Graduation Studio

A TRANSITION TOWARDS FLOATING CITIES.

BUILT ON SHAPE SHIFTING LAND.

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The images depicted through out the research plan act as a reminder of the devastation millions face due to the ongoing global climate crisis, as evidence in support of the need for the proposed design intention.

Fig. 1 - Aftermath of Flash Floods in Bangladesh

General Problem

The implications of rising tides

The term climate change refers to a long-term shift in global or regional climate patterns, and is now usually specifically associated with the rise in global temperatures from the mid-20th century to present, due in large part to the massive increase in human industrial activity over that time. (For further information regarding the global impact of human induced climate change, refer to the appendix section of the research document.)

Our planet continues to warm up rapidly, resulting in historic droughts, deadly floods, landscape-altering wildfires and unusual weather events around the globe. It is inherently also causing steady sea level rise, which scientists believe is rapidly approaching a tipping point, meaning that the sea levels will continue to rise, even if we were to immediately decrease greenhouse gas emissions.

Bangladesh, China, India and the Netherlands were the four countries singled out as being at high risk due to rising sea levels by the United Nations, however this is a global issue, with nearly 900 million people, one in every ten people on earth, living in low-lying coastal areas and in acute danger. Major cities on every continent are at risk, including Bangkok, Lagos, London, Mumbai, New York and Shanghai.[1]

Bangladesh is at the epicenter of the global climate crisis, with 80% of the country being a floodplain, constantly affected by floods, storms, riverbank erosions, cyclones and droughts. Although the Bangladeshi population is no stranger to flooding, as it ordinarily takes place every year during monsoon seasons, the current rainfall patterns are becoming erratic, with rainfall fluctuating across the year. The country has become susceptible to flash floods occurring more frequently and ferociously than ever in recorded history. Figure 1, depicts a young girl and boy attempting to navigate through the high water after the flash floods in the region o Bangladesh.[2]

Bangladesh is a low-lying coastal country located between India and Myanmar, and is one of the world's most densely populated countries. The average elevation of Bangladesh is nine meters above sea level and most of its population centers are on the low lying flood plain, with typical elevations of one meter or less. The population of Bangladesh has grown to approximately 170 million people with the low-lying, flat and fertile land of Bangladeshi's coastline creating the ideal environment for urban development and the agricultural base to support the population. As such, newer communities continue to develop at these lower elevations, placing millions at risk.

The country of Bangladesh is defined by its rivers, having an elaborate network made up of 230 rivers and a land area that at certain points barely rises above sea level. Its people live on the rivers and waterways, relying on them for the agricultural and industrial sectors, as well as for domestic use.

However, what was once the lifeline of the Bangladeshi people may lead to the country's ultimate demise as severe flooding and the rising sea levels will overwhelm the country. With the low elevations of a majority of the country, the WorldBank Institute estimates that 3.5 million Bangladeshis to be displaced each year due to flooding and the UN estimates that by 2050 about 20% of Bangladesh will be underwater due to rising sea levels, with a loss of 30% of the country's agricultural land and 19.9 million Bangladeshi's being permanently displaced.[3]

1 (Masterson et al.)

2 (BBC)

3 (Vaidyanathan)

Specific Problem

600,000 marooned in Sylhet as new areas go under water

In the north-eastern part of the country, the city of Sylhet was established in 1867 and is known to many as the spiritual capital of the country of Bangladesh. The city is located near the Haor Basin, a large saucer-shaped floodplain with an area of around 113km undergoing persistent subsidence as the rivers erode the fertile soil. The city has sunk in some areas by 12m over the past 200 years, and continues to sink today. The city today is a large, metropolitan environment with a population of almost one million people. The population continues to increase at a rate of 3.64% per year, resulting in large groups of people in sub-standard housing and in acute danger during the monsoon floods due to their settlement in low-lying areas of the city.[4]

Like many cities within Bangladesh, the city of Sylhet stands out as a climate change hot spot due to its unique geography, high population density as well as its limited capacity for adaptation. Sylhet is no stranger to monsoons, with its four month long annual season providing ample rain to naturally irrigate crop fields and replenish its ground water supply. In more recent years, the effects of climate change have been felt in the disruption of this natural pattern, with severe droughts followed by frequent extreme events of rain and flash floods, destroying property and crops in its wake (Figure 2 depicts the elevation of Sylhets varied regions depicting the specified areas risk of flash flooding. The risk assesment examines each wards risk based on the percentage of the ward area that will be inundated during heavy flooding).

In 2020, Sylhet faced flash flooding that directly affected thousands, with thousands more still recovering from the longer term impacts.The unforgiving disaster swept away homes, belongings and livelihoods, with over a quarter of the country flooded during that monsoon season. According to the Flood Forecasting and Warning center, approximately 84% of Sylhet districts were submerged during the floods, forcing the population to flee their homes in search of dry land. The flash floods left 482,000 people displaced and 83,394 acres of cropland damaged and 135,770 homes destroyed in the region of Sylhet. [5]

As of 2024, several efforts to mitigate the flooding in Sylhet have been discussed by the Ministry of Water Resources. This includes improving early flood warning systems as well as constructing a 15 km dike along both sides of the Surma river. As Sylhet continues to tackle the tragedies associated with flash floods, resources must be allocated to the continuing research of innovative and resilient solutions.[6]

4 (Akter, Nurunnaher & Islam, Md & Karim, Md & Miah, Md & Rahman, Md)

5 (Saif Hasnat and Ives)

6 (Impact that Matters)

