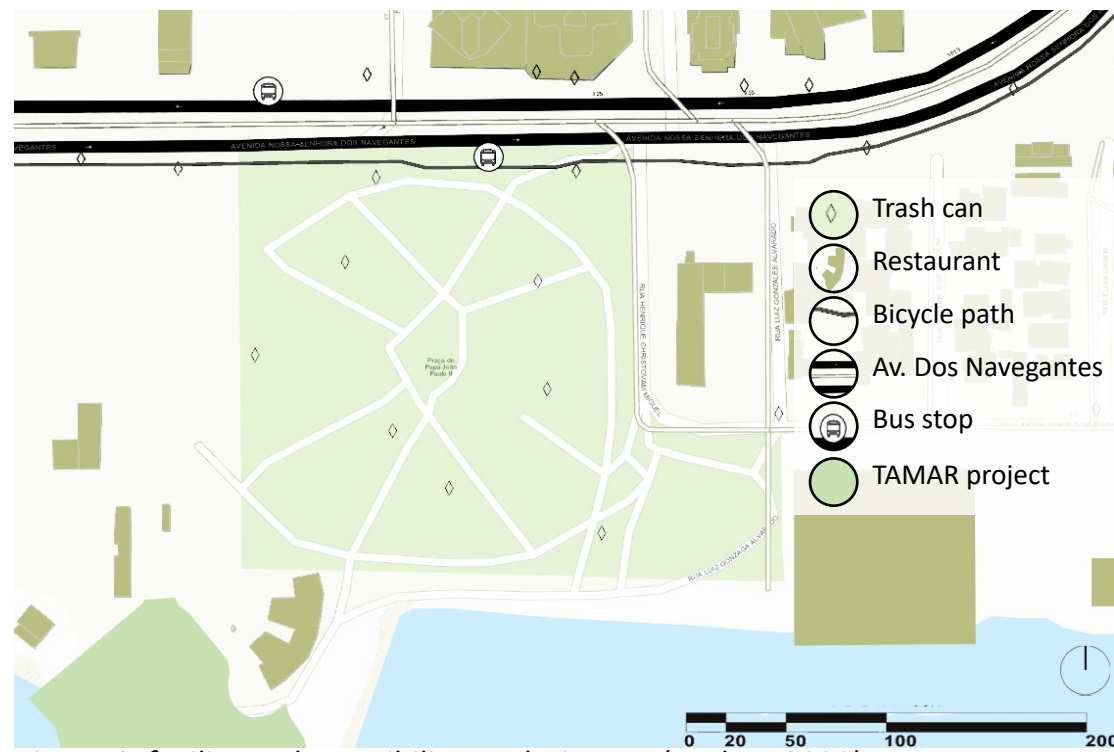


Figure 6: facility and accesibility analysis map (Author, 2020)



Figure 7: vegetation analysis map (Author, 2020)

Vegetation

Trees are located mainly along the edges of the square and along the road (Figure 7). They function as road separation and provide shadow areas for pedestrians. The number of trees on the square itself is very limited resulting in a lack of comfortable shadow areas. The square itself contains grass as main vegetation. As a result of lacking maintenance and poor soil this has either died or has been trampled by people and turned to sand.

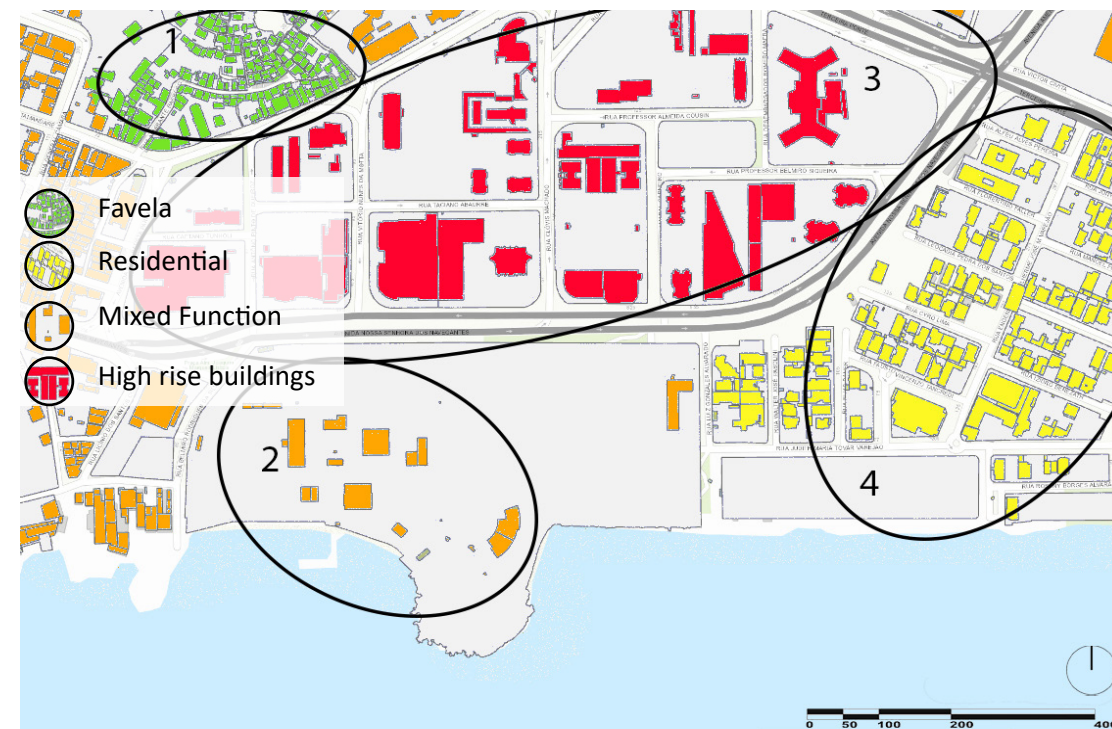


Figure 8: built environment analysis map (Author, 2020)

Built environment

There are four types of built environment in the surroundings of Praça do Papa (Figure 8). The first is the Favella (1). These are low rise buildings which are clustered close together and have been built by residents from scraps. These are considered the poorest and most dangerous areas in the city. The medium rise buildings (2) differ in function from commercial to a restaurant or naval buildings. North of the square many high-rise buildings (3) are found which are used and inhabited by more up-scale people. The residential area (4) East of the square is slowly growing more commercial. The users of these types of built environment are currently not using the square as a public space.

3.2 Climate factors

General climate

The general climate for the state of Espírito Santo to which the city of Vitória belong, according to the Köppen classification system is classified as Aw (Figure 9). This translates to a tropical climate which is characterised by a dry winter. This corresponds with the tropical (A) climate which is found in 81.4% of Brazil (Alvares et al., 2013).

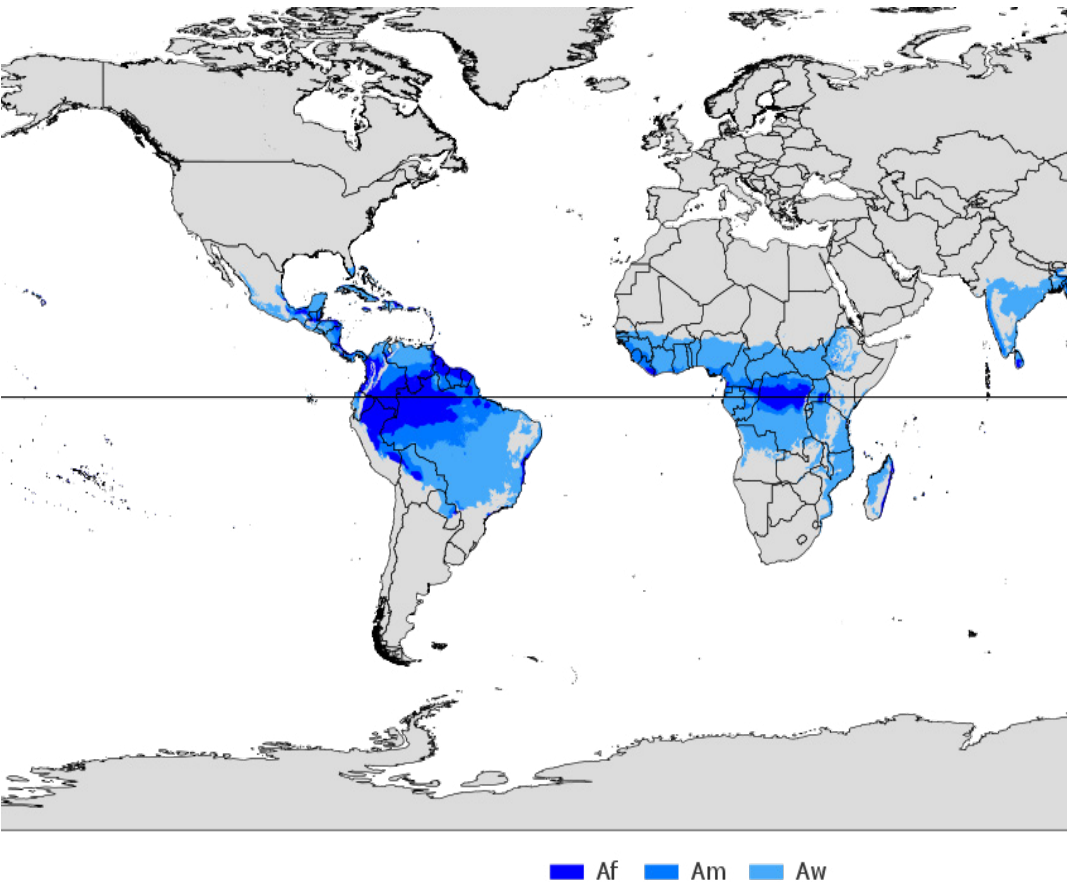


Figure 9: dispersion of tropical climates in the world (www.wikipedia.org, 2020)

Rain

The average amount of rainfall which corresponds with the Aw climate in Vitoria translates into 1100mm per year. In comparison, the average amount of rainfall in the Netherlands is 700mm per year (Climate and average weather in Netherlands, no date). The amount of rain for Vitória has not proven to cause any problems currently. As a result, solutions for water storage will not be implemented in the design. The creation of a more climate-resistant design will inevitably result in a larger permeable surface for rainwater, improving the situation as an additional benefit

Temperature

The average annual temperature in Vitória lies between 22-26 °C. Figure 10 below shows the feeling of the average temperature in the city throughout the year (Average Weather in Vitória, Brazil, Year Round - Weather Spark, no date). 75 °F corresponds with 23 °C, 85 °F with 30 °C and 95 °F with 35 °C. From halfway through the fall season until the end of spring there are periods throughout the day which are considered comfortable. Between 12 PM and 6 PM however, the outside temperature is still considered warm. During the summer months, these times of day are even considered hot. Generally, temperatures above 35 °C are not reached. These tropical temperatures require outside spaces where people can seek shelter in the shade. As these facilities are currently non-existent at the Praça do Papa, this creates an opportunity that should be taken.

