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LARC 8500: Graduate Colloquium
Introduction and Review of Literature

Area of Interest

Gender-Sensitive design is a practice of design that reaches beyond the language and context of architecture. The field of architecture historically has been predominantly male and is only recently starting to transition into a gender balanced field. The AIA (American Institute of Architects) reports that as of 2020 women only make up 17% of registered licensed architects (The American Institute of Architects, 2020). In education, the gap has been narrowed and the male to female ratio of students in architecture school is nearly 50:50 (Arieff, 2020). So why is the ratio in the practice of architecture so low? The connection from learning environments to the practicing world must be looked at closely. The path from learning environments to professional environments is a linear connection so why is the imbalance so skewed? Product design is a quick turnaround, tangible way to assess the gap between men and women in the build environment. Take the design of a standard electric guitar for example, it was designed by men for men to use. When women started to use the instrument, specifically St. Vincent, the design was modified. St. Vincent shortened the neck, narrowed body, placed the strings closer together, and even reduced the pick size. The intent of the guitar design was not to create a guitar for women, but instead it was a guitar designed by women (Scrippa, 2016). This is not the only example of an item that was originally design with the intention for the maker, in this case men, to use and modified by the user, women, later (Scrippa, 2016). There are many other products predominantly designed for men, for example, automobile safety features are designed for the standard male body and is why women tend to suffer more serious injuries than men do in vehicle crashes (Criado-Perez, 2019). CPR mannequins are representative of the male body resulting in men having a 23% increased chance of surviving administered CPR compared to

women (Paschal, 2021). Many industrial products including toilets, pianos, even our smart phones have been designed for the standard dimensions of a male hand (Chang, 2021).

Landscape architecture is objectively more fluid and organic when it comes to the design process and build environment. This fluidity of space is believed to provide a 'feminine' aesthetic and ethics of care to landscape design. However, the gender-imbalance of the profession is still apparent. 24% of all landscape architects are women while 75% are men and women earn on average 94% of what men earn in a year as of 2020 within the profession of landscape architecture alone (Zipa, 2020). So, if something as small as a phone is designed as if only the designer will be using the product, then what does that tell us about the built environment? What does this tell us about the femininity of landscape design? If only male designers are designing landscapes for all user types, then it is not unreasonable to assume we must assume that the space they designed will tend to cater towards the designer, thus creating an imbalanced and inequitable environment.

The Problem of Spatial Inequity: Gender-Imbalanced Public Space

The profession of architecture in general has predominately been male. This fact, similar to, the St. Vincent guitar case, may suggest that spaces have been designed thus far for the male benefit. Even if this gender insensitivity or lack of gender awareness is not a part of the design intention, but simply the result of having one gender present in the design decision-making of spaces that should engage all genders. Due to this apparent lack of representativeness, it is unlikely to design equitable spaces for the benefits of all equally. I have observed various spaces where there is a subtle display of inequity. Learning environments, the public realm, healthcare and healing settings, professional environments and product design to name a few. Details as simple as making a sidewalk large enough for a stroller or offering adequate lighting to a

secluded location can make spaces more accessible and safe thus encouraging women to be present. Learning environments such as elementary school classrooms and play yards, college settings with forced social aspects and even the newly navigated virtual platform with both passive and engaging instruction. All three institutional settings address the aspect of unequal sociability and inaccessibility to common resources as well as engagement and participation.

We see such inequities almost everywhere in professional environments, particularly in leadership and through the provided resources for employees and in the collaboration of offices, teams, co-workers, etc. Recognition for work, salary and bonus and the ability to voice opinions are how workplaces thrive and are often where we see an equity gap between genders. Resources such as allocated research funding, paid maternity or paternity leave and even resources like restroom or desk locations or office temperatures all place women in at a disadvantage within the professional setting. Perhaps there is an intangible dimension of equity that we will never reach purely based on the preconceived thoughts of professionals towards the idea of gender-equity and thoughts of women in the workplace.

The public realm addresses parks and open spaces, public transportation and the streetscape. All parts of the public realm face issues of safety, lighting, walkability, natural surveillance and reliability. Things the public has a right to use yet falls short. During 1990, in Vienna a study was done on why there were less and less young girls using public spaces as they got older. The city planning council concluded that if they continue to plan public spaces for the existing user, then they will continue to see a decline in the number of female users (Gardner and Begault, 2019). In order to design a space that will include all types of users and will strive for gender equity, then female designers must be brought into the picture.

The designed research puts forward the following arguments: First learning spaces is a direct lineage to the professional world. So, fostering equitable environments in an education centered environment will thus foster equitable environments in the professional world. Second, learning spaces stretch beyond the footprint of the education facility to the public and social realm. How we teach and prepare children in elementary school for the next grade, bleeds into how our children interact in social scenes and social landscapes. Therefore, developing equitable learning space is paramount to creating equitable public space through the idea of sociability.

The Expected Outcome and Research Questions:

The study will find out co-related external environmental factors to perceived injustice in learning spaces by asking the questions:

- What are the language and terms misused in our learning environments?
- What are social, psychological conditions and spaces that engender gender insensitivity in our learning environments?
- Finally, to remediate the existing design/learning environments, what can be done differently to promote the success of all genders in order to create a diverse team of future designers?

The research can use the following approaches will guide the factor assessment of the gender-imbalanced learning environments we experience in the physical, intangible, social and psychological world of education.

- 1) The study illustrates how ordinary language and terminology we used in the social world can influence the way we perceive or use spaces and meanings. The goal is to

Research Question:

Using the analysis of the history and theory of two landscape architects, one male and one female, in what ways can we change the design of learning environments that will encourage the use and promote the success of all genders in order to create a diverse team of future designers?

Review of Literature

In order to find the answer to where are all the women in the professional world of landscape architecture, we will follow the career paths of Martha Schwartz and Peter Walker. We will start from their childhood upbringing to their education and through their experience in the professional world. This timeline will be used to pinpoint where the gender-equity gap lies in the field of landscape architecture.

Martha Schwartz and Peter Walker

Martha Schwartz was named one of the most influential Landscape Architects in 2012 for her ambitions and sometimes controversial garden designs (Lan, 2012). Schwartz was born in 1950 in New York City to Milton and Stella Schwartz. She grew up with her father Milton Schwartz who studied architecture at the University of Illinois in Champaign and was encouraged from a young age to pursue a career in art and architecture (Leavitt, 2015).

Peter Walker was raised in Pasadena, California by his mother. Walker would take the train to Southern California frequently to visit his grandparents, who he had a great relationship with. It was these train rides through the vast agricultural landscapes that first peaked his interests in design (LAD, 2013). He graduated from Berkeley High School and went on to attend the University of California where he focused on how agriculture and nature inform one another

provide the equitable use and most-up-to-date terminology to avoid bias and misconception while conducting the research.

- 2) The study identifies areas and aspects of the gender sensitivity in our learning environments. Behavioral patterns and user perceptions/participants will be mapped but as they relate to spatial dimensions. Then measure the degree and intensity of gender insensitivity and its related perceptions such as inequity, inequality and gender injustice and develop a visual analysis of each category.
- 3) Using the measurements above, the study comparatively analyzes the prominent difference between most influential female landscape architects and male landscape architects. Their upbringing, education, exposure, project types will be discussed in relation to spatial sense and perceptions.
- 4) The study finally outlines the physical forms and spatial aspects related to gender sensitivity and recommends design remedy to bridge the gap.

Significance

The difference between spaces design for women and spaces that are designed by women is an important concept that this research will focus on. Designing learning spaces that promote gender-equity and will provide opportunities for success for all genders can only be designed by those who are using such spaces. This does not suggest that only women can design spaces for women, but women need to be a part of the design process and obtain decision-making power. This starts with providing environments that welcome and support all genders.

and can landscape architecture. Walker attended the Harvard Graduate School of Design as well where he received his Master of Landscape Architecture (LAD, 2013).

Growing up in New York, Schwartz was influenced by the various styles of architecture and was fascinated with the idea of combining art and landscape design (Leavitt, 2015). She went on to receive her Bachelor of Fine Arts and her Master of Landscape Architecture from the University of Michigan. She studies at The Harvard Graduate School of Design from 1976-77 where she worked with Peter Walker. Schwartz and Walker married in soon after in 1979. Together, they opened The Office of Peter Walker and Martha Schwartz (LADP, 2013). Walker introduced Schwartz to the concept of combining her love for art with landscape design (Leavitt, 2015).

In comparison to Schwartz, Peter Walker went on to work for Lawrence Halperin after graduation as well as Hideo Sasaki. He worked on projects that ranged from urban housing projects to resolutions for post-World War II effects. Most of his projects were large-scale and tended to stay at that level (LAD, 2013).

Walker became the Director of the Urban Design Program at Harvard GSD in 1976. At this time, Schwartz was returning to the University of Michigan and their relationship began to unfold (LAD, 2013). The details of this relationship are overlooked and enforce the idea that while women may be shamed and removed from a particularly controversial situation, men will continue to be protected. Schwartz left Harvard GSD and Walker was promoted to director.

Schwartz was influenced by a range of designers including Sasi Judd, Robert Smithson, Michael Heizer and Sol Lewity. Each incorporated an element of art or sculpture within their practice of landscape architecture. Schwartz was particularly inspired by Isamu Noguchi. Her design aesthetics reflects that of Noguchi as well as the concept of minimalism seen in his

projects (Leavitt, 2015). Her design characteristics are described as being bright colors, sharp like and artificial structures (Lan, 2012). She takes on the idea of creating spaces that are both functional and meaningful as well as somewhat controversial. Through her career Schwartz received several awards and prizes as well as creating famous landscapes around the world. Some awards include the ASLA President's Award of Excellence, the ASLA Merit Award and the Honorary Fellow of The Royal Institute of British Architects (Lan, 2012).

In an interview Martha Schwartz said:

"We lose a lot of women in the field of landscape architecture after having children because the job is rigorous and demanding so they choose to be with their children, which I completely understand. But the way we construct our workplace, hours of work, whether we can establish more flexible working rules and to promote policy that can support women and children, will affect many people's life choices. It is up to us to make changes." (Schwartz, 2020)

She discusses the many roles she has taken on throughout her career and states that her own practice would not have been possible without the option of being able to work from home (Schwartz, 2020). This is a consistent issue seen throughout all professions. Perhaps the gender gap stems from the issue of women not having childcare options during working hours. Or perhaps the gap lies in the stigma of "the women architect" that is still apparent today.

The #MeToo Movement and the Workplace

Gender harassment has existed in the workplace and in education from for as long as women have been allowed in these environments (Knepper, et. Al, 2020). The #MeToo Campaign is a movement against sexual harassment that began in 2006 and has grown rapidly

If women are given more responsibility in the office setting as well as in roles they make take on in education settings, then the environment will feel more inclusive (Fuhmans, 2018). Anonymous surveys of students concerning sexual harassment can allow institutions to gauge how their students might be feeling beyond just what they can observe. Encouraging conversations and pointing out inappropriate behaviors can begin to open the eyes of those who don't necessarily know they are doing anything wrong (Bell, et. Al, 2002). The #MeToo movement has helped bring awareness to the obvious forms of gender harassment, but it has a far way to go.

