CITY RISK DIAGNOSTIC FOR URBAN RESILIENCE IN INDONESIA

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# ABBREVIATIONS

<table>
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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>ACCRN</td>
<td>Asian Cities Climate Change Resilience Network</td>
</tr>
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<td>AMSL</td>
<td>Above Mean Sea Level</td>
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<td>Bappeda</td>
<td>Badan Perencanaan Pembangunan Daerah (Local Planning Agency)</td>
</tr>
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<td>BLH</td>
<td>Badan Lingkungan Hidup (Environmental Agency)</td>
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<td>BMKG</td>
<td>Badan Meteorologi dan Geofisika (Agency for Meteorology and Climatology)</td>
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<td>BNPB</td>
<td>Badan Nasional Penanggulangan Bencana (National Disaster Management Agency)</td>
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<td>BPBD</td>
<td>Badan Penanggulangan Bencana Daerah (Local Disaster Management Agency)</td>
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<td>BSB</td>
<td>Balikpapan Super Block</td>
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<td>CBD</td>
<td>Central Business District</td>
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<td>CPI</td>
<td>Center Point of Indonesia</td>
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<td>DCR</td>
<td>Disaster and Climate Risk</td>
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<td>DSDP</td>
<td>Denpasar Sewerage Development Project</td>
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<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
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<tr>
<td>GIS</td>
<td>Geographic Information System</td>
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<td>GRDP</td>
<td>Gross Regional Domestic Product</td>
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<td>HDI</td>
<td>Human Development Index</td>
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<tr>
<td>NGO</td>
<td>Non-Government Organization</td>
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<td>ND</td>
<td>Neighborhood Development</td>
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<td>Pusdalops</td>
<td>Pusat Pengendalian Operasi (Disaster Command Center)</td>
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<td>PVMBG</td>
<td>Pusat Vulkanologi dan Mitigasi Bencana Geologi (Center of Volcanology and Geological Hazard Mitigation)</td>
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<td>RTBL</td>
<td>Rencana Tata Bangunan dan Lingkungan (Neighborhood Development Plan)</td>
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<td>RTRW</td>
<td>Rencana Tata Ruang Wilayah (Spatial Plan)</td>
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In 2012, the World Bank initiated the Building Urban Resilience in East Asia program, aimed at increasing the resilience of cities to disasters and the impact of climate change by using a risk-based approach to making public investment decisions. The objective is to demonstrate a scalable methodology and practical tools for risk assessment that can be used for city-level investment decisions. As part of this program, a book entitled “Building Urban Resilience: Principles, Tools and Practice” was published in 2013, providing a framework to implement urban resilience activities. With the support from East Asia Infrastructure for Growth (EAIG), a regional trust fund supported by the Australian Government, an activity was conducted to experiment with the implementation of this framework in Indonesia.

This activity started with engaging selected cities that have reasonable complexity and are experiencing significant growth. The next step involved conversations about disaster and climate risks confronting the cities and the options that they could consider in building resilience. The result of this experiment is presented in this book. It is hoped that this will be the first in a series of publications on the development and adaptation of principles, tools and practices for urban resilience in the Indonesian context.

The book begins with two chapters on the disaster and climate vulnerabilities in the context of Indonesian cities, and the basic framework developed by the World Bank Building Urban Resilience in East Asia program. The subsequent two chapters describe the Rapid Risk Diagnostic as the first step in the urban resilience engagement, and the summary of the diagnostic findings in selected Indonesian cities. The final chapter provides a glimpse of how options to invest in resilience can be materialized in practice as part of a city’s development. Presented with many visuals, maps and illustrations, we hope the book will be enjoyable and informative for urban development practitioners.
With an average annual urbanization rate estimated at 4.1% between 2000 and 2010, Indonesia is one of the most urbanized countries in Asia. Its urban population, 54% in 2010, is projected to reach 68% by 2025. Rapid urbanization leads to dense settlements and a concentration of critical infrastructure. It is estimated that at least 110 million people in 60 Indonesian cities are regularly exposed to natural hazards, including tsunamis, earthquakes, floods, as well as disasters related to climate change.

Urbanization offers opportunities for Indonesia, potentially boosting regional economic growth and creating vibrant cities and metropolitan areas. Urbanization and the agglomeration economies that it generates are an important element in Indonesia’s development as a middle-income country. If managed properly, urbanization can generate positive returns that create opportunities for economic growth, poverty reduction and shared prosperity.

City management may lack core competencies to manage sustainable urbanization, as indicated by the many Indonesian cities developing without a disaster risk perspective. This can lead to increasing occurrences of annual disasters and a higher than average death toll of urban residents.

In addition, Indonesia’s cities’ resilience to natural disasters has been weakened by the rapid construction of physical assets in urban areas amid weak enforcement of building codes and zoning regulations. Indonesia’s fast-paced, and not always well-planned, construction of physical assets has seen demand for urban housing and commercial facilities multiply over the past decade. Since weak enforcement of spatial planning regulations are common, real estate and construction activities are prone to deliver structures of substandard quality.
Cities and metropolitan areas are expected to rapidly expand, with urbanization potentially boosting regional economic growth. However, this rapid growth is not always well-planned, leading to the lack of a robust urban ecosystem. Rising income levels and the need for housing and commercial spaces are driving rapid physical construction, but this can be accompanied by an increase in disaster and climate vulnerability. Urban resilience, therefore, becomes a critical factor in managing these challenges.

Figure 1. Urbanization, Disaster and Climate Vulnerability, and Resilience
Data on disaster occurrence and impact on housing show that in the past decade the more urban areas of Indonesia have become more vulnerable to natural disasters. Figure 2 shows a comparison of the number of disaster-impacted buildings and houses over the past two decades. Disaster impact on housing is a useful proxy for the degree of vulnerability of urbanized areas. In the past decade alone, between 20 and 50 percent of post disaster reconstruction budgets have been spent on housing. Statistics also show that the proportion of post disaster budget in 2011 was concentrated in urban provinces. This suggests that many assets have not been built to appropriate standards in the first place.

Figure 2. Comparison of disaster-impacted buildings and houses over the past two decades.
FRAMEWORK FOR BUILDING URBAN RESILIENCE

The rapid expansion of built-up urban areas provides an opportunity to develop and manage new settlements in a way that incorporate resilience into urban planning. The aftermath of a natural disaster can prompt decision-makers to push through with corrective and preventive action. Resilience goes beyond risk mitigation measures. It increases preparedness and the capacity to respond to disaster and swiftly recover from its impact. However, this approach is not yet seen as a part of everyday urban development, medium- and long-term investment planning, urban governance, and risk management.

The World Bank in East Asia and the Pacific has compiled a set of tools to help cities and rapidly growing urban areas to embark on urban resilience investment. The tools comprise of three major building blocks: 1) Assessment and Diagnostic; 2) Resilience Measures; and 3) Enabling Framework. Each building block consists of distinct components as visualized in Figure 3, below.

Figure 3. Building Blocks of Urban Resilience.
As urban space is a dynamic system with constant changes, risk assessment and diagnostic must become part of the day-to-day planning system and spatial management. Recognizing that development does not operate in an empty space, building resilience can be achieved through urban upgrading (i.e., ‘retrofitting’ existing systems to be more resilient to particular risks), and/or managing urban space as a human ecosystem, preserving its interlinked and fragile components. Finally, to ensure that resilience building can become an integral part of urban management, a Disaster Risk Management framework must be in place, and includes institutions, geospatial information, and financing.

This Urban Resilience framework outlines three major components, namely:

1. **Risk sensitive land use planning.** This could range from revising land use plans to take into account the results of risk assessment, detailed land use zoning in targeted development areas based on hazard micro zonation, and other instruments governing site allocation and control.