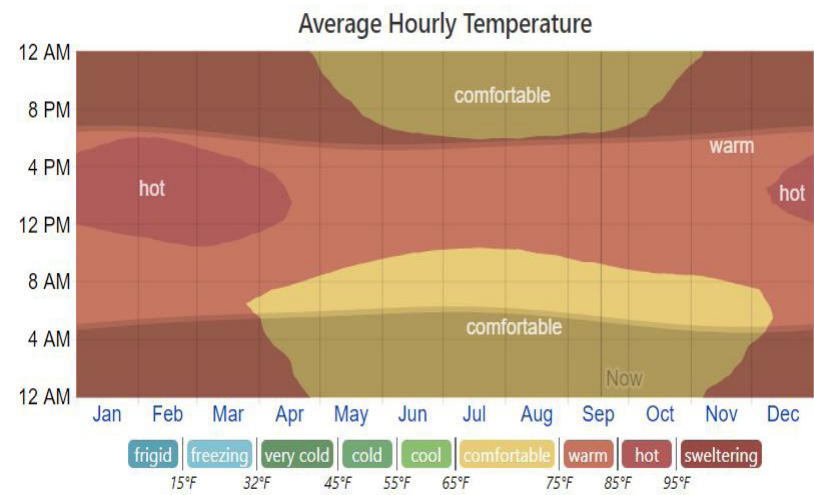


Figure 10: average temperature in Vitória (www.weatherspark.com, 2020)

Wind

Figure 11 depicts the wind flows. The general wind direction in Vitoria is from the South-East during the summer months. This wind is warm and dry thus the only cooling effect comes from the flow of air. During the winter months the prevailing wind direction is from the South. The airflow comes from the water, which results in a cold and humid wind (Average Weather in Vitória, Brazil, Year Round - Weather Spark, no date). Besides cooling the area, this winter wind can be experienced as uncomfortable. Measured at an altitude of 10 metres, the average wind speed in Vitória is 12 km/h. The wind speed on the ground highly depends on the surroundings in the area as buildings and other large elements can function as wind blockers (Average Weather in Vitória, Brazil, Year Round - Weather Spark, no date). The negative effects of the cold, humid winds and the relatively high wind speeds in the city require design interventions to reduce their effect on visitors.

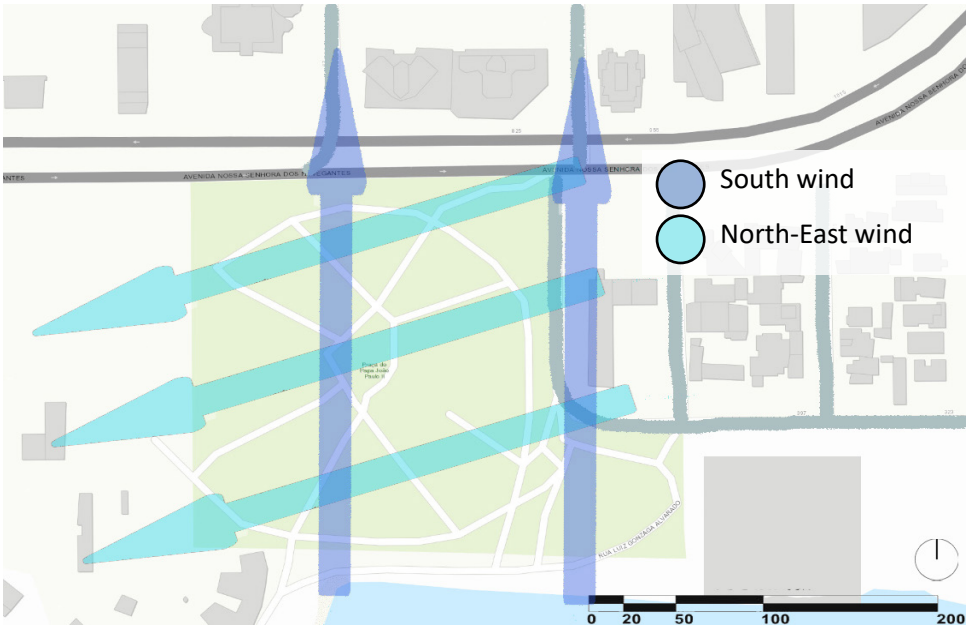


Figure 11: prevailing wind directions (Author, 2020)

3.3. Vitória's landfills

The city of Vitória characterises itself by being built up out of a series of landfills. Originally it consisted of a chain of 34 islands surrounded by mangroves (Freitas, 2003) which have been linked to for the current city shape (Figure 12).

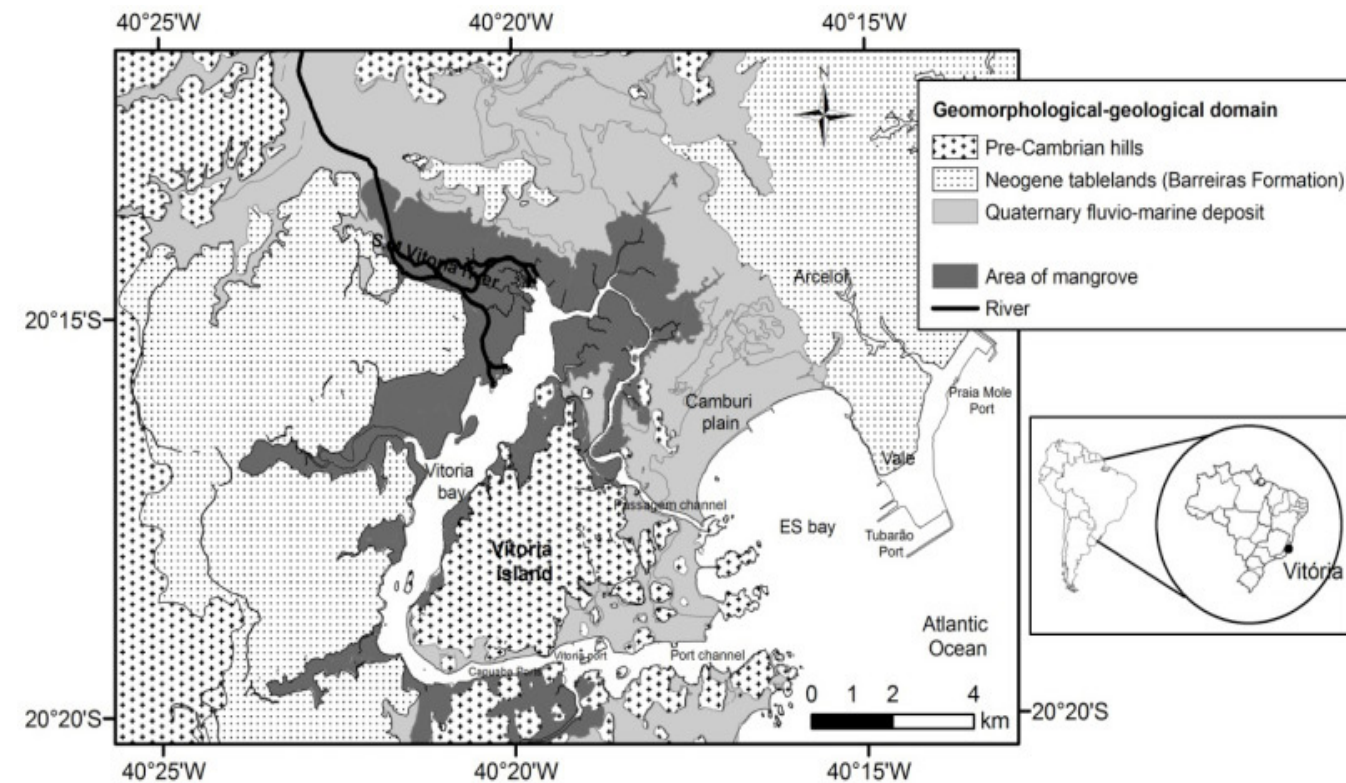


Figure 12: Vitória's original, scattered city shape (Machado et al. 2016)

The first landfill activities occurred as early as 1812 and several of the interventions for landfilling have occurred to create a more beneficial position for the port of Tubarao. Next to this, the early landfills intended to improve the flow of people and trade to modernise the city (Machado et al., 2018). Figure 13 indicates Vitória's landfills and corresponding dates.

All the early landfills do not consider (protected) nature. Environmental questions started to rise in the 1980's resulting in a 1989 agreement name 'priority inversion'. This should provide living facilities to the city's population as well as protecting the mangrove areas. Almost 200 years after the first landfill activity occurred, nature is considered for the first time resulting in many mangrove areas lost at the cost of port expansion. In the current situation, landfilling is only allowed in mangrove areas which have no more capacity of self-recovery.

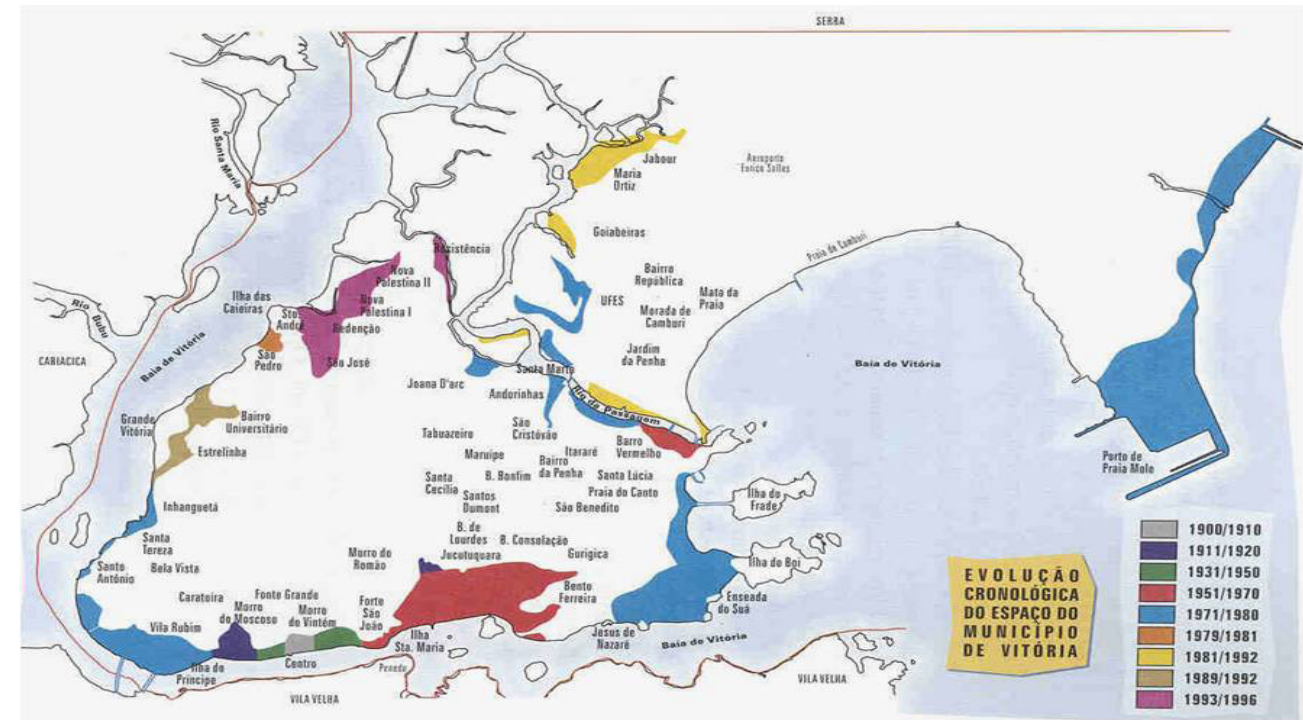


Figure 13: landfills and corresponding dates (www.deolhonailha-vix.blogspot.com, 2020)