Awareness and Education

Only about a third of surveyed male architects reported that they were not paid more than their female colleagues and almost all the surveyed male architecture students reported that females were presented with the same opportunities as male students (Stratigakos, 2016). However, it is known that the wage is on average 95% of what men earn in a year (Zippa, 2020). Healthy competition between students in a university is expected and highly encouraged, however when the same resources are not provided to women as they are to men, then the competition is skewed. Also, if women do not feel safe or respected in their learning environments again the competition is skewed.

Until recently, there has been limited recorded history of women designers. In school, the famous architects are celebrated and often women are left out of the picture (Stratigakos, 2016). The way women architects are depicted in history is discouraging for young women who are studying architecture. During an interview with CNN after winning the Architects' Journal's inaugural Jane Drew Prize for "outstanding contribution to the status of women in architecture", Zaha Hadid stated:

worldwide to start conversations about sexual violence against women (Johnson, Widnall and Benya 2018). The #MeToo movement encourages women to speak out against sexual abuse, however, it does not make that connection between gender discrimination and inequality within the workplace (Fuhmans, 2018). It then can be concluded that in order to avoid workplace harassment, the more equitable the workplace must become. The current imbalance between men and women in the workplace leads to the constant harassment of women in the workplace and in turn, discourages women to enter the field of landscape architecture.

The #MeToo Movement and Education

Gender harassment and other discriminate actions such as less promotions and the wage gap are numerical statistics we can assess in the workplace when determining the gap in gender-equity. Within the school environment the numerical statistics matters but should be looked at more subjectively. As of 2020, it is reported that women only account for 17% of registered architects (The American Institute of Architects, 2020). However, the ratio of men to women in architecture school is nearly split 50:50 (The American Institute of Architects, 2020). The gap from school to the professional world should be a linear correlation. Accounting for the fact that some women take time off to raise a family can slightly tilt the numbers towards the men, but not by 33%. Therein lies a separate issue within the realm of education that accounts for this large gap. One suggestion for why women do not advance as quickly as men do in their careers is due to the gender harassment within the learning environment that are followed into the workplace and create an undesirable environment (Bell, et. Al, 2002). "These norms are gender roles and stereotypes that have become systemic in organizational culture, structure or behaviors" (Krook and Mackay, 2011). Microaggressions towards female students are hard to recognize and may go unnoticed but need to be addressed in learning environments as well (Edwards, et. Al, 2019).

"I used to not like being called a woman architect: I'm an architect not just a woman architect. Guys used to tap me on the head and say, 'You are okay for a girl.' But I see the incredible about of need from other women for reassurance that it could be done, so I don't mind that at all" (Hadid, 2012).

This is important to consider when looking at the representation and depiction of women in architecture. There are a limited number of renowned women to look to for inspiration, Hadid's comment about allowing herself to become that reassurance and be that guide for women architects is inspiring. Recognition from other women architects as well as male counterparts is imperative in the quest for achieving gender-equity.

Conclusion and Goal of Research

The goal of this research is to better understand that gap that lies between the educational world and the professional world and determine how one can influence the other in order to create a gender-equitable learning environment. There is a lack of research between the two as a correlation or linear path, however, there is research relevant that could be applied to landscape architecture within the context of product design and large-scale urban planning.

It is understood that women in public open space often have more specialized needs than men (Frank and Paxson, 1989). They are less likely to feel comfortable using uninviting or unwelcoming space (Bunston and Brenton, 1992). The same assumption can be made about the workplace. Unencouraging and uninviting workplace environments can deter women from entering male-dominated fields. In order to create a gender-equity workspace, the following must be evaluated and changed:

1. Who is designing spaces where women are expected to thrive?

2. Why is there a lack of female leadership within education institutions and the profession?
3. How are we educating the public about the lack of support and resources women receive that stretch beyond simply accepting half women and half men?

References:

- Bas-Arzuaga, D. (2020, January 6). *Women in Architecture*. American Institute of Architects. <https://www.aia.org/articles/6252982-women-in-architecture>
- Bell, Myrtle P., James C. Quick, and Cynthia S. Cychota. 2002. Assessment and Prevention of Sexual Harassment of Employees: An Applied Guide to Creating Healthy Organizations. *International Journal of Selection and Assessment*
- Bunston, T. and Breton, M. (1992). *Homes and Homeless Women*. Journal of Environmental Psychology.
- Chang, T. (2021, January 7). *Industrial Design: Why is it still a Man's World?* Core 77. <https://www.core77.com/posts/103849/Industrial-Design-Why-Is-It-Still-a-Mans-World>
- Criado-Perez, C. (2019, February 23). *The Deadly Truth about a World Built for Men*. The Guardian. <https://www.theguardian.com/lifeandstyle/2019/feb/23/truth-world-built-for-men-car-crashes>
- Edwards, Lauren Hamilton, Maja Husar Holmes, and Jessica E. Sowa. 2019. Including Women in Public Affairs Departments: Diversity Is Not Enough. *Journal of Public Affairs*.

- Zippa. (2021, September 9). *Landscape Architects Demographics and Statistics in the United States*. Zippa the Career Experts. <https://www.zippia.com/landscape-architect-jobs/demographics/>

- Franck, K. and Paxson, L. (1989). *Women and Urban Public Space: Research, Design, and Policy Issues*. In E. Zube and G. Moore.
- Fuhrmans, Vanessa. 2018, October 23). What #MeToo Has to Do with the Workplace Gender Gap. *Wall Street Journal*. <https://www.wsj.com/articles/what-metoo-has-to-do-with-the-workplace-gender-gap-1540267680>
- Gardner, J & Begault, L. (2019, April 9). *How Better Urban Planning Can Improve Gender Equality?* Behavior Scientist. <https://behavioralscientist.org/how-better-urban-planning-can-improve-gender-equality/>
- Johnson, Paula A., Sheila E. Widnall, and Frazier F. Benya. (2018). *Sexual Harassment of Women: Climate, Culture and Consequences in Academic Sciences, Engineering, and Medicine*. Washington, DC: National Academies Press. <https://doi.org/10.17226/24994>.
- Knepper, et. Al. (2020, May 9). *The Slippery Slope: Struggling for Equity in Academy in the Era of #MeToo*. Public Administration Review.
- Krook, Mona Lena, and Fiona Mackay. 2011. Introduction: Gender, Politics, and Institutions. In *Gender, Politics and Institutions*
- Landscape Architecture + Design Profiles. (2013, July 8). *Peter Walker*. <http://ladprofile.weebly.com/peter-walker-1932.html>
- Paschal, A. (2021, March 8). *A World Designed for Men with a "Just Make it Pink" Mentality*. UX Collective. <https://uxdesign.cc/a-world-designed-for-men-with-a-just-make-it-pink-mentality-6e74077d43ca>
- Scippa, G. (2016, February 19). *St. Vincent's First Guitar for Women*. LifeGate. <https://www.lifegate.com/st-vincent-designs-first-guitar-for-women>
- Stratigakos, D. (2016). *Where are the Women Architects?* Princeton University Press.

DESIGNING EQUITABLE LEARNING ENVIRONMENTS:

Bridging the Gap through Gender-Sensitive Design Strategies

Hannah Smith | LARC 8600 | Dr. Chang

Presentation Overview



Topic of Interest

Topic

Achieving Gender-equity within learning environments in order to create a diverse team of future designers

Goal

Create a learning environment that encourages and promote the success of women in the field of landscape architecture

Area of Interest

Physical design and psychology of learning environments



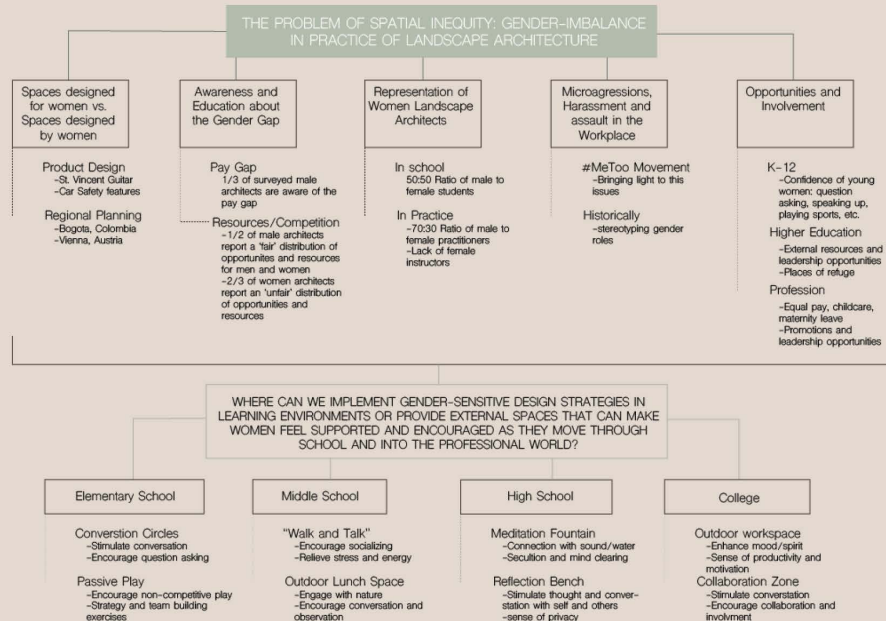
Gender Imbalance in Landscape Architecture Profession

Project Introduction

Research Question

Where can we **implement gender-sensitive design strategies** in **learning environments** or provide external spaces that can make women feel **supported and encouraged** as they move through school and into the **professional world**?

