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A working landscape for New Orleans

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Abstract:
This paper studies how strategies aiming at working landscapes can simultaneously improve stormwater resiliency and spatial quality in two suburban neighborhoods of New Orleans that were hard hit by hurricane Katrina in 2005. A spatial strategy mitigates stormwater flooding problems during a 1/10-year storm event and explores the potential of water as an amenity in the city.

The paper identifies the need for a new approach by quantifying problems concerning (1) hydrology, (2) vegetation and (3) vacancy. Based on topography, subsidence rate, problems with rain flooding and the original appearance of the landscape, 4 landscape zones are distinguished that provide basic concepts for interventions on all scale levels, addressing the 3 problems stated above. A new water plan for the area based on retain-store-discharge principles and a robust network of native vegetation form a new landscape framework. By utilizing the empty space(s) due to vacancies following the hurricane to serve as water storage, this problem turns into an opportunity to re-create attractive residential areas with a high quality of life.

The results of this study illustrate how preparation for the future and a changing climate pose challenges, but also offer opportunities for the creation of attractive delta cities.

Keywords: *Working landscape, New Orleans, stormwater flooding, landscape architecture, water management.*

'Water as an amenity' as strategy for a delta city that suffers from stormwater flooding.

Introduction

Deltas are highly dynamic landscapes, and subject to constant change. As a result, human intervention and innovation has always been necessary to safely live and work in deltas. The location of an urban region in a delta brings prosperity and economic wealth, but at the same time there are disadvantages and challenges to be overcome. Being low-lying areas, deltas

are prone to flooding by the rivers that form them, large volumes of rainfall - typical of coastal climates -, and storm surges from the adjoining seas. The rapid urbanization of the world's delta puts natural resources at risk and amplifies possible consequences, both economical and psychological, in the case of disaster (McGranahan *et al*., 2007). The recent concerns about climate change and socio-economic trends of progressing urbanization and continuing investment make life in the urban delta even more complex, and a sustainable strategy for dealing with water in urban deltas all the more relevant.

New Orleans, located at the mouth of the Mississippi river (see fig. 1), is a typical urban delta city. Like many delta cities around the world, historically the city has a two-fold relationship with water as both a resource and a threat. Since hurricane Katrina devastated the city in 2005, the Dutch Dialogue workshops – initiated by local architect David Waggonner and the Royal Dutch Embassy - US and Dutch professionals have engaged in an exchange of knowledge exchange aiming for new harmony in the landscape, equally inspired by Dutch water cities and a love for 'the big easy'. Continuing on Dutch Dialogues II (please refer to Meyer *et al*., 2008) and providing input for Dutch Dialogues III (April 2010), this paper explores how a transformation of the New Orleans' storm water system can increase stormwater resiliency, provide a climate-adapted future, and at the same time contribute to the revival of the city.