2. **Urban upgrading** to apply zoning plans and regulations to bring existing infrastructure and assets to resilient standards. This may include improving the capacity and structural strength of key infrastructure, such as drainage, roads and bridges, embankments, telecommunications and power lines. This may also include retrofitting assets such as public buildings, private dwellings, and rearranging settlement layouts to enforce zoning.

3. **Managing and restoring key ecosystem elements and services, such as water catchment and retention, green space, natural habitats; and maintaining the connectivity as well as functioning of this natural system.**

In practice, city managers may not have the above three activities in the right sequence. For example, a city may complete its land use planning process without incorporating risk information or undertaking investment on drainage. The following year that city may experience major flooding. The normal cycle for updating the land use plan may not come in 2 years. In such instances, the city needs to undertake special measures to address the flooding risk and incorporate them into their ongoing infrastructure development.
RAPID RISK DIAGNOSTIC AS A STEP TOWARD BUILDING URBAN RESILIENCE

To initiate urban resilience building efforts, risk assessment needs to be carried out. However, since most urban areas develop naturally, high resolution data -- instrumental for conducting risk assessment -- are not usually readily available. At the same time, cities continue to grow, adding new areas or modifying existing ones. This potentially introduces new risks and vulnerabilities.

In practice, most city governments and their residents are quite familiar with the occurrences of low impact and high frequency events, like floods, landslides, or even small earthquakes. These events are considered ‘normal’, yet their causes and impact are not often observed properly. As the city grows, these events become exacerbated over time and their impact become more complex to analyze.

Rapid risk diagnostic can be used to initiate a conversation between city officials and stakeholders on disaster and climate risks, their general spatial distribution, and how they influence the city’s growth pattern and trends. Using available low resolution data such as atlases, records of events as remembered by residents or information reports, and news on investment developments, specific geographic areas around natural hazards and investment locations can be easily pinpointed. Such rudimentary but targeted diagnosis, just like a general physician diagnosing illness symptoms, may lead to city managers having a clearer picture of issues and locations to focus on. More detailed and thorough risk assessments can then be conducted in smaller geographic areas where generating new and higher resolution data will be more manageable and less costly. Figure 4 illustrates the concept of risk diagnostic as a conversation starter for more detailed risk assessment.

Figure 4. City Rapid Risk Diagnostic leading to Detailed Assessment.
The diagnostic applies a simple process of compiling existing data on: (i) the cities’ overall spatial structure, and their growth trends and directions; (ii) the pattern of disaster occurrence and the main affected areas; and (iii) an understanding of major urban investments being undertaken.

Figure 5. Flow of city rapid risk diagnostic.

Development creates a dynamic and changing spatial structure, and influences the pattern and direction of growth. Development also increases vulnerability to the environment and society. Disaster occurs in vulnerable locations. With the knowledge of a city’s risk profile and resilience options, vulnerable investments, are addressed to reduce disaster risk, decrease vulnerability, and improve spatial structure.

The rapid risk diagnostic prepares a city’s risk profile, by providing a storyline of each city in terms of location, concentration of risks and urban investment activities, and options for integrating resilience into those ongoing urban investments. As the concept of urban resilience is relatively new, it is important that the risk profile provide visual illustration of how a resilient city could physically look like. More importantly the city risk profile also provide a list of measures that can be undertaken to boost resilience along the two previously-described pillars of urban upgrading and ecosystem management/restoration.
Rapid risk diagnostics have been carried out in Indonesia in six medium and large cities as a pilot project. The six cities are: Balikpapan, Makassar, Palembang, Denpasar, Semarang, and Yogyakarta.

The aim of this disaster and climate profiling is three-fold. **First**, to identify the key locations and urban infrastructure to be prioritized in order to create urban resilience. **Second**, to assess the prospects of incorporating risk reduction in urban development planning. **Third**, to provide strategy options for building urban resilience. The strategy options focus on three instruments:

(i) **risk-based** land use and infrastructure investment planning; (ii) urban **ecosystem** management; and (iii) urban infrastructure **upgrading** for resilience.

The six cities selected to pilot the diagnostic are combination of metropolitan and large cities in Indonesia. This type of city is most at risk from disaster and climate change due to their complex system and density. They face growing issues which drive risks. These cities experience hazard events that adversely affect populations.
4.1. BALIKPAPAN RISK PROFILE

Balikpapan is a seaport city located on the east coast of Borneo Island in East Kalimantan Province. The location makes the city a strategic hub for fisheries and tourism. It is also a resource-rich region, known for its abundance of petroleum and gas.

34,018 Ha
COVERING AREA
(Bappeda, 2012)

27°C
Average Temp.
(Bappeda, 2012)

555-973 mm/month
Rainfall Intensity
(BMKG, 2013)

51.66%
(20,090.57 Ha)
Topography are Hilly area

42.33%
(21,305.57 Ha)
Slope between 15%-40%

555,579
Population
(BPS, 2012)

1,32%
Growth Rate
(BPS, 2012)

4.07%
Poverty Rate
(BPS, 2012)

1,107.85 people/km²
Population density

Most of Balikpapan’s population live in Balikpapan Tengah sub-district – the center of the city. The sub-district has more than 8,900 people per square kilometer, or about 8 times more than the population density of all of Balikpapan.

Unsurprisingly, capital-intensive urban developments are taking place, including freeway development, airport expansion, coastal road development, and industrial park development. New settlements continue to expand rapidly to the north and eastern coast sections of Balikpapan. Development on the west coast is also intensifying, particularly for industrial activities.
The existing built up area (5,517.36 ha or 10.96%) stretches along the south coast of Balikpapan (Bappeda, 2012), comprising of settlements, industrial activities, commercial activities, and public buildings.
Overall, the city is prone to four types of hazards: flood, landslide, fire, and drought. The city will also potentially be impacted from a rise in sea levels, as Kalimantan coastal areas have experienced an upward trend of sea level. This could exacerbate flooding, intensify coastal erosion, changes in deposition, and salt intrusion in groundwater and/or river water.

Floods affecting the river basin and lowland area, particularly during rainy season, are due to high rainfall intensity and poor drainage systems. One of the areas most impacted is the business district along MT Haryono Street.

Fires occur mostly in areas with higher population density. Fires are becoming more frequent annually. In addition to residential fires, other sources of fire hazards are coal-bed, as most forest areas in the city have coal-bed underneath, and hence are prone to fire.

High landslide risks are scattered in the areas of Batu Ampar, Damai, Gunung Bahagia, Gunung Samarinda, Gunung Sari Ilir, Karang Joang, Kariangau, Klandasan Ulu, Lamaru, Sepinggan, Teritip and Telaga Sari (BLH, 2012). In 2013, a landslide occurred on Soekarno Hatta Street (Bappeda, 2013). The increasing number of landslide events every year is quite alarming.

1,318.66 Ha HIGH RISK AREA
29,657 Ha MEDIUM RISK AREA
20,028.94 Ha LOW RISK AREA
85% RED-YELLOW PODZOLIC SOIL*

*The hills and valleys in the city of Balikpapan are dominated by red-yellow podzolic soils. This condition makes the city of Balikpapan prone to landslide during the rainy season.
The urban poor, who live in slum areas, are more vulnerable to disasters due to their lower capacity in performing adaptation and recovery. The majority of the slums is along the west coast (Balikpapan Bay) and south coast (Makassar Strait), specifically in six villages (Baru Ulu, Baru Tengah, Margasari, Klandasan Ulu, Klandasan Ilir, and Gunung Bahagia) covering 55.68 ha or 61.12% of all slum areas in the city. Slum areas also exist in hilly areas (Muara Rapak and Sepinggan village) covering 24.96 ha or 26.41% of all slums and river basin areas (Mangga Besar and Ajiraden river) covering 11.34 ha or 12.47%.

The development in Balikpapan is concentrated in southern part of the city and so is the population. The denser and more developed areas presented in darker colors are the areas prone to disasters, particularly fires and floods. These areas are where most of the city’s economic activities take place and where strategic infrastructure is located.