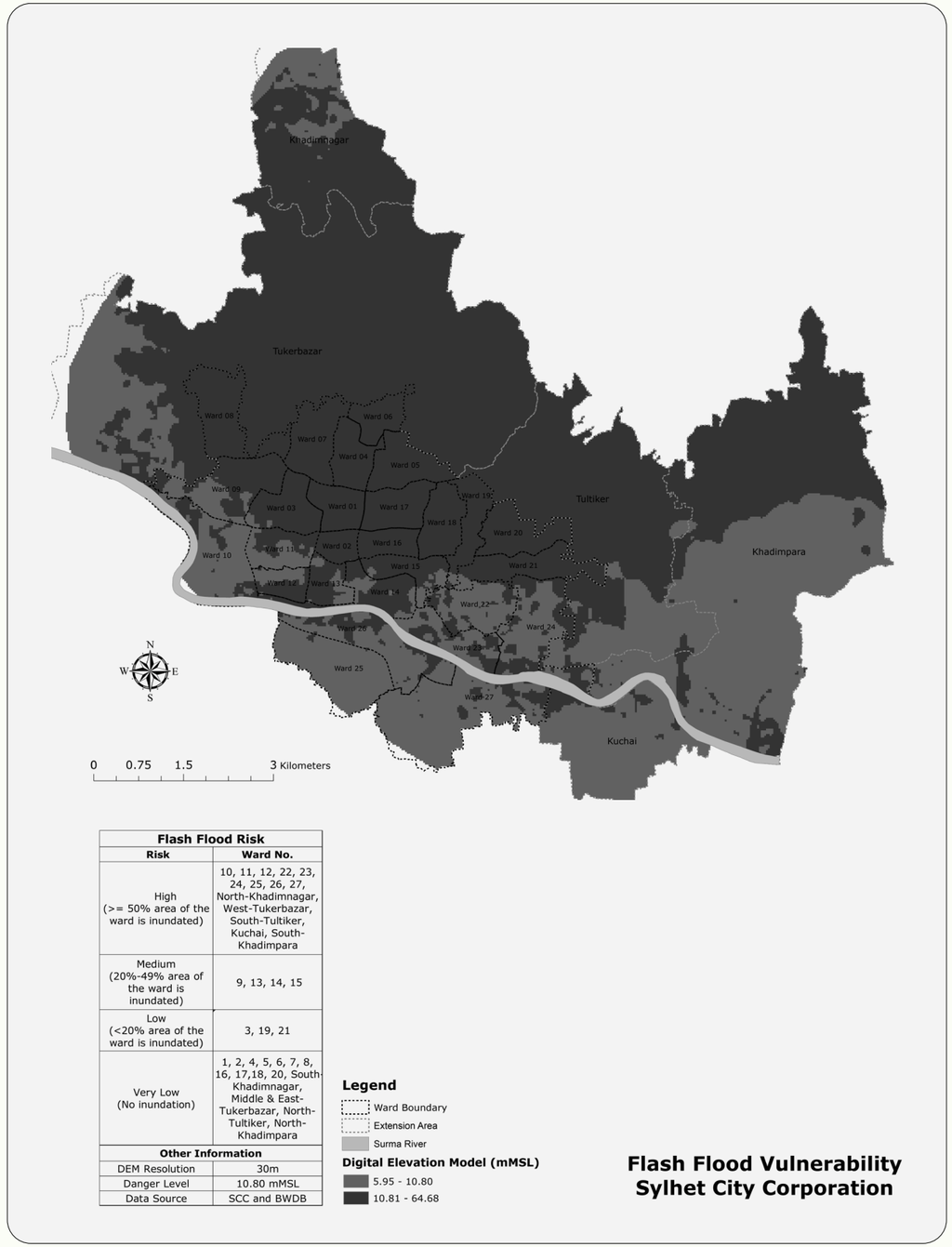

Fig. 2 - Assessment of flood vulnerability in Sylhet.

1. Cultural, traditional and societal landscape of Sylhet, Bangladesh

2. Understanding the possibilities and limitations of floating architecture

How can the development of **amphibious housing solutions** for **vulnerable urban environments** such as **Sylhet** act as the foundation and key driver for the transition towards **floating cities** as a viable response to **climate change.**

3. What are the implications of climate change on the region of Bangladesh

Research Question

A shift towards floating cities

With the number of people displaced as a result of climate change climbing to 40.5 million by 2050, the United Nations predicts 19 million will originate from Bangladesh due to the extreme low elevation of the major population centers in the country. The threat posed to vulnerable populations requires innovative solutions, otherwise mass migration from low lying areas could overwhelm the infrastructure of higher altitude areas. The concept of amphibious living could provide such a solution.

How can the development of amphibious housing solutions for vulnerable urban environments such as Sylhet act as the foundation and key driver for the transition towards floating cities as a viable response to climate change.

The research question can be broken up into three main sub questions.

0.1 How can ethnographic research provide a system for the numerous factors involved in transitioning the complex social, economic and geographical landscape of Sylhet, to ensure that the prototype structures meet the needs of a wide range of individuals to grow and flourish within the floating city?

The research hopes to provide a basis for the design of amphibious floating typologies that directly serve the needs of Sylhet's most vulnerable communities. As such, the research will explore the cultural and societal systems of Bangladesh to ensure the appropriate programmatic elements exist within the project. The process also aims for a sense of intersectionality to be realized during the development of the floating prototype. The aim of the research is to ensure accessibility to and inclusion of all of the diverse communities, through the use of community involvement throughout the building process. Subsequently, learning about the traditional building methodologies of Bangladesh, will respect the cultural and societal beliefs and ideals of the communities, while also reducing costs and ensuring the skill base to construct the prototypes is locally available. This will be augmented with modern technological advances to ensure the viability and resilience of the housing structures and that they can be seamlessly incorporated into any future floating city.

0.2 How can the use of scientific research and data aid in various low, moderate and extreme predictions for Sylhet's vulnerability by the ongoing climate crisis?

Three main subgroups of climate change will be analyzed, with the overarching research looking into the predictions associated with the rise sea levels, as well as the disruption of weather patterns and flooding as points of interest. The analysis will map three specific situations for the given site - mild, moderate and extreme climate change threats. The aim of the research is to further understand which communities are at higher risk of the implications associated with climate change, as well as what properties the dwellings will require to manage the progressive challenges and threats that the scenarios present.

0.3 Can amphibious typologies become a vehicle for the exploration of resilient and adaptive architectural solutions in the face of human induced climate change?

The core aim of the project is to identify housing solutions that are able to respond to the current need for resilient housing for vulnerable communities while also preparing them for the future of climate change. The amphibious housing solution will host properties that enable it to provide shelter and immediate support during flooding as well as provide resources for the home to be self sufficient in case of emergencies when response and support are unable to reach them. The aim is that this housing design can be seamlessly transitioned towards a permanently floating condition, with the appropriate programmatic elements needed for the shift, as our society will most likely not be able to reduce the warming of the Earth's surface, meaning that a plan to address a 5-10m rise in sea levels becomes a necessary component of any planned solution.

04

Hypothesis

Floating Typologies

Is the implimentation of a floating community typology a viable response to support the worlds population in an age of global sea rise ?

The chapter will discuss the hypotheses derived from the overarching question,which was in turn developed in regards to the viability of floating communities in mitigating climate change.

0.1 Floating cities will provide a viable response in the mitigation of several current and future environmental issues.

The floating typology will provide the vulnerable communities of Sylhet with infrastructure to withstand the current flash floods caused by irregular weather patterns, providing climate resilient refuge. The prototype will ensure its ability to withstand flash floods while providing water/energy/ sewage storage to allow the occupants to self sustain themselves during scarcity and unreliability of city resources. The prototype will in turn be designed to continuously adapt, with its ability to permanently float and sustain itself once the threats of rising sea levels cause coastal land to begin disappearing.

02. Floating cities will provide adequate space for farming, to provide solutions for the threatened agricultural sector.

The floating structure will provide adequate space for farming as a formal program, in order for the occupants to have the opportunity to sustain themselves without relying on the threatened resources of the urban community.

03. Floating cities will ensure their accessibility to all economic, cultural and social classes.

A series of steps will be followed through out the research, design and execution of the project to ensure its viability within all vulnerable urban environments with differing social and economic classes.

04. Offshore cities will provide opportunities for renewable resources.

The use of renewable resources is essential in the final metamorphosis stage of the prototype approaching 2050, as the resources provided by the urban city will be threatened by rising sea levels.

05. Offshore cities will ensure their reliance and viability for self sustenance during flooding when resources are scarce and unavailable. As well as aid in the preparation towards threats posed by rising sea levels.

The main goal of the housing typology is to ensure the protection of the communities at their current state of frequent flash flood while preparing them for the reality of rising sea levels due to be experienced by 2050.

Goals / Aim

For Combatting Rising Sea Levels

The transition towards floating cities aims to provide a viable response for the vulnerable communities of Sylhet in combating human induced climate change.

To achieve the goal the research aims to respond to the following -

0.1 Understanding the impacts of Sylhet, Bangladesh in the various projections laid out by governmental and scientific agencies.

02. Insights into the current living conditions of Bangladeshs' most vulnerable communities will aid in the design of typologies that are informed by daily challenges.

03. Implement traditional building solutions and materials alongside modern technology to ensure the accessibility of the prototype to all social and economic classes.
04. Analysis of case studies involving floating structures to further understand the possibilities and limitations of the project.

05. Provide a detailed design plan for transitioning vulnerable communities towards resilient offshore cities in the near future as the threats of rising sea levels are realized.

