Asian Cities Climate Resilience

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Protect, adapt or relocate?

Responding to climate change in coastal Indonesia

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Abstract

On the coast of Java, Semarang City faces a multitude of climate-related problems including sea-level rise, flash and tidal floods, subsidence and coastal erosion.

Using four case-study villages, this working paper explores how households are coping with the impacts of climate change. How do they decide whether to protect, adapt or relocate their property to areas less affected, and what are the costs?

Understanding household risk assessments and decision-making processes should effectively tailor government policies to reduce vulnerability and support local adaptation strategies. By bringing together all stakeholders, an urban climate governance approach should ensure a more resilient city.

Acronyms

ACCCRN	Asian Cities Climate Cange Resilience Network
APO	*Alat pemecah ombak* (breakwater)
BAPPENAS	National Development Planning Agency
BAPPEDA	Regional Development Planning Agency
BPS	*Badan Pusat Statistik* (Central Bureau of Statistics)
CBA	Cost–benefit analysis
CCROM-SEAP IPB	Center for Climate Risk and Opportunity Management in Southest Asia and Pacific, Institut Pertanian Bogor (Bogor Agricultural University)
DKP	*Dinas Kelautan dan Perikanan* (Maritime and Fisheries Ministry)
GHG	Greenhouse gas
IDR	Indonesian Rupiah
IPCC	Intergovermental Panel on Climate Change
IUCCE	Initiative for Urban Climate Change and Environment
JBIC	Japan Bank for International Cooperation
NGO	Non-governmental organisation
P5L	*Paguyuban Pengendali dan Penanggulangan Air Pasang Panggung Lor* (Panggung Lor Association for Tidal Flooding Control and Prevention)
PERDA	*Peraturan daerah* (local regulation)
PERWAL	*Peraturan walikota* (city mayor regulation)
PESTEL	Political, economic, social, technological, environmental and legal
PT GMI	PT. Guna Mekar Industry
PT IPU	PT. Indo Perkasa Usahatama
RPJMD	*Rencana pembangunan jangka menengah daerah* (Indonesian regional long-term development plan)
RT	*Rukun tetangga* (household groups or local community authorities)
SEA	Socio-economic analysis
SLR	sea-level rise
SWOT	Strength, weakness, opportunities and threats
UMK	*Upah minimum kota* (city minimum wage)
VA	Vulnerability assessment

1 Introduction

Indonesia is facing the impacts of climate change. According to the National Action Plan on Climate Change Adaptation (RAN-API Bappenas) the country is experiencing a range of phenomena that are believed to be caused by climate change, including increased air and sea-surface temperature, changes in precipitation, sea-level rise and increased incidents of extreme weather (Bappenas, 2014)

From December to February, increased precipitation is apparent on Java Island and in East Indonesia, including Bali, and there has been a significant decrease in precipitation from June to August across almost all of the Indonesian territory, with the exceptions of Pandeglang (Jawa Barat), Makassar (Sulawesi Selatan), Manokwari, Sorong (Papua) (Kementerian Lingkungan Hidup, 2010). Based on simple ocean data assimilation (SODA) between 1960 and 2008, the rate of sea-level rise in Indonesia has increased from 0.8 mm/year to 1.6 mm/year since 1960, and significantly increased to a rate of 7 mm/year from 1993 to the present. The sea-level rise is projected to reach 35–40 cm by 2050, and up to 175 cm by 2100 relative to the year 2000. Extreme weather events such as storms and small-scale tornados are increasing, causing increased occurrences of intense flooding and landslides. According to report from Badan Nasional Penanggulangan Bencana that in the year 2013 as much as 87% of disasters in Indonesia was a hydrometeorologycal disaster such as floods, landslides, drought, etc (BAPPENAS, 2014).

Semarang City is the capital of Central Java Province. As an urbanised centre on the coast, the city is experiencing a range of climate-related issues ranging from sea-level rise to extreme weather. Sea-level rise in Semarang is happening at 8–10mm/year (Diposaptono *et al*., 2009) faster than the the country's average. Beyond the impacts of climate change-related phenomena, the city also faces a multitude of environmental challenges including flash and tidal floods, land subsidence, land movement and coastal erosion. A recent study by BGR[1] shows that land subsidence has been caused by groundwater extraction. The subsidence averages 8–10cm/year (Abubakar, 2006) but can reach up to 21 cm in some areas of Northern Semarang (ISSET, 2010).

This study seeks to explore how residents of the coastal areas of Semarang City are taking measures to cope with, or adapt to, the impacts of climate change, including sea-level rise (SLR) and coastal erosion, the effects of which are enhanced by land subsidence. The study also seeks to understand how affected residents make decisions about whether to remain on site and adapt to the impacts of a changing climate, or whether to relocate to a less affected area. Understanding the decision-making processes and risk assessments carried out by households can be useful for tailoring policy responses to climate change at the local level, to better support households in their decisions.

1.1 Background: the city of Semarang

Semarang, especially northern parts of the city, is facing increasing inundation by sea water. According to the City Spatial Plan of Semarang 2011–2031 (DKP Kota Semarang, 2011) the coastal region is 0–0.7m above sea level, while low land areas are 0.75–5m above sea level. Based on projections of sea-level rise, coastal areas and lowland areas in Semarang will be affected significantly by rising sea levels in the short term (until 2012), medium term (until 2025), and long term (up to 2045). Calculations of sea level projection by Setiadi *et al.* (2009) suggest that SLR in Semarang City will continue to rise steadily to 2045, with a dramatic increase from 2024 (Table 1).

Table 1. Sea-level rise projection in Semarang City, 2006–2025

Year	Elevation above sea level (cm)	Changes in sea level (cm)	Land subsidence (cm/year)	Coastline sea level (cm)
2006–2007	90	8.00	5	103.00
2007–2008	90	9.46	5	104.46
2008–2009	90	10.92	5	105.92
2009–2010	90	12.38	5	107.38
2010–2011	90	13.84	5	108.84
2011–2012	90	15.30	5	110.30
2024–2025	90	34.28	5	129.28
2044–2045	90	63.48	5	158.48

Note this assumes a sea-level rise of 1.46cm/year
Source: Setiadi et al. (2009).

From 2000 to 2012, the sea level in coastal areas rose by 1.1m; by 2025 it is projected to have risen by almost 1.3m and by 2045 it is expected to have risen by almost 1.6m (Setiadi, *et al*, 2009).

In addition to existing estimates, a vulnerability assessment (VA) carried out as part of ACCCRN activities in the city also included sea-level rise estimates. These predict that the average increase from 2000 will be approximately 21 cm by 2050, and 48–60 cm by 2100. Table 2 provides sea-level rise scenarios in Semarang City by climate change impact taken from the VA by CCROM IPB (ISSET, 2010).

Table 2. Sea-level rise scenarios in Semarang City (cm)

	2000	2025	2050	2100
SRESA2: MODERATE	2	10	21	60
RANGE	0–4	4–20	9–41	15–112
SRESB1:MODERATE	2	10	21	48
RANGE	0–4	4–22	9–42	18–85

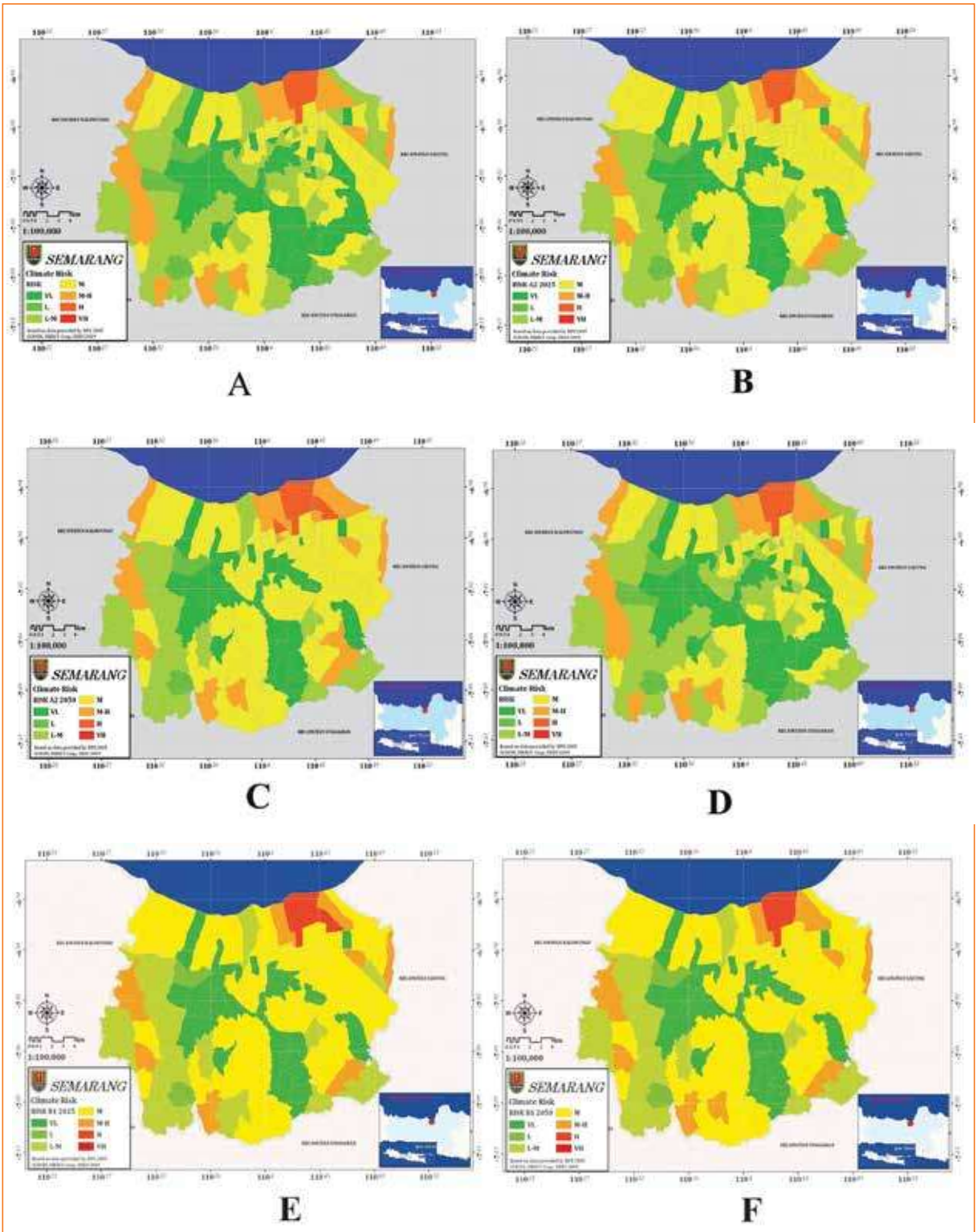
Source: ISSET, 2010.

Figure 1. Simulation of sea-water inundation over the next 100 years in Semarang

The dark blue shading in the eastern and western parts of the city represent 20cm of inundation. The lightest blue represents 80cm of inundation as it increases over time (DKP Kota Semarang, 2008)

An alternative estimation by the Maritime and Fisheries Ministry in Figure 1 (DKP Kota Semarang, 2008) is slightly more pessimistic, with an SLR difference of about 20cm over the next 100 years. However, DKP Kota Semarang provides a more complete spatial analysis of the consequences of such changes. With the estimated sea-level rise of 0.8m in the next 100 years, the estimated seawater inundation in Semarang City will reach distances ranging from 1.7–3.0km inland, where the total inundated area will up to 8537.9ha.

Figure 2. Classification of villages (exposure to climate risk based on different climate scenarios)



(A) and (D): Climate risk baseline; (B) Climate risk A2: 2025; (C) Climate risk A2: 2050; (E) Climate risk B1: 2025; (F) Climate risk B1: 2050 (ACCCRN, 2010a and 2010b). The dark red shading indicates very high climate risk. Medium risk is indicated in yellow and very low risk is indicated in dark green.

The classification of villages based on the level of exposure to climate risks is shown in Figure 2. This shows that there are no villages classified in the very high risk category (VH, in dark red) at present (baseline conditions). Currently the most at-risk villages are classified as medium to high risk (M-H, in orange). There are about 15 villages (8 per cent) in the M-H risk category. These include Bandaharjo, Bangetayu Kulon, Bubakan, Gunungpati, Kudu, Mangkang Kulon, Mangkang Wetan, Mangunharjo, Mangunsari, Ngadirgo, Penggaron Lor, Podorejo, Tanjung Mas, Tugurejo and Wonoplumbon. The remaining are 63 villages (36 per cent) classified as medium risk (M, yellow); 47 villages (27 per cent) as low to medium risk (L-M, light green), 6 villages (3 per cent) as low risk (L, light green), and 46 villages classified as very low risk (VL, dark green). In the future (2025 and 2050), more villages will be exposed to higher climate change-related risk, particularly under scenario SRESA2.

Many people living in the northern part of Semarang are vulnerable to the predicted impacts of sea water inundation; vulnerability is determined by their physical, social and economic conditions. More than 20 villages along on the coastline are experiencing the effects of coastal erosion, with increased tidal floods and land subsidence (Marfai and Hizarbon, 2011). Research by Miladan (2009) suggests that communities in the coastal area of Semarang are exceptionally vulnerable, particularly economically – this was also found as part of the ACCCRN vulnerability assessment.

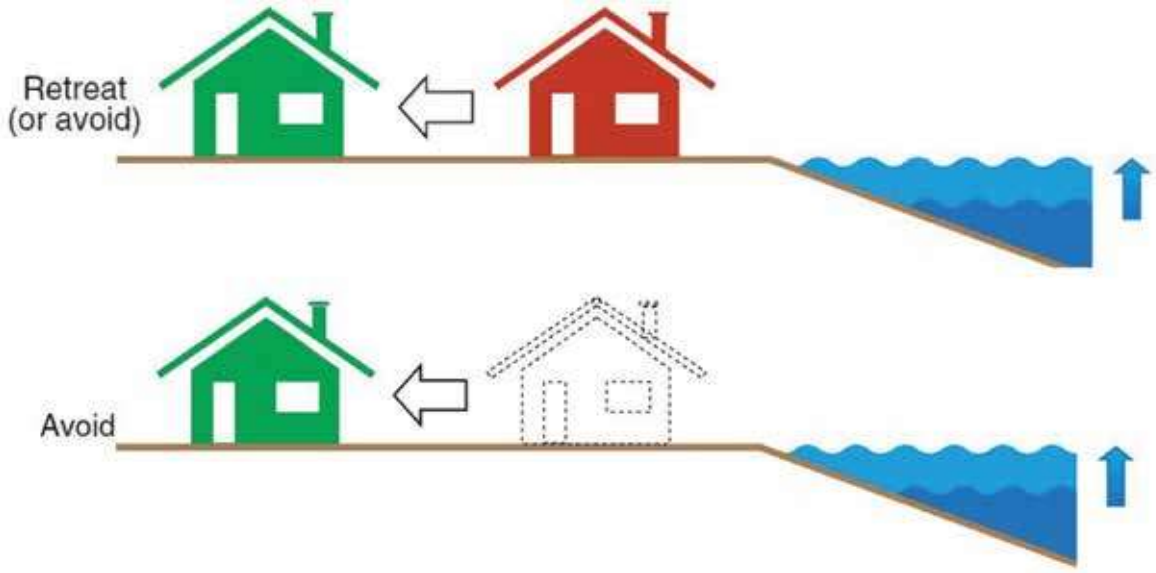
1.2 Adaptation or relocation?

