Integration of Green Infrastructure in Social Housing and informal settlements upgrading: Bottom-up Participatory revitalization strategies in Indonesia

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1. Introduction

Cities and their communities are complex and dynamic systems that constantly evolve under the burden of population, climatic and societal change (UN-Habitat. 2016). Water is central to the health of cities: access to clean water; prevention of disease from wastewater; and deal with the challenges of storms and flooding, increased by climate change (IPCC, 2018). The Australia-Indonesia Centre's Urban Water Cluster (AIC UWC, 2016) supports the transition towards cities in which the water cycle is managed to protect and enhance the health of waterways, mitigate flood risk and create public spaces that harvest, clean and recycle water. Integrated water management will support biodiversity, public green space, healthy waterways, connected communities and sustainable social housing. Ultimately, our goal is to promote cities that integrate water sensitive planning and design to create connected, resilient, and liveable communities.

The project explored socio-institutional, infrastructure adaptation and green infrastructure pathways to a water sensitive future and applied this knowledge to four social housing neighbourhoods in Bogor (Indonesia): Pulo Geulis, Griya Katulampa, Cibinong and Sentul City. This paper described the Cluster's Revitalisation plan for one of these neighbourhoods, Pulo Geulis, a mixed area of social housing and informal settlement located in the middle of the catchment area of the Ciliwung River. Pulo Geulis community experiences significant environmental challenges issues related to water management and sanitation, but also demonstrates great potential to become a more Water Sensitive community through the adoption of WSUD (Water Sensitive Urban Design). A comprehensive Roadmap to Revitalisation, was developed in collaboration and consultation with Pulo Geulis residents and is presented in this paper. The roadmap for the revitalisation of Pulo Geulis community and their physical environment was developed together with members of the community, local and international academics and government stakeholders to provide a clear strategy for the leapfrogging of Pulo Geulis to a more water sensitive community, increasing their resilience to risks associated with climate change. The aim of this vision is the transformation of the community and their environments to reduce environmental impact, foster the local economy, integrate informal areas into the city structure and transition to a more water friendly Bogor.

The main objectives of this paper are to:

- Present the context information of the case study,
- Show the methodology for the co-design of the revitalisation roadmap,
- Present the visions for the transformation of the public spaces in Pulo Geulis by introducing Water Sensitive Urban Design that uses green or nature-based

infrastructure to improve living conditions, promote the local economy and reduce environmental impacts, and

- Provide a Roadmap for the revitalisation of the Pulo Geulis community and its transition to a more water friendly neighbourhood, that could be replicated by other social housing and informal areas

2. Water Sensitive Cities Framework

The Water Sensitive Cities (WSC) framework is comprised of three pillars that promote resilient and sustainable urban water systems that positively engage the community (Wong et al, 2012). The first pillar considers a city as a water supply catchment in which access to a variety of water supply sources at multiple scales is readily available. The second pillar considers urban water systems that provide ecosystem services which enhance and support the natural environment. The third and last pillar considers communities that have water sensitive key decision makers and in which water has socio-economic capital. The WSC framework promotes diverse solutions that incorporate a blend of centralized and decentralized infrastructure. WSCs display thriving and liveable green and blue spaces which are both enjoyed by the community and an integral part of the water catchment (Brown et al, 2014).

