University of Hawaii at Manoa

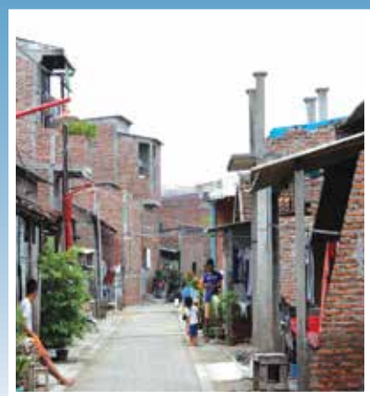
Department of Urban & Regional Planning

FALL 2016

PRACTICUM REPORT

VULNERABILITY ASSESSMENT

KEMIJEN, SEMARANG INDONESIA



UNIVERSITY of HAWAI'I MĀNOA

USAID FROM THE AMERICAN PEOPLE

REPORT SUBMISSION:

Fall/2016 Practicum – PLAN 751

Submitted to Department of Urban and Regional Planning, University of Hawaii at Manoa in partial completion of the Masters in Urban and Regional Planning.

INSTRUCTORS:

Dr. Dolores Foley (UHM), Dr. Wiwandari Handayani (UNDIP) and Micah Fisher (UHM)

STUDENTS:

Ranjeeta Acharya, Rasmi Agrahari, Maitry Biswas, Theresa Dean, Sarah Eggert, Emily Kukulies, Jessica Okamura, Maja Pilgaard Schjervheim, and Matthew Pine.

ACKNOWLEDGEMENTS:

A special thank you to the Semarang City Resilience Office, Kemijen residents and community leadership, government officials, nonprofit organizations, and faith- based organizations that articulated the vulnerabilities, challenges, opportunities, and milestones of planning and adapting to flood, subsidence and climate change.

Supported by USAID Grant: AID-OFDA-G-13-00048 (2013-2017)

Diponegoro University
Studio Student Partners
Aditio Setionurjaya
Deny Aditya Puspasari
Diana Kristina S
Maria Ekacarini Jayanimitta
Tresnasari Ratnaningtyas
Government Agencies
Disaster Management Board of Semarang City
Environmental Agency of Semarang
Health Agency of Semarang
Polder Banger Management Board
Semarang City Planning and Development Board
Water Management Agency
Resilience Office of Semarang City
Purnomo Dwi Sasongko
Luthfi Eko Nugroho
Wiwandari Handayani
Mega Anggraeni

Nonprofit Organizations
Bintari Foundation
Grobak Hysteria
PATTIRO Semarang
Perdikan
Mercy Corps Indonesia
Kemijen Community Leadership
RW and RT's of Kemijen
Bapak and Ibu Lurah of Kemijen
Pembinaan Kesejahteraan Keluarga
Local military and police representatives
University of Hawaii at Manoa
Dr. Kem Lowry
Dr. Keith Bettinger
Hendri Yuzal

IMAGES: Unless otherwise indicated, all images, photos, and diagrams were produced by UH/UNDIP students (2016)

CURRENCY: The November 2016 conversion rate used by the project team for IDR to USD was averaged to IDR 13,500 = 1 USD

TABLE OF CONTENTS

EXECUTIVE SUMMARY

In 2016 the University of Hawaii (UH) partnered with Diponegoro University (UNDIP) in a joint studio/practicum project to work on an urban resilience project in collaboration with the Resilience Office of the City of Semarang, Indonesia. The Resilience Office had two core objectives for the studio/practicum. First, they hoped the practicum could help develop an approach to conducting vulnerability assessments to build resilience in key target sectors in Semarang. Second, the Resilience Office also identified geographical priority areas. In particular, they hoped that focusing the work on Kemijen (a kelurahan, or urban village administrative unit) could present a strategic opportunity for piloting a vulnerability assessment and action plan on flooding and flood-related issues.

Kemijen is a unique community when it comes to building resilience. The area has experienced flooding for over 20 years, which is compounded by dramatic land subsidence that continues to undermine many development projects supporting the community. However, Kemijen has also made significant institutional and programmatic interventions that provide the foundation for building a framework for resilience going forward. The vulnerability assessment focuses on Kemijen as a test case for developing a vulnerability framework approach, while also looking for opportunities to implement action plans that tackle key resilient-building efforts for the community.

The UH and UNDIP joint studio/practicum (the project team) began by reviewing all documentation for the region and developing a comprehensive review of resilience frameworks. In addition, the project team met remotely with subject matter experts that ranged from sectoral expertise to administrative staff from the City of Semarang. These discussions helped guide research and provide perspectives on the complex inter-related aspects regarding resilience in the area. The project team identified key exposure, sensitivity, and adaptive capacity indicators to map the scope of work for the assessment. A series of household surveys, government interview questions, NGO interview questions and community focus group activities were designed to guide data collection and approach analysis.

With support from USAID, the project team was able to travel to Kemijen, Semarang and conduct the study. The project team completed a series of stakeholder engagement activities and field research to identify vulnerabilities in Kemijen. Although the initial vulnerability assessment highlighted flooding as the core problem, data indicated a complex interaction of four key elements that all require due consideration in order to effectively move towards building resilience. These include, understanding Kemijen in terms of: i) the dynamics of the community as a settlement area, ii) land subsidence, iii) flooding and polder management; and iv) solid waste, wastewater, and water supply. These four areas shaped the core analytical components of this report. Striving for resilience demands an integrated approach and the project team views these sectoral components as profoundly inter-connected. In turn, multi-sector collaboration is required due to the complexity of the issues and the inter-relatedness of their impacts. An integrated approach bridges structural and non-structural interventions and adopts the best practices of the Rockefeller Foundation's 100 Resilience Cities initiative. The Resilience Office is well positioned to facilitate and lead the initiative to build urban resilience by convening multiple stakeholder groups. As such, this report responds to the call to develop vulnerability assessments to build urban resilience.

Specific to Kemijen, the project team suggests a careful phased approach. The first phase focuses on immediate investments to improve the quality of life in the area. The project team identified that the polder investments had made a dramatic and immediate difference in reducing flooding. Although there remain questions about the overall polder design relative to neighboring kelurahan, completing the polder will decrease flood impacts for more residents. The second phase is to build multi-sector collaboration and outreach to ensure the equitable, just and optional relocation of people in Kemijen. Recommendations at the end of this report outline numerous potential interventions that respond to the core analytical areas of this report, ranging from water management issues to subsidence challenges, settlement approaches, and waste and health issues.

With the drastic rates of subsidence, some relocation is inevitable. In the event that resettlement takes place, approaches to relocating people should be conducted in ways that prioritize the most vulnerable and also adequately ensure the commensurate support for those affected. Although much of Kemijen is zoned for settlements – and in some neighborhood units informal settlements are actually increasing – land subsidence continues to present a constant strain at multiple scales. For example, local households invest costly amounts in raising their foundations on average every five years, and government funds are regularly responding to the need to raise roads/pathways and maintain drainage infrastructure. Those households that cannot invest in raising their foundations or that the government cannot fully serve are relegated to living with constant inundations and costly pumping requirements.

This report shares a vulnerability assessment geared towards approaching resilience in strategic phases. The overall approach supports the principle of first ensuring livability and improving quality of life, while making strategic investments for longer term sustainability considerations. The second phase prioritizes a precedent-setting approach by ensuring just practices for relocating strategic areas in Kemijen by focusing on the most vulnerable located in areas that support the most critical infrastructure. By approaching resettlement in these ways, affected communities and potential relocation areas will gain trust in the process and believe that moving can be an attractive option.

Urban resilience is a relatively new concept and the project team was encouraged by the Resilience Office's commitment to trial innovative approaches. In Indonesia, Semarang has the most progressive and innovative institutional outfit to plan for resilience. Implementation will serve as a guide to other cities across Indonesia. Vulnerability assessments provide for careful ways to gauge resilience and develop action plans. By beginning to set precedence in Kemijen, the Resilience Office of Semarang can continue to initiate and implement timely urban resilience efforts, while also finding new approaches to address key vulnerabilities for its residents. Resilience is premised on the dedication and commitment from the many sectors of government, the partnership fostered with communities, coordination among civil society groups, and cooperation with the private sector. Cities are made of people, and Kemijen can build resilience through the collaboration of individuals in a set of common principles that meet its complex challenges.

I. Introduction

The University of Hawaii (UH) received funding from the United States Agency for International Development (USAID/OFDA) which allowed collaboration with Diponegoro University (UNDIP) to conduct a joint vulnerability assessment in Kemijen. In 2016, UH and UNDIP partnered as a part of a joint studio/practicum course titled Urban Resilience: Flood Management in Semarang. The aim of the joint studio/practicum was to conduct a vulnerability assessment and develop an action plan to address flooding and related issues in a strategic area in Semarang. The location is an urban village administrative unit (kelurahan) called Kemijen. Figure 1 below is the joint studio/practicum members (henceforth, the project team).

Figure 1: Joint Practicum Opening in Semarang

Kemijen, like other kelurahan located in densely populated urban agglomerations along the north coast of Java, face risks from a multitude of urban development challenges, which are also made more complex through climate change. Kemijen is also strategically located near the main railway lines and benefits from proximity to industrial employment areas. In addition, the City Government of Semarang (henceforth, Kota Semarang) have also implemented key interventions on flood management, most notably the Banger river polder system. The complex urban vulnerabilities combined with the strategic location and the catalyzing effect of existing flood management interventions is the reason Kota Semarang's Resilience Office requested that the project team focus efforts in Kemijen. There is a sense that if the Resilience Office can get things right in Kemijen, the challenges for other neighboring kelurahan will become easier.

II. Kemijen Background

Indonesia is a country consisting of diverse islands and cities. In recent years, Indonesia has experienced an increase in the frequency of severe climate-related hazards with floods and windstorms, droughts, landslides, forest fires, heat waves, storms and others climatic events (ISET, 2010). With a population of approximately 1,584,068 people, Semarang is one of the larger cities in Indonesia and serves as the Capital of Central Java province. In 2016, Kota Semarang (not to be confused with the neighboring District of Semarang) was included in the Rockefeller Foundation's 100 Resilient Cities initiative. Through 100 Resilient Cities, Kota Semarang crafted a guiding framework for a Resilient Semarang in 2016, which included a roadmap of strategies to address climate change. Kemijen plays an important role for meeting key objectives of the framework.

Coastal areas are densely populated by residential and industrial development, which have been seriously affected by flooding in the past decades. Floods impact Kemijen through high rainfall events that take place upstream, localized high intensity rainfall events, and coastal tidal flooding that has worsened from dramatic land subsidence in low-lying regions. Although flood conditions spike and worsen during the rainy season, flooding can happen throughout the year in Kemijen. Such risk conditions have shaped complex individual and community adaptations of Kemijen residents.

Kemijen Geography

Kemijen is located in the northern region of Kota Semarang, with a total area of 140.9 hectares. Approximately 11% (15.86 hectares) of the kelurahan are characterized as a slum area. It is a vibrant community, with common social structures such as mosques, churches, schools, health centers and other places for community gatherings. Kemijen is intersected by two rivers, the Banger River and the East Flood Canal. Other unique features are the railroad tracks which run along hamlet (rukun warga, henceforth RW) V and RW VI, and the international port adjacent to the kelurahan, on the Northwestern side. The coastal community is also located near the harbor and other industrial business districts. The kelurahan is divided into 11 RWs (see Figure 2, below).

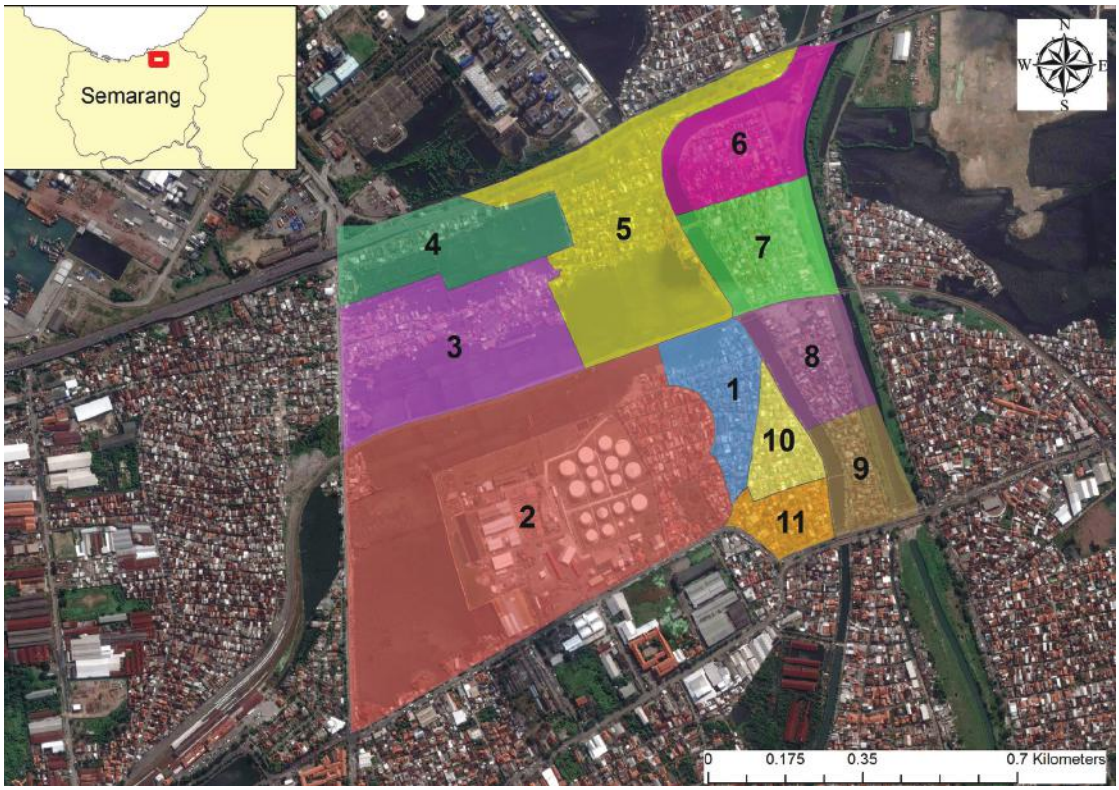


FIGURE 2 Map of Kemijen by RW

Source: Kota Semarang for administrative boundaries; Google Maps for base maps

Kemijen History and Demography

Although there is little information available about the area before the late 19th century, Kemijen was originally a marsh when people first began settling there. In the late 1800s the Kemijen area changed with the introduction of the key railroad lands that would begin to connect key areas across Java. This in turn provided employment opportunities and came to be settled by thousands of people. The 1990s also saw an increased expansion of industrialization, providing employment opportunities that led to people moving to the area. The 1997 Asian financial crisis also had a demographic effect has people began to flock here to find work in urban centers. Kemijen became a place of low cost housing options in proximity to various employment opportunities. Unplanned growth in this way also increased vulnerabilities, especially in regards to flooding.

There are several small informal and formal businesses in Kemijen. Along the boundaries of Kemijen are main roads that support an assortment of businesses which service the nearby industrial clients, such as auto and tire repair shops. Other boundary businesses support the many workers who use the transportation corridor such as convenience stores, lunch stops and snack shops.