Adaptation efforts are the steps taken to reduce the impacts of climate change, or to prevent the harmful effects of disasters in disaster-prone areas. In general, adaptation can be understood as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2007). Various types of adaptation can be distinguished, including **anticipatory**, **autonomous** and **planned**. Anticipatory adaptation takes place before impacts of climate change are observed, also referred to as proactive adaptation. Autonomous adaptation is not a conscious response to climatic stimuli, but is triggered by ecological or socio-economic change, also referred to as spontaneous adaptation. Planned adaptation arises from a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain or achieve a desired state (IPCC, 2007).

The response to climate change impacts can also be categorised into four possible steps, using the example of SLR (see Figures 3 and 4): avoiding the impact by retreating or relocating from coastal areas; avoiding coastal areas to begin with; adapting by protecting; or adapting by accommodating the sea-level rise **(Eichorst, 2010 in Yuniartanti, 2012)**. Methods of adaptation include elevating homes, building embankments, land reclamation and relocating to another area not at risk of flooding due to the rising sea level. In this instance, adaptation refers to actual adjustments or changes in decision-making environments, which might ultimately enhance resilience or reduce vulnerability to observed or expected changes in climate. Investment in coastal protection infrastructure to reduce vulnerability to storm surges and anticipated sea-level rise is an example of actual adjustment. In order to develop an adaptation strategy, one needs to understand the nature of potential disasters arising from climate change. In this way, adaptation can effectively reduce the impact of climate change (ibid).

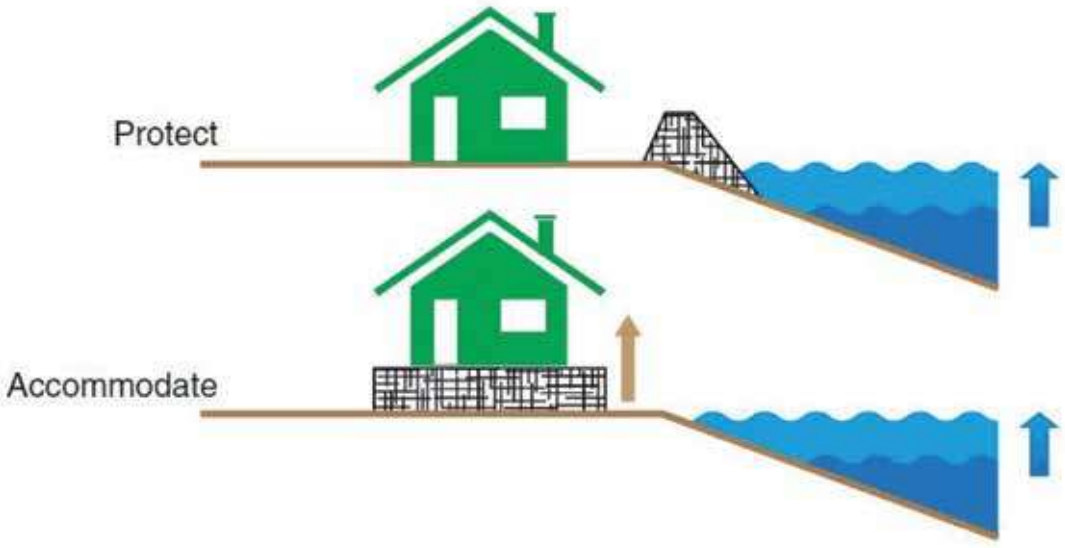
This study seeks to examine the relocation patterns and forms of adaptation in Semarang coastal communities impacted by an increase in sea level. Currently in Semarang, some households are adapting to SLR by elevating their homes on raised platforms; however, this is only a temporary measure given the constant sea-level rise in combination with severe land subsidence in certain areas of the city. Relocation may be regarded as the most effective form of adaptation in the long term, however many people choose not to due to a number of socio-economic factors. This is even the case when the municipality has built flats which are targeted at residents of areas suffering from natural hazards. Understanding why some people relocate and others remain will have implications for the development of Semarang City (Hidayah, 2009).

Figure 3. Community relocation solutions to respond to rising sea levels due to climate change



Source: Eichorst (2010) in Yuniartanti (2012).

Figure 4. Community adaptation solutions to respond to rising sea levels due to climate change



Source: Eichorst (2010) in Yuniartanti (2012).

A deeper understanding is needed of the reasons behind the choices people make about where to live, especially those who are vulnerable to climate change in the coastal region. By understanding these choices, including the cost–benefit decisions behind them, and people's likely future plans, this can help inform the development of government policies that are more appropriately tailored to the needs of the local population.

Drawing on the relocation patterns and forms of adaptation used by households, this working paper seeks to compare household evaluations of the cost of two alternative strategies to mitigate the impacts of climate change: relocating to other areas or staying in the same home by adapting it or making adjustments to current living conditions. One strategy may have higher costs than the other. Therefore, it would be expected that the decision of the affected people to relocate or remain in place and adapt would be preceded by calculations, especially related to the evaluation or assessment of the costs imposed by risks, compared to the living expenses incurred when deciding to relocate or adapt. This study therefore seeks to analyse and compare the tradeoffs made by households when they choose to mitigate risks either by relocating (retreating or avoiding) or adapting (protecting or accommodating).

1.3 Study objectives

Based on the above background, this study has the following objectives:

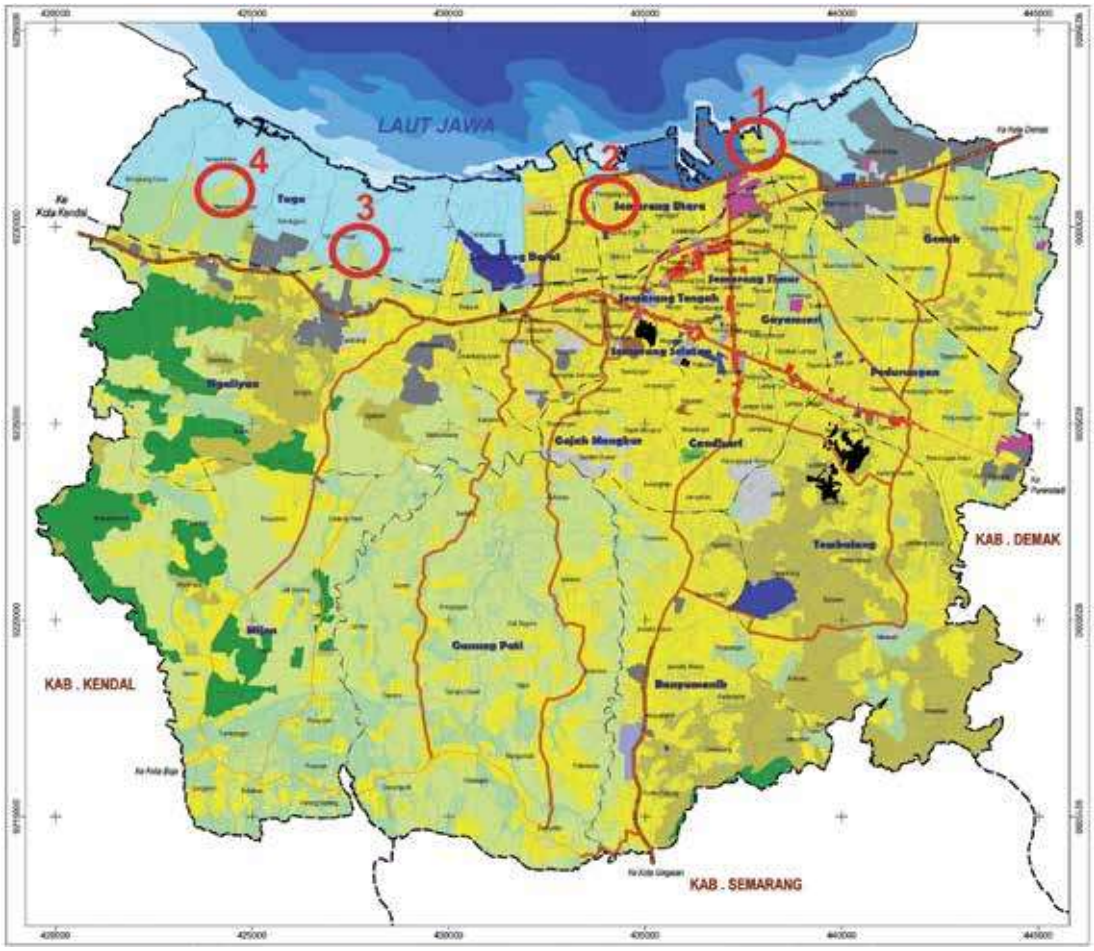
1. Understanding the patterns of relocation and adaptation of residents in areas prone to climate change impacts in coastal Semarang**.**
2. Understanding households' assessments of the cost of risks when choosing relocation or adaptation.
3. Evaluating the cost of risks for each action, either relocation or adapting.
4. Understanding the strategies and appropriate government policies to mitigate climate change impacts in Semarang based on the result of the comparative analysis of the cost valuation.

2 Research

2.1 Case study locations

This research, using the retreat-protect-accommodate framework outlined in the previous chapter, was conducted in four villages in coastal areas of Semarang city. The selected villages are in areas exposed to climate change impacts (see Figure 5).

Figure 5. Four vulnerable villages: (1) Tanjung Mas (2) Panggung Lor (3) Tugurejo (4) Mangkang Wetan



Each village has different characteristics, particularly (1) main livelihood of households (2) forms of vulnerability to climate change impacts, and (3) types of adaptation used by the residents. In Tanjung Mas, most people chose relocation; it is also the village suffering the most severe land subsidence, in combination with tidal floods.

In general, those that relocate do so because they have a job other than working as fishermen which allows for greater mobility, for example, working in a factory. The study area characteristics can be seen in Table 3. The differences may influence the choice of adaptation strategies to climate change (protect, adapt, or relocate), as the cost of reducing exposure to risk is balanced against the cost of relocating.

Table 3. Characteristics of case-study areas

Study area	Main source of livelihood	Vulnerabilities faced	Responses
Tanjung Mas	Fishing and fish trading	■ Many houses are submerged by tidal floods ■ Many houses are inaccessible as roads are flooded ■ Severe land subsidence	**Protect:** Elevating houses a minimum of 1m every 5 years; constructing a second storey in house; constructing simple embankments and water pumps to remove water from the tidal floods; elevating roads (funded by the community); and constructing an integrated drainage system to minimise the impact. **Adapt or accommodate:** Stay in the house and make simple adjustments such as protecting household furniture. **Relocate:** Leaving the house by selling it to someone else; having a house in another area while keeping the house in Tanjung Mas; or leaving the house without selling it and moving elsewhere.
Panggung Lor	Entrepreneurial and services	■ Many houses are submerged by floodwater runoff from Semarang River ■ Many houses are inaccessible as roads are flooded	**Protect:** Building embankments along Semarang River; building pump houses to remove accumulated water; constructing integrated drainage channels; forming P5L associations (Panggung Lor Association for Tidal Flooding Control and Prevention) to address the problem of flooding.
Tugurejo	Fishpond and rice farming	■ Decline in fishpond fish production	**Protect:** Building breakwaters (APO); buildin dikes in each pond.
Mangkang Wetan	Fishing and fishpond farming	■ Decline in fishpond production ■ Changes in livelihoods ■ Many houses are damaged by coastal erosion	**Protect:** Building permanent concrete embankments surrounding residential areas; building drainage channels and sluice gates in an integrated manner to remove seawater at high tide. **Adapt:** Open-water fishing in addition to fishpond farming; repairing homes according to economic conditions and affordablility.

Source: Primary data analysis (2013)

2.2 Methods

This research used two sampling techniques: area and purposive sampling. Area sampling was based on the results of the vulnerability assessment carried out in 2010 ahead of a city climate resilience project (ACCCRN, 2010) which identified four areas as particularly vulnerable, and which were the sites of the survey. In addition, the determination of the four study areas was also based on the results of a preliminary survey (pre-survey) of the locations vulnerable to climate change impacts.

For purposive sampling, this research used criteria of the various possible adaptation strategies:

- **Accept** (remain in the vulnerable area and accept all risks)
- **Accommodate** (e.g. by elevating homes, as part of the acceptance of risk)
- **Protect** (e.g. building embankments, as a form of protection against risk)
- **Retreat** (relocate homes but maintaining assets in areas exposed to risk), and
- **Avoid** (relocate to a safer place, removing assets from areas exposed to risk).

The data collection was done through a pre-survey, household surveys, in-depth interviews and focus group discussions (FGD) as outlined in Tables 4 and 5.

Table 4. Data collection process

Data collection technique	Measures carried out
Presurvey	Observation and short interviews with key actors in the community, for example chairmen at village level; household group chairmen; chairmen of P5Ls; local community leaders.
Survey	Field survey using a questionnaire (using purposive sampling) and semi-structured interviews to follow up the questionnaire. Where possible, the household heads were the target of the survey and interview.
In-depth interview	Interviews with key informants including experts from BAPPEDA[2]; environmental and urban academics from the Soegijapranata Catholic University of Semarang; urban and regional planners from Diponegoro University; and community leaders. A full list of interviewees is in Appendix 1.
Focus group discussion (FGD) in four case study locations	Discussions with the community at each study area with the involvement of some academics, decision makers, and community leaders. Afer the questionnaires, the community leaders were asked to announce the FGD, which were open to the respondents to the survey and other people who are knowledgeable about the location – the majority of participants were male (see table below). The FDG was used to get more information about the location, to confirm the results from the survey, and also as a place to discuss solutions to the problems identified - e.g. whether to relocate, how to adapt in the same place with government support. One FGD was carried out per village site. .

