Increasing Flood Resilience Low-Income Urban Neighbourhoods in the Global South

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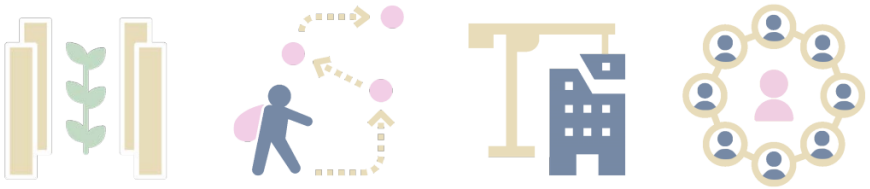

MAJOR RESEARCH PROJECT

INCREASING FLOOD RESILIENCE:
LOW-INCOME URBAN NEIGHBOURHOODS IN THE GLOBAL SOUTH

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ABSTRACT:

Poverty and flood disasters are two evils in the Global South that have long suppressed the abilities of the urban poor to improve their quality of life. Grounded within a context of weak institutional capacities, most urban populations in these low-income nations are not served by a network of institutions, infrastructure, services, nor regulations. Faced with the threats of climate change, local governments and low-income communities are looking for a shift away from flood-control infrastructure and towards flood resilience. Through a multi-disciplinary approach that incorporates spatial factors such as green infrastructure, mobility, buildings, and social networks, a holistic urban design approach to flood management can be achieved. However, flood resilience cannot be fully achieved without the presence of an agile community that is willing to lead various interventions into their spatial environment and everyday lives. And as agile communities cannot arise under social marginalisation of the urban poor, a truly resilient flood management approach is one that encapsulates added social values to achieve sustainable livelihoods for all. Through proposing multi-scalar design schemes that portrays all the aspects of flood resilience mentioned, flood adapt urban areas and communities are fostered to achieve overall flood resilience and thus, sustainable livelihoods.

THE PROJECT:
AN INTRODUCTION

1

Climate Change & Flooding:
Increased frequency and severity of flooding due to climate change emphasises the importance of adaptation of mitigation.

2

Urban poverty:
Urban poverty magnifies vulnerabilities and impacts during disasters and often dictates where people live (i.e flood-prone zones).

3

Resilience:
A rising discourse where urban systems cope with unexpected shocks and achieve sustainability over time.

Global Flood Impacts:

Annual average costs from flooding in Europe:
€4.5 billion

This average is estimated to increase by 2050 to:
€23 billion

Global economic losses from flooding in March 2019:
€8 billion

18/23
of the countries affected is part of the **Global South**.

Fig. 1: (Insurance Journal, 2019)

The Global South

This term is a metaphor for underdevelopment as it refers to low and medium income nations of Latin America, Asia, Africa and Oceania (Dados and Connell, 2012). These nations are often defined as being both politically and culturally marginalised (Dados and Connell, 2012).

Climate Change

Most urban centres in these regions have large deficits in the infrastructure and services needed to limit direct and indirect impacts of flood disasters (Mitlin and Satterthwaite, 2013). These are also the same regions at risk of extreme weather, as they are located in low elevation coastal zones, are prone to cyclones, hurricanes, typhoons, extreme rainfall, heat waves, and other disasters (Mitlin and Satterthwaite, 2013). Thus, climate change has disproportionate impacts on them and amongst the global population, low-income urban dwellers of the Global South has the largest exposure to future disasters (Mitlin and Satterthwaite, 2013).

Institutions, Infrastructure, Services and Regulation

The global North-South divide is based on four factors: institutions, infrastructure, services and regulation. High income nations have established strong networks of institutions, infrastructure, services and regulations (ibid, 2013).Their city planning and land-use regulations are highly capable of adjusting to heightened risks associated with climate change. Thus, an adaptive capacity for climate change risks is built over time.

Contrastingly, low-medium income countries have very weak institutional capacities. Most urban populations in the Global South are not served by a network of institutions, infrastructure, services, nor regulations (Mitlin and Satterthwaite, 2013). The livelihoods of said urban dwellers fall outside the regulatory framework as they are often established informally. Institutional capacities are further crippled by the fact that informal settlements and participants of the informal economy are regarded as 'the problem' by most local governments (ibid, 2013). This reflects an unadaptive governance that is unrepresentative, unaccountable and anti-poor.

The Project

The project is set within a context of urban poverty in developing countries of the Global South. In the face of climate change and rise in exposure to increased vulnerabilities, the relevance of establishing resilience is ever-increasing.

The Global South context underlines a framework of problems faced by urban low-income neighbourhoods, which are often established informally.

In order to create appropriate and attainable solutions, a thorough understanding of the context of the urban poor is essential.

Fig. 2: Flood in Jakarta (Floodlist, 2014)

Fig. 3: Flood in Jakarta (CNN, 2013)

How can urban design practices help increase the flood resilience of a low-income urban neighbourhood whilst fostering sustainable livelihoods?

1

Catalyse a paradigm shift in flood management:
place urban design at the core of a flood management framework to increase adaptive capacities through a holistic flood management approach.

2

Increasing resilience:
creating a toolkit of design interventions that minimises flood impacts and protects livelihood assets to increase flood resilience.

3

Reconceptualising low-income riverside neighbourhoods:
create an integrated design approach that help establish a sustainable livelihood despite instances of flood events.

METHODOLOGY

1

Conceptualising the problem:

Understanding the **problems**.

Creating clear **objectives** to address problems.

Understanding relevance and **contribution to practice**.

2

Synthesising the research:

Analysing literature and **case studies**.

Synthesising common **concepts** and successful **interventions**.

3

Developing a solution:

Creating a design toolkit.

Choosing an appropriate **site** and analysing its **contexts**.

Analysing how the **problems** resonate within the site.

Realising possible **urban design interventions** for the site.

Final **proposals** for the site.

4

Evaluating the proposal:

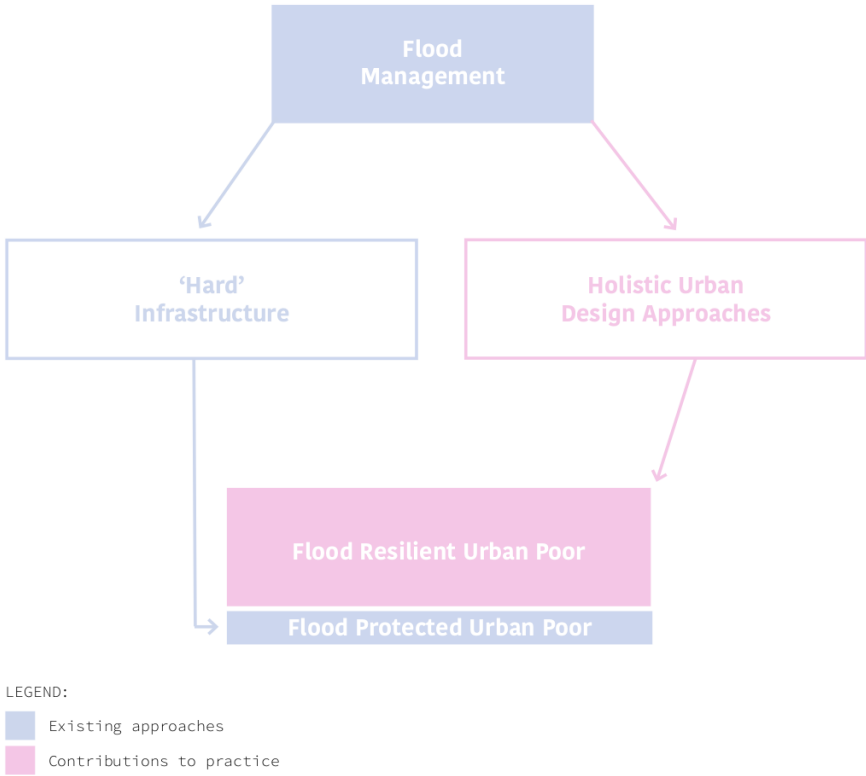
Evaluating overall contribution of the proposal towards achieving the project objectives outlined.

Evaluating the toolkit against practicality and transferability towards other sites with similar issues.

CONTRIBUTION TO PRACTICE

The EU, UN and World Bank are raising awareness for resilient cities. More and more neighbourhoods are transforming to achieve resilience towards flood disasters (Serre et al., 2016). However, there is still no conceptual framework to analyse or justify specific urban design strategies or measures that contribute to improving urban flood resilience (Serre et al., 2016). There is a lack of tools present to guide urban design professionals to integrate resilience into their daily practices.

Furthermore, current tools and concepts that contribute to improving urban protective systems work in silo. There is a lack of holistic approaches to achieve both a defensive mechanism against urban disaster and improve the quality of life of urban dwellers. This is relevant for countries in the Global South where urban poverty is a prevalent issue and a new approach for urban resilience should parallel efforts to achieve sustainable livelihoods.



RESEARCH:
LITERATURE REVIEW & CASE STUDIES

URBAN POVERTY & FLOOD DISASTERS

Poverty and flooding are **“two interrelated and interdependent social evils that combine to make human life more miserable”** (Dube, Mtapuri & Matunhu, 2018).

Poverty is any form of inequality such as social exclusion or living conditions that are essential to human dignity (Asselin, 2002).

It dictates a community’s ability to fulfill needs regarding education, nutrition, health care, sanitation, access to water, housing, income and participation (Asselin, 2002).

Urban disasters severely impact populations in poverty and may even create poverty amongst those who was not in it. Most low-income households in low-middle income countries live in informal settlements located on dangerous sites with high risks of disaster (Mitlin and Satterthwaite, 2013). They gravitate toward sites deemed unsuitable for residential or commercial development - giving informal settlers less fear from being evicted (ibid, 2013).

In the face of climate change, the livelihoods of informal settlers in low-middle income countries face greater risks due to large deficits of infrastructure and services. The population of informal settlers are most vulnerable due to 3 factors: neighbourhoods on high risk sites, poor quality housing and lack of risk-reducing infrastructure (Mitlin and Satterthwaite, 2013). In relation to urban flood disasters, this means that informal settlements are often located on floodplains, live in houses that are unable to withstand the floods, and lack drains that can cope with storm water runoffs and all-weather roads or paths.

Fig. 4: Flooding and the urban poor in Bangladesh (NY Times, 2017)

Fig. 5: Flood shelter for the impacted urban poor in Nepal (NY Times, 2017)

Fig. 6: Destroyed housing after Myanmar flood (UN News, 2015)

GREEN INFRASTRUCTURE

Current discourse on flood resilience revolve around the green infrastructure (GI) approach (Lennon et al., 2014). This approach is “an interconnected network of natural areas and other open spaces that conserves natural ecosystem values and functions (Benedict & McMahon, 2006, 1).” It is focused on the receptors of flooding (people and their assets) and the pathways by which flood water reaches its receptors (river channels, drainage system, etc.) (Lennon et al., 2014). It is a holistic approach that benefits from overlapping functions across different systems (hydrology, transportation, economy, etc.) (Rouse and Bunster-Ossa, 2013, 19).

The use of urban green space offers significant potential in moderating effects of climate change such as water runoff and increased temperatures (Lennon et al., 2014). With increased precipitation due to climate change, there will be an increase in surface water run-off. This is especially true in urban areas as urbanisation significantly effects rainwater interception, storage and infiltration processes (CIRIA, 2019). Hindrance to these processes often lead to increased surface runoff and hence, vulnerability to flooding.

However, as urban areas are characterised by having a well-established built form, creating large new green spaces is not always a feasible option (Gill et al., 2007). The GI approach focuses on the enhancement, creation and integration of smaller scale multifunctional green networks and spaces into ecologically sensitive urban development to reduce surface water runoff (Lennon et al., 2014). A modeling exercise in Manchester reveals the following results (Lennon et al., 2014):

Green Cover - increasing green cover in residential areas by 10% reduces runoff by 4.9%
Tree Cover - increasing by 10% reduces runoff by 5.7%
Green Roofs - adding green roofs to all buildings in town centres, retail, high-density residential areas, reduces runoff by 17-19.9%

This calls for innovative ways to add green space into urban areas. Some measures include: adding green to roofs, building facades, railway lines, street tree planting, converting streets into greenways, etc. Such measures should especially be targeted in areas with high numbers of vulnerable populations (low-income households) since green and tree cover is relatively lower in residential areas with higher levels of economic deprivation (Pauleit et al., 2005).