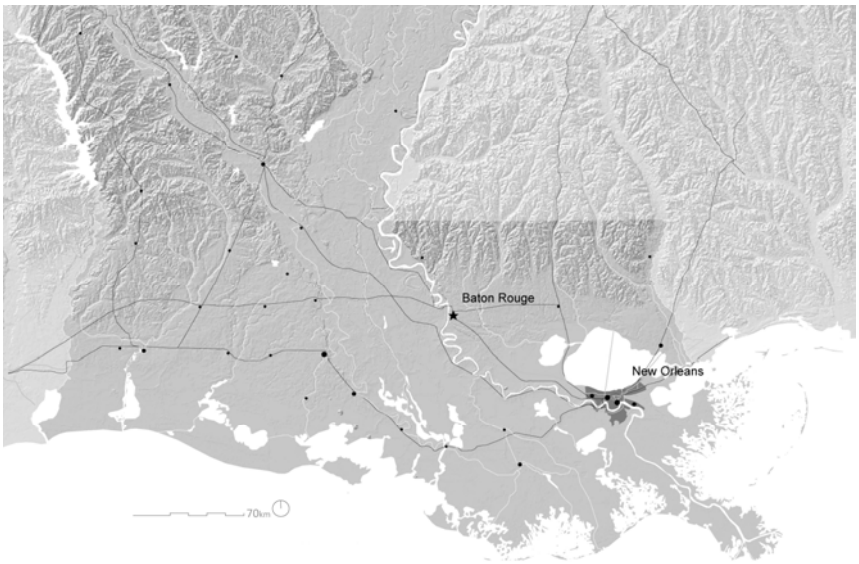


Figure 1. *Louisiana and the Mississippi deltaic plain.*

Today's state of affairs in New Orleans

It has now been well over 5 years since Katrina struck the South Louisiana coastline near New Orleans, flooding 80% of the city up to 3m (Campanella, 2008), and forcing virtually all citizens to evacuate. Since 2005, 15 billion US Dollars have been invested in a hurricane risk reduction system on the perimeter of the city, built by the U.S. Army Corps of Engineers. Once completed in 2011 it will provide protection against 1/100-year storm events, and is designed to withstand a 1/500 year storm event without catastrophic failure (USACE, 2008); a better than ever before safety against hurricane threats. These considerable investments however, do little to improve the

day-to-day quality of the living environment for the residents of New Orleans, which varies greatly related to topography. A two faced city can now be observed behind the dikes:

The historical parts of the city, located on higher grounds, again do well. Flood elevation levels were low here and the population is close to the pre-Katrina levels. Again the same lively, festive and easy-going atmosphere is buzzing through the streets. These neighborhoods provide the lush greenery, rich experiences, colonial architecture and bustling nightlife; all that New Orleans is famous for. However elsewhere large parts of the city are by all means still severely damaged. It is in the low-lying suburbs, the former back swamp of New Orleans, where the city's problems are concentrated, the lack of landscape quality is most manifest and interventions are most needed. The Gentilly and Lakeview neighborhoods are typical examples of such low-lying areas and form the focus area of this study (see fig. 2 & 3).

***Figure 2**. 61,310 Residential addresses (29%) vacant or unoccupied (GNOCDC, 2009)*

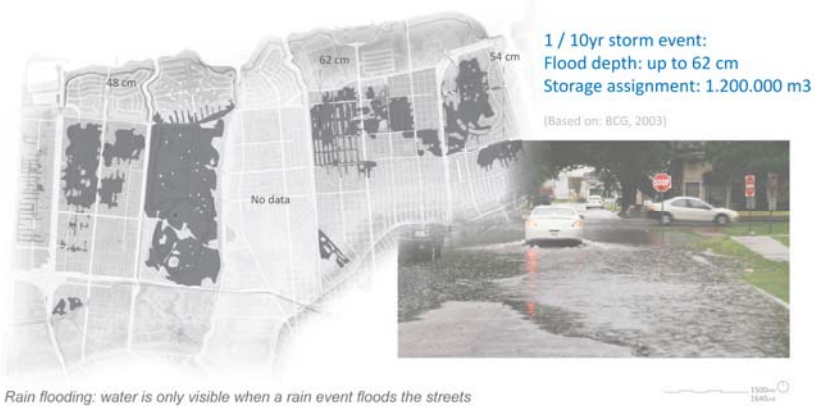
***Figure 3.** Study area and topography, (LSU, 2000)*

Lack of landscape quality

Being landscape architects we have tried to tackle four main problems in these areas, which together determine this landscape quality: rainflood events, subsidence, the permanent consequence of vegetation loss, and vacancy and its resulting changes in atmosphere of the neighborhoods.

1) In New Orleans extreme precipitation events - with interior floods as a consequence - have occurred frequently in the past decades (Faiers *et al.,* 1997; NASA Earth Observatory, 2007). The city has a sub-tropical climate; average monthly temperatures in the city range from 12 to 28 °C and average annual precipitation is approximately 1572 mm (1961-1990). Rainfall is extremely intensive; rainfall in excess of 75 mm in 24 hours, or 100 mm in 48 hours is an almost annual event in the city (Stuurman in: Meyer *et al.*, 2009). The effects of climate change mean that New Orleans has to prepare itself for even more intense rainfall events - based on in situ observations Groisman *et al.* (2004) observe a linear trend of an increase of 26% during heavy precipitation events - separated by longer periods of drought (Boesch, 2002).