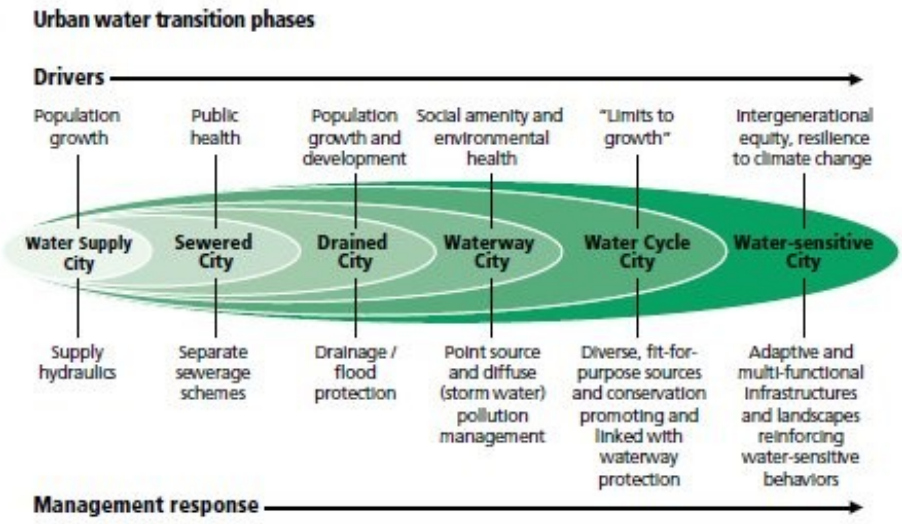

Figure 1: Urban water transition phases (Brown et al, 2015)

The concept of leapfrogging describes the potential for a city to jump over undesirable development stages on their path to becoming water sensitive (Binz et al. 2012; Sauter& Watson, 2008) (see Figure 1). It is common for authors to frame the concept of leapfrogging in the context of a developing country, e.g. Binz et al. (2012) define leapfrogging as "a situation in which a newly industrialised country learns from the mistakes of developed countries and directly implements more sustainable systems of production and consumption, based on innovative and ecologically more efficient infrastructure"

Water Sensitive Urban Design is based on integration of the two keys fields: Integrated urban water cycle planning and management (IUWCM) and urban design. It aims to ensure that water is given due prominence within the urban design process through integrating design with the various disciplines of engineering and environmental science associated with the provision of water service including the protection of aquatic environments in urban area. WSUD is an interdisciplinary social and physical sciences concept accounting for context and place (Wong and Ashley, 2006).

3. Case Study sites selection

Four Case study sites were selected as areas of analysis and demonstration. The case Study sites are located within the Ciliwung River catchment, within the jurisdictions of the governments of City of Bogor (Kota Bogor) and Bogor Regency (Kabupaten Bogor). They were selected based on their spatial/social/economic conditions to provide a comprehensive range of the different ways in which cities develop and transform over time, especially in developing countries (UN Habitat, 2017)

Pulo Geulis is located in the Desa (Village) Babakan Pasar, in the Tengah subdistrict of Kota Bogor, and is less than 300 meters from the Bogor Botanical Gardens. The island of Pulo Geulis covers an area of just over 3.58 ha and is the home of approximately 2,600 inhabitants in under 560 dwellings, yielding a population density of 700 people per hectare (see Figure 2). The community is multicultural (Sunda, Chinese, and Indonesian) yet live harmoniously, sharing use of the Vihara (temple) for meetings of multiple religious groups. The island also have 5 Secolahs or small Mosques. The local leaders for Village (Lurah), the RW (RukunWarga: Community Association) and 5 RTs conforming Pulo Geulis (Rukun Tetangga: Neighborhood Association) play a key role in community organisation and governance of the island (for community organization in Indonesia see: Yuliastuti et al, 2015).

The water from the Ciliwung River is used by some members of the community for bathing, washing, fish production in cages, and as a public gathering place for socialising. This connection with the river is important to the people and there is a long history of communal use of this water stream. Some members of the community are not concern with the use and contact of river water for some activities (laundry, playground, fishing), however laboratory test show that the water is largely polluted by bacteria and also chemical waste (Sabilaa et al, 2014), and it is not safe for any household use. It is difficult to restrict these activities by regulations; for some members of the community there are no other choices for access to water. In addition to the health risk from polluted water, flash floods occur regularly meaning that activities at the water's edge could pose a risk for the community.