However, increasing green space on its own is not enough to moderate the unpredictable increases of surface water runoff in the context of climate change. Although it is very effective at the local level, it needs to be considered alongside increased storage of surface water runoff (Lennon et al., 2014). Methods to store surface water runoff include Sustainable Urban Drainage (SUDs) techniques such as creating swales, detention basins and retention ponds in parks (Mansell, 2003).

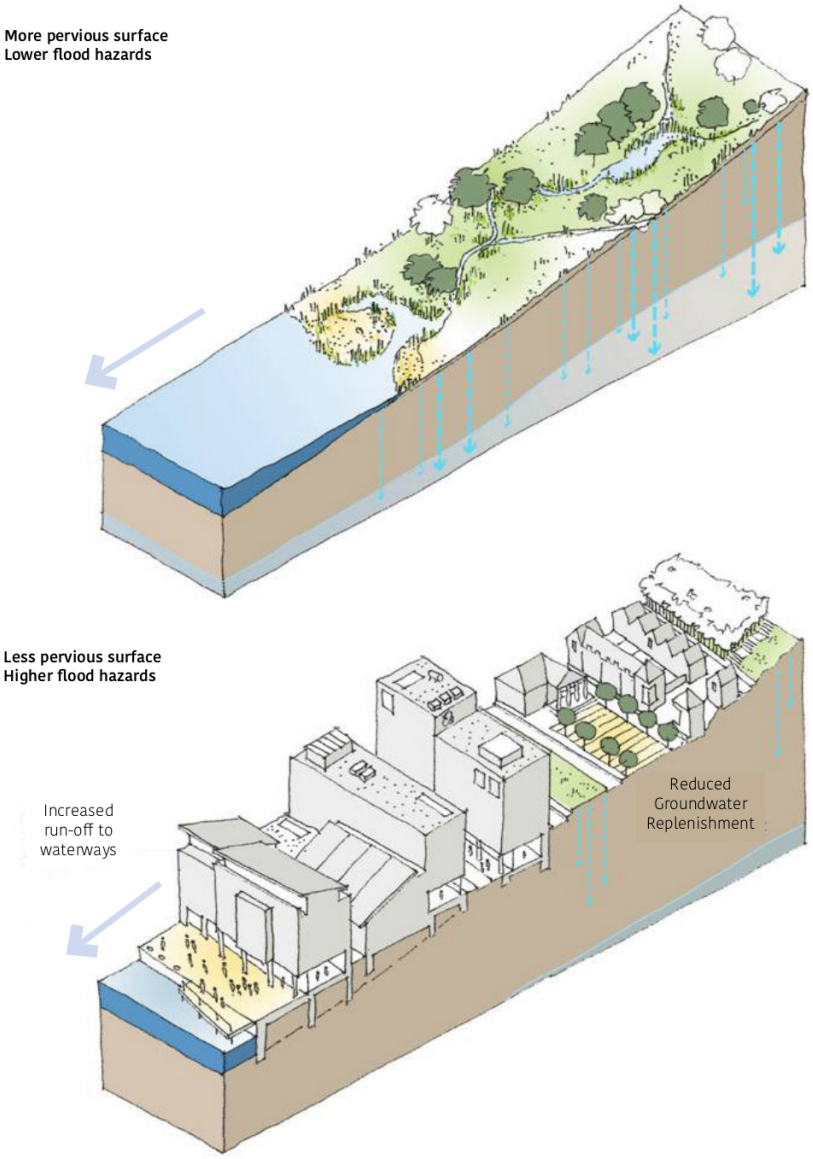


Fig. 12: Surface water run-off (CIRIA, 2019)

MOBILITY

Mobility plays a large role in the functionality of urban areas - it defines access to connections and the overall connectedness of a place to its surrounding environment. The main modes of transportation for most low-income urban dwellers are walking, cycling and motorcycling (Liao et al., 2016). However, in times of floods, most low-in-

A neighbourhood's resilience can be analysed against the **DS3 Model** (Serre et al., 2012). Resilience is understood through the neighbourhood's operations. It is defined as, "the ability of a neighborhood to absorb disturbance and recover its functions following these disturbances" (ibid, 2012). The DS3 model provides qualitative analysis to identify design measures that contribute to a neighbourhood's flood resilience by assessing them against three capacities:

1. **Resistance Capacity**
2. **Absorption Capacity**
3. **Recovery Capacity**

The three factors are focused on the physical urban dimension essential for flood resilience (Serre et al., 2016). Each component of the neighbourhood or added design intervention to increase its flood resilience would fall into improving either one of the three capacities, two out of three, or all three.

A successful design proposal to increase the flood resilience of an urban neighbourhood would have interventions that increase each capacity, thus overall increasing the neighbourhood's resilience.

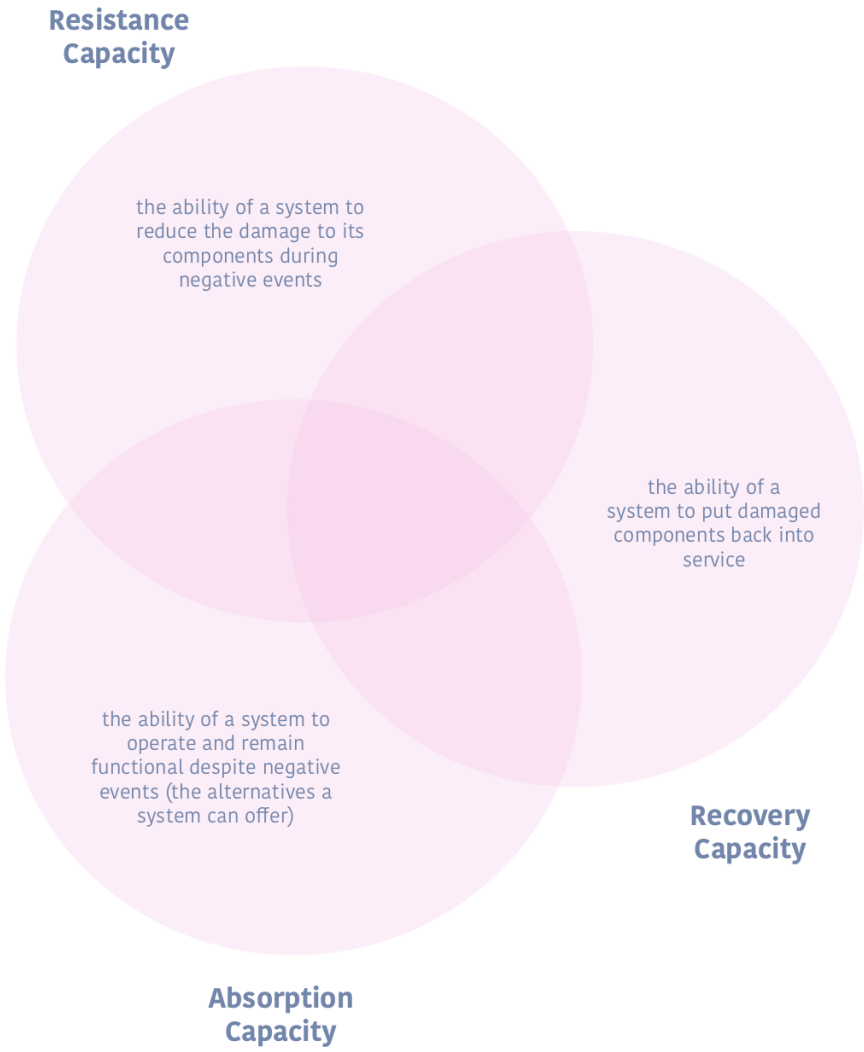


Fig. 19: DS3 Model (Serre et al., 2012)

LITERATURE REVIEW SUMMARY: CONCEPTUAL FRAMEWORK

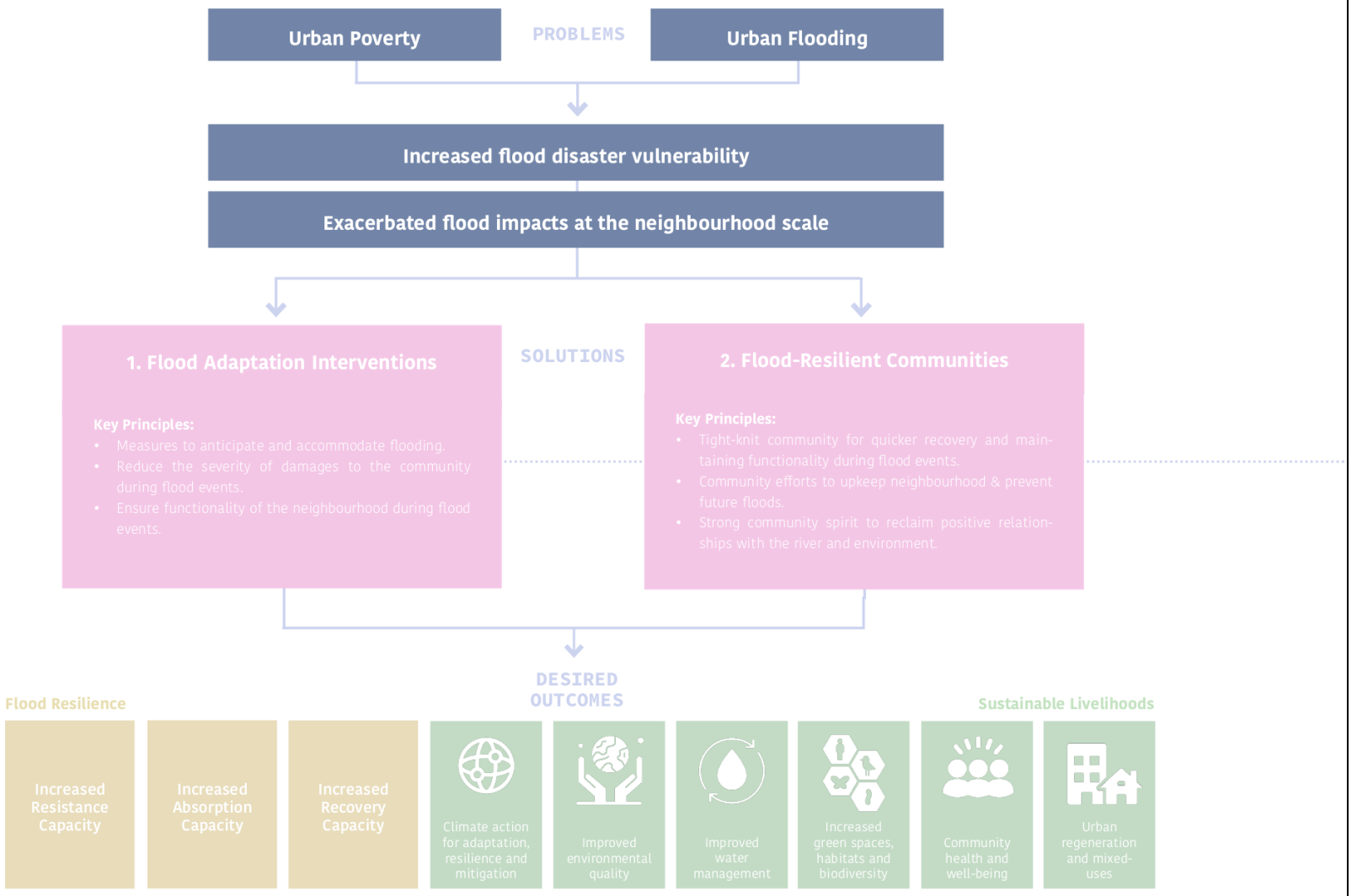


Fig. 20: Original site (Naturvation, 2017)

Fig. 21: Future plans (Naturvation, 2017)

Lessons Learned

- Flood adaptation measures is key to planning a sustainable urban renewal project within flood prone areas.
- 'Hard' infrastructure and urban design measures should go hand-in-hand to add social value to flood resilience.
- Green spaces play a key role in reducing flood risks.
- Although the entire masterplan has a holistic set objectives, it does not provide alternatives or any consideration to increasing the neighbourhood's absorption capacity in times of flood.
- Reorganising canals or other flows of water should be a consideration for water sensitive masterplans.
- Local government efforts should be met by NGOs and the community to ensure proper representation and considerations of all the site's issues - best way to truly achieve sustainability for the environment and communities.