Already today, the large volumes of rain in short time periods often exceed the capacity of the outdated and broken storm water system in the city, inflicting nuisances and large amounts of property damage (US Army Corps of Engineers, 2009, NWSFO, 1997). Fig. 4 shows the floodwaters during a 1/ 10-year storm event, which can rise up to 60cm in the study area (BCG Engineering, 2003).



Rain flooding: water is only visible when a rain event floods the streets

Vegetation loss: fragmented structure and barren streetscapes

Perforated city fabric: vacancy is related to topography and results in deserted and neglected atmosphere. Grey plots are occupied. Small contramal shows empty plots in red

Figure 4. *Lack of landscape quality*

2) With an at-the-time world-class drainage system the swamps and marshes at the fringe of the city were drained at the beginning of the 20th century. Since then, fast discharge, a deep drainage regime and only small amounts of open surface water result in a low groundwater table, dry soils and consequently subsidence of these now urbanized, former 'backswamp' lands (USACE, 2006). Originally located slightly above sea level these lands have now fallen up to 3m below sea level, causing them to suffer the worst from Katrina's floodwaters (Campanella, 2008). The subsidence resulting from soil settlement complicates the draining of the city and worsens existing water problems by shifting subsurface drains and canals, loosening joints and causing leaks, breaks, and bottlenecks in the system. Also subsidence causes substantial damage on roads and sidewalks.

3) Both the strong winds and the brackish flood waters of Katrina destroyed 70% of the urban canopy, an estimated total amount of 100.000 trees. The loss of the urban canopy leaves the city far more susceptible to storm water and wind damage during future storms, and negatively impacts the microclimate through a lack of shade during hot summers. The remaining fragmented green structure and barren and deserted looking suburban landscape offers little to no opportunities for local fauna. Additionally the hurricane decimated the tree stock and nurseries in all of South-Louisiana, hampering recovery (Lerardi, 2008; HikeforkaTREEna, 2009).

4) Heavy emotions after Katrina and unsupported plans for urban renewal led to a 'laissez-faire' policy following the storm; a strategy focused on short-term recovery. Today, 20% of the New Orleanians have not returned (Times-Picayune, 2009) and it is questionable whether they ever will, as people have rebuilt their lives elsewhere in the U.S., leaving their lots empty, overgrown or in ruins in what were once thriving middle class suburbs. The resulting striking image of a perforated urban tissue with closed schools, unoccupied grocery stores, and scattered inhospitable structures has a detrimental effect on aesthetics. Large numbers of inactive plots give parts of the area a feeling of neglect and desertedness. In this condition, the poor urban environment not only provides limited possibilities for natural life, but also fails to inspire the human mind, and does not offer reason to pass time in the public space. As vacancy is strongly related to topography it is most significant in the lowest areas, which sustained the most damage during the storm. In Lakeview and Gentilly over 30% of the residential plots are currently unoccupied, with some neighborhoods close to a 50% loss of inhabitants (GNOCDC, 2009).

New normal conditions

It is important to realize that the situation in New Orleans today is a 'New Normal' condition, no longer solely related to the recovery from Katrina (Campanella, 2008; GNOCDC, 2009). The stabilizing rates of return (see fig. 5) imply the perforated tissue will not heal on its own accord and needs a structural rethinking. At the same time however, it offers opportunities for changes in water management.

21st Century Urban Water Management

A paradigm shift can be observed regarding the way we relate to water. Since the 1980's and 1990's new developments regarding ecology, global climate change, and risk management have created a shifting approach towards water management. While traditional water management focused

purely on safety through technical interventions, a much broader approach that incorporates ecology and spatial planning has now become dominant. In this '21st century water policy' it is increasingly recognized that an integrated approach towards the disciplines of water management and spatial design together can address water-related problems more adequately and at the same time enhance spatial quality. Instead of seeing water solely as a threat, the potential of water as a tool to create a sustainable environment with high spatial quality is acknowledged (Commissie waterbeheer 21e eeuw, 2000).