The landfill on which the design site is located (Praia do Suá) doesn't emerge until the 1970's (Figure 14). The soil is filled with so called technogenic deposits, which result from the human interventions in the physical environment and causing humans to be the main geological agent (Machado et al., 2018).

The landfill areas in Vitória make up about 10% of the surface of the city and 93% of this is urbanised (Machado et al., 2018). This percentage indicates that it is relatively unique to find an open area such as the Praça do Papa on one of these landfills. The need for urban space is thus large which makes it more of a waste that the current square is barely used. As the need is so high, it is not of added value in its current state.

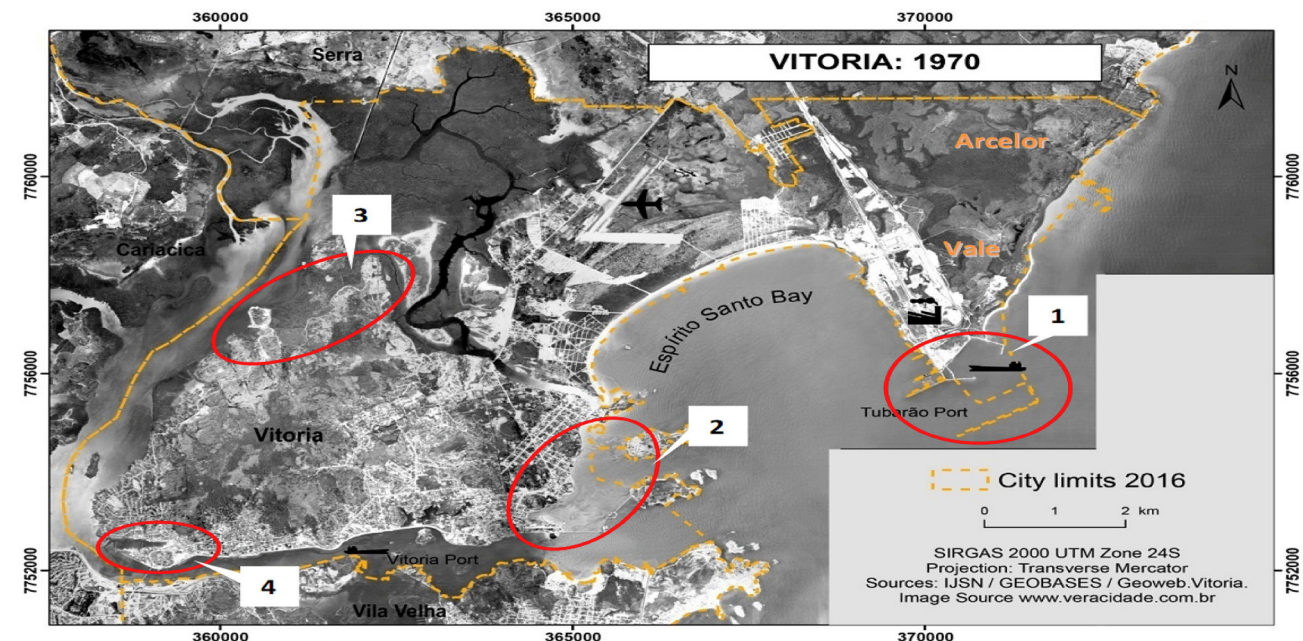


Figure 14: location of Praça do Papa before the landfill (Machado et al. 2016)

3.4 Viewpoint analysis

The Praça do Papa is surrounded by several different landscapes. As the square is barely being used currently it is important to take surrounding factors into account and create attracting factors for people visiting the surroundings to consider the square as a pleasant part of the environment.



Figure 15: North side square (Author, 2020)

The North edge (Figure 15) of the square characterises itself by high-rise buildings. The function of these buildings differs from commercial offices to high-end apartments. These high rise buildings result in a lot of movement from people going to and coming from work or leaving their house. This movement, however, does not appear to translate into movement on the square itself. There is a large road which separates the square from the rest of the city. Crossing opportunities are limited, but access through public transport works well since the bus stop is located right at the square.

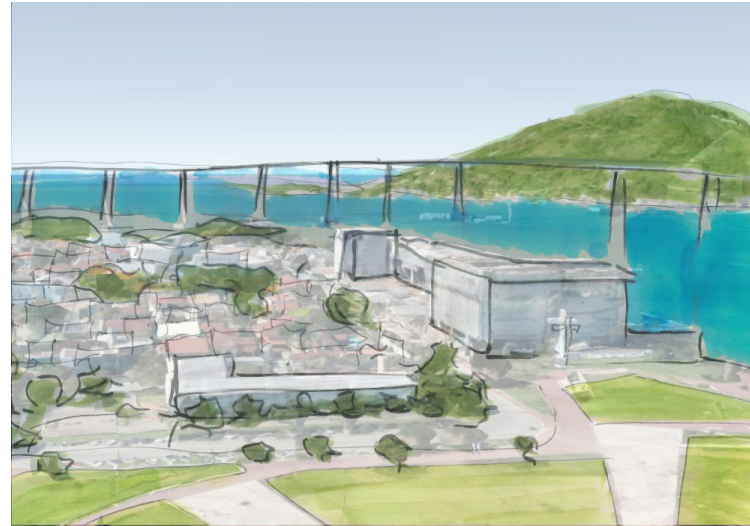


Figure 16: East side square (Author, 2020)

The South edge (Figure 16) of the square resides two buildings which attract many visitors. These are The Campaneli Theatre and the Espaço Baleia Jubarte. Again, the visitors of these spaces result in a lot of movement, but do not result in people residing on the square. The spectacular view on the bay and the bridge leading to Vila Velha are strong points for this side. In Vila Velha, on the hilltop, one finds the 16th century convent of Penha. This can be seen from every point on the most prominent street in Vitória



Figure 17: South side square (Author, 2020)

The South edge (Figure 17) of the square houses a spectacular view of the hills in Vila Velha. The only facility located on the square is on this side; restaurant Papaguth. The price range is on the higher end, making the facility accessible to only part of the population that would visit the square. Behind the restaurant a protected nature area is found, and it provided a viewpoint to look at the bay. It houses the TAMAR project as well, which functions as a marine turtle sanctuary (The Brazilian marine turtle project TAMAR in Vitória, Espírito Santo, no date). The protected nature area is accessible through one path only making it hard to find. It has potential to attract many spontaneous visitors but is currently unused. The waterfront provides seating, but the fluctuating tides make swimming difficult. There is no clear access to the water, only the rocks provide a way to climb up.



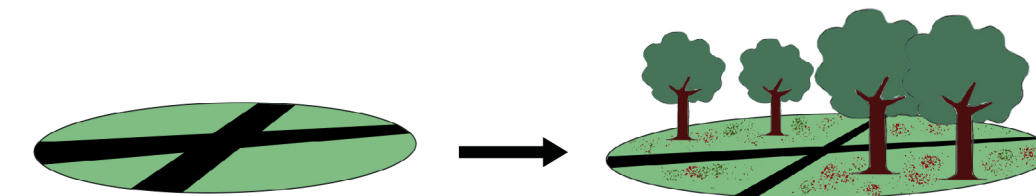
Figure 18: West side square (Author, 2020)

The West edge (Figure 18) of the square can be considered as mainly practical. It contains a large parking space which provides opportunities for people who visit the square by car. Every Wednesday the parking lot sets the stage for an organic market. This attracts many visitors and movement, but they are again not attracted to the square. The buildings mainly belong to the navy and port authorities. They thus have their own function, but do not connect to the square in any way. An opportunity lies in workers who can visit the square during their breaks. On the hilltop in the background another Favela can be seen, contrasting strongly with the high-rise commercial buildings around the Praça do Papa.

4. Landscape structure plan

4.1 Design principles

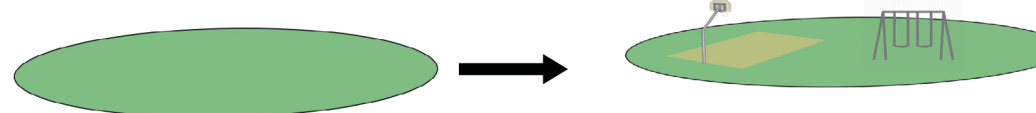
The following design principles were retrieved from the literature and used as building blocks for the final design.