2 Am Sandtorkai/Dalmannkai, Hamburg, Germany

Project Specifications

- **Timeline:** 2009
- **Scale:** neighbourhood
- **Size:** 109,000 m2
- **Site:** an existing mixed-use neighbourhood

Project Objectives

- To build an attractive living environment in city closely connected with the river.
- To find an alternative from building dykes through innovative design strategies in managing flood risks (Serre et al., 2016).
- Using urban regeneration as an opportunity to increase of flood resilience.

Issues

The neighbourhood lies on the estuary of the River Elbe and has several harbour basins (ibid, 2018). It is currently not protected by surge barriers, making the area sensitive to tide dynamics where a normal tide can cause 3-4m increase in water levels (ibid, 2018). The area experiences heavy water surges during winter where a high tide could increase water levels by 5-6m. The highest flood level in Hamburg ever recorded was 6.45m above sea water in 1976 (Kluge, 2012).

Flood Adaptation Interventions

1. **Connections between the neighbourhood and its environment**
   - Flood secure bridges connecting the neighbourhood with adjacent parts of the city centre - constructed higher than the current reference level. This provides an alternative when ground level infrastructure cannot achieve their function during floods.
2. **Urban design measures within the neighbourhood**
   - Adding green areas and public open spaces to reduce amount of water and speed of water arriving to the neighbourhood - mainly promenades, piers and squares.
   - Significant land use strategies - higher density of uses in the neighbourhood with higher proportion of public spaces rather than necessary access roads.
   - All open public spaces are on the waterside and are closely interlocked.
   - The neighbourhood's sewer system consist of separate systems for drainage sewage and rainwater.
3. **Retrofitting individual buildings**
   - Creating multifunctional buildings where the basement are used for flood-protected parking and ground-level is used for public amenities.
   - Apartments and offices are located in the highest levels to fully protect the building's critical functions from floods.
   - Install temporary flood protection measures to keep floodwater out of buildings and allow urban functions within it to continue despite floods. This reduces possible damage and time required to recover, which contributes to the neighbourhood's overall functionality.

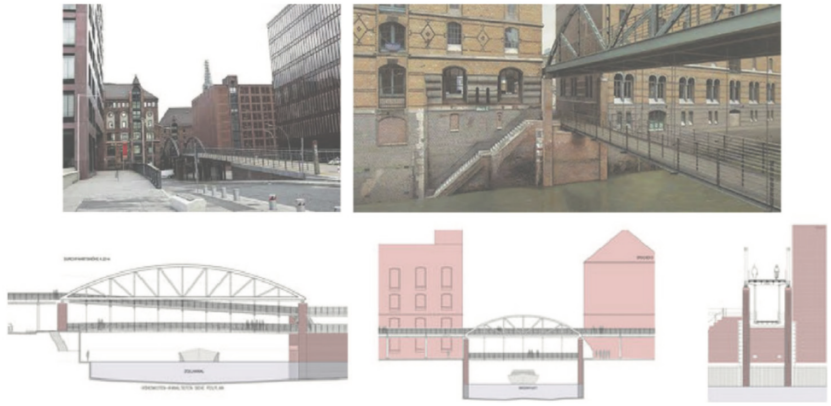


Fig. 22: Transport connections (Serre et al., 2016)

Fig. 23: Land uses and multi-level topography (ibid, 2016)

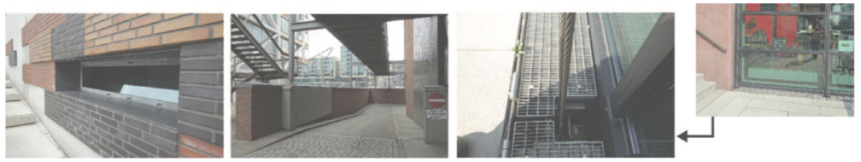


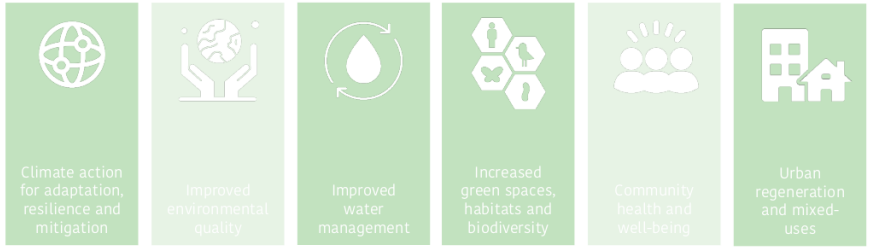
Fig. 24: Building flood protection (ibid, 2016)

Project Implementation

- Government-led neighbourhood regeneration.

Outcomes

Sustainable Livelihoods



Flood Resilience

Lessons Learned

- A government-led regeneration project is the perfect opportunity to re-assess a site's environmental hazards in the face of climate change & retrofit plans accordingly.
- Most of the design measures are related to transportation connections to provide accessibility in and out of the neighbourhood at different water levels - this alone increased all three capacities of the neighbourhood.
- Measures regarding land use strategy has the function of creating space for storing rainwater.
- The creation of multidimensional topography combines all components of the neighbourhood and purposefully align it with different flood management functions.
- Building related design measures function to reduce flood impact and protect assets inside them.
- The influence of already existing traditional flood risk management is still relevant.

3 Vin An & Ha Bao, Mekong Delta, Vietnam

Project Specifications

- **Timeline:** -
- **Scale:** neighbourhood
- **Size:** -
- **Site:** two semi-urban low-income neighbourhoods

Project Objectives

- Community efforts to minimise flood impacts to their households & maintain functionality.
- Maintaining positive relationships between the community and harmless, small floods.

Issues

The neighbourhoods lie in the delta of the Mekong river with a dense network of water channels (Liao et al., 2016). They experience seasonal floods that starts in July and lasts about 3-4 months with water levels of up to 3-4m. The floods have been a part of the settlement for many years and are at times, 'harmless.' The community recognises the benefits of the smaller floods such as: source of agricultural irrigation, domestic water uses, alternative fishery resources, carries waste away, and recharges groundwater (ibid, 2016). The government built full dykes, drainage and other flood control infrastructure in order to protect rice fields and maximise agricultural production (ibid, 2016). However, due to the severity of the flooding, the communities created localised flood adaptation measures, which are especially helpful when centralised measures failed. This transformed the neighbourhoods into an "amphibious ecology" (Brocheux, 1995).

Flood Adaptation Interventions

1. **Living in stilt houses**
   - Houses built on stilts has gaps between the floor panels to increase ventilation and reduce the force of the waves. This also helps floodwater drainage.
   - Height of the stilts depend on the highest water reference level in the past with additional height to anticipate higher floods. The space on the ground is also used in dry season as shelter from heat, to raise poultry, and storage.
2. **Creating footbridges to improve mobility**
   - Temporary footbridges are widely used to maintain mobility during floods - used to connect houses to grocery stores in Vin An and along the alleys to connect to the road dykes in Ha Bao.
   - They are usually made of bamboos (sometimes concrete around the richer households) and is often adjusted to ensure it is always only 20-50cm above the water to lessen harm when someone falls.
3. **Positive relationship with the river and small floods**
   - Interviews reveal that the communities see moderate floods as somewhat beneficial for poorer households who don't have to pay for water. The specified floods support non-potable water uses and is used for dishwashing, laundry and bathing when sediments settle and water becomes clear.
   - Prolonged floods also brings fishes into the neighbourhoods - wild fishing becomes an alternative source of income.

Fig. 25: Self-built stilt housing (Liao et al., 2016)

Fig. 26: Stilt houses: storage (left) and gathering space (right) (ibid, 2016)

Fig. 27: Self-built footbridges (ibid, 2016)

Project Implementation

- Community-led & financed.

Outcomes

Sustainable Livelihoods

Flood Resilience

Lessons Learned

- Localised, not centralised, measures manifests a sort of ecological wisdom in the neighbourhoods where floods are not seen as something to be stopped, but something to adapt to.
- Giving more responsibility to property owners increase the flood absorption capacity of the households and their ability to make timely adjustments after every flood. This creates a flood aware and agile community.
- They have a positive relationship with their environment as these localised responses are not ecologically destructive like 'hard' infrastructure measures. Thus, they have better biodiversity and water quality in their rivers.
- When helped with subsidies, each neighbourhood could even achieve system-wide neighbourhood-level flood adaptation measures (Liao et al., 2016).

Outcomes

Sustainable Livelihoods

Flood Resilience

Lessons Learned

- In informal settlements of low-income countries (with less local government competencies), community-led efforts are necessary to improve the neighbourhood's livelihood - the importance of "taking matters into one's own hands."
- Small efforts can amount to large ripple effects - such as the improvement of overall quality of environment and livelihood.
- This increases the neighbourhood's resistance and absorption capacities against food risks.

	Climate action for adaptation, resilience and mitigation	Improved environmental quality	Improved water management	Increased green spaces, habitats and biodiversity	Community health and well-being	Urban regeneration and mixed-uses
Establishing Green Infrastructure						
1A						
1B						
1C						
1D						
1E						
1F						
Maintaining Mobility						
2A						
2B						
2C						
2D						
2E						
Retrofitting Buildings						
3A						
3B						
3C						
3D						
3E						
3F						

Fig. 32: Sustainable livelihood outcomes of each intervention

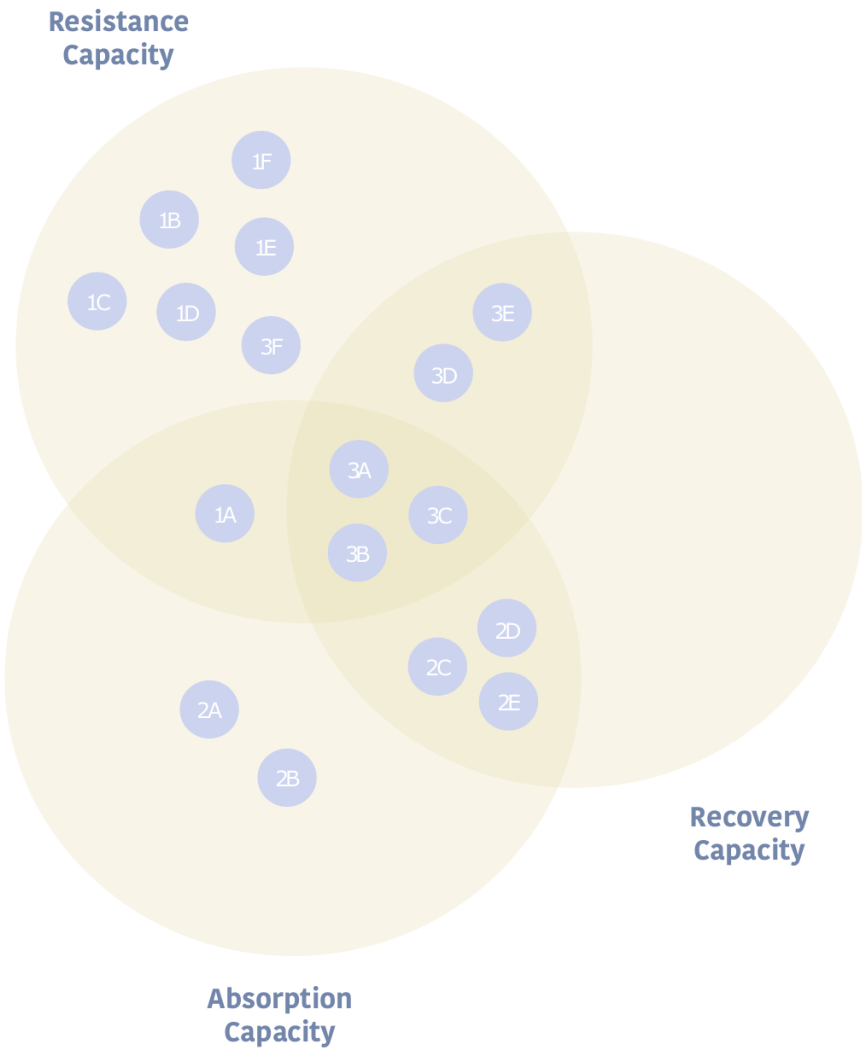
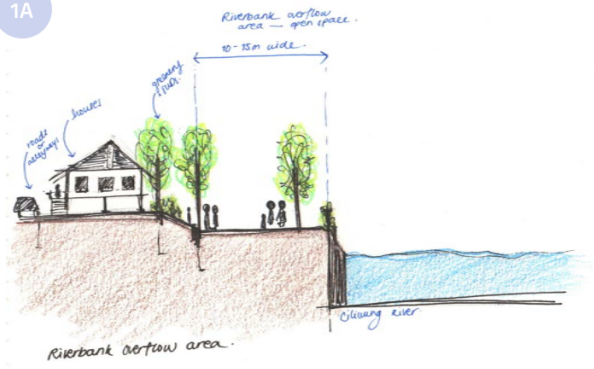


Fig. 33: Interventions and **DS3 Model** (Serre et al., 2012). Refer to **Appendix I** for further elaborations.

