4. Double Trouble

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Abstract

Maintaining the function of the systems and recovering from shocks or chronic stresses is what, nowadays, refers to Urban Resilience. Resilience is a term derived from the Latin verb resilire, which means bounce. It was used as a synonym of resistance in different contexts such as medical, psychological, among others. However, since the 1980s, the concept of resilience was mostly associated with the ecological field and referred to as the capability of dealing with catastrophes (Fooken 2016: 13ff; Voss & Dittmer 2016: 179ff; Wink 2016: 1ff). Currently, it is a topic frequently discussed worldwide due to the Anthropocene, which is aggravating climate change at an accelerated pace. In this context, the term is used to emphasize the constant symbiosis between humans and nature (Prominski 2014: 6ff). The approach of this paper tackles flood risks in a specific neighborhood in the city of Hannover. For that matter, historic events and actions implemented by the municipality, as well as the study of data provided, will be mentioned in this document. After going through a research and discussion phase, the intention is to develop guidelines and propose design strategies to address flood threats at the study case site.

Flooding events and future threats

Nowadays, about half of the world population inhabit urban areas. By 2030, the projection rises this number close to 70% (United Nations 2018: www), representing a threat to natural ecosystems and the damage of natural terrains because of construction. Thus, topics such as Urban Resilience and Adaptive Cycle have become more critical issues to address worldwide, mainly due to climate change. These concepts deal precisely with that process of "bouncing back" of a city in different contexts such as economic, social, environmental, among others (Meerow et al. 2015: 38ff). As mentioned before, climate change -natural shocks and stresses- is one of the risks a city has to cope with. Particularly in this case study, the approach focused on a flood risk area of a neighborhood in Hannover called Südstadt.

The city of Hannover is the capital of the federal state of Lower Saxony, and it is home for approximately half a million citizens (Hannover.de 2019b: www). Its morphology is shaped by two rivers that run through its extension: Leine and Ihme. Leine has around 281 kilometers long and flows across the whole region passing through two big cities, Hannover and Göttingen, and also through several towns. On the other hand, Ihme is relatively small, around 6 kilometers long, and flows into the Leine river in the center of Hannover. As for Südstadt, it is located in the southwest of the city center (see Figure 1), reachable in a short time -5 to 15 minutes- by any public transportation or by foot. Its western limit is the Masch lake, which is an artificial lake built from 1934 to 1936 (Hannover.de 2019c: www). Moreover, the Leine river shapes its western border, and they have a connection between each other. Worth to mention is also that this neighborhood houses around 24 000 residences, making it the second-largest residential area in the city. Furthermore, around 40% of these buildings were built before 1950 and less than 3% since 1990 (Landeshauptstadt Hannover 2015: www).

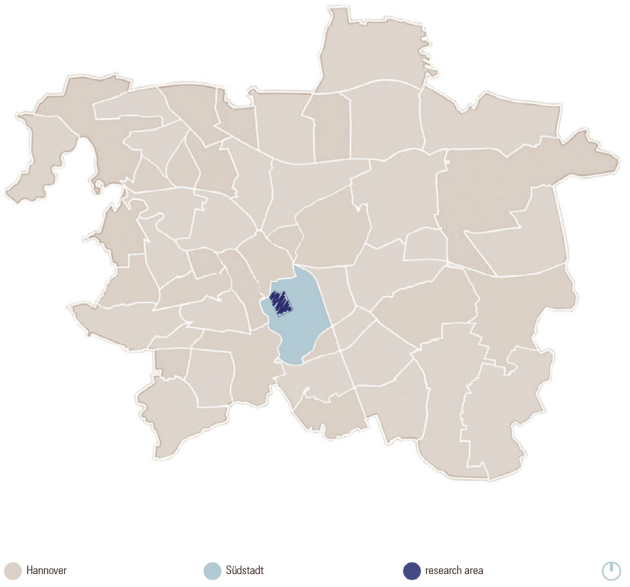

Fig. 1. Location of Südstadt (STS Hannover, 2017)