Source: Primary data analysis (2013)

Table 5. Focus group participants

	Focus group participants			Household survey respondents
Study area	**Male**	**Female**	**Total**	
Tambak Lorok, Tanjung Mas	23	1	24	50
Mangkang Wetan	20	6	26	45
Panggung Lor	25	2	27	42
Tapak, Tugurejo	11	6	17	21

The research focus was to understand the options for coping with climate change for local residents, using the following tools to analyse the data collected:

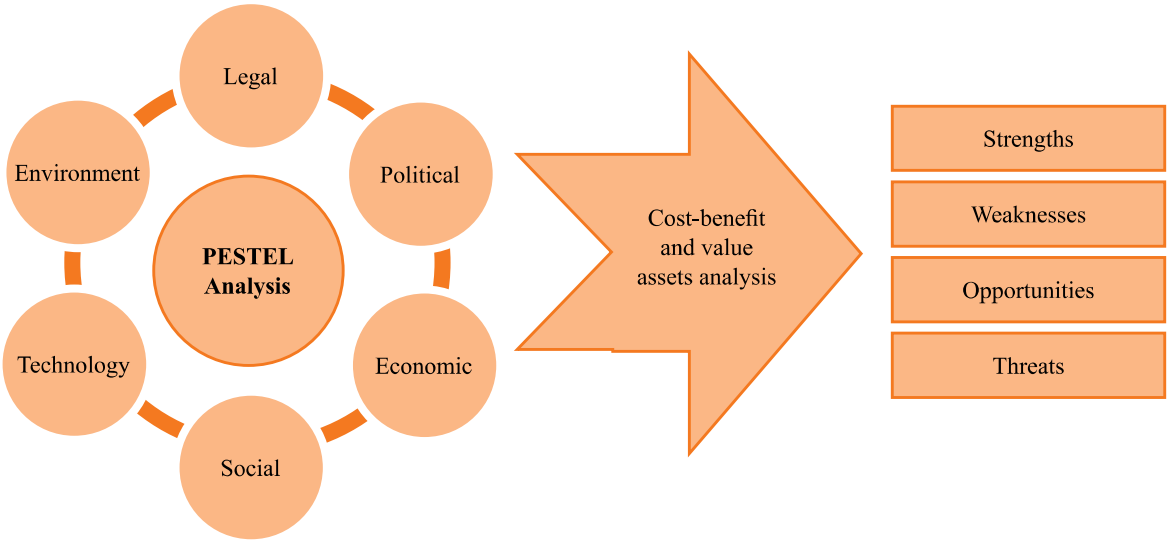
a. **PESTEL and SWOT analysis:** PESTEL considers the political, economical, social, technological, environmental and legal components of the matter at hand, while a SWOT analysis considers strengths, weaknesses, opportunities and threats. SWOT is intended to determine the positive and negative potential contained in the relevant community adaptation strategies to climate change, both of which are influenced by internal factors and external factors. This analysis is done to then offer recommendations which maximise the positive strengths and minimise weaknesses. The PESTEL and SWOT analyses were done in each case-study community, based on FGD discussions and interviews, to understand the contexts within which they operate, and their weak and strong points. This analysis can help to shape government policy recommendations to minimise vulnerability to climate change.

b. In addition, this research used cost–benefit analyses (CBA) and socio-economic analyses (SEA). CBA was used to analyse the cost (or financial risk) arising from the various strategies incurred by households for dealing with climate change. This was then analysed using SEA, comparing the costs for adaptation or relocation, with the average household income. SEA was used to analyse the reason behind the chosen strategy. Assets in this research were translated into human, social, physical (including technological), financial and natural assets (including access to natural resources). This analysis assumes that the values of the assets held or accessible to households will greatly influence their choice of adaptation strategies: whether to remain and accommodate or adapt, or whether to relocate. In general, people would be expected to accomodate if the value of their asset is higher than the cost of doing so. Conversely, they would be expected to relocate if the value of the asset is lower than the cost of protecting, accommodating or adapting.

The inter-relationship between the PESTEL, SWOT, cost–benefit and socio-economic analyses is illustrated in Figure 6, while Figure 7 illustrates the sustainable livelihoods framework which shapes the socio-economic analysis. The sustainable livelihoods framework demonstrates that vulnerability to climate change impacts will also be shaped by other changes in institutional structures and processes. Vulnerability to shocks and stressors can reduce the value of livelihood assets including human, natural, financial, physical and social. As these assets are vital livelihood drivers, this could affect a household's livelihood strategies and outcomes, which can also be affected by other factors including changes in structures and processes. In this case, the decision to adapt to climate change impacts, or avoid them by relocating, is a livelihood strategy which will influence livelihood outcomes. However, this decision will also be shaped by the overarching institutional structures and processes, at the scale of community, city government and national government.

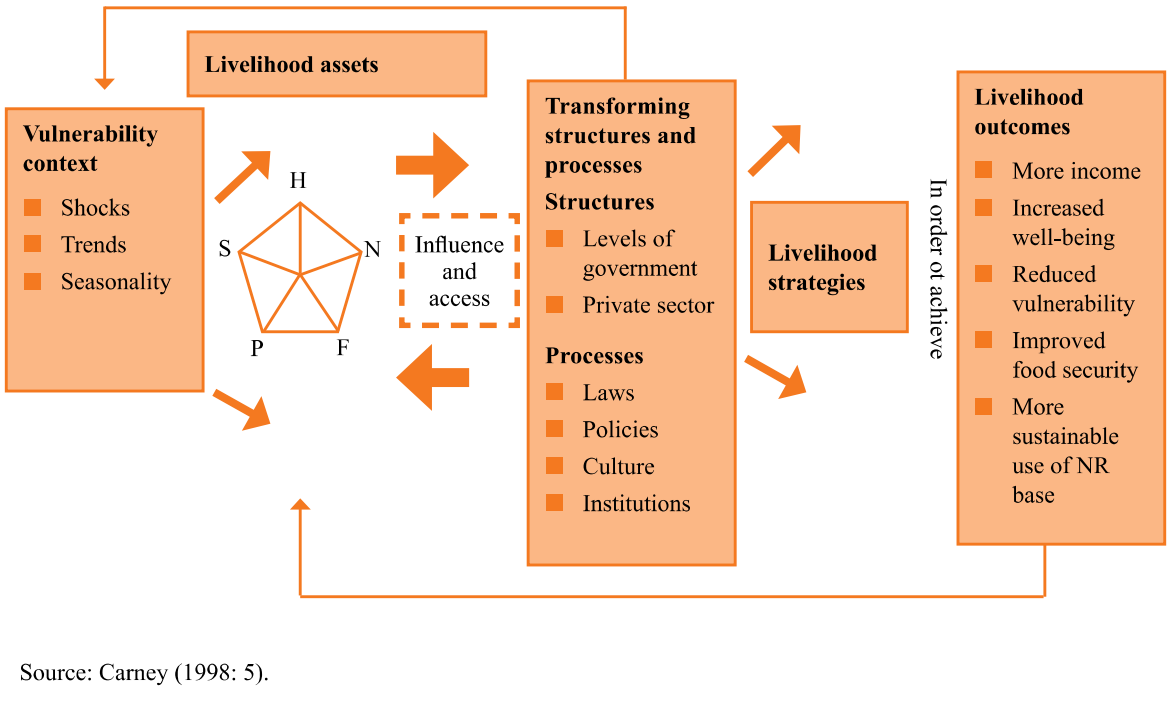
The research methodology seeks to understand the different factors shaping household decisions to protect or relocate. As the research draws on four village case studies, with very few respondents per village, it does not offer a comprehensive overview of strategies applied by all households in Semarang. However, the case studies do identify key strategies applied when facing particular climate impacts and other natural hazards, and thus can be the basis for recommendations to better support these strategies at a city scale.

Figure 6. PESTEL and SWOT analysis map



Source: Burke, John (2014)

Figure 7. Sustainable livelihood framework



Source: Carney (1998: 5).

3 Research findings and analysis

3.1 Case study findings

This section provides an overview of the results of the data collection. It includes the main livelihood sources and climate change and other risks faced by each of the four case-study villages in Semarang, and measures used by households to address these risks. Figures 9, 11, 13 and 15 summarise the results of the household survey for each village.

3.1.1 Tanjung Mas

The village of Tanjung Mas has an area of 3.24km^2, with a population of 30,643 people, spread across as 7,511 households, representing very high-density levels of 9,458 people/km^2 (BPS, 2013). The main source of income for the male respondents is fishing, while women in general are traders who sell fish caught by their husbands. Tanjung Mas has a fish market which has become the primary means of local livelihoods. Some residents also work as factory workers in the nearby industrial areas, particularly young men. In addition to their main jobs as fishermen and fish traders, many residents have additional jobs in the trade and services sectors such as running market stalls and motorcycle taxis.

Tanjung Mas is bordered by the Java Sea in the north. To its south there is a main ring road. The village is adjacent to the Port of Tanjung Mas and several major industries, such as Indonesia Power, Sriboga. The port and industrial areas support the village economy by providing jobs, but also have a negative impact on the community, especially the expansion of tidal flood areas to village houses. The port and industrial areas are reclaimed land areas, so the village settlement is at a lower elevation. Residents of Tanjung Mas always feel the impacts of tidal floods, especially during the twice-daily high tides. In addition, this village is sited on land that is highly prone to subsidence, and some homes have sunk so that only their roofs are visible. In combination with tidal flooding, this means that many homes have had to be abandoned by their owners. As an adaptive mechanism, households have elevated their homes an average of 1m every five years, to prevent tidal floods entering their homes and to combat subsidence. They pay for this by saving money specifically for this measure every day. However, this is a costly option which is not available to residents on low incomes who see their homes sink and flood (Figure 8). Instead, lower-income households take more simple actions to protect their assets, such as elevating furniture such as beds and kitchen units, as well as electronic goods.

Figure 8. Vulnerable house in Tanjung Mas

Source: IUCCE (2013)

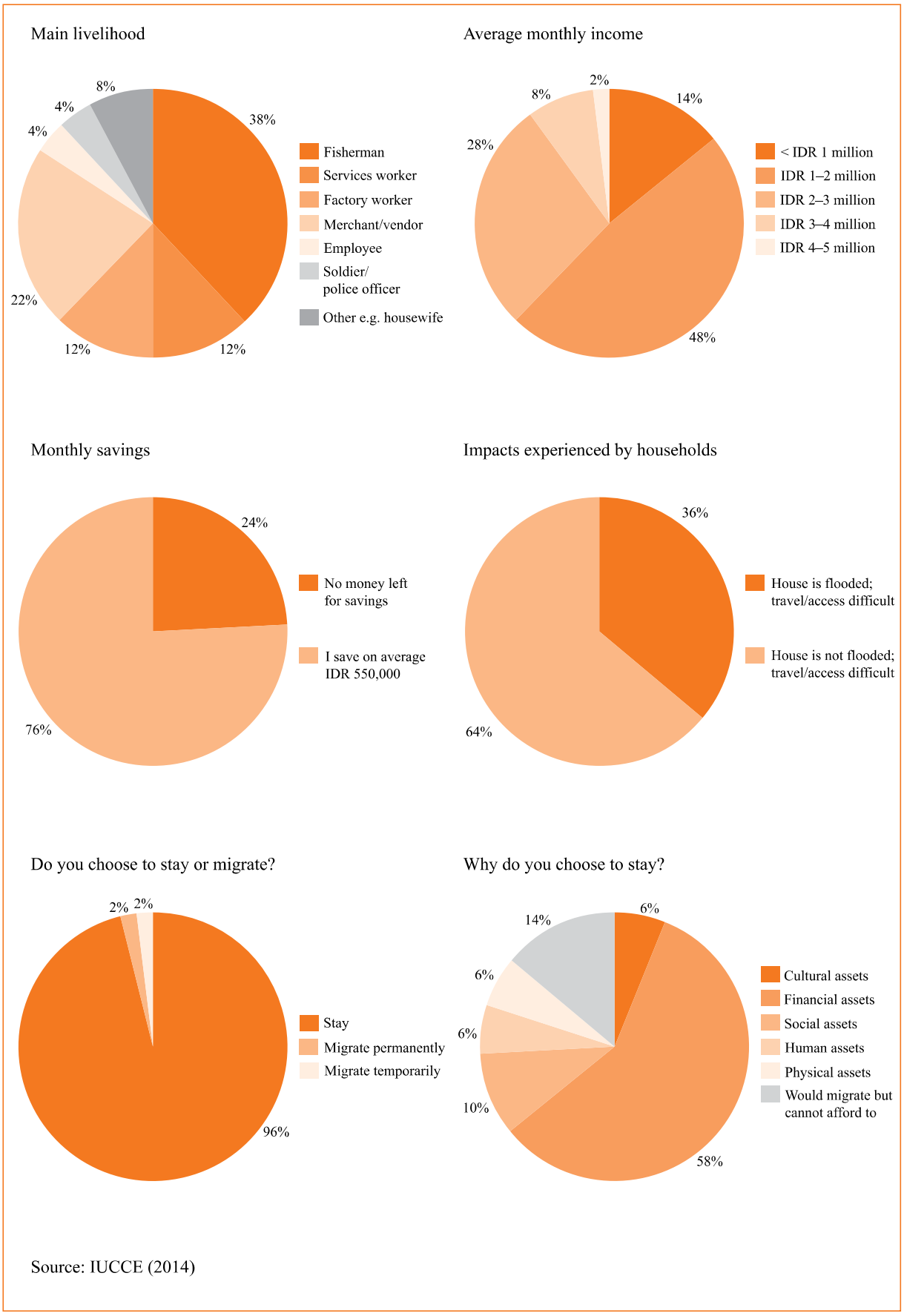
To maintain road accessibility, residents continue to elevate the road, a task which is generally performed by the households themselves. As this area is highly exposed to a severe but slow onset of natural hazards, the residents of Tanjung Mas are also burdened by a decrease in the market value of their land, which is far cheaper compared to other land in the city. As a result, some households have abandoned their submerged houses as there is no possibilty of selling them (data was not collected on the proportion of houses abandoned). Those who leave the village often relocate to government-built housing, which itself is in an area at risk of landslides, or alternatively they move to private sector housing in southern Semarang.