Map of Literature Review

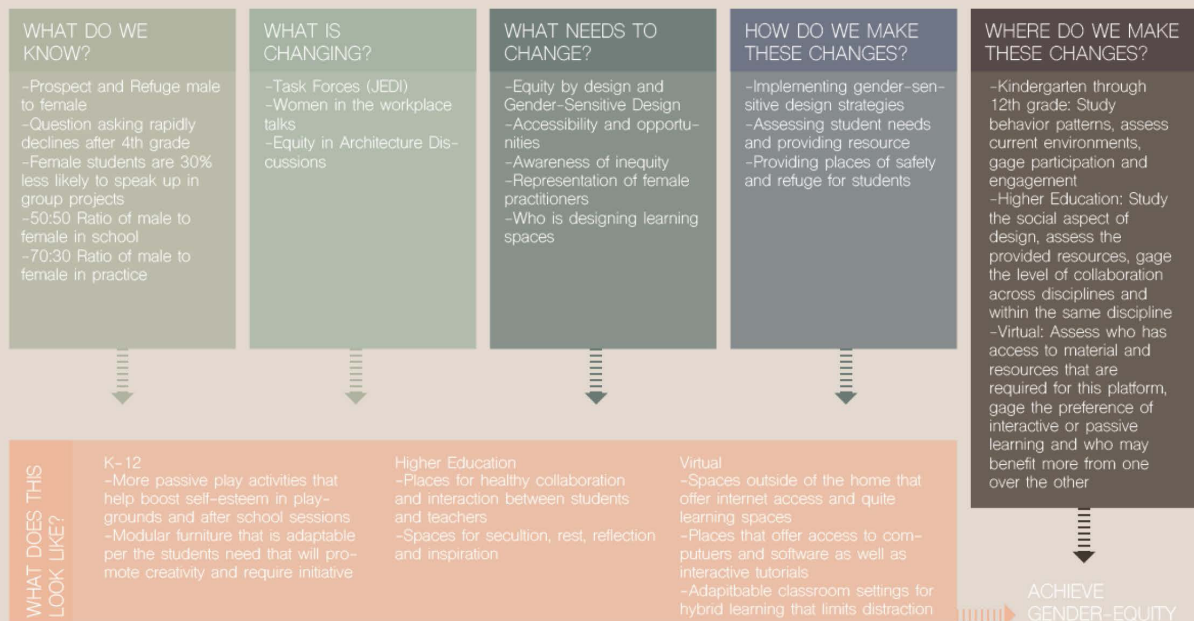


Learning Spatial Typologies

Women's experience of space is directly related to the design of that space. Gender-inclusive design strategies require a comprehensive understanding of gendered differences in the experience of space in specific contexts. This context being learning environments.

	DEVELOPMENT STAGE	PHYSICAL ENVIRONMENT CHARACTER	PSYCHOLOGICAL ENVIRONMENT CHARACTER	MIXED-GENDER SOCIALIZATION
ELEMENTARY SCHOOL	Early Childhood	Collaborative: Moderate Distracting: Moderate Inclusive: High	Nurturing: High Encouraging: Moderate Engaging: High	High level
MIDDLE SCHOOL	Adolescent	Collaborative: Low Distracting: Moderate Inclusive: Low	Nurturing: Low Encouraging: Moderate Engaging: Moderate	Low Level
HIGH SCHOOL	Young Teen	Collaborative: Moderate Distracting: Moderate Inclusive: Moderate	Nurturing: Low Encouraging: Moderate Engaging: Moderate	Moderate Level
COLLEGE	Young Adult	Collaborative: High Distracting: Low Inclusive: Moderate	Nurturing: Low Encouraging: High Engaging: High	High Level

Conceptual Framework





Clemson Elementary

RC Edwards Middle School



Daniel High School

Clemson University



Site Selection

Methods of Research

Case Study

- Product design
- Learning spaces
- Urban Fabric

Spatial Typology Analysis

- Elementary School
- Middle School
- High School
- College

Plan of Work and Analysis



Environments:

- Physical
- Psychological



Spatial Characteristics



Areas of
Implementation:

- Environments
- Spatial relations

Conclusion



Through **understanding** and **implementation** of gender-sensitive design strategies, **gender-equity** can be achieved within learning spaces and will lead to an **equitable profession** of landscape architecture.

The Cycle Continues

Questions?

Terminal Project
Hannah Slyce
Fall 2020

IMPACTS OF FLOOD ON URBAN ECOLOGY & VULNERABLE GROUPS

- 1. INTRODUCTION
 - 1.1. Background
 - 1.2. Significance
 - 1.3. Research question
 - 1.4. Research focus
- 2. LITERATURE REVIEW
 - 2.1. Urban ecology
 - 2.2. Existing infrastructures
 - 2.3. Environmental justice
 - 2.4. Citations
- 3. RESEARCH METHODS
 - 3.1. Typological analysis of existing policy & technique
 - 3.2. GIS analysis of potential sites
 - 3.3. Case study
- 4. DESIGN APPLICATION
 - 4.1. Site selection criteria
 - 4.2. Conceptual framework

SECTION 01 - INTRODUCTION

1.1. BACKGROUND

As we progress further into the Anthropocene and continue to rely on fossil fuels for energy, the rapidly changing climate will only get worse. At this point, the United States and other countries must shift into a realm of thinking that progresses away from reversing the effects of climate change and onto a method of mitigation strategies. The damage to the environment has been done, ecosystems have been

The goal of this study is to assess current flood mitigation techniques and evaluate them based on *contribution to wildlife habitat, ability to protect the urban fabric, and how they protect vulnerable groups*. Additionally, the study aims to determine the best management practice to maximize benefits in these three areas.

The typological analysis of techniques will then be used to design a flood mitigation plan that utilizes the landscape to protect the urban fabric, restore wildlife habitat while protecting vulnerable groups and preventing environmental injustice.

The frequency and intensity of storm events will increase as we venture further into the Anthropocene. Because the policies required to reduce the effects of climate change require global participation, the only thing we can do is prepare our cities for future disaster events.

By understanding the current technologies for mitigating flood and evaluated their impacts to the environment and urban ecological fabric, this research will provide designers and policymakers with the information they require to make the best decisions regarding flood mitigation. This information can then be utilized to retrofit or replace current outdated techniques and begin to reestablish aquatic edges as functioning ecosystems and flood buffers.

1.3. RESEARCH QUESTION

What is the best method to mitigate flood that benefits wildlife habitat, vulnerable groups and the urban fabric? What is the benefit of each technique to wildlife habitat, vulnerable groups and the urban fabric? Where is the best location for green infrastructure that will maximize benefits to wildlife habitat, vulnerable groups and the urban fabric?

1.4. RESEARCH FOCUS

The focus of research will be on green and grey infrastructure. Green meaning landscape techniques involving plant materials and grey to be concrete or other man-made materials. Additional focus will be given to combinations of green and grey methods along with large-scale restoration techniques. Additionally, I will utilize current literature to evaluate the impacts of flood on urban environments, wildlife habitat, and vulnerable groups, while assessing the economic impacts of each flood mitigation technique. I will also look at case studies that utilize new techniques as a method of evaluation in addition to the scientific literature.

SECTION 02 - LITERATURE REVIEW

2.1. URBAN ECOLOGY

destroyed, atmospheric changes have been monitored, and urban environments experience increasingly more devastating flood events each year. Because the policy required to alter the course of the Earth's global future is not standardized or agreed upon, the way cities are organized, planned and developed must be reevaluated. Without this major upheaval in the urban landscape, enormous ecological, social, physical, and financial strain will occur and displace and devastate human and animal communities.

Major issues with urban flood are obvious. Urban environments are typically densely populated and house the major commercial and business districts of a city fabric. Not only do 55% of the world's population live in urban environments but also a good majority of developed country's impoverished reside within urban environments as well. The causes of urban flood are not as obvious. The problem is not the city itself but the way that the city has been developed and designed over the centuries. The most populous and successful cities are located along bodies of water. In order to better suit shipping industries many cities have devastated their coastlines to create shipping ports, dug out natural rivers to make way for larger shipping vessels and in turn replaced a natural system with hard concrete infrastructure to prevent the inevitable, flood and erosion. Other atrocities to the landscape and aquatic edges come from humanity's need to be as close to the water as possible and the ultimate creation of the tourism industry. Following the Baby Boom, American's coastal landscapes changed forever with the development of the hospitality industry. Natural buffers between the coastline and inland areas were destroyed to build vacation homes and hotels, removing dunes and maritime forests, exposing the cities within to tidal flooding. The combined effort of climate change, poor development practices, removal of natural landscape buffers, and human settlement choice, has led to a problem known as urban flood. The removal and destruction of natural landscape buffers has not only posed a series of problems for humanity but has proven to be disastrous for ecology as well. Coastline species diversity has been greatly impacted by human development patterns. Destruction of coastal and other aquatic habitat has caused many rare and endemic species to go extinct, something that unlike human property cannot be replaced.

In addition to the major destruction to ecological habitat, centuries of systematic poverty and social injustice has led to trickle-down devastation to many lower income and vulnerable groups, especially in coastal environments. Most infrastructures to mitigate the effects of flood are concentrated in wealthy areas, or places where the most income is generated due to tax revenue. When flood events occur, the disenfranchised are most impacted, losing property and lives due to dangerous conditions associated with rapid flooding. In addition to the property damage, there is immense psychological stress and impacts to human health from living in a flooded environment.

1.2. SIGNIFICANCE

Nearly 60% of the world's population resides in urbanized areas. As expected, more developed countries tend to have more urbanized populations. In the United States, approximately 80% of the population lives in urban areas. An increase in urbanized landscapes means there is a decrease in natural landscapes. Urbanization has extreme effects on regional landscapes. Historic settling of land has led to the conversion of many low lying, fertile lands into agricultural areas. As populations continue to grow, urbanization influences the continued conversion of wild lands and even agricultural lands into urban and suburban uses. As city populations continue to grow, the growth is not compact or infilled, but sprawled and spindled, growing in patchy linear strips along highway corridors. The ever-increasing sprawl has even led to the integration of housing into wildlands. Because of this growth, ecologists have come to recognize that there are very few wildlife habitats and ecosystems that are completely devoid of human touch (Pickett et al. 2001 p. 128).

The field of urban ecology is a relatively new field of science and stands as a confluence of traditional ecology, human geography and urban studies. The definition of an urban ecosystem has been determined by Pickett et al. as one in which humans live in high densities or have built infrastructure that covers a significant percentage of the landscape. Boundaries of urban ecosystems are often set by the extent of the urban influence and include watersheds, airsheds, commuting radii or even just conveniences of the population. These boundaries are constantly at flux and can be changed and defined by political, research, or biophysical reasons (Pickett et al. 2001 p. 129). For urban ecologists there exists two pedagogies of research: *ecology in the city* and *ecology of the city*. An ecology in the city concerns functions of habitats or organisms within the city limits. This approach focuses on the physical environment, soils, vegetation and wildlife within the city framework. Ecology of the city examines the entire urban area from an ecological perspective. This approach involves the examination or even experimentation of existing urban assemblages of native and exotic species. The idea is that the novel assemblages can prove to be useful for assessing the effects of climate change on biodiversity in the future since many species assemblages within cities are well versed to disturbances and can thrive in a diversity of conditions. (Pickett et al. 2001 p. 130-139). While urban ecology serves as a method of understanding urban environments it can also be used as a planning approach for future development of cities. Ian McHarg revolutionized planning and design when he created an environmental approach to site analysis, focusing on layers of natural and ecological systems within a site along with the usual engineering, economic and social criteria. Anne Winston Spin detailed an approach that focuses on natural processes embedded into the city, and how those processes impact the economy, human health and community. Her research was used to determine how natural processes within the city impact environmental justice (Pickett et al. 2001 p. 142).