Fig 4 - Stability eludes climate refugees in Bangladesh's sinking cities

Problem Statement

Bangladesh is a **low-lying coastal** country located between India and Myanmar, and is one of the world's most **densely populated** and most ***vulnerable countries to the human induced climate crisis***. The average elevation of Bangladesh is nine meters above sea level and most of its population centers are on the low lying flood plain, with typical elevations of one meter or less. Scientific data predicts that portions of Bangladesh, including the city of **Sylhet** will be **underwater by the year 2050**, with the rest of the country facing constant **threats from flash flooding events**. As such, communities developed within the lower elevations are in acute danger and must be transitioned to **adequate housing.**

Research Goal

The research aims to support the implementation of a floating community typologies as a viable response to support the worlds population in an age of global sea rise.

AIM

0.1 Understanding the impacts of Sylhet, Bangladesh in the various projections laid out by governmental and scientific agencies.

AIM

02. Insights into the current living conditions of Bangladeshs' most vulnerable communities will aid in the design of typologies that are informed by daily challenges

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03. Implement traditional building solutions and materials alongside modern technology to ensure the accessibility of the prototype to all social and economic classes.

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04. Analysis of case studies involving floating structures to further understand the possibilities and limitations of the project.

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05. Provide a detailed design plan for transitioning vulnerable communities towards resilient offshore cities in the near future as the threats of rising sea levels are realized.

Research Question

How can the development of **amphibious housing solutions** for **vulnerable urban environments** such as **Sylhet** act as the foundation and key driver for the transition towards **floating cities** as a viable response to **climate change**.

Research Sub Questions

The research sub questions aim to provide guidelines for the speficic topics of intrest within the proposal for offshore living.

#1

0.1 How can ethnographic research provide a system for the numerous factors involved in transitioning the complex social, economic and geographical landscape of Sylhet, to ensure that the prototype structures meet the needs of a wide range of individuals to grow and flourish within the floating city?

- Ethnographic Research
- Literature Review

#2

0.2 How can the use of scientific research and data aid in various low, moderate and extreme predictions for Sylhet's vulnerability by the ongoing climate crisis.

- Mapping Analysis
- Literature Review

#3

0.3 Can amphibious typologies become a vehicle for the exploration of resilient and adaptive architectural solutions in the face of human induced climate change?

- Case Studies
- Literature Review

Methodology

Transcending 2050

The research aims to provide viable solutions to combating and mitigating the impact of global climate change to threatened urban environments such as Sylhet. The research seeks to understand and analyze several pieces of information vital to the viability of the design and execution of floating cities.

Several forms of analysis will be conducted to reach a thorough and comprehensive analysis of the topic at hand.

01. Data Collection

This phase of the research will primarily be conducted during the planned excursion in Dhaka and Sylhet by incorporating several methods.

- A conversation with individuals from a range of age groups will be initiated, in hopes of understanding their current housing needs. Residents will be asked to describe the successes and shortcomings with their current housing situations as well as what can be modified to improve their quality of life.
- A conversation with individuals who identify themselves as farmers or fisherman will be initiated,in hopes to understand their current situations and techniques in terms of protecting their crops and livestock during flooding. This is essential to the planning and designing process to ensure the ability to create and self maintain the inhabitants of the floating city.
- A photographic report will also be created in order to document and present the current housing provided to the residents of Sylhet. As well as conduct photographic research on the impacts of and disruption caused by the heavy rainfall.
- A mapping exercise will be conducted in order to visualize the changes in Bangladesh's landscape through out its existence. Mapping of Bangladesh's terrain through out its existence, for further understanding of the changes that have occurred over time.
- Mapping tools will be used for predictions of the percentage of Bangladesh that will be underwater by 2050 in three different scenarios - mild, moderate and extreme rising sea levels.

02. Literature Reviews

A series of literature will be reviewed to provide objective evidence for the basis of the design interventions. Analysis of a series of articles reports and interviews regarding global climate change and rising tides.

03. Case Studies

A series of case studies will be analyzed of current and passed ideations of floating cities. The hope is to further understand their successes and shortcomings to assist with the design process.

- Triton City — Buckmister Fuller
- Vision for Tokyo — Kenzo Tange
- Oceanix — BIG and United Nations
- Floating Farm — Goldsmith Company
- Maldives Floating City — DutchDocklands
- Floating office — William Alexander

04. Deconstruction Process

The process involves the envisioning of the ultimate outcome, this process allows for the meticulous charting of a path towards that goal. The process allows for the project's capabilities and success metrics to be defined upfront, as such steering the development of the project with precision.

06

Theoretical Framework

A basis for Design

A rapidly growing research field focusing on the relationship between climate change, vulnerability and human migration has been recognized by several academics and practitioners. In the past several decades various fields of study have paid close attention to the linkage and implications of climate change and human migration.[7] The consensus within the research and analysis communities of climate centered migration was the idea that environmental migrants' migrate due to the fact that their place of origin simply does not generate sufficient or desirable opportunities for survival and/or employment due to the damage it has undergone. The conversations surrounding environmental migration has since broadened, rather than simply focusing on one's livelihood opportunities or lack thereof. The understanding of the consequences posed on communities with environmental degradation has greatly expanded, to include factors such as safety, human rights, quality of life, community as well as ones right to self preservation.

Although the discourse on environmental migration is limited due to the lack of precise data and strong scientific understanding of the concepts, causes, dimensions and implications, the aim of this research is to convey that the implications of climate change, specifically rising sea levels, will leave a large number of displaced migrants in its wake, and therefore provide sufficient evidence to support the transition of vulnerable communities, such as Sylhet, towards floating cities.

01. Climate Change

The research is set to provide a series of data, analyzing the potential impacts of climate change in the country of Bangladesh with a specific focus on the city of Sylhet. Generative maps will provide the necessary information required for the distinction to be made between Sylhet's most vulnerable and susceptible communities towards the threats posed by the global climate crisis.

One of the resources that will aid in the data collection is by the organization Climate Central. This is an independent group of scientists and communicators whose research reports on the everchanging statistics of climate change and the impact on human lives. The use of science, data and technology allows for the generation of thousands of storylines, addressing issues such as climate science, sea level rise, extreme weather, energy and related topics.

The organization's coastal risk screening tool was utilized to generate maps showcasing areas threatened by sea level rise and coastal flooding, through the combination of advanced global models of coastal elevations with the latest projections for future flood levels. Maps could be selected to showcase projections based on five risk categories - year, water level, temperature, warming choices as well as ice sheets. The generation of maps in relation to sea level rise has provided several beneficial visuals in response to the aim of this research. Mild, moderate as well as extreme scenarios allow for the visualization of which portions of Bangladesh will be below sea level by the year 2050 based on the factors assigned to the generative map. Although several international initiatives regarding the combatting of climate change are currently taking place with the aim that the most extreme scenarios would not occur, it is vital to understand the full range of consequences of our actions and how they will in turn shape our future built environment.

02. Community Organization

Although the aim of transitioning vulnerable communities of Sylhet towards offshore living is mainly targeted as a response to the threats of rising sea levels, it also has the opportunity to provide adequate solutions to the current issues faced by Bangladeshi people on a daily basis, in hopes of improving their quality of life.

7 (Rana and Ilina)

The process allows for the **project's capabilities and success** metrics to be **defined upfront**, as such steering the **development** of the project with precision.

The transition towards floating cities

Ultimate Outcome

A Floating City

- Possibilities and challenges of a floating structure
- Transition of vulnerable small scale city infrastructure

(The aim of the foating city is to provide viable solutions to the threats of rising sea levels leaving large portions of Bangladesh permanently underwater. As such small infrastructure such as education, medical and governmental facilities will be relocated.)

