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# Asian Cities Climate Resilience

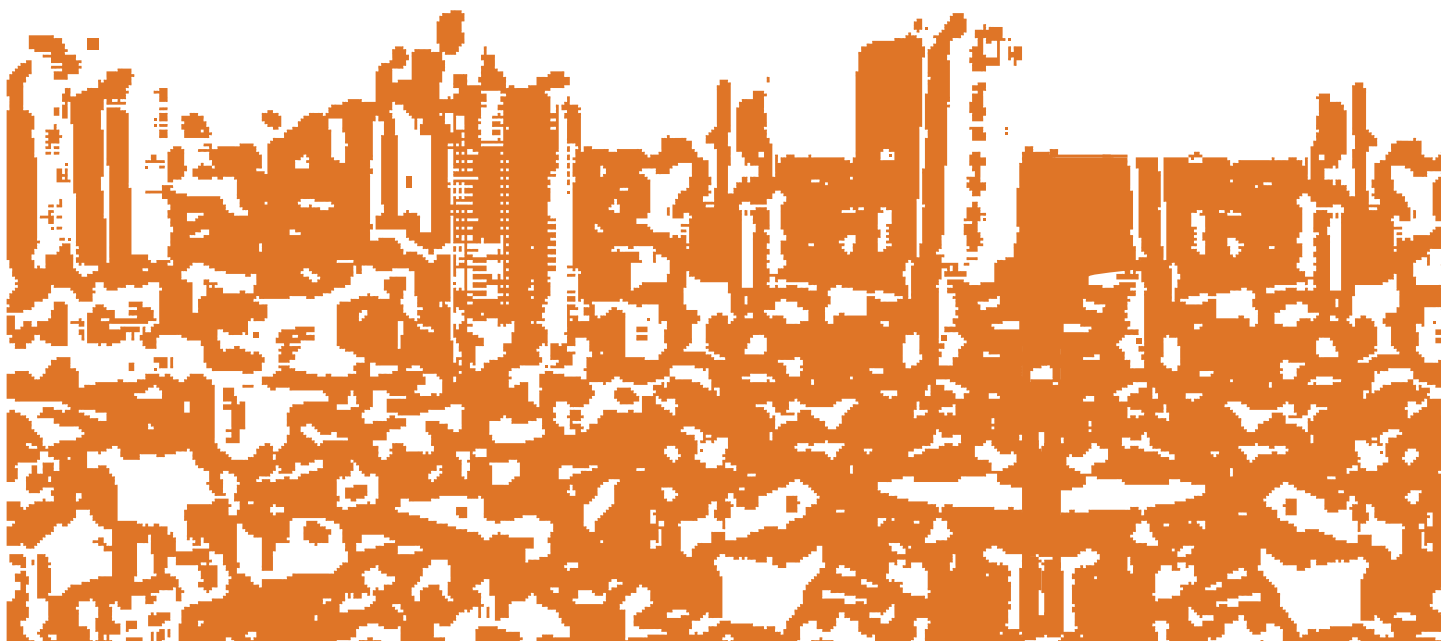
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## **Can urban regeneration improve health resilience in a changing climate?**

### **Lessons from Indonesia**

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# Contents

<b>Abstract</b>	<b>6</b>
<b>1 Introduction</b>	<b>7</b>
1.1 Structure of the paper	8
1.2 Urban regeneration	9
<b>2 Linking urban regeneration, climate change and health resilience: an assessment of national policy</b>	<b>11</b>
2.1 Slums alleviation regime of the last decade	11
2.2 Urban settlements in the National Climate Change Adaptation Plan	13
<b>3 The research framework</b>	<b>15</b>
3.1 Social factors influencing the health of urban residents	16
3.2 Physical and geographical factors influencing health of urban residents	17
3.3 Urban regeneration and its contribution to health	18
<b>4 Comparative case studies</b>	<b>21</b>
4.1 Methods	21
4.2 Data collection	21
4.3 Case study cities: selection and description	22
<b>5 Social, physical and geographical features of the neighbourhoods</b>	<b>27</b>
5.1 Social features	27
5.2 Physical and geographical features	31
<b>6 Vertical housing for the urban poor in hazardous areas and health outcomes</b>	<b>34</b>
6.1 Potential and opportunities	38
6.2 Uncertainty and challenges	39
<b>7 Conclusion</b>	<b>41</b>
<b>References</b>	<b>43</b>

# List of figures

Figure 1. Research strategy diagram	9
Figure 2. Examples of vertical and non-vertical housing	19
Figure 3. Geographical locations of Semarang and Pekalongan	23
Figure 4. Percentage of respondents who buy drinking water and perceptions of price	29
Figure 5. Self-assessment: quality of neighbourhood and level of happiness	30
Figure 6. Ratio of floor space to total occupants (m <sup>2</sup> /person)	31
Figure 7. Self-assessment: residents' perceptions of climate risks	32
Figure 8. Standardised net density and percentage of respondents experiencing hot days	33
Figure 9. Self-assessment: residents with rats and mosquitos in the home (%)	35
Figure 10. Residents' emotional state during hot days (%)	35
Figure 11. Resident's emotional state during floods (%)	36
Figure 12. The disability-adjusted life year (DALY) indicator (in years)	38

# List of tables

Table 1. Typology of the case studies	22
Table 2. Key features of the case-study areas	28

# List of boxes

Box 1: Satellite images of the case studies	26
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# Acronyms

BAPPENAS	National Development and Planning Agency (Badan Perencanaan Pembangunan Nasional)
BPS	Central Bureau of Statistics ( <i>Badan Pusat Statistik</i> )
DPU	Department of Public Works ( <i>Departemen Pekerjaan Umum</i> )
KIP	Kampung Improvement Programme
P3KT	Integrated Urban Infrastructure Development Programme (Program Pembangunan Prasarana Kota Terpadu)

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# Abstract

Climate change presents multiple challenges for local governments in developing countries. These challenges are acute, particularly in cities that experience continuous and rapid population growth, requiring adequate land-use and infrastructure planning. Frequently these cities see informal settlements built in hazardous locations. The health of residents in large cities can be affected by the impacts of climate change including increased rainfall events, flooding and heatwaves, contributing to an increase in vector-borne diseases. In Indonesia, urban regeneration programmes and projects are seen as potential ways to increase well-being by providing decent housing. Urban regeneration is a broad idea to improve neglected urban areas. By comparing two Indonesian cities, Semarang and Pekalongan, this study assesses the extent to which urban regeneration can be considered a climate change adaptation option, and explores the potential challenges and outcomes in using urban regeneration as an adaptation strategy for enhancing health resilience, such as through improved housing and sanitation, at the city level. The study finds several benefits from urban regeneration (and in particular the construction of planned vertical housing) such as increased protection from extreme weather events, reduced land-rights issues, reduced prevalence of vermin such as mice and rats, and better coping capacity during heatwaves when compared to non-vertical informal housing. However, there was no direct indication that housing type had any positive or negative correlation with incidences of diarrhoea, dermatitis or respiratory problems. Further research is needed to evaluate the potential of urban regeneration, in particular of housing, as an adaptation measure and to better understand what core factors constitute ‘success’ and ‘well-being’ in formal and informal housing areas and how such results can contribute to the development of an informed adaptation policy at the city level.

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# 1 Introduction

Climate change presents the greatest global and local environmental and social challenge facing city governments today. A significant increase or decrease in the quantity of rainfall and the increase of temperatures pose potential threats to the health and life of city residents (McGranahan, 2007). Furthermore, a large proportion of the built environment is often of inadequate quality and lacks basic services, especially in the cities of developing countries. Consequently, city residents in such built environments are highly vulnerable to climate change impacts including health impacts given that ‘health among low-income urban dwellers in many nations is as bad as or worse than that of low-income rural dwellers’ (Satterthwaite, 2011:1).

The Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (2014:19), in a very high-confidence category, projects that ‘throughout the 21st century, climate change is expected to lead to increases in ill-health in many regions and especially in developing countries with low income’. Threats to the health of city residents is one of the essential challenges arising from climate change, which makes it integral to link climate change (ecological systems) and the built environment (both physical and social systems) when considering adaptation.

A number of strategies for making cities more resilient to climate change have been developed and implemented in many parts of the developing world. These strategies include early warning systems, flood barriers, improved drainage and building on higher ground. Despite these efforts, a number of approaches remain problematic. Some studies argue that climate change strategies at the city level are mostly disjointed, incremental and unsystematic (Corfee-Morlot *et al.*, 2011; Smith *et al.*, 2009). At the operational level, these strategies are mostly small interventions, which can contribute to particular aspects of adaptation, but do not address all aspects of resilience given the magnitude of the impacts resulting from climate change.

A recent study on adaptation typologies (Biagini *et al.*, 2014) concludes that adaptation actions have so far focused on capacity building, management and planning, and practice or behaviour intervention, but overlooked physical infrastructure and technological interventions which can reduce the exposure to risk faced by urban residents. For example, 134 project components in 38 countries funded by the Adaptation Fund (2014) shows that almost 30 per cent of project components fall in the capacity-building category, followed by behaviour intervention (20 per cent) and management and planning (15 per cent). Adaptation strategies focused on physical infrastructure account only for 6 per cent.<sup>1</sup> This does not mean that the first sets of adaptation options are not important to improve resilience. Capacity-building projects, for example, are critical because they provide an enabling environment and are relatively inexpensive and result in low risks if unsuccessful. They can address some of the underlying drivers of vulnerability by educating and informing citizens, for example. Thus, ‘soft’ measures (small-scale and low-risk options) are often preferred by policymakers over ‘hard’ measures (large-scale but high-risk options). Howlett (2014) explains this tendency from policymakers’ point of view by examining theories in policy failure and success. He concludes that such tendencies occur

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<sup>1</sup> Interestingly, the Adaptation Fund has funded such adaptation categories as knowledge management (20 per cent) and ecosystem-based adaptation (6 per cent) as parts of project components. These could be classified as stand-alone categories of new and emerging adaptation types as well.

clearly in the case of climate change and is a result of risk-averse policymakers' decisions, who 'are often happier do nothing or little rather than do something which might lead them to be blamed for a failure.. [they prefer] to engage in a number of procedural strategies intended to downplay a problem and deny the need for substantive action to deal with it [climate change] rather than take positive action towards its remediation' (ibid). We acknowledge that small-scale and low-risk interventions formulated through a careful process can enhance urban resilience. Yet, despite the robustness of these kinds of interventions, they are often not enough, due to the complexity of urban systems and the need to address both the physical and the socio-political drivers of risk.

While Howlett (2014) explored under what circumstances a shifting of adaptation options from soft to hard could occur, this research aims to examine how hard measures could be a significant option in improving multiple outcomes including climate change, urban space and health. This research investigates a strategy known as urban regeneration, particularly focusing on improving poor-quality housing through slum-upgrading projects, as a possible option to adapt to climate change and to improve health resilience of city residents in an Indonesian context. In particular, we are interested in the vertical development of public housing, in the form of public rental flats for the poor, locally known as '*rusunawa*', as the example of urban regeneration. Our focus is on the direct impacts of climate change (e.g. floods, tidal inundation and hot days) and the consequences these have when they interact within a sub-optimal built environment as a physical system. We focus on three key variables: the density of neighbourhoods, quality of residential housing, and geographical locations in which urban residents live.

To do this, our research has two broad objectives:

- To assess the extent that urban regeneration, in particular housing for low-income groups, is being considered as an adaptation option in Indonesian cities, and
- To explore the potential challenges and outcomes in using urban regeneration, particularly housing construction for low-income groups, as an adaptation strategy for enhancing health resilience in particular, at the city level in Indonesia.

## 1.1 Structure of the paper

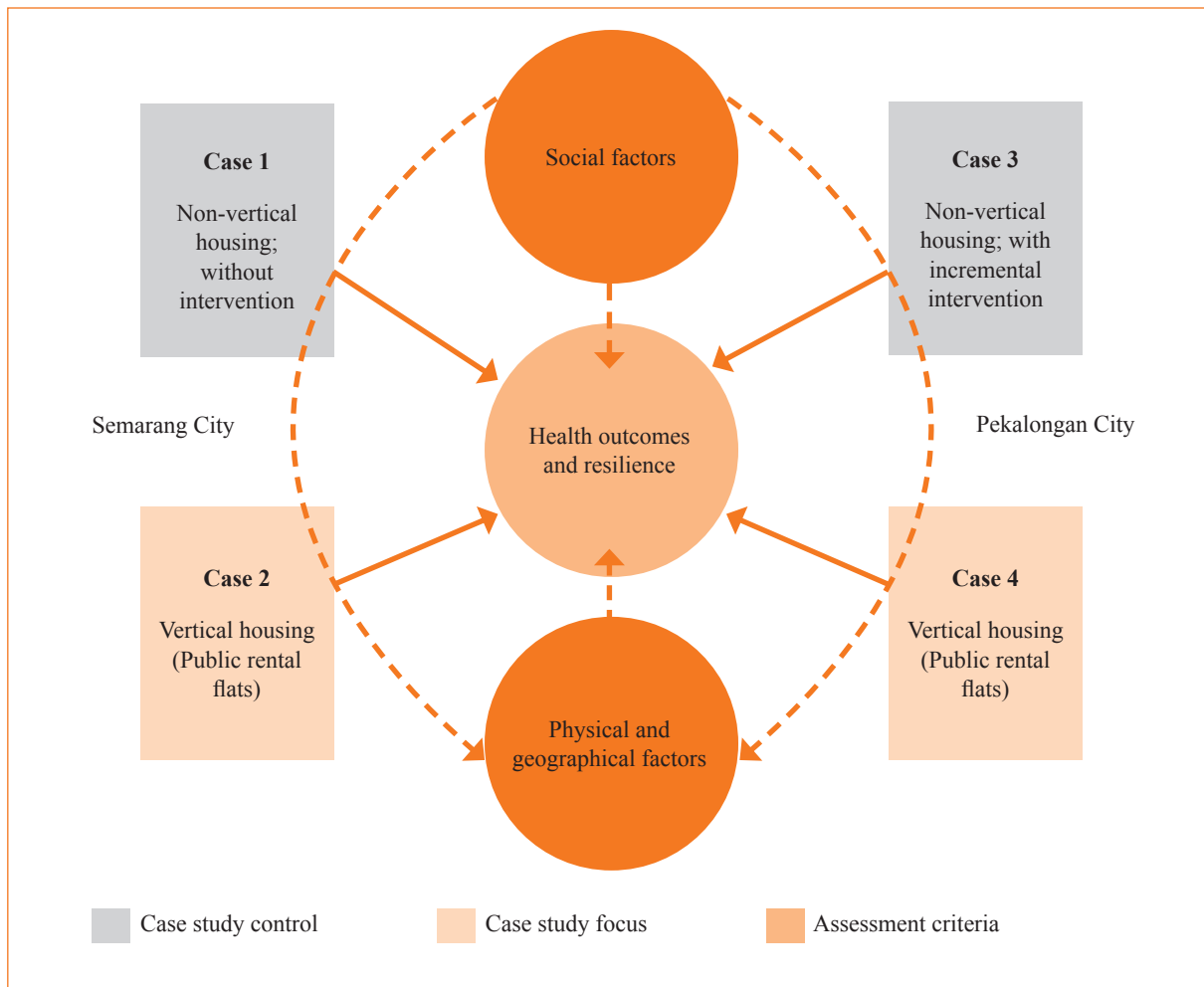
Our research is a two-part examination of urban regeneration and the health of slum residents in Indonesian cities. Our first analysis uses interview data to consider government and civil society perspectives on the use of urban regeneration to enhance the health of the urban poor. The results of these interviews are presented in an analysis of the policy and literature surrounding slum upgrading and urban renewal.