Flooding events have already occurred for a long time in Hannover; however, in February 1946 the worst of them was registered, turning into an unforgettable catastrophe in the history of the city. On the one hand, there was a major rainfall, and on the other, melted snow from the Harz National Park reached the inner city. Both rivers and the lake were overflooded blocking a large area of the city and 4,69 meters more than the average height of the water level was registered on this event. One of the collateral damages was the destruction of historical documents stored within the building of the state capital archive (Mlynek 2009: 301). In 1981 and 2003, other major flooding events took place in Hannover, reaching again more than a 4-meter high water level in both of them. In 2003, another catastrophe occurred across Europe and the most severe damages registered were in the south center of Germany. On the other side, there were still vestiges from the major rainfall in Hannover flooding event, partly in the north of the city. After that, the City Hall council agreed in 2006 to develop a prevention and

contingency plan for flood areas protected by regional planning. The potentially vulnerable areas are evaluated by the rate of flooding events based on historical statistics. Furthermore, they are divided into four categories: high (HQ25), medium (HQ100) and low probability (HQ200), and extreme event (HQ extreme). The numbers next to the acronyms represent how often an area could be flooded. Consequently, the risk talks about events happening once every 25, 100 or 200 years. The areas that fall into any of the categories are registered as protected priority zones in the Regional Planning Department. Moreover, there are other prevention plans including the excavation of Ihme's ridge and the expansion of the Benno-Ohnesorg Bridge at the Linden district. There are also combined strategies that connect built protective measures, for example, from 2013 to 2014, a levee was constructed in Ricklingen connecting it with the protection walls nearby the district (Hannover.de 2019a: www). Nonetheless, even after the construction of the measures mentioned above, there is still a probability that some protected areas overflood under major rainfalls, especially the south side of the lake. However, it is worth to mention that the water level has not reached 4-meter height again.

Residences, open spaces and the lake

The goal of this case study is to develop strategies to address flooding threats in Südstadt, as mentioned above. The assigned area has around 45 hectares, and before thinking about designing, it was necessary to follow some processes to understand the background, function, and constraints of the site. An essential factor to consider for this analysis was the morphology of the zone. In the same way, land use and connectivity were important factors to be taken into consideration. The first step of the analysis was a short field survey through the streets of the area to build an opinion about it. Afterwards, that information was complemented with data -mapping and statistics- collected from different sources, e.g., regional city planning, official web pages and records from the previous flood events in Hannover. Furthermore, there was information provided by university researchers and representatives of entities, who are either involved or working with floods (prevention, theory, planning, etc.). Subsequently, it was possible to have a general understanding and criterion of the analyzed zone. As a final phase,

there were debates and discussions to propose guidelines for the design of a Master Plan.

The visit through this neighborhood was on Monday afternoon, therefore, the expectation of movement on the streets or inside the houses was low. Mainly, the research area is divided into two uses: public buildings (red shades) and housing (grey shades). Moreover, the residential use covers the majority of the area of this site (see Figure 2). Buildings of private residences with garages below the street level were found as a common denominator. The western border of the area faces the eastern bank of the Masch lake and is configured by the Sprengel Museum (1) and the NDR broadcast (2). Next to it, there is the lake's parking lot (3). Following the path, directly in front of the sidewalk is an open space - sort of a playground - and another building of NDR broadcast (4) just behind it. Closing the corner, there are offices of a children psycho-analysis facility (5) to be found. In general, this border could be categorized as cultural giving that also the lake promenade has a constant movement of people in and around it. Besides that, every year it hosts a summer festival (Maschseefest), which brings not only the attention of Hannover inhabitants but also foreigners and visitors.