 Settlement expansion to the northern part of the city increased the risk of floods and landslides in the downstream and coastal areas. The coastal road development plan and expansion plan of Sepinggan Airport are located in the area prone to flooding and sea level rise. Both investments will affect the natural carrying capacity of the areas and increase risks of sea level inundation.

West coast industrial estate development, including land reclamation, will further affect the water quality and coastal ecosystem (e.g. declining coverage of natural mangrove forest).
In the medium and long term, the key issues that will dominate Balikpapan are: (i) effective flood control investment; (ii) landslide prevention; and (iii) minimization of the impact of industrial and coastal development. The latter is in response to the Balikpapan Spatial Master Plan which is oriented toward coastal reclamation, in view of the prospect of the rise in sea level induced by climate change.

1. FLOOD CONTROL
2. LANDSLIDE PREVENTION
3. MINIMIZATION INDUSTRIAL AND COASTAL DEVELOPMENT IMPACT
For flood control and anticipating the rise in sea levels, Balikpapan can refer to the lagoon concept in Foster City, California, for the area’s coastal road development plan. Balikpapan would also benefit from the lessons learned by Brisbane in Australia, which used backflow prevention infrastructure as part of the integrated drainage system.

**Resilience Options**

Risk-based infrastructure investment planning options include continuing investments on flood control infrastructure and implementing evacuation plans in the event of flooding or rising sea levels (integration between the new development areas at the coast with the mainland). Disaster and climate risk information also needs to be strengthened to support risk-sensitive land use and infrastructure planning.

The involvement of the community and the private sector in urban ecosystem management is needed for improving greenery in water catchment areas in conserving mangrove forests. In addition, zoning control and strict permit issuance for landslide and flood prone areas need to be exercised.

Urban infrastructure upgrading is focused on slum areas. The most essential infrastructure are: (i) seawalls for protecting coastal areas including vulnerable slums; and (ii) fire response paths which are developed by clearing and strengthening pathways, particularly on the west coast of Balikpapan Bay and in the slum areas of Klandasan Ulu.
Learning from the success in greenery and conservation, active involvement of the private sector in incorporating resilience into on-going investments is possible. Investments in Balikpapan is quite high, so it is important to clarify the indirect economic returns as an incentive. However, it is important to ensure a legal basis for making mandatory for investors to integrate flood control and hazard safety measures in their investments.

Balikpapan needs effective measures to control flooding, particularly in anticipation of greater coastal development. Bappeda (2012) has planned to adopt the lagoon or seaside lake concept, which will control the flow of water emitting from the river to the sea. It will resemble a giant pool 50 meters in diameter, located around the Balikpapan Super Block (BSB). If the concept is applied, the land reclamation for coastal roads will orient towards the river sanctuaries. There will at least be 3 (three) locations built as flood channels. The lagoon concept can also function as tourist destinations, such as restaurants and other attractive sites.

In the upper and mid stream areas, Balikpapan has implemented several countermeasures to prevent flooding periodically, including river normalization, drainage system development and maintenance as well as bendali construction. Currently, the city is constructing its fourth bendali that is expected to reduce by 80 percent the flooding of MT Haryono street. However, instead of declining, flooding has increased. The provision of such infrastructure should therefore be accelerated to cope with rapid development and increasing rainfall intensity. If this is the case, the projected locations for the development of Bendali and other drainage facilities as listed in Balikpapan’s Spatial Master Plan need to be secured immediately. This is to avoid the conversion of functions of those critical locations. When some designated areas Bendali have been occupied by private use, a negotiation should be considered to buy the land with market price.

The new developments along the south and east coast requires countermeasures in the rise of sea levels, such as land elevation and floating construction, particularly around the coastal road development areas and Sepinggan airport. Building a sea wall to protect the activities along the south and east coast of Balikpapan is one alternative. Furthermore, floating slums in 6 (six) villages (Baru Ulu, Baru Tengah, Margasari, Klandasan Ulu, Klandasan Ilir, and Gunung Bahagia) could be upgraded to reduce the frequency and severity of flooding, and to transform them into neighborhood attraction.
Makassar, the capital city of South Sulawesi Province, is a coastal city strategically located as the gateway to Eastern Indonesia and a trading hub. The city has substantially developed its coastal areas, including its west and north coasts, where more industrial and commercial activities are concentrated. Furthermore, sporadic development also occurs along the main two rivers, Tallo River and Jeneberang River, jeopardizing the sustainability of conservation areas along the river basins.

In 2008, Makassar’s Human Development Index (HDI) reached 77.09, then increased to 79.55 in 2012. The increase of HDI could be a result of the city development. Furthermore, the number of poor have declined, from 64,477 persons in 2008 to 46,355 persons in 2012, declining further by 2014 to 44,217 persons.

Urban development in Makassar originally began in the west coast and has expanded to the north and east. According to the master plan, the city is divided into several development zones:

- The Old Town, mainly commercial activities;
- Panakukkang Area, mainly consists of offices and settlements;
- East Biringkanaya, mainly consists of education facilities;
- North Biringkanaya, consists of industries; and
- Mariso, at the southern of the city and the islands at Makassar Strait, mainly for tourism.
Built up area

Between 2011 to 2012, the amount of wet-farm land has been reduced by 5,316 hectares due to land conversion to settlements and commercial areas. This reflects the city’s economic dynamic, fueled by the industrial and trade sector.
Makassar is prone to three types of hazards: flood, fire, and strong wind. It is potentially also prone to earthquakes, although so far, the frequency and the intensity has been relatively small. Most epicenters have been far from the city. As a coastal city, Makassar is also prone to the rise in sea levels, affecting particularly the smaller islands that belong to Makassar’s administration such as Kodingareng, Barrang Lompo, and Barrang Caddi.

The height of inundation from flooding ranges between 30 and 50 cm, in 19 locations, including the main access road to Sultan Hasanuddin Airport and the toll road entrance (Tol Reformasi).

Fire events have increased over the years, mostly in highly populated areas. On average, the number of events is 113 per year.

Within the period of 1993 – 2002, the sea level in Makassar Strait rose up to 7.5 cm. By 2050, it is estimated that the sea level increase in Makassar could reach 1.14 m. The most at risk areas are Tallo, Biringkanaya, Mariso, Tamalanrea, and Wajo Subdistricts.

Whirlwind of 50 to 60 kilometers per hour affect residential areas in Barombong, Tamalate, Manggala, Panakkukang, Tallo, and Biringkanaya subdistricts.
Some 11 percent of poor families in this coastal area live in Ujung Tanah Sub-district, while 7.1 percent live in Tallo Sub-district and 6.93 percent live in Mariso Sub-district. Buloa Village in Tallo Sub-district is where poor communities are concentrated. They are vulnerable to disaster and climate risks. The number of households who live in riverbank or tidal areas is 55,915.
In the medium and long term, the key measures to reduce risk in Makassar are: (i) effective flood control; (ii) fire mitigation; and (iii) minimizing the impact of coastal development caused by land reclamation. The development along the coasts should anticipate the disaster and climate risks, particularly the rise in sea levels. The key locations that need attention for resilience investments are Tallo and Jeneberang river basins, as well as the east coast where the Center Point of Indonesia (CPI) is located. In addition to those, the area of Soekarno-Hatta seaport is in an area vulnerable to a rise in sea levels.
Urban ecosystem management measures are needed, such as revitalization of mangrove forests in coastal areas as well as conserving forests and water catchment areas upstream in order to reduce sedimentation in the estuaries, particularly Tallo estuary, which has increased due to high land conversion. Building a number of water retention ponds in upstream areas of the Tallo catchment should be considered.

The options for risk-based infrastructure investment planning include effective flood control, by managing development upstream, as well as holistic improvement of the drainage networks. The area is equipped with secondary and local drainage systems, a solid waste management system, and water infiltration mechanisms such as biopore, catchment wells, and rainwater harvesting. All these should be the minimum requirement to which developers must comply. The municipality can ask the private sector to build a mini polder in order to improve the quantity of water catchment areas.