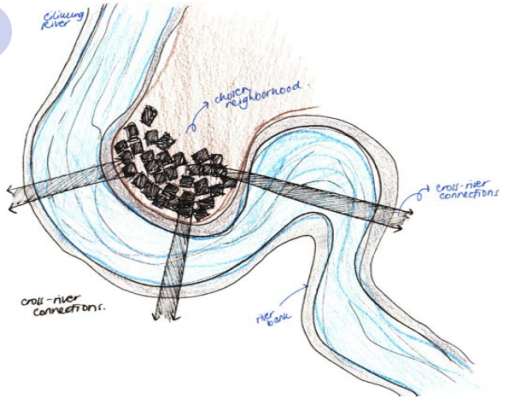
Flood Adaptation Objectives	Urban Design Interventions	Spatial Specifications	Community-Led?
Establishing Green Infrastructure	1A. Riverside Overflow Area	• 10-15m of the riverbank that is underused. • Waterfront public open/green spaces.	⊗
	1C. SUDs	• New developments or regenerated areas. • Existing public open spaces.	
	1E. Network of Green Spaces & Roofs	• Converting underused plots to pocket parks.	
	1F. Tree-Planting	• Riverside and roadside. • Areas lacking vegetation.	
Maintaining Mobility	2B. Inter-Building Bridges	• Using the structures of large mixed-use buildings to build pedestrian flyovers.	⊗
	2C. Cross-Water Linkages	• Bridges to link areas of interests across the river.	
	2D. All-Weather Roads	• Busy roads, high streets.	
Retrofitting Buildings	3D. Multifunctional Buildings	• Large buildings in frequently flooded areas should be mixed-use with housing above ground.	⊗
	3E. Ground-Level "Void Decks"	• Large residential buildings in frequently flooded areas retrofitted with "void decks".	

Interventions at the city scale are implemented through a strategic-level or masterplanning manner. The materialisation of large scale interventions require high institutional and systemic capacities of the local government, limiting any possibility of being led by the community.

1A



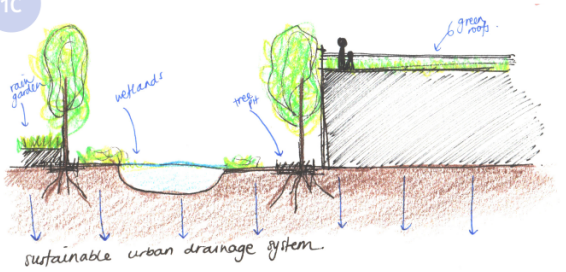
2C



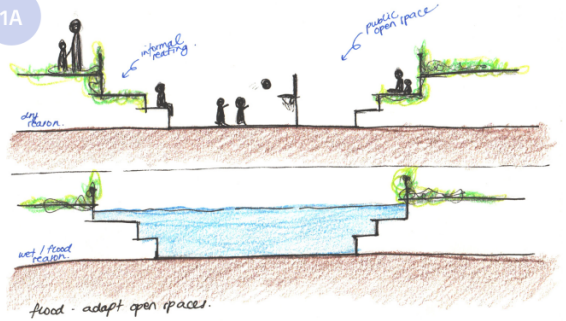
Flood Adaptation Objectives	Urban Design Interventions	Spatial Specifications	Community-Led?
Establishing Green Infrastructure	1A. Flood-Adapt Open Spaces	• Existing open spaces should be retrofitted to be flood adapt. • New open spaces should be flood adapt.	⊗
	1C. SUDs	• In and around open spaces, buildings and roads.	✓
	1D. Improved Waste Management	• Community recycling and trash bins distributed around the neighbourhood.	
	1E. Network of Green Spaces & Roofs	• Added vegetation around large open areas with impervious surfaces. • Green roofs on top of new build and retrofitted structures.	
	1F. Tree-Planting	• Riverside and roadside.	
Maintaining Mobility	2A. Footbridges	• Between properties and public amenities. • Access points in and out of neighbourhoods.	✓
	2C. Cross-Water Linkages	• Access points of the neighbourhood to other parts of the city across the river.	⊗
	2D. All-Weather Roads	• Retrofit all main roads in frequently flooded neighbourhoods.	
	2E. Space for Boats	• Ensure some alleys are wide enough to act as 'service' vehicle access for rescue boats during floods.	
Retrofitting Buildings	3D. Multifunctional Buildings	• Business owners with homes nearby subsidised to build mixed-use buildings instead.	✓
	3E. Ground-Level "Void Decks"	• Large residential buildings (old and new) should include "void decks" that also function as social space.	⊗

Interventions at the neighbourhood scale are implemented through redevelopment schemes or building new developments. It is a set of design guidelines to guide community-led proposals for such schemes.

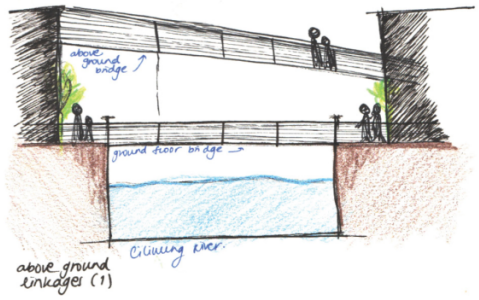
1C



1A



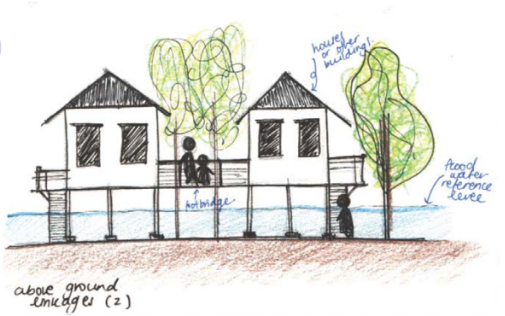
2C



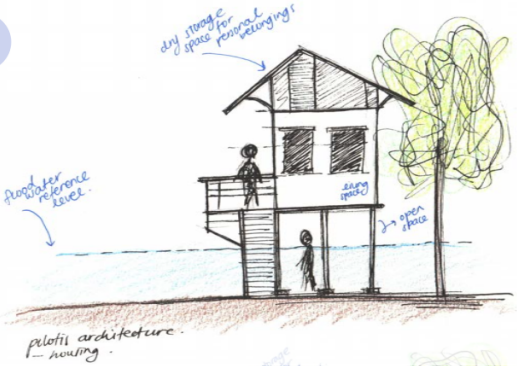
Flood Adaptation Objectives	Urban Design Interventions	Spatial Specifications	Community-Led?
Establishing Green Infrastructure	1C. SUDs	• Setting up SUDs in and around individual properties. • Shared SUDs between a few households (community gardening, etc.)	✓
	1E. Network of Green Spaces & Roofs	• Increasing vegetation around the property (green roofs, walls, etc.).	
	1F. Tree-Planting	• Around the property, especially near roads and open spaces.	
Maintaining Mobility	2A. Footbridges	• Between households and to public amenities.	✓
	2B. Inter-Building Bridges	• One household to another - especially for extended families, or household with lonesome elderlies.	
	2E. Space for Boats	• Space to store boats between a few properties. • Lower-income families collectively invest in a boat for flood-evacuation.	
Retrofitting Buildings	3A. Pilotis Architecture (Stilt Housing)	• Additional floors or stilts to create “void decks.”	✓
	3B. Spaced Floor Panels	• Ensuring structures are more porous and resilient against heavy flood waves.	
	3C. Built-In Flood Protection	• Larger buildings with underground parking or uses on the ground floor should have gates or other flood-protection measures to protect assets.	
	3D. Multifunctional Buildings	• Business owners with homes nearby subsidised to build mixed-use buildings instead.	
	3F. Self-Build Septic Tanks	• Underneath individual houses, especially in informal settlements where such infrastructure is often overlooked.	

Interventions at the property scale are implemented by the initiative and funding of individual property owners and act as design guidelines for retrofitting or making larger structural alternations to the property.

2B



3A



3D

Fig. 34: 2015 works of the Ciliwung River embankment (detik.com, 2015)

Relevance of the Chosen Site:

Jakarta is a megacity that experiences annual floods during its rainy season (Maclean, 2014). In the context of rapid urbanisation and rising sea levels, floods engulf many kilometers of residential areas with up to 4m of sewage-infused water from the Ciliwung River (ibid, 2014).

In January 2014, some neighbourhoods evacuated 9 times to escape up to 4m of water inside their homes (Maclean, 2014). Saripudin, a resident in a riverside neighbourhood, confessed, **"We feel stressed when we have to keep evacuating our houses... Children cannot go to school, and we do not work during this time (ibid, 2014)."**

Despite efforts to encourage households in flood-prone neighbourhoods to relocate to low-cost government housing further inland (Maclean, 2014), the majority prefer to stay than risk lose their current social networks. Many of the riverside residents are part of the urban poor and work in informal labor. Their informal settlements are near city centres and provide cheap (sometimes free) land (ibid, 2014).

"If we move from here, we will have to pay rent somewhere. We cannot afford it so we will make do how to live with floods," Saripudin.

However, beyond reducing productivity, flood water bring health hazards such as diseases, skin infections, and diarrhoea. The waste-infested water takes 1-2 weeks to fully subside and houses are left stained and foul smelling (ibid, 2014).

Ahmad Hussein, spokesperson for the Red Cross in Indonesia recognises that, **"The issue is not why they live there, but how to save them in times of flooding (Maclean, 2014)."**

Adaptive measures are sought after to reduce day-to-day urgency of much needed structural measures. However, Marcus Moench, president of ISET-International reveals that, "This is particularly challenging in mega-cities like Jakarta because of the numbers of people involved. The challenge is how to create housing designs that allow for water flow, and do it well. It takes a long-term high level of investment." But, the current urban form is high impervious and garbage from communities simultaneously clog rivers and drain canals (Maclean, 2014).

Recent government efforts include demolishing informal settlements located within 15m of the Ciliwung River to make way for an **inspection road** to monitor causes of floods and reduce impact for the communities (Munk, 2016). This adds to the amount of impervious surfaces with no added benefits to the communities, revealing:

"A tension trade off between what is best to mitigate flooding hydrologically speaking and what is best for the communities (Moench, 2014)."