The understanding of urban ecology lead to the creation of the new field of landscape ecology. Landscape ecology evaluates the impacts of urbanization on the greater landscape region, shaping regional planning approaches to greenfields, restoration of brownfields and the integration of a designed ecology into urban systems. This has led to the generation of landscape urbanism and considering the ecology of and within a city as a mechanism of design. As the world continues to urbanize, there is a greater demand for land worldwide. No longer is there a traditional timeline of transition of wildlands to rural to urban. Many regions are experiencing direct land conversion due to the increase in demand for urban lifestyles. Investments can turn an undeveloped rural area into a booming urban acropolis seemingly overnight. With unchecked development, extreme damage to ecosystems and the existing ecology will occur. That is why in recent years, there has been an increase in interest in sustainable design solutions and sustainability plans to address years of detrimental development practices. While sustainability is at the forefront of many city planners' minds, the sustainability plans often suffer from a lack of holistic planning. Many sustainability plans do not consider the overall connections between each designed approach. For example, there is a heavy focus on the retrofit of existing hard infrastructure like roads and sewers, and establishment of large, easy to deploy green infrastructures like street trees and parks. Because of these focuses, smaller towns and smaller neighborhoods are often left out of the conversation and sustainable approaches are not designed into these small-scale developments (Childers, 2015 p. 3776-3777).

Urban ecosystems are the front lines of environmental and sociological change. From an ecological perspective, they provide the perfect experimental setting to observe the human amplification of succession. Spatial heterogeneity and localized feedbacks play a large role in the ecology of these urbanized systems and provide the perfect test subject to see how small changes within these environments can impact the success of tactics. However, it must be understood that no two urban environments are the same. The urban environment is not created anew but is developed over time and within the context of the region. As climate change accelerates, this regional context will play an important role in the challenges that are faced due to urbanization. Because these cities are products of human planning and regional contexts, urban areas are going to change and respond in different ways depending on location. Climate change will apply stress to the human-made infrastructure and shift ecosystems in new and often unfamiliar states. The real challenge of urban ecology is to create a mechanism for predicting the changes that face urban areas in the future. As cities grow and mature, they have the potential to act as hotspots for microevolution and provide a space to understand the "new wild" that will become normal as the world progresses into the Anthropocene and as existing urban infrastructure is stressed by changes in frequency and intensity of disaster events and the intrusion of invasive species (see kudzu and electrical poles) (Tanner et al. 2014 574-576).

policies. However, often policy learning and adaptive management is tied up in fiscal responsibility. In many conservative towns, such as coastal Florida, the adaptive management policies used are those that are the cheapest. These are rarely the best. Brody et al's study did determine that many local jurisdictions in Florida were exhibited policy learning and updating policies as coastal flood events increased, however the policymakers disproportionately choose updates that were less expensive in order to be more politically viable. The policies that are most effective tools include relocation of structures or addressing structural concerns such as dam and drainage maintenance. These however were often not selected to be enforced and instead local governments chose to focus on public outreach and tightening of existing policy (Brody et al. 2009 p. 924-925). In general, it can be concluded that conservative coastal towns, which covers most of the coastal south, chose policies that are cheap, which is not always the most effective in flood mitigation.

Coastal communities are going to continue to be adversely impacted by storm events and the associated floods. Current infrastructure in place to mitigate and protect inland communities is often hard and grey. While historically, grey infrastructure did a fine job in protecting private and public investments, the rapidly changing environment from anthropogenic climate change, has caused storms to increase in frequency and intensity. At its infancy, grey infrastructure was paired with unaltered natural habitat. Coastal cities were protected by rich wetland, coastal marsh, or maritime forest which created a buffer against storm surge. If any floodwaters did surpass the natural buffer the levees or dams created by humans protected the city. Innovations in mitigation infrastructure have recently been discussed as policy initiatives. While these techniques, known as green infrastructure, seem innovative, they are just mimicking natural processes that humans have removed. Examples of green infrastructures include vegetational buffers and reestablishment of coastal wetlands, while grey infrastructures include bulkheads, breakwaters, levees, revetments, and sea walls. The real innovation comes from the combination of green and grey infrastructures to create green new technologies. These novel infrastructures include the combination of coastal vegetation and sills, breakwaters and edgings, or can even include hard infrastructure that is made up of natural materials such as oyster shells, or materials that can provide habitat for aquatic life (NOAA, Living Shorelines).

When planning for future urban resilience there must be consideration of multiple benefits of urban infrastructure. Adaptation to climate change can be viewed as an opportunity to improve urban infrastructure by using green and blue infrastructures to provide multiple benefits such as protection and habitat restoration (Alves et al. 2020 p.2). While many jurisdictions are skeptical of green infrastructures from one reason or another, green infrastructure is ecologically and socially required to move forward amidst climate change. It is also economically viable in the long run. Alves defines green infrastructure as "a network of interconnected multifunctioning green spaces that maintain and enhance ecosystem services and resilience," (Alves, 2020, p.2). Many studies have determined that green infrastructure alone may not be able to

On the topic of disaster events, hurricanes and storm events are forecasted to increase due to global climate change. The combination of a rising global mean temperature and increase in mean sea surface temperature has been shown through modeling studies to increase hurricane intensity (Meixler, 2017 p. 24). Hurricanes cause the most damage to coastal areas due to storm surge. High intensity storm surge can cause massive damages due to erosion, creating and enlarging ponds, removing natural vegetation and damaging existing infrastructure within coastal wetlands. Coastal wetlands are increasingly important as they provide disturbance regulation and prevention by operating as a buffer against normal storm surge. This buffer protects inland natural areas and wildlife habitat along with urban infrastructure. In North America, following Hurricane Sandy, Meixler et al. found that low salt marsh (ecological benefit) and paved surfaces (human infrastructure) were the most impacted. They also found that 38% of the damage was long term, meaning that the function would not return after repairs were made. An estimated \$6.5 million in possible loss of ecosystem services was determined, with flooding and deposition making up much of the financial loss. The ecosystem services that were damaged by the hurricane were disturbance regulation, waste treatment, habitat, aesthetics, recreation and cultural values (2017).

2.2. EXISTING INFRASTRUCTURES

As the battle to combat the effects of climate change continues, policymakers often have a unique opportunity to learn from previous decisions and the effects of those policies to the urban environment. Such as the urban fabric provides urban ecologists the opportunity to study the potential impacts and state of a rapidly changing world, policymakers can also use the outcomes of their policies after disaster to learn and change the course of action.

The average amount of yearly flood has increased six-fold since the 1960's, causing an estimated \$19 billion of damage a year (Brody et al., 2009 p.912). Since the costs of retrofitting existing construction and development would exceed governmental budgets financially and in government reach, local communities resort to policy-based mitigation techniques to stem risks to public and private property. Often these strategies are embedded in planning documents such as development codes, land use plans and zoning ordinances. Because flood is repetitive spatially and often chronic, planners have an opportunity to learn from the events and update policy to proactively buffer the effects of subsequent floods. Brody et al, states that "an adaptive approach to environmental risk management is one of the most effective decision frameworks for facilitating policy learning." (Brody et al. 2009 p. 913). Meaning that planning departments are acting as scientists, testing hypotheses as to how well policies work as mitigation techniques. Adaptive management is a tool that local policymakers use to update codes, plans and ordinances under constant changing environmental conditions, political shifts, or a new understanding of information. Adaptive management means that policymakers can react swiftly to new information and can use that to make better informed

combat extreme climate hazards, just as grey infrastructure alone is not able to do so either. As suggested by NOAA, a combination of green and grey infrastructures should be implemented to maximize flood mitigation. Grey infrastructure is already implemented throughout the world and should be retrofitted and improved and connect to a series of green infrastructural techniques. Simple green infrastructural techniques include pervious paving. Benefits of this technology includes lowering reflection and evaporation which includes energy savings and pollutant reduction. Additionally, pervious pavements enhance water quality by reduction of runoff and allowing groundwater recharge to occur (Alves, 2020, p. 6). While these simple techniques alone cannot prevent flood, the combination of grey infrastructures such as drains and collection basins with these simple green infrastructures can make a big difference.

Habitat restoration is a big driver behind a lot of green infrastructure projects. The reestablishment of salt marshes, reefs, mangroves and dunes can greatly improve biodiversity and reduce erosion and flooding. Beyond the coastal protection services, restoration can provide recreation, fisheries, carbon sequestration and storage, and allow the coastal environment to sustain and adapt to climate change processes with minimal human intervention due to ecologically function. This means that once established, a restored coastal site is more economically viable than a technique that must be consistently maintained such as a drainage system (Ruckelshaus et al. 2016, p. 505). However, coastal protection benefits can vary dramatically over space and geographic contexts. The value of restoration projects in providing protection services is extremely site and context specific. Whether or not green infrastructure at this scale can contribute to coastal protection depends entirely on the physical and social vulnerabilities of an area including economic constraints and the extremity and nature of the flood or storm. There are many factors that affect the spatial distribution of vulnerability hazards along coastlines. These factors include shoreline type, relief, natural habitat, sea-level change, wave exposure, surge potential, and social exposure. For example, rocky shorelines in the west coast are less prone to erosion and inundation than beaches, bluffs or deltas. In this case a sea wall can often be enough and be least prone to erosion and inundation in these areas. Natural habitats such as dunes, marshes and mangroves can reduce wave height and stabilize and strengthen sediment buildups that dissipate wave energy. Social exposure is affected by how many people live within these critical coastal areas and are affected by coastal hazards. Some factors cannot be altered through management, but some can. For example, protection of coastal habitat can aid in resilience, along with critical understanding and selection of beach infrastructure for the right shoreline type. Additionally, people, property and infrastructure can also be moved out (or into for infrastructure) a coastal hazard region (Ruckelshaus et al, p. 507). Through case study, Ruckelshaus also determined factors that affect flooding and erosion damages. These factors include wave height and period, relief, substrate type, natural habitats, wind speed and duration, distance from coast and distance from natural habitats. For example, sites located

at higher elevations above average sea level are safer than those at or below. Often management cannot change this as sediment and elevation building is created by wetlands. Communities or infrastructure located near the coast are obviously more at risk than those further inland meaning that good management would include relocation of these communities and infrastructures inland to reduce risk. Additionally, communities or infrastructure located near natural habitats benefit more from ecosystem services than those farther away. Therefore, good management would include prioritizing habitat restoration projects near communities or infrastructure.

2.3. ENVIRONMENTAL JUSTICE

Pickett claims that the study of social structures and how these structures came to exist is critical in understanding the complexity of the ecology of urban systems (Pickett et al. 2001 p. 143). Urban ecosystems allowed for human populations to no longer be dictated by the limitations of their local ecosystem. Human social development enabled the human species to escape those limitations wherein the local ecosystem no longer regulated population size, structure or genetic diversity. This led to what social scientists call social differentiation. Often this differentiation comes through a form of race, class, gender, age, and clan. Social differentiation is critical for human ecological systems because it dictates who gets what, when and how. The allocation of resources including natural, socioeconomic, and cultural, is highly dependent on social differentiation. As it is rarely equitable, the uneven allocation of resources creates hierarchies and rank amongst the human ecosystem and split groups into communities, regions, nations and societies. Even within smaller communities, rank is still determined based on wealth, power, status, knowledge and territory. Within each community, there is an unequal distribution of wealth, power, status, knowledge and territory. Social differentiation occurs at all different scales. It can take different spatial patterns and have varying biophysical effects on human population including the distribution of land use within urban areas, the stratification of communities and the social differentiation of ownership and households (Pickett et al. 2001 p. 145).