Resilient Solution for Rising Sea Levels

- Introduce farming pods
- Zero waste treatments
- Self-sustaining systems *(Energy/Water/Wind/Sewage/Storage)*

Larger Scale Implementation

- Most **Vulnerable** Urban **Communities**
- **Shared Culture**
- **Accessibility** of floating typology

Small Scale Resilience during states of Emergency

- **Water/Sewage** Storage
- **Energy** Production

(The aim of the small scale intervention is to provide the occupants basic programmatic functions during the first few weeks of flooding disasters when resources are scarce and unavailable.)

Immediate Solutions for Disrupted Weather Patterns

- Understand the **cultural** and **social** identity of Bangladesh
- **Locally** sourced **recycable materials**
- **Local** building techniques and carpentry
- Modular Design
- **Floating** Ideology

Framework Diagram

Fig 3 - Providing aid after flooding in Jamalpur.

04. Housing Infrastructure

The aim of this research is to provide a basis for the need for floatingdwelling typologies that will aid in mitigating the impacts of climate change impacting Bangladesh's urban settlements.

Several studies have examined various aspects of housing infrastructure within Bangladesh, all with diverse findings. As environmental displacement has become extreme in geographically and environmentally vulnerable areas in Bangladesh, Md. Arif Uddin Khan further explains the implications on the increasing number of slum areas within Bangladesh. Displaced individuals migrate to slums due to multiple factors, but the research explains that the urban slums are mostly located in low-lying, environmentally hazardous areas that are themselves at risk. Coupled with inadequate facilities such as food, fresh water, sanitation, shelter and employment, the result is that this migration often results in a greater negative impact to their livelihoods.

Several other consequences are associated with the mass migration within Bangladesh, examined by Md. Faysal Ahmed during his research into the topic "Urbanization and Environmental Problem: An Empirical Study In Sylhet City, Bangladesh". The cross sectional study aims to provide relevant information regarding the consequences of unplanned urbanization on Sylhet's environment. Rapid expansion and urbanization of cities due to various factors including the climate crisis, have created social, economic, environmental and cultural issues. The research dives deeper on specific impacts of urbanization within Sylhet, including assessing the pressures placed on housing, employment, infrastructure as well as social services such as education, health and transportation systems.

The research has a stark conclusion: Bangladesh's current infrastructure is not equipped to meet the economic, social or cultural needs of mass climate migrations.[8]

05. Offshore Living

The architectural typology associated with floating infrastructure first emerged in the 1960's, through several utopian projects. With the innovations and technological advancements of the 21st century as well as the need for solutions in response to rising sea levels, conversations associated with floating architecture have since resurfaced. The analysis of several case studies ranging both in chronological and programmatic differentiations are vital to understanding the possibilities and limitations associated with such a typology.

Kenzo Tange's 1960 Master Plan for Tokyo was aimed to address the challenges industrial cities faced due to urban sprawl. Several examinations have been published criticizing the proposal for a new physical order of Tokyo to support its growth and revitalization. An article published by Cambridge University examines the visionary urban scheme in terms of its mobility rather than its monumentality which is much discussed. The essay by Hyunjung Cho conveys that the unrealized offshore city was driven by the author's firm belief in the perception that mobility was the underlying factor influencing the development of the post war Japanese economy, accompanied by the strong ambition to provide proper urban infrastructure for the adequate circulation of traffic. The bold statement by Kenzo Tange in regards to his investigations of alternative urban forms launched his exploration of a series of visionary projects that culminated with the plan for Tokyo 1960. [9]

Bijarke Ingels, in partnership with the United Nations, has produced a floating city concept, whose floodproof infrastructure rises with sea levels while producing its own food, energy and fresh water with a fully integrated zero water closed loop system. The city is modeled after the firm's initial floating housing concepts that were realized in Poland, with each compartment housing 12 students. The projects success has led to its implementation at a larger scale of 200 units in Gothenburg as well as conversations for the Paris Olympics to realize a floating village in the Seine as nomadic, inpermanent forms of architecture. The firms success with floating prototypes and designing architectures that combat rising sea levels has awarded them a large scale urban project in New York City which is also facing threats to rising sea levels by 2050. The firm's success has ultimetly led them to their ambitious collaboration with the United Nations for the project titled " Oceanix City", focused on the requirements of Busan, South Korea and aiming to assist in solving the sea level rise in the country. Complex changes are currently facing coastal cities, as such a prototype development that was approved in 2021 in an attempt to innovate breakthrough solutions to provide shelter for 10,000 inhabitants. The prototype's design is set to be approached through a hyper-local level according to its co-founders, to account for the rich social, economic, political and cultural uniqueness of its host country. Although the prototype is designed to hold the identity of South Korea, it plays a key role in understanding the possibilities and limitations of floating cities in the 21st century.[10]

8 (Ahmed, Md. Faysal & Islam, Md.)

9 (Cho H.)
10 (Ingels)

Relevance

A viable option to rising tides

As the world's population continues to grow exponentially, it begins to threaten the limits of essential global resources. A study published in 2018, conveyed the challenges humanity faces in terms of achieving a "high quality of life" for over seven billion people without destabilizing critical planetary processes. Scientists concluded that the earth could sustain, at most, seven billion people, although achieving "high life satisfaction" for everyone would inevitably transgress the Earth's biophysical boundaries, ultimately leading to ecological collapse.[11] As essential resources are over consumed by human life, it is further accelerated by the human induced climate crisis, inevitably threatening all forms of life. Sustainable coastal urbanization can act as a generational opportunity to advance climate action, clean energy and environmental protection and revitalization.

As 9 of ten of the world's largest cities are threatened by climate disruption, while also being responsible for over two thirds of all greenhouse gas emissions, the design of our future cities is a key factor to mitigating the impacts imposed on all forms of life. Floating cities may act as a viable response to some of the most pressing challenges of the future, promoting sustainability, adaptation to climate change, mitigating overpopulation and advancing building technologies, they have the potential to shape the future of our society.

0.1 Rising Sea Levels

According to the scientific magazine Nature Communications, at our current trajectory with regard to rising sea levels, 200 million people will live below sea level by the year 2100, with an additional 160 million impacted by higher annual flooding. 70% of the 200 million individuals directly affected by rising sea levels will reside within eight countries of Asia, with 32 million from Bangladesh. This will in turn trigger a mass displacement of climate refugees, both within countries and across borders.[12]

Our research into the climate crisis has brought forth several realities that our world must come to terms with regarding our changing environment. The United Nations Secretary General has warned that entire communities and countries will begin to disappear in the coming decades, as sea level rise continues to accelerate. With 900 million individuals currently residing within low-lying coastal cities, the development of floating architecture has inevitably become of great interest and research, as the demand for resilient and adaptive architectural solutions will continue to grow. The viability of offshore living will allow for communities to not only adapt to rising sea levels, to extreme weather conditions and flooding through the design of infrastructure that cannot be submerged and that can withstand raging flood waters. The transition towards floating cities represents a promising yet challenging frontier, as it can offer innovative solutions for harmonious living amidst the rising sea water levels.

0.2 Overpopulation -

Overpopulation is defined as an overabundance phenomenon in which a species' population becomes larger than the carrying capacity of its environment. Approximately eight billion people make up the current population of the earth, with the United Nations suggesting the world population will grow to 9.7 billion by 2050. As the world's population continues its upwards motion, the demand for resources such as land, fresh water and energy grows at an even greater pace. The exploitation and strain on the Earth's resources has led to severe consequences such as deforestation, loss of biodiversity, increased carbon emissions with a direct connection to the leading effects of climate change and widespread habitat destruction, including of many of the coastal environments that in the past protected vulnerable inland agricultural lands.