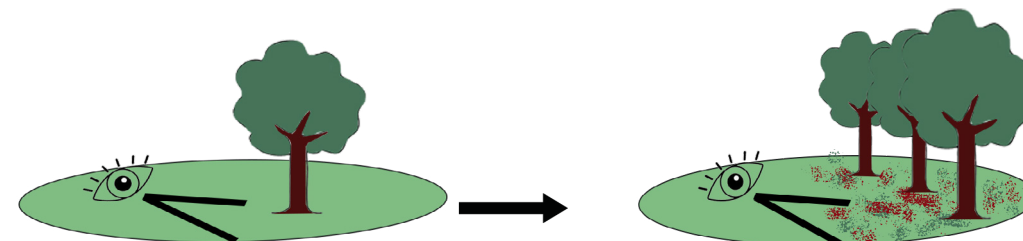
Plant vegetation to reduce heat absorption



Light coloured walkways to reduce heat absorption



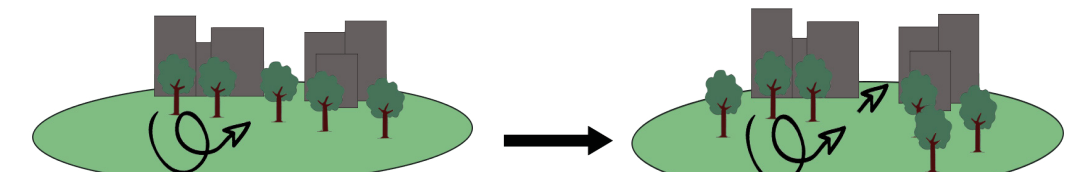
Introduce areas with a clear function



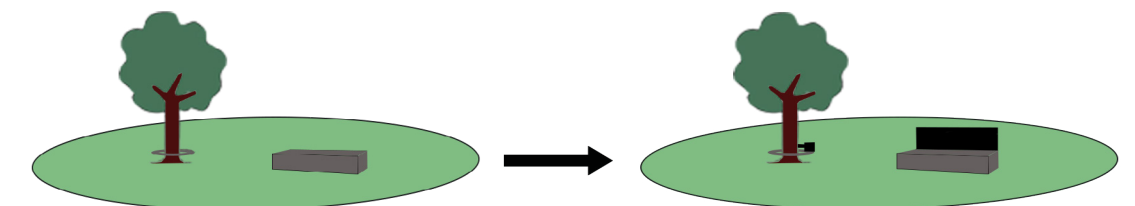
Create visually interesting areas



Create shaded walkways



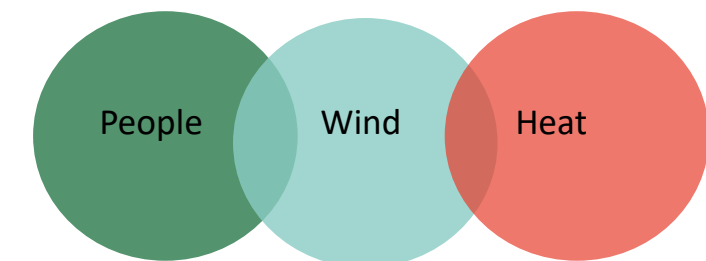
Allow cooling airflow into neighbouring streets



Create wind shelter spots



Figure 19: design principles (Author, 2020)



4.2 Design models

There is an endless amount of ways to make a design model for the Praça do Papa. The most significant factors identified in the analysis have led to three different models. Each of these models focusses on elements which contribute to improvement of the factors from the analysis.

Model for people

A model for people (Figure 20) includes many different functions and elements as individuals have different motivations to visit a park. This leads to a mix of social interaction and privacy spaces. A space is considered private if it is at a distance of at least 4 metres to others. Visitors generally prefer to stay on paved surfaces and reside in shaded areas (Rasidi, Jamirsah and Said, 2012).

Areas with clear functions such as playgrounds or sports areas are preferred. However, it is important not to cut off the view on these with vegetation or built elements (Cooper Marcus and Francis, 1998). To engage visitors, it is important to create a visually interesting space and create a connection with nature through vegetation or water bodies. This is accomplished by incorporating an element of mystery through biomorphic forms and patterns (Ryan et al., 2014).

Model for temperature

The model for temperature is depicted in figure 21. Reduction of the average (experienced) temperature is achieved through several interventions. Creating shaded places which give visitors a choice to sit in the sun or not gives them a perceived control of temperature, helping to increase comfort (Lin, 2009). The increase in comfort is not only perceived, as shaded areas decrease the effect of short-wave radiation from the sun (Lenzholzer, 2013b). Planting trees is not only beneficial for creating shade. Research has found that trees can cool an area up to 5 times its height under the influence of down winds (Taha, Akbari and Rosenfeld, 1991). Decreasing the Sky View Factor, areas exposed to direct sunlight, helps cool down the surface and thus decreases the average temperature on site (Tan, Lau and Ng, 2016).

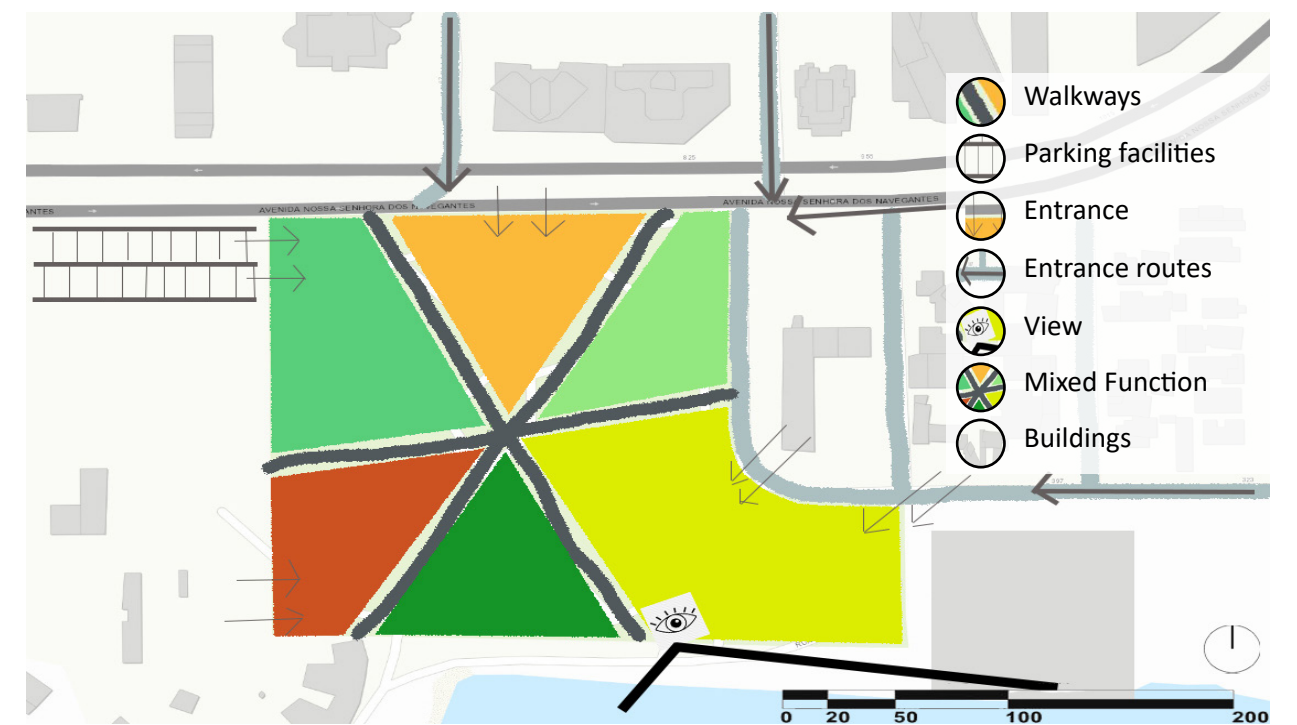


Figure 20: design model for people (Author, 2020)

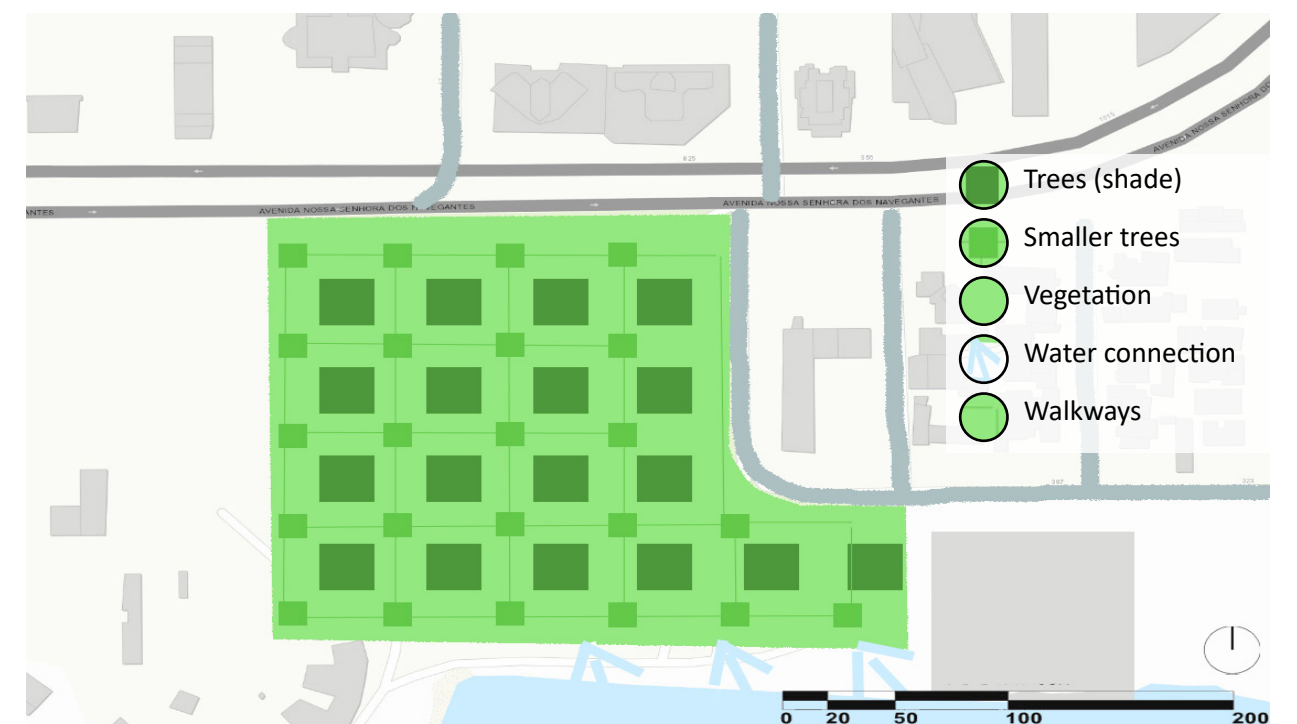


Figure 21: design model for temperature (Author, 2020)

Model for wind comfort

Figure 22 displays the model for wind comfort. The most important factor for obtaining wind comfort is the arrangement of obstacles in relation to the main wind directions. To create a cooling flow during summer months, trees should be placed parallel to the summer wind direction. To prevent cold winds during winter months, trees should be placed perpendicular to the winter wind direction (Tan, Lau and Ng, 2016). Making sure the edges of the park are not fully planted with trees creates benefits for the surrounding area. Keeping a connection with the water results in a cooling airflow into perpendicular streets (Qaid et al., 2016) (Lenzholzer, 2013). However, shrubs or other small obstacles are needed to reduce the intensity of the windflow. Alongside natural solutions to create wind comfort, man-made elements for shelter can provide options for shelter (Lenzholzer, 2013).

