Recycling Houston

Bringing synergy between improving water safety, reducing energy consumption and reinforcing living quality in suburban

P2 Report, January 2015 / Song-Ya Huang, 4317645
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Tittle: Recycling Houston
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Motivation

A friend, Emmanuel Oni, who was born and lived in Houston for 25 years, and living in New York currently, once told me his perception of Houston. " Basically, there are four types in Houston. They are **downtown**, the high-rise cluster, **very rich neighborhood**, **very poor neighborhood**, and the majority is the rest, typically **suburban**. I must, but really don't like to drive in Houston, especially after living in New York. Even when I'm very close to the place I'm going, it's hard to orientate myself. Most of the suburban looks almost the same. Everywhere is similar house with lawn and highway in the background." Emmanuel pointed out some very interesting urban phenomenon: the extreme mono-centric economic structure, the segregation of the social-economical classes, the fast-developed suburban that need to reinforce the identities, and the highly automobile dependence.

Growing up in the dense Asian country (Taiwan), the life in suburban is very unfamiliar, interesting and questionable for me. Why the big private open space (lawn) is needed, why don't use the parks? Isn't it very inconvenient and expansive to use the car to everywhere, even grocery? Without the public transportation, how can the kids go out before they can drive a car? But currently, the data from U.S. census bureau shows in last year: someone moved to Houston from elsewhere in the U.S. every 9.5 minutes. Which means the suburban living style attractions are much more than disadvantages. And I'm curious to discover and experience these kinds of suburban living qualities.

The suburban life style has it's advantage but also results many issues for Houston. The energy consumption is a significant one. Texas flourishes because of the oil production and is also the biggest energy consumer in the U.S. The oil highly affected urban structure of Houston. The urgent question nowadays is how the city can be transformed in this post-oil era? Climate change, which is interconnected with energy use, is also a threat for Houston. Flooding is a worry for Houstonians for over 100 years, but it gets more serious in the recent decades.

In this project, I want to focus on the research for the three major issues of Houston: energy consumption, water safety and living qualities. And I will try to bring up some suggestions for **How Houston urban structure can be transformed in this post-oil era** by integrating the three aspects: energy, water and living qualities, especially in the suburban.

Chapter 2 Problem field


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Houston context/ Historical perspective: The city based on oil

Foundation of Houston: Railroad, oil and ship channel

Houston was established by the Allen brothers at the confluence of Buffalo and White Oak Bayous in 1836. At first, it was just 147 swampy acres in the middle of nowhere. In 1850s, because of its location, Houston became the railroad hub to transport inland products, cotton majorly, to the port of Galveston and Beaumont. Railroad networks grew bigger onwards. In 1890s, Houston was already the railroad center of Texas. After the huge storm in 1900, which destroyed almost entire Galveston including the port, Houston ship channel was constructed and took over the shipping business from Galveston. At the same period, oil was discovered in 1901. Railroad, oil and ship channel became three major factors influencing urban development in Houston.

Railroad network was the backbone of urban growth in Houston. In the 1940s, automobiles started to become the major transportation. Most of highways were built alongside railroads, and they reinforced the developments rapidly. The size of Houston grew into double in this period. Urban pattern in Houston is basically following the "Jefferson Grid", especially in the early development. (see the Houston wards map from 1920, p.12) Since oil was discovered and ship channel was constructed, energy (oil) and exports are engines drive the economy in Houston until today.

1836

The Allen brothers founded a new city at the confluence of Buffalo and White Oak Bayous.

1900s

The city grow to approximately 9 square miles and had a population of 44,000.

- 1901 Discovered oil

1910s

The population expanded beyond the central core, the city annexed area along the ship channel for controlling navigation and wharfage.

- 1914 Ship channel constructed

1940s

The city expanded double of it's size and reached nearly 600,000 population.

- 1942 Ship industry and medical center estabilised (because of WWII)
- 1948 First highway was constructed (reaching Galveston)

- The maps show the urban growth of Houston. Infrastructure lines are the current situation, only used to indicated the location (source: City of Houston, Planning & Development Department)

Energy shapes the economy, environment and society

The report, 2015 Houston Employment Forecast, published that the region now ranks as the top U.S. export gateway, overshadowing New York, Los Angeles, Seattle and Detroit. A study by the Brookings Institution found that the number of export-supported jobs likely exceeds 400,000 today. The U.S. Bureau of Economic Analysis estimates that mining (in Houston, almost entirely oil and gas extraction) and energy industry (chemicals, refining, oil field equipment manufacturing, fabricated metal products, pipelines and engineering) accounted for $186.6 billion, or 38.1 percent of Houston's GDP, in 2013.

While Houston grows strongly in the economic perspective, oil also influences other sides of Houston significantly. Job opportunities and relatively low living cost continuously attracts huge population not only inside U.S. but also oversea. Fast expansion (almost without limits from geographic features) overwhelms nature environment. The cheap oil price also affects the human behaviors on transport. This kind of sprawl urban form and the high car-usage shape Houston as a high automobile dependence city today.

1950s

By the end of the decade, Houston was 350 square miles with nearly 1 million residents.

- 1956 Lake Houston is created to supply fresh water

1960s

Several important annexations took place in the 1960s, such as expansion of Lake Houston and international airport

- 1961 NASA established

1980s

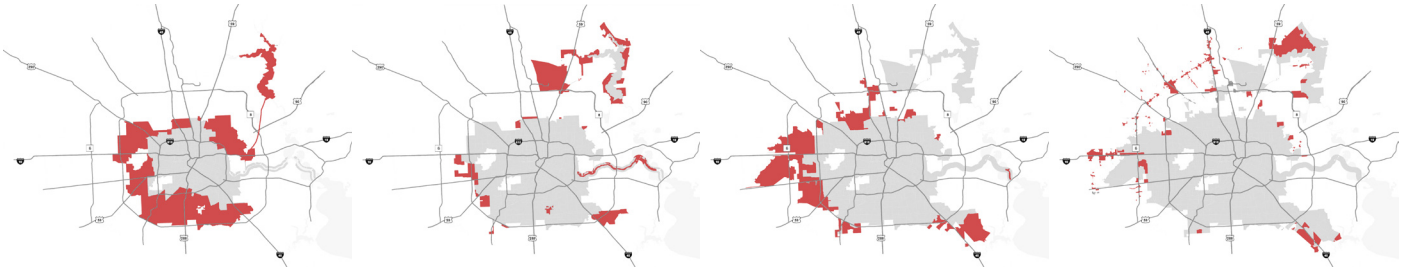
Throughout the 80s, annexation was considerably more limited than it had been in the past. But still, the city's population had grown to 1.6 million residents

- 1974 Oil crisis

2000s

Despite slower growth in size, the city's population continues to grow. In 2012, more than 2.1 million people called Houston home.

- 1999 Texas law governing annexations changed and general purpose annexation became more difficult.



Houston context/ Societal perspective:
The most sprawling, least dense, most automobile dependent major city in America

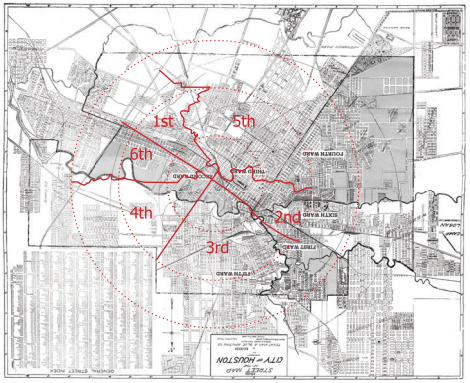
Wards of Houston: legal entities in the past, cultural entities today

When the city of Houston was founded in 1836 and incorporated in 1837, its founders—John Kirby Allen and Augustus Chapman Allen—divided it into political geographic districts called "wards." The ward system, a precursor to today's City Council districts, was a common political tool of the early 19th century, and is still used in some American cities. Historically the wards reflected geographic boundaries, without consideration of the population density within the wards. Betty Chapman, a historian, said "They really were mixed societies in the early days. Where you worked dictated where you lived, not who you wanted to live around."

The City of Houston abolished the ward system in the early 1900s. While the wards no longer exist legally, area residents still identify certain communities, especially that have been a part of the city since incorporation, as being "wards" of the city. The ward identification appears on signage and in casual conversation from Houstonians. Will Howard, an assistant manager of the Texas and local history department of the Houston Public Library, said during that year "They are cultural entities today, not legal entities, and like any culture, they are almost obligated to change."

Todays, the wards become a more obvious division in the societal aspects. If we compare to the racial/ethnic distribution map on the next page, it can be seen that each wards has their majority groups.

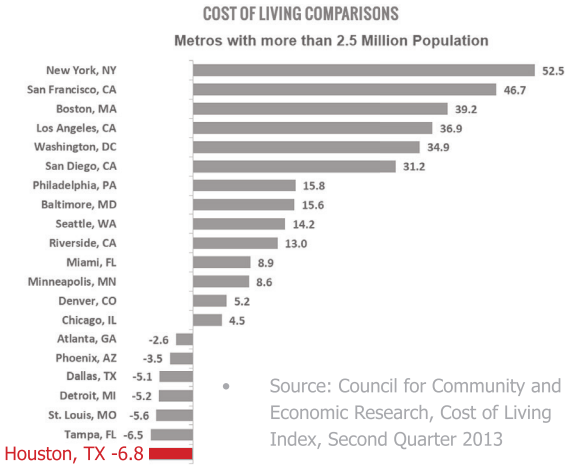
- Left: Street map of the City of Houston, 1920 (source: Texas Map & Blue Printing Company)
- Right: Current neighborhoods in Houston(source: Urbane, www.mapurbane.com)



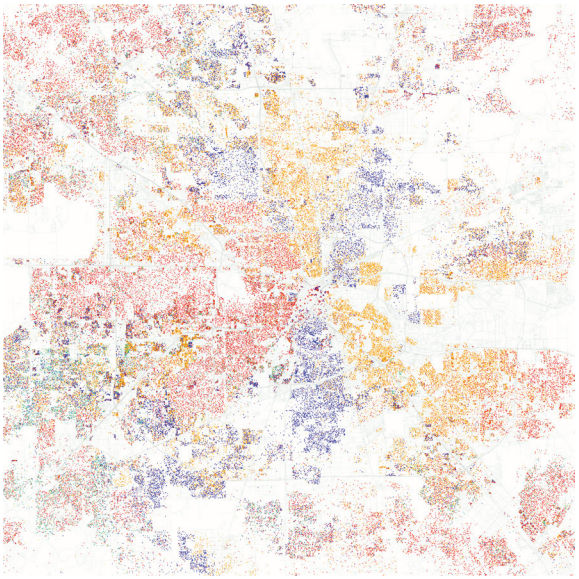
Expanding city: attractions of living in Houston

The Houston-The Woodlands-Sugar Land Metropolitan Statistical Area (MSA) added more residents last year than any other U.S. metro area. That's according to the U.S. Census Bureau's recently released estimates. The New York-Newark-Jersey City metro area ranked second in population growth while the Dallas-Fort Worth-Arlington metro ranked third. Someone moved to the region from overseas every 20.6 minutes, while someone moved to Houston from elsewhere in the U.S. every 9.5 minutes. No racial or ethnic group represents a majority of the population. (Anglos comprise 38.8 percent of total population; Hispanics comprise 35.9 percent; Blacks 16.7 percent; Asians 6.7 percent; other and mixed races 1.9 percent.)

In U.S., New York and Los Angeles represent the two opposite sides of living style. Some people enjoy living in dense mixed-functions urban areas with convenient public transport systems. Other people like to own a bigger house with nice yard for kids to play in. For the people who are attracted by Houston, here is some main factors. The flourishing economy provides job opportunities. Although comparing to the income in New York, the salaries are lower. But if people also consider the living cost, they can actually save more money and afford to buy their own houses in Houston.



- Source: Council for Community and Economic Research, Cost of Living Index, Second Quarter 2013

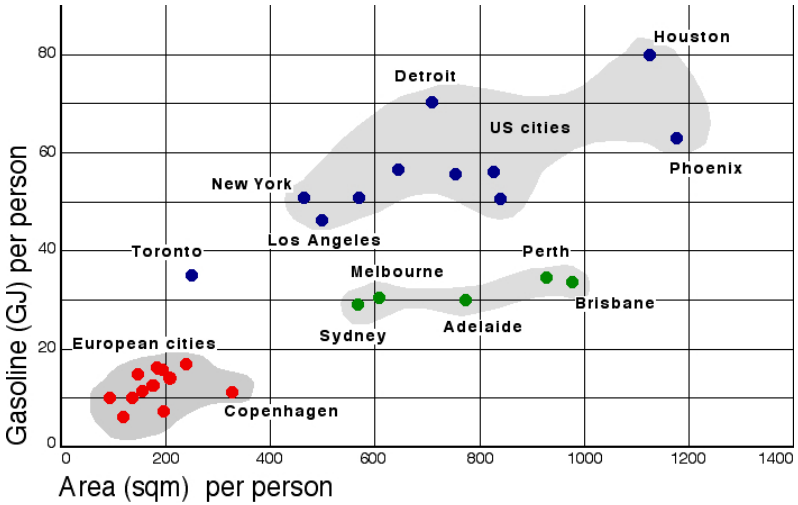


- Map of racial/ethnic distribution in the city of Houston, 2010 census. Each dot represents 25 people. Red dots represent White people, orange dots represent Hispanic people, blue dots represent Black people, green dots represent Asian people, and gray dots represent other people (source: Data from Census 2010. Base map © OpenStreetMap, CC-BY-SA)

Houston suburban: the most sprawling, least dense, most automobile dependent major city in America

While population keeps pouring into Houston, the city also shows the warming welcome to the people. Comparing to other suburban area, such as Los Angeles, Houston has relatively loose regulations in urban development, especially in previous decades. Highways support the suburban to grow further. People are used to drive 2-3 hours everyday to work (also because of the traffic jams). The data shows that 77% of the people drive alone to work everyday, 10% carpool, and only 2% use public transportation.

The suburban does have it's living qualities, but also results serious urban issues for Houston. "The relative intensity of land use in the ten US cities is clearly correlated with gasoline use overall and in the inner and outer areas. The strongest relationship is with the population density in the inner area… These patterns suggest that urban structure within a city is fundamental to its gasoline consumption" (Newman & Kenworthy, 1989, p.25).



- Suburban in Houston (Source: https://www.flickr.com/photos/nelsonminar/5343099039/)

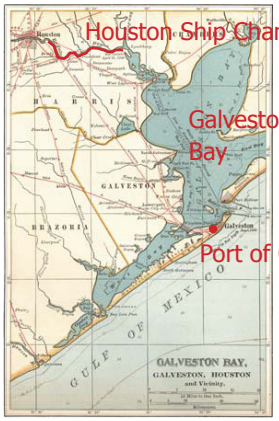
- Downtown and suburban (Source: http://3.bp.blogspot.com/)

- Source: Newman and Kenworthy, 1989, Gasoline consumption and cities: a comparison of US cities with a global survey

Houston context/ Geographic perspective: The bayou city

Where the city was born: Buffalo bayou

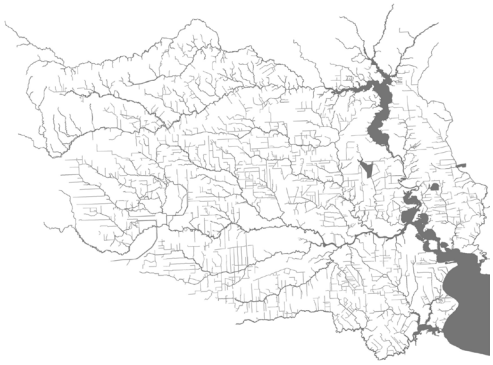
Houston was established by the Allen brothers at the confluence of Buffalo and White Oak Bayous in 1836. The Bayous provides the transportation in the early years. People's life was highly related with the water in that period. After the port of Galveston was destroyed by the storm in 1901, people decided to protect the exports by moving into the edge of Galveston bay. Houston ship channel was constructed and opened in 1914. It locates at the month of Buffalo and White Oak bayous. Industries started to occupy the waterfront onwards. Today, the water is more disconnected with the urban fabric, especially near the ship channel.