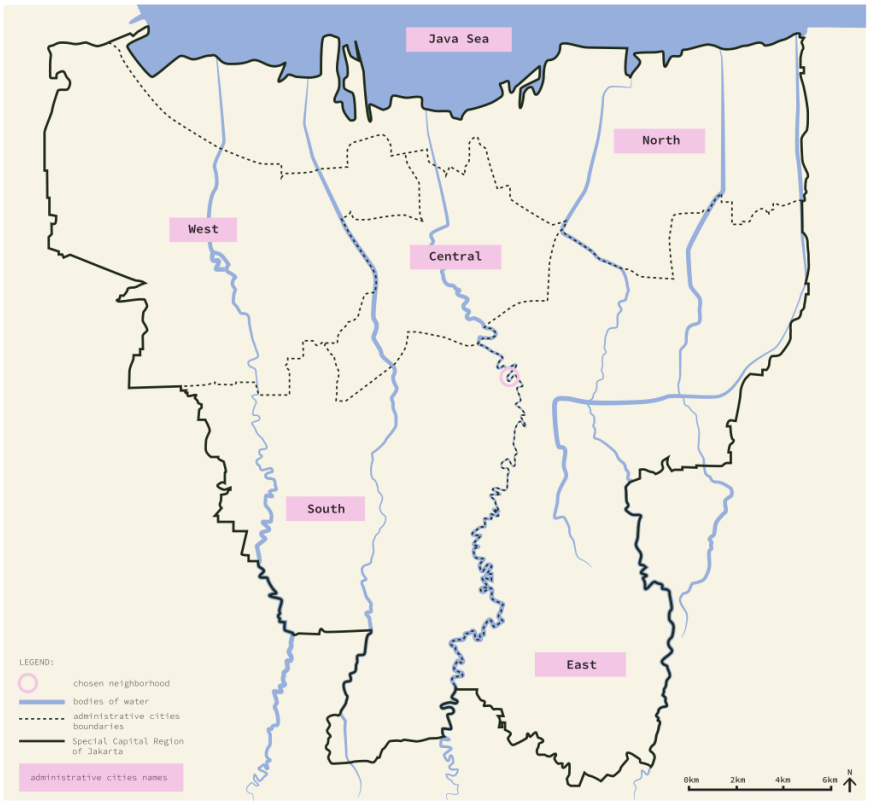


Fig. 35: Map of Jakarta

Jakarta's Administrative Boundaries:

'Kabupaten' (Region) → **Adminsitrative City (City)** → **'Kecamantan' (District)** → **'Kelurahan' (Village/Sub-District)** → **'Rukun Warga/RW' (Wider Neighborhood)** → **'Rukun Tetangga/RT' (Smaller Neighborhood)**

Jakarta has a ultra-local administrative structure that is unique and embedded in dense local bonds (Read, 2012). The 'RT' level existed since 1944 and is the lowest of all municipal administrations. There is currently an average of 260 residents per RT in Jakarta, each with its own locally appointed leader (ibid, 2012). The RTs and RWs work hand-in-hand with other state-sponsored grassroots organisations to fulfil their communities' needs.

Ethnographic accounts of neighbourhoods in Jakarta emphasises the strongly community-centred nature of life in urban localities, particularly in the lower-class districts (Read, 2012). RT communities represent an informal group of neighbours who provide immediate assistance to individual households in tasks such as: repairing households and providing support in times of emergency (Guinness, 1986).

"The imposition of the RT administrative boundaries... fix(es) the boundaries of intense social interaction, so that residents tend to think first of fellow RT members as their closest allies (Guinness, 1986, pg. 151)."

This context of good local administrative support is highly appropriate for the design toolkit where communities are not dependent on unreliable government institutions to realise the suggested design interventions to increase flood resilience.

Chosen Site:

- **'Kabupaten' (Region):** Special Capital Region of Jakarta
- **Adminsitrative City:** East Jakarta
- **'Kecamantan' (District):** Jatinegara
- **'Kelurahan' (Village/Sub-District):** Kampung Melayu
- **'Rukun Warga/RW':** 02, 03
- **'Rukun Tetangga/RT':** 12, 13, 14, 15 & 13, 15

Scale of Proposals:

- **Sub-District Scale:** strategic framework where the chosen neighbourhood is the target beneficiary.
- **Neighbourhood Scale:** design guidelines for community-led redevelopment schemes
- **Property Scale:** re-design of 4 properties within the chosen neighbourhood.

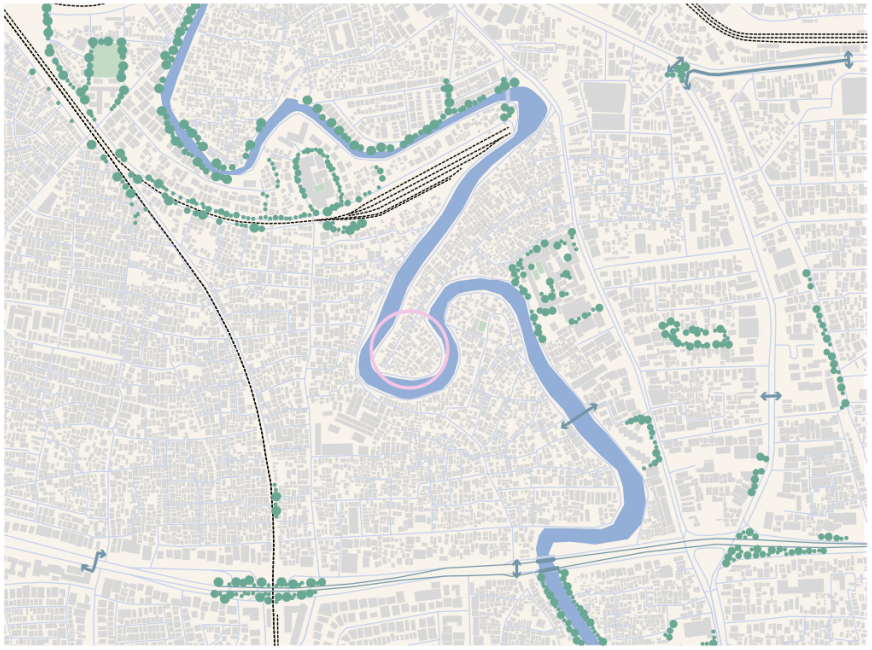
ANALYSIS: SUB-DISTRICT SCALE

Site Context

LEGEND:

chosen neighborhood

Urban Form

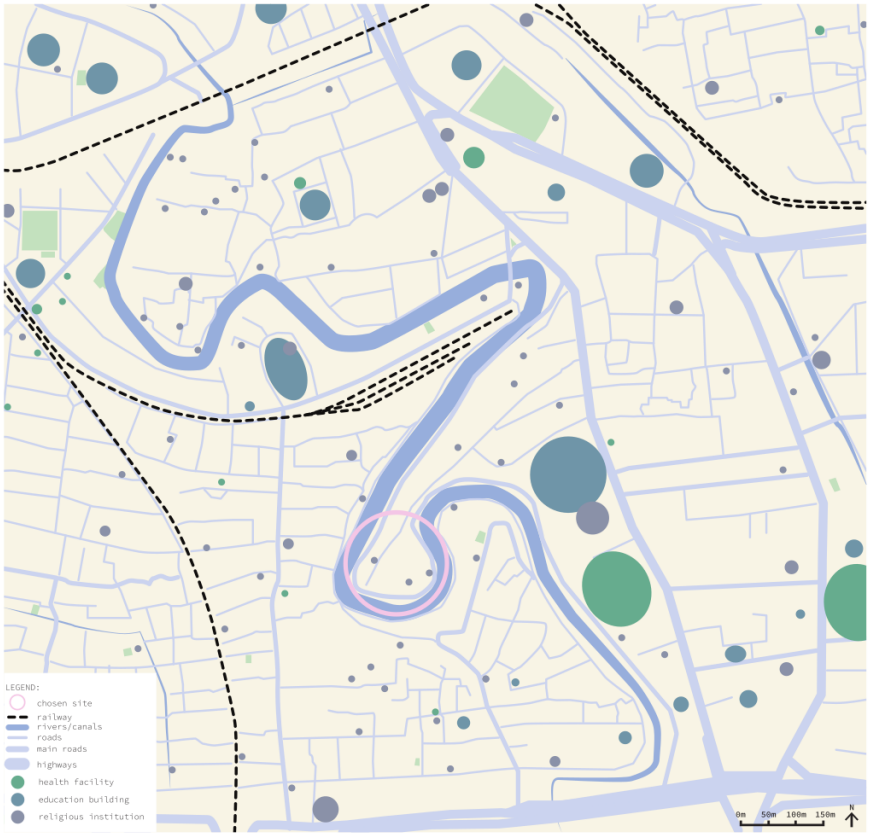


LEGEND:

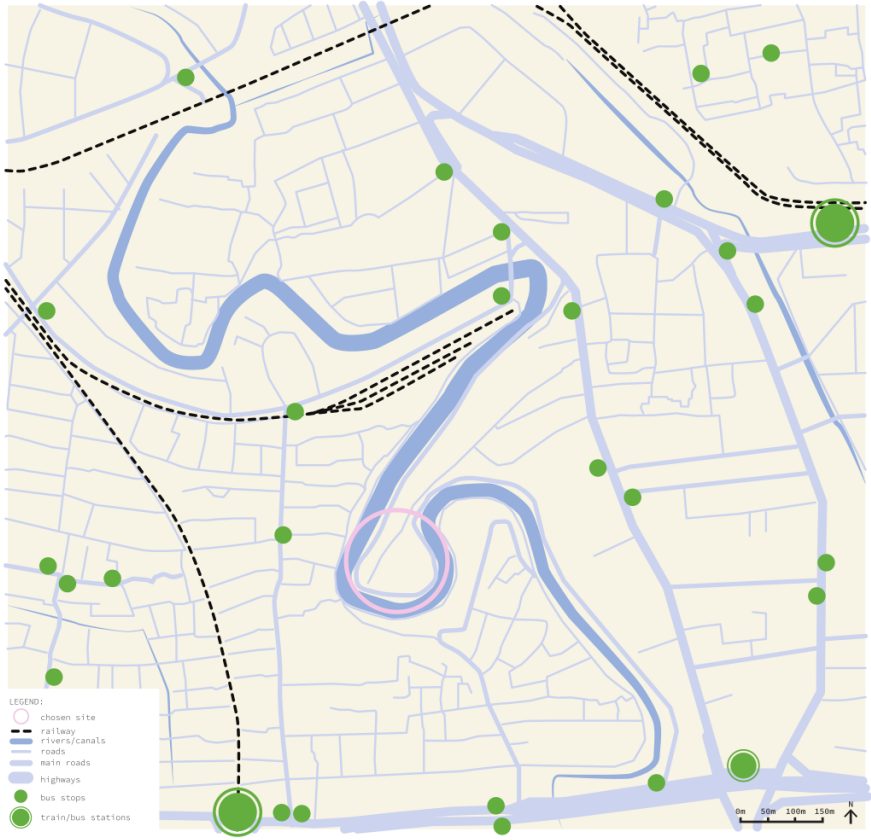
- buildings
- green space
- water
- roads
- traffic bridge
- traffic flyover
- pedestrian flyover
- existing trees
- railway

- Very dense clusters of small buildings structures in small street blocks. Larger buildings along main roads.
- Very few cross-water linkages and low pedestrian mobility along main roads.
- Barely any green or open spaces.
- Great dominance of impervious spaces throughout, with some trees planted around railways, riverbank, and large public buildings (schools/hospitals/religious facilities).