Fig. 2. Land use (Base map source: Hannover.de, Open Geodata, 2019: www)

Both lateral limits of the studied area are shaped by two two-way avenues of significant importance in the city (see Figure 3): Rudolf von Bennigsen Ufer (1) and Hildesheimer Street (2). Both streets have a four-lane avenue with a bus line, bike lane on both sidewalks, and on Rudolf von Bennigsen Ufer there is the lake promenade as mentioned before. The subway lines one, two and eight travel through Hildesheimer Street and they transport a large number of people. There is high traffic of vehicles, and it is possible to find all sorts of commercial locals on both sides of this avenue. On the other hand, the rest of the streets within the site can be categorized as secondary and even tertiary. Among them, parallel to Hildesheimer Street, there is the Meter Street (3). Before the major flooding events already mentioned, a tram line circulated through it and, for that reason, it had to be moved to the avenue underground, and the street prioritizes bikers now. Due to this change in the character of the street, it was decided to close the north extreme of it. When flooding happens, the first thing to consider would be the reduction of traffic impact on the streets. Hildesheimer Street would be on the priority to be protected and then the bank of the lake, and the third protected area would be Meter Street.

Fig. 3. Mobility (Base map source: Hannover.de, Open Geodata, 2019: www)

Generally, the area is situated at a range between 48-63 meters above sea level. The site nearby the bank is lower than the inland of the research area, and also there are two lower spots on the Meter street. Looking at Figure 4, it can be noticed that most of the potential flooding areas are naturally the ones almost at the same height as the lake. This indication helps to recognize the vulnerabilities in the morphology and, therefore, possible intervention spaces.

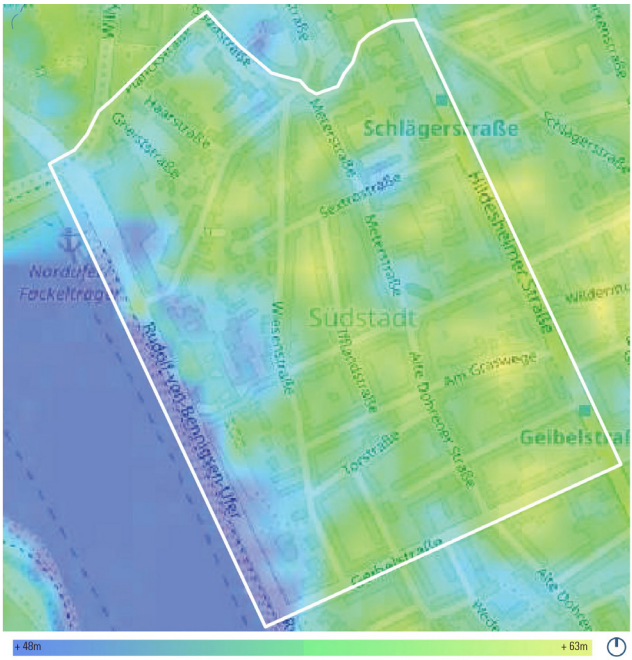

Fig. 4. Topography (Topographic-Map, n.d.: www)

The material of the pavements is also an essential factor that increases flood risks. Inside the sites in the research area, the ground would be separated into two types: permeable and non- permeable pavements (see Figure 5). As a result of the investigation, it has been noticed that most of the residential areas are covered by a high percentage of green surfaces, which have quite a high ability to absorb water in case of sudden rainfall. On the other hand, those non-permeable pavements are sealed by concrete, for example, streets, the base structures of buildings or parking spaces.

Fig. 5. Soil typology (Base map source: Hannover.de, Open GeoData, 2019: www)

The flooding risk map, published by the Hannover government, shows the regular and under extreme events flooding areas (see Figure 6). The red contours represent a medium flood risk (HQ100), which means the areas could be overflooded once every 100 years, as mentioned before. On the other side, the blue contours show the flood-prone area under extreme events and the flooding depth can also be seen on the map. Generally, the areas at risk can be found in two specific zones of the site: the first one along the banks of the Maschsee Lake, with an average flooding depth between 0.75 to 1 meter, and only partly could reach 2 meters. The second one is located between Wiesen Street and Meter Street, and there the average flooding depth is relatively shallow, from 0.5 to 1 meter.