The need to invest in elevating their house every 5 years, or else risk losing it, is causing people to feel they do not have a home (property without property). According to residents, despite owning their house, the regular expense of saving for home elevation makes it feel like renting, particularly as this expense is equal to the cost of renting. While some people have chosen to relocate to other areas, usually abandoning their homes, this is often because they do not work as fishermen, and therefore their dependence on the village's coastal location is not so strong. According to residents, people opt to stay despite the tidal flood because their livelihoods are tied to the area. Figure 9 summarises the results of the household survey questionnaire.

The results of the 50 surveys in the village show that most respondents earn a total monthly income[3] of between IDR 1–2 million While the majority of respondents work as fishermen, there can be differences in income due to different types and sizes of boat. One respondent earns between IDR 4–5 million as they worked in fish processing.

3 *The Indonesian national poverty line is set at IDR 200,262/month (US$ 16.6) – see www.worldbank.org/en/country/indonesia/*

Figure 9. Survey results in Tanjung Mas



Source: IUCCE (2014)

From the monthly income, more than three quarters said that they are able to save on average IDR 550,000 – but nearly a quarter saved less or not at all. Of the respondents who saved, some used these savings towards elevating their houses.

Regarding the impacts of a tidal flood, nearly two thirds said that although their homes were not flooded, they experienced difficulty of access. Flooding tends to last 30–60 minutes each time. Although most felt that the most appropriate prevention method would be to elevate their house, a few mentioned building a dyke to protect their house or moving themselves and their belongings above the flood water level. Only 10 per cent (5 respondents) felt their house did not require elevating.

Despite the risks of tidal flood in the village, nearly all respondents said that they would remain in the village. Only one wanted to relocate and one had moved to a safe temporary location during the floods. The reasons cited for remaining in the area exposed to floods included financial assets and livelihoods (fishing); cultural assets in the village; and social assets. Fourteen per cent said that they were willing to relocate but lacked the funds to do so.

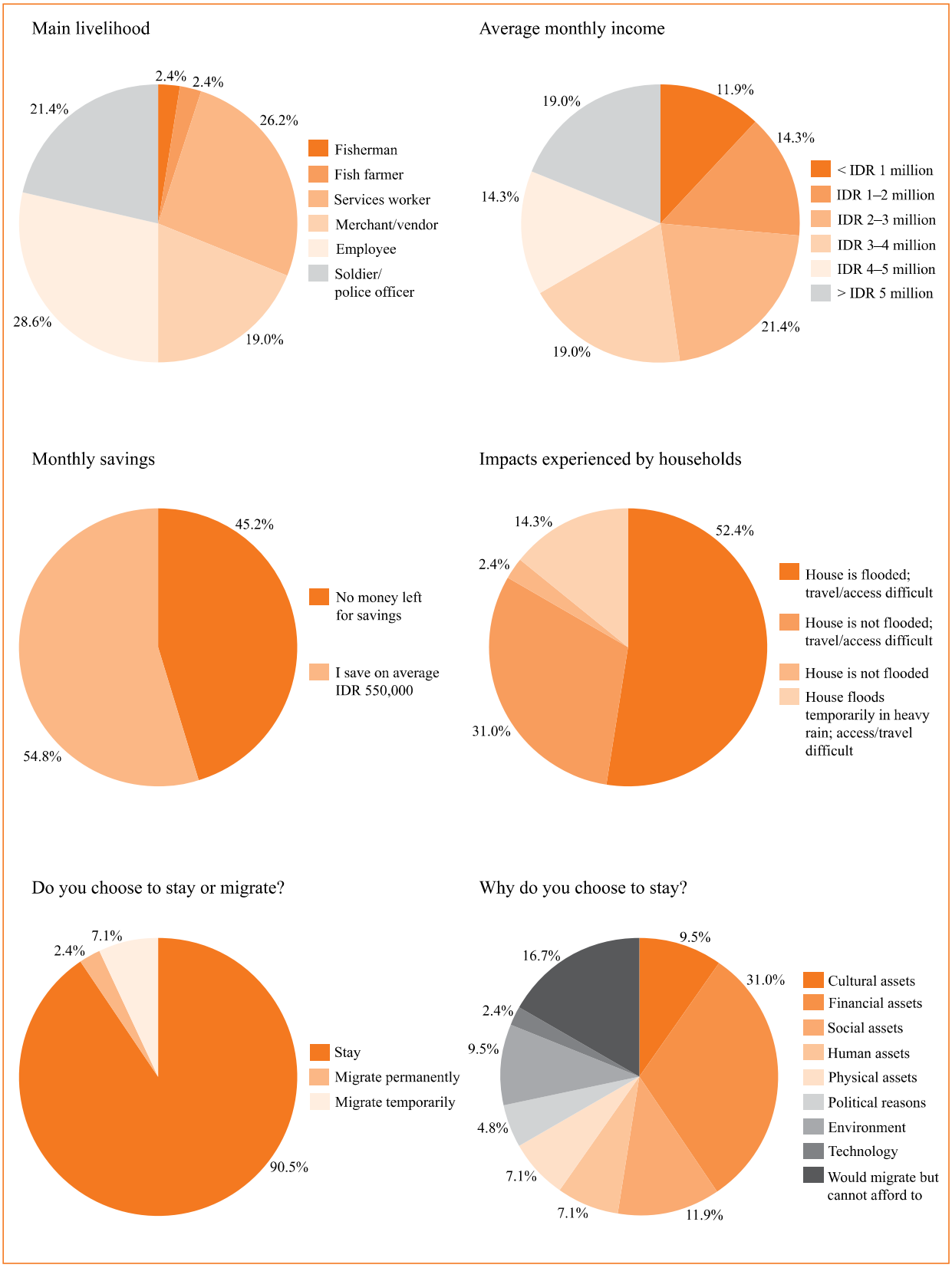
3.1.2 Panggung Lor

The village of Panggung Lor has an area of 1.40km^2 with a population of 14,184 people, spread across 3,484 households, so the density reaches a very high 10,131 people/km^2 (BPS 2013). Figure 11 summarises the household survey results for the village. Panggung Lor is not a fishing village, and the main livelihoods of residents are more heterogenous than in Tanjung Mas. Panggung Lor is not exposed to tidal floods, being located south of the main northern branch of the Semarang ring road. The village is at the estuary of two waterways, the West Flood Canal and the Semarang River, and is prone to floods during heavy rains. Flooding impairs accessibility and flood village houses. As the village is at a lower level than the river, water needs to be pumped from the settlement. Some roads are being elevated by the villagers themselves, to facilitate accessibility during times of flood (Figure 10).

Figure 10. Land Subsidence in Panggung Lor

Source : IUCCF (2013)

Figure 11. Survey results in Panggung Lor



In addition to elevating the road, the other form of adaptation is building dikes along the Semarang River to prevent water runoff flooding the houses, and to build a pump house to pump floodwater out. In Panggung Lor there are 20 pump houses, each consisting of four water pumps. Residents have established an institution that deals with the impact of flooding, the Panggung Lor Tidal Flooding Control and Prevention Committee (P5L). Duties and functions of P5L include tackling the impact of tidal flooding, such as cleaning up rubbish that blocks residential drainage, and maintaing the embankment and pump house. The operational budget consists of residents' contributions, the amount of which is determined based on the economic capacity of each citizen.

There were 42 respondents in the village. Nearly a third are employees and the rest either work in the service sector, are retired civil servants, soldiers or police, or are merchants. Only one person was a fisherman.

In terms of income, only 12 per cent earn an average income of less than IDR 1 million – many of these are retirees who rely on their children for money.

In terms of saving, more than half were able to save on average IDR 500,000, though the remainder said that they were not able to save monthly. However, some respondents expressed that rather than save, any spare money is used to elevate their house or the road in front of it.

In terms of the impacts experienced by the people in the village, more than half experienced floods in terms of difficulty of access, while a third said their homes flooded. Only 14 per cent only experienced temporary flooding during heavy rains.

In terms of adaptation methods applied, respondents use their savings to elevate their homes and roads and to contribute to maintaining the village drainage, floodgate, and the P5L programme for managing drainage. Only one person contributed to the dike.

In terms of remaining in the village or relocating, most said that they would remain in the village. Only three people said they would temporarily relocate during floods and only one said he would relocate. This persons was rented a house in the village and so is more mobile and can rent elsewhere. Reasons given for remaining in the village included financial assets (i.e. strategic location close to their jobs and the city centre), while other said that they were actually willing to relocate but lacked the funds. Some cited social assets in the village, due to the many problems the villagers had lived through together.

3.1.3 Mangkang Wetan

The village of Mangkang Wetan has a total area of 3.47km^2 with a population of 6,384 people spread over 1,738 households, so the density level reaches 1,840 people/km^2 (BPS 2013). While most respondents are fishpond farmers and fishermen, some are also traders and entrepreneurs, while many women are housewives.

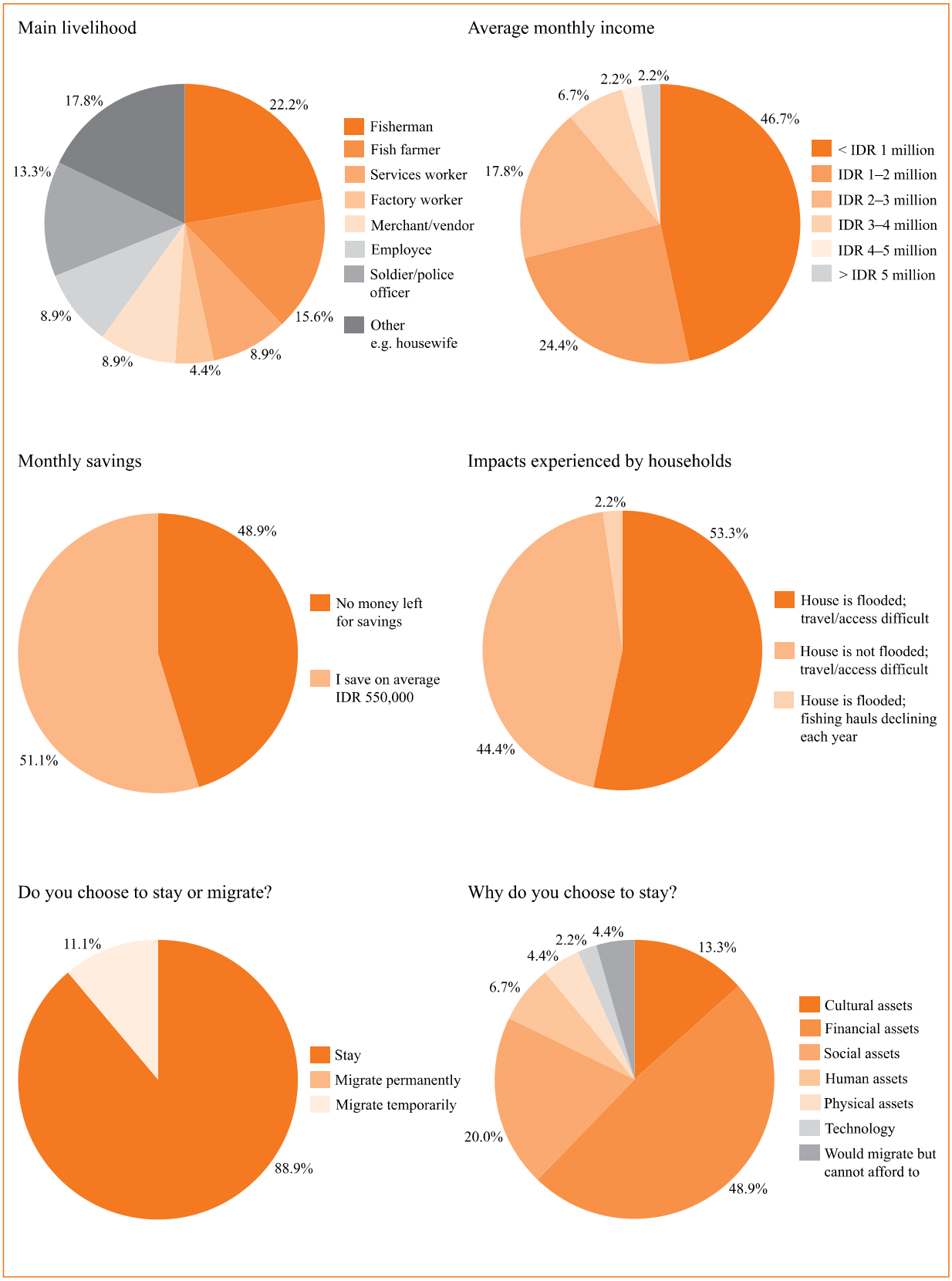
Mangkang Wetan is a coastal village on the Java Sea and adjacent to the plywood industry area, which is performing shore reclamation. Since the 1990s, the number of people working as fishpond farmers has fallen as aquaculture has declined, partly due to the intrusion of tidal flooding, which causes fish harvest failure. This decline has resulted in many fishponds being sold to an international company which buys land for commercial and tourism development, causing many fishpond farmers to become open-sea fishermen. However, they are also seeing declines in fish catches, requiring them to sail further out to sea, leading to additional fuel cost, which affects incomes.

In addition to experiencing livelihoods vulnerability, residents also experience other vulnerabilities due to tidal flooding, e.g. damage to houses due to erosion by tidal water. During the annual *musrenbang*[4], residents independently asked local government to build concrete embankments around residential areas to prevent tidal flooding (Figure 12). The embankments have been built during a multi-year process from 2008–2013, with the support of the Water Management Agency and the Housing Agency of Semarang muncipality, though a shortage of funds mean that those currently built are not of concrete, but are non-permanent embankments built by the government and the villagers. The plan will be to eventually have concrete embankments equipped with an integrated drainage flow to drain tidal floods.

Figure 12. Embankment surrounding houses to protect against flood and sea water inundation in Mangkang Wetan

Source : IUCCE (2013)

Figure 13. Survey results in Mangkang Wetan



Although exposed to climate change impacts, in general people prefer to stay rather than relocating to another area. This is because the main livelihood of the people is fishing and fishpond farming, so they are unlikely to leave the area. There were 45 respondents to the survey of Mangkang Wetan village. Nearly a quarter are primarily fishermen. Others are housewives, fish farmers, or retired.

The average monthly income ranges from nearly half earning less than IDR 1 million, while nearly a quarter earn between IDR 1–2 million. About a fifth earn between IDR 2–3 million. Only four respondents earn over IDR 3 million. The difference in income depends on the type of fishing boat used. The bigger the boats and engines, the greater the catch.

In terms of monthly savings, nearly half do not have sufficient income to save, while the rest have monthly savings, on average only IDR 180,000. This small saving capacity can explain the need for government support in building the embankment.