Within the small narrow streets of the eleven RW are also businesses that serve the neighborhood's internal and external clients. These sources of income are assests for the economic health of the community but are also vulnerable to the hazards discussed in this assessment. The woman shown (upper right) sells snacks and beverages at the pump house each evening. She caters to the men and boys who come to the water's edge to race birds. This business operates daily and provides enough income to support her small household.

The group of people shown (lower right) are peeling garlic for resale. Their work areas are within 15 meters of the canal, an area vulnerable to flooding and contamination.

According to government statistics collected at the kelurahan level (2014), 13,410 people live in Kemijen. This consists of 3,969 families, with 6,709 males and 6,701 females. The population density is 9,493 inhabitants per square kilometer (Mulyana et. al, 2013). In 2010, approximately 82% of residents did not have a high school education and the student absentee rate was around 20%, however this number tends to rise in poorer areas (Taylor, 2010). Most people find work through the strategic proximity to the neighboring industrial centers, the nearby local market, and as fishermen. The project team also identified various informal shops that sold snacks and small household goods providing for additional household income throughout this vibrant community. Other common informal jobs include collecting waste from households or selling fish caught in the retention pond.

III. Vulnerability Assessment Methodology

Overview

The initial focus of this vulnerability assessment is on flooding challenges. Floods are the most visible risks to the community, affecting infrastructure, and other key features of the area like the canal and recently built polder system. In order to better understand the complexity of the challenges in Kemijen, the project team conducted a literature review to collect and review different studies, plans and projects in Kota Semarang, with a specific eye towards collecting Kemijen-specific information. The project team collectively adopted key principles of participatory planning. The key components of the assessment included research and stakeholder engagement to identify drivers, antecedents, and vulnerabilities. These planning and engagement activities provided the project team with essential information to develop a vulnerability assessment and action plan for cultivating resilience in Kemijen. Figure 3, articulates in greater detail the approach and conceptualization of drivers, antecedents, and vulnerabilities, and the approach for developing an action plan.

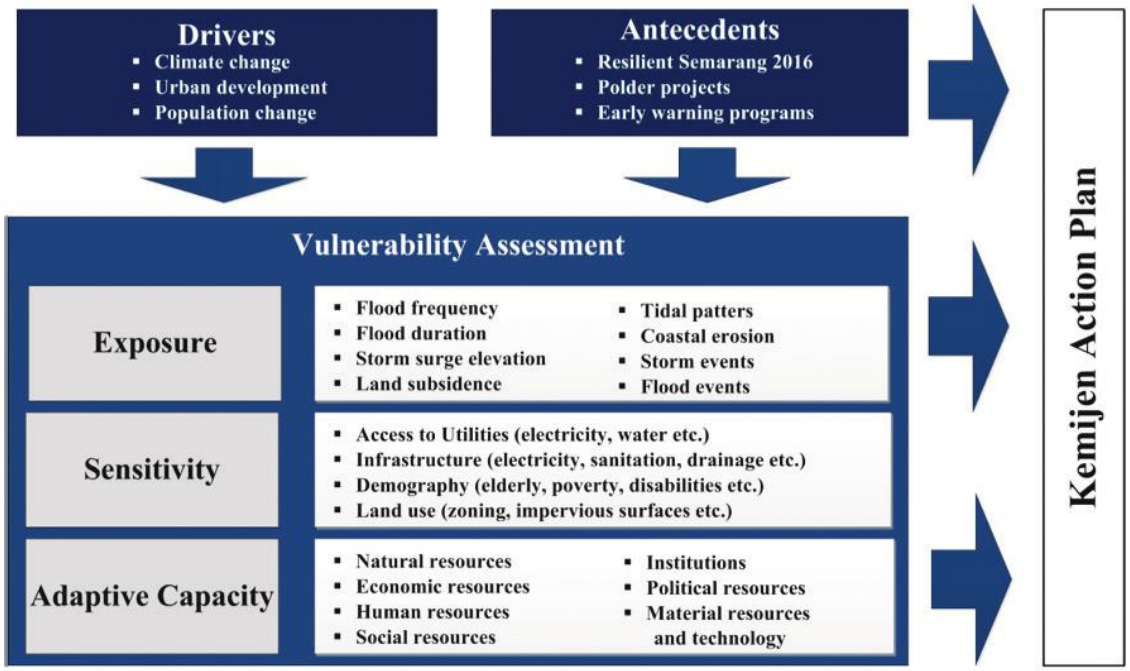


Figure 3: Vulnerability Assessment Conceptual Framework

Drivers and Antecedents

Through meetings with stakeholders and subject matter experts, the project team identified key drivers for adapting and building resilience in Kemijen. As a small residential community, the primary driver has been to enhance the local capacity to address flooding. However, due to the socio-economic conditions improving collaboration with government, non-governmental organizations and international organizations are secondary drivers to developing actionable steps. There are various government agencies that have prioritized addressing floods and flood related issues. Due to increased awareness, infrastructure, programs and partnerships that have taken place in Kemijen, the community has reduced flood impacts in recent years. However, flooding is a complex issue. Floods continue to occur in Kemijen and are made worse by the uncertainty of climate change. Various studies and plans have identified the causes of flooding and other challenges like land subsidence, land use and settlement. Despite these resilience milestones, challenges remain.

Vulnerability Assessment

There have been many publications that express the aims and milestones of flood adaptation. The major findings provided guidance into the different exposure, sensitivity, and adaptive capacity vulnerability indicators to consider when conducting a vulnerability assessment. The project team identified an extensive amount of indicators and questions. Select vulnerability indicators were prioritized and informed stakeholder engagement.

USAID (2014) defines a [climate] vulnerability assessment as an analysis of the extent to which human and ecological systems are likely to be affected by climate variability and change. Vulnerability is categorized into three components: exposure, sensitivity and adaptive capacity. These aspects of vulnerabilities not only identify the current and potential impacts or threats from flooding, but the ability to cope with events. The project team designed the assessment to focus on both social and physical vulnerabilities by engaging stakeholders who may not typically be involved in planning. By engaging with a diverse group of stakeholders, the project team was able to complete an assessment to serve as a guide and tool for understanding the resources, awareness, exposure, sensitivity and adaptive capacity of the community. The project team learned that flood events impact residents in several ways. Not only are communities directly exposed to floods – and thus its dangers to human health and affects

to property and personal possessions – but also secondary factors influencing sensitivity. Floods increase illnesses such as diarrhea, fever, dengue, or skin rash as people interact with unsanitary conditions. Floods also restrict movement around the city, whereby some must forgo work or school (Marfai et al, 2008). Repeated tidal flooding from the sea and its salinity in particular, also results in corrosive long term impacts on infrastructure. The depth of input provided to the project team from various stakeholders (see Appendix A), combined with fieldwork activities described below, provided for broad insight into the opportunities, limitations and challenges of resilience planning in Kemijen.

Exposure

The extent to which something is subject to a climate stressor: whether it is in harm's way. ***(USAID, 2014)***

Sensitivity

The extent to which something will be positively or negatively affected if it is exposed to a climate stressor. ***(USAID, 2014)***

Adaptive Capacity

The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. ***(IPCC, 2014)***

Transect Walk

In October 2016, the project team conducted field level activities in Semarang to collect the core data of the vulnerability assessment. A series of transect walks helped to better understand context and sense of place in Kemijen. The project team was able to informally discuss some of the challenges with flooding and how it impacts residents. By walking through Kemijen, the project team was able to experience life among communities exposed to flooding and initial discussions helped to identify some of the most vulnerable areas (See Figures 4, below). The transect walks also helped to contextualize the approach and scope of more intensive aspects of the fieldwork.

Figure 4: Transect Walk

Government Interviews

The project team also had the opportunity to interface with high level Kota Semarang officials at City Hall. Through a series of breakout group interviews among the key agencies of the city government, the project team collected data and learned of the approaches to addressing sectoral and planning challenges in Kemijen specifically, and Semarang overall.

Community Focus Group Discussion

A focus group discussion (FGD) was held with community leaders and residents in Kemijen (See Figure 5). The focus group was hosted by Kemijen leaders in the kelurahan government office. There were breakout groups and representatives from neighborhood groups (RT), health extension workers, police and public safety representatives, local interest groups and general community members in attendance. A cross section of stakeholders were separated into three working groups for the FGD, which were guided through a set of prompt questions, and yielded rich information about the history of hazards, locations of resources, patterns of flooding and more.

Figure 5: Focus Group Discussions

Non-governmental Organization Interviews

A select group of representative NGOs working in Kemijen (and Semarang) were also interviewed. The organizations invited ranged from environmental, social, and governance issues. For example the Bintari foundation works on regional sustainability issues through conservation initiatives. Grobak Hysteria works on participatory mapping and place building initiatives. PATTIRO works on governance, specifically holding public institutions to accountability. Perdikan is working with communities in Kemijen to support the most vulnerable through economic development opportunities. Finally, Mercy Corps has helped convene a network of cities on urban resilience initiatives and has specifically supported efforts in understanding vulnerability in Kemijen.

Household Survey

A household survey (see Appendix B), was designed by the project team to collect information on five key modules that would help to collect information towards an integrated approach for urban resilience. This includes flooding, polder flood maintenance system, waste and wastewater, settlement areas, and land subsidence. The intention was to complement the literature reviews and document analysis, government interviews, and NGO discussions with household perspectives in Kemijen (see Figure 6). The household survey was completed in two parts. The household survey was piloted in RW VII, VIII and XI. Then teams consisting of UNDIP, UH students and a translator conducted surveys in the RWs that had not been previously surveyed. The remaining eight RWs were represented in the household survey. The participating households provided nuance and depth about preferences and perceptions in terms of flooding, land subsidence, and what it is like to live in Kemijen.

Approximately 70% of the respondents were females as the interviews took place during the day at people's homes. Some of the women use their homes for work and provided context on economic opportunities in the area. For instance, a woman in RW VI taught young children how to read. Her neighbor had a warung or stand to sell snacks. Respondents ranged from newcomers to long term residents. The age range of people surveyed was between 18 - 90 years old.

Figure 6: Household Survey

IV. Settlement

Overview

Natural disasters are often complex phenomenon because although natural hazards cause disasters, disasters are by no means natural. The extent to which a disaster happens is also highly contingent upon socio-economic factors. Therefore, the project team began analysis by developing an understanding about a sense of place. The team sought to explain foremost the factors that have transformed Kemijen into a settlement area. In other words, what were some of the reasons people were first drawn to Kemijen, and what are reasons compelling residents to stay (despite constant exposure to hazards and a lack of basic services)? The responses from the household survey and engagement with other officials helped to provide a clearer picture of the paradox of why residents prefer to stay in Kemijen despite the challenges.

The historical events that emerged as influencing settlement in Kemijen included the development of the rail, industrialization, and the planning agency's (Bappeda) decision to zone parts of the area as settlement until 2031. The Indonesian Railway Preservation Society (IRPS) believes the first train station built in the city is Semarang Station in 1864, located in Kemijen, which highlights the strategic location and importance of the area (National Geographic Indonesia, 2014). Land subsidence has dramatically altered spaces in Semarang however, and has literally submerged the historical record of some of these rail structures.

Residents in Kemijen have speculated that people first moved to the area because of the development of the rail. Others who had lived in Kemijen for decades also mentioned moving to the area because of the railroad, and even worked at the railroad company's warehouse until it closed. Although many of the submerged tracks were abandoned the area has continued to be a strategic location for the poor and for new migrants to settle. Those who continue to make Kemijen their home had to adapt to the severe subsidence conditions, and it has become a densely populated area for those willing to trade off hazard risks to remain in the strategic location.

Where the roof once was . . . . . .

look for the line of colored plaster. We quickly learned on our walks through the area, that this is where the ceiling once was. This photo shows where the building was extended in height, but not covered with concrete. They had enough funds to add height, but not to plaster the wall to a finished look again.

This household is trying to beautify their area with a vertical garden in recycled water bottles. This is an attempt to make the best of the situation, but doesn't cover up the fact that the family cannot afford to finish plastering their home, or has chosen not to improve their home in that way anymore.

"I was able to raise my house but I couldn't finish the floors. I have wooden floors with dirt underneath, until I can afford more concrete...there is nothing else I can afford to put into this place"

RWIX Resident

A second theme influencing settlements in Kemijen came with the wave of industrialization in the 1990s. In Indonesia, the fifth five-year development plan Pelita V, which lasted from 1989 to 1994 focused on industrialization throughout the country (Hadi, 1997). Pelita V had the effect of increasing industrialization national GDP by 7%. Semarang experienced significant growth in the industrial sector in parallel, providing for a magnet for migration and development for people across the Province of Central Java (Hadi, 1997). Presently, there seems to be a growing interest to draw more foreign investors to Semarang.

Kemijen as both a settlement and industrial area was further designated when Bappeda officially zoned it as such, to continue in the same way until 2031. Figure 7 below provides a broad explanation of zoning for Kemijen. There have been discussions among Bappeda to begin to modify zoning designations before the end of 2016. Such re-evaluations of zoning designation helped to guide household surveys by the project team in order to explore varying perspectives and options about re-zoning for resilience.

Figure 7: Land Use in Kemijen *(Source: Government of Semarang)*

KEMIJEN IS A VIBRANT SETTLEMENT AREA

FROM THE DAY WE ARRIVED IN KEMIJEN, *we observed the vibrant life in the community. Walking down the well-maintained residential side streets the homefronts had signs of pride and there was activity everywhere.*

We were impressed that the residents exhibited such a welcoming spirit of generosity. Residents were open with their time, stories and resources. They were gracious hosts that spoke fondly of their neighbors and with concern for the community.

Household Survey Results

Survey responses identified four main reasons people were hesitant to move from Kemijen: strategic location, connection to place, a lack of economic means to move, and uncertainty about alternative accommodations. Many respondents recognized the proximity to places of employment – especially the port – as strategic reasons for staying in Kemijen. Respondents recognized that flooding and land subsidence posed a challenge to health concerns, but livelihood considerations seem to top the list for reasons to stay. If opportunities arise for employment in other places, people indicated they would be more open to moving.

Another common reason for staying in Kemijen as opposed to moving was connection to place. Residents noted a sense of pride in living in Kemijen and recounted the vibrancy of place through association to local organizations and the numerous events held in the community. Additionally, people had moved to Kemijen decades ago, and raised their children and their children's children in the same neighborhood. One survey participant even said, "No. We won't move. If we have extra money, we will eat more chicken. This is where our children are from." Many residents expressed hope in the polder system to ease flooding problems that they had experienced over the years (see section VI for more on flooding and polder system management).

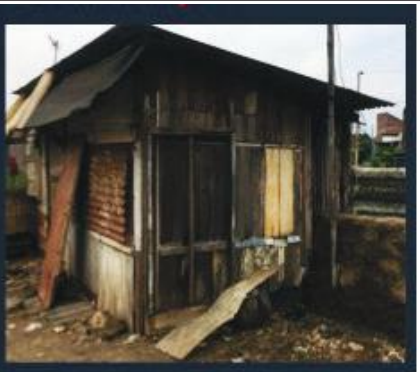
A third reason given for not moving away from Kemijen due to recurring flooding or land subsidence issues was the lack of enough money for moving costs or the economic transition costs for starting over in a new place. In addition, many households cited the large investments they had made to adapt their homes to flooding. Moving away would mean money lost investments. Leaving the security of homes that had been paid for, to non-secure public housing or rental homes was not preferable to most of the survey participants.