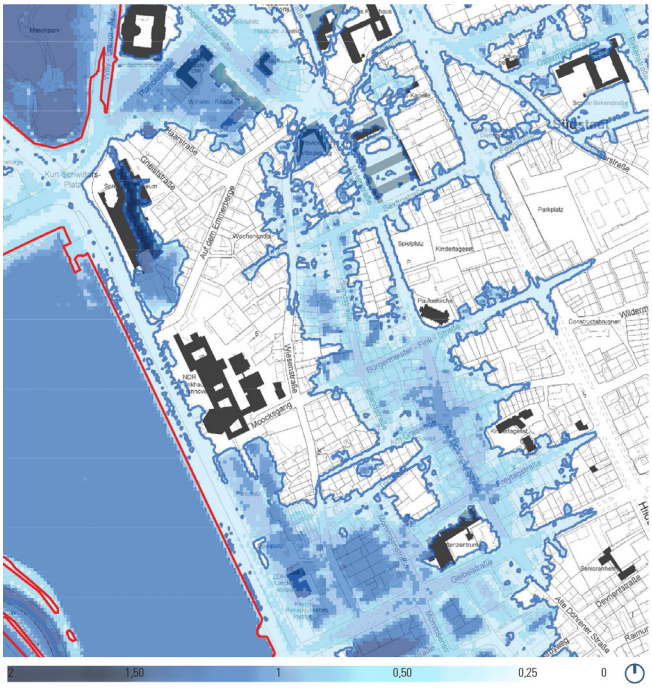

Fig. 6. Flooding risk areas (Niedersächsisches Ministerium für Umwelt, Energie, Bauen und Klimaschutz, n.y.: www)

Configurating axes as shields

After collecting all the information necessary, at this point, it is possible to establish guidelines that will constitute the base for the Master Plan. It will compose the last section of the case study and contains design strategies and measurements dealing with flood risks. This plan will consider all the factors and characteristics that configured the research area.

After the prior processes, it was clear that the area could be facing a double menace: heavy rainfall and overflood of the lake. Giving that the site is designated as HQ100, the potential intervention structuring should be capable of facing this long term risk. On the other hand, short term measures should withstand heavy rainfalls due to the higher probability of this occurrence. With these premises, it was possible to identify two main axes (see Figure 7) capable of facing flooding in case of an extreme event. On one side, the coastal avenue (green shade) that forms the division between the lake's western border and the city. Thus, it plays a vital role because it can delay the water

entering the residence zone in case the lake overfloods. As a second axis, Meter Street (mustard shade) can function as a collector of water in case of major rainfalls. Moreover, in case the first axis can not hold the flood any longer, it becomes a second layer delaying the water entering further into the city.

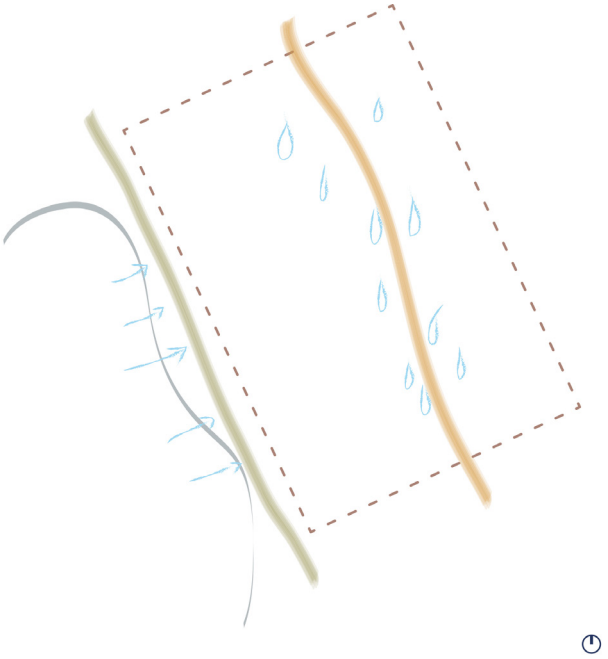

Fig. 7. Two axes (Own depiction)