Urban ecosystem management measures are needed, such as revitalization of mangrove forests in coastal areas as well as conserving forests and water catchment areas upstream in order to reduce sedimentation in the estuaries, particularly Tallo estuary, which has increased due to high land conversion. Building a number of water retention ponds in upstream areas of the Tallo catchment should be considered.

Urban infrastructure upgrading is focused on slum areas. The most essential infrastructure is the seawall to protect coastal activities, including slums vulnerable to sea level rise. Fire response paths need to be built by clearing and strengthening pathways in densely populated slums.
Principles of sustainable coastal development should be mainstreamed in planning regulations. The City Spatial Plan (RTRW) has outlined strategies to strengthen mitigation and adaptation in the coastal areas. The focused areas are the west coast (Losari Beach and Centerpoint of Indonesia), the north coast (North Beach and Untia Beach), and the riverbanks (Jeneberang, Tallo, and Pampang).

The strategies include:
1) Revitalizing the areas through well-planned, controlled, and limited reclamation activities, by complying with the regulations related to mitigation and adaptation (i.e. sedimentation and abrasion);
2) Stipulating elevation standards for coastal development;
3) Developing drainage systems;
4) Adopting the waterfront concept when developing coastal and riverbank areas, by integrating built-up areas with green open spaces and productive mangrove forests.

Makassar needs to limit development in lowland areas. Clear and well-defined elevation standards for infrastructure and reclamation are required to ensure the connectivity of drainage systems from the mainland to the lowland. Other measures that will help include ensuring the continuity of river normalization of the three main rivers (Jeneberang, Tallo, and Pampang) and improvement of the urban canal system (pumping canal of Panampu and Jongaya).

Makassar should also prioritize balancing built-up areas with green open space and mangrove forests, particularly in the coastal and riverbank areas. In addition, groundwater use in coastal areas should be limited to reduce land subsidence. Consequently, controlling development upstream should be part of the efforts to improve the function of water catchment areas, in order to control flooding in the lowlands. This policy implementation requires effective cooperation with the upstream regions, particularly Maros and Gowa Districts.
Palembang is the economic center of South Sumatra Province. The spatial development of Palembang developed according to the expansion of economic and service activities in the region, including mining and plantation. The city’s growth started with the Musi River, which has been utilized as the area’s main transportation channel since the early stages of the region’s development. Many industrial activities are located by the Musi river.

Gross Regional Domestic Product (GRDP) of Palembang in the last three years is dominated by manufacturing industry (BPS, 2012). There has been an increase on trade, hotel and restaurant contribution to the GDP.

Over the last decade, Palembang has experienced rapid physical development initiated by both the government and the private sector. Major investments are underway which may generate an increase in population, in supporting activities such as residential areas, and trigger complex environmental and land use issues. Intensified urban activities are increasing the vulnerability of Palembang.

Further, the urban area is expanding towards the northern and eastern part of Palembang. Governmental offices and settlements initiated development in the east, while residential areas expanded into the north. More recently, development is gravitating towards the south, where small industries and business activities are emerging. This development has become more intense with the establishment of Jakabaring, a new development center.
New economic centers are being established at Sako, Jakabaring, and Sukarami. These developments will entail conversion of land from agricultural land and wetlands, to built-up areas, comprised of proposed settlements, commercial and services establishments, industry, offices, and public buildings.

The land use is dominated by settlements, commercial and services, industry, offices, and public buildings.

34,29% of the city consists of wetland while the rest is plain areas. (Bappeda, 2012)
Palembang is prone to two main types of hazards: flood and fire. The locations of flood hazards are relatively evenly distributed across the city since Palembang was originally composed from wetlands. The areas that are highly prone to flood are those located along Musi Riverbank. In the case of fire, the most vulnerable part is the central area. In addition to those hazards, localized typhoons have also hit Palembang several times, since deforestation had created more barren land which had caused micro climate to change triggering unstable local weather pattern.

About 7,125 hectares of Palembang are susceptible to flooding; some 83 hectares are periodically flooded and over 7,000 hectares lowland and watershed areas are frequently flooded during the rainy season. The duration of the floods is also increasing. In 2007, floods lasted only a few hours, but in 2013, the inundation lasted a few days. In February 2013, massive flooding occurred, impacting 54 villages in 9 subdistricts: Gandus, Ilir Barat I, Ilir Barat II, Ilir Timur I, Kemuning, Kertapati, Plaju, Seberang Ulu I, and Seberang Ulu II. Several public facilities and roads were affected as well, including Karyajaya Terminal, R. Soekamto Street, Mayor Ruslan Street, and May Salim Batubara Street. This indicates higher vulnerability and diminishing risk management capacity.

On average, fire events occurred 6 times a month and distributed evenly across Palembang. Out of 107 villages, 43 villages are prone to fire hazards. The vulnerability to fire is generated by the many buildings built of easily flammable material. Fire prone locations are across several high density commercial areas, such as Seberang Ulu I Village, Kelurahan 1 Ilir Village, 2 Ilir Village, 1 Ulu Village, 7 Ulu Village, 3 Ulu Village, and 10 Ulu Village. Palembang is also affected by the peat fire commonly occurring in the surrounding districts. Palembang is vulnerable due to population density and building conditions (particularly in slum areas), type of land use (along riverbank and wetland), as well as the absence of community level countermeasures in dealing with natural hazards.
There are more than 22,000 poor in the area, or about 15 percent of the population (BPS, 2012). Some 212,800 houses are of permanent structure, while more than 42,000 constructions are semi permanent and some 28,300 units are built on temporary structures (Ministry of Public Works, 2009). Semi-permanent houses are also found in slum settlements across 42 of 107 villages in Palembang. Slum settlements in Palembang are generally located along the riverbank areas, such as Keramasan River, Sekanak River, and other tributaries.

Ineffective drainage systems to carry increasing inflow during the rainy season has been exacerbated by high sedimentation in the drainage channels downstream. This reduces the channels’ capacity and increase risks of flooding.

By converting and reclaiming wetlands, Palembang is expanding towards the fringe areas in all directions.

The growth of the city began from Musi River, which, since has long been the area’s main channel for transportation – of goods and of people.
Major Urban Investment

The key issues Palembang faces are: (1) controlling the increasing conversion of wetland to built-up areas; (2) prevention and reduction of flood risks; and (3) minimization of the negative environmental impact of rapid development along the riverbanks.

Land acquisition through the conversion of wetlands is critical, and demands that the city balances economic growth and environmental sustainability.

1. WETLAND CONVERSION CONTROL
2. FLOOD REDUCTION
3. MINIMIZE IMPACT RIVERBANK DEVELOPMENT
Palembang has already enacted Local Regulation Number 11 Year 2012, regarding Supervision of Wetland Utilization and Control, in order to ensure proper implementation. Hence the experience of Manchester City in the UK and New Jersey in the USA could be adopted. Manchester City revitalized the riverside through zoning control, while New Jersey provided incentives for voluntary conservation of wetlands. Both approaches seek to balance environmental conservation with economic development, capitalizing on wetlands as a water attraction and a historical district for preservation.

Risk-based land use and infrastructure investment planning:
The key issue for resilience of Palembang is how to capitalize flood risk zoning into multi spatial sub-urban retrofitting (particularly in the densely populated downtown/old city). Land consolidation and water management should also be integrated, in order to produce a canal-rich waterfront downtown with waterways as alternatives for public transportation. Also required is urban settlement design and housing architecture that are flood-resilient.

Development on reclaimed wetlands should entail strict requirements on the provision of disaster mitigation infrastructure and of water catchment preservation, through retention pools, biophores, rainwater harvesting, etc. Neighborhood Development Plans (RTBL) are needed in areas with specific urban functions and key investments. For example, the Jakabaring area.