Furthermore, the lack of interest in moving can also be attributed to a lack of trust and uncertainty in the alternatives outside of Kemijen. The findings from the household survey in Kemijen are not unique, however, as similar studies from around Java highlight the reasons why people continue to live in hazard-prone communities. Taylor's study (2015) from Surabaya and Surakarta for example, accurately summed up sentiments from Kemijen: "Communities will not relocate if it means they become worse off or more vulnerable" (p. 622).

Housing investment varies across Kemijen

There is more investment in housing than most outsiders seemed to realize. The housing in Kemijen is more varied than we expected. The neighborhood was described by many of those we interviewed outside of Kemijen as a slum.

Most homes were of permanent quality brick construction that may or may not have plaster finishing. Along almost every street, a house was being improved. Homes were being raised, rebuilt, getting new floors or new finishes.



There were some informal buildings of wood which served as homes but most were only functioning as storage areas or had been abandoned. These were mostly along the banks of the canal or retention bond in what may be the easement areas.

Relocation Case Studies and Lessons Learned

Survey and FGD results highlight that Kemijen residents do not want their settlement zoning changed. Doing so would create uncertainty for residents that already face vulnerability. However, as land subsidence and climate change are likely to worsen flood hazards in Kemijen, a relocation program should be explored through a careful approach. Due to the lack of trust in relocation programs, such an effort should start small and focus on building trust among residents and showcasing that relocation can be a viable option. Relevant government agencies can begin developing a better understanding of various policies and planning processes concerning relocation due to natural hazards that have been tested to varying degrees of success across Indonesia. A brief examination of several relocation case studies has been included in Appendix C and is referenced here to make preliminary suggestions as a basis for exploring the appropriate policy for Semarang.

Several lessons can be learned from cases in nearby cities in Java (see Appendix C). First, flooding is a major concern that has caused other cities like Solo and Surabaya to conclude that the best way to promote livability for vulnerable residents is relocation, as opposed to infrastructure investments in communities. The difference in Kemijen, however, is that there has been major investment in infrastructure such as the polder and numerous layering to raise street levels.

In Surakarta (Solo) in particular, the participation of the community in co-producing a standard compensation policy means that concerns that may not have been understood by government agencies were included in the process. Through attempting to understand the preferences and concerns of the community residents in relocating, more households began to be open to the idea of moving. By providing basic services in the new settlement as well and ensuring the viability of the relocation option, thus resulted in greater incentive to move.

One of the main similarities between Kemijen and the case studies of Solo and Surabaya is that all three communities vulnerable to flooding had a mixed presence of residents with land tenure and those without land tenure. This is a very sensitive issue, as those who did not possess land tenure in both Solo and Surabaya did not receive compensation or offers of compensation to be moved. If the city of Semarang is to develop standard relocation policies, the question of how to include residents without legal tenure and provide incentive to these households will be one of the most difficult issues. Additionally, not unlike Surabaya where there were complications about the jurisdiction and management of the settlement area by different government agencies, there may be similar complications in Kemijen. The railroad company owns much land (currently underwater) in Kemijen. If the railroad company's interest in Kemijen is renewed in the future, there may be competing interests if relocation is ever enacted. Overall, although there are many case studies of relocation to learn from around Java, numerous questions remain that must be considered in developing a relocation policy that is unique to Kemijen and Semarang, namely: who is responsible for developing a relocation plan and who will take the lead in ensuring it is done adequately?

Summary of Findings on Settlements

Despite the interconnected challenges related to land subsidence, flooding, and waste, Kemijen has hosted a sustained and resilient population for decades. Various discussions with community members and local officials have revealed that residents have had a lack of choice in mobility, due to economic circumstances and the availability of employment in the areas. Furthermore, while Kemijen residents have had to adapt to challenging environmental conditions over the years, there is a noticeable vibrancy and sense of pride of living in the community. In looking ahead, any recommendations must consider not only historical events affecting settlement in the area, but resident preferences and concerns as well. Action steps aimed at improving the current living situation of residents (regardless of land tenure status) with the continued development and expansion of the polder and efficient waste management must be considered simultaneously with studies on how to develop an appropriate relocation policy that would address alternative options to living in Kemijen as well as sufficient compensation. In the next section, we examine the ways in which Kemijen has transformed the most over the past two decades, namely due to dramatic land subsidence.

V. Land Subsidence

Overview

In Semarang, land subsidence and the comprehensive knowledge of it is essential for several important planning and mitigation efforts (Abidin et al, 2010). Figure 8 below highlights that land subsidence is at the center of key planning efforts like flood control, groundwater extraction regulation, and design and construction of infrastructure, and others. Land subsidence in Semarang is widespread along the northern coastal areas and affects quality of life of its residents. Rob (tidal flooding) is frequent and severe in Semarang and has had enormous impacts to quality of life, health and sanitation, and the economy. This is especially true in Kemijen.

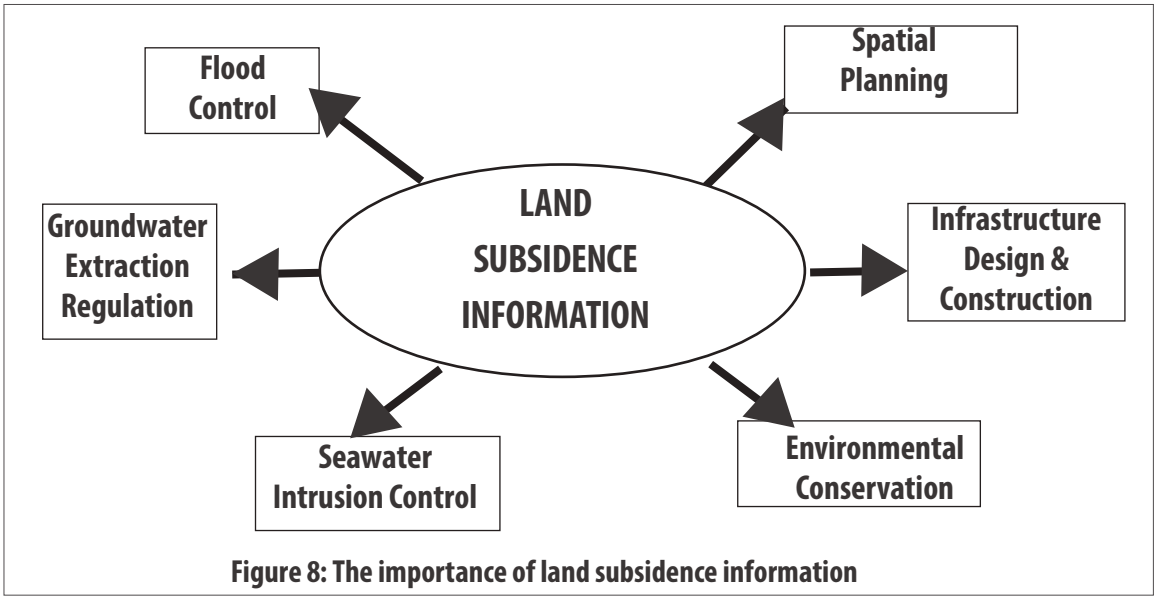


Figure 8: The importance of land subsidence information

The northern part of Semarang is composed of very young alluvium soil with high compressibility (Abidin et al, 2012). These alluvial deposits in the coastal area of Semarang consist of beach, floodplain, tidal, near shore, and alluvial fan deposits coming from up river sedimentation flowing into the ocean. The shoreline of Semarang expanded relatively quickly from about 1695 to 1991. In total, the shoreline has expanded about two kilometers in this time frame (Abidin et al, 2012). Because of this rapid expansion, it can be expected that the natural compression of this soil is still occurring, which is causing the land subsidence (Cooksley et al, 2009).

Overexploitation of groundwater is also a cause of land subsidence. This leads to a rapid decline in water levels, which dries out the soil and therefore speeds the compaction causing rapid land subsidence. The increase of the population and urban growth, and therefore groundwater extraction, has accelerated this natural land compression quite substantially (Cooksley et al, 2009) (Abidin et al, 2012). Natural land subsidence, natural settling, rarely goes above one centimeter a year whereas man made land subsidence, water extraction, can be as much as fifty centimeters a year depending on location (Cooksley et al, 2009). In Semarang specifically, land subsidence has been observed at fifteen centimeters or more.

The soil makeup is very important in understanding how land subsidence works. The soil in Semarang is made up of sands, clays, and gravel (Cooksley et al, 2009). As over pumping of water occurs, the aquifers are depleted. The clay layers of the soil have a very low permeability and therefore, the aquifer cannot be recharged as fast as it is being depleted. This causes the sand layers to compress causing land subsidence. This lack of regeneration causes consolidation within the soil layers, which is irreversible. Therefore, land subsidence cannot be reversed, only stopped (Cooksley et al, 2009).

The volume of groundwater has greatly increased since the turn of the twentieth century (Cooksley et al, 2009). In 1901, water extraction was at about on half million cubic meters of water per year. In 2000, water extraction was around 53 million cubic meter of water per year. A significant portion of this increase happened in the 1980s and 1990s. In 1990 alone, 67 new groundwater wells were added in Semarang, mostly in the west. These wells pump 2,651 cubic meters of ground water per day. These are only the officially registered wells in Semarang; it is believed that there are wells that are not registered and pumping water as well. Several scientific studies have been done to monitor land subsidence in Semarang. The results are very conclusive showing that the most severe of the subsidence in Semarang occurs in the northern parts (Cooksley et al, 2009). Figure 9 shows a map of roughly 25 thousand ground motion data points, which clearly shows the northern part of Semarang is the most affected area.

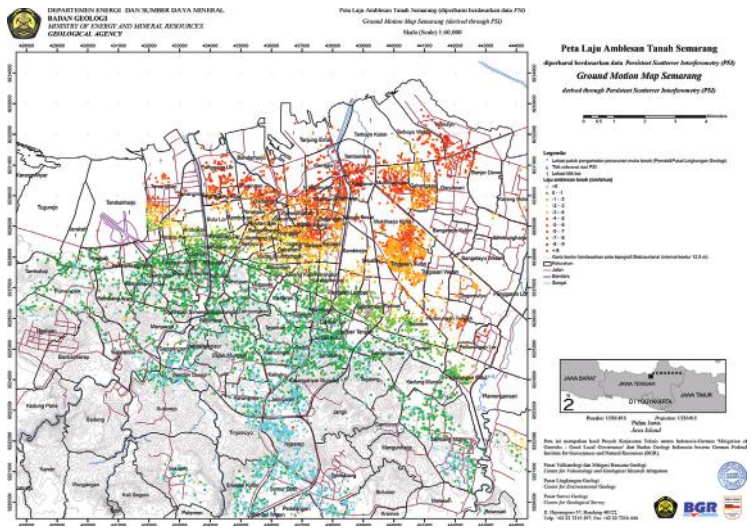


Figure 9: Ground Motion Data Points Showing Land Subsidence

Source: Departemen Engergi Dan Sumber Daya Mineral

From the ground motion data points, a land subsidence map was created showing which areas of Semarang are experiencing the most land subsidence (see Figure 10, below). Kemijen is located precisely in the deep red section on the map, indicating that it lies in the worst land subsidence locations.

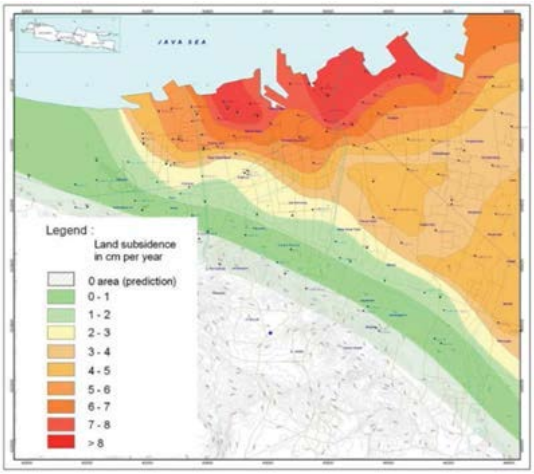


Figure 10: New Land Subsidence Map

Source: Cooksley et al, 2009

The spatial plan for Semarang for 1975 to 2000 does not include the issue of land subsidence even though the risk from both land subsidence and flooding existed at the time of the plan generation (Miladan, 2016). The municipal government understands that over extraction of water is an important factor causing land subsidence. The municipality has sought to enforce sanctions on those who are illegally extracting water. However, a lack of options for water supply makes it difficult to enforce such a ban. It is also difficult to monitor water extraction and enforce such sanctions. A field observation made in 2013 indicated that many illegal groundwater wells still existed (Miladan, 2016).

In 2008, Kota Semarang began to implement mitigation methods towards land subsidence in cooperation with several stakeholders such as the Central Java Province, the Geology Agency under the Ministry for Energy and Natural Resources and the German Federal Institute for Geosciences and Natural Resources (Miladan, 2016). These stakeholders worked with the municipality to conduct a vulnerability assessment of land subsidence for the coastal area of Semarang and determined that Kota Semarang is experiencing significant economic losses due to land subsidence (estimated at USD 59 million). Based on these estimates, the municipality and provincial governments put forth several mitigation methods to combat land subsidence. They include strict law enforcement and handling of groundwater extraction, detailed information of land subsidence risks, environmental impact statement, zoning to regulate development in land subsidence risk areas, reassessment of spatial planning to include relocation, developing building codes, and reassessing land reclamation development (Miladan, 2016).

The Central Java provincial government is the coordinator of land subsidence mitigation strategies through their Bappeda office in partnership with the Energy and Mineral Resources Agency (Miladan, 2016). However, implementation strategies are not reflected in any plans and have not reached the kelurahan level, which has the responsibility to inform residents of government plans and projects. As such, Kota Semarang has not planned on how to adapt to land subsidence in coastal areas. Furthermore, because of the two levels of government, provincial and municipal, it is difficult to get adaptation strategies off the ground. Although the provincial government is responsible for leading land subsidence efforts, they cannot interfere with the municipality's land use plans so when the municipality adjusts plans to allow land subsidence areas to be urbanized, the provincial government cannot stop it. This broad authority, or lack thereof, across government agency coordination results in difficulties developing spatial plans for land subsidence adaptation in Semarang.

Moreover, the severity of flooding by both tidal floods and riverine flooding in Semarang is also increased by land subsidence (Mondeel and Budinetro, 2010). During the wet season, the Banger River experiences high water levels and sometimes overflows. Rather than being captured by the Banger river, rainwater floods the urban areas. Communities in the coastal areas like Kemijen have tried to adapt to the risk of land subsidence by raising their floor levels or elevating the building. The project team notably observed the silent competition between the government and local community in raising the level of the roads and raising the levels of the floors in homes, respectively.

Experiencing Land Subsidence in Kemijen

"I can't go visit my family for the Lebaran holidays because I have to constantly monitor the water level in my house".