A history of disenfranchisement and forcing people of color and minority communities to the outskirts of urban areas has led to a long and hard history of mistrust of planning and policymaking jurisdictions. These communities often receive unequal impacts in the form of environmental injustices. While many times this is because of a misunderstanding of how the community thrives within their landscape, the communities are still rendered invisible to the decision-making process (Barra, 2020, p. 12). For example, several coastal restoration projects are underway to preserve the Louisiana coastline and to prevent inland flooding to New Orleans and other urban environments. The largest and most controversial portion of this project includes a stretch of land within a historic African American community with 'good sediment.' The master plan aims to harvest the 'good sediment' with massive sediment diversions placed along the coast of

this community to remove and replace within areas that are flood prone, hoping to reestablish wetlands and prevent the further sinking of the Mississippi River Delta. Residents of the community are rightfully fearful that this diversion will put several feet of additional water into the local wetlands causing potential flooding during storm events and removal of the ecology that supports the local fishing industry (Barra, 2020, p. 1-2). Barra makes the claim that "race and nature work as instruments of power to render narrow visions of nature and racial hierarchies as natural or common sense, (p.4). Like the old-world view of the sublime and dominance over nature, mankind views race as something that man must hold dominance. In the rural coastal south and most of the United States, race and nature have been elements of control. Predatory real estate practices have historically forced African American and other minority communities out of areas deemed 'prime real estate' for coastal development, and even now, it is happening for environmental protection (Barra, 2020, p. 4). The ironic conjecture is that these communities were forced to these coastal areas because they were deemed 'unlivable' by the wealthy white communities. Climate change and the emergence of the Anthropocene is having an unequal effect on minority communities. Because of rapidly changing environments, many members of these communities become climate refugees and must leave their homes and property behind due to natural disasters. Environmental protection must be done but it also must be done in a way that is equitable for minority communities and those historically marginalized.

Amenities such as parks and green space are unequally distributed along racial and socioeconomic lines. These amenities have proven physiological, psychological, and economics benefits to communities in which have them, yet historically marginalized communities are left out (Hasala et al. 2020, p. 2). When parks and greenspaces are installed in these communities often gentrification occurs, pushing these communities to undesirable areas. The placement of technology and infrastructure aimed at mitigating environmental issues such as flooding often follow these same patterns of gentrification when those communities are the ones who need it the most. In addition, when green infrastructure is placed within these communities, it is often not as well maintained as those within white communities. This further provides means for skepticism within these communities and a mistrust that creates a barrier to well-meaning implementation of green infrastructure projects, which in all is rooted within a deep history of environmental racism mentioned above (Hasala, 2020, p. 3).

Due to environmental injustice, blight and a general lack of planning efforts, many vacant, abandoned and unproductive land parcels exist on the margins of urban fabrics and exist within marginalized communities. These parcels can offer opportunities to create functional green spaces for communities. Community benefits of vacant lot beautification projects have immense benefits to the wellbeing of the residents. Many resident-led projects seek to change the narrative and overturn the stigmatized negative images of their communities (Draus, 2020, p. 1). Because of the realities of gentrification, park programs

and beautification must include provisions to ensure that the benefits primarily go to the long-term residents; these considerations are often left out of privately developed parks or even joint efforts between private investors and planning agencies. With the popular notion that urban parks can provide green infrastructure and ecosystem services to the communities they exist within; marginalized communities are further damaged by the shift from traditional infrastructures to green technologies. James Corner claims, "landscape is bound to the marketplace and only available at a price, (Corner, 1999 p. 157). For those marginalized communities dictated by their socioeconomic status, they are left out of the conversation due to a lack of participation within the white marketplace. For example, the High Line, a very notable park project in New York City, spent over \$150 million to create just the first two sections of a park project that establishes a semi-wild landscape within the city center, when prior to development it existed as a prime example of a ruderal landscape inhabited by primary succession and providing habitat for urban ecology and recreation for those that were brave enough to dare (Draus, 2020, p. 4). The park masquerades as an attempt to better the city and provide space for residents, but as Corner, the notable High Line park designer suggests, "landscape is bound to the marketplace," access to the park is tied up with private partnerships providing security and issuing out permits to sell goods and provide restaurant services along the park space (Loughran, 2014). The idea of a public park has become a mere commodity of neoliberal capitalism. The goals of the High Line are not to provide amenities or green infrastructure to the community, (and let's not forget the community that was pushed out of lower Manhattan to make way for the project and new development associated) it was to make money for the city and the developers that invested (Loughran, 2014). Public parks should benefit the public, they are funded using tax dollars and should provide essential services to the communities they are located within. As soon as parks become money making industries, they are no longer public and enter the private industry. Tax dollars, that are paid by all individuals including those excluded from spaces like the High Line, should go to providing essential services to communities, not making rich white people richer.

The future of park design can follow two trajectories: green gentrification and green reparations. Green gentrification meaning the transformation of working-class areas into upper middle-class areas through the establishment of parks and greenways. Green reparations meaning the establishment of green spaces that are undertaken with a specific intent of achieving social equity (Draus, 2020, p. 5). Transforming ruderal landscapes such as the High Line raises several questions concerning the ecosystem services these projects claim to provide, especially considering the high costs of maintenance in a time of climate change. Perhaps the ruderal and 'weedy' landscapes provide an informal green space that acts as a buffer to gentrification, establishing the green infrastructural benefits while neglecting to feed into gentrification and

displacement driving markets. Perhaps the best method is a combination of bottom-up and grassroots park creation that is supported by local governments (Draus, 2020, p. 13).

2.4. CITATIONS

- Aves, A., Vojnovic, Z., Kapelan, Z., Sanchez, A., & Gersonius, B. (2019). Exploring tradeoffs among the multiple benefits of green-blue-grey infrastructure for urban flood mitigation. *Science of the Total Environment* 703(2020), 1-13.
- Barra, M. (2020). Good Sediment: Race and Restoration in Coastal Louisiana. *Annals of the American Association of Geographers*, 0(0), 1-17.
- Brody, S., Zahran, S., Highfield, W., Berhardt, S., & Vedlitz, A. (2009). Policy learning for flood mitigation: a longitudinal assessment of the community rating system in Florida. *Society for Risk Analysis*, 29(6), 912-929.
- Childers, D., Cadenasso, M., Grove, J., Marshall, V., McGrath, B., & Pickett, S. (2015). An ecology for cities: a transformational nexus of design and ecology to advance climate change resilience and urban sustainability. *Sustainability*, 7, 3774-3791.
- Corner, J. (1999). Eldetic Operations and New Landscapes. *Recovering Landscape: Essays in Contemporary Landscape Architecture*, 153-169.
- Draus, P., Haase, D., Napieralski, J., Sparks, A., Quershi, S., & Roddy, J. (2020). Wastelands, Greenways and Gentrification: Introducing a Comparative Framework with a Focus on Detroit, USA. *Sustainability*, 12, 1-17.
- Hasala, D., Supak, S., & Rivers, L. (2020). Green infrastructure site selection in the Walnut Creek wetland community: A case study from southeast Raleigh, North Carolina. *Landscape and Urban Planning*, 196, 1-13.
- Loughran, K. (2014). Parks for Profit: The High Line, Growth Machines, and the Uneven Development of Urban Park Spaces. *City & Community*, 13(1), 49-68.
- Meixner, M. (2017). Assessment of Hurricane Sandy damage and resulting loss in ecosystem services in a coastal-urban setting. *Ecosystem Services*, 24(2017), 28-46.
- Pickett, S., Cadenasso, M., Grove, J., Nilon, C., Pouyat, R., Zipperer, W., & Costanza, R. (2001). Urban ecological systems: linking terrestrial ecological, physical, and socioeconomic components of metropolitan areas. *Annual Review of Ecological Systems*, 32, 127-157.

Ruckelshaus, M., Guannel, G., Arkema, K., Verutes, G., Griffin, R., Guerry, A., Silver, J., Faries, J., Brenner, J., & Rosenthal, A. (2016). Evaluating the benefits of green infrastructure for coastal areas: location, location, location. *Coastal Management*, 44(5), 504-516.

Tanner, C., Adler, F., Grimm, N., Groffman, P., Levin, S., Munshi-South, J., Pataki, D., Pavao-Zuckerman, M., & Wilson, W. (2014). *Frontiers in Ecology and the Environment*, 12(10), 574-581.

SECTION 03 - RESEARCH METHODS

3.1. TYPOLOGICAL ANALYSIS OF EXISTING TECHNOLOGIES

A typological analysis will be conducted to rank and stratify policy, coastal infrastructures and restoration techniques for use in coastal management. Each physical technique will be evaluated based on three basic concepts that contribute to landscape infrastructure: presence of vegetation, impacts to coastal slopes, and habitat potential. Policy technique will be evaluated based on effectiveness, utilization and costs of full implementation.

3.2. CASE STUDY

A series of regional or national case studies will be conducted to understand and document existing landscape infrastructure projects with goals to restore biodiversity, protect urban infrastructure and respect vulnerable communities. Potential selections for case study include:

- i. Lumberton Community Floodprint – NC State Coastal Dynamics Design Lab
- ii. Living Breakwaters - SCAPE
- iii. Central Seawall Project – Field Operations

3.3. GIS & HISTORICAL ANALYSIS OF POTENTIAL SITES

GIS will be used to review coastal SC communities with chronic flooding. Sites will be analyzed for flood zones, damaged houses, current zoning and future land use plans, tourism, historical coastlines and infrastructures, demographics, public parks and conservation areas, endangered species habitat and coastal waterways. Historical analysis will be used to observe any shifting land use or coastlines.

SECTION 04 - DESIGN APPLICATION

4.1. SITE SELECTION CRITERIA

The goals of this project are to increase urban ecology and biodiversity while protecting urban infrastructure and vulnerable communities. Site selection will be based on GIS analysis of coastal SC. An ideal site will be impacted by chronic flooding during hurricane season or heavy rains. Site selection must also include

proximity to a low income or historically disenfranchised population. Additionally, the site must contain a vacant property or park-like space to utilize as larger scale green infrastructure that which can be connected to a series of green interventions.