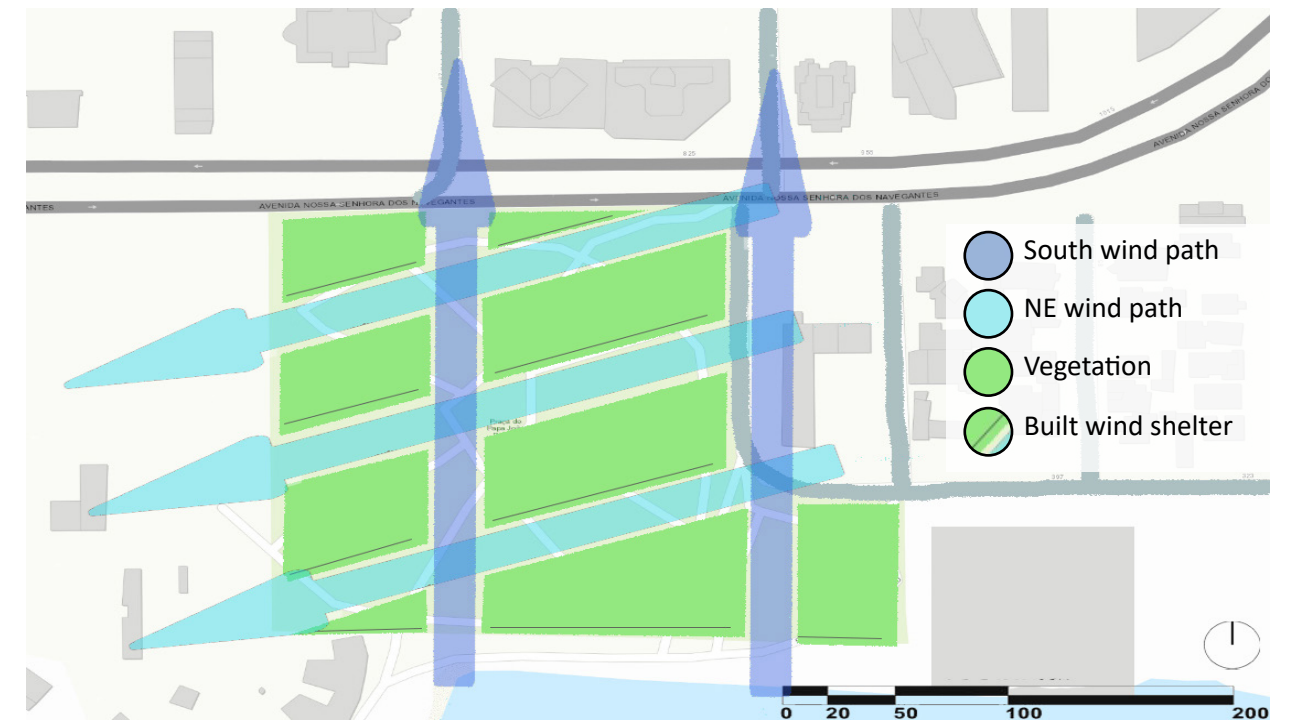


Figure 22: design model for wind comfort (Author, 2020)

4.3 Model assessment

All three models include good aspects and elements which can be improved. Through a multi-criterion analysis in [table 1](#) these aspects are evaluated.

In overall score, the model for people contains the most useful elements to create a successful design. However, there are elements from the other two models which, when added to the model for people, can improve it even further ([Figure 23](#)). Elements from the model for temperature are used to lower the average temperature on the square through the implementation of shadow areas. By adapting it to climate factors like this, the design becomes more time resistant. To ensure a cooling flow of wind during summer months and prevent an uncomfortable condition on the square during winter wind moths' elements from the model for wind are needed. The combination of these elements leads to a final, layered model: the model for people with nature ([Figure 24](#)).

Criterion	Model for people	Model for temperature	Model for wind comfort
Lowers the average temperature	-	++	+
Decreases the open character	++	+	-
Creates more inclusive facilities	++	-	-
Resolves the South-wind problem	--	-	++
Creates a sensibly pleasant space	++	+/-	-
Creates a time-resistant design	+	++	-
Creates a functional space	++	-	--
Creates shaded areas	+	++	+
Total score	8	4	-2

Table 1: multi-criterion analysis (Author, 2020)

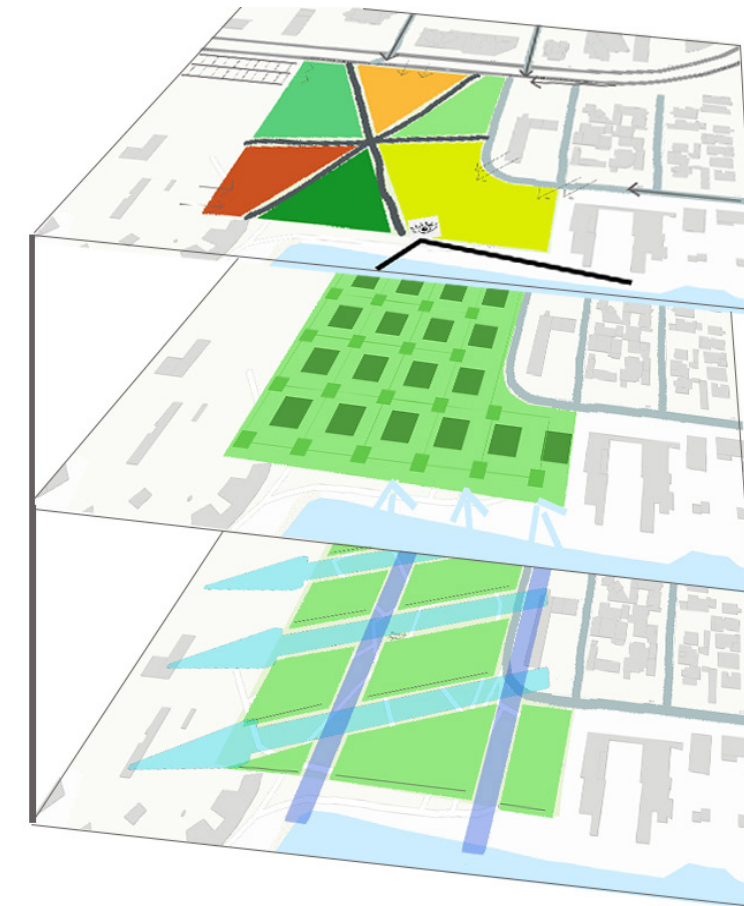


Figure 23: layered approach on design models (Author, 2020)

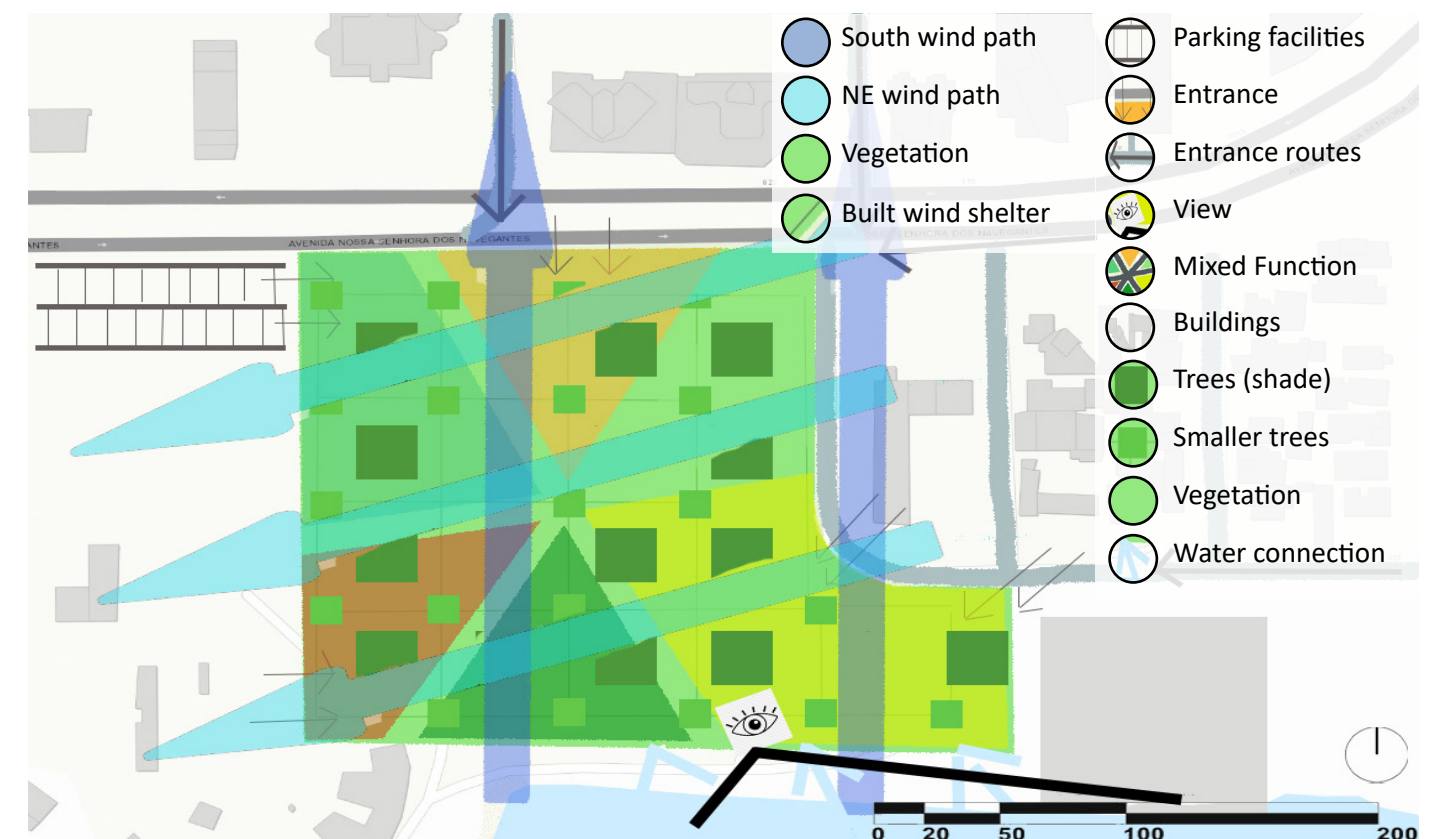


Figure 24: the model for people with nature (Author, 2020)

4.4 Reference design

A reference project which is known for its layered design model is the Parc de la Villette located in Paris (France). It was designed by Bernard Tschumi Architects as a park for the 21st century (How the Parc de la Villette Kickstarted a New Era for Urban Design | ArchDaily, no date). Situated in the North-East corner of the city a design was created on one of the few remaining open spaces where a slaughterhouse used to be located (Bernard Tschumi Architects, no date). The park covers an area of 135 acres, making it the largest park in the city of Paris (AD Classics: Parc de la Villette / Bernard Tschumi Architects | ArchDaily, no date).