The second section is a comparative case study of the cities of Semarang and Pekalongan to assess the role of urban regeneration in improving health and climate change outcomes. We used a survey tool in four case-study neighbourhoods to compare health outcomes in three different types of urban neighbourhood, which are considered vulnerable to the impacts of climate change. Figure 1 further illustrates the research strategy.

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Figure 1. Research strategy diagram



## 1.2 Urban regeneration

Urban regeneration is the broad idea of revitalising particular areas of a city, which are not functioning adequately. The areas targeted for urban regeneration can vary from dense informal settlements to unattractive or economically-declining city centres. However, with regard to climate change, urban regeneration to ensure adequate housing is of more importance due to the high vulnerability of informal-settlement residents to climate change impacts. There are approximately one billion people living in informal settlements in developing countries around the world (UN-Habitat, 2012). Archer (2014:3) notes that people living in such settlements are ‘usually particularly at risk to the impacts of climate change because of poor-quality housing, lack of risk-reducing infrastructure and services, and often because they live on sites exposed to flooding or landslides’.

Urban regeneration is a combination of both ‘soft’ and ‘hard’ measures with emphasis on physical outputs. ‘Hard’ measures refer to the combination of effective utilisation of urban land (e.g. vertical development such as high-rise buildings, protection of the natural landscape), changes in land-use structure and elements (e.g. mixed-use development, integrated green and blue infrastructure networks), and physical revitalisation (e.g. retrofitted and strengthened buildings, infrastructure improvement) (Balaban and Oliveira, 2014). ‘Soft’ interventions as urban regeneration are the combination

of vision and concerted actions to overcome problems of cities through social, economic and environmental solutions that can survive in the long term. The features of urban regeneration therefore include an intervention that:

- Promotes partnerships between government, the private sector and communities,
- Establishes institutional changes that are able to respond to social, economic and environmental changes in the long term,
- Fosters collective actions or at least creates an avenue for the emergence of collective action,
- Opens space for negotiations to address or respond to the problems that has changed in cities, and
- Has the potential to bring policy and institutional changes to accommodate specific proposal (Roberts, 2004).

Some urban regeneration projects were introduced by the Indonesian national government with the first efforts in Jakarta and Surabaya in 1969 (Silas, 1992) through the Kampung Improvement Programme (KIP), a slum-upgrading programme. These efforts were upgraded with assistance from the World Bank until the 1980s. In the 1990s, the programme changed its name to the Integrated Urban Infrastructure Development Programme (P3KT), which integrated Kampung upgrading as part of the city-scale infrastructure development programme. It was believed that Kampung improvement alone was not sufficient to deliver expected outcomes.

The P3KT was a very centralised programme. The project was terminated in 2000 after a decentralisation programme was fully implemented. The improvement of human settlements was no longer a role solely played by the central government. After 2000 and following the Asian financial crisis, a number of settlement- and infrastructure-improvement projects existed, although they were packaged under either community empowerment programmes or poverty alleviation programmes. In the last five years, the Indonesian government has focused on the development of public rental flats for low-income groups.

Each programme actually highlights a particular condition of urban regeneration. KIP and P3KT, for instance, perhaps facilitated more substantial collective actions at the grassroots level (Silas, 1992) than the development of public rental flats projects. In general, these programmes promoted partnerships within and across levels of governments, but they had not successfully engaged the private and community sectors. The ability of these programmes to open space for negotiations and to bring policy and institutional changes to accommodate specific proposals was limited as they were heavily physically rather than socially oriented.

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## 2 Linking urban regeneration, climate change and health resilience: an assessment of national policy

This section is a literature and policy review focused on the Indonesian government and civil-society perspectives in response to issues within the intersection of human settlement and climate change. Our findings from the review are supported with data collected from ten interviews with key state actors at the city and national government levels and three interviews with non-governmental organisation (NGO) actors, which we conducted to explore the potential and challenges of urban regeneration as a strategy for enhancing urban health resilience in Indonesia. The interviews focused on attitudes towards urban regeneration, available institutional support, key drivers to make urban regeneration happen, and any foreseeable challenges with the strategy.

After conducting the interviews, we organised a workshop at the regional level involving 21 city administrative authorities in the Central Java Province with the aim of disseminating our initial research findings, to verify the output of the analysis of the survey data, and to explore additional perspectives with regards to linkages between rental flat development for the poor, climate change and urban health. Each city administrative authority was represented by officials from the special unit responsible for public rental flats management and the local development planning agency, environmental office and health agency.

The literature and policy review looks at the variety of literature regarding slum upgrading, urban revitalisation and urban renewal since they provide similar characteristics and they are a part of the conceptual trajectory of urban regeneration over the last half century. The aim of our review is to explore why there is a need for urban regeneration as a strategy to address the impacts of climate change.

### 2.1 Slums alleviation regime of the last decade

The proportion of the Indonesian population living in slums is a subject to debate as the criteria of slums is a moving target. For example, the Department of Public Works (DPU) employs six criteria, which contain more than 20 sub-criteria to define slums, while the Central Bureau of Statistics (BPS) uses only four criteria. The DPU in 2014 stated that 34.4 million Indonesians live in urban slums. However, this number is dubious if the criteria of ‘access to adequate drinking water and sanitation’ is used, because the BPS indicates that 77 million Indonesians in urban areas in 2012 had no adequate access to drinking water and 28 million had no adequate sanitation in 2013. In addition, there is an on-going dispute over the existence of slums in term of geographical locations. For example, the DPU declared that in 2014 there were 34,473 hectares of slums in 3,201 areas, while according to the National Development and Planning Agency

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(BAPPENAS), slum areas cover 38,431 hectares, which are in 4,501 areas according to the BPS. Needless to say, the different criteria and calculations from different institutions complicate an understanding of the actual extent of slum settlements and the proportion of the population impacted.

In the last decade, there have been two mainstreamed responses at the national level regarding slum alleviation in Indonesia. On the one hand, there was an attempt to address the issue of slums through physical and technocratic means. This approach was driven by the DPU, which has considerable financial support to operationalise their points of view with regards to slums alleviation. This approach, to some extent, cannot be separated from political economy motivations. It was characterised by a requirement of hierarchical and diverse strategic planning documents from the central to city-level government. Planning consultant firms had the most influence in the preparation of this plan, while the participation of the city government was only to legitimise this approach. In general, city governments who lacked leadership, databases and clear visions with regards to slum alleviation in their administrative authorities tended to accept this approach. Most city governments embraced a premise that it is better to take the slum-alleviation package instead of getting nothing. Unfortunately, most of these documents ended up in the filing cabinets and with no real action on the ground. The one-size-fits-all approach, which was commanded by the consultant firms, often did not reflect the complexity of the specific slum in every city because many treated slum-alleviation plans and projects through a mass production paradigm and too often sacrificed the interests of slum dwellers and city governments in the process.

On the other hand, there has been an attempt to raise advocacy and network development at the national level, known as the Working Group for Human Settlement Development (Pokja PKP), to address the issue of slums based on local strengths. In principle, this approach places city governments as responsible for addressing the problem of slums in their administrative areas. This particular approach believed that the root causes and problems of slum building vary, as do the potential solutions. In addition, this approach considered the city governments along with other local actors as those that were best able to understand the problem. Addressing slum challenges is not only with regard to alleviation measures to improve the situation, but also includes preventive efforts to avoid the recurrence of slums. The Directorate of Housing and Settlement at BAPPENAS has hosted the development of advocacy and networking for slum alleviation in the last few years. This strategy offers a more bottom-up approach and calls for a different role to be played by the DPU. Maintaining this advocacy and networking initiative becomes the greatest institutional challenge since BAPPENAS does not have large financial resources to offer directly to the city government, given that those resources are located in the DPU.

There is now, however, an indication of mutual understanding between these two institutions. Pokja PKP at the national level has been successful and appears to be a productive communication channel between the DPU and BAPPENAS, and other related institutions such as the State Ministry for People's Housing (Kemenpera), National Land Agency (BPN), Central Bureau of Statistics (BPS), NGOs, and financial institution etc. During an interview, one senior officer of the Directorate for Human Settlement Development at the DPU stated:

*We [in the working group for human settlement development] are complementing each other because this [alleviation of slums] is a collaborative effort from the DPU, BAPPENAS, BPN and Ministry for Economic Coordination. We are all equal; we are basically one. Therefore, we always attend following the invitation from the working group; we share data we had in the working group (DPU, 2014a).*

This paradigm shift is also confirmed by a former Indonesian minister of the DPU, and also a former UN Ambassador for Millennium Development Goals (MDGs) in Asia and the Pacific. She stated (DPU, 2014b):

*Slums ten years ago were seen as a burden, because the government saw this as a problem to be alleviated, while the availability of resources in the government was relatively limited. A human-oriented approach, through pro-poor, pro-jobs and pro-environment, is actually more important than improving the physical condition directly [...] The existing assets [human] are as important as new infrastructures. Humans are additional resources available that can be empowered [...] The DPU are now also increasingly aware that they can no longer build **for** the community, but they have to build **with** the community [emphasis added].*

This paradigm shift with regards to housing provision was remarked by the enactment of Law 1/2011 regarding housing and human settlements, which amended Law 4/1992. While the previous law placed the community as the main agent responsible for providing their own shelters, the new law reforms the concept of housing provision. It emphasises and specifies the role of the state – the national government – to provide shelter particularly for the poor (Salim, 2011). This seems to contradict the new concept of building ‘with’ the community, but there is space for public participation in this new institutional architecture. The law is encouraging the development of local forums to manage land and administer project management – including the design of houses – and then propose these plans for funding from the government. However, while the regulations are now in place, there are no incentives or operational support for the communities to form such forums or any acknowledgement from the government on how long the process should take from initiating a forum to receiving housing. The National Medium-Term Development Plan 2010–2014 (BAPPENAS, 2010) targeted development of 650 twin blocks of affordable rental flats that can accommodate 836,000 low income families. Evaluation by the end of 2011 showed that 235 twin blocks were completed, but only 61 per cent were occupied (DPU, 2012). A final evaluation figure is not yet available and this ambitious target is likely still unachieved. Despite some critics, this programme is likely to continue in the upcoming National Medium-Term Development Plan 2015–2019.

Recently, the president of the Republic of Indonesia amalgamated the Ministry of Public Works and the State Ministry for People’s Housing. This manoeuvre provides new hope for a better integration in terms of the provision of infrastructure and human settlement development. This new institution is known as the Ministry of Public Works and People’s Housing (PU-Pera). PU-Pera just concluded a nationwide data modernisation process. In late 2014, it was declared that the total slum area in Indonesia is 34,473 hectares, which are spread over 3,201 areas in 415 Indonesian cities. The ministry recently published a new progressive slogan ‘100-0-100’, representing their commitment to deal with slums and housing for the poor. The slogan means that by 2019, Indonesia will have 100 per cent access to clean water, 0 per cent slums, and 100 per cent access to sanitation. As the data on the location, size and nature of slums across the country are now up to date through the PU-Pera data modernisation process, slum alleviation programmes will be more concrete. A mid-level officer in the Directorate for Human Settlement, PU-Pera stated:

*Our director [national director] said that we had enough with macro-planning documents. The slum-alleviation regime has changed. We will leave a hierarchical model of using a planning documents approach and will enter those identified locations directly [...] This reduces our overhead costs by minimising consulting service costs to third parties (PU-Pera, 2014).*

With this new regime, it is argued that the participation of city governments and slums dwellers will be paramount. Yet strategic and operational measures toward that idea have not been formulated, including who will facilitate it, what their tasks are, who is going to equip the facilitators with appropriate knowledge and skills, and what the funding procedure is. A working unit for housing and settlements (Satker PP) – a number of national government officers who are appointed to stay at the provincial level across the country – will likely not be sufficient to handle 3,201 slum areas in 415 cities. Furthermore, most of the officers are engineers by training, so equipping them with social and participatory skill is essential. Although the paradigm shift has occurred and the slum-alleviation regime has changed, there is still a huge challenge in implementing this programme on the ground.

## 2.2 Urban settlements in the National Climate Change Adaptation Plan

The connection of liveable housing, adequate infrastructure and health has been acknowledged in the national government policy. The National Action Plan for Climate Change Adaptation (RAN-PI), which was launched in mid-2014, mentions that life-system resilience is one of the national policy’s objectives in responding to climate change adaptation. Life-system resilience is largely about community access to all the resources they need for living or require for sustaining their lives. The scope of this broad policy direction includes public health, human settlements and infrastructure.

In the health sector, the national government focuses on: identification and control over vulnerability factors and public health risks resulting from climate change; utilisation and strengthening of early warning systems for managing both communicable and non-communicable diseases resulting from climate change; improving regulation and capacity building both at the national and local levels; and increasing the use of science, technological innovation and community participation with regards to climate change adaptation in health sectors. As for infrastructure, the objective of the national government is to increase the coverage of basic services and strengthen the infrastructure systems to be reliable and of good quality in facing the impacts of climate change. The main objective of the national climate change policy in the field of human settlements is to ‘establish accessibility for climate change adaptive housing, which is affordable and inhabitable’ (BAPPENAS, 2014:36).

Development of rental flats for low-income groups is one of the alternative projects to solve the issue of housing backlog. It has also the potential to alleviate slums when both urban renewal and urban revitalisation strategies do not work or are not feasible. In other words, development of rental flats is urgent when relocations involving the urban poor have to be made and at the same time there is limited availability of land. National government passed Law 20/2011 to regulate vertical housing development, including the development and management of public rental flats.