4.2. CONCEPTUAL FRAMEWORK

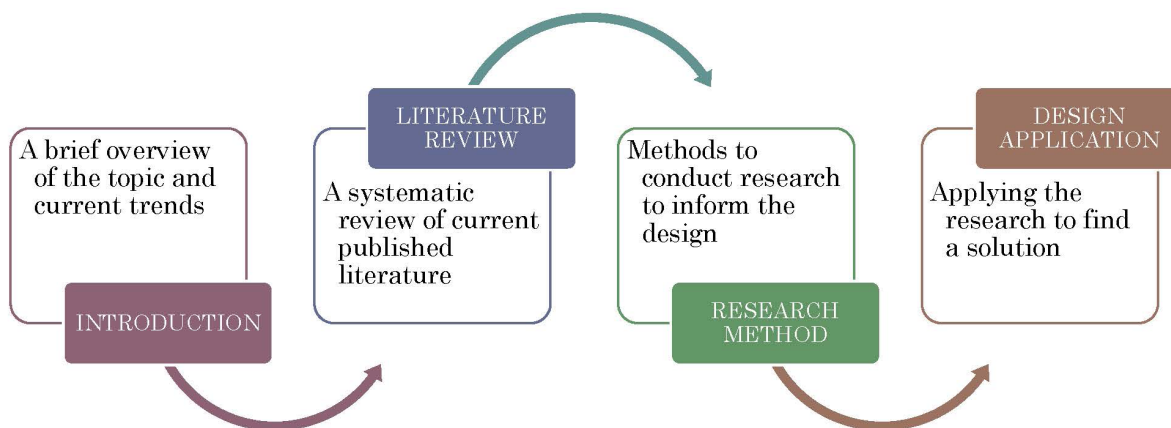
This most resilient designed landscapes are found at the confluence of social, environmental and economic considerations. The design proposal aims to create and facilitate a resilient network of landscape infrastructure that responds to the economic, social and environmental needs of a community. Simply focusing on policy, hard infrastructure, soft infrastructure or environmental restoration will not accomplish this goal. The best and most resilient solutions involve the combination and remix of these four tools. Green infrastructure must not be isolated or stand alone as individual projects. There must be a connected, robust network of green technology and solutions to be truly resilient and encourage high functioning urban ecology. Grey infrastructure must not solely be grey, it must be dynamic and made of materials that can withstand rising seas and increased flood events. The grey, hard infrastructure must also be tasked with increasing urban ecology by providing protection to ecological habitats as well as the human environment. Policies must be accessible, and useful. They must encompass the needs and requirements of all communities and not just those with higher tax brackets. Restoration projects must consider the needs of the human environment and provide high quality habitat that is also useful as a public amenity that doesn't negatively impact vulnerable human populations. Resilience is not a simple endeavor. The solution must be multilayered and dynamic that encourages an ever changing and responsive network.

This project will focus on providing a solid, well designed and well researched mitigation strategy for a disadvantaged community that takes into consideration the needs and historical context of said community, focusing with high attention to stormwater and other physical infrastructure such as roads and housing, flood prevention, along with access to high quality, functional greenspace that provides habitat for coastal species and other urban ecology.

Coastal Urban Flood: Designing for Resilience & Vulnerable Communities

TERMINAL PROJECT RESEARCH PROPOSAL

Topics to be discussed...



Introduction

Background, significance, question & focus

Background



Poor development practices on our coasts paired with increases in frequency and intensity of storm events due to global climate change has created a hotbed for flood disaster in our coastal communities

Background

40% of America's population lives on the coast and approximately 35% of critical marine habitats have been destroyed by human touch. 60% of the world's major marine ecosystems are degraded or being used unsustainably.



Background

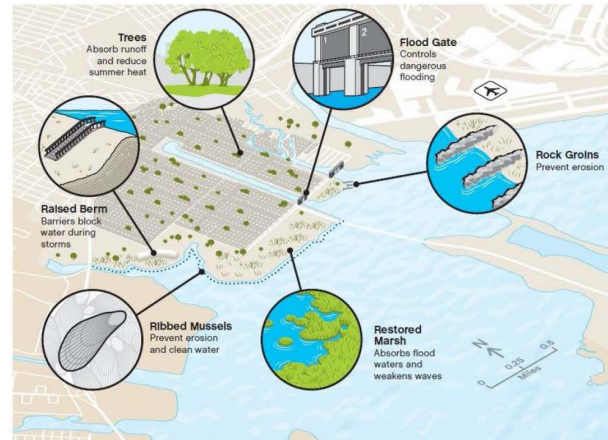
Centuries of systematic poverty and environmental injustice has led to devastation to many vulnerable communities during times of environmental disaster.



Significance

The goal of this study is to assess current flood mitigation techniques and evaluate them based on

- *contribution to wildlife habitat,*
- *ability to protect the urban fabric, &*
- *how they protect vulnerable groups.*



Significance



By understanding the current technologies for mitigating flood and evaluated their impacts to the environment and urban ecological fabric, this research will provide designers and policymakers with the information they require to make the best decisions regarding flood mitigation.

Questions

- i. What is the best method to mitigate flood that benefits wildlife habitat, vulnerable groups and the urban fabric?
- ii. What is the benefit of each technique to wildlife habitat, vulnerable groups and the urban fabric?
- iii. Where is the best location for green infrastructure that will maximize benefits to wildlife habitat, vulnerable groups and the urban fabric?

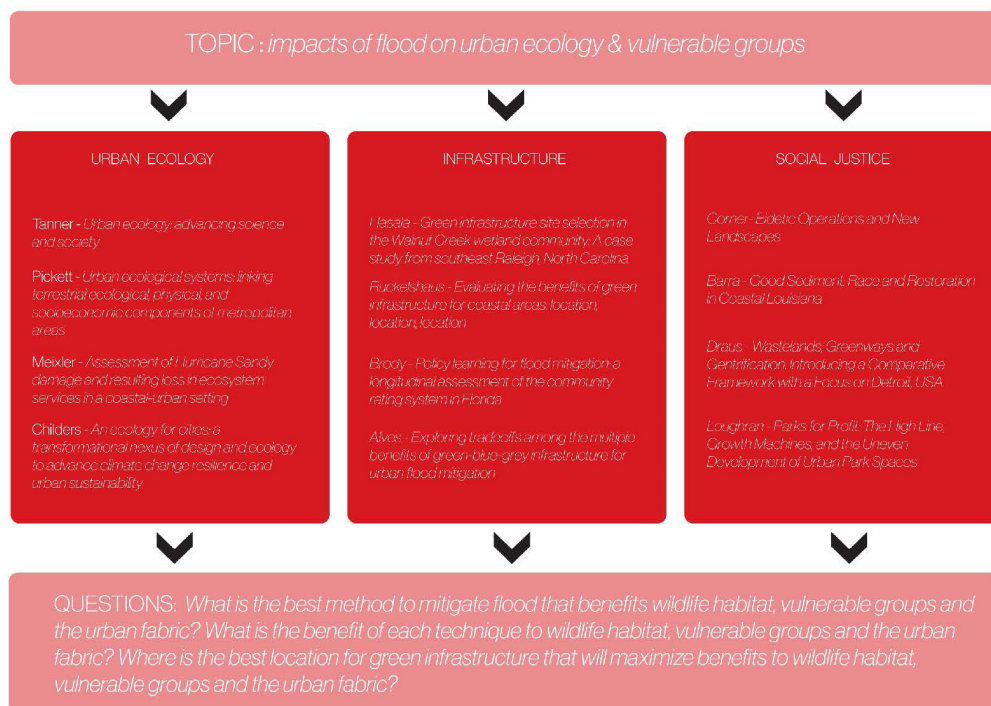
Focus

The focus of research will be on green and grey infrastructure. Green meaning landscape techniques involving plant materials and grey to be concrete or other man-made materials. Additional focus will be given to combinations of green and grey methods along with large-scale restoration techniques.



Literature Review

Current academic literature trends



Literature Map

Urban Ecology

Ecology *in* cities verses ecology *of* cities.

- IN: function of habitats and organisms within city limits
- OF: examining the entire city through ecological perspective, focusing on the novel assemblages of native and exotic species
- Can be useful for assessing the effects of climate change on biodiversity
- Can serve as a method of understanding urban environments and assist in planning efforts

Urban Ecology

Landscape ecology as a new field

- Evaluating the impacts of urbanization on the greater landscape region
- Shifted regional planning to include reclamation of brownfields, establishment of greenfields and integration of ecology into landscape design.
- Landscape urbanism as an idea that ecology of and within a city should be considered as a mechanism of design.

Urban Ecology

“New wild”

- Humans has irrevocably changed ecology and the landscape
 - Amplification of succession
 - Destruction of habitat
 - Development
- Using city ecology to understand how the earth’s habitats will shift during climate change
- Using that information to better design cities and landscapes

Urban Ecology

Novel disaster

- Losses due to climate change floods have increased six-fold since the 1960’s causing an estimated \$19 billion in damages each year.
 - Hurricane Sandy estimated \$6.5 million in ecosystem services
 - Erosion, ponding, removal of vegetation, damage to existing coastal infrastructure.
 - Low salt marsh and paved surfaces were the most damaged
 - 38% of the damage was long term and unrepairable

Existing Infrastructures

Adaptive planning

- Policy based mitigation strategies are very common in local governments in an addition to hard infrastructure
 - Adaptive management allows planners to act as scientists, testing hypotheses on how certain policies will work to mitigate flood when new information is available
 - Many conservative communities use this, but only select updated polices that are fiscally conservative, sometimes not being the best solutions
 - New emergent technologies are not considered because of political or perceived financial burdens.

Existing Infrastructures



Existing Infrastructures

Network of living infrastructure

- Green infrastructure is defined as interconnected multifunctioning green spaces that maintain and enhance ecosystem services
 - May not be able to combat extreme events due to climate change alone, but when paired with updated grey infrastructure, can be effective
 - Even simple isolated green infrastructures such as pervious paving and green roofs can significantly reduce flood effects.

Existing Infrastructures

Habitat restoration may have limited effects

- Coastal habitat restoration greatly improves biodiversity and reduces erosion and flooding
 - Also contributes to recreation, fisheries, carbon sequestration and facilitates adaptation to climate change
 - Also can be more economically viable once established
 - However! Benefits are dependent on location
- Other methods plus restoration (policy based) must also be established

Environmental Justice

Social differentiation defines human society.

- Power dynamic that determines who gets what, where and why.
- Rarely equitable.
- Happens within differentiated groups as well
- Systematic disenfranchisement has forced people of color and minorities onto the outskirts on urban fabrics
 - These outskirts are usually undesirable by the people in power due to flood risk, pollution, or location
 - This has led to general distrust of policymakers and government officials

Environmental Justice

Environmental protection is unjust

- Infrastructure to protect against flood and storm surge is usually located within wealthy parts of town
- If any at all, the infrastructure in minority communities is not as well kept and does not serve as well
- When larger restoration projects occur, areas where minority communities reside are effected negatively
- Distrust from years of environmental racism has caused distrust of green infrastructure
- Celebrity status of green infrastructure and ecosystem services has caused an upsurge in parks for profit
 - Parks for profit negatively impact the working class.
 - Best green infrastructure is community led and bottom-up.

Research Method

Typological analysis, case study & GIS evaluation

Analysis of existing technology & policy in coastal environments

- Using a quantitative approach, policy will be evaluated based on criteria of
 1. cost
 2. effectiveness
 3. utilization
- Existing technologies will be evaluated under the same criteria
- New technologies and restoration will also be evaluated based on contribution to biodiversity & applicability.