The park is renowned for its layered design guided by three basic concepts: lines, points and planes (Figure 26). Three models which could function separately, but together create a strong design. The lines are promenades and covered walkways, leading visitors through the park over predetermined axes. Points in the design are represented by over 25 buildings, or red follies. Eye catching elements which support different activities and serve as points of reference (Figure 25). The planes in the design differ in function from playgrounds and sports fields to artistic natural areas. These include 10 themed gardens which visitors can spontaneously visit and explore (AD Classics: Parc de la Villette / Bernard Tschumi Architects | ArchDaily, no date).

Tschumi achieves the incorporation of the park in the city scape well. “Unlike Fredrick Law Olmsted who designed Central Park and conceived it as a place to escape from the city, Tschumi viewed the park as a

continuation of it” (How the Parc de la Villette Kickstarted a New Era for Urban Design | ArchDaily, no date). Its “non-function” however, which means that park areas have no function other than the one users give to it gains criticism. Next to that it is often criticised for not representing the history of the space (AD Classics: Parc de la Villette / Bernard Tschumi Architects | ArchDaily, no date). This makes it a good example for the Praça do Papa design, as the site did not exist before the 1970’s and thus barely contains historical elements.

As the park functions as a continuation of the city where users come to simply pass-through, enjoy a day of wandering or visit a cultural activity it seems to accomplish everything the Praça do Papa does not. The proposed design interventions will transform it from an open space into an interconnected, climate adapted urban green space



Figure 25: red follies (www.tschumi.com, 2020)

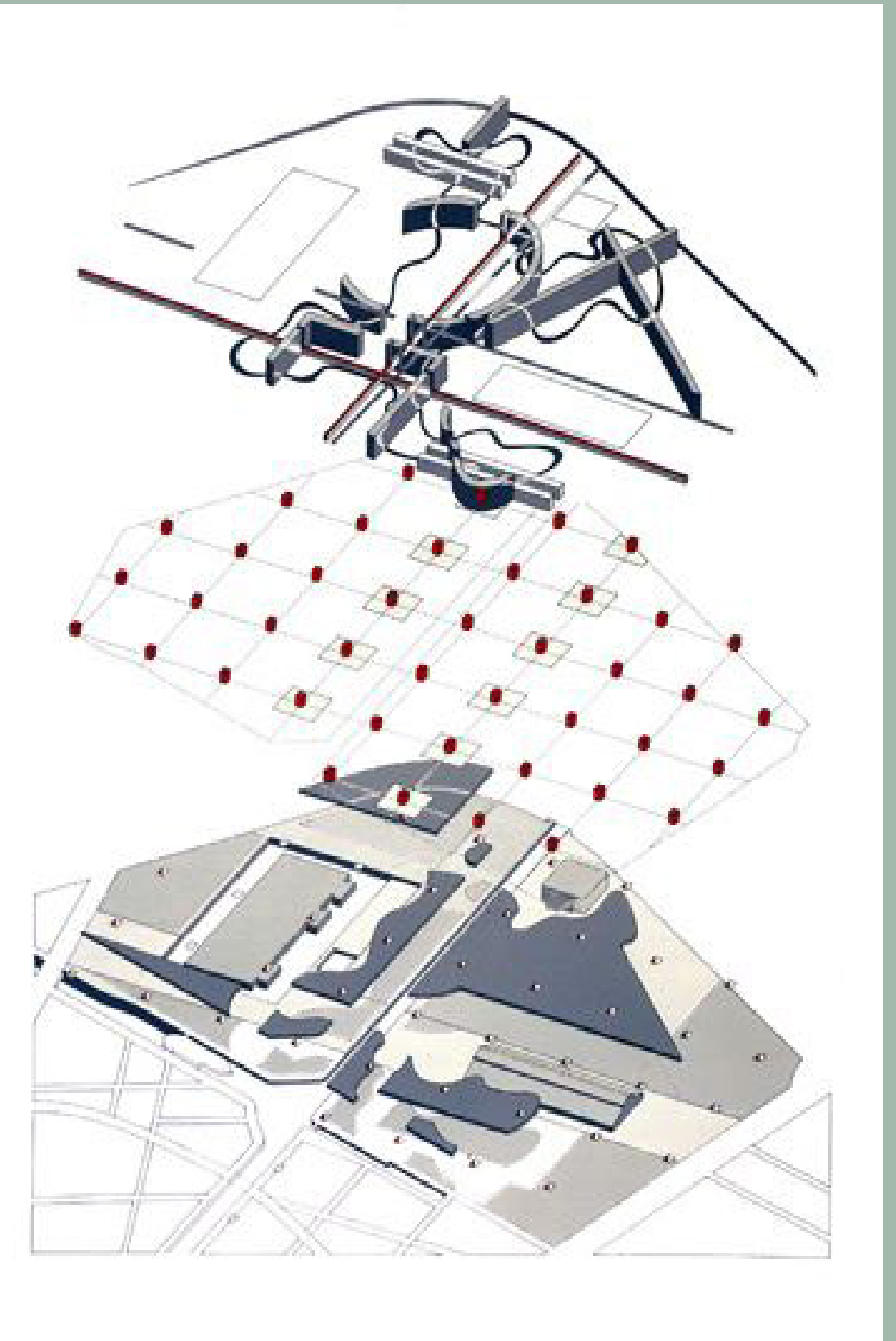
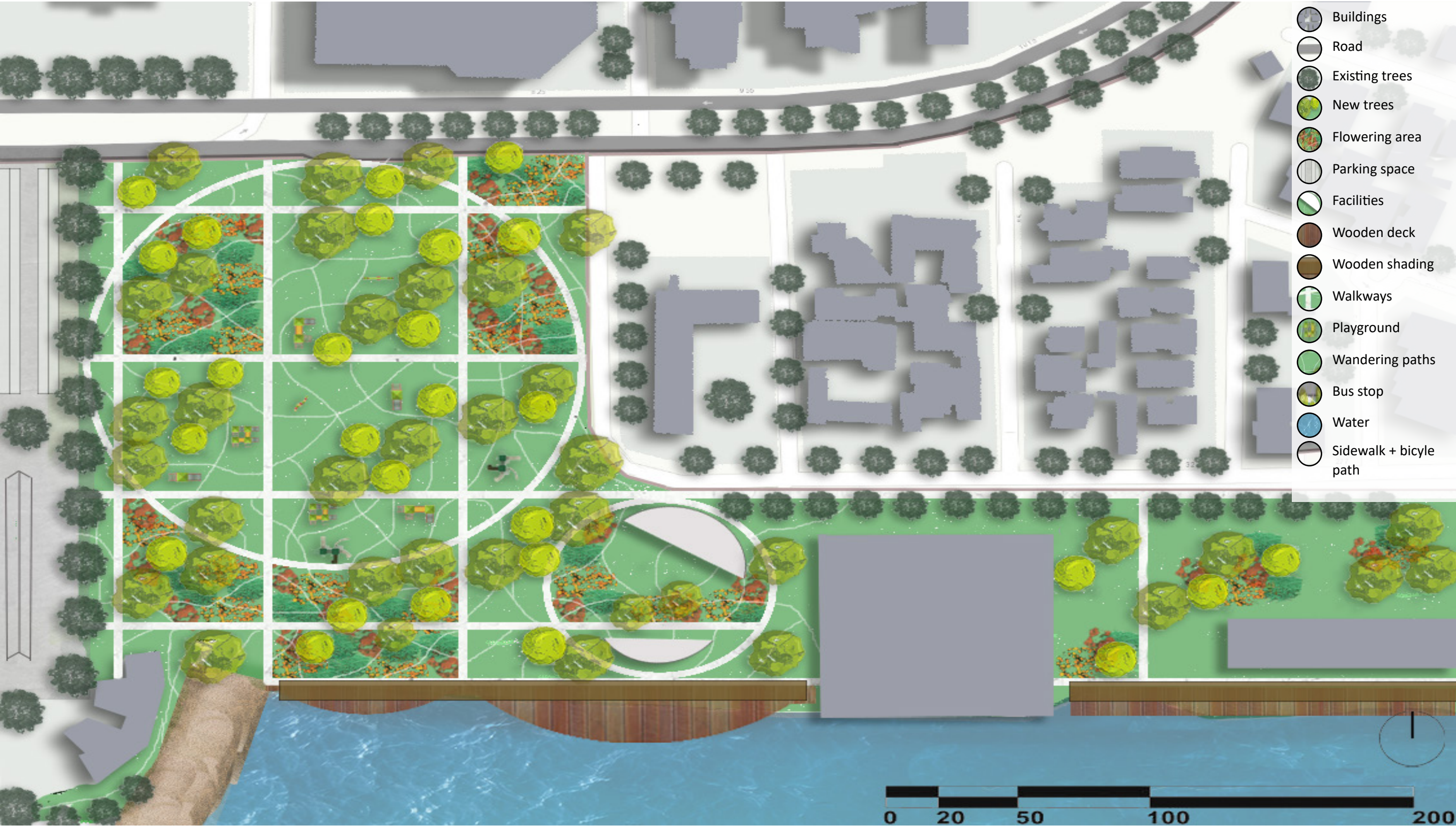


Figure 26: layered design Parc de la Villette (www.tschumi.com, 2020)

4.5 Landscape structure plan



The final landscape structure plan (Figure 27) shows the layered model approach which combines the favoured aspects of the three individual models from section 4.2 The general structure is formed by the placement of trees, allowing for a cooling flow throughout the square and into the streets perpendicular to the square.

The walkways have a geometrical pattern which creates logical routes and connects the square to the theatre and the museum to the East. The circular walkway provides space for running or cycling, adding a clear sports function. The walkways divide the square into several different areas. These have different functions from playground to flowering

areas which provide a sense of mystery as visitors wander through them. The trees are combined with seating to create shadow areas which are more comfortable. These seating elements also contain man-made wind shields to provide a comfortable area throughout every season.

5. Detail Design

5.1 Detail plan

The detail map (Figure 29) provides more insight into the arrangement of the different areas divided by the walkways. Pages 19 and 21 further specify the materials and species used for the design. Both the flowering areas and the view from the wooden deck provide visually interesting spaces for visitors. There is a large amount of seating space giving people from neighbouring commercial buildings the opportunity to go outside comfortably during lunch break or for families to spend a whole day at the playground. All the principles from section 4.1 are used and displayed in this detail design. The visualisations in section 5.2 and 5.3 will show these in more detail.