Managing the human population is one of the greatest challenges we continue to face as a society, as the pressures on the environment from continually expanding populations impact all areas of our world. The transitions towards floating cities can act as a mitigator towards reducing the pressure on overcrowded metropolitan areas, in an aim to restore the balance between rural and urban environments.

0.3 Food Production

Scientists have concluded that if the production of food continues in the current trajectory, by the year 2050 society will face a shortage of land equivalent to the size of North America.[13] he transition towards offshore cities and societies provides an opportunity to rebalance that shortage, with ample marine environments for food production, while assisting in the adaptation to intensifying climate impacts such as flooding, which decimates agricultural yield.

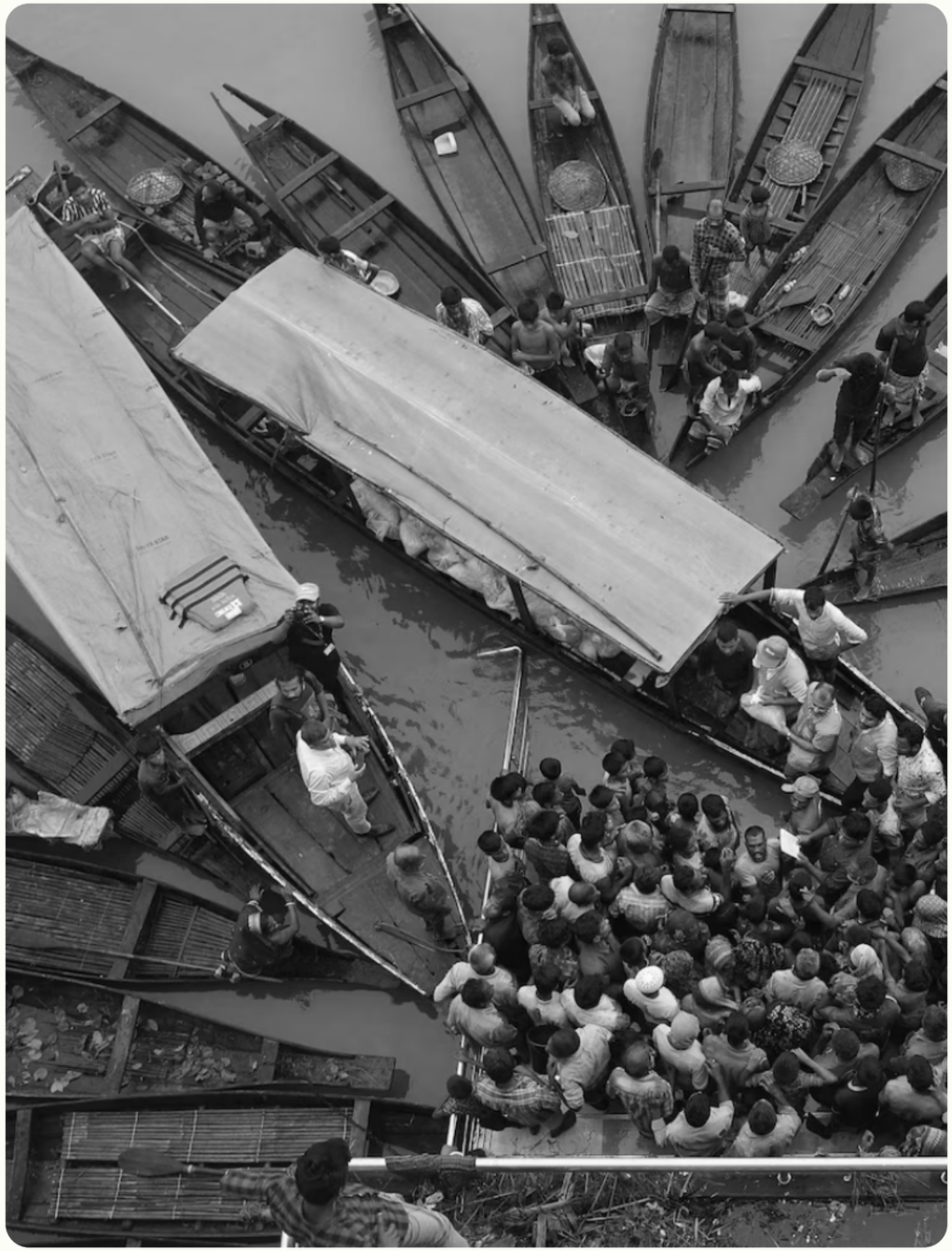
0.4 Renewable Resources

The prototype for floating living will ensure the self sustenance of the community which it serves. It is essential that sustainability is a key factor of the design approach as the community cannot rely on the existing infrastructure of the urban city as its fate from rising sea levels is not known. As such, floating living cities will require a certain level of renewable resources implemented to ensure its ability to sustain itself.

0.5 Affordability

A sense of intersectionality must be realized during the development of floating prototype. An approach that understands the inequalities surrounding different economic, social and cultural groups with an aim to consider them all. Floating living must ensure the accessibility and inclusivity of all diverse communities, through the use of community involvement throughout the building process.

11 (O'Neill et al.)
12 (Kulp and Strauss)
13 (Novenario)



▶ Fig 5 - People gather to collect food aid after Bangladesh

Fig. 6 - Rescuers in orange life vests escort stranded people to higher ground in Bangladesh

Definitions

Floating Cities

- **Climate Change -** changes in the earth's weather, including changes in temperature, wind patterns and rainfall, especially the increase in the temperature of the earth's atmosphere that is caused by the increase of particular gases, especially carbon dioxide
- **Greenhouse Gas -** any of the gases that are thought to cause the greenhouse effect, especially carbon dioxide
- **Floodplain -** an area of flat land next to a river that regularly floods when there is too much water in the river
- **Monsoon Season -** a period of heavy rain in summer in South Asia; the rain that falls during this period
- **Amphibious -** able to live both on land and in water
- **Prototype -** the first design of something from which other forms are copied or developed
- **Resilience -** the ability of people or things to recover quickly after something unpleasant, such as shock, injury, etc.
- **Biodiversity -** the existence of a large number of different kinds of animals and plants which make a balanced environment
- **Flooding -** large amounts of water covering an area that is usually dry; the fact of this happening
- **Migration -** the movement of large groups of individuals in response to changing environmental conditions
- **Refugee -** a person who has been forced to leave their country or home, because there is a war or for political, religious or social reasons
- **Sea levels -** the average height of the sea, used as the basis for measuring the height of all places on land
- **Ice Sheets -** a layer of ice that covers a large area of land for a long period of time
- **Ethnographic -** connected with the scientific description of different peoples and cultures, with their customs, habits and differences
- **Overpopulation -** the state of a population exceeding the capabilities of the environment to sustain it
- **Inadequate -** not enough; not good enough

Appendix

Backgroud Information

While the Earth does have natural warming and cooling cycles, the current extreme warming is believed to be due to the impact of humans - a result of increasing industrialization and extreme damage to ecosystems caused by exploding human populations and migration towards cities and urban environments. These are often located on coastal or low-lying areas leaving large, mostly impoverished, populations extremely susceptible to the effects of climate change Pictured on the right Figure 7, depicts a family of three in search of refuge during a flash flood in the region of Bangladesh. According to scientists at the Intergovernmental Panel on Climate Change (IPCC), our world currently faces a critical tipping point towards unavoidable climate hazards over the next two decades, with expected global warming of 1.5C. The possibility of exceeding the IPCC warming level could result in even more severe irreversible impacts, posing risks to societies, including industry, agriculture, infrastructure and low-lying coastal settlements.[14]

The long-term change in weather patterns is already causing changes to the Earth's local, regional and global climates. The changes observed have a broad range of effects including droughts, increased storm activity and severity, and even localized cooling in some areas as the interlocked global weather systems are disrupted. Human activities are estimated to have increased the Earth's global average temperature, with the last four decades surpassing the average temperature increase on the Earth's surface since 1850. There are several contributing factors, with the largest being the emission of greenhouse gases through the use of fossil fuels, such as gas,oil and coal - this is calculated to account for 90% of all carbon dioxide emissions and over 75% of all global greenhouse gas emissions.