GIS analysis of potential sites

- To determine the best location for a network of green infrastructure and habitat restoration, GIS will be used to analyze potential sites. Criteria include
 - Proximity to vulnerable communities
 - Ability to form a network of green infrastructure
 - Proximity to urban development
 - Ability to reduce erosion and flood

Case study

- Identification of a similar project to analyze based on the criteria
 - Functioning as a flood mitigation strategy
 - Ability to help vulnerable communities without gentrification or negative effects to livelihoods
 - Proximity to urban development
 - Network of green infrastructure
- Additional considerations will be back to see if case study was implemented and accepted by a southern government.

Design Application

Site selection criteria & conceptual framework

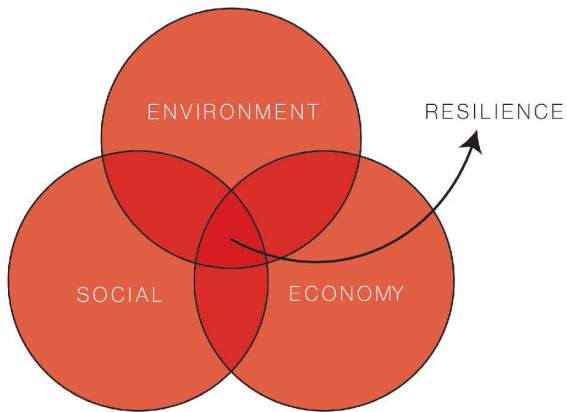
Site Selection Criteria

Since goals of the project are to increase biodiversity and encourage urban ecology while preventing urban flood and damage to vulnerable communities, site selection will be based on these criteria:

- i. Impacted by chronic flooding
- ii. Coastal community
- iii. Proximity to low income or other historically disenfranchised populations
- iv. Presence of vacant properties and or open space to utilize as a large green park



Conceptual Framework



The most resilient designs are found at the confluence of social, environmental and economic considerations. This project aims to recreate a resilience network of landscape infrastructure that responds to the economic, social and environmental needs of a community.

Conceptual Framework

POLICY

relocation, jurisdictional lines, FEMA insurance, flood zones, building codes,

HARD INFRASTRUCTURE

levees, dams, seawalls, jetties, canals, breakwaters, groins

SOFT INFRASTRUCTURE

bioswales, retention ponds, green roofs, permeable paving, parks

RESTORATION

wetlands, salt marsh, dunes, beach nourishment, maritime forest

GOOD

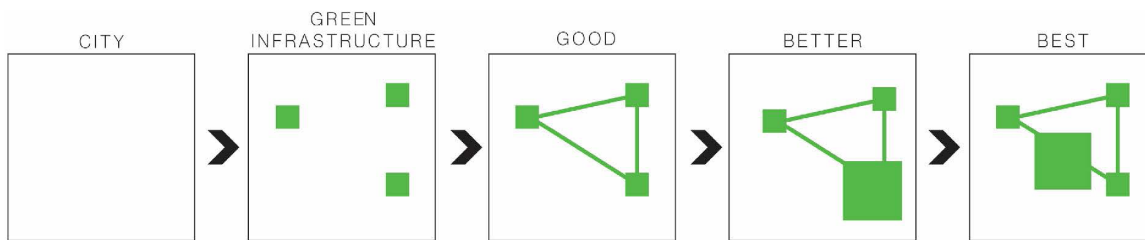


BEST



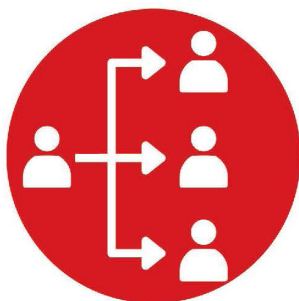
Conceptual Framework

USE OF GREEN INFRASTRUCTURE

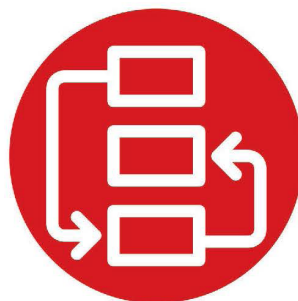


Conceptual Framework

TOOLS FOR ENVIRONMENTAL JUSTICE



i. PROCEDURE
PUBLIC INVOLVEMENT



i. DISTRIBUTION
ALLOCATION OF FUNDS



i. RECOGNITION
CONSIDERATION OF
NEEDS + HISTORY

Conceptual Framework

The project will focus on providing a solid, designed and well researched mitigation strategy for a disenfranchised community that takes into consideration

- i. Needs and history as a community
- ii. Attention to stormwater and other physical infrastructure such as roads and housing
- iii. Flood prevention
- iv. Access to greenspace
- v. Providing habitat for coastal species and other urban ecology

STUDENT WORK **LOW**

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Bailey Chrisman
What are the best practices for designing residential landscapes that preform ecological functions

Background:

Urban development has been on the rise since the 1950's causing ecological corridors to be fractured and replaced with unsustainable turf lawns. Suburban development began to grow at an aggressive rate after the great depression and WWII. The government used urban development as a way to stimulate the economy that had been drained and a way to reintroduce soldiers to civilian life. Soldiers could purchase a home in the suburbs for less than 10% down on the asking price thanks to the GI bill and land developers bought up huge tracks of land on the outskirts of cities for construction. The factory style construction, simple uniform designs and small lawns kept them cheap the sometimes they were cheaper than rent in the city. The factory style of thinking has continued into today's development of suburban sites, with cost effective design being the highest priority.

Urban sprawl is unavoidable because of population growth and suburban living becoming more popular, the trend of unsustainable landscape design is being passed down as the new normal. Residential landscapes start out as construction sites, the vegetation is clear cut and compacted by heavy construction equipment. Selective cutting is costly and often time the plants don't survive. The soil is contaminated by construction debris and a top layer of turf grass is used to replace the once ecologically beneficial plants that use to exist on site. After the homes are constructed the lawns are left as turf with a few plantings separated by mulch. The current landscape practices are unsustainable and provide little to no ecological benefits, turf lawns require mowing and watering, often they are fertilized only to have the rain wash the fertilizer

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Best practices:

Suburban developments consist of three phases, design, construction, and post construction. The first two phases are the most important when considering residential landscapes that will perform ecological services. Ecological services are split into four main categories, this study focuses on regulating services, these are defined as basic services that make life possible. Plants work to clean the air and filter water while bacteria decompose waste, insects such as bees and butterflies pollinate flowers and plant roots stabilize soil helping with erosion. Pollination, decomposition, flood control, water filtration, and climate regulation all fall under regulating services. In order to improve a sites ecological functions designers and scientist have developed concepts such as xeriscaping, biomimicry, ecological corridors, conservation subdivisions and plant communities in an attempt to improve the quality of life for humans and animals. Combining these best practices and using them in the first two phases of construction would improve suburban residential landscapes and allow for ecological functions to thrive.

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into local water tables. Plantings are often simple with no pollination benefits, and they are separated from each other in specific planting pits requiring constant maintenance. These current practices lead to a lack of biodiversity and further fracture ecosystems into unconnected islands.

The purpose of this study is to develop new guidelines for residential landscapes that will promote ecological services, specifically focusing on regulating services. Ecosystem services are broken into four categories according to the national wildlife federation. Regulating services are responsible for pollination, water purification, and climate mitigation. In this study I hope to find out the best practices for designing residential landscapes that will perform ecological services and the way the individual residential sites can be woven together to form an ecological corridor. By changing the way suburban developments design their landscapes the hope is that the importance of ecological landscapes will be utilized in future construction projects. The design will focus on residential developments and changing the way they are handled from construction to completion, prioritizing the health of the site. Researching existing suburban developments landscape plans will illuminate the issues with the current practices. Which will help design new strategies that will protect the landscape during the construction phase and also aid in designing planting plans. The planting plans will consist of designed plant communities that add biodiversity and create corridors of wildlife in the suburbs. The goal is to create a prototype for residential landscapes that will turn suburban developments into ecological corridors.

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Ecological landscaping: Uses principles from horticulture, ecology, and natural sciences to produce a landscape design that preforms ecological function. The focus is on how it works and not just how it looks. This is not a replication of the natural world but instead it is a human centered design that incorporates natural systems and processes. The goal of ecological design is to provide ecosystem services as well as using less water, pesticides, fertilizer, and less maintenance.

Storm water management: Is a growing concern in urban areas and is costly with ecological landscaping storm water runoff can be handled in a more cost-effective way. Trees and vegetation can slow down the water flow helping infrastructure better handle peak water flow. This also helps with waste or pollution getting into the water ways, methods like bioswales, green roofs, and water collection on site are all strategies that could be used to improve the ecological function of a site.

Biodiversity: a variety of life forms within an ecosystem. Because suburban developments clear cut the landscape and replace it with a monocrop of turf grass there is a lack of biodiversity in plants and animals. This leads to fractured ecosystems and turns suburban developments into islands of unsustainable turf grass that provides no ecological function. Providing for biodiversity should be incorporated into the design of the site long before the construction phase takes place.

Xeriscaping: Using native plants that require minimal water. This approach is beneficial in areas where access to water is limited.

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What are the best practices for designing residential landscapes that preform ecological functions

Biomimicry: is the practice of mimicking natural systems that already exist in nature. This is beneficial for determining planting communities, for example what plants grow with each other in nature and why.

Ecological corridor: is the practice of linking fragmented habitats by enlarging them and giving them a chance to spread.

Conservation subdivision: Is a strategy that attempts to preserve open space by placing houses closer to each other where 50-70% of the land is persevered for open space.

Plant selection: Is the strategy of "right plant, right place" identifying where plants grow naturally, we can make better decisions on where to put them in our design. "Selecting plants that are adapted to the temperatures and available water of the environment in which they will be placed is a fundamental step in creating an ecological landscape." It is important to remember that the plants ecological function is the most important and not necessarily what the plant is.

Plant communities: groups of overlapping populations of plants that coexist and interact where the boundaries are fluid. These plants have similar needs, so they preform best together, it is more important that the plant preform an ecological function and not as important as what the plant actually is. Using locally adapted plants will keep us from having to ament the soil and will take advantage of the "right plant, right place" method. For example, large trees form microclimates for understory trees, shrubs, perennials and ground covers, all of them preform their own ecological functions but together form a community. It is important to use a variety of species at different ages to increase the resiliency of the community.

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Plant density: Usually plants are separated with enough room for their mature size however this leaves space for weeds to fill in the open spaces, often costing money or time to pull the weeds season after season. Planting species more densely like in nature will suppress weeds which reduces competition allowing for the plant size to increase.

Case study:

Methods:

This study would use qualitative analysis to evaluate how well the site is meeting or not meeting the best practices for ecological design. The steps for designing the ecological landscape would be the same as a traditional landscape design just with different goals as the end result. The focus would be to conserve, preserve, and regenerate with these goals being thought of right from the start of the project. The design should conserve existing plants of value and protect them during the construction phase by roping them off and making them off limits. Preserving resources is also important in ecological design, resources such as water, plant communities, and reusing materials such as topsoil and rock. Finally, the design should regenerate what has been lost from construction so natural ecological services can be performed. The evaluation would be conducted by visiting the site during all three phases of construction and making interventions along the way.