-  Paubrasilia Echinata
-  Handroanthus Serratifolius
-  Kniphofia
-  Juniperus Horizontalis
-  Alternanthera Dentata
-  Wooden deck
-  Wooden shading
-  Wooden seating
-  Wind shelter bench
-  Lights
-  Walkways
-  Wandering walkways
-  Tree seating
-  Playground
-  Water

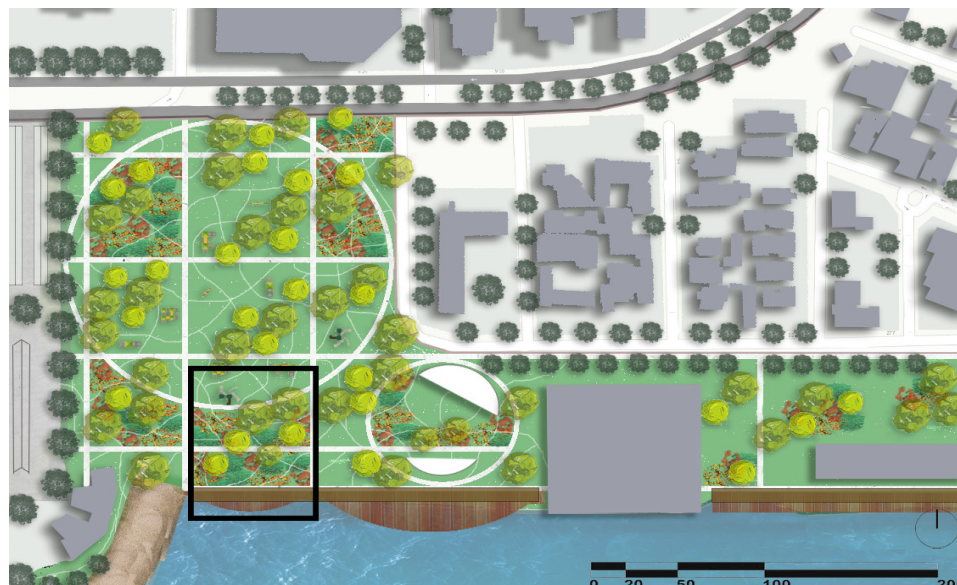


Figure 28: Detail location (Author, 2020)



Figure 29: Detail map (Author, 2020)

5.2 Vegetation and function



Figures 30, 36 and 37 show a visualisation of the square where to different spaces meet. The circular walkway provides a border and is used for sports. On the right hand side, there is shaded seating, looking over flowering areas. The species and their flowering periods are further defined in

Figures 31-35 and Table 2. The playground knows a sandy underground combined with grass as this takes up less heat. The seating elements which surround the playground can be used on both ways, to experience shelter from the wind or to enjoy the cooling airflow.

Figure 30: Visual vegetation and function (Author, 2020)

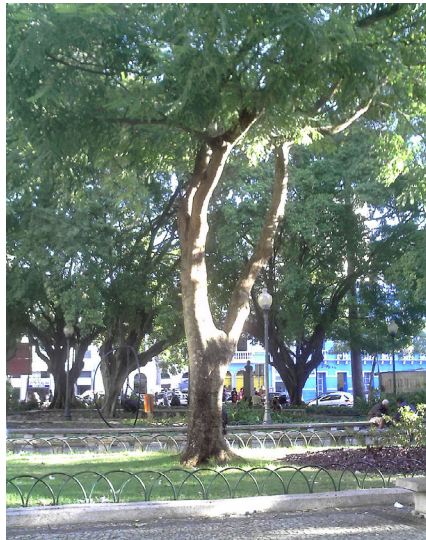


Figure 31: *Paubrasilia Echinata* (www.wikipedia.org, 2020)



Figure 32: *Handroanthus Serratifolius* (www.wikipedia.org, 2020)



Figure 33: *Kniphofia* (www.appeltern.nl, 2020)



Figure 34: *Juniperus Horizontalis* (www.appeltern.nl, 2020)



Figure 35: *Alternanthera Dentata* (www.toptropicals.com, 2020)

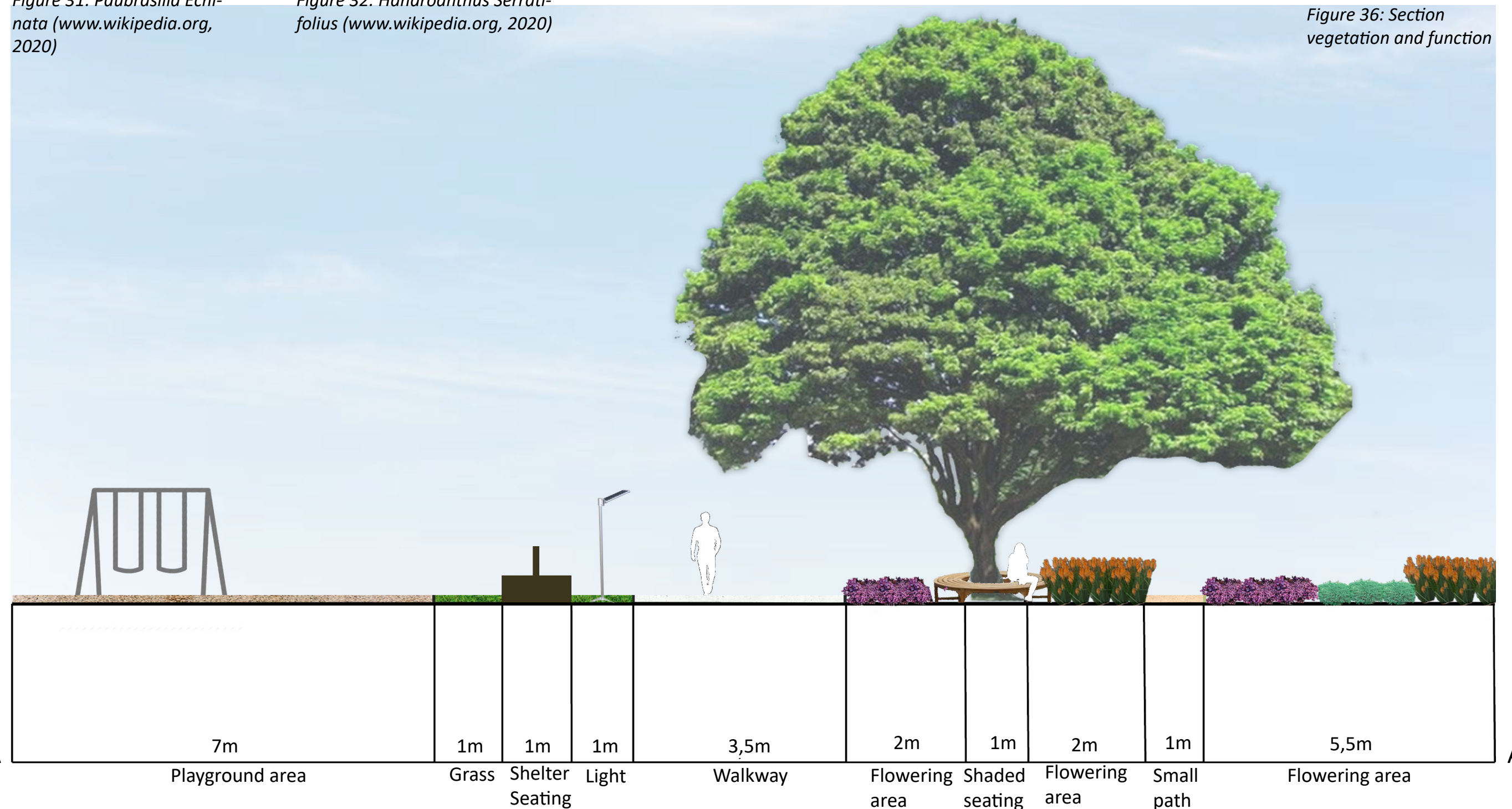
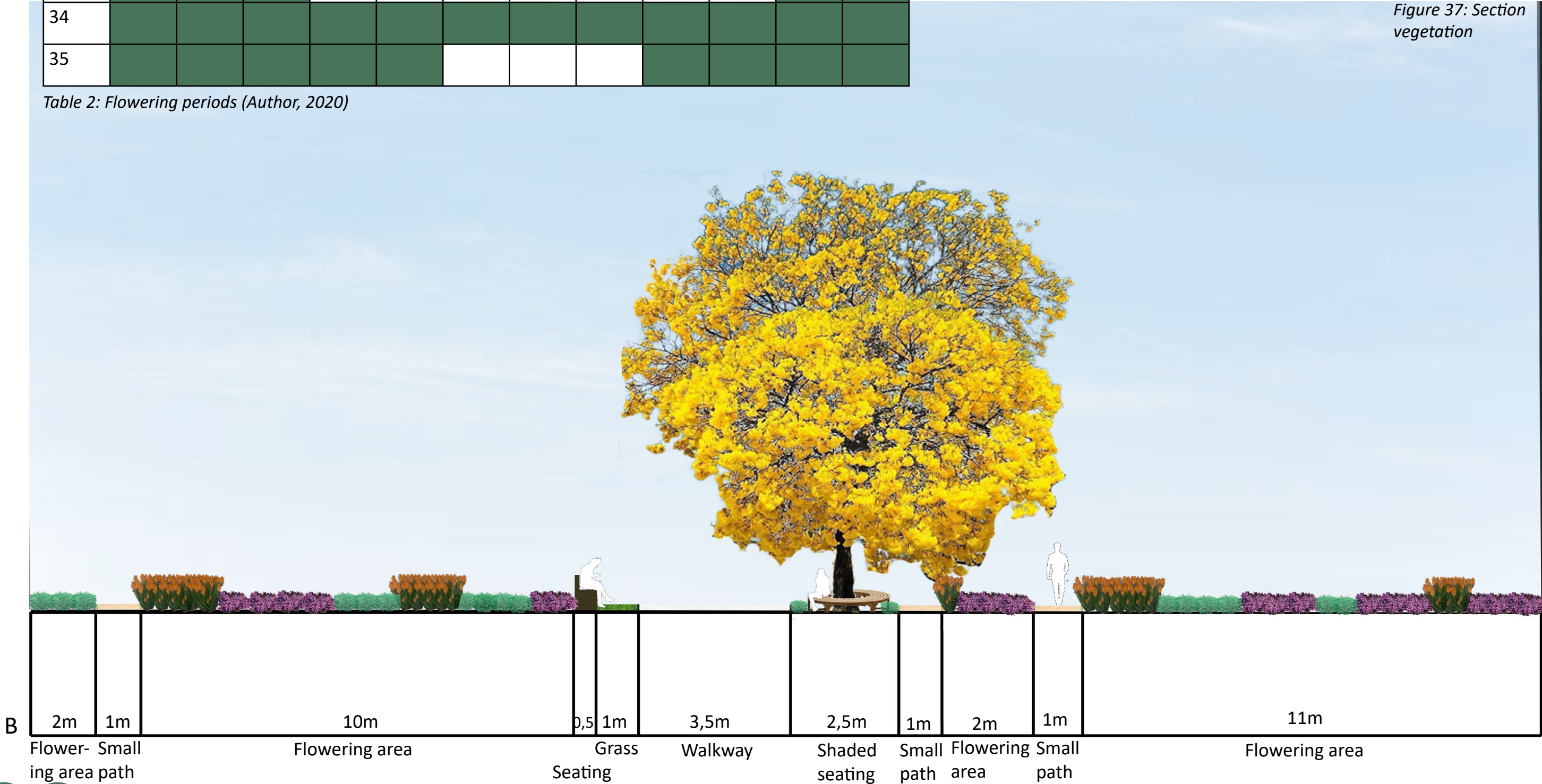


Fig.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
31												
32												
33												
34												
35												

Table 2: Flowering periods (Author, 2020)

Figure 37: Section vegetation



5.3 Waterfront



Figure 38: Visual waterfront (Author, 2020)

The waterfront (Figure 38+ 41) provides an area for relaxation and creates a closer connection to the water. This clearly displays a combination of a pleasant space for people and wind comfort.