Considering the substance of the law, this research applies the vertical development of public housing, in the form of rental flats for the poor, known as *Rusunawa*, as the example of urban regeneration for this research. In the Indonesian context, the development of public housing represents a productive collaboration between different levels of government. The national government is responsible for financing, while provincial government is in charge of infrastructural provision, especially building access (e.g. roads) when necessary. In addition, the city government is responsible for land and basic service provision, operation and maintenance. The development of public rental flats demonstrate significant institutional changes and urban physical growth management, which could be seen as an opportunity for the urban poor who are the most vulnerable to the impacts of climate change. This facilitates opportunities for the urban poor who are currently living in informal, unrecognised and degraded settlements to improve their living conditions through occupying legal, acknowledged and adequate housing at an affordable price.

Vertical development of public rental flats can foster the integration of housing provision with other urban sectors beyond housing in terms of provision of clean water and basic services, health improvement, social welfare, poverty alleviation and disease control. The physical solution of vertical development of public housing in the form of rental apartments can offer another dimension of resilience through the reduction of climate change-related exposures, especially floods, inundation and other consequences, as long as the buildings are properly managed and maintained, and located in areas that people are willing to move to, with good transport connections and access to health centres, schools and markets.

Although the Indonesian government policy on paper has acknowledged the linkages between poverty alleviation and climate change adaptation, an interview with the senior advisor of the national secretariat for climate change revealed that there are no climate strategy documents at the city level that consider either slum alleviation projects or the development of rental flats for vulnerable communities as an adaptation option. Some factors that may hinder city governments to propose this alternative include the absence of incentives to use funding in each sector or institution at the city level of government in a collaborative manner and the tendency to avoid risks associated with such capital-intensive adaptation projects.

Overall, there is obviously a potential to integrate the management of slums and climate change through urban regeneration and in particular through the development of rental flats for low-income vulnerable groups. However, an empirical understanding of the potential of this strategy is needed.

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## 3 The research framework

The literature focusing on the relationship between climate change and health continues to develop. It is now agreed upon that climate change has an impact on human health both directly and indirectly (McMichael, 2003; McGranahan, 2007; Kovats and Akhtar, 2008; McMichael *et al.*, 2009; IPCC, 2014). McGranahan (2007) for instance categorises six direct and indirect impacts of climatic changes on health, which include the outbreak of various diseases (faecal, respiratory and vector-borne diseases), injury, temperature stress, malnutrition and mental health. Technical understanding of the mechanisms or pathways that shape current and future impacts of climate change on health is also improving. Increases in extreme rainfall due to changing climatic patterns for example lead to an increase in the frequency of floods and their longer duration. Moreover, increases in sea-level rise can result in permanent inundations, especially in low-lying coastal areas where a high proportion of urban residents are located. In these circumstances, the urban residents' health is at risk due to various impacts such as the contamination of wells, scarcity of clean water, disruptions in road access and thus access to community health centres, and the spread in disease vectors leading to disease outbreaks. Additionally, increasing hot temperatures and intensity of heatwaves may increase psychological pressures and stress in urban residents. Climate change impacts on health mostly affect low- and medium-income communities living in least developing countries (IPCC, 2014; Kovats and Aktar, 2008), especially women (Armstrong, 2013) and children (Bartlett, 2008). Many have agreed that climate change presents one of the most important challenges to human health for the future.

However, the notion that climate change is the biggest threat to global health is now being challenged. Although climate change is likely to trigger undesirable health outcomes in the future, such as water- and mosquito-borne diseases, heat stress-related illness, death and injuries due to extreme weather events, there is no strong evidence that climate change will be catastrophic for health at least in the next three decades due to the time lag between greenhouse emissions and their impacts on the environment (Papworth *et al.*, 2014). Papworth *et al.* (2014) suggest that the health research community should not be overemphasising climate change because it might shift the focus away from the existence of non-communicable diseases that already exist in the community, particularly low-income communities, healthcare disparities, and the reality of inequality and poverty.

The following section presents some linkages between climate change and the health of urban residents through the lens of urban regeneration. In this framework, urban regeneration can be understood as a public intervention that attempts to fix inequality in cities and to assist urban poor in achieving better living conditions. Urban regeneration strategies in this study are systematically limited to only two typical elements of urban regeneration: infrastructure revitalisation and vertical development. As for the urban health dimension, this framework considers mainly the health of urban residents. Finally, climate change variables that are considered to influence urban residents' health in this framework are limited to increasing and/or decreasing rainfall and increasing temperatures.

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### 3.1 Social factors influencing the health of urban residents

The health resilience of urban residents is affected by multiple factors including social factors. Several key variables of social factors include the lifestyle of residents, urban residents' awareness of health, access to health and basic services, and capability of the urban system to maintain the vitality of basic services even during disruptions.

The lifestyle and behaviour of residents refers to the day-to-day community practices that involve a set of processes of how residents interact with their built and social environment. In this sense, it is important to understand what services urban residents can access in their neighbourhood, how urban residents might impact negatively the environment they live in, and what consequences these interactions have from a community and public health point of view.

A high level of awareness by the residents of what constitutes a healthy living environment in the community is obviously an important variable that influences the perceived quality of the built environment. However, this variable is not necessarily linear, which to some extent depends on other contributing factors such as the level of education, income and the availability of health intervention programmes and institutions operating at the urban community level.

Access to health and basic services (e.g. running water, sanitation, solid waste collection) is a major determinant of the health of urban residents. However, the benefit acquired by those who access these basic services and infrastructure are not necessarily the same since the quality of service plays an important role (Heller, 1999). Neighbourhoods that have a higher level of health and basic service coverage and quality are more likely to have healthy residents than those residents living within neighbourhoods that have much lower or no service coverage. Accessibility and coverage of these services are also influenced by other factors such as demand and supply, affordability and the power relationships within the city to some degree (Chaplin, 1999). This can include for example neighbourhoods with particularly disadvantaged and marginalised populations versus richer better-off neighbourhoods.

The notion of urban health inequality basically underlines all these above social factors and it affects negatively the health of urban residents, especially the residents who reside in informal settlements. Sverdlik (2011: 123) points out that 'urban health inequalities usually begin at birth, are reproduced over a lifetime (often reinforced by undernutrition), and may be recreated through vulnerabilities to climate change and a "double burden" of communicable and non-communicable diseases'. Hence, the quality, access and affordability of health services are in fact a crucial component of urban residents' health status and futures.

Finally, the capability to maintain the vitality of health and basic service systems including the capacity to respond quickly to any situation that could potentially disrupt service delivery is an important variable for urban health resilience. This capacity basically builds on the local institutions and institutional arrangements at the city level that ensure the sustainability of basic services to the residents and even recovery of these services when something, including climate and weather challenges, disrupts the systems (Tyler *et al.*, 2010). Satterthwaite (2011: 1) claims that a major failure in addressing urban health issues properly is that 'so many of the factors essential to health and well-being are the domain of organisations that are not health agencies, and they do not understand their role as it relates to health'. He suggests making health part of city development agendas and partnerships. A number of examples of typical comprehensive hard interventions (e.g. urban regeneration) can be found in cities that also have positive health outcomes. Unfortunately, less emphasis has been given to understanding the role of these kinds of comprehensive, large-scale interventions in improving health resilience. Therefore, the adaptation and resilience research agenda should move on to examine the combination of these options in practice.

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## 3.2 Physical and geographical factors influencing health of urban residents

Physical and geographical factors also play an influential role in urban residents' health. We have chosen to focus on three key variables: the density of neighbourhoods, the quality of residential housing, and the geographical locations in which urban residents live. In developing countries where the population growth is high and the economic activities are often concentrated in only a few centres, densely populated neighbourhoods are an unavoidable feature especially around the city centres. As part of the manifestation of the urbanisation process, densely populated neighbourhoods in cities offer both advantages and disadvantages. A high level of density in an unplanned neighbourhood has made it difficult for city authorities to find land or space to put proper basic infrastructure in place. In such high-density neighbourhoods, it is hard to find land available for green open spaces or playgrounds, which according to some studies actually play a key role in social and mental health of people (Kent and Thompson, 2014; Maas *et al.*, 2009). Additionally, an urban environment that has high-level density prevents sunlight exposure into neighbourhoods making such areas a fertile ground for mosquitos, rats and other disease vectors.

Despite acknowledging the risks of over density, Satterthwaite (2011) argues that densely populated areas in cities could provide also positive opportunities, mainly from economies of scale that such areas produce for example in terms of lessening the cost of infrastructure and basic service provision. Thus, it improves the affordability for the community to access services and makes it economically feasible for private organisations to deliver services in such areas, particularly if these are not provided by public agencies. In transforming this opportunity into reality, however, it also depends on the extent of productive engagement between the government and people in the neighbourhoods. For instance, in Thailand (Sperling and Ramaswami, 2013) and in a number of regions in Indonesia (Some *et al.*, 2009) granting legal land rights and assistance to community groups in informal settlements have been successful approaches to promote improvement of neighbourhoods and to encourage genuine initiatives in the provision of basic services. Maintaining neighbourhoods' proximities to the city centre by increasing the density of urban neighbourhoods without sacrificing the quality of life of its inhabitants is technically possible. Hasan (2010) for instance proposes re-engineering housing designs that can be expanded for accommodating population growth in Karachi to ensure the maintenance of the quality of life for the residents.

The quality of residential housing is likely to affect the health of its occupants, and can be determined by a set of criteria based on construction, efficiency and comfort. A proper permanent structure is critical to ensure that all residents are safe from anticipated but excessive exposures of the external environment (e.g. rain, wind, heat and cold). A residential house, which is equipped with basic utilities (e.g. piped water, sewer and drainage) and follows healthier design principles (e.g. percentage of building coverage or floor space, ventilation and flooring), will deliver a degree of comfort for its occupants. High-quality residential housing enables its occupants to be healthier both physically and mentally than those living in poor-quality housing.

Finally, geographical locations in which urban residents live play a significant role in influencing the residents' health (McMichael, 2003). Typically vulnerable locations such as dense urban settlements in low-lying areas or near riverbanks are more likely to expose residents to higher health risks. Urban settlements located in unstable land sites are also at risk from landslides during extreme rainfall.

Providing revolving funds for empowering residents in particular areas of a city to improve sanitation through community-driven improvements (Trémolet *et al.*, 2010) may be a robust solution to improve health resilience and living conditions in general, but it may be insufficient to cope with more frequent floods hitting the area and causing the sanitation system to collapse. In this context, government-led infrastructure improvements and flood control should be made an urgent immediate priority. However, it would be better if these measures are done in parallel because a multi-risk approach is highly crucial in dealing with the multiple impacts of climate change.

### 3.3 Urban regeneration and its contribution to health

Investments in urban infrastructure and basic services will provide many benefits to the health of the urban poor. A number of studies (e.g. Daly, 1998) confirmed that every single dollar invested for the poor in the developing world results in a higher value added for the environment when it is spent on basic services than the same amount of investment for the rich in the developed world. However, in responding to the potential impacts of climate change on one hand, and the existence of chronic poverty and inequality in developing countries on the other, a more comprehensive investment in infrastructure and basic services, typically through urban regeneration strategies, may result in better outcomes than a typical model of incremental infrastructure investment. Recently, Balaban and Oliveira (2014) noted the need to understand the role of urban regeneration in response to climate change and examined empirical evidence from the revitalisation of commercial centres in two Japanese cities, Yokohama and Kanazawa. They argue that urban regeneration projects offer a number of opportunities to address climate change, although evaluating the outcomes is not always straightforward. While Balaban and Oliveira's (2014) research is relatively comprehensive, it does not examine the contribution of these strategies to producing public and community health outcomes especially in a changing climatic context.

In general, urban regeneration may be useful as a strategy in responding to climate change and may deliver some advantages to enhance urban health resilience. In this paper, we consider two types of regeneration: the improvement or upgrading of infrastructure, and the development of high-rise public rental flats or vertical development. In general, Indonesian public rental flats projects mostly consist of four storeys, and in a big city such as Jakarta the projects involve construction of public rental flats of up to sixteen storeys. High-rise apartment buildings and other vertical developments are a major element in urban regeneration, likely to be effective in reducing the density of buildings in vulnerable neighbourhoods, which is a key variable determining urban residents' health. Vertical development also makes it possible to allocate land for putting basic infrastructure (e.g. water pipelines, drainage) in place properly and even to expand them when necessary. Additionally, it is an instrumental strategy to provide more open green space to moderate hotter temperatures, to catch more intense rainfall, to lower the risk of floods and inundations, and to reduce psychological pressure on residents by providing more space for better social interactions.

Vertical development projects in over-crowded vulnerable neighbourhoods involve physical revitalisation. This means the redevelopment of residents' houses, which eventually leads to improved housing quality and results in strengthened buildings. However, on-site redevelopment that would mean demolishing existing houses to build new apartments is much more complicated than development in a new location. Therefore it is important to include consideration of where people will live while the new apartments are being built, if this occurs on the same site. Collective improvement of residents' housing quality and the built environment will likely result in positive outcomes including preventing disease vector spread, while strengthened buildings may prevent unexpected consequences of extreme storms, which are projected to become more common in a changing climate. Vertical development projects, which are allocated for the resettlement of communities living on riverbanks or in areas exposed to landslides, aim to enable the community to stay away from hazardous spots and increase their resilience. Figure 2 shows an example of vertical and non-vertical house from the case study.

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## Figure 2. Examples of vertical and non-vertical housing

Vertical (V)



Semarang (S)

Non-vertical (NV)



Semarang (S)



Pekalongan (P)



Pekalongan (P)

Photos by Rukuh Setiadi

Mix-used development is also a key element in urban regeneration. An example of mix-used development includes development of residential housing and various supporting facilities (e.g. schools, local markets, and health centres) on the same site or block. Mix-used development may shorten the distance between health centres and vulnerable urban neighbourhoods. Eventually, a physical integration of health centres within the neighbourhoods, will likely shape residents' lifestyles and behaviours.

Urban regeneration will deliver other co-benefits beyond health outcomes, such as increasing property values in the neighbourhoods. In the presence of expected economic benefits gained by residents or property owners, the collaboration with the private sector will enable the implementation of urban regeneration projects. The changing of the neighbourhood's image is another co-benefit of this strategy, giving the residents pride in their neighbourhoods since urban regeneration may increase their sense of belonging and willingness to be active agents in their neighbourhoods.