The city needs at least an additional 30 pools through which runoff can be channeled and retained during peak flow periods.

The city has also established detailed procedures for evacuation along the main corridors, including the development of evacuation routes and training programs, as well as facilities in the event of an emergency.

Urban infrastructure upgrading for resilience:
Make mandatory building code requirements that minimize fire risk.

The Municipality of Palembang has carried out various actions to control flooding, including river normalization, construction of retention pools, construction of retaining walls (turap), and formation of river diversions.

Urban ecosystem management option:
Located along a major river with most of the land being wetlands, Palembang has the opportunity to transform itself as a waterfront city. It can adopt a development approach that is water-sensitive, in order to maintain its ecosystem and hydrologic functions, while capitalizing on its natural and cultural heritage.
Integrated investments in reconverting former wetlands into “rebuilt” blue spaces, as well as land consolidation and settlement retrofitting could return Palembang back to its glory days as a water-oriented economy.

As Palembang is expanding by converting and reclaiming wetlands, it can mitigate the impact of this conversion by introducing water-sensitive development in the Jakabaring area.

This means entailing strict requirements for providing disaster mitigation infrastructure and maintaining water catchment areas, through the provision of retention pools, biophore, and rainwater harvesting. Detailed Neighborhood Development Plans (RTBL) can be formulated to integrate built up areas with the surrounding water features.

A priority investment could be for the creation and improvement of the canal network and waterways as new and alternative public transportation. Flood prevention through redevelopment of the Musi River corridor into a historic district with its Ampera Bridge and surrounding commercial areas on both sides of the river -- currently prone to flooding -- can be equipped with more integrated flood protection measures through a system of canals and embankments. Combined with urban upgrading, the corridor could be developed as a prime tourist attraction, to highlight the city’s heritage as a trading hub of the Sriwijaya Kingdom.
4.4. DENPASAR RISK PROFILE

Denpasar is the capital city of Bali Island Province and one of Indonesia’s main tourist destinations. While originally dependent on farming and agriculture, the area has transformed into an integrated location for trade, services and government. Tourism started in Sanur on the coast, but urban growth has since been influenced by tourism and trade activity along the eastern coast.

The city expanded from the central part of the city, which used to be the center of Badung Kingdom. The area then became an integrated location of trade, services and municipal center, and extensive growth in Sanur led to expansion in the southern part of Denpasar. Housing complexes, factories and warehouses proliferated in North Denpasar, while Margaya in West Denpasar is becoming a commercial area, in order to support economic spillover from tourism in Kuta, Badung District.

A new residential area is also emerging in Gunung Talang in western Denpasar, previously dense with paddy fields.
Today, housing complexes dominated land use of Denpasar. The expansion of settlements is clear. Of the total land availability of 12,778 hectares, more than 61% is used for housing, while rice fields occupy some 21% of land, state-owned forest land take up 4.21% of land. The rest of the land is divided up as follows: grassland has 3.10%, community forests have 0.59%, non-rice farming takes up 0.27%, fishponds comprise 0.08% of land, while the rest of the land -- 9.20% -- comprise of sands, swamps and wetlands.
Settlement-dense Denpasar is prone to several types of hazards, including floods, fire, tsunami, earthquakes, strong wind and landslides. Given the population density, Denpasar is also prone to other types of disaster, such as flood-related disease outbreaks and poor sanitation. Denpasar is particularly vulnerable due to population density and land use activity near hazard prone areas. The existence of slum settlements in the city also contributes to vulnerability, particularly related to fire hazards.

There are 18 locations in Denpasar that are prone to flooding: they are across 11 villages and cover an area of 495 hectares. Flooding occurs due to poor drainage and high rainfall intensity.

Fire is the disaster that occurs most frequently, especially in highly dense settlements and in some commercial areas from east to south.

As it lies on the active Australian and Indonesian plates, Denpasar has the potential of experiencing an earthquake and a tsunami. According to Indonesia’s earthquake index, Denpasar is categorized as “high-risk”. The possibility of tsunami in Bali is high since it is situated in between two earthquake generators. The epicenters are likely located at the ocean south of Bali Island.

Landslides in Denpasar commonly occur in relatively limited areas that have steep slopes, such as riverbanks. However, as riverbanks are considered attractive and are rapidly converted into built-up spaces, they become risk areas and require serious attention.

Whirlwind have also struck Denpasar several times, at speeds between 5 and 20 knots or about 30 kilometers per hour.
Some 62% of built up areas are settlements (Bappeda, 2011). West Denpasar has 13 slum areas across 11 villages, consisting of 589 housing units and 605 households. In total, the slum areas cover 23.1 hectares.

In South Denpasar, 18 slum areas are scattered across 10 villages and consist of 361 housing units, impacting 417 households and 2.67 hectares.

In East Denpasar, 24 slum areas across 11 villages have 453 housing units, impact 519 households and 4.9 hectares.

In North Denpasar, there are 6 slum areas across 11 villages, with 267 housing units, 373 households is 373. The total size of of the slum area is 44,206.05 m².
As a tourist city, Denpasar continues to prioritize development in coastal areas. The municipality routinely conducts river dredging or normalization, particularly in areas frequently struck by flooding, such as Loloan, Badung, and Padang Sambian. Besides those rivers, the Spatial Plan (RTRW) mandates normalization in other major rivers: Ayung River, Mati River, Buaji River, Ngejung River, along with their tributaries, which function as regional and urban drainage channels.

1. FLOOD CONTROL
2. LANDSLIDE PREVENTION
3. RIVER DREDGING
In the medium and long term, Denpasar should focus on three measures: (i) flood mitigation; (ii) tsunami preparedness in tourist areas, fish processing areas, and high-density settlements; (iii) fire mitigation.

Flood mitigation should be integrated with infrastructure development, with the river basins managed and flood-prone areas clearly designated. Coastal management, economic and social development should apply risk-based land use and infrastructure investment planning, by synchronizing zoning regulations.

Balance between upstream and downstream development is also important, particularly as Badung District is under the framework of the Sarbagita secretariat, that is Denpasar, Badung, Gianyar, and Tabanan. This joint secretariat allows for horizontal coordination and decision-making in other jurisdictions.

Denpasar should also adopt a community-based fire management system, by providing guidelines, standard operating procedures and training for community volunteers and hotel association.

**Risk-based land use and infrastructure investment planning**, includes accelerating the implementation of comprehensive flood mitigation, ensuring controlled development in flood-prone areas, tsunami risk-based land use and infrastructure investment planning in coastal areas, as well as strengthening emergency and rescue capability for a “Tourist-safe Denpasar”.

**Urban infrastructure upgrading for resilience** means fire mitigation planning should be undertaken, specifically infrastructure improvement in order to improve service coverage and response times during fire emergencies. Evacuation planning in every community should be developed through a participatory approach.

**Urban ecosystem management options**: The RTRW of Denpasar specified Ngurah Rai Forest Park in South Denpasar as the protected coastal area with mangrove forests. Restoration of mangrove ecosystems along the coasts is urgently needed in order to simultaneously reduce the impact of abration, sea level rise, and tsunami, as well as offer a new tourist attraction. Denpasar could apply stricter spatial development controls upstream, particularly settlement development in flood and landslide prone zones in North and West Denpasar. One option to address this issue is to establish inter-region cooperation, particularly with Badung District.

The prospects of incorporating resilience in on-going investments in Denpasar is promising, because the RTRW has already incorporated some resilience measures, particularly in response to the continuous development of the coastal areas. However, there is a need to integrate it with existing investments, towards comprehensive, water-sensitive, and tsunami-safe spatial development.
Honolulu, Hawaii, adhered to the Primary Urban Center Development for coastal area concept – and Honolulu’s experience provides an example of balancing economic growth with the needs of the residents. This concept could be considered by Denpasar, in order to control rapid development that jeopardizes the natural ecosystem. The coastal area of Honolulu is also equipped with tsunami mitigation measures, including updated community-based evacuation plans. Denpasar could enhance its near coast ocean-floor data to develop more accurate evacuation plans and utilize the Banjar (traditional village) as well as the Pecalang (traditional safeguard) in designing evacuation plans and other mitigation measures.