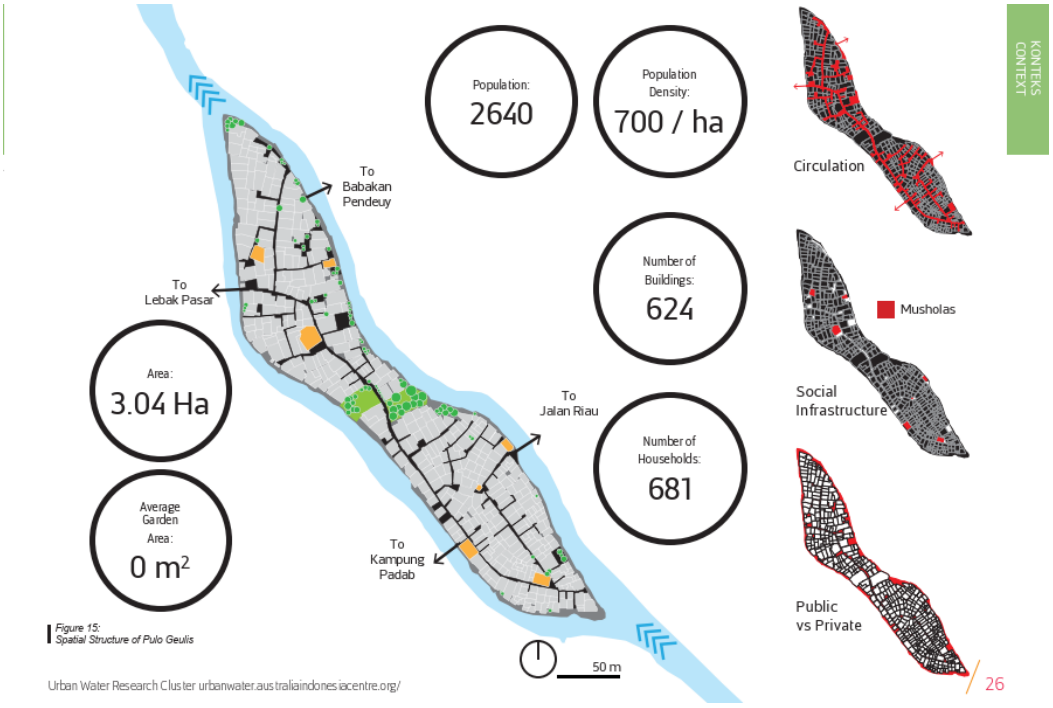

Figure 2: Pulo Geulis – Case Study site context

The island is on average 6.5 m above the water level of the river. Fluvial flooding is reportedly not problematic as river water levels do not come within less than 1.5 m below the island's elevation.

However, internal flooding does cause issues when heavy rainfall is trapped within the impervious and dense urban environment, with almost no green areas in the island. Small drainage systems, in the forms of small trenches built in front of some houses, aims to minimise the impacts. Water pollution from household wastewater to the river is also a constant problem, with most houses located at the river's edge throwing wastewater directly to the Ciliwung River.

4. Socio-spatial analysis and Codesign methodology

In order to understand the community's water and urban related challenges and opportunities, different data collection tools and methods were used in the different phases of the project: including the Visioning, Community Mapping, Problem Solution Tree, Scenario Modelling and Urban Design Workshops (see Figure 3). To face the challenge of the complexity of the urban fabric and the lack of spatial data of the site, different tools were used such as drone mapping surveys to generate an ortho-rectified image of the island, tri-dimensional modelling using the results of the drone mapping survey in Pix4D program, and sections and elevations obtained using REVIT tools.

Figure 3: Project Methodology and timeline

In addition, a Water Balance Model for the island was generated using AquaCycle software to understand the current and future water cycles of the island. The following section will present in more detail all the methods and tools described above. More detailed information on the output of the community workshops and results of the water modelling can be found in the technical reports for Green Infrastructure and infrastructure adaption modelling reports produced by the AIC UWC for this project (AIC UWC, 2019).