Institutional and legal frameworks to support urban regeneration as a strategy to enhance urban health resilience are likely available to implement urban regeneration. Spatial and infrastructure planning schemes and building regulations are some examples of basic institutional frameworks available mostly at the city level. Using planning schemes and building regulations to encourage urban regeneration may be a useful strategy in adapting to climate change especially in cases where climate change adaptation is not yet a recognised policy issue or is marginalised or not well understood by the majority of city actors.

Despite some of the health-related advantages and potentials aforementioned, there are some issues that need to be considered in relation to urban regeneration. Urban regeneration is a relatively expensive type of intervention and requires a high degree of collaboration between national and city governments, and non-state actors. Therefore, its usefulness and uptake also depends on the capacity of city governments to facilitate its use, the participation of non-government organisations, readiness of the private sector, and its affordability for residents or project beneficiaries. Urban regeneration projects for people living in slums with no land titles should be understood differently: such projects would require more political will and government support than pure cost-benefit calculations; hence, the focus should be on broader social benefits rather than solely economic costs given the potential benefits to health and livelihoods. It would be different in the case of lower-middle-income households who have the capacity to invest and pay rent. Dealing with social costs and resistance during the process of urban regeneration is another key issue to be anticipated. When facilitating urban regeneration strategies, participatory and community-based dialogues would be the most essential approach and a key element for any urban regeneration in practice.

Urban regeneration does not necessarily provide all of the promised outcomes when the project fails to consider public concerns. A longitudinal mental health study, following an urban regeneration project in Manchester (Huxley *et al.*, 2004), showed this possibility. Mental health index, life satisfaction and self-reported GP visits for anxiety-related health issues in an area undergoing urban regeneration remained the same in comparison to a matched control area. In Indonesia (Some *et al.*, 2009), Thailand (Sperling and Ramaswami, 2013) and Ghana (Osunamu *et al.*, 2010), many successful urban regeneration projects, especially those involving the provision of basic services and upgrading settlements for low-income communities, share common features of significant local action and partnership.

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# 4 Comparative case studies

## 4.1 Methods

This research is a comparative case study in the cities of Semarang and Pekalongan to assess the role of urban regeneration in improving health and climate change outcomes. We compare health outcomes in three different types of urban neighbourhoods, which are regarded as vulnerable to the impacts of climate change – using a total of four case-study neighbourhoods. An informal settlement, which has had or has no planned improvements by the government, has been selected to represent the first category. Physically, it is a dense non-vertical neighbourhood with a mixed tenure status. The second type of neighbourhood selected for this case study is also an informal settlement: a less dense non-vertical neighbourhood, which has had its physical characteristics enhanced through incremental interventions (e.g. provision of sanitation, building improvements). In this second type, all residents registered their land and have been granted various land rights. The third type of neighbourhood selected for this study is represented by two neighbourhoods from each city, which have experienced urban regeneration in the form of vertical development.

## 4.2 Data collection

We collected data in each class of urban neighbourhood and focused on five themes:

1. **Physical attributes of the neighbourhoods:** number of people in each house, types of houses and materials, basic services in each household, infrastructure in the neighbourhood, and perception of residents about the neighbourhood as a physical environment.
  2. **Interactions with built and social environments:** roles of neighbourhood for each resident, the meaning of social interaction for residents, space for social interactions in the neighbourhood, and type of space used for social interactions.
  3. **Climate change impacts in each neighbourhood:** most pressing impact of climate change in the neighbourhood and existing coping strategies, and specific preventive measures taken by each resident in dealing with personal health.
  4. **Health outcomes in each neighbourhood class:** residents' health information and cases and residents' spending on health.
  5. **Future expectations:** expectations of residents about the neighbourhood and resident attitudes toward urban regeneration.
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Data was collected through the distribution of questionnaires to every household in the selected neighbourhoods. Table 1 illustrates all these case studies including their typologies and number of respondents, of which there were 361 in total. We used proportional random sampling especially for the larger sites of case studies 2 and 4, as examples of vertical housing. In all case studies people were informed prior to the survey, and there was an option for them to participate in or decline the survey.

Table 1. Typology of the case studies

City	Typology of neighbourhoods	Case study	Population (households)	Respondents (households)	Percentage (respondents/population)
Semarang	Non-vertical housing; without interventions	1	85	85	100%
	Vertical housing (rental flats)	2	650	100	15.4%
Pekalongan	Non-vertical housing; with incremental infrastructure interventions	3	100	76	76%
	Vertical housing (rental flats)	4	189	100	52.9%
<b>Total</b>			<b>1024</b>	<b>361</b>	

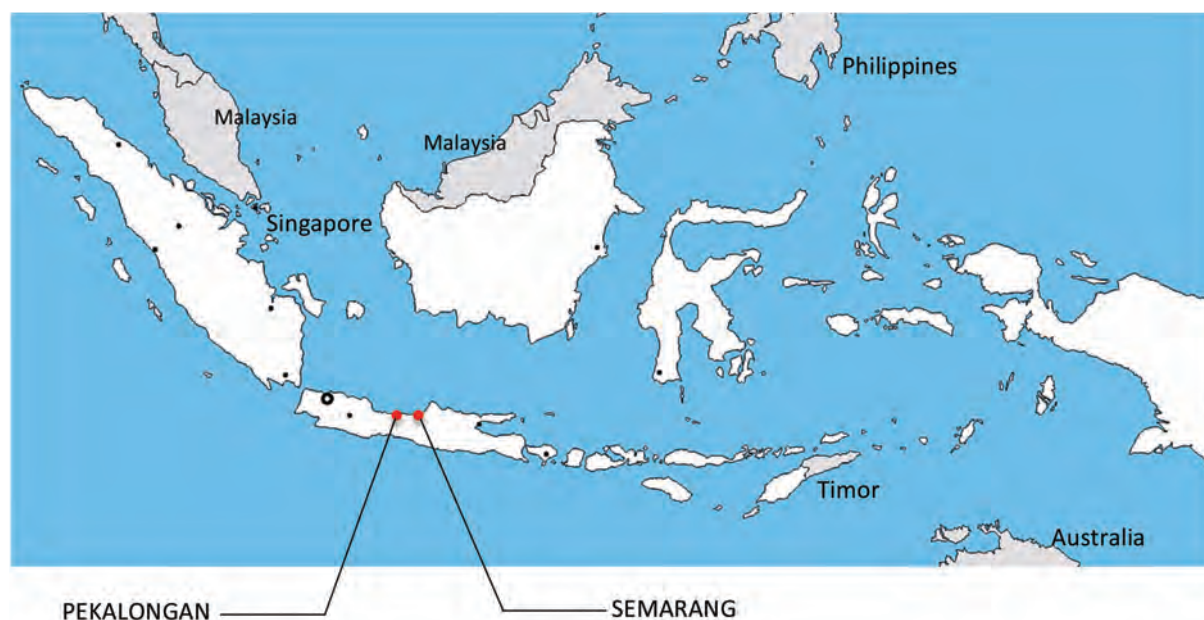
On average, 81.6 per cent of respondents were women aged 26–60 years, employed in non-formal jobs. Many of them are self-employed. Approximately 70 per cent of people living in these neighbourhoods are low-income earners.<sup>2</sup> Most respondents were women because they were at home during the survey, while most men were at work. However, in the survey women were able to give information on behalf of all family members.

### 4.3 Case study cities: selection and description

The case study sites used in this research are in the cities of Semarang and Pekalongan in Indonesia. These cities are the earliest adopters of climate adaptation policies amongst approximately 500 city governments in Indonesia (BAPPENAS, 2014). Figure 3 indicates the geographical location of the cities of Semarang and Pekalongan. Both share a basic similarity in terms of geographical situation – both are located on the north coast of Java and they are challenged by almost the same urban and socio-environmental problems that are likely to increase in magnitude due to climate change.

<sup>2</sup> Total family income falls into two low-income brackets. In this study, the lowest income bracket is up to IDR 1 million per month or approximately US\$2.7 per day. The second-lowest income bracket is from IDR 1–1.5 million per month (between US\$2.70–4 per day).

## Figure 3. Geographical locations of Semarang and Pekalongan



Edited by authors from a free source of map on: d-maps.com. [http://d-maps.com/carte.php?num\\_car=5486&lang=en](http://d-maps.com/carte.php?num_car=5486&lang=en)

### 4.3.1 Case study 1, Semarang City: non-vertical housing, without interventions

The first case study site is located on Tlogomulyo sub-district, particularly in Rukun Warga (RW) 2 ('Citizen Association' 2), an administrative neighbourhood unit below the sub-district, which consists of several blocks. This neighbourhood covers about one hectare of residential area and consists of four *rukun tetangga* (RTs) or neighbourhood associations, the formal and lowest administrative unit that is equivalent to blocks. A total of 85 households live in this neighbourhood. This neighbourhood was established in the 1970s through BANPRES (Presidential Assistance Project), with the relocation area of a typical slum located near to the city centre of Semarang, which was also a traditional market. After more than four decades, the physical condition of this neighbourhood has declined due to lack of investment.

This neighbourhood is clustered around vacant land in the north part of Tlogomulyo. The railway connecting the cities of Semarang and Solo (Surakarta) is situated on the north side of this neighbourhood (see Box 1a). Although the neighbourhood has four public wells, none provide drinkable water. The people therefore have to rely on drinking-water vendors who regularly visit the neighbourhood. The average house size in the neighbourhood is relatively small compared to the majority of houses in the city; some have two floors. Approximately 60 per cent of adults in this neighbourhood are self-employed. They collect used tyres to be recycled into other rubber-based products. They keep the tyres outside their homes and along the streets. Hundreds of tyres become water pockets during the rainy seasons and provide a fertile environment for mosquitos to breed during dry seasons. A few residents of this neighbourhood have developed an autonomous adaptation mechanism to reduce the risk of mosquitos breeding in the tyres. For example, they construct open storage areas equipped with a tin roof or simply cover the tyres with recycled plastic sheets. A few people in the neighbourhood breed domesticated animals, especially chickens, which are kept outside their houses. Drainage systems in this neighbourhood are not well maintained and some parts are not equipped at all. These situations in combination with climate change impacts present a challenge to the health of the inhabitants.

### 4.3.2 Case study 2, Semarang City: vertical housing

This neighbourhood has an area of approximately 6 hectares and is administratively located in Kaligawe sub-district (see Box 1b). It consists of seven twin block units of vertical public housing. Each block mostly has four floors of 94 housing units. Approximately 650 households live in this neighbourhood. The Gayamsari toll road connecting the city centre of Semarang to the southern regions of the city stretches along the western side of this neighbourhood. On the east flows the Banjir Kanal Timur River, one of the main river systems of the city. In between this neighbourhood and the river, there is a water-retention pool for flood control, a traditional market, and a natural pond. The history of this neighbourhood goes back to the 1970s, when the government relocated a number of people here to develop toll road projects in Semarang. The first three blocks (blocks A, B and C) were allocated as compensation to those who lost their land to the toll project. However, the rest of the blocks, which were developed in 2009, are owned by the city government of Semarang and people living there pay monthly rent to the city government. The government selects the occupants based on applications. Monthly rent for the top floor and ground floor is IDR75,000 (equivalent to US\$6.25) and IDR110,000 (equivalent to US\$9.1) respectively, while the monthly rent for the second and third floors is IDR90,000 (equivalent to US\$7.5) and IDR100,000 (equivalent to US\$8.3) respectively. The physical conditions of the buildings vary, in which housing units in blocks A, B and C are of poorer quality than that of the rest of the blocks (D, E, F and G). Housing blocks in this neighbourhood are located a considerable distance from one another. However, the utilisation of space in between these blocks is not yet optimal and seems neglected.

The city government of Semarang established a special service unit for public rental flats (UPTD Rusunawa) and this institution is responsible for the technical management of public housing. In each block, there is a *paguyuban*, an informal community association led by a chair, who is elected democratically. The *paguyuban* chair is responsible for maintaining communication with the UPTD Rusunawa, as it does not have an office on site.

### 4.3.3 Case study 3, Pekalongan City: non-vertical housing, incremental interventions

This case study is located in Tirta sub-district, on the outskirts of the western part of Pekalongan City (Box 1c). The total population of this village is about 10,500 people. This study focuses on Rukun Warga (RW) 8. Within this neighbourhood, we examine RTs or blocks 3 and 4, which are populated by 100 households. This neighbourhood was established informally without proper and legitimate development planning procedures as a part of the euphoria of decentralisation reform from the end of 1999 until early 2000 following the collapse of President Suharto's regime. Under this regime, access to land was limited to the upper class and it left large inequalities in society, especially for poor and marginalised groups. Therefore, during this period of regime collapse, local people who were mostly from marginal groups appropriated vacant land and built housing on it to exercise their rights to land.

This neighbourhood was built on neglected lowland rice fields, riverbanks, and former railways used for transporting sugarcane from state-owned plantation fields to a sugar factory outside the city of Pekalongan. The land that is currently occupied by residents in this neighbourhood legally belongs to and is under the authority of the state-owned railway company (PJKA). After inhabiting this neighbourhood for nearly one and half decades, residents are now required to pay rent for the land at IDR26,000 (just above US\$2) per household per year. This neighbourhood is now situated at a relatively moderate density. Vacant land between buildings can be seen and is still often encountered.

The polluted Brengi River flows not far from this neighbourhood and some houses have been built just beside the river. The water of the river is black because of the flow of batik dye mixed with a variety of domestic waste. Batik is the art of painting on fabric and the batik industry employs 70 per cent of adult residents in the city. According to residents living in the area, the water level of the river is shallow, but the sedimented mud is very thick, up to one metre deep. The surface of the river during the dry season is fully covered by water hyacinth.

Since 2006, led by the Office of Community Empowerment, the city government of Pekalongan has invested in a programme with a target of increasing the welfare of the poor and the improvement of their neighbourhoods and housing

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conditions. The target of the programme was 5,068 urban poor households, who were living in slum and inadequate housing, and they were spread over 286 location points. This case study neighbourhood was included in the programme and has received much support from it. The concrete form of the programme includes:

- Housing renovation: this project provides eligible households with building materials they need, with value at IDR2 million (approximately US\$165), for physical improvements to their homes. As this is just an incentive, every household depending on their capacity also tops up the fund to accomplish their own aspirations.
- Community-based sanitation: this project is a part of a collaboration between the city government and an initiative at the national government level, which were concentrated in this neighbourhood. Almost all households in this neighbourhood can have sanitation and local drainage systems installed for free.

Unfortunately, development assistance programmes for this neighbourhood have stopped, due to a new policy of the city mayor. The city mayor will not allow any form of development assistance to be allocated for households living on the riverbanks or land owned by state for public uses. The early 2014 flood hit many parts of the city including this neighbourhood. People living in the area directly adjacent to the river have said that they waited up to one month before the water completely receded from their homes. In this context, the construction of vertical housing or relocation of the settlement to a safer location may be a rational option that should be considered, preventing any further inefficiency of investment.