DENPASAR SEWERAGE DEVELOPMENT PROJECT (DSDP)
Source: Poetoegraphy, 2008

The Sanur Tsunami Evacuation Map shown was formulated by a working group under the leadership of the BPBD. The plan provides guidance for more detailed planning at the sub-village level.

To achieve a regionally integrated risk sensitive development, it is important to recognize the challenges in inter-municipal collaboration and development coordination. The Sarbagita Metropolitan Area cooperation scheme needs to be tapped, since some triggers for potential disaster are caused by development in upstream regions, particularly in the northern part of Badung.
Similarly, disasters in Denpasar can impact other regions in the metropolitan area. The *Sarbagita* Joint Secretariat can be empowered to foster effective multi-region cooperation in conducting seamless risk analysis, and risk sensitive urban planning and investment. This entity can be utilized to implement regionally comprehensive disaster-risk based land use planning and infrastructure development, particularly to reduce the impact of land conversion in upstream regions.

The Secretariat could act as a facilitator to establish collective decision-making processes among the local governments. Most importantly, the secretariat could initiate agreement that disaster and climate risk reduction measures should be implemented in a synergy, through open and transparent negotiation processes.
4.5. SEMARANG RISK PROFILE

Semarang is physically unique, with coastal areas, flat land, and hills. With 19 watersheds and 14 rivers, Semarang is one of Java’s major port cities and plays a significant role in the development of Central Java Province.

With the population concentrated in the city center, Semarang ranks as the country’s 6th most populated city (World Bank, 2012). The average population density is 4,087 persons per square kilometer, and the most densely-populated area is South Semarang, with more than 14,000 person per square kilometer.

In the past, the old town area of Semarang in the city’s northeast was the epicenter of growth. Semarang’s urban development began in the 17th century, when the colonial administration (VOC) designated an area of 31 hectares, known as Kota Lama.

Today, Kota Lama Semarang is no longer a growth center. Gradually, social and economic activity shifted to the city’s central business district (CBD). Since the establishment of Tanjung Mas Seaport, activity is particularly concentrated along the north coast.
The city has expanded in various directions. New settlements were established in the southern part of the city, including Banyumanik and Tembalang.

To control development, Semarang ensured that measures to reduce risks and manage disasters are included in the Spatial Planning (RTRW), specifically through zoning regulations. However, despite the presence of disaster risks, the by-law Semarang Spatial Plan for 2011 – 2031 has not fully recognized potential key hazards such as flooding and landslides.
The city is prone to seven types of hazards: flooding, land subsidence, sea level rise, landslides, fire, strong wind, and drought. Hazards with potentially the most impact are floods, land subsidence, and sea level rise. Flooding predominantly affects the north coast of Semarang, due to high rainfall intensity, land subsidence, road inundation, and poor drainage systems. Flooding greatly impacts commercial activities.

Flooding occurs more frequently in the northern part of Semarang and mostly caused by tidal floods and poor drainage systems. Some 91 villages are particularly prone to flooding (ACCCRN, 2010; BPBD, 2010; Fire Department, 2010). The drainage systems are ineffective and carry increasing inflow streams during the rainy season. High sedimentation in the drainage channels downstream means reduced capacity and greater vulnerability to floods.

Fire hazards occur more frequently in the city center, where economic activity is concentrated.

The rate of Sea Level Rise in Semarang is about 7.88 mm/year, and reaches 1.7 – 3.0 km inland. This leads to inundation of some 7,500 to 8,500 hectares and economic losses due to disruption of commercial activities.

Landslides occur in the south, specifically the eight villages in Gunung Pati subdistrict.
Settlement expansion to the south and southwest; declining mangrove ecosystems along the north coast. The densely populated and dominantly covered by built-up areas are illustrated using darker colors. Hence, the darker colored areas represent those with higher vulnerability to disasters, particularly fire, sea level rise and land subsidence. Those are areas of major economic activity and strategic infrastructure. Accordingly, the impact of disasters here will be more significant than in other parts of the city.

In 2009, some 73,000 people in Semarang lived in poverty (BPS, 2009). In 2012, a study carried out by the Islamic University of Sultan Agung (Unissula) reported that slum areas had grown to 42 locations, and so have the number of squatters. 13 of these slums are in North Semarang.
Semarang’s north coast is exposed to multi-hazard high risks, while areas in the south and southwest are exposed to landslide. The Neighborhood Development Plan (RTBL) that includes the accompanying zoning regulation in high-risk areas, particularly the northern part, is essential, in order to reduce environmental damage. It should be noted that fiscal discretion in Semarang is low and fluctuates from year to year, ranging from 8% to 20%. This indicates that Semarang needs other sources of financing to ensure investments towards resilience.

1. FLOOD CONTROL
2. LANDSLIDE PREVENTION
3. MINIMIZATION INDUSTRIAL AND COASTAL DEVELOPMENT IMPACT
Risk-based infrastructure investment planning options. New developments along the north coast require countermeasures to sea level rise, such as land elevation and floating construction, particularly in new areas for industrial development near Achmad Yani Airport and the expansion of Tanjung Mas Seaport.

Semarang should formulate and implement a risk-based Neighborhood Development Planning (RTBL) for industrial and other strategic areas in the north coast and in Central Semarang. The city must also control groundwater use. Options include improving the supply of tap/pipe water, as well as utilizing rainwater harvesting in all sub-districts, particularly in the north coast areas.

Undertake a strategic natural environment review on the RTRW under climate change criteria, in order to inform existing and future development investment in the high risk areas.

Urban Infrastructure upgrading: As part of Semarang’s flood response program, since 2010 the West Flood Canal (WFC) has seen improvements through normalization; the repairs completed in 2013, and have significantly reduced the impact of flooding in the northern and western parts of Semarang.

The East Flood Canal (EFC), on the other hand, has not been improved, at the time of study for this publication in 2013. Coordinating the upgrading and operation of the canal system is critical, as they are managed by different river authorities. Development of areas in the south -- prone to landslides -- has been rapid. The hills in these areas need to be strengthened, by building anchored walls, particularly where the slopes are steep, the soil is unstable, and where important infrastructure need safeguarding. The municipality should also enforce zoning control and apply stricter rules about the issuance of construction permits.

Urban ecosystem management: To protect activity in the north coast, Semarang must revitalize the area’s mangrove forests. This can reduce the impact of sea level rise, land subsidence, and coastal inundation. Similarly, development upstream must be managed, particularly settlement development in Banyumanik, Tembalang, and West Semarang. Greenery programs, water harvesting, and other efforts to maintain water catchment coverage should be integrated with any development that takes place in those areas.
Flood management remains a major task for Semarang. The existence of West and East Flood Canals is not adequate in tackling the floods, because of the compounding effect of land subsidence along the coast. Semarang needs an integrated drainage system as well as land acquisition schemes for flood-prone areas, so that they can be cleared from built-up activities and repurposed as urban catchment areas and coastal ecosystems.

Brisbane is the sister city of Semarang. Flood hazards occur frequently in Brisbane, as the city was built on a river and close to Moreton Bay, with many creeks and tributaries running through the suburbs. During the summer months, severe storms with heavy rainfall are common. These storms can result in flooding from Brisbane River and connected creeks, storm surges along the coastal areas, and overland flow flooding. Brisbane responded by developing an integrated drainage system that covers the whole city. The system is complemented by a backflow prevention device. The device ensures that storm waters will flow only to one direction through a piped storm water system, as well as minimize the amount of water that flow back to the roads/surfaces.