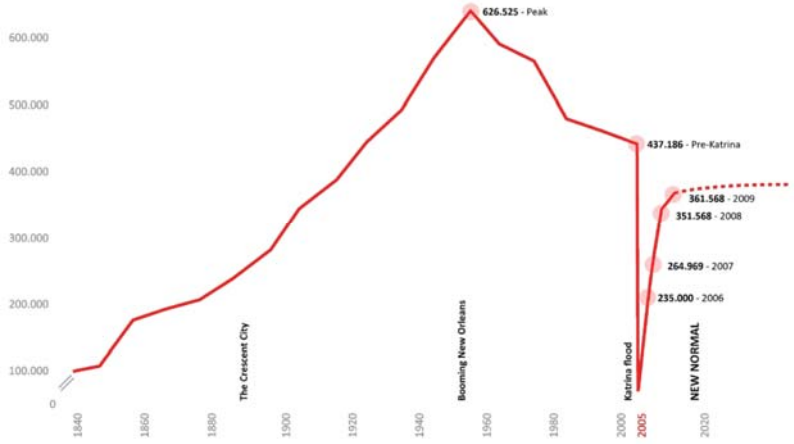


Figure 5. *Stagnating rates of return. (Campanella, 2008; Times Picayune 2009)*

Next to integration in spatial planning, challenges associated with a changing climate require 21st century water management to be flexible in order to withstand unexpected events in the future. Therefore the aim is to reserve enough space for water, maintain sweet water reservoirs and oppose drought through working with what nature has to offer. Inclusion of ecological processes is strived for, and technical interventions are proposed only when 'soft solutions' are not adequate or possible' (Commissie waterbeheer 21e eeuw, 2000). One of the ways this paradigm articulates itself in relation to storm water is the 'three-stage-strategy':

1) *Retain* stormwater as close to the source as possible. This relieves area's elsewhere and opposes water shortages in dry periods,
2) *Store* water that cannot be retained in retention area's such as ponds, swales, wetlands or other water bodies, where it has an additional purpose,
3) Only when retaining and storing capacities are no longer adequate should the water be *discharged* from a local water system into a regional water system.

Instead of a static system which confines water to be removed quickly from the city, these principles illustrate a dynamic strategy and physical environment in which there is more room for water to move, and water levels are allowed to fluctuate. Water is guided to where we want it to have additional purpose. One of the best examples of such an approach is *Waterplan 2* for the city of Rotterdam (Municipality Rotterdam *et al.*, 2007). The document combines possible solutions for Rotterdam's water challenges for both it's short-term problems, and the adaptation on the long

run to the consequences of climate change, with the ambition to make Rotterdam a more attractive place to live. The city brands itself as a delta city in which the water is part of its (renewed) identity. People feel more comfortable in an identifiable environment to which they can relate (Norberg-Schulz, 1980). It offers people a sense of place and prevents alienation from the city that one person lives. Additionally, such *legible landscapes* engage people with the landscape and its issues, and the processes and systems shaping it. By bringing people in close contact with their natural environment, public awareness and community support can be created for the substantial transformations our cities will have to undergo in order to adapt to complex environmental issues such as climate change. Nassauer (1995) and Saito (2007) among others, therefore plead for the uncovering of invisible ecological processes in an active representation for human experience. Landscape is a tool to achieve such social engineering and this is another reason for delta cities to combine the benefit of open water with the necessity to provide more room for stormwater in the city's fabric.