The global climate system is an interlocking series of different systems that have a huge capacity to absorb and mitigate disruptions to the overall stability of the global climate, however as a result of humanity's continued activities , the ability of these systems to compensate is almost exhausted. The rising of our sea's levels is one of the most severe effects of the global climate crisis. Since 1880, the average sea levels have swelled over 23 cm, as our oceans continue to absorb 90% of all excess heat captured in the atmosphere by the increase in greenhouse gases. Every year, the sea rises by 3.2mm, with the rise accelerating and projected to reach 31cm by 2050.

The unparalleled toll taken on our oceans is linked to three primary factors which in turn are all induced by the ongoing global climate crisis. When water is heated it expands, approximately half of the sea-level rise in the past 25 years is attributable to warmer oceans simply occupying more space. As well as the persistently higher temperatures on the Earth's surface leading to a greater than average summer, resulting in the melting of the globe's frozen waters, specifically the Greenland and Antarctic ice sheets, but also of glaciers and tundra around the world. These sources are estimated to contain around 2% of the world's water - should this all melt, the United States Geological Survey estimates that sea levels would rise 70 meters, submerging almost every major population center on the planet.

The continued warming of our earth has had devastating results on people's health, lives and livelihoods. Our critical infrastructure, including energy and transportation systems, have been increasingly adversely affected by hazards from heatwaves, storms, drought and flooding as well as slow-onset changes, such as sea level rise. Addressing this crisis will be humanity's greatest challenge in the next 50 years.[15],[16]

14 (McGrath)

15 (CNN)

16 (NASA)

Fig 7 - People wade through the water as they look for shelter during a flood.

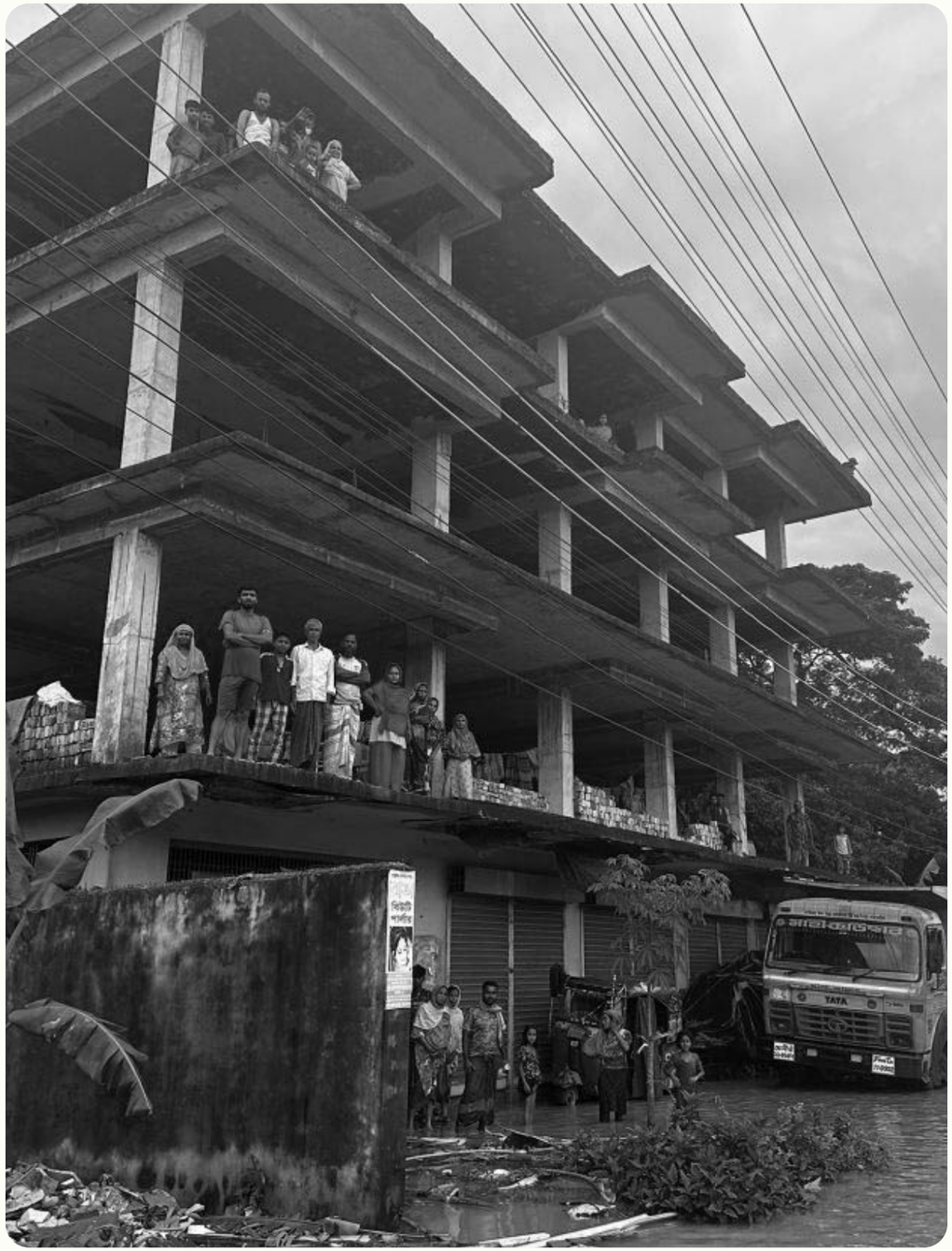


Fig 8 - People in Bangladesh are seeking shelter from flooding in buildings throughout the city

Appendix

Rising Sea Levels Implications

There are several consequences associated with rising tides, having wide-reaching implications not just on our physical environments but on the economic, social and cultural fabrics of vulnerable nations across the world. The flooding by saltwater can cause irreversible damage on coastal habitats and poison freshwater aquifers, destroying agricultural land and disrupting fish populations, washing away critical infrastructure and industrial resources and displacing populations as their housing is destroyed and the environment becomes incapable of supporting them.

The impact rising tides plays amongst communities should also be considered from the financial and economic implications. Severe storms and flooding are already,responsible for billions of dollars of annual damage and property loss. The continued rise will continue this trend and make recovery impossible as critical and immovable infrastructure around the world, such as sewage treatment plants, power stations as well as roadway infrastructure is at risk of permanent flooding.

Humanity has also made major changes to the coastal environments that naturally protect against the encroaching sea. The continued rising of sea levels will further exacerbate this by leading to an excess of beach erosion as well as the loss of coastal marshes. The natural existing shorelines offer communities protection from flooding and waves during storms, while also serving as a key habitat for several species. The threat of rising sea levels, also threatens the loss of these natural buffers.[17]

The flooding can also contaminate communities fresh water supplies, in turn promoting water borne diseases and threatening the physical and mental health of the affected population, while also contaminating viable farmland, as more salt compromises freshwater sources. The loss of large swaths of farmland have forced communities of people off land they occupied for generations.