This approach can be replicated in Semarang, along the two canals. Development of the city’s coasts should recognize more water-sensitive land use.

For the hilly parts of Semarang’s south, rain harvesting and controlled development are options for reducing flood risks, conserving water, and mitigating land subsidence. Here, the City of Sumida, Tokyo can serve as inspiration. Having high rainfall and situated around two large rivers -- Sumida and Arakawa rivers -- Sumida residents often suffer from flooding but also paradoxically have inadequate water supply. Semarang can adopt Sumida’s example, by regulating permit requirements for property or residential developers in the Building and Neighborhood Development Plan (RTBL).

But the implementation of rainwater utilization also requires the support of municipal government officials, as well as cross-agency cooperation and coordination. Local residents and businesses should also be informed about the short- and long-term benefits of rainwater utilization.
Yogyakarta is a tourist city with rich cultural heritage, located near the south coast of Java Island. The city is part of the Special Region Province of Yogyakarta and, due to urban agglomeration of its surrounding cities and suburbs, has evolved into a metropolitan city. The urban form took shape originally from the Sultan’s Palace, or Keraton, in the heart of the city. Settlements then grew in all directions from the city center, as infrastructure such as road networks and service centers developed. The development of tourism and educational institutions has also influenced the city. As a result, built-up areas are expanding towards the surrounding rural and riverbank areas.

Yogyakarta as a city dates back to 1755, from the Keraton, with the Royale Palace Square and fortress as the city’s main elements. Later, a settlement for abdi dalem or the royal servants were built in the areas surrounding the Keraton. Traditionally, Yogyakartans believe in the influence of Mount Merapi in the north and the coastal area in the south, and hence the development of settlements should follow the same pattern, in a north-south direction.
Yogyakarta used to be a relatively small city. In the 1930s, the city had a population of only 60,000 people (Baiquni, 2004 in Baier, 2012). The city has evolved into a metropolitan city, encompassing surrounding cities and suburbs. Since the 1970s, migration to the city has grown rapidly. The city’s population now crosses its administrative boundaries, particularly towards Sleman and Bantul districts.

In recent decades, new centers of commerce, education and tourism have grown in parallel with developments of settlements, both formal and informal. As Yogyakarta has limited available land, rapid migration into the city has resulted in low-income communities settling in natural disaster hotspots such, as vulnerable riverbank slums (Bawole, 2012).
Yogyakarta is prone to flooding, flash flooding of cold lava (*lahar*), landslides, strong wind, earthquakes, and fire. Most flooding, *lahar*, and landslide events are concentrated in settlements located along the riverbanks, whereas fire occurs in densely populated areas, particularly in the northern part of the city. Yogyakarta is also at risk from volcanic ash rain, due to its proximity to Mt. Merapi, one of the world’s most active volcanoes.

Lying atop the active Opak fault between Yogyakarta and Bantul District, earthquakes pose a constant threat to Yogyakarta. Earthquakes frequently occur at shallow depths, making many structures very vulnerable. The first recorded earthquake in Yogyakarta Province took place in 1840. Three earthquakes were followed by tsunamis. In 2006, Yogyakarta was struck by a strong earthquake, causing more than 5,000 fatalities. The damage is estimated to exceed USD $3.1 billion. According to the Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG) and the Center of Volcanology and Geological Hazard Mitigation (PVMBG), the latest and most damaging earthquake occurred on May 27, 2006; the quake had a magnitude of only 5.8 – 6.2 on the Richter scale (Bappeda, 2008). This highlights the increase exposure of built up assets in recent years.

Most flooding, lahar, and landslide occurrences are concentrated in villages located along the riverbank areas, including Code, Gajahwong, and Winongo River. Due to the expansion of built-up areas and poor drainage systems, the capacity of water catchment areas has declined. Lahar flows primarily through the Code River, a tributary of Mount Merapi. Landslides, on the other hand, strike areas of high development density.

Fires in Yogyakarta also occur in densely populated areas, with the frequency being 40 to 50 times a year.
Population growth and expansion of built-ups areas related to tourism and educational institutions, increase Yogyakarta’s vulnerability to disaster risks. The situation is worsened by development projects carried out by the private sector which did not pay adequate attention to environmental impact, particularly in riverbank areas. Limited available land and high demand for settlements, hotels, restaurants and other commercial activities has forced development onto urban land that had been set aside as conservation or watershed protected areas.
Increased construction has led to greater density along the Code, Winongo, and Gajahwong rivers. Development takes place despite the fact that the area is geologically unstable and prone to landslides. The rivers are also heavily silted by volcanic sediment, reducing their channel capacity and causing frequent overflow. Overcrowding also increases the risk to fire.
Resilience Options

These three rivers are key urban ecosystems that need careful management to ensure that rapid development will continue to balance between economic growth and ecological wellbeing. Upstream development must be controlled. On-going investments in waste management systems are required in order to control river pollution from commercial and settlement activities along the riverbanks. The Kartamantul inter-administration Joint Secretariat can be beneficial and the city should take advantage of their presence in order to address more complex disaster regimes beyond their administrative boundaries.

Risk-based infrastructure investment planning options include accelerating the implementation of effective flooding, lahar, and landslides mitigation along the riverbanks; and restricting the development of hotels, restaurants, and housing along these areas.

Urban infrastructure upgrading should first formulate a fire mitigation plan, specifically by providing fire hydrants in the most strategic and/or dense areas and improving accessibility for emergency response.

Urban ecosystem management focuses on managing Yogyakarta’s watershed, by controlling development from the upstream to the downstream region. Comprehensive waste management is also required to control pollution. The city needs more green and open spaces to preserve the urban microclimate.
Yogyakarta is a major tourist attraction with a rich cultural heritage, as well as a center for education. There is opportunity here to turn the city’s three rivers into historic districts with environmental attractions. The City of Kyoto, Japan -- sister city to Yogyakarta -- can be the inspiration. Both cities are rich in cultural heritage, and both are prone to multiple disasters. Kyoto has several rivers and canals, such as the Katsura and Kamogawa (Kamo) rivers; the latter flows through the city and has been designated as cultural heritage. The watershed boundary area is preserved and used by the government as green open space and cyclist lane. It has become one of the city’s main tourist attractions.

The Kampung development along the Code river serves as a starting point for Yogyakarta, and the community living along the rivers may become the center point of any redevelopment effort. Other rivers such as the Winongo and Gadjahwong rivers can follow suit. One option is to adopt a combination of riverbank natural protection on the upstream segment of the rivers, neighborhood upgrading on the middle segment, and commercial development for tourism small business on the lower segment. The three river corridors can be turned into river walks with nature attractions on the north, traditional kampung walks in the middle, and souvenir arcades in the south near the Palace areas.

Riverfront redevelopment can offer both resilience and economic benefit more broadly for the community and the city.
The aim of the Disaster and Climate Risk (DCR) Rapid Diagnostic is to promote evidence-based planning and budgeting practice, by combining technical expertise with community knowledge. Such a diagnostic allows decision makers to identify high risk areas against existing and potential natural hazards; this identification can help local governments initiate disaster preparedness and prevention mechanisms. The risk profile derived from the rapid diagnostic allows municipalities to focus on development corridors that have vulnerable population and assets and can improve the cities’ overall resilience.

This section outlines how the DCR Rapid Diagnostics encourages local government and stakeholders to undertake disaster and climate risk reduction efforts, by integrating resilience into on-going or planned urban investment in Indonesia. A case study was carried out in the City of Yogyakarta, where the Risk Profile produced through the DCR Rapid Diagnostic formed the basis for a pre-feasibility study on redevelopment planning along the Winongo River, identified by the diagnostic as a potential risk. The river redevelopment plan provides a clearer picture on the spatial re-arrangement required along the corridor. The process as presented in the diagram below reflects continued conversation amongst residents about disaster and climate risks and how to build resilience through investments.