This statement was made by a woman whose house is below street level. She is not capable of elevating her house and thus suffers from drainage runoff from the heightened road in front of her house. Those who can afford it, have raised their homes, but those who cannot, face the worst inundations and are highly dependent on the costly running of water pumps. The woman in Figure 11 (next page), constantly operates a non-stop pump to regulate the water levels inside her home.

Aside from subsidence creating a dependency on maintaining water levels that enter the home, images in Figure 12 highlight another challenge. Subsidence has become so severe that people are living in homes that not only require floors to be heightened, but also ceilings to be raised. The project team encountered numerous cases in which people were living in homes with very low ceilings.

Figure 11: Land subsidence effects on housing

Summary of Subsidence Findings

Land subsidence is a hazard that will continue to occur in the foreseeable future and will severely threaten people and urban infrastructure. Stopping groundwater extraction from deep wells can help to slow the process. The coastal areas of Semarang, and specifically Kemijen, are experiencing the combined effects of land subsidence and sea level rise which will increase challenges for protecting against tidal flooding (Abidin et al., 2013). Therefore, adaptations and policies need to be implemented by various stakeholders to both help reduce the drivers of land subsidence and control its effects (Cooksley et al, 2009). Land use planning and policy in Semarang coastal areas, which include the completion of the polder system, improvements of drainage systems, and most importantly, firm monitoring of groundwater extraction, are ways of which the impact of land subsidence can be minimized. In the next section, we examine these aspects, particularly related to the changing dynamics of flooding, and the large scale structural measurements that have been implemented to address flooding and subsidence.

VI. Flooding and the Polder System

Overview

Semarang is one of the most vulnerable places to flooding in Central Java and has been for some time (Miladan, 2016). Figure 12 below, highlights the types and severity of flooding in Semarang and indicates that Kemijen is one of the most affected areas. Ever since the Dutch colonial era, Semarang has been trying to solve the flooding problem by developing urban drainage systems. Despite all the efforts over the years, Semarang still experiences flooding on a regular basis. Flooding in Semarang is not only caused by inadequate drainage systems for water discharge due to heavy rains, but also due to localized rainfall events, riverine flooding, and tidal flooding. The increase of industrialization in Semarang has accelerated the urbanization of the city, which increases the water runoff because of the increase of non-permeable surfaces that urbanization tends to encourage. As such, Semarang has seen an increase of seawater inundation over the last three decades (Miladan, 2016).

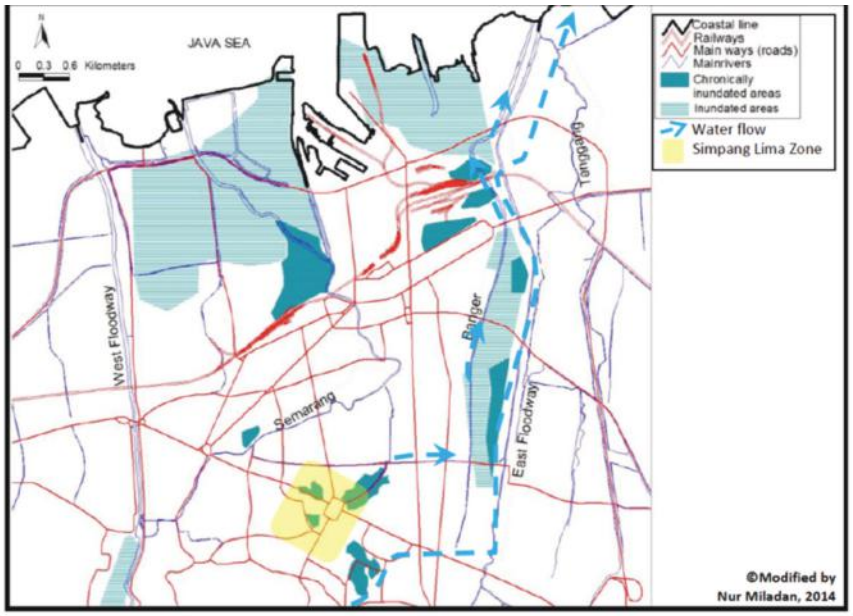


Figure 12: Bangor River Flood Map 1975

Since the 1980s, the increase of urbanization in Semarang has not been supported by proper infrastructure (Miladan, 2016). In addition, the coastal areas of Semarang were all but forgotten in urban development planning as the center of the city began to shift to the south. Severe land subsidence resulted in tidal flooding becoming a chronic problem. Tidal flooding concerns also did not enter into any of the planning documents between 1975 to 2000. The municipality has since then recognized that tidal flooding is a serious issue and has incorporated it as a planning priory in their planning documents until 2030.

Urban institutions and the municipality have made efforts to solve flooding issues in Semarang by establishing several plans, including the Semarang Urban Drainage Masterplan Project, large infrastructure investments like the Tawang Polder, and numerous other maintenance projects to address this issue (Miladan, 2016). These plans and projects provide important benefits to the city, however, overall have not yet been able to avoid regular flooding that continues to affect the city perennially. Urban institutions remain hopeful however, and the Resilient City office has helped to generate knowledge and develop a network of planning efforts to continue to make progress. For example, the Asian Cities Climate Change Resilience Network (ACCCRN) was inspired early on by efforts in Semarang, and integrated structural and non-structural efforts like the Banger Polder Pilot Project, can act as catalyzing forces to address flooding.

Living with Water for 18 years

Unfortunately not everyone can afford to adapt. One resident in Kimijen stated that she has experienced flooding in her home every day for as long as she can remember. "My home has had standing water inside it continuosly for 18 years". Her home has sunken and unlike other households, she cannot afford to raise her home or fill in the floor. As a result, water floods her home on a consistent basis.

Other households have adapted by pumping out water. This woman cannot afford the pump, or the power to run the pump. As a result, she just lives on islands of dry spots she has been able to create.

The ad hoc urban planning realities in cities across Indonesia has no doubt affected the current situation in Semarang (Miladan, 2016). The first urban planning document for Kota Semarang was the Master Plan of 1972 to 1992. Since the 1970s therefore, Semarang expanded continuously in notable ways. Industrial and commercial activities helped to bring about settlement expansion. However, residential and commercial centers moved to the southern parts of Semarang. The north was still mainly marshlands, fishponds, the port, and later, industrial activities like factories. With this rapid expansion, the quality of settlement areas deteriorated in the North, and became dominated by informal settlements. The city government released a new master plan and identified the northern part of Semarang as a new area for industrial development and settlement area. This contradicts the colonial Dutch master plan that envisioned the northern area to remain an area for agriculture and catchment area. This context is important for understanding flood infrastructure and flood management interventions that have taken place in the past decades. In short development of upstream areas to the South has created conditions of larger volumes at faster speeds traveling to central and coastal areas. Secondly, the development of the city has expanded beyond the existing drainage infrastructure. Thirdly, the coastal areas that experience severe land subsidence have not received the interventions to protect it from regular events.

Flood Management: The Polder System

The Banger Polder Pilot Project was established as part of a cooperative agreement in 2003 between the Indonesian government and the Netherlands. A technical agreement was signed and the Polder Management Board was created in order to oversee the design, fund management and planning, and construction of the Banger River Polder. The board created a mission and vision of, 'dry feet for all' with the auspicious goal of ridding the residents of Kemijen of coastal inundation and rainwater flooding. The pilot polder project was designed to address all three types of flooding events, known locally as banjir rob (tidal flooding), banjir kiriman (river flooding), and banjir lokal (localized flooding). Due to the low elevation and proximity to the coast, as well as being a natural floodplain in the watershed, Kemijen residents experienced flooding events on dry days as well as rainy days before the polder was constructed. Now that the infrastructure is in place, almost fully constructed and operational, an initial evaluation and assessment of the system has been provided. Figure 13 in red, provides a geographical explanation of the polder. The system consists of a gate in the North, retention ponds to the West (still to be constructed), and other localized drainage infrastructure. This polder system is described in detail in the next section.

Infrastructure

The Banger polder is a system that functions beyond the administrative boundaries of Kemijen and takes a watershed approach to flood management. The Drainage Master Plan for Kota Semarang outlines the engineering specifications of the system. The polder system is a network of connected drainage canals connected to a series of pumps and enclosed within embankments and a dam. There are seven main components of the polder system, which are subdivided into pieces that protect Kemijen from high coastal water levels and tidal flooding, and pieces that assist with the efficient drainage of riverine and flooding cause by rainfall in upstream areas. A northern dike, eastern dike and dam are currently under construction to prevent coastal water inundation. A pump station, retention pond, embankments, and drainage canals are already in place to manage flood events.

The drainage canals are subdivided into a tiered system with tertiary, secondary, and primary components. The tertiary component is comprised of the system of drainage canals throughout the individual streets in Kemijen. The secondary component consists of the sewers on the main roads and the primary components are the Banger River and the East Food Canal. The tiered drainage system works to gather water throughout Kemijen and send it all to the Banger River. A large pump at the mouth of the river then shifts water from the river to the West Flood Canal, which then flows into the ocean. A retention pond is planned to hold water during periods of increased rainfall when the capacity of the polder is exceeded. The formal retention ponds have yet to be constructed and neighborhood fishponds are currently being used as a temporary solution. Embankments have been created to prevent water from coming in and out of Kemijen and the surrounding areas. This is to allow the polder to only drain the area for which it was built. This has caused problems in neighboring communities as water is now prevented from moving into Kemijen and floods their areas. The polder system does not rely solely on gravity to drain water from the area. The system is designed and constructed to incorporate both gravitation and pumping mechanisms to drain the area. Specific improvements to the polder system include normalizing channels and increasing the amount of bridges and culverts, adding a pump station with a total pumping capacity of 13 cubic meters, and adding a large holding pond with a 20.67 hectare area. In addition to the formal system, there are community-based pumps that are funded and constructed by community members and leaders. These pumps promote drainage throughout Kemijen and push water to the river.

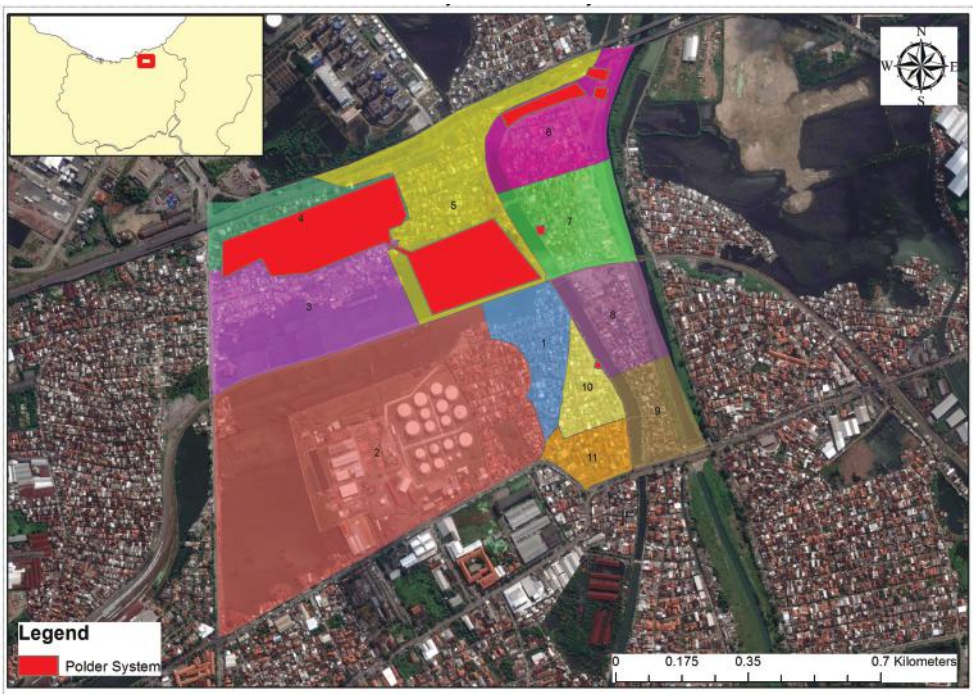


Figure 13 : Polder System in Kemijen

The land allocated for the construction of the polder system is owned by the national train company, PT Kereta Api Indonesia (PT KAI). Previously, PT KAI had negotiated the use of the land to residents who have built permanent homes in the area. To date, there are approximately 50 to 75 permanent households situated on the designated polder land. Since residents have legal standing to be in the area, negotiations between PT KAI and residents are now required to move the families before construction of the polder can continue. The demand for land is only increasing as the neighborhood continues to experience growth. Settlement patterns in designated infrastructure lands can be attributed to this increased demand for land in a limited area. Future maintenance will be a collaborative effort between the city government and the local community.

Pumping water and controlling flows are integral parts needed for the system to function properly. The pump stations and the pumps themselves are therefore the most critical component of the whole polder system. When rainwater is scarce and flow rates decrease, water quality becomes even more degraded. This is due to the inability of liquid waste from households to be flushed out of the canals. During periods of low water flow rates liquid waste will remain stagnant in the drainage canals. To address this issue, during the dry season water is pumped from outside of the neighborhood into Kemijen to maintain certain flow rates. While water quality is a known hazard, it is not a major concern at the moment for the Polder Management Board due to budgetary constraints. Since this is a pilot project, the polder has been built for only a 10-year storm event and relies on the system of retention ponds to collect and store water during larger rain events. There have already been requests sent to the central government to upgrade the secondary channels to make drainage more efficient.

Figure 14. Secondary Drainage

Management, Operation and Maintenance

The Department of Public Works has the administrative and legal authority to manage this type of infrastructure. However, the Polder Management Board was created as the authority to manage the polder. Maintenance requirements for the polder will focus on the pump houses. A concern is that solid waste currently gets into the pump stations and drainage canals which will need routine cleaning in order to prevent clogging. Routine cleaning of the secondary channels will also be necessary as flow becomes restricted when solid waste and excess water cannot flow into the primary channel.

The board has created a long term maintenance plan that slowly shifts the financial responsibility of maintenance from the government to the community over a five-year period. The Polder Banger Management Agency currently pays for the polder. After completion of the project, and the polder is fully operational, the government will pay the full costs of system maintenance. Each additional year thereafter there will be a 25% incremental transfer of fiscal responsibility to the community. By the fifth year, the plan is to have the community predominately responsible for the system costs. This places a financial burden on a community that may not have the financial means to contribute a significant portion of their income to a large infrastructure maintenance fund. The estimated fee collection for the community maintenance of the polder is as follows: residents (tiered by low, medium and high incomes), companies (tiered by medium and large), and routine municipality subsidy. Low income residents will be required to pay IDR 3,000 (USD .20); medium income residents will be required to pay IDR 4,500 (USD .30); and high income residents will be required to pay IDR 7,500 (USD .60). Medium and large companies will be required to pay a significantly larger portion of the fees including IDR 30,000 (USD 2.2) and IDR 60,000 (USD 4.4) respectively. A routine municipality subsidy of IDR 27,500,000 (USD 2,037.0) has been designated by the operation and maintenance cost plan.

To implement this financial management plan, the board has tried to engage local businesses in the area, including the electric and natural gas companies in Kemijen, to contribute a larger portion of the funds. However, during the household survey some respondents were not aware of the polder project and others were shocked with the plan for the community taking on the maintenance cost. Also, stakeholder engagement with businesses is essential to ensure the long term financing of the polder.