These factors will ultimately cause the migration of whole populations of people from the affected low-lying regions. The potential refugee crisis that would occur would dwarf any previous migration and will have extreme ramifications on inland communities. Humanity has historically not reacted well when faced with mass migration events, and the potential for rich, coastal populations to move to lower income inland areas known as climate gentrification, would potentially be more disruptive than any previous migration event.

Other impacts of climate change reinforce and exacerbate the already extreme consequences of rising sea levels. The damage caused by heavy rainfall, which previously would have been classed as 500 or 1,000 year floods are now occurring 30% more frequently, impacting not only the coastal communities but also higher elevation cities that would be the potential refuges from the rising tides.[18]

17 (United Nations)

18 (Merz, B., Blöschl, G., Vorogushyn, S.)

Annotated Bibliography

Built on Shape Shifting Land

Ahmed, Md. Faysal & Islam, Md. (2014). Urbanization and Environmental Problem: An Empirical Study In Sylhet City,Bangladesh. Research on Humanities and Social Sciences. 4. 161-172.

The paper by Md. Ahmed and Md. Islam regards the urbanization and environmental problem in Sylhet, Bangladesh. The paper specifically examines the consequences associated with mass unplanned urbanization and the environmental concerns the issue poses. The use of cross sectional data conducted by Sylhet city, Social surveys as well as the FGD method were applied during the primary data collection. The paper conveys the environmental issues cities face due to urbanization, concerning cultural, economic and social aspects. The extremes of urbanization have pressured critical city infrastructure such as education, sanitation, health facilities and housing availibility. The papers proposed resolutions involve governmental authorities taking proper action towards initiatives and policies to aid the threats posed on cities.

Akter, Nurunnaher & Islam, Md & Karim, Md & Miah, Md & Rahman, Md. (2022). IMPACT OF FLASH FLOODS ON AGRI-BASED LIVELIHOODS IN SYLHET HAOR BASIN. Annals of Bangladesh Agriculture. 26. 61-73.

The research paper focuses on the region of Sylhet, Bangladesh in terms of its vulnerability to natural disasters and climate change. The study dives deeper into the causes and impacts of flash floods within the city, proposing practices to mitigate the damage. The study provides surveys and data, within areas of moderate and high probability of flash flooding to analyze which sectors of the community are at higher risk to the impacts of climate change. The survey concludes that the agricultural sector is the most vulnerable to flash floods and demonstrates the alternative livelihood tracks adopted by individuals within the sector. The study also reveals the current measures undertaken by communities in an attempt to mitigate the impact of flooding, while demonstrating the success and failures of their structural measures as barriers. Overall the research paper provides essential information in understanding the impact the region of Sylhet faces due to human climate change.

Angela Fritz and Rachel Ramirez. 2009. "Earth Is Warming Faster than Previously Thought, Scientists Say, and the Window Is Closing to Avoid Catastrophic Outcomes." CNN. August 21, 2009. https://edition.cnn.com/2021/08/09/world/global-climate-change-report-un-ipcc/index.

The article by CNN reporters conveys the small window of opportunity our society has in terms of avoiding catastrophic outcomes as the Earth continues to warm up at an accelerating pace. The article provides a general synopsis of the UN intergovernmental panel on climate Change report as well as the conclusions provided by the IPCC assessment report on climate change. The article provides key examples for the implications associated with the global climate crisis providing insights on the flooding that took western Europe by storm and the wild fires raging across California, in an attempt to urge its audience to act towards providing solutions for mitigating the crisis.

BBC. 2021. "Bangladesh at 50: Why Climate Change Could Destroy My Ancestral Home." BBC, March 26, 2021. https://www.bbc.com/news/world-asia-56485667.

In celebration of Bangladesh's' 50 year independence, the article by the British Broadcasting Corporation (BBC) follows Qasa Alom in his reflection of the impact climate change has had on the country his family calls home. The article takes the reader through the emotional journey of a young Qasa Alom, who spent the holidays roaming the land and exploring the rice paddies with his younger brother, but a land whose magic soon wore off. The powerful narrative by Qasa Alom provides data regarding the climate crisis while also engaging with local families to document their beliefs and insights on the everchagning landscape of their country.

Cho H. Kenzō Tange's A Plan for Tokyo, 1960: a plan for urban mobility. Architectural Research Quarterly. 2018;22(2):139-150. doi:10.1017/S1359135518000301

The paper by Hyunjung Cho regarding his analysis of Kenzo Tange's "A plan for Tokyo" presents itself as a juxtaposition to the existing studies conveying the plans' monumentality. The study conducted, explains that the plan proposed for Tokyo is simply a complex design for urban mobility. The paper examines a series of essays on the topic at hand, with the conclusion that the regarder plan was a model city for an automobile society against the backdrop of Japan's rapis motorisation. The paper also studies the workflow of Tokaido Megalopolis by Kenzo Tange, to support his argument regarding the architects interest in the preparation of cities for the emerging information driven society. The essay provides a contradicting response to the praised papers written on the topic, allowing for not only the possibilities but the limitations of floating cities to be argued.

Impact that Matters. 2024. "Sylhet Bangladesh Floods 2024 | SNV." Snv.org. 2024. https://www.snv.org/update/sylhet-bangladesh-floods-2024.

The platform is focused on providing information regarding the recent flooding in Sylhet, Bangladesh. The chosen article regarding Sylhet floods specifically focuses on the surge of the Surma river past its 10.8m danger mark, displacing thousands of people. The article conveys conversations amongst flood management advisors and project managers collaborating with governmental organizations in an attempt to mitigate the effects of flooding. The article dives deeper in the causes for the flooding of the Surma River and its impact on nearby communities. The part of interest within the article is the current response by local government officials in developing a flood mitigation strategy and how other agencies are supporting their efforts. Local initiatives to mitigate the impact of rising sea levels is essential as the transition towards floating living will take several years to complete, which in turn leaves communities in acute danger until its realization.

Ingels, Bjarke. "Floating Cities, the LEGO House and Other Architectural Forms of the Future." Www.ted.com, 3 June 2019, www.ted.com/talks/bjarke_ingels_floating_cities_the_lego_house_and_other_architectural_forms_of_the_future?subtitle=en. Accessed 5 Apr. 2023.

Bjarke Ingel was welcomed onto the TED talk stage to discuss his current work, specifically his projects regarding "Floating Cities, the LEGO House and Other Architectural Forms of the Future." The conversation took the viewer through a series of Ingels past, current and future projects, demonstrating the key attributes of his work in relation to current climatic issues. The firms journey with floating structures originated at a small scale in Poland as a series of dwelling units for 12 university students. The project then evolved to an additional 60 small scale buildings and the implimentation of a similar project in Gothenburg in the form of 200 dwelling units. The firms success with cliamte responsive projects led them to their current projects with the city of New York, as well as the "Oceanix" project in collaboration with the United Nations whose qualities are specifically studied within this research.

Kulp, Scott A., and Benjamin H. Strauss. "New Elevation Data Triple Estimates of Global Vulnerability to Sea-Level Rise and Coastal Flooding." Nature Communications, vol. 10, no. 1, 29 Oct. 2019, https://doi.org/10.1038/s41467-019-12808-z.

The journal published by Nature Communications is a data driven analysis of the global vulnerability of sea level rise to coastal cities. The journal provides statistics for three scenarios of sea level rise, low, median and high increase in carbon emissions. The data is valuable in understanding approximately how many thousands of coastal communities are vulnerable and in need of adequate and viable solutions to the ongoing climate crisis. The data provided estimates that one billion people occupy land less than 10m above current high tides, including 230 million below 1 meter, an alarming statistic that places greater emphasis on the need for floating solutions.