The main risk faced by residents in the village is tidal flooding, which is worsened by the fact that the village is located between the coast and rivers. The impacts cited by respondents included more than half experiencing flooding in their homes and resulting difficulties in access; the rest did not experience flooding at home but did face difficulties in access. One respondent also said that their fishing hauls had been reduced by floods.

In terms of adaptation methods, many had chosen to elevate their homes; some also elevate roads using collective village funds. Only one respondent suggested developing coastal tourism. Alongside this, nearly half felt that another approach was to wait for support from goverment to prevent flood impacts. Many said that they planned to stay despite being exposed to tidal and river flooding, while only five would temporarily relocate until conditions were safe for return.

Regarding the decision to stay, nearly half chose to stay because of financial assets, such as the fishermen's homes being very close to their workplace. Social capital in the area, such as family, was cited by a fifth and some felt a tie due to cultural assets, particularly as working in fisheries is an occupation passed down through generations. Only two people said they were willing to relocate but were constrained by funds, and one cited the protection offered by dikes as a reason to stay.

3.1.4 Tugurejo

The village of Tugurejo covers a total area of 8,56 km^2 with a population of 6,456 people spread over 1,636 households, so the density level reaches 754 people/km^2 (BPS 2013), which is lower than the other case-study villages. Most respondents' livelihoods were generally similar to the Mangkang Wetan village (fishpond farmers and fishermen) some are also traders and entrepreneurs and working in the service industry. As in Mangkang Wetan, the land for fishponds has decreased.

Tugurejo lies on the Java Sea and adjacent to a large industrial area, housing numerous companies including PT. Guna Mekar Industri (PT. GMI), PT. Indofood Sukses Makmur, PT. Charisma, PT. Silver Hill and PT. Barali Citra Mandiri.

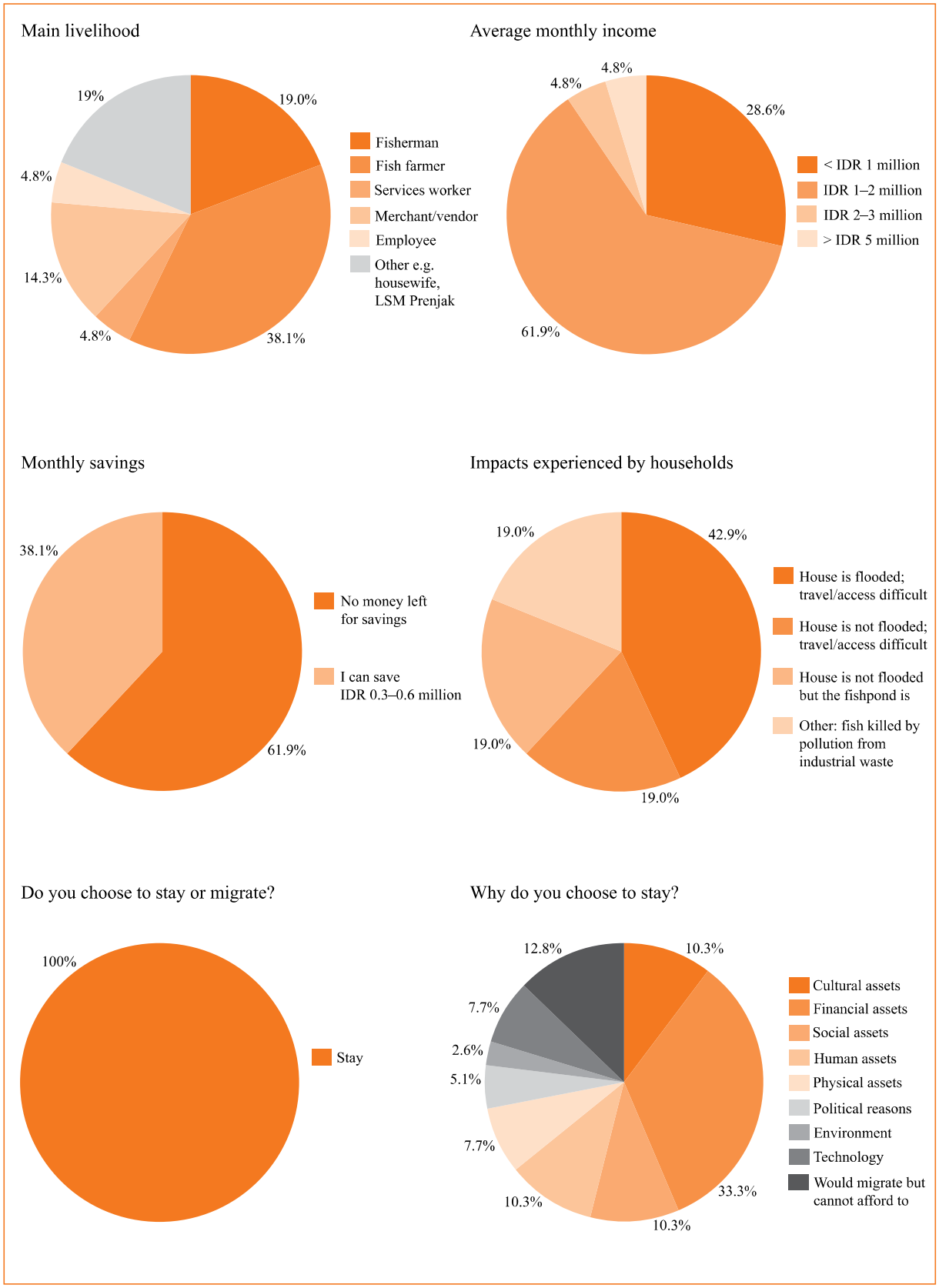
The main risk faced by households is coastal abrasion (land erosion by the sea), though this has not yet flooded their homes. However, abrasion has threatened their livelihoods because many fishponds are located on the coast. According to residents, abrasion has caused a decrease in aquaculture yields, especially for those raising shrimp, and many ponds are not functioning anymore. Although many people are still building ponds, the level of productivity has decreased which is thought to be caused by industrial waste being dumped in the river. As a result many people sell their ponds to industrial groups, such as polymer industries.

To counteract coastal abrasion, residents have independently built an APO (*Alat Pemecah Ombak*, or breakwater) to dampen the waves so that seawater does not inundate their ponds. APOs are quite low technology, made of old tires slotted over bamboo sticks planted into the ground, into which mangrove trees are planted. This community initiative has received further support from international funders, including the Asian Cities Climate Change Resilience Network (ACCCRN) which Semarang is part of. In Tugurejo, public awareness about the impact of climate change is quite high. Local community groups have organised their own non-governmental orgnanisation, Prenjak, which focuses on environmental issues. The Prenjak youth organisation initiated the movement to plant mangroves so to prevent abrasion and are also exploring opportunities for eco-tourism in the mangroves, as well as a mangrove nursery so that seedlings can be sold to other coastal communities (Figure 14).

Figure 14. Fish pond vulnerable to abration in Tugurejo

Source : IUCCE (2013)

Figure 15. Survey results in Tugurejo



In addition, a group of fish farmers has also formed their own organisation called *Sido Rukun*. Both community organisations cooperate in solving problems in Tugurejo, especially on issues related to environmental awareness and the impacts of sea-level rise on their ponds. Although exposed to negative impacts, because their houses have not flooded, generally people choose to stay. Additionally, while the industrial area may have a negative impact on fishpond production, residents also acknowledge that it has become a bridge to the community's economic prosperity because many people work in the factories.

The number of respondents in Tugurejo village was smaller, with only 21 people representing their families. In parts of the village with fishponds, most respondents were fishpond farmers. The rest were fishermen, housewives or members of the local community organisation.

Most stated their average income as between IDR 1–2 million. Over a quarter earn less than IDR 1 million. One respondent earns over IDR 5 million because he not only owns fishponds, he also opens some to the public for fee-paying fishing.

Based on their monthly incomes, the majority claim that they have no spare money for savings. However, more than a third have savings, on average IDR 90,000. This suggests that the community is less financially capable of elevating their homes or building permanent embankments.

In terms of hazards almost half said that during heavy rain their homes flood, causing difficulty in access. Meanwhile, almost a fifth had not experienced flooding in their homes but had faced access difficulties. Equal numbers also experienced inundated fishponds or the effects of industrial pollution on fish production.

Measures which residents thought could reduce impacts included building dykes to protect homes. Many cited government plans to develop coastal tourism areas, which should include Tugurejo (fishing, mangroves etc.). This is something that the Prenjak NGO is already working on. All respondents had chosen to remain in the village despite coastal abrasian.

Like residents in the other villages, reasons to stay included wanting to be close to their fishponds, or because of the future opportunities that tourism offers. Some cited the APO breakwater as offering sufficient protection. As in the other villages, many respondents had multiple reasons for staying.

4 Analysis

Based on the findings of the field research, the vulnerabilities faced by the inhabitants in each study area have their own characteristics, both physical and social, which are closely linked to their livelihoods and land use. The risks faced by the respondents are not only driven by climate change, but to other drivers of change such as land-use change and pollution. Where livelihoods are dependent on natural resources, changes in the natural environment could have detrimental effects.

In addition, adaptation efforts have different characteristics in each area. Very few people chose to move away from their villages despite facing climate-related impacts, even where income was not a limiting factor. However, those who have moved away would not have been in the village to participate in the survey.

Respondents can be divided into three categories. The first includes those with a relatively good income, i.e. mostly fishermen who own their own boats, with sufficient income to elevate their homes from floods, and who did not want to move because their income-earning potential was tied to their location. The second category consists of people with a middle-range income, who generally also wanted to remain in the village. The third group consists of poorer households who still need to hire boats to work. They were more willing to move elsewhere as they had no particular assets tying them to the area and who faced high costs if they remained. Their decision to stay will have had many consequences, not only in terms of the money and time needed to adapt to climate-related hazards, but also potentially in terms of stress, poor health and other impacts on their income earning-ability. The following section applies a cost–benefit analysis to household choices, as well as a PESTEL and SWOT analysis.

4.1 Cost–benefit analysis

The cost–benefit analysis enables a calculation of the costs incurred by the choice to remain on site, using a **surrogate market value** (Hufschmidt *et al*. 1983) and **non-market valuation** approach with **dichotomous choice** (Fauzi, 2006), which in this case is the choice to stay or relocate. The costs and benefits will be calculated based on the direct costs incurred for adaptation measures to climate-related risks, and the direct benefits from the economic opportunities (i.e. income earned) of households in the village. The costs include elevating homes and roads, building dykes, building pump houses, as well as the cost of fuel for fishermen. The estimation of cost here is derived from the household monthly expenditure. Benefit is calculated based on the inhabitants' monthly income from e.g. open-sea fishing and fishpond farming. By comparing the monthly income (benefit) to the monthly expenditure (cost), this enables an estimation of the cost incurred in staying in an area facing climate risks, whilst recognising that this is a rough calculation and other factors also play a role in determining location choice, including non-quantifiable factors such as social assets and cultural assets in the communities.

In the village of Tanjung Mas, the main adaptation strategies used are elevating houses and roads, building extra storeys on homes, and building dykes. Housing elevation is generally done every five years, costing on average up to IDR 50 million per house, which requires savings of around IDR 850,000 per month over the period, if evenly spread. In terms of road elevation, while this is done by the residents collectively, it usually receives government financial assistance as well as NGO support. Where government funds are unavailable, the community raises funds independently through community contributions, which reach up to IDR 200,000 per household.

The main adaptation strategy in Panggung Lor is also housing elevation, with similar costs to Tanjung Mas. Additionally, in Paggung Lor, residents routinely contribute to the community P5L organisation, at IDR 25,000 per month. This contribution goes towards paying for electricity for the pumps and salaries for those who maintain the pumps, drainage systems and embankments.

In Tugurejo, the main adaptation strategies are to protect aquaculture ponds by building embankments between each pond and an APO/breakwater. Currently, the breakwater alone is not sufficient to prevent the tide entering the ponds, so continuous embankment construction is required, at an average cost of IDR 180,000 per month. Fishermen are also burdened with additional fuel costs as they must travel longer ranges to make sufficient catches, requiring an extra three litres of fuel per day at a total cost of IDR 19,500 or IDR 585,000 per month.

In Mangkan Wetan, which was also a fishpond farming area, residents have constructed breakwaters and embankments for each pond. Additionally, they have built levees around the residential areas, with costs supported by government and NGOs. The local fishermen have faced similar additional fuel costs to Tugurejo, up to IDR 19,500 extra per day.

The following tables summarise the average monthly spending incurred by households in each village, including subsistence costs (food, water, electricity) and the additional climate-related costs (elevating houses, building dykes etc.). The difference between income and expenditure is then calculated, and offers an estimation of the percentage of income going towards covering adaptation costs.