**NEXT STEP**

**MAKING CONCRETE RESILIENT INVESTMENT: WINONGO RESILIENT RIVER REDEVELOPMENT CASE STUDY – YOGYAKARTA**
Figure 6. Risk diagnostic followed by continued “risk and resilience conversation”.
The Pre-Feasibility Study outlined, among others, the issues related to different segments of the river, potential themes for redevelopment, and specific potentially transformative priority projects. Along the Winongo River corridor, eight communities have already organized themselves to manage the area. Each community is part of the conceptual development and planning process.

**Potential Themes**

- **Nature Tourism**
  - Recreation/Sport Activities including Outbond
  - Dam for Water Activities
  - Reflection Areas (forested park, bathing areas, etc.)
  - Floodplain restoration
  - Some F&B to support tourist

- **Commercial Tourism**
  - Riverwalk with more Commercial nodes (F7B/markets)
  - 1st Phase of Kampung Wisata tourism walk within neighborhood
  - Performance Theater

- **Cultural Tourism**
  - Riverwalk with cultural focus
  - Art&Craft Market?
  - Also some nature tourism?
  - Riverwalk with gentle topo, dam/waterfall, enhance parks

**Summary of Issues**

- **Problems:**
  - Area floods regularly (worst within project area)
  - Housing in floodplain
  - Inequality

- **Opportunities:**
  - Available (agricultural) Land = candidate for relocation?
  - Scenic winding river
  - Near existing Karangwaru
  - Riverwalk
  - Significant institutions

- **Problems:**
  - Most dense/crowded
  - Few roads and crossings

- **Opportunities:**
  - Most central location to tourist
  - Gateway bridge and open space
  - Existing markets, Cokro retail
  - Existing “theater”, museums.

- **Problems:**
  - Water quality worsens downstream

- **Opportunities:**
  - Close to kraton/Taman Sari & Heritage Attractions
  - School, theater, museum
  - Craft production
  - Accor project/fish market?

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*Figure 7. Issues and Potential Themes for Redevelopment of Winongo River, Yogyakarta.*
As illustration, the central segments of the river have been designated as commercial areas for community-based tourism, featuring traditional neighborhoods or “kampung” walks. Under such plans, basic infrastructure for accessibility must be provided, and attractions as well as landscaping further upgraded. Also required in the plan: improvements to existing embankments, construction of pedestrian areas with proper drainage and sanitation, and development of commercial strips to accommodate community businesses.

The Winongo Riverwalk Pre-Feasibility Study, carried out by AECOM (2014) and supported by the World Bank, estimated between USD 94 to USD 157 million for the costs for resilient redevelopment. This investment was estimated to bring economic benefits of between USD 30-70 million annually, or USD 200-450 million total, capitalized at 15% over the life of the project. The calculations were based primarily on commercial spending from tourists, and do not take into account additional benefits such as improved health, economic productivity, flood prevention, increased property value, and improved transit and mobility.

![Tourist Streets & Kampung Walks](image)

Figure 8. Illustrative concept of ‘Kampung” walk along, Winongo River.
According to Indonesia’s spatial planning regulations, each city is required to develop a detailed spatial plan at the scale of 1:5,000, including in areas with high population density such as the Winongo river zone. The detailed spatial plans typically outline designations of land use or zoning regulations, which broadly include settlement (low and high density), green open space, and river buffer zone, commercial areas, etc. Under the existing planning hierarchy, exceptions to the general zoning (e.g., using part green open space to accommodate settlements) can only be done through the development of Building and Neighborhood Development Plans, also known as the RTBL (Rencana Tata Bangunan dan Lingkungan). The RTBL provides an opportunity to codify existing spatial solutions needed for redevelopment into the formal spatial plan. It requires high resolution maps at scales of up to 1:2,000.

Once a target area is identified and options for resilience selected, collaborative geospatial investigation is carried out by local technical agencies and community, in order to identify areas where adjustment and/or exception to the existing spatial plan is required to reduce the vulnerability. This exercise is called Collaborative Hazard Microzoning delineation.
Figure 9. Process of Hazard Microzoning.

- Identification of secondary data and stakeholders mapping
- Field hazard delineation and interview
- Map validation
- Land-use zoning recommendation to find local spatial solution
- Thematic maps verification workshop
- GIS studio work to produce quality geospatial
Hazard Microzoning is a detailed geo-referenced thematic mapping (1:2,000 in scale) capturing existing hazards. It includes geographical, socio-economical, and structural profiles of an area, such as land use parcels and status, i.e. settlements, commerce, public utilities, open space, etc.; key assets and basic infrastructures; and natural features i.e. river, swamp, bushes, etc. The high resolution map provides a better understanding of the spatial distribution of disaster vulnerabilities and also enables stock-taking of available space where measures to reduce risk and improve resiliency can be undertaken. Such measures may include construction of flood control structures, such as embankment, small water retention and overflow areas, as well as the rearrangement of settlements to create space for water. This process is about finding local solutions to reduce disaster and climate risks.

Collaborative hazard microzoning along the Winongo River -- one of Yogyakarta's largest rivers -- had produced thematic maps which identify likely hazards to be incorporated in the RTBL. One output of hazard microzoning, for example, identifies structures located within hazard zones, and also available land parcels for in situ relocation.
The hazard microzoning and the Pre-Feasibility Study identified several structural measures and environment revitalization that will help increase resiliency. This multi-discipline analysis, involving a diverse group of experts from economists, environmentalists, hydrologists, community development specialists, legal advocates as well as community representatives. With the help of experts and planners, the community and the government can manifest their vision of riverwalk redevelopment.

Figure 11. Selected renderings of proposed design in Winongo (AECOM, 2014).
Figure 12A. River redevelopment in Karang Waru, Winongo implemented by the community under the Neighborhood Development (ND) Program of the National Government.

Previous urban upgrading investments made along the Winongo river have provided concrete examples of how redevelopment on riverbank areas can increase resilience to flood and landslide risks. Figure 12 A and B provide illustrative examples of the upgrading projects.
The Winongo River case study in Yogyakarta demonstrates the case for investing in resilience, and that it can be initiated within the city’s existing development programs, as well as other relevant government investments in municipalities. The Disaster and Climate Risk Rapid Diagnostic has helped cities identify risks and select development corridors where resilient investments can be implemented, without necessarily creating Disaster Risk Management specific projects such as flood protection programs.

Many resilience-building investments can be integrated within urban redevelopment spaces, such as along densely populated river corridors. For example, segment number 1 out of the 8 segments within the Winongo River has been selected as a pilot site for the Ministry of Public Works and Housing’s National Slum Upgrading Program. The community-based Winongo Redevelopment Plan enables the city to implement investment plans for the designated segment. For fiscal year 2015, an estimated of IDR 10 billion has been allocated for Slum Upgrading Investment, which will improve access to basic service delivery, promote positive externalities of lower-income households, generate local income and reduce the area’s vulnerability to disasters risk and climate change. The Rapid Risk Diagnostic has provided the impetus for the city government and stakeholders to embark on conversation on disaster risks – and this has led to concrete investments towards urban resilience.

Figure 12B. River redevelopment projects implemented by the Community with support from the City Government budget.
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Yogyakarta


The Book was developed based on the experiences of conducting disaster and climate risk rapid diagnostic in the cities of Balikpapan, Denpasar, Makassar, Palembang, Semarang and Yogyakarta in Indonesia around 2013. The rapid diagnostic produced city risk profiles which were used as dialogue and conversation tool by the city government and their stakeholders on addressing their most significant risk through resilient urban investment.

The Book summarizes the risk profile and resilience options in each city as well as provide illustrative example of concrete resilient urban investment, primarily through risk sensitive land use zoning, urban upgrading, and ecosystem management/rehabilitation using Yogyakarta as case example. It also serves as practical implementation in Indonesia of the World Bank’s Building Urban Resilience in East Asia framework, 2013.