Social Infrastructure & Green Spaces

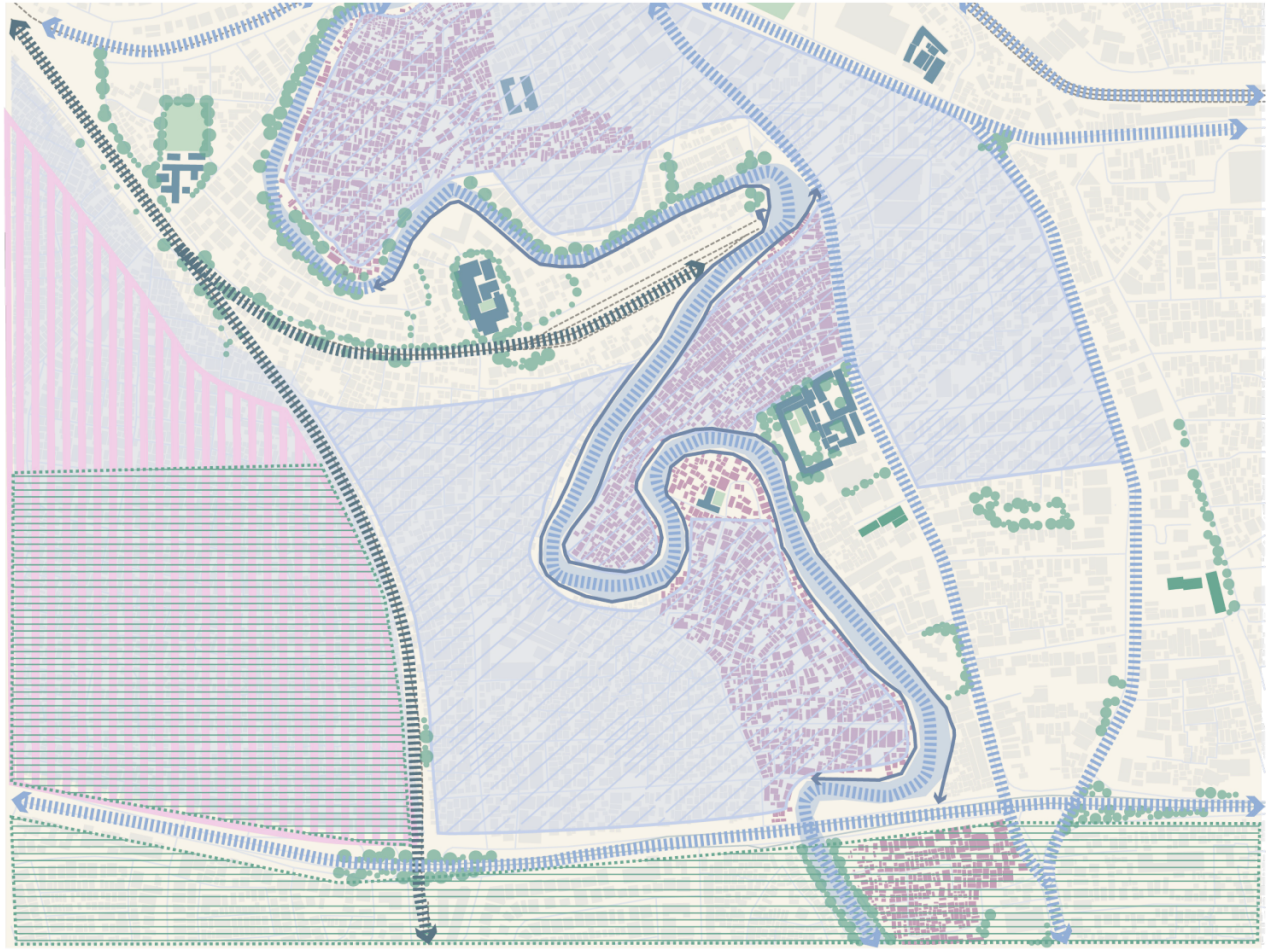


Transport Connectivity



- Interviews reveal that most households own a motorbike and is the main mode of daily transportation.
- The second mode of transport is walking, using 3-wheeled taxis ('bajaj'), or the public bus.

Summary of Constraints



LEGEND:

- roads
- railway
- rivers/canals
- existing green space
- existing buildings
- main education facilities
- main health facilities
- small buildings in dense blocks*
- >90% impervious surfaces + no vegetation
- highest flood risk altogether
- most inaccessible to economic centres*
- most inaccessible to social infrastructure*
- ~15m inspection road
- significant barriers to mobility*
- narrow railroad in dense neighbourhood
- existing trees

SPECIFICATIONS:

*

Unorganised, very dense, small buildings within larger blocks. Most buildings are only accessible by narrow alleyways, characteristic of informal settlements.

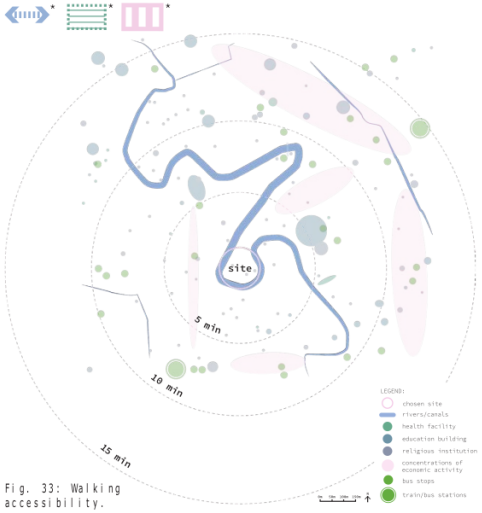


Fig. 33: Walking accessibility.

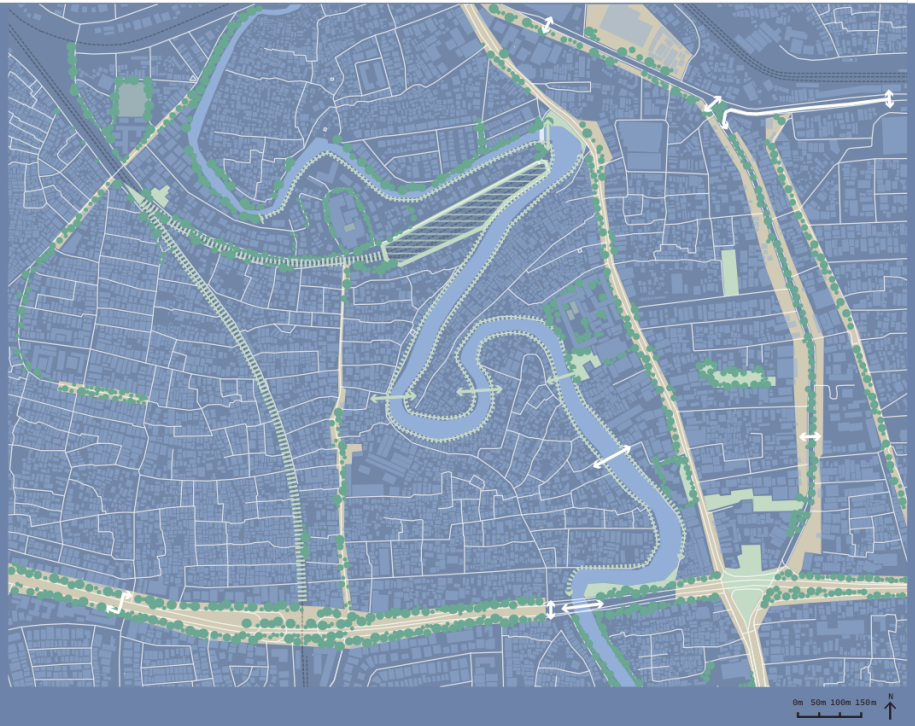
Most facilities are within a 15 minute walking radius, but large barriers (river, large main roads, and railway tracks) results in further distance.
The location of the site, and other neighbourhoods south-west of the river, is disadvantaged by the river and lack of cross-bridge linkages, limiting the community's mobility.

PROPOSAL: STRATEGIC FRAMEWORK

Design Strategies

1. A Walkable Green Urban Network

Using a network of green infrastructure to increase surface water absorption, pedestrian mobility and accessibility to social infrastructure and economic centres.



LEGEND:

- retrofitting SUDs into streetscape
- pocket green spaces
- rooftop garden
- green path flyover
- riverside green path
- pedestrian bridges
- governement-led tree planting

INTERVENTIONS:

1A 1C 1E 1F 2C

OBJECTIVES:

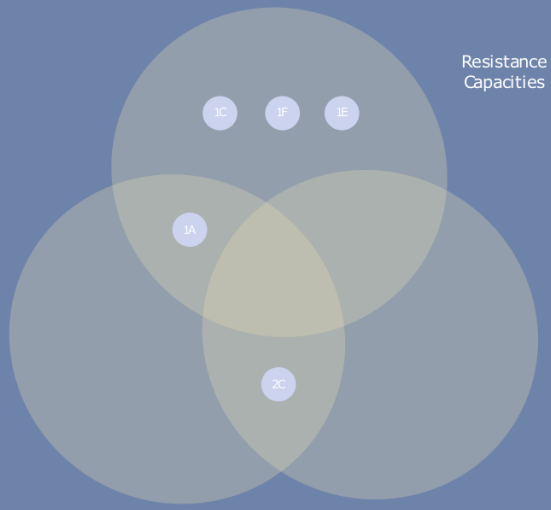
Outcomes

- Sustainable Livelihood
- Flood Resilience

TOOLKIT INTERVENTIONS:

	Climate action for adaptation, resilience and mitigation	Improved environmental quality	Improved water management	Increased green spaces, habitats and biodiversity	Community health and well-being	Urban regeneration and mixed-uses
1A						
1C						
1E						
1F						
2C						

DS3 MODEL:



Concepts

1.1: Green Links to Social Infrastructure & High Streets

LEGEND:

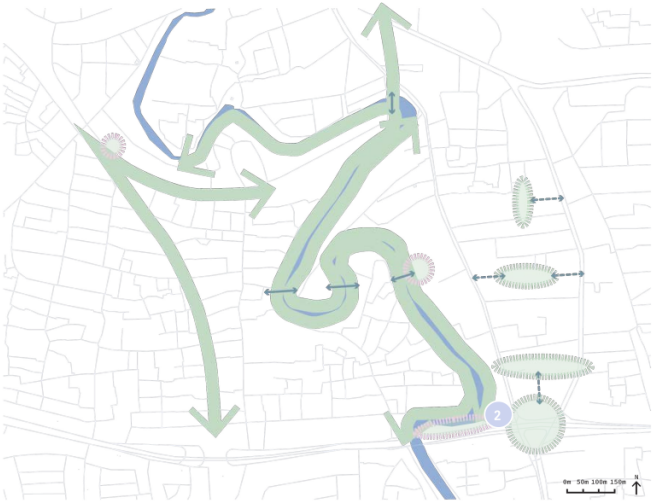
- bridges
- green paths
- points of accessibility
- health facilities
- education facilities
- SUDs high streets

New green links (riverfront paths, pedestrian bridges, railway green roofs) improve pedestrian accessibility for communities to reach economic centres and social infrastructure services. This creates a more cohesive sub-district and ensures equal access to opportunity areas for previously marginalised communities while increasing pervious surfaces.

1.2: Green Links and Nodes

LEGEND:

- bridges
- green link infrastructure
- access points
- pocket parks
- green links entrances



New pocket parks accompanies green links by creating nodes within the sub-district. This increases legibility while providing entrances to the green links. Pocket parks located along the high street increases water absorption capacities and creates previously inexistent outdoor gathering spaces for the communities. The plots identified are either large empty land, or underused plots (parking spaces, etc.).

Examples

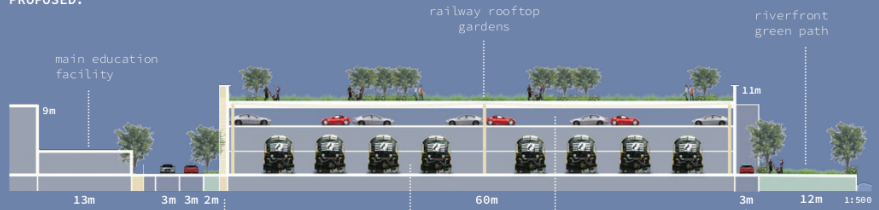
EXISTING:
(Google Earth, 2019)

main education facility

railway stop

undesirable pedestrian environment

PROPOSED:

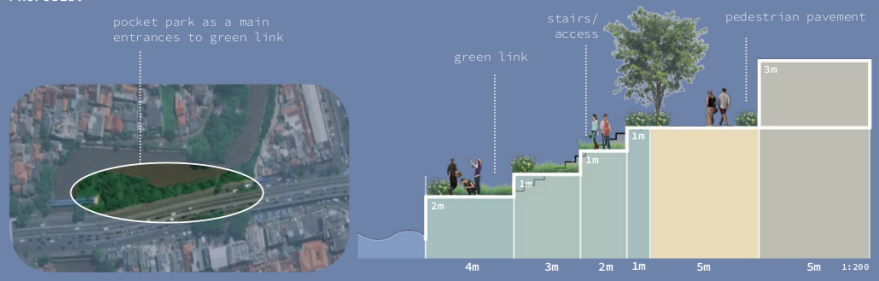


EXISTING:
(Google Earth, 2019)

underused plot

isolated body of water and impervious surface

PROPOSED:



PROPOSAL: STRATEGIC FRAMEWORK
Design Strategies

2. High Street Densification
Increasing the residential density of high streets through infill/redevelopment of vacant plots to create mixed-use and flood resilient urban centres for the sub-district.