#### 4.3.4 Case study 4, Pekalongan City: vertical housing

This case study site is situated in Slamaran and is administratively located in Krapyak Lor sub-district (Box 1d). The neighbourhood covers an area of approximately two hectares and consists of three twin blocks of vertical housing. Each block has four floors with a total of 96 housing units. Each unit consists of an open studio without any partition that is equipped with one small bathroom, a kitchen and balcony. When the fieldwork was conducted, there were only 189 households living in this neighbourhood. This is less than its maximum occupancy due to the on-going renovation of more than ninety units. Low-income earners are likely to be attracted to this neighbourhood. At the time that our survey was conducted, 76 households were already on the waiting list to fill up the units. These housing flats are for rent and targeted at low-income groups, with incomes below IDR2 million (less than US\$165) per month.

This neighbourhood complex was built in a location that is higher than the surrounding settlements, and the Java Sea lies 1.5 kilometres to the north. A canal flows along the west side of this neighbourhood that could connect this area with a dense old coastal fishing town and the coast of Pekalongan. Construction of vertical public housing in this neighbourhood was a part of the housing development programme initiated by the national government through the Public Works Department. Housing Block B was first developed in 2007 and has been operating since 2009, with two other blocks (blocks A and C) following in 2013. The rent here is more expensive than the equivalent unit in the city of Semarang. Rent per unit per month on the first and fourth floors is IDR125,000 (equivalent to US\$10.40) and IDR100,000 (equivalent to US\$8.30) respectively, while the rent on the second and third floors is IDR110,000. The maximum lease duration allowed is three years. A division within the Public Works Agency in the city government of Pekalongan was established and is responsible for the management of the flats with an operational office in the complex.

In the centre of each block, the housing management provides a simple garden. Housing blocks in this neighbourhood have a considerable distance between one and another. However, the utilisation of space in between these blocks is not yet optimal and seems neglected. Two pumping wells were built to provide water for the residents. The water is distributed to each block and each household has an individual water meter. The majority of inhabitants work in the informal sector or are self-employed. Some public areas in this neighbourhood, such as parking spaces and corridors, have been used by some people for personal purposes related to their profession. Within this neighbourhood, some facilities, including after-school informal educational facilities and a small mosque, are available for the residents. It is also situated not far from a public school and health centre facilities.

Box 1 situates the location of each case study within the city and shows satellite images of case studies. The satellite images show two contrasting physical typologies of human settlement in case studies.

## Box 1: Satellite images of the case studies



Box 1-A: Case Study 1 – Non-vertical neighbourhood/Informal settlement in Telogomulyo Sub-District (Semarang City)



Box 1-B: Case Study 2 – Vertical neighbourhood/Public rental flats in Kaligawe Sub-District (Semarang City)



Box 1-C: Case Study 3 – Non-vertical neighbourhood/Informal settlement in Tirto Sub-District (Pekalongan City)



Box 1-D: Case Study 4 – Vertical neighbourhood/Public rental flats in Krapyak Lor Sub-District (Pekalongan City)

# 5 Social, physical and geographical features of the neighbourhoods

In the following sub-sections, we focus on comparing some key features that may contribute to and may be useful in explaining health outcomes of residents in the three different classes of neighbourhood as used in the study (see also Table 2).

## 5.1 Social features

As is typical of urban neighbourhoods, the interaction between residents and their environment as a natural resource in these case studies has been relatively weak. Community livelihoods in these neighbourhoods have not relied on environmental components such as rivers, ponds or fertile productive land. The health of the environment or its ecosystems is less important for the residents. This to some extent has contributed in shaping the attitude or behaviour of residents towards these critical environmental components. For example, in the case study areas of non-vertical informal settlements, where the coverage of waste collection service is low, some residents dump rubbish directly into the rivers or waterways. In the case study areas of vertical housing (public rental flats) with poor management, some residents leave rubbish in open vacant land nearby. This irresponsible lifestyle in turn could affect negatively the health of residents.

Some residents use their homes as a place of work. They open up shops providing groceries and fresh food to the neighbourhood. Some others offer services such as hairdressing, tailoring, electronics repair, laundering and crafts where they live. Surprisingly, 28.5 per cent of residents of the public rental flats use their homes as a place of work, compared to only 14.8 per cent in the informal settlements. A general claim saying that living in vertical dwellings limits entrepreneurship or scope for adopting different livelihoods for residents is debatable according to this case study. However, combining their place of residence and work raises concerns regarding the health of residents and safety, especially when these homes are not designed originally for such purposes.

The impact of climate change on children in urban contexts should not only consider children who live in clearly vulnerable areas in non-vertical urban settlements. Children living in typical high-density buildings should be considered also. The ratio between adults and children is also higher in vertical housing than in non-vertical. In vertical housing, for every 10 adults there are 7–8 children, while there are only 4–5 children in non-vertical housing.

Table 2. Key features of the case-study areas

Key features	Case 1	Case 2	Case 3	Case 4
<b>General</b>				
Neighbourhood's physical typology	Non-vertical	Vertical	Non-vertical	Vertical
Type of interventions	Not available	Comprehensive*	Incremental**	Comprehensive*
Total households	85	650	100	189
Number of people/room	2–3	4	2–3	4
Built-up areas/people	10	4	17	4
Children for every 10 adults	4–5	7–8	4–5	7–8
<b>Services and infrastructures</b>				
Access to water (%)	100	100	100	100
Private sanitation (%)	65	100	98	100
Waste services (%)	0	100	35	100
Permanent structure (%)	25	100	82	100
Tiled floor (%)	46	100	96	100
Drainage/sewer (%)	73	100	92	100
<b>Social</b>				
Land title (%)	55	100	100	100
Buys drinking water from private vendors (%)	93	94	15	6
Has good social relationships (%)	94	84	99	80
<b>Residents' assessments of local health services</b>				
Affordable (%)	72	75	99	75
Representative (%)	86	76	100	84
Easily accessible (%)	65	88	97	92
<b>Existing climate risks</b>				
Floods	Rain-induced	Tidal and rain-induced	Rain-induced	n/a

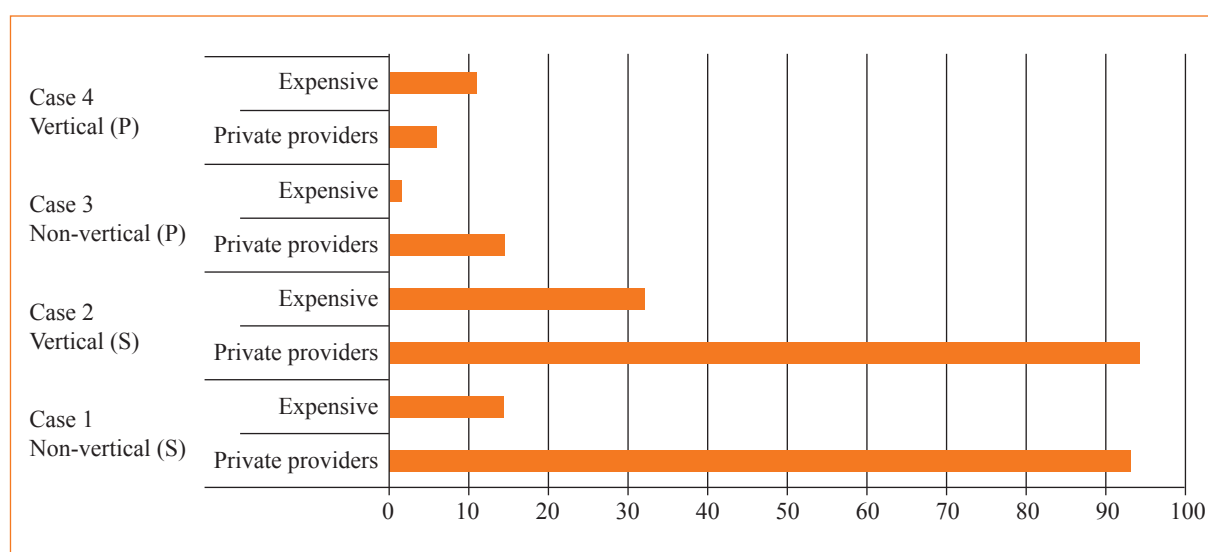
\* Rental flats development (includes basic service provision)

\*\* Provision of sanitation and building renovations

Dependency on private vendors for drinking water is paramount in the city of Semarang (cases 1 and 2), much more than in the city of Pekalongan (cases 3 and 4). In cases 1 and 2, more than 90 per cent of the population rely on private vendors for drinking water, while less than 15 per cent do so in cases 3 and 4. Our survey shows that there is no relationship between the dependency on private vendors and the type of housing people live in. Dependency on private vendors for drinking water in the case study areas of Semarang is higher because the quality of water provided by the city government-owned water company is relatively poor, while the water produced by community wells is undrinkable. In all cases, water from water companies and wells<sup>3</sup> are used for washing. So, the level of dependency on private vendors is influenced more by the quality of water provided by water companies or community wells in each city.

The results indicate that the price of water in the city of Semarang is much higher than in the city of Pekalongan. Figure 4 shows the perception of respondents on water prices and the percentage of respondents who rely on private vendors for drinking water. Residents who rely on private vendors for drinking water are likely to categorise water prices as expensive. Private vendors charge more per unit of water than public water companies. For instance, private vendors charge US\$0.3–1.20 per gallon of drinking water depending on their brands while public water companies charge US\$0.18–0.30 per cubic meter of water depending on the household class.

Figure 4. Percentage of respondents who buy drinking water and perceptions of price



Our results also show that the main reason for living in the case study area is cheap housing or rent, especially for the vertical housing, which is followed by family reasons. There are no issues with land rights for the rental flats (cases 2 and 4) since they have been built on government land. However, in the non-vertical housing areas, especially in the city of Semarang, land titles are quite problematic since 45 per cent of respondents have not registered their land. In the non-vertical housing in Pekalongan (Case 3), all the land has been registered, either as Freehold Right (HM) or Building Right (HGB) land.<sup>4</sup>

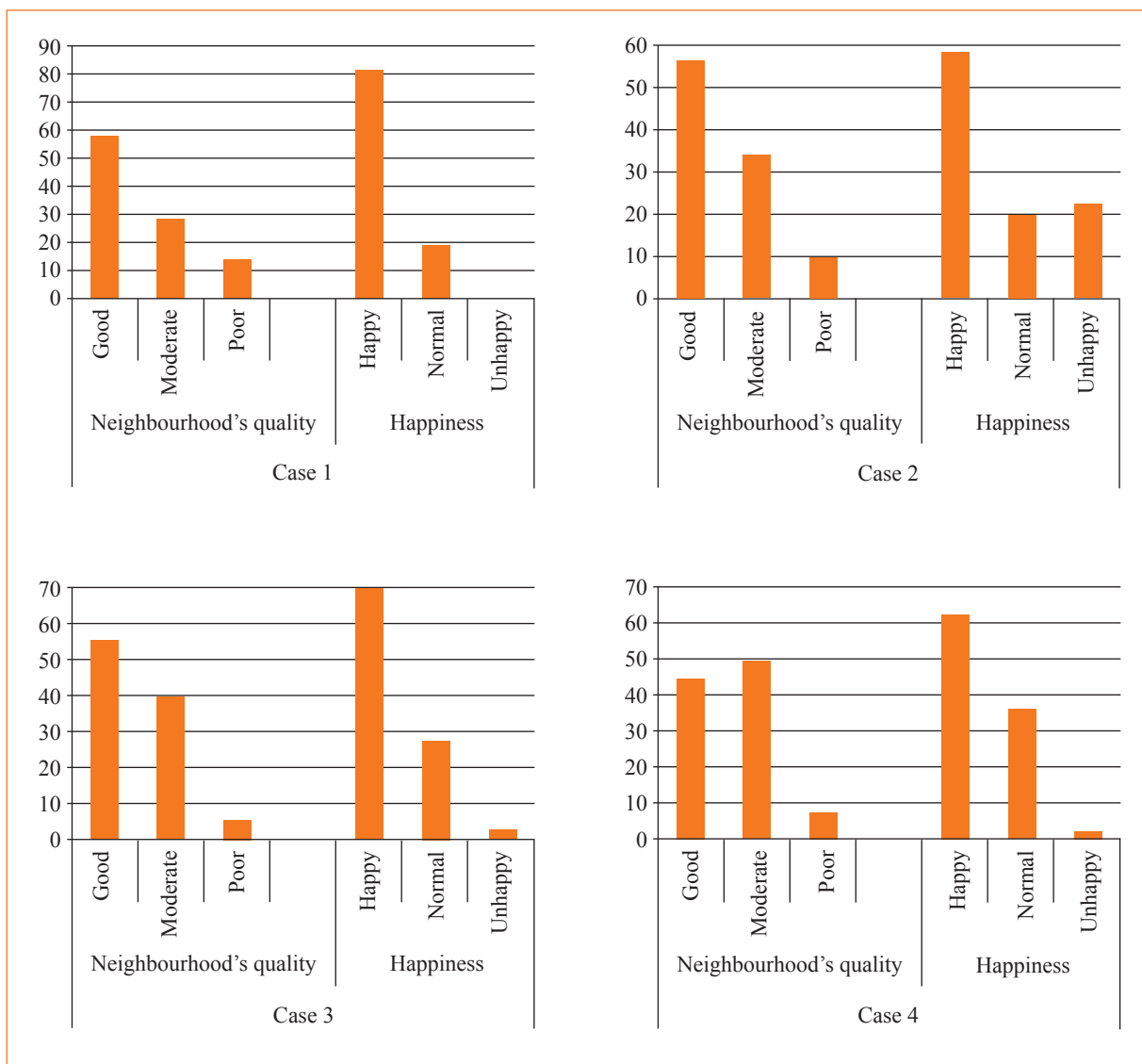
<sup>3</sup> In this working paper, sources of water which the community has to pay for are associated with the water company. These sources are usually managed by the water company and users are individually metered, although the source of water could be from wells not surface water. Sources of water for which community does not need to pay are associated with wells.

<sup>4</sup> The freehold right (HM) is the highest right to land that can be owned by Indonesian citizens only. This right is for life and can be inherited. The building right (HGB) is the right to establish a building on the land even if it does not belong to the builder. This right can be given to Indonesian citizens and corporations located and established under Indonesia's law with a maximum period of 30 years. Other land rights include the cultivation right (HGU), the right to use (HP), and right to rent (HS). See Hadullah (2011: 9) for further information.