Figure 6. *Westersingel Rotterdam. The city brands itself as a delta city (Photograph by authors, 2009)*

Water management in New Orleans

Compared with an average store/discharge ratio of 9:1 in the Netherlands (Hooijmeyer *et al.*, 2005) the drainage system in New Orleans - with a 1:1 ratio - is highly dependent on discharge. The system is still mainly made out of the historical system put in place at the beginning of the 20th century and aims for an as-fast-as-possible discharge of its storm water through heavy-duty pumps with enormous capacities (up to 350m^3/s) (USACE, 2008). The pumping stations in place are not able to fully utilize their enormous pumping capacities though. The pumps can theoretically pump 0,77" – 1,13" of storm water out of their catchment areas per hour (USACE, 2007), much higher numbers than the 0,5"/h of the commonly applied rule regarding discharge of the New Orleans drainage system (USACE, 2009). This implies frustrations in the system upstream of the pump. Furthermore the torrential rainfall in New Orleans is of such magnitude that even if the storm water could be delivered to the pumps without frustration, the peak discharge of the first hour exceeds their capacity, see table 1 (USDC Weather Bureau, 1961).

The frequent rain flood events prove that the strategy based on discharge is unsuccessful. In this sense, the technocratic system not only functions inadequately, but also is also conceptually outdated for it relies on fast

discharge and hard tech civil engineering alone. Measures aimed at retention and storage of water, combined with an ecological approach to water management, do currently not play a part in the technocratic system of New Orleans (see fig. 7). Practice in New Orleans today is thus noted to be different from the trend in contemporary water management as outlined above. It belongs to a paradigm characterized by a fight *against* the water and nature in general, this in contrast to contemporary thinking which is increasingly common in the Netherlands and abroad, and seeks to work *with* nature, aiming at mutual benefit and to profit from open water as quality in the city's public space (Commissie waterbeheer 21e eeuw, 2000).

Table 1. *Storage I discharge ratio's.*

I(t) * C - Q(t) = S I = Runoff (Rain-Infiltration) + Seepage Seepage = unknown	Q (l/s/ha)	Q (*/h/ha)	Required Storage 1/ 10 yr (%)			Required Storage 1/ 100yr (%)		
			1h	6h	24h	1h	6h	24h
NL Similar Situation (1,5 l/s/ha)	1,5	0,02	7,7%	14,0%	[illegible]	10,9%	21,1%	[illegible]
MO Rule of Thumb (0,5" /h)	35	0,5	[illegible]	-0,4%	-39,6%	[illegible]	6,7%	-28,6%
MO PS#4 Current Capacity (3720 cfs)	55	0,77	[illegible]	-9,1%	-73,5%	[illegible]	-2,8%	-62,5%
MO Mile Q | 50% available storage after 24 hours (1/ 10yr)	9	0,13	7,2%	[illegible]	5,9%	10,6%	[illegible]	15,9%

Rainfall data (USDC Weather Bureau, 1961)			
Stormevent	1 hr	6 hrs	24 hrs
1/ 10yr	3,37	6,32	9,26
1/ 100yr	4,75	9,38	14

(C) Runoff Coefficient	Freeboard (m)	dH(max) (m)
0,457	0,9	0,5

Because virtually all drainage infrastructures in the main Metro polder of New Orleans are submerged, covered, or hidden by floodwalls, water is barely visible to the residents. Large parts of the city can be characterized as consisting of nearly 0% open water, providing little to no resemblance to the native habitats of a delta city. This in contrast to Dutch delta cities where discharge/storage proportions mean that by law up to 11% of the land can be required to be open water (Hooijmeyer *et al.*, 2005). With few or no links to their natural environment, the citizens in New Orleans become detached and unaware of the landscape they live in.

Figure 7. *Technocratic watermanagement: subsurface drains, deep drainage regime, discharge dependend system, floodwalls. (Sewerage and Water Board of New Orleans, unknown date; Hooijmeyer et al., 2005; USACE, 2009)*

Future Perspectives – A working landscape

Just over five years after the storm the unique situation in New Orleans means that it is now time for a long term and integrated strategy aiming at the revival of the city. Major disasters cause devastation on the one hand, but create opportunities on the other. Hurricane Katrina in this sense was also an eye-opener. The reconstruction of the resulting perforated urban fabric now makes it possible to structurally transform the New Orleans water system. While flooding problems are far from uncommon in delta cities, the unique situation in New Orleans represents a chance to structurally improve the city's storm water resiliency and at the same time contribute to its revival.