Impacts of the System

Kemijen experienced banjir flooding on a daily basis until the Banger Polder Pilot Project closed off the area to rob inundation. Some of the residents believe that the polder has solved all of their flooding problems. Others are still experience flooding and are not so sure that the polder has fixed everything. It is evident that not everyone has experienced the benefits of the polder.

An FGD and a household survey also informed how flooding was affecting the residents, the adaptation strategies of the residents and the government, and whether or not they were successful. According to the FGD, the polder had greatly reduced the rob situation but there are still areas that experienced flooding, mainly from rainfall. Figure 15 shows a representation of the results of the FGD in which areas in blue identify areas that still experience flooding. In addition to the polder system, the government has also invested in other intervention and improvement projects (see Figure 16).

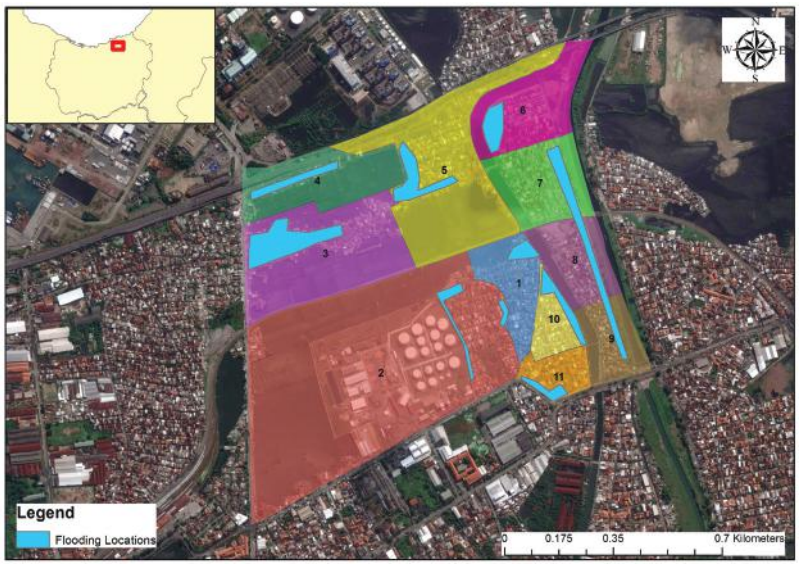


Figure 15: Map of Flooding Locations in Kemijen After Polder Implementation

Figure 16: Observed Government Funded Improvement Projects

Vulnerabilities of the System

Vulnerabilities to the polder system could impact community vulnerability since the community relies, in part and possibly fully in the future, on the system to help drain excess water and prevent flooding. The Polder Management Board's main concern is to address the main mission and vision, 'dry feet for all'. Primary concerns are on making the polder fully operational and therefore there is less concern on the waste management and sanitation issues. However, members of the board recognize that flooding issues (waste, land subsidence, settlement etc.) are interconnected in Kemijen. Waste clogs the polder system, which prevents proper drainage and therefore increases flooding. Efforts to inform the community on how waste impacts flooding have not been successful, mainly due to the insufficient solid waste services provided to the community. The government has yet to provide full solid waste services to Kemijen which means that there is a lack of frequent collection and disposal of waste. However, waste management issues have been a consistent problem with Kemijen and others have found more pressing issues that add to the vulnerability of the system.

Looking at the vulnerability of the pumps to failure is critical since the pumps are the most critical component of the system. If pumps are inundated with floodwater, they cannot operate. In order to reduce the likelihood of failure, the Polder Management Board has equipped the Banger Polder with 4 pumps: 2 are automatic and 2 are manual pumps. If the 2 automatic pumps are inundated and fail to function properly, the 2 manual pumps will be employed since they can still function even if they are inundated. Implementation of the engineering plans has also been a difficult process and adds to the vulnerability of the system. In the original design plans, the walls of the embankment along the Banger River was sloped to encourage social activity around the infrastructure. This did not happen during final construction. The polder was constructed to handle 10-year flood events. As a pilot project, managers believe that the community must buy into the project before capacity can be added. The land belongs to the train company and many residents currently live on land that is designated for the polder infrastructure. The system is vulnerable to incomplete construction if this issue is not addressed and land is not acquired to complete the retention pond.

Community Perspectives and Recent Developments

The polder infrastructure has been generally well received by the community members interviewed. However, attitudes were not homogenous across all of Kemijen. Residents in the RWs closer to the Banger river had a better opinion and reaction overall to the polder. They agreed that the polder had begun to address their flooding issues and expressed high hopes that the progress would continue. Residents in the outlying RWs, particularly RW III and RW IV, expressed less enthusiasm for the polder however no opinions were negative. The Polder Management Board has expressed that the polder needs to be proven effective in order to receive buy-in from the community. Only when the community is interested in the long-term viability and sustainability of the polder will the board and the government consider additional investments in the infrastructure. This is particularly important given the fact that the polder currently operates at a 10-year flood event capacity. The likelihood that a storm event larger than this will occur is relatively high over the coming years. If a large scale flooding event occurs before more investment is made into the system, then this may erode confidence and support for the polder.

Community adaptation to the polder system have been ongoing (See Figure 17). Many RW and RTs have collected funds to maintain smaller community funded pumps that specifically address localized flooding on the streets. Many residents interviewed stated that they pay around IDR 10,000 (USD 0.7) a month for the community pumps. Funds collected also pay for community toilets and other community needs. However, due to the implementation of the polder system, community pumps are not used as often. For the most vulnerable residents, household pumps are still in place and running frequently due to flood and tidal floods, and land subsidence.

Figure 17: Community Level Pumps at RW and RT Level

Community members have instituted their own system of pumps in their households and throughout the streets in order to aid in water drainage. These informal system of pumps has been a helpful adaptation to the polder system. Now, residents can pump water from their homes into the street, where at the end of streets community pumps are used to push water away from their neighborhood and towards either major roads or to the river. The localized pumped water then flows into the formal polder system, either into the drainage canals or the river, where the polder then pumps it to the coast. This community adaptation has allowed for the polder to become even more of an asset to the community. Where the effect of the polder may be weaker is in the outlying RWs, where community pumping and individual adaptation has filled the gap.

In November, 2016 the Prime Minister of the Netherlands completed a second tour of Semarang as the polder is in the final stages of implementation and is now operational. Indonesia and the Netherlands continues to have a strong working international partnership and the Netherlands is committed to assisting Indonesia in addressing their flooding issues as evident by the water management cooperation efforts (The Jakarta Post, 11/22/16). It is not yet clear what specific interventions will emerge for Kemijen and Semarang coastal areas as part of this partnership.

Summary of Findings on Flood and Polder Management

During the household survey and transect walk, UH and UNDIP observed the flood adaptation strategies and cases of land subsidence. This is important to note because some of the adaptation strategies were in response to the issue of land subsidence, which is related to flooding. The coastal areas of Semarang are experiencing the combined effects of land subsidence and sea level rise which will increase the tidal flooding phenomena (Abidin et al., 2013). Flooding could potentially get worse in the future if subsidence continues at its ongoing alarming rate.

To alleviate some of the impacts of flooding and land subsidence, the government is raising the roads all over Kemijen so the road is higher than the water level during floods. The problem with this is that not everyone can implement this adaptation strategy in their own home so their home becomes lower than the road causing water to runoff into their homes. Those with capital can raise the level of their floors to be above the road level and flooding is not an issue. This adaptation strategy of raising surfaces is really the only way to combat land subsidence.

Overall adaptations and policies need to be implemented in order to better manage the banjir issue that plagues Semarang (Cooksley et al, 2009). Land use planning and policy in Semarang coastal areas, to include the finishing of the polder system, improvements of drainage systems, and most importantly, vigilantly addressing the subsidence issue, are ways to minimize the impacts of flooding. Next the project team turns to important factors related with waste, that results in blockages to the system and wastewater, which creates vectors for disease.

VII. Sanitation, Waste Management & Water Supply

Overview

Both solid and liquid waste are significant sources of environmental degradation and health hazards in Kemijen. There are three major forms of waste that should be considered as contributing to this issue: solid household waste, liquid household waste and industrial waste. All these waste sources are potential health hazards (Naik & Stenstrom, 2012) and contribute to environmental degradation in the area. Although solid waste management in Indonesia has improved steadily since the 1970s, the economic crisis of 1998 resulted in a decline of solid waste management services in the country (UNEP 2004). This low proficiency of solid waste management can be attributed to a combination of a lack of waste management regulations on a national level and insufficient enforcement on a local level (Meidiana & Gamse, 2010), as is also evident in the case of Kemijen. However, the issue of liquid and solid waste must be analyzed as stemming from an array of interactions between social, political, and economic factors. This section of the report details sanitation and waste challenges based on such an analysis of the three major waste categories of industrial, household, and wastewater. By employing this approach, the project team was able to identify key ways to understand holistic long-term approaches to address waste in Kemijen. The conclusion highlights existing capacities and waste collection systems within the community, lack of waste collection services on a central level and the impact of liquid and solid waste on infrastructure and health. Finally, the section concludes with a set of carefully selected recommendations based on the analysis of the waste situation and vulnerability assessment of the area. Further analysis of waste as part of a larger system and its influence on flooding can be found in the systems approach part of the report.

Solid Waste Management in Kemijen

Transect walks and community FGD mapping exercises allowed us to identify six major waste disposal sites in Kemijen respectively in RW II, III, IV, V, VIII and IX. These six main areas are identified in Figure 18. Only the waste from a dumpster in RW IX is regularly removed as part of an official waste management service. The waste disposal site in RW III is a waste bank where waste that has resale value is collected and sold, whereas invaluable waste is burned. The remaining waste collection sites are informal and in practice permanent as they are not serviced. In addition to the major waste sites there are waste dispersed in the Banger Canal, in adjoining side canals and drainage, and in some alleyways and in fishponds in the area. Residents on occasion burn waste in alleyways next to households.

At the household level, most people have individual wastebaskets that are picked up every one to two days by a community member. The service is provided for a monthly fee of IDR 7,000-10,000 (USD 0.50-0.70). Residential streets are generally free of waste showing willingness and capability of residents to remove waste from their homes and immediate surroundings. The waste that are collected from the households, are taken to one of the six main waste collection sites. Depending on which of the major disposal sites the waste are taken to it will either be removed from the area by official collection services (site in RW IX) or sold (waste bank in RW III), or remain at the site and possibly spread during flooding (sites in RW II, IV, V, VIII).

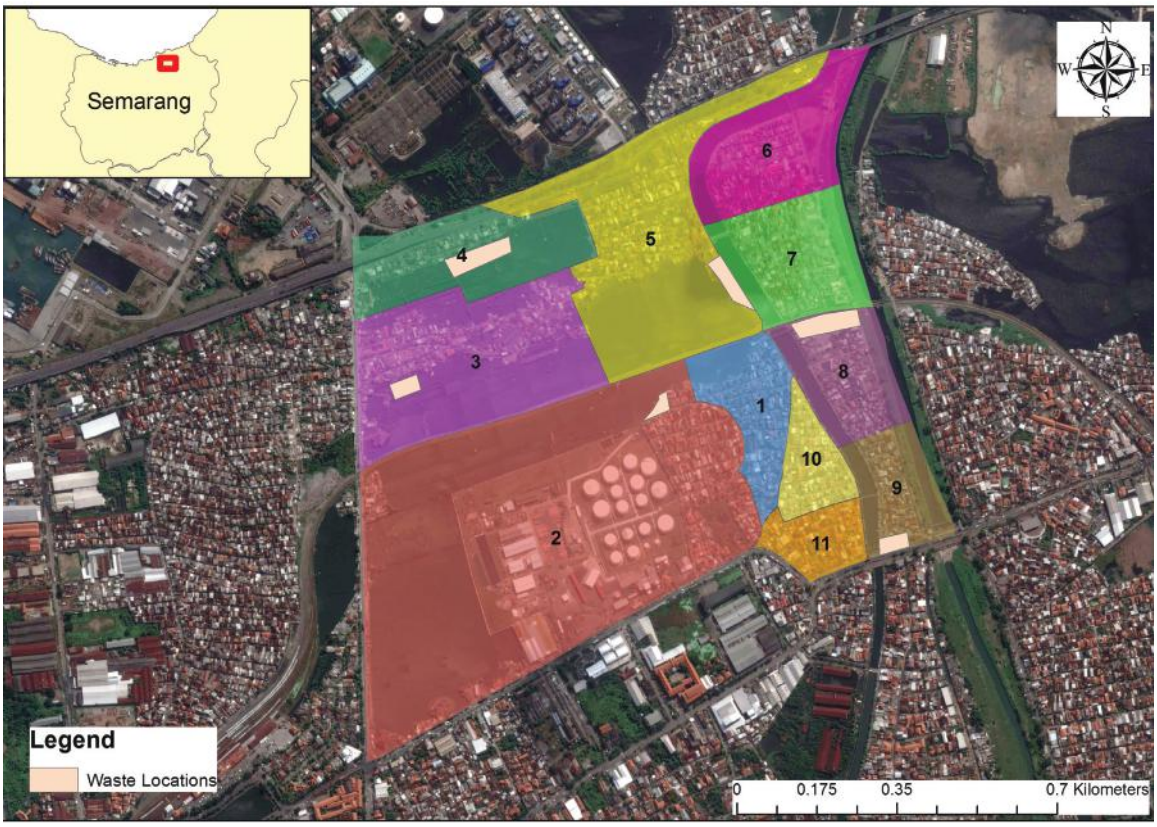


Figure 18: Waste Locations in Kemijen

Most RTs also have one or two sites with community waste bins for organic and regular waste shown in Figure 19. During the community FGD, it was expressed that people do not use the communal bins because they believe the waste from these will end up in the canal. Reportedly these bins are emptied from once a day to two times a week as part of the same informal system as the household waste. The previous statement might thus refer to leakage from one of the major waste sites. Additional surveying is needed to fully understand how communal bins are utilized in the area.

Figure 19: Community Waste Bins

Outside of the six main waste collection sites there is also waste piled up in the Banger Canal and in the smaller drainage system (see Figure 20). This is a substantial problem in relation to flooding as it clogs drainage and pumps, which reduces the capacity of the Banger Polder to function during flooding as confirmed by Perdikan and the Polder Management Board as well as community leaders. Structural implications of waste in drainage and the Banger Canal are discussed in more detail in the Flood Management and Polder section of this report. Waste also decreases flow in canals and contributes to less circulation of water and thus increased bacterial growth (WHO, 2006).

Origin and Extent of Waste

It has been estimated that residential areas on average are the source of about 75-80% of total waste generation in Semarang (Supriyadi, Kriwoke & Birley, 2000). Community members and leaders identified several sources of waste and there was varying perceptions on this topic. Waste situated at the six major waste collection sites comes mainly from the surrounding households but at least one site also receives waste from a factory outside Kemijen. (see Figure 21.) In this case waste that has resale value is sold and the rest is left at the informal landfill.