According to people's self-assessments, in all case study areas, people have either good or moderate social lives and social ties. However, the quality of social life and social ties is slightly lower in the public rental flats due to new people who have recently moved into the area and because there is less space for social interactions such as community halls. Local health services in all case studies are relatively equal. The majority of people living in these neighbourhoods perceive that local health centres are affordable, are well-maintained, and are easily accessible.

Regardless of the measurable and comparable facts, overall, residents in each case study area consider that their neighbourhoods are in either good or moderate condition, and their views are consistent with the level of happiness reported for living in the neighbourhood. Figure 5 shows the comparison of overall neighbourhood quality and the feelings of residents.

Figure 5. Self-assessment: quality of neighbourhood and level of happiness



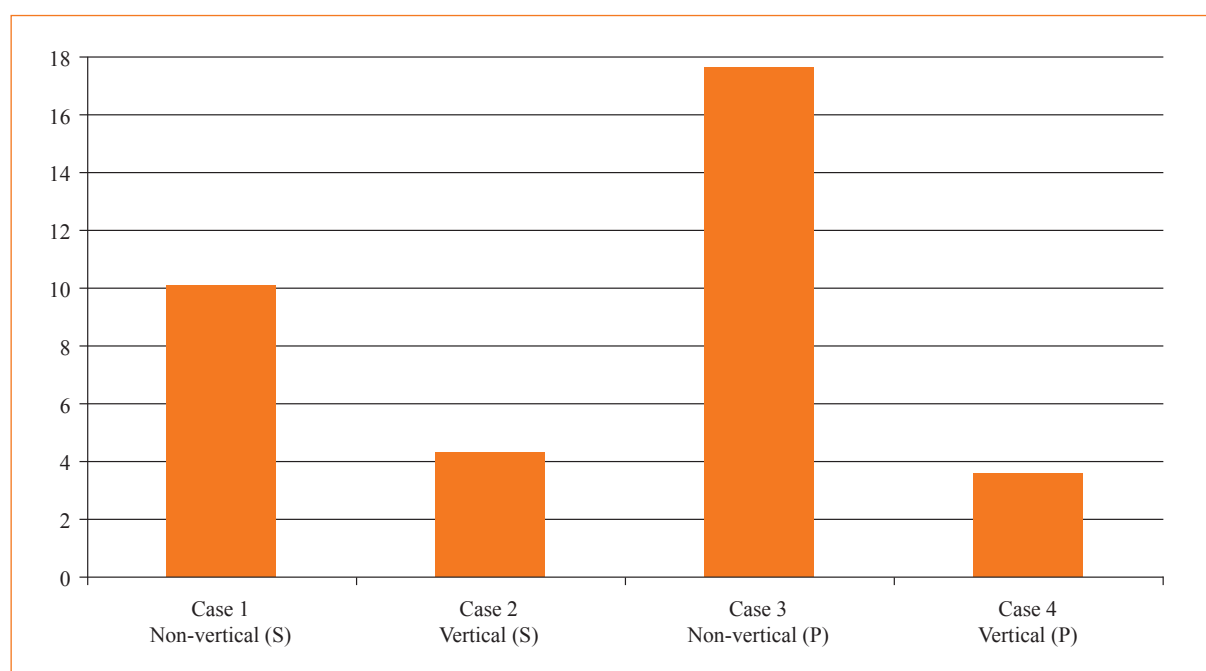
This study found no relationship between the type of housing and the residents' valuing of such facilities as playgrounds for children or green open spaces. However, the results indicate that the residents in the bigger cities (cases 1 and 2) value playgrounds and green open spaces more than residents in the smaller city area (cases 3 and 4). This does not, however, mean that those living in Case 3 (houses) and Case 4 (public rental flats) in the city of Pekalongan do not need these facilities. Some reasons for this difference include the availability of the existing informal green open spaces and some vacant land in these areas, which function as formal green open spaces for the residents. Another reason could be the length of lease in public flats (Case 4), which is limited to three years in Pekalongan; this could reduce community interest in caring for their neighbourhood.

In terms of disaster management, a local institution known as the Regional Disaster Management Board (BPBD) is available in the cities of Semarang and Pekalongan. This board consists of representatives of various sectors and agencies. As part of a nationwide programme since 2007, BPBDs are well established and continuously equipped. The performance of the BPBD in each city to respond to extreme events is relatively equal in each case study area, since institutional arrangements and coordination mechanisms follow a single design prepared by the National Disaster Management Board (BNPB). Basic service provisions such as temporary shelters, clean water, sanitation, medication and health treatment during and after disruption events fall under the BPBD's mandate.

## 5.2 Physical and geographical features

The satellite images in Box 1 show that physical or building density in the informal settlements (cases 1 and 3) is higher than the density of public rental flat neighbourhoods (cases 2 and 4). However, the number of people living in vertical housing (public rental flats) is greater than in the non-vertical housing (informal settlements). The ratio between occupants and the number of rooms is also higher in the vertical housing. Every single room in the vertical housing (cases 2 and 4) is occupied by four people on average, while in the non-vertical housing it two people. The net floor space of the vertical housing is about 4m<sup>2</sup> per person, while in the non-vertical housing is 10–17m<sup>2</sup> per person. Figure 6 illustrates the ratio of floor space in built-up areas and total occupants of each case study area.

Figure 6. Ratio of floor space to total occupants (m<sup>2</sup>/person)

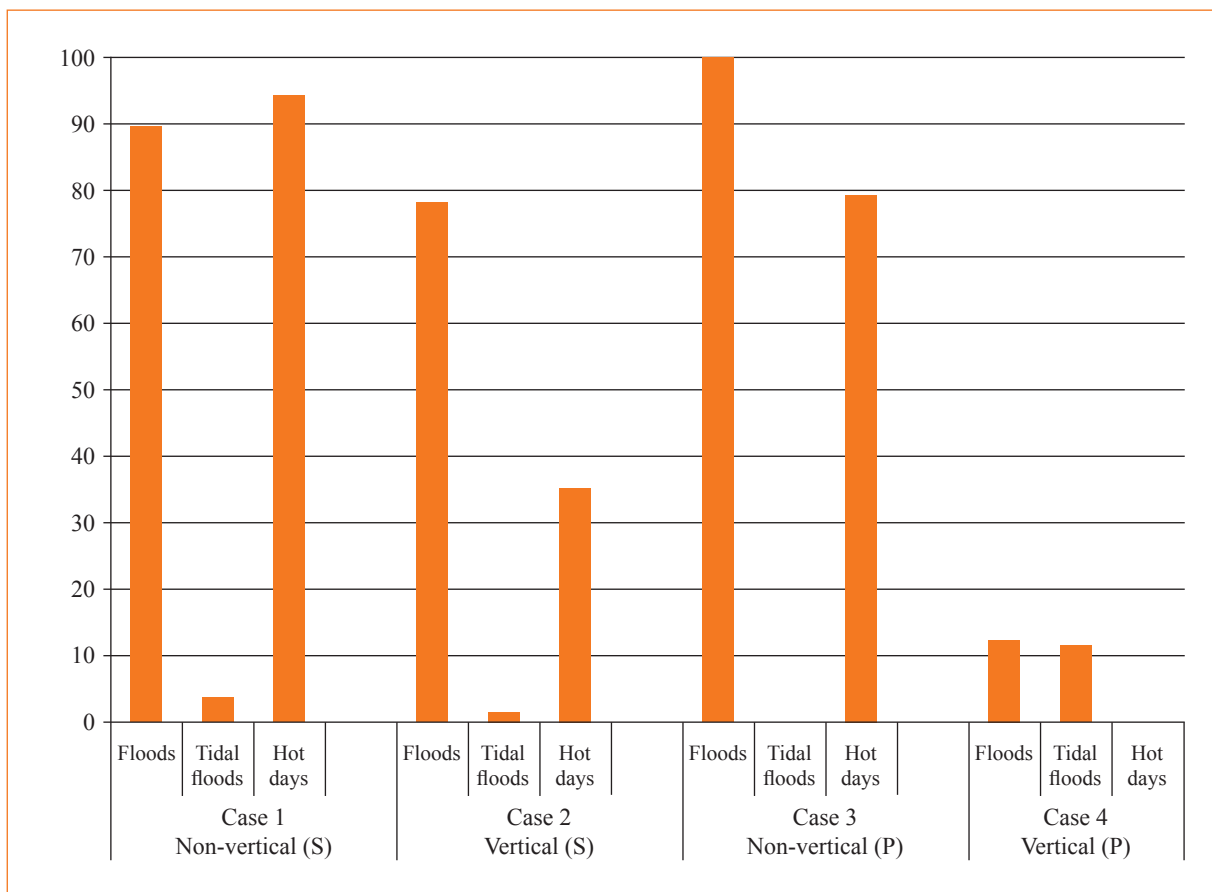


The first case study (non-vertical housing in the city of Semarang) has the poorest physical indicators. This case study area was deliberately chosen as it represents a typical neighbourhood that is declining due to lack of investment and has no government interventions. Land tenure in this area is mixed: some residents own their land and have building rights whereas some residents have been given the land but have not registered their land rights. The third case study area (non-vertical housing in the city of Pekalongan) has a level of physical indicators in between. The case study represents an incremental type of government intervention. In 2006 the city government of Pekalongan invested in a programme under a flagship poverty alleviation programme, through housing renovation projects and community-based sanitation projects. The second and fourth case study areas (public rental flats in Semarang and Pekalongan respectively) have better physical conditions in the sense that all units in the flats are of permanent construction, connected to running water and equipped with basic services.

The self-assessment of the community regarding climate risks in each neighbourhood shows that flood is the most common risk, mentioned in almost every case study, with the exception of Case 4 (public rental flats in the city of Pekalongan). This location is not significantly affected by rain-induced flooding and tidal floods because the floods actually occur in the surrounding neighbourhood.

There is an indication that public rental flats lessen the risk to their residents caused by an increase in temperature than non-vertical neighbourhoods do, with the exception of those areas with a large proportion of green open spaces (Case 3). In a typical low-rise urban area with a lack of green open space (Case 1), the increase of temperature affects them significantly. Figure 7 shows the self-assessment of residents regarding climate risks that they experience.

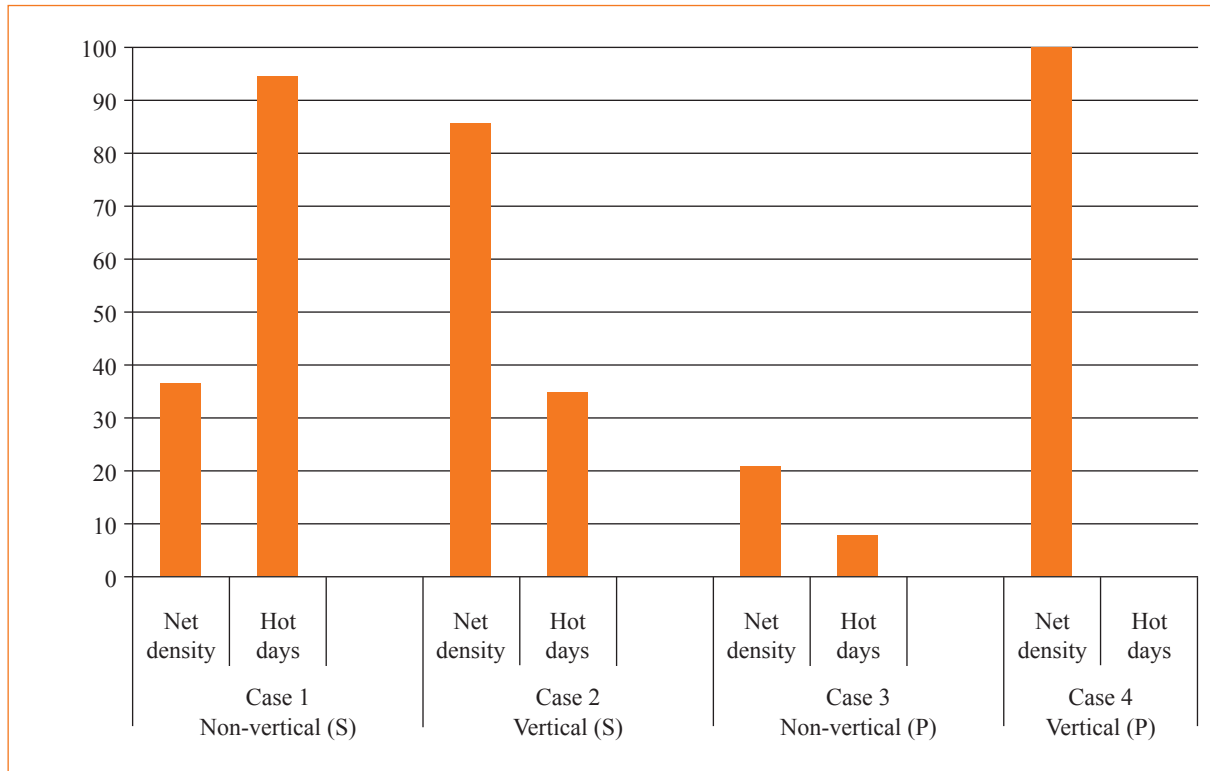
Figure 7. Self-assessment: residents' perceptions of climate risks





The effect of hot temperatures on living amenity should not be associated and do not necessarily affect those who are living in a neighbourhood with a high level of net density<sup>5</sup> of vertical housing as demonstrated in cases 2 and 4. Figure 8 demonstrates the comparison of standardised density level and residents' experiences with regards to hot days.

Figure 8. Standardised net density and percentage of respondents experiencing hot days



<sup>5</sup> We calculated the net density by dividing the total floor space by the number of residents, then standardised the density into a percentage, where the most dense was equal to 100 per cent.

## 6 Vertical housing for the urban poor in hazardous areas and health outcomes

In this section, we present some health outcomes resulting from different types of interventions. An emphasis has been placed on the robustness of vertical housing development for improving the health of residents. Firstly, in general, there is no clear-cut relationship between different types of disease and the types of neighbourhood, demonstrated by the four case studies. We surveyed the health status of residents including family members over a year (2014). According to these results, the incidence of diarrhoea and respiratory problems, for instance, appears unrelated to the type of housing occupied. However, there is an indication that public rental flats may reduce the risk of dengue fever to residents. Our survey did not find any family members living in vertical housing affected by dengue fever.

Secondly, public rental flats could provide better and healthier living environments, especially through the reduction of disease vectors, in particular rats and mice. Unfortunately, it does not seem to be effective in reducing the prominence of mosquitos. Figure 9 illustrates self-assessment of residents regarding the existence of rats and mosquitos in their home. It seems that all types of physical interventions (e.g. urban renewal, upgrading or regeneration) still allow mosquitos to be present in residents' houses. Additional measures are required to deal with this matter.