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What are the best practices for designing residential landscapes that preform ecological functions

ecological design be more cost effective than the conventional design methods? How can we design ecological corridors?

Outline

1. Into (what is happening to residential developments and why is ecological function a concern
 - a. Introduce your contribution to the research synthesizing best practices for preforming ecological functions
 - b. Introduce case study applications of best practices to a local residential development area
2. Lit review
 - a. Best practices 1
 - b. Best practices 2
 - c. Best practices 3
3. Compare best practices with case study
4. A synthesized list of best practices useful to research, architects, and real world application and how could they be implemented to improve ecological function in local residential development area

Research Questions:

How can plant communities be used to improve the ecosystems of residential landscapes?

What are the current successful designed plant communities? What are the current practices in residential landscape construction and why is it harmful? What are the different scales of landscape sites and how will the design change with the size of the site? What are the current maintenance issues surrounding residential landscapes and how can they be avoided? Can



PREFORMING ECOLOGICAL FUNCTION IN OUR RESIDENTIAL LANDSCAPES

Bailey Chrisman



Contents

- Introduction
- Best practices
- Case study

Introduction

Background, significance

Background

Urban development has been on the rise since the 1950's causing ecological corridors to be fractured and replaced with unsustainable turf lawns.

Suburban development began to grow at an aggressive rate after the great depression and WWII.

The government used urban development as a way to stimulate the economy that had been drained and a way to reintroduce soldiers to civilian life.



1950's suburban development

Background

Soldiers could purchase a home in the suburbs for less than 10% down on the asking price because of the GI bill, causing land developers to buy up huge tracks of land on the outskirts of cities for construction.

The factory style construction, simple uniform designs and small lawns kept them cheap, often cheaper than rent in the city.



Levittown home

Background

The factory style of thinking has continued into today's development of suburban sites, with cost effective design being the highest priority.



Current suburban housing development

Significance

The goal of this study is to evaluate current construction practices in suburban developments and compare them to ecological best practices to see if these developments provide any ecological services



Clear cut woodlands for housing development

Significance

The purpose of this study is to develop new guidelines for residential landscapes that will promote ecological services, specifically focusing on regulating services.

Researching existing suburban developments landscape plans will illuminate the issues with the current practices. Which will help design new strategies that will protect the landscape during the construction phase and also aid in designing planting plans.

The planting plans will consist of designed plant communities that add biodiversity and create corridors of wildlife in the suburbs.

Literature Review

Best practices in ecological design

Best Practices

Suburban developments consist of three phases, design, construction, and post construction. The first two phases are the most important when considering residential landscapes that will perform ecological services.

Ecosystem Services

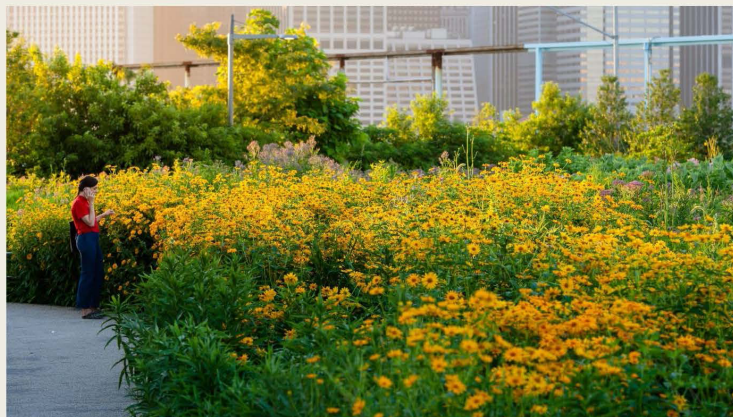
Ecosystem services are defined as basic services that make life possible for people, they are broken into four categories according to the national wildlife federation.

Regulating services are responsible for pollination, water purification, and climate mitigation and soil erosion



Ecological Landscaping

uses principles from horticulture, ecology, and natural sciences to produce a landscape design that performs ecological function. The focus is on how it works and not just how it looks. This is not a replication of the natural world but instead it is a human centered design that incorporates natural systems and processes. The goal of ecological design is to provide ecosystem services as well as using less water, pesticides, fertilizer, and less maintenance.



Storm water management

is a growing concern in urban areas and is costly, with ecological landscaping storm water runoff can be handled in a more cost-effective way. Trees and vegetation can slow down the water flow helping infrastructure better handle peak water flow. This also helps with waste or pollution from getting into the water ways, methods like bioswales, green roofs, and water collection on site are all strategies that could be used to improve the ecological function of a site.



Biodiversity

a variety of life forms within an ecosystem. Because suburban developments clear cut the landscape and replace it with a monocrop of turf grass there is a lack of biodiversity in plants and animals. This leads to fractured ecosystems and turns suburban developments into islands of unsustainable turf grass that provides no ecological function. Providing for biodiversity should be incorporated into the design of the site long before the construction phase takes place.

Xeriscaping

using native plants that require minimal water. This approach is beneficial in areas where access to water is limited or maintenance requirements need to be low.



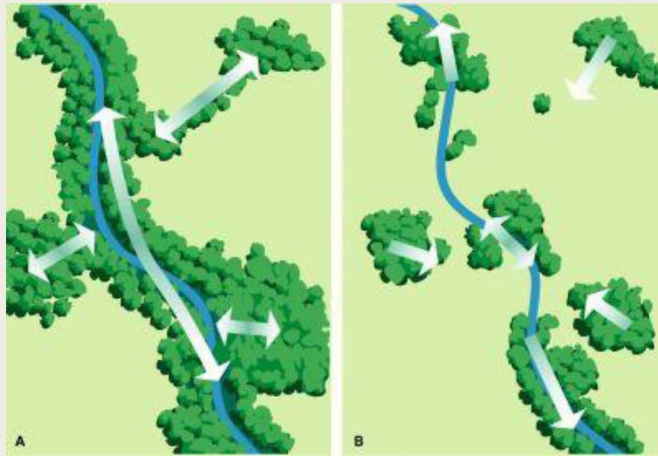
Biomimicry

is the practice of mimicking natural systems that already exist in nature. This is beneficial for determining planting communities, for example what plants grow with each other in nature and why.



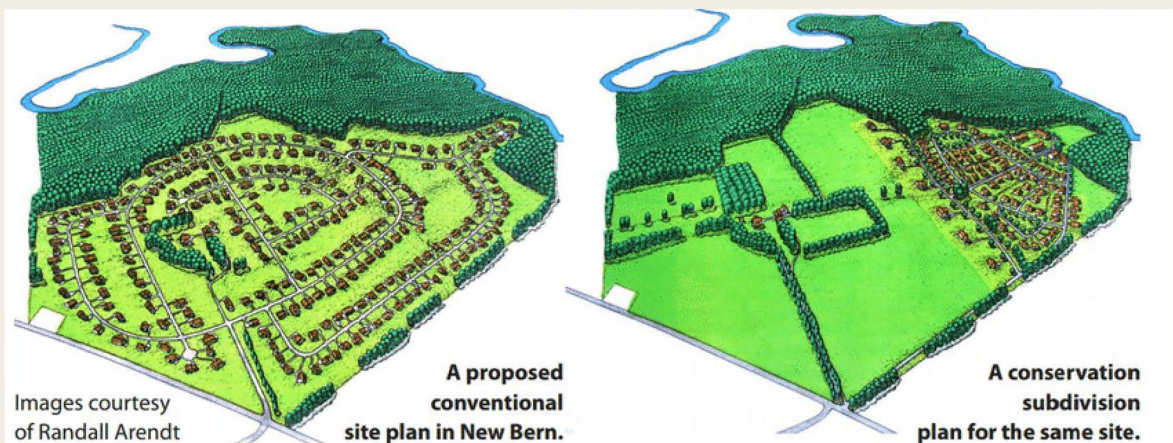
Ecological Corridor

is the practice of linking fragmented habitats by enlarging them and giving them a chance to spread.



Conservation Subdivision

is a strategy that attempts to preserve open space by placing houses closer to each other where 50-70% of the land is preserved for open space.



Plant Selection

is the strategy of “right plant, right place” identifying where plants grow naturally, we can make better decisions on where to put them in our design.

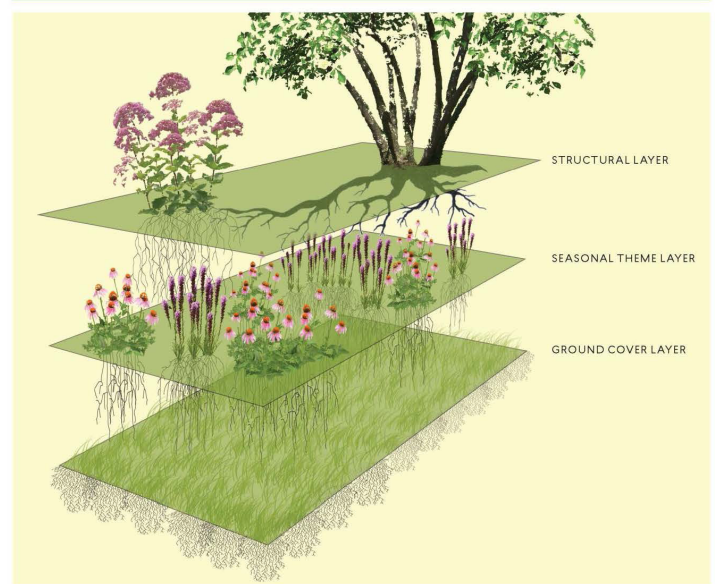
“Selecting plants that are adapted to the temperatures and available water of the environment in which they will be placed is a fundamental step in creating an ecological landscape.”

It is important to remember that the plants ecological function is the focus and not necessarily what the plant is.

Plant Communities

groups of overlapping populations of plants that coexist and interact where the boundaries are fluid. These plants have similar needs, so they perform best together, it is more important that the plant perform an ecological function and not as important as what the plant actually is.

LAYERS OF A DESIGNED PLANT COMMUNITY



Plant densely

Plantings are closer together to lower maintenance costs and prevent invasive weeds from spreading



Methods

Analysis of current construction in suburban developments

A qualitative analysis of how well the site is meeting or not meeting the best practices

Suburban developments consist of three phases, design, construction, and post construction. The first two phases are the most important when considering residential landscapes that will perform ecological services.

CASE STUDY: TOLL BROTHERS



Preconstruction



Preconstruction



Preconstruction



Post construction



Post construction



Post construction



Post construction



In Closing

This study would use qualitative analysis to evaluate how well the site is meeting or not meeting the best practices for ecological design. The steps for designing the ecological landscape would be the same as a traditional landscape design just with different goals as the end result. The focus would be to conserve, preserve, and regenerate with these goals being thought of right from the start of the project. The design should conserve existing plants of value and protect them during the construction phase by roping them off and making them off limits. Preserving resources is also important in ecological design, resources such as water, plant communities, and reusing materials such as topsoil and rock. Finally, the design should regenerate what has been lost from construction so natural ecological services can be performed.