As mentioned before, the decision was to create these two fronts, which will shape the Master plan in this case study. They have different characters, on the one hand, the coastal avenue (green shade) comprises public buildings and open spaces. Additionally, the closeness to the lake and its frequented promenade turn this axis to a future cultural waterfront. On the other hand, Meter Street, mostly surrounded by private properties and some public spaces, turns to the inland axis in the Master plan (see Figure 8). In both axes, it is proposed to configure a two-layer drainage concept. That first one is a pipeline that will be in charge of collecting water, but most of all, to channel it through the canalization pipes. On the cultural axis -the Waterfront- that line will travel along the lake promenade. On the other side, the pipeline in the residential axis -the Inland- will

have the same function, but the street soil will absorb the water and drain it later through the sewage system. Secondly, it was decided to propose a more organic strategy, which can also improve the landscape of the zone. Both axes use open and green spaces to create that second layer drainage through natural reservoirs. This strategy has an extra feature on the Inland, to connect the open spaces across the axis.

Fig. 8. Master Plan (Own depiction)

The short term measure: Inland

The residential area of the Meter street is located 500 meters away from the border of the lake and, as referred to in the analysis section, it does not belong to the high-risk flood areas. That means flooding events do not exceed 1 meter higher than the average levels, and they could take place due to sudden and intense rainfalls. As a circumstance, the roads can be blocked, as well as pavements and public open spaces, not only because unsealed surfaces can not absorb surface water, but also because drains are sometimes not for evacuating the excess of water. Therefore, as a complementary measure of the city drainage system, water is driven to sealed ground,

which should have adequate capacity for absorption and then its drainage through a sewage system. It is no coincidence then, that the lowest parts of the area function as squares today. Nevertheless, these spaces have not enough capability of absorption, and this lends a substantial functional burden onto them. For that reason, the design proposal is to implement anti-flooding strategies to increase the resilience of the area, towards the climate change that sooner or later will affect the inhabited zones.
As it has already been mentioned, to avoid smaller floods, which have to be quickly and silently stopped, the so-called short term measures will be in charge of evacuating the overflooded areas.

Looking closer, the connection of the green spaces and the public buildings of the old tram route, as it has been proposed before in the Master plan, will have a meaningful impact on the urban character of the area. For that matter, the proposal is to establish a small cultural and public core that can simultaneously be a historic reminder - of the street as the primary connection to the South - and bring a new character to this axis within the residential district.
Specifically, the measures are going to be applied by the following actions:

As a main conceptual urban axis, the Meter street should be unsealed and the material installed on that surface must be permeable, which allows water to be absorbed by it and, simultaneously, be evacuated through the sewage system. At the same time, this highlights the public character of the axis.
Moreover, the street becomes a low-velocity one, maintains the current lane priority for bikes and hosts a broader path for pedestrians. Additionally, there is the possibility that this axis becomes the host for different types of public and collective activities (flea markets, street concerts, cultural events, among others). Besides the spatial connection, the intervention could unify, promote interaction and interest of the residents and not just of possible visitors.

As for the elements that shape this public lane, it is proposed the re-design of the two playgrounds and the area in front of the

Paulus church (see Figure 9), with the main purpose of giving them a versatile function. The main idea for this measure will be to save rainwater more than avoiding flooding, an inspiration that relies on the concept described in the Water Square Benthemplein, designed by De Urbanisten in Rotterdam, Netherlands (De Urbanisten n.d.: www)

Fig. 9. Plan Inland (Own depiction)

For that matter, it is proposed the configuration of slopes in the open spaces already mentioned before so that they can be used with a double purpose.When the surface is dry, they function as public spaces (stages, playgrounds, skate areas, etc.). On the other hand, if a sudden rainfall occurs, they will immediately become retention basins, containing and absorbing surface water. Furthermore, when the rain stops, a drainage system drives the water away from the basins at a controlled pace to avoid overflooding the canalization, and the primary function will be restored (see Figure 10). Finally, the material to be used in these spaces will be the same as the one on Meter Street to present them as an extension of the road.

These urban interventions will have an enormous impact on the area, which is why it is extremely important to take into consideration all the factors that could be affected by them and, most importantly, how they could adapt through time.