- Source: Map of Galveston Bay, Houston, and vicinity (c. 1900), from the 10th edition of Encyclopædia Britannica.

- Houston, 1891 (Source: Perry-Castañeda Library Map Collection)

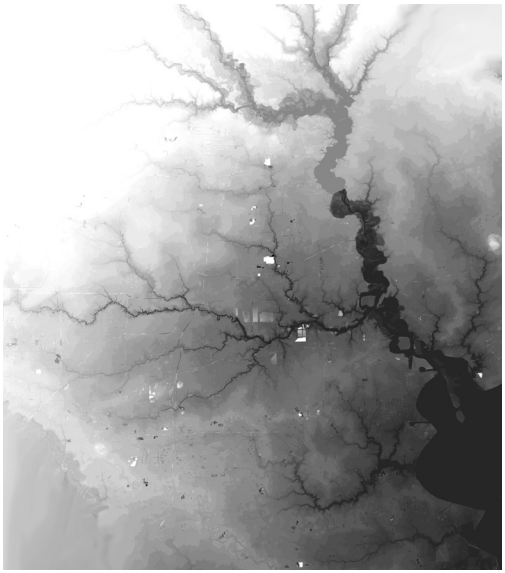
- Natural and man-made drainage system in Harris County (source: Susan Rogers, Super Houston)

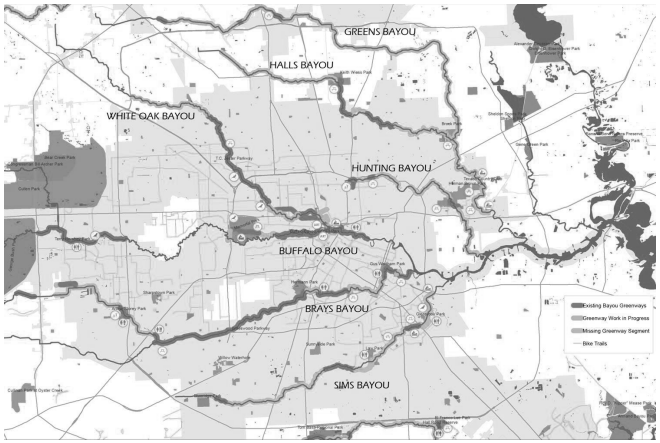


Flat plain and water system

Houston is located on a flat plain with intertwining bayous. There are 2047 km of natural water system. The flat plain and heavy rain result another man-made city networked with 2285 km of drainage ditches and channels. Because of the small height different, the water are mainly very shallow and slow. The fresh water supply is supported by the lakes locating on the upper stream of Galveston watershed.

- Galveston water shed height map (Source: GIS datafrom Texas A&M)



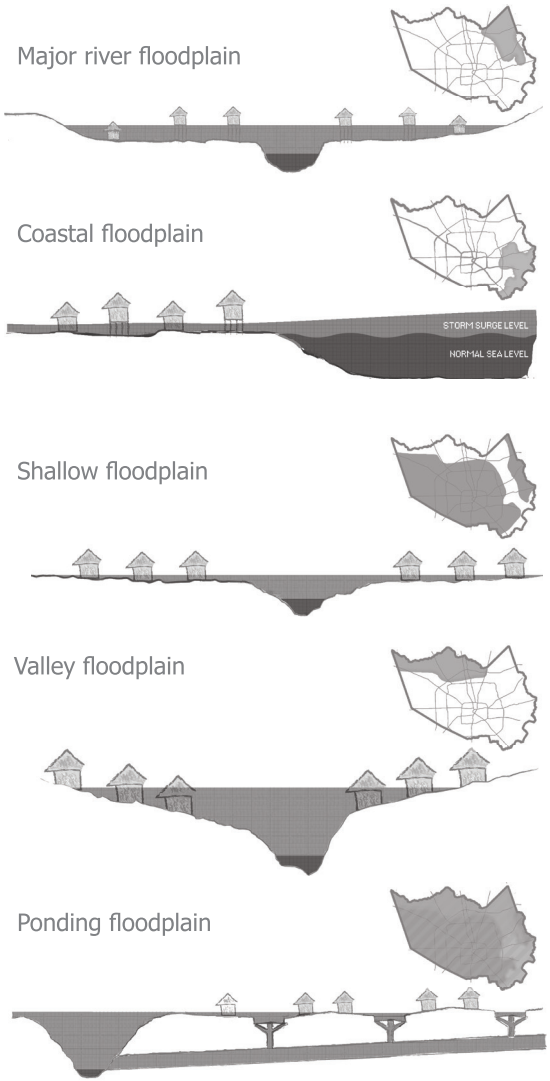


- Bayous in City of Houston (Source: Houston Park Board)

Living with water: flood risk

Life of houstonians are highly effected by water. Because of the geographic features, almost every properties are facing the flooding risks. According to the locations, there are several types of floodplains.

- Major river floodplain: It's a specific area at the east-north side. The floodplain is large, deep and swift. The flood conditions may last a week or more.
- Coastal floodplain: Coastal flooding happens when unusually high tides or hurricane surge occurs. It can flood low-lying structures.
- Shallow floodplain: It exist throughout much of the county and affect thousands of residences and business. When the channel capacity is exceeded, flooding begins, but lasts hours, rather than days.
- Valley floodplain: It's generally located in the northwestern portion of the county. Flooding can be very deep and extends for a few days.
- Ponding floodplain: This type of flooding doesn't restricted to any one area of the county. When intense local rainfall exceeds storm sewer or roadside ditch capacity, the water can pond in streets deep enough to flood residences that are not even near a creek or bayou.

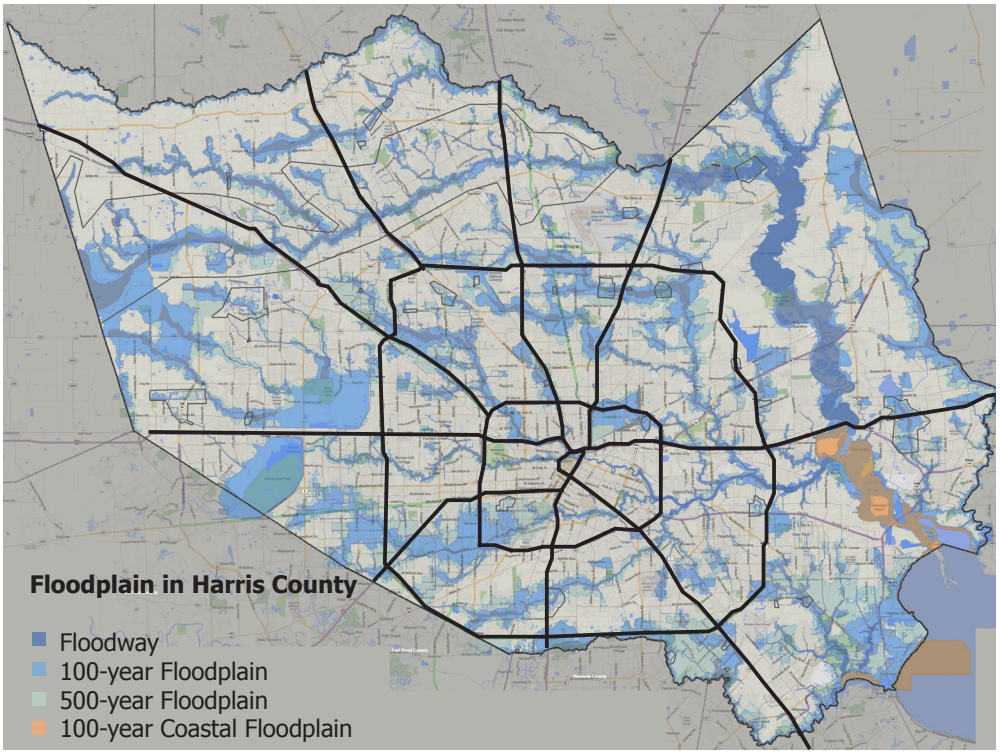


- Floodplain types in Harris County (Source: Harris County Flood Control District)

Problem definition 1:
Flooding with heavy rainfall

Flat plain and heavy rainfall result the city with 4332 km of drainage ditches, channels, and bayous, but they are still not efficient to protect the city from flooding. During Tropical Storm Allison in 2001, the deluge of rainfall flooded 95,000 automobiles and 73,000 houses throughout Harris County. Tropical Storm Allison destroyed 2,744 homes, leaving 30,000 homeless with residential damages totaling to $1.76 billion.

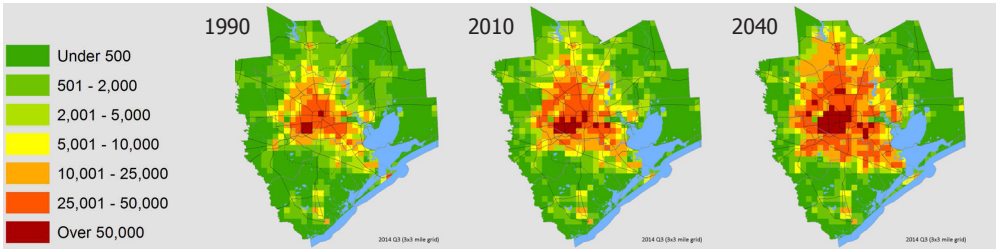
- Houston downtown during Tropical Storm Allison



- Floodplain in Harris County (Source: http://mycity.maps.arcgis.com/)

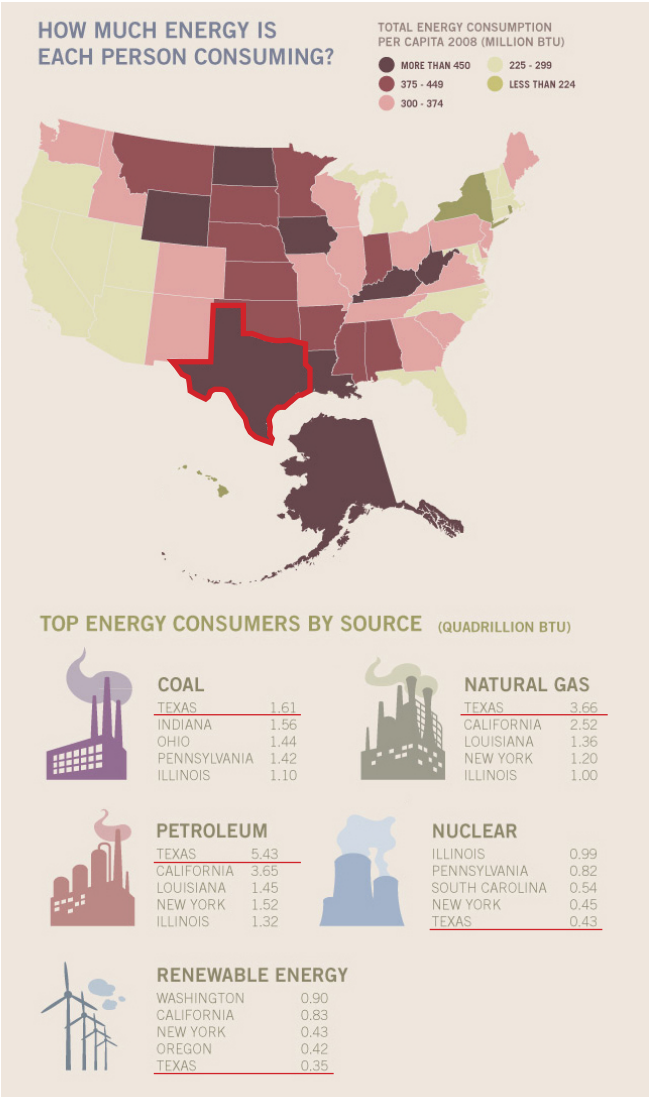
Problem definition 2:
Rapid population growth & urban sprawl

"While oil made Houston boom, a more complicated set of factors made it sprawl. State annexation laws allowed the city to aggressively absorb surrounding areas… Meanwhile, it's always been cheaper for developers to build horizontally than vertically, and because Houston faces few physical impediments such as rivers, lakes or mountains…there isn't any physical reason stopping them. "It's all about land availability and cost…." says Ric Campo, CEO of the national real estate firm Camden Property Trust, based in Houston. "(Governing, 2013)
Historically, Houston has been viewed as "the most sprawling, least dense, most automobile-dependent major city in America." But an annual survey in 2014 from University's Kinder Institute for Urban Research pointed out in that half the residents of Harris County, of which Houston is part, would prefer to live in an area with a mix of development, including homes, shops and restaurants as opposed to a single-family residential area. Not only people having the wills and also government is trying to move toward denser and more livable urban life by proposing an endless list of plans and policies. But still, Houston is looking for a stronger solution and vision to "go urban".



- 2040 population growth and urban sprawl prediction (Source: United States Census BureauRefered)

Problem definition 3:
High energy-consumption



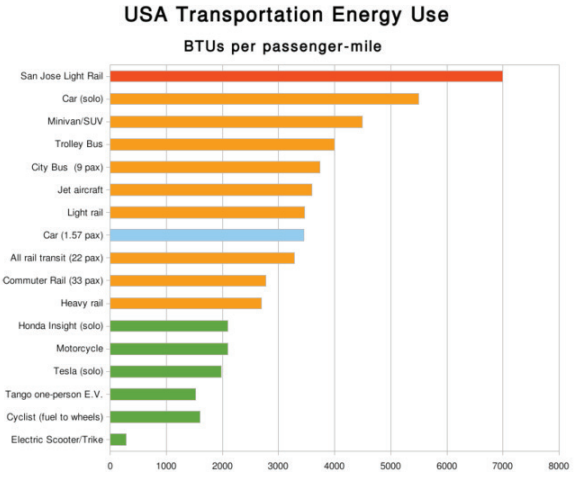
- Statistic evidence of high energy-consumption in Texas (Source: http://magazine.good.is/)

American consumes over 20% of the world energy while the population is only 4.33% of the world. Texas is the biggest energy consumer in the total energy use, and also has highest energy consumption rate per person. Cooling /heating system and transportation are the two main factors of personal consumption, which strongly depend on the coal, natural gas and petroleum, the non-renewable resources. Although Texas is recognized as the oil state, the renewable energies should get more attention in future development.