Table 6. Costs of adaptation: Tanjung Mas

Principal income (per month)	**Average spending on living costs**		**Calculation of adaptation costs (income minus expenditure)**	**Percentage of income spent (cost of adaptation/ principal income x 100)**
	Not related to climate change (IDR per month)	**Related to climate change (IDR per month)**		
2 million (generally fishermen)	Daily food: 1.2 million Electricity: 70,000 Water: 45,000 Schooling: 200,000 Gas (LPG): 30,000	Elevating the house: 850,000 Contribution towards elevating the road: 50,000	2 – 2.445 million = (–)445,000 (to cover any shortfall, women generally work as fishmongers)	900,000/2 million x 100 = 45% (45% of people's income is put towards the cost of climate change adaptation)
Amount	**1.545 million**	**900,000**	**445,000**	**45%**

Source: Primary data analysis (2013)

Table 7. Costs of adaptation: Panggung Lor

Principal income (per month)	Average spending on living costs		Calculation of adaptation costs (income minus expenditure)	Percentage of income spent (cost of adaptation/ principal income x 100)
	Not related to climate change (IDR per month)	Related to climate change (IDR per month)		
4 million (generally self-employed)	Daily food: 1.8 million Electricity: 90,000 Water: 60,000 Schooling: 500,000 Gas (LPG): 30,000	Elevating the house: 850,000 Contribution towards elevating the road: 50,000 Contribution to P5L: 25,000	4 – 3.405 million = 595,000 (in general, still have money left over for savings)	925,000/4 million x 100 = 23% (23% of people's income is put towards the cost of climate change adaptation)
Amount	**2.480 million**	**925,000**	**595,000**	**23%**

Source: Primary data analysis (2013)

Table 8. Costs of adaptation: Tugurejo

Principal income (per month)	Average spending on living costs		Calculation of adaptation costs (income minus expenditure)	Percentage of income spent (cost of adaptation/ principal income x 100)
	Not related to climate change impacts (IDR per month)	Related to climate change impacts (IDR per month)		
2 million (generally fishermen and fish farmers)	Daily food: 1.2 million Electricity: 45,000 Water: 30,000 Schooling: 150,000 Gas (LPG): 30,000 Fishermen: Purchasing nets: 25,000 Fuel: 1,500,000 Fish farmers: Fingerling seeding: 600,000	Fishermen: Fuel surcharge: 585,000 Fish farmers: Manufacturing and maintaining ponds and embankments: 180,000 Making an APO seawall: zero (government assistance)	Fishermen: 2 – 3.565 million = (–)1.565 million Fish farmers: 2–2.235 million = (–)235,000 (to cover any shortfall, in general they work as both fish farmers and fishermen; women sell raw materials and processed food such as fish crackers etc.)	Fishermen: 585,000/2 million x 100 = 29% (29% of people's income is put towards the cost of climate change adaptation) Fish farmers: 180,000/2 million x 100 = 9% (9% of people's income is put towards the cost of climate change adaptation)
Amount	Fishermen: 2.98 million Fish farmers: 2.055 million	Fishermen: 585,000 Fish farmers: 180,000	Fishermen: (–)1.565 million Fish farmers: (–)235,000	Fishermen: 29% Fish farmers: 9%

Source: Primary data analysis (2013)

Table 9. Costs of adaptation: Mangkang Wetan

Principal income (per month)	Average spending on living costs		Calculation of adaptation costs (income minus expenditure)	Percentage of income spent (cost of adaptation/ principal income x 100)
	Not related to climate change impacts (IDR per month)	Related to climate change impacts (IDR per month)		
2 million (generally fishermen and fish farmers)	Daily food: 1.2 million Electricity: 45,000 Water: 30,000 Schooling: 150,000 Gas (LPG): 30,000 Fishermen: Purchasing nets: 50,000 Fuel: 1,500,000 Fish farmers: Fingerlings seeding: 600,000	Fishermen: Fuel surcharge (585,000 Fish farmers: Manufacturing and maintaining pond: 180,000 Making an APO seawall: zero (government assistance) Making a neighbourhood levee: zero (government assistance)	Fishermen: 2–3.615 million = (–)1.615 million Fish farmers: 2–2.235 million = (–)235,000 (to cover any shortfall, many do additional work such as running stalls and motorcycle couriering)	Fishermen: 585,000/2 million x 100 = 29% (29% of people's income is put towards the cost of climate change adaptation) Fish farmers: 180,000/2 million x 100 = 9% (9% of people's income is put towards the cost of climate change adaptation)
Amount	Fishermen: 3.03 million Fish farmers: 2.055 million	Fishermen: 585,000 Fish farmers: 180,000	Fishermen: (–)1.615 million Fish farmers: (–)235,000	Fishermen: 29% Fish farmers: 9%

Source: Primary data analysis (2013)

Table 6 suggests that the cost of adapting to climate risks in Tanjung Mas averages IDR 900,000 per month, and the average income is IDR 2 million (many are fishermen), which means that 45 per cent of the household's income is spent on adaptation measures monthly. Table 7 suggests that the costs of adapting to climate risks in Panggung Lor averages IDR 925,000 per month, which includes both household-level adaptation spending and contributions to collective measures. As the average income is IDR 4 million, this means that proportionately, adaptation costs are only 23 per cent in the village, making it more bearable than in Tanjung Mas. And Table 8 shows that the average cost of additional fuel demands in Tugurejo average IDR 585,000 per month for open-sea fishermen, and maintenance of embankments for fishpond farmers averages IDR 180,000 per month. If the average village income is estimated at IDR 2 million per month, this means fishermen face a higher adaptation cost burden of 29 per cent of monthly income, compared to 9 per cent for fishpond farmers. Table 9 demonstrates that the proportions were the same in Mangkang Wetan.

However, looking at the total income versus expenditure per village, the additional adaptation costs incurred in Tanjung Mas, Tugurejo and Mangkang Wetan are bringing households into debt, with outgoings exceeding incoming income. It is only in Panggung Lor that households can still make savings even when the costs of adaptation are taken into account. This suggests that in the three other villages, the ongoing costs of adaptation may not be sustainable for households unless they find a way to increase their income (for example, housewives selling fish at the market to cover income shortfall) or reducing their expenditure. Livelihood diversification may also be an important strategy, particularly for those relying on a particular natural asset (fish) for generating income. If unsustainable adaptation spending has to continue, it may be that households will have to consider relocation to an area with lower housing-protection costs, as otherwise, to avoid creating new financial vulnerabilities for themselves.

4.2 Socio-economic analysis

The second type of analysis is a socio-economic analysis, which assesses what role household assets play in determining residents' adaptation or relocation decisions. In theory, if the value placed upon the combined assets exceeds the costs required to protect the assets from climate-related risks, this would be one reason to stay rather than relocate. In particular, financial assets (income) are strongly linked to location for fishermen, fishpond farmers and fish sellers. Additionally, there are few barriers to access as these jobs have low educational requirements, although some start-up costs (buying/renting boats or building fishponds) will be incurred. Additionally, working in such jobs enables a daily (rather than monthly) income to be earned, unlike most other jobs.

In addition to financial assets, residents may also own high-value fixed physical assets in the area which are worth protecting – such as homes and fishponds. Many residents have strong social ties in their villages – some stated that staying together to face climate threats they have in common has strengthened social cohesion, so social assets was cited as a reason to stay, as these relationships have developed over many years and would be hard to re-create in a new location. Additionally, many inherited their house or land and therefore said they must remain out of respect for their ancestors, demonstrating that cultural assets also play a strong role in tying people to their location.

In other cases, residents viewed their current location as having potential, e.g. future income-earning opportunities. For example, in Tanjung Mas and Tugurejo, many people felt that their villages should be developed as alternative tourism areas for fishing village or mangrove tourism.

Some residents stated that because the climatic impacts are temporary rather than constant, they are willing to live with these inconveniences. They also felt that these impacts can be resolved through technological solutions, such as elevating houses, building dykes, installing a water pump and clearing the drains. However, this raises the question of to what extent the residents are aware of climate change and how it may lead to more severe and more frequent impacts, particularly in the case of flooding, and that slow-onset impacts like sea-level rise will continue. If residents do not have this information, they may be adapting only to climate variability, as opposed to climate change, raising the possibility of maladaptation and wasted resources if their measures are insufficient to address future climate impacts. This suggests that there is a need to raise awareness and provide information about possible scenarios regarding sea-level rise and flooding, to ensure that residents make the appropriate decisions in terms of the their spending.

This analysis demonstrates that the decision to relocate or adapt is not purely based on financial reasons, but considers a complex group of interlinked factors, which means that the cost of having to adapt houses and land to climatic impacts is outweighed by the other assets, including social, cultural, natural, physical and financial, tied to the particular location.

4.3 Integrated PESTEL and SWOT analysis

The third component of analysis is the combined PESTEL and SWOT analyses, which will enable a consideration of how political, economic, social, technological, environmental and legal components can influence the decisions taken by households. It also highlights whether there are any crossovers with the strengths and weaknesses of the chosen adaptation strategies, the opportunities the villages face, as well as the challenges. These PESTEL and SWOT analyses were compiled by the researchers, as a way of reviewing the community-level data (both surveys and focus group discussions) as well as information gathered from in-depth interviews with government and academic experts.

The analysis in Table 10 demonstrates that certain economic factors can be considered a weakness, namely the increased costs imposed by adapting to climate impacts, which can comprise up to 45 per cent of monthly income (Tanjung Mas), which can create financial vulnerabilities at the household level. However, despite the economic risk we have seen in the previous sections that there are numerous other reasons why people choose to stay in an exposed area. The income earned by fishermen is also a strength, and this income is very much dependent on their coastal location.

Table 10. PESTEL and SWOT analysis in study areas

Political			
Strengths	**Weaknesses**	**Opportunities**	**Threats**
Tanjung Mas			
Coastal areas have government programmes to address climate change (e.g constructing break waters, elevating roadside residences).	Programmes more for the benefit of politicians ahead of elections.	Global attention related to climate change impacts in Semarang e.g ACCCRN.	The programme has not arisen from the community but from outsiders.
Panggung Lor			
Has technological support from goverment to revitalise and strengthen river and build a pump house in West Kanal to minimise flooding.	The utility and infrastructure not given yet from developer (PT. Tanah Mas) to Government as a regulation about housing area, so Government program can't throught in to that area.	Reducing flooding in the local area	Nothing action fromGovernment to address in land issues or climate change impacts, so many adaptation measures might impact negatively on the villages. Pumps are costly to run (operated by P5L).
Tugurejo			
Coastal areas have government programmes to address climate change (e.g constructing break waters); community youth organisation interested in preserving mangroves.	Government has not prioritised the construction of breakwaters.	Semarang City Government plans to invest in mangrove eco-tourism in the Tapak region in Tugurejo.	In general, the land is owned by private industry. It does not belong to the community or government, so any industrial adaptation measures might impact negatively on villages.
Mangkang Wetan			
Coastal areas have government programmes to address climate change (e.g constructing breakwaters/ APO, mangrove planting and manufacturing dikes surrounding residential areas).	Climate change is still a marginal issue.	Global attention related to climate change impacts in Semarang e.g ACCCRN.	In general, the land is owned by private groups. As land does not belong to the community or government, this means they are politically weak.

Economic			
Strengths	**Weaknesses**	**Opportunities**	**Threats**
Tanjung Mas			
Local economic resources support the main livelihoods of the local community (e.g fishing, fish market, harbour).	45% of income is spent on the costs of climate change adaptation (e.g elevating homes and roads).	Currently, local people have sufficient income to meet their adaptation needs in addition to their daily needs.	Fishing catches have declined year on year, while operating cost for fishing is increasing (e.g. higher fuel prices) – the costs of adaptation may be unsustainable.
Panggung Lor			
Most livelihoods are entrepreneurial, so most people are not overly dependent; Panggung Lor has the highest average income of the four villages.	23% of income is spent on the costs of climate change adaptation (e.g elevating homes and roads, P5L).	In general, people still have savings.	P5L operational costs continue to increase, which needs addressing.
Tugurejo			
Local economic resources support the main livelihoods of the local community (e.g fishing and fish farming). Community groups receive support from international NGOs with the mangrove reforestation project.	29% of income is spent on the costs of climate change adaptation. However this spending is also contributing to increased pollution levels (e.g buying more fuel, manufacturing pond embankments), which could increase further.	In general, people have sufficient income for both their normal daily needs and for climate change adaptation. There is potential to diversify income to eco-tourism and mangrove seedling selling.	Fishing catches have declined year on year, while operating expenses have increased (e.g. higher fuel prices; ponds are often inundated by tidal floods).
Mangkang Wetan			
Local economic resources support the main livelihoods of the local community (e.g fishing and fish farming).	29% of income is spent on the costs of climate change adaptation (e.g buying more fuel and manufacturing pond embankments).	In general, people have sufficient income for both their normal daily needs and for climate change adaptation.	Incomes from fishing and fish farming have declined year on year, while operating expenses have increased (e.g. higher fuel prices; ponds are often inundated by tidal floods).

Social			
Strengths	**Weaknesses**	**Opportunities**	**Threats**
Tanjung Mas			
There are strong social bonds among community members. They find strength in collective dealing with adversity despite living in vulnerable areas.	Social bonds, however, do not contribute to strategies for coping with climate change impactd (e.g. no collective programmes).	This strong social bonding can help to build collective strateies for coping with climate change impacts.	Social bonding is static. As more people decide to move away from the local area, the remaining bonds might weaken.
Panggung Lor			
There are strong social bonds among community members. They have formed a collective P5L organisation.	There are still many people who do not want to pay dues/contribute to P5L.	The P5L can be used as a form of social capital to build collectivity to cope with the impacts of climate change.	There are still many people who do not want to be involved actively in the P5L organisation; costs and contributions may have to rise as impacts worsen.
Tugurejo			
There are strong social bonds among community members. They feel comfortable despite living in vulnerable areas. There is a community youth group and a fishermen's group.	Only some people are active in responding to climate change issues.	Community organisations have already demonstrated their ability to collectively take action and generate new income-earning opportunities.	As more people start to work in factories rather than fishing, social ties around traditional livelihoods may decline.
Mangkang Wetan			
There are strong social bonds among community members. They feel comfortable despite living in vulnerable areas.	Social bonds are not geared towards responding to climate change issues.	This strong social bonding can help to build collective strateies for coping with climate change impacts.	Although the social bonds are strong, because they are more cultural they are not well organised.

Technological			
Strengths	**Weaknesses**	**Opportunities**	**Threats**
Tanjung Mas			
Simple technology is used to minimise climate change impacts (e.g. breakwater, water pumps, elevating houses and roads).	The main use of technology is to elevate houses, which is very expensive.	Awareness of technology to reduce impacts could improve.	The main use of technology is done individually, not collectively (e.g. elevating own house, using own water pump).
Panggung Lor			
There is technology that can be used to minimise the impact of climate change (e.g. elevating houses and roads, building embankments, pump house).	The operational costs of the pump house are very expensive (electricity costs, maintenance, personnel).	The technology is used collectively, not individually.	Government assistance is still weak, while operational technology (e.g. automatic pump) is very expensive.
Tugurejo			
Simple technology is used to minimise the impacts of climate change (e.g. building a breakwater/APO and pond embankment).	The breakwater, which is made of bamboo, tyres and mangroves, requires maintenance and has not expanded in length.	There is public awareness that the breakwater/APO is greatly helping to reduce the risk of climate change impacts.	The mangrove requires care and grow slowly.
Mangkang Wetan			
Simple technology is used to minimise the impacts of climate change (e.g. building a breakwater/ APO, pond levees and dikes surrounding the settlements).	Although the breakwater technology has been in place for a long time, it has not been increased in size.	There is public awareness that the breakwater/ APO and embankments surrounding residential areas are greatly helping to reduce the risk of climate change impacts.	There is public awareness that the breakwater/APO is very simple.