Three main sources were reported as contributing to waste in the canals and fishponds. Firstly, the waste comes from upstream communities. Community members and leaders repeatedly expressed this perception. It is a corroboration of waste as a widespread issue extending beyond Kemijen and an indicator that broader system approaches are needed to fully tackle the waste management situation in the area. This suggests that the market is a source that can be eliminated relatively efficiently by in situ services such as a regularly serviced container.

Figure 20: Waste Fills the Canal

Figure 21: Informal Landfill with Textile Waste

Some community members, organizational workers, and government officials expressed that there is a bad waste culture among residents who still view waterways as a way to transport waste out of the area. Others expressed that rather there was a sense of discouragement amongst community members, knowing that regardless most of the waste would not be taken out of the area. As mentioned earlier we observed several examples of good waste culture in the community.

Lastly it is likely that the waste from the informal landfills transfer to the canals and fishponds during heavy rain and flooding as most of the sites are in close proximity to these water sources. Thus, identifying waste generation sources is useful in order to understand the contributors to waste generation it is important however to emphasize that regardless of the initial sources of waste, there are substantial deficits in the magnitude and frequency of official waste management services. There is a need for designated and regularly serviced temporary waste collection sites that are appropriately located in terms of minimal risk of leakage to surface waters. Ultimately this inadequacy results in large amounts of waste remaining in the area. Shortage of publicly available land is a spatial barrier which makes designating areas for waste management problematic. Nonetheless as is evident by the informal landfills in the area, there are in fact open spaces in the kelurahan which are not being used effectively due to unresolved ownership matters. It is apparent that in the absence of designated land for waste management, that land is informally designated as waste collection sites in a way that leads to environmental degradation. Recognizing this contradiction is a step towards identifying possibilities resolving spatial obstacles to efficient waste management in the area. As such this acknowledgement opens up room for community, government and private landowners to cooperate on identifying possible solutions to this matter that can prevent environmental degradation for all.

Industrial Solid and Liquid Waste

There are several industries in the general vicinity, including an oil refinery. Most of these are small-scale industries, and some are connected to the Banger River Watershed. As mentioned earlier some of these industries also deliver waste to landfills inside Kemijen. Most water contamination from large industries comes from upstream areas further south that are connected to the East Flood Canal. According to the Environmental Agency however large-scale industries are required to do environmental impact assessments and report an environmental management plan to the agency every 6 months. Smaller scale industries in the area are not equally subject to stringent environmental regulations. The extent of solid and liquid waste contamination from these industries is thus less certain. More research is needed to understand whether solid and liquid wastes at these facilities transfer to nearby areas during flooding.

Sanitation Systems

As confirmed through the household survey and community FGDs, sanitation systems in Kemijen vary both between households and between RWs. While most homes in RW I, V and VI have septic tanks; this is a sparser occurrence in other RWs. Those who do not have septic tanks installed in their home usually have toilets that have direct discharge to a shallow pond next to the house as shown in Figure 22, or that discharges into the drainage pipes leading to the Banger canal. Members of the community also use the Banger canal directly as a toilet. Through community interviews it was made known that there is a 'bathroom line' by the canal every morning at 4am.

In addition to individual sanitation systems four communal toilets have been constructed which are situated in RW V, VII, VIII and IX. However, community feedback indicates that these toilets are not being utilized to their potential. Some community toilets were reported to not be in use at all. More research is needed to understand the underutilization of these toilets. Due to irregular and insufficient wastewater sanitation systems there is a concern that leakage of sewage into surface waters is a major contributor to health issues in the area.

Sanitation and Health Issues

Accumulated solid waste in urban areas is a domain for insects, parasites and rummaging animals. These life forms increase the prevalence of air- and waterborne illnesses. Liquids that leak from waste sites transfer contaminants to surrounding areas and surface waters (Le Courtis, 2012). Further, reduced flow in the canals indicate a presence of standing water, as was observed during transect walks. Standing or slow flowing water attracts mosquitoes that use the water as breeding grounds (WHO, 2016). Perdikan and the Ministry of Health confirm that waste has implications for the health situation in the area. Larva that was observable in slow flowing waters in the area, and dengue fever is a major issue in the area according to local health workers and community members. A community program, led by government health workers, has been installed to monitor dengue cases in Kemijen. This program has reportedly been effective in reducing the prevalence of dengue and continued support will be important to achieve lasting control of outbreaks in the area.

Figure 22: Standing Water Due to Lack of Drainage from Household Waste

Other than vector borne diseases, water that is contaminated by wastewater can lead to diarrheal diseases and skin infections. Due to contamination, flooding increases risk of viral diseases through direct contact with floodwater and contamination of drinking wells (Phanuwan et al. 2006). Since a large amount of households receive piped water for bathing and cooking, and drinking water from bottle services, contamination of drinking wells is less of an issue in the area. There are however households who use water from shallow wells for cooking and washing which still indicate a risk of direct contact with pathogens. Moreover, contaminated water creates issues even in the absence of flooding. Standing and slow running water is located close to households throughout Kemijen and children were repeatedly seen playing and bathing in water where solid waste, sewage, apparent bacterial growth and living larva were evident.

The flood related health issue most frequently reported by the community was skin infections and dengue fever as well as diarrheal disease amongst kids. Perdikan also reports respiratory diseases due to mold while the Health Agency reports more serious incidents such as miscarriages and birth defects. Increased health issues due to flooding are also evident from the absence of children in schools during flood season. It is clear that flooding and sanitary issues have mutually reinforcing effects. Solid waste and sludge reduces capacity of pumps and drainage and flooding spreads contaminated water and increases residents' contact with diseases.

Figure 23: Piped Water in Kemijen

Water Supply

Clean and safe water supply is a necessity for human life. The provision of water services in urban areas is the responsibility of Perusahaan Daerah Air Minum (PDAM) Local Government Owned Water Utilities in Indonesia. Although there is a relatively good supply of piped water in Kemijen (see Figure 23), it varies between RWs. For example, most of RW I and II have access to piped water, whereas in RW III, IV and V few of respondents reported having access to piped water. Some respondents reported of getting water from shallow wells for IDR 3,000 (USD 0.20) per cubic meter of water. There were varying perceptions of quality, however mostly both the well water and the piped water were only used for cooking and cleaning. Some reported that they would use these sources of water for drinking purposes when it "doesn't smell bad" usually by boiling the water first. The quality of water is not recommended for drinking purposes due to chemical treatment of the water. Some respondents said that they buy bottled water regularly.

Summary of Findings

Successful implementation of waste reducing actions requires identification of underlying issues leading to lack of waste management in the area. This section has attempted to identify some major areas that need improvement. Firstly, the greatest area of breakdown in the waste management chain is at the point of removal of waste from the area. This is both due to a lack of officially designated land for waste management and a lack of central services collecting the waste from the area. Further there is a need to incorporate the role of waste when addressing local vulnerability to flooding. Several times government officials and NGOs have stated that "dry feet come first" meaning that waste and sanitation issues have low priority relative to more direct flood issues. In this way flooding takes away from the economic and administrative capacity to deal with waste and sanitation issues. Although such a prioritization is understandable when dealing with scarce resources, it is in this case counter-productive. Waste and flooding are interconnected problems that should be addressed together. In addition, clean and safe water supply is necessary to support urban life in Kemijen. Results from the transect walk and household survey identified the opportunity for adopting rainwater harvesting.

VIII. Potential Action Steps

Overview

The flooding vulnerability assessment identified land subsidence, solid and liquid waste management, the polder system, and settlement legacies as the primary interacting components that play a role in flooding abatement and complications in Kemijen. Each of the preceding sections included summary findings and key conclusions for each key sector. In moving towards potential action steps this section of the report is geared towards compiling from the sectoral analysis to recommend some strategic action plans.

Previous development interventions have made important strides in reducing vulnerability. We review some of these sectoral projects and suggest next steps build on these key successes. For example, the polder project is a large infrastructure endeavor inspired by Dutch design that was commissioned specifically to rid Kemijen of tidal and riverine flooding events. However, the polder has come up against several issues around settlements, land rights and waste management that prevent the polder from coming to full fruition. The polder has allowed for the opportunities to address these issues and integrate them into the design of future resilience-building interventions. In that sense plans to become more integrative in terms of approach by engaging multiple institutions and stakeholders into the decision making and implementation processes can address these types of issues while also increasing resiliency. For example, while the polder has succeeded in hard infrastructure implementation, there are aspects of waste – both solid and wastewater – that need to be addressed to enhance the long-term functionality of the polder. This concept has been suggested by previous research that analyzed 10 ACCCRN cities and recommended the same approach; one built on targeting government institutions to support adaptive capacity measures in a holistic and systematic fashion (de Silva, 2012). Examples of activities utilized in an integrative approach can be found in Appendix D. The Resilience Office is uniquely positioned to facilitate multi-stakeholder engagement and interagency collaboration.

An Integrated Approach to Employing Interventions

Based on the analysis of the physical characteristics of Kemijen, including the rate of land subsidence, the inability to abate the issue, and the extent to which flooding will continue despite large scale infrastructure efforts, we conclude that long term sustainable settlement in Kemijen will become increasingly insurmountable for residents. Land subsidence disrupts any short or long term infrastructure constructed in the area. Homes and roads will need to be continually raised, even if policies were put into place to stop or minimize deep well-water extraction. The polder will also be affected by land subsidence and, in addition to maintenance measures, the pumps and embankments will have to be raised regularly. Flooding will also continue as climate change will heighten sea levels, increase the severity and frequency of storms, and exacerbate erosion. Taken holistically, the physical vulnerabilities of Kemijen and other coastal communities in similar situations will be increasingly complex and costly to overcome. That said, there are ways to think in terms of staging key interventions utilizing a collaborative approach that act as a catalyst for building in the direction of greater community resilience. This approach aligns with flood management best practices in cases described in Appendix D.

The stepwise approach suggested below is to approach interventions in two stages. The first is a significant and immediate investment to improve the quality of life in the area. Findings suggest that addressing key barriers in issues such as solid waste and sanitation can significantly meet goals of improving quality of life. There are key leadership steps that must be taken however to meet these goals, often coming up against difficult political decisions such as setting aside the necessary land for waste collection. Furthermore, programs to address sanitation can also be implemented in conjunction with the interests of setting aside retention areas central to the successful operation of the polder system. Second, to begin to set aside the land for improving the quality of life for Kemijen, the government can also utilize this opportunity to institute and ensure a fair, incentive-based relocation

program for mutually identified sites in Kemijen. By highlighting an attractive relocation program, communities may be more apt to consider relocation away from especially vulnerable areas. Working together with committed local institutions and civil society groups can help to achieve these short and long-term approaches. Below, the project team outlines a menu of options emphasizing the way that implementing these interventions are undertaken can serve as multiple catalysts for achieving a more resilient Kemijen, and in turn present options for creating a more resilient Semarang. The following recommendations are based on this overarching goal.

Action Steps

Action Step 1: Finalize the Retention Pond & Increase Polder Capacity

The project team recognizes the limitations for completing the retention pond are significant. Most notable are the land tenure issues for residents who currently live and build homes on land designated for the retention pond. Some reports even highlight temporary structures to benefit from potential relocation plans in the future. These are complex and very political challenges to take on. However, by delaying the construction of the retention pond a larger subset of the community is left significantly more vulnerable to flooding events when they occur. Therefore, government institutions, NGOs and community members are encouraged to begin working with the residents living in the formal retention pond area to address the difficult issues such as compensation for building investments, land tenure rights, and attachment to place due to family, historical and financial ties. By working on this intervention through principles of transparency and accountability, this initial interagency and stakeholder collaborative effort can serve as the starting point for guiding interventions that will be needed in the future, particularly when other residents become too burdened to stay in Kemijen.

The polder is designed to contain water within the watershed and prevent water movement into and out of the area without pumps. If a storm exceeds the 10-year return period, then the system relies on retention ponds that are not yet fully constructed. To date, the area designated for the retention ponds are community fish ponds that are adjacent to homes and regularly floods into RW III. Large storm events would flood the fish ponds and leave the adjacent homes susceptible to increased flooding. Increasing the capacity of the polder by realizing retention ponds and installing the requisite pumping system would ensure that all residents of Kemijen are less exposed to flooding. Also, due to legal land ownership and settlement incongruence, finishing the retention pond has already proven difficult. However, if the land issues can be addressed then finishing the retention pond can help prevent larger storm events from causing flooding around adjacent homes. This would be a more cost effective solution than increasing the capacity of the whole polder system while also ensuring that all residents of Kemijen see the benefits of the polder.

Action Step 2: Dredge the Banger River

This action step addresses the immediate goal of providing a higher quality of living to all residents in Kemijen. Health and environmental issues surrounding the water quality issues in the rivers and canals have caused residents to become increasingly sensitive to flooding events. When residents come into contact with polluted waters it erodes their ability to recover and maintain school and work schedules. Long term these issues cause employment issues and exacerbates poverty cycles. During field visits the project team identified important maintenance dredging activities being undertaken. Instituting a systematic, adequately funded, and regular maintenance program will continue to protect the community.

Dredging the Banger River can help to remove accumulated solid waste and sediment at the bottom of the river. Removal of these materials will increase the effectiveness of the polder by decreasing the likelihood of clogged pumps and reduce routine maintenance costs. The Polder Management Board can work with institutions responsible for waste management to address solid waste and water quality issues that will simultaneously reduce the vulnerability of the polder system to clogging and failure. Focusing on regular maintenance responsibility also institutes a program of accountability among stakeholders that can be parlayed into initiating governance mechanisms among other sectoral interventions.

Action Step 3: Implement an Integrated Waste Management (IWM) System

There is existing waste management capacity within the community. These exist both in the form of informal waste collection services on a household level and in the form of recycling of waste for sales and handicraft. These existing capacities are considerable resources with potential for expansion to an IWM system. Not only is building on existing capacities more resource efficient but it is also an opportunity to grow alternative sources of income for community members. The most pressing challenge for waste management in Kemijen is the absence of a collection facility, which in turn results in waste collecting in rivers and informal landfills (see Figure 19, 21, and 22 above). A program that seeks to rid the community of informal landfills would require significant leadership to find the land area and to work to formalize the management of such a facility. Finding such space is urgent and a crucial step in progressing to a IWM system. Government removal of waste from collection sites within Kemijen must be done with a frequency that is parallel to the aggregate waste volume in the area. Doing so would have profound effects on the health, hygiene, and appearance of Kemijen.

Close cooperation between government, community, local landowners and industries is a crucial first step in tackling the waste issue in Kemijen. There is both will and capacities within the community to move towards an IWM system. There is also an influx of waste from neighboring areas and industries that can be addressed through collaborative cross-jurisdictional forums. Furthermore, existing informal waste management systems can also be improved both in terms of efficiency and safety within an IWM framework. Further the 3R waste program (reduce, reuse, recycle) has increasingly become a mainstream waste management policy in Indonesia, and has also begun implementation in Kemijen. A community based recycling system that integrates the three R's is the most feasible as it is low cost compared to centralized waste management systems. Sorting waste at the source is less time consuming, hazardous and expensive than sorting from aggregated waste sites (Kardono, 2007). Although existing reuse and recycling practices in Kemijen does not include organic waste, the potential for composing should also be investigated as it is estimated that 60-70% of household waste in Semarang is organic (Supriyadi, Kriwoke & Birley, 2000).