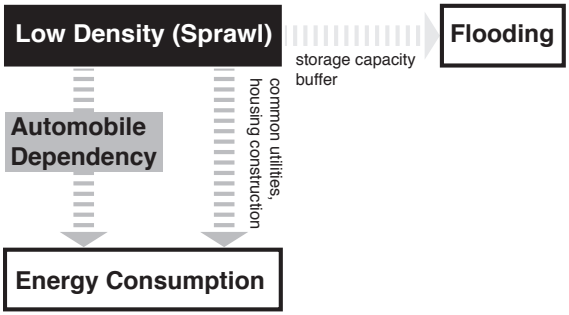
Interrelations between three challenges

Theoretically, if the density is more centralized, the energy consumption and flooding issues can be improved. The intensification process is critical. What is the suitable density for Houston? What kind of relation between built area and landscape? What is the efficient transport system according to the context? In a recent study from Brad Templeton indicates that public transportations are not more efficient than cars in lots of American cities. Instead, he says "we would get more efficient by pushing small, fuel efficient vehicles instead of pushing transit, and at a lower cost."

Theoretical framework in the next chapter will review the theories and methodologies, in order to find ideal intensification strategies for Houston. The smart answer to these questions should be an integrated system that takes also future trends and techniques into account.



- USA Transportation Energy Use (source: http://www.templetons.com/brad/transit-myth.html)



Chapter 3 Theoretical framework: Intensification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Intensification research: methodologies for Houston suburban

Historically, Houston has been viewed as "the most sprawling, least dense, most automobile-dependent major city in America." In order to find a solution for the on-going trend of urban sprawl, it is often hypothesized that changing the urban structure and density accompanied by certain travel and land-use patterns can result in changes in energy consumption (Banister 1997; Newman and Kenworthy, 1999) When talking about the urban features of Houston, water is a unique and distinctive theme. Flat plain and heavy rainfall result the city with 4332 km of drainage ditches, channels and bayous, but they are still not efficient to protect the city from flooding. In the situation of Houston, flooding protection and water quality are significant factors effecting living environment and real estate market. Energy consumption and water safety are on the high agenda nowadays for Houstonian. Intensification, as a key solution for the issues, is a hot topic for urbanist, government, also people and real estate market.

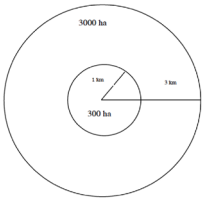
The aim of theoretical research is to review the literatures in order to answer the three questions about intensification in Houston suburban:
How to intensify in order to reduce automobile dependence?
How to define urban form and volume?
What urban functions are needed?

Reconstruct the automobile dependence city model (Newman and Kenworthy, 2006), Spacemate (Berghauser Pont and Haupt, 2005), Spacematrix, (Berghauser Pont and Haupt, 2010), Mixed Use Index (MXI) (Van Den Hoek; Mashhoodi & Berghauser Pont, 2011) and other methods are discussed to answer the questions. The conclusion of the theoretical framework is to explain how the methods can be used for the study and decision-making in different aspects of intensification in Houston. Furthermore, water, as a distinguish feature in Houston, is taken into consideration, especially from the intensified-location and real estate market point of views.

How to intensify in order to reduce automobile dependence?

Reducing automobile dependence in order to address issues of viability and sustainability is one of the top priorities when discussing urban development of Houston. Car dependence and large ecological footprints as well as the loss of many urban qualities including walkability, viable public transport, jobs access, and other urban amenities have been tied together. Now, obesity levels, stress levels and children's mental health development have been linked to automobile dependence (Newman & Kenworthy1989: Gee and Takeuchi 2004; Hillman 1997).

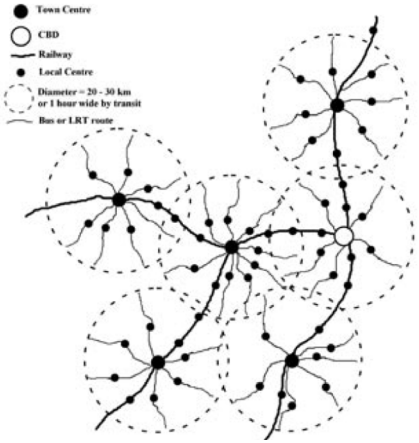
People will arrange their location and their mode of travel accordingly. In urban center, it becomes whether the time available for car travel is less than the time it would take to access the urban center using a bike, walking, or riding public transit. Ped Shed model creates circles of activity for 10 minutes of walking or 30 minutes of walking. Thus two types of centers can be examined using this technique. The Local Center is essentially a Transit-Oriented Development with sufficient intensity of activity to make it an effective and viable transit center. The Town Center (Regional Center or Sub Center) is a place providing viable services for a region within a city.



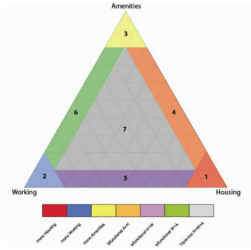
- Ped Sheds for Different Scale Center: The Local Center is defined by its 10- minute Ped Shed and the Regional Center by its 30-minute radius (Source: Newman & Kenworthy, 2006)

Long-term data (Newman & Kenworthy, 2006) from cities around the world appear to show that there is a fundamental threshold of urban intensity (residents and jobs) of around 35 per hectare where automobile dependence is significantly reduced. The range would be from about 8,000 to 19,000, with jobs and residents being interchangeable for transport demand. This suggests the approximate minimum base of people that appears to be necessary for a reasonable Local Center – and a public transport service to support it. If a 30-minute Ped Shed for a Town Center is used, then the range again is from around 70,000 to 175,000 people and jobs. Any less than this means services in such a center become impractical.

Urban amenity is enhanced if there is sufficient intensity of urban activity. If some urban amenities are provided first, they can attract increased urban development. This is particularly obvious when the amenities are associated with a public transport node. (Newman & Kenworthy, 2006) Transit cities are 20 to 30 kilometers in diameter. It is best to try to create a series of these with a rail and bus service that feeds into a Town Center. Along the lines feeding in to the Town Center would be a number of Local Centers. The whole city would be made up of transit cities joined together and linked by a fast rail service. Most people in the city could then live within the framework of local services in the Local Center. Main services, including work, would be located in the Town Center.



- A Conceptual Plan for Reconstructing an Automobile City (Source: Newman & Kenworthy, 2006)



- Categorizing mixture of function, MXI (based on Van Den Hoek, 2011) (source: Mashhoodi, BERGHAUSER PONT, 2011)

How to define urban form and volume?

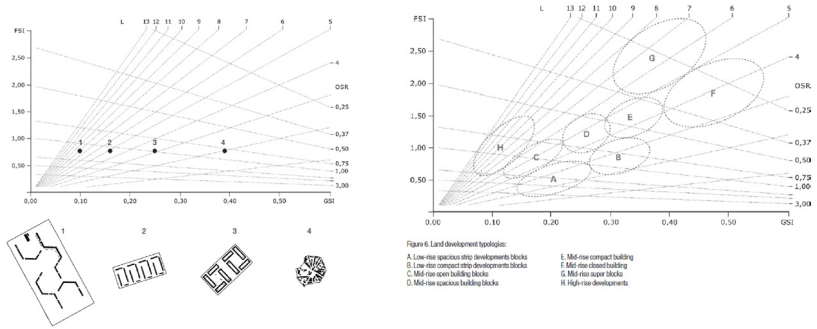
"How can we make plans where main issues and qualities are taken care of, but that still leave enough freedom to incorporate changes during the process from design until realisation? " The Spacemate is a tool for understanding the relation between quantitative and spatial properties. (Berghauser Pont and Haupt, 2005) It provides a coherent measurement technique and reveals a linkage between densities and typologies of land development, urban environments, and non-built space. It suggests that density is defined as a combination of intensity, compactness (GSI), height (L), and pressure on non-built space (OSR), in order to assess all four variables simultaneously. Further more, the Spacemate chart can also be used to investigate the degree to which a relationship exists between the variables and the various building typologies.

Urban areas have a large variety of forms and surface characteristic. Basically, the microclimate (air temperature at local level) of these areas is influenced by the three major urban elements: buildings, greenery and pavement. Wong et al.(2010) ran a crossed test with STEVE tool and TAS software on an office building in Singapore. The result shows that variables such as GnPR, height and density show a high degree of impact in altering the temperature or microclimate. The degree of impact on the air temperature can be up 0.9–1.2 O C. The highest impact is GnPR due to shading effect of trees. And the cooling load reduction due to the impact of the variables is in the range of 5–10% if addressed effectively.

- The seven functions:
- Residential
- Working:Offices
- Working: Industries
- Services
- Commercial uses
- Cultural & recreational uses
- Public & social functions

What urban functions are needed?

In the research of Mashhoodi and Berghauser Pont in 2011 focuses on the conceptual level which looks at mixed-use from the perspective of the synergy and compatibility of land uses. They transformed the method, Mixed Use Index (MXI), from Joost van de Hoek. It is an indicator shows the composition of a study area, and whether an area is mixed or mono-functional. The MXI shows in percentages how the three primary functions (residential, major employment and service functions) are distributed. Together they are always 100%. Based on MXI, Mashhoodi and Berghauser Pont use 7 types as represented in left diagram. Three types are considered mono-functional. Here more than 80% of the total gross floor area (GFA) is either residential, working or services (type 1, 2 and 3). Type 4, 5 and 6 are composed of a combination of two functions and in type 7 all different land uses are represented by at least 10% GFA.



- Left: the Spacemate :showing four cases with same FSI (source: Berghauser Pont & Haupt, 2006)
- Right: Land development typologies (source: Berghauser Pont & Haupt, 2006)

Water as a distinctive factor in Houston intensification research

Bayous are the unique and distinctive natural theme of Houston. Houston is also called "the Bayou City". There are seven bayous spreading across the area inside the city. Flat plain and heavy rainfall result the city with 4332 km of drainage ditches, channels and bayous, but they are still not efficient to protect the city from flooding. In another words, water is a precious natural quality but at the same time the disaster for the people in Houston. When talking about the real estate market, water is also a key factor that can drive the market to two opposite ways. The waterfront with sufficient investment and lower flood risk, which presents better living quality, attracts density significantly. But still, most of the areas alongside bayous are facing high flooding risk. By providing flood protection and other public service, it's possible to predict the density flow and intensification locations precisely.

Conclusion: how to use the methods for Houston

- First, the area can be categorised with the Spacemate into land development typologies
- Second, the land use and function can be analysed with the Mixed Use Index (MXI). The result is useful to identify where has high potential to become a center, and which area is lacking the amenities to support the density.
- The model of reconstructing an automobile city and the provided data of population and size are the concept to consider the location and distance of transport and center points. At the same time, water is the factor that needs to integrate when choosing the location.
- Spacematrix is tool that can assist flexible designs of the urban form based on different developing levels.
- While the data of surrounding building morphology with energy consumption can be the guidelines for micro scale design, such as open space ratio, greenery, and pavement…

Chapter 4

Opportunities
& project aims

Opportunity / Bayou Greenway:

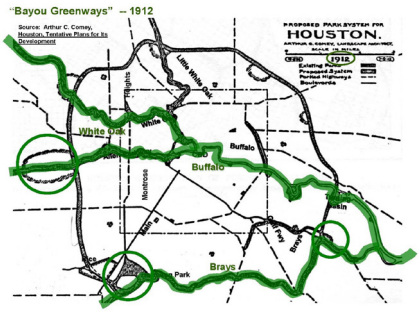
It was in 1912 that Arthur Comey, a visionary urban planner, laid out a master plan for Houston where its park system is organized around its bayou corridors.

"The bayou city of Houston is in store for one of the largest parks projects in the nation. As of now, the major bayous are disconnected from one another and leave many communities without access to green space. Houston has 75 miles of trails along the major bayous but has the potential to expand the trails to 150 miles in the city, connecting 77 parks with linear greenways along the banks of its bayous. Nearly 60 percent of all Houstonians would live within 1.5 miles of one of these parks or trails." (Houston Park Board)

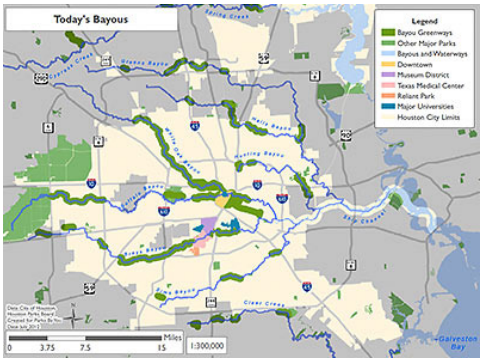
"Ours is a city where currently the automobile creates our geography. We are connected by huge ribbons of concrete and pavement as far as the eye can see. Yet inside the concrete sprawl, we must create parallel connections at the human scale. …We may have a sprawling city, but the sprawl of our city is powerfully matched by the sprawl of our waterways." (Houston Water Board)

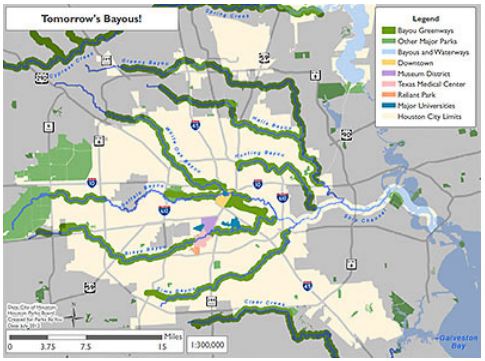
There are the main aspects that Houston wants to tackle with this project:

- Alternative transportation for commuting, ex. Hike and bike trails
- Wet-bottom detention areas flood prevention
- Natural water purification and runoff reduction
- Recreation opportunities
- CO2 sequestration
- Increasing property values along the corridor

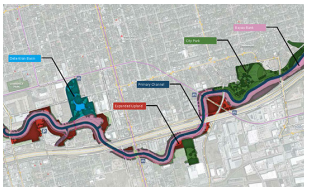


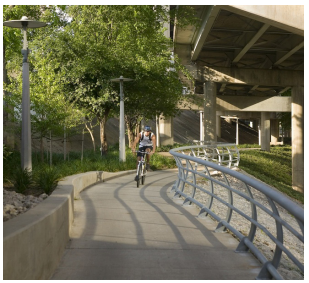
- Master plan from Arthur Comey, 1912 (source: Houston Park Board)





- The two maps show the Greenway project the area alongside bayous into continuing green corridors (Source:Houston Parks Board)





- The plan shows how the Greenway project will connect the open space along bayou (Source: Houston Parks Board)

- Photos show the section of buffalo bayou near downtown(Photo credit: http://www.flickr.com/photos/23910074@N07/8592296523/

Opportunity / Recyclable urban elements: Parking lots, vacant lots, un-used public space

A major part of the strategies for intensification in this project focus on a better use of the existing built-up areas or in other words to 'build the city inwards'. Here are the three main urban elements that are considered with high potentials to be recycled.

