NATURE-BASED FLOOD MITIGATION STRATEGIES IN AUSTRALIA

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Australia is a mostly dry continent, where the majority of Australian urbanised areas are located along waterways for access to drinkable water.

In a changing climate, Australia is expected to become drier on average, but extreme rainfall events, which are responsible for most major flooding events, are predicted to occur more often and increase in intensity [IPCC 2018, IPCC 2021].

Such trends have manifested over the past few years, as severe droughts from 2017-2019 and widespread east coast flooding that recently impacted Australia. This has resulted in a pressing need to increase our resilience and management of such events as well as finding ways to mitigate their costly impact on densely populated areas [Gissing (2022), Goodwin (2022), Coates (2022), George (2022)].

This raises the question of whether Australia's integrated urban water management (IUWM) strategies can be enhanced to improve water retention and reduce flooding using nature-based solutions.

NATURE BASED MITIGATION STRATEGIES

With the continued population growth of Australia, urbanisation, and climate change, there is a need to make Australia more resilient to flooding, as well as to increase water storage.

A recent panel discussion during COP26 saw insurance leaders argue for a greater focus on resilience, especially on property flood resilience measures for building repairs, continued investments into flood defences, and the inclusion of natural flood management approaches [Scott 2021].

The push for nature based strategies is attributable to the ecological benefits, both on a local level such as cooling and water storage, and on a larger scale helping combat climate change with carbon regulation.

Historically, Australia's approaches to flood management mainly involved the use of structural interventions. These included levees to protect urban areas or farmland, dams to mitigate flood flows, retarding basins which temporarily store floodwaters, flood bypasses which redirect floodwaters, modifications to river channels, and floodgates which control river flow [NSW Government 2005, The Geneva Association 2020].

Over recent decades, there has been greater uptake of nature-based solutions as part of IUWM strategies.

The 2022 IPCC summary for policy makers also made reference to nature-based flood mitigation strategies. The report stated: 'Enhancing natural water retention such as by restoring wetlands and rivers, land use planning such as no build zones or upstream forest management, can further reduce flood risk (medium confidence)' and 'Natural river systems, wetlands and upstream forest ecosystems reduce flood risk by storing water and slowing water flow, in most circumstances (high confidence)' [IPCC 2022].

The World Bank has been funding nature-based projects throughout the world through its Global Program on Nature-Based Solutions for Climate Resilience [World Bank].

Examples of projects include the Odra-Vistula Flood Management Project and the Ma'anshan Cihu River Basin Improvement.

The Odra-Vistula project aims to use a combination of grey and green infrastructure to improve flood resilience, using green measures to open space for the river to inundate the natural floodplain, while also diminishing flood velocities.

The Ma'anshan Cihu River project aims to improve drainage and flood protection capacity in urban areas through a combination of rehabilitation and environmental management approaches.

THE URBAN ENVIRONMENT: SPONGE CITIES

Governments internationally are now promoting and implementing a wider uptake of natural flood management.

The development of these new approaches is most advanced in Europe.

China has also been investing heavily into a combination of grey (i.e. structural interventions) and green (natural strategies) flood mitigation techniques, which has been coined sponge cities.

In 2014, China approved an initiative to improve water retention and minimise the impacts of riverine flooding on their susceptible largely populated cities. The scheme initially involved 30 cities, with the aim to have 80% of city regions implementing sponge city concepts, absorbing and reusing 70% of rainwater by 2030.

The objective of these projects is to improve the resilience to smaller flooding events, accommodating a 1:30 year event instead of the 1:10 year event that the majority of their current drainage systems are designed to handle [Nguyen et al., 2019].

A Sponge City integrates green and grey infrastructure into one hybrid system, collecting and storing water. The sponge city concept was proposed by Chinese researchers in 2013, led by Professor Kongjian Yu [Yu 2015]. It takes inspiration from international IUWM strategies such as Best Management Practices in the United States, Water Sensitive Urban Design in Australia, and Sustainable Urban Drainage System in the United Kingdom. A rendered example of a sponge city is shown in Figure 1.

Figure 1: A rendered example of a sponge city (Source: [Turenscape]).

Sponge Cities have four main principles: urban water resourcing, ecological water management, green infrastructure, and urban permeable pavement.

Urban water resourcing aims to improve the absorption and storage of rainwater to mitigate stormwater runoff and increase the amount of water retained for water supply.

Ecological water management is achieved via water self-purification systems and the provision of ecologically friendly waterfront designs. Green infrastructure reduces water and soil pollution by purifying, restoring, adjusting, and reusing stormwater (Figure 2). Urban permeable pavement involves using porous materials for roads and paths which allows water to soak directly into the material and mitigates rainwater outflow into drainage systems.

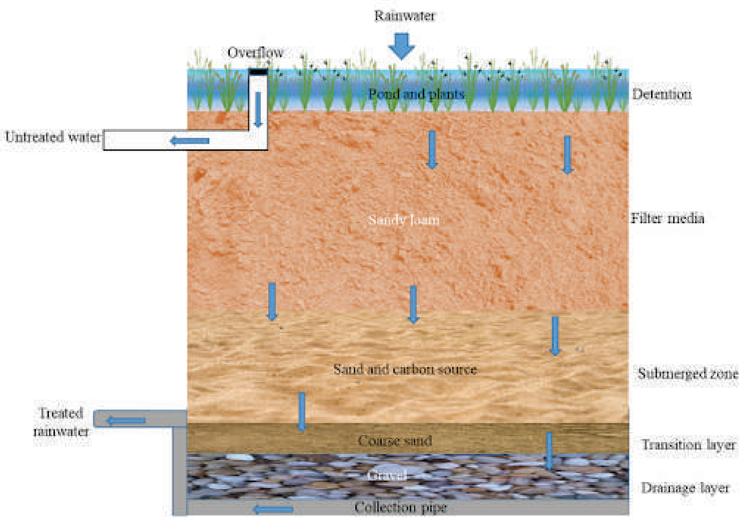

Figure 2: An example of green infrastructure, a rain garden, which absorbs and stores rainwater (Source: [Nguyen et. al. 2019]).