INTERVENTIONS:

2B 2D 3D 3E

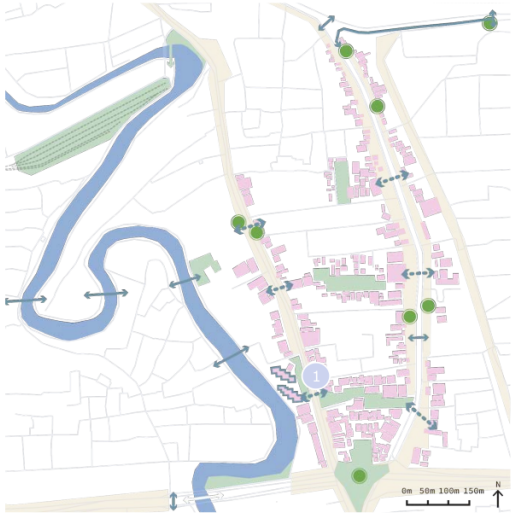
OBJECTIVES:

Concepts

2.1: Residential Densification - Infill/Redevelopment

LEGEND:

- pedestrian bridges/flyovers
- pedestrian flyovers
- retrofitted SUDs
- pocket green parks
- existing government housing towers
- legible plots
- public transport services

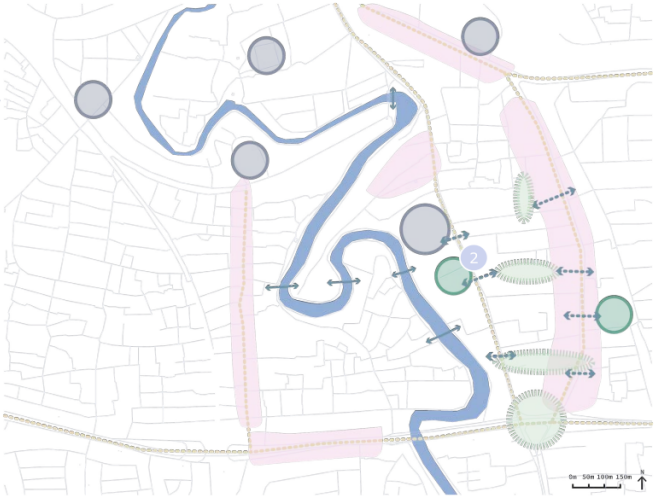


These high streets are the least dense in the sub-district, providing opportunities for infill/redevelopment to build more government housing. The buildings on legible plots have low-medium height and are met with wide roads or proposed pocket parks. Densification of these high streets can be part of a longer redevelopment scheme to rehouse informal settlers locally as their neighbourhoods are being regenerated and made less dense. These plots are appropriate for infill/redevelopment due the existing infrastructure. This will result in compact and multifunctional patterns of land uses and efficient delivery of public services, thus increasing flood resilience.

2.2: Mobility & Social Cohesion through Densification

LEGEND:

- bridges
- new pedestrian flyovers
- all-weather roads
- pocket parks
- health facilities
- education facilities
- economic centres



Increasing building heights provide the opportunity to build inter-building bridges and improve pedestrian mobility throughout the high streets. This increases flood resilience through ensuring mobility and functionality during flood disasters. Flyovers also increase accessibility to new pocket parks and existing social infrastructure.

Examples

EXISTING:
(Google Earth, 2019)

government housing towers

proposed plot for pocket park

low rise buildings across tower

PROPOSED:

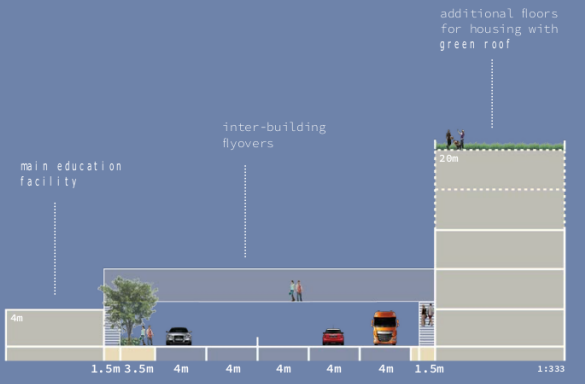
EXISTING:
(Google Earth, 2019)

main education facility

health facility

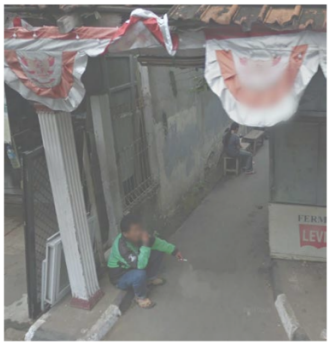
low rise buildings met with wide road

PROPOSED:



Findings from Interviews/Observations

ALLEYWAYS



- Children gather and play in the alleyways and garages during off-school hours.
- Women also use alleyways to gossip or lend household items to one another.

SMALL FAMILY BUSINESSES

'Warung' = small family owned restaurants

'Warteg' = small family owned shops

Trolley household item sellers

- Locals run many informal businesses. The majority of their customers are fellow local residents.
- The **'warungs'** are an important gathering space and is often busy.
- Alleyways are important business spaces for trolley sellers.

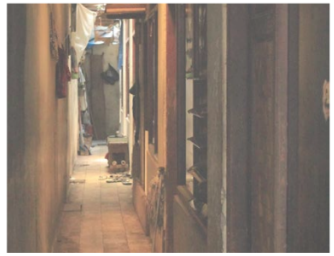
STAY AT HOME WOMEN

- Most men work outside the neighbourhood (nearby high streets or further).
- During work hours, women tend to stay in the neighbourhood looking after young children, doing household chores or chatting with neighbours.

TIGHT-KNIT COMMUNITY

- Neighbours look after other children in the neighbourhood when parents are away.
- It is very common to treat neighbours as a family member. The local term **'gotong royong'**, which means 'communal helping of one another' accurately depicts their social culture.

BLURRED PROPERTY BOUNDARIES



- Most structures are informal; made with sheets of wood, plastic, or corrugated iron.
- They lean on each other and create very blurred property boundaries.
- Hallways and living rooms are often shared between properties.

PROPOSAL: COMMUNITY-LED REDEVELOPMENT

Design Objectives & Guidelines

1. Establishing Green Infrastructure

i. Identified empty plots of land converted into flood-adapt open spaces incorporated with green infrastructure elements (SUDs, trees, gardens, and proposed green path).
ii. Larger alleyways should be retrofitted with SUDs to increase surface water absorption.
iii. Community recycling and trash bins placed every 100m along the green path to improve waste management and prevent river pollution.
iv. Relatively larger structures should be retrofitted with roof gardens shared between neighbours.
v. Encouraging community tree-planting within private properties, open spaces, and along the green path.

INTERVENTIONS:

1A 1C 1D 1E 1F

3. Retrofitting Buildings

i. 'Warung's with very small, single floor structures, relocated to an additional floor of the owner's house (through RT funding).
ii. RT funding should also be used to build additional floors for most structures to convert the ground levels into additional communal spaces that act as a "void deck" during floods.
iii. Water reference levels from past flood events should be considered when retrofitting/constructing structures.

INTERVENTIONS:

3D 3E

2. Maintaining Mobility

i. Cross-river footbridges should be wide enough to accommodate motorbikes, improving mobility in and out of the neighbourhood.
ii. Households with vulnerable residents should establish footbridges to nearby households for immediate assistance during disasters.
iii. Some alleyways should be made more prominent (wide enough to fit rescue boats during floods) and made into all-weather roads.

INTERVENTIONS:

2A 2C 2D 2E

4. Fostering Community Cohesion

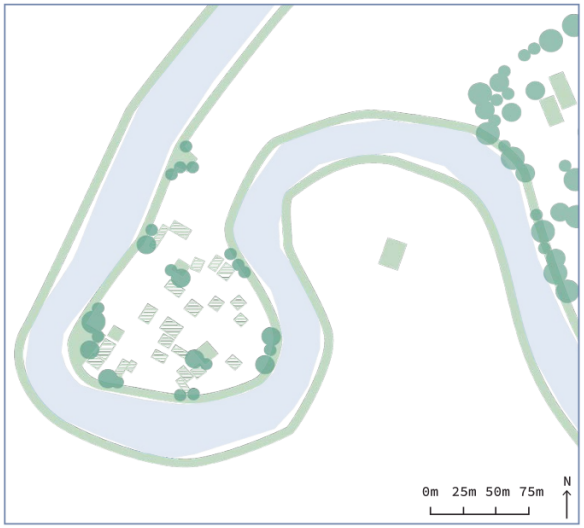
i. Construction of additional structures and planting of trees/vegetation will be conducted through community volunteers organised by the RT/RW leaders.
ii. Community recycling and proper waste management should be encouraged and taught to each other.
iii. Creating a sustainable livelihood and increasing flood resilience should be embedded in the community's identity through the inherent 'gotong royong' culture.

ACTIONS:

Leadership | Funding | Education

Concepts

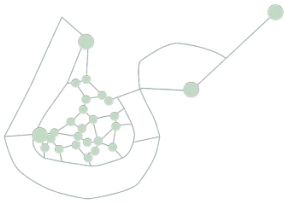
1. Establishing Green Infrastructure



LEGEND:

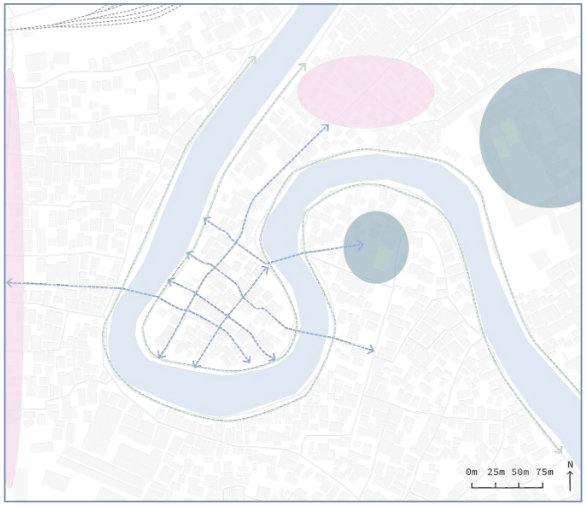
- riverside green path
- public green space/roof
- semi-private green roof
- tree planting

CONCEPT:



- Increasing overall water absorption capacities of the neighbourhood's urban form.
- Creating a network of green spaces that can be used for socialising and playing.
- Improving the ecological state of the neighbourhood and encouraging positive interactions with the river.

2. Maintaining Mobility



LEGEND:

- riverside green path
- prominent alleyways
- social infrastructure facilities
- economic centres

CONCEPT:

- Increasing mobility in and out of the neighbourhood.
- Enhancing existing connections and creating new connections to significant points of interests (economic centres, social infrastructure facilities, etc.).

3. Retrofitting Buildings

LEGEND:

- public green space/roof
- existing buildings
- semi-private green roofs
- very small structures
- public rooftop
- blurred property boundaries

CONCEPT:

- Declutter small structures that are flood hazards and replacing lost floorspace above ground (overall better urban form).
- Creating additional gathering spaces amongst blurred smaller properties and larger properties (void decks, green roofs).

4. Fostering Community Cohesion

LEGEND:

- green social spaces
- 'void' deck social spaces
- community bins

CONCEPT:

- To enhance the 'gotong royong' social culture by adding social spaces throughout a neighbourhood constrained by geographical barriers.
- Fostering leadership and education in flood resilience.