Interventions that address health, safety and environmental concerns surrounding the current waste management situation would have profound benefits. It can also aid in the long term health and economic sustainability of the community members. Reducing and controlling waste will also have a significant impact on the efficacy of the polder system. By remediating current issues and planning for management in the future, long term environmental impacts can also be reduced. Green spaces that have removed liquid waste contaminates can become a safe and welcoming environment for future community members to enjoy.

Action Step 4: Crackdown on Deep Wells that Exacerbate Land Subsidence and Provide Water Supply Options

Deep wells have been known to exacerbate land subsidence. The project team discovered that although respondents in Kemijen indicated a high level of households (approximately 80%) receive piped water connections, there should be efforts to rid the area of deep wells. There are multiple strategies to achieve water supply targets, including programs from PSDA, the water utility, and from rainwater harvesting. The latter was evaluated by the project team. For example, the peak of the rainy season usually occurs from December to January with 27.7 to 34.8mm/day (Harwitasari, 2009). This large amount of rainwater can be collected and stored by households and maximized for the next six months in dry season. This is not a new concept many countries in the world especially countries similar with Indonesia follows some good example of harvesting rainwater. Rainwater harvesting campaigns at the RT level can be conducted in collaboration with PDAM, PSDA, community leaders and local NGOs so that people become interested in rainwater harvesting. This strategy will help residents adapt in place by gaining access to another reliable, healthy clean water source.

Action Step 5: Develop Key Principles for Fair, Incentive-based Relocation Strategies

As indicated in earlier action steps, finalizing the retention pond can serve as an opportunity to pilot the equitable relocation of homeowners that live in vulnerable areas, and those located in designated key infrastructure areas (e.g. retention pond area). The difficulties facing Kemijen in terms of flooding and land subsidence are projected to continue well into the future. Floods and subsidence have impacted households in the community for years, and while some improvements will be made with the completion of the polder system, challenges associated with climate change and other hazards will persist. At the same time, the stories of connection to the community, as well as accounts of adaptation and resilience, show the strength of residents of Kemijen and their commitment to the neighborhood's future. Therefore, developing key principles with the community on a fair, incentive based relocation strategy provides avenues for cultivating resilient systems beyond Kemijen.

Action Step 6: Adaptation Pilot Projects in Areas Affected by Retention Pond

If relocation of residents is not viable in the short term, an alternative is to introduce a home adaptation pilot project for the affected households that can allow for continuity. One home adaptation pilot project that could be considered would be to replicate the floating home that was built in Semarang. Another option could be to use more traditional techniques that are found in other cities in Indonesia such as stilted homes, to allow for households to remain in the same place despite the construction of the retention pond. Relocation strategies recommended in Action Step 2 will take time and resources. While engagement activities and strategies are being developed, residents within the retention pond area are still at high risk for experiencing flooding. Engaging with NGOs and other community partners to develop in place adaptation strategies, such as floating homes, can be a temporary solution.

References

Abidin, H. Z., Andreas, H., Gumilar, I., Sidiq, T. P., & Fukuda, Y. (2013). Land subsidence in coastal city of Semarang (Indonesia): characteristics, impacts and causes. *Geomatics, Natural Hazards and Risk,* 4(3), 226-240.

Abidin, H. Z., Andreas, H., Gumilar, I., Sidiq, T. P., Gamal, M., Murdohardono, D., & Supriyadi, Y. F. (2010, April). Studying land subsidence in Semarang (Indonesia) using geodetic methods. In *Proceedings of the FIG Congress 2010*.

Asian Cities Climate Change Resilience Network, (2010). Community Based Vulnerability Assessment: Semarang and Bandar Lampung, Indonesia.Retrieved from *https://www.acccrn.net/resources/community-based-vulnerability-assessment-semarang-and-bandar-lampung-indonesia*

Brotosunaryo, P. M., Wahyono, H., & Sariffuddin, S. (2013). Strategi Penataan Dan Pengembangan Sektor Informal Kota Semarang. Jurnal Riptek, 7(2), 71-80

Bruins, H.J., Evenari, M., & Nessler, U. (1986). Rainwater-harvesting agriculture for food production in arid zones: The challenge of the African famine. *Applied Geography,*6(1), 13-32.

Centre for science and Environment. (n.d.). Legislation on Rainwater Harvesting. Retrieved from *http://www.rainwaterharvesting.org/policy/legislation.htm*

Centre for science and Environment. (n.d.). Rainwater Harvesting in Tokyo, Japan. Retrieved from *http://www.rainwaterharvesting.org/international/tokyo.htm*

Center for Science and Environment. (2014). Urban rainwater harvesting: case studies from different agro-climatic regions. New Delhi, India: Pasi, N., Matto, M., & Iainer, S.

City of Tulsa. (n.d.). Flood Control and Drainage. Retrieved from *https://www.cityoftulsa.org/city-services/flood-control.aspx*

De Silva, J., Kernaghanab, S., Luquec, A. (2012). A systems Approach to Meeting the Challenges of Urban Climate Change. *International Journal of Urban Sustainable Development.* Vol. 4, No. 2, November 2012, 125–145

Fauzi, A., & Anna, Z. (2010). Social resilience and uncertainties: the case of small-scale fishing households in the north coast of Central Java. *MAST*, 9(2), 55-64.

Fussel, H.M & Klein, R.J.T. (2006). Climate Change Vulnerability Assessments: An Evolution of Conceptual Thinking. *Climate Change.* 75(3), 301-329.

Gallaway, J. H., & Bernasek, A. (2002). Gender and informal sector employment in Indonesia. *Journal of Economic Issues,* 36(2), 313-321.

Garanaik, A. & Sholtes, J. (2013). River Bank Protection. Presentation, Colorado. *https://www.engr.colostate.edu/~pierre/ce_old/classes/ce717/PPT 2013/River Bank Protection.pdf*

Hadi, S. (1997). The Environmental and Social Impacts of Industrialization: Lessons from Central Java. *Journal of Coastal Development*, 1(1), 1-6.

Harwitasari, D., & Van Ast, J. A. (2011). Climate change adaptation in practice: people's responses to tidal flooding in Semarang, Indonesia. *Journal of Flood Risk Management*, 4(3), 216-233.

Herbert. J. P., & Landrieu, M. J. (2015). Resilient New Orleans: Strategic actions to shape our future city. Retrieved from *http://www.100resilientcities.org/page/-/100rc/pdfs/Resilient_New_Orleans_Strategy.pdf*

International Institute for Geo-Information Science an Earth Observation,. (2007). Community-Based Analysis of Coping with Urban Flooding: a Case Study in Semarang, Indonesia. Enschede. Retrieved from *http://itc.nl/library/papers_2007/msc/upla/anggraini.pdf*

IPCC. (2014). Glossary to Climate Change 2014: Impacts, Adaptation, and Vulnerability. Available: *http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-AnnexII_FINAL.pdf*

Jakarta Post (2016) Rutte visits "Little Netherlands' pledging more help'. *http://www.the jakartapost.com/news/2016/11/23 rutte-visits-little-netherlands-pledging-more-help.html.*

Kirmanto, D., Ernawi, I. S., & Djakapermana, R. D. (2012). Indonesia green city development program: An urban reform. In Proceedings of the 48th ISOCARP Congress (pp. 1-13).

Kongrukgreatiyos, K. (2013, October 1). Saving Surat: Building a Resilient City. Retrieved from *http://www.100resilientcities.org/blog/entry/saving-surat-building-climate-change-resilience-against-floods#/-_/*

Kuehn, F., Albiol, D., Cooksley, G., Duro, J., Granda, J., Haas, S., & Murdohardono, D. (2010). Detection of land subsidence in Semarang, Indonesia, using stable points network (SPN) technique. *Environmental Earth Sciences*, 60(5), 909-921.

Lassa, J., Setyono, J.S. (2014). Micro-finance for Community Based Sanitation as a Tool for Climate Adaptation and Risk Management Tools: A Case Study from Semarang City, Indonesia. IRGSC Working Paper No. 10. *http://www.irgsc.org/pubs/wp.html*

Le Courtois, A. (2012). Municipal Solid Waste: turning a problem into resource. *Private Sector & Development,* (15).

Mannila, S. (2015). Informal Employment and Vulnerability in Less Developed Markets. In *Sustainable Working Lives* (pp. 17-33). Springer Netherlands.

Marfai, M. A., Almohammad, H., Dey, S., Susanto, B., & King, L. (2008). Coastal dynamic and shoreline mapping: multi-sources spatial data analysis in Semarang Indonesia. *Environmental Monitoring and Assessment,* 142(1-3), 297-308.

Meidiana, C., & Gamse, T. (2010). Development of waste management practices in Indonesia. *European Journal of Scientific Research*, 40(2), 199-210.

Mercy Corps. (2010). Vulnerability and Adaptation to Climate Change: A Community-based Vulnerability Assessment. Indonesia. Retrieved from *http://resilient-cities.iclei.org/fileadmin/sites/resilient-cities/files/Images_and_logos/Resilience_Resource_Point/MercyCorps___Oct_2009___A_Community_Based_Vulnerability_Assessment.pdf*

Miladan, N. (2016). Communities' Contributions to Urban Resilience Process: a Case Study of Semarang City (Indonesia) Toward Coastal Hydrological Risk (Ph.D.). University of Paris East.

Muh Aris Marfai , Lorenz King, Junun Sartohadi, Sudrajat Sudrajat, Sri Rahayu Budiani, Fajar Yulianto, The impact of tidal flooding on a coastal community in Semarang, Indonesia

Mulyana, W., Dodman, D., Zhang, S. and Schensul, D. (2013). Climate Vulnerability and Adaptation in the Semarang Metropolitan Area: A Spatial and Demographic Analysis. Technical Briefing. UNFPA & IIED.

Mulyana, W., Setiono, I., Selzer, A.K., Zhang, S., Dodman, D. and Schensul, D. (2013). Urbanisation, Demographics and Adaptation to Climate Change in Semarang, Indonesia. (Urbanization and Emerging Population Issues Working Paper 11). London, UK. International Institute for Environment and Development.

Naik, K. S., & Stenstrom, M. K. (2012). Evidence of the influence of wastewater treatment on improved public health. Water Science and Technology, 66(3), 644-652.

Phanuwan, C., Takizawa, S., Oguma, K., Katayama, H., Yunika, A., & Ohgaki, S. (2006). Monitoring of human enteric viruses and coliform bacteria in waters after urban flood in Jakarta, Indonesia. *Water Science and Technology*, 54(3), 203-210.

Radjawane, I., Hartadi, D., & Lusano, W. (2011). Coastal Vulnerability Assessment in Semarang City, Indonesia Based on Sea Level Rise and Land Subsidence Scenarios. Presentation, Yantai, China.

Ravishankar, S.(2016, March 3). Cities Offer Ideas to Solve Chennai's Flooding Problem. Retrieved from *http://www.100resilientcities.org/blog/entry/cities-offer-ideas-to-solve-chennais-flooding-problem#/-_/*

Siagian, T.H, Purhadi, P., Suhartono, S., Ritonga, H., (2014). Social Vulnerability to Natural Hazards in Indonesia: Driving Factors and Policy Implications. *Journal of Natural Hazards*. 70:1603. dos:10.1007/s11069-013-0888-3.

Shepard, W. (2016, August 12). Can 'sponge cities' solve China's urban flooding problem? Retrieved from *http://www.100resilientcities.org/blog/entry/can-sponge-cities-solve-chinas-urban-flooding-problem#/-_/*

Stinson, O.(2015, June 26). Learning from Disaster: Tulsa's Resilient Floodplain Design. Retrieved from *http://www.100resilientcities.org/blog/entry/learning-from-disaster-tulsas-resilient-floodplain-design#/-_/*

Supriyadi, S., Kriwoken, L. K., & Birley, I. (2000). Solid waste management solutions for Semarang, Indonesia. *Waste Management and Research,* 18(6), 557-566.

Sutabto, S.J., Ginting, S. (2009, May 11). Use of Proposed Reservoirs to Reduce Flood in Semarang City. Paper presented at Climate Change Impacts on Water Resources and Coastal Management in Developing Countries. Menado.

Taylor, J. (2010). Community-Based Vulnerability Assessment: Semarang, Indonesia in K. Otto- Zimmermann (ed.), Resilient Cities: Cities and Adaptation to Climate Change Proceedings of the Global Forum 2010, Local Sustainability 1, pp. 329-337. DOI 10.1007/978-94-007-0785-6_34.

Taylor, J. (2015). A Tale of Two Cities: Comparing Alternative Approaches to Reducing Vulnerability of Riverbank Communities in Two Indonesian Cities. *Environment and Urbanization*, 27(2).

The President Post,. (2016). Semarang-Dutch Company to Build Polder in the Banger River. Retrieved from http://www.thepresidentpost.com/2013/12/12/semarang-dutch-company-to-build-polder-in-the-banger-river/?utm_source=rss&utm_medium=rss&utm_campaign=semarang-dutch-company-to-build-polder-in-the-banger-river

Thomas, T.H., & Martinson, D.B. (2007). Roofwater Harvesting: A Handbook for Practitioners. Delft, The Netherlands, IRC International Water and Sanitation Centre. (Technical Paper Series; no. 49). p. 160

Wisner, B., Blaikie, P., Cannon, T., & Davis, I. (2005). At Risk (2nd ed.). London: Routledge.

United Nations, (Retrieved 10th May 2009). "Sanitary Country Profile Indonesia". Sanitation 2004-Indonesia, *http://www.un.org/esa/agenda21/natlinfo/countr/indonesa/sanitationIndonesia04f.pdf*

United Nations Environment Programme (2016). Examples of Rainwater Harvesting and Utilisation Around the World. Newsletter and Technical Publication of United Nations Environment Programme. Retrieved from *http://www.unep.or.jp/ietc/publications/urban/urbanenv-2/9.asp*

USAID. (2014). Quarterly Progress Report 12. Retrieved from *http://pdf.usaid.gov/pdf_docs/PA00K3ZC.pdf*

USAID. (2014). Climate-Resilient Development: A Framework for Understanding and Addressing Climate Change. U.S. Agency for International Development, Washington, DC. March. Available: *http://www .usaid.gov/sites/default/files/documents/1865/climate-resilient-development- framework.pdf*

Visscher, J.T., Lee, M.D. (1990). Water Harvesting in Five African Countries. Occasional Paper Series. The Hague, The Netherlands: IRC

WHO. (2016). Dengue and severe dengue. Retrieved November 23, 2016, from World Health Organization, *http://www.who.int/mediacentre/factsheets/fs117/en/*

World Bank. (2012). Cities and Flooding: A guide to integrated urban flood risk management for the 21st Century. Washington, DC: Jhga, A.K., Bloch, R., & Lamond, J.

Yadav, S.M. (2015). Lessons from Surat floods: Planning structural and non-structural flood control measures. IAHR World Congress, 36. Retrieved from *http://89.31.100.18/~iahrpapers/84293.pdf*

Yuliastuti, N., Saraswati, N. (2014). Environmental Quality in Urban Settlement: The Role of Local Community Association in East Semarang Sub-District. *Procedia- Social and Behavioral Sciences*. Vol. 135. pp. 31-35.