Parking lot

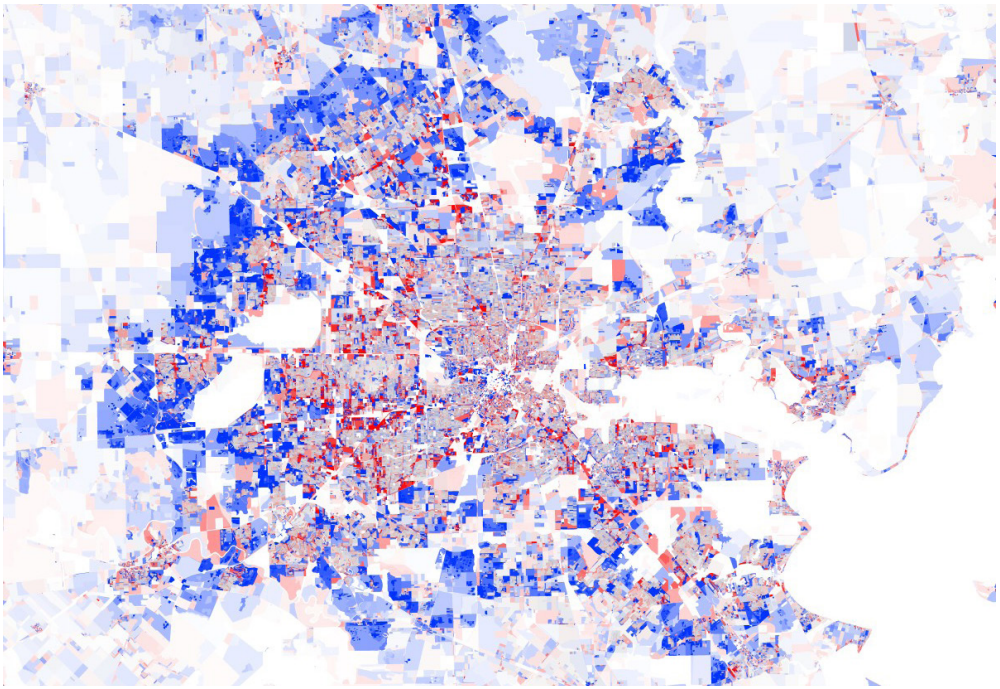
The bottom graphics in the next page show the incredibly high percentage of land is occupied by the parking in the downtown Houston. This situation also happens in the other parts of Houston, while the parking need is actually lower than the provided parking space.

Vacant lot

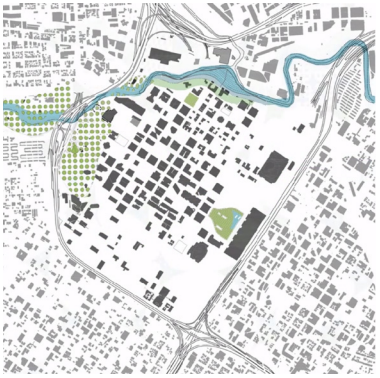
The top map in the next page points out that while the city is still expanding outwards, some existing built areas are losing the population. Lots and buildings become vacant, espacially inside the second loop.

Un-used public space

While Houston is depending on a huge amount of motorways, the spaces alongside infrastructures are often only used as buffer. There are high potentials to provide other functions to support the nearby neighborhoods. This kind of un-used publics can also be found along the water system, rail tracks, etc.



- Houston population change 2000-2010: Blue indicates the it increased more than double, red is decreasing ,and gray is stable (map credit: Stephen Von Worley at DataPointed)

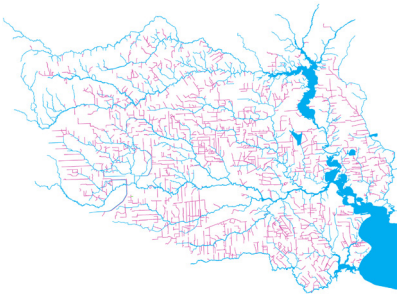


- Right: the map shows downtown Houston when taking out parking spaces(Source: Shuffle City)
- Left: downtown Houston(Photo credit: Alex Maclean)

Project aims

The Bayou Greenway project is mainly considering about the natural drainage system (blue), bayous, for improving the flooding damage from heavy rainfall. If we also take the man-made system (pink), ditches and channels, into consideration, the city can have a stronger water protection (from 2076 km to 4332 km). In the project, I will elaborate from this point and discus how the water system can be transform into not only performing as flooding protection but also combine with the energy deduction and production network. And how the water and energy system can reinforce living quality, especially in suburban.

The project will try to achieve the objectives in three scales: neighborhood, district and city. In neighborhood scale, living qualities and cultural circumstances in suburban (why suburban is so attractive for people) are considered in the first place. Then the aim goes to transforming the recyclable urban elements with integrated design interventions that can reinforce the existing qualities while water safety and energy production are also increased. In district scale, neighborhood interventions are translated into prototypes, and used as common strategies over the district. With these neighborhood strategies, urban systems and flows (energy, transportation, water, open space, etc.) are adjusted to be more sufficient. Intensification possibilities are also discussed according to the urban structure. In city scale, the design strategies are summarized from the previous scales into more general principals that can apply on the similar area over Houston. The conclusion of the project is to provide a city vision including water safety and energy, in order to have a better consideration in this post-oil era.



- Natural and man-made drainage system (map credit: Susan Rogers, Super Houston)

The feasibility is also an important consideration when discussing these changes in Houston. As I mentioned in the previous chapters, investments (both governmental and individual) are highly focused in some particular areas, which means economic-social conditions gap is significant when comparing different suburban in Houston. The design strategies in this project are also considered in different development levels. Some strategies are more focused on how the people can improve their living environment individually with small changes and low budget. Other strategies will try to integrate the potential values for energy and water, in order to attract bigger stakeholders to participate.

Relevance

Scientific relevance

Climate change which is interrelated with flooding and energy consumption in on the high agenda for not only urbanists but also many professions in other fields. Being a high automobile dependent city and facing serious flooding risks, Houston suburban is an ideal model to do the integrated research on intensification with water and energy aspects. This project is trying to review the current theories from different fields. By discussing Houston suburban, the aim is to coordinate the theories, data and my observations to provide overall remarks for the integrated research on intensification, energy and water. The research is focusing on Houston but still shares common issues with other suburban areas over the world.

Societal relevance

The selected site of this project is especially focuses on the suburban area with serious flooding problems and low economic-social conditions. One of aims in the project is to provide strategies for the area that is neglected by the government or investment flows. With more considerations, small individual changes can also have big influences for their living environments.

Chapter 5 Research question & Methodology

Research question

Main research question

In the intensification process, how to recycle existing urban elements and integrate them with bayou systems in suburban areas to bring synergy between reducing energy consumption and reinforcing living quality in Houston?

The main research question can be elaborated into three sub questions that focus on three different processes and result in three intended end products:
1 intensification strategies and urban structure of the whole project area
2 prototypes set-up in three themes: residential lot, water and public space
3 three local scale interventions based on three kinds of prototypes.

Sub questions & methodologies

1 How to intensify the suburban area by transforming the bayous and urban structure to reduce flooding risk and achieve low carbon energy system?

- Area analysis (mapping) in three categories: living quality, water safety and energy
- Setting up objectives for future urban systems based on area analysis
- Intensification potential analysis based on theoretical framework
  - Spacemate: categorizing land development typologies
  - Mixed Use Index (MXI): identifying potential areas for intensification
- Strategic plan: translating the intensification model and data from Newman (2006) into the project location

2 For residential lots, water system and public space, what are the prototypes that can provide water storage capacity, generate more energy and reduce consumption while increasing the spatial quality?

- Area analysis to identify the common typologies in three categories: residential lots, water system and public space
- Data collection to provide scientific threshold for water storage capacity, energy production and reduction
- Prototypes design based on building morphology and energy consumption research, case study and site visit
- Scenarios of prototypes (different developed levels): Spacematrix

3 How to implement the prototypes on sites, and still preserve the neighborhood characters and reinforce the living qualities?

- Mapping and observing to understand the neighborhood characters and existing qualities.
- Research-by-designing to test how to transform the prototypes to existing sites.
- Implementing two scenarios in each sites to discuss the result (ex. energy production amounts) and factors (ex. density, stakeholders) in different developed levels.

- The analysis details and research processes can be seen in Research framework P.42
- Refered methodologies and theories can be seen in Theoratical framework P.24

Chapter 6 Research framework

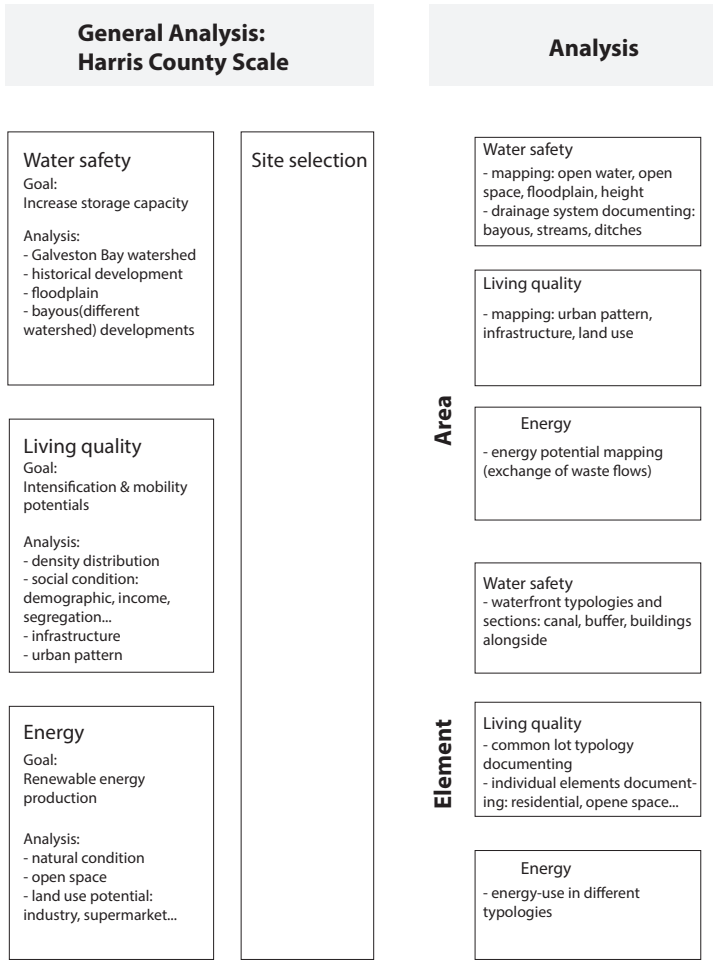
Research Framework & Intended end products

Research framework can be viewed as four sections:

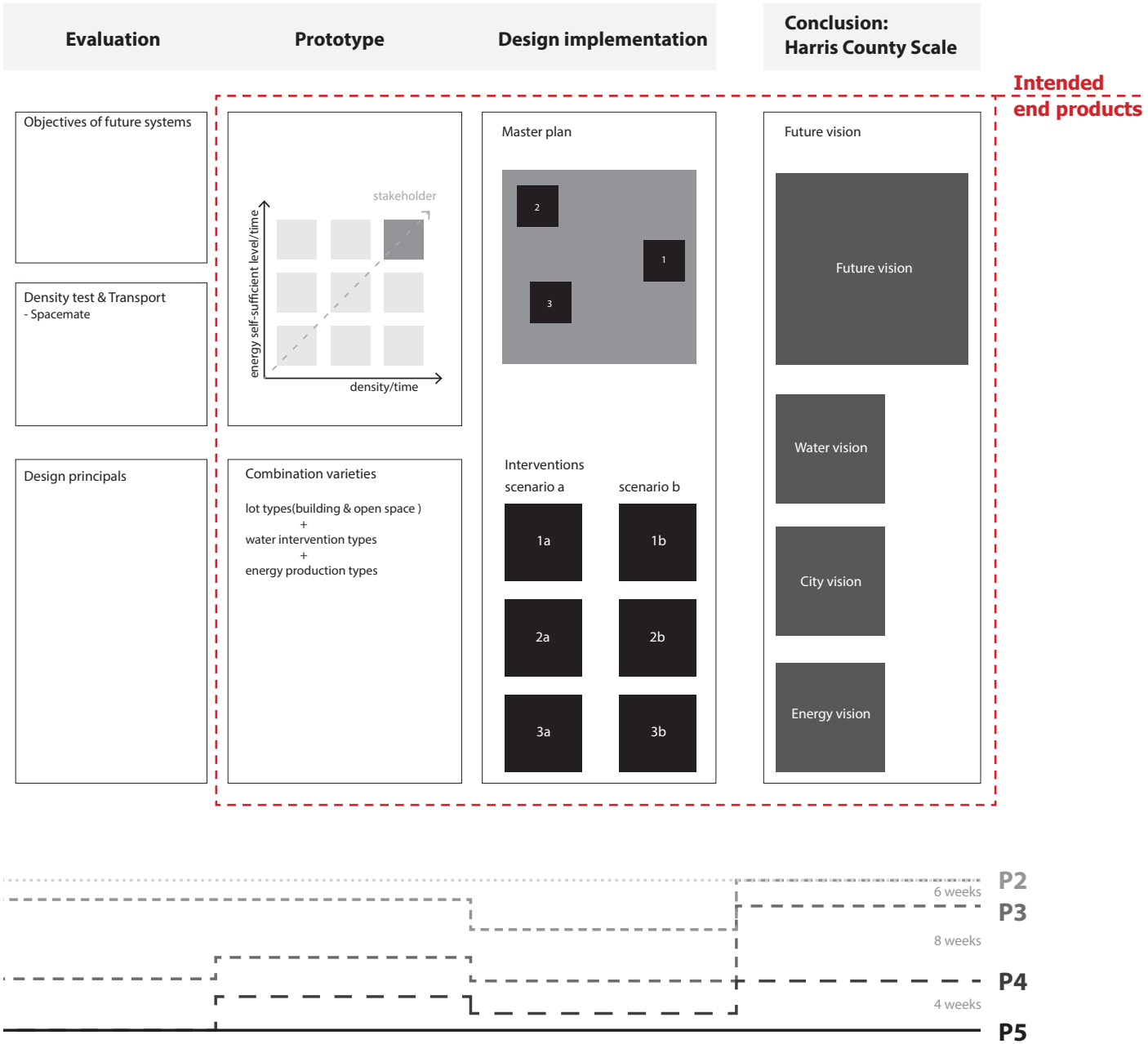
1. **General Analysis** for the whole Houston context with problem statements, which leads to the focused site
2. **Site analysis and evaluation** with methodologies to continue to the design phase
3. **Design phase** containing three intended end products, which are the answers for the three research questions.

- **intensification strategies and urban structure of the whole project area**
- **prototypes set-up in three themes: residential lot, water and public space**
- **three local scale interventions based on three kinds of prototypes**

4. **Conclusion**: linking the design back to the Houston context



Time-working plan


Evaluation
Prototype
Design implementation
Conclusion:
Harris County Scale
Intended
end products
Objectives of future systems
Density test & Transport
- Spacemate
Design principals
stakeholder
energy self-sufficient level/time
density/time
Combination varieties
lot types(building & open space)
+
water intervention types
+
energy production types
Master plan
2
1
3
Interventions
scenario a
scenario b
1a
1b
2a
2b
3a
3b
Future vision
Future vision
Water vision
City vision
Energy vision
P2
6 weeks
P3
8 weeks
P4
4 weeks
P5

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E SMITH

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Theory Paper

Houston Suburban Intensification

Methodologies for how, where, what to intensify

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11th Graduation Lab Urbanism Conference

January 9th 2015

Paper abstract –Historically, Houston has been viewed as "the most sprawling, least dense, most automobile-dependent major city in America." In order to find a solution for the on-going trend of urban sprawl, it is often hypothesized that changing the urban structure and density accompanied by certain travel and land-use patterns can result in changes in energy consumption (Banister 1997; Newman and Kenworthy, 1999)

The aim of this paper is to review the literatures in order to answer the three questions about intensification in Houston suburban: How to intensify in order to reduce automobile dependence? How to define urban form and volume? What urban functions are needed? Reconstruct the automobile dependence city model (Newman and Kenworthy, 2006), Spacemate (Berghauser Pont and Haupt, 2005), Spacematrix, (Berghauser Pont and Haupt, 2010), Mixed Use Index (MXI) (Van Den Hoek; Mashhoodi & Berghauser Pont, 2011) and other methods are discussed to answer the questions. The conclusion of this paper is to explain how the methods can be used for the study and decision-making in different aspects of intensification in Houston. Furthermore, water, as a distinguish feature in Houston, is taken into consideration, especially from the intensified-location and real estate market point of views.