Example: New Neighbourhood Waterfont

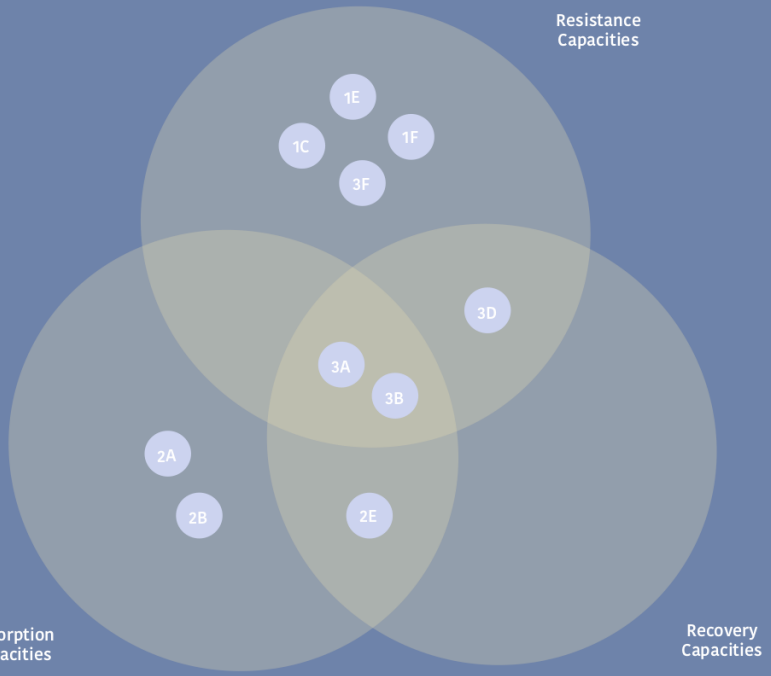
Outcomes

1. Sustainable Livelihood Outcomes

TOOLKIT INTERVENTIONS:	Climate action for adaptation, resilience and mitigation	Improved environmental quality	Improved water management	Increased green spaces, habitats and biodiversity	Community health and well-being	Urban regeneration and mixed-uses
1C	■	■	■	■		
1E	■	■	■	■	■	
1F	■	■	■	■	■	
2A	■					
2B	■				■	■
2E	■					
3A	■				■	
3B	■					
3D	■				■	■
3F	■			■		■

2. Increased Resilience Capacities

DS3 MODEL:



CONCLUSION:
REFLECTIONS & LIMITATIONS

REFLECTIONS

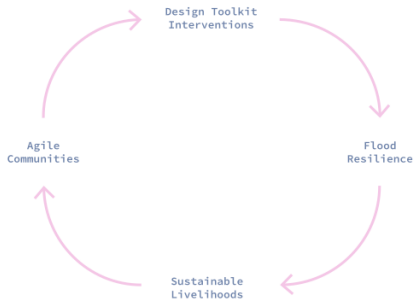
- Through drawing concepts from the literature review and successful interventions from the case studies, a design toolkit for increasing flood resilience of a low-income neighbourhood was created.
- Through choosing and analysing a site within the chosen context of the Global South, the toolkit was tested and applied in three different scales: the sub-district scale, neighbourhood scale, and property scale.
- The toolkit was created in three different scales as the research revealed that flood resilience cannot be achieved within a silo - whether a silo in disciplinary (only relying on engineering solutions), or a spatial silo (only relying on one spatial intervention such as a riverbank overflow area). Thus, more flood resilience would be achieved if all three scales of the proposals were implemented.
- The application of the toolkit reaped both desired outcomes outlined in the research stage: sustainable livelihoods and increased flood resilience capacities. However, both the research and the application revealed that such desired outcomes cannot be achieved without an agile community (especially in the context of Global South nations where local governance are often unable to provide the needed infrastructure or institutional support).
- Fostering community cohesion is as important of a design objective as others.

LIMITATIONS

- **Case Studies:** Although some of the case studies directly reflect the Global South context, the research was made richer by drawing examples from cities that have successfully become flood-resilient. However, as some of the successfully interventions from the later case studies were drawn into the toolkit, the application stage proved that some of them were not appropriate for the chosen site. Interventions such as retrofitting built-in flood protection cannot be applied to the types of structures often found in informal settlements. Other interventions such as installing all-weather roads, cannot be conducted without full government funding and support.
- **Toolkit:** As mentioned before, to fully achieve flood resilience, flood management cannot work in a silo - this includes an urban design silo. The toolkit could further be aggrandised by adding guidance on the types of 'hard' infrastructure (flood control) and spatial specifications on where to install them to ensure they also add social value. This would help local governments avoid installing infrastructure such as the 'inspection road' that minimally contribute to flood resilience and not at all contribute to improving livelihoods.
- **Application:** The analysis of the site would be richer if further geographical factors such as topography, types of soil, health of the river, and others were included. This would require expertise from other disciplines and create a more holistic, multi-disciplinary approach to flood management with urban design at the core.

OVERALL CONTRIBUTIONS

- The toolkit, especially that of the sub-district scale, successfully encapsulate a holistic approach to flood management that fosters flood-adapt urban areas whilst adding social value.
- It developed a sympathetic approach towards the urban poor and digressed from the common perceptions of informal settlements as the source of increased urban flood exposures.
- As communities learn to adapt to floods and implement the interventions from the toolkit at the neighbourhood and property scales (with the help of local governance), they would become more flood resilient and improve their livelihoods. As their livelihoods improve, they would be able to implement more interventions, thus further increasing flood resilience and improving livelihoods.
- This creates a paradoxical solution that address both the prevalent issues of urban poverty and flood disasters faced by urban dwellers in the Global South.



FURTHER OPPORTUNITIES

- This project and the toolkit created established a bedrock for flood management that have gone beyond flood control solutions towards flood resilience through urban design.
- The role of urban design is key within the collaborations of many disciplines and stakeholders (local government, communities, NGOs, etc.) in increasing the food resilience of low-income urban areas.
- With further research into the different SUDs, 'hard' infrastructure types, building materials, design of flood-adapt open spaces, and others, the design toolkit would be made more comprehensive.
- Furthermore, the project highlights the need for a formal method of assessing flood resilience and social values - which have been attempted through drawing concepts from the Sustainable Livelihoods Framework (Department for International Development, 2010) and the DS3 Model (Serre et al., 2012). With a better understanding of how different design interventions can increase resilience whilst simultaneously adding social value, governments and communities could better plan for a flood-resilient future.

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APPENDIX I:
DS3 Model Elaborations

Design Toolkit		DS3 Model		
Design Interventions	Full Description of Interventions	Resistance Capacity: Contribution of the design intervention to reducing damage	Absorption Capacity: Contribution of the design intervention to creating alternatives	Recovery Capacity: Contribution of the design intervention to reducing recovery time
1A: Flood-Adapt Open Spaces	Open spaces that operate for the public during the dry season that can adapt into a flood basin to store excess rainwater and reduce flood impacts to the rest of the neighborhood.	Reduces flood impact by retaining the water in the open space flood basin - thus reducing overall severity of flooding to the neighborhood.	The open space would become a small pond during floods or heavy rain - can alternatively still allow interaction between the community and body of water.	As water dries away or is infiltrated - open space will function normally again. Furthermore, the less severe the flood event was to the neighborhood, the quicker it will recover.
1B: Riverside Overflow Area	Ensuring minimum 10m of the riverbank is lined with open space as overflow area in case of flooding. This also creates a better waterfront urban realm.	Reducing damage to households in the neighborhood by ensuring that the open spaces along the riverbank are the areas most severely af ected by flooding - also ensures that the neighborhood will only be impacted by severe floods that spans beyond 10m from the river.	Allows the neighborhood to be fully functional during mild floods - only reduction in open space.	Increases recovery time if the neighborhood is not as severely af ected by flood impacts.
1C: Sustainable Urban Drainage Systems	Increasing amount of pervious surfaces and other measures to increase levels of rainwater infiltration in the neighborhood.	SUDs will increase infiltration of water thus reducing severity or frequency of floods caused by sewer system damages.	-	SUDs will help increase the time for flooding to reduce, thus allowing the neighborhood to continue its functions quicker.
1D: Community Waste Management	Community waste bins and recycling bins, especially for riverside informal settlements where there is often a lack of local governance on waste management in the neighbourhood.	Less trash build up in the neighbourhood and in the river will lessen flood hazards in the future.	-	Better waste management would also increase recovery time as trash build-up would be less of a problem when floods reside.
1E: Network of Green Spaces & Roofs	Adding more green open spaces spread out throughout the area, or adding more vegetation to existing open spaces such as converting roofs into green roofs.	Increasing amount of pervious surfaces would increase surface water runof absorption capacities of the area and lessen extremetieis of flood events.	-	-
1F: Tree-Planting	Community-led or local government led tree-planting on riverbanks or roadside to increase rain water absorption.	Trees would absor rainwater and reduce surface water runof , thus lessening changes of flood.	-	-
2A & 2B: Footbridges & Inter-Building Bridges,	Ensuring above ground mobility and inter-building connections (especially for households with very strong social links – i.e extended family, elderly living alone, etc.).	-	Provides alternative routes allowing movement (although limited) within and in and out of the neighborhood even during flood periods.	-
2C: Cross-Water Linkages	Above reference water level foot bridges to better connect the neighborhood to public amenities, social infrastructure and transport infrastructure across the river.	-	Allows movement in and out of the neighborhood even during flood periods - ensures connectivity to social/transport/other infrastructures outside of the af ected area.	Allows more points of access into the neighborhood to aid with evacuation and recovery processes.
2D: All-Weather Roads	Retrof ting roads to become all-weather roads - constructed to ensure higher degree of flood resistance as it is more pervious.	-	Would allow for roads to still be in use despite flooding in other areas - maintaining mobility.	If roads are still in use, service vehicles and rescue teams could come to af ected areas easily, thus increasing recovery time.
2E: Space for Boats	Ensuring some alleyways (especially in the informal neighbourhoods) are wide enough for emergency. Also ensuring space within the area or individual properties to store boats during dry season.	-	Boats can be used during floods to mobilise af ected communities and aid during rescue ef orts.	Boats can be used to rescue af ected communities and bring in help to manage floods during times of disaster, thus reducing recovery time.
3A: Pilotis Architecture (Stilt Housing)	Elevated housing, above ground storage and sturdy materials. Ground level of each household could be used as a small scale, semi-private "void deck."	Provides leeway for floodwater to fill up area under the living space and thus reducing flood impacts onto living space and overall structure of housing (up to the reference water level).	Provides semi-private open space for each household during the dry seasons and high storage space for valuables for further safety.	Increases recovery time by limiting damage to living spaces and structure for each household.
3B: Spaced Floor Panels	Spaced out flood panels to increase time for floods within individual to reside and help structures become more resilient to heavy flood waves.	Reduces damage to structures af ected by the floods - especially in times of heavy waves.	-	-
3C: Built-In Flood Protection	Flood gates, waterproof windows, and other flood protection intervention that can be retrofitted to buildings to inrease flood resilience.	Protects the structures and assets stored in the property from flood water.	-	-
3D: Multi-functional buildings	Mixed-use buildings with less critical functions operating at the lower levels (such as parking, small public space), public amenities such as shops/small restaurants at the elevated ground level, and critical functions such as housing and of ces at the highest levels.	Provides leeway for critical functions of the building - compromising flood impacts toward public amenities and other less critical functions.	-	Increases recovery time by limiting damage to living spaces and structure for each household.
3E: Ground-Level "Void Decks"	Setting aside the ground floor of large residential buildings as a "void deck" for flood space in wet season and social space for the communities during dry season.	Reduces damage to the critical functions of the building (housing with all the stored assets) during times of flood even up to the height of one floor.	-	Increases recovery time by limiting damage to living spaces and structure for each household.
3F: Self-Build Septic Tanks	Individual households (especially in informal settlements) to create septic tanks underneath homes to treat domestic wastewater to mitigate dumping of untreated wastewater into the river.	Reduces likelihood of floods and overall damage to the neighbourhood as flood water would not be as polluted or disease-infested.	-	Increases recovery time as flood water would not be as polluted and is easier to cope with.