FIGURES

Appendix A. Cooperative Studio Stakeholders

GOVERNMENT AGENCIES

Disaster Management Board of Semarang City (Badan Penanggulangan Bencana Daerah)

Environmental Agency

Health Agency

Polder Banger Management Board

Resilience Office of Semarang City (Pusat Informasi Publik)

Semarang Planning Board (BAPPEDA)

Water Management Agency

NON-GOVERNMENTAL ORGANIZATIONS

BINTARI Foundation

Grobak Hysteria

PATTIRO

Perdikan

Mercy Corps

KEMIJEN COMMUNITY

RW and RT Community Leaders

Pak and Bu Lurah

Pembinaan Kesejahteraan Keluarga (PKK)

Local military and police representatives

Residents of Kemijen

Appendix B. Household Survey in English and Bahasa

INTRODUCTION

- Name; Age; gender; # in household
- How long have you lived here?
- What do you do, and where do you work?
- Where do you access clean water?
- What's the solid waste management situation here?

FLOOD

- When did floods begin happening here?
- What are the causes of flooding?
- Where do the floods occur? How extensive? What is the duration and depth?
- What happens when it floods? Please describe. Are there situations where you need to evacuate? What are those conditions?
- What is the effect on family members?
- What are the greatest losses suffered during floods?
- Are there any health team visits in case of flooding?
- How do you receive information that it will flood? And how do you prepare?
- What are government efforts or community initiatives to reduce flooding?
- Are these initiatives already in place in case flooding should happen again?
- Are there dues residents pay for infra support (elevate roads, pumping, etc.)?
- In the event of flooding, is there a quick response function by gov't or others?
- Is there an evacuation route that has been previously established?
- What type of outreach has there been about flood programs? Who convenes these meetings? How often is the community involved in these meetings?
- What happens after a flood (in relation to time wasted and loss of materials)?
- Have there been any casualties due to floods?
- How would you characterize the cost of flooding?

SETTLEMENT/RELOCATION

- The prediction is that flooding and the subsidence will continue to get worse in the future. How will you adjust to worsening conditions?
- In these conditions do you think it is safe to live here? Have you thought about moving? Would you like to move? What would it take for you to move?

ADDITIONAL QUESTIONS

- Who manages the polder system, especially the sub polder? How is the community involved with that? What are the operational costs?
- How does the waste management system work here? Are any fees for garbage?
- Specific questions: for households along the banks of the train station. How do you anticipate if the train passes by? Are there ever any casualties?

PENDAHULUAN

- Nama; umur; gender; jumlah anggota keluarga di rumah
- Sudah berapa lama tinggal disini?
- Apa pekerjaan Anda dan dimana?
- Dimana Anda memperoleh air bersih/minum?
- agaiman kondisi pengelolaan sampah disini?

BANJIR

- Sejak kapan mulai banjir disini?
- Apa penyebab banjir disini?
- Dimana banjir sering terjadi? Berapa luasan genangan? Berapa lama dan berapa tinggi banjirnya?
- pa yang biasanya terjadi saat banjir? Mohon jelaskan. Apakah ada kondisi dimana Anda perlu mengungsi? Seperti apa saja kondisi tersebut?
- Apa dampak banjir terhadap keluarga Anda?
- Apa kerugian terbesar yang dialami saat/sesudah terjadi kondisi banjir?
- Ada petugas kesehatan yang mengunjungi daerah ini saat kondisi genangan?
- Bagaimana cara memperoleh informasi bahwa banjir akan terjadi? Bagaimana cara siap siaga atas kemungkinan terjadinya banjir?
- Apa upaya pemerintah atau prakarasa masyarakat untuk mengurangi banjir?
- Apakah prakarsa ini sudah siap menangani kondisi banjir kedepan?
- Apakah ada iuran untuk prasarana disini (meninggikan jalan, pompa, dll)?
- Apa respon masyarakat saat banjir; apa tanggapan ormas atau pemerintah?
- Apakah ada jalur evakuasi yang pernah disiapkan sebelumnya?
- Sosialisasi apa saja yang telah dilakukan tentang banjir? Siapa yang mengundang pertemuan tersebut? Seberapa sering masyarakat dilibatkan?
- Apa yang terjadi setelah banjir surut (terkait kehilangan waktu dan barang)?
- Apakah pernah ada korban jiwa terkait banjir?
- Bagaimana Anda menjelaskan kerugian dan biaya dari banjir?
- Ada prediksi yang mengatakan bahwa kondisi banjir dan penurunan tanah akan menjadi lebih buruk. Bagaimana Anda akan menyesuaikan diri terhadap kondisi ini?
- Apakah Anda merasa nyaman menetap disini? Apakah Anda pernah mempertimbangkan untuk pindah dari sini? Apakah Anda ingin pindah dari sini? Apa yang Anda perlukan atau pertimbangkan untuk bisa pindah ke tempat lain.

PERTANYAAN TAMBAHAN

- Siapa yang bertanggung jawab mengelola dan memelihara polder? Dan sub-polder? Sejauh mana masyarakat terlibat dengan hal ini? Berapa biaya operasionalnya?
- Bagaimana pengelolaan sampah dilakukan disini? Apakah ada iuran untuk sampah?
- Untuk rumah di pinggir rel kereta api, bagaimana Anda mengantisipasi lewatnya kereta api? Apakah pernah ada korban jiwa?

Appendix C. Relocation Case Studies in Java

The Indonesian NGO, Yayasan Kota Kita, or Our City Foundation, has studied relocation procedures in the cities of Solo and Surabaya. The methodology was similar to the work conducted in Kemijen, as community residents, government officials, NGO staff, and civil society leaders were all consulted through interviews or focus group discussions (Taylor, 2015). Each city had different results from the planning process for relocation of communities due to flooding issues.

In Solo, seasonal rains in November 2007 caused extensive flooding and subsequent damage to thousands of households in riverbank settlementS that prompted the local government to initiate intervention measures (Taylor, 2015). As repairing communities was costly, the appropriate solution to the floods was to relocate communities to safer, less vulnerable areas. Similar to the responses to the household survey conducted in Kemijen, residents of the riverbank settlements were reluctant to the idea; many people considered the area to be a strategic location and cited lack of economic means to move as major reasons for such hesitancy. Furthermore, historical methods of relocation in places like Jakarta were known to be less than ideal, with little notice or warning to eviction.

However, in Solo, the Mayor was committed to departing from such relocation methods and the planning process that resulted was inclusive and participatory (Taylor, 2015). The resulting comprehensive policy had standardized compensation measures for community resident with legal land tenure, and 1,000 households were successfully relocated to a new area that also had basic services provided by the government. Those who did not have legal land tenure were less responsive to relocation, as such households only qualified for disaster aid and were not provided with compensation to move.

The other case study of relocation policy conducted by Yayasan Kota Kita was in the second-largest city in Indonesia, the city of Surabaya. The riverbank settlement in Surabaya was quite different in terms of governance than the city of Solo, as the settlement was in an area that was under the jurisdiction of the provincial water department but was managed by the city government (Taylor, 2015). Unlike Solo, where the Mayor was the clear leading actor, there were complications in decision-making and consensus due to the difference in jurisdiction and management of the area.

In mid-2002, the Mayor of Surabaya sent an eviction notice to riverbank communities, citing pollution and flooding as the reasons for the notice (Taylor, 2015). In response, those in the communities risking eviction who did not possess legal tenure self-organized as a civil society organization to research eviction alternatives. The research gained enough traction that the eviction was not carried out; however, seven years later a new call for eviction was sent out in 2009 (Taylor, 2015). As of the analysis by the Yayasan Kota Kita in 2015, there was still no consensus between the community and the participating government agencies about how to proceed with relocation.

Appendix D. Integrated Approach Best Practices

World Bank (2012) provides a guideline as 'Integrated Flood Risk Management' to take steps as measures against flooding. In the steps the management plan includes both structural and non-structural measures. Structural measures range from heavily-engineered interventions, such as floodways and reservoirs while non-structural measures are also very important. Structural measures bring success only if non-structural measures follow with it as integrated approach. Kemijen is following mainly different structural measures in terms of flood management, but there are some non-structural measures which could be explored. The following table identifies some of the best practices of structural and non-structural measures.

Structural measures range from heavily-engineered interventions	• Conveyance systems to remove flood risk from the affected areas (creating channels, conveyance and storage, modification of rivers, relief channels, floodplain restoration, etc.) • Flood storage (on-line and off-line storage) • Maintenance of the drainage systems • Sewers and drains, major versus minor systems, interface with river systems, semi-natural systems, surface water management plans, • Groundwater management (groundwater flooding, land subsidence, rainwater harvesting) • Flood defenses (inland flood defenses, demountable and temporary flood defenses, property level defenses, critical infrastructure) • Barrier and embankment systems for estuary and coastal flood protection (coastal management, coastal structures, flood barriers) etc
Non-structural measures	• Flood awareness campaigns • Health planning and awareness campaigns • Land use planning and flood zoning • Flood insurance, risk financing, compensation and tax relief • Solid and liquid waste management • Emergency planning, rescue, damage avoidance actions and temporary shelter • Business and government continuity planning • Early warning systems • Evacuation planning • Flood recovery and reconstruction

Appendix E. Flood Management Best Practices

100 Resilient Cities initiative found best practices of cities to deal with disasters and make cities resilient. The initiative creates a platform where different cities can come and share their challenges and success stories in managing shocks and make their city more resilient. Cities can learn ideas from other cities to implement in their scenario. Following are some examples of different cities managing floods from 100RC cities.

Name of the City and Description	Context	Project(s) Summary
Georgetown: Georgetown is the capital of Guyana. It is the country's largest urban center and containing a large portion of its commerce. The coastal city is situated on the Atlantic Ocean coast at the mouth of the Demerara river estuary.	Rapid unplanned urbanization in Georgetown has resulted in what was once a well-connected network of canals and drains being built over. Floods now frequently inundate Guyana's capital.	• By analyzing water flow in Georgetown's 200-year-old drainage network, the city identified the main reason of flooding as the destruction of main water discharge canals. To improve the situation, the city identified maintenance of water discharge channels as key, as a result the city decided to recommend small floating dredging equipment which would keep the canals free of obstructions. • In addition the city is being advised by the Arcadis (global design, engineering and management consulting company) team members to import a manatee (fully aquatic, mainly herbivorous mammal) into the canals, to eat the vegetation that is clogging them and enable a freer flow of water. (Ravishankar, 2016)
Lent: Lent is situated in the Dutch province. It is located in the municipality of Nijmegen, about 2 km north of that city, on the north bank of the Waal river.	The river Waal takes a sharp bend near Nijmegen and becomes narrower, forming a bottleneck. At times of high water, the river could not cope with the volume of water and causes high flood to Lent.	• To handle such flooding events the Dutch Government launched a unique project called "Room for the River". The idea was to make more room for the river to overflow, rather than building right on its banks. A 300 meters inland and a 4 kilometer long secondary channel have been dug which has resulted in the formation of a small island and new waterfront at Lent. The waterfront is a public open space with a paved sloping surface into the water. Three new bridges connect the island to Nijmegen-Noord. • This project resulted in a 34 centimeter drop of water level in the river. (Ravishankar, 2016)

Appendix E. Flood Management Best Practices - *continued*

Name of the City and Description	Context	Project(s) Summary
Jakarta: The city is the capital and most populous city in Indonesia. It is a low flat basin area and one of the most flood prone cities in the world. There are thirteen rivers cut through Jakarta, all of which lead to the Java Sea.	Jakarta is prone to monsoon floods and sea level rise, making it vulnerable to flooding. Contributing to the problem is poor maintenance and the garbage and trash that closes the drainage system.	• After the 2007 floods, the Indonesian government in collaboration with the Dutch water research institute Deltares decided to open up a new channel that would take floodwater out into the sea rather than letting it flood the city. • Jakarta Urgent Flood Management Project (JUFMP) with the World Bank in 2013 started to protect the retention basins and floodways in and around the city. Dredging of canals and rivers, and strengthening embankments is already showing significant result in reducing flood impacts. (Ravishankar, 2016)
New Orleans: It is a major port in the United States and also the largest city and metropolitan area in the state of Louisiana. The city is located in the Mississippi River Delta on the east and west banks of the Mississippi River and south of Lake Pontchartrain.	In 2005 Hurricane Katrina devastated the city of New Orleans, resulting in 1,500 fatalities.	• Since Hurricane Katrina the city has been working on a water management plan. in 2010 the Greater Orleans Urban Water Plan was finally implemented as an attempt to create what its' architects called a "Living Water System". The canals were widened and their surroundings turned into green public spaces. New Orleans has since put in place pervious pavements, which allows rainwater to pass through them into underground storage basins. • To prevent land subsidence they advise people against groundwater extraction and emphasize ground water recharge through rain water harvesting. (Ravishankar, 2016; Herbert & Landrieu, 2015)
Surat: Is a city in the western Indian state of Gujarat. The city is situated along the Tapi River on the west coast of India.	The city faces flooding due to both upstream and monsoon flooding.	• The city has put in place early flood warning systems to ensure that loss of life is minimized among its teeming population. • The city also managed to restore a clogged and polluted lake, and has turned the surrounding area into a public space replete with entertainment and games for children and adults. • The city authority works on a public private partnership model to restore and clean water bodies in Surat. (Ravishankar, 2016; Yadav, 2015; Kongrukgreatiyos, 2013)

Name of the City and Description	Context	Project(s) Summary
Tulsa: The city is situated along the Arkansas River at the foothills of the Ozark Mountains in northeast Oklahoma. It is the second largest city in the state of Oklahoma	The combination of climatic and topographic elements in the Tulsa area have resulted in major flash flooding,	• The city utilizes structural engineering measures such as constructing dams to protect from floods. As a result of the city has incorporated many innovative and regulatory changes. in the early 1990s, FEMA ranked Tulsa first in the nation for its floodplain management program. FEMA increased Tulsa's community rating from Class 5 to Class 3 As of 2000, Tulsa was the only U.S. community rated as Class 3. Specific activities that FEMA cited were:"...acquisition of nearly a thousand flood-prone properties and the preservation of more than a quarter of its floodplain as open space; strong building codes, including the requirement of a two-foot safety factor (freeboard) in floodplain construction; and community outreach to advise residents of flood hazards and offer mitigation solutions and technical assistance. • Tulsa designed a system that is visually appealing, environmentally sustainable, and perhaps most importantly, provides multiple benefits to prevent flooding.
Sponge Cities in China: In 2015, a pilot project was launched to build sponge cities in China to include 15 cities , with and additional 14 cities by the year 2016. Cities such as Beijing, Chengdu, Chongqing, Shenzhen, Guangzhou, Shanghai and Wuhan all have large scale projects underway.	Many cities in China experience severe flooding. The system has not keep pace with the expanding development above the surface. in 2013 alone, 230 of these cities were hit by severe flooding, according to the Ministry of Housing and Urban-Rural Development (MoHURD).	• A sponge city is one that can hold, clean, and drain water in a natural way using an ecological approach. • The pilot project also suggested that these projects will work only if implemented for the whole city. Implementing this concept only one small area or neighborhood is not enough. (Shepard, 2016)