Key words –intensification; Houston; methodology; automobile dependence; energy consumption; water

1 Introduction: Problem statement and on-going trends

American consumes over 20% of the world energy while the population is only 4.33% of the world. Texas is the biggest energy consumer in the total energy use, and also has highest energy consumption rate per person. Historically, Houston has been viewed as "the most sprawling, least dense, most automobile-dependent major city in America." In order to find a solution for the on-going trend of urban sprawl, it is often hypothesized that changing the urban structure and density accompanied by certain travel and land-use patterns can result in changes in energy consumption. (Banister 1997; Newman and Kenworthy, 1999)

When talking about the urban features of Houston, water is a unique and distinctive theme. Flat plain and heavy rainfall result the city with 4332 km of drainage ditches, channels and bayous, but they are still not efficient to protect the city from flooding. During Tropical Storm Allison in 2001, the deluge of rainfall flooded 95,000 automobiles and 73,000 houses throughout Harris County. Tropical Storm Allison destroyed 2,744 homes, leaving 30,000 homeless with residential damages totaling to $1.76 billion. In the situation of Houston, flooding protection and water quality are significant factors effecting living environment and real estate market.
Energy consumption and water safety are on the high agenda nowadays for Houstonian. Intensification, as a key solution for the issues, is a hot topic for urbanist, government, also people and real estate market.

The aim of this paper is to review the literatures in order to answer the three questions about intensification in Houston suburban: How to intensify in order to reduce automobile dependence? How to define urban form and volume? What urban functions are needed? Theories, modeling tools and data are discussed to answer the three questions in the following three paragraphs. By reviewing the individual theories from different aspects, the paper tries to put all pieces together to reach a comprehensive study for Houston in the last paragraph. Furthermore, water, the distinguish factor in Houston, will be added into the discussion as the conclusion.

2 How to intensify in order to reduce automobile dependence

"The relative intensity of land use in the ten US cities is clearly correlated with gasoline use overall and in the inner and outer areas. The strongest relationship is with the population density in the inner area… These patterns suggest that urban structure within a city is fundamental to its gasoline consumption" (Newman & Kenworthy, 1989, p.25).

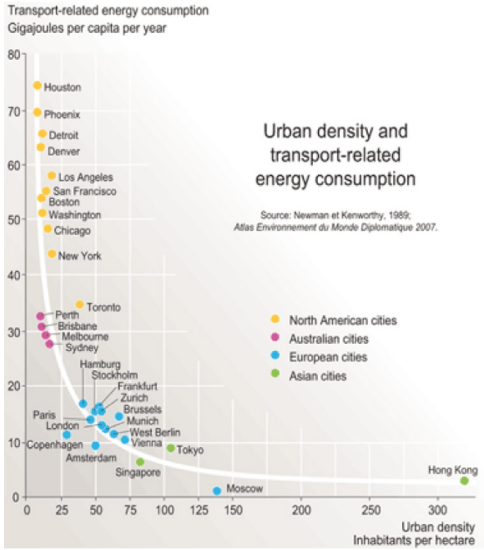

Illustration 1 Urban density and transport-related energy consumption, Source: Newman & Kenworthy, 1989

Reducing automobile dependence in order to address issues of viability and sustainability is one of the top priorities when discussing urban development of Houston. Car dependence and large ecological footprints as well as the loss of many urban qualities including walkability, viable public transport, jobs access, and other urban amenities have been tied together. Now, obesity levels, stress levels and children's mental health development have been linked to automobile dependence (Newman & Kenworthy1989: Gee and Takeuchi 2004; Hillman 1997).

How to intensify in order to reduce automobile dependence? The design theory (how a city can restructure itself to overcome automobile dependence) from Newman and Kenworthy in 2006 is reviewed as follow to answer the question.

2.1 Explaining car dependence in terms of access to amenities in centers: Urban center viability and size of population/ jobs in ped sheds

Time constraints mean that people will arrange their location and their mode of travel accordingly. In particular for an urban center, it becomes whether the time available for car travel is less than the time it would take to access the urban center using a bike, walking, or riding public transit. This element can be assessed using the Ped Shed model to create circles of activity for 10 minutes of walking or 30 minutes of walking. Ten minutes is the accepted time people will take to get to public transport or to a local amenity before that trip exceeds the whole travel-time budget. Thirty minutes covers the whole travel-time budget for those walking to urban services, and particularly jobs, within the Ped Shed. Thus two types of centers can be examined using this technique. The Local Center is essentially a Transit-Oriented Development with sufficient intensity of activity to make it an effective and viable transit center, supported by local services that bring people there as part of its multiple urban functions. The Town Center (Regional Center or Sub Center) is a place providing viable services for a region within a city. (see illustration 2).

Long-term data from cities around the world appear to show that there is a fundamental threshold of urban intensity (residents and jobs) of around 35 per hectare where automobile dependence is significantly reduced. (See data research in Newman & Kenworthy, 2006) Which means there is a threshold of approximately 10,000 residents plus jobs within this 10-minute walking area. The range would be from about 8,000 to 19,000, with jobs and residents being interchangeable for transport demand. This suggests the approximate minimum base of people that appears to be necessary for a reasonable Local Center – and a public transport service to support it (Newman & Kenworthy 2006: Pushkarev and Zupan 1997; Ewing 1996; Frank and Pivo 1994; Seskin et al. 1996; Cervero et al. 2004). If a 30-minute Ped Shed for a Town Center is used, then the range again is from around 70,000 to 175,000 people and jobs. This number could be the basis of a viable Town Center based on standard servicing levels. Any less than this means services in such a center become impractical.

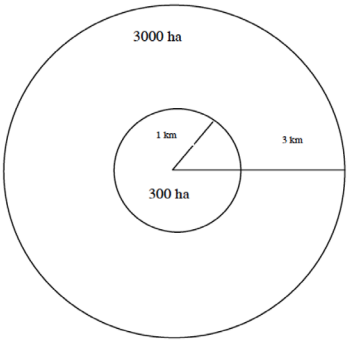

Illustration 2 Ped Sheds for Different Scale
Center: The Local Center is defined by its 10- minute Ped Shed and the Regional Center by its 30-minute radius
(Source: Newman & Kenworthy, 2006)

2.2 Intensification model: Amenity, density and transport

If amenity is high then density can be easily created. If amenity is low, density generally is hard to provide. However, there is a chicken and egg issue, as amenity often is not provided without a minimum of density to support it. Urban amenity is enhanced if there is sufficient intensity of urban activity. If some urban amenities are provided first, they can attract increased urban development. Density creates amenities, but also amenities attract density. This is particularly obvious when the amenities are associated with a public transport node. (Newman & Kenworthy, 2006)

An urban rail node can provide faster access and quieter urban environments than a bus node. Rail nodes attract large pedestrian flows. The attractions for people and jobs are thus vastly increased around urban rail centers (Newman 2001; Dittmar and Ohland 2004). For automobile dependence to be overcome, Ped Sheds with an urban rail node will have the potential for much higher densities. If only a bus node is pro-

vided, medium densities need to be designed across the Ped Shed. Transit cities are 20 to 30 kilometers in diameter. It is best to try to create a series of these with a rail and bus service that feeds into a Town Center. Along the lines feeding in to the Town Center would be a number of Local Centers. The whole city would be made up of transit cities joined together and linked by a fast rail service. Most people in the city could then live within the framework of local services in the Local Center. Main services, including work, would be located in the Town Center. This theory recently has been applied to the development of the Metropolitan Plan for the Sydney Region (www.dinpr.nsw. gov.au).

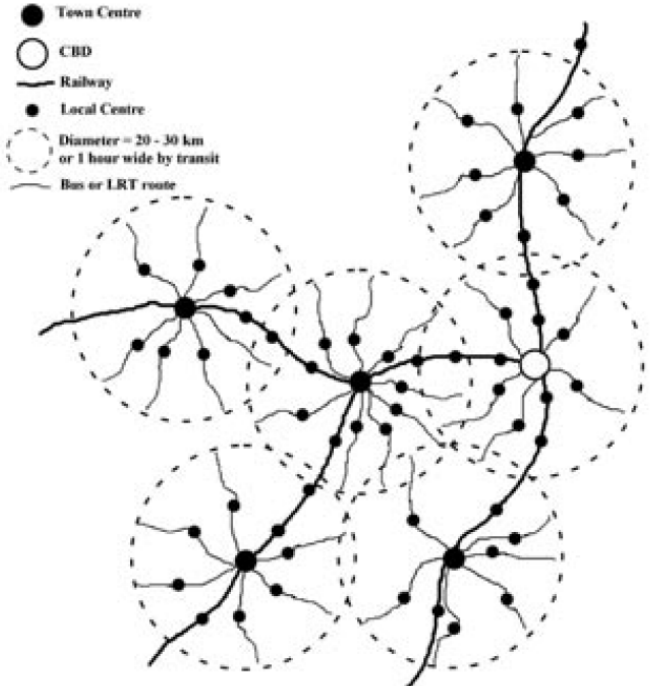

Illustration 3 A Conceptual Plan for Reconstructing an Automobile City (Source: Newman & Kenworthy, 2006)

3 How to define urban form and volume

This paragraph will discuss how to research and design the ideal urban form and building volume in two aspects. The first one is reviewing the The Spacemate from Berghauser Pont and Haupt. It deals with current changes in the urban planning and design practice, and presents a tool based on the knowledge of the relation between physical density and urban form. The second one is to look into the impact of surrounding urban morphology on building energy consumption.

3.1 Spacemate and Spacematrix

"How can we make plans where main issues and qualities are taken care of, but that still leave enough freedom to incorporate changes during the process from design until realisation? " The Spacemate is a tool for understanding the relation between quantitative and spatial properties. It is able to define programmatic demands and spatial ambitions simultaneously, without fixing a detailed program or a final image. It's a design and planning instrument based on a combination of density concepts can help planners and designers understand the capacity of space and assist in designing appropriate conditions for largely unpredictable developments. (Berghauser Pont and Haupt, 2005)

The Spacemate method provides a coherent measurement technique and reveals a linkage between densities and typologies of land development, urban environments, and non-built space. It suggests that density is defined as a combination of intensity, compactness (GSI), height (L), and pressure on non-built space (OSR), in order to assess all four variables simultaneously. The FSI on the y-axis gives an indication of the intensity in an area and the GSI on the x-axis reflects its compactness. The OSR and L are gradients that fan out across the diagram. Combining these four variables gives every project a unique 'spatial fingerprint'. The four examples with the same FSI can now be seen to occupy different positions in the Spacemate (see Illustration 4). Further more, the Spacemate chart can also be used to investigate the degree to which a relationship exists between the variables and the various building typologies. (see illustration 5)

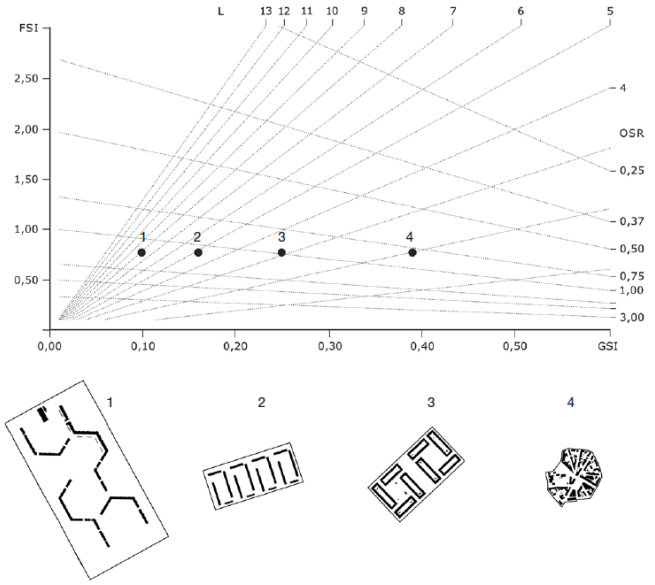

Illustration 4 the Spacemate :showing four cases with same FSI (source: Berghauser Pont & Haupt, 2006)

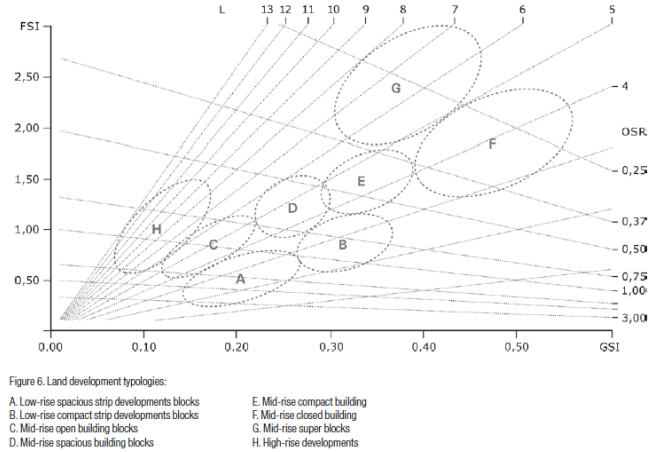

Figure 6. Land development typologies:

A. Low-rise spacious strip developments blocks
B. Low-rise compact strip developments blocks
C. Mid-rise open building blocks
D. Mid-rise spacious building blocks
E. Mid-rise compact building
F. Mid-rise closed building
G. Mid-rise super blocks
H. High-rise developments

Illustration 5 Land development typologies (source: Berghauser Pont & Haupt, 2006)

Berghauser Pont and Haupt published the Spacematrix on 2010, which is based on Spacemate but adds network density (N) into the existing variables. The new variable N not only contains quantitative information but also gives an indication of the dimensions of the urban form. FSI, GSI, OSR and L are dimensionless variables. Thus, by adding the variable N to Spacemate, the 'spatial fingerprint' of an area becomes more precise. The length of the network is used to determine the network density (N). This network density can then be used to calculate the average distance from street to street (fabric width/grain size), the porosity of the fabric (width of open space) and the street profile.

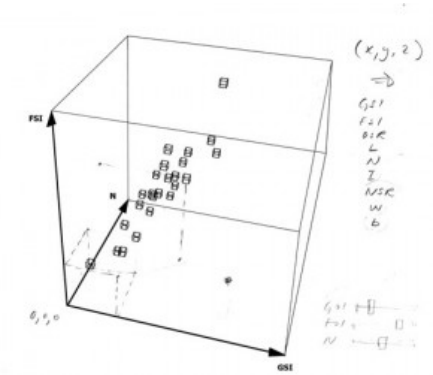

Illustration 6 Spacematrix (source: Berghauser Pont & Haupt, 2006)

3.2 Impact of surrounding urban morphology on building energy consumption

Urban areas have a large variety of forms and surface characteristic. Basically, the microclimate (air temperature at local level) of these areas is influenced by the three major urban elements: buildings, greenery and pavement. A research from Wong et al. in 2010 took the six parameters (green plot ratio (GnPR), sky view factor (SVF), surrounding building density, the wall surface area, pavement area, albedo) and ran a crossed test with STEVE tool and TAS software on an office building in Singapore. (see the completed test in N.H. Wong et al. 2010)

The result shows that variables such as GnPR, height and density show a high degree of impact in altering the temperature or microclimate. The degree of impact on the air temperature can be up 0.9–1.2 O C. The highest impact is GnPR due to shading effect of trees. The effect of GnPR overrides the effect of the other variables. And the cooling load reduction due to the impact of the variables is in the range of 5–10% if addressed effectively. Although 5% may seem a small percentage of energy saving, a note should be taken that this saving is only from one building. This energy saving can be compounded when we see it at the macro level with all of the buildings have the potential to save energy by 5% due to only by a proper master plan design.