4.1 Visioning Community Workshops

The construction creation of a shared future vision for the community was the first step in the transition for Pulo Geulis towards a more water friendly settlement. This vision encapsulated the future aspirations of the community in terms of environmental performance, and social and economic uplifting. This visioning tool methodology has been used in other communities in Australia (Bendigo, Elwood, Adelaide) that had been selected as pilot projects for the CRC for Water Sensitive Cities Transition Strategy (Rogers et al, 2016). For the construction of a well-informed future vision, it is important to understand the local context and the main constrains and potential barriers and enablers as seen/understood by the community. For that reason, a series of activities (community workshops) were conducted to gather data to inform the vision, together with the community, using different analysis tools/methods including Community Mapping, Problem-Solution tree analysis, and Transect

Walks. The following section of this paper describes the methodology, aims and key results of each activity.

The first activity of the Community Visioning workshop (ran in Nov 2017) was to map the places in the neighbourhood that are problematic because of environmental or social conflicts, and to map sites that have potential to provide positive transformations for the community. The participants were divided into three focus groups: women, men and youth to obtain a wider range of feedback from the participants and also avoid some participants being reluctant to voice their opinions in front of other members of the community (see Figure 3). Large format satellite photos were used to identify geographically the locations of the important places and problems/opportunities in the area. Local researchers served as facilitators to orientate and explain the activity to the community group, and as mediators in the group discussions.

Figure 3: Visioning Workshop with Pulo Geulis Community

The workshop participants also identified the main problems related to water, sanitation, and community wellbeing in the area, using Problem-Solution tree methodology. This methodology has been widely used to obtain feedback from community and stakeholders about the main problems and to understand the causes and effects of each problem in the community and surrounding environment (Brown et al, 2016). After identifying the main problems, the participants were asked to think about possible solutions to address those problems, the actions needed to deliver the solutions and the potential benefits. This exercise also served to explore different alternatives to solving or mitigating the existing problems and discuss how future population growth and change in climate patterns may introduce new challenges/opportunities.

4.2 Scenario and Urban Design Workshops

After consulting with the community about their main challenges and opportunities (in the Visioning FGD), a series of possible urban scenarios for the allocation of new public open space and green infrastructure solutions were proposed by the design team to address the water pollution issues and lack of public and green spaces in the island. These scenarios considered different possibilities within the existing fabric of the island and looked for alternatives to address to the challenges of lack of public open space and poor wastewater management. The scenarios used the recommendations from the green infrastructure research team to propose feasible solutions and fit-for purpose infrastructure (see AIC UWC, 2016).

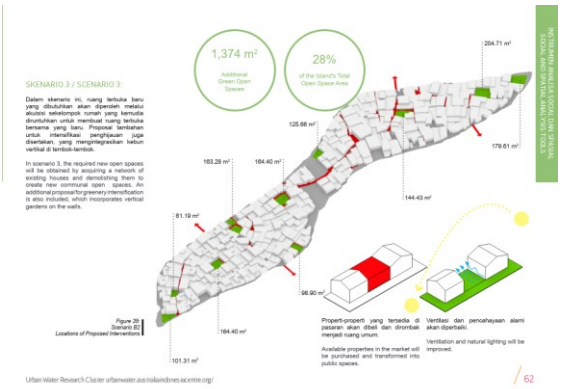

Figure 4: Scenario Workshop and Urban Design results

After the community selected the desired spaces for the pilot interventions, a series of urban design options where created and discussed with the community in a Urban Design Workshop (see Figure 4), seeking the feedback from the community regarding the different aspects of the urban design and green infrastructure to be included in the proposal. The Urban Design approach was based on a multi-use layering of functions (economic, ecological, amenity) that could support the community well-being and reduce its environmental impact, while providing space to upscale existing community initiatives such as urban agriculture, fishery, and local food business. In the Urban Design Workshop (ran in July 2018) the community was presented with a series of proposals for the design of the public space and their feedback and suggestions were collected regarding:

- Uses: Type of more common activities in public space and what mix of activities is more suitable for each demonstration site,
- Urban Design elements: Types of urban furniture, vegetation, lighting, shadowing desired in the new public space,
- Surface distribution: Amount and material types (concrete, wood, brick, etc) of hard surfaces (floor) and green (vegetation) and blue (water) surfaces distribution in the new public space,
- Environmental Uses: Location and mix of the proposed Green Infrastructure tools to provide a better environmental performance and community health (wastewater treatment with constructed wetlands, rainwater harvesting and reuse, food production with Vertical Gardens, etc), and
- Comfort: Quality of the urban space to provide a comfortable and secure used for the community (security and lighting, provision of shade, relaxation, etc)