Thirdly, residents in public rental flats have a lower level of depression than those living in non-vertical neighbourhoods when experiencing floods and particularly during hot days. Figure 10 shows the emotional state of residents during hot days, while Figure 11 shows the emotional state of residents when experiencing floods. In the non-vertical neighbourhoods (cases 1 and 3), the flood physically entered the residents' houses. In contrast, in the public rental flats, floods only inundated the surrounding neighbourhoods, and only in the case of heavy might flooding affect the ground floor which is mostly vacant (e.g. parking space). The public rental flats in the city of Pekalongan actually played an important role during a catastrophic flood in the city in early 2014. The complex became an evacuation site for people from surrounding settlements, which were badly inundated.

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Figure 9. Self-assessment: residents with rats and mosquitos in the home (%)

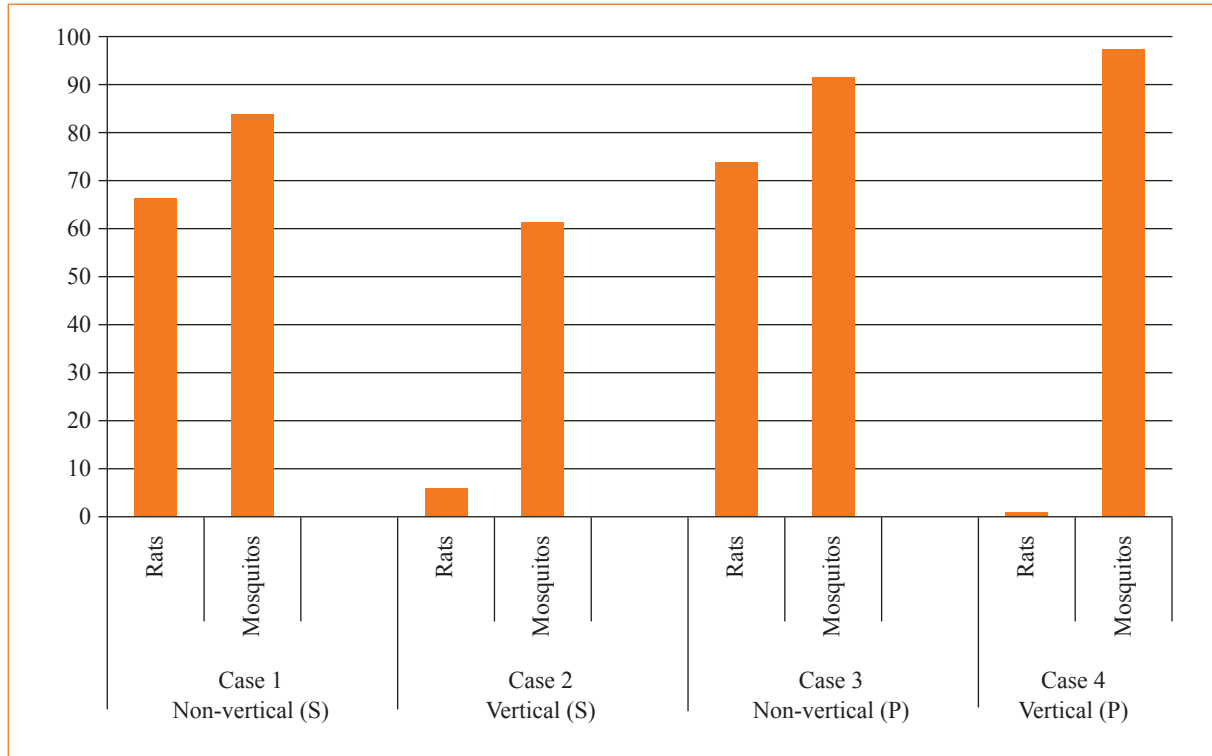


Figure 10. Residents' emotional state during hot days (%)

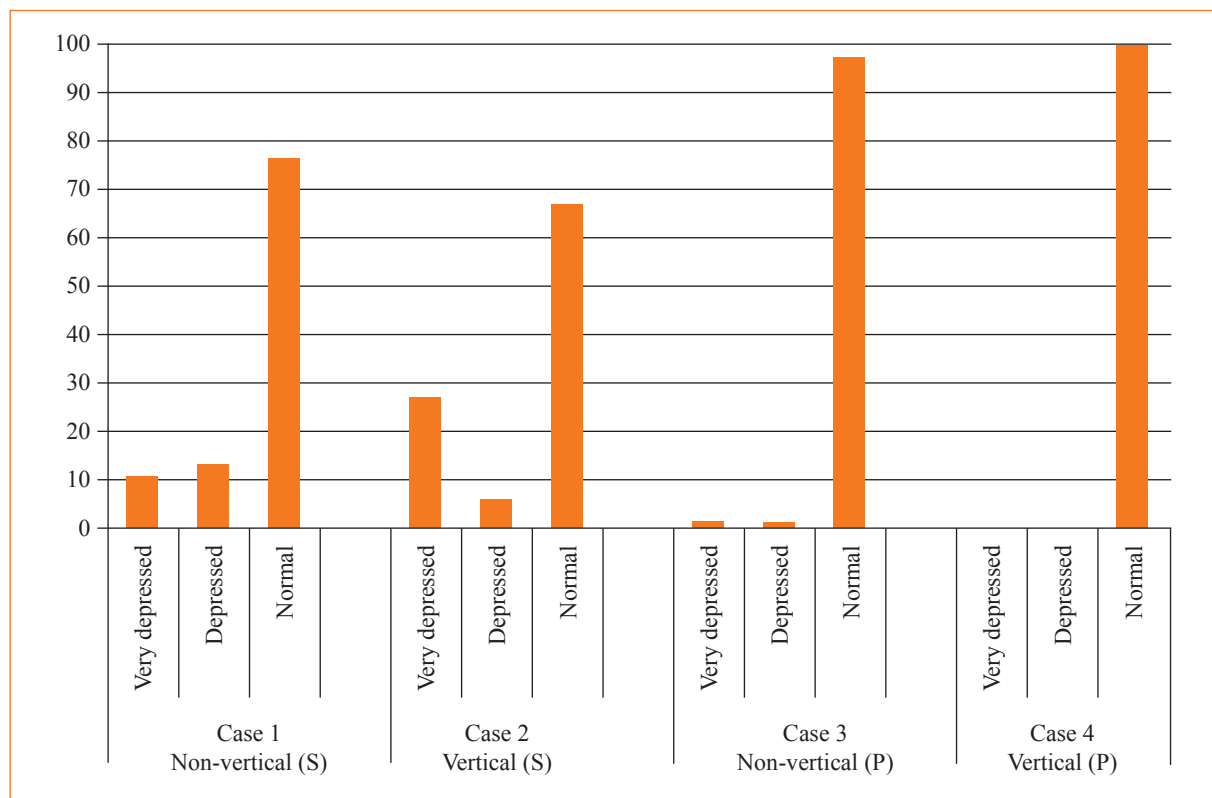
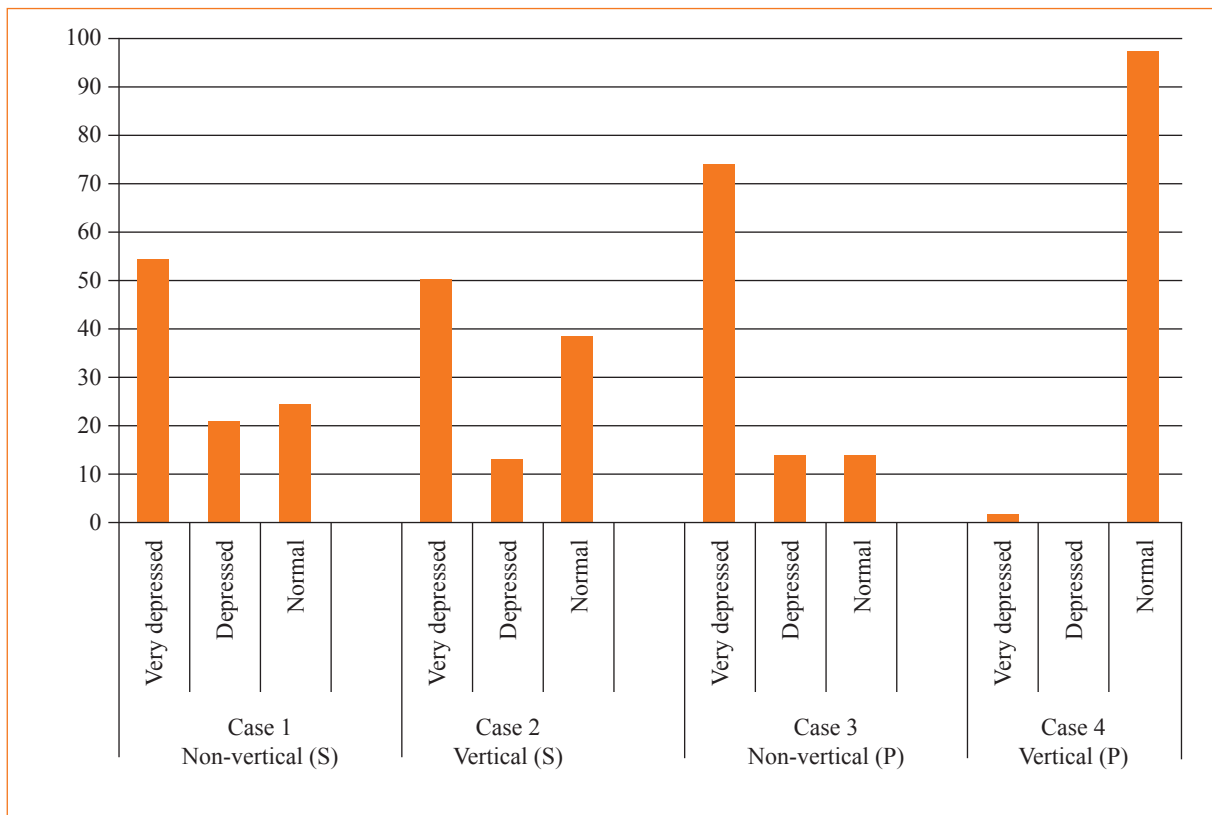


Figure 11. Resident's emotional state during floods (%)



McGranahan (2007) states that the health of urban residents represents a valid alternative indicator on urban well-being compared to others, such as income or consumption-based indicators. For example, having a high income is generally a good indicator but if most of one's income is spent on medication, then the relevance of high income is questionable. McMichael (2003) suggests looking at current health status and pre-existing disease burdens because these factors play a significant role in a changing climate and are specific for public health research. Campbell-Lendrum *et al.* (2003) and Kovats *et al.* (2014) suggest using the burden of disease and the disability-adjusted life year (DALY) as a technical indicator to measure the impact of climate change on the residents' health. The burden of disease refers to the total number of premature deaths and morbidity within the population.

Southeast Asia, where this case study is located, has the highest DALY totals amongst other regions in the world (Costello *et al.*, 2009). DALY is the sum of two sub-indicators known as Years of Life Lost due to premature death (YLL) and years of life lived with disability (YLD) (Campbell-Lendrum *et al.*, 2003). YLL calculates the average gap between the age of death and the maximum life expectancy, while YLD calculates the average time lost due to injury or duration of illness, which is experienced by each individual in a particular geographic region or country. As DALY was firstly designed to compare global health, it counts all causes of disability and death including cardiovascular diseases, diarrhoea, malaria, accidental injuries in coastal and inland floods and landslides, and the unavailability of recommended daily calorie intake. However this study limits the cause of disability only to that from water- and vector-borne diseases, respiratory problems, and extreme-event-related deaths and injuries because these characterise the most obvious direct impacts of climate change on health in urban informal settlements.

Therefore, some indicators investigated in this section include:

- The frequency of illness of residents related to faecal, respiratory and vector-borne diseases,
- The duration of illness and disability,
- The age at death of family members, and
- The percentage of residents under stress conditions due to climatic change (hot temperatures, floods, etc.).

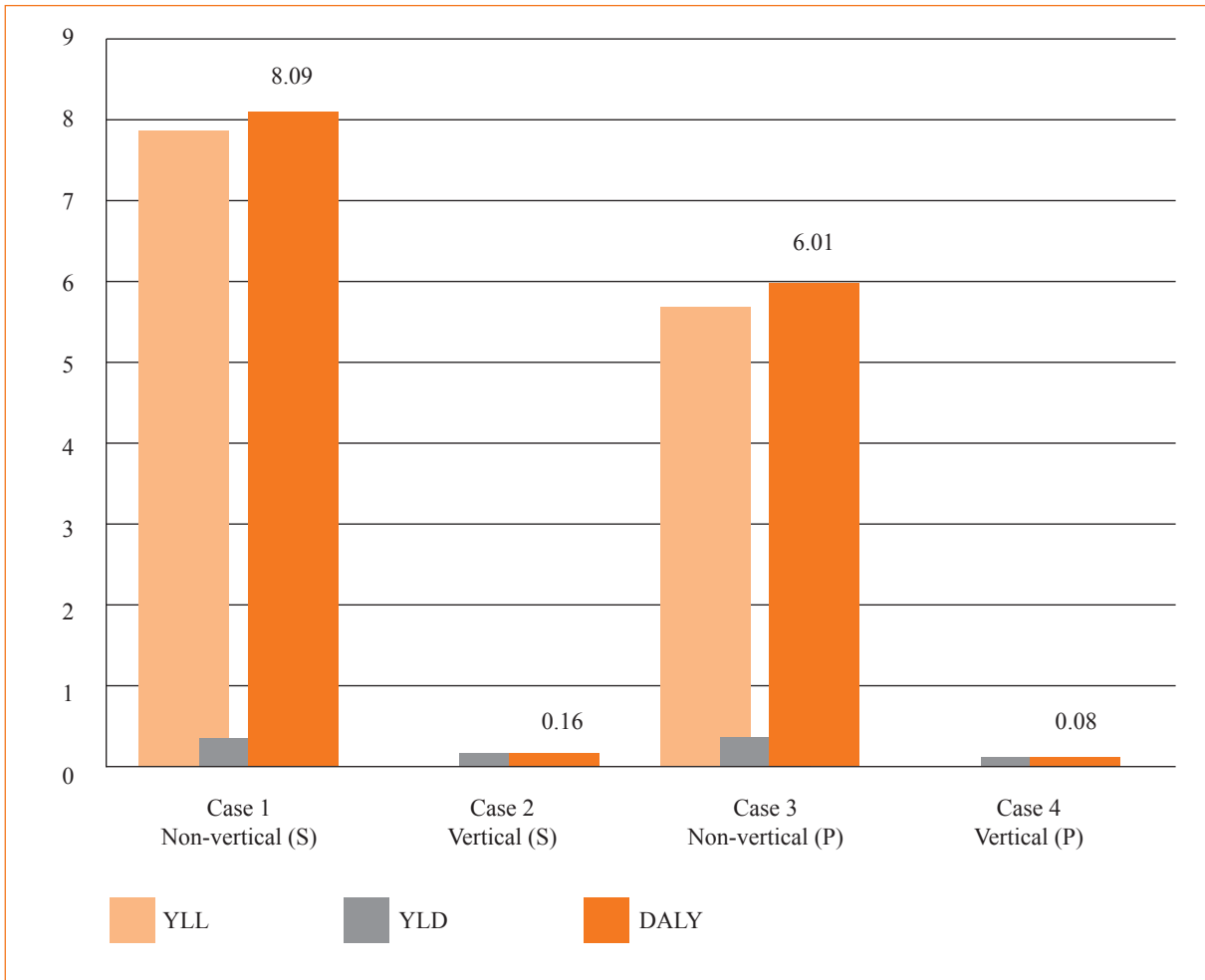
It is not possible to compare the age of death between both types of housing due to the short length of lease in the public rental flats. Our survey did not find any incidences of family member death in the vertical housing, although there were some incidences in the non-vertical housing. The survey data in this study demonstrates that people in neighbourhoods that receive incremental interventions have an opportunity to live longer than people in neighbourhoods that have no intervention. The years of life lost (YLL) calculation shows that people who live in the informal settlements without any planned intervention will reduce their lifespan by 7.9 years, while it reduces lifespan by 5.7 years for those who live in the informal settlements with partial interventions. However, in relation to this study, the YLL due to premature death that could be linked to a climate-related disaster, such as floods and storms, was zero for all four case studies. There were no cases of death for these reasons.