4 What urban functions are needed

After the Second World War, urban design has been heavily influenced by the "Functional City" paradigm proposed by the CIAM international movement. CIAM suggested, amongst other things, a separated distribution of functions in cities. However, within the last decades, the urban design paradigm has shifted towards the opposite, mixed-use developments. In sustainable development mixed-use is regarded as one of the key factors (Bernick & Cervero 1997; Furuseth, 1997; Grant, 2005; Mashhoodi & Berghauser Pont 2011). Pros argue for advantages from various points of view for the mixed-use development. From environmental perspective, proximity of living, working and amenities, and mix of compatible functions in various scales, mixed use is an encouraging factor of greener modes of transport such as walking and biking. (Moudon et al., 2006; Lee & Moudon, 2004; Moudon et al., 2007; Moudon & Lee, 2003; Cervero and Kockelman, 1997; DETR, 2001; Mashhoodi & Berghauser Pont 2011). Others consider mixed-use related issues as effective drivers of urban vitality. These issues include the presence and combination of primary and secondary uses, variety in opening hours, the extend of variety inprimary land uses, the proportion of locally owned ormore generally independent businesses, the presence and size of street markets and types of specializations (Jacobs, 1961; Montgomery, 1998; Jacobs, 1994; Lynch, 1960; Sennet, 1990; Relph, 1976; Canter, 1977; Punter, 1991; Comedia, 1991; Mashhoodi & Berghauser Pont 2011). Other benefits of mixed-use mentioned in literature are promoting more diverse social groups, greater equal opportunities in terms of access to amenities and job opportunities, making cities more attractive places to live, improving economic viability of commercial centers, increase safety, encouraging more affordable housing in town centers e.g. converting spaces above the shops and vacant commercials into residential units, optimum use of infrastructure, and so on (Grant, 2002; Stead & Hoppenbrouwer, 2004).

In the research of Mashhoodi and Berghauser Pont in 2011 focuses on the conceptual level which looks at mixed-use from the perspective of the synergy and compatibility of land uses. They transformed the method, Mixed Use Index (MXI), from Joost van de Hoek. It is an indicator shows the composition of a study area, and whether an area is mixed or mono-functional. The MXI shows in percentages how the three primary functions (residential, major employment and service functions) are distributed. Together they are always 100%. Based on MXI, Mashhoodi and Berghauser Pont use 7 types as represented in illustation 7. Three types are considered mono-functional. Here more than 80% of the total gross floor area (GFA) is either residential, working or services (type 1, 2 and 3). Type 4, 5 and 6 are composed of a combination of two functions and in type 7 all different land uses are represented by at least 10% GFA.

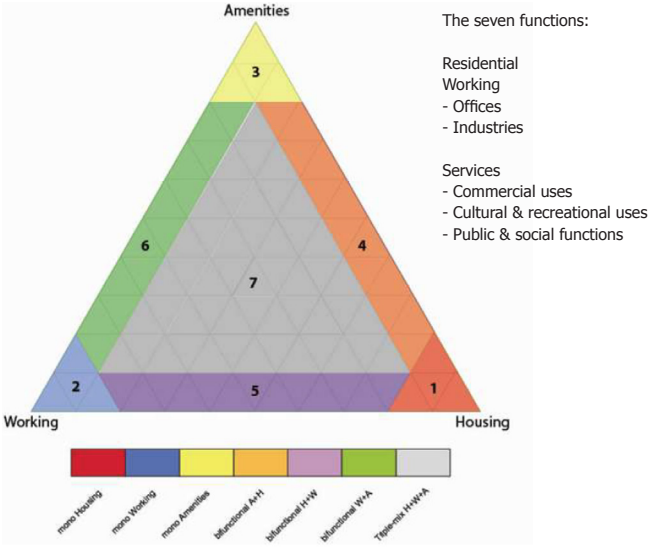

Illustration 7 Categorizing mixture of function, MXI (based on Van Den Hoek, 2011)

5 Conclusions

5.1 Water as a distinctive factor in Houston intensification research

Bayous are the unique and distinctive natural theme of Houston. Houston is also called "the Bayou City". There are seven bayous spreading across the area inside the city. Flat plain and heavy rainfall result the city with 4332 km of drainage ditches, channels and bayous, but they are still not efficient to protect the city from flooding. In another words, water is a precious natural quality but at the same time the disaster for the people in Houston. When talking about the real estate market, water is also a key factor that can drive the market to two opposite ways. The waterfront with sufficient investment and lower flood risk, which presents better living quality, attracts density significantly. But still, most of the areas alongside bayous are facing high flooding risk. By providing flood protection and other public service, it's possible to predict the density flow and intensification locations precisely.

5.2 Using the reviewed methods for Houston intensification research

To evaluate if the theories mentioned above are ideal for the intensification research in Houston, the area need to be narrowed down and focus on specific urban characteristics. The purpose of this paper is to research the methodologies for designing suburban areas in Houston. It will focus on one suburban at the north of Houston first, and try to conclude common strategies for the whole suburban environment. The focused area is a high automobile dependent neighbour. 70% of the area is mono-function residential land use and has relatively equal density over the whole area.

Then the question is how to use the methods for intensification possibilities research?

- First, the area can be categorised with the Spacemate into land development typologies (example as illustration 4).
- Second, the land use and function can be analysed with the Mixed Use Index (MXI). The result is useful to identify where has high potential to become a center, and which area is lacking the amenities to support the density.
- The model of reconstructing an automobile city (illustration3) and the provided data of population and size are the concept to consider the location and distance of transport and center points. At the same time, water is the factor that needs to integrate when choosing the location.
- Spacematrix is tool that can assist flexible designs of the urban form based on different developing levels.
- While the data of surrounding building morphology with energy consumption can be the guidelines for micro scale design, such as open space ratio, greenery, and pavement…

7 Further research

As the book "More water: design and management of Dutch water cities" (Hooimeijer & der Toorn Vrijthoff, 2007) pointed out, tuning and integration of urban water and real estate management seems obvious. However, it does run across a few problems: Development often aims at densification whilst the urban water system also claims space. Water managers work with a linear planning and single aims with normative objectives. Urban developers have a wide range of aims and objectives wherein the result a product is of negotiation. There is a dissonance between the scale of the water task and the scale of redevelopment: the water task will be dealt with in little steps and not wholesome resolutions.

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Graduation Plan

Graduation Plan: All tracks

The graduation plan consists of at least the following data/segments:

Personal information	
Name	Song-Ya HUANG
Student number	4317645
Telephone number	0649171931
E-mail address	songyahuang@gmail.com
Studio	
Name / Theme	Delta Interventions
Teachers	Han Meyer Nico Tillie
Argumentation of choice of the studio	Most of the highly developed urban areas are located on deltas, where the populations are concentrated. Water is not an essential element in some cases, but it definitely is an interesting element that brings valuable qualities. The site of Delta Interventions this year, Houston, is the case that not only needs the focus on additional qualities of water, but sees water (flooding) as main urban challenge. I'm from the island country, Taiwan. While surrounded by the sea, water safety is a serious concern for me. The understanding and knowledge of water are the reasons I join Delta Intervention studio.
Graduation project	
Title of the graduation project	Recycling Houston: Bringing synergy between improving water safety, reducing energy consumption and reinforcing living quality in suburban
Goal	
Location:	Houston
The posed problem,	1 Flat plain with heavy rain: Flat plain and heavy rainfall result the city with 4332 km of drainage ditches, channels, and bayous, but they are still not efficient to protect the city from flooding. During Tropical Storm Allison in 2001, the deluge of rainfall flooded 95,000 automobiles and 73,000 houses throughout Harris County. Tropical Storm Allison destroyed 2,744 homes, leaving 30,000 homeless with residential damages totaling to $1.76 billion. 2 Rapid population growth & urban sprawl:

	Historically, Houston has been viewed as "the most sprawling, least dense, most automobile-dependent major city in America." But today, not only people having the wills and also government is trying to move toward denser and more livable urban life by proposing an endless list of plans and policies. But still, Houston is looking for a stronger solution and vision to "go urban". 3 High energy-consumption: American consumes over 20% of the world energy while the population is only 4.33% of the world. Texas is the biggest energy consumer in the total energy use, and also has highest energy consumption rate per person. Cooling /heating system and transportation are the two main factors of personal consumption, which strongly depend on the coal, natural gas and petroleum, the non-renewable resources. Although Texas is recognized as the oil state, the renewable energies should get more attention in future development.
research questions and	Main research question: In the intensification process, how to recycle existing urban elements and integrate them with bayou systems in suburban areas to bring synergy between reducing energy consumption and reinforcing living quality in Houston? Sub questions: 1 How to intensify the suburban area by transforming the bayous and urban structure to reduce flooding risk and achieve low carbon energy system? 2 For residential lots, water system and public space, what are the prototypes that can provide water storage capacity, generate more energy and reduce consumption while increasing the spatial quality? 3 How to implement the prototypes on sites, and still preserve the neighborhood

	characters and reinforce the living qualities?
design assignment in which these result.	The main research question can be elaborated into three sub questions that focus on three different processes and result in three intended end products: 1 intensification strategies and urban structure of the whole project area 2 prototypes set-up in three themes: residential lot, water and public space 3 three local scale interventions based on three kinds of prototypes.
This should be formulated in such a way that the graduation project can answer these questions. The definition of the problem has to be significant to a clearly defined area of research and design.	

Process

Method description

Methods are described in three design processes to answer the three sub questions:

1

- Area analysis (mapping) in three categories: living quality, water safety and energy
- Setting up objectives for future urban systems based on area analysis
- Intensification potential analysis based on theoretical framework
    - Spacemate: categorizing land development typologies
    - Mixed Use Index (MXI): identifying potential areas for intensification
- Strategic plan: translating the intensification model and data from Newman (2006) into the project location

2

- Area analysis to identify the common typologies in three categories: residential lots, water system and public space
- Data collection to provide scientific threshold for water storage capacity, energy production and reduction
- Prototypes design based on building morphology and energy consumption research, case study and site visit
- Scenarios of prototypes (different developed levels): Spacematrix

3

- Mapping and observing to understand the neighborhood characters and existing qualities.
- Research-by-designing to test how to transform the prototypes to existing sites.
- Implementing two scenarios in each site to discuss the result (ex. energy production amounts) and factors (ex. density, stakeholders) in different developed levels.

Literature and general practical preference

Literatures are reviewed in order to answer the three questions about intensification in Houston suburban:
- How to intensify in order to reduce automobile dependence?
- How to define urban form and volume?
- What urban functions are needed?

Reconstruct the automobile dependence city model (Newman and Kenworthy, 2006), Spacemate (Berghauser Pont and Haupt, 2005), Spacematrix, (Berghauser Pont and Haupt, 2010), Mixed Use Index (MXI) (Van Den Hoek; Mashhoodi & Berghauser Pont, 2011) and other methods are discussed to answer the questions.

Reflection

Relevance

Scientific relevance:

Climate change which is interrelated with flooding and energy consumption in on the high agenda for not only urbanists but also many professions in other fields. Being a high automobile dependent city and facing serious flooding risks, Houston suburban is an ideal model to do the integrated research on intensification with water and energy aspects. This project is trying to review the current theories from different fields. By discussing Houston suburban, the aim is to coordinate the theories, data and my observations to provide overall remarks for the integrated research on intensification, energy and water. The research is focusing on Houston but still shares common issues with other suburban areas over the world.

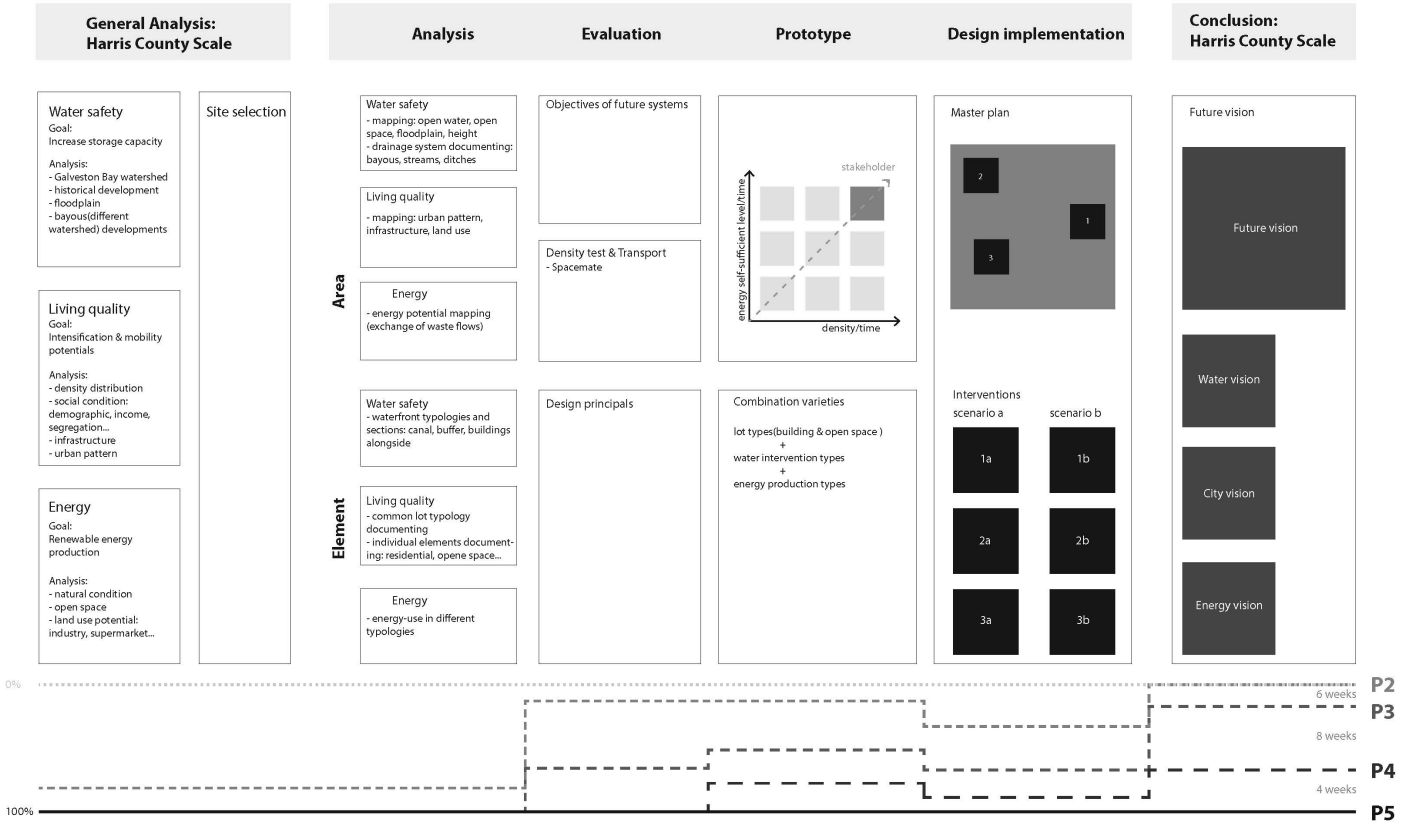
Societal relevance:

The selected site of this project is especially focuses on the suburban area with serious flooding problems and low economic-social conditions. One of aims in the project is to provide strategies for the area that is neglected by the government or investment flows. With more considerations, small individual changes can also have big influences for their living environments.