Masterson, Victoria, Stephen Hall, and Madeleine North. 2024. "Rising Sea Levels Are a Global Threat – Here's Why." World Economic Forum.World Economic Forum. September 20, 2024. https://www.weforum.org/agenda/2024/09/rising-sea-levels-global-threat/.

The article by the World Economic Forum provides an overarching explanation into the collected data, statistics and understandings regarding global sea level rise. The information provided by the forum conveys background information regarding the reasonings behind the spotlight placed on the topic in recent years as well as the basis for measuring the rise and its history. The article also provides valuable insights on the causes of sea level rise as well as which countries face the greatest threats in regard to the crisis as well as how certain parts of the world are adapting to combat and mitigate the rising sea levels.

Merz, B., Blöschl, G., Vorogushyn, S. et al. Causes, impacts and patterns of disastrous river floods. Nat Rev Earth Environ 2, 592–609(2021). https://doi.org/10.1038/s43017-021-00195-3

The article published in regards to the causes, impacts and patterns of disastrous river floods provides a synthesis into the atmospheric, land surface and socio-economic process that lead to the production of river floods and the disastrous consequences associated with them. The study explains that the hazards and impacts of flooding is projected to increase in many regions around the globe, with future flooding hot spots mainly in Asia and Africa. As Bangladesh has one of the most extensive river networks, understanding the distinct cause of river floods, is essential in assessing the risk, while invoking flood risk systems and management concepts to vulnerable communities.

McGrath, Matt. "Climate Change: IPCC Scientists Say It's 'now or Never' to Limit Warming." BBC News, April 4, 2022. https://www.bbc.com/news/science-environment-60984663.

The article by the British Broadcasting Corporation (BBC) reflects on the information conveyed during the UN's intergovernmental panel on climate change, in an attempt to provide guidance on plans of action to avoid an extremely dangerous future. The article dives further into the societal behaviors that can result in a reduction in greenhouse gas emissions, through policies that place infrastructure and technology in place to aid in changes to human lifestyles and behaviors. The main goal of the report is to convey the need for machinery to remove carbon dioxide directly from the atmosphere, which for many patrons is extremely contentious as the technology is fairly new and currently very expensive. The article wraps up the conversation regarding the UN report with the notion that some participants are highly skeptical with the approaches presented, referring to them as pipe dreams.

NASA. 2024. "What Is Climate Change?" Science.nasa.gov. NASA. March 2024. https://science.nasa.gov/climate-change/what-is-climate-change/.

The article provided by the US National Aeronautical and Space Agency (NASA) conveys a background into the aspects of climate change. The article is essential for the basic understanding of climate change, while also providing illustrations on the progression of global temperature increases through out history in an attempt to convey the drastic acceleration of warming on the earths surface. The article provides a high level overview of the known causes, effects and indications of global climate change and provides sources to other websites and resources in regards to the global climate crisis.

Novenario, Celine. "5 Reasons Why Floating Development Is Set to Take the World by Storm." Global Center on Adaptation, 17 Oct. 2022, gca.org/5-reasons-why-floating-development-is-set-to-take-the-world-by-storm/.

The article by the global center on adaptation conveys five of the overarching reasons behind our societal shift towards offshore living. The article demonstrates some of the key aspects of offshore cities that experts believe are a promising adaptation and environmental solution to the global climate crisis. The article provides a basis for the relevance of the design prototype and assists in the argument made within the research plan.

O'Neill, Daniel W., et al. "A Good Life for All within Planetary Boundaries." Nature Sustainability, vol. 1, no. 2, Feb. 2018, pp. 88–95, https://doi.org/10.1038/s41893-018-0021-4.

The article titled "A good life for all within planetary boundaries", conveys the challenges imposed on the earths vital resources as the world's population continues to grow. The article places great emphasis on achieving a high quality of life for each individual, alongside indicators that can be designed to quantify the resources associated with meeting basic human needs. The study demonstrates that no country meets the basic needs for all its citizens at a globally sustainable level of resource use. The article provides a basis for the need of civilizations to look further into the possibilities of providing higher quality of living for its people without straining the Earth's vital resources.

Rana, Md Masud Parves, and Irina N. Ilina. "Climate Change and Migration Impacts on Cities: Lessons from Bangladesh." Environmental Challenges, vol. 5, no. 10.1016, Dec. 2021, p. 100242, https://doi.org/10.1016/j.envc.2021.100242.

The essay by Md. Rana and Ilina convey the impacts climate change and human migration place on cities specifically in the case of Bangladesh. The essay demonstrates the interlinked relationship between climate change and human migration. The paper's aim is to review the current trends of climate change in the region alongside the urbanization of cities, in order to explore the nexus between climate induced human mobility and their subsequent impact on urban cities. The paper claims that the country of Bangladesh requires systematic transformative spatial planning in order to identify the weaknesses and strengths of particular cities in dealing with the issues of climate induced migration. The paper provides critical information in the case of Bangladesh requiring a new form of typology, in an attempt to mitigate the mass climate migration straining the resources of its cities.

Saif Hasnat, and Mike Ives. "Bangladesh Floods Cause Death and Destruction in Sylhet." The New York Times, 24 June 2022, www.nytimes.com/2022/06/24/world/asia/sylhet-bangladesh-floods.html?login=email&auth=login-email. Accessed 27 Oct. 2024.

The article by the New York Times conveys the intensifying effects of global climate change during the annual monsoon season. The article provides a detailed description regarding the 2022 flash floods that took place in Sylhet, with interviews from local scientists. The article describes the hardships faced by families throughout Sylhet through the loss of their homes, belongings and livelihoods. The article is sentimental for all readers as it provides stories and interviews from local community members regarding their experiences and hardships.

United Nations. 2023. "Climate Change-Induced Sea-Level Rise Direct Threat to Millions around World, Secretary-General Tells Security Council | UN Press." Press.un.org. February 14, 2023. https://press.un.org/en/2023/sc15199.doc.htm.

The United Nations meeting coverage and press release web page was a critical resources in understanding the severity of climate change, alongside the proposed projects to mitigate the threats on vulnerable societies around the world. The specific article focuses on climate induced sea level rise directly threatening millions of people around the world. The article summarizes the conversations that took place during a United Nations meeting between the Secretary General and security council. The article provides dialog from various points in the meeting, allowing for a broad understanding of a variety of thoughts and arguments between officials representing different countries.

Vaidyanathan, Rajini . 2022. "Bangladesh Floods: 'I Have Nothing Left except My Life.'" BBC News, June 27, 2022, sec. Asia. https://www.bbc.com/news/world-asia-61949495.

The article by the British Broadcasting Corporation (BBC) reports on the Bangladesh floods that took place in north-east Bangladesh leaving more than four million Bangladeshis stranded. The article follows the family of Shumana Akhter Aisha whose home was surrounded by a blanket of water. The article documents their journey and hardships endured during the flooding ranging from being trapped in their home, to their attempt to reach resources resulting in their boat filling with water, submerging and their loss of consciousness. The article provides other statistical information regarding the floods in the Sylhet region, with data from the world bank and United Nations. The article provides a heart-felt story that resonates with the reader in an attempt to not only educate on the issues of rising sea levels but also urge the reader to act.

Fig 9. - Health concerns rise as Bangladesh floodwaters linger

Notes

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Fig. 10 - People carrying relief materials wade through floodwaters in Feni

A TRANSITION TOWARDS FLOATING CITIES.

BUILT ON SHAPE SHIFTING LAND.

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