The infrastructure for cities and waterways needs to be individually designed as each is unique.

Water processes are also seasonal, so the design should reflect variability and periodic flood change [Palazzo (2018)].

A more comprehensive understanding of nature's processes in cities is emerging as a source of design inspiration, leading to a new spatial expression, besides ecological benefits. This is an interesting advancement in urban design, with evolving layouts replacing fixed forms. A good example is Billancourt Park in France (Figure 3), where water defines the constantly changing spaces of the gardens.

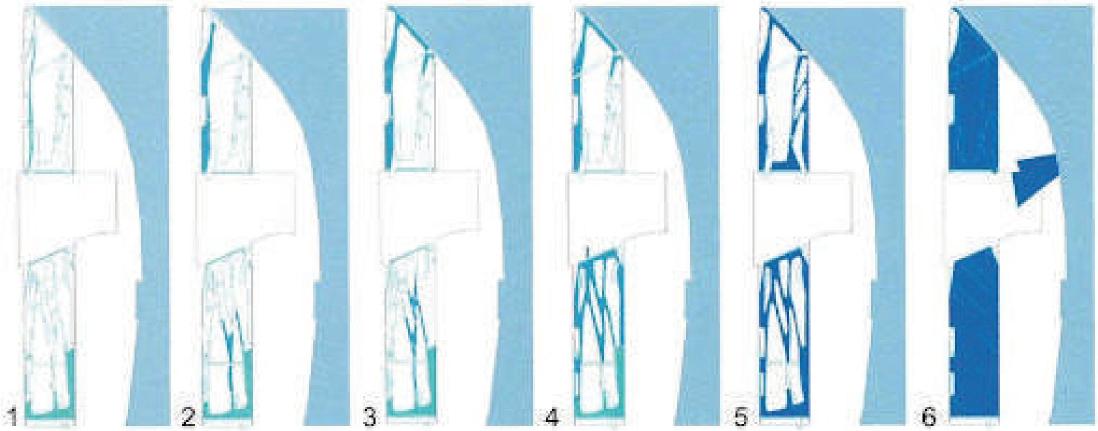

Figure 3. Map of Parc de Billancourt showing varying water levels: 1) Permanent water, 2) Normal rain, 3) Heavy rain, 4) Annual flood, 5) 10-year flood, 6) 50-year flood. Courtesy of AgenceTer, Paris. (Source: [Palazzo (2018)]).

NATURAL FLOOD MITIGATION STRATEGIES

Several of the natural flood management strategies being implemented internationally are being, or have the ability to be, implemented in Australia.

These can include:

- River restoration
- Floodplain restoration
- Wetland restoration
- Wetland creation
- Leaky barriers
- Offline storage
- Forest management
- Run-off management
- Green Infrastructure

River restoration seeks to restore the natural channel properties in streams. It can reduce downstream flood risk and increase water storage by allowing the river to flow on to its floodplain. It can also improve water quality, habitat diversity, sustainment of low flows, and enhance landscape appeal [Dixon 2016, Environment Agency 2018].

Floodplain restoration involves removing barriers to restore natural processes and to improve the floodwater capacity of floodplains [Environment Agency 2018]. Meanwhile increased wetlands could reduce or delay flood peaks and attenuate floods.

Both can also have significant ecological benefits, and wetlands can help combat climate change by acting as carbon sinks [Environment Agency 2018, Naturally Resilient Communities, Acreman 2003, Acreman 2013].

Leaky barriers consist of obstacles in channels which slow water accumulation in order to delay the flood peak [Environment Agency 2018]. Meanwhile offline storage consists of floodplain areas that have been adapted to store or attenuate floodwater. This can also help slow water accumulation, as well as improved water quality and provide habitat provisions [Environment Agency 2018].

Afforestation can help reduce flood risk at a catchment, flood plain or riparian locality. It provides multiple benefits such as enhanced water and air quality, habitat, carbon regulation and cool local climates [Environment Agency 2018].

Run-off management includes farm dams, swales, and sediment traps which store water in upper catchment areas and benefit water storage, water filtration, habitat, carbon sequestration, sediment retention and water quality [Environment Agency 2018].

Green infrastructure involves new concepts such as green roofs, street trees, rain gardens, swales, parks, rainwater tanks, permeable paving and green parking lots. Typically in urban areas, they can reduce smaller and flash flooding, and enhance water and air quality, habitat, and amenity [Naturally Resilient Communities, Chapman Taylor].

SUMMARY

Not only do all these natural flood management strategies reduce flooding and increase water storage, but they also yield multiple co-benefits.

The majority of these natural techniques help mitigate smaller flooding, but their impacts on larger events are unknown or limited. Nevertheless, the European Commission states that although such additional benefits may not always be quantified or monetised, their advantages are important and compare favourably against traditional measures [European Commission 2011].

Australia is primed to further adopt and implement several (if not all) natural flood mitigation strategies outlined, providing several other ecological benefits and assist with combating climate change.

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