To this end the huge amount of space left vacant after hurricane Katrina should be considered both as a necessity and a chance to introduce extensive surface water and green structures of native and storm proof vegetation in the Lakeview and Gentilly neighborhoods. By creating more room for water and reforesting the city, both the city's water problems can be addressed and its living environments—and thus attractiveness for residents—can be improved. This paper proposes a transformation process aimed at a *working landscape* with a re-envisioned storm water system based on contemporary 21st century water management as its backbone (Commisie waterbeheer 21e eeuw, 2000). Such a working landscape works two-fold:

Perform: in working landscapes, the aim should be on the inclusion of landscape processes, with as target a healthy and vital system that prevents nuisances and is productive. This means cooperation with and use of these processes in a symbiosis, without blocking or frustrating them, with environmental problems as a result.

Inform: a working landscape should engage in interaction with the human perceiver, and trigger the human imagination and creativity. A design must not only be beautiful in the aesthetic sense, but also enrich people with facts, stories and thoughts, by revealing richness and dynamics in the landscape. As such landscape is a tool to create a sense of belonging and identity.

A working landscape in this way may turn these low-lying areas into attractive and distinctive suburbs that New Orleans and its inhabitants so rightly deserve.

Research by design

The landscape architectural design forms an important part of this research, for only the creation of a design allows for conclusions whether the introduction of surface water in the perforated urban fabric is both possible and sensible, and thus is a valid concept.

The proposed strategy for New Orleans finds its inspiration in the richness of the surrounding original landscapes of the Mississippi delta, which are structured by a topographical gradient. Hardwood forest is found along the higher grounds of (former) riverbanks, followed by brackish bald cypress and tupelo swamp forests with saline marshlands closest to the sea. In the suburban area of Gentilly and Lakeview four landscape zones are revealed that refer to those original landscapes, and are further based on topography, subsidence rate, and problems with rain flooding. A fourth zone consists of a manmade landfill in the north of the study area. The zones provide basic

concepts for interventions on all scale levels, addressing the problems stated above. The zones can be recognized in the bottom layer of figure 8, where the dark green is the hardwood forest zone of the natural levees and the brown color indicates the man-made landfill zone. Each landscape zone has its own strategy regarding hydrology and vegetation. In the lowest areas more space is reserved for open water in large surfaces and branching networks, while on the higher grounds infiltration in wadi's (swales) and a higher building density are the main principles. An integral approach towards spatial development ensures that investments work towards more than one end at the same time.

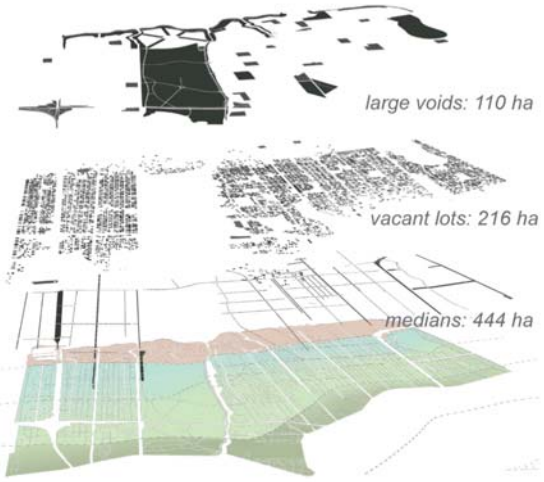


Figure 8. *Design space and landscape zones*

Waterplan

A vital part of the transformation is a new strategy regarding water management, advocating an interconnected surface water system based on the three-stage-strategy: store-retain-discharge principle. The ratio between storage and discharge of a drainage system is a choice. New Orleans needs either a higher discharge capacity or a higher storage capacity to oppose its rain flood problems. As discussed above, for this design the retain-store discharge principle is favored over the fast-discharge principle that is currently applied since it is more flexible and resilient towards the future. Additionally it offers possibilities for water to serve as an amenity in the city and opposes subsidence by creating a higher ground water level. Figure 9 illustrates the growth of the network over time.