From this point of view, strategies used in this case study should deal, not only with the resilience of the city towards climate change but also with the character of the surroundings to prevent other kinds of problems such as functional, cultural, issues of heritage, among others.

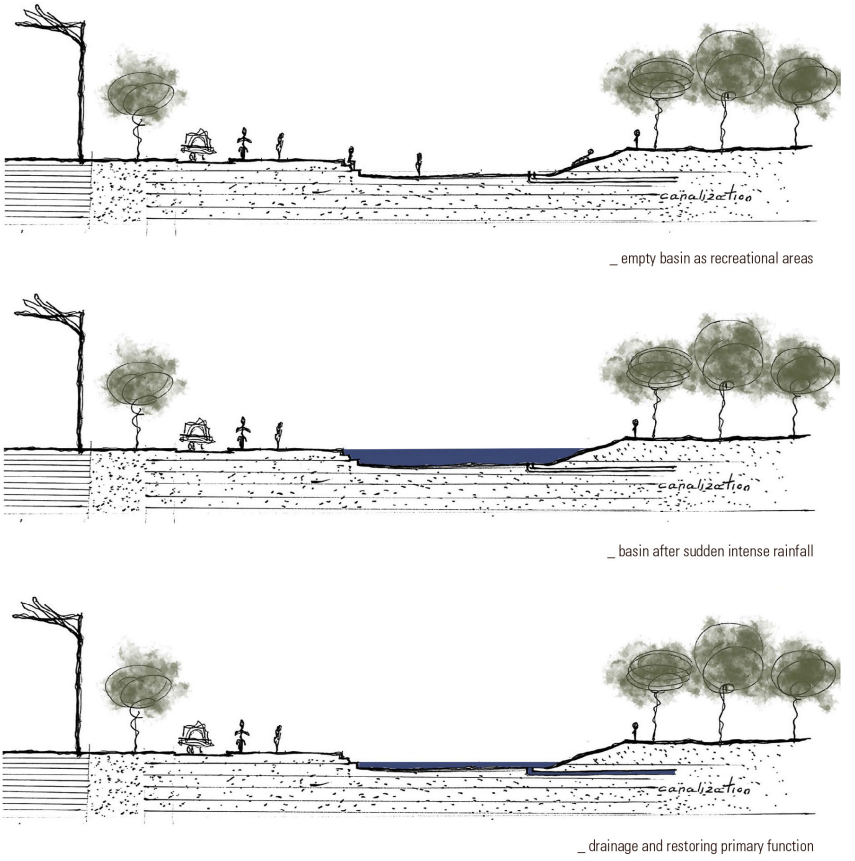

Fig. 10. Sections Inland (Own depiction)

The long term measure: Waterfront

The aim of the long term measure is not only to deal with the flood but to strengthen the natural and cultural dynamics of the area. Spatially, the core idea is to divide the axis into three anti-flooding zones. The Maschsee lake represents the first buffer zone, in the case of the overflood of the Leine river. However, if besides the lake's overflood there is an extreme weather event (strong precipitation), probably, the lake would not be able to contain the excess of water.

For that reason, to cope with this type of condition, it is proposed the construction of a 0,5 meter- high natural slope, which will surround the lake's bank like a ring. In case those measures are still not enough to prevent the water from coming into the residence area, the proposal is to create two anti-flooding zones close to the Rudolf von Bennigsen-Ufer street (see Figure 11).