5. Green Infrastructure adoption

The incorporation of green-blue infrastructure or green infrastructure into urban neighbourhoods, or water sensitive urban design, has the potential to mitigate the environmental impact of poor water management and improve the resilience of cities and towns of Bogor to respond to future urban and climatic challenges (IPCC, 2018). The water sensitive approach is being increasingly followed in several cities across the globe (e.g. Singapore, Melbourne, Rotterdam) in an attempt to become more sustainable, liveable and productive, and mitigate the impacts of population growth and climate change on the water system. Water sensitive urban design has been quoted as “a significant tool for designing resilient regions and improving the flexibility and adaptability of urban infrastructure.” Green infrastructure technologies serve to achieve this through the incorporation of a network of natural systems, that are affordable, low-energy solutions for effective management of stormwater and greywater while providing various other ecological and societal benefits associated with urban greening.

Effective implementation of water sensitive biophysical solutions may result in more effective stormwater and greywater management, climate adaptation, less heat stress, more biodiversity, food production, better air quality, sustainable energy production, clean water and healthy soils as well as the anthropocentric functions such as increased quality of life through recreation and shading. The success of green technology deployment will depend on how effectively this infrastructure is integrated within the framework of design and planning of cities. The project used a range of methodologies for the allocation and sizing of Green Infrastructure based on hydrology models, DEM (Digital Elevation Model), and EPA SUSTAIN Siting Tool (System for Urban Stormwater Treatment and Analysis Integration).

6. Urban Design recommendations for a water sensitive Bogor

The following section explains the tools and methods used to develop the revitalisation plan for Pulo Geulis, and presents the final urban design strategy (UDS) for a range of scenarios based on the community's aspirations to transition to a more Water Sensitive community.

The aim of the proposed UDS for Pulo Geulis, is to develop or upgrade the urban infrastructure to provide enhanced environmental and social performance for the neighbourhood and its residents. The UDS described in this section translates the vision of the community, to be a healthier, more liveable, and productive neighbourhood, into a comprehensive strategy to address current and future conditions for their livelihoods (i.e. climate change impact and population growth). Improving access to water sanitation, creating communal spaces, and strengthening of local infrastructure to manage population growth are three key issues that were addressed by the USD to achieve a healthier community and local environment. At the same time, the USD addressed the need for the economic development of the community leveraging the heritage and natural setting asset and opportunity for growing productivity.