Environmental			
Strengths	**Weaknesses**	**Opportunities**	**Threats**
Tanjung Mas			
Tidal flooding is regular but not constant. The area is strategically located close to the airport, harbour and market with road access to the city centre.	While flooding is not constant, it is regular and likely to worsen with sea-level rises and subsidence.	The area is a strategic region which can be used as capital by the community to improve economic access and convenience..	There will always be physical changes in the area due to tidal flooding and land subsidence.
Panggung Lor			
Tidal flooding is temporary, but the area is a strategic region close to the airport, harbour and market with road access to the city centre etc.).	Tidal flooding occurs regularly and may worsen with sea-level rises.	The area is a strategic region which can be used as capital for the community to improve economic access and convenience.	Physically, the region is lower than the tide and therefore highly at risk from sea-level rises.
Tugurejo			
Tidal flooding is only temporary, and does not submerge homes.	Tidal flooding is a regular occurrence, may worsen with sea-level rises.	The presence of mangrove forests is good for eco-tourism.	Severe coastal abrasian means land use may change.
Mangkang Wetan			
Tidal flooding is only temporary, and does not submerge homes.	Although the tidal flooding is instantaneous, it happens continuously over long time periods.	The presence of mangrove planting is helping to prevent abrasion.	Coastal abrasian means continuing physical changes to the area.

Legal			
Strengths	**Weaknesses**	**Opportunities**	**Threats**
Tanjung Mas			
The area has a legitimate government, ranging from the neighbourhood RT/RW to villages.	The neighbourhood programme is more concerned with urban administrative services than climate change issues.	The presence of government officials up to neighborhood level means that a direct government structure could serve the community.	Government lacks an understanding of environmental issues and climate change.
Panggung Lor			
The area has a legitimate government, ranging from the neighbourhood RT/RW to villages. There is also an official organisation to tackle the impacts of climate change (P5L).	P5L was formed because local government was unresponsive and is better able to meet local needs. As local government may not improve it may continue to pass the burden of dealing with climate change impacts to the community.	There are two legal organisations, the village government and the board of P5L.	Government officials lack an understanding of environmental issues and climate change.
Tugurejo			
The area has a legitimate government, ranging from the neighbourhood RT/RW to villages.	Climate change has not been a major issue for village government.	The presence of government officials up to the level of neighborhood (RT/RW) means that a direct government structure could serve the community.	Government officials lack an understanding of environmental issues and climate change.
Mangkang Wetan			
The area has a legitimate government, ranging from the neighbourhood RT/RW to villages.	Climate change has not been a major issue for village government.	The presence of government officials up to the level of neighborhood (RT/RW) means that a direct government structure could serve the community.	Government officials lack an understanding of environmental issues and climate change.

Source: Primary data analysis (2013)

The analysis shows that in general, all of the communities are currently able to take measures to cope with climate-related risks. However, this creates potential economic risk, particularly for those residents who spend a large proportion of their monthly income on adaptation costs and ultimately end up with no monthly savings. This is unsustainable in most instances, but particularly so where there is potential for climatic impacts to worsen in frequency and severity, requiring further expenditure and creating economic vulnerability. This could trap residents in a cycle of poverty where they are merely coping with climatic impacts as they come, rather than adapting, which requires a long-term view.

Additionally, a number of residents highlighted the problem of lack of accessiblity during flood periods, particularly for the residents of Panggung Lor. Whilsts measures can be and are taken at the individual level, there is a need for a broader city-level programme to manage floodwater to ensure that risks do not worsen at the level of individual communities. For example, Semarang is carrying out some activities to reduce flooding, such as building the Jatibarang Dam, cleaning and repairing the West Canal River, building a retention pond, and building more pump houses.

The analysis suggests that residents have a lot of confidence in the ability of technological solutions to aid adaptation, for example that floods can be overcome using drainage systems in each location, or using water pumps to drain their houses. It appears that they have assimilated these technologies into their daily lives: the use of these technologies is not regarded as a major problem but a fact of life. However, as climate change could worsen the impacts, technological solutions may become an increasing burden. The sooner residents are informed and made aware of climate change impacts, the better they can plan their response.

Community-led collective solutions are working well in two of the sample villages: Panggung Lor with P5L, and Tugurejo with the Prenjak youth group and the fishermen's group. This is an opportunity for other villages to follow their examples and use collective approaches that can also offer income-diversification opportunities, like eco-tourism in Tugurejo. However, the risk is that the local government authorities then do not carry out their duties because they see community groups and residents taking the necessary steps. The challenge is finding the right balance beween community-led and household-level initiatives with government initiatives, so that they complement each other to maximise the mitigation of climate impacts.

5 Supporting government adaptation policies in coastal areas

The government has some policies to enable people to remain living in the same place, however there is scope for further innovation. One policy of the Semarang municipal government is to build public rental housing on municipal land for people vulnerable to disasters, particularly those living in villages like Tanjung Mas where they face double impacts from tidal floods and subsidence. The Mayor's Regulation of Semarang City (PERWAL) 7, 2009, outlines the eligibility requirements for the occupancy and rental of flats owned by the Semarang City government in Article 3 as follows:

a) Those affected by urban developments or projects implemented by Semarang City government

b) Residents who are living in informal settlements in the region

c) Those on a low-income and/or on the City Minimum Wage, as proven by a statement letter from RT[5] (*Rukun Tetangga* or household groups) or the village administrative office (neighbourhood level)

d) Prospective residents who do not have permanent jobs (seasonal workers).

Many of those who would be eligible for municipal flats would include those with a low adaptive capacity, due to lack of adequate housing, a secure income source, or both. Therefore, one could consider this public rental housing programme as a contribution to disaster-risk management in the city, by providing residents with secure housing. There are several rental flats in the city, two of which are located in Bandarharjo and Kaligawe sub-districts. This effort was initiated by the government to give those who have a higher level of vulnerability, whether to sea-level rise or other potential disasters such as landslides, a less exposed place to live.

The flats are provided with a rental subsidy. However, it is not always simple for people to move to municipal rental properties from their current location. Coastal locations are very important for the livelihoods of many villagers and the distance between their current homes and the flats can be as far as 10 kilometres. In many cases, the conditions of the new flats are not of a high standard and there are limited facilities, sometimes even no running water. Moreover, the overall quality of newly built flats is decreasing. Consequently, while some people choose to relocate or live elsewhere, including in rented housing which is not provided by the government, many choose to remain in their current housing, for economic but also social and cultural reasons.

However, it may be that if residents had access to better information and an awareness of future climate change impacts, they might take a different approach to adaptation – rather than investing in technologies to reduce the impacts on a regular basis, they may also consider relocation more seriously, and choose to invest money they would spend on elevating their house in buying a new house elsewhere, for example. Or they would ensure that they invest in long-term adaptation solutions, for example capable of coping with more extreme floods than those currently experienced.

Semarang City has also been involved in the international Asian Cities Cliamte Change Resilience Network (ACCCRN) initiative. City officials have been invovled in developing a climate-resilience strategy and implementing city-level projects, including mangrove reforestation in Tugurejo. Another initiative has been a flood forecasting and early-warning system, which should build the capacity of residents to respond more effectively, by knowing for example when the pumps need to be running. This has been supplemented by in-depth studies about the city's master drainage plan, the economic impact of flooding, and the impact of abrasion on coastal households. The information gathered through this initiative could be used to inform local residents, and can be used to plan appropriate measures at the city level.

Other policy recommendations specifically tailored to address the adaptation needs of each Semarang village are outlined Table 11, which also considers the gaps in existing policies. Across all of the case study sites and beyond, there is scope for better information sharing about existing measures and approaches applied by villages, so that villagers can learn from each other and also inform government approaches. Additionally, all villages will require awareness raising about climate change impacts in future.

Table 11. Policy recommendations

Household/village adaptation needs	Existing government initiatives/policy	Gap	Options
■ Houses are in poor condition, too exposed to flooding (e.g. only one storey) and in certain cases are sinking due to land subsidence	■ Provision of subsidised municipal housing through the Mayor Regulation ■ City government must provide land and cover the costs of building public housing (Indonesia Law n20, 2011)	■ Municipal flats are seen as being too far away from livelihoods, lacking basic services ■ People lack the necessary funds to construct a new life in the new area	■ Possibility of subsidising rental in private sector housing (requires private sector to build affordable housing) ■ Protect housing in existing villages more effectively ■ Provide funds for house and road elevation
■ Need areas of polder (reclaimed land) to combat sea-level rise and subsidence	■ Commitment to build polder between levels of Indonesian government (at city, provincial and national level) with cooperation from The Netherlands government in Kemijen and Tambaklorok areas	■ Polder should be located in areas vulnerable to flooding ■ Need studies about suitable locations and different models/ technologies for embankments ■ A green belt would preserve areas to reduce surface water runoff	■ Possibility of co-funding with private sector to fund embankment construction, particularly in industrial areas ■ Introduce a green belt as part of urban planning
■ Need for more embankments (set out in Semarang mid-term plan) ■ Need more effective drainage systems and pump houses capable of coping with more rainfall	■ Commitment between Semarang Municipality, Central Java Province, and Japan Bank for International Cooperation (JBIC) to normalise Asin River ■ Embankment built between 2008–2013 to protect housing	■ The embankment is not sufficient to protect rice fields and housing, affecting production	■ Expand embankment construction to protect agricultural and aquacultural areas

Household/village adaptation needs	Existing government initiatives/policy	Gap	Options
■ Pump houses are costly to operate	■ Some pump houses built by Province of Central Java government are operated by Semarang municipality	■ Pump is not able to cope with large floods ■ Government cannot subsidise operation costs of non-government run pumps	■ More pumps to be built and operated by government, in a way which complements existing pump houses such as those of P5L
■ Need elevated roads to ensure continued access, but which do not displace flooding into houses	■ Some government-led road elevation programmes	■ Accessibility of roads during floods inside villages is still a problem ■ Road elevation is partial due to expense	■ Government support for community-led road elevation schemes
■ Lack of awareness about likely climate change impacts including more intense and frequent rainfall, sea-level rises	■ ACCCRN initiative includes capacity-building and awareness-raising component	■ Information may not reach those who are most vulnerable or who need to make decisions based on longer-term financial planning	■ Awareness-raising campaign targeted at vulnerable households ■ Capacity building of government agencies
■ Need protection from coastal abrasian to protect fishponds	■ Local Semarang Regulation 12, 2010 about Semarang mid-term planning development (RPJMD) includes need for coastal green belt (mangroves) and a green belt 'grand design' in Semarang	■ Local community youth group initiative to plant mangroves, sell seedlings, run eco-tourism is still opertaing on a very small scale – needs to be spread across the coastal area ■ Budget is still limited, reliance on NGO support ■ Much coastal land is industrial and owned privately	■ When permission is granted for coastal development, a contribution should be required for supporting mangrove plantation ■ Increase the budget to protect the coastal mangrove green belt and support expansion
■ Manage industrial waste to protect fish breeding	■ Central Java Province Regulation (*Peraturan Daerah*) 5, 2012 about standard of waste-water quality ■ Government Regulation (*Peraturan Pemerintah*) 27, 2012 about environmental permits	■ Industrial pollution continues to affect fishing catches in open seas and fishpond farming ■ Many industries still drain their waste water into the river	■ Monitoring of waste discharge needs to be increased and fines applied to industries ■ Increased law enforcement

Based on an analysis of existing government policies related to adaptation in four village, patterns of similarities between these villages can be seen. As policy development in Indonesian cities often targets city-level populations, these recommendations may provide an effective strategy to improve the life of poor and vulnerable people in coastal areas.

- **Provide publicly accessible information on flooded and potential climate change impacted areas:** within these four villages, only two were already provided with this information. This was due to their own awareness of the issues. The survey results show that everyone needs should have access to this type of information so related policies should be developed. This information can be disseminated through regular circulars to every sub-district in Semarang, on public information boards in front of sub-district administration office or in other strategic places such as mosques or markets.
- **Improve access to funding**: as the sub-districts have limited budgets for local development, coastal areas that have more needs should receive additional support from city government agencies. However, policies should provide a clear mechanism for access to this funding, as the granting of funds should not be limited to the city government. Funding to collective community approaches may be more cost-effective.
- **Improve participatory processes:** while preparing development plans, cities in Indonesia must go through a participatory process called *musrenbang*, where representatives from each sub-district provide feedback or suggestions based on people's needs. However, the finding from the research shows that representatives often do not have a good understanding of what people's need really. This is due to the direct appointment of representatives. If more participatory community-level workshops on climate change adaptation needs were held before the *musrenbang* process, the results taken to the *musrenbang* would better reflect the real needs of the sub-districts.
- **Allocate an appropriate budget each sub-district based on their needs**: for Indonesian cities, each district receives an annual budget. It is then redistributed to each sub-district. In Semarang, although the amount for each district is different, each of their sub-districts receives an equal amount. For coastal areas that may require more funding for tackling climate change impacts, this leads to a problem, as these areas will be less developed, meaning that poorer, more vulnerable populations will lack adequate facilities. If policies are developed requiring each village to assess their real needs, budget proposals could be made prioritising spending in these areas. However, this would require capacity building as many people employed at sub-district level are inexperienced in budget proposal development.
- **Continue actions to tackle flooding:** the community would like continuous support from the government to help fund the construction of polders, pump houses, embankments and drainage systems, as they think these measures have huge benefits for the neighborhood. However, the city budget is limited so it is important to map needs to prioritise which areas and actions to fund.
- **Support/mandate needs assessments:** the survey results show that most community residents prefer to stay in their current locations. Not everyone can accept the options to relocate from local government. Almost all respondent stated that they needed help to reduce flooding by building supporting infrastructure such as embankments, drainage systems and pump houses. As each sub-district has different needs, the government needd to assess the problems, potential solutions and strategis to support each district. This can be done by mandating each sub-district administrative office to do a needs assessment in their area.

For those who want to relocate to the municipal flats, government should be ready to support them until the community has adapted to the new location and if necessary, help them to establish new livelihoods in their new location.

6 Conclusion

Using four case-study villages, this study has explored the climate change impacts faced by households, and the steps they have taken individually and collectively to reduce these negative impacts. The study has also explored some of the cost implications, to examine why relocation has not been considered a primary option for those affected by climatic hazards that are likely to get worse over time. The findings show that households spend a proportion of their income on adapting their houses and land to protect them from hazards, but that this cost can be a burden which will increase their vulnerability to shocks and stressors over time.

The analysis of income and expenditure, and of socio-economic reasons behind decisions to remain in the same location, reveal that proximity to income-earning opportunities is an important factor influencing location. This is particularly the case for those working in fishing or fish-farming industries, where other members of the household can also participate e.g. as market sellers of the catch. This makes them reluctant to move to municipal flats far from the coast, particularly as people believe the flats lack sufficient infrastructure such as a water supply. There is a role here for government to evaluate potential locations for municipal housing that would be more closely located to people's places of work.