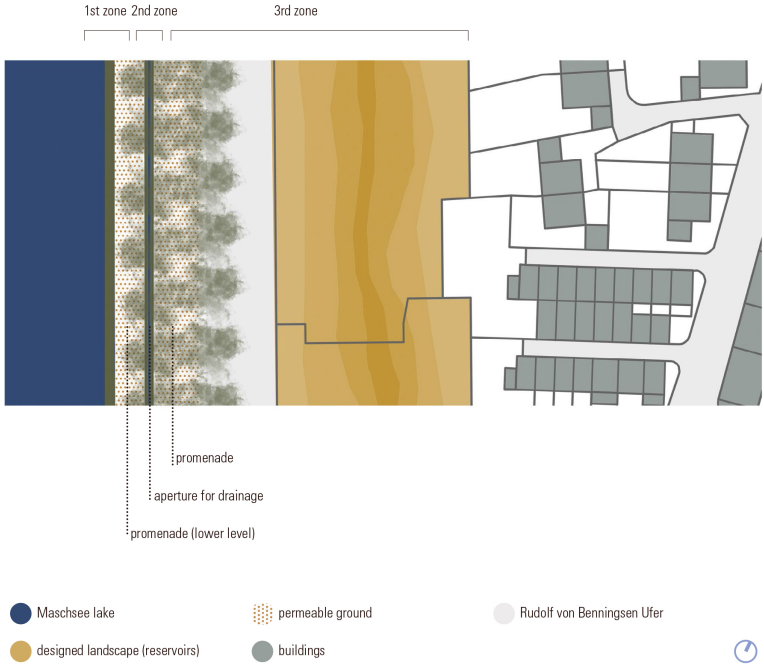

Fig. 11. Plan Waterfront (Own depiction)

The interventions in the first and second zone are slightly connected, so it makes sense to present them together. The one in the first zone aims to transform the existing conditions, from a natural permeable border to a new strong wall of 0,4 meter-high. The objective of this strategy is to stop water without destroying the lake banks during a flood event. Moreover, during the drying period, it will be like a bend that frames the promenade and embellishes the site. Finally, the remaining water in the first zone will run off naturally due to the permeability of the ground.

The second zone will be an open gutter driving the overflooding water to an underground tank (see Figure 12). The opening of the gutter will be on the first zone wall, shaped by a double wall aperture. The underground tank is circular with a 2-meter diameter. Furthermore, the function that serves the second zone has a double benefit. The first one is to trap the water in the tank if

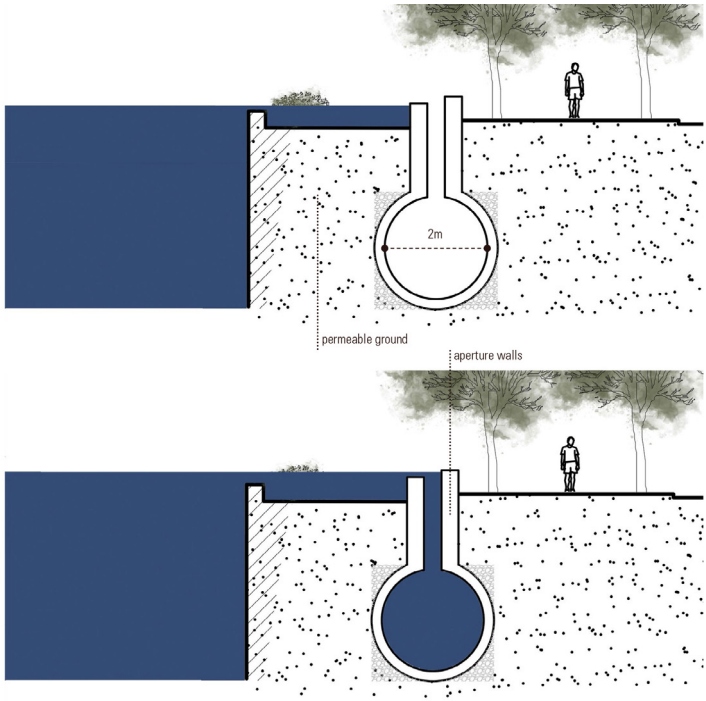

Fig. 12. Gutter and underground tank (Own depiction)

the first zone overflows. It will be driven away through the sewage system avoiding the flooding of the area, as it could happen without the tank. The second one is that, even in case of a huge overflow, when both zones are not enough to bear it, then it will reduce the amount and speed of the water flowing into the city, providing a time advantage to evacuate the area. Moreover, the walls of the gutter separate the two anti-flooding zones and can feature both of the promenades as recreational spaces, which can also safely host cultural events, as it is already happening every year in August with the summer festival Maschseefest.