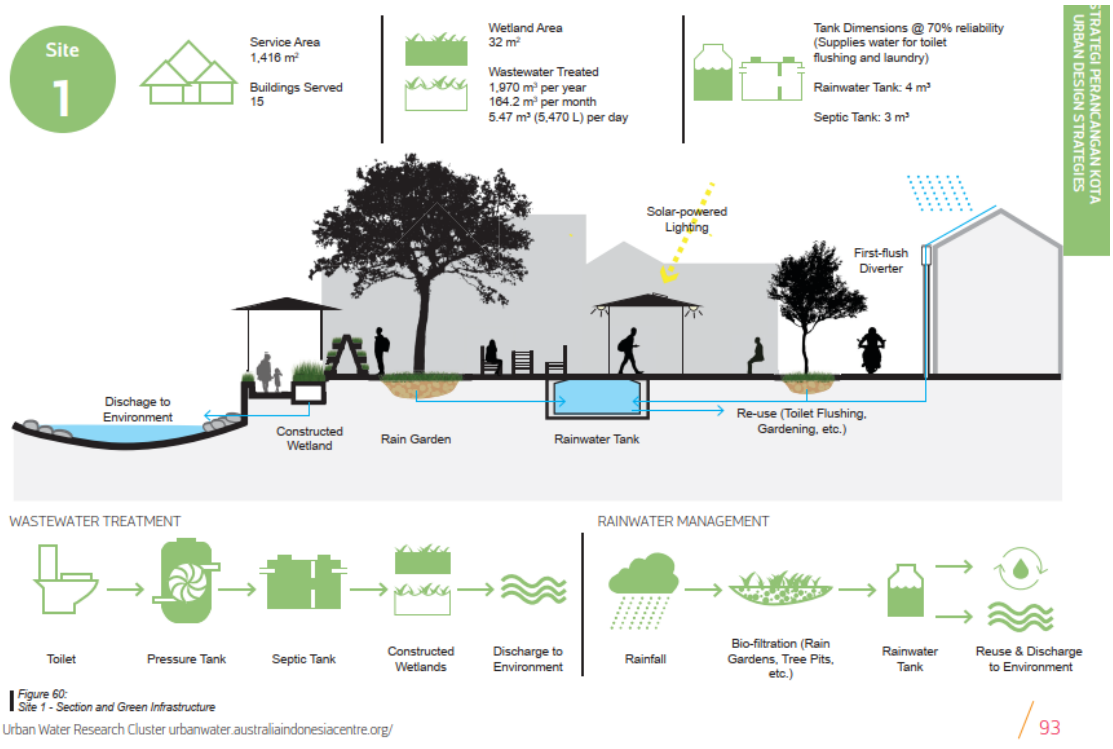

Figure 60:
Site 1 - Section and Green Infrastructure

Urban Water Research Cluster urbanwater.australiaindonesiacentre.org/

Figure 5: Water system section project site 1 in Pulo Geulis, Bogor.

The recommended strategies to support the transition of the area towards a more water sensitive city and community are as follows:

- Link public and private space, through shared green open spaces that serve multiple uses for water collection and storage, including the recycling of grey, black and rainwater from buildings and paved surfaces using biofilters, constructed wetlands, bioswales, raingardens and other Green Infrastructure tools.
- Ensure that new housing development includes an analysis of carrying capacity through WSUD to cater for population growth and promoting the use of compact housing parcels, adjacent to open spaces for community access.
- Promote recreational and productive activities in underutilised buildings and available open spaces, and support local economy initiatives (such as urban farming and fish production)
- Provide guidance for retrofitting of existing buildings, including design and materials preferences.
- Create zones for multi-purpose usage, (children playground, community markets, festivals, exercise, etc). The usage and maintenance of these shared community alley zones should be managed by the neighbourhood units, with support from the municipality
- Develop public walkways along the Ciliwung River, to promote a better mobility in the island and enjoy the landscape and natural settings.

7. Moving towards a Water Sensitive Cities in Indonesia

The Indonesian government has been promoting programs for the reduction of slum areas in Indonesia in the last decade (ADB Report, 2016). Some of these programs have been successful in reducing the percentage of population living in high risk areas and unsanitary conditions (ABD Report, 2016). However, the social impact of relocation and land clearing, and the lack of adequate social housing, remain an important factor to be considered for the transformation of cities towards a more water sensitive society.

The AIC UWC team approach for the island of Pulo Geulis recognized the value of the community in the collective construction of their habitat and propose to improve their living conditions with strategies that reduce to a minimum the need to relocate and evict populations from the lands were they have been living for many years. The roadmap for the revitalisation of Pulo Geulis, may present a new intervention model for many similar social housing projects or informal or slum settlements located on riverbanks throughout Bogor and Jakarta, where thousands of inhabitants struggle to have a decent living for themselves and their families. The revitalisation roadmap presented in this report, offers an alternative pathway for such high-risk populations, and could be adopted by governments and communities in similar situations, to achieve a positive transformation of the urban environment in which these vulnerable communities live.