At the same time, income diversification could reduce household financial vulnerability. This is particularly the case for households relying on natural resources for their livelihoods, such as fish, as fish stocks are declining and this may worsen due to pollution and the effects of climate change. Having alternative sources of work can secure a steady income and help to continue financing adaptation strategies at the household and community levels.

Households and village groups have taken their own measures to adapt, creating social assets. However, government should support and complement these measures with their own policies and approaches. On an institutional level, the government, from the municipal level down to the village government and household groups (RT) needs to increase its role in climate change adaptation. Climate change should be mainstreamed in all developments and environment initiatives in the region. Dissemination of information about the impacts of climate change needs to happen at the village-government level. The government must understand that programmes to build climate change resilience are as important as building well-being into economic programmes. This could reduce not only economic vulnerability but create social assets that also reduce vulnerability.

Secondly, the government has a role in developing appropriate climate change adaptation technology tailored to the character of each region. For example, in Tanjung Mas, government needs to build an embankment that surrounds the village and install integrated drainage that can be used for waste water disposal. For Panggung Lor, because the levees and water pumps have already been built, the government should provide subsidised electricity for operating the water pumps. For Tugurejo and Mangkang Wetan, more breakwater construction tools may need to be provided. At the same time, making a greenbelt with mangroves should be a priority programme. Government can play a role in providing land for these greenbelt areas and should also annex land along the coast currently owned by private companies needs to be done, so that people do not need to worry about future land-use changes.

Thirdly, all stakeholders, including the community, need to encourage the strengthening of social bonds between them. Using social capital helps to build climate-change resiliance, such as the P5L organisation Panggung Lor. By strengthening the social bonds in the community, people can start to think beyond just elevating their house to measures that can benefit everyone in the village. Collective approaches can also be less costly e.g. than each household having to regularly spend money to elevate their home. The government should encourage the strengthening of social bonds through RT village governments and religious groups in each region, to improve climate-change awareness and develop community-led initiatives which could also be supported by government funding.

Government intiaitives also need to be forward looking to ensure the best results. Household-level decisions to remain in one place or relocate will differ based on income, so policies should be tailored to the needs of different income groups. If relocation is the only solution, then government should provide incentives to encourage relocation which are targeted at the most vulnerable groups. For example, the provision of municipal housing would be more beneficial if combined with training for new livlihoods in the new area, so that people are more confident in establishing their new lives. Where there is financial capacity and sufficient technical and scientific knowledge in the village, adaptation in situ can be the most appropriate approach to dealing with climate change impacts. And ultimately, an urban ‘climate governance’ approach that brings together all stakeholders will ensure a more resilient city.

References

Abubakar, M (2006) *Menata Pulau-Pulau Kecil Perbatasan*. PT Kompas Media Nusantara, Jakarta, Indonesia.

ACCCRN (2010a) *Vulnerability and adaptation assessment to climate change in Semarang City*. Semarang, Indonesia. See http://tinyurl.com/acccrn-2010a-semarang

ACCCRN (2010b) *City resilience strategy: Semarang's adaptation plan in responding to climate change.* Semarang. Indonesia. See www.acccrn.org/resources/documents-and-tools?tid[]=25

Anonim, (2013), *Pestel Analysis,*available on https://www.kbmanage.com/concept/pestel-analysis

Bappenas (2014), *Rencana Aksi Nasional Adaptasi Perubahan Iklim (RAN-API); Laporan Sintesis*, Jakarta.

BPS (2013), *Semarang in Figure 2013,* Semarang.

Burke, John, 2014, *Introduces PESTLE and SWOT Analyses.Northumbria University, Nuwcastle,England*

Carney, D (ed.) (1998) *Sustainable rural livelihoods: what contribution can we make?* UK Department for International Development (DfID).

DKP Kota Semarang (2011) *City Spatial Plan of Semarang 2011–2031*. Perda Kota Semarang tentang RTRW 14, 2011, Semarang, Indonesia.

DKP Kota Semarang (2008) *Dokumen rencana tata ruang wilayah pesisir kota Semarang 2008–2023.* Semarang, Indonesia.

DKP Jakarta (2008) *Strategi adaptasi dan mitigasi bencana pesisir sebagai akibat perubahan iklim terhadap pesisir dan pulau-pulau kecil*. Jakarta, Indonesia.

Diposaptono, S., Budiman, Firdaus Agung (2009) *Menyiasati perubahan iklim di wilayah pesisir dan pulau-pulau kecil*. PT Sarana Komunikasi Utama, Bogor, Indonesia.

Fauzi, A (2006) *Ekonomi sumber daya alam dan lingkungan.* Gramedia Pustaka Utama, Jakarta.

ISSET (2010), *Kajian Kerentanan dan Adaptasi Terhadap Perubahan Iklim di Kota Semarang,* Semarang.

Hufschmidt, MM, DE James, AD Meister, BT Bower and JA Dixon (1983) *Environment, natural systems, and development: an economic valuation guide*. John Hopkins University Press, Baltimore.

IPCC (2007), *Climate Change 2007: impact, adaptation, and vulnerability*, Martin Parry (ed.), Cambridge University Press, Cambridge and New York.

Hidayah, N (2009) *Studi preferensi migrasi masyarakat kota Semarang sebagai akibat perubahan iklim global jangka menengah*. Unpublished report, Department of City and Regional Planning, Faculty of Engineering, Diponegoro University.

Marfai, MA and Hizbaron, DR (2011) Community's adaptive capacity due to coastal flooding in Semarang coastal city, Indonesia. Analele University din Oradea-SerieGeografies. See http://istgeorelint.uoradea.ro/Reviste/Anale/Art/2011-2/6_536_AUOG_Marfai.pdf

Miladan, Nur (2009) *Kajian kerentanan wilayah pesisir kota Semarang terhadap perubahan iklim*. Unpublished Master of Engineering thesis, Urban and Regional Development, Diponegoro University.

Kementerian Lingkungan Hidup (2010), *Indonesia Second National Communication Under The United Nations Framework Convention on Climate Change* (UNFCCC), Jakarta.

Setiadi, R, FH Mardiansjah and NAH Pratiwi (2009) Alternatif kebijakan antisipasi migrasi perubahan iklim di kota Semarang. *Jurnal Riptek* 3:2. See http://tinyurl.com/Setiadi-2008-Semarang

Sugiyono (2005) *Memahami penelitian kualitatif.* Bandung: CV. Afabeta.

Yuniartanti, RK (2012) *Migrasi vs adaptasi sebagai solusi dampak perubahan iklim di kawasan perkotaan.* Proceedings of the *Ikatan Peneliti Lingkungan Binaan Indonesia* (IPLBI**) (**Built Environment Research Association of Indonesia**)** 2012 Scientific Meeting.

Appendix 1. List of interviewees/experts

Ir. Purnomo DS, MM, MT	Decision maker, BAPPEDA Kota Semarang
Feri Prihantono, ST	BINTARI (a civil society organisation)
Ir. Jawoto Sih Setyono, MPD	IUCCE expert, lecturer on urban and regional planning, Diponegoro University, Semarang
Dr. Ing. Wiwandari Handayani	IUCCE expert, lecturer on urban and regional planning, Diponegoro University, Semarang
Wijanto Hadipuro, Ph.D	Lecturer, post-graduate programme on environmental and urban studies, Soegijapranata Catholic University, Semarang
Ir. Gunawan Wicaksono	Secretary of BLH Kota Semarang (Semarang Environemntal Agency)

Appendix 2. Survey questions

Evaluating household risk in responding to climate change impacts in Semarang's coastal area

IDENTITY OF RESPONDENT

Name:

Male/female:

Age:

Address:

SOCIAL AND ECONOMIC PROFILE

1. **What is your level of education?**
    a. Did not finish elementary school
    b. Elementary school
    c. Junior high school
    d. Senior high school
    e. University/college

2. **What is your main livelihood?**
    a. Fisherman
    b. Fish farmer
    c. Service industry
    d. Factory worker
    e. Merchant/vendor
    f. Employee
    g. Public service/soldier/police
    h. Other (please specify)

3. **What is your monthly average total income from your main livelihood?**
    a. < IDR 1 million
    b. IDR 1–2 million
    c. IDR 2–3 million
    d. IDR 3–4 million
    e. IDR 4–5 million
    f. > IDR 5 million

4. **Do you have an additional livelihood?**
   a. No
   b. Fisherman
   c. Fish farmer
   d. Service industry
   e. Factory worker
   f. Merchant/vendor
   g. Public service/soldier/police
   h. Other (please specify)

5. **What is your monthly average total income for your additional livelihood?**
   a. < IDR 1 million
   b. IDR 1–2 million
   c. IDR 2–3 million
   d. IDR 3–4 million
   e. IDR 4–5 million
   f. > IDR 5 million

6. **Who earns the main income in your family?**
   a. Father
   b. Mother
   c. Both father and mother are working
   d. One of the children
   e. Other (please specify)

7. **How many people are economically dependent on your family?**
   a. 1 person
   b. 2 people
   c. 3 people
   d. 4 people
   e. 5 people
   f. More than 5 people (please specify)

8. **How much are your monthly expenses for the following?**

   ■ **Food**

   a. < IDR 0.9 million
   b. IDR 0.9–1.2 million
   c. IDR 1.2–1.5 million
   d. IDR 1.5–1.8 million
   e. > 1.8 million (please specify)

   ■ **School fees**

   a. Free (supported by government)
   b. < IDR IDR 30,000
   c. IDR 30–40,000
   d. IDR 40–50,000
   e. IDR 50–60,000
   f. > IDR 60,000 (please specify)

- **Pocket money for children**

a. < IDR 30,000
b. IDR 30–40,000
c. IDR 40–50,000
d. IDR 50–60,000
e. > IDR 60,000 (please specify)

- **Electricity**

a. < IDR 30,000
b. IDR 30–40,000
c. IDR 40–50,000
d. IDR 50–60,000
e. IDR 60–70,000
f. > IDR 70,000 (please specify)

- **Water (PDAM)**

a. IDR 20–30,000
b. IDR 30–40,000
c. IDR 40–50,000
d. > IDR 50,000 (please specify)

- **Other costs (please specify type of cost and IDR/month)**

9. After your monthly expenses, can you save any of your income?

a. No money left for savings
b. Yes, I can save (please specify average IDR/month)

10. What size is your house?

a. Smaller than 60m2
b. 60–70 m2
c. 70–80 m2
d. 80–90 m2
e. 90–100 m2
f. Larger than 100 m2

11. What type of house do you live in?

a. Permanent cement walls with ceramic floor
b. Semi-permanent half-cement walls with no ceramic floor
c. Wooden boards with no ceramic floor

12. What is the status of your house?

a. Private property (SHM)
b. Rented house
c. Other (please specify)

VULNERABILITY

13. How long have you lived here?

a. Since I was born – my parents and ancestors also lived here
b. I moved here in (please specify when)

14. Are you aware of any of the following? (Yes/No)

- Strong emotional bonds among the inhabitants
- Passing on traditional/local knowledge and customs
- Good relationships and cooperation among inhabitants
- An atmosphere of safety and mutual sharing and giving

15. Have you and your family ever suffered from the following diseases? (Yes/No)

- Skin diseases
- Diarrhoea
- Malaria
- Dengue Fever
- Bronchitis
- Pneumonia
- Typhus
- Cholera

16. What kind of health facility do you use to treat those diseases?

a. Puskesmas (local public health service)
b. Hospital
c. Doctor
d. Buying medicine/self-treatment
e. Other (please specify)

17. How much money do these illnesses cost to treat? (in IDR)

- Skin diseases
- Diarrhoea
- Malaria
- Dengue Fever
- Bronchitis
- Pneumonia
- Typhus
- Cholera

18. What kind of water supply do you use every day?

a. Private ground water
b. Private artesian well
c. Communal artesian well (pay per use)
d. Water piped from public water supply (PDAM)
e. Other (please specify)

19. Where do you dispose of your household's waste water?

a. Septic tank
b. Trash dump
c. Pour away onto the ground
d. River
e. Other (please specify)

20. Which of these best describes the condition of your fishpond?

a. I do not have a fishpond
b. Normal, no change
c. Fewer catches
d. More catches

21. Have you ever been affected by the following? (Yes/No)

- House floods and experience difficulty in access/travel
- House does not flood, but experience difficulty in access/travel
- House floods; fishing catches have declined in recent years
- House does not flood
- House floods temporarily during heavy rains, making access/travel difficult

PROTECT, ADAPT OR RELOCATE?

22. To tackle the problems caused by climate change impacts, have you chosen to stay or migrate?

a. Stay, and protect and mitigate the impact by elevating house and road
b. Migrate elsewhere
c. Migrate temporarily (retreat)
d. Migrate permanently but somewhere close by
e. Other (please specify)

23. Which of the following reasons have influenced your choices and why? (please describe)

a. Cultural assets
b. Financial assets
c. Social assets
d. Human assets
e. Physical assets
f. Would migrate but cannot afford to

24. If you have chosen to stay, will you do any of the following to tackle the problems? (Yes/No)

- Elevate the house
- Build a dyke to protect the house
- Keep myself and my belongings safe from the flood waters
- Don't have problem with flooding and the house is high enough
- Other (please specify)

25. Have people in your area done any of the following to tackle the problems? (Yes/No)

- Elevating their house themselves using their own money
- Elevating their house using the money from regular social gathering
- Building a dyke by collecting money from local inhabitants
- Elevating the roads by collecting money from local inhabitants
- Improving drainage and installing floodgates by collecting money from local inhabitants
- Other (please specify)

26. Are there any government programmes to tackle the problems?

a. No
b. Yes (please specify)

27. If there is no government programme, what would you like government to do? (please specify)

28. According to you, if there were any government programmes, who would need to be supported first, those who migrate or those who stay?

a. Those who migrate
b. Those who stay

29. If there was a government programme to build municipal flats, would you be interested in living there?

a. No
b. Yes

30. If yes, how much money would you be prepared to spend on rent each month? (IDR/month)

Semarang

Date (please add)

Name and signature

Protect, adapt or relocate? Responding to climate change in coastal Indonesia

Asian Cities Climate Resilience Working Paper Series

This working paper series aims to present research outputs around the common theme of urban climate resilience in Asia. It serves as a forum for dialogue and to encourage strong intellectual debate over concepts relating to urban resilience, results from the ground, and future directions. The series is also intended to encourage the development of local research capacity and to ensure local ownership of outputs.

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