For the last zone, the proposal, as mentioned in the Master plan, is the formation of reservoirs across the Rudolf von Bennigsen Ufer. After analyzing the land use in this area, it was noticeable that there is enough free space, such as parking or open spaces, to set these retention basins, which can retain water in case of an extreme flooding event. The morphology of this zone is the main advantage for the design measure giving that it is at the lowest topographic level of the research area. For that reason, water could naturally be driven there. Moreo-

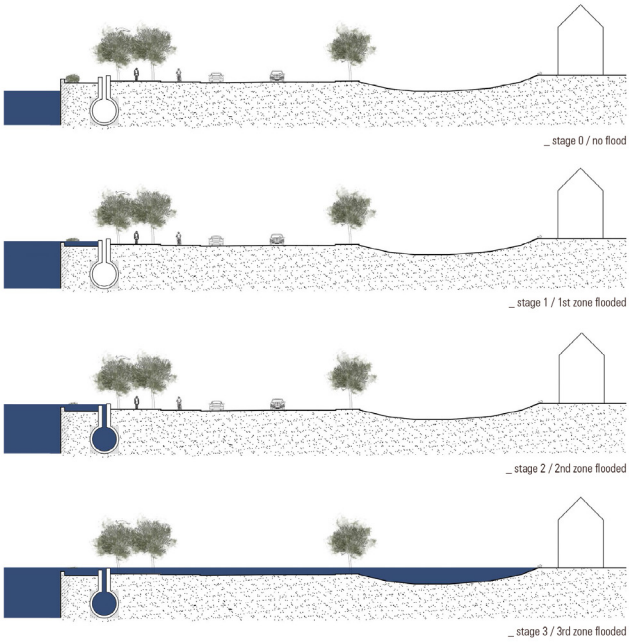

Fig. 13. Sections Waterfront (Own depiction)

ver, the avenue separates the third zone from the first two. Thus it is possible to use also that surface to collect water in case of an extreme flood event. The assemblage of the Waterfront zones creates an extension of the lake's promenade, which inhabitants and visitors can use as open spaces. The idea beyond the design is to create natural reservoirs with the same function of the retention basins in the Inland axis. Their purpose is to collect and absorb the rainwater and, when they are empty, transform into recreational areas. Besides, they will be hosts of a variety of flora and fauna enhancing the landscape of the neighborhood.

Conclusion

As an overview, this case study focused on adjusting present conditions to future circumstances and coping with possible natural disasters. Moreover, the proposal of organic strategies will face not only flooding events, but also transform the character of the neighborhood landscape. On the other hand, to increase the resilience of an area, the design strategies encompass the determinants from the previous analysis of the site. Giving that the plan depicted in this document benefits inhabitants and the city, it possible to think that the government can look at this as an investment. Hence, the interventions could become pilot projects or urban tools, which could be replicated in different areas of the city with similar conditions or circumstances. Some questionings emerge during the design phase of this research, for example, while thinking about the conception of a cultural axis as an extension of the lake's promenade. How is the lake border going to interact with the sidewalk across the street? Will inhabitants use these public spaces, or will it become a residual area? And, on a bigger scale, by implementing new land uses in the site, would it affect its residential character? Everything was taken into account while designing, and it was important to collect diverse information from different profession fields to acknowledge the urban structure of the research area and develop the most pragmatic interventions. In other words, resilience considers not only the climate but also the general transitions of the urban structure and human life. Climate change is a reality that will gradually be experienced in all cities worldwide and will affect the urban structure, urban habits and, of course, the way of living of the inhabitants. Sudden rainfalls, extreme amounts of water falling from the sky to the sealed surfaces and overflow

of the water bodies are probably going to influence everyday life as we currently know it. Both natural phenomena may seem like a threat today for the existing situation. Nevertheless, by applying the strategies that have been proposed in this case study and changing some of the standards, it is possible to cope with the difficulties as a society and teach ourselves how to treat better the source of life called Earth.

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