The following are key considerations for governments in adopting a revitalisation model of transformation of social housing and informal settlements:

- It is vital to understand the value of social capital in the collective environmental upgrading of communities and the potential for residents to develop solutions to improve resilience and liveability of these settlements as an alternative to mass relocation and land clearing strategies.
- Working together with the community from early stages of the upgrading process, using their local knowledge and social capital as agents for the positive transformation of their urban

environments, sharing responsibility for reducing pollution and providing water and sanitation services. A decentralized model of water management will reduce the pressure on existing water provision systems and the need for investment in large and inflexible traditional pipe, pump, and pit infrastructure (Domenech, 2016).

- The importance of providing public spaces, especially in very densely populated social housing and informal settlement areas, is vital for the well-being and health of the community. Providing alternative options for public space allocation in informal settlements reduce the risk of developing diseases associated with poor ventilation, overcrowding and humid environments, which will reflect in the reduction of resources expended in treating these afflictions in the community

8. Public spaces as platforms for environmental and social revitalization

Public spaces in social housing projects and informal settlements need to be multifunctional to accommodate as many uses as possible to provide the community with different alternatives to use and enjoy open public spaces. Also, the public space could include green infrastructure options to reduce the water pollution (septic tanks, constructed wetlands, bio-filters), reduce the need from public water use (with rainwater harvesting tanks) and provide alternative sources of food and income (urban farming, local products selling, tourism).

- A set of guidelines, regulations, and tools for the design of public spaces (such as parks, squares, sidewalks and riverfronts) in informal and formal areas of the city should be established by local and national government. Such guidelines should provide an orientation on the adoption of WSUD solutions that can improve the environmental performance of urban areas, such as the ones included in the demonstration sites of this project. Many successful examples of these guidelines exist in Australia, Singapore, Hong Kong and other countries (ABC Guidelines Singapore, 2016; WSUD Guidelines City of Melbourne, 2015) and prove that with government support, the successful adoption of green infrastructure by developers and communities can substantially improve the water management cycle in social housing projects and informal areas.
- It is also important to consider how water sensitive urban design can manage the existing areas to be healthier, more productive, liveable, and sustainable for the Pulo Geulis residents. Additionally, the urban upgrading of Pulo Geulis should not adversely impact the surrounding settlements and downstream areas.
- As the average rainfall of Bogor City is quite high, the potential to have rainwater harvesting system is very high, as demonstrated in the Water Balance Model section in the AIC UWC Report. This water can be used for non-potable uses in houses and green areas, such as irrigation, toilets flushing, laundry, etc, reducing considerably (up to 35%) the use of potable water for these uses.

This paper presented a summary of the project activities to support of the rapid transition of developing cities towards more water sensitive city and communities, improving their resilience to climate change impacts such as floods, landslides, and draughts. Finally, the main findings of this case study and possible future steps are:

- Adoption of green infrastructure in social housing projects is an important element of a revitatlisation plan that aims to lessen the impact of the Pulo Geulis settlement on the urban environment and has the potential to deliver similar benefits to other informal settlements.

Also, natured-based solutions could support ecological services provision and improve local resilience to emergencies, such as floods and landslides.

- Communities in social housing projects and informal settlements have the potential to be the main agents of the positive transformation of their urban areas if provided with the tools to manage the transition towards a more resilient community. The process of engagement and active participation of the community in the development of the Revitalisation plan showed that when communities are involved early in the upgrading process, the social and natural system's transformation have a better chance of success.
- Multi-functional public space can be one of the main drivers of community well-being by providing amenities for recreation and community gatherings in social housing projects and informal settlements. By introducing Green Infrastructure into public spaces, connected with productive areas such as vertical urban farming and fishponds, these green and blue public spaces provide opportunities for food security and uplifting of the local economy.
- The methodology presented in this paper plan can be a good reference for the wide adoption of WSUD in other social housing projects and informal settlements in similar contexts, giving the community the tools to leverage against common land clearing and top-down slum upgrading strategies. Future steps are needed to evaluate the impact of nature-based solutions in public space and provide better cost-benefit analysis for its wider implementation. Additionally, the offer of Green Infrastructure products and services in the local market should be increased to cope with the increasing demand of natured-based solutions for housing and commercial projects, increasing as well new business development and employment opportunities in the city.

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