Time planning

See the attachment at next page

Project framework & Time planning



• See p.42 for clear version

Preliminary Design

Contents

General Analysis: Harris County Scale

Water safety
Goal:
Increase storage capacity

Analysis:
- Galveston Bay watershed
- historical development
- floodplain
- bayous(different watershed) developments

Living quality
Goal:
Intensification & mobility potentials

Analysis:
- density distribution
- social condition: demographic, income, segregation...
- infrastructure
- urban pattern

Energy
Goal:
Renewable energy production

Analysis:
- natural condition
- open space
- land use potential: industry, supermarket...

Site selection

Analysis

Area

Water safety
- mapping: open water, open space, floodplain, height
- drainage system documenting: bayous, streams, ditches

Living quality
- mapping: urban pattern, infrastructure, land use

Energy
- energy potential mapping (exchange of waste flows)

Element

Water safety
- waterfront typologies and sections: canal, buffer, buildings alongside

Living quality
- common lot typology documenting
- individual elements documenting: residential, opene space...

Energy
- energy-use in different typologies

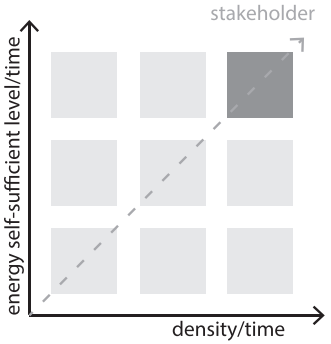
Evaluation

Objectives of future systems

Density test & Transport
- Spacemate

Design principals

Prototype

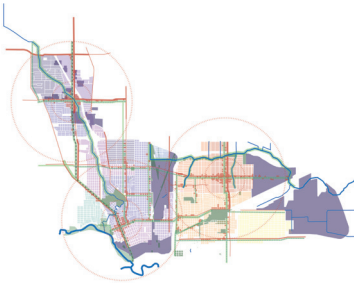


Combination varieties

lot types(building & open space)
+
water intervention types
+
energy production types

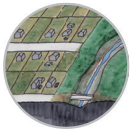
Design implementation

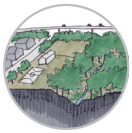
Master plan

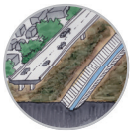


Interventions

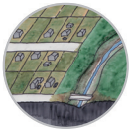
scenario a

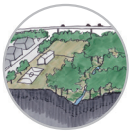


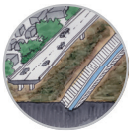




scenario b







Conclusion: Harris County Scale

Future vision

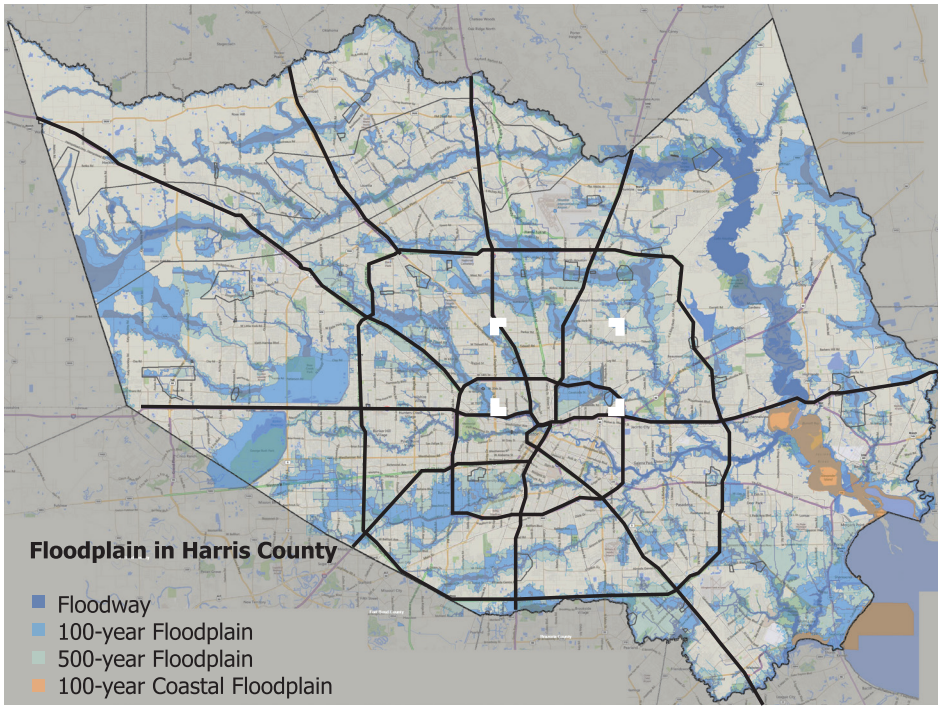
Future vision

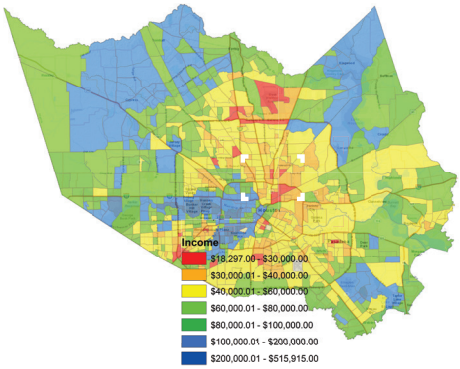
Water vision

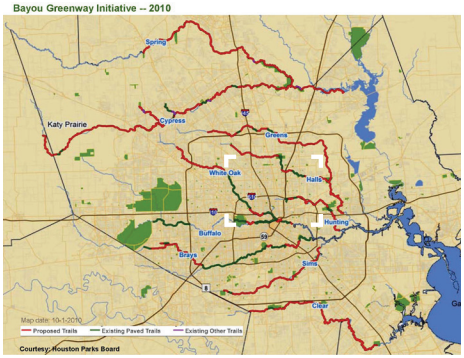
City vision

Energy vision

Location


Floodplain in Harris County
Floodway
100-year Floodplain
500-year Floodplain
100-year Coastal Floodplain


Income
$18,297.00 - $30,000.00
$30,000.01 - $40,000.00
$40,000.01 - $60,000.00
$60,000.01 - $80,000.00
$80,000.01 - $100,000.00
$100,000.01 - $200,000.00
$200,000.01 - $515,915.00


Bayou Greenway Initiative -- 2010
Spring
Katy Prairie
Cypress
Greens
White Oak
Halls
Buffalo
Bayou
Sims
Clear
Proposed Trails
Existing Paved Trails
Existing Other Trails
Courtesy: Houston Parks Board

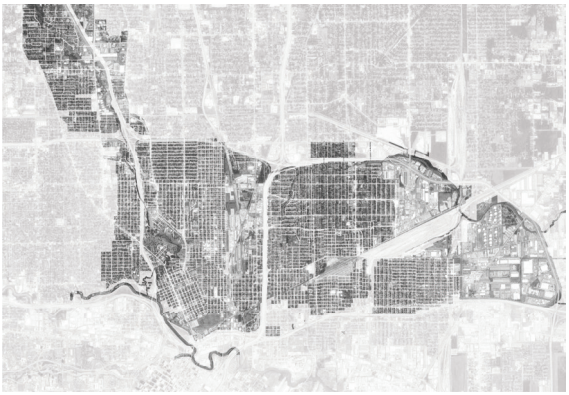
Why Here

In the central part of Houston, there are sevarel bigger floodplains. They are basically following Brays Bayou, White Oak Bayou and Hunting Bayou. Brays Bayou locates at the west side within the most wealthy district. Houston Medical Center, the biggest medical center in the world, is in this area. The flooding issues already have a lot of focuses. This project chooses the north side of Houston along Hunting Bayou and Little White Oak Bayou, in order to not only tackle the flooding but also the other issues in the more vulnerable area.

Rotterdam

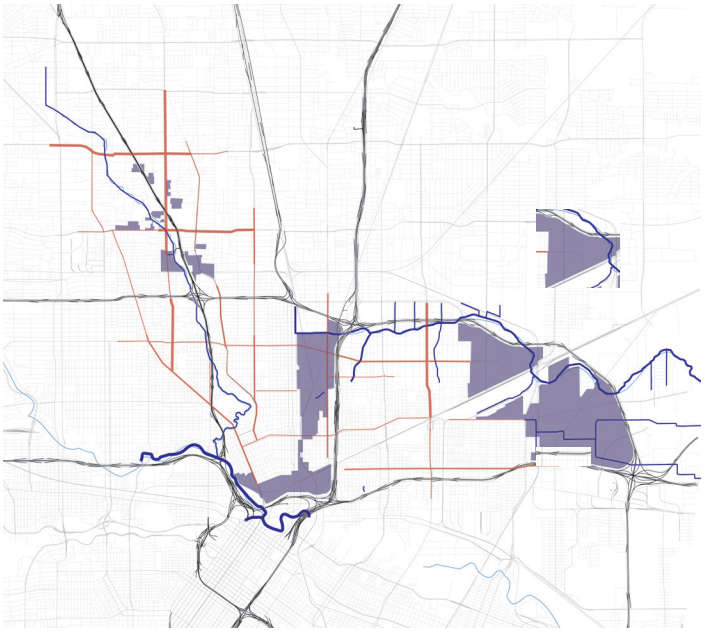
13.20 km

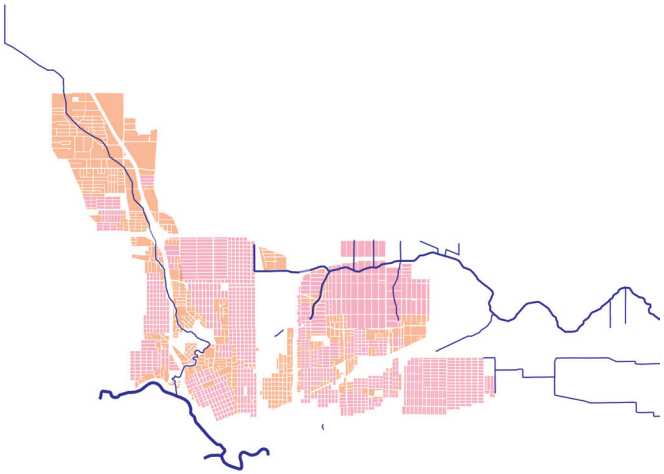
Site



14.25 km

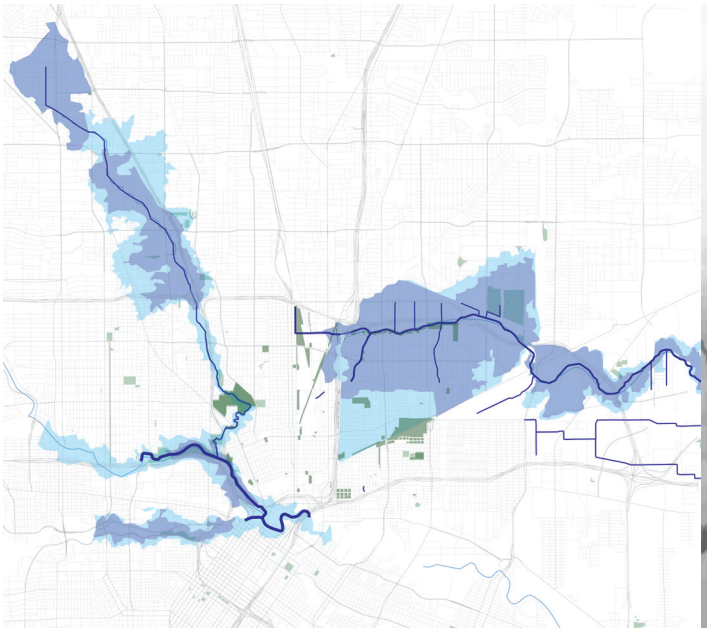
Spatial analysis

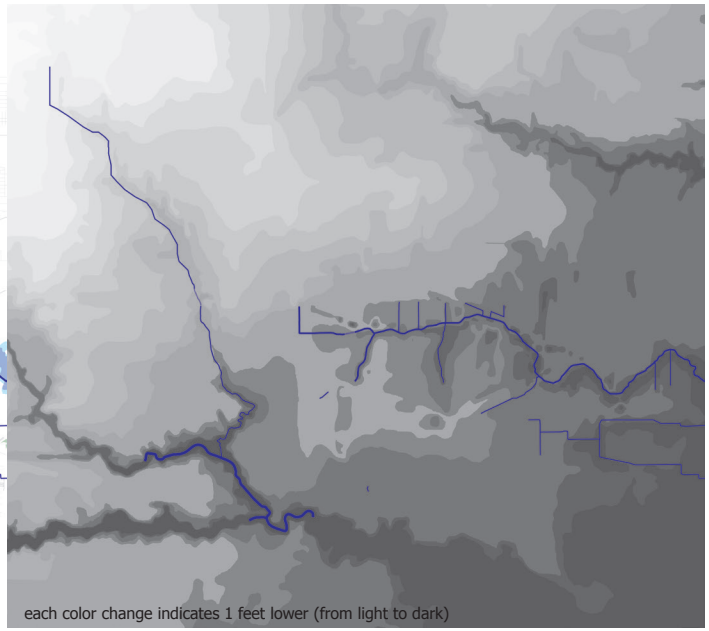




Infrastructure
The site locates right above downtown Houston. It's divided by several highways and big industrial zones. There are no obvious centers. Most amenities are spread along the main roads.

Urban pattern
Except the industrial area, almost of the land are residential suburban. The pattern can be divided into two types: regular and irregular. The regular patterns are following the grid system. The blocks are repeated in similar typologies. Basically, these areas are the older parts. The irregular pattern are more difficult to categorized the typologies.

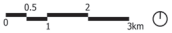




Water and open space

The two bayous are almost parallel with the highways with some bigger open space in between. There are two major floodplains. These floodplains are formed by the height difference.

Legend



highway


main roads with amenities


industrial zone


irregular urban pattern


regular urban pattern


500 years flood plain

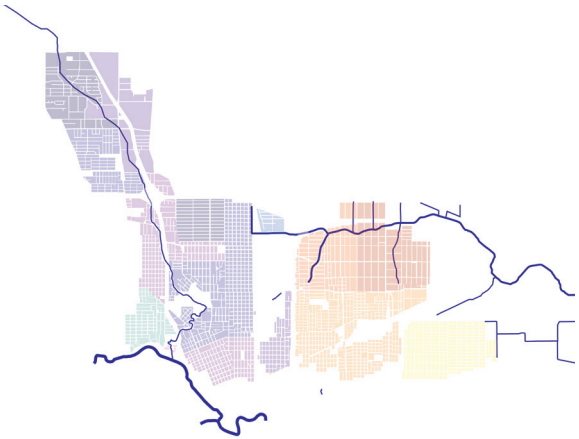

100 years flood plain


open space

Neighborhood analysis

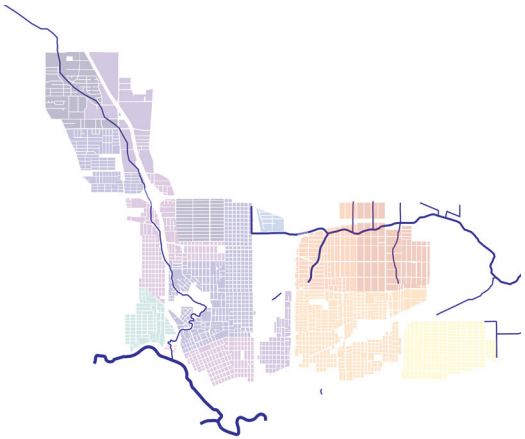
West side

The neighborhood conditions are better than east side, especially the west-south area(green). The single houses are the majority (bottom). There are some exceptions, such as gated communities (top) and new community development (middle).