Dutch standards (Van de Ven, 2009) regarding freeboard and the allowed water fluctuation (dH max) are applied and tested in this study (see table 1) according to the following formula:

$$I(t) * C - Q(t) = S$$

A reduced drainage regime at a proposed freeboard of 0.9m counters subsidence and drought by moistening the soils. A generally allowed water fluctuation of 0.5m creates storage capacity in new canals and ponds strategically located in vacant space—voids, plots and medians varying in size (see fig. 8)—within the working landscape structure. New Orleans' large City Park, covering more acres than New York's Central Park and located in the centre of the study area, is re-envisioned as a 'water machine' that can store 852.500m^3 of water during rain events.

By combining LIDAR terrain data (LSU, 2000) with the flood depth and -area data (BCG Engineering, 2003) a floodwater volume of 1.200.000m^3 for the residential areas of Gentilly and Lakeview was derived with GIS-tools. It was found that transformation of 20% of the gross available design space in the total neighborhoods, together with the proposed design for City Park could solve 89% of the stormwater during a 1/10-year storm. Gross available design space is shown in fig. 8 and is defined in this calculation as the combined area of empty lots, larger voids and unused medians, which sums

up to 771 ha. The amount of water that can be stored in the design space is dependent on the area and height of the available water fluctuation. Not all of the gross available design space is available for water due to a desire not to use all vacant plots for water retention, losses in for example embankments and provisions necessary for maintenance. Apart from the lake, a smaller portion of the water system of the park is assigned to mitigate storm water run off from the park itself, but is only sufficient to mitigate 26% during a 1/10-year storm. The result is that during extreme storm events flooding would in this way concentrate in City Park, while residential areas are spared.

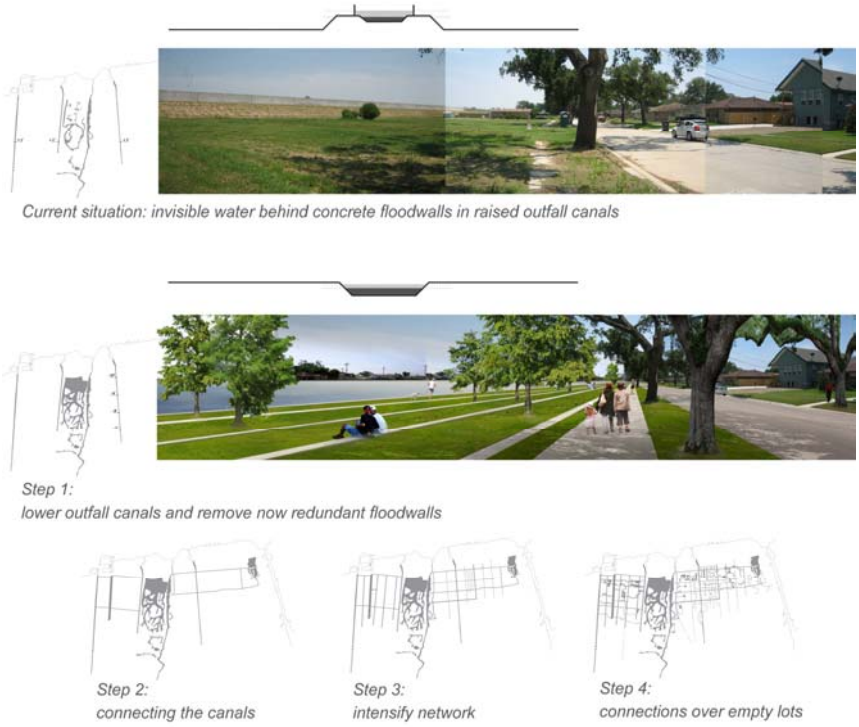


Figure 9. *Waterplan based on store/retain/discharge principles. A growing network of canals improves stormwater resiliency, reduce subsidence and bring water as an amenity in the neighborhood.*

Landscape framework

The park will function as an anchor point and showcase for the new landscape structure in the neighborhoods and demonstrate how an interpretation of the former appearance of the landscape can provide a connection with place and nature, and enrich the character and identity of the city. Several water surface level zones ensure close proximity to the water throughout the park.