The shaded walkway and seating provide pleasant spaces during the warm season and the deck allows people to enjoy the wide view of the bay. By limiting the closed-off area caused by the wooden shading, the connection to the water and the wind flow is maintained. By doing this, a cooling airflow can enter the square and even work into streets perpendicular to it.

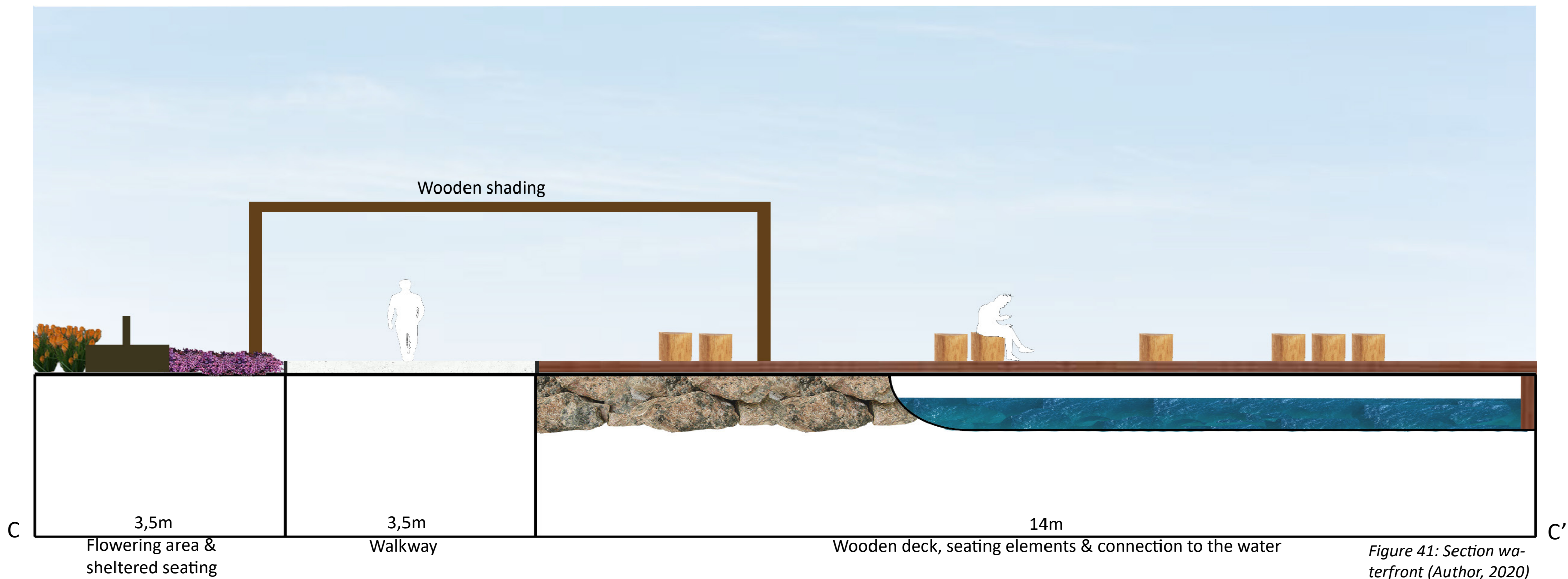
Figures 31 and 32 display the materials used for both the wooden deck and the walkways throughout the square. These specific materials are used because of their lighter density and lighter colour, decreasing the amount of heat they absorb.



Figure 39: Wood (www.webwinkel.noppe.be, 2020)



Figure 40: White concrete (www.cgaxis.com, 2020)



6.1 Discussion

This chapter discusses the literature used to build up the design and reflects on assumptions on which certain design steps are based.

Within the given time span for this research and considering that the design site is in Brazil, all the principles which generally result in people's appreciation of an urban public space are taken from literature. As there was no survey conducted on what inhabitants of Vitória would prefer on the site it is uncertain whether this design will increase the use of the space. Residents and passers-by will notice the changes in the square, but it is questionable whether these are extreme enough to encourage people from all over the city to notice and visit the space.

The focus of the design is on climate adaptation within the city of Vitória and creating a lively space for the public. By choosing this focus, other factors which influence the site have been left out of the research or have not been researched as thoroughly. It is assumed that the design interventions have enough of an effect to make the space more pleasant and climate proof. This is, however, difficult to say as this is based on literature and not on personal experience with tropical climates.

All the maps are designed with ArcGIS Pro data. The information these maps provide can contain inaccuracies or outdated information resulting in small mistakes in the maps. Information on existing facilities and surrounding buildings comes from various websites. Because of this it is always possible that information was missed or that information is outdated.

For the design itself the images have been created with full grown trees. It takes several years for these trees to reach the visualised size which results in a phased execution of the design. The design site is located on a landfill area and thus does not have a naturally fertile soil. For all the planting in the design, it is assumed that the soil is prepared first.

The political situation in the city is complicated and maintenance work in public spaces cannot be compared to the situation in the Netherlands. By including a broad variety of planting in the design it is assumed that this will be taken care of to maintain the outlook of the plan.

The literature on climate adaptive design is broad, but a large amount of this is focussed on the Urban Heat Island Effect. Gathering information on pedestrian wind comfort has proven to be more difficult as this is a subjective parameter which uses many technical details on wind flows and wind tunnels in research.

A lot of practical information used came from the book by Lenzholzer (2013)

which provides a clear outline of designing with the effect of the elements. It contains a lot of specific information on materials and examples of what design interventions can look like. Others such as Marcus Cooper (2000) and Rasidi (2000) provide more general ideas which work well for people in public spaces, but do not delve into specifics on materials.

When given more time to conduct research and create a design it would be interesting to create a space through more participation. Speaking to residents to hear their insights on what the space should be like or obtaining the preferred walking routes through observation. By conducting more research into tropical species, the planting could result in a design which takes biodiversity more into account.

6.2 Conclusion

To answer the design question formulated at the beginning of this thesis project, three sub-questions help to achieve this.

1: Which factors currently obstruct the use of the Praça do Papa?

The factors which obstruct the use were identified through map analysis. There is a lack of facilities and the lack of vegetation and shaded areas fully exposes the square to the elements which makes it unpleasant for people to stay for a longer amount of time. The general Aw climate results in high temperatures in combination with and unpleasant, humid wind from the South during winter months. In terms of accessibility, walking and cycling are slightly obstructed. There are crossroads for pedestrians, but the road that needs to be crossed is at least 5 lanes wide. There is a cycling path along the square, but this is not facilitated throughout the whole city.

2: Which design guidelines can be applied to overcome the impact of climate at the Praça do Papa?

Creating shaded areas cool down the square through the effect of vegetation and giving people the choice to sit in the shade or the sun influences their perception of the temperature because they have an influence on this themselves. With planting, the effect of short-wave radiation is decreased, and the area does not heat itself up as fast as with stone materials. It is important to determine the main wind direction to leave space for cooling wind flows.

Wind flows around obstacles, so trees and other object should not be placed too close together to prevent wind tunnel effects. Next to natural elements, there are seating arrangements with man-made wind shields to create more comfort.

3: Which design interventions are preferred by people in public spaces / parks?

There are several aspects which result in people valuing a space more. Urban spaces with a mixture of private and more public spaces are preferred as well as spaces with a clear function (e.g. sports facility). Walking on paved surfaces and shaded seating make people more comfortable. It is important to make to space visually interesting. This can be achieved by incorporating an element of mystery with the use of biomorphic shapes.

How can design for adaptation to climate factors be combined with stimuli which contribute to an increase in the use of the public space?

The implementation of principles which reduce the effects of climate factors are at the same time beneficial to create a more comfortable space for people and thus increase the use. Creating shaded areas decreases temperature and makes it more comfortable. The effect of wind is reduced by implementing sheltered areas which are also more comfortable for people.

6.3 Reflection

In this section I will reflect on the learning objectives I set for myself at the beginning of this project and the process of creating this design.

Throughout the process I experienced definite improvement with previous design making. The proposal gave me a clear plan and focus for research and I pushed myself to continuously make design decisions and keep moving forward instead of getting stuck on details.

Prevent analysis-paralysis during the starting phase of the process.

The proposal writing largely helped me to prevent analysis paralysis this time. By specifying my research question quickly, I managed to filter out useful articles and information much easier, leaving other topics out. Sticking to my planning and setting up smaller goals every day helped to keep moving forward in the process.

Challenge myself with a less familiar subject

My interest has always been in designing for people's use and the psychology behind this. I always feel that I do not know enough about biodiversity, plant species and climate factors. In this thesis I tried to challenge myself by focussing the design on climate adaptation and combining it with a pleasant space for people which I am more familiar with. In the give time span in feel I have conducted as much I depth research as possible. If given more time, it would be interesting to delve into the technical details of climate adaptive design. This would include the effect of wind tunnels and the specifics of vegetation on temperature reduction.

Create a design with a consistent 'language'

To achieve this goal, I selected a colour palette for a clear language in all the maps. Next to that, I tried to use the same base map. Throughout the analysis I feel I have a clear language and all the maps correspond with each other. For the visuals I found it difficult to maintain a clear language because all images represent different views. For future designs I can develop this skill further as I am not satisfied with my level yet.

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Figure 18: Author (2020)

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