The official data at the sub-district level in the last twelve months, from November 2013 to November 2014, before this survey was performed, revealed that there were 247 total deaths out of approximately 20,000 people in that period of time. In most cases (80 per cent), the cause of death was unknown, usually relating to missing data due to poor data management at the sub-district level. Of the known causes of death, cardiovascular-related disease accounted the second highest cause of death (8.5 per cent) and was followed by diabetes, kidney failure and liver disease (6.4 per cent) and accidents (2.2 per cent). Dengue fever, respiratory disease and cancer were insignificant causes of death. Each contributed to only 0.8 per cent of deaths. The small total sample size may be too limited to relate housing type to climate change-related health impacts, in particular to the age of death indicator. Were the geographical coverage of this case study expanded, the findings would be relevant to the fifth IPCC report, which states with medium confidence that the impacts of climate change will result in increasing loss of life but not at a massive scale.

Lastly, the years of life lived with disability (YLD) totals are lower in the public rental flats, and considerably lower in the public rental flats with better management (Case 4). YLD is different to YLL because it only accounts for the severity of a disease from its capacity to cause ill health or trigger disability. The YLD in this study shows the average number of days that people in the neighbourhood will experience ill health due to diarrhoea, respiratory problems and dengue fever in their lifetime, as possibly climate-related diseases. The YLD due to injury were ruled out of the equation because there were no cases of injury that could be linked to climate-related disasters, such as floods and storms, in all case study areas. The YLD of people in public rental flats in both cities are better than in the other non-vertical neighbourhoods. In the city of Semarang, the YLD of the public rental flat neighbourhood is 56.7 days per person, which is lower than the YLD in the non-vertical neighbourhood at 70.3 days per person. In the city of Pekalongan, the YLD of the public rental flat neighbourhood is 28.3 days per person, which is considerably lower than the YLD in the non-vertical neighbourhood at 114.5 days per person. This suggests that residents living in vertical developments will spend less of their lifetime suffering with illness, living healthier and safer lives than their non-vertical counterparts.

The disability-adjusted life year (DALY) indicator, which is the sum of the YLL and YLD, shows that public rental flats appear to have better health performance (see Figure 12). However, we need also to be aware of the limits of the DALY indicator that is used in this situation. The limit in using DALY is significant as it is extremely difficult to find the age of death data in areas where populations constantly move as in the case of public rental flats. This requires further study to better understand which indicators are useful in measuring and understanding 'well-being' in both formal and informal settlements. It is also a sensitive topic to ask about in a questionnaire. During the fieldwork, the questionnaire survey was conducted with the consent of respondents and we provided an option for respondents to withdraw their participation at any time.

Figure 12. The disability-adjusted life year (DALY) indicator (in years)



## 6.1 Potential and opportunities

Our survey data regarding all physical indicators show that public rental flats are mostly equipped with better or at least complete services and infrastructure in comparison to a typical non-vertical neighbourhood of low-income groups. All services from water to sanitation and from drainage to waste collection are fully provided, and basic infrastructure such as a permanent building structure, floor and drainage are available.<sup>6</sup> Public rental flats in both cities also experienced less risk from inundation, both through rain and tidal-induced floods, in comparison to the other case study areas in non-vertical neighbourhoods. Public rental flats also scored lower on the YLD outputs. From all of these perspectives, public rental flats seem promising as a strategy for low-income groups to adapt to the impacts of climate change when they are properly managed and maintained. It is also central to provide vulnerable groups, including the urban poor, with the opportunity to realise their basic right for inhabitable shelters.

<sup>6</sup> However, it is important to note that these services and infrastructures have different levels of service.

At least two reasons explain why public rental flats have better performance indicators in comparison to other typical non-vertical neighbourhoods of low-income communities. Firstly, there is a legal framework available that regulates vertical housing development. The central government passed Law 20/2011 regarding vertical housing, which specifies basic requirements that should be fulfilled by developers, including administrative, technical and environmental requirements. For instance, in Article 34 one administrative requirement stipulates that:

*The construction of vertical housing is based on the calculation of and the determination of the building floor coefficient and the building base coefficient, which are aligned with the environmental carrying capacity and threshold and refer to the spatial plans.*

This law containing 120 articles and 266 paragraphs applies to any kind of vertical housing development, and especially those that are funded by the government. Complying with these basic requirements aims to drive the development of public rental flats away from land-right disputes and hazardous spots. The law also demands city governments to comply with the fulfilment of basic services and infrastructure. Regardless of its level of service, all types of basic services and infrastructure are costed into public rental rents. This provision does make a significant contribution to the resilience and health of its residents. In addition, the huge amount of investment that both by the central and city governments have to make does not provide an incentive for them to use trial and error when developing public rental flats but makes them more mindful for example in selecting sites for public rental flats.

Secondly, typical non-vertical neighbourhoods dominated by low-income communities are in a state of decline in terms of physical and functional features due to a lack of investment by public agencies and land owners. Roberts (2004) states that no city is immune to changes that accrue from both external and internal factors. Climate change presents external factors, while existing urban systems reflect internal factors, and these factors interact with each other. Besides these factors influencing the growth of a city, they also have the potential to degrade a particular function of the city and even make the city's achievements less significant. In many vulnerable neighbourhoods, this situation is exacerbated by inequality that makes it difficult to re-invest and to revitalise critical infrastructures or to afford to invest in basic services.

The development of public rental flats deserves to be considered as one possible alternative in improving health resilience, enhancing the living conditions of the vulnerable urban poor and providing protection from the impacts of climate change, and providing them with inhabitable shelter according to their rights. However, the same can be said for public investment that has gone into improving sanitation and facilities in existing informal settlements rather than in new vertical dwellings. These investments, regardless of housing type, would also result in better outcomes and produce health benefits as long as the settlements are not located in hazardous areas that are more exposed to risks. For example, the third case study of an informal settlement near the riverbanks in Pekalongan demonstrated the highest YLD indicator because of the high flood risks that people experience. In this case, higher investments in sanitation are not likely to significantly increase positive outcomes for people's health due to the existing risks.

In all the study areas, the majority of residents have in common what they dislike about their neighbourhoods. Approximately 93 per cent of them consistently dislike mice and mosquitos in their home, and about 95 per cent of residents are not happy with sewers which do not work properly. Unfortunately, there are some challenges which span all housing types.

## 6.2 Uncertainty and challenges

The national climate change adaptation strategy (BAPPENAS, 2014) assumes that providing affordable and inhabitable housing equipped with complete basic services and infrastructure is one of the better strategies for dealing with the impacts of climate change. Yet, this study indicates that where affordable and inhabitable housing is provided, not all health-related issues are effectively dealt with. Although we see an indication that living in high-rise public housing may have lowered the risk of dengue fever, heat stress during hot days and depression during the rainy seasons, there was little variation between the neighbourhood types when it came to incidences of diarrhoea, dermatitis and respiratory problems.

The management of the public rental flats may become one of the stressors determining the robustness of this option as a climate-adaptation strategy, as the maintenance varies with each city government. This study does not specifically measure the performance of city governments (e.g. the Special Service Unit for Public Rental Flats); however, it does indicate that better management of public rental flats delivers better health outcomes. Although the national government has no legal authority to be involved in local government assets, the legal framework (Law 20/2011, Article 57), which is set by the national government, states that the national government can subsidise the management of public rental flats. The way public rental flats are operated and maintained will considerably influence the robustness of public rental flats as a strategy to adapt to climate change, which in turn depends on each city government initiative and creativity, such as through accessing available resources at the national government level and empowering the participation of residents.

Encouraging participation of residents in public rental flats in neighbourhood maintenance for a better health outcome is possible, but is somewhat complex in comparison to non-vertical neighbourhoods. The occupants of non-vertical housing privately own their houses, with less than 9 per cent renting. In contrast, in the vertical housing most of the occupants are tenants. The length of lease may produce a different 'sense of place'. The length of stay in the vertical housing is limited to ten years in the city of Semarang, and only three years in Pekalongan. This regulation was created due to the limited units of public rental flats available, while the real demand is actually high. The limit of stay in public rental flats raises an important question: where will these residents live after three years? Public rental flats will not be a long-term adaptation strategy unless the government can close the demand and revise the regulation regarding the limit of stay.

Additionally, residents' self-assessments in this study show that residents living in vertical housing have a lower quality of social life and ties within their neighbourhood, or in other words, they become individualistic or more isolated. All these factors may create disincentives for effective participation and hamper the robustness of public rental flats as a climate change adaptation strategy in urban areas. This in turn has serious implications for resilience of the communities as decreased social ties and activity can leave particular individuals and families more vulnerable in times of distress. Investing in flood reduction measures and improved sanitation also provides net benefits in general and hence investing in these measures also in non-vertical housing areas could provide positive outcomes.

Finally, the biggest challenge is that vertical housing is not attractive to people in general. Almost all residents in the non-vertical case study neighbourhoods dislike vertical housing, with almost 90 per cent expressing this in Semarang and 100 per cent in the case of Pekalongan. However, those already living in the public rental flats have a contrasting perception. In the case study area of Semarang, about 35 per cent of respondents did not like living in the flats, compared to only 4 per cent in the case study area of Pekalongan. This study suggests that the management of public rental flats may influence the perception of public flat residents. However, the perceptions of people living in the non-vertical neighbourhoods are mainly driven by personal belief instead of experience. Therefore, in advocating the development of public rental flats as an adaptation strategy, it is also essential to allow vulnerable people living in hazardous spots to experience living in a public rental flat.

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## 7 Conclusion

Climate change is projected to impact especially on low-income urban dwellers (Satterthwaite, 2011). The extent of such impacts, including flooding, increased rainfall, an increased number of hot days and an increase in vector-borne disease, clearly result in different impacts and vulnerabilities depending on the settlement type and place that people inhabit. Typically vulnerable locations such as dense urban settlements in low-lying areas or near riverbanks are more likely to expose residents to higher health risks. Urban settlements, which are located on unstable land sites, are also at risk from landslides during extreme rainfall. In Indonesia, these challenges are well-recognised at both the national and city level and the government has embarked on several programmes of public housing and urban regeneration to enable city populations to be more resilient. Indonesia's National Action Plan for Climate Change Adaptation (RAN-PI) advocates for life-system resilience, which is one of the national policy directions in considering climate change adaptation and includes public health, human settlement and infrastructure.

By comparing two Indonesian cities, Semarang and Pekalongan, this study assessed the extent that urban regeneration is considered as an adaptation option, and explored the potential challenges and outcomes in using urban regeneration as an adaptation strategy to enhance health resilience at the city level. Vertical housing can increase people's health resilience given that all types of basic services and infrastructures are provided by the government. Those living in vertical housing were less likely to encounter issues with land rights, lower risks from dengue fever, less heat impact during hot days, and less depression during the rainy seasons. However, this study also found that the type of neighbourhood has nothing to do with the incidences of diarrhoea, dermatitis or respiratory problems.

Yet, our study also indicates that non-vertical sites enable stronger social ties between residents, which also impacts on their capacity to adapt and cope during times of distress as well as on people's well-being and their perception of well-being within their community. This requires further study to better understand which indicators are useful in measuring and understanding 'well-being' in both formal and informal settlements and what successful adaptation to climate change looks like across different neighbourhoods and income groups. For example, improving sanitation and housing options in non-vertical settlements while simultaneously strengthening land tenure systems could result in similarly positive outcomes as in vertical housing. Yet, other factors, such as population growth, the fact that non-vertical housing is often located in high risk areas, and projected increases in extreme events (including flooding and increased rainfall events) also impact on the range of potential outcomes and benefits that can accrue from investing in areas with non-vertical housing.

Hence, a multi-risk lens that looks at population growth rates and projections, climate change projections, infrastructure needs and maintenance, and health services, should be used when planning for new settlements or making decisions about urban regeneration in existing areas. The reality is that some areas will remain vulnerable, and become even more so, due to these multiple stressors, which also calls for greater and more careful evaluation of where investments should be made in the long term.

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The newly established Ministry for Public Works and People's Housing has set an ambitious target, which declares that by 2019, Indonesia will have 100 per cent access to clean water, 0 per cent of slums, and 100 percent access to sanitation. When developing this agenda further, it is of paramount importance to also consider the impacts of climate change and in particular the ways that climate change adaptation can enable the achievement of such goals. Ultimately the integration of climate adaptation into public health and housing programmes will determine how successful these are in a changing climate. Further research should look into how such integration can be achieved in the context of Indonesian cities and how urban regeneration can result in multiple benefits, including the development of an informed evidence-based adaptation policy at the city level.

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# Can urban regeneration improve health resilience in a changing climate? Lessons from Indonesia

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