The starting point of the design in the residential context should be a pattern analysis of the urban fabric, by which opportunities for water storage and urban design can be discovered. The aim of the pattern analysis is to find possibilities for large joint surfaces of water—and thus retention volumes—throughout the gross design space, minimizing losses in embankments. Concentrations of plots are interesting in this respect, while isolated plots are not. A second condition for utilizing vacant plots for water retention is finding connections in order to realize an interconnected and thus resilient water

system. In addition to unused road medians, which offer promising linear connections, also joined vacant lots may provide such links in the system. It is essential from both an economical as well as socio-political perspective to find solutions that minimize the amount of plots to acquire or trade ownership.

The exact scale of the transformation depends on the results of this analysis as well as the ambition level and priorities of the city. Canals of different size and character can offer multiple living environments related to water, and contribute significantly to the storage assignment. A higher ambition level results in more storage capacity, and also means additional opportunity for an interesting urban design. Figure 10 and 11 illustrate the perforated urban fabric and potential transformation of one of the lowest lying and hardest hit areas in the study area into a “water neighborhood” characterized by 20% open water. The design is based on a pattern analysis as described above, combined with a reasonably high ambition level as is illustrated in figure 12.

Figure 10. *Perforated urban fabric as a starting point for the design.*

Hazards regarding health issues and water quality can be counteracted by critically designing slopes and borders according to technical design principles which include the prevention of stagnant water through guaranteed flow and ecological mosquito management (Metzger, 2004; Norris, 2004; Walton, 2003).

Figure 11. *Possible transformation based on pattern analysis and ambition level +++*

Figure 12. *Ambition levels: a more complex transformation offers more storage capacity and potential for urban design.*

Typical native plant and tree species associated with the ecosystems in each landscape zone form the main character within the landscape framework, while accent species bring identity in different neighborhoods within those zones. Native species ensure robustness to local climate (extreme winds and downpours) and additionally provide habitat to local fauna. The trees introduce shade in the public space and therefore positively influence the microclimate of the city during Louisiana's hot summers. Temporal functions reserve space awaiting development. Tree nurseries can be one of those functions, fulfilling the need for seedlings to reforest the city on-the-spot, as well as occupying and bringing meaning to neglected land. In a future stage these functions can give way to water bodies that will act as buffer zones and are designed as beautiful amenities within the neighborhoods.

The flow and dynamics of water are the life that runs through the city's new veins. The prominently visible open water system educates residents about the fact that they live in a delta city where they have to reside with water, which can act both as a resource and a threat. People have to realize that also initiatives on their private property (rain barrels, native vegetation, permeable materials) are needed to cope with the rainwater problem in the future. Through incentive planning, the community can and should be engaged with such interventions on plot level. All together this study shows how canals, grass lined swales, nurseries and retention ponds can be developed in order to not only function well but also look good; truly water as an amenity for the great city of New Orleans.

Figure 13. *Water as an amenity in New Orleans*

Conclusion

Preparation for the future and a changing climate poses challenges, but also offers opportunities for the creation of attractive delta cities. Five years after the storm the unique situation in New Orleans means that it is now time for a long term and integrated strategy for the revival of the city. The strategy based on 21st century water management proposed in this paper mitigates rain flood events by reducing peak discharge, offers conditions for native, sustainable vegetation and provides attractive public space.

The results of this research indicate that strategies aimed at attractive working landscapes have much potential to offer a soft and sensible solution to the water challenges in New Orleans, and at the same time improve landscape quality.

Landscape architecture, contemporary water management and urban planning together can build a city that learnt from its past and will be more resilient and climate adapted in the future. A city with a vibrant and truly unique atmosphere that can have an exemplary function for other delta cities in the world in terms of approach to storm water system adaptation. Also by revealing landscape processes to the residents they will be more engaged with landscape issues, generating increased awareness and support. Let us not wait for another disaster to trigger such a relation to water and landscape, but let us start today with the creation of climate adapted and attractive delta cities around the world.

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