East side

Most of neighborhoods on east side are covered by the floodplain. The social-economic conditions are almost the lowest comparing with other parts of Houston. The density is also lower, and a lot of residential lots are vacant, especially near the water ways. Most of the housings are 1-2 floors single houses(top &middle), but there are also multi-family houses (bottom).



1
Upper stream: very narrow (2m) with shallow depth (50 cm).

2
The bayou is canalized and becomes wider.

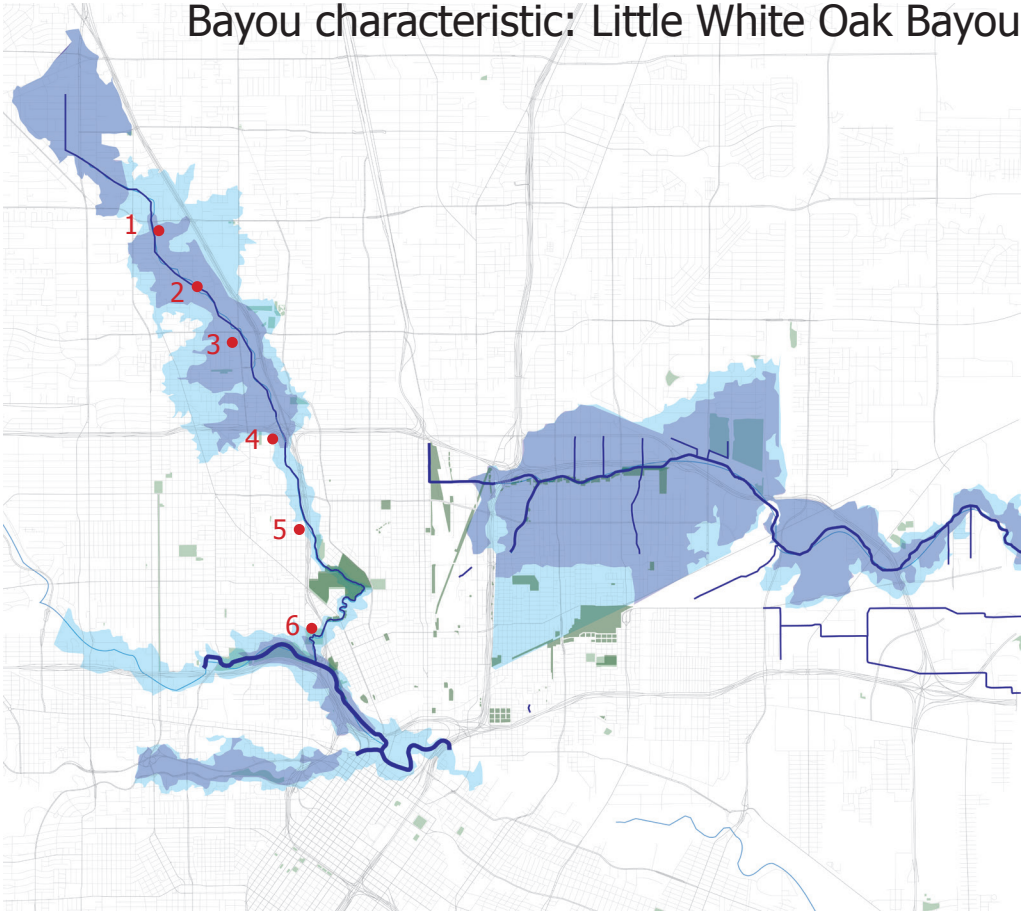
3
Crossing with highway: the bayou is approximately 5m high and 20m wide. There is huge buffer space between the water and neighborhoods.

4
The bayou goes underground at the big highway intersection.

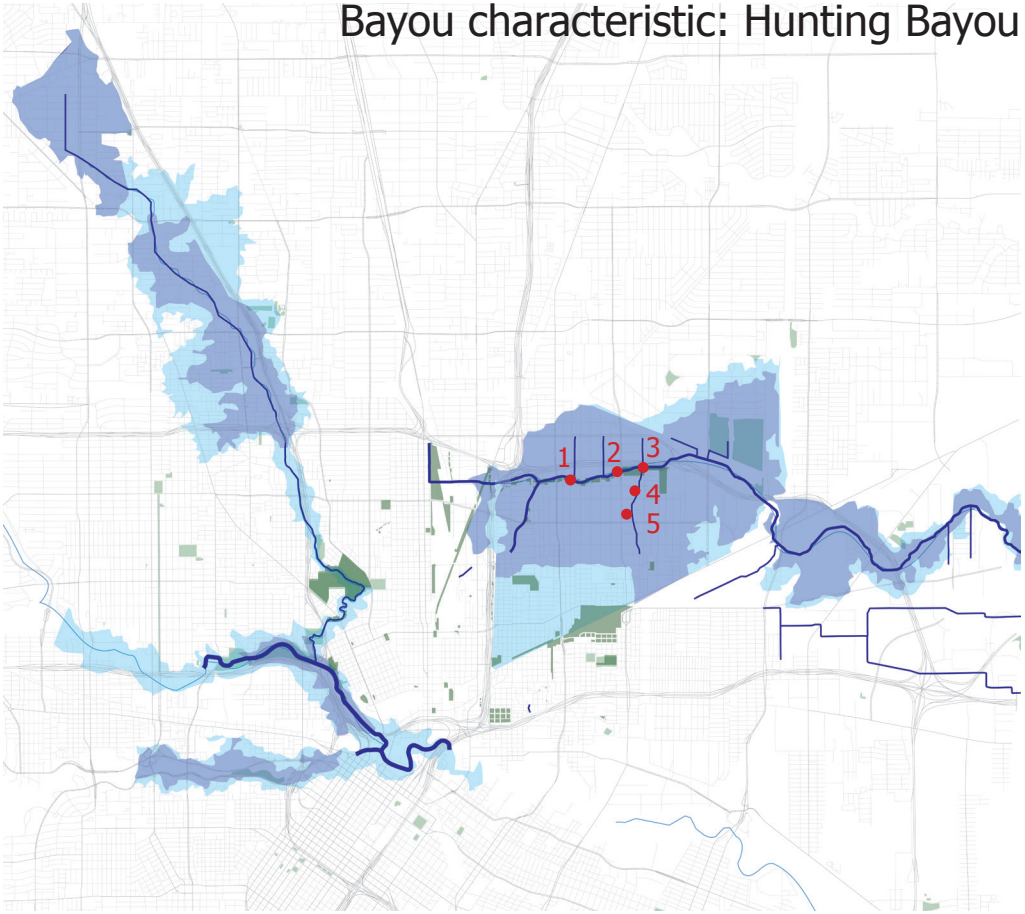
5
The water goes parallel with highway, and the waterfront is more natural. Although the bayou provides nice view, but there are no access for people.

6
The bayou passes through several big public spaces. The end of Little White Oak Bayou is hiding inside a park. The area remains very natural without any human activities.

Bayou characteristic: Little White Oak Bayou



Bayou characteristic: Hunting Bayou



1
The upper stream of Hunting is different from Little White Oak Bayou. It is deep and wide. The waterfront is developed as a park, but people don't really use it.

2
The bayou becomes less deep and wide when it goes east.

3
The intersection of Hunting bayou and it's branch.

4
The branch is canalized, and it goes through the neighborhoods with very small buffer in between.

5
Crossing between branch and main road. It's about 2.5m high and 8m wide.


2


3

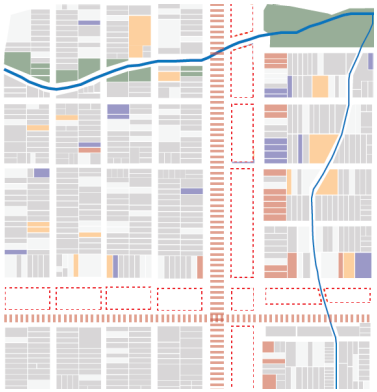

4


4

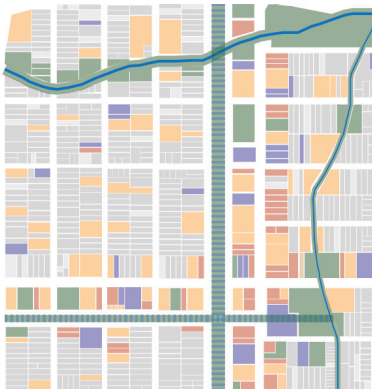

5


5

Strategy



current



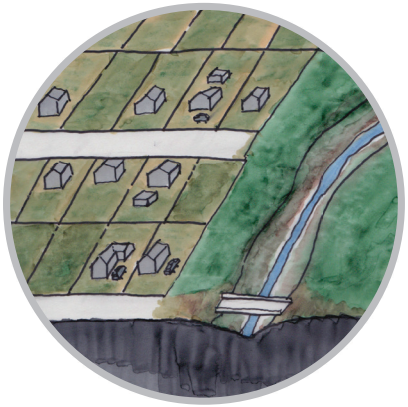
possibility

Strategy

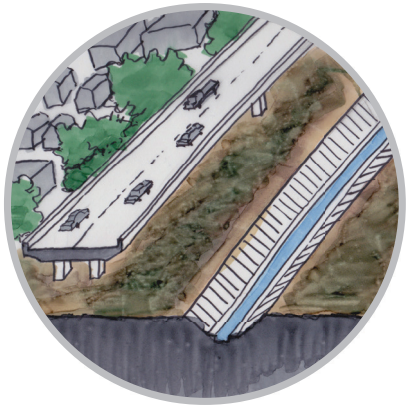
The main strategy is to provide a new backbone for intensification to happen: converting part of the existing blocks into linear axises. The strategy leads to the design interventions and prototypes set-up. The spatial characteristics are different based on the locations. Basically, they be categorized into three: residential lot, infrastructure buffer and public open space.

Strategy demonstration: residential lot

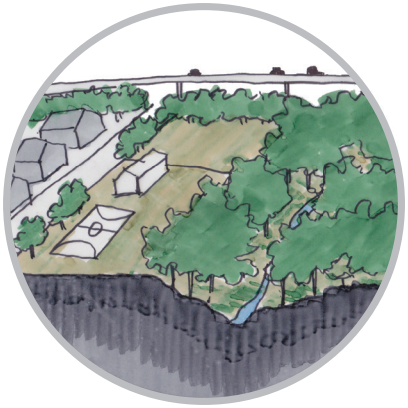
Prototypes & design interventions categories



Residential lot

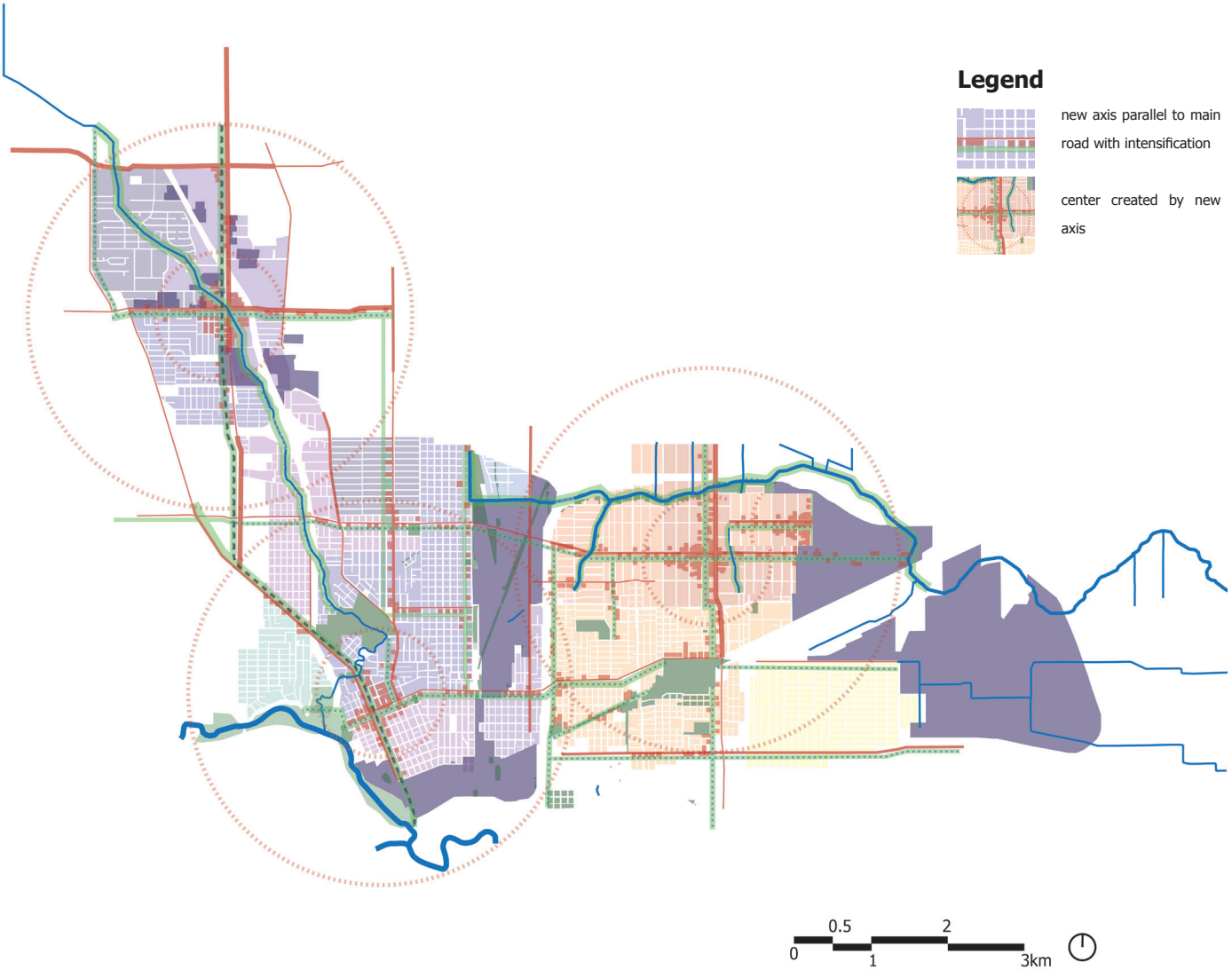


Infrastructure buffer



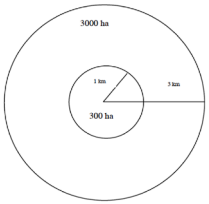
Public open space

Strategic plan



Reference theory

Ped Sheds for Different Scale Center: The Local Center is defined by its 10- minute Ped Shed and the Regional Center by its 30-minute radius (Source: Newman & Kenworthy, 2006)



A Conceptual Plan for Reconstructing an Automobile City (Source: Newman